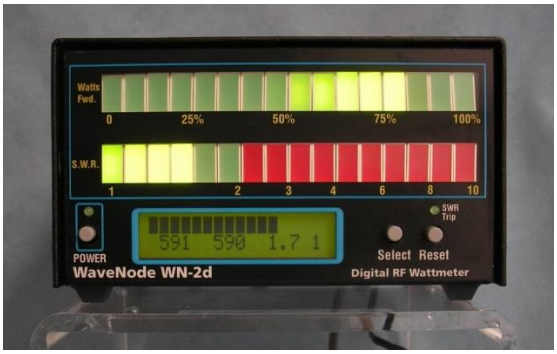
Manual of Operation for WaveNode Model WN-2d .

Revision 2.0



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1. GENERAL DESCRIPTION OF OPERATION

The Basic Station Monitor consists of the WN-2d signal processing unit and in-line coax sensors. The WN-2d contains all signal processing for four coax in-line sensors, and no calibration is necessary. The interface to the computer is made via USB port.

Future software enhancements will be made available at the WaveNode website at:
www.wavenode.com.

Software Upgrades are ALWAYS made available to WN-2d owners at NO charge.

2. WN-2d FEATURES:

Stand-alone operation, or run in conjunction with your PC for simultaneous viewing of all four channels. Powerful 16-bit RISC processor with 12-bit A/D converter allows fast sampling and data transfer via USB port. Local selection on the unit of Channel number, SWR reset, and input/output port monitoring.

- The RF sensor modules require no user calibration. The user can add additional sensors at any time. Accuracy is guaranteed when installed at any time with factory calibration.

- All input sensors are sampled **simultaneously** for forward and reflected power in the signal processing unit by a 12-bit A to D converter for maximum resolution and repeatability. The user will be surprised by the resolution and accuracy provided by this instrument at any power level.
- The sensor values are digitally processed to provide Peak, Average and accumulated power. Sensor values are compared for gain, linearity, and statistical views of transmitted RF. Continuous graphical displays are provided for gain, speech compression, SWR, Peak, Average power, and other data.

- The user can label the meter titles and add additional graphic information to the interface screen to personalize the screen as he likes. Meter titles can be changed as station equipment is changed or re-configured by the operator. Your screen is personalized to minimize confusion about which sensor is monitoring which antenna or tuner input.

- The RF power is sampled .each 50 milliseconds, and all data is updated. All data and statistics are updated, and accurate data is provided in any transmission mode including SSB. This allows manual tuner optimizing even in SSB mode. A single CW dit gives accurate power and SWR data that is held on the screen for a user selectable time up to 1 second.

- SWR Protection is provided on any of the four input sensors. The operator selects which sensor is to be monitored. The SWR trip level and time duration can be set to provide protection for linear amplifiers and other SWR sensitive equipment. When SWR exceeds the level and time set by the operator. An internal relay is latched and the sensor panel reporting an SWR failure flashes RED until the reset button on the graphical screen is pressed. If the software is running in Background mode, a message will pop up on the screen and an audio alert will sound.

- An LED shows proper interface communication to the computer. Proper WN-2d operation is indicated on the graphical screen for Network -based Monitoring.

- Supply power can be provided via a wall transformer supply, or any station supply of 11 to 16 volts DC.

- Power Ranges are selected by the user, or an auto-ranging mode can be chosen. Each sensor has independent range selection.

- SWR display is shown on a panel for each sensor. In addition, SWR is shown on a graphical pie-chart-style indicator for easy adjustment of antenna tuners. No staring at crossed-meter SWR indicators again.

- Accurate Peak RF power is assured by use of a precision analog Sample-and-Reset circuit for each sensor. The Peak Power reported is the true Peak Envelope Power during each 50 millisecond sampling period.

- A complete menu of SWR graphing capability is provided. An SWR graph can be generated for any combination of the four in-line RF sensors. Frequency range and frequency interval are chosen by the user. The minimum power required is 2 watts.

- Audio announcing of RF Power, SWR, and SWR protection events. Useful to the visually-impaired operator. Single key strokes make the announcement.

- All graphs, button selections, screen positions, etc are saved on power down. The software will return to the same state when re-opened. This saves you time when starting up the software.

3. ADDITIONAL INPUTS/OUTPUTS AVAILABLE TO THE OPERATOR:

A. Four Logic Outputs:

Four additional outputs that are controlled by buttons on the graphical screen are provided to be used as desired. Some possible uses include amplifier control, antenna switching, or on/off control of remote equipment.

B. Four Analog Inputs:

These inputs are available to the operator to be configured as desired and their value is continuously updated on an auxiliary meter viewing panel. Potential uses include Linear Amplifier monitor functions that have traditionally been done with mechanical panel meters. These analog inputs have a total range of 0-20 volts, and are viewed on the four meters on the Aux #1 Screen.

Additional information on these functions are available on the WaveNode website and on the CDROM. Circuit information is also provided to use these I/O ports in practical applications.

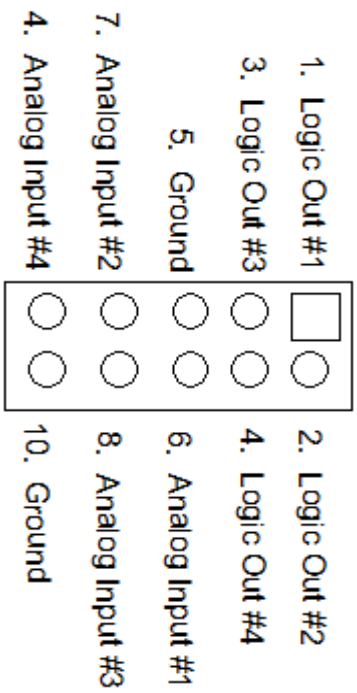


Figure #1. The Expansion Connector (Rear Panel)

Pin Assignment and Function for Expansion Connector

4. INSTALLATION AND CHECK-OUT:

A. Each sensor is factory calibrated and is ready for plug-in and use. Plug the sensor(s) into the rear panel 6-pin MiniDin connectors, and the USB cable to any computer USB port. Refer to figure 8 to locate the connector locations.

B. Insert the installation disk into your CD-ROM. Follow the instructions "Wavenode WN-2(d)(m) Installation Instructions" found in the root directory. A printed installation sheet is provided with the unit. Also note that the CD contains a separate directory with useful information about your WN-2d system.

C. Choose how to power your interface unit. You can choose either "wall-wart" operation, or a simple connection to an external 11-13 volt supply. Maximum current is 320 ma. (270 ma. typical).

Power the WN-2d control box :

1. Plug in a 12V DC supply (5.5/2.1 mm plug, +12 volt center pin) into the WN-2d supply plug.

2. Start the software. The flashing LED on the front panel will indicate the unit is communicating correctly with your computer. Each LED on or off represents a sample update of the video data. The round communication indication on the PC screen also indicates correct USB operation when flashing Green.

3. Each RF sensor is placed in series with the coax cable to be monitored. Coax cables should be kept as short as possible between Transceivers and sensors.

4. If linear amplifier performance monitoring is desired, sensors must be installed in series with the amplifier's input and output.

VOLTAGES TO THE SWR PROTECTION RELAY MUST NOT EXCEED 20 VOLTS DC. IF YOUR APPLICATION REQUIRES 120 VAC OPERATION, YOU MUST USE AN EXTERNAL BUFFER RELAY WHOSE COIL CAN OPERATE ON < 20 VDC.

5. GRAPHICAL MENUS:

The graphical screens consist of a top screen and several secondary screens that can be activated to provide additional graphical data screens. Closing a screen does not stop the data gathering functions for that screen, the data screen is simply not visible until re-activated. Pausing the mouse over a button or display will give a short text description for that item.
Also, clicking the Mouse button over any of the Meters will provide a large view of that meter for easy viewing at a distance.

A. TOP SCREEN:

The top screen has four meter panels as shown below. Each meter panel indicates updated data every 50 milliseconds. The top panel also has list boxes to select SWR metering, SWR trip level, and SWR fault time to trigger an SWR fault warning. Large versions of each meter can be turned ON by clicking on a meter. The SWR protection circuit operates even if the screen is closed to the system tray.

You can observe a single, large meter by clicking on any meter, then minimizing the large screen with the "Minimize" selection in the top row of the Main screen. Minimizing the Main screen will allow a small Message screen to pop up in the event of an SWR protection event, even if the Main Screen is not visible. Minimizing the screen with the Minimize selection on the Menu Bar is preferable to using the "-" button at the top-right.

A panel box allows selection of Peak or Average to be displayed in the meter panels. The peak hold time and averaging time are also selected by list boxes. Note that the graphical meters show peak and average power at all times.

The four auxiliary digital outputs are set or reset with the buttons on the bottom row. At Bottom-Left a button is provided to toggle the Audio Announcing feature On or Off.

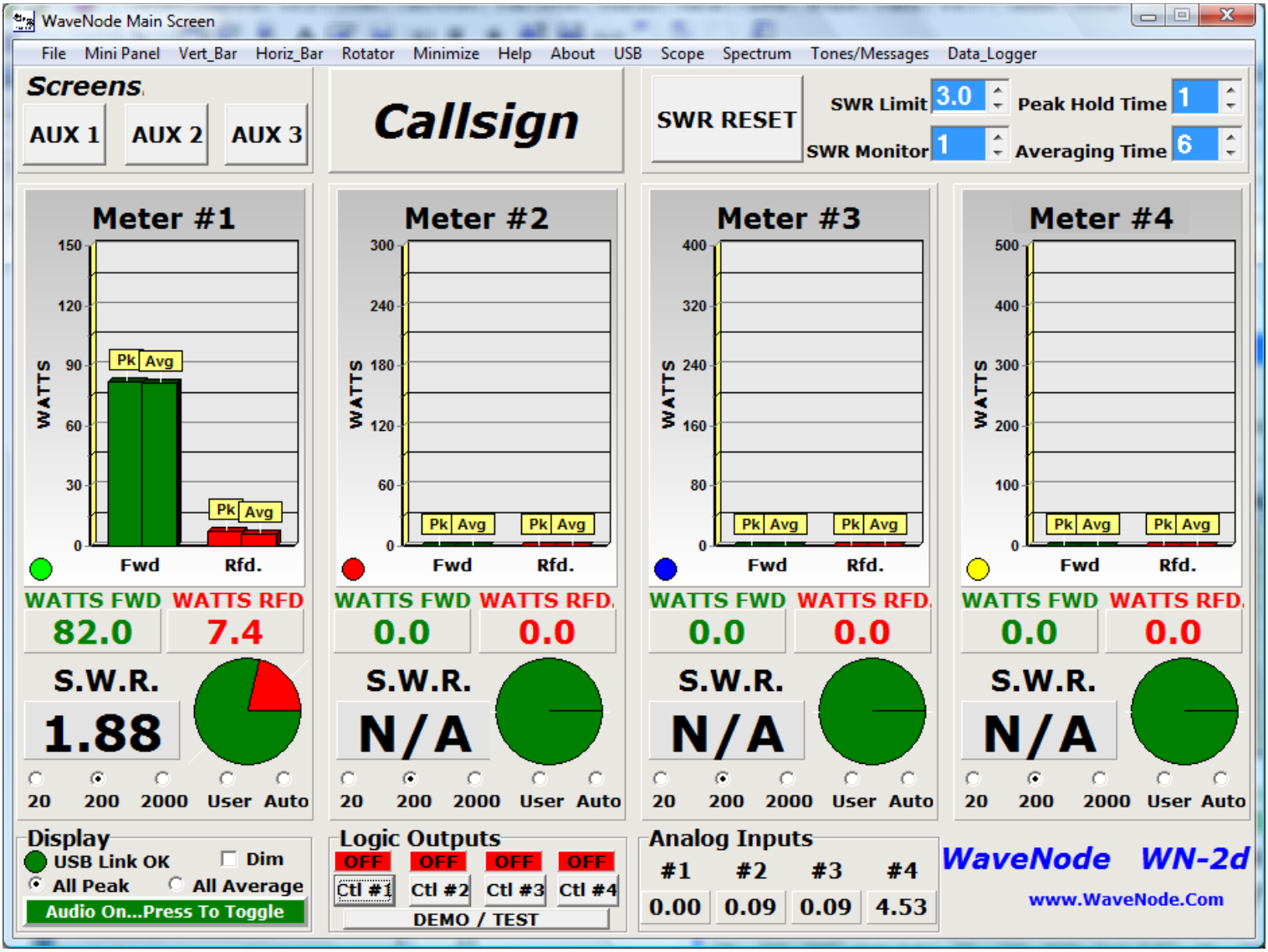


FIGURE 2. - Main screen of Wavenode Interface.

The "Callsign", Meter Titles, and preferences are input by the operator and saved.

B. POWER SCREEN (Aux #1):

This panel displays the elapsed average RF power, and the auxiliary meters that display the auxiliary analog inputs. The operator can program and use these inputs to display other station data. These meters are set in software to read the four auxiliary analog inputs. All four auxiliary inputs are available on the rear panel expansion connector (10 pin ribbon connector).. The scale is 0-20 Volts DC.

Notice that the Configuration Menu on Figure #9 provides the user with a method to label the title, vertical axis and Vertical Maximum on each meter. The "Scale Factor" input box allows the user to scale the voltage on the meter. For example, if the user wants 1 Volt to be shown as 10 volts on the meter, the "Scale Factor" should be set to 10. Note that meter #1 below has been configured for 200 degree max scale, and the meter reads degrees Fahrenheit directly using a 10 millivolt/degree semiconductor sensor.

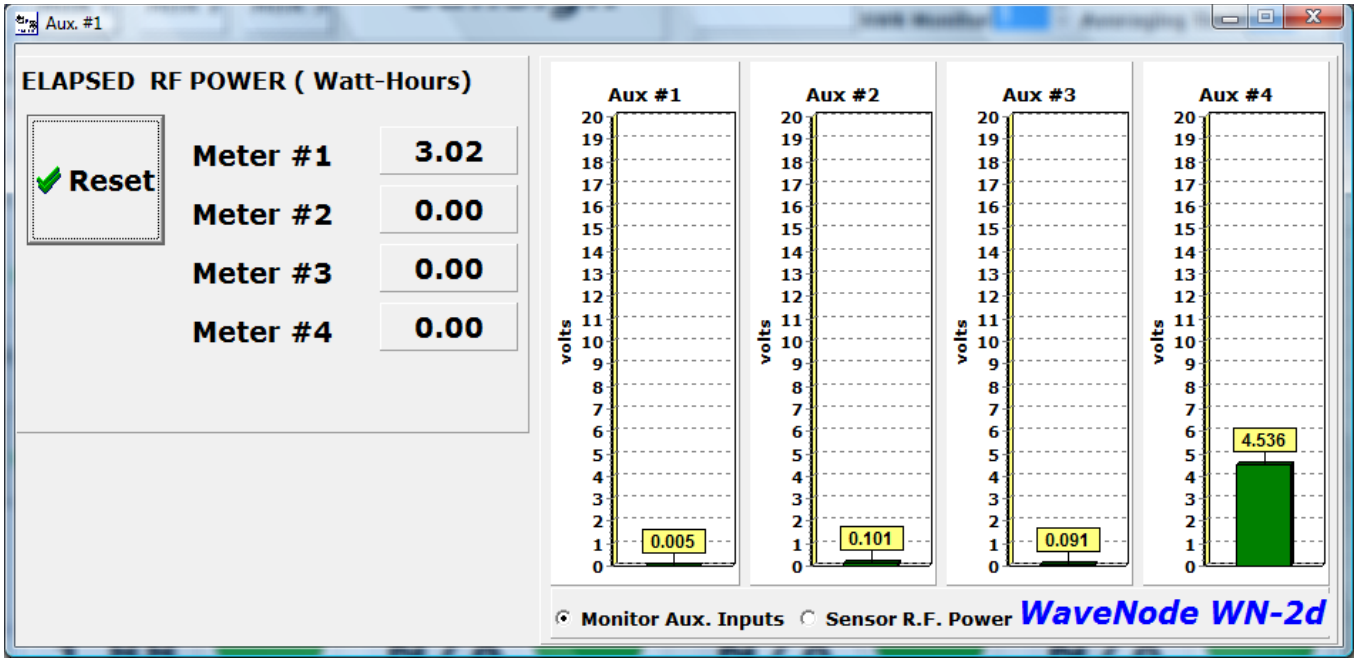


FIGURE 3 – The Aux.#1 Screen

The left Panel displays watt-hours of radiated RF power for each sensor. The meters at right are auxiliary meters for operator use. The Meter titles, Scales and Vertical axis are labeled by the user for their unique application with the Configuration Menu.

C. RF POWER GRAPH SCREEN (Aux. #2)

This panel has three graph panels. Each graph displays the data for the sensor selected in the list box for that graph. The top and middle panel can display data for any sensor selected and the bottom graph is used to display gain data for the top two graphs. The graph can be set to display sensor level vs time, or a histogram of samples and power levels. The data can be reset and started with the "GRAPH RUN /STOPPED" button.

The graph update rate can be controlled to reduce CPU usage by the software. The peak or average data shown on the graphs is the peak or average power for THAT specific 50 millisecond time sample point on the graph, and updated data is provided for each data point.

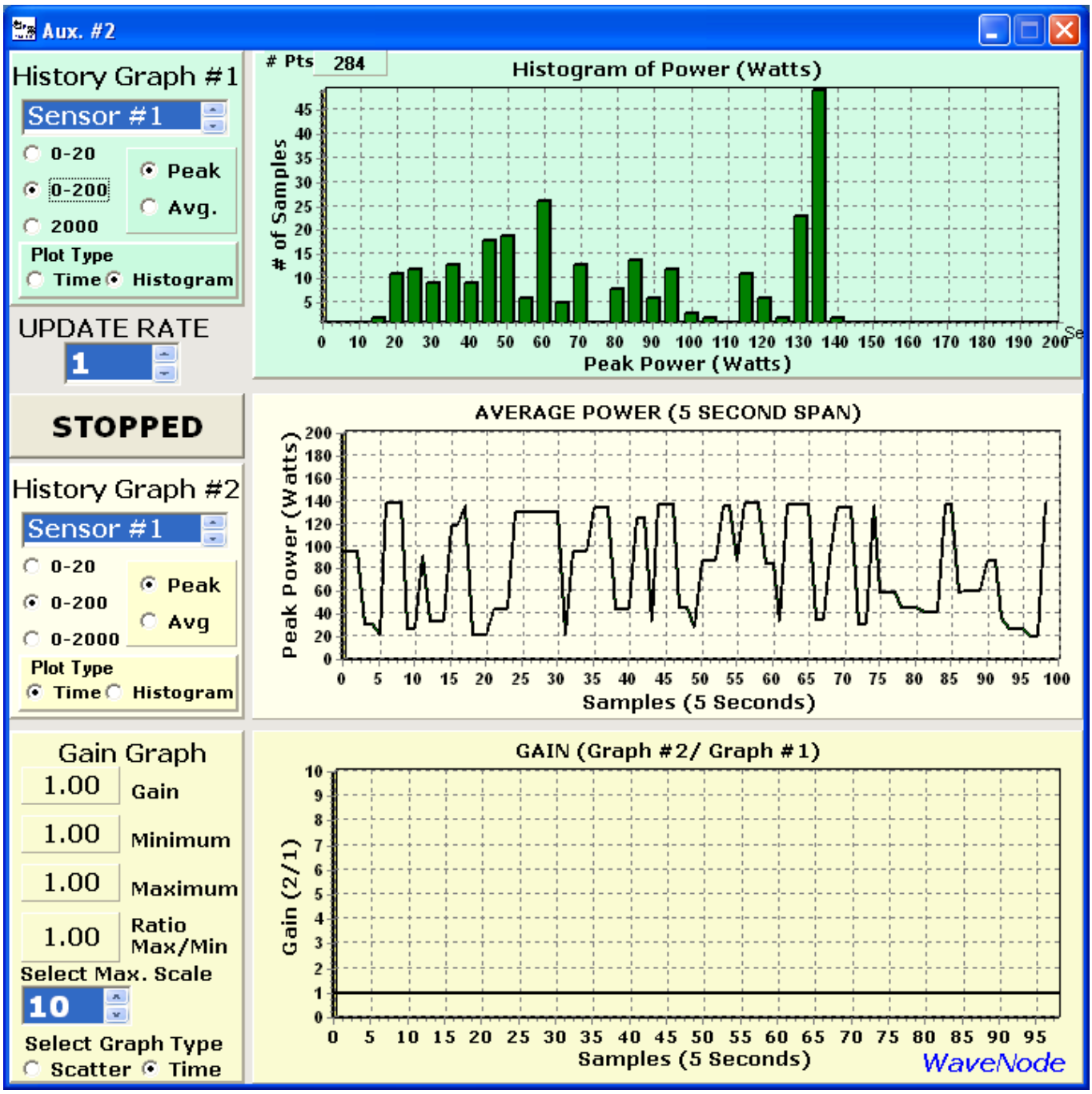


FIGURE 4- The Aux. #2 Screen

THE REAL-TIME STATISTICS SCREEN
Peak power Histogram of a 140 watt transmitter on SSB with Speech Compression turned On.

D. SWR GRAPHING SCREEN (Aux. #3)

This screen is used to plot antenna SWR. The screen prompts the user for the frequency range to be plotted and the frequency datapoint intervals. The user tunes the transceiver to the frequency prompt, and keys the transmitter with a short pulse (CW, FM, etc.). The SWR data is entered on the graph and prompts the user for the next frequency point. When the desired frequency end point is reached, the graph data is automatically updated. Multiple sensors can be plotted on the same graph by selecting the sensors in the Sensor Selection panel at the top/right.

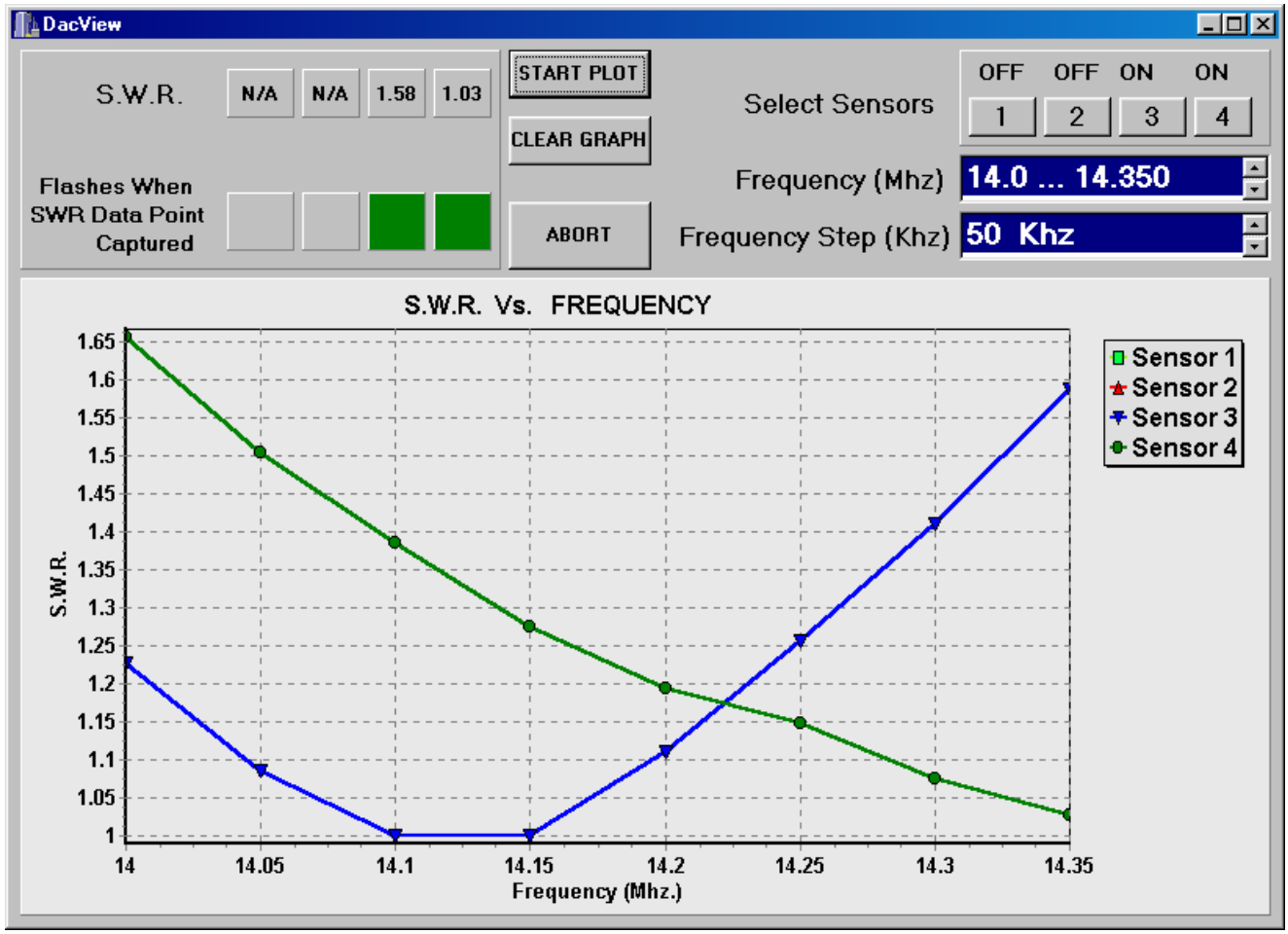


FIGURE 5- The Aux #3 Screen

THE SWR GRAPHING SCREEN (Aux. #3)

Figure 5 shows an SWR plot from 14.0 to 14.35 MHz using sensors 3 and 4. Sensor 3 shows the SWR into the antenna tuner, and Sensor 4 shows the SWR of the antenna/coax system. Note the antenna tuner is doing exactly what it should do, it provides SWR matching between 14.1 and 14.15 MHz as tuned for this application.

E. ADDITIONAL ACCESS CONNECTORS:

A 10-pin Ribbon Cable Expansion connector is provided on the PC board to allow the user access to the additional I/O capabilities.

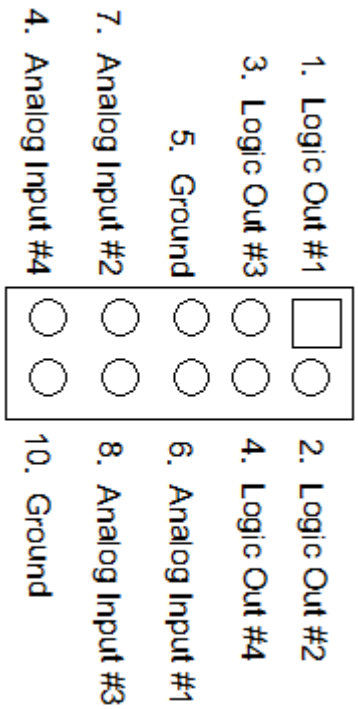


FIGURE 6- The I/O Expansion Connector

Iinput/Output Connector pin assignment

6. INFORMATION FOR SOFTWARE/HARDWARE EXPANSION:

The WaveNode website provides information for programmers wishing to write their own software to show the WaveNode data. This is done with Windows Messaging, and avoids the use of dll files. A complete description of how to use this messaging Is provided in the "WN_InOut.h" file that is provided on the CDROM and on the Software support page of the WaveNode website.
The information on your CDROM includes:

A. A sample program with source files written in Microsoft C++. The program demonstrates how to send data to, and **r**eceive data from, the WaveNode software. Using Windows Messaging allows the user to write their application in C++ or Visual Basic.
B. The sample program demonstrates that power, SWR display, rotator signals, and all the WaveNode data can be accessed with your application.
C. A complete source code listing for the "WN_InOut.h" file in the WaveNode software that sends and receives Windows messaging. This file is commented completely for easy understanding.

7. CONNECTOR LAYOUT INFORMATION:

The figure below shows the PC board connector positions and their pin orientation.

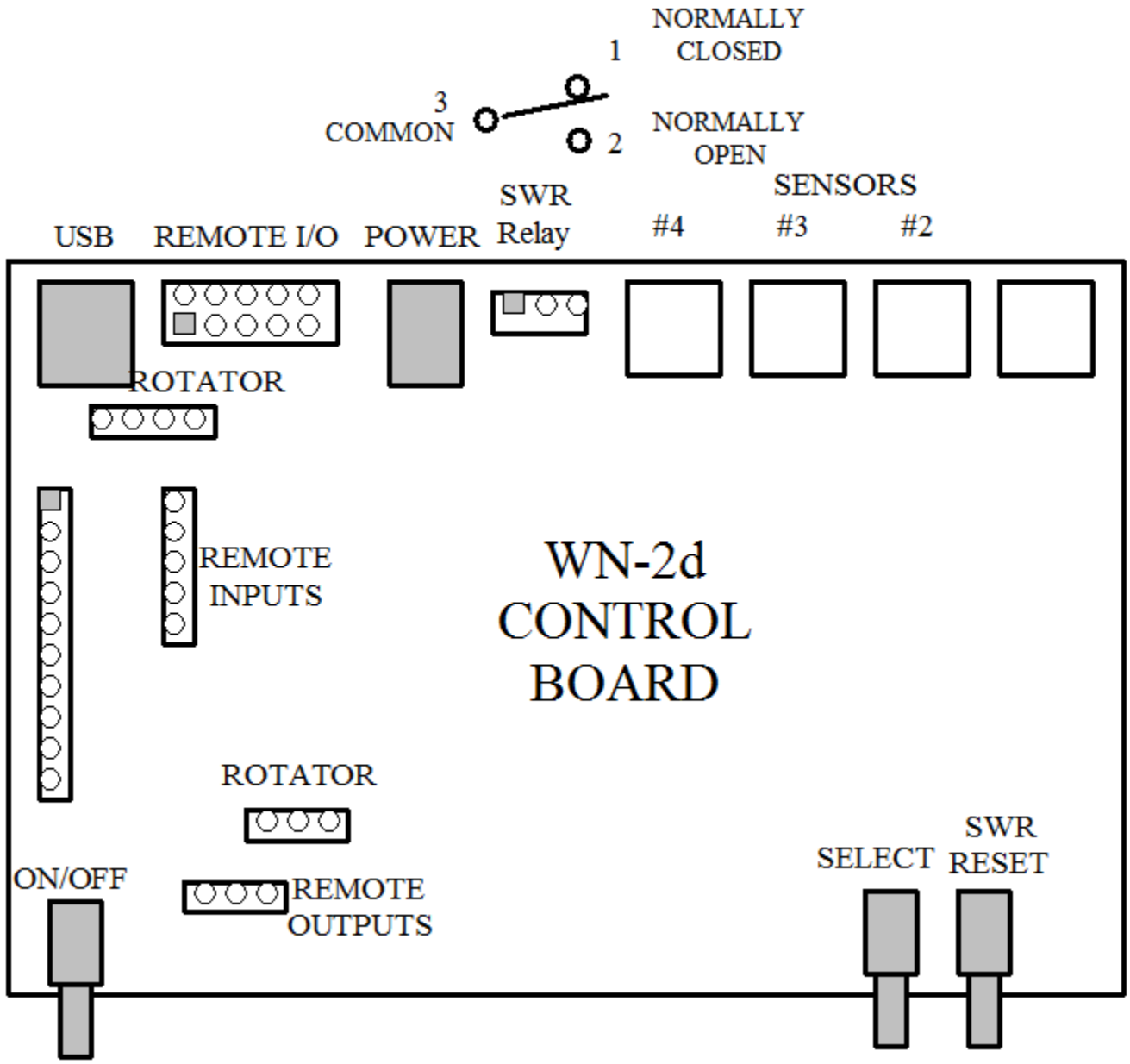


FIGURE 7. CONNECTOR POSITION (PC Board)

8. DETAILED DIRECTIONS OF OPERATION:

A. Main Screen

1. The top screen shows the meters and digital values for the four power sensors. The meters display forward peak, reflected peak, forward and reflected average power for all four sensors simultaneously. The rectangular panels show forward, reflected power and SWR for each sensor. The power display can be set to a selected range, or the "Auto" button will automatically select the correct range. This is a matter of operator preference.

2. Several list boxes are provided to select the following operator preferences:

- The level at which the SWR protection relay will trip.

- The Averaging time for meter display. The number chosen represents the number of samples averaged together for the average power display on the panel.

- The Peak Hold Time. The number of sample times that the peak envelope power and SWR will be displayed. A larger number will hold the Peak detector for a longer period.

- SWR Monitor. This selects which of the power sensors will be monitored for excess SWR and trip the SWR relay. The "NO" selection is used when SWR protection is not desired. The “ALL” selection allows monitoring all the sensors for high SWR protection.

- The SWR reset button. This button resets the SWR relay.

- SWR Tuning Indicators: These are provided to allow easy tuning of the station antenna tuners. The operator has immediate feedback of SWR as the tuner is adjusted. Simply adjust your tuner for maximum green in the pie-chart, the chart will turn completely red when the SWR exceeds 5:1.

- Access to the other screens functions are selected by the buttons at top-left. The lower four buttons Set/Reset the optional logic outputs that are controlled by the user. These are four, 3.3 volt logic signals available on the rear panel 10-pin ribbon connector.

- See the connector figure for more details.

B. The Aux. #2 Screen:

This screen is used to provide various data regarding power, linearity, gain, etc. There are three graphs shown on this screen. The upper two are identical, and can display data for any one of the four sensors. The sensor is selected in the list box for that graph. The graphs can be stopped, or will run continuously. The user can clear the graphs by stopping, then starting, the graphs again.

The power range for each graph is selected in the panels on the left. The top two graphs can be chosen to show a histogram of power level vs number of samples. This is a visual graphic of your transmitted power samples and is updated each sample period. The effect of speech compression is to push more samples to the upper end of the power spectrum, and this can be observed if compression is turned off. The other graph option is a traveling waveform of sample value vs time (much like an oscilloscope).

The bottom graph is used to display the relationship of the sensors plotted in graphs 1 and 2 above it. The user can graph gain vs power output (to show linearity) as a scatter graph, or gain as a function of time. The samples are collected in SSB or AM mode, and a linear system shows the gain as constant with power. CW operation has only one power, either ON or OFF, so linearity can be plotted by sending a string of dits while varying the linear amplifier drive power. This graph is especially useful with linear amplifiers, with one sensor on the input and the second sensor on the amplifier output.

C. The Aux. #3 Screen:

This screen is used to plot SWR of antennas. Any sensor, or combination of sensors can be selected for the plot.

The user follows the steps outlined below:

- Select the sensors to be plotted

- Select the frequency range to be plotted in the listbox.
- Select the frequency step size increments (more increments take longer).
- Follow the message box instructions. They will remind you what the next frequency is to be set on the transmitter.
- Send a single dit at each frequency prompted by the message box.
- A green box on the top left will flash when a good SWR value is computed at each frequency.
- You should see the box flash green before moving to the next frequency point.
- When the last point is entered, the graph will be complete.

D. The Configuration Menu:

The configuration Menu is used by the operator to make the screen titles suit your station equipment. The menu is accessed by the button at the top left of the Main Screen labeled "File". The software comes with default titles, such as “METER #1”, however, you may not remember what Meter #1 means, so you could change it to “40 MTR DIPOLE” or “LINEAR AMP”. Also, the top panel can contain your callsign.

The auxiliary button titles on the main screen, the auxiliary meter titles and scales are customized with this screen also. When you have finished modifying the software titles, click the **Save** button and these items will be saved and reloaded each time you start the software.

For each meter, click on the button that describes the sensor you have installed for that meter number.

For instance, if you have installed the LP-1 HF sensor in meter #2 position, click the button in the LP-1 column adjacent to Meter #2. This will instruct the software what type of sensors are in each meter position. You only need to do this one time, the settings are saved in a separate .ini file. You can put any sensor in any location, just select the appropriate sensor next to each meter on the configuration menu.

The Maximum Meter Range for any of the four meters on the Main software page can be set to any integer number desired by the operator. For example, if the user wants Meter #1 full scale to be 150 watts, enter "150" in the User Meter #1 Range box at the top-right. All the meter maximum scales can be set by the operator, and then selected whenever they wish by clicking the "User" Radio button under the corresponding meter.

The Bargraph Range edit boxes allows the bargraph range on the WN2-d LCD and LED display to be changed. For example, if the maximum power to be displayed on the bargraphs is 100 watts, set the bargraph range to 100 watts.

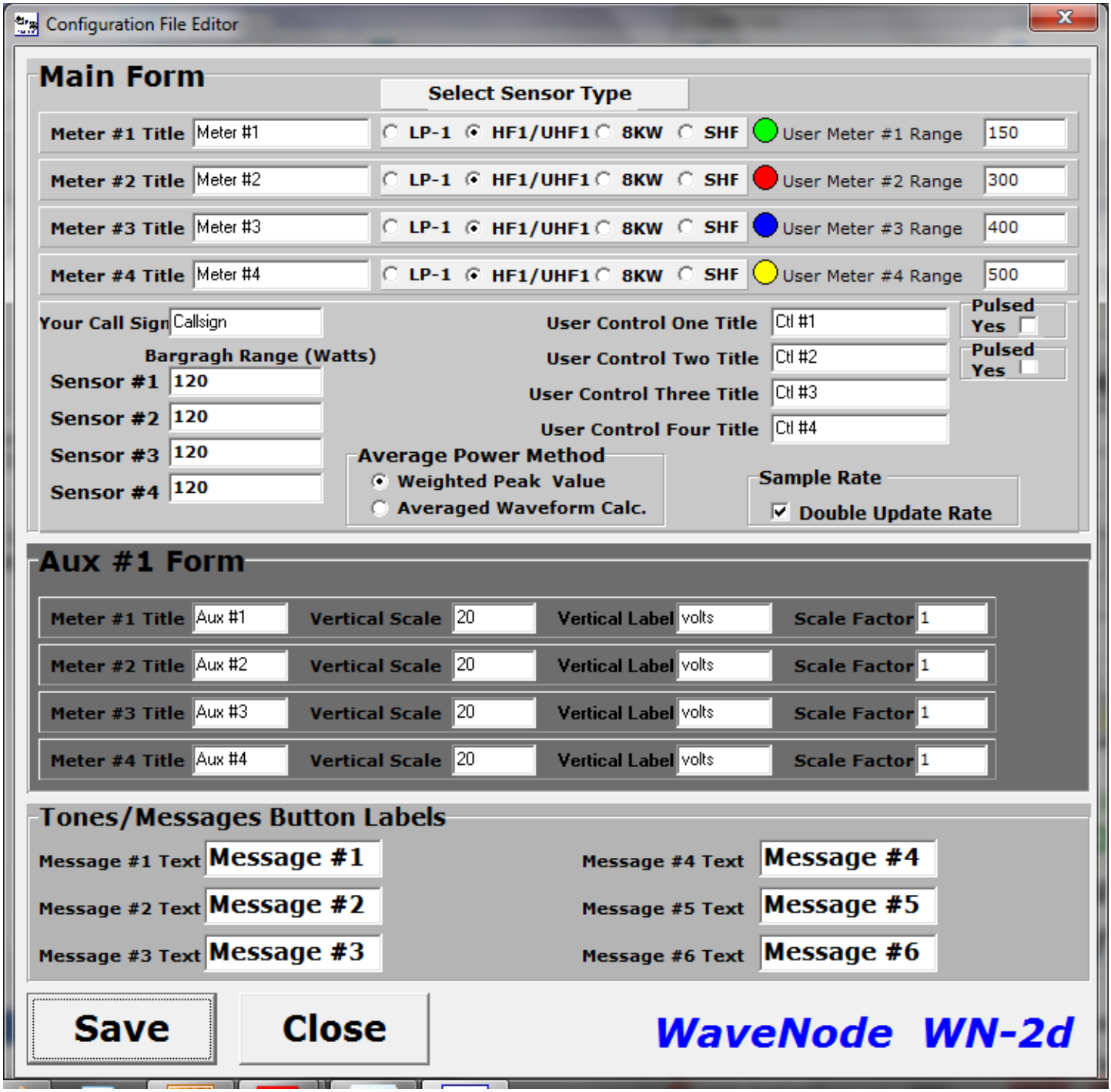


FIGURE #8

E. The SWR Protection Relay:

The SWR protection relay a set of contacts at connector J2. Refer to figure #7 for connection information. This relay is for +24V maximum operation and the contacts are rated for 1 Amp.

The default power-up condition is to select no RF sensors to be monitored. The user can then select which RF sensor to monitor by means of the "SWR Monitor" list box on the main panel.

The SWR protection relay will never stay "ON" if the WN-2d is turned OFF.

9. OPERATION WITH SOUND:

The WN-2d will give an audio announcement of RF Power, Peak Power, SWR, and SWR protection status on any of the four meters. Start by pressing the 1, 2, 3, 4 key to get an announcement of of the power on that channel.

Press again for each voice announcement. Now press the "t" key to select the tone mode. Now press the "p" or "s" key to start the tone for SWR or Power.

Each time you press the "p" or "s" key again, the power or swr will be announced, then the tone will resume. To turn off the tone, press the "t" key again. To hear an announcement or tone for another meter, press the number key for that meter. The operator should set the "Peak Hold Time" selection on the Main Menu to "1" if using the tone mode. This will allow the tone to respond most quickly when adjusting antennas, tuners, and amplifiers.

The audio feature can be turned OFF/ON with the Toggle button at the bottom-left of the Main screen.

The computer must have a sound card and headphones/speaker to provide the audio announcement.

1. Press 1, 2, 3 or 4 to hear the power on that meter.
2. Press "t" to enable the tone mode on the meter number most recently pressed. "Not Available" will be announced if the power is less than 2 watts forward power.
3. Press the "s" key for SWR tone, or the "p" key for power mode. When using power tone, the tone will increase in pitch as the power increases. The pitch will increase about 20 Hz for each power increase of 20 watts. Press "s" key for SWR tone. The pitch will decrease as the SWR decreases toward 1:1 SWR.
   With no RF present, the tone will be at it's lowest pitch for power or SWR. If the tone mode is enabled, you can press "s" or "p" for a voice announcement, then the tone will immediately resume. **Remember**: you must press the "t" key to enable the tone mode for either SWR or Power tone.
4. Press "a" to toggle the audio feature On and OFF.
5. Press "r" to reset the the SWR tripped condition. You must correct the SWR fault condition, or select another sensor, to prevent the SWR trip feature from activating again when transmitting.
6. Press the "h" key to access the Help file. An announcement is made when the the help file is ready to be read.
7. Press the "e" key to exit the Help file and return to normal operation.
8. If the SWR protection is tripped, an audible announcement will be made to alert the operator. When the SWR protection has been successfully reset, an audio announcement will indicate that.

10. CORRECT OPERATION OF WN-2d to COMPUTER INTERFACE

When the computer and WN-2d are communicating correctly, a green flashing indicator on the software screen will show. When the interface is not correctly working (power off, computer stopped, etc), the indicator will flash RED and a message is shown adjacent. This is useful for LAN or Internet connection to the host computer, since proper WN-2d operation can be monitored from a remote site when no RF power is present.

11. HOW TO VIEW ONLY ONE METER or SAVE SCREEN SPACE

Click directly on the meter you wish to view as a separate meter. A small view of that meter will pop up. Click on the small meter to create a large meter on the screen. Close the small meter if you don't wish to keep it on the screen. Then click the "Minimize" button at the

top left of the main screen. This will hide the main screen, and only the one meter will be visible. You can open several large/small meters by clicking on the appropriate meter panels. SWR protection is still operating. When you want to view the main screen again, click the double-box button on the small window bar that is probably at the lower left of your screen.

At the bottom of the large meter, there is a checkbox labeled “Peak Hold”. When checked, this will allow the meter to hold the maximum power levels detected, and hold them until the user clicks the “Reset” button. This allows the meter to act as an infinite-time, peak hold meter.

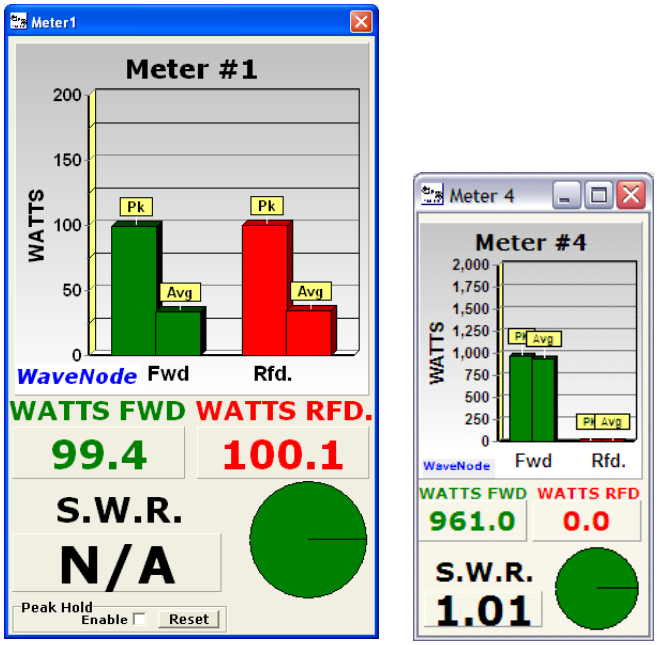


FIGURE #9 (Large or Small Meters)

12. THE STAND-ALONE GAIN GRAPH

This graph is opened by clicking on the bottom graph on the AUX #2 screen, the gain graph. This graph provides a large view of the gain scatter and gain time charts to allow easy viewing for amplifier tune-up. The sensors to be compared for gain are still chosen from the bottom chart on the Aux #2 page, but you can set the gain scale and stop/start the chart separately from the Aux #2 chart.

The two sensors being compared are shown at the upper-left as "GAIN = Sensor/Sensor" so there will be no confusion about which two sensors are being measured. The name you have chosen for your sensors on the configuration page will be shown on the "GAIN= " position.

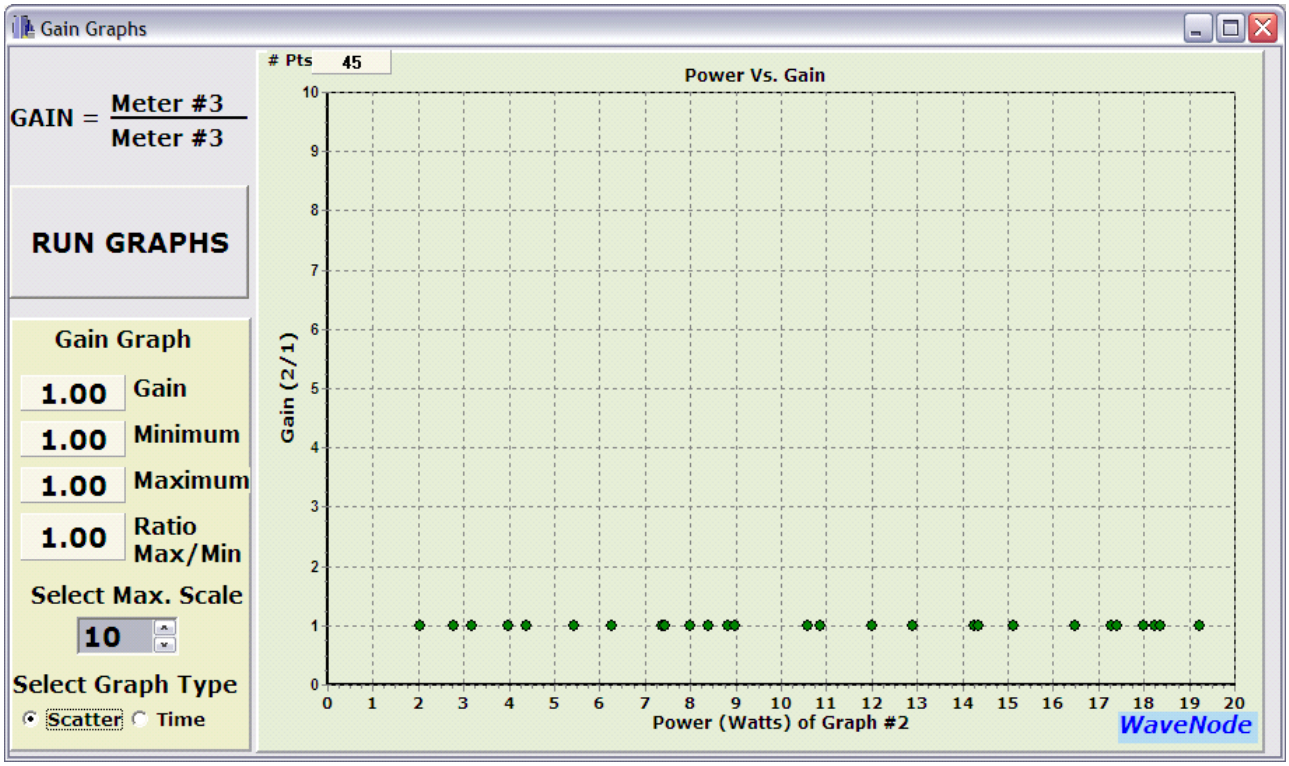


FIGURE #10 (Opened by clicking on Aux #2 Bottom Graph)

13. ***THE MINI-PANEL:***

The Mini-Panel is opened by clicking on Mini-Panel on the Menu bar, or just click on the "Callsign" Panel. This is a small panel showing power and SWR on all meters. Click the "HIDE" and "SHOW" buttons to hide or view the main screen. The color bars on either side of each panel flash when RF power is present on that meter.

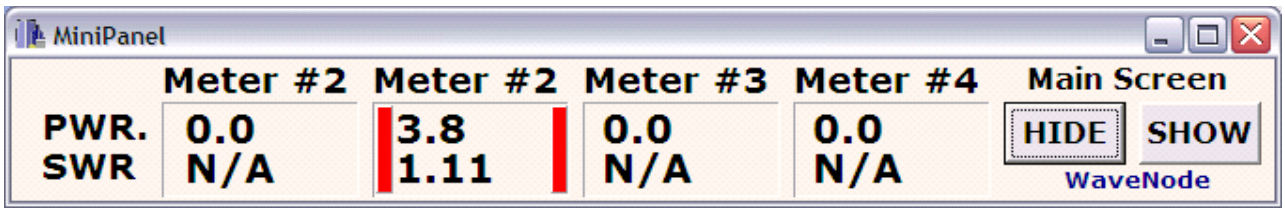
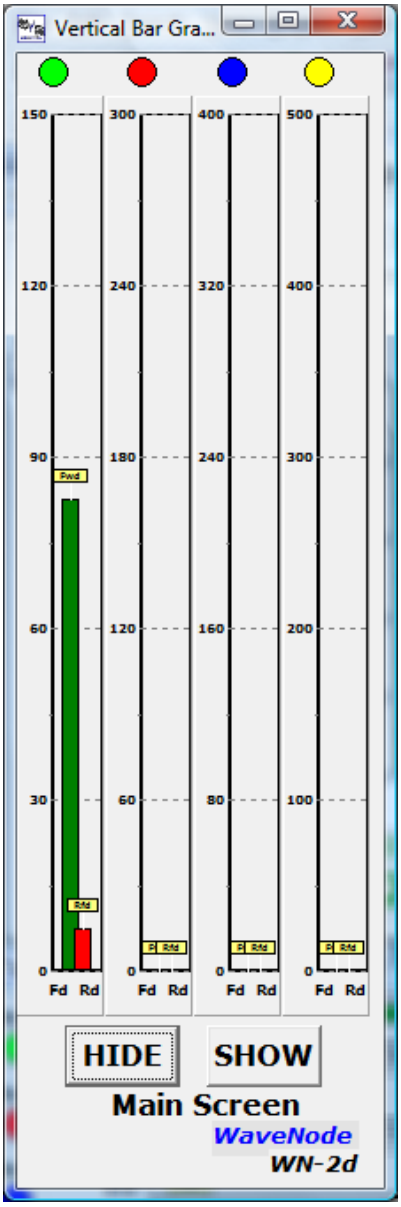


FIGURE #11

14. ***Horizontal and Vertical Bar Graphs***

These graphs are to provide a fast visual indication of power in a minimum amount of screen space. The "Hide" and "Show" buttons allow the Main screen to be hidden quickly.



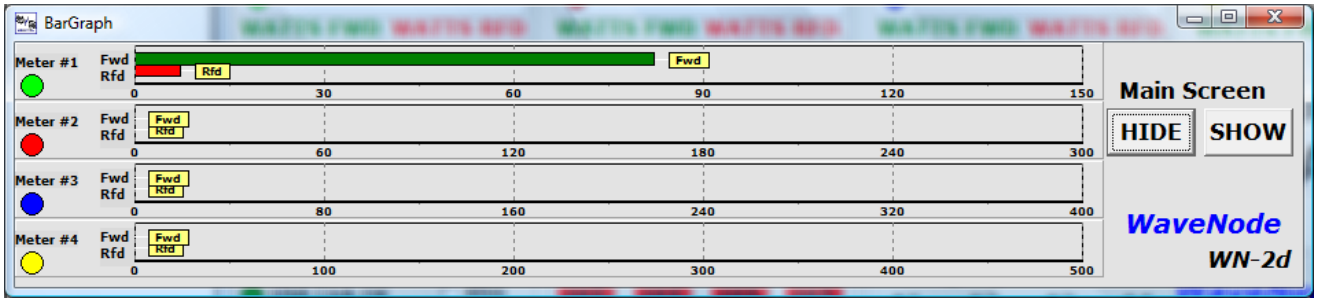


FIGURE #12 The Bar Graphs

15. Modulation Oscilloscope Operation

The modulation Oscilloscope allows the user to continuously monitor the waveform of the modulation present on the RF envelope. All the features found on a Digital Oscilloscope are available.

Vertical Gain: Select the appropriate gain button for your RF power to be observed.
Sensor: Select sensor #1 or #2 to be observed.
Scan: Changes color each time the scope display is updated.
Trigger:
Auto: Triggers the display at time=0.
Norm: Triggers when the data exceeds the trigger level chosen by the Trigger Level buttons.
Stop: Stops the scope to allow the user to examine the waveform.
Persistence: Saves 10 sweeps of the oscilloscope.
Main Page: Hides the Main Page.

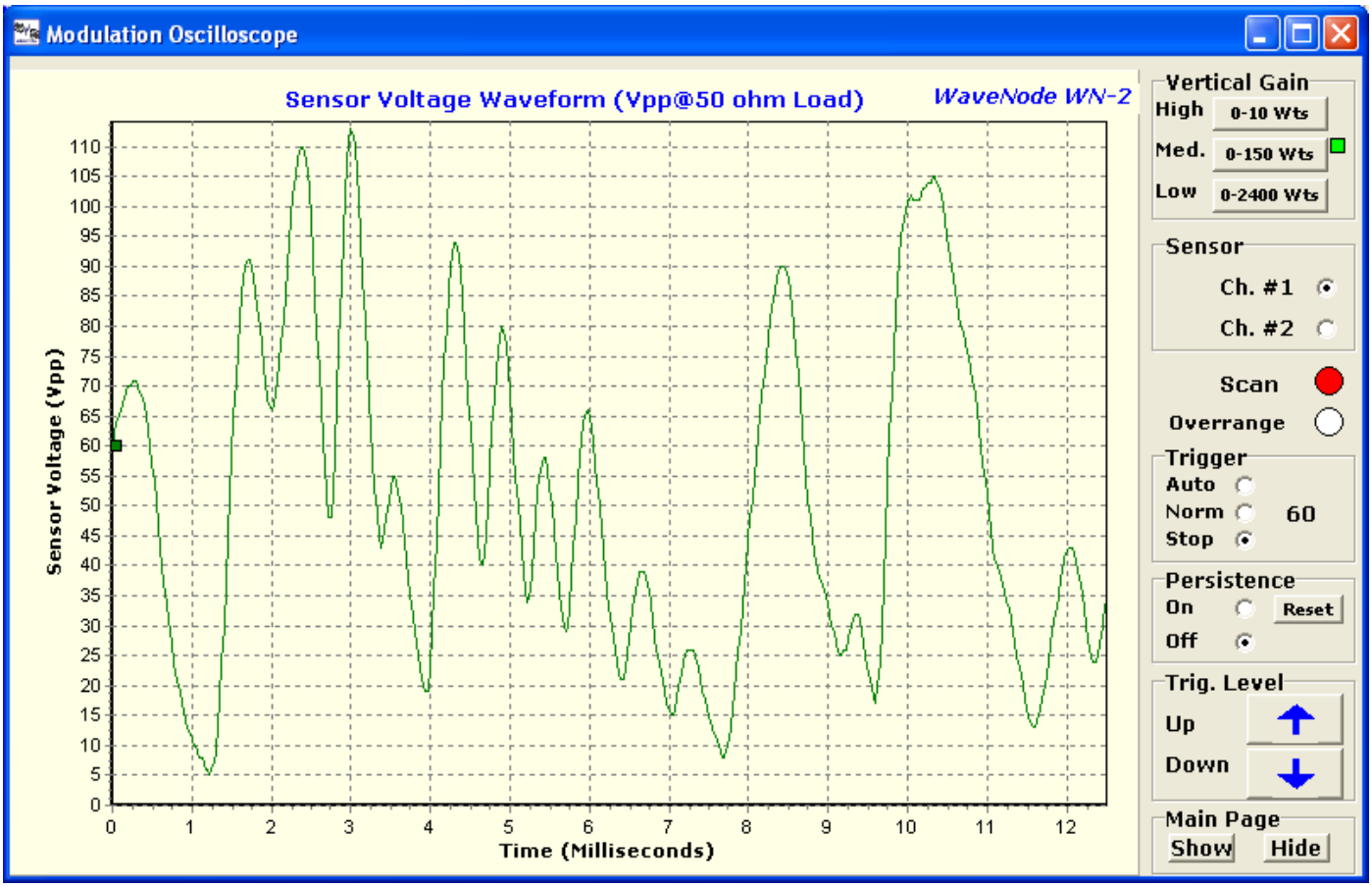


FIGURE #13 The Modulation Oscilloscope (SSB Speech Pattern)

16. Modulation Spectrum Analyzer

The Spectrum Analyzer displays the frequency spectrum of the modulation envelope. The analyzer does an FFT (Fast Fourier Transform) on 1024 sample points. This allows the operator to view the bandwidth of the transmitted signal directly on the coax sensors in real time. The operation of the spectrum analyzer buttons:

Vertical Gain: Select the gain appropriate for the RF level being measured.
Sensor: Select Sensor #1 or #2 to be observed.
Horizontal: Select the horizontal scale on the display.
Trigger: Select the trigger mode required. The Stop button allows the viewer to examine the data.
Averaging: Averages the data over 20 sweeps . This is very helpful for averaging the display with audio modes or when using the tones menu.

The analyzer allows the user to set transmitter bandwidth, power levels, and linear amplifier drive levels while monitoring the RF for undesirable splatter, intermodulation products, etc. The display below shows a typical SSB modulation spectrum with little or no energy above 2.4 KHz. Remember that each 10 db represents a 10:1 ratio of power.

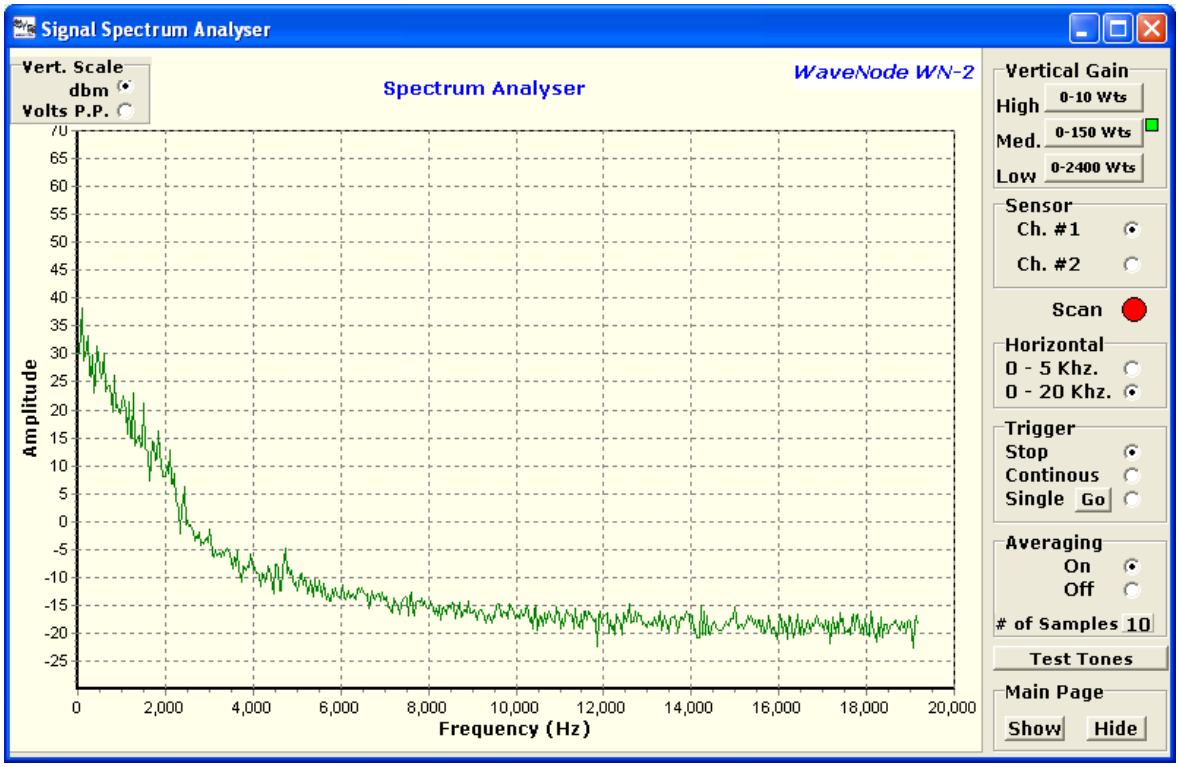


FIGURE #14 A typical SSB Modulation Envelope.

The Spectrum Analyzer has an additional screen labeled “ModView”. This screen allows quick visual feedback of out-of-band power relative to the normal speech bandwidth of 0-3.2 kHz. Below is a view of the screen with normal AM or SSB modulation. Notice that the peak speech power between 400-800 Hz is at 47 dbm and the largest out-of-band energy is between 4.6-5.0 kHz at -8 dbm. A contextual “Help” button is provided that provides additional technical information about the screen and the measurement it is providing.

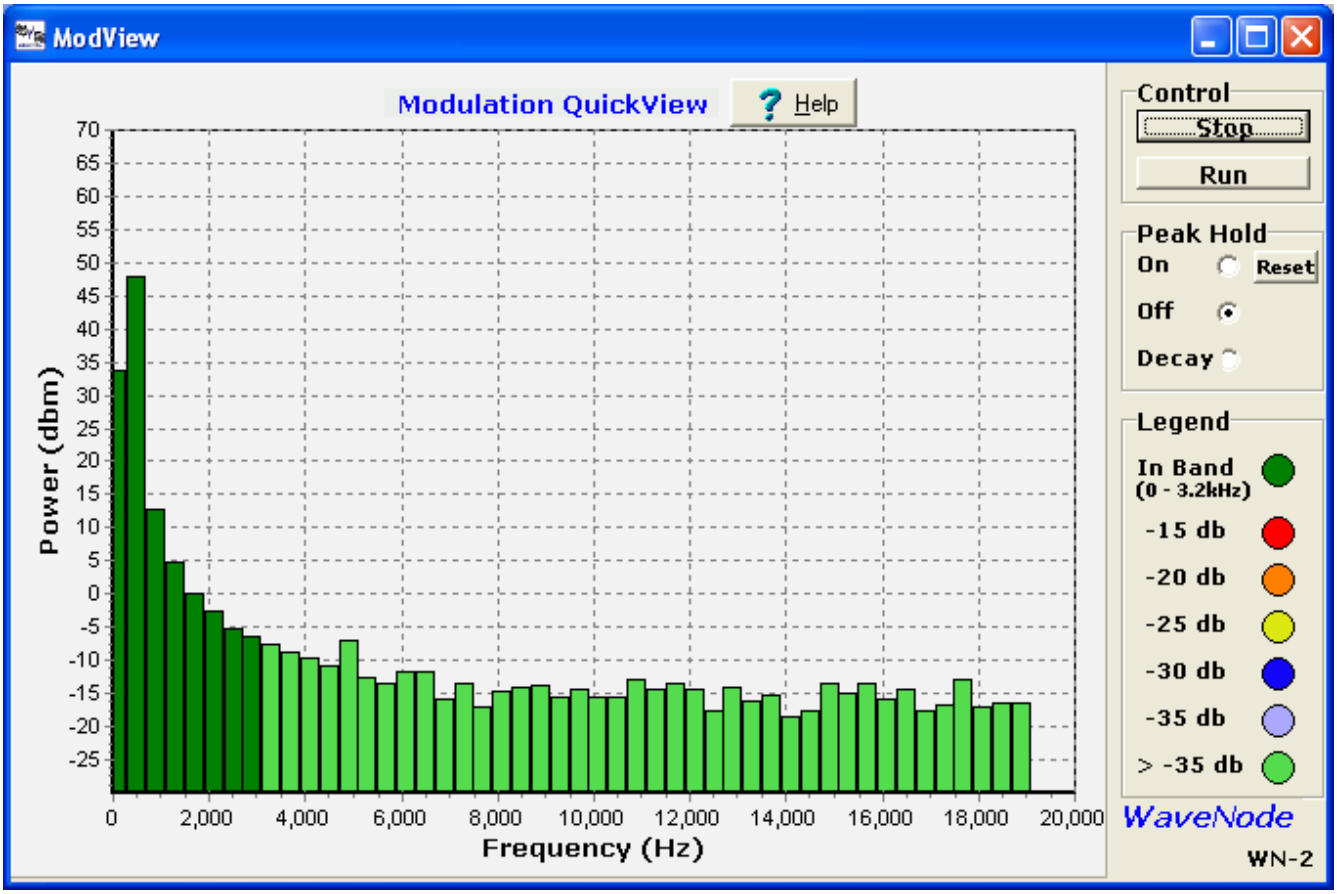


FIGURE #15. A typical SSB Speech Energy Plot.

17. The Tones and Messages Menu

This menu provides useful tones to use with the oscilloscope and/or Spectrum Analyzer. These are generated by the sound card in the PC and should be input to the transmitter in the same way audio in sent for digital modes. The tones will play for ~ 3 seconds in normal operation, but can be made continuous by checking the "Continuous" select box. The tone will continue until the "STOP" button is pressed.

Single Tones: Three second sinusoidal tone at the frequency selected.

Tune Tones: Three buttons that generate a sinusoid with different duty cycles. The 440/30Hz tone is a 440 Hz sinusoid modulated with 30 Hz half-sine pulses. This allows low duty-cycle amplifier tuning with minimum bandwidth.

Single Tone + Impulse: A sinusoidal tone with 50 microsecond pulses superimposed. These tones are especially useful with SSB, since a single tone would produce only a steady RF level. The pulses insert audio energy from 200 Hz to 10 Khz.

Messages: These are .wav files that the user can record for announcement, station ID or other purposes. These messages are files named "message_one.wav" through "message_six.wav". Use any PC recorder such as "Sound Recorder" to record your messages. Save the files with the file name in the WaveNode software file directory.

The top Checkbox will sample the waveform five times and average. It will then stop the display so the data can be examined in the spectrum analyzer.

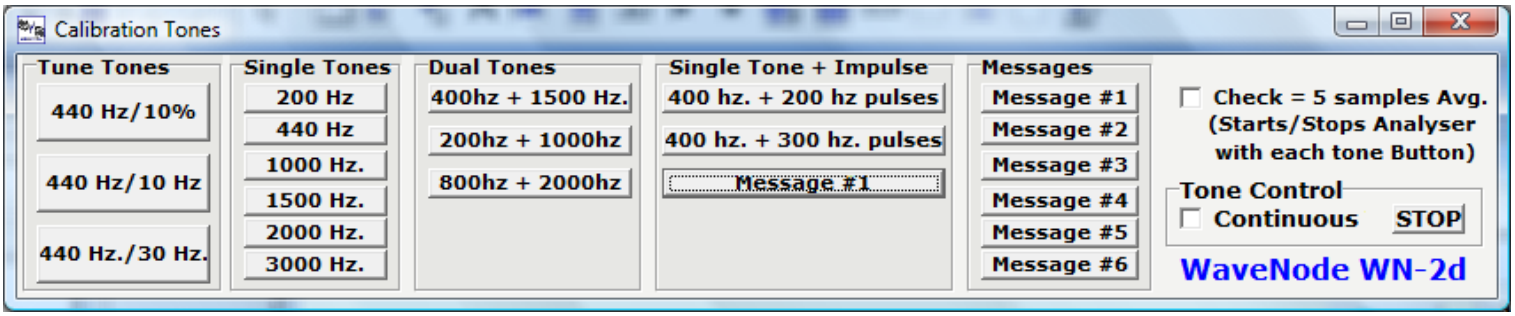


FIGURE #16: The Tones and Messages Menu

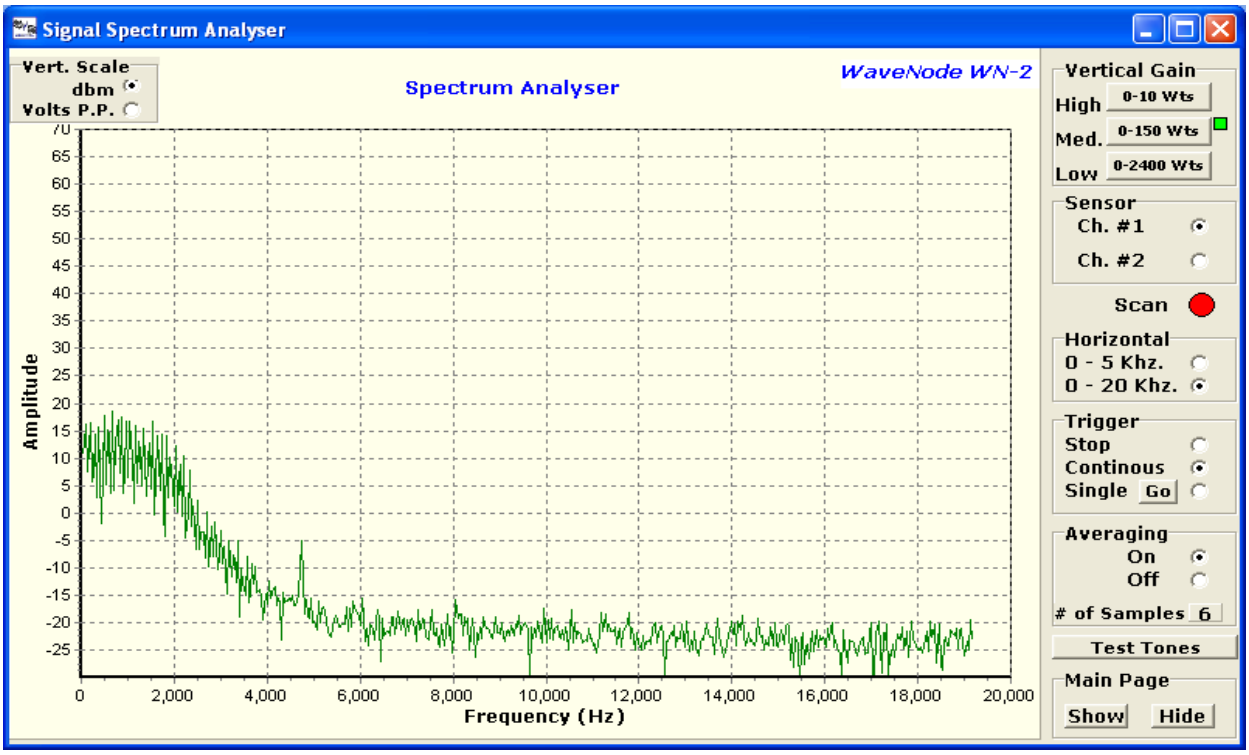


FIGURE #17: Modulation Envelope Using (400Hz + 200 Hz Pulses) in SSB Mode

The view in Figure #17 shows the Modulation Bandwidth using the 400Hz + 200 Hz Pulse tone. Note that the bandwidth of the transmitted signal is 20 db down at about 2.5 KHz. The display shows that no appreciable energy is transmitted above 2.5 KHz, which is desirable in closely-spaced band conditions.

18. The Rotator Controller Accessory:

Features of your RT-1/ RT-2 Rotor Control System:

- Point and click control on a map centered at your location. Just one click sends your rotator exactly where you want it. Six map views are available, configured to your location.

- Controls 2 independent rotators, and indicates both rotators on the same map. Two auxiliary antennas at 90 degrees can also be indicated.

- No alignment is necessary, but provision is made to trim the antenna pointing.

- Supports Overlap, speed control, and all Yaesu features. Use your rotator box controls normally also. Uses the Yaesu interface plug, no opening or modification of your Rotator Control Unit.

- Simple connection to your control box that will never lose communication with your WN-2d or with your Yaesu control box. Perfect for remote operation where reliability is most important. There are no communication protocols or addresses to set. It just works!

Installation and Checkout:

The rotator controller is configured for use with Yaesu DXA and DXC series or rotators. These rotator control boxes have a 6-pin Minidin interface on the rear panel. Plug the cable supplied with the WN-2d rotator controller into the control box, and make the following checks:

- Turn your rotator #1 full CCW, and open the rotator screen. The pointer for your rotator should be within a few degrees of 180 (South).

- Turn your rotator full CW and adjust the Range #1 potentiometer on the rotator control board until the pointer is at 270 degrees. The Overlap indicator should be on.

- Repeat this procedure for rotator #2 using the Range #2 potentiometer. This completes the alignment in most cases.

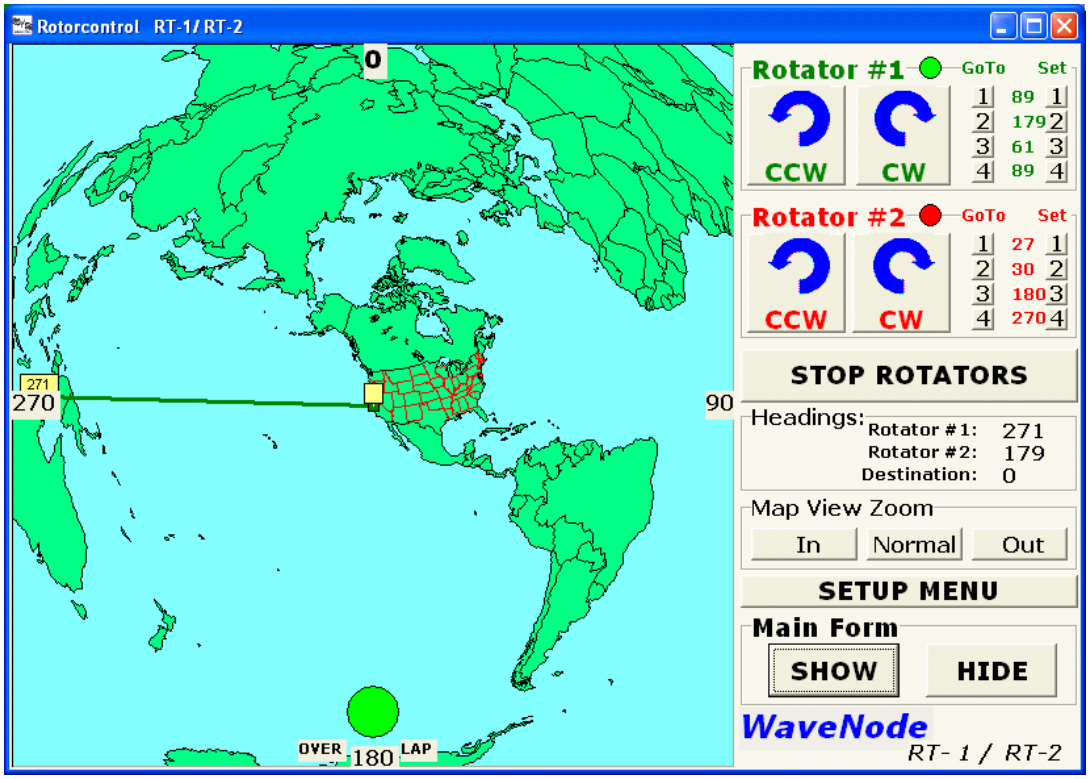


FIGURE #18 The Dual Rotator Screen Showing Rotator #1 at Full CW position

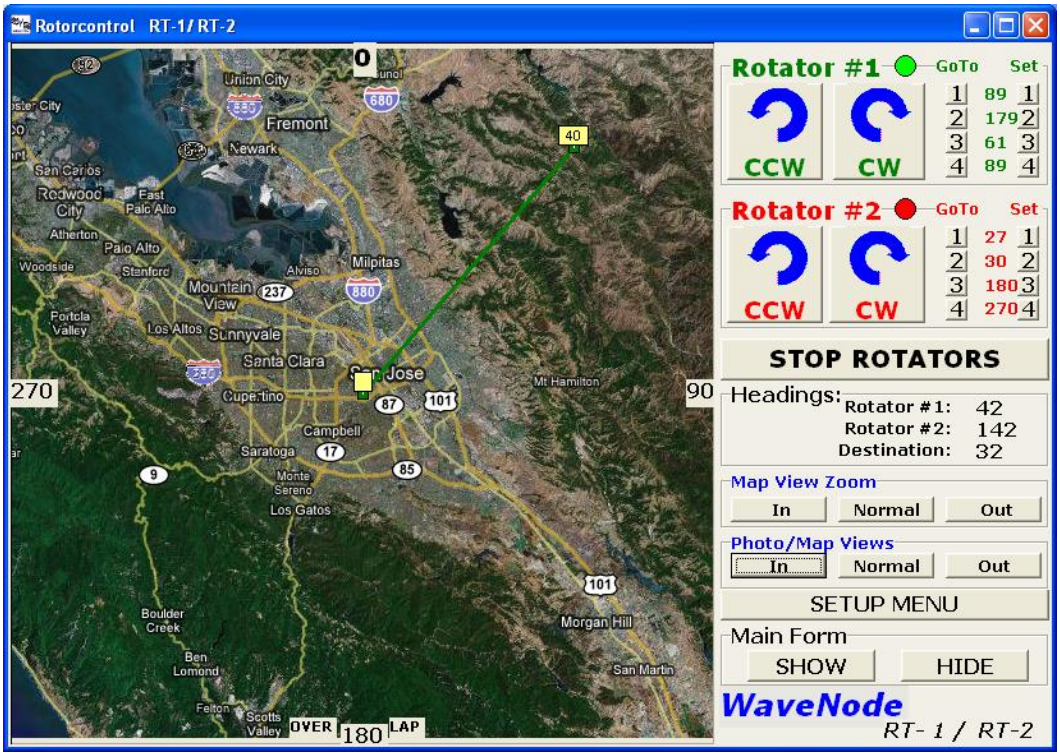


FIGURE #19 The Dual Rotator Screen Showing the photo Views

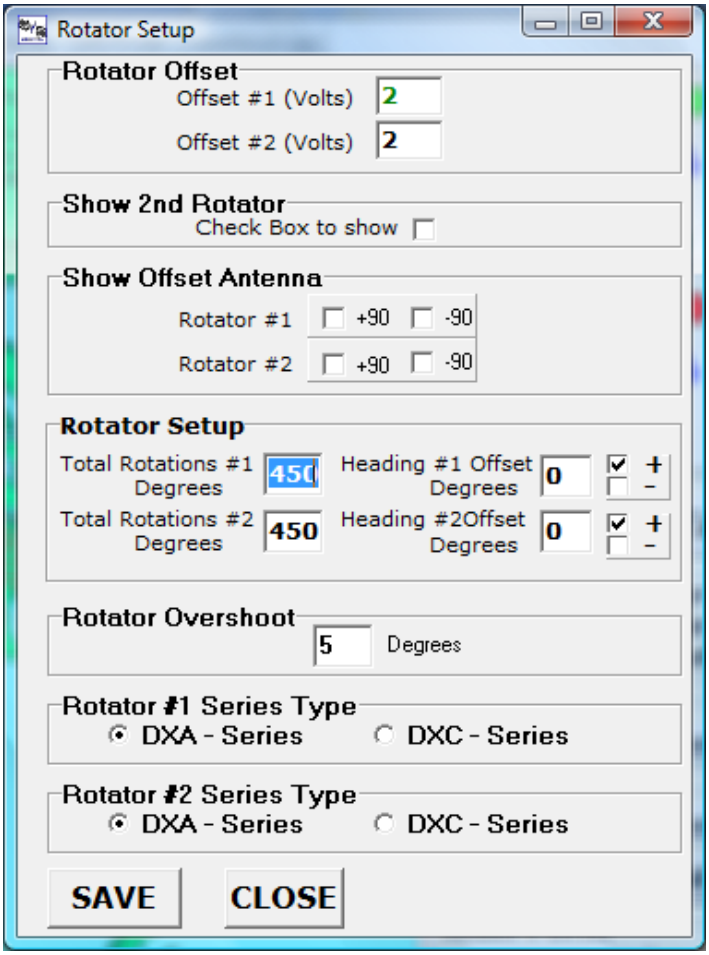


FIGURE #20 The Rotator Setup Menu

Rotator setup Menu Selection:

- Access the rotator setup menu by pressing the “Setup Menu” button on the Rotator screen. The default values shown in fig. 18 will be sufficient in most installations.

- Offset #1 and Offset #2: Leave these at 2 volts for normal, top North, operation.

- Show 2nd Rotator: Click this box if you have a 2nd rotator installed.

- Show Offset Antenna: Check these boxes if you have a 2nd antenna controlled by the same rotator that is at 90 degrees to the main antenna. Check the appropriate box for 90 degrees CW or 90 degrees CCW.

- Rotator Setup: Leave at 450 degrees for rotators that have 90 degrees overlap such as Yaesu. If your antenna does not point true North when the rotator indicates North due to mis-alignment, you can correct this by adding a Heading Offset with appropriate polarity. Enter only integer values in the boxes.

- Rotator Overshoot: Most rotators will “coast” a few degrees when the motor voltage is removed. Five degrees is a good starting point, and you can adjust this a bit if needed.

- Use the “Save” and “Close” buttons on the Setup Menu to save your settings, and then close the Menu.

- There are four presets for each rotator. Four buttons preset the position, and four to return to a preset position. Note on Figure #17 that the directional heading for each preset is shown next to it’s “Set” button.

- A rotator pointer will turn BLUE when RF is present for that rotator, and the indicator in the yellow box will indicate the peak power instead of the directional heading. Therefore, you should connect RF sensor #1 to your antenna on Rotator #1 and RF sensor #2 to your Rotator #2. This method will allow the operator to observe the power associated with a given antenna.

- Click on the Map to rotate the antenna to that point. The antenna that will move to the directional heading is the last one that was controlled by the CW or CCW button. If you wish to change antennas to be controlled by clicking on the map, just momentarily click it’s CW or CCW button to change antennas. You may rotate only one antenna at a time.

- Speed control is provided for each rotator with the potentiometer on the rotator control board.

- The Map View Zoom buttons are used to select the view on the map. The user can use any map, image, or even a satellite photo as a map background picture. The map image must be a .bmp image of 550x550 pixels. You can use a larger image, but it will be cropped to 550x550 to fix the map. Six views are selectable by the user, and the default views supplied were generated using WinGCM great circle projection map maker. The user is encouraged to put their own location at the center of the map.

Generating the Map View Backgrounds for Your Location:

A. There are six images the user can select using the "Map View Zoom" buttons. These images are any .bmp file and are named small.bmp, small_photo.bmp, medium.bmp, medium_photo.bmp, large.bmp and large_photo.bmp. The images must be saved in the Wavenode program folder.

B. The small, medium and large bmp photos can most easily be generated using any Great Circle map generator, mapping software, satellite image or whatever view the user wishes. A great circle map is best used for background maps that cover a large portion of the earth, since the map pointer will show the true directional heading to any point on the earth.

C. Install the program WinGCM that is included on your CDROM. Fig. #20 below shows the "Settings" menu that was used to generate the background map in Fig #18 above. You may use any Great Circle map generator software to make the background maps. The WinGCM software has it's own Help Menu you can refer to.

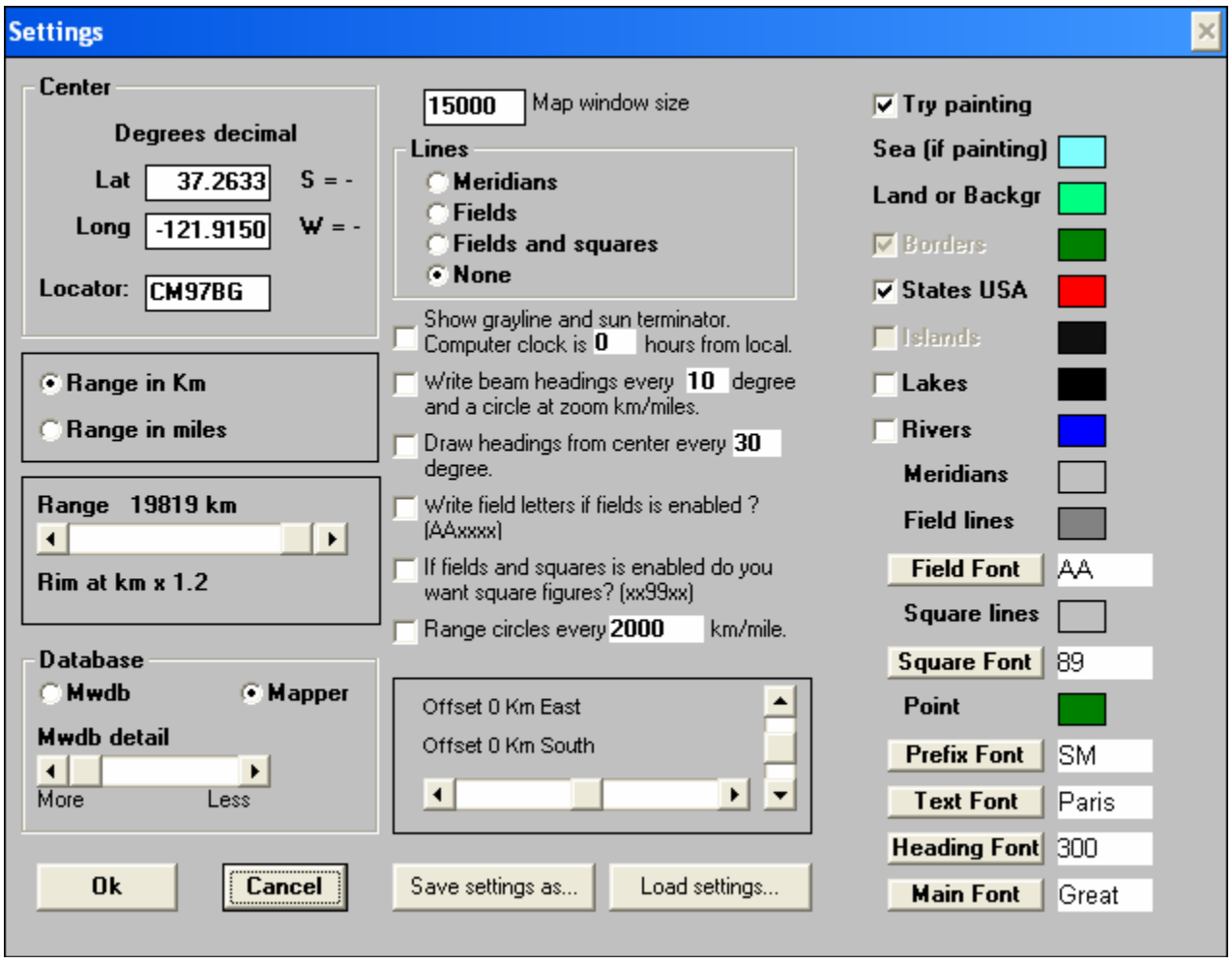


Figure #21. The menu settings used to generate Figure #18

D. Enter your Latitude and Longitude at the top-left of the menu, and adjust the "Range" slider bar to size the map range correctly. Use the "Start" button to draw the map, then use "File->Save As bmp" to save your map. Save your map as small.bmp, medium.bmp or large.bmp in your Wavenode software directory. These are the maps that will be displayed when clicking on the "In", "Normal" and "Out" Map View buttons on the rotator display.

The photo view buttons were generated using the Google Map website. The maps were chosen to be centered at the antenna location. The maps were then imported to

Paint.exe using the Alt->PrintScreen and Paste buttons. Use the photo crop functions to adjust the photo to the size you want and center the map to your location. Save the photo as a bmp file to your WaveNode program folder using the name small_photo.bmp, medium_photo.bmp or large_photo.bmp. Experiment with the map zoom until you have the map views exactly as you wish to see them.

You may wish to use other types of maps, photos etc. It's the user's choice to be as creative as they wish. Use Google aerial views, road maps, geological maps, and annotate them as you wish using Windows Paint or other drawing software. If you need assistance making the maps correctly, send us an email at contact@wavenode.com and provide us with your latitude and longitude. We will generate the maps and email them to you.

19. ***Data Logger Operation:***

Figure #22. The Data Logger Screen

A. The Data logger utility will capture the following data approximately one time each second. The data captured is time and date stamped at the beginning of each row of data. A maximum of 100,000 points can be captured in a single file, which allows the accumulation of data over a 24 hour period. The data collected is:

Date and time
Peak Power Channel #1
Peak Power Reflected #1
Average Power Channel #1
Peak Power Channel #2
Peak Power Reflected #2
Average Power Channel #2
Peak Power Channel #3
Peak Power Reflected #3
Average Power Channel #3
Peak Power Channel #4
Peak Power Reflected #4

Average Power Channel #4
Power Monitor Voltage
Total Accumulated RF Power #1
Total Accumulated RF Power #2
Total Accumulated RF Power #3
Total Accumulated RF Power #4

B. The Data capture begins when the "Start" button is pushed, and ends when either the Cancel button is pressed, or the pre-selected number of data points has been reached. The data is stored in a file in the WaveNode program folder with the name "Datalog~date~time".

C. To bring the data into an Excel file for graphing, open the file using Excel. Excel will prompt you asking how to open the file:

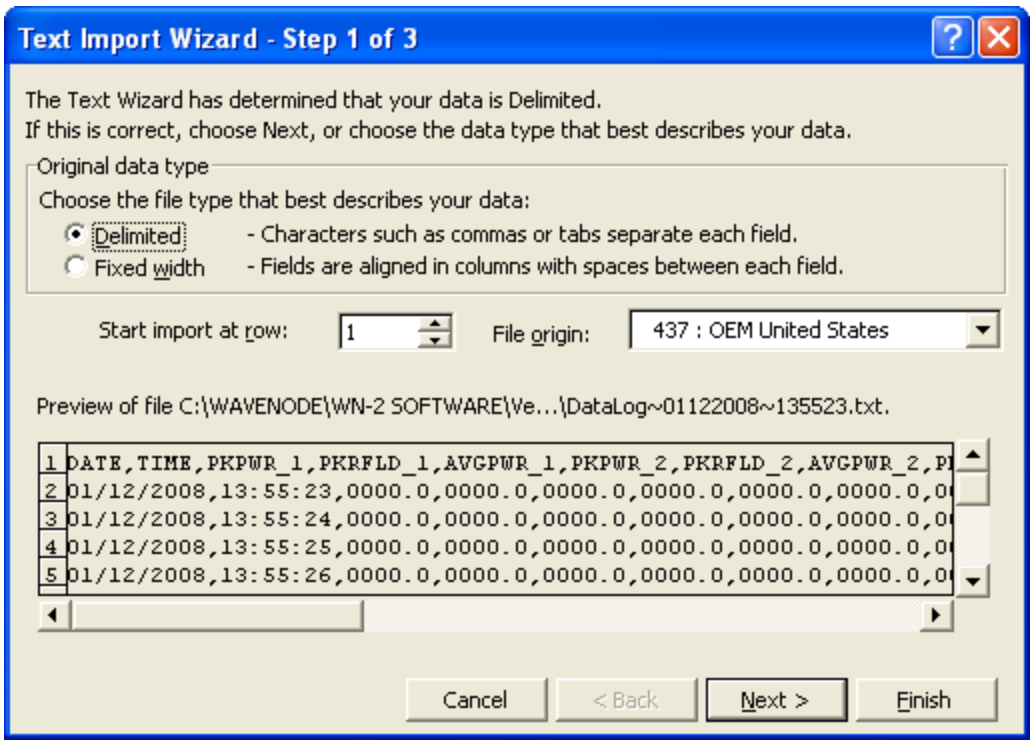


Figure #23. Opening the data file in Excel

When the data format screen is shown as in Figure #23, click the "Comma" box:

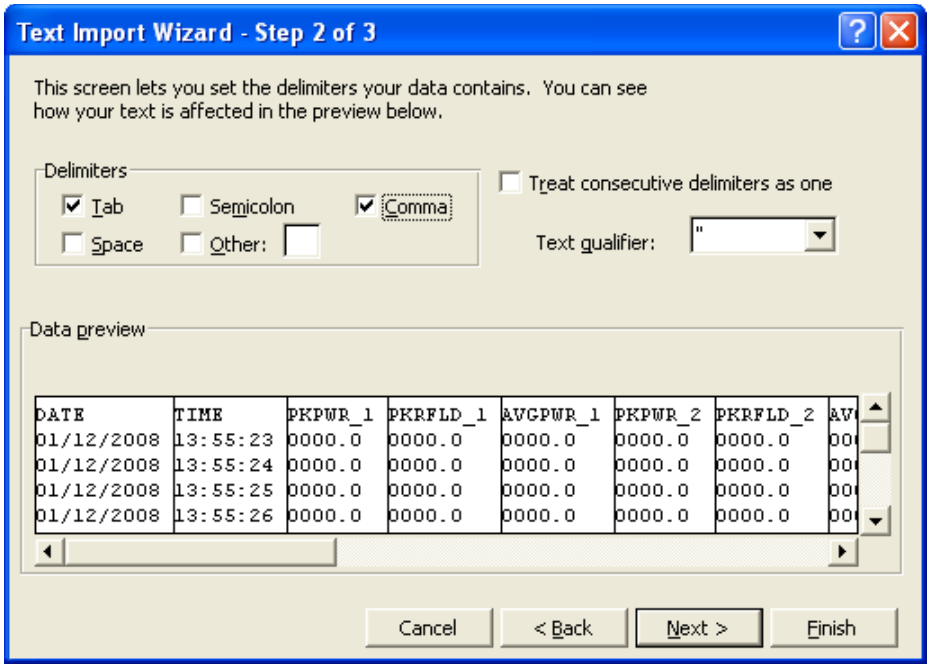


Figure #24. Opening the data file in Excel

Now the data is organized in rows of data for each time point. Use the Excel utilities to graph or organize the data in the desired format.

Example: Plot the Peak Power over the entire time of the data.

1. Import the data to Excel.
2. Click on the "B" column at the top box and while holding down the "CTRL" button, click the "C" column at the top. Both columns should be highlighted.
3. Click on the Graph Icon in Excel, then "XY(scatter)" selection. The graph is ready and can be labeled as desired.

20. ***Fault Email/Text Message Menu;***

The WN-2 has provision to send the user a text or email when a fault condition occurs. The type of fault will be indicated. Select the Email item from the Menu:

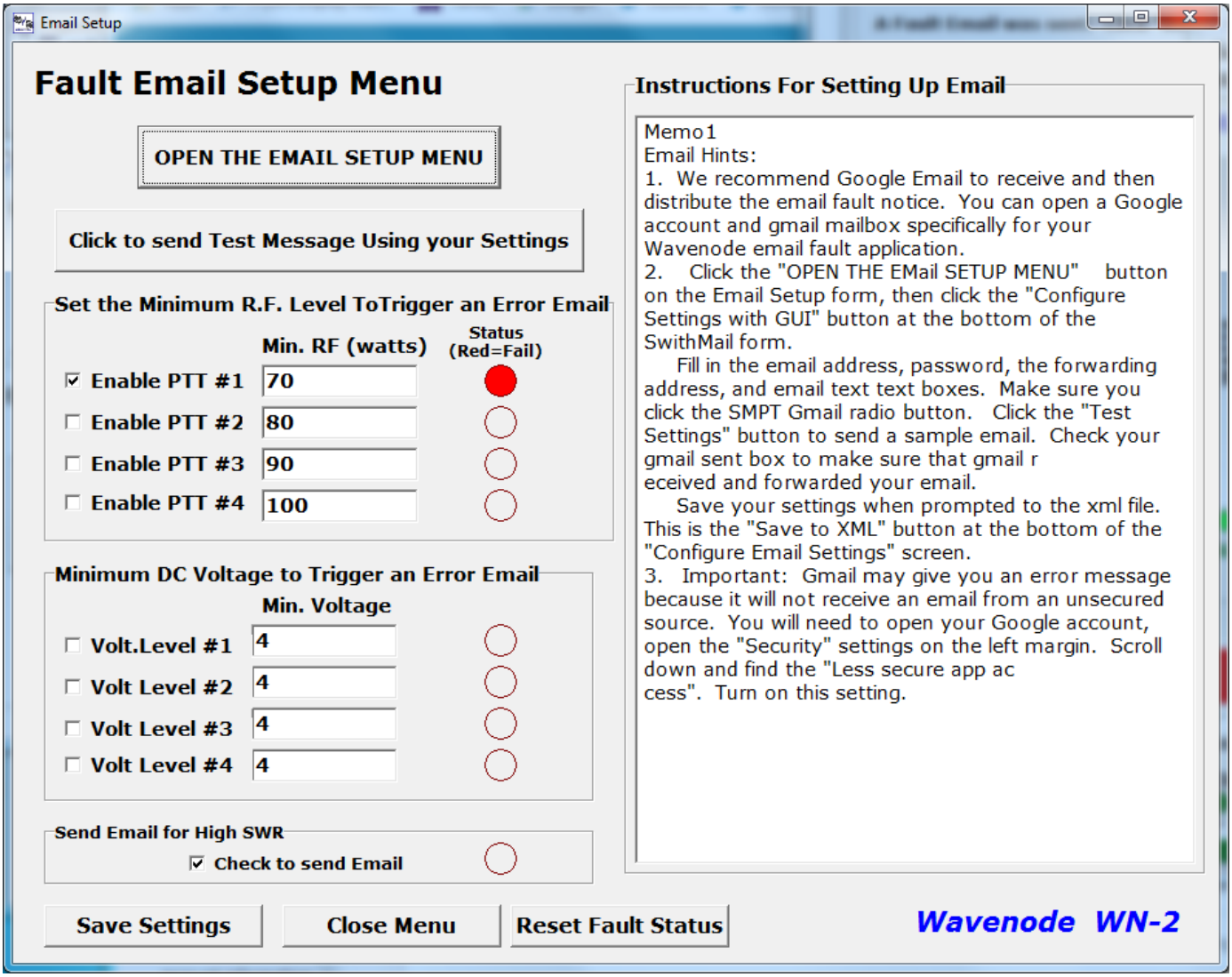


Figure #25. Email Fault Selection

Use the check boxes to select what fault conditions will send an email.

- Power less than a preset level when the PTT line goes true=low: This will require a 10K external pull up resistor if the PTT line is open when transmit=false. Maximum 12 VDC on the logic input line. The 16-pin connector on the rear provides the PTT inputs for sensors 1, 2, 3, 4 on logic inputs 1, 2, 3, 4. (Refer to Figure #1 for connector diagram pin assignments).
- DC Voltage from external sources such as power supplies, batteries, etc can also trigger a fault if they fall below a user-specified level. Use the four analog inputs on the connector pins 10, 11, 12, 13 for the DC sense lines.
- An SWR fault can also trigger an email. Use the Main screen to set the trigger level and sensors to be monitored.

Click the “Save Settings” button. Now click the “Open the Email Setup Menu” button. Click on the “Configure Settings with GUI” button. View Figure #27.

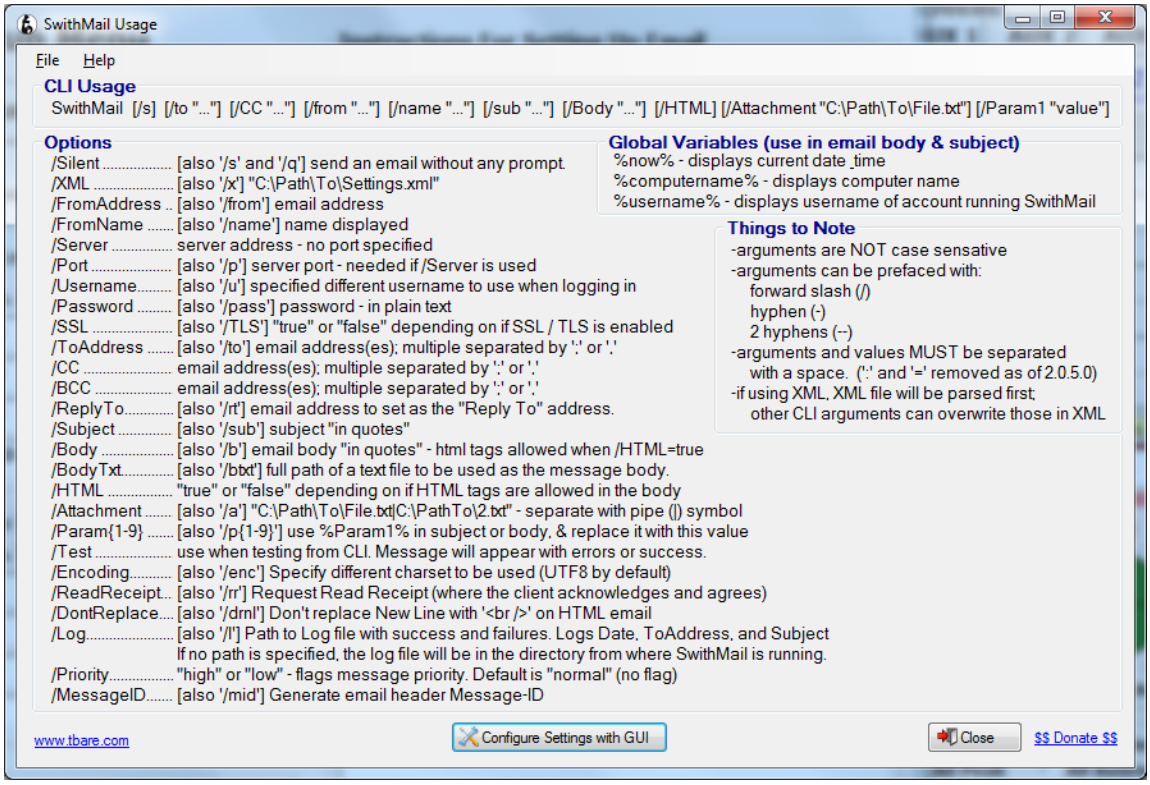


Figure #26. Email Usage

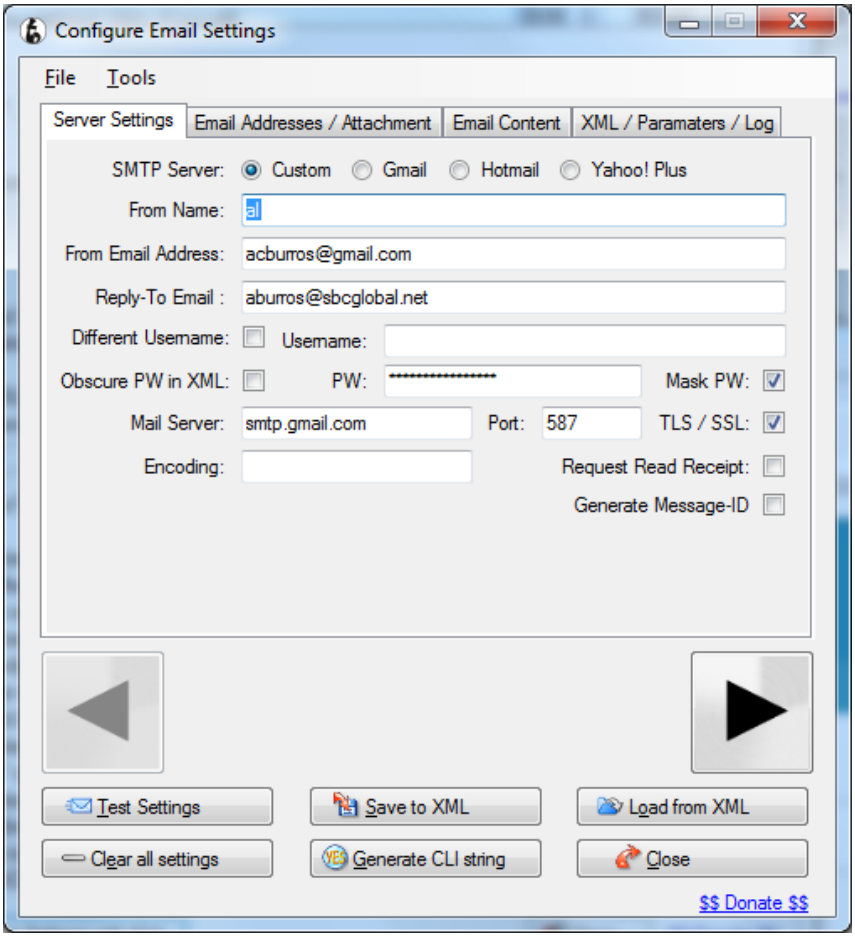


Figure #27. Email Settings

Viewing Fig. #27, fill in your email address/password to send the fault message to. Add message content as you like. When finished, click “Save to XML” to save your settings. Click the “Test Settings” button to send yourself a test email. We suggest using Gmail, but you will need to go to your Gmail account to reduce the security settings. You may want to open a new Gmail account just to handle fault emailing, then set that account to forward your emails to their intended recipients. If your test email was received, you are ready.

If a fault email is sent, you will see the message below in Figure #28. No new fault messages will be sent until you click “Reset”. This prevents multiple messages being sent unnecessarily. You can view what fault event triggered the email by observing Figure #25. Notice in Figure #25 that a fault was detected on “Enable PTT #1” line. This indicates that the fault was detected when the transmit level on sensor #1 was lower than the 70 watt threshold set by the user. Click the “Reset Fault Status” button to reset the indicated faults, and allow another fault email.

Figure #28

21. ***Specifications:***

RF Power measurement accuracy:	*+/- 10% full scale. +/-5% @ 100 watts.*
Power Requirements:	*12-16 Volts DC @ 350ma maximum.* *(power supplied via standard 5mm connector)*
PC requirements (if PC interconnect required):	*Windows XP, 2000, Vista, OS7. USB interconnect. (USB type-A to type-B cable) supplied.*
LCD Display:	*Yellow Backlit, high contrast, 16X2 display.* *Data update rate 20X/second.*
LED Display	*Dual, Green 16-element Bargraphs.* *85 mcdl brightness.*
Size and Weight	*5.75 inches wide X 4.0 inches deep X 3.1 inches high. 1 pound (without sensors)*
Auxiliary Logic Outputs(four). *Logic low.* *Logic High.*	 *< 0.3 volts DC* *> 3.3 volts DC (1K ohm series resistor)*
Auxiliary Voltage Measurement Input (four) *Input Voltage Range* *Input Impedance* *Accuracy*	 *0-20 volts DC* *10K Ohms* *+/- 5%*
Peak detector capture time (full scale). *Peak detector hold time*	*250 Microseconds* *50 milliseconds to infinite (user selectable)*
Modulation Oscilloscope update time. *Viewing Bandwidth.*	*2 updates/second* *20 Khz (-3db bandwidth)*
Modulation Spectrum Analyser update time. *Viewing Bandwidth.* *Resolution*	*2 updates/second* *20 Khz.(-6dBm Bandwidth)* *20 Hz.*
Completely backward compatible with all WaveNode RF sensors.	

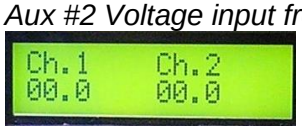
22. ***Front Panel View and Operation:***

A. Front Panel.

Power Switch: Powers the unit On and Off.
USB LED: Blinking LED indicates correct data transfer to/from the PC.
LCD Display: Displays the data that is selected by the “Display” button.
Display Button: Increments the display each time it is pushed. There are seven selections:

1. *Sensor #1 Peak, Average power, and SWR.*
2. *Sensor #2 Peak, Average power, and SWR.*
3. *Sensor #3 Peak, Average power, and SWR.*
4. *Sensor #4 Peak, Average power, and SWR.*

5. *Aux #1 and Aux #2 Voltage input from 10 pin ribbon connector.*



6. *Aux #3 and Aux #4 Voltage input from 10 pin ribbon connector.*

SWR RESET *switch:* Used to reset the SWR protection relay if it trips. Also, when held down, it will display to the user the following items:

1. The Sensor number and SWR trigger value to cause an SWR alarm and trip the relay.
2. The sensor types that the WN-2d has been programmed for.
3. The maximum bargraph power value.

View when "RESET" button is held down
Sensor #3 will trip the SWR relay if SWR exceeds 3.0
This sensor selection and trip level can be changed with the software running on host PC.

Sensor types for four RF sensors selected
These sensor types are selected on the Configuration Menu on the host software.

Power Range for the bargraph.
This is selected on the Configuration Menu on the host software.

The values shown in the photos above are saved in EEPROM when the RESET button is held down and the SWR LED blinks three times.
The SWR trip LED will blink 3 times to indicate the new values are stored.

These values can be modified ONLY by selection from the PC software.

The default programmed values are:

1. Sensor #1 is the SWR protected sensor and the trip SWR = 3:1.
2. The sensors types are all HF-1 or UHF-1 sensor.
3. The maximum bargraph power value is 2000 watts.

SWR TRIP LED: When lit, indicates the SWR relay is ON. It is important to remember that the sensor SWR being monitored by the WN-2d hardware is set to default sensor #1. Any, all, or none of the four sensors can be the protected sensor, but it must be selected on the Main page of the WN-2d software. When monitoring SWR on the LCD display, the SWR being monitored is the same as the channel number at the right of the LCD display.

23. ***Rear Panel View and Connections.***

The rear panel connections are:

1. Sensor #1 Input
2. Sensor #2 Input
3. Sensor #3 Input
4. Sensor #4 Input
5. SWR Trip Relay Contacts
6. Power Input (12-16 Volts DC @ 300 ma)
8. Expansion Connector (10 Pin Ribbon Cable Connector)
9. USB Connector to PC.

Sensors #1 to #4 are the coax sensor plugs. The CDROM contains documentation on this connector and how to interface to it if the user wishes to use sensors different than WaveNode sensors.

The DC Power connector is the DC power for the unit. This is 12-16 volts DC at 300ma maximum current. The center pin is positive.

The SWR relay contacts are a standard 3-pin connector with pins on 0.100 inch centers. The pins are the common, normally-open and normally-closed pins of the relay.

The 10-pin expansion connector is documented in the WN-2d software help file. It has 4 analog inputs and 4 logic outputs. The CDROM contains documents with suggested circuit connections to these pins. They are especially useful for monitoring and controlling external devices in remote applications. Pin 1 of the connector is at the top-right in this photo.

!!IMPORTANT!!

Open the configuration menu of the WN-2d software and click the correct sensor type for each of the four sensors. Select the bargraph range you wish to use. On the main screen, select the SWR protection sensor and SWR trip value desired. **Hold the SWR trip button on the WN-2d down until the SWR LED blinks 3 times.** Now your selections are stored in the WN-2d non-volatile memory. You can change your settings and store them again at any time.