HOMEBREWER
Magazine

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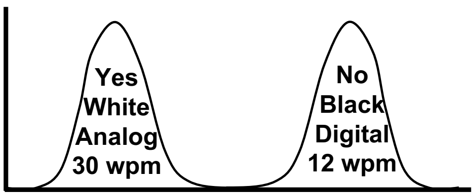
Our Cover ...

The Micro908 Antenna Analyzer is featured on our cover showing one of the many uses for this project. Using the complex impedance readings provided by the Antenna Analyzer, one can graphically represent the antenna's characteristics on a Smith Chart to determine corresponding lengths of feedline needed for an optimized transmitting system. Other computations can be done manually to determine L/C component values. Future software updates will provide onboard computations for later uploading and plotting data to the PC.

From the Editor

"Bimodal"

I was walking around the vendor and project tables at this year's Pacificon QRP Forum in October, entranced by the abundance of novel homebrew projects and clever kits from the vendors, when the background of overlapping discussions started coming into focus. Like moving out of a foggy mist into an area of perfect clarity, I heard one QRPer after another exclaiming the virtues of one project while almost simultaneoulsy contrasting it against another. Time and time again, as I moved among the many tables bustling with shoulder-to-shoulder hams, I heard these comparisons and contrasting commentary about projects, operating practices and technologies. Although I didn't realize it at the time, this is when my theory of bimodal nature took birth.



Bimodal - a statistical distribution having two peaks - is a concept that can be extended to our normal QRP activities, contesting, homebrewing and reading of the mail lists. It occurs to me that we all have strong preferences and skillsets that guide our everyday actions and we often reflect these biases in the way we communicate. Having these biases is a natural and good thing, as they often allow each of us to contribute our own particular strengths and gifts. Biases can, however, limit oneself and others if they are conveyed with blinders that stiffle creativity and lower the bar of innovation.

For example, consider the homebrewer who is looked down upon for varying the intensity of an LED by using a PIC microcontroller to generate pulse-width modulated waveform instead of using a simple potentiometer. Using a PIC might be considered quite an overkill solution by someone who thinks only in analog terms -- but think of the possible extensions of this method, like being able to create an additional pulsing indication, reversing the current to drive a bi-color LED, etc. Conversely, the "digital guy" might be trying to solve all his design problems with a digital sledgehammer when he is totally unawareness or closed-minded to simple and elegant analog solutions. See, the condition usually swings both ways ... bimodal.

We here in HOMEBREWER Magazine, as with other publications, try to cover the broad range of our subscribers' interests. However, unlike other mags, we strongly target both "center frequencies" of that bimodal distribution. We feature leading edge digital and microcontroller-based projects for use in ham radio, yet we also have basic and beginner RF projects that are based solely in analog designs. We understand that sometimes an analog or digital sledgehammer can be just the right solution for the grand design you might be looking to create. As they say on one of the cable channels, we present the facts -- simple and complex, digital and analog, iambic A and iambic B -- and let you make the decision.

Affilialtion with the AmQRP

We're very pleased to welcome yet another QRP club in under the AmQRP affiliate umbrella -- the **Arizona sQRPions**.

Having a local QRP club join with the growing ranks of other clubs across the country has a great impact on its members, and also what the organization is able to do. The group just needs the desire to take on a little work along the way with the guidance of experienced AmQRP leaders and embrace the sponsorship for the benefit of QRPers everywhere. AmQRP is only interested in fostering greater unity for QRPers and proliferating the hobby, which ultimately brings more solidarity and benefits to all in the community. We strongly believe in giving back everything we have to the hobby such that it can grow and flourish — this is one major way of doing that. We'll expand on this "AmQRP affiliation" concept a bit more in the next issue.

Elmer 160 Course & the PIC-EL Kit

We are all very fortunate for the emergence of a "PIC elmering" course being established this fall by John McDonough, WB8RCR. Recognizing the latent desire held by many within the QRP community, John has devised a structured, online series of instructional lessons that lead one through a better understanding of the PIC microcontroller - both from a hardware as well as software perspective. You can participate by following along in the lessons at www.amqrp.org/elmer160.

The AmQRP felt so strongly about the importance of the Elmer 160 Course that it volunteered to provide ample and timely hosting of lessons on the main AmQRP website. Perhaps even more beneficial, we activated a design team lead by Craig Johnson, AA0ZZ, to develop a PIC-based "evaluation card" specially suited for the course material. The AmQRP kitting team is currently at work preparing the pc board and kit for availability and soon all students will be able to use it interactively with the online lessons. See www.amqrp.org/elmer160/board for full details, including those for ordering.

Enjoy the Issue!

As we head into this holiday season, let us relish the bimodal nature that we each have as humans and savor the the benfit it brings to our lives and to the QRP hobby we all enjoy so much.

73 and Happy Holidays!

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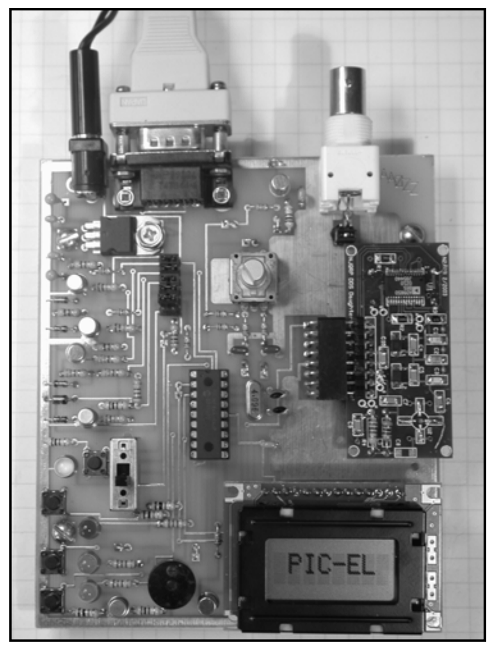

PIC-EL Kit produced by the AmQRP for the Elmer 160 Course. Has built-in programmer for the 16F84A and circuits to provide basic ham uses. Works with DDS Daughtercard.

Joe Everhart, N2CX and George Heron, N2APB

Micro908 Antenna Analyzer II

Here's a low cost, portable, microcontroller-based instrument that automatically determines SWR and reactance characteristics of an HF antenna system. Advanced features of DDS frequency control, LCD tuning display, PC data collection and plotting, numerous operating modes and easy software upgradability make this design attractive for homebrewers and antenna enthusiasts.

N2APB and N2CX have been complementary halves of a design team working together in the NJQRP club over the past seven years – sort of like the "Sonny & Cher" duo as applied to the world of QRP project design. We've been fascinated with opportunities that digital computing technology brings to the design of standard analog and RF radio equipment, measurement fixtures and QRP accessories. Four years ago we created a prototype of an antenna analyzer – actually the predecessor of the one described here – using relatively common components to create a very inexpensive piece of test equipment.

Since then technology has advanced in the microcontroller world as well as on the RF digital synthesis front. We've dusted off the design and augmented the approach with some precision signal generation via a DDS integrated circuit, used a ubiquitous LCD for the user display interface, and incorporated a much more flexible and powerful microcontroller unit for the computationally intense demands lying ahead.

In this paper we describe the design of an antenna analyzer that has two tremendously exciting aspects to it. One is that it is based on some pretty current technology – the AD9850 **Direct Digital Synthesis chip** from Analog Devices and a quite flexible MCU (**microcontroller unit)** from

Motorola called the HC908AB32. These two technologies give QRPers considerable measurement and user interface power.

Secondly, the hardware platform on which the antenna analyzer software runs is a multi-use, reconfigurable and field-programmable instrument called the **Micro908**. For the first time QRP homebrewers have available an inexpensive-yet-powerful computing platform tailored to serve the specific needs in the ham shack. The concept and modules have been developed over the last several years as chronicled in QRP Quarterly magazine as the "Digital QRP Breadboard", and now is available as a kit from the AmQRP Club.

Both of these important aspects – the Antenna Analyzer software and the Micro908 platform on which it runs – will be discussed in this paper. So as Sonny & Cher said back then, "I've Got You Babe" and let's dig into it all!

Overview

The Micro908 Antenna Analyzer is a small and inexpensive measurement device designed to determine antenna performance across the amateur bands through use of automatically collected SWR and complex impedance readings. The figure below shows the block diagram of the Antenna Analyzer.

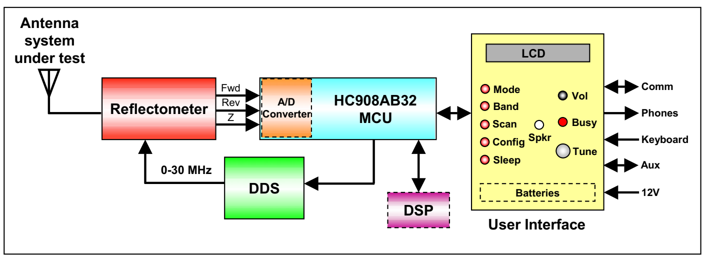

Figure 1 – Block Diagram of the Micro908 Antenna Analyzer

A very low power transmitter is swept across selected frequencies by a microcontroller. The transmitter's signal is delivered to the antenna system through a reflectometer consisting of an absorptive SWR bridge and diode-compensated buffer amplifiers. The data provided by the reflectometer are digitized and used by the microcontroller to compute SWR and impedance values. The microcontroller retains the frequency and corresponding results throughout the measurement period.

During this measurement period, the microcontroller rapidly displays the individual frequency and SWR values on an LCD. When all data are collected the microcontroller statically displays selected frequencies and the associated SWR readings.

The frequency and SWR data may also be downloaded to a PC attached to the Antenna Analyzer via a serial cable. A special software program for the PC collects the data pairs and graphically represents the antenna performance. This plot clearly shows the resonant frequencies of the antenna system under test. The PC may also be used to remotely control the Analyzer for manual selection of frequencies of interest.

Thus, with a press of a button the Antenna Analyzer is able to automatically and quickly determine and display the frequency for which the antenna system is best matched, along with the associated complex impedance values at those frequencies.

Manual operation allows the user to control the band/frequency of operation while viewing the display of SWR results.

The Analyzer also functions as a simple frequency source in manual mode. This signal may be used in troubleshooting various RF equipment.

The Micro908 Antenna Analyzer has a built-in speaker to allow use of the unit when conditions do not permit easy viewing of the display. The device may be configured to sound a tone whose pitch is varied based on the value of the computed SWR. Thus the operator may manually tune for lowest pitch and be assured that the specific frequency is the point of lowest SWR. The feature may also be enabled for automatic scanning, although one's sanity will be stressed with this tone sounding all the time. Headphones may also be used to listen to the tone.

The audio output feature is useful in yet another way for limited viewing scenarios. The unit may be configured to audibly annunciate the displayed measurement results via Morse code through the speaker or headphones.

The Micro908 Antenna Analyzer is designed to be field-usable and operator friendly. The handheld form factor lends itself to convenient operation while away from the bench by means of pushbutton controls along the left top side of the unit. The operator is able to easily select the various modes and options with the left hand while making frequency and volume adjustments with the right hand. Various interface connectors are placed along the top side of the unit, including the RF connector, serial port connector, and several other connectors (for aux, keyboard, paddles) that find use on the Micro908 in other applications. The remaining interfacing connectors are located along the right side panel of the unit – headphones, audio input (for using the Micro908 as an audio filter), external power jack and the power switch. The unit can be battery operated and the enclosure was selected to hold eight AA cells.

Another exciting aspect to the Antenna Analyzer project concerns the nature of the software used to control the microcontroller. There are a growing number of computer-controller ham radio construction projects being offered today by clubs, small companies and being described in the literature. For the most part, however, they do not provide the source code and design details that are of great interest by a growing number of homebrewing amateurs capable of dealing with software modifications and improvements. The Micro908 Antenna Analyzer project supplies fully documented source code and design methodology for the software used to control the device. The same is true for the software used for the companion remote control and display program in the PC.

The Micro908 Antenna Analyzer represents a unique, inexpensive and fully functional design for the QRP homebrewer community. The Analyzer is a project of great educational appeal - wideband transmitter design and software control of its operation. The low-cost, straightforward and modular design places construction of the Analyzer well within the grasp of a great many radio amateurs.

Antenna Analyzer Features

- Automated, microcontrolled antenna network analyzer
- A powerful 8-bit microcontroller (NJQRP HC908 Daughtercard) controls all aspects of the operation
- A low power DDS signal generator (the NJQRP DDS Daughtercard) is swept across HF spectrum.
- Precise and self-calibrating reflectometer design measures forward and reflected signals and impedance data
- Automatic scanning results displayed as frequencies of lowest SWR and complex impedance
- Configurable frequency scanning limits and step sizes
- Manual control option displays SWR and complex impedance at selected frequencies
- Audible tones provided assists in eyes-free tuning for minimum SWR
- Displayed results annunciated via Morse through internal speaker or via headphones
- Serial port connects to PC for optional remote control and display/plot of antenna performance
- Battery-operated for convenient field use, or can use external 12V for bench operation
- Power-saving "sleep" feature powers down unit after presettable period of inactivity
- Full hardware and software source material freely available via GNU Public License

Other Micro908 Features

In addition to providing useful hardware modules that allow the Antenna Analyzer software application to operate, the Micro908 hardware platform also sports capabilities that allow other applications to run.

- KK7P DSPx daughtercard provides signal processing services for digital modem, audio filtering, etc.
- Paddle input allows Micro908 to serve as memory keyer, keyed local oscillator, etc.
- Keyboard input port provides ability for textual data input for digital modem (PSK31, RTTY, etc.)
- Auxiliary port available for custom input/output needs

Micro908 Hardware Platform

The Antenna Analyzer II software program was designed specifically to run on the Micro908, which is an ideal computing platform for ham radio homebrewers and experimenters. Designed and developed over a 2-year period, it was chronicled in QRP Quarterly magazine as the "Digital QRP Breadboard project". Now officially named the "Micro908", the unit is ready to be rolled out in kit form by the American QRP Club and serves as the common hardware platform for a growing list of powerful applications in addition to the Antenna Analyzer — a Portable PSK31 Digital Mode Controller, a DSP-based Audio Filter, a "commander" remote controller for transceivers, a memory keyer, and other applications in development.

The Micro908 platform was designed to be easily operated on the bench as well as in hand while portable. It is comprised of a single 5" x 5" printed circuit board containing all components, connectors, controls, a 2x16 character LCD, and three daughtercards. The 5.5" x 7" x 1.5" plastic enclosure is also large enough to hold an 8-cell AA battery back enabling convenient field use.

A number of standard ham radio peripherals may be connected to the Micro908. One may plug in an antenna, paddles, a PC-style keyboard, headphones, an audio line to drive an SSB transceiver, a keyline to drive a transmitter, and custom control lines via an auxiliary jack.

The Micro908 is built around three daughtercards that are available within the homebrewing community. The **HC908 Daughtercard** plugs in as the main computing engine for the platform and provides flexible programming, field updates, powerful processing and a multitude of input/output lines for controlling all the devices in the unit.

The **NJQRP DDS Daughtercard** serves as a precise and accurate signal source that is programmable by the HC908. This plug-in module gives the Micro908 platform the ability to serve as an audio and RF signal source for testing and network analysis.

The third plug-in module is the **KK7P DSPx Daughtercard.** This optional module gives the Micro908 platform a powerful signal processing capability suitable for serving as a digital modem for PSK31, PACTOR and other digital modes of operation. Although not necessary when running the Antenna Analyzer II software, when this DSP card is coupled with the HC908 controller, the Micro908 becomes and even more formidable portable computing platform.

Referring to the schematics shown at the end of the paper, let's go through a module-by-module inventory of the Micro908 platform and see what functionality is available as a system.

HC908 DAUGHTERCARD

The HC908 Daughtercard is a modular microcontroller board that holds the powerful-yet-inexpensive Motorola 68HC908AB32. The daughtercard has lots of memory and I/O, and peripherals like counter/timers, asynchronous serial ports, and A/D converters to make the project useful for many standalone applications around the radio shack. It also contains the clock, reset pushbutton, voltage regulator and RS-232 drivers. The software supplied with the project allows for easy self-programming of the chip – just download new software programs to the chip and it burns the code into its flash memory. No need for special, expensive or complicated programming hardware with this project!

The HC908 Daughtercard was developed and made available in 2002 by the NJQRP Club. Articles describing the daughtercard have been previously published (QRP Homebrewer #9) and complete information can be found on the project's web pages at www.njqrp.org/hc908. The HC908 Daughtercard is plugged into two mating 2x34 pin connectors on the main pc board of the Micro908.

Downloading Software to the Micro908

One of the prime goals for the Micro908 was to be able to easily and inexpensively load new or updated software into the HC908 Daughtercard even after the project was built and field deployed. The daughtercard has ample onboard flash program memory; the microcontroller retains its program memory even when power is removed.

The microcontroller on the HC908 Daughtercard has the ability to be in-circuit programmed, which means that a conventional +5V power supply and proper timing is all that's required in order to burn a new program into its flash memory ... even while the daughtercard is in the Micro908. A special boot loader program was developed that allows one to download the binary image of the new software program over the built-in RS232 serial data port connected to your PC. One can even develop a custom program with the free software development tools on the PC, download it to the HC908 Daughtercard and the new or improved program can then be run. In this way you can take advantage of newer software programs that are provided for download on the HC908 and Micro908 websites, or you can develop your own customized versions of the programs and flash the daughtercard directly with your own code. Any "dumb terminal" may be used to communicate with the HC908 Debug Monitor to perform the download of the new software and burning of it into the microcontroller's flash memory. A useful public domain (freeware) terminal program called Tera Term is available to run on Microsoft Windows platforms.

DDS DAUGHTERCARD

In 2002 the NJQRP created the DDS Daughtercard in advance of coming applications like the Micro908 that would need signal generation capabilities. It is a small pc board containing just the bare DDS essentials – an Analog Devices AD9850 DDS chip, a 100MHz clock oscillator, a 5th-order elliptic filter and a monolithic RF amplifier to boost the raw 200 mV p-p DDS signal to a more usable 1-volt level. Additionally, a 5-V regulator is provided so you only need provide a single 12-V battery or power supply. The three digital control lines, the power supply, and the output signal are all available on a pin header at the board edge. Articles about the DDS Daughtercard have been previously published (HOMEBREWER #1) and full schematic and technical detail can be found on the project website at www.njqrp.org/dds. An 8-pin connector at the board edge allows the DDS Daughtercard to be plugged into the main pc board of the Micro908.

REFLECTOMETER

The reflectometer module is a basic absorptive SWR bridge driven by the computer-controlled DDS frequency source, whose output in turn drives an antenna system. The analog outputs of the SWR bridge are digitized by the built-in A/D converter on the HC908 microcontroller. By sweeping the DDS frequency across a given ham band and computing the SWR of the antenna system at various points along the way we have a rudimentary antenna analyzer.

SWR Bridge & Diode Detector — A Wheatstone bridge is composed of 49.9-ohm resistors with the antenna as the "unknown" leg of bridge. When the antenna is at resonance, presenting a minimum impedance with a pure 50-ohm resistive "real" component, the bridge is balanced and the AC voltages on each side of the bridge are identical. No AC current flows between the legs.

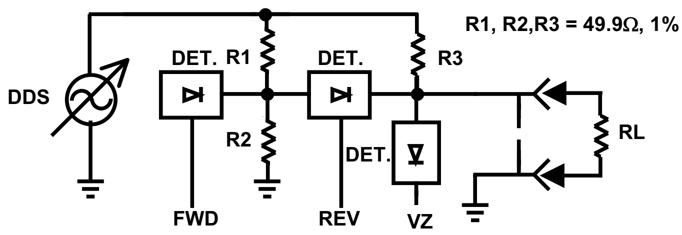

Figure 3: Schematic of the SWR bridge and diode detectors

However when the antenna system is not resonant, the complex impedance of the antenna is not 50-ohms but something greater, which creates a bridge imbalance. The 1N34 diode samples that AC signal imbalance, rectifies it, and after filtering, the DC signal is directly analogous to "reflected" sample of more familiar SWR bridges. We then sample the "forward" power using another diode detector on the original incoming signal. These forward and reflected DC signals are presented to the next stage for compensation, buffering and amplification.

The basic equations used by the analyzer for SWR computations are:

P = (REV/FWD) = reflection coefficient
SWR = (1+P)/(1-P)
Z = 50 * VZ/(2*FWD – VZ)

And further, an estimate of the resistive and reactive parts of Z can be determined.

R = (2500+Z^2) * SWR/(50 * (SWR^2 + 1))
X = SQRT (Z^2 – R^2)

Note that in the above equations the only inputs are DC measurements so the computations are straightforward – no messy complex algebra or trigonometry involved!

Buffer Amp — There are two reasons for employing the op amp circuits in **Figure 4**. The first amplifier in each path (FWD and REV) compensates for the nonlinearities in the diode detectors when the bridge is operated at very low power levels. These first stage op amps employ 1N34 diodes (or 1N5711 diodes as now used) in their feedback paths to counteract these nonlinearities in the bridge diodes. This action essentially moves the natural knee of the curves closer to zero, thus improving the accuracy of the readings FWD and REF readings ultimately presented to the A/D input on the microcontroller.

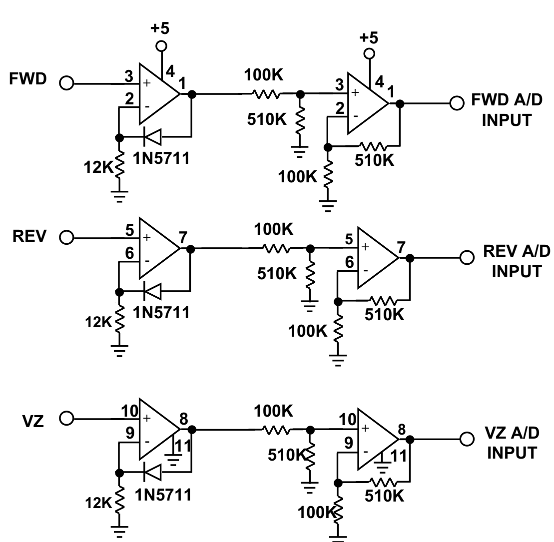

Figure 4: Schematic of the LMC6485 buffer amp.

The second purpose for the op amps is to amplify. The DC signal levels coming from the bridge, and through the unity gain of the first compensation stage, are fairly low. In order to make the most use of the 8-bit A/D, we need to amplify the detector voltage up to the 5V range of the A/D. Further, the output of the op amp circuits is quite low which provides a better condition when presenting signals to the 10K input impedance of the A/D. (The output impedance of the diode detectors themselves is approximately 100K-ohm. If those signals were directly input to the A/D, they would be greatly affected by the lower impedance of the A/D.)

Liquid Crystal Display

LCDs have become commonplace in our microcontroller projects. The Micro908 platform uses an inexpensive 2-line by 16-character/line device to display status and measurement information to the user. The software driver for this display assumes that a common HD44780 controller-based LCD is used, so one could actually use larger or smaller LCDs fairly easily instead of the specified one. One could also upgrade the Breadboard's capabilities to use a graphic LCD with an appropriate software driver in place. The Micro908 pc board was designed to accommodate a specific 128-by-64 pixel graphic LCD from Seiko: model number G1216. Although slightly more expensive as compared to character-based LCD modules, the advantages of using a graphical display downstream become obvious when considering the types of data representations typically used for displaying SWR, frequency spectra, and tuning aids.

Keyboard

A standard PS2-style keyboard, similar to many keyboards used on PCs these days, can be used with the Micro908. The utility of this input device comes about when we develop "digital modem" software programs for support of PSK31, RTTY, PACTOR, PSK63, et al. This combination of DSP co-processing and fast alpha-numeric input by the operator is the basis for PSK31 and other digital modes intended to be supported by this project. The small Dauphin keyboard in the photos is particularly well-suited for portable use with the project.

DSP Daughtercard

One of the many goals for the Breadboard continues to have it perform as a stand-alone digital mode controller, allowing the user to communicate using PSK31 (et al) without the need for a completely dedicated PC. To do this, and other audio filtering functions, a signal processing is required and we designed the Micro908 platform to accommodate the KK7P "DSPx" daughtercard. This DSP card, containing an Analog Devices ADSP-218x digital signal processor and mating codec (integrated A/D and D/A converter), is provided as a completely assembled and tested 2" x 2" plug-in board from Lyle Johnson, KK7P. Developed initially to replace a discontinued Analog Devices DSP evaluation board, it is the main embedded computing engine within the DSP-10 project. Further, the same DSP algorithms (i.e., software) are used to provide audio filtering in the Elecraft K2 transceiver. The DSPx daughtercard is powerful enough to demodulate the digital mode audio baseband signals coming from your transceiver's speaker to ultimately display PSK31 data being received, for example. Similarly, it can simultaneously modulate the data you type on the Micro908 alpha keyboard and send that audio out as audio tones suitable for input to your SSB rig. There are truly some real exciting applications coming along for the Micro908 platform based on use of the KK7P DSPx daughtercard.

Miscellaneous Circuits

A shaft encoder provides ultimate flexibility to the operator as a continuous rotation menu selector, numeric dial setting, frequency tuning, and so on. A Morse paddle may be connected to an input jack of the Micro908 and software performs as an iambic keyer, which in turn drives an external transmitter through the Keyline output on the Aux connector. A tone is also sounded, under control of the HC908, and is output through an LM386 audio amplifier. This audio tone can be the sidetone for the keyer, the output for an Audio Voltmeter, or mode confirmation beeps. Finally, room is provided within the Micro908 enclosure for an eight-AA cell pack, thus providing portable power for the field use of the unit.

Antenna Analyzer Software

The real heart of any project running on the Micro908 hardware platform is the software controlling it. This is certainly the case for the Antenna Analyzer, as the system components are controlled and operated in unison to create a fine-tuned measurement system. Let's walk through the program logic a bit to see how things are accomplished.

The main operation of the Antenna Analyzer is achieved as a sequence of five basic operations that repeatedly occur within in the loop of the main program …

- Set the DDS frequency
- Display the frequency on the LCD
- Read the analog signals from the reflectometer
- Compute the SWR and impedance
- Store the results in list for later display and post-processing

When the scan is complete, the program analyzes the list of scan data to determine antenna resonance (the frequency of the minimum data point) and the Q of the antenna system (how sharp the dip is).

Setting the DDS Frequency – The DDS frequency, phase and control bits are serially delivered to the device via three I/O lines coming from the HC908 Daughtercard: data, clock and load. Per the details provided in the AD9850 data sheet, the HC908 delivers these 40 bits of programming information by repeatedly setting the data line to the desired value, and toggling the clock line in order to move the data bit into the DDS chip. After 40 such bit clocks, the load line is toggled which instructs the DDS chip to put that 40-bit programming word into effect. At that point, the output of the DDS changes and the new frequency is present on its output.

Display Frequency on LCD – The frequency is displayed to the LCD by placing the binary coded decimal (BCD) value of each digit into seven sequential locations LCD_dat+0 through LCD_dat+6. These digits represent the 10 MHz position through the 10 KHz position in the frequency display. The LCD driver routines take these BCD numbers and display them to specific locations in the LCD memory, thus making them appear on the display itself. The numbers contained at these locations represent the start of increment/decrement functions (used in scanning), and in subsequent calculation of the DDS programming 40-bit word (used in setting the DDS frequency.)

Read Analog Signals – The forward voltage FWD and reverse voltage REV are read as 0-5V analog signals by the A/D converters built into port D of the HC908. These 8-bit converters quantize the analog signal to one of 256 values, based on the analog signal presented on the respective port D input pin. Thus a granularity of 19.531 mV is achieved. This level of precision is entirely adequate for determining even the low-end knee of the diode detectors primarily because of the compensation diode placed in the second op amp circuit for each signal path.

Compute the SWR — Using measured values to calculate SWR means that instrument is self-calibrating. This is a good thing in test equipment! The following simple equations are coded in the software, using the FWD and REV signals read by the A/D.

P = FWD/REV

SWR = (1+P) / (1-P)

Store the data in list – Each frequency sample's computed SWR and impedance value is stored in a list in RAM memory for processing at the conclusion of the scan. Further, the raw data may uploaded to a PC for additional processing, plotting, display and storage.

Operating the Antenna Analyzer II

The Analyzer has three Modes – manual, automatic and remote. In **Manual Mode** the unit is operated by direct user manipulation of the **Tune** control (rotary encoder) to change the frequency of the signal being delivered. This operation is analogous to that of a standalone VFO, however in addition to the frequency being displayed in the LCD, the SWR and impedance measurements are also continuously computed and displayed. This allows the user to go to a specific location to see the antenna's performance there, or to manually "diddle" the frequency (i.e., move it back and forth about a center frequency) to determine approximate bandwidth of the network response.

While in Manual Mode, the user may press the **Band** control to cycle through the list of ham bands. Each time the Band control is actuated, the lowest frequency of the next band is set into the DDS and displayed on the LCD. Using this control allows the user to quickly change frequency to take manual measurements on different bands.

In **Automatic Mode**, the unit sweeps the DDS frequency from the **Start** setting to the **End** setting, incrementing the frequency each time by the **Step** amount. Each of these settings is settable by pressing the Config pushbutton to get into the Configuration sequence. Settings are already present for each band, but the user has the option of saving the newly-specified settings for default operation thereafter.

The **Step** setting is also used in Manual mode. Thus the user may specify how fast the frequency changes when the **Tune** control is rotated.

Scanning is started in the Automatic Mode by pressing the **Scan/Stop** pushbutton. This actuation initiates the frequency scanning and measurement sequence and turns on the **Busy** LED. During the scan, the frequency, SWR and impedance values are displayed on the second line of the LCD. One is able to optionally turn off this display of data during the scan, as it will greatly increase the speed of the overall scan. If the user wishes to stop or abort the scan while in progress, the **Start/Stop** pushbutton may be actuated.

Once the automatic scan is complete, the **Busy** LED is turned off and a list of **resonant frequencies** and their associated SWR and impedance values will be displayed. A resonance is determined to be located at the points in the collected data where the SWR experiences a "monotonic minimum" – that is, when the SWR is detected as decreasing in a monotonic fashion (unchanging direction), then increasing in a similar monotonic way. This algorithm can detect multiple resonance points in an antenna system even when some resonances are more pronounced than others. In this results display mode, the resonant frequencies are presented individually to the LCD with an indication in the rightmost position that there is **More Data** to be viewed. Pressing Scan button advanced through the list of resonant frequencies until the list is exhausted, whereupon the More Data indication is no longer displayed.

If the Micro908 device is inactive for more than the default time of 60 seconds, the unit is put to sleep – i.e., it is placed in extreme low power mode – until the **Sleep** pushbutton is actuated to resume operation at the same point. The inactivity timer is configurable within the Configuration user interface.

One can enable/disable the **Tones** within the Configuration user interface. When enabled, a tone whose pitch is determined by the current SWR reading is annunciated via the internal speaker and through the headphone jack. Lower SWR readings produce lower tones. In this way, the unit may be used in situations when the LCD is not easily viewable.

One may also enable/disable **Morse Readout** of the frequency data within the Configuration user interface. When enabled, the frequency and SWR results are annunciated via the internal speaker and through the headphone jack. In this way, the measurements and computations are accessible when the LCD is not easily viewable.

Whenever Tones are enabled, the volume is adjustable with the **Volume** potentiometer on the front panel.

In the **Remote Mode**, communication is established with a PCLink program running on a PC for the purpose of uploading/downloading of data, and for establishing a link for remote control.

Basic Uses for an Antenna Analyzer

Antenna analyzers are extremely useful devices to have around any ham shack or homebrewer's workbench. A small list of the things that many frequently want to do includes:

Antenna SWR measurements — The antenna is simply connected to the analyzer antenna terminal and the analyzer is set to the desired frequency. The readout gives the resultant SWR. If the frequency is tuned across a ham band, the minimum SWR point (resonance) can be found as well as the SWR end points (usually 2:1).

Measure feed point impedance of antenna — Connecting the analyzer directly at the antenna terminals or remotely through a half-wavelength of transmission line allows direct measurement of the antenna terminal impedance. This is often useful with vertical antennas. A matching network may also be connected to the antenna and then adjusted for best SWR on the analyzer.

With short vertical antennas measuring the impedance directly at the feedpoint allows estimation of ground loss or loading coil loss. For example a ¼ wave vertical will have a resistance of about 36 ohms at resonance. Any higher reading indicates ground loss. Similarly shorter antennas (when resonated) will have lower resistance values. Reading a good SWR may mean excess loss and measuring the actual impedance allows gauging just how much loss.

The analyzer can be used to adjust an antenna tuner for a perfect match without the need to transmit a strong signal from the station rig. The analyzer sources only milliwatts of power, thus lessening the possibility of interference.

The analyzer can measure the values of inductors and capacitors connected across its antenna terminal.

Series resonance of a tuned circuit can be accurately measured. The series combination is connected across the analyzer antenna terminal and the analyzer is tuned for the lowest resistance. The frequency where this occurs is the resonant frequency.

Advanced Uses for an Antenna Analyzer

The analyzer is an instrument that can be used for a number of uses well beyond simple SWR and impedance measurements. The following list outlines some of the uses. Detailed methods are available in a number of references including the MFJ-259B manual which can be found on-line. See the list of references for the URL

Determine characteristic impedance of transmission line. — Using an electrically long length of the line connect a non-inductive resistor or about the correct resistance at the far end and the analyzer at the near end. Measure impedance while tuning the analyzer across the HF range. Note the observed impedance indication. If it varies with frequency try another value. When it matches the transmission line characteristic impedance it should remain approximately equal over a wide frequency range.

Determine length of ¼ and ½ wave phasing lines — Half wave lines are easy – terminate the far end in the 50 ohms and read the near-end SWR. It will be 1:1 at the frequency where the line is ½ wavelength. A quarter wavelength is half this length. There are more sophisticated means for direct ¼ wave line determination.

Coaxial Cable Loss – Leave the far end of a transmission line open while measuring SWR. A table of feedline loss versus SWR in the ARRL Antenna Book can be consulted for the corresponding value

Determine antenna tuner loss – An excellent method for using an analyzer to measure tuner loss was published in QSR by Frank Witt, AI1H. See the references for the publication information. In addition the articles can be downloaded from the ARRL Member's Only site. The same method can be used to measure balun loss.

Measure inductor Q – The series impedance and inductance of an inductor can be measured and used to calculate coil Q. For high-Q inductors a series resistance can be used to get an in-range resistance value and the known resistance is subtracted from the reading to calculate Q.

Estimate quartz crystal parameters – Since the Analyzer can be tuned precisely the series resonant frequency and series resistance of a quartz or ceramic resonator can be measured. An off-resonance measurement of the parallel capacitance can also be estimated.

Measure magnetic loop resonance and SWR — As with quartz crystal measurements, the high-Q characteristics of magnetic loops make their measurement difficult with analog-tuning analyzers. The precision DDS in this analyzer overcomes that difficulty.

Of course, since the Antenna Analyzer II software is easily able to be updated though quick 'n easy downloads from the project website.

Upload Analyzer data with PCLINK

PCLink is an optional program from your PC that connects to the Micro908 Antenna Analyzer to upload, display and save data collected by the instrument. The Antenna Analyzer II connects to the serial port of a PC for uploading raw measurement data for graphical display and plotting, and for remote control of the unit. The mode is entered merely by connecting a standard RS-232C serial cable between the Antenna Analyzer and a PC that is running the companion PCLink software provided with the project.

Data Display — After the Analyzer has completed a manual or automatic data collection scan, it may be connected to a host PC which is running software that uploads the frequency and SWR data from the unit and displays a graphical plot of that data on the video monitor. This view of the data can present a more detailed and visually-intuitive representation of the antenna system performance. Options are also present in the PCLink software package to allow data storage, retrieval and hard copy printout.

Remote Control — The PCLink software running on the host PC allows all operations of the Analyzer to be run from the PC keyboard and display. This mode is useful when the Analyzer is located in an inconvenient or slightly remote location from the operator's bench. Thus, the host PC is a virtual control panel for the Analyzer.

Calibration — The PCLink software package also provides the user with a precise way to calibrate the Analyzer. Specific parameters to be set include: the transmitter frequency, the low and high edges of each band, specific bands of interest (i.e., an ability to select only certain bands to be scanned by the Analyzer), and SWR readings.

There are default values for each of these parameters, so the Calibration function (and hence the PC) is not mandatory. However, great flexibility comes about through use of this facility.

The display screen for the PCLink application indicates the uploaded SWR readings as a red line on a graph. Thus the antenna system shows a "dip" where the SWR is better (lower).

The controls on the PCLink screen allow the user to Connect to the Analyzer for subsequent manual control, Collect and Display the Data, Calibrate the system, set the Band for either graph view or for manual control, and to initiate a Scan.

The PCLink program was written in Microsoft Visual BASIC. The project source code and forms files are posted on the AmQRP website for those interested in modifying the code and experimenting with customized programs.

Notes

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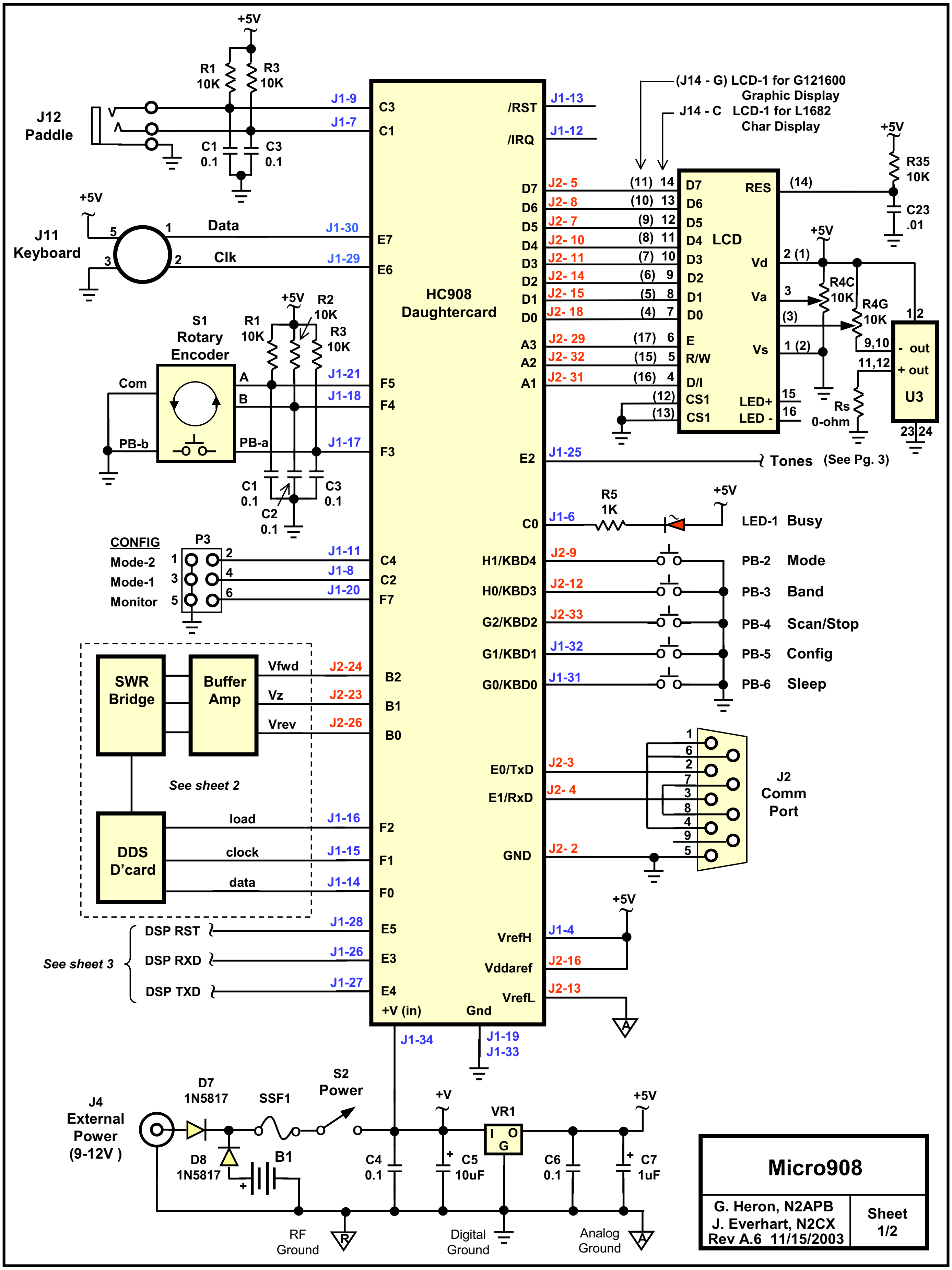
2) The Micro908 is expected to be available as a kit from the AmQRP Club in early 2004. The basic kit (pcb, parts, controls and connectors) is expected to be around $125. HC908 and DSPx daughtercards are available as a bundled price adder. Enclosure and keyboards are additional options. Full details on the project, kit and Antenna Analyzer software may be found at www.amqrp.org/kits/micro908.


+5V
R1
10K
R3
10K
J12
Paddle
J1-9
J1-7
C3
C1
C1
0.1
C3
0.1
/RST
/IRQ
J1-13
J1-12
(J14 - G) LCD-1 for G121600
Graphic Display
J14 - C LCD-1 for L1682
Char Display
R35
10K
C23
.01
J11
Keyboard
Data
Clk
J1-30
J1-29
E7
E6
D7
D6
D5
D4
D3
D2
D1
D0
J2- 5
J2- 8
J2- 7
J2- 10
J2- 11
J2- 14
J2- 15
J2- 18
LCD
RES
Vd
Va
Vs
LED+
LED -
CS1
R/W
D/I
E
HC908
Daughtercard
S1
Rotary
Encoder
Com
PB-b
PB-a
R2
10K
J1-21
J1-18
J1-17
F5
F4
F3
A3
A2
A1
J2- 29
J2- 32
J2- 31
R4C
10K
R4G
10K
U3
- out
+ out
Rs
0-ohm
E2
J1-25
Tones (See Pg. 3)
C2
0.1
C0
J1-6
R5
1K
LED-1 Busy
CONFIG
Mode-2
Mode-1
Monitor
P3
J1-11
J1-8
J1-20
C4
C2
F7
H1/KBD4
H0/KBD3
G2/KBD2
G1/KBD1
G0/KBD0
J2-9
J2-12
J2-33
J1-32
J1-31
PB-2 Mode
PB-3 Band
PB-4 Scan/Stop
PB-5 Config
PB-6 Sleep
SWR
Bridge
Buffer
Amp
Vfwd
Vz
Vrev
J2-24
J2-23
J2-26
B2
B1
B0
See sheet 2
E0/TxD
E1/RxD
J2-3
J2- 4
J2
Comm
Port
GND
J2- 2
DDS
D'card
load
clock
data
J1-16
J1-15
J1-14
F2
F1
F0
DSP RST
DSP RXD
DSP TXD
See sheet 3
J1-28
J1-26
J1-27
E5
E3
E4
VrefH
Vddaref
VrefL
J1-4
J2-16
J2-13
+V (in)
Gnd
J1-34
J1-19
J1-33
J4
External
Power
(9-12V)
D7
1N5817
D8
1N5817
SSF1
S2
Power
B1
C4
0.1
+V
C5
10uF
VR1
C6
0.1
C7
1uF
RF
Ground
Digital
Ground
Analog
Ground
Micro908
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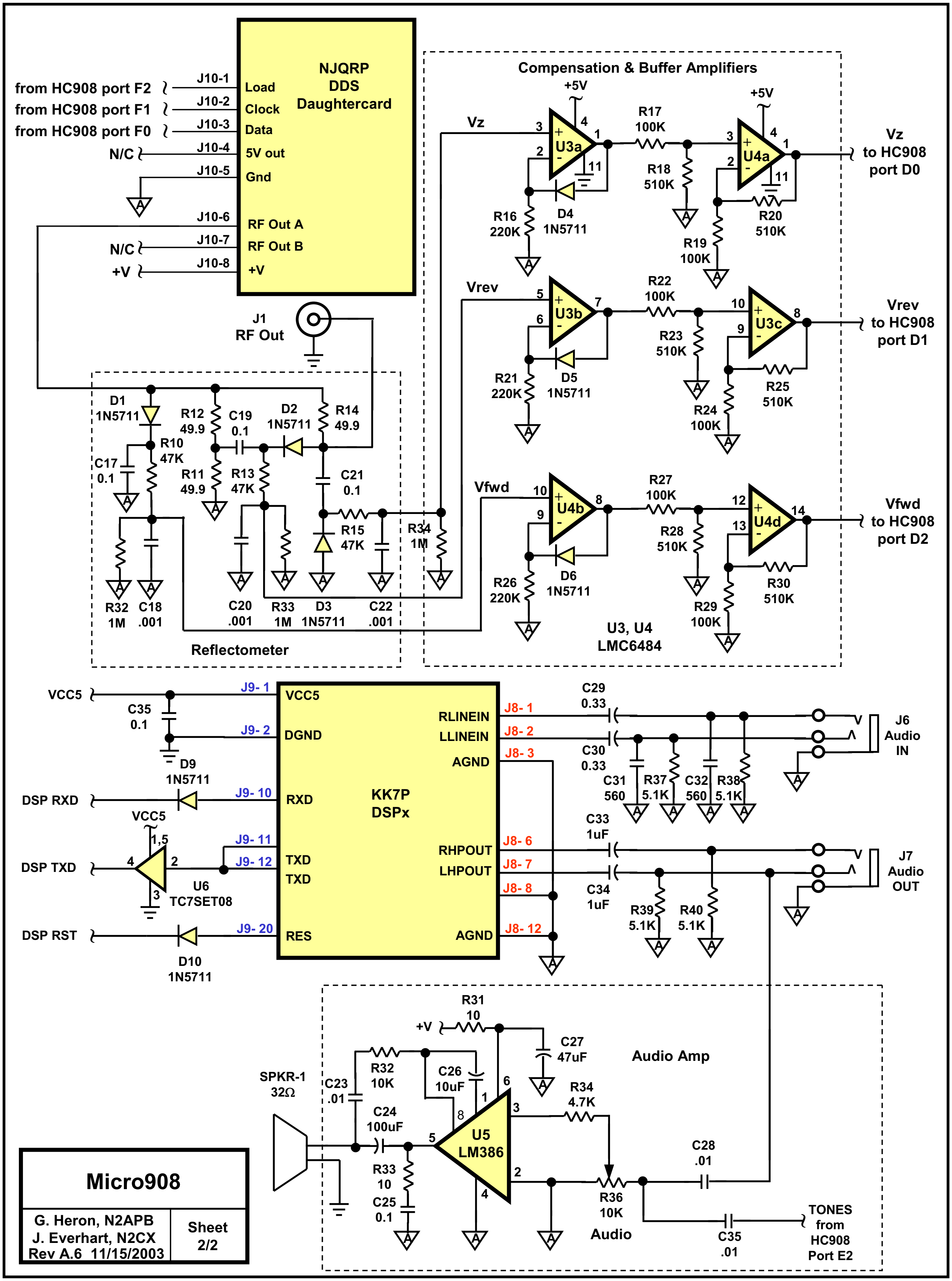
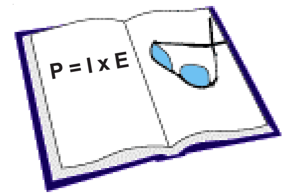


NJQRP
DDS
Daughtercard
from HC908 port F2
from HC908 port F1
from HC908 port F0
N/C
+V
J10-1
J10-2
J10-3
J10-4
J10-5
J10-6
J10-7
J10-8
Load
Clock
Data
5V out
Gnd
RF Out A
RF Out B
+V
J1
RF Out
Compensation & Buffer Amplifiers
+5V
Vz
U3a
U4a
R17 100K
R18 510K
R16 220K
D4 1N5711
R19 100K
R20 510K
Vz to HC908 port D0
Vrev
U3b
U3c
R22 100K
R23 510K
R21 220K
D5 1N5711
R24 100K
R25 510K
Vrev to HC908 port D1
Vfwd
U4b
U4d
R27 100K
R28 510K
R26 220K
D6 1N5711
R29 100K
R30 510K
Vfwd to HC908 port D2
U3, U4
LMC6484
D1 1N5711
R12 49.9
C19 0.1
D2 1N5711
R14 49.9
R10 47K
C17 0.1
R11 49.9
R13 47K
C21 0.1
R15 47K
R34 1M
R32 1M
C18 .001
C20 .001
R33 1M
D3 1N5711
C22 .001
Reflectometer
VCC5
C35 0.1
D9 1N5711
DSP RXD
DSP TXD
DSP RST
U6 TC7SET08
D10 1N5711
J9- 1
J9- 2
J9- 10
J9- 11
J9- 12
J9- 20
VCC5
DGND
RXD
TXD
TXD
RES
KK7P
DSPx
RLINEIN
LLINEIN
AGND
RHPOUT
LHPOUT
AGND
J8- 1
J8- 2
J8- 3
J8- 6
J8- 7
J8- 8
J8- 12
C29 0.33
C30 0.33
C31 560
R37 5.1K
C32 560
R38 5.1K
J6 Audio IN
C33 1uF
C34 1uF
R39 5.1K
R40 5.1K
J7 Audio OUT
R31 10
+V
C27 47uF
Audio Amp
SPKR-1 32Ω
C23 .01
R32 10K
C26 10uF
C24 100uF
R33 10
C25 0.1
U5 LM386
R34 4.7K
R36 10K
Audio
C28 .01
C35 .01
TONES from HC908 Port E2
Micro908
G. Heron, N2APB
J. Everhart, N2CX
Rev A.6 11/15/2003
Sheet 2/2

Joe Everhart, N2CX



RF Power Meter Cookbook Part 2: Measurement Techniques

We learned last time that transmitted power is surprisingly tricky to measure -- especially so at QRP levels. N2CX continues the saga of measuring low power levels by presenting some basic circuits and explaining the subtle nature of their use. Gain a firm understanding of the building blocks in this installment.

This series was originally intended to be presented in twp parts. However as writing progressed it became obvious that including everything needed was a larger task. To limit the Cookbook as planned would mean leaving out important material, so Part 2 presented here will not be the end. There will be an additional installment so that everything can be covered.

This installment presents detailed functional blocks with component values to use in building several different power and SWR meter configurations. Performance tradeoffs of these circuits will be discussed to allow you to choose which are appropriate to your needs. The focus in the next issue will shift to calibration and adjustment. This techniques described there will be practical with common equipment and some simple test circuits to use both now and in the future in your shack.

Analog or Digital?

Part 1 of the cookbook implied that the end result would be digital RF power meters. However there is no need to limit the building block usage to only digital projects. We will also examine how to make analog instruments using the same modules.

Analog vs. digital is not really an issue at all. As with many things in this world there is no clear-cut choice overall as to which is better. It's really more a matter of chosing what works best in a given situation. Digital techniques usually make processing information easier, particularly when multi-digit precision is necessary. The internal complexity of digital circuitry and microprocessors is hidden so the end result may seem to be simpler circuitry to do the same task as a bunch of op-amps, multipliers, etc. And well-designed digital circuits are very stable and predictable.

On the other hand, working directly with analog signals seems intuitively more obvious and for low cost non-precision uses, analog circuits are easier to understand and design and much simpler to use when adjusting for maximum or minimum values.

The accuracy and precision of digital processing and the ease of analog displays can be combined in some cases. Providing the user with a selectable display preserves the readout advantages of both methods.

Building Blocks

The functional blocks to be described are:

- A basic RF diode detector
- A compensation circuit for added accuracy
- An accurate QRP dummy load
- An accurate HF directional coupler
- A resistive return loss bridge

These blocks will first be described individually in terms of how they work, what they are used for and how well they perform. Following that discussion combinations of the blocks will be examined so that the builder can see which will be most suited to his needs.

Basic RF Diode Detector

The simple semiconductor diode is the primary component in the majority of the RF detectors familiar to most of use homebrewers. Its small parts count and broadband performance make it very attractive to use and since its operation is easy to understand we are quite comfortable with it. The circuit in Figure 1 as was described in Part 1 of the Cookbook provides a positive DC voltage out that is approximately equal to the peak voltage of an input sine wave. This approximation is quite good at input voltages well above the diode's rated forward drop. This is about 0.2V for germanium diodes, 0.7 volts for silicon and somewhere in between for Schottky diodes.

See **Figure 1** – Basic RF Detector

For simplicity we will use 1N34 germanium diodes in the circuits from here on. Perhaps a follow-up article will show how Schottkys can be used.

We can see the effects of the approximation by examining the output voltage from the basic detector over a range of input voltages. SPICE modeling was done to prepare the charts that follow.

See **Table I** – Simple Diode Detector has Inaccuracies

Table I shows DC detector output for RF input levels corresponding to power levels of 10 ohms and down (QRP plus a 2:1 margin). The absolute accuracy is above 5% down to inputs of ½ watt – not bad for high level transmitters and even the high end of the QRPp range. However accuracy falls rapidly when the peak input voltage falls below the 5-watt level. It is only about 10% for 100 mw and nearly useless for anything but gross readings below a couple of milliwatts.

Worse yet, since power is proportional to the square of the voltage, power accuracy is only about 10% at 5 watts and 50% at ½ watt! Still it is entirely adequate for relative readings. For good accuracy at low powers analog meters can be used in several ranges with either hand-generated calibration charts or special meter scales.

The benefit of breaking metering into ranges is best shown by several charts. Since very sensitive meters are best for low power measurements the detector circuit will be redrawn to deliver an output current as shown in Figure 2. Meter M1 is a 200-uA unit although more sensitive movements can be used as well. Resistor RS in series with M1 is used to set the maximum current for each range to be read. For a multi-range instrument a set of switched trimpots is used. They are set for initial calibration and not reset during normal use.

See **Figure 2** - Detector with Analog Meter

Tables II through IV show meter readings as a fraction of the full-scale value and the percentage voltage reading error for ranges from 20V rms down to 1V rms. Accuracy deteriorates at low power as in the previous example. However since each range covers a smaller maximum to minimum range using either calibration charts or custom meter scales will minimize the reading error down power levels in the 10's of milliwatts.

See **Table II** – 20V range using 150k RS

See **Table III** – 10V range using 68k RS

See **Table IV** – 5V range using 32k RS

See **Table V** – 2V range using 11k RS

See **Table VI** – 1V range using 4k RS

Low Level Detector Compensation

A simple detector compensation first described in radio amateur literature by John Grebenkemper was described in Part 1 of the Cookbook. The compensation circuit consists of an operational amplifier using a feedback network consisting of a diode, D2 (ideally matched to the detector diode) and resistor RC. Figure 3 shows the compensation circuit schematic diagram.

DC input from the basic detector of Figure 1 is fed to op-amp U1. The output of U1 is fed back to the diode/resistor network. Resistor Rc is sized so that the feedback at low DC input levels is minimized, amplifying U1's output. As the diode goes into conduction at several tenths of a volt, the feedback increases lessening the amplifier's gain. At high voltage levels the feedback is nearly 100% so the output is nearly the same as the input. For reference the schematic is also given for a good op-amp candidate, the LMC6484. There are two op-amps per package so a dual detector such as is used for SWR meters can be made using a single IC.

See **Figure 3** – Detector Compensation Circuit

The compensation is approximate and varies over the input range. By varying the value of RC the amount of compensation and just where it "kicks in" can be varied somewhat. A number of SPICE runs were made to observe results Vs RC. The optimum value was seen with 12 as can be seen in Table VII. Absolute accuracy is maintained to a couple percent from 22 Vrms to as low as about 150 mV. Inaccuracy peaks at about 9% a 50 mv and drops to less than 1% at 30 mv. Below that it falls off the end of the table!

See **Table VII** – Compensated Detector with RC = 12k

This compensation circuit can be used to good benefit as has been demonstrated in popular QRP wattmeters as was described previously in Cookbook Part I. Some precautions are needed to preserve accuracy, particularly at low input values.

First the diodes should be matched as described in the original Grebenkemper article. Second a good operational amplifier is required for repeatably accurate results. It must have a low input offset voltage, a very low input bias current and be capable of rail-to-rail operation on both its inputs and outputs. Previously one of the best choices was the RCA CA3140. However a modern improved replacement is the National Semiconductor LMC6482. The circuit has been duplicated by some using inexpensive low-performance op-amps such as the LM358, however performance suffers greatly at low signal levels with these chips.

Two additional observations are in order. It is important that the diode in the compensation circuit is kept at the same temperature as the detector diode. Since it is used to counteract the voltage drop of the other diode and since the drops are temperature sensitive this means that ideally they should be collocated so that their case temperatures will track. Finally, the op-amp supply voltage must be at least as high as the highest detector input voltage. This is most important for straight power meter applications since the inputs will see the highest input voltage.

Precision Dummy Load

In earlier discussion of RF power it was assumed that the power was measured into a good 50-ohm dummy load. This is important since accuracy of the dummy load will directly affect power readings. Ideally the load should be exactly 50 ohms and be entirely resistive with no stray inductance or capacitance. Fortunately this is simple to do over the HF range. Part 1 described several resistor combinations that yield good results.

Figure 4 illustrates a practical set of values. Four 200-ohm 2-watt, 5% resistors are connected in parallel to form a net 50-ohm resistor with a rated dissipation of 8 watts. They are inexpensive when purchased from Digikey. They carry both Yageo and Panasonic tin film resistors for less than $.30 each. Buy a bunch and you can make a whole slew of good dummy loads. For best accuracy select four whose parallel combination measures slightly more than 50 ohms using a digital multimeter. Then shunt these with a low-wattage high value resistor to give a total resistance of 50 ohms. We'll talk more about this in the next Cookbook installment.

See **Figure 4** - Precision Dummy Load

The construction technique used is important to minimize stray reactance. I prefer the method used by Dave Ottenberg, WA2DJN in and article in the QRP Homebrewer (Ref 1). He builds his loads using a BNC male connector and two pennies to make an accurate load.

Using his BNC-mounted load, a terminating wattmeter is simple. The terminating wattmeter uses the precision dummy load and a diode detector. The detector can be built into yet another BNC connector (Figures 5,6). A pair of pigtail leads coming from the detector provides the output DC connection. To make a small terminating detector then these BNCs are connected to the ends of

A BNC tee connector (Figure 7). The tee can then be connected to a mating female BNC connector on a rig to be checked out. The DC output is fed directly to a meter or, for better accuracy, to the meter through the compensation circuit of Figure 3.

See **Figure 5** - BNC-Mounted Detector

See **Figure 6** - BNC Detector Circuit

See **Figure 7** - Terminating Wattmeter Components

Accurate Directional Coupler

An excellent building block for use as both a directional wattmeter or SWR indicator is what amateurs often call a Stockton Bridge (Ref 2). Introduced in the previous installment, it is shown in more detail in Figure 8. This is a composite of several designs with component values tailored for general use. It has the distinct advantage that it introduces less than 1 dB loss when used so it can be left in-line all the time.

See **Figure 8** - Accurate Directional Coupler

Using ferrite-core transmission line transformers makes this coupler easy to duplicate, gives it predictable performance and broadband accuracy over the 3 to 30 MHz spectrum. Two load resistors are used (located either side of T2) in order to get a good 50 ohm match. ½ watt resistors are fine since the maximum voltage they will see with the maximum 10 watt input is only 4.4V DC as can be seen in Table VIII. This corresponds to about 0.4W. Since the accuracy of readings depends on the accuracy of these resistors it is recommended that they be selected in pairs that will be within 1% or so of the exact 50-ohm value desired. Beginning with 10 or so 5% resistors will probably result in two sets of pairs within that range as observed on a digital multimeter on the ohms range. They can be either carbon film or tin film resistors that are quite inexpensive at Digikey or comparable suppliers.

See **Table VIII** - Directional Coupler Voltages Vs Input Power

It is instructive to see how the voltages vary with SWR. SPICE simulations were done using an input peak voltage of 10V, which corresponds to a power of 1W. The resulting data is presented in Table IX.

See **Table IX** - Directional Voltages Vs SWR

These voltages will scale up or down according to the input power in the ratios indicated in Table VIII. Now check the effect of these rather low Vfwd and Vrev voltages referring to the earlier uncompensated and compensated detector output values (Tables I and VII).

With the basic uncompensated detector of Figure 1 the absolute accuracy of power readings will be drastically affected below 1 watt of either forward or reverse power. Relative SWR of course will be usefully read with input power of as little as 200 mW in that it will give a meter deflection that decreases as the SWR improves.

On the other hand the NoGaWatt meter using this same type of circuit uses analog microammeters with specially-drawn meter scales that can give quite useful results over a range of QRP power levels. I highly recommend the NoGaWatt Directional Wattmeter kit offered by the Northern Georgia (NoGa) QRP Club (Ref 3). If offers most of the components needed though you may care to get additional 100 ohm resistors to select as above for best accuracy. Kanga US also offers a similar kit (Ref 4) which is a kit version of the original Stockton Wattmeter.

Adding the compensation circuit in Figure 3 can give better than 10% absolute accuracy down to well below 100 mw. This is what makes the OHR WM-1 and WM-2 wattmeters so good.

The directional coupler building block can be used in this way with analog meters – but be sure to use the compensation circuit and arrange for range switching to get meter accuracy over a wide input power range.

The same bock can also be used to make a digital directional wattmeter. One using a PIC microcontroller and an uncompensated detector has been described by G4FON (Ref 5). It is a simple implementation though it admits to being a relative reading instrument rather than one that provides calibrated readings. He offers it as a simple way to eliminate the need for relatively fragile and unavailable analog meters.

As will be described in the last section of this installment there is a relatively easy way to use the compensated directional coupler with a readily available microcontroller kit to achieve a digital display device with calibrated accurate performance.

For further reading on directional couplers there is an excellent (though mathematical) discussion of their operation and a program to examine its performance in Reference 6.

Resistive Return Loss Bridge

There is an alternate building block that can be used for RF Power and SWR measurements. This circuit is a resistive return loss bridge (Figure 9). As described in Cookbook Part 1 it is a variant on the familiar Wheatstone bridge that features very broadband performance and almost the simplest circuit that can provide both forward and reverse samples to determine SWR.

See **Figure 9 -** Resistive Bridge

It has several shortcomings, though as compared to the directional coupler just mentioned. First it has an inherent 6-dB loss. Thus it passes only ¼ of its input power through to its load. Normally it must be removed from the transmission path after taking readings. On the plus side of the balance sheet, though this can an advantage when used to adjust an antenna tuner. Some transmitters automatically drop their output when they see an SWR of over 3:1. This can lead to erratic tuning as the transmitter drops in and out of this self-protective mode. The loss of the resistive bridge prevents the transmitter from seeing more than a 2:1 SWR so the transmitter stays “happy”. And some simple transmitters even go into oscillation under mismatch conditions. This makes tuner setup very difficult. The resistive bridge prevents this condition as well.

Another shortcoming is that the resistive bridge gives accurate power readings only when fed into an exact 50-ohm load. It does indicate useful relative readings with higher load SWRs so it is useful under these conditions.

The only bandwidth limitations with the resistive bridge is that component and wiring stray inductance and capacitance must be kept to a minimum. A symmetrical layout and short leads easily give good results over the HF range. As mentioned in part 1 SMT components can be used to extend this up to UHF and when stripline techniques are employed, up to the microwave region.

Back down at HF, however, the most critical item is the type of resistor used. Either carbon film or tin film resistors as earlier suggested for dummy loads are fine. As before resistor accuracy is important to retain reading accuracy. Use of paralleled 100 ohm 2 watt tin film resistors will served for input powers of 5 watts or even 10 watts for short key-down periods. Extreme accuracy is not needed for the two left-hand 50-ohm legs. They can be anywhere from 45 to 55 ohms so long as the top and bottoms are both the same value to within 1% or so. Selecting the right parallel pair to get 50 ohms ***is*** however important for the top right-hand bridge leg.

The resistive bridge building block can be used with either analog or digital metering. Since the voltage levels applied to the detectors are higher than with the directional coupler block, SWR reading accuracy can be maintained down into the 100’s of milliwatts. Table X shows calculated voltage values.

See **Table X -** Resistive Bridge Voltages Vs Input Power

The table also shows something that needs to be considered when using the detector compensation circuit. The Vfwd sample voltage (and the Vref with high SWR) is much higher than before. The op-amp circuit will not work correctly when it is fed an input voltage that is higher than its DC supply voltage. This means that the op-amp needs to have at least a 12 volt DC supply for bridge input powers of 5 watts RF. If higher powers are to be measured, a 100k potentiometer can be used to decrease the detector output to a safe level.

Power and SWR Readouts

Space in the current article prevents a complete description of how to implement readout building blocks. Detailed description will come the next installment. The discussion of microammeter usage for readout was touched on in the detector section and this will be expanded to include some “real” component values for useful multi-range analog displays.

No detail has yet been given for digital readouts. Part 1 of the series set the stage by mentioning the NJQRP QuickieLab as a prime candidate. Software for a voltmeter application is described along with the hardware involved in Reference 7. Three “display” types were developed the common numerical LCD readout, an audible Morse code indication and an output tone whose pitch is proportional to the value being displayed. These same display options will be retained in the power meter software that will be described in the future column.

References:

1. The “Common Cents” QRP Dummy Load, by Dave Ottenberg, WA2DJN, NJQRP QRP Homebrewer, Issue #2
2. A Bidirectional In-Line Wattmeter David Stockton G4NZQ Sprat No. 61 P. 12
3. NoGaWatt www.qsl.net/nogaqrp/projects/nogawatt
4. Kanga US www.bright.net/~kanga/kanga/stockton.htm
5. QRP Wattmeter, Ray Goff, www.qsl.net/g4fon/wattmeter.htm
6. RF Directional coupler Tutorial, michaelgellis.tripod.com/direct.html
7. QuickieLab www.njqrp.org/quickielab/index.html

Common Cents Dummy Load - WA2DJN

Power Meter Tables – *N2CX*

Basic Diode Detector				
Pi(W)	Vin (RMS)	Vin(pk)	Vo(DC)	Vo Error
				%
10	22.361	31.623	31.1	1.65
5	15.811	22.361	21.9	2.06
2	10.000	14.142	13.8	2.42
1	7.071	10.000	9.63	3.70
0.5	5.000	7.071	6.74	4.68
0.2	3.162	4.472	4.15	7.20
0.1	2.236	3.162	2.88	8.93
0.05	1.581	2.236	1.97	11.90
0.02	1.000	1.414	1.21	14.44
0.01	0.707	1.000	0.789	21.10
0.005	0.500	0.707	0.513	27.45
0.002	0.316	0.447	0.283	36.72
0.001	0.224	0.316	0.173	45.29
0.0005	0.158	0.224	0.102	54.38
0.0002	0.100	0.141	0.0475	66.41
0.0001	0.071	0.100	0.0256	74.40

Table I – Simple Diode Detector has Inaccuracies

Vrms	Vpk	Mtr Rdg	% Error
20	28.284	184	0.000
18	25.456	166	-0.242
16	22.627	147	0.136
14	19.799	129	-0.155
12	16.971	110	0.362
10	14.142	91.4	0.652
8	11.314	72.8	1.087
6	8.485	54	2.174
4	5.657	35.6	3.261
2	2.828	17	7.609

Table II – 20V range using 150k RS

Vrms	Vpk	Mtr Rdg	% Error
10	14.142	199	0.000
9	12.728	179	0.056
8	11.314	158	0.754
7	9.899	138	0.933
6	8.485	117	2.010
5	7.071	97.2	2.312
4	5.657	77	3.266
3	4.243	56.8	4.858
2	2.828	36.7	7.789
1	1.414	16.8	15.578

Table III – 10V range using 68k RS

Vrms	Vpk	Mtr Rdg	% Error
5	7.071	200	0.000
4.5	6.364	180	0.000
4	5.657	159	0.625
3.5	4.950	137	2.143
3	4.243	117	2.500
2.5	3.536	96	4.000
2	2.828	75	6.250
1.5	2.121	54.7	8.833
1	1.414	34.2	14.500
0.5	0.707	14.4	28.000

Table IV – 5V range using 32k RS

Vrms	Vpk	Mtr Rdg	% Error
2	2.828	199	0.000
1.8	2.546	177	1.173
1.6	2.263	155	2.638
1.4	1.980	134	3.805
1.2	1.697	112	6.198
1	1.414	90	9.548
0.8	1.131	68	14.573
0.6	0.849	47.3	20.771
0.4	0.566	26.1	34.422
0.2	0.283	7.71	61.256

Table V – 2V range using 11k RS

Vrms	Vpk	Mtr Rdg	% Error
1	1.414	203	0.000
0.9	1.273	178	2.573
0.8	1.131	153	5.788
0.7	0.990	128	9.923
0.6	0.849	103	15.435
0.5	0.707	80.1	21.084
0.4	0.566	56.1	30.911
0.3	0.424	34	44.171
0.2	0.283	14.2	65.025
0.1	0.141	1.9	90.640

Table VI – 1V range using 4k RS

Vin (RMS)	Vin(pk)	Vo(DC)	Vo Error
			%
22.361	31.623	31.500	0.39
15.811	22.361	22.200	0.72
10.000	14.142	14.100	0.30
7.071	10.000	9.950	0.50
5.000	7.071	6.990	1.15
3.162	4.472	4.410	1.39
2.236	3.162	3.120	1.34
1.581	2.236	2.200	1.61
1.000	1.414	1.380	2.42
0.707	1.000	0.980	2.00
0.500	0.707	0.695	1.71
0.316	0.447	0.443	0.94
0.224	0.316	0.318	-0.56
0.158	0.224	0.229	-2.41
0.100	0.141	0.150	-6.07
0.071	0.100	0.108	-8.00
0.050	0.071	0.077	-8.89
0.032	0.045	0.045	-0.62

Table VII – Compensated Detector with RC = 12k

Pin	Vin	Vin	Vfwd
W	Vrms	Vpk	pk
10	22.36	31.62	4.4
5	15.81	22.36	3.11
1	7.07	10	1.39
0.5	5	7.07	0.98
0.2	3.16	4.47	0.62
0.1	2.24	3.16	0.44

Table VIII – Directional Coupler Voltages Vs Input Power

SWR	RL	Vin	Vfwd	Vrev
	Ohms	vpk	vpk	vpk
1:1	50	9.8	1.39	0
1.5:1	75	9.83	1.16	0.229
2:1	100	9.85	1.05	0.345
3:1	150	9.86	0.935	0.46
4:1	200	9.87	0.878	0.518
5:1	250	9.88	0.844	0.553
6:1	300	9.88	0.822	0.577
7:1	350	9.88	0.805	0.593
8:1	400	9.88	0.793	0.606
9:1	450	9.88	0.784	0.615
10:1	500	9.89	0.786	0.623
1.5:1	33.3	9.75	1.72	0.342
2:1	25	9.7	2.05	0.679
3:1	16.7	9.6	2.7	1.34
4:1	12.5	9.5	3.34	2
5:1	10	9.41	3.97	2.635
10:1	5	8.94	6.9	5.63

Table IX – Directional Voltages Vs SWR

P	Vin	Vin	Vfwd
(W)	RMS	pk	pk
10	22.36	31.62	15.81
5	15.81	22.36	11.18
1	7.07	10	5
0.5	5	7.07	3.54
0.2	3.16	4.47	2.24
0.1	2.24	3.16	1.58

Table X – Resistive Bridge Voltages Vs Input Power

Power Meter Figures – *N2CX*

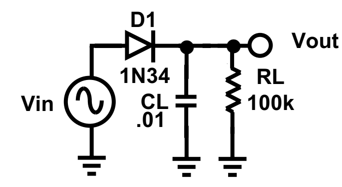


Figure 1- Basic RF Detector

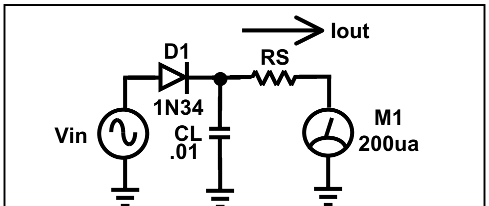


Figure 2- Detector With Analog Meter

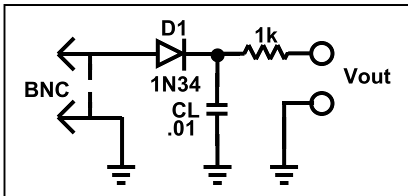


Figure 6- BNC Detector Circuit

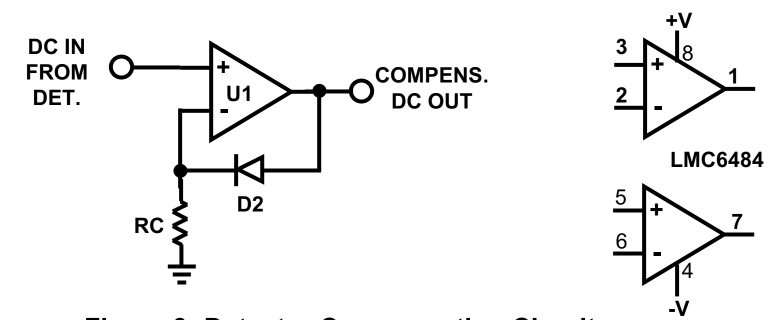


Figure 3- Detector Compensation Circuit

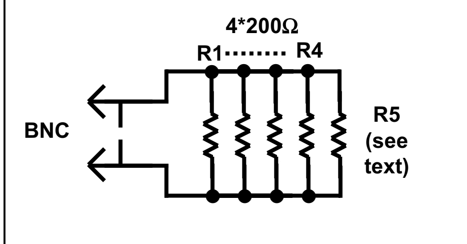


Figure 4 - Precision Dummy Load

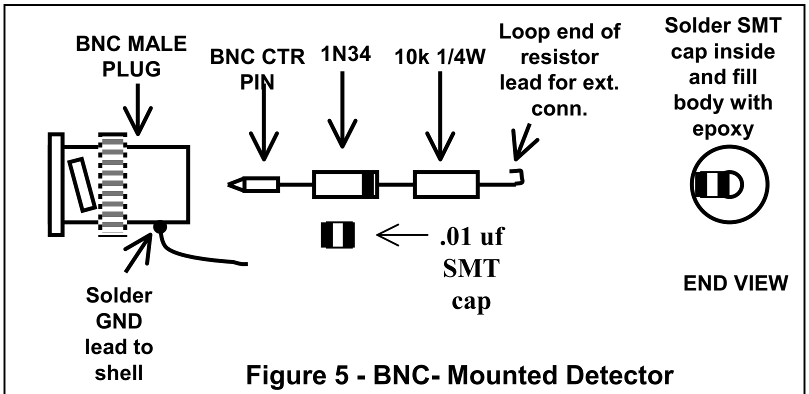


Figure 5 - BNC- Mounted Detector

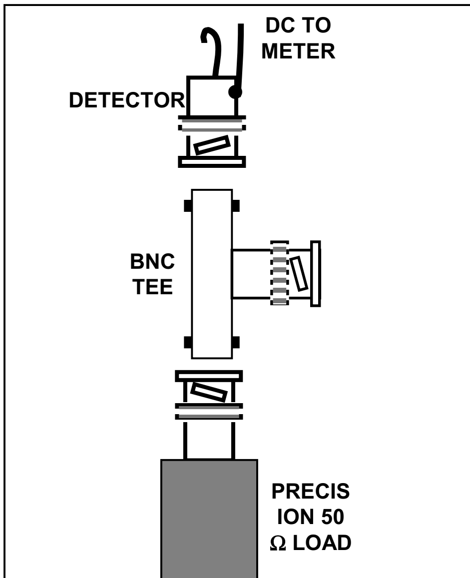


Figure 7 - Terminating Wattmeter Components

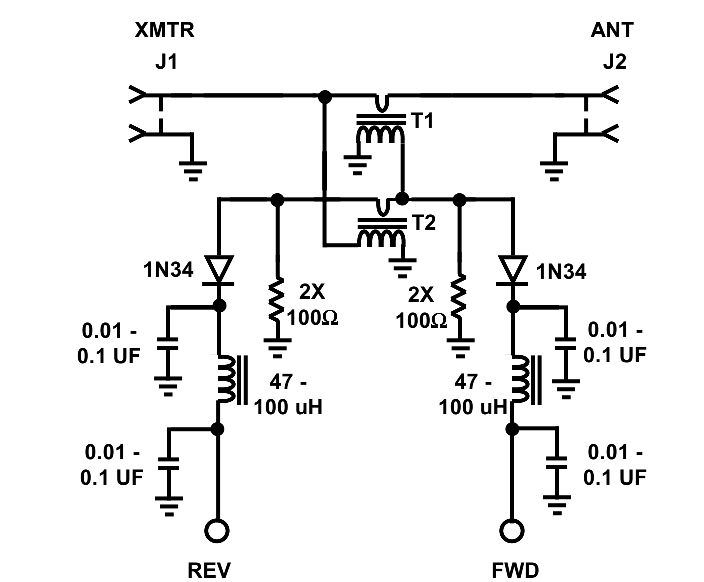


Figure 8 - Accurate Directional Coupler

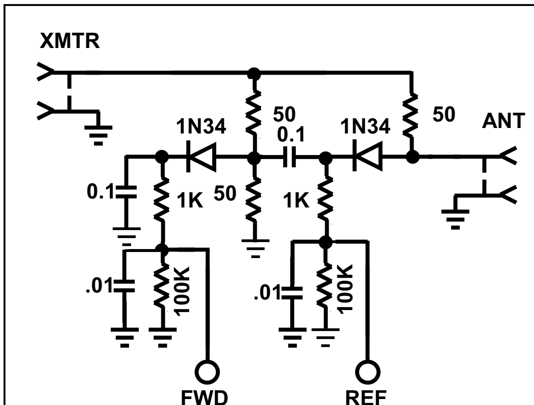


Figure 9 - Resistive Bridge

Mark Spencer, WA8SME

Aaron's Clock, No Hands Required

No-hands Clock complete with key fob transmitter for control.

Typical of any new Ham, Aaron, KD7UCD, wants to operate his station in accordance with the FCC regulations and in a responsible manner. He also is enthusiastic about participating in all of the public service operation opportunities that are open to him now that he is a Ham, including ARES and SKYWARN. Unlike the typical Ham though, Aaron is blind, which complicates many things for him.

Aaron, and others like him, inspired the no-hands clock. Micro-controller technology is very powerful, flexible, adaptable, and relatively inexpensive. This micro-controller based project allows Aaron to determine the current time, outside temperature, and when it is time to ID his station at the touch of a button. The information is announced by audio tone Morse code, hence no-hands are required. Because there are mobility issues, this project also uses wireless technology to allow the user to query the no-hands clock through a pocket sized, key fob transmitter.

Circuit Description

The circuit diagram in figure 1 also serves as a block diagram of the no-hands clock for the following overview discussion. The central component of the no-hands clock is a Basic Stamp 2 (BS2) by Parallax. The BS2 micro-controller communicates with and controls the other components of the no-hands clock by serial communication. In turn, the BS2 communicates with the user through Morse code. The Dallas Semiconductor DS1302 device is a Trickle Charge Timekeeping Chip that provides a real time clock. The Dallas DS1620 Digital Thermometer and Thermostat Chip is remoted from the no-hands clock to provide outside air temperature data. The Parallax 28004 (Receiver) and 28005 (Transmitter) pair provide the remote control interface for the circuit.

Of course the real brains behind this simple circuit is in the software. I will not detail the software in this article because the program listing has extensive documentation. The builder should be able to review the software comments and gain an understanding of the logic and commands used to make the no-hands clock work. A 9-volt DC, wall plug, power cube, powers the clock. The current requirement is approximately 15mA. This wall-power source is backed up by a 9-volt battery that is isolated by a diode until a main power failure occurs. The internal voltage regulator of the BS2 reduces and regulates the 9-volt wall-power source to 5-volts, which in turn becomes the power source of the other no-hands clock components. The BS2 communicates with the user via the speaker or buzzer. Audible "beeps" indicate when switches are pressed or Morse code is sent to report the requested data. The BS2 communicates with the DS1302 and DS1620 devices through a simple serial bus. Common clock and data lines are shared between the devices with unique chip-select lines used to address the discrete device.

The DS1302 clock chip requires only an external crystal to drive an internal oscillator to operate. The resistor tied to the I/O pin provides current limiting protection in case the BS2 data line somehow gets out of sync with the DS1302. When power is first applied, the clock time is set to all zeros. The series of four momentary-ON SPST switches connected to the BS2 are used to set the clock time. Each switch is pressed to advance the appropriate time digit one digit at a time (i.e., 10's hr, 1's hr, 10's min, 1's min). The clock is programmed through software for a 24-hour format. When the user requests a reading of the time, a command is sent by the BS2 to the chip and then receives the current time from the chip. Only the hour and minute digits are used in this project, the other digits of day, date, and seconds are disregarded. The time is sent by the chip in BCD and ASCII format so that the digits are ready for visual display. The BS2 program converts this format into numbers 0 through 9 that are in turn transmitted in Morse code.

The DS1620 thermometer chip requires only the current limiting resistor on the I/O line and a power supply bypass capacitor mounted at the device between Vcc and ground for operation. The chip is mounted in a weather resistant housing and connected to the BS2 by a length of multi-conductor wire so that the chip can be mounted outside of the shack. I used an 'AA' cell battery holder for the housing that is painted white to deal with radiation absorption complications that would prevent accurate temperature measurements. The chip requires initial programming when it is first put into service. The chip has numerous modes of operation; in the no-hands clock application, the free-running mode is used. When the user requests a reading of the temperature, a command is sent by the BS2 to the chip and it receives the current temperature from the chip in two's compliment binary data of the temperature in degrees Centigrade. The BS2 program accomplishes binary arithmetic to convert the temperature into Fahrenheit and both temperature readings (F and C) are transmitted by Morse code.

The user accesses the no-hands clock through a wireless connection made up of a small receiver that is connected to the BS2 and a hand held transmitter that resembles the car door locking, key fob transmitter common to most car remote control locking systems. The user pushes the appropriate button on the transmitter, and the corresponding line on the receiver goes to high state (+5 volts). The BS2 constantly polls the receiver lines looking for a command to execute in response to the user's input. The range of the transmitter is advertised to be 75 feet. However, being within earshot of the no-hands clock is far enough for this application.

Construction and Start-up

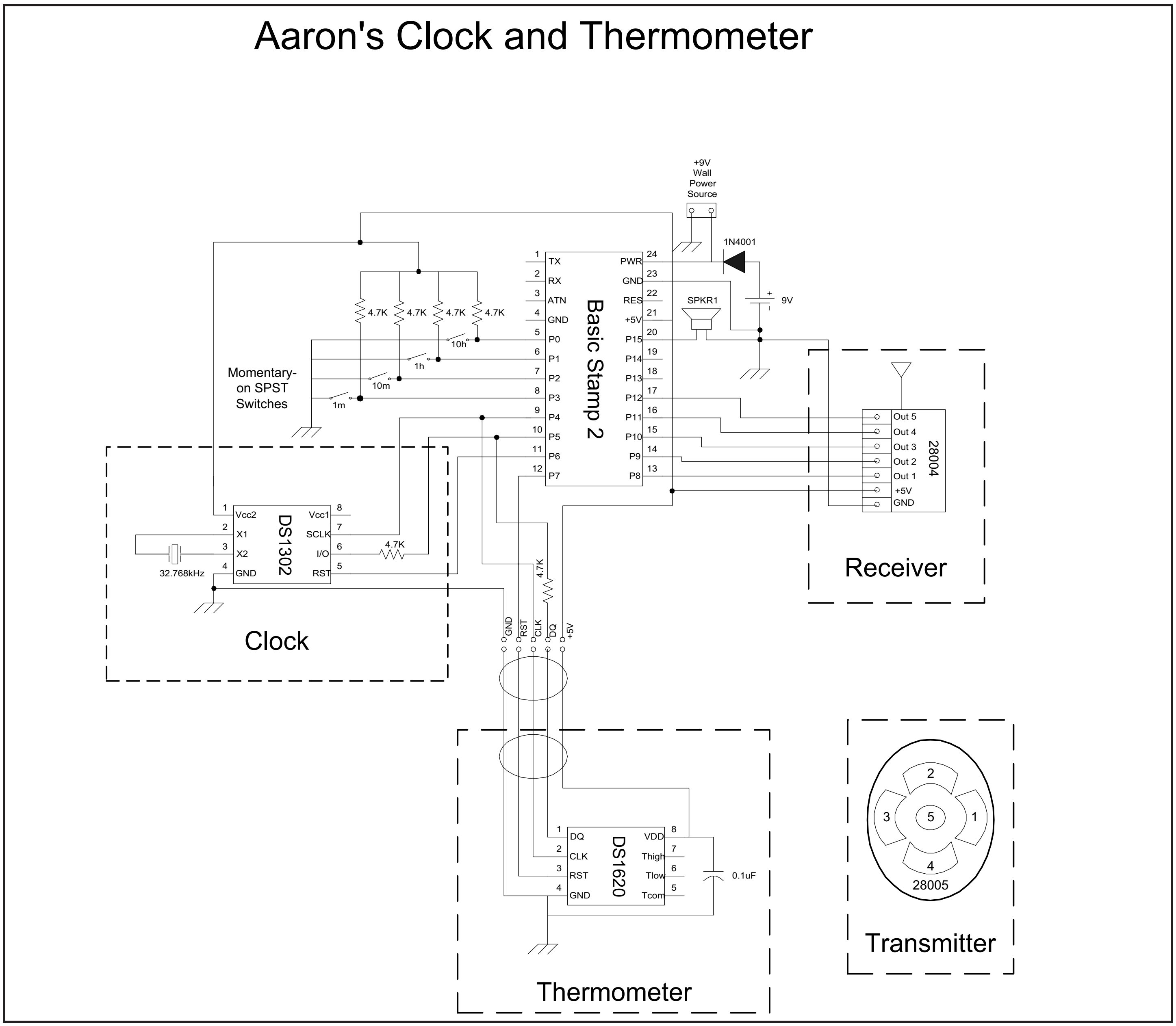
Refer to the accompanying photos of the project to see how the no-hands clock is constructed and housed in its final form. The wiring of the circuit is not critical. I used wire wrap connections between points. The BS2 should be socketed so that it can be easily removed for programming. A buzzer is used for the speaker source in this project to limit current requirements; the tradeoff is that the buzzer fixes the frequency. Other buzzer frequencies are available as desired by the builder. If additional frequency agility is needed, a piezo speaker can be substituted. A few lines of code will need to be changed if this substitution is made as documented with the software.

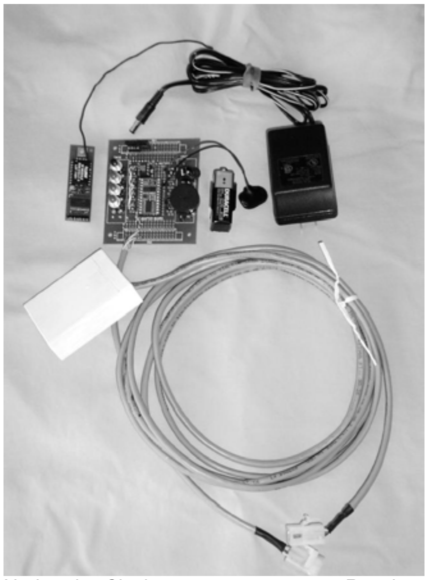
When the BS2 is first programmed, be sure to include the indicated four lines of code that are commented out in the final version of the software. These four lines of code accomplish two things that need to be done only one time. First, a memory location is used in the BS2 to store and hold the previous code transmission speed. Two lines of code put an initial number value in the memory location, subsequent user changes in the code speed will change this value and therefore those two lines of code will not be required. Two lines of code are needed to place a 'fresh' DS1620 chip in the continuous mode of operation. This mode is maintained in the chip's internal non-volatile RAM, even if power is lost, therefore the two lines of code will not be required after the DS1602 is initialized. After the BS2 is first programmed and run, the four lines can be commented out and the BS2 reprogrammed for the final time.

Operation

Operation of the no-hands clock is straightforward. Once power is first applied or after a total power failure, the DS1302 clock chip will need to be set to the current time. The four momentary-ON switches are pressed to advance the appropriate time digit (in a 24-hour clock format). The BS2 provides audio feed back with a 'beep' each time a button is press. The backup battery should maintain the clock time during a main power failure.

To access the time, press key button 1 on the transmitter. The time will be sent via Morse code. Pressing key button 2 will activate a 10 minute timer. When activated, the BS2 transmits a single 'beep.' Each passage of the 10 minute interval will be signaled by three beeps sent as the letter 'S' by the BS2. Pressing key button 2





No-hands Clock component parts. Receiver module, main circuit board, battery and power cube, remote temperature sensor in enclosure with interconnecting cable.

again will turn off the ID timer and a double 'beep' will be sent by the BS2. While the no-hands clock is in the ID mode, the user can request the current time and temperature. Pressing key button 3 will request the temperature. The BS2 responds by sending the temperature in Fahrenheit first and then the temperature in Centigrade (i.e., 68 F / 20 C). If the temperature is negative, a leading 'M' will be added to the temperature digits. Pressing key button 4 changes the Morse code transmission speed in ten steps. When button 4 is pressed, the BS2 responds with the appropriate digit representing the code speed step 0 (the highest speed) through 9 (the slowest speed), sent at the step code speed. Keep pressing button 4 until the desired speed is reached. The no-hands clock defaults to the fastest speed because operator proficiency will improve with use. If higher speeds are desired, simply decrease the code speed number documented in the software listing and reprogram the BS2.

Because there was an extra key button and excess memory available in the BS2, one additional function was added. When button 5 is pressed, a unique personalized message is transmitted. The length of this message is limited by the amount of available memory. In this case, "KD7UCD DE WA8SME K" is the message sent (additional memory is available for a more lengthy message). The message can be easily changed when the BS2 is programmed. Software comments should help the user in making this change.

Teachers and Science Fair Participants

Some of the concepts demonstrated in this project that provide an exceptional learning experience include:

· Adapting technology for disabilities
· Cultural diversity
· Computer programming
· Serial communications
· Computer bus communications
· Remote sensors
· Temperature conversions
· Two's compliment mathematics
· BCD and ASCII code conversion
· Time formats
· Wireless technology
· Morse code
· Micro-controller technology

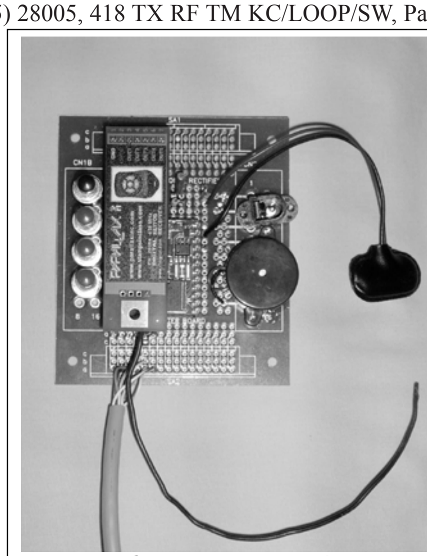
There is an unlimited number of other possibilities. An exceptional adaptive circuit called Az ScQRPions Stinger Singer[1], a CW audible frequency counter, could be interfaced with the no-hands clock to include an option to read (hear) the operating frequency. This kit project produces a frequency counter that samples the RF from the transmitter antenna feed line and reports the digits of the frequency to the user in Morse code. One channel of the key fob transmitter/receiver can be used to control this inexpensive addition to the visually impaired Ham shack. Other remote sensors can be added or substituted to adapt the circuit to the individual user.

The Value of Adaptive Technology

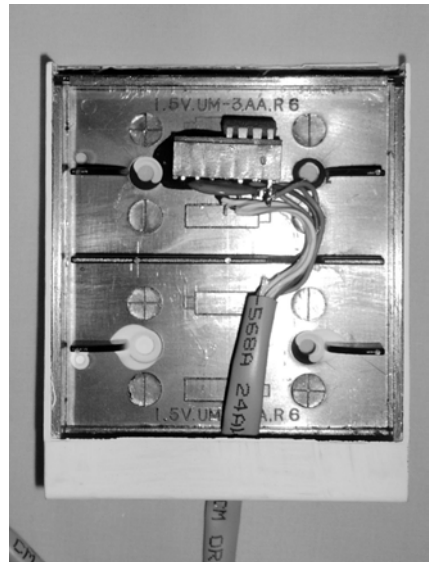
The no-hands clock project gave me a glimpse into the world of the visually impaired. Not only will this project help you learn about micro-controller technology but make you a better operator to boot. The no-hands clock is just a starting point that I hope will stimulate your imagination and perhaps encourage you to help others who need just a little different point of view to make Ham radio more enjoyable and more fulfilling.

Parts List

1) Basic Stamp II Module, Digikey Corp., 701 Brooks Ave. S., POBox 677, Thief River Falls, MN 56701-0677, 1-800-344-4359, www.digikey.com
2) DS1302-ND, IC Timekeeper T-Charger 8-DIP, Digikey Corp.
3) DS1620-ND, IC Thermometer/Stat DIG 8-DIP, Digikey Corp.
4) 28004, 418 RX RF REC SIP/WIRE/SW, Parallax Inc., 599 Menlo Drive, Suite 100, Rocklin, CA 95765, 1-888-512-1024, www.parallaxinc.com.
5) 28005, 418 TX RF TM KC/LOOP/SW, Parallax Inc.
6) Piezo Buzzer, 3-20 VDC, 2.7 kHz, 273-059, Radio Shack.
7) 'AA' Battery Holder, 270-409, Radio Shack.
8) DC Power Jack, Size K Coaxial, 274-1565, Radio Shack.
9) Interlocking Connectors, 274-236 and 274-226, Radio Shack.
10) 9V Battery Snap Connectors, 270-325, Radio Shack.



No-hands Clock main circuit board with receiver module installed (hidden is the BS2). Black wire is the receiver antenna.



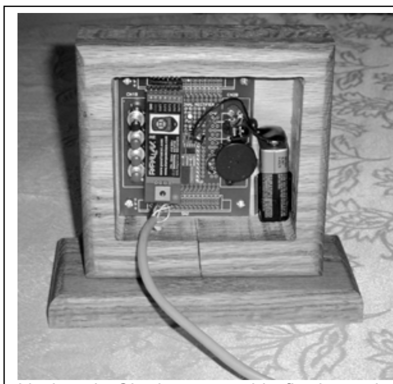
No-hands Clock DS1620 temperature sensor mounted in weather resistant enclosure. Device mounted in IC socket that is epoxied in an 'AA' battery case. Outside of case is painted white to avoid heat absorption errors.

Notes

1) The author can be reached at 83 Main Street, Apt. 12-B, Newington CT 06111. Email: mspencer@arrl.org

2) A copy of the clock's operating instructions in Braille is available from the author.

3) The ScQRPion Stinger Singer Frequency Counter is available through Bob Hightower, 1905 N. Pennington Dr., Chandler, AZ 85224, $20, postage and handling included. A review of the Frequency Counter can be found at: www.qrp-i.com/KA8MAV_SSS_Review.htm.



No-hands Clock mounted in final wooden enclosure rear view. Antenna is sandwiched between layers of wood for protection.

Jeff Grudin, AC6KW

The Manhattan Project ... A Sidekick Rx + Transmitter

I wanted more than just building a kit with components that get stuffed into pre-made pc boards. I really wanted to make things as my dad had from the schematic with an understanding of how it all worked. What follows is intended as an inspirational piece for those of you saying "I think I can, I think I can ..."

Building has always been an enjoyable part of the hobby for me. When I was just a young harmonic, I used to build tube rigs with my dad. Actually, I did a lot of cable lacing and a little building, but it was exciting nonetheless. I was always amazed at how my father could look at a schematic and then figure out how to connect what to what and end up with a radio that worked. I remember the excitement that came over our faces when we clicked the switch for the first time and saw the tubes begin to glow, then again at hearing the sounds of the first signals coming through the speaker. That moment made all the hours of work worth it.

After getting my Ham license and finding out about QRP and building, I was excited that I would be able to build again. Of course, this would be a whole different ball game. My father, who had long since passed on, wouldn't be there to help me. The tubes had been replaced with transistors, point to point wiring replaced by circuit boards, and no more lacing of big cables of wires that were so easy to get crossed.

The first rig I built was a NC40 club rig. I bought it from an older gentleman who just didn't like those transistor things. He had a built a 20-meter QRP rig with acorn tubes and a 20-meter quad. Behind his desk was a map of the world with so many pins in it that there was hardly any paper left. This QRP thing must work. I couldn't wait to build this rig and get to re-experience that excitement that my dad and I would have when we would click on the power and hear our new receiver come to life.

Building the NC40 was pretty easy. It was kind of like putting a model car together. Part A goes in hole A, part B in hole B. After a while you have all the parts in and as long as you were careful not to make any mistakes it would all work. After hours of careful building I got to click on that switch and get that reward of those first sounds blasting over my headphones. I was hooked.

I built rig kit after rig kit until I had to start selling them to make room and finances for more. With each one that excitement of first power-up dwindled a little. The epitome was building the K2. After many hours of building I had an incredible rig. It was as good, or better than any commercial rig I could buy, but it was also as complicated. It was way beyond my knowledge of electronics and I couldn't follow the path of electrons from the battery to the antenna. I realized that when building these kits, I wasn't really following the schematic and getting a thorough understanding of how the radio worked. I was just placing part A in hole A, and so on.

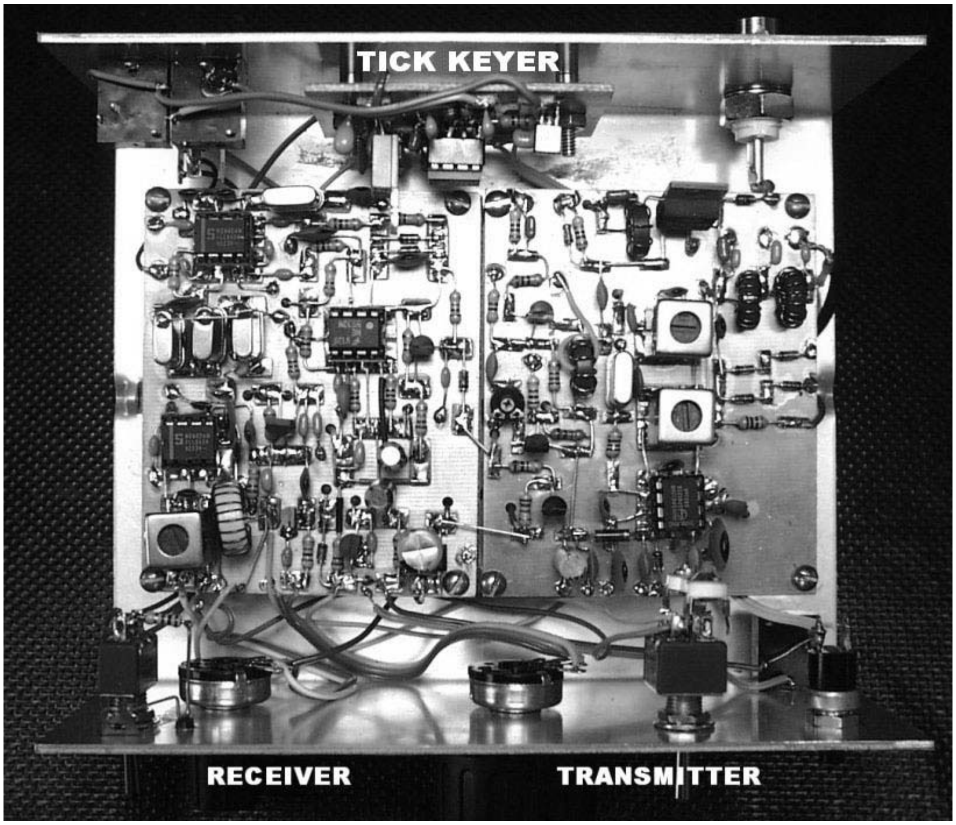
I wanted more. I wanted to make things as my dad had from the schematic with an understanding of how it all worked. I built a few projects by making printed circuit boards. These were fun and offered the excitement of learning more about how the project worked, but involved a lot of work and bother to make the boards. Then came Manhattan building, I was intrigued. It looked simple enough and more like the point-to-point wiring of old. I built a few simple projects and was impressed with the simplicity of it, but could I build a project as complex as a receiver in this style?

Then on QRP-L came the announcement of the Sidekick receiver kit. Here were all the parts. Frank Roberts, VE3FAO, had done the layout of the point to point wiring so I had a chance of building and having it work. I couldn't wait until Pacificon to get my hands on this kit so I would be able to build something more complicated without the aid of a pc board.

Construction

To begin building the Sidekick, the first thing you do is cut all the little pads. I used a little Exacto miter box and saw. Then I scrubbed the board with Soft Scrub and a scrubbing pad. The layout was great but very large, so the next thing I did was scan it and resize it to the size of the board. Then using carbon paper, I traced the outlines of the pads onto the board. This greatly simplified the placement of the many pads. After the pads were all placed, dried and tinned, the soldering began. Place part A on pad A, Part B on Pad B. This sounds kind of familiar. Well it is sort of. One needs to be a little closer to the schematic to be sure the parts are placed on the right pads and in doing so, one must follow the schematic more closely than when building on screened pc boards. After a few hours of building, my board was starting to look a lot like the photo in the instructions.

Then it was done. I wired all the external connections and connected up my power supply. I flipped the power switch and on came that familiar rush of static. With a few twists of the wrist to align it, the signals came blasting in. There was



that feeling again. I felt more like I had built this myself from the parts and a schematic. I showed my family and listened to a few QSOs and put the receiver away, realizing that it would never get much use but it was a fun project to build.

Needed a Transmitter

Then I thought, the receiver would be much more useful if I had a transmitter to go with it. I had built an SW40+ from SWL before and I had the schematic and parts list. Could I build the matching transmitter from that? I think I can, I think I can….

The first problem would be getting the parts together. I started by comparing the parts list to my junk box. I found that I had about 1/2 of the parts I needed, including an NE602 that would be hard to find. I then looked in the Mouser catalog and found I could order most of the other parts that I would need. The toroid cores could be ordered from Bytemark. Once I knew that I could get all the parts, I knew the project was feasible. So I ordered the parts.

While waiting for the parts, I began working on the layout. I decided that I would use smaller pads that were easier to make. To make the pads I used a nibbler tool from Radio Shack. I know you are all thinking that it isn't as classy as buying hundreds of dollars worth of shears and brakes and punches and such, but for $10 and few minutes I can cut all the pads I need. Once the pad size was determined, I started working on the layout starting out from the C9 connection to the VFO of the receiver and slowly working my way toward the antenna. To do the layout, I started by making standard size boxes for each type of part. A resistor was 0.1875 x 0.5 in and a capacitor was 0.1875 x 0.375 in, and so on. Then I could eyeball approximately how much room would be needed for each part. I soon had the transmitter laid out. This time I had a thorough understanding of the schematic and how the transmitter would work. I am enclosing a copy of my layout. While you are welcome to use it, I would strongly recommend that you try to lay it out yourself. You will get much more out of the project by doing so.

Building the transmitter was very similar to making the receiver – first I had to cut the pads. The IC pad was 1" x 1", the transformer pads were 3/8" x 1". After thoroughly cleaning the board, I glued on the pads and tinned them. The next step was drilling the through holes. Then I began soldering the parts to the pads. Place the lowest profile parts first then move up to taller and taller parts. The last parts are the IC sockets and the transformers. As I added each part, I would check and double check the schematic to be sure my layout was correct.

Once the transmitter was completed, firing it up would not be as simple as with the receiver was because it first had to be wired to the receiver to work. So I found a box to put it in and designed the panel layout and mounted the boards. I hooked it all up with a dummy load and my oscilloscope and hit the key. This time there was nothing. Not to worry, troubleshooting is part of building.

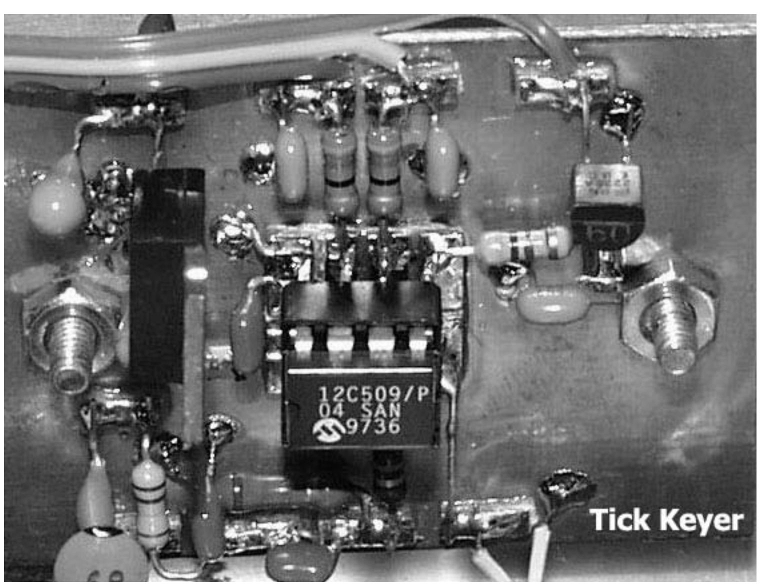
I sat down and rechecked the layout and the schematic – it all seemed right. I then started following the path of the voltage from the keyline toward the antenna. I found there was power to the NE602 and I was getting a signal from the VFO, but nothing was coming out. I started tearing into all the old rigs I had looking for a NE602 that wasn't soldered in. I found one and plugged it in and hit the key again. Now my oscilloscope came to life. I was putting out a nice clean sin wave at 0.5V p-p. Well I new that wouldn't get me very far, but with a few simple alignments I was soon putting out 2.4 watts.

Needed a Keyer

I had that feeling of accomplishment again. I had now built something from the schematic and had an almost useable rig. What I really needed was a keyer to make it complete. Then I remembered that I had a Tick keyer chip lying around. I decided there was room in the case for another small board, so I did another layout for a Tick keyer and built and installed it in the box. Now I had a complete rig.

I also wanted to have the complete lower 40 meter range of frequencies. If I did this by altering capacitors such that my 1 turn pot had the whole range in one swoop, then it would be difficult to tune. I elected to add a Sub Band switch. By using a double pole double throw switch to switch in one of two trim caps in place of C7 on the receiver, I am able to set two ranges of 35 kHz to cover the band. This spreads out the frequencies and makes tuning a snap.

Of course it was 2:00 pm and 40 meters was awash in static and not a signal to be found so I would have to wait for another time to make the first QSO. I got up early the next morning and fired her up. There was a CQ from N5KY in New Mexico booming in at 589. I gave my reply and back he came and gave me a 579. When I told him I was QRP with a



homebrew rig, he told me my signal was clean and the rig sounded great. That brought a big smile to my face.

If you want to build the transmitter, you will first need the Sidekick. So order one and build it – they were once available as a parts kit from W5JAY, but no longer. Either ask around for an unbuilt kit or you can collect the parts yourself. The transmitter will not work without the receiver because the VFO is on the receiver board. The Sidekick also comes with the schematic that is needed as a guide in building the transmitter. The parts are listed on the schematic or on my layout. All of the parts except the NE602 are available through Mouser Electronics and Bytemark. The NE602 is available from Radioshack.com (SA602AN, PN 900-7085).

I know I can, I know I can ...

The moral of the story is that if you want more than building kits by dropping parts into holes, try laying out some projects Manhattan style and building them. It is really pretty easy and you will have a greater feeling of accomplishment when you finish because now You can say, "I know I can, I know I can……"

NOTE: See Sidekick schematic and AC6KW parts layout on following pages.

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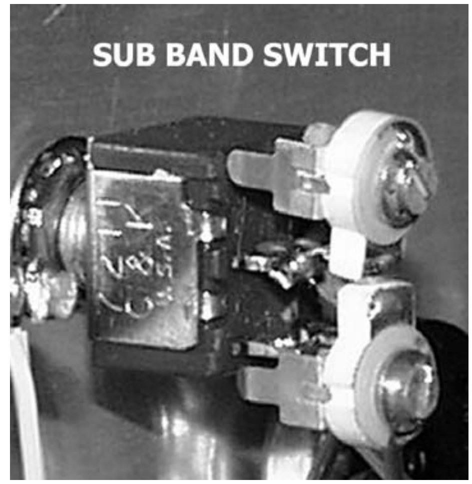

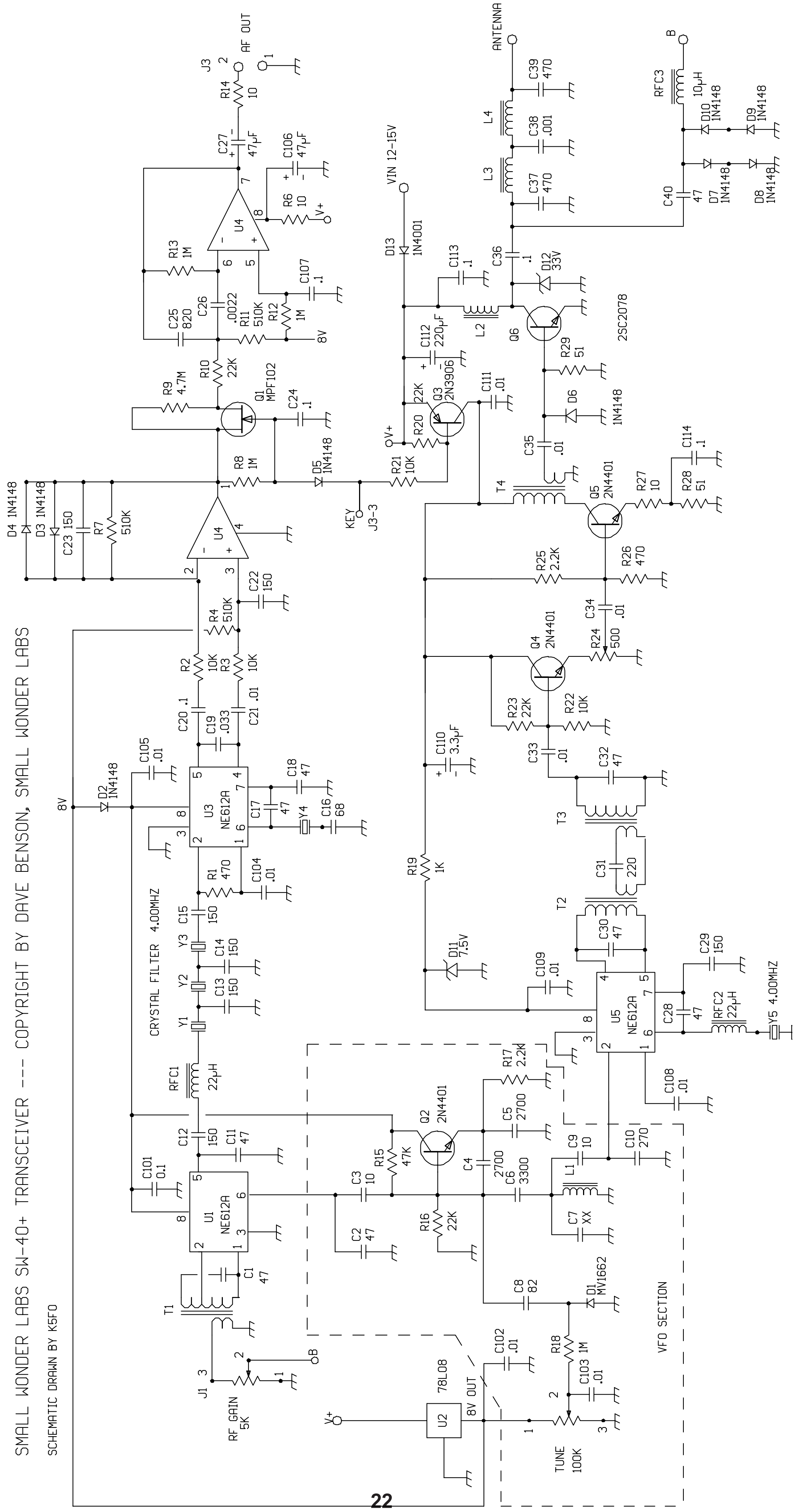
SMALL WONDER LABS SW-40+ TRANSCEIVER --- COPYRIGHT BY DAVE BENSON, SMALL WONDER LABS
SCHEMATIC DRAWN BY K5FO
CRYSTAL FILTER 4.00MHZ
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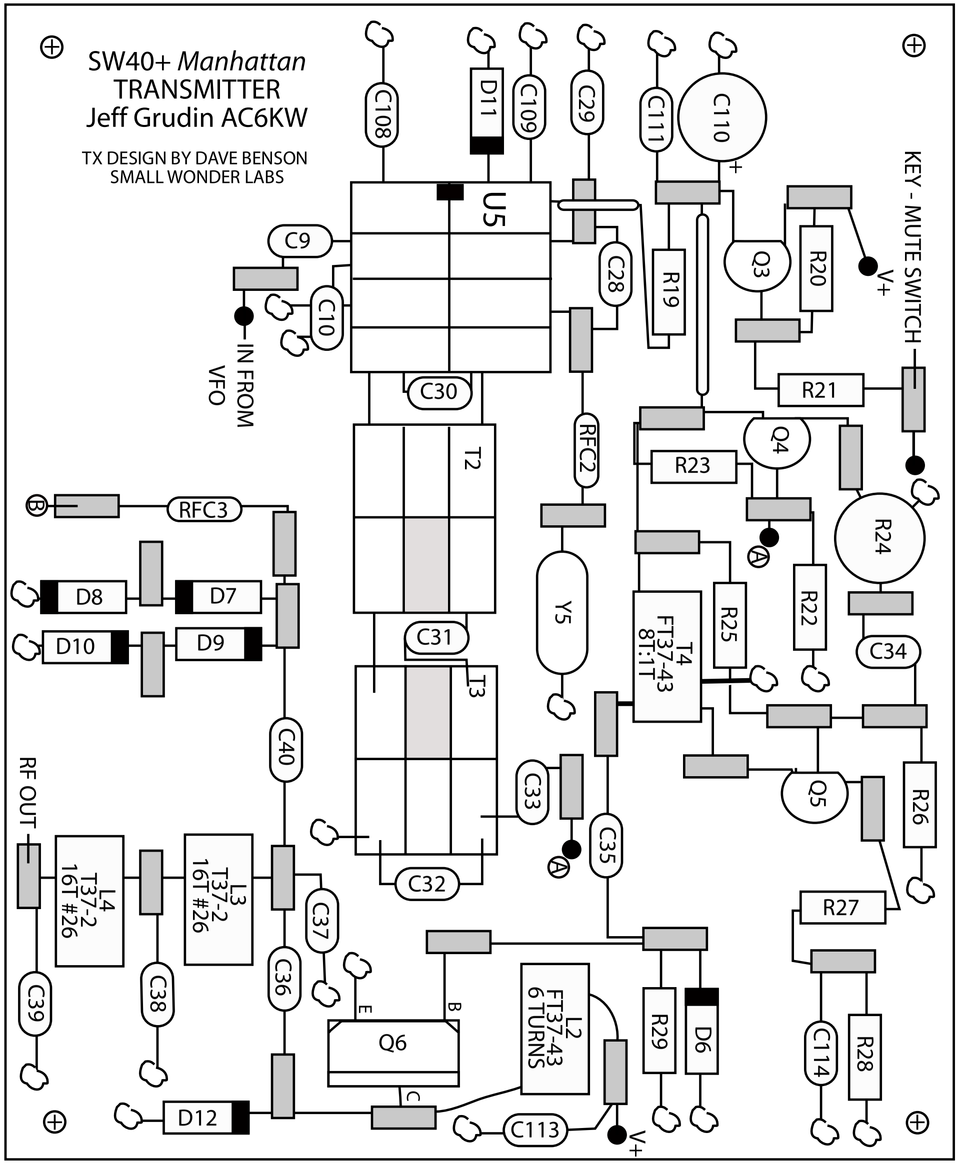
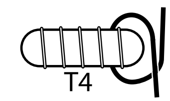
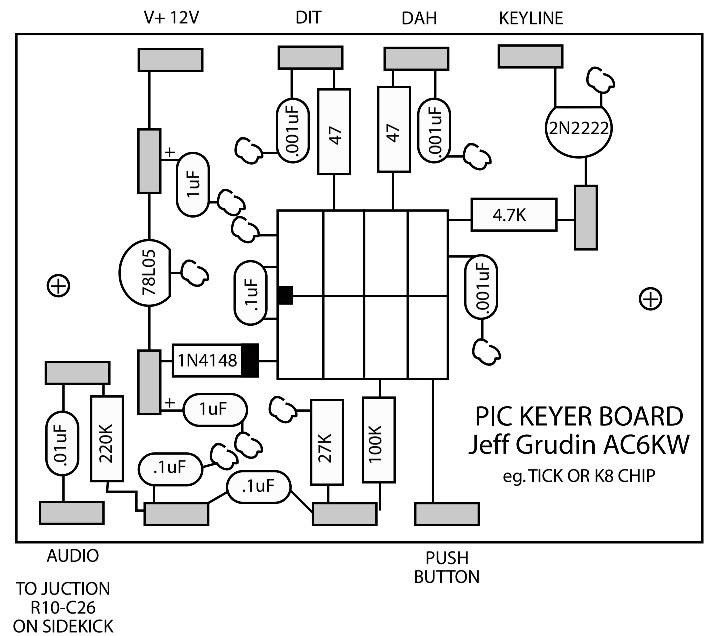
AF OUT
VIN 12-15V
RF GAIN 5K
TUNE 100K
KEY J3-3



Supplemental Parts List

T4	Wind 8 turn primary and install, then wind 1 turn secondary with insulated wire
U5	NE602/NE612
Q3	2N3906
Q4, Q5	2N4401
Q6	2SC2078, or NTE235
D7,8,9,10	1N4148

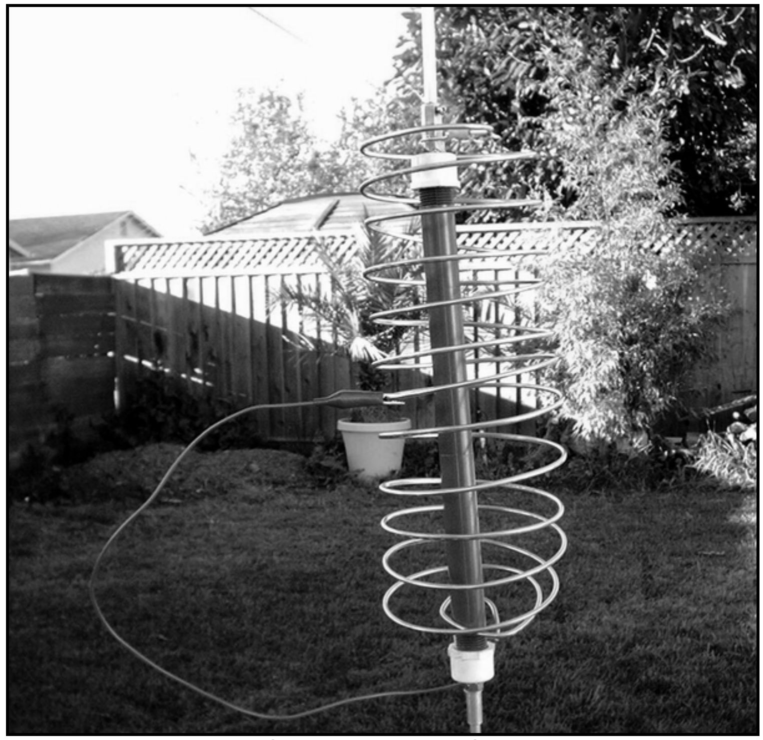




James Bennett, KA5DVS

Multiband Coil for the PAC-12

Did you build the award-winning PAC-12 multiband portable antenna designed by KA5DVS when it originally appeared in QRP Homebrewer #8? Or perhaps get the kit version from Pacific Antenna? If so, you're in for a real treat as James describes how to homebrew a single coil for multiband use.


PAC-12 with Multiband Coil 1

Since publishing the PAC-12 original article, one of the most common requests I get is how to construct a multi-band coil. I tried many designs in finding one that meets the PAC-12 design criteria. To meet this, the design must be simple, require minimal tools, have easily obtained parts and be lightweight and easily packed for travel/portable operation. After quite a few rounds of prototyping, I came up with a solution that I am happy with.

Materials List

1) Aluminum Grounding wire, RS # 15-035
2) 5/16" ring terminal for 10-14AWG wire (yellow), (1 needed)
3) 12" PVC riser (nipple) or section of PVC pipe
4) End-caps (2) to fit riser or pipe, should be flat top not rounded.
5) 1/4 ring terminal for 18-22 wire (red), 1 needed
6) Section of stranded wire, 18-20AWG recommended, length 15"
7) Alligator clip

The design still uses PVC risers and bolts through the end-caps as before. However, you will need to find a 12-inch riser or fabricate a 12-inch coil form from PVC and slip caps. Please refer to the original PAC-12 article located on the NJQRP website: www.njqrp.org/pac-12.

To form the coil, I used the aluminum ground wire available from the TV antenna section at Radio Shack. It is approximately 10 AWG bare aluminum and comes in a forty-foot coil.

The wire is wound into a smaller coil using a mailing tube or section of PVC. Just about any round form of 3"-4" outside diameter will work well. You can of course make the coil even larger but you it may be difficult to pack. You could even just use the coil as supplied by RS that will give a coil diameter of approximately 8 inches. To wind the coil, secure the end using tape or a hole in the form and then just wind the coil by wrapping the wire around the form.

You will need to keep the turns spaced closely together and expect the coil to expand slightly when removed from the form. For 20 meters and higher, you will need approximately 10-20 turns depending on the diameter of your coil form. You will need around 20-40 turns for 40 meters.

For 20 meters and higher I suggest winding at least 20-30 turns as a starting point. If you want to operate on 30 or 40 meters, you will need to use most or all of the 40 feet of wire. In this case, I recommend using a longer riser or section of PVC. When assembling the PAC-12, just remove one or both of the base rod sections as they will not do well supporting the larger coil. Once the coil is wound, crimp the 5/16-inch fitting onto one end of the wire. This will become the top of the coil.

For the other end, you will need to drill a hole in the pvc tube support near the opposite end cap, which is the end with the 1/4-inch bolt. The free end of the coil can then be formed into a hook to place into this hole to keep the turns of the coil spread out. It is also possible to just bend the coil end around the PVC to hold it in place but a drilled hole will provide a better anchor for the coil. Note that the bottom of the coil is not connected to the base of the antenna but instead is left floating.

Prepare a jumper lead using the1/4-inch ring terminal, section of stranded wire and the alligator clip. Crimp or solder the terminal to one end of the wire and attach the alligator clip to the other. Alternatively, you can just purchase alligator clip leads and cut it in half or cut off one end depending on length. Once complete, connect the ring terminal on the end of the coil form with the 1/4-inch bolt and secure it with the coupling nut. Assemble the antenna as usual.

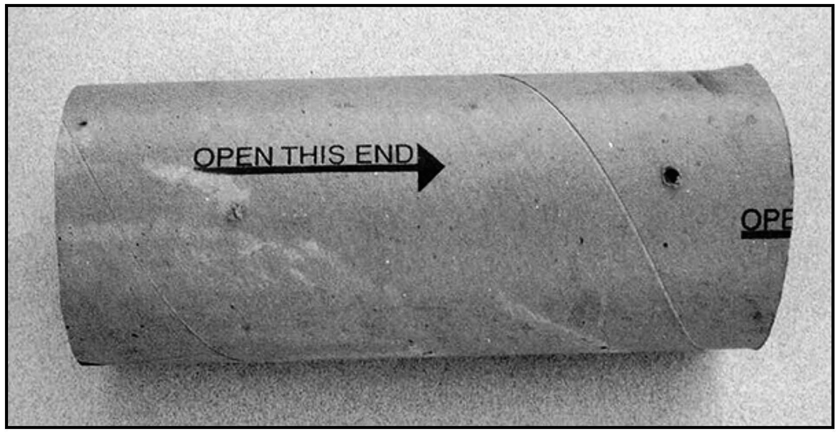
The antenna may be tuned over its entire range by using the alligator clip to attach to coil turns. You can use the receiver as a rough tuning indication by listening to the static level as you move the tap. Use an antenna analyzer or SWR meter to fine tune. Depending on the number of turns and size of the coil, you will be able to cover a wide range of frequencies by careful tuning.

To pack up the antenna, remove the coil from both ends of the support and simply collapse it like a spring. Secure with cable ties or twist ties to make a compact package.

If you build and use this coil, please send me an email to let me know how it works for you. Digital photos are always appreciated and they might end up in my regular column.

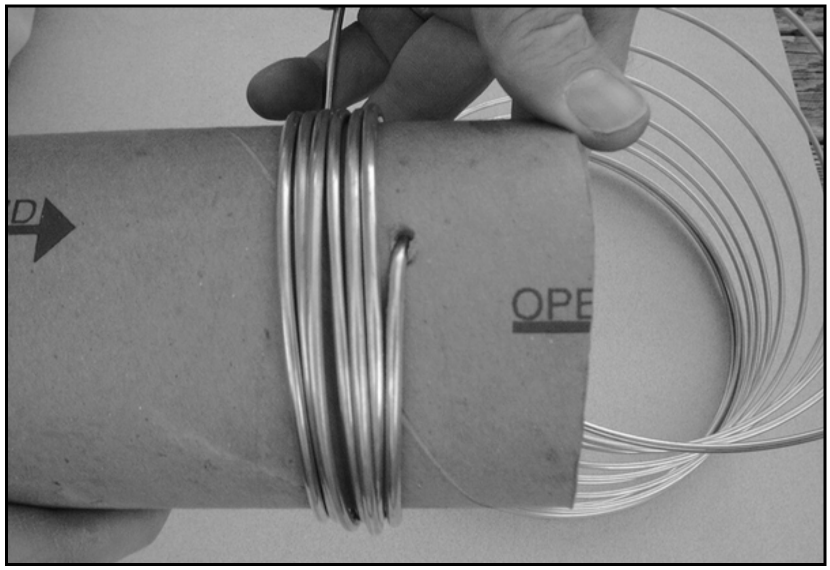
The author may be reached at: 1196 Phillips Court, Santa Clara, CA 95051, or by email at jwbennett@sprintmail.com

Radio Shack p/n 15-035 Aluminum wire

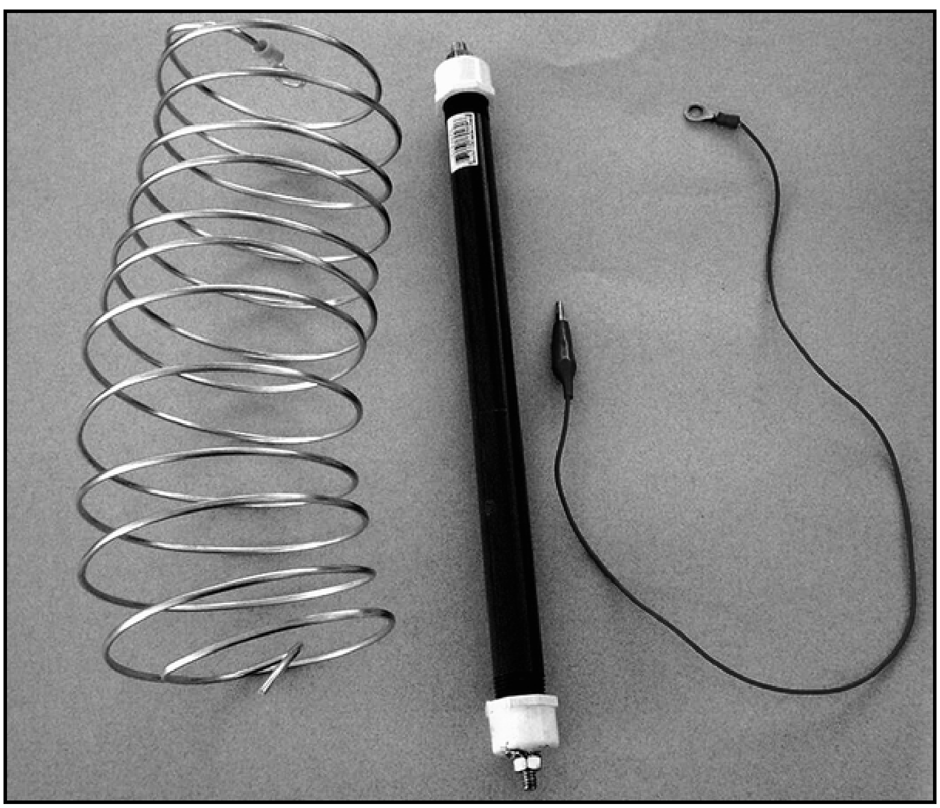


Winding Tube with Hole and Photo 3: Securing for Winding


Complete Coil



Winding the Coil


Multiband Components

Dave Ek, NK0E

Build the "PicWx" ... a PIC-based APRS Weather Station

NK0E started this series with a simple PIC16F84A design and has since been adding various hardware and software pieces to create a functional weather station that connects via serial port to your PC or ARPS system. The PicWix project is being presented in a tutorial fashion ... follow along!

Hi again, everybody! We began this article series almost two years ago in the pages of QRP Quarterly, but have now decided to continue the project here in HOMEBREWER Magazine. You can catch up on the first four installments of my PicWx project by visiting the AmQRP website (www.amqrp.org/picwx). Also, the editor tells me that the entire article set will be included as a bonus on the CD-ROM that all subscribers will get with HOMEBREWER issue #5. What a deal! So review the online version of my project and we'll dive in right now to the current progress.

Background on the PicWx Project

In this installment, we'll complete our anemometer by going through the calibration process. But first, since this is the beginning of the second year for publication of this series on the PIC Wx project, I want to take a moment to review what I'm trying to accomplish with this project and how it relates to ham radio. After all, this *is* a ham radio journal, right?

It's no secret that many hams are interested in the weather. I almost always get a weather report from the other operator during a QSO, and many of us are trained weather spotters for the National Weather Service. Many hams already possess weather stations at home, and some of those hams broadcast weather observations at their QTH via the Automated Position Reporting System (APRS) on 144.390 MHz using 1200-baud packet radio. APRS can be used for many things, including reporting your position and heading, exchanging messages, and even sending email, and anyone who has connected their packet radio system to their PC running APRS software (like WinAPRS or UI-View) can see this information depicted graphically on a map.

I began experimenting with APRS early in 2002 and found it intriguing. It's also popular—at any time I can count 50 or 60 active stations heard by my station either directly or through digipeaters. Some of these stations are fixed in location, while others are in vehicles whose movements are then trackable. Even the National Weather Service sends out APRS messages with weather alerts (at least in some areas). With very little imagination, you can think of any number of interesting applications for APRS.

In my case, the notion of broadcasting weather data from my QTH via APRS was intriguing, but alas, I had no weather station. Sure, they're easy to find and buy, but they can be a bit pricey. Besides, I have the know-how to build a weather station of my own and hook it into the APRS system to get my weather observations broadcast—and that's the basis for this series of articles.

If you've been following along up to this point, you know that our station currently consists of a temperature and humidity sensor and an anemometer, along with some PC software to display the readings. One of the things that I haven't done yet is connect the weather station to my APRS software so that the weather observations are broadcast over APRS. I use UI-View (http://www.packetradio.org.uk/) as my APRS software, and it includes a rudimentary ability to pick up and broadcast weather data from a file that some other software creates. For example, my PicWx PC software would write a file every few minutes that contains the various weather data, and UI-View would look for the file every few minutes and broadcast its contents. UI-View looks for a file that contains data in the following format:

```
Aug 17 2002 19:47
272/000g006t069P000b0150h61
```

The second line of this data contains the actual weather data, according to the following format:

```
CSE/SPDgXXXtXXXrXXXpXXXPXXXhXXbXXXXX
```

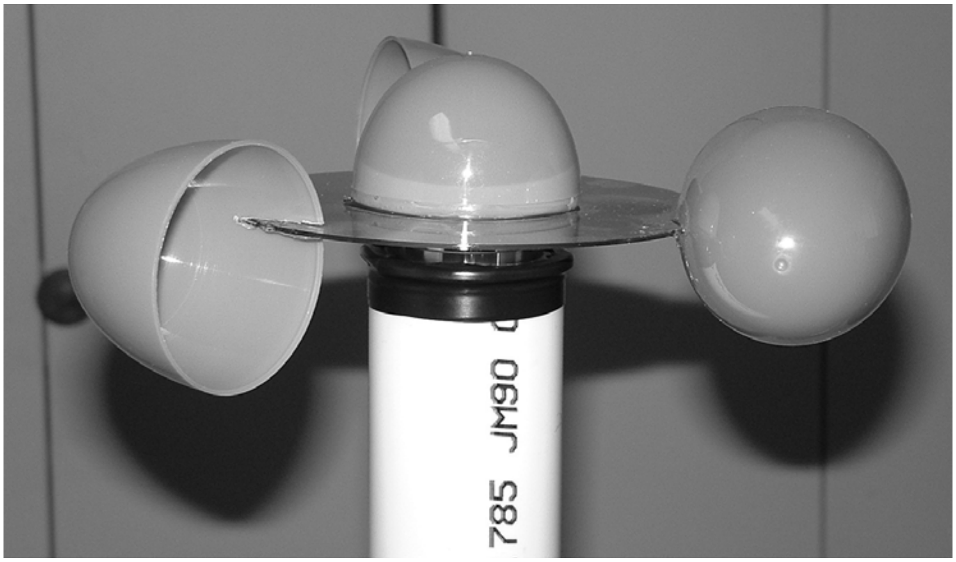
Where:

- CSE/SPD is wind direction and sustained 1 minute speed
- t is in degrees F
- r is Rain per last 60 minutes
- p is precipitation per last 24 hours (sliding 24 hour window)
- P is precip per last 24 hours since midnight
- b is Baro in tenths of a mb
- h is humidity in percent. 00=100
- g is Gust (peak winds in last 5 minutes)

I'm still researching this format, but you can see where we're headed. At some point, my PicWx software will need to create this file for UI-View so that the weather data can be broadcast. I'll try to work this into one of the next installments, so we can actually get our data out to other APRS users.

Calibrating the Anemometer

As I mentioned last time, the easiest way to do the calibration is to mount the anemometer on a vehicle and then take anemometer readings at various speeds. I mounted my anemometer onto the end of a 1.5" ID PVC pipe about four feet long. I had to build up the diameter of the motor a bit with some electrical tape before it would fit snugly into the end of the pipe. To secure it, I used some additional electrical tape wrapped around the side of the motor and the pipe. Figure 1 shows my mounting arrangement, including the addition of an Easter egg "hat" to cover the bearings. Once I'm ready to mount the anemometer permanently, I'll probably use some epoxy to attach it to the pipe.



Experimental Procedure

My plan for calibrating this puppy was for me to stick the pipe up vertically outside the passenger window of my wife's minivan and take readings while my 17-year-old son Andrew drove. Andrew would hold the van at a fixed speed while I took several readings using the CW output on the LED that I included for just this purpose. Then, when I was done, I'd average the readings at each speed and use some math software to calculate a best fit straight line through the data. Easy, right?

Yeah, right. I discovered that "easy" is a relative term when it came to calibrating my anemometer with a vehicle. I live in the middle of Colorado Springs, a city of around 400,000 people, and probably the same number of bumps and potholes in the roads. Not to mention hills and curves—there must be a city ordinance against building straight streets in this town! And it seems like every one of those 400,000 people is on the road at the same time—traffic is lousy! I decided I'd stick close to home and calibrate for speeds from 10 MPH to 40 MPH, and maybe try calibration at 50 to 60 MPH later. So, Andrew and I backed out of the driveway and headed up the street at 10 MPH. I tried not to make eye contact with any of my neighbors as we tooled up the street with me holding my Easter egg contraption out the window, looking like the geek that I am.

The first thing I discovered was that the bumps and seams in the road made it a challenge to read the LED output, so I had to redo some trials. The hills and curves were making it a challenge for Andrew to hold a fixed speed, too, and there was significant variation in the readings, especially for higher speeds. There was also some wind to further skew the readings. In short, I managed four or five data points for 10, 20, and 30 MPH. Frustration mounted, and I decided to call it quits in favor of another try at a later date, if I could find a flat, smooth, straight road with light traffic. In the mean time, I had enough data to do a trial calibration.

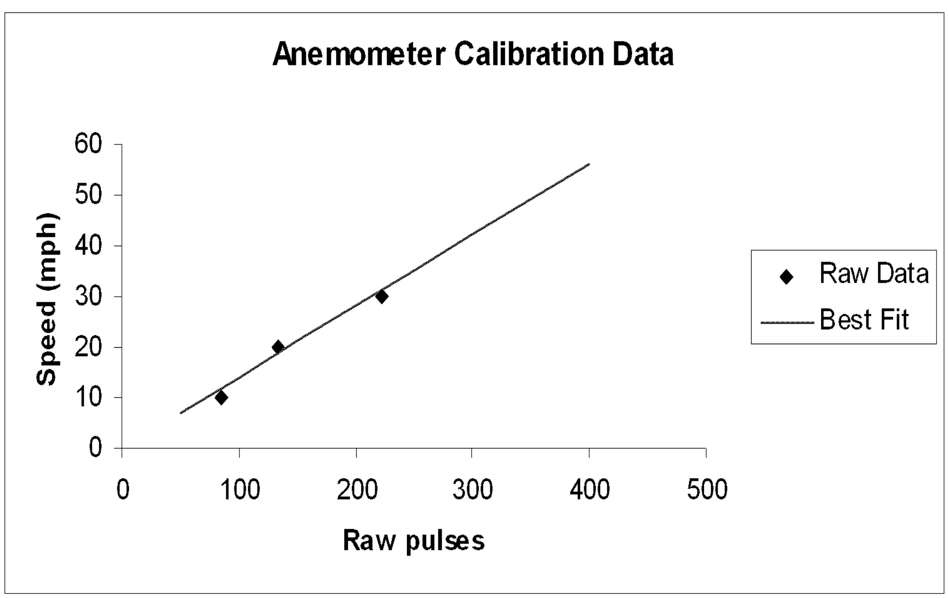
Analysis & Results

The following table gives the data that I took and the average values:

Speed (MPH)	Data points (raw anemometer output)	Average output
10	80, 107, 77, 77	85.25
20	125, 120, 133, 162	135
30	242, 260, 254, 186, 177	223.8

You can see that there is significant variation in the readings, especially at 30 MPH, but data is data, and I had no reason to throw out those data points.

Three data points aren't exactly a ton of data, but it's enough to draw a line through. I used Microsoft Excel to plot the data and compute a best fit straight line using a linear regression. Excel makes this easy to do by providing the SLOPE and INTERCEPT functions. Figure 2 shows a plot of my data and the resulting straight-line fit. Surprisingly, the fit is rather good. The slope is 0.14, and the y-intercept is negative 0.8 (close to zero, as I would expect it to be). Although it looks like a good fit, I'll feel better about the data once I go out and attempt another calibration, this time with points at 40 and 50 MPH.



My Excel spreadsheet turned out to be a very convenient way to analyze the data. You can download a copy of the spreadsheet (calibrate.xls) from the AmQRP PixWix web pages.

For those of you who don't have Microsoft Excel, there are a few other options. One is to simply graph your data by hand and draw a line through the data and compute the slope graphically. Many calculators are also capable of doing linear fits. Finally, I wrote a command-line program to do the same thing. It's called linfit.exe and can also be downloaded from the AmQRP site. To run it, simply type "linfit" at the command prompt, and follow the instructions. Here's a sample session (text that I typed as the user is in boldface):

C:\Documents and Settings\Dave\My Documents\wx project\part5>**linfit**

How many points (max of 20)? **3**

point 1: enter x, y: **85.25, 10**
point 2: enter x, y: **135, 20**
point 3: enter x, y: **223.8, 30**

slope: 0.140628
y-intercept: -0.815357
error: 7.69%

Error is the average percent difference between the actual y values and the y values from the fit.

Once you've determined the slope of your data, enter it into the PicWx software by clicking the Settings button on the main screen. The slope is entered in the edit box labeled "M". Figure 3 (next page) shows the settings entered for my anemometer. I left the y-intercept ("B") set to zero. You can leave it at zero, or you can enter the value that you obtained (which should be close to zero—if not, your data may be suspect).

I'll be going back out to try another calibration soon. I can think of several reasons why mine was not as successful as it could have been, including poor speed control and windy conditions.

PIC Programmer Notes

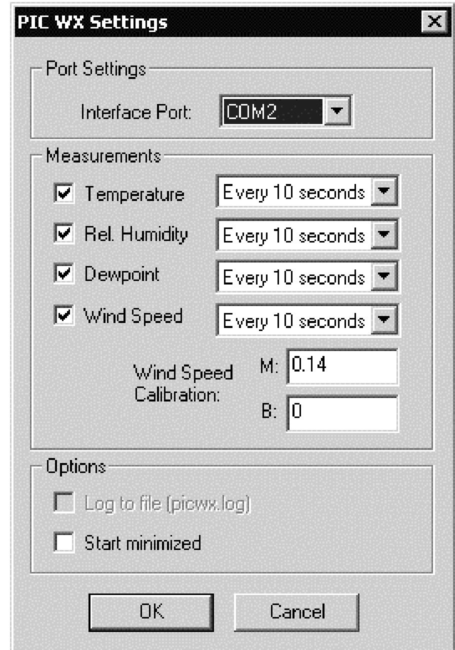
You may have noticed that there are many other microcontrollers in the PIC family from Microchip. They vary in capability (and price), with the more sophisticated ones having built-in serial communications, A/D converters, and other goodies. It turns out that many simple programmers for the PIC16F84 can be adapted to program these other chips fairly easily. The PIC16F84 uses pins Vdd, Vss, MCLR/Vpp, RB6, and RB7 (pins 14, 5, 4, 12, and 13, respectively) for programming. Recently, I became interested in the PIC16F73, which has more data lines, an integral UART, and A/D conversion, and when I looked at its data sheet, I saw that this chip used the same five lines (but on pins 20, 19, 1, 27, and 28) for programming. It occurred to me that all I needed to do to program this chip using my Ludipipo programmer was to create an adapter to get the right programming signals to the right pins of the 16F73. I breadboarded a test and, lo and behold, it worked! So, don't let the fact that your programmer was designed with the PIC16F84 in mind stop you from trying out other PIC chips.

That being said, I recently opted to purchase a "commercial" programmer for the sake of convenience. There are several available, including the PICStart Plus from Microchip and the EPIC Plus from MicroEngineering Labs, but I purchased the Warp-13a programmer from Newfound Electronics. It's the only programmer I could find (besides the pricey PICStart Plus) that worked directly with the MPLab development software. The Warp-13a runs from a serial port, includes a ZIF socket, and will handle almost all the PIC parts up through the 40-pin models. I paid less than a hundred bucks for the programmer. If you're interested, you can see details at www.newfoundelectronics.com. I purchased mine from the Mark III Robot Store (www.junun.org/MarkIII/Store.jsp).

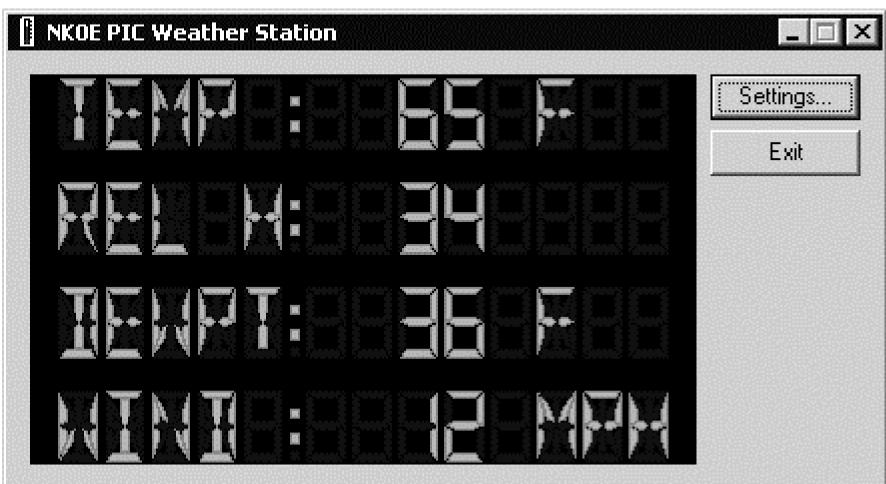
Wrap-Up

Next time we'll start work on a barometric sensor, probably using the Motorola MPX4115 pressure sensor. I've seen various plans on the Internet for barometers and even model rocket altimeters that are based on the MPX4115, so we should have plenty of experience from which to draw. The MPX4115 outputs an analog voltage proportional to the barometric pressure, so we'll need some sort of A/D conversion to turn this into a digital output. See you next time!

NK0E can be reached at 5605 Oro Grande Drive, Colorado Springs, CO 80918.
Email: nk0e@earthlink.net

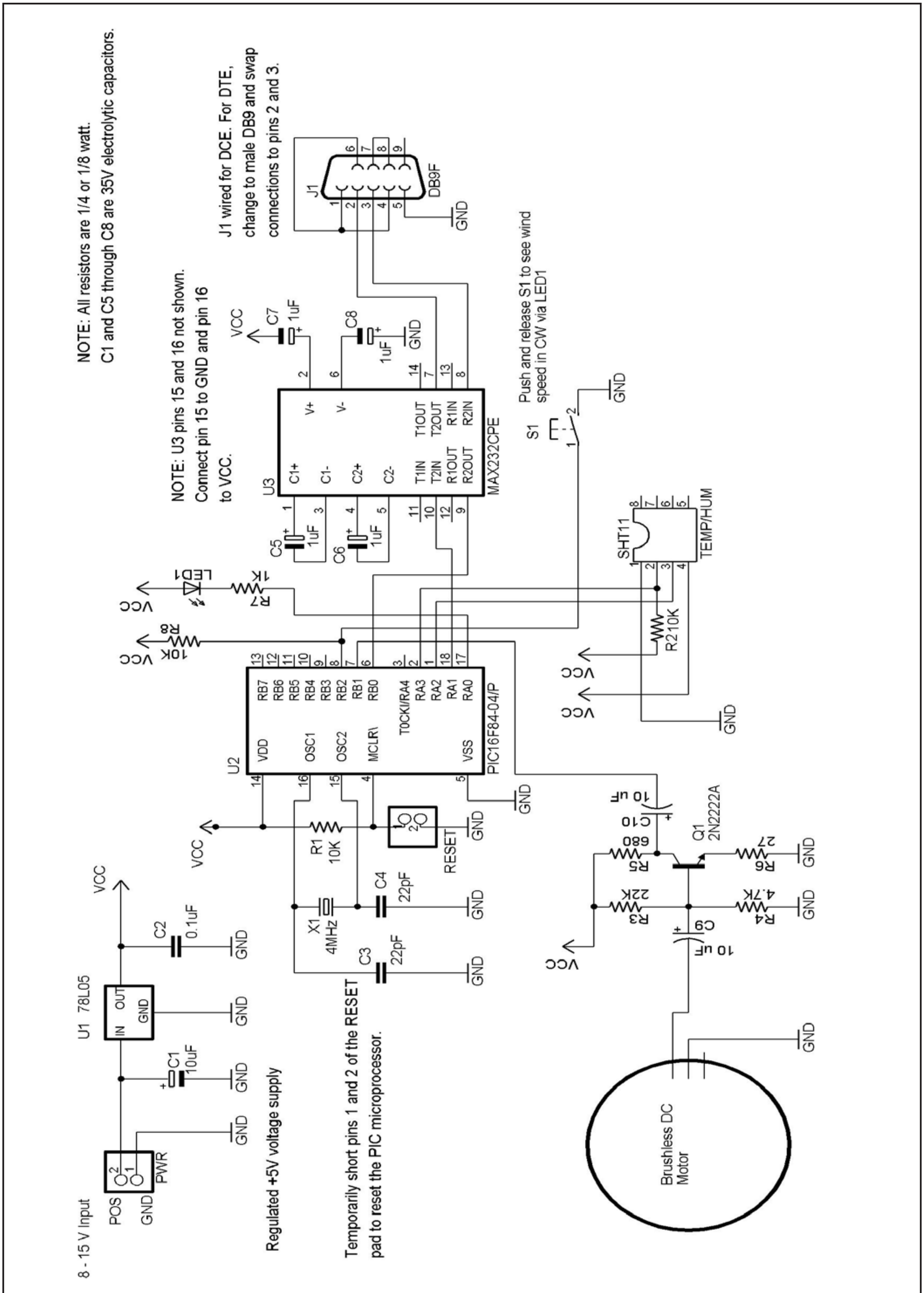


Settings for anemometer



Measured/calculated vales are displayed within a window on the PC screen.

Anemometer with center hub cap removed to show brushless DC motor.


NOTE: All resistors are 1/4 or 1/8 watt.
C1 and C5 through C8 are 35V electrolytic capacitors.
J1 wired for DCE. For DTE, change to male DB9 and swap connections to pins 2 and 3.
NOTE: U3 pins 15 and 16 not shown. Connect pin 15 to GND and pin 16 to VCC.
Push and release S1 to see wind speed in CW via LED1
8 - 15 V Input
POS
GND
PWR
U1 78L05
IN
OUT
GND
C1
10uF
C2
0.1uF
VCC
Regulated +5V voltage supply
Temporarily short pins 1 and 2 of the RESET pad to reset the PIC microprocessor.
U2
PIC16F84-04/P
VDD
OSC1
OSC2
MCLR\
VSS
RB7
RB6
RB5
RB4
RB3
RB2
RB1
RB0
T0CKI/RA4
RA3
RA2
RA1
RA0
R1
10K
RESET
X1
4MHz
C3
22pF
C4
22pF
U3
MAX232CPE
C1+
C1-
C2+
C2-
V+
V-
T1IN
T2IN
R1OUT
R2OUT
T1OUT
T2OUT
R1IN
R2IN
C5
1uF
C6
1uF
C7
1uF
C8
1uF
J1
DB9F
LED1
R7
1K
R8
10K
R2 10K
SHT11
TEMP/HUM
S1
C10
10 uF
Q1
2N2222A
R5
680
R6
27
R3
22K
R4
4.7K
C9
10 uF
Brushless DC Motor
GND

Dave Ottenberg, WA2DJN

Universal Power Supply

Here's a simple power supply you can build for the bench for all those common voltages used in your HOMEBREWER projects!

I often visit a ham friend in the neighborhood who loves working on receivers and building various electronic circuits. I noticed that he had an interesting power supply and I decided to build one like it - with the addition of an output that can be varied from 0-to20 volts. The advantage of using such a "universal" power supply is that you can simply power up just about any circuit you might have on the bench, including those with dual-rail op amps, merely by patching from the supply's many binding posts down to the circuit-under-test. Flip a switch and you'll be cookin' ... figuratively, of course!

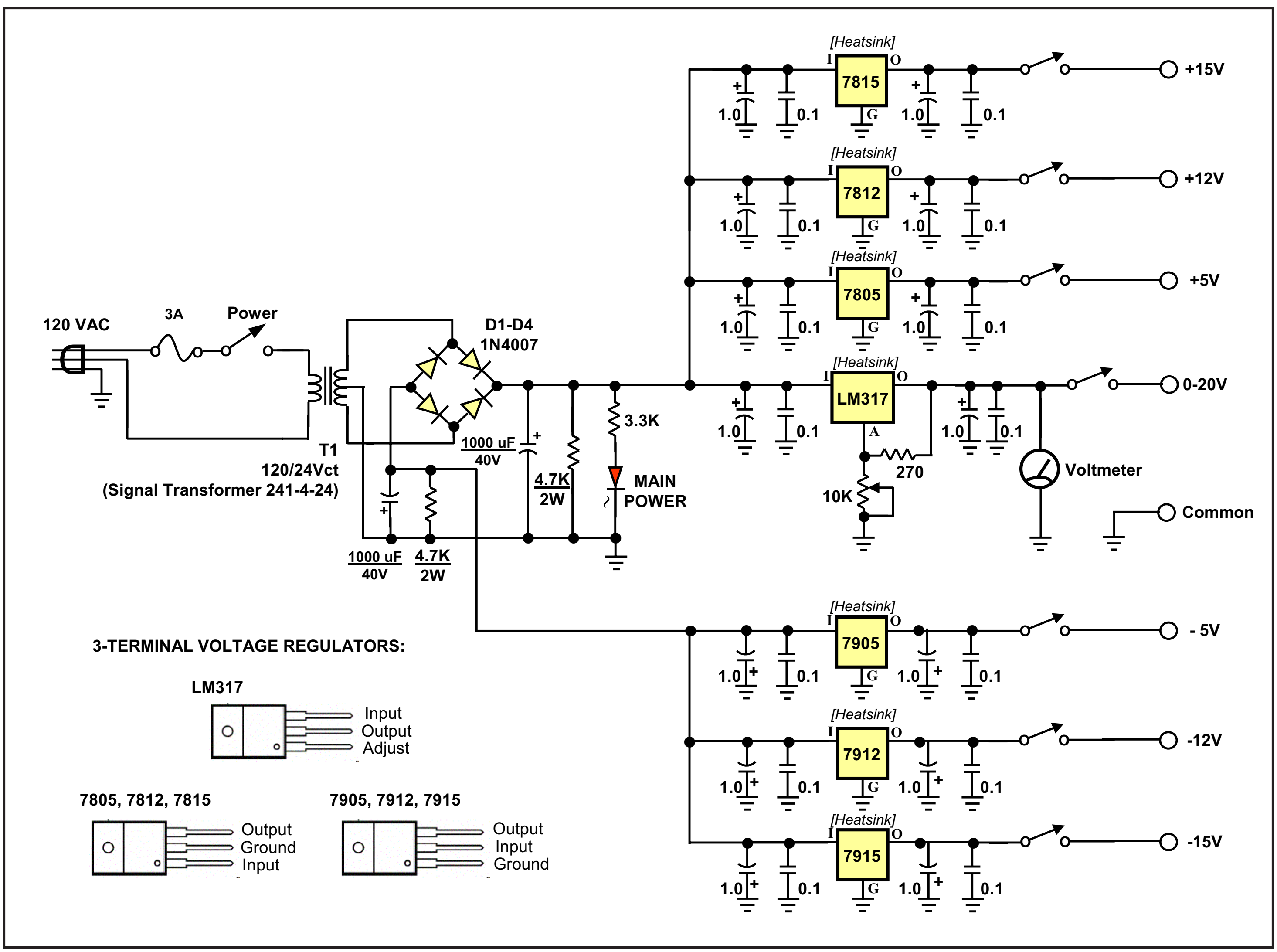
The components are quite common and all can be found at Mouser Electronics (www.mouser.com). I put a master power control switch on the AC side of the circuit, as well as one for each of the seven outputs. There may be times when I want to power several different circuits, but not others that may be connected into the unneeded binding posts.

One only caution I should offer is that the diodes in the bridge rectifier portion of the circuit are rated at 1 A, as are each of the 3-terminal regulators. Thus, if multiple supply outputs are being used to deliver maximum power output, the ratings of the rectifiers could be exceeded. If this is a concern, just just heftier diodes.

You can try adding individual LEDs for indicating the status of each separate output.

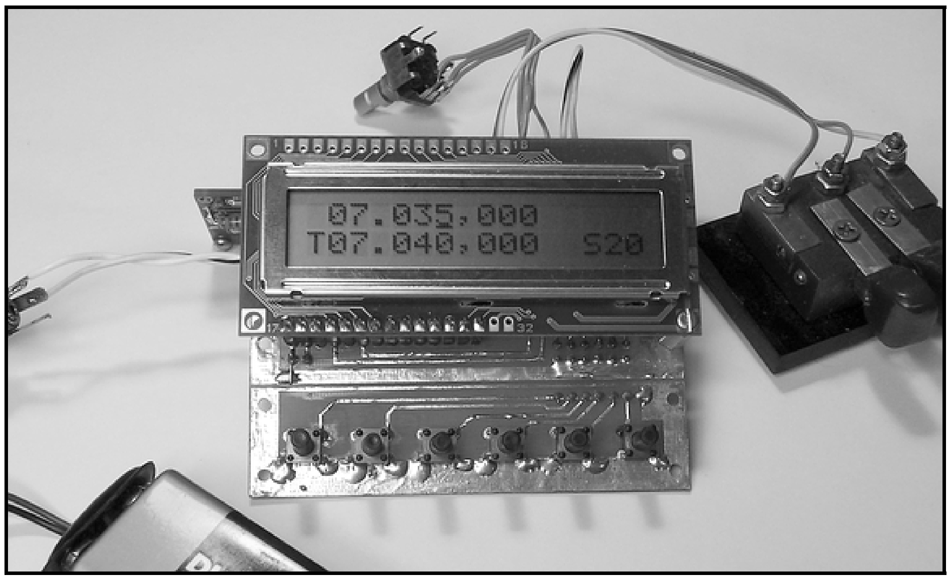
Be careful about polarities of the diodes and electrolytic capacitors used for filtering. Don't skimp on the small bypass caps on the regulator inputs and outputs, as they help prevent unwanted oscillation.

WA2DJN may be reached at 37 Fredrick Drive, Ocean, NJ 07712, or by email at WA2DJN@monmouth.com



Steve Weber, KD1JV

"Melt Solder" DDS Controller … a multi-band QRP transmitter using the NJQRP DDS Daughtercard



Steve "Melt Solder" Weber is a master with the ATmel controller chips and he's designed a circuit with the NJQRP DDS Daughtercard that is super feature-rich. The project serves as a multi-band QRP transmitter on the HF ham bands, with paddle input, dual-memory keyer and speed control, programmable IF offset, EEPROM-stored settings, RIT and XIT split mode operating, LCD display, Rx mute, Tx sidetone generation, and logic to drive an antenna selection relay … *Wow!*

The MS-DDS controller can be built on simple, 1-layer pc board (see Notes section for availability) or even on a small piece of perf board. One with solder pads would be ideal. Most of the connections are made off the board, so only a few components need to be wired up to the controller chip. The board can be cut down to the outline of the LCD display and mounted to the back of the display by using single inline package (SIP) pins and sockets.

Using another SIP connector, the DDS Daughtercard can be plugged directly into the microcontroller board as shown in the photo. This arrangement makes for a compact transmitter module. Otherwise, the DDS module may be mounted elsewhere in an enclosure, but try to keep the connections to the board less than 6" long. If possible, use ribbon cable. Keep the lines short, as long cables may result in improper operation of the DDS chip.

Small "TAC" switches are a good choice for the push buttons. They are inexpensive and have minimal bounce. The ones pictured on my board are from Mouser (p/n 612-TL1100F).

A 2x16 (2 lines of 16 characters) LCD display module is required. Nearly all LCD modules use the same pin assignment and control codes, a standard set by Hitachi many years ago. Those stating use of the HD44780 controller chip will likely work fine; however, some very inexpensive surplus displays may not be compatible. LCD modules can come with three possible locations for the connecting pins: top, bottom and side. Try to get one with the connections along the top edge of the display, as this will mate best with the pin out of the controller. Also, a display with an LED backlight is highly recommended, despite the additional cost, as these are much easier to see at night. The display used in the unit pictured is the Seiko L1682 (available from Mouser, p/n 628-L168200J)

OPERATION

Default power up is at 7.040,00 MHz, Tuning rate = 100 Hz, Code speed 20 wpm.

Tuning

A rotary encoder is used to tune the frequency of the VFO. A simple and inexpensive mechanical encoder from Mouser (p/n 318-ENC160-24P) or

Digi-Key (p/n P10860-ND) will do the job here.

Tuning Rate

Pushing the **STEP** pushbutton advances the tuning rate and a beep sounds (via side tone) when the button is pushed. The current turning rate is indicated by a line under the selected decade digit. Tuning rates of 10 Hz to 10 kHz may be selected.

Band Select

Operating frequency can be selected in two ways and is determined by the state of pin 5 of the controller.

With pin 5 open … bands are selected by pushing the **BAND** push button. A beep sounds when the button is pushed and the frequency advances to the next higher band. All bands from 160 meters to 10 meters can be selected. Pressing BAND while at 10 meters rolls around to 160 meters.

Relay driver information for the selected band is output on pins 6, 7 and 8 in a BCD format and can be decoded with a BCD-to-decimal decoder chip. Note that 17m/15m and 12m/10m share the same filter select codes.

160m = 000, 80m = 001, 40m = 010, 30m = 011, 20m = 100, 17m & 15m = 101, 12m & 10m = 110.

With pin 5 grounded … bands are selected by inputting BCD codes on pins 6, 7 and 8. Pin 6 is the least significant bit. The three-bit band codes are: 000 for 160 meters, 001 for 80 meters, 010 for 40 meters, 011 for 30 meters, 100 for 20 meters, 101 for 17 meters, 110 for 15 meters, and 111 for 12 meters. Note that there are nine bands but only eight possible input numbers, so 10M is left out of the selection.

The band input code is read on power up and each time the **BAND** button is pushed. This allows selecting a particular band if a single band rig is being used, or if you wish to select filters with a mechanical switch.

Split Operation

Pushing the **SPLIT** push button first activates the RIT function. A beep sounds when this button is pushed. Both the transmit and receive frequencies are displayed in this mode. A "T" indicates the transmit frequency. In the case of RIT, the receive frequency will be on the top line of the display and the transmit frequency on the bottom line.

Pushing the **SPLIT** button a second time will activate the XIT function and restores the original operating frequency, if it has been changed. The transmit frequency will now be shown on the top line and the receive frequency on the bottom line. Again, the letter "T" indicates the transmit frequency.

Pushing the **SPLIT** button a third time will restore the original operating frequency and exit split mode of operation.

The band switch is locked out while in split mode.

FUNCTION Button

The **FUNCTION** button accesses the code speed, tune up mode, program keyer memories, calibration mode and program IF offset frequency functions. If the controller is in Straight key mode, and if function button is held closed for 10 seconds, it will jump directly to calibration and IF offset.

Pushing and holding down the **FUNCTION** button scrolls through the functions, with a few second delay between the options. Activate the desired function by releasing the button when the desired function appears in the upper right corner of the display.

Code speed selection

Push the Function button and release when "**KS_**" is displayed. Code speed can be changed using the paddles or tuning encoder. There is an automatic 5 second time out, or the function button may be pressed again. Code speed is indicated on the lower right of the display : S20.

Tune up mode

Push and hold the function button closed until "**TU_**" is displayed and release the button. Either the dot or dash paddle may now be used to key the transmitter to facilitate adjusting an ATU. There is an automatic 10 second time out for this function.

Program Keyer Memories

Release function button when "**SM?**" is displayed. Push **M1** or **M2** to select which memory you wish to program. The function can be escaped by pushing the FUNCTION button again.

Use the paddle to key in your message, up to 43 characters long, including word spaces. Ideal letter and word spacing is used to distinguish between letters and words. To be sure of word spaces, pause slightly longer than you might otherwise between words. Once your message has been entered, push **M1** or **M2** again to store the message. The message will automatically be repeated, so you can tell if you keyed it in properly or if it needs to be redone.

Calibration Mode

Push and hold the **FUNCTION** button until "**CRF**" is displayed. The button must be held for about 10 seconds after "**TU_**" is displayed to enter this mode. When the button is released and this mode started, the display will change to 10.000,000_

This mode allows you to adjust the constant used as the DDS reference frequency to match the exact frequency of the actual reference oscillator. If calibration is not done, the output frequency can be off as much as 3 or 4 kHz at the higher frequencies. The transmit frequency of each band is calculated using the reference frequency constant, each time a new band is selected.

Calibration is done at 10.000,000 MHz Connect an accurate frequency counter to the DDS frequency output. Allow the reference oscillator to warm up for 5 or 10 minutes. Adjust the output frequency to exactly 10.000,000 MHz using the tuning encoder. The display tuning rate is left at 100 Hz, but the rate at which the output frequency changes will be much slower. Ignore what the display says and go by the reading on the frequency counter. The display is kept active, just so you know something is happening when you tune.

Once the output is set to exactly 10 MHz, push the **FUNCTION** button to store the results and exit back to normal operation. The new calibrated reference constant will go into effect immediately. It is stored in EEPROM and is retrieved on subsequent power ups.

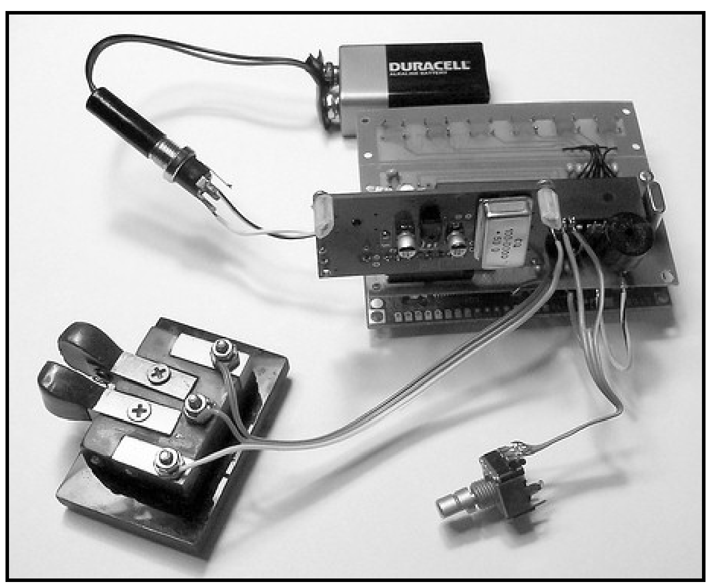
Program IF offset frequency

When the VFO is being used with a super heterodyne receiver, the VFO output frequency needs to be offset by the IF frequency in order to get a direct reading display. The IF offset is nominally subtracted from the transmit frequency, for low side LO injection. If the result is negative, the offset is added to the transmit frequency for high side LO injection.

If using the VFO with a Direct Conversion receiver, leave the offset set to zero. Simply use the RIT function to get the desired beat note, after carefully 0 Hz zero beating the station you with to talk to.

Select a band which is close to the offset frequency you need.

Push and hold the **FUNCTION** button until "**SO?**" is displayed, then release the button. There is no escape for this function. Now tune the frequency to the desired offset frequency. This is best done while the VFO is connected to the receiver and the receiver is on. If the BFO has



not yet been set, use an oscilloscope to find the frequency which gives the peak response out of the crystal filter. Now adjust the BFO trimmer to give the desired beat note. Store this offset by pushing the **FUNCTION** button again. The VFO will now go back to normal operation and the IF offset will take effect.

If the BFO trimmer has already been set, tune the offset frequency to give the proper beat note and store. Be sure to set it to the proper side of zero beat, which would be the lower frequency side if using a typical ladder filter. If a offset has be previously programmed, entering offset mode will set the VFO to this offset frequency so that it can be trimmed.

Bypassing corrupted data

It is possible for the data stored in EEPROM to become corrupted. Should this happen, hold closed the **STEP** button on power up and the default reference frequency values and zero offset will be loaded. To avoid this problem, use an on/off switch in the rig/controller supply line, rather than using the power supply's on/off switch. A power supply with a slow discharge rate can cause the problem.

Keyer Memories

Pushing **M1** or **M2** will send the message stored in that location, provided a message has been stored. Messages can be paused by closing the dot paddle and stopped by closing the dash paddle.

Straight Key Mode

Power up with straight key in paddle jack.

Transmit frequency

If you are building a new rig from scratch based on this VFO controller, there is no need for a transmit mixer or mixer filters, as the VFO will produce the actual transmit frequency directly. Simply connect the output of the DDS to the transmitter driver.

If you are adapting to an existing rig that includes a transmit mixer and wish to continue using it as to minimize the amount of modifications you need to do, this case can be taken care of by grounding pin 4 of the controller. This will keep the IF offset active during transmit.

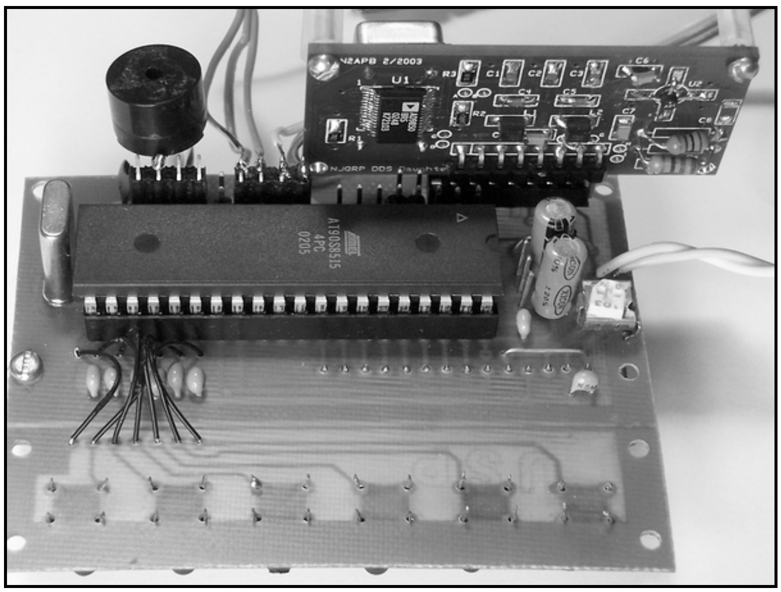
NOTES

1) A partial kit for the MS-DDS Controller is available from the AmQRP Club. It contains a 2.5" x 3" pc board and a pre-programmed ATmel microcontroller. See the AmQRP "kits" web page for ordering details (www.amqrp.org/kits/ms-dds).

2) Source code is available for download on the MS-DDS web pages.

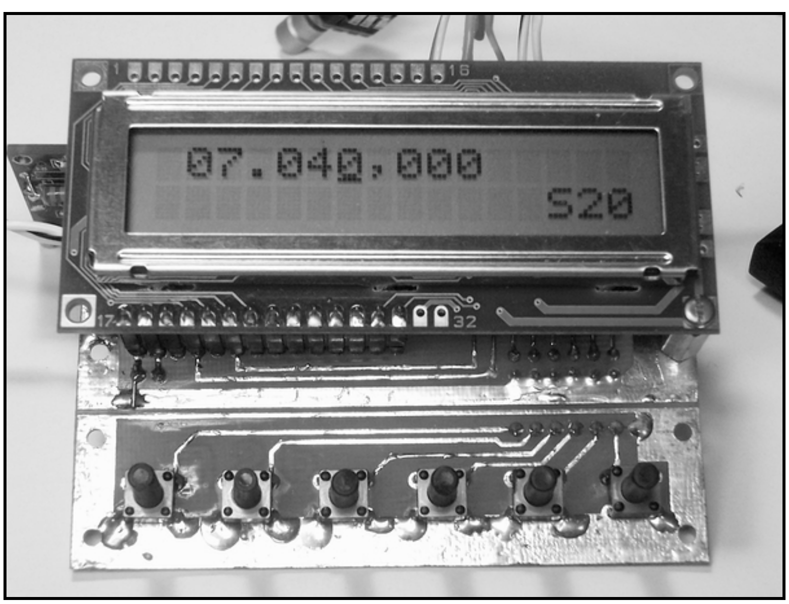
3) The NJQRP DDS Daughtercard is available from the NJQRP Club for $22 (US & Canadian orders) or $26 (DX orders). Full project details and ordering information is at www.njqrp.org/dds

KD1JV may be reached at 633 Champlain Street, Berlin, NH 03570. Email: kd1jv@moose.ncia.net. Website: www.qsl.net/kd1jv/

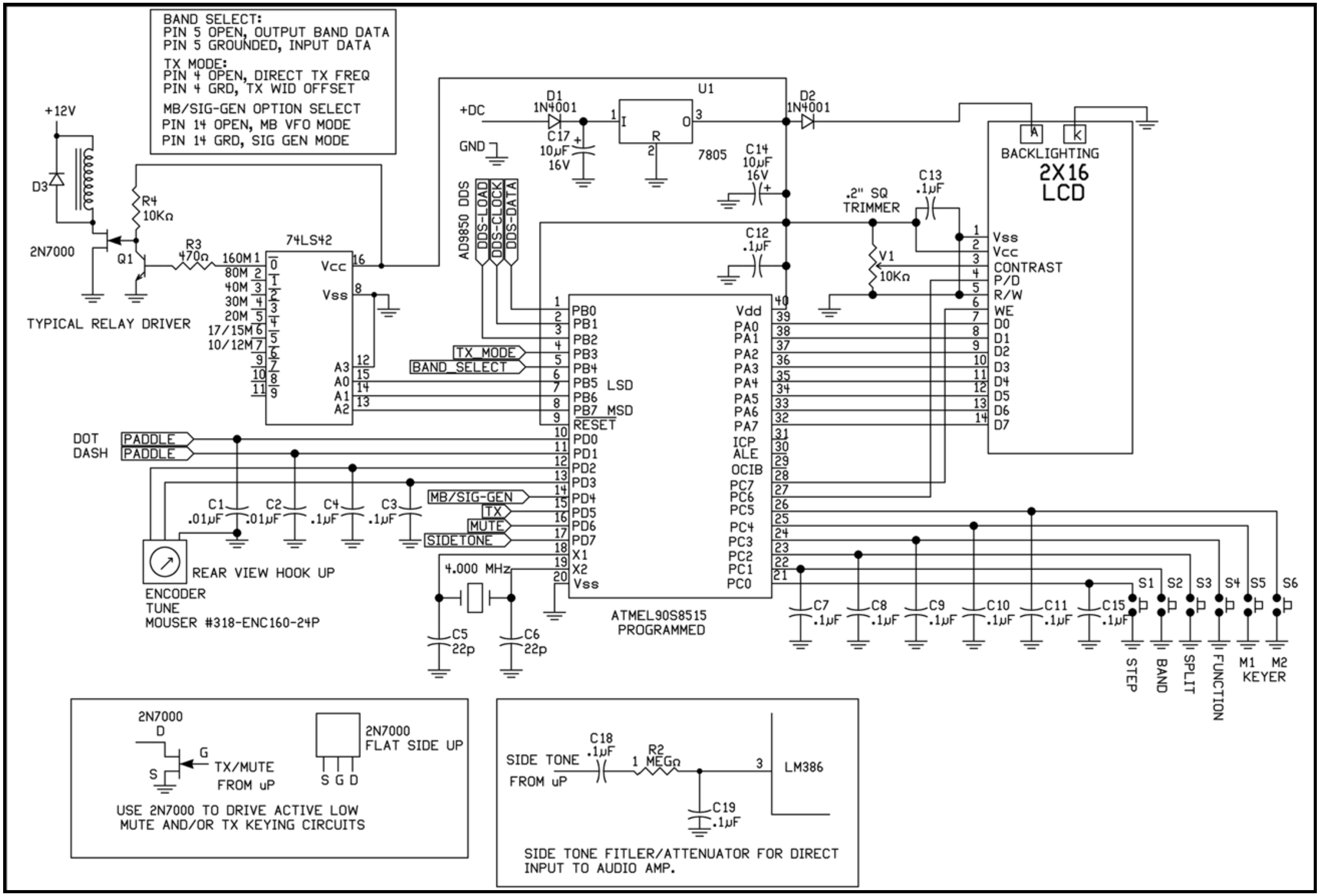


Bottom side of the MS-DDS board is shown here on the right. The DDS Daughtercard plugs into the SIP socket near pin 1 of the 40-pin ATmel microcontroller chip. To the left of the DDS card is the main interface SIP header, with the piezo and keyer lines soldered to its pins.

The pins of the six pushbuttons can be seen along the bottom edge of the pc board, with jumper wires bringing the signals over to the ATmel. The front third of the board is able to be cut and detached from the main controller to provide for the switches to be mounted in a different position (e.g., on the front panel of an enclosure.)

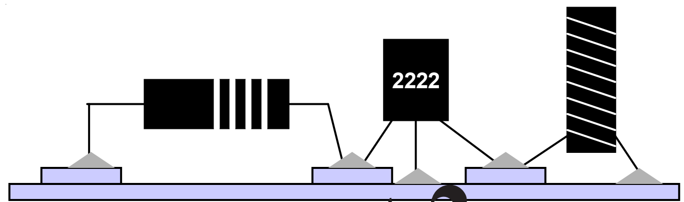


Top side of the MS-DDS controller board is shown here on the left. The transmit frequency is indicated as 7.040,000 MHz. The underscore on the digit at the 1 kHz position indicates that the tuning rate is set at 1 kHz. The keyer speed is 20 wpm, as indicated by the "S20". The six micro pushbuttons arranged along the bottom edge of the board have conveniently-long shafts, allowing for actuation by depression or by using them as a "lever switch".



Schematic of the KD1JV "Melt Solder" DDS QRP Transmitter.

Chuck Adams, K7QO



Manhattan-Style Building Techniques Part 2

Last time, master homebrewer K7QO described the basics of material and tool selection and how he successfully prepares for the project construction. Now read how Manhattan pads are created, mounted and used as circuit nodes on the bare copper-clad base board.

The next thing after making a board to be used for a project is to make up enough printed circuit board pads to use. Jim Kortge, K8IQY, has excellent results making very small rectangular pads. He uses an Adel Nibbler. Jim and others saw my work at Pacificon in 1999 and 2000 and thought that the circular pads looked good and worked well.

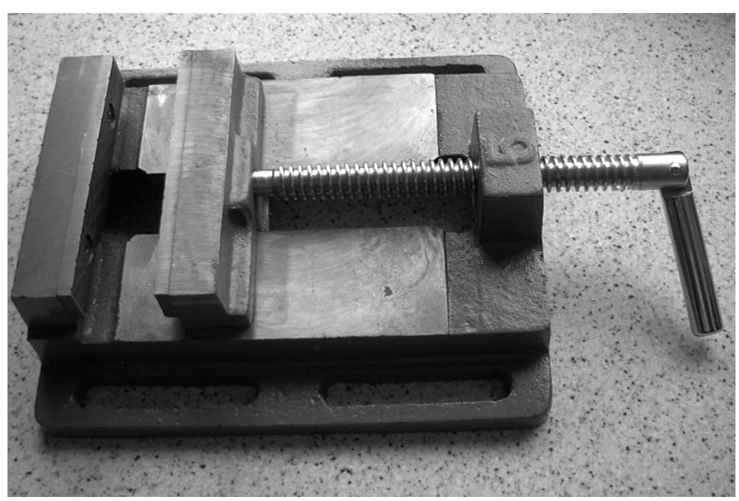
Harbor Freight Tools has a **2,000-pound punch kit** with part number 44060-1VGA. It sells for $16.99 and I happened to catch it on sale. It consists of the punch with dies for making 2.38, 3.18, 3.97, 4.76, 5.56, 6.35, and 7.14 mm circular punches in metal or in this case printed circuit board material. I started with pad sizes of 4.76mm but now have settled on the smaller 3.18mm pad size. This size works best for me in saving room on the board, getting components closely spaced, and still large enough to easily solder several component leads to during construction. Remember that by pads I am referring to the material punched out of the printed circuit board; that is, the circular sections that pop out of the punch. Also for using integrated circuits (and I always use sockets) with these sized pads, you can only do the corner leads, due to spacing, in what I call the "lunar lander" configuration. Probably for this reason alone a lot of people will tell you to go with the nibbler and the rectangular pads so that you can use pads for each of the leads. You can go with rectangular pads for the ICs or sockets and circular elsewhere but I just tack solder to the remaining leads of the socket with pads only on the four corners used to hold the IC socket to the printed circuit board, and this works well for me.

I made a modification to the punch that you may want to try. I found that with the printed circuit board material I use, several things happened when I punched out the pads using the punch and dies. There is a small raised point centered in each punch. This point holds and keeps the material being punched from moving laterally. The raised point made the pads concave and it also caused the copper to develop a fine hairline crack on one or both sides in the copper plating. I used an ordinary metal file and removed this center raised point. By removing the point the pads now come out rather nice and flat. You may not want to do this as this is a permanent modification to the tool parts. Experiment with one of the punches. Try one punch size before and after this modification and see which configuration works best for you. If you don't like the results, then you have only made one modification to one of the punch sizes. You might want to use the smallest size to experiment with as it will be the least likely candidate for making pads.

Another thing that I bought at Harbor Freight is a **5" drill press vise**. This is part number P31000 and it is in the $15 price range, the same as the punch. It is both heavy and sturdy and sits right on the desktop while in use and stores away in a relatively small space. I prefer it for most small work compared to a portable vise that clamps to a desk edge. I use this for holding all kinds of things while sanding, filing, etc. In using the punch to make printed circuit board pads I sometimes found it required considerable pressure. By putting the punch in the vise, I could exert more pressure and move along the printed circuit board material faster, thus punching out more pads in a shorter period of time. You can either wait on this purchase or use a vise that you already own.

What I do is get some board material that is going to be large enough to make a hundred or so circular pads of the desired size. I make every attempt to cut the pads as close as possible to reduce the waste of board material. You have to practice to find the technique and procedure that works best for you. Be sure to clean this board material before you start in making the pads. This will make the pads nice and clean and shiny and easier to glue and to solder.

Harbor Freight hand punch



Harbor Freight bench vise

Punch & vise making pads

In the photograph showing this setup you will note that I use a small plastic container to collect the pads as they are punched so that I don't have to chase the little critters all over the desktop and floor. Also note that one or two pads may still be in the punch when you finish, so check before putting the tool back into its case for storage. I punch up a batch of pads at one time to maximize the number that I can punch for time and effort expended in setting up the tools. The plastic container is just a simple butter container that has been recycled for such use. I store left over pads in a pill bottle for later use.

Mounting The Pads

Now after reading all this some people may consider me cheap. Although this is not the case, I sometimes find that bargains are worth getting. Besides Harbor Freight I like to visit the everything-for-a-dollar thrift stores. They have some unusual stuff that often comes in handy. I use their notebooks for keeping journals, logs, and QRP experimental notebooks. I also buy my super glue there for single tubes and sometimes two tubes for a dollar or less. Super glue does the best job for me of installing pads on the printed circuit board. Read the label on the glue and always be careful. Wear glasses or goggles at all times. A large number of us have seen discussions go on and on for threads on this topic on the mail lists. Super glue is just that, a glue, and every precaution should be used in applying it to the board, etc. I just love the stuff and if you experiment you can make a neat joint for the pad. I apply the glue to the printed circuit board at the point where I want the pad to go by placing a very small drop there. With care you can get the same size drop in the exact place you want it every time. Don't rush and don't use too much pressure. I hear the urban legends about mistakes and you don't want 35 hours into a big project lost due to a slipup on your part. Again, read the labels and be careful. I keep Acetone handy to clean up as needed.

Some people will recommend that you go to a hobby shop and buy a large bottle of super glue. I find that they are expensive and am concerned about the shelf life of the stuff. Some people recommend keeping it in the refrigerator, however this can be dangerous if children live in the house. Also note that you can buy the glue in different set up speeds – instant, regular and slow. These speeds provide different times in which to move the materials being glued together. You can experiment if you wish and decide which you prefer. As I say, education is expensive no matter how you get it.

I glue the pads as I make progress on the project. There is no need to get too far ahead as your placement and circuit details may change. I use the "build a section and then test it procedure" in a lot of my projects. By only placing pads as I go I do have the opportunity to modify the circuit and the layout on the board before it becomes too crowded and I don't have room to make the changes that I need. Some builders prefer to go ahead and lay out a project completely and do all the pads at one time to reduce time in setting pads and working with the glue. What you do depends on your own experiences and the techniques that you have developed or learned.

Circular pads glued down

If the pad is placed incorrectly or if you change a circuit you can remove the pad by the "pop-a-pad" technique (tm de K7QO) using chain nose pliers and then clean the spot with Acetone. (Read the labels of dangerous chemicals and use them outside and upwind from the fumes. Acetone is highly toxic and volatile/flammable chemical found at any paint supplier.) Just use the pliers to hold the pad and the rotate/twist it in place to break the glue bond. Super glue does not have a good shear strength and can easily be removed in this manner. Because of the Young's modulus you cannot just pull it off — that is why the guy with the hardhat in the advertisement is being held up below an I-beam.

I am hoping that you are reading this article through several times before you rush out the door and start buying stuff. While you are in Harbor Freight for the shear and punch ask them about item #32279. This is a $5.99 set of six tweezers that I just love to use – not only for placement of pads but for picking up parts while building a kit and for retrieving parts dropped into a crowded board or case. You'll see what I mean after you get the set and use them for a while. You'll feel like a brain surgeon with a fine instrument. You can also find similar tweezers at some surplus vendors at hamfests like Dayton and HamCom. The tweezers are made of stainless steel, have very fine points, and the super glue should not stick to them. Be sure to keep them out of the reach of children.

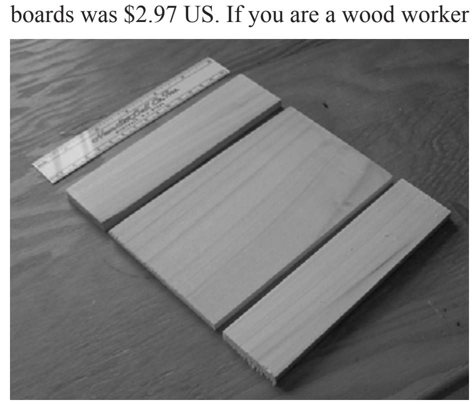
I locate the spot on the printed circuit board where I want a pad to go. I then place a very small drop of super glue centered on the spot. I then use the tweezers to pick up a pad from my supply of pads and place the pad at the spot on the board. I GENTLY push on the top of the pad to seat it in the location I want and then hold the pad in place for about 5 seconds or so. The glue sets rapidly, but don't play here and test to see if the pad will move. If you haven't waited long enough, it will move and then you'll have a mess on your hands. Just be patient as the rewards are great. You'll get the hang of this after a few pad placements. I do put the pads with the smoothest side up.

After another 15 seconds or so I then take the soldering iron and solder and tin the pad. I use just a little bit of solder. This process does two things. It pre-tins the pad for later soldering of component leads to it. It also helps "cure" the super glue under the pad and solidify the structure. Be careful not to use too much heat here and cause a portion of the super glue to vaporize. The fumes are not good for you. I use a small 12 cm by 12 cm computer fan (115VAC at 8W) near the work area to draw the fumes away from the work area. It is quiet and I have the soldering iron and the fan on a multi-outlet switched setup so that I can turn everything off with one switch. This keeps me from leaving the soldering iron plugged in and on for days at a time. Don't have the fan blowing air across the work area unless you need the additional cooling during the summer months. Make sure that even in this configuration the fumes are not blown in your direction.

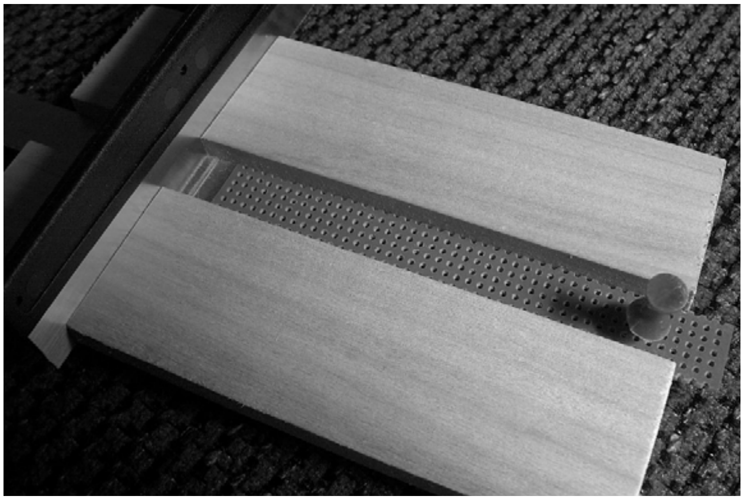
Manhattan-Style IC Pads

If you are going to do much Manhattan Style building, then you probably will be using integrated circuits in your work. I have used a technique called the "Lunar Lander" that involved placing round pads at the four corner pins of an IC. Jim Kortge, K8IQY uses square pads and I made up some using another technique shown below.

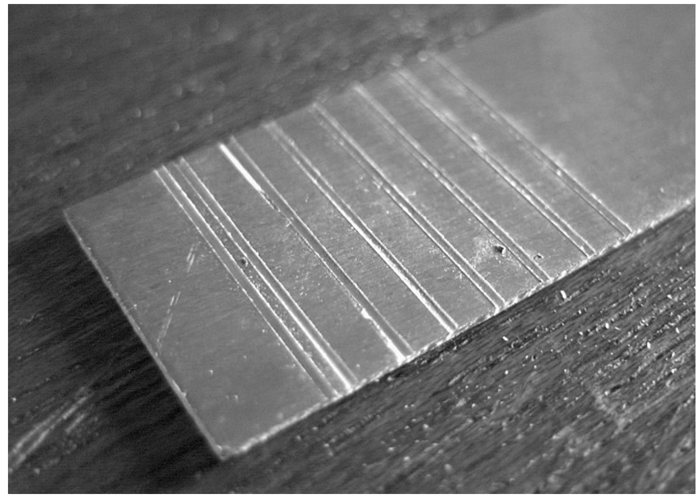
I went to Home Depot and bought two boards shown in the next photograph. I chose Poplar as it is the cheapest and the total price of the two boards was $2.97 US. If you are a wood worker



Wood pieces for making cutting fixture



Fixture for holding strips of copper-clad board prior to cutting slots.



Slots cut into cooper-clad start forming the IC pads.

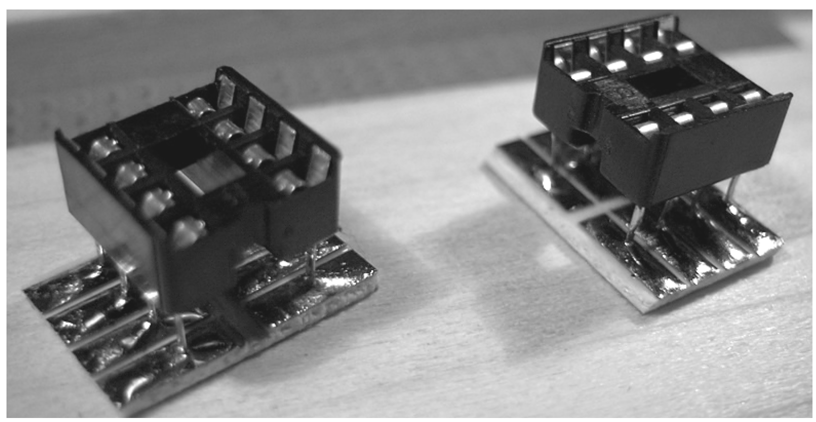
you may use what ever you have on hand. In fact, if you have a router you can think of ways to do this with one piece.

I simply used a mitre box and saw and cut one wide piece to a length of 15 cm and two of the narrow pieces also 15 cm long. Using wood glue, take one of the small width pieces and glue it to one side and nicely matched along the edges. You can sand later if there is some variance, but it is not necessary.

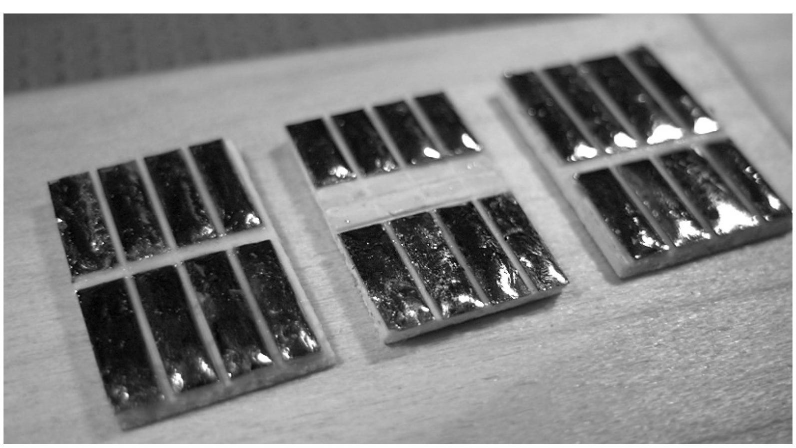
Now cut a piece of PC board to the width that you want the IC pad to be. You may need to experiment in this area. I personally like 1.5 cm for the Manhattan pad. Using this piece glue the other board separated from the first by the width of the PC material. Allow just a little area so that the PC material isn't too difficult to slide back and forth in the "canyon" like area between the boards. You don't want it too loose. I also cut a piece of vector board with 0.1" spacing on holes to the same width. This material is used to prototype computer and IC type circuits. We will be using this to measure 0.1" spacing on lands on the pad.

Now you should use a mitre saw with a very thin blade. The one that you used to make the pieces will not do, so some expense involved here at the hobby store. Using the blade with a right triangle make a cut at right angles to the "canyon" about 2 cm or so from one end of the boards. You are making a mitre board for making IC pads. I slide my vector board material into the canyon and matched it to one end and made the mitre saw cut even with the end, but I recommend you do not cut at the midpoint but close to one end but not too close. Look at all my pictures and you can see what I mean. Use a push pin like you use at the office and put in one of the holes and into the board material about 1 cm from the opposite end from the blade.

With this setup I can now (holding the vector board down gently) remove the pin, move the vector board one hole away from the blade then reinsert the push pin. Now by moving the PC board against the vector board and making a cut down through the copper material I can make pads spaced 0.1" apart. Do as many as you need for several pads. Then use the shear or the tools of your choice to cut the material for 8-pin sockets, 14-pin socket, etc. Here is a series of photographs showing the steps. Make a few for practice and yours will look a lot nicer than this one. After you make the 8-pin pads, cut a double wide path at right angles to the other cuts. Otherwise you will have opposite pins shorted to each other



Just solder the socket onto the "Manhattan IC pads" and then glue the whole assemby onto the copper-clad baseboard of your main project!



After cross-cut made to create separate sides, boards are cut off for desired pin count and tinned with solder. Eight-pin IC pads are shown here.

and that just won't work. Hint #1: Use an ohmmeter to check for shorts after you do this. Don't skip this step or you will generate a lot of headaches for your self later. Hint #2: You might want to tin the pads before gluing them down to the PC board material.

The next time we meet I'll review my soldering techniques and present a number of working projects. Until then, may all your projects work the first time and every time!

73 es dit dit.

Chuck Adams may be reached at k7qo@commspeed.net. His website is www.qsl.net/k7qo

TEST TOPICS ... *AND MORE!*

Joe Everhart, N2CX

TTAM this time features an integrated theme. Each section describes an aspect of Field Strength Meter (FSM) technology. The first section, **Designed for Test**, gives a brief overview of FSM telemetry and describes the basic module used for the remote-reading function. Then **Coming To Terms** defines terms and a method for preprocessing the information to be sent to make it easier to interpret. Finally **Stimulus and Response** gives some clarification and enhancement for adjustment of the NJQRP FSM, the Sniffer. Subsequent TTAM columns will detail the remaining functional blocks of the remote-reading FSM and describe its usage.

Designed For Test

An overview of FSM telemetry was presented in TTAM 13. As shown in Figure 1 antenna testing can be made easier by providing a means of reproducing field strength readings at both ends of a test range. Several methods of accomplishing this telemetry (measurement at a distance) were discussed. All converted the DC output of an FSM to a form that can easily be transmitted via a radio link across a distance of several hundred yards. This conversion hardware is represented in the figure by a pair of 'black boxes."

The method that will be presented here uses a voltage to frequency at the FSM and a frequency to voltage converter to reproduce the original DC voltage at the other end of the link. This method uses precision devices which convert the DC to a tone in the audio frequency range (300 to 3000 Hz) which corresponds the normal audio capabilities of common radios (and other communications means) used for voice transmission.

The FSM to be used produces a DC output between about .25 and 2.5 VDC so the converter needs to operate in this range. A convenient way to perform the action is to use an integrated circuit device specifically designed for voltage to frequency conversion (VFC) applications. The National Semiconductor LM331 IC is an inexpensive and widely available choice (See Ref 1). And what's more, the same device also does the complementary as frequency to voltage converter (FVC).

Circuit diagrams for these chips are taken from the data sheet of Ref 1 and an application note for that chip as shown in Ref 2. The VFC schematic is shown in Figure 2. A DC input voltage at pin 7 is converted linearly to a square wave output at pin 3. With 0.25VDC in the circuit produces a 250 Hz output and 2.5 VDC results in 2500 Hz. The graph to the right of the schematic diagram shows this graphically. Details of the inner workings are provided in the data sheet so will not be repeated here. The square wave output needs to be low-pass filtered for transmission and its level must be set at an appropri-

ate level for transmission. This interface circuitry will be described in the next installment of TTAM.

Figure 3 presents the FVC circuit. Its input is a single frequency (single frequency at a time) on pin 6 in the form of a square wave. Internally each cycle of this input triggers a one-shot multivibrator with a fixed pulse width. The output at pin 1 is the average DC value of the one-shot output. So for low frequencies the average value is low and goes up proportionately with increase input pin frequency. Once again the result is illustrated in the sketch to the right of the schematic diagram. Component values are chosen so that the output DC value of the FVC is identical to the input of the VFC.

This conversion to and from frequency can be thought of as kind of modulation and demodulation process. The primary reason for performing the conversion is that since the information transmitted from one end of the telemetry path is frequency, it can be performed with minimal degradation so that the DC out of the FVC follows the input to the VFC very accurately.

However just how to transmit that audio transmitted from one end of the "antenna range" is another matter entirely. Being hams we can conceive of a number of ways. Several of these and some interface circuitry to aid in this job will be discussed in a future TTAM/.

CTT - Reference Voltages and Scaling

Many measurements we have to make involve reading quantities that swing over a large range. In order to get reading accuracy we often want to focus on a narrow portion of the range of measured values. One example of this is using an expanded scale analog voltmeter to measure AC line voltage. Ordinarily a voltmeter might read, say 0 to 150 volts. But if you are reading AC line voltage, most of the scale is unimportant. You don't really need to know what the voltage is unless it is zero or somewhere around the nominal 120V area. An expanded scale voltmeter does just this by showing only a portion of the entire range, such as 95 to 135 volts in the MFJ "120 AC Line Volt Monitor Meter" which indicates only the range of 95 to 135 volts.

A device that is ideal for using in the remote-reading FSM being discussed in this TTAM is a special RF detector chip manufactured by Analog devices - the AD8307. Its output is a DC voltage that increases by 25 mV for each dB of input over an input range of -75 to +15 dBm. Generally we would want to read only a small portion of this range at a time though, say 10 dB at a time so that we can clearly see small changes on an analog display. Even with a digital type display a more limited range is easier to interpret.

This can be performed using operational amplifiers and some circuit magic! Here's how it's done.

An operational amplifier has a positive and a negative input and its output voltage is related to the difference in voltage between the two input pins. For zero difference in the inputs the output voltage is zero. The output goes positive when the (+) input is positive with respect to the (–) input and vice versa. The amount of output voltage swing per unit of input voltage difference, the voltage gain, can be set by using resistors to feed back a portion of the output back to the (–) input. The ratio of these resistors is the resultant voltage gain. We'll get back to this in a minute.

Refer next to Figure 4. If connect the op-amp (+) input to ground (Voffset1 is 0) and feed input signals to the (-) lead we amplify the difference between ground and the (–) input. The (+) pin acts as a reference so that we note inputs referenced to it. The difficulty is that the output voltage goes negative as the input increases! This is an inverting amplifier and is the first op-amp stage in the figure. It has a voltage gain equal to the ratios of the resistors as mentioned above, thus ***scaling*** the voltage by the amount of the gain but with inverted polarity. If we then add a second inverting amplifier with unity gain, we get back an amplified version of the original signal, this time with the correct polarity. (For the moment assume that the Voffset2 connected to the (+) pin on the second amplifier is set to 0).

Figure 5 shows a voltage ranging from 0 to 2.5VDC produced by a hypothetical detector for an input of -100 to 0 dBm. If we used an analog meter to read this and the 2.5V was full scale, we would really have to squint to read the scale in 1% increments. On the other hand if we ***scaled*** the voltage by a factor of 10, zero to full scale of the meter would be a 10 dB range which would be much easier on the eyes.

A simple way to do this is by using the amplifier in Figure 4. If this voltage is fed to the amplifier, the lower part of the voltage range will be amplified by 10 producing an output voltage scaled by a factor of 10 so it will correspond to a 10 dB range if read on a meter. For reasons we will see in a later column we can usually ignore what happens with voltages above the desired range.

We can apply an op-amp "trick" to read other parts of the input range. We do this by applying a different reference voltage to ***offset*** the input to the op-amp. If we want to expand the input voltage range of 1 to 1.25 volts we apply a Voffset1 voltage of the negative of the offset (-1V) to the (+) lead of the first op-amp. The gain of the op-amp remains the same but the final output voltage of amplifier chain goes from 0 to 2.5V as the input changes from 1 to 1.25V as illustrated in **Figure 6**. Any segment of the input voltage range can then be ***offset*** by using a Voffset1 voltage which is the negative value of the desired offset. The same idea can be applied to the second op-amp by applying a different Voffset2 to it in order to set the output voltage range above ground.

What has been accomplished is "picking off" a portion of the input voltage range and expanding the scale of the output reading by a factor set by the gain of the op-amp. In this example instead of reading 100 dB at a time we read 10 dB. Furthermore by setting the offset voltage appropriately we can set this 10 dB expanded reading anywhere in the 100 dB of the input voltage span. We will apply these same ***offset*** and ***scale*** techniques to a FSM circuit in an upcoming TTAM

Stimulus & Response

As the designer of the NJQRP Sniffer I've received a number of letters asking for assistance from folks trying to adjust it so that the meter is properly zeroed. The manual describes the procedure briefly but I thought it appropriate to expand on it here.

The Sniffer (**see schematic in Figure 7**) is comprised of a tuning section followed by a bridge type detector, several stages of DC amplification, and finally, an analog meter. When it is adjusted correctly, the meter needle is close to zero at its low end and deflects upward as signals are detected. Due to the high gain amplifier adjustment is rather "touchy" so it is best performed stage-by-stage as described below.

One unusual characteristic of the circuit is use of biased LEDs to provide a DC reference voltage for the DC detectors. This gives them a fairly stable above-ground bias point. But one side-effect is that within the amplifier chain measurements should be referenced to this bias voltage. Failure to do so will give voltage readings that seem too high.

The signal that the DC amplifier works on is the differential between the two detector diodes. When the Sniffer has no RF input this differential wants to be zero to keep meter M1 at zero. In order to get zero differential voltage, potentiometer R1 is set to balance the voltages across the two diodes. This voltage will be less than a millivolt and is at a high impedance so it is difficult to measure at the diodes. So the best place to measure it is at the low impedance output of the first amplifier stage U1 pin 7. To do so, connect a VOM or DVM (initially on a 10 volt range) with its negative lead on the bias reference on the anode of LED-2 and the positive lead on LED-1. Now adjust R1. It will make the voltage at U1-7 swing from slightly positive to slightly negative. Set it as close to zero as you can. I mean ***really*** close because a millivolt difference will cause a perceptible deflection on meter M1. Be sure to set the DVM to the lowest range you can to get enough resolution. The manual calls this zero setting a "null" and this has been interpreted by some as a minimum reading. Perhaps a more intuitively obvious term might be "zeroing" the output.

Now set the DVM back to its 10 volt range and move the positive lead to the output of the second amplifier stage at U1-1. This reading will be 100X as large as the amplifier input so it probably will not be zero. Adjust R1 to zero the voltage at this point as before, going to a low DMM range to get as close to zero as you can. The voltage at this point will drift around after you first turn on the circuit so let it settle until it's fairly stable before making a final setting. This adjustment will be even "touchier" than the zeroing done at U1-7 due to the high gain of the second stage.

At this point the Sniffer meter M1 should be close to its zero point. It may not be exactly zero due to normal variation between the voltage drops of LED-1 and LED-2. You can now perform your final zero adjustment of R1 to bring M1's needle as close to zero as possible. It is normal for the meter needle to drift slowly around the zero setting due to thermal effects on the detector diodes and the high DC gain of the amplifier chain. You may have to fine tune R1 as you use the Sniffer to keep M1 zeroed.

Notes

1. LM331data sheet: http://www.national.com/ds/LM/LM231.pdf

2. LM311 Application Note: http://www.national.com/an/AN/AN-C.pdf

3. Sniffer: http://www.njqrp.org/sniffer/

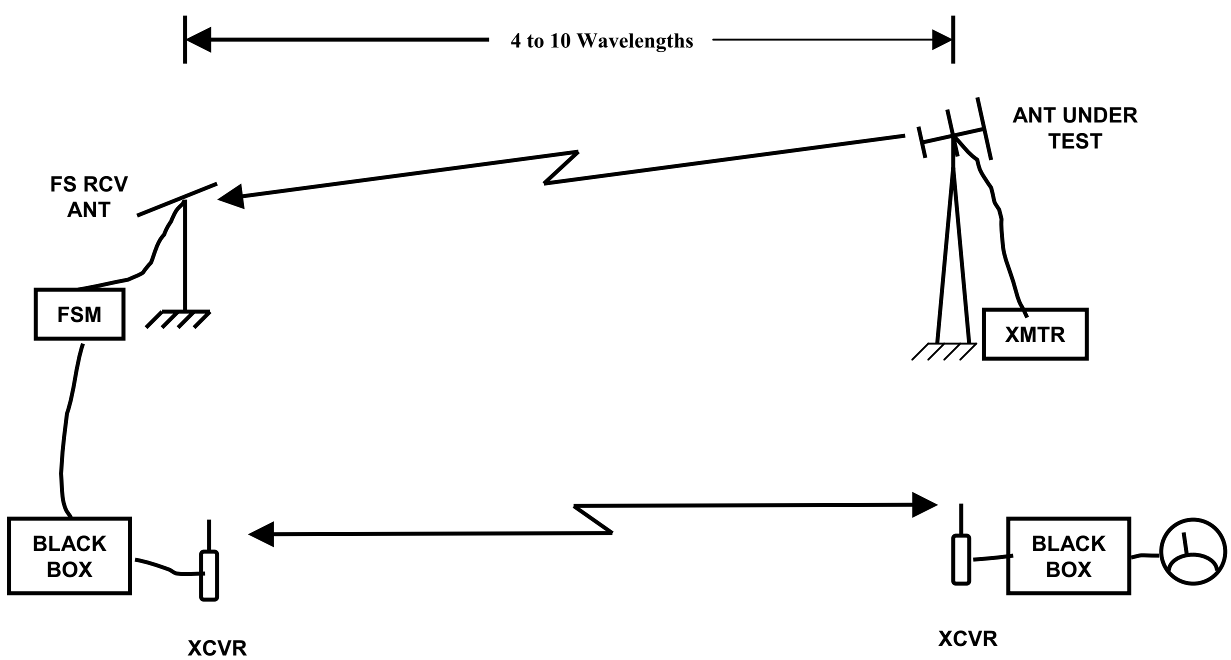


Figure 1 - Remote field strength monitoring

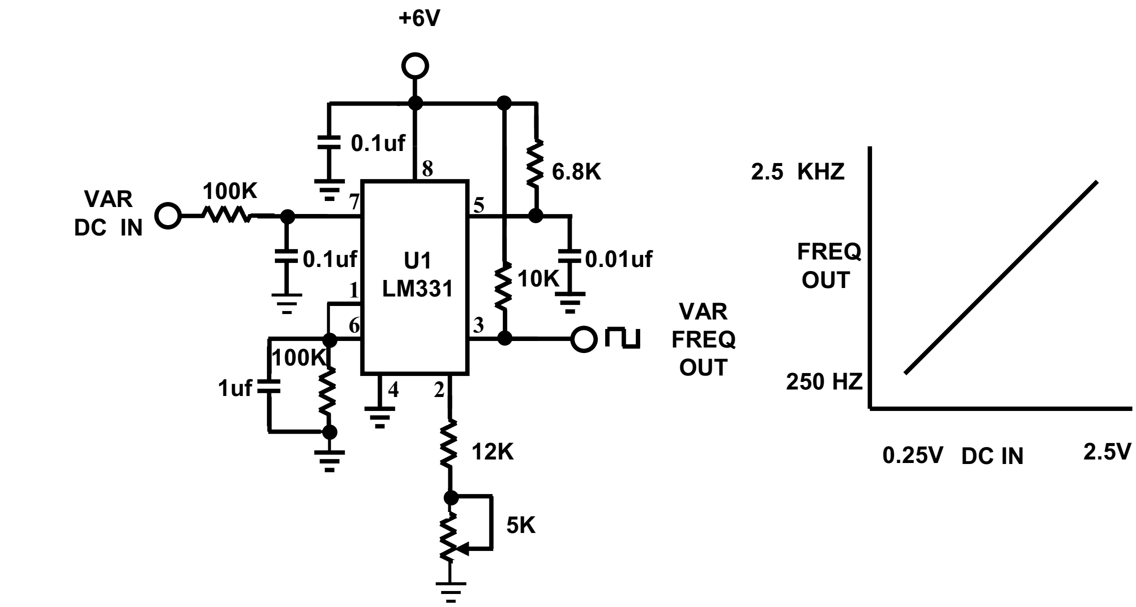


Figure 2 - Voltage to Frequency Converter

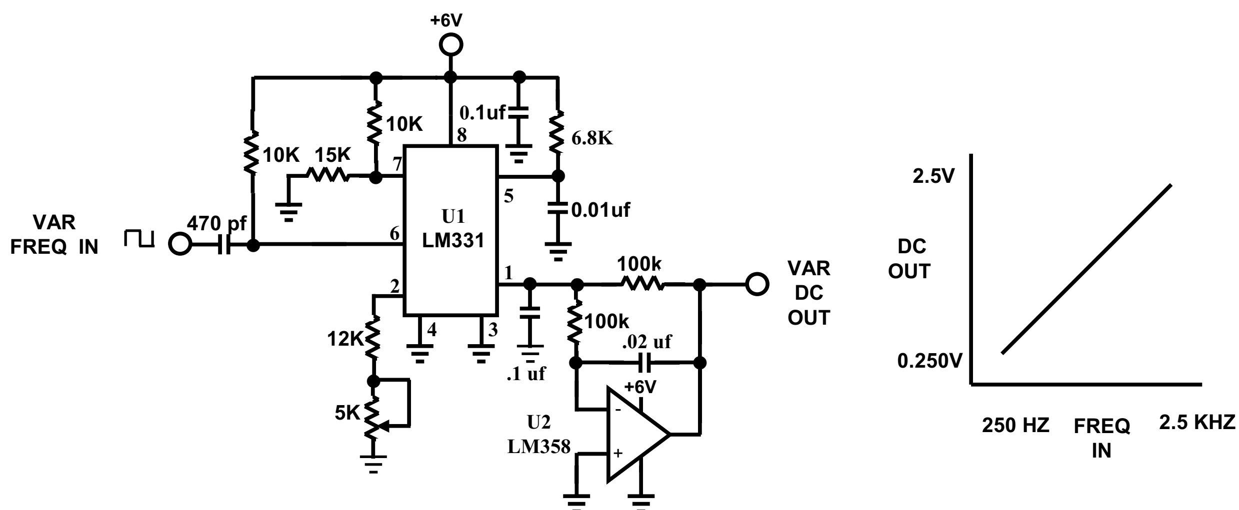


Figure 3 - Frequency to Voltage Converter

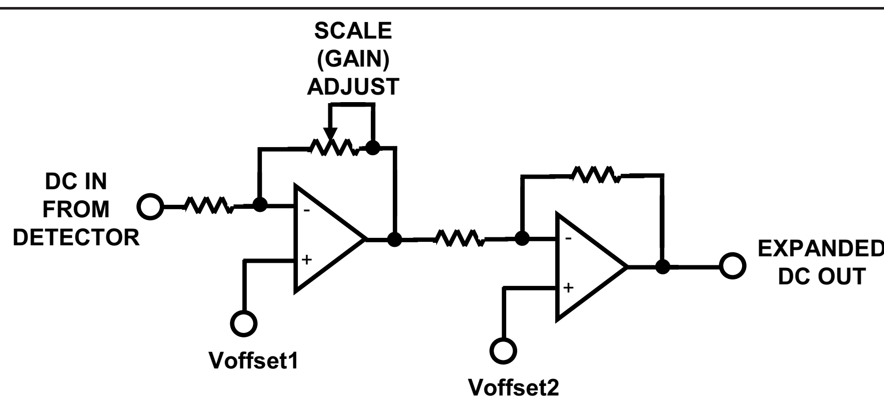


Figure 4 - Offset and Scaling Circuit

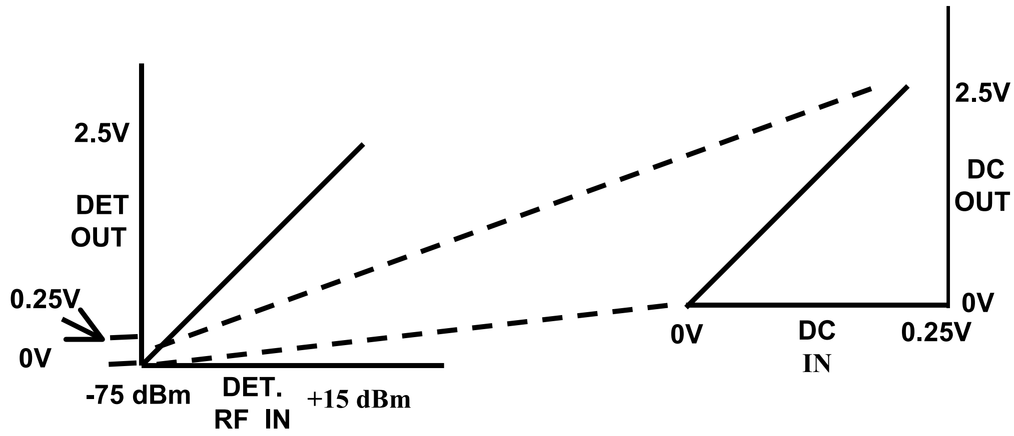


Figure 5 - Detector Output and Expanded Portion

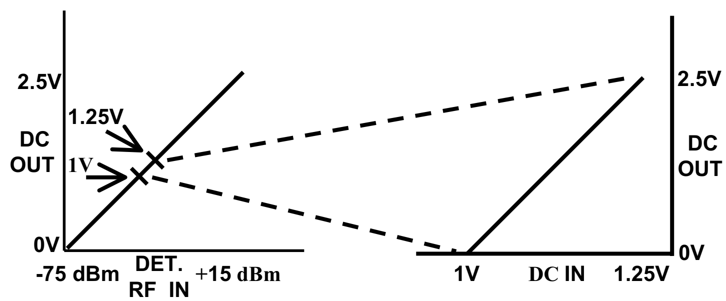


Figure 6 -Detector Output and Expanded Portion

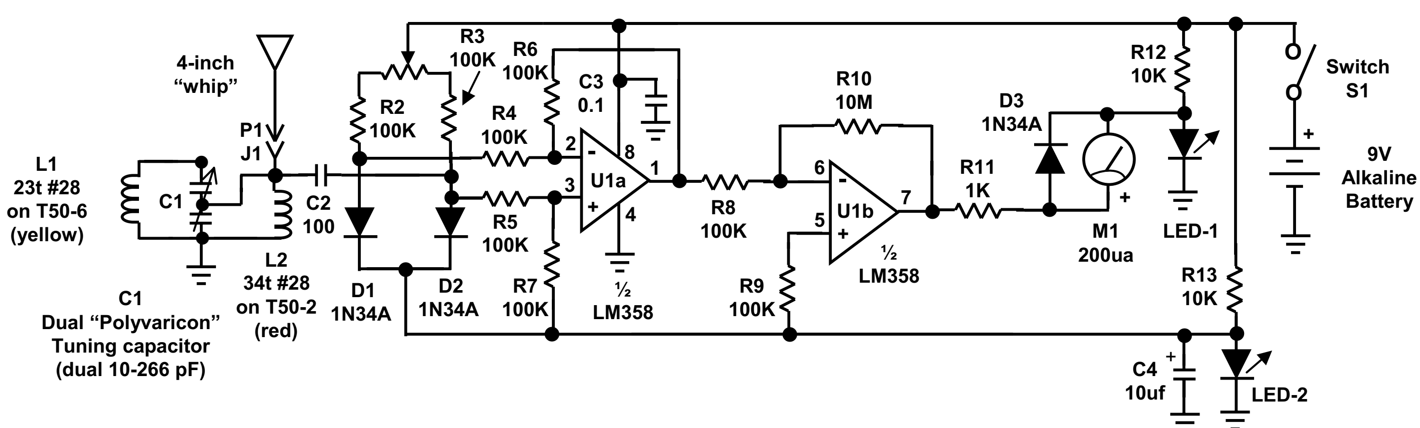


Figure 7: Sniffer schematic

QRP Operating

Richard Fisher, KI6SN

“A Quick, Easy and Well-Oiled Dummy Load for the QRP Operator”

While we’re proud to wave the flag as QRPers, a sense of duty and tradition pushes many of us to view ourselves first and foremost as good and true radio amateurs.

Regardless of the power level at which we operate, in front of mind is good amateur practice – clean, melodious signals and an adherence to operating procedure and codes that would make the late Hiram Percy Maxim, W1AW, proud.

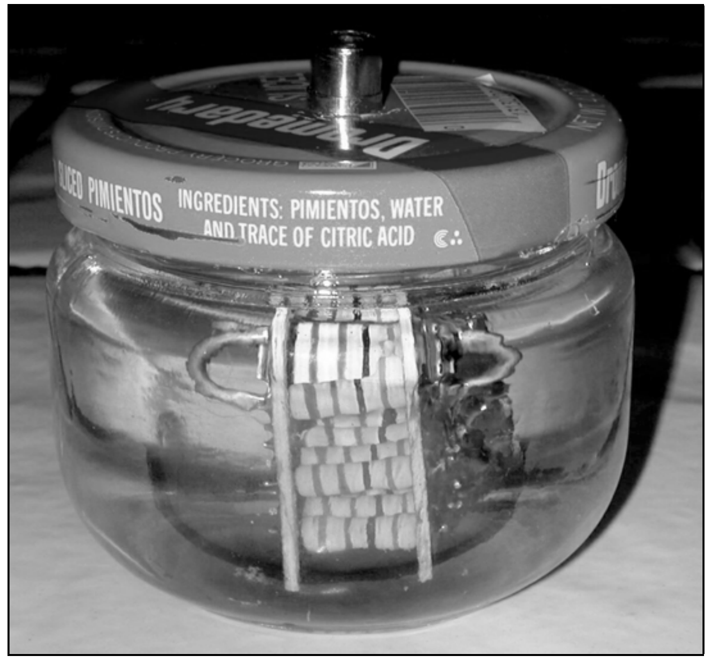
To that end, this quarter’s QRP Operating looks at a well known, but not-often-enough-used station accessory that allows testing of transmitting gear without sending signals – good or otherwise – into the ether.

Every radio experimenter should have a non-radiating RF dummy load in his radio shack.

The “dummy” part of the name refers to the load that tricks your QRP transmitter or transceiver into thinking it’s got an antenna hooked to its RF output port. The load, in the case of the unit described here, is 50-ohms. That’s become the industry standard for output matching antenna to radio. RF, of course, refers to radio frequency – such as 7.040 MHz, 14.060, or any of the other high frequency QRP operating haunts.

The operative descriptive word, however, is non-radiating. The whole point of using a good dummy load is to confine your RF signal to a 50-ohm load that is shielded from sending your signal for others to hear. Most of us have been bothered at one time or another by the infernal “tuner-upper” – the operator who keys down on or near your operating frequency and tunes. And tunes. And tunes. His HF antenna is his “load,” and others on the band pay the price for his not having a non-radiating element on hand.

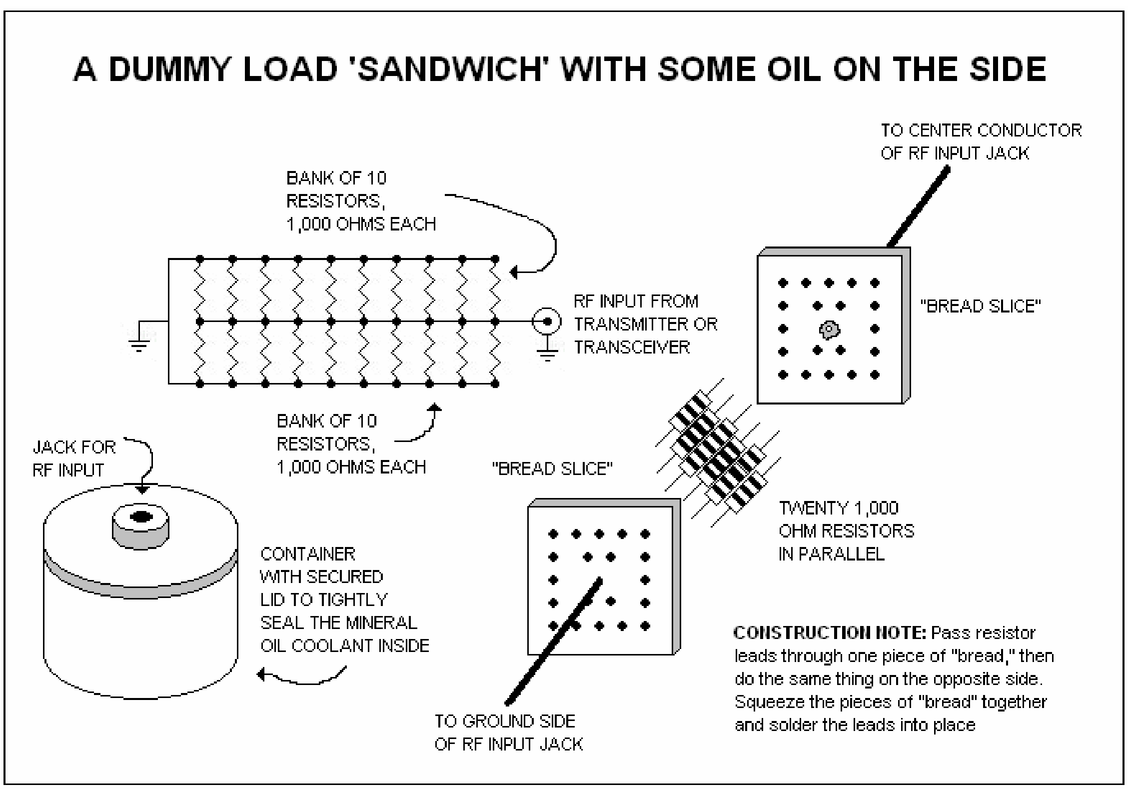
That’s pretty poor operating practice. And even as QRPers, we want to be part of the solution – not part of the problem.



At KI6SN, the resistor load, suspended in mineral oil, is capable of comfortably handling more than 20-watts of key down power.

So, to that end, why not try your hand at building an inexpensive and versatile non-radiating RF dummy load for use in your low power operations?

The accompanying schematic is just one of a jillion combinations that can be used to achieve a 50-ohm presence that will keep your RF signal “in the house.”

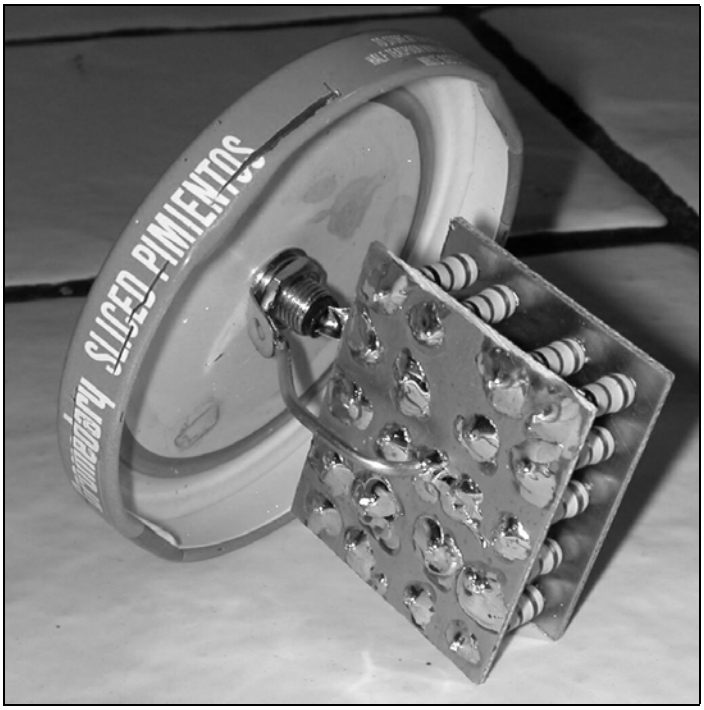


In this version, 20 resistors are configured in parallel to achieve the necessary 50-ohms. Why 20? Put simply, there’s safety in numbers. In the version built at KI6SN, 1,000-ohm, 1-watt resistors were used. Combined, the unit should safely dissipate up to 20-watts of power.

You’ll see in the accompanying schematic that the resistors are configured in two banks of 10 in parallel. That equates to 100-ohms per bank. Put those two banks in parallel and you’ve got 50-ohms.

Since my QRP station operation does not exceed 5-watts output – and most operation at KI6SN is in the 2-watt or below region – the 20-watt dissipation factor leaves a very comfortable margin for short key-down testing.

If you’d like an even greater cushion using this schematic, select



The 20-resistor dummy load's connecting wires are soldered to a standard RCA phono jack in the metal lid of the pimiento jar.

resistors rated for 2-watts and you've protracted your dummy load's dissipation factor to 40-watts. Choose resistors rated at 3-watts and you can handle about 60-watts of RF output, and so on.

You'll find there's nothing magic about the number or value of resistors you have in parallel. As long as you've achieved a combined parallel total of 50-ohms and the resistors have a comfortable power rating for your output, that's what's important.

Some of us – I gaze into the mirror – are challenged by the arithmetic for determining resistance in parallel. Thanks to smart and philanthropic people who manage Internet sites, there are many on-line calculators that can quickly determine paralleled resistors' total value.

Here's a site I've used to "do the math":
www.packetradio.com/bux_parallel_resistor_calculator.htm

Simply type in each resistors' value that you're combining in parallel, press the CALCULATE button and the total value appears in a box on the screen.

Remember: We have two banks of ten 1,000-ohm resistors for this unit. For the calculation of one of those banks, I put 1000 in each of the 10 boxes on the web site. Hit CALCULATE and you get 99.99999999999998-ohms. Round that up to 100-ohms.

Since we'll have two banks of 100-ohms in parallel, put 100 in two of the web site boxes and hit CALCULATE. You get 50-ohms. You're in business.

The important thing is to be sure that you've chosen resistors that are capable of dissipating the power you're going to be running. A good rule of thumb is to select hefty resistors capable of handling more power than you'd ever expect to put into them.

Initially, for the KI6SN version of the dummy load, I wanted to use resistors rated for at least 2-watts. Unfortunately, my supplier was out of them, so I opted for 1-watt units. For many years, according to web sites and amateur literature, dummy loads that were used for dissipating high power levels included a provision for immersing the load resistors in mineral oil – a medium that acts somewhat like a heat sink.

The renowned Heathkit Cantenna was a very popular dummy load that utilized oil immersion.

So, when the resistor power rating here fell below what I would have liked, the mineral oil option was exercised. I don't know just how much oil immersion adds to the dissipation factor, but for a trip to the drug store and a small investment in a container, I figured it would be worth the effort.

Most oil immersed dummy load designs call for at least one pint of oil coolant to give sufficient cooling. These generally are for dummy loads that handle higher power levels than those at QRP. But a pint is still a good guideline to follow for your design as well.

Also, please note that the **GLASS JAR USED IN THE DUMMY LOAD CONSTRUCTED FOR THIS COLUMN IS FOR ILLUSTRATIVE PURPOSES ONLY** – allowing readers to see the resistor package immersed in the mineral oil. A metal enclosure capable of containing **AT LEAST ONE PINT** of mineral oil is required for a non-radiating dummy load using oil as a heat-dissipating medium. Metal has proven to be a durable, time-tested and safe vehicle for this application**. A GLASS CONTAINER SHOULD NOT BE USED IN AN OPERATIONAL VERSION.**

The accompanying drawing shows the resistors' physical configuration. Part of the diagram shows how two small pieces of printed circuit board can be used to create a dummy load "sandwich" – with the PC board acting as the "bread." The resistors are like the bologna.

One piece of "bread" is connected to the center of the RF signal input jack. The other slice is connected to the ground side of the input jack. This puts the load in operating position: across the output terminal of the RF generating device.

With the resistor banks soldered to the connector, which is positioned on the container's lid, the container can then be filled with mineral oil for further heat dispersion. Affix the lid tightly into place – suspending *and totally covering* the resistors in the oil – and you're ready to roll.

That's all there is to it. Quick and simple. And you'll have a station accessory that if smartly used and cared for, will last a QRPer's lifetime.

WORDS OF WARNING: *Improper design or use of a dummy load even at QRP levels can result in burns or a chance of fire.*

A web site managed by veteran builder and QRPer Monty Northrup, N5ESE, has excellent safety tips – highlighted in red – as well as a bit of theory on dummy load operation. Consider it required reading:
www.io.com/~n5fc/dummy1.htm

The bottom line is to never introduce power levels or key down periods that exceed the projected power limits of your dummy load. And never leave unattended a dummy load during key down periods. As cited on N5ESE's excellent web site: *WARNING! Dummy loads dissipate energy by generating heat. Heat generated in a small space translates to temperature*

Mineral oil, available off the shelf in the laxative area of your local drug store, is a long-used medium in dummy loads.

rise, and temperatures can be hot enough (under the right circumstances) to burn people and ignite adjacent materials. Because of the thermal mass of the dummy load and its enclosure, that heat can stay around for a long time. Always locate your dummy load in a safe place, where there is no chance that it will burn people or catch something on fire.

For more theory and information on dummy load principles using mineral oil, check out the web site:

http://www.seits.org/repeater/dummy2.htm

The schematic, illustration and photographs accompanying this quarter's column touch on the details of building this dummy load. At KI6SN, I found that cutting two pieces of PC board material 1 X 1.25 inches provided two fine pieces of "bread" for our sandwich.

Stacking the pieces of PC board – one on top of the other – it was easy to drill matching holes for the resistor leads to pass through. There are 20 holes in each of the rectangular pieces. Separate the two and place the 20 resistors between them – passing each resistor's leads through the matching PC board holes on each piece of "bread."

Once all the resistors are in place, squeeze the two "slices" so they press against the bodies of the resistors. Then solder each of the 40 resistor leads securely in place. A small hole drilled in the center of each piece of "bread" is the place to solder a wire that connects the resistance load to the input jack.

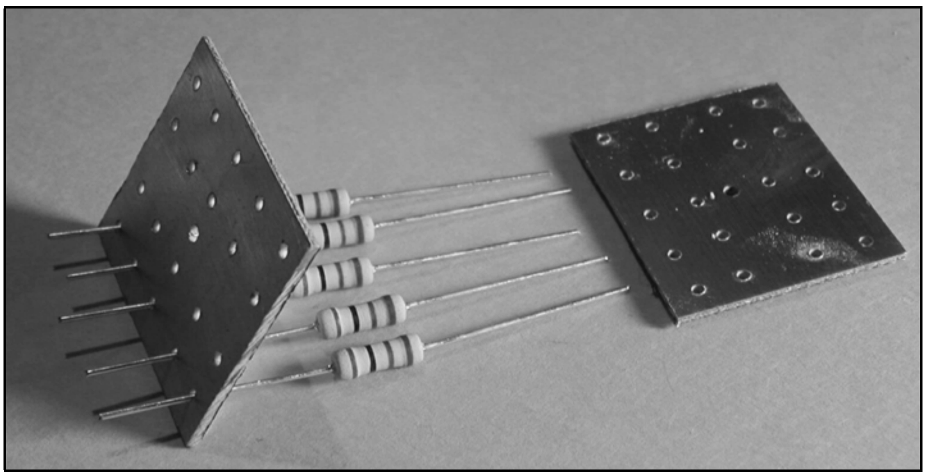
The input jack passes through the lid of your dummy load housing and is fastened tightly to prevent mineral oil from leaking. For extra protection, I sealed the area around the jack's base with hot glue. The resistance load is soldered to the jack and hangs suspended in the mineral oil beneath the lid.

Once the jack and the resistor / PC board "sandwich" have been soldered into place, then it's merely a matter of filling the container with mineral oil, tightly securing the lid and providing an input RF source.

Prior to applying power, check the unit's resistance with an ohmmeter. It should be very close to 50-ohms. If not, check your work.

At KI6SN, the load without mineral oil measured 50.9 ohms. That's right on the money. After adding oil and suspending the package in it, the resistance measured 49.8 ohms.

KI6SN can be reached at 1940 Wetherly Way, Riverside, CA 92506, or by e-mail at ki6sn@aol.com.



Holes are drilled through two pieces of printed circuit board material, with the resistors going between them.

Radio To Go

James Bennett, KA5DVS/6

"Antennas to Go"

I remember being at a hamfest in the NJ area about 10 years ago. I was looking over one seller's table and noticed a good-sized box of aluminum project boxes. I saw several that would be useful for some projects that I had in mind and inquired of the seller as to what was the price. He replied $5. I asked, you mean $5 for each. No, he replied, for the whole box. As there were at least a couple of dozen project cases in the box, I asked again if he was sure. His reply has stuck with me ever since. He said, "They are not worth much since no one builds things anymore." I remember thinking that I still do and there must be others. I just could not accept that there were no other hams that enjoyed tinkering with and building equipment.

A little later, I discovered and joined the QRP-l Internet group. From QRP-l, I came in contact with a group of hams in New Jersey. This was the group that would eventually become the NJQRP club. At last, I had found a group of hams who had fun building things. The rest as they say is history.

I want to congratulate George, Doug, Joe, Jim, Paul and everyone involved with Amqrp on the introduction of the Homebrewer magazine. This is a great day for the QRP movement to see the introduction of such a publication. With the bar set this high, we can all look forward to a great future.

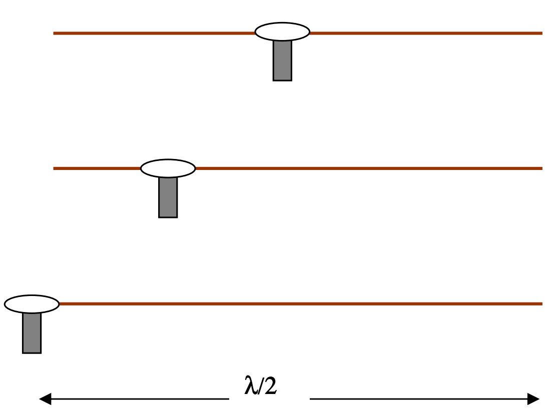
I appreciate the opportunity to bring you this column in Homebrewer. Finally, I can look back to that hamfest experience and think, yes there are hams who still build things. In fact, the QRP movement has heralded a new era in home construction and experimentation. One only has to take a look at all the homebuilt equipment on the cover of the first issue of Homebrewer to confirm that building is alive and well.

Last time around, we looked at options for portable power. This time I will cover some options for lightweight portable antennas and take a look at what works and why.

For portable operation associated with a business or pleasure trip, space is often limited. This is especially the case when traveling by air. Thus, an antenna that is easy to pack, lightweight, quick setup and efficient is desirable. Often, these features are mutually exclusive but not always. The choice of antenna also depends strongly on the conditions of the location chosen for portable operation. Wire antennas can meet the criteria above, however, the dependence on supports may limit their use in some areas.

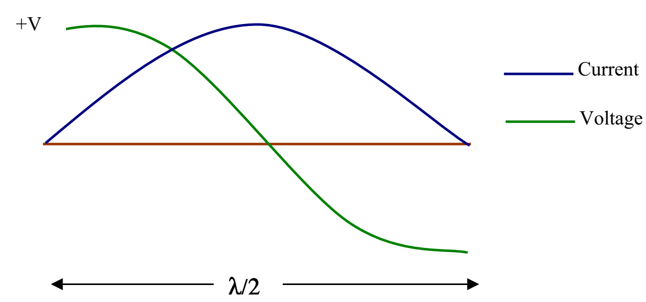
One of the simplest resonant antennas is a half wavelength dipole. Many of us started with and often still use this type of antenna with much success. Let's think a bit about what constitutes a dipole.

Below, is an example of 3 half-wavelength antennas each with a different feedpoint.



Which of these is a true dipole?

This is actually a trick question, as all three of these are dipole antennas. To be a dipole, an antenna must simply be long enough to have 2 electrical poles. This happens at one half wavelength long and thus the antenna is known as a half wavelength dipole. To see why this is the case, consider the following diagram.



Current and voltage distribution in a half wavelength conductor.

This distribution does not change as the feedpoint changes, only the impedance varies. We typically use center feed as that approximates a 50-ohm load. With proper matching, we can feed the antenna anywhere along its length. This gives us some versatility in how the antenna can be erected. It also reduces the dependence on a counterpoise or other ground to complete the missing half of the dipole.

Let's take a look at some practical examples of simple wire antennas.

Simple Center Fed Dipole

For great portability, I have constructed a center fed dipole using a BNC to binding post adapter and two-quarter wavelength sections of wire. This case is an example of a current fed antenna as the feedpoint is at the

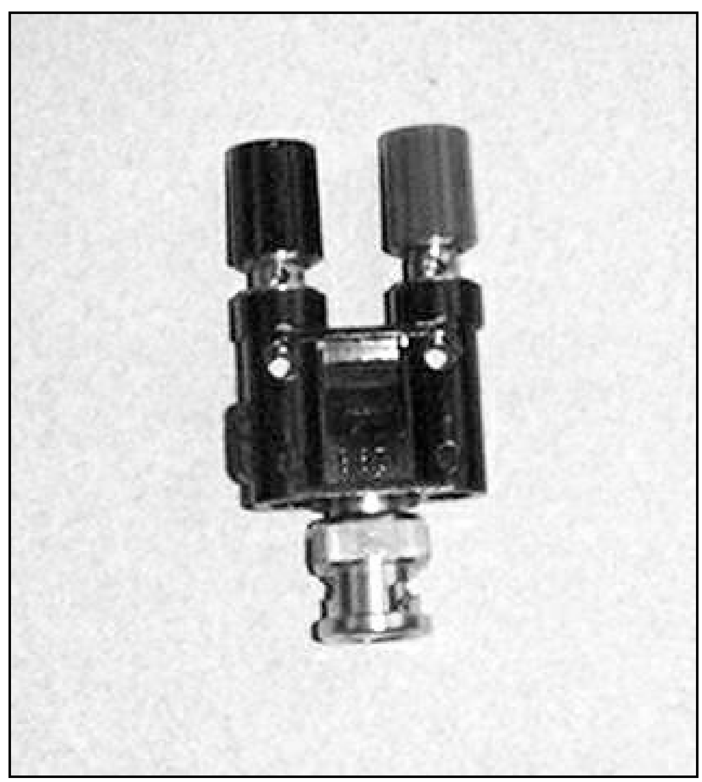
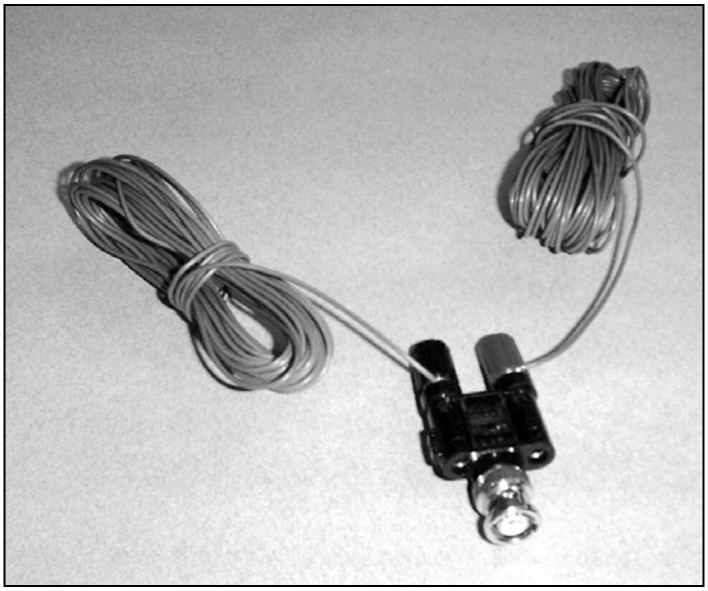


PHOTO 1: BNC adapter

maximum current and minimum voltage. These BNC to binding post adapters are a quick and easy way to quickly assemble a dipole. They are available from many sources including Jameco: www.jameco.com. One of these is a great addition to a travel kit in addition to a small spool of stranded wire.

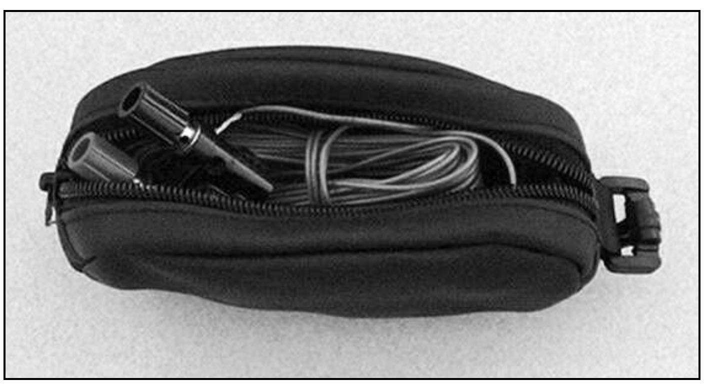
This antenna is simple to construct, and can be reconfigured easily for other bands just by changing the wires.



BNC adapter dipole

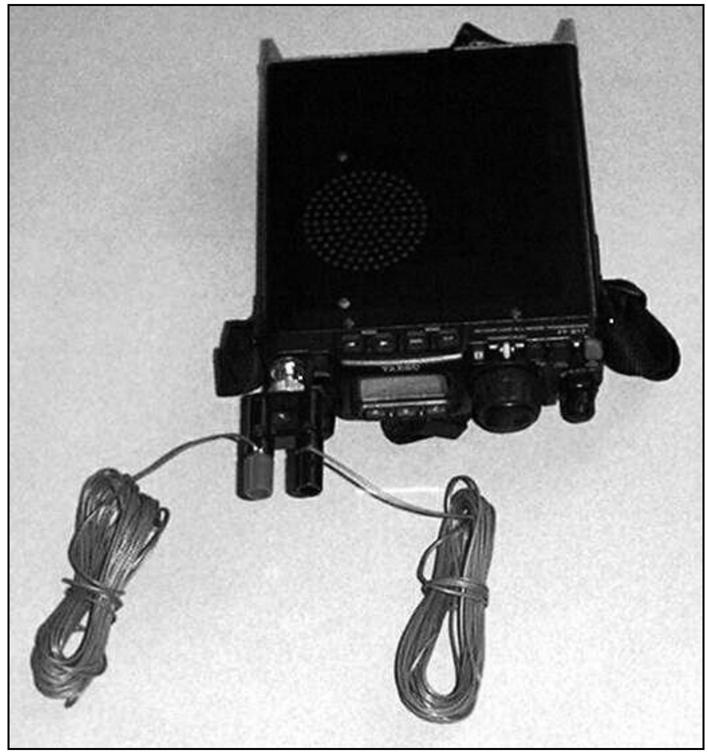
This simple dipole can either be connected to a feedline or just connected directly to the radio antenna jack or to an antenna tuner for multi-band capability. Alternatively, the wires can be cut for the lowest frequency band to be used and coiled up at the ends to shorten for higher frequency.

This antenna only requires a couple of properly spaced trees or other supports or if used with a feedline can be assembled as an inverted vee. It also fits easily into a small pouch for packing. Here is an example of a pouch designed for a MP3 player into which the antenna and adapter fit nicely.



Dipole in small pouch

For quick setup, the adapter may be connected directly to a transceiver or tuner and supported in a V configuration by whatever convenient supports are available.



Dipole on 817

Dipole on Z11 tuner

Of course, a feedline can be used with this configuration as well to allow additional mounting options.

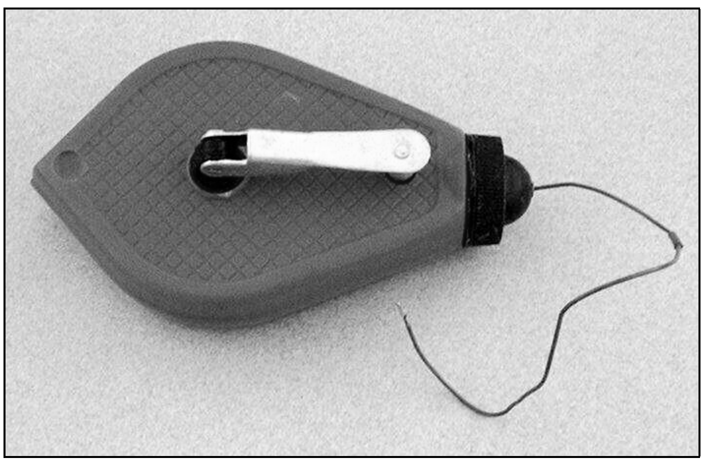
End fed half wave (dipole)

If only one support is available, we can feed a half wavelength of wire at one end and support the opposite end in a tree or other convenient support. This simple configuration comes at a cost however. The feedpoint impedance increases at the ends and requires a matching network. In this case, we are feeding at a voltage maximum (current minimum) and thus the matching network must match the high impedance to the much lower feedline impedance. An example of a matching network for a half wavelength is the circuit used in the NJQRP Rainbow bridge/ tuner. A parallel LC circuit of the proper values provides impedance transformation and allows us to feed the dipole at the end rather than the center. With an Altoids sized box for the Rainbow and a half wavelength of small stranded wire, it is possible to quickly set up a portable station and be on the air. The Rainbow Bridge provides a visual feedback of the match. You can read more about the Rainbow bridge tuner on the NJQRP page: http://www.njqrp.org/Rainbow/rb_home.html.

A half wave antenna system such as this has the advantage of requiring only one support and can be erected horizontally, sloping or as a vertical. As a vertical, it will give omni-directional performance.

Random wire with a tuner

A simple antenna is just a random length section of wire connected to some type of matching network. This network typically contains variable inductance and or capacitance to provide impedance transformation from the 50-ohm transmitter output to the highly variable impedance of the random length wire. Also, only a single support is needed and thus the antenna can be erected quickly. The trade off is the need for the tuner/matching network as well as a match indicator such as a SWR meter. Some newer rigs such as the Elecraft K2 and K1 as well as many others now have built in automatic antenna tuners. This makes using a simple random length wire much easier in the field. In some cases however, the built in tuner may not have sufficient range to match the wire on all bands and multiple wires or a variable length wire may be necessary. Here are a couple of examples of wind up holders for single wire antennas. The first is a chalk line reel filled with wire instead of the chalk line. This idea was posted on QRP-l a few years back and works quite well. The second photo is a Radio Shack catalog # 278-1374A shortwave antenna. It consists of a wire spool containing approximately 30 ft of stranded wire. Both of these can be used with or without a tuner depending on the configuration.



Chalk line antenna reel

RS short-wave antenna

I always carry a small spool of stranded 24AWG wire in my travel kit. It can always be used to build a set of quarter wave wires. I have even heard of some people just stripping the end of a quarter wave wire and inserting it into the center of a SO-239 or BNC jack on a of a radio. It is usually possible to not even cut the wire but just spool off enough to bring it to resonance. It is hard to get much simpler than that.

As we have seen in the examples in this column, a simple dipole antenna either center or end fed can be easily assembled and produces an effective portable antenna. Even if you use another antenna, a simple wire dipole such as the ones described here is a good item to include in a field or emergency pack.

Until Next time

There are many options for portable antennas and I will discuss more of my favorites in future columns. Next time around, I will take a look at portable vertical antennas.

Thanks to all those who sent me notes after my first column. Thank you for reading my column and I hope you have fun taking your radio to go.

72/73

James Bennett

KA5DVS/6

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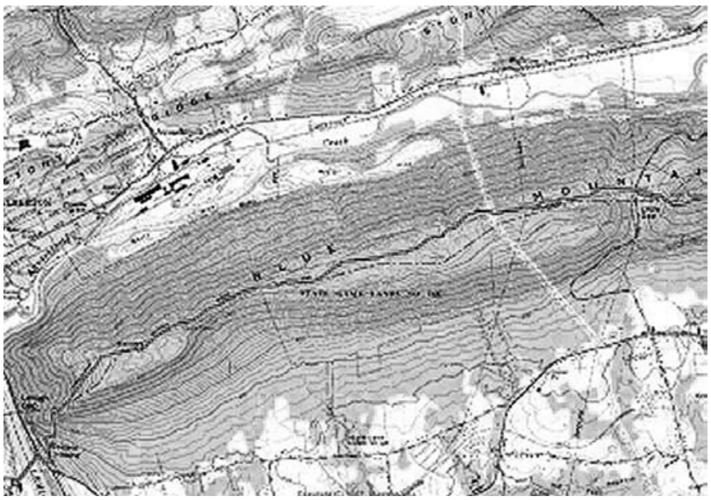
QRP in the Great Outdoors

Ron Polityka, WB3AAL

The other day I was asked a question from a fellow QRP operator. He would like to take his QRP radio to the field and operate from the Great Outdoors. Joe was wondering what he would need for a day trip. This is a very good question that many people never give too much thought; they just make the mad dash out to the wilds.

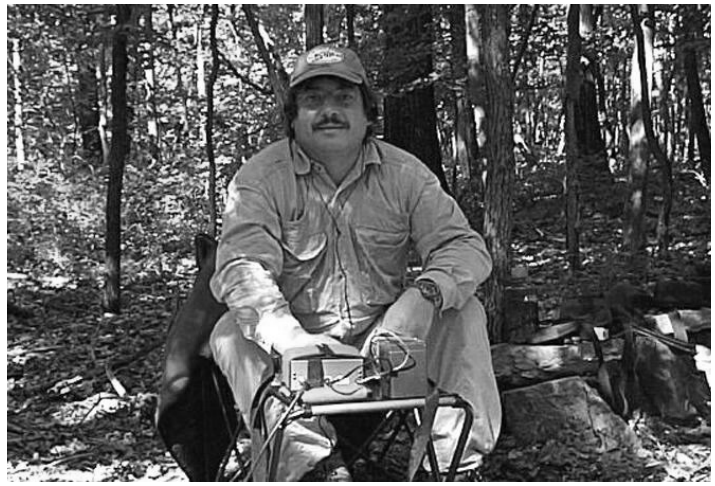
You first need to pick a location on a map that you would like to call Camp QRP. Knowing your limitations is one thing you must consider. Do you plan on driving to Camp QRP or will you be hiking after the paved road ends? No matter what you decide, you need to do a few things to be prepared.



Topographical map of the Lehigh Gap area

The first and most important thing you should do is let someone know of your plans. They should know your time of departure and when you will be home, give or take an hour. You should also give them the specific location of Camp QRP just in case you are hours past your designated time of being home. The next thing that you should do is check out the weather forecast for the area. This way you can be prepared for all kinds of weather. If there is a chance of rain you might want to take along a light weight rain suit. The new suits that are out on the market weigh only ounces.

The radio gear selection will be one of the most important choices you make for your trip. If you plan on hiking into your Camp QRP, you would want to make your pack as light as possible. You will want to take a reliable radio that you have already operated and know how it works. The last thing you would want to do is fumble around outdoors trying to get the radio to work. There is a large selection of radios on the market that are hiker friendly. The next selection you need to make is the power source. This depends largely on the power consumption of the radio. At one time I hike a few hundred yards with a Kenwood TS-50S and a deep cycle battery. This is where the name "Pack Mule" started to follow me around. Now I have graduated to the K1 by Elecraft or my trusty SW+ mono-band rigs by Small Wonder Labs. You will want to choose a battery that will not spill acid on your gear and that will supply enough of current for your expedition. You can hike with a 12 VDC @ 2.5 Ah (amp hour) battery that can last for a few hours of operating time. Also available are five watts solar panels that can be carried in to supplement you power on those bright sunny days if your rig consumes power. The last thing you need is to run out of DC power, so make sure the battery has a full charge.



WB3AAL operating just north of Rt 183 near Strausstown, PA

The other important choice of equipment will be the antenna. Do you want to carry a dipole or a vertical? A dipole is great but you need to have a way to hang it in a tree. If you want to go the route of an inverted-vee you will need only one center support, but with a dipole you might need three supports depending on the transmission line you use.

40 meter dipole

If you plan on using a dipole, you might want to think about a mono-band rig. Maybe you can use ladder line to convert the dipole into a doublet. I tried this with several different types of ladder line. I was not satisfied with the performance. When in the forest, the trees will react with the ladder line and change the operation of the antenna. You might have to experiment with different type of transmission line to make your doublet work. Traps are fine but they are big and bulky when hiking. How do you get the support in the tree? There are a few different ways to string a line in a tree, but you will want to choose one that will not knock you unconscious. If you plan on using a sling shot you will need to check your local and state laws. In some areas a sling shot can be illegal. You can tie a parachute cord onto a rock but I have found the weight of the rock is hard to throw up over a branch that is 15 to 20 feet high. I came up with a low tech device that works great and does not weigh much at all. I use an old tennis ball with a sheet metal screw in the side. Then I tie a 20 pound mono-filament fishing line onto the end and throw it over the branch. I use the fishing line to support my antenna. The one draw back is you can not let any fishing line lay after you have left the area. Fishing line, no matter how big or small, can kill the animals in the outdoors. So if you plan on using this method, please remember all the animals that you are sharing the outdoors with that day. You can substitute the fishing line with nylon twine. Remember that man made items will stay around in the environment for a long time. A few of us are playing around with a vertical antenna that uses the "Black Widow" fishing pole sold by Cabela's. So far we are experimenting with two different types of verticals. The one that Ed, WA3WSJ, has developed is working on 40 and 20 meters with a lot of success. The one I am working on uses a coil that you can tap for the different frequencies. I have run into a small problem with this antenna but I think I am onto working the bug out of the design. The antenna that I am working on should be capable of operating with 100 watts of output. This antenna is being designed for my QRO operations at Lighthouses and Lightships. The vertical has one advantage over the dipole. You do not have to worry about the direction you set up the antenna and the setup time is about five minutes with the radials. Sometime, depending on the tree cover, the dipole can take up to an hour of setup time. To me this is time not on the air working your fellow ham. You will need to make your own decision on the antenna you want to use outdoors.

K1 with Paddlette PK-1 Paddle Key

There are some other pieces of equipment you will need to make a choice on. A good comfortable headset is a must have when copying the Morse code outdoors. When you are chatting to a fellow ham with CW, you want to be sure the series of dits were sent by him and not some pesky wood pecker in the tree above you. This has happen to me and I was not sure what was going on until the dits continued for a few minutes. You can pick up a cheap headset but make sure it will fit your own listening habits when listening to the code. The next item would be the key you use. If you are into straight keys, well that is an easy one to figure out. As for the paddles, you have to have a keyer built into the paddles or the rig. Make sure they are very easy to work with outside and you are comfortable with them.

Poqet PC for logging

Don't forget your paper and pencil or pen. If you have not mastered reading the code in your head this will be a must have item. It will also help to keep a log of who you worked in your expedition. Don't forget about a clock for the QSO time. I have a watch that can be set in the 24 hour format. It will also read the temperature, elevation and barometer. I am a well prepared hiker. I like taking my Poqet PC for logging. It does weigh more than paper but it is nice to keep count of how many QSO's you have made outdoors.

Now onto some of the non-ham items you will need for a day trip of hiking to Camp QRP. I guess the first and foremost item you need is a good comfortable backpack. The new high tech packs that are out on the market can make for an enjoyable hike. If you plan on hiking into the forest a couple of hundred feet you can take a case or a box. You do not have to be high tech for a short jaunt. When I go for a short trip I usually hike in about 500 feet from the road. I use a padded case that I can fit my gear and camera into it with plenty of room to spare. A tree that is down or large rocks would serve as a good chair and table. If you prefer not to sit on the ground you can take along some type of small covering. I sometimes take a small 1/16" foam pad that I picked up in the area where they sell Craftsman tools. This pad is what they use to line the draws of a tool box. It is very light and can be folded into a small square. If you have cabin fever in the winter time you can take a hike like I do. You will need to be prepared for the cold winds so dress warm and take a tent.

Calling CQ on 40 meters

When going out for a day trip you might want to take a small snack. You will need to keep the energy up while making those QSO's. Please remember to take a bottle of water or Gatorade to quench your thirst. If you are out on a hot day you can become dehydrated.

One important item you need to remember is to take along some type of bug spray with Deet in it. This will help keep away the mosquitoes and ticks. The Lime disease and West Nile Virus are becoming a real threat in the Eastern PA area.

The last thing you need to remember during the fall and winter time is your state's hunting seasons. Go into the search engine called Google, it can be found at www.google.com and type in the following: (your state) Hunting Seasons. This should bring up a web site with all your home state's seasons. Be careful and safe when outdoors.

I have been operating from the Appalachian Trail once a month since March 2000. I have logged 336 QSO from the outdoors.

72,

Ron WB3AAL

The author may be reached at 1155 Robeson Street, Second Floor, Reading, PA 19604, or by email at wb3aal@verizon.net.

Tuning Up

Rich Arland, K7SZ

"Sniff … Sniff, Sniff … Sniff, Sniff, Sniff!"

Oh, hello. No, my nose is not running, I was just "sniffing". What, might you say, is "sniffing"? Why, it's using one of the recent kits from the New Jersey QRP Club, the "Sniffer." Prior to Atlanticon 2003, the NJQRP produced a small field strength meter (FSM) kit as part of its Atlanticon festivities and sent them out in advance to all pre-registered attendees. The idea was to have as many attendees as possible build their Sniffer kits and enter a competition that would be held during Atlanticon on Saturday evening. This is one of those events where you had to be there to appreciate the festivities … er, mayhem! The Sniffer competition consisted of scouring the main ballroom, where the Atlanticon forums were, held using your Sniffer to "sniff "out the small RF emitters that had been hidden by the Atlanticon Staff. It truly was "Geek City" watching about forty or fifty people running madly around the ballroom checking out the tables, display stands, flag poles, and even on the Atlanticon Staff members! George Heron, N2APB, had a small RF device in his … well, close to his pants pocket, with the antenna running up his back and down his leg. Let us just say that nobody found the ***exact*** location of that "bug", but George sure had a BIG grin on his face! The Sniffer competition was great fun and one of the most interesting activities during the QRP convention.

Sniffing 101

Why does the average ham need a Field Strength Meter? Quite literally, this one device can be used to do a multitude of things including: checking transmitter output and the outputs of various stages within the transmitter, comparison of antennas in the near and far RF fields, obtaining a rough estimate of a directional antenna pattern, and sweeping your shack for RF bugging devices – hey, I'm not paranoid! If the FSM is made tunable through the desired ranges, then it really becomes an absorption wave meter, provided some form of calibration chart is included to show the general operating frequency. The degree of accuracy is of course somewhat subjective, but you can get a ballpark frequency determination if you are careful in calibrating the scale.

The other big selling point regarding a FSM is that they are easy and inexpensive to build and they provide rudimentary proof that RF energy is present (or not) while troubleshooting gear. Given the simplicity of the overall design, it is hard to beat a FSM.

As you can see, having a FSM or two kicking around the shack is a sound idea. For the ARRL Field Day every QRPer should have at least one FSM on the equipment list just to ensure that the favorite Field Day "Death Ray" antenna is functioning properly. Actually, if you do any antenna experimentation, then a FSM is a must-have piece of test gear. Computer modeling of antenna designs is wonderful but it is entirely theoretical. Erecting your new antenna and comparing the results to a "standard" will tell you a lot more about the new design and how it actually plays compared to using just a computer model. The FSM is ideally suited for this task and can take the guess work out of process.

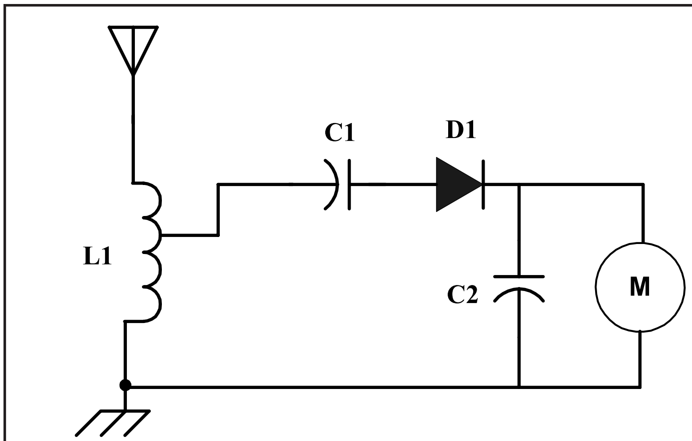


Figure 1

Let's take a look at what makes up a basic FSM and how it works. First, there needs to be some way to capture the RF energy. This can be something as simple as a piece of wire of any length coupled directly to a diode in series with a .001µF capacitor across a small meter. See Figure 1. Crude but workable. This will let you know if there is RF around. It won't tell you much beyond that, like the approximate frequency, and it will be very insensitive – but it ***will*** work. What do you expect for three parts! We can certainly do better.

Figure 2 shows how we can increase the sensitivity by using two diodes to form a voltage doubler. Each half cycle of the incoming RF energy is rectified and stored in an associated capacitor. The output is taken across the capacitor and applied to the meter, which will yield a much more sensitive device. Increased sensitivity can also be achieved by using a 50-microampere meter in place of a 1-milliampere meter movement. With this design sensitivity is greatly improved; however, with no LC tuned circuit components to form a frequency-determining network ahead of the diodes, all we can really determine is that RF is present. We don't know what frequency we are looking at, just that there is some RF there.

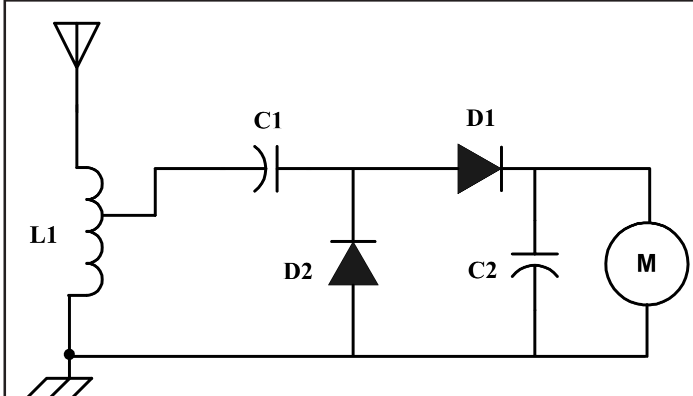


Figure 2

A Diode is a Diode, is a Diode…*NOT!*

Now for a word about silicon diodes: all diodes are not created equal. Standard silicon rectifier diodes – the types we normally use in power supplies for rectification of the AC wave form – have a 0.6 to 0.7 volt forward voltage drop. This means that it takes at least that much to turn the diode "on" and start it conducting.

Would you believe that you can increase the sensitivity of your FSM by using germanium diodes? These diodes have a much lower turn-on voltage. Because the forward voltage drop is about half that of a silicon diode (about 0.3 volts) it takes half as much RF voltage to drive the germanium diode into conduction. This means that you have a much more sensitive instrument because you will not need an extra 0.3 to 0.4 volts to turn the diodes "on".

If you want to really guild the lily, shop around for some hot carrier or Schottky diodes that feature a 0.2 volt forward voltage drop. Not only is the Schottky diode turn-on voltage lower, the time it takes to go from conduction to non-conduction, also known as quick recovery time, is very fast, which means that they can handle much higher frequencies than silicon diodes. Schottky diodes are a bit more expensive, but they provide the ultimate in sensitivity, short of placing some form of DC amplifier ahead of the meter movement. They key here is to shop around and check out places like Dan's Small Parts and other component suppliers on the Internet.

An Absorption Wavemeter

A plain vanilla Field Strength Meter is a great idea, but as stated earlier, without some form of LC tuned circuit ahead of the detector diodes we really don't have what we need. What we QRPers ***really*** need is a frequency selective FSM that will give us an indication of the approximate frequency of the received RF energy. By adding an LC circuit to the input to the FSM we create a very rudimentary form of a frequency selective voltmeter. Figure 3 shows a basic absorption wavemeter. RF energy enters the LC circuitry where the desired frequency is selected and all others are rejected. This RF energy is then rectified by the diodes to provide a voltage that charges the capacitor. This voltage is then displayed on the meter. Notice the only thing we've added is an LC circuit composed of a coil of wire (the "L") and a tunable capacitor (the "C"). As you tune the capacitor through its range, you will be selecting various frequencies that are a product of the L/C ratio ($F_o = 1/2\pi\sqrt{LC}$) If you are only interested in one frequency and want to save money you can make this a fixed frequency device by soldering a fixed mica capacitor across the coil providing the proper LC ratio for the frequency you want to monitor.

By adding taps to the coil, or by selecting one of several inductors, you can achieve the ultimate FSM in the form of a band switched absorption wavemeter. Small molded RF chokes available from Mouser or Digi-Key make great inductors for this application. Likewise, a 365 pF capacitor from a transistor radio will provide your tuning cap. Add a couple of Schottky diodes, a couple of storage capacitors, and a meter movement, and you have the makings of a great little weekend project that will be very useful around your shack, in the mobile and at Field Day.

So you don't like to scrounge parts, huh? Then take the alternative route and contact the New Jersey QRP Club (www.njqrp.org/sniffer) and order one of their "Sniffer Kits" for about $20 plus postage. What a value for only $20! You get all the parts for a tunable FSM that is extremely sensitive. Additionally, you have the opportunity to widen your ham radio horizons by building this simple kit using Manhattan-Style construction. If you've never tried this method of homebrewing a piece of gear, then you really don't know what you're missing. Once hooked on Manhattan-style construction you'll never go back to etched circuit boards! Besides, it's ***FUN!***

Good luck constructing your FSM, no matter which route you choose. The idea is to expand your knowledge and have some fun at the same time. Ultimately you'll gain valuable homebrewing experience and end up with a piece of simple test gear that will make life around the shack a little simpler.

73, Rich K7SZ

email: richard.arland@verizon.net

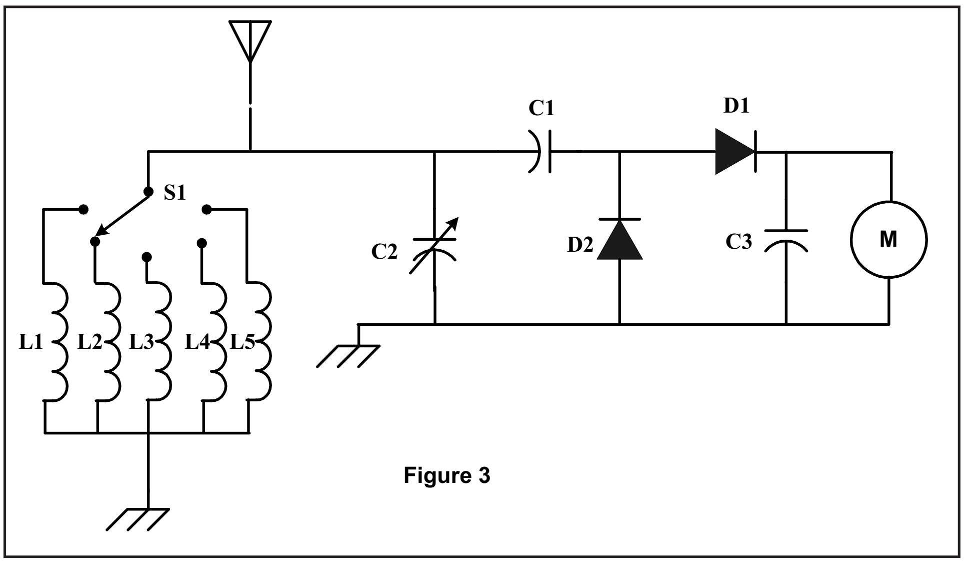
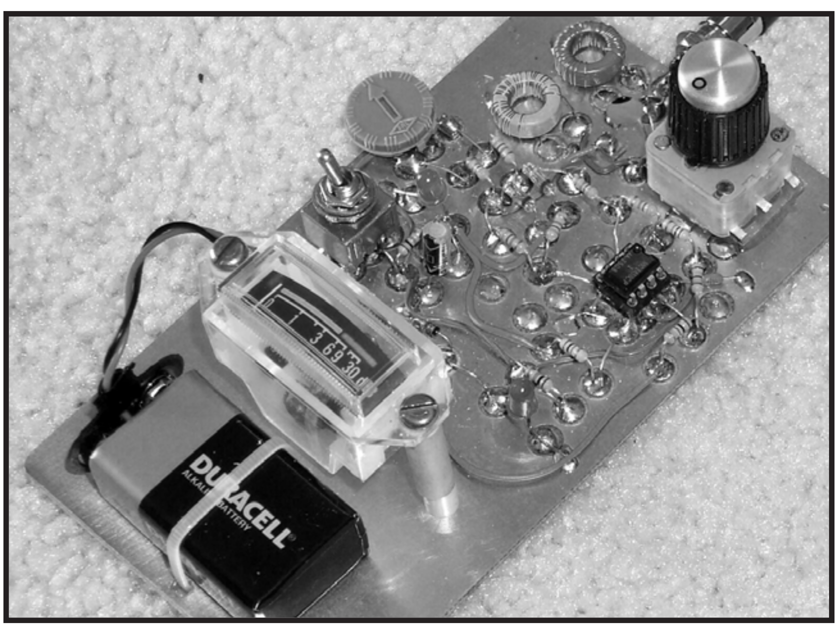


Figure 3



NJQRP Sniffer Field Strength Meter, built Manhattan-style

Four State News

Dave Bixler, W0CH ***email: qrp@netins.net*** http://4sqrp.com

Welcome to the news from the Four State QRP group. I hope everybody has had a good summer and is ready for the cooler temperatures and static-free bands of the fall season.

Here in the middle of the country, July and August were extremely hot months and most of us were content to stay near the air conditioners. Well, to celebrate the return to cooler temperature and the anticipation of the fall indoor QRP operating season, we recently had our second annual fall "Ham-Out". What is a "Ham-Out" you ask? The term "Ham-Out" was coined by Walter Dufrane, AG5P to describe our first fall outing last year. It is a combination camp-out, cook-out, swap meet and field day all rolled into a full weekend of serious QRP outdoor fun.

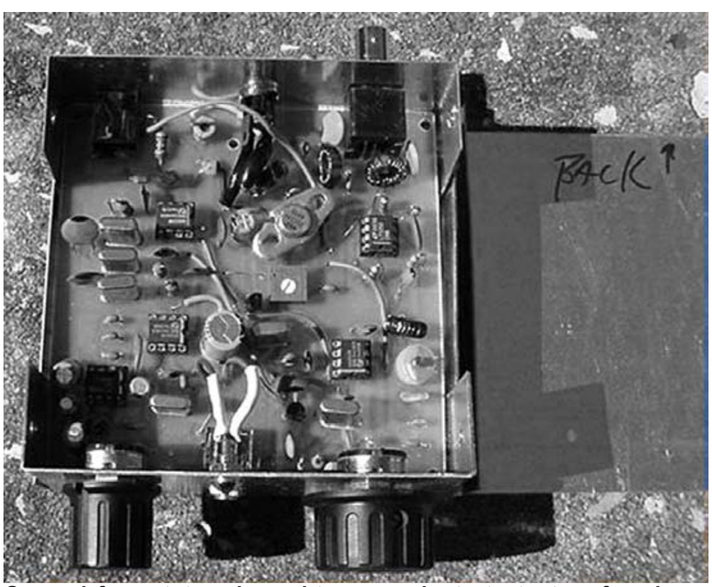
On the weekend of September 19th through the 21st we descended upon the Twin Bridges state park, near Wyandotte, Oklahoma. Located in the north-east corner of Oklahoma at the confluence of the Neosho and Spring Rivers, this is one of nicest state parks in the four state area.

Four intrepid campers, Walter AG5P and Joy NQ5R Dufrane, Gene Sailsbury, NØMQ and Foy Cochran KCØOCK arrived Friday afternoon to stake out the campsites for the group. Bill Holt, AB5XQ and yours truly stopped in later just in time for a round of Joy's delicious charcoal grilled burgers and some lighthearted QRP discussion. The rest of the four state gang arrived Saturday. A total of 21 QRP'ers and guests participated in the activities.

Since the Ham-Out was timed to coincide with the fall NEQRP club's QRP Afield contest, several portable stations were set up to allow participation in the on-the-air operation. Most of the action was on 20 meters and several callsigns were activated to pass out the Oklahoma SPC. Propagation and activity seemed to be sparse, but we had many nice contacts with other QRP'ers from coast to coast.

Rex Terry, KC5UVN another prolific builder, demonstrated a homebrew all-band antenna tuner. Rex band-switched multiple toroids to make the tuner to work everything between 80 and 10 meters. Also, Rex fired up his neat Small Wonder White Mountain 20-meter SSB transceiver, complete with a built-in digital frequency display and internal battery pack.

Jim Shelton, WØEB and Dave Lancey, WDØBBN drove over from Wichita Kansas for the Day. Jim set up a newly constructed Pac-12 antenna for its initial RF test. Jim reports that it worked very well. I noticed that Jim used one the KD1JV "Tenna Dippers" to check out the antenna. Also, Jim brought along his homebuilt KG6CYN DDS signal generator/VFO project that looked and worked really nice.



Several four-staters brought new gadgets to test or for show-and-tell. Bill Holt AB5XQ, who is a very proficient builder, brought his just-finished scratch-built 40-meter SST. Bill etched his own PC board and even made the case himself. A real work of beauty, Bill put it on-the-air for several QSO's.

Local ham and homebrewer Jay Rupar, KØETC from Joplin, brought his new DDS VFO project for show and tell. Jay built it with the NJQRP Daughterboard kit. He's using software written by another area ham, WBØLQZ. The VFO sweeps from 10 Hz to 30 MHz. Looks like DDS technology is here to stay and is now within the reach of the average QRPer.

One of the main attractions of the Ham-Out is the lunch banquet. Joy NQ5R, made up two big pans of pot roast for the main course. Add to that all the veggies and side dishes, it was one super meal. And to top it off, Tom N2UHC brought a big bowl of his wife Jeanette's famous "Pink Stuff" for desert. Talk about good eating! You didn't have to ring the dinner bell twice around here!

After lunch, some parts swapping and horse trading went on around the two swap tables and Larry Sparks, NØBHU's car trunk. A lot of good stuff found new homes and one QRP'er even found a new beam antenna for the upper HF bands. Building parts are always popular around here and I found a couple of nice aluminum project boxes and a three gang variable capacitor (thanks Walter) for this winter's building season.

Later in the day, Bob Dyer, K6KK of Wilderness Radio fame dropped in for a visit. Bob has recently relocated to Joplin, Missouri and reports that Wilderness is back in business after the move from California. It's really great to see Bob here in Four State area and we look forward to having a local source for the famous Wilderness QRP line of kits.

Saturday evening, Joy fired up the charcoal grill and we all enjoyed a round of hamburgers and other treats. We operated CW and discussed QRP under kerosene lamp light well into the evening before retiring to our tents for a well deserved sleep and dreams of homebrew rigs. Sunday morning, Joy did her magic again with campfire biscuits and gravy. How she does that, I have no clue, but they sure were tasty!

Hey, that reminds me that 4SQRP is going to have another builder's contest. Look for the details on the group web site soon and if you can make to the March meeting, you can see some of the nicest home-built stuff in QRP-land.

Well, that's enough for now. 72 for now and I'll see you in the next HOMEBREWER. I hope you all have a nice fall season and work some good DX!

N2CQ QRP Contesting Calendar

Ken Newman, N2CQ

Tips and Tricks for QRP Contesting

I'm guessing that the average HOMEBREWER subscriber is "melting solder" more often than into contesting. QRP however has many other fun outlets and what could be more fun than making your own rig or kit and using it in a contest to see how it well does? Some may be unsure if they can't operate at the average 20 WPM on QRP contests. Not to worry! Most QRP Contesters will answer your call at the speed you use - even at 10-15 wpm!. I know some RTTY fans can work some CW contests using RTTY software or a TNC that can actually copy CW and put it on the screen. The MFJ TNC I have does surprisingly well.This could get you started until your speed builds up. Future issues should include more basic tips to help contesting more fun so ...

Look at the Contest Calendar below, select one that looks interesting, and get the rules at the website. For a suggestion, a good strart could be the very popular Amateur Radio Society (ARS) Spartan Sprint on the first Monday of each month.

First Tip of the Month: Keep your station and log in UTC time as most hams do. The first Spartan Sprint on the Calendar is Dec 2 0200z-0400z (Z=UTC). Being sure you are on at the same time as the other contesters, that is Dec 1 from 9PM to 11PM EST, would be a big help!

Try QRP contesting and we'll look for you!

Any contesters out there can share some of their QRP contesting tips by sending them to me and I'll be happy to publish it in an upcoming column.

See www.amqrp.org/contesting for monthly listings and active links.

72,

Ken Newman, N2CQ

email: n2cq@comcast.net

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N2CQ QRP CONTEST CALENDAR

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AGB NYSB -"New Year SnowBall" Contest
Jan 1, 0000z to 0100z
http://www.qsl.net/eu1eu/agb_nysb.htm

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AGCW Happy New Year Contest
Jan 1, 0900z to 1200z
http://www.agcw.de/

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The World QRP Federation (WQF) QRP Party
Jan 3, 0000z to 2400z
http://ruqrp.narod.ru/index_e.html

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AGCW-DL QRP Winter Contest (CW)
Jan 3, 1500z to Jan 4, 1500z
Rules: http://home.online.no/~janalme/rules/agcwdl.txt

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Adventure Radio Society - Spartan Sprint (CW)
Jan 6, 0200z to 0400z (Monday Evening US/Canada)
http://www.arsqrp.com/

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Fox Hunt (Tue Eve USA)
Jan 7, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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North American QSO Party (CW)
Jan 10, 1800z to Jan 11, 0600z
http://www.ncjweb.com/naqprules.php

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Fox Hunt (Tue Eve USA)
Jan 14, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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070 Club PSKFEST Contest
Jan 17, 0000z to 2400z
http://www.podxs.com/html/pskfest.html

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Michigan QRP Club Contest (CW)
Jan 17, 1200z to Jan 18, 2359z
http://www.qsl.net/miqrpclub

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LZ OPEN CONTEST (CW 80M/40M)
Jan 17, 1200z to 2000z
http://www.qsl.net/lz1fw/lzopen/index.html

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North American QSO Party (SSB)
Jan 17, 1800z to Jan 18, 0600z
http://www.ncjweb.com/naqprules.php

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Run For The Bacon (CW)
Jan 19, 0100z to 0300z
http://fpqrp.com

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Fox Hunt (Tue Eve USA)
Jan 21, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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CQ WW 160-Meter DX Contest (CW)
Jan 24, 0000z to Jan 25, 2359z
http://www.cq-amateur-radio.com/awards.html

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Fox Hunt (Tue Eve USA)
Jan 28, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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UBA DX Contest (Belgian) (SSB)
Jan 31, 1300z to Feb 1, 1300z
http://www.uba.be

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North American Sprint (CW) ... QRP Category
Feb 1, 0000z to 0400z
Rules: http://www.ncjweb.com/sprintrules.php

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Adventure Radio Society - Spartan Sprint (CW) ... QRP Contest!
Feb 3, 0200z to 0400z (Monday Evening US/Canada)
Rules: http://www.arsqrp.com/

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Fox Hunt (Tue Eve USA)
Feb 4, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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New Hampshire QSO Party (All) ... QRP Category
Feb 7, 0000z to Feb 8, 2400z
Rules: http://www.sk3bg.se/contest/nhqp.htm

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10-10 Int. Winter QSO Party (SSB - Ten Meters) ... QRP Category
Feb 7, 0001z to Feb 8, 2400z
Rules: http://www.ten-ten.org/

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Minnesota QSO Party (All) ... QRP Category
Feb 7, 1400z to 2400z
Rules: http://www.w0aa.org/

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AGCW Straight Key QSO Party (CW 80M) ... QRP Category
Feb 7, 1600z to 1900z
Rules: http://www.agcw.de/

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North American Sprint (Phone)
Feb 8, 0000z to 0400z
http://www.ncjweb.com/sprintrules.php

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Fox Hunt (Tue Eve USA)
Feb 11, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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FISTS Winter Sprint
Feb 14, 1700z to 2100z
http://www.fists.org/sprints.html

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QRP ARCI Fireside Sprint
Feb 15, 2000z to 2400z
http://personal.palouse.net/rfoltz/arci/firesid.htm

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Run For The Bacon
Feb 16, 0100z to 0300z
http://fpqrp.com

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Fox Hunt (Tue Eve USA)
Feb 18, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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ARRL International DX CW Contest
Feb 21, 0000z to Feb 22, 2400z
http://www.arrl.org/contests/

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Colorado QRP Club Winter QSO Party
Feb 22, 2200z to Feb 23, 0359z
http://www.cqc.org/contests

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Fox Hunt (Tue Eve USA)
Feb 25, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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CQ WW 160-Meter DX SSB Contest
Feb 28, 0000z to Feb 29, 2359z
http://www.cq-amateur-radio.com/awards.html

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UBA DX CW Contest
Feb 28, 1300z to Feb 29, 1300z
http://www.uba.be

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FBYO Winter QRP Field Day
Feb 28, 1600z to 2400z
http://www.extremezone.com/~nk7m/

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High Speed CW Club Contest
Feb 29, 0900z to 1100z & 1500z to 1700z
http://www.morsecode.dutch.nl/hscindex.html

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Adventure Radio Society - Spartan Sprint
Mar 2, 0200z to 0400z (Monday evening in US/Canada)
http://www.arsqrp.com/

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Fox Hunt (Tue Eve USA)
Mar 3, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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CZEBRIS Contest
Mar 5, 1600z to Mar 7, 2359z
http://www.sk3bg.se/contest/czebris.htm

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ARRL International DX Contest (SSB)
Mar 6, 0000z to Mar 7, 2400z
http://www.arrl.org/contests/calendar.html?year=2004

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Fox Hunt (Tue Eve USA)
Mar 10, 0200z to 0400z - http://www.cqc.org
Truffle Hunt
30 min before Fox Hunt - http://fpqrp.com

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Pesky Texan Armadillo Chase
Mar 11, 0200z to 0400z
http://www.w5nc.org/ptac/default.htm

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AGCW QRP Contest
Mar 13, 1400z to 2000z
http://www.agcw.de

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Elecraft QSO Party
Mar 13, 1500z to Mar 14, 1500z
http://www.elecraft.com

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Second Class Operator's Club Marathon Sprint
Mar 13, 1800z to 2400z
http://www.qsl.net/soc/contests.htm

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North American Sprint (RTTY)
Mar 14, 0000z to 0400z
http://www.ncjweb.com/sprintrules.php

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UBA (Belgian) Spring Contest
Mar 14, 0700z to 1100z
http://www.uba.be/

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Wisconsin QSO Party
Mar 14, 1800z to Mar 15, 0100z
http://www.warac.org

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Somerset Homebrew Contest
Mar 20, 0000z to 2400z (Any 4 hours)
http://www.sk3bg.se/contest/somerset.htm

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Virginia QSO Party
Mar 20, 1800z to Mar 22, 0200z
http://www.qsl.net/sterling/uf1.htm

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Spring QRP Homebrewer Sprint
Mar 22, 0000z to 0400z (Sunday evening in US/Canada)
http://www.njqrp.org/data/qrphomebrewersprint.html

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AmQRP KITS

"PIC-EL" -- www.amqrp.org/elmer160/board
*Multi-function PIC16F84A-based project board used in the online PIC Elmer 160 course ...**$35** (DX + $4)*

Micro908 Antenna Analyzer -- www.amqrp.org/kits/micro908
Handheld control & computing platform for antenna measurement, PSK31 digital modems, signal source & VFO, audio filters, and more. (See web page for introductory price, or email to n2apb@amqrp.org, or write to N2APB at address below.)

NJQRP KITS

SOP Receiver Kit -- www.njqrp.org/sop
Direct Conversion receiver for 80m/40m. Easy assembly, easy to mod. Good manuals.
Basic SOP Receiver kit ... $38 (DX + $8)
Audio Frequency Dial ... $10 (available only with Basic kit)
Controls & Jacks Option ... $10 (available only with Basic kit)

HC908 Daughtercard -- www.njqrp.org/hc908
*Self-contained, in-circuit programmable microcontroller for Micro908 Antenna Analyzer II, HC908 Commander, etc ... **$40** (DX + $8)*

DDS Daughtercard -- www.njqrp.org/dds
*A precison dc-30 MHz DDS VFO-on-a-card with 101 uses ... **$23** (DX + $5)*

Islander Amp -- www.njqrp.org/islanderamp
A simple audio amplifier built Manhattan-style using the Islander Pad Cutter (sold separately) ... $9 (DX + $3)

"Badger" SmartBadge Kit -- www.njqrp.org/badger
*Morse-sounding ID badge with customized faceplate ...**$20** (DX + $5)*

"Islander" Pad Cutter -- www.njqrp.org/islanderpadcutter
*Diamond-tipped end mill cuts 5mm isolated pads in copper pcb..... **$9** (DX + $3)*

N2CAU "Tip Tapper" Iambic Paddle -- www.njqrp.org/tiptapper/index.html
*Credit card-sized, tactile contacts, waterproof, customized faceplate ... **$29** (DX +$5)*

Atlanticon 2004 QRP Forum -- www.njqrp.org/atlanticon
*Our fifth year for this fabulous QRP weekend! It's being held at the Holiday Inn Select (Baltimore North) in Timonium, MD on March 26-27. Attendees see a full day of QRP presentations, and get the proceedings, badge and the famous "Atlanticon Kit" in advance for the fun activities planned that Saturday night. Register in advance: **$10.***

PSK31 Audio Beacon Kit -- www.njqrp.org/psk31beacon/psk31beacon.html
*Board generates PSK31 audio tones from programmed character string, suitable as input to transmitter or decode with DigiPan PSK31 PC software ..... **$25** (DX + $5)*

N2CX Halfer Antenna -- www.njqrp.org/n2cxantennas/halfer/halfer.html
*End-fed half-wave & counterpoise wires for 40m. Includes insulators & detailed application notes. .... **$9** (DX + $3)*

NK0E "Serial Sender" Kit -- www.njqrp.org/palmserialsender
Electronic keyer and interface between Palm PDA running GOlog contest logger and rig, keys rig with contest info, software for plug-in paddles, includes enclosure ... $34 (DX + 5)

Atlanticon Proceedings -- www.njqrp.org/atlanticon/proceedings.html
Bound sets of QRP articles and technical material on homebrew projects and operating practices, with fold-out schematics and block diagrams from past Atlanticon QRP Forums.
*Atlanticon 2002 .... **$15** (DX + $3)*
Atlanticon 2003 .... $10 (DX + $3)

NJQRP Website-on-CDROM, Volume 1 -- www.njqrp.org/cdrom
CD-ROM contains all projects, kit info, articles, meeting recaps & photos ever published on the NJQRP website over its 5 year history. Great for quick 'n easy reference. ... $10 (DX+3)

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2419 Feather Mae Ct.
Forest Hill, MD 21050
Or pay by PayPal to n2apb@amsat.org

4SQRP KITS

KD1JV Tenna Dipper -- http://4sqrp.com
A low power antenna analyzer and ATU tuning aid ... **$25 for US** (DX add $4)
Order from: Gene Sailsbury, 603 North Free Kings Hwy, Pittsburg, KS 66762

AZ ScQRPion KITS

W5JH Brass Paddle -- www.swlink.net/~w5jh/brasspaddle.htm
Dual-lever paddle made almost entirely of brass ... **$25 for US**
Order from: J. Haigwood, 6926 W. Charter Oak Rd., Peoria, AZ 85381

NORCAL KITS

NorCal Keyer — www.amqrp.org/kits/NCKeyer
*Memory keyer, with 3 programmable 40-character memories, iambic A & B mode, straight key and bug mode, 2 beacon modes, and variable speed control by either a 100K pot or the paddles themselves **.... $15***
Order by sending check/MO to Doug Hendricks, 862 Frank Ave, Dos Palos, CA 93620.

Resistor Kit -- www.amqrp.org/kits/resistor
*A resistor kit of 2000 1/4-watt carbon film resistors with 25 of each of the common values ... **$25 for US & Canada** (DX add $4)*
Sending check/MO to Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821

BLT Tuner -- www.amqrp.org/kits/blt
*A simple Z-Match antenna tuner for QRP use on 10m-40m. Includes new aluminum case! ... **$39 for US & Canada** (DX add $6)*
Sending check/MO to Doug Hendricks, 862 Frank Ave, Dos Palos, CA 93620.

NorCal Crystals -- www.amqrp.org/kits/crystals
*Crystals for QRP calling freqs on 20, 30, 40 and 80 meters ... **$3 each** for 7.040, 10.116 and 14.060, and **$.25 each** for 3.579*
Sending check/MO to Doug Hendricks, 862 Frank Ave, Dos Palos, CA 93620.

About ... HOMEBREWER Magazine

WHAT IS HOMEBREWER?

HOMEBREWER Magazine is a full-size, 60+ page quarterly publication of the American QRP Club. It is intended for builders, experimenters, ham radio operators and low power enthusiasts all around the world.

Each issue, HOMEBREWER features many of homebrew projects for beginners all the way up to the advanced digital and RF experimenters.

HOMEBREWER also has regular columns and contributions on membership happenings, field operations, commercial equipment reviews and contesting.

FORMAT

HOMEBREWER is a larger-format, increased content version of either QRPp or QHB magazine. It is at least 60 pages containing content-rich homebrewing and construction material, with additional sections dealing with operating, contesting and local club happenings throughout the country.

ANNUAL CD-ROM

On an annual basis, included in every 4th issue starting with HB #5, we include in the envelope a CD-ROM containing PDF versions of each of the previous four issues, including bonus material: software, tools and reference material.

"HB Extra!"

A very nice extra feature for subscribers of HOMEBREWER can be found online at www.amqrp.org/homebrewer/extra ... "reprints" of all graphics published in past issues of the magazine, and most of these reprints are in full color and increased resolution!

Each black & white issue of HOMEBREWER is brought to life in even greater detail for HB readers at this website through the presentation of graphics in their original vivid color. To make it even better yet, we're able to present additional graphics that many times don't make it to the printed journal due to size limitations.

HB Extra! is not a full online version of each issue. HOMEBREWER will remain a printed journal of QRP operating and homebrewing adventures. However, with HB Extra! the staff of HOMEBREWER and each individual author wish to augment the reader's overall experience by providing Extra material to help in understanding and enjoyment of the article topics.

QUALITY

The quality of journal is intended to be first class in every respect, including technical content, editing integrity and journalistic standards. We know the combined subscriber bases of QRPp and QHB will enjoy this publication aspect of the American QRP Club.

HOW MANY ISSUES DO YOU HAVE?

Those with residual QRPp and QHB subscriptions will receive HOMEBREWER in fulfillment of prior subscriptions. For example, if you had two issues remaining in your QRPp subscription, and four issues remaining in your QHB subscription, you will receive six issues of HOMEBREWER magazine. After that, or even before, you can renew your HOMEBREWER subscription at the regular price.

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