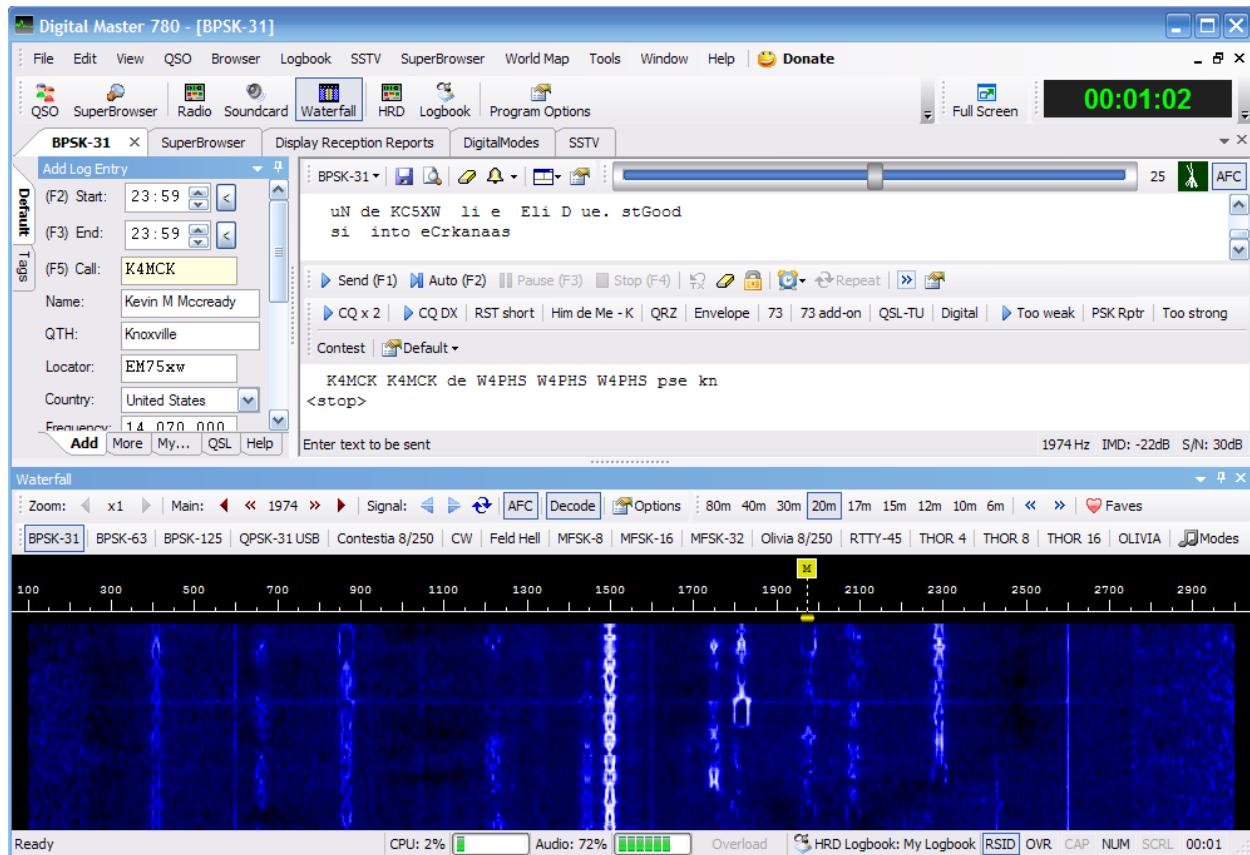


Ham Radio Digital Modes

Phil Sherrod – W4PHS

September 5, 2011

Copyright © 2011. All rights reserved.



Contents

Introduction	5
Advantages of digital modes	5
Hardware for digital communication	6
The SignaLink sound interface	6
Computer control connection.....	8
Software for digital modes.....	9
Downloading and installing Ham Radio Deluxe.....	9
Starting and configuring Ham Radio Deluxe	10
Ham Radio Deluxe main screen	11
Ham Radio Deluxe logbook screen	12
Setting your station information.....	12
Configuring call sign lookup	13
Configuring the spotting list.....	15
Logging a QSO	17
Tuning the radio and logging an entry from the spotting list.....	18
Configuring automatic eQSL.cc log uploads	19
Digital Master 780 – Digital operation in Ham Radio Deluxe.....	21
Configuring your call sign and station information.....	22
Configuring your sound card	23
Configuring the logbook connection	24
The DM780 main screen	25
Soundcard panel.....	25

QSO entry panel	25
Receive text panel.....	26
Outgoing text panel.....	26
“Waterfall” panel.....	26
Configuring macros.....	26
Common digital abbreviations	30
Experimenting with macros.....	32
Selecting modes, bands, and frequencies	33
Preparing for your first QSO	36
Answering a CQ.....	37
Calling CQ	39
Logging a QSO in DM780.....	40
Adjusting SignalLink audio levels	41
Popular digital operating modes.....	42
PSK-31, PSK-63, and PSK-125.....	42
RTTY – Radio Teletype	44
Hellshreiber and Feld-Hell	45
MFSK16.....	46
Speed/bandwidth comparison of text digital modes.....	47
SSTV – Slow Scan TV.....	48
Winlink 2000.....	50
APRS	51
Equipment needed to use APRS	51
APRS packet transmission	52

Digipeaters: APRS repeaters.....	52
I-Gates and Internet sites	52
TNC: Terminal Node Controllers.....	54
APRS Transmission paths.....	54
Index	55

Introduction

Digital operation modes have become popular among hams over the last few years, but digital operation is not new to ham radio. In fact, the original operating mode, CW, is a digital mode. Morse code uses binary symbols (dots and dashes), and it uses variable-length character encoding like PSK-31. Radio Teletype, RTTY, started to be used by hams shortly after World War II, and it is still popular today.

I have helped a number of hams get on the air with digital operation. My experience has been that 90% of the effort goes into getting the Ham Radio Deluxe program installed, configured, and getting them through the initial steps of using HRD. So a large portion of this guide will be devoted to installing and learning how to use HRD.

Advantages of digital modes

Digital operating modes will never replace CW or SSB phone, but they do offer a number of advantages.

- The narrow bandwidth of digital modes (including CW) allows a low power station to make DX contacts that would be impossible with the bandwidth of SSB. The standard operating power for PSK-31 is in the range of 15 to 40 watts. On several occasions, I have had solid communication from Tennessee to hams in North Carolina who are using 2 watts.
- Foreign accents are not a problem when operating with CW or digital modes.
- Some digital modes such as Winlink and SSTV can transmit images as well as text.
- Some digital modes use an ACK/NAK verification system to detect errors, and they automatically retransmit packets until the transmission is successfully received.
- Some digital modes can transmit formatted documents, spreadsheets, pdf files, and other types of files that have structure. This is particularly important in emergency communication where a list of supplies can be sent much more conveniently and reliably digitally than via phone communication.
- Using the Winlink system, you can send and receive e-mail via radio, and you can exchange e-mails (possibly including file attachments) with standard e-mail systems like Gmail and Hotmail.

Hardware for digital communication

The equipment required for digital operation is modest:

- A radio. A HF or VHF/UHF radio may be used depending on the digital mode and the format of the data packets.
- A computer running software capable of encoding/decoding digital modes.
- A sound card interface. While it is possible to use the sound card interface available in most computers, a SignaLink external sound interface is recommended.
- Optional packet modems. For high-speed Winlink operation using the Packtor 3 protocol, a special (and fairly expensive) modem is required. Also, a special modem is required for 9600 baud VHF/UHF packet operation. However, most digital modes such as PSK-31, RTTY, and SSTV can be done using an inexpensive sound card interface. Winlink can operate through a sound card using the WINMOR protocol.

The SignaLink sound interface

If you already have a SignaLink USB sound interface installed, you can skip to page 8.

The great thing about most digital modes is that you can use the inexpensive and popular SignaLink USB sound interface. While it is possible to use your computer sound card with a connection like RigBlaster, it is much better to use a secondary soundcard that is *not* controlled by the computer operating system. The SignaLink is a soundcard interface that has been shown to work reliably with all digital modes including WINMOR. Another advantage of an external sound card is that you can listen to music or other sounds through your computer's speakers while operating in digital modes.

The SignaLink USB sound interface is made by Tigertronics, and it costs about \$100. When you order it, you must select the appropriate cable to connect to your radio. The SignaLink connects to your computer via USB, and it is powered by the USB, so you don't have to have another wall transformer.

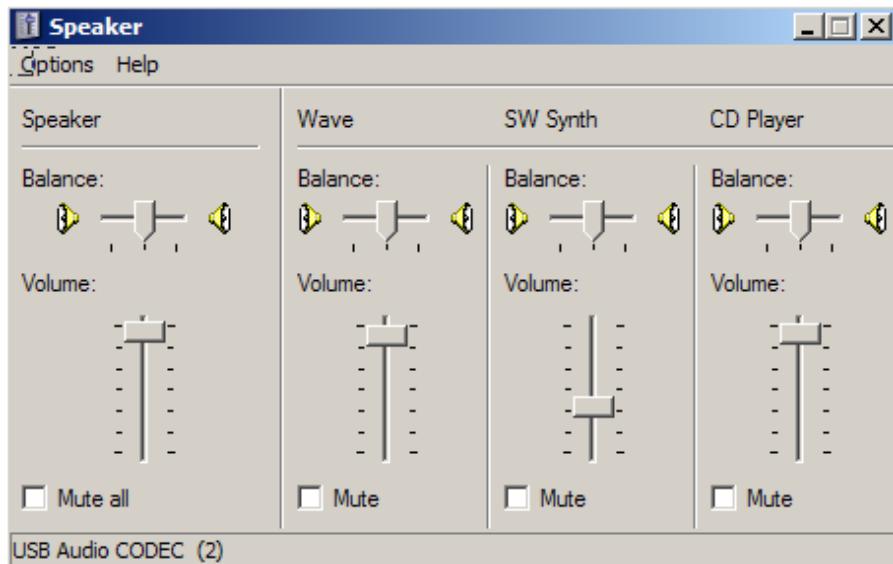


Once you receive your SignaLink, you have to open it and install jumpers to configure it for the type of radio you're using. This process takes about five minutes. We recommend that you do *not* purchase the pre-configured jumper blocks sold by Tigertronics. Several of us have been shipped the wrong version of the headers, and it is very confusing to figure out what the problem is. Installing the jumpers manually is very easy.

Set the RX and TX knobs on the SignaLink to the halfway position (straight up), and set the DLY knob to full counterclockwise (minimum delay). You may have to adjust the receive and transmit levels later.

It is recommended that ferrite beads (RF chokes) be placed on both ends of the SignaLink cables. It's also a good idea to use a Radio Works choke on your antenna feed line to keep RF out of your shack.

After you connect the SignaLink to your computer, you will see a new soundcard listed in your hardware. Be certain to follow the SignaLink set up for the Windows operating system by following the manual that describes the procedure. It is critical that you set certain Windows volume levels, which are specifically described, to a maximum volume in order to trigger the VOX in the SignaLink, and allow transmission. Even if your radio does not use the Signalink VOX, such maximum levels are necessary.



Computer control connection

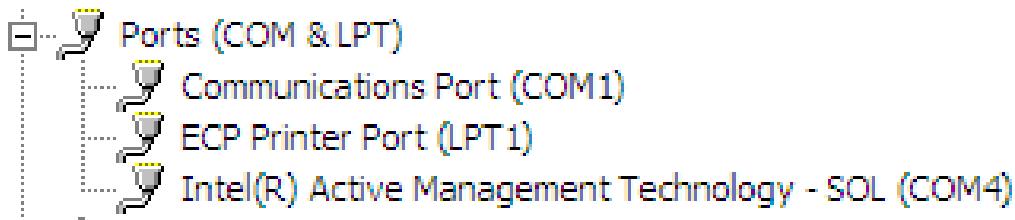
In addition to installing a Signalink and connecting it to your computer, you also need to install a cable that the software can use to control your radio. It is possible to manually tune your radio and operate without computer control, but life will be *much* easier if your software can control your radio.

Some of the newer radios are equipped with USB ports for radio control, but the majority of radios use serial connections. Since it is rare to find a new computer with a serial port, USB-to-serial adapters are normally used to connect the serial link to the computer.

All manufacturers sell their own radio-to-computer cables, and they work fine. But brand-name cables usually cost two to five times as much as generic cables. I recommend you get on eBay and search for a cable for your radio. If you have an Icom radio with a CI-V interface, do an eBay search for "Icom CI-V interface cable". You should be able to find one for about \$12 including shipping.

Note: Be sure to get a cable that has a USB converter built into it so that you don't have to buy a separate serial-to-USB adapter.

When you connect a serial cable that includes a USB adapter, Windows will show an entry in the "Ports (COM & LPT)" section of the device list. The COM port number assigned to the connection by Windows will be displayed. It is COM port 1 (COM1) in the following screenshot:



Since a serial connection is used to the radio, you must set the baud rate and possibly the number of bits and parity in your radio. You should consult the manual for your radio to determine how to do this. I suggest using the default baud rate that the radio is set to. If you have a choice, choose 8-bit characters and no parity. Make a note of the COM port number and baud rate, because you will need to know them when you configure the software.

Software for digital modes

Digital modes encode data as modulated sounds, so you must run software that has the capability of doing this encoding and decoding. There are a number of good programs available for popular digital modes such as PSK-31, RTTY, and SSTV, but the focus of this paper will be on the outstanding **Ham Radio Deluxe** program and its **Digital Master 780 (DM780)** digital component.

Ham Radio Deluxe (HRD) is the most popular ham radio program in the world, it has been under development for many years, and it is free. The DM780 digital component can encode and decode all of the popular digital modes such as PSK-31, RTTY, and SSTV. It also can handle about 80 obscure digital modes such as Thor, Throb, Olivia, Feld-Hell, and Domino. DM780 *cannot* send or receive Winlink/WINMOR messages or APRS packets, but that will be covered later.

Downloading and installing Ham Radio Deluxe

If you already have Ham Radio Deluxe installed and are familiar with its operation, you can skip to page 21.

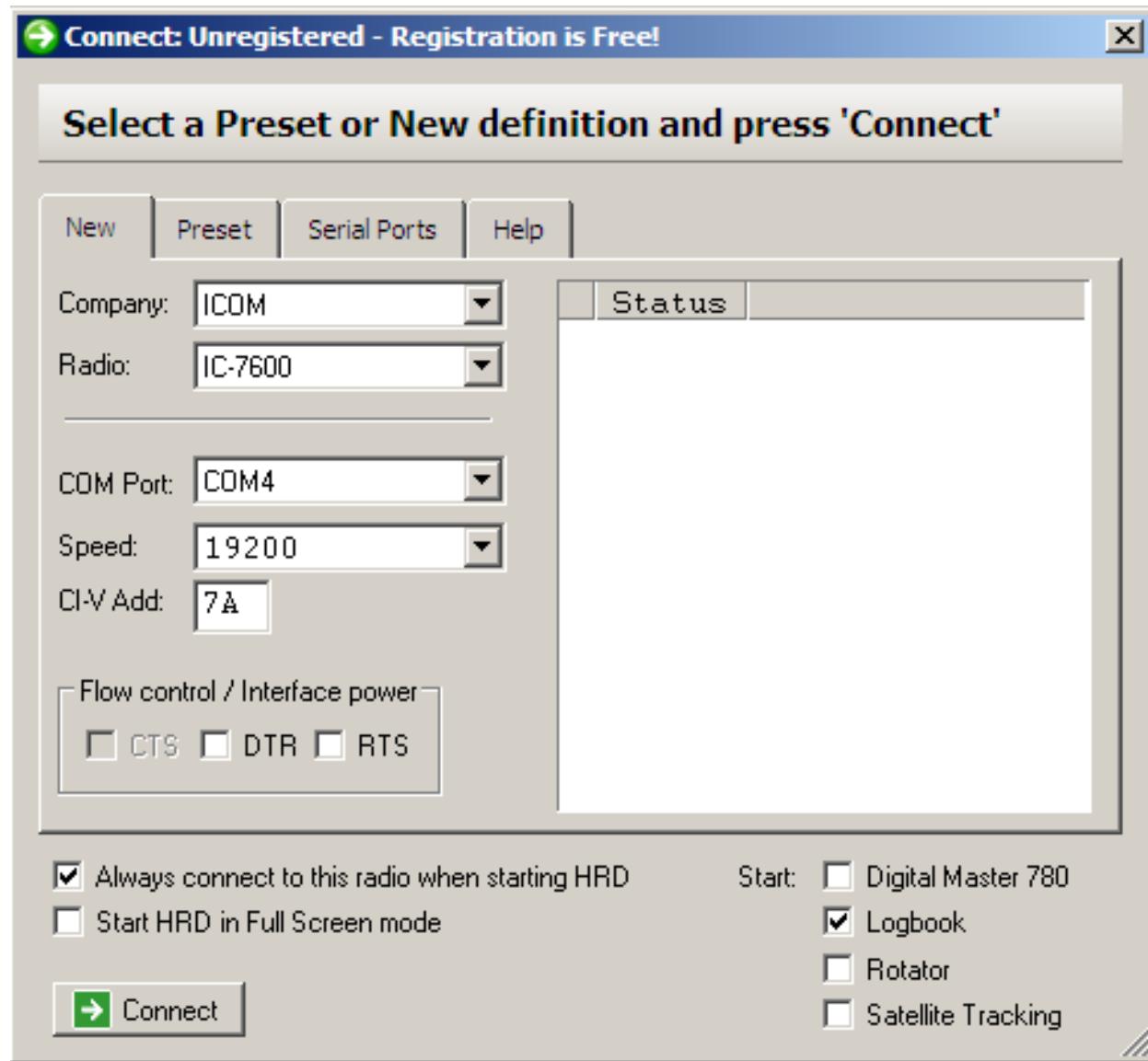
You can download the free HRD installation from <http://www.ham-radio-deluxe.com/HRDv5.aspx>. You should install **Version 5** of HRD. The older Version 4 was frozen several years ago and is no longer being developed.

In addition to providing extensive digital support, HRD is a wonderful program for controlling your radio and logging contacts.

If you have problems installing or using Ham Radio Deluxe, there are helpful support forums available at <http://forums.ham-radio.ch/>

Starting and configuring Ham Radio Deluxe

The first time you start Ham Radio Deluxe, it will display a screen where you can enter information telling it what type of radio you have and how to communicate with it.



Select the make and model of your radio in the upper fields. Select the COM port of the serial command interface to your radio and the baud rate in the lower fields. I recommend checking the boxes at the bottom of the screen "Always connect to this radio when starting HRD" and "Start/Logbook".

If you're not sure which COM port your radio interface is connected to, open the Windows Control Panel screen, then enter the Device Manager section, and expand the "Ports (COM & LPT)" entry. You should see the COM port listed with its port number.

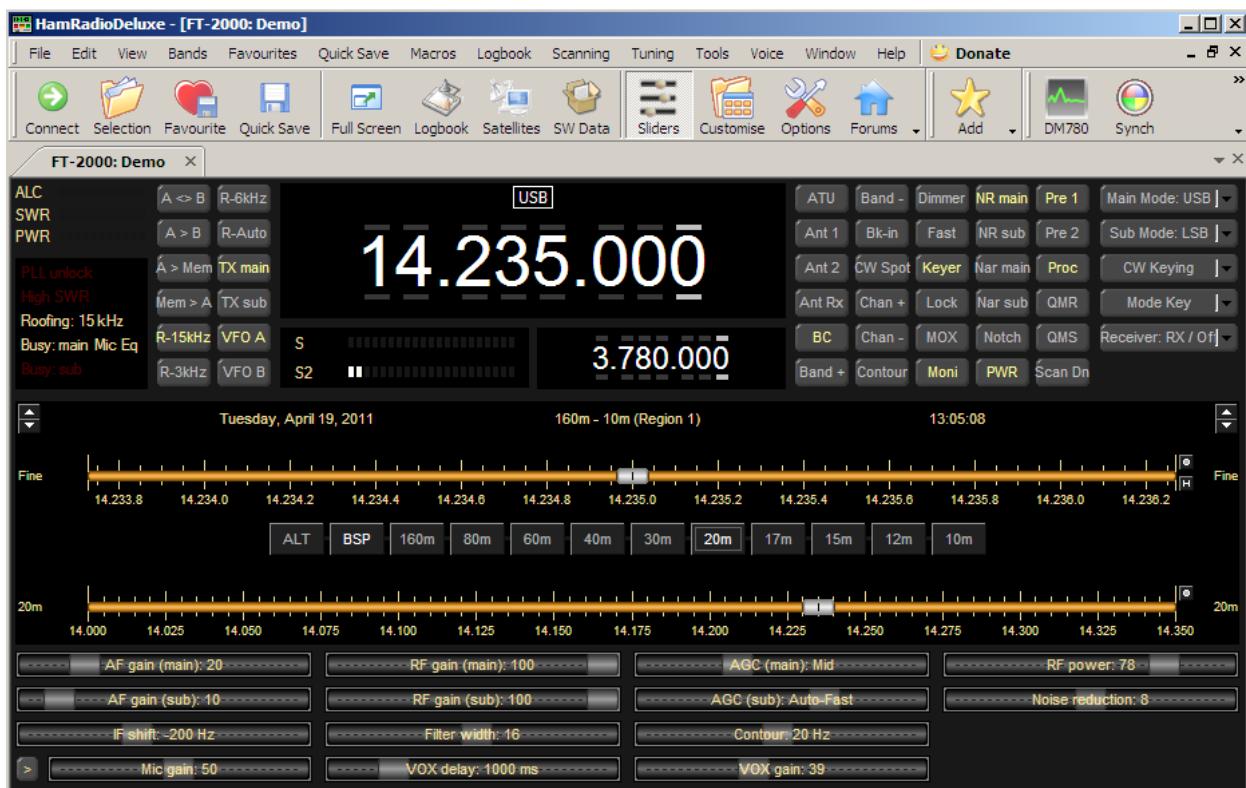
Make sure the baud rate you specify in HRD matches the baud rate set in your radio. See above for more information about the radio control connection.

Click the “Connect” button after you enter your radio’s information.

If you need to change the radio or COM port settings later, click the “Connect” icon at the left end of HRD’s main screen (see below).

Ham Radio Deluxe main screen

The HRD main screen displays the digital frequency it is receiving from your radio, a virtual tuning bar, and buttons to control your radio. If you checked the option to open the logbook when HRD starts, you can minimize the logbook to view the main screen.

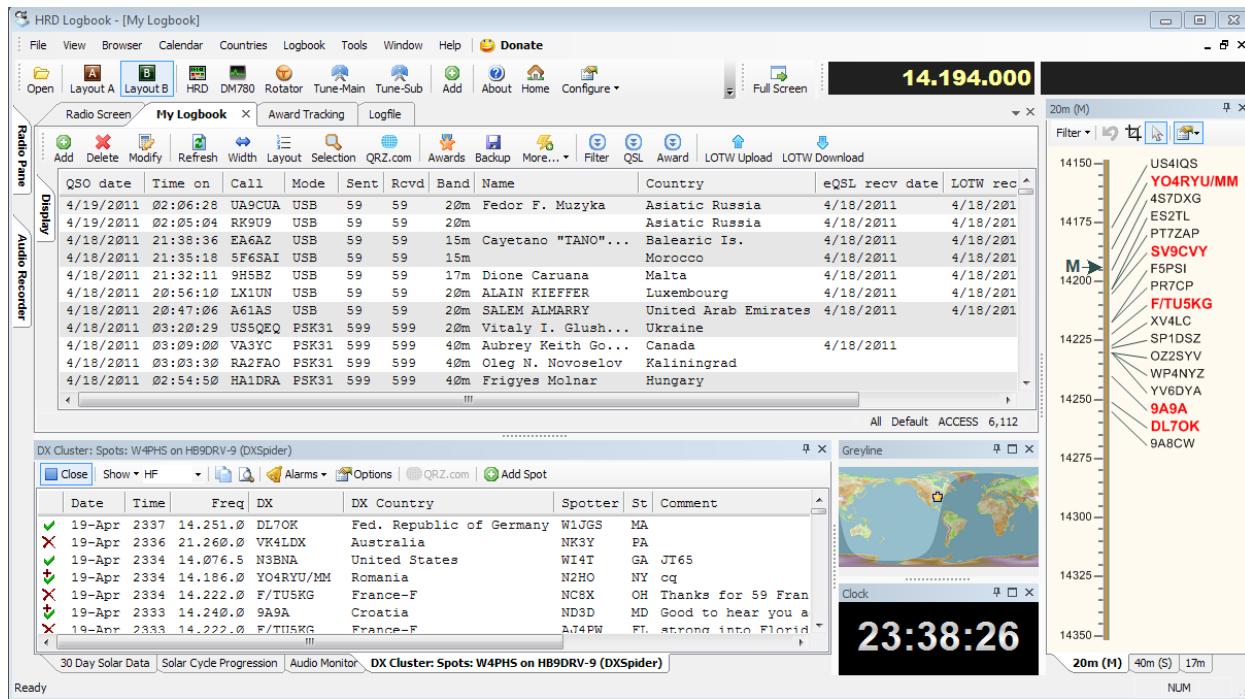


Many of your radio operations including changing bands and frequencies, selecting antennas and filters can be accomplished by clicking items on this screen.

HRD has a remote-operation mode where a copy of HRD running on a remote computer can connect through the Internet to a HRD server running on the computer connected to your radio. You also can use remote desktop software to view and control HRD operations. This type of remote operation is especially useful for digital modes that don’t require a voice signal to come though the Internet.

Ham Radio Deluxe logbook screen

HRD has an excellent logbook facility. Here is an example of the logbook screen:

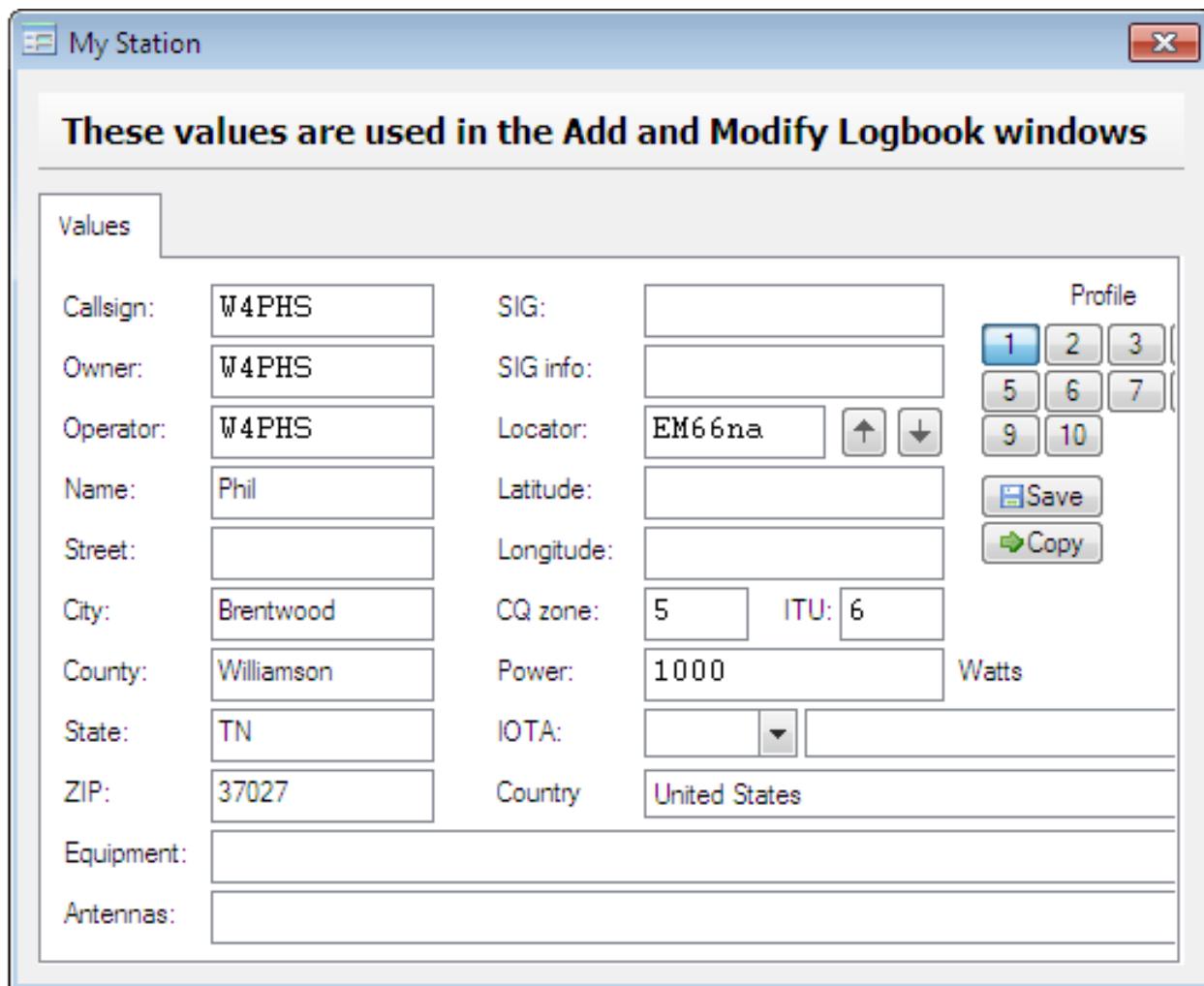


The logged QSOs are shown in the upper panel, the current spots for the band you're tuned to are displayed in the vertical field on the right, and the running, real-time spot log is shown in the bottom field.

The logbook screen is very flexible. You can choose to display fields such as the spotting screen or hide them. You can select which items are displayed on logbook lines for each QSO, and there are many other options and settings. I will cover only a few. See the HRD manual and help files for additional information.

Setting your station information

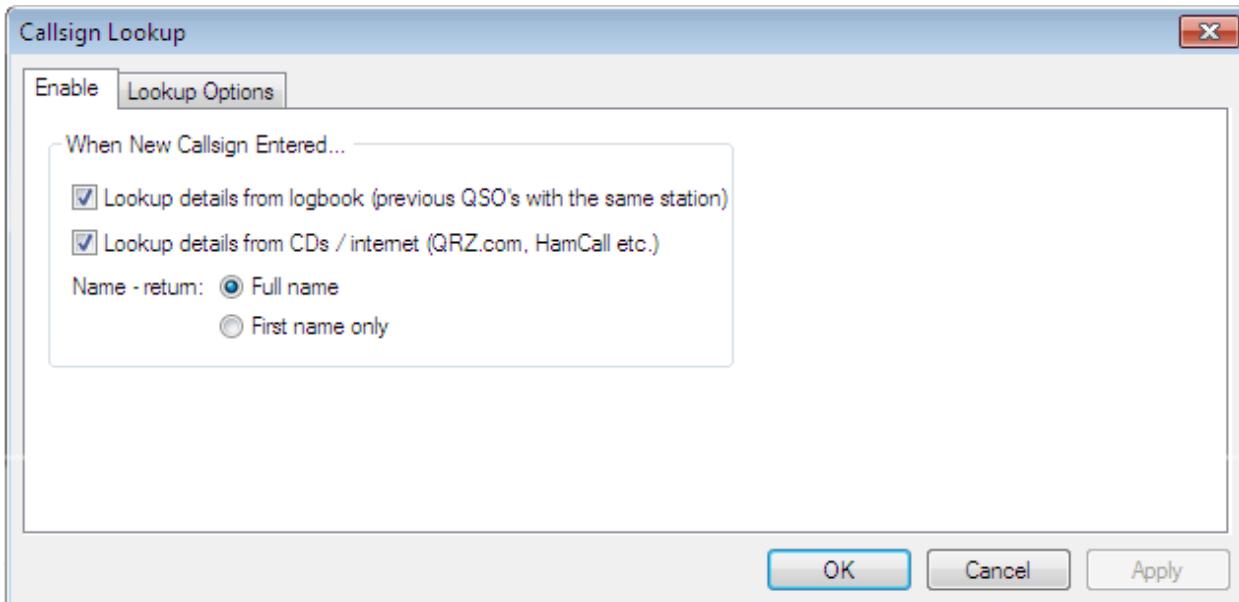
The first thing you should do in the logbook is enter your station information. To do that, click "Configure" on the logbook screen toolbar, and select "My station" from the drop-down menu. You will see a screen like this:



Enter your call sign, name, and other information, then **click the “Save” button**. Note, if you click the ‘X’ to close the screen without first clicking “Save” your information will not be saved.

Configuring call sign lookup

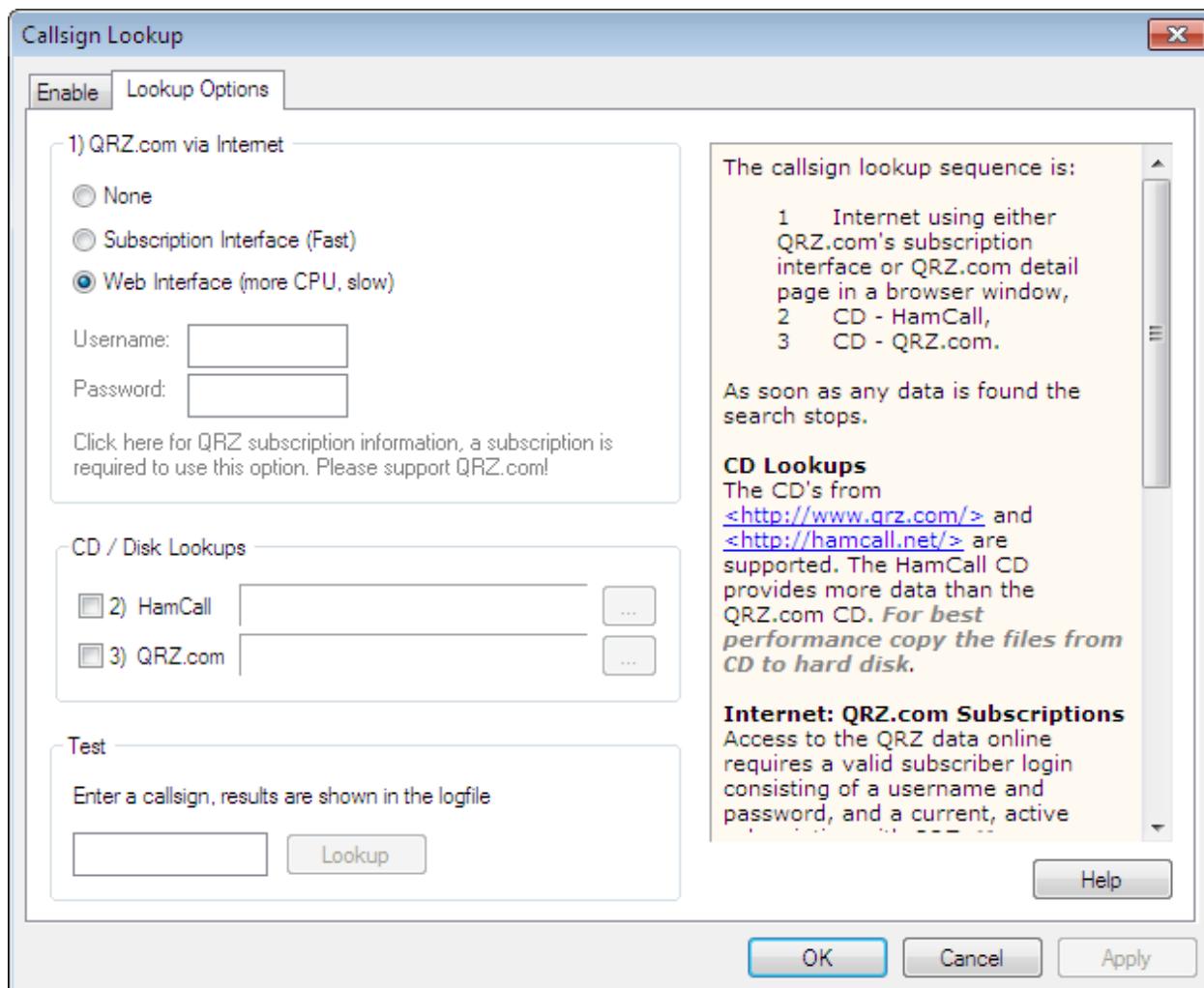
One of the many useful features of HRD is its ability to look up call signs automatically and display the QTH and other information about the station. In order to use this, you need to first configure the call sign lookup options. Click “Configure” on the logbook toolbar, and select “Call sign lookup” from the drop-down list. HRD will display a screen with two tabbed pages. On the “Enable” screen, click both boxes to do lookups from previous QSOs and from CDs/Internet.



On the “Lookup Options” screen, check the “Subscription interface” if you have a subscription to QRZ.com (<http://www.qrz.com/>) or check “Web interface” if you don’t have a subscription to QRZ.com. Note, QRZ.com is a wonderful resource of great value to hams. Not only does a subscription to QRZ.com get you a faster and better way for HRD to lookup call signs, you are also providing support to a worthwhile organization.

If you have a QRZ.com subscription and check the “Subscription interface” box, then enter your QRZ.com username and password in the appropriate fields.

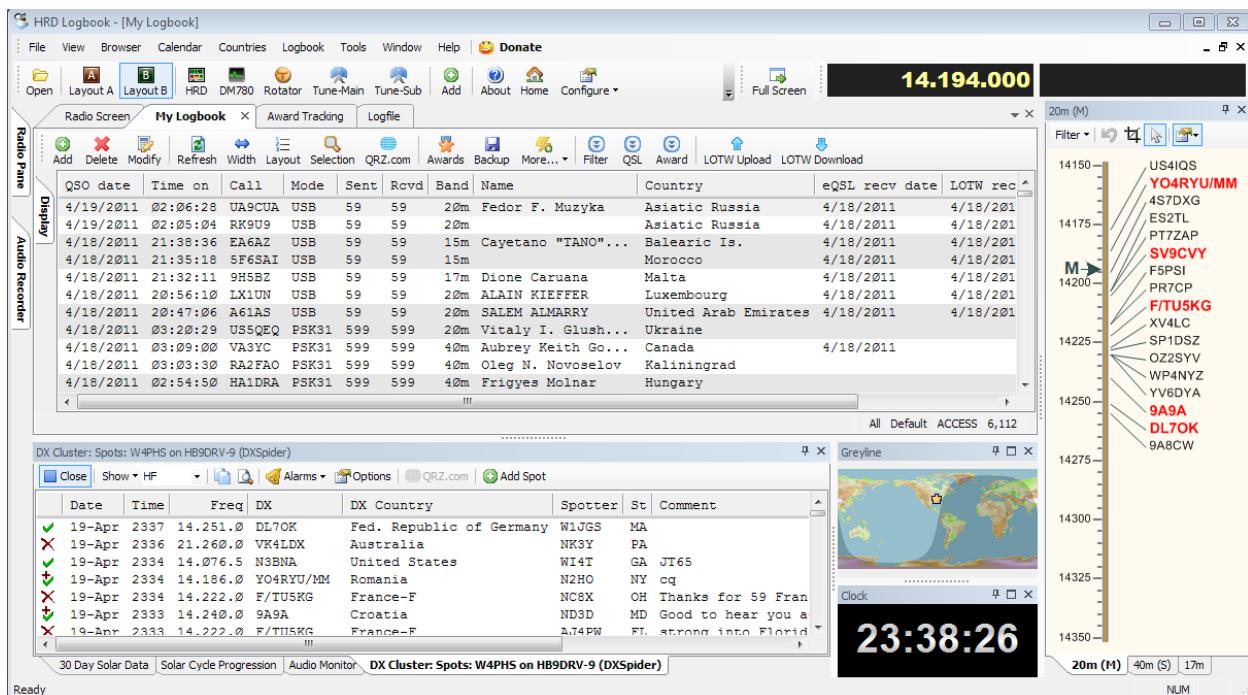
Once you set option on both of the call sign lookup screen, click “OK” to close them.



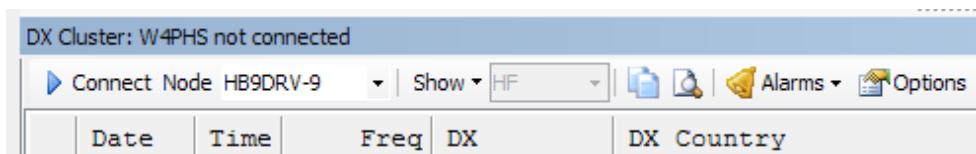
Configuring the spotting list

HRD includes a built-in “spotting list” that connects through the Internet to a DX cluster so that it can display spots of interesting stations that other hams have submitted.

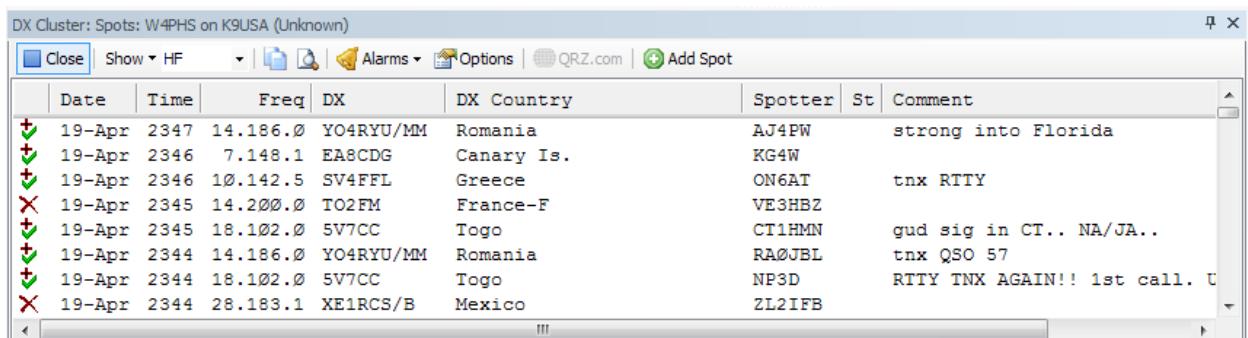
There are two parts to the spotting list: (1) on the right side of the logbook screen you will see a vertical panel that shows stations on frequencies in the band you’re tuned to, and (2) the lower panel shows a real-time log of spots that scrolls as they are received. The real-time log displays spots received for all bands.



Before you can view spots, you must select which DX cluster server you want to connect to. Above the bottom field, you will see a menu bar with “DX Cluster” followed by a bar with “Connect”, “Node”, “Show” and other fields. Open the drop-down list by “Node” and select the DX cluster you want HRD to connect to. I recommend using either HB9DRV-9 or K9USA which you will find about halfway down the list.

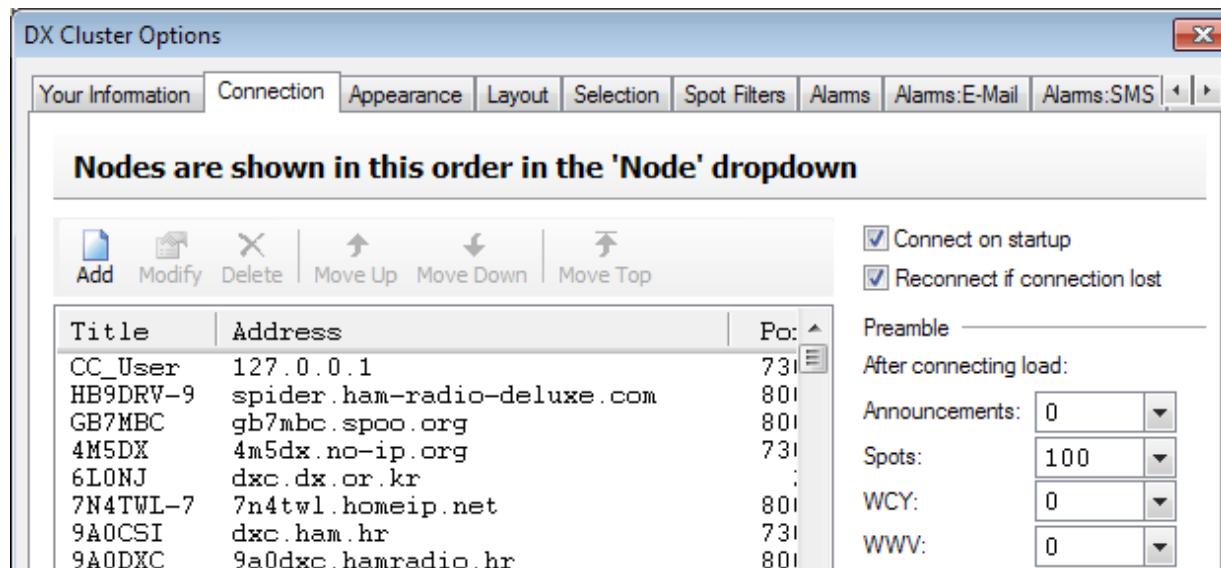


After you select the DX cluster, click the “Connect” button at the left end of the line. HRD should connect to the DX cluster and start displaying the real-time log in the lower panel.



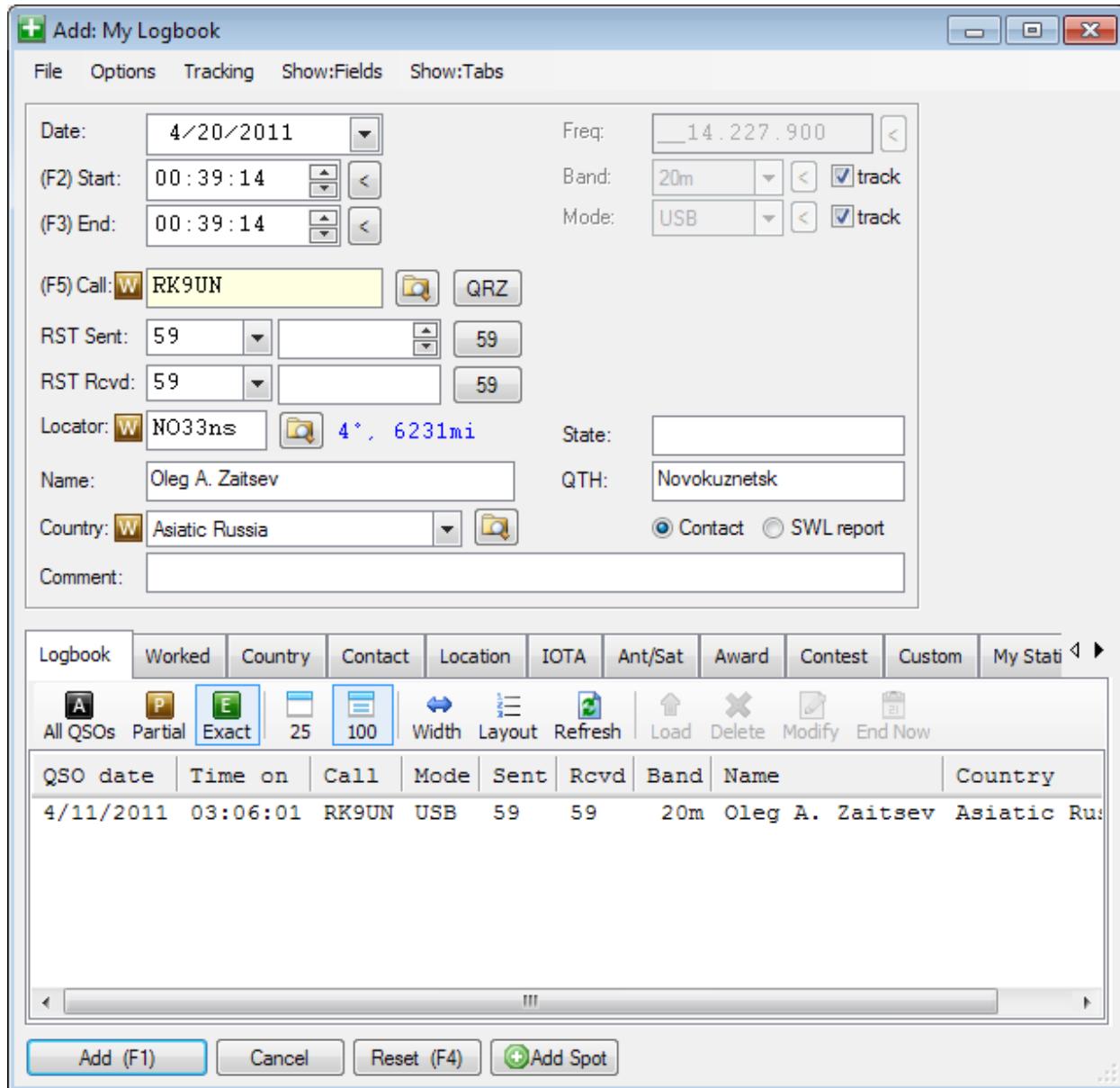
As spots are received for the band you're working, they will be displayed in the right panel spotting list.

To avoid having to manually connect to a DX cluster each time, click “Options” on the line with the “Connect” button to open the DX cluster configuration screen. Select the “Connection” tab and check the option boxes to connect each time HRD is started.



Logging a QSO

It is very easy to log a QSO in HRD. Click the “Add” button at the left end of the logbook toolbar to open the QSO entry screen. Enter a call sign in the “Call” field and press the Tab key to tell HRD to look up the call sign and fill in the other fields for you. In the screenshot below, all fields other than the call sign were filled in automatically when I pressed Tab.

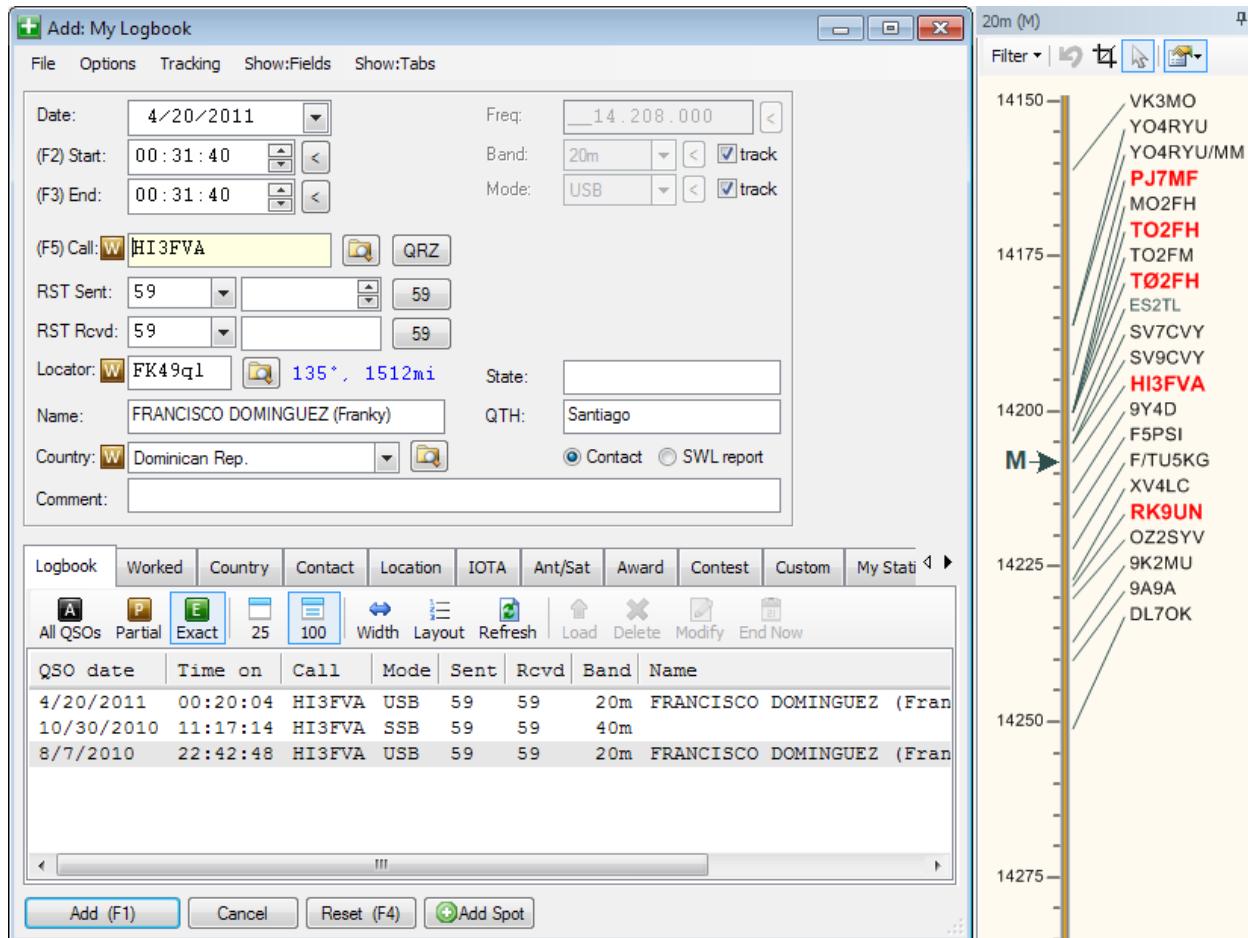


When you are ready to write the QSO to your logbook database, click the “Add” button at the bottom of the QSO screen, or press F1. Click “Reset” to clear the QSO entry fields.

Tuning the radio and logging an entry from the spotting list

You can click on a call sign in either the spotting list in the right panel or the real-time log in the bottom panel to tune your radio to the frequency of the spot and fill the call sign into your logbook QSO entry screen. If QRZ lookups are enabled, HRD will fill in the other fields with information about the station. The bearing and distance to the station are displayed in blue next to the “Locator” field. If you have worked the station

before, information about previous QSOs will be displayed in the lower field of the QSO entry screen as shown below:

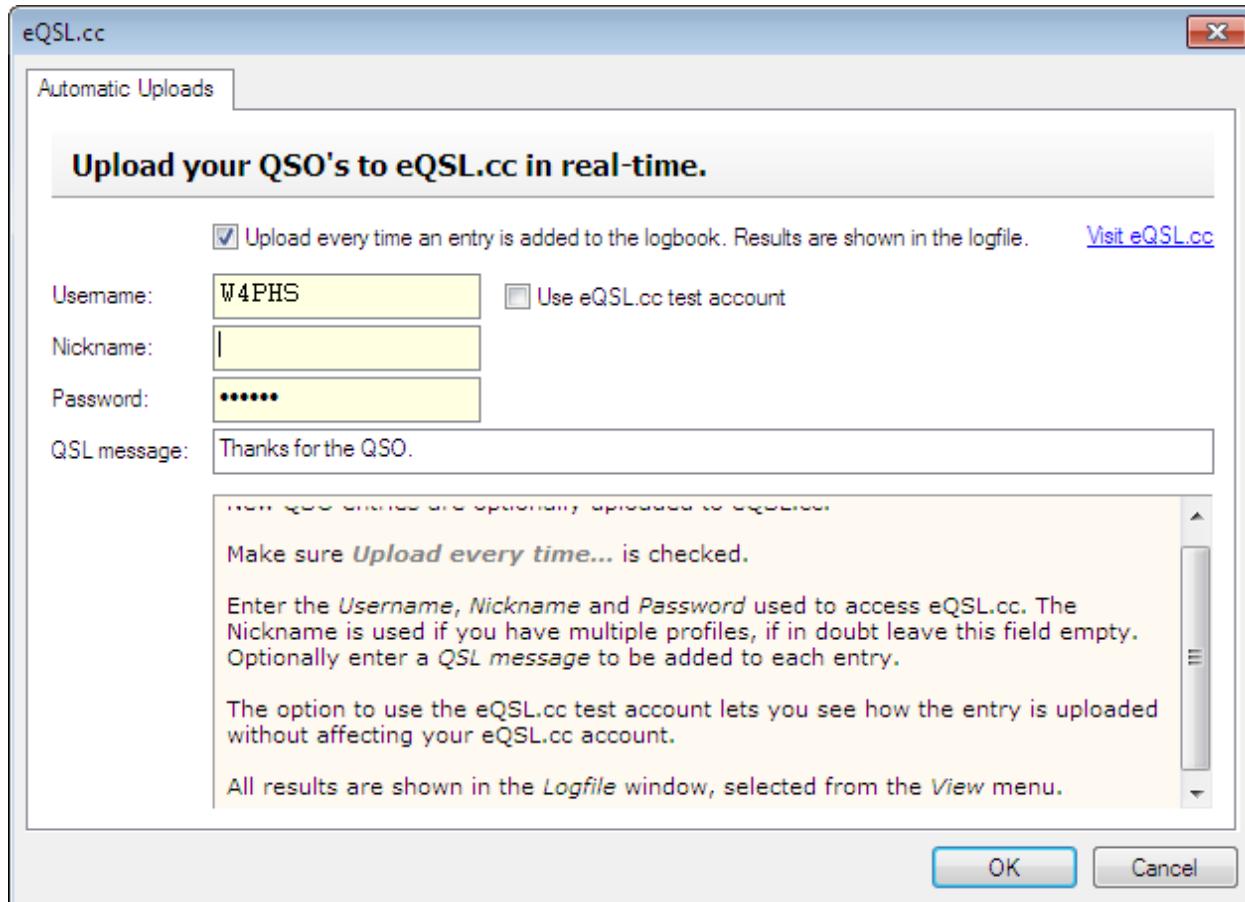


Configuring automatic eQSL.cc log uploads

HRD has a nice feature that you can engage to tell it to automatically upload log entries to your eQSL.cc account as soon as you add them to your log book. This feature is widely used by people all over the world; often I find that as soon as I log a QSO, the QSL from the other station has already been posted to my eQSL.cc account.

If you haven't established an eQSL account, go to <http://www.eQSL.cc> and create one.

To enable automatic eQSL logging in HRD, click the "Configure" icon on the logbook screen, and select "eQSL.cc" from the drop-down list. A screen like this will be displayed:

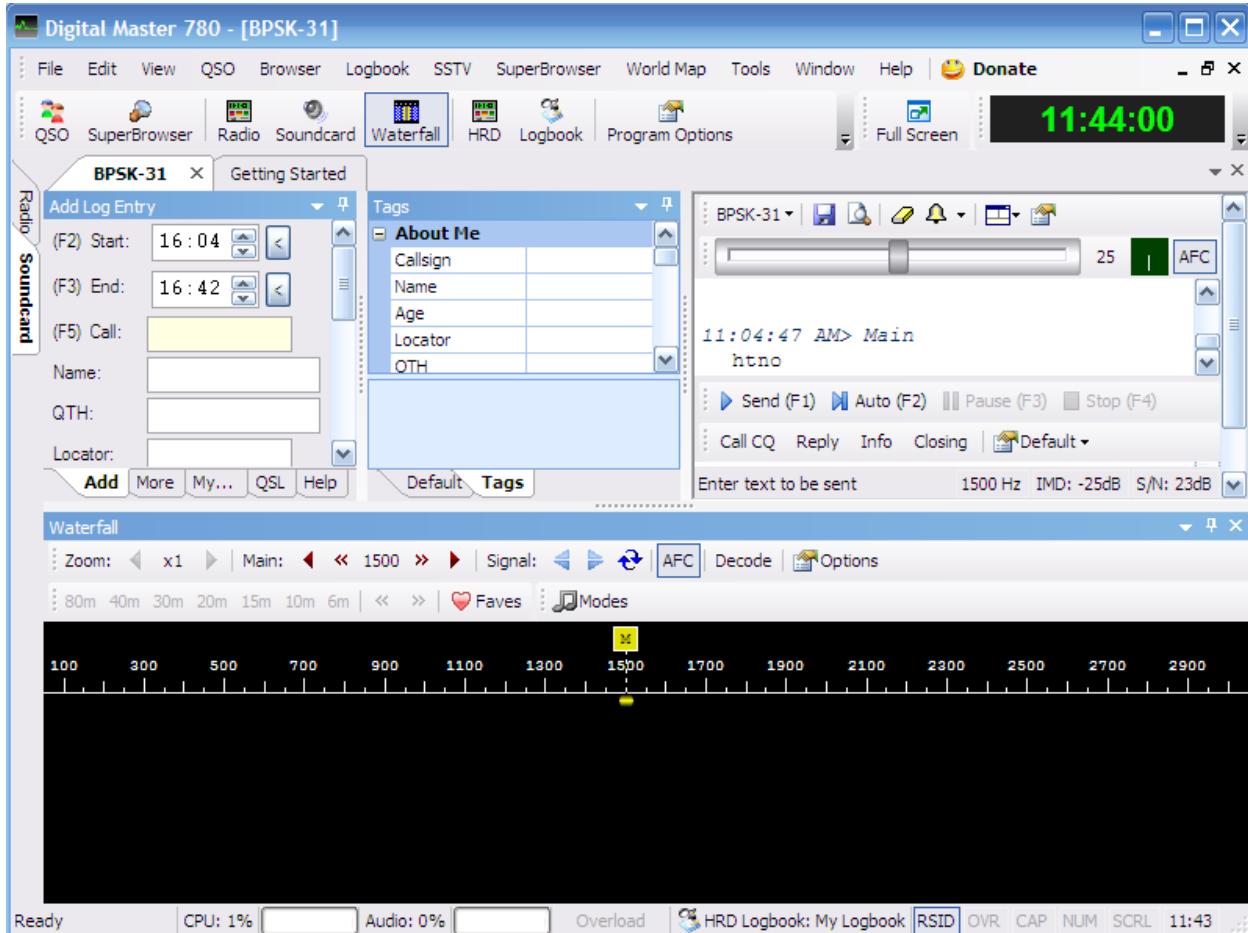


Enter your eQSL.cc user name which is usually your call sign, if you have set up multiple QTH entries for your account at eQSL, enter the one you're using in the "Nickname" field, enter your eQSL password, and optionally enter any text you would like to have sent with the QSL. **Check the box at the top "Upload every time an entry is added to the logbook."**

Digital Master 780 – Digital operation in Ham Radio Deluxe

We're finally ready to get into the digital section of Ham Radio Deluxe!

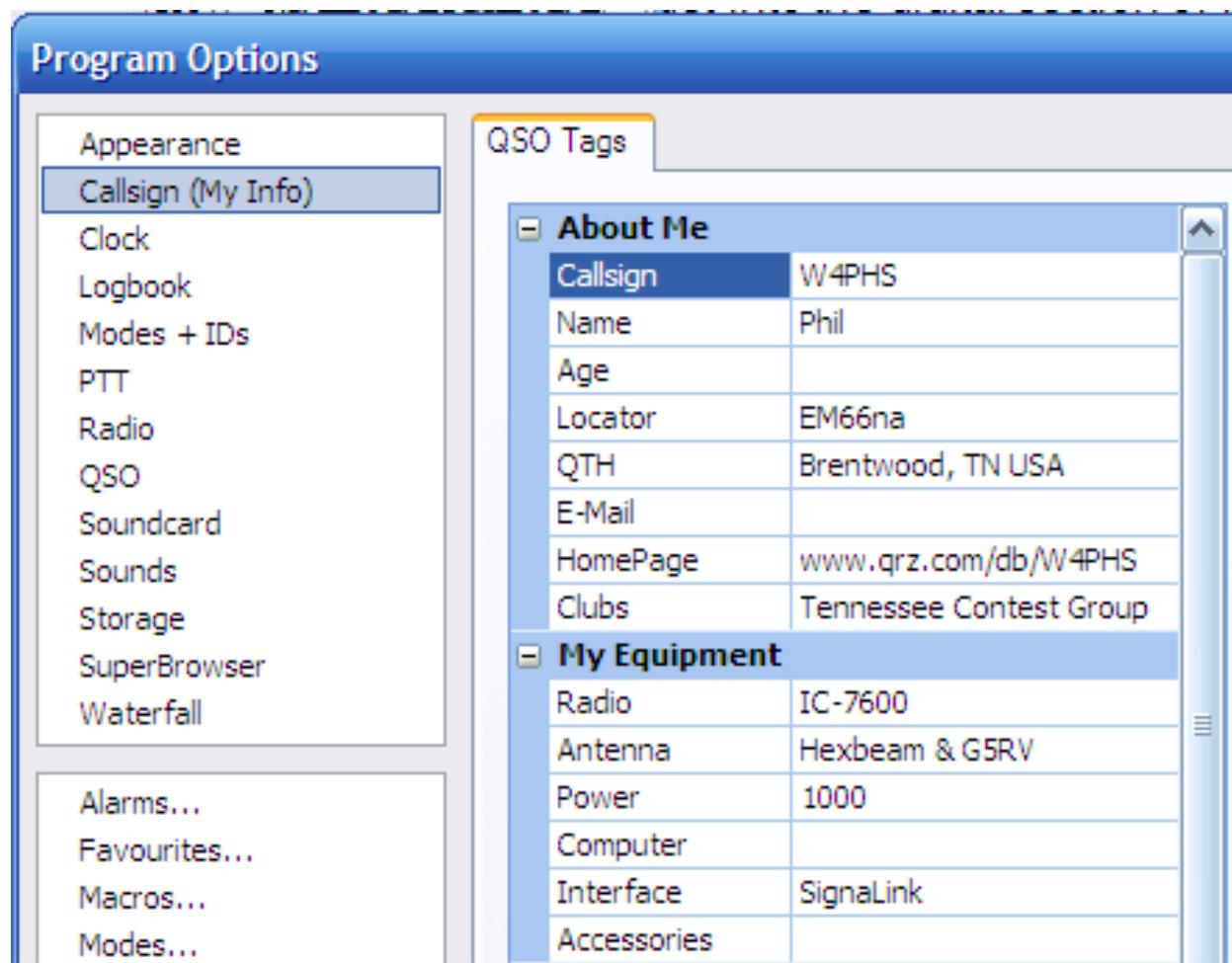
The digital component of HRD is called **Digital Master 780 (DM780)**. To open it, click the button labeled “DM780” on either the logbook toolbar or the main HRD screen toolbar. The main DM780 screen will be displayed:



Several items must be configured before you begin operating digital modes.

Configuring your call sign and station information

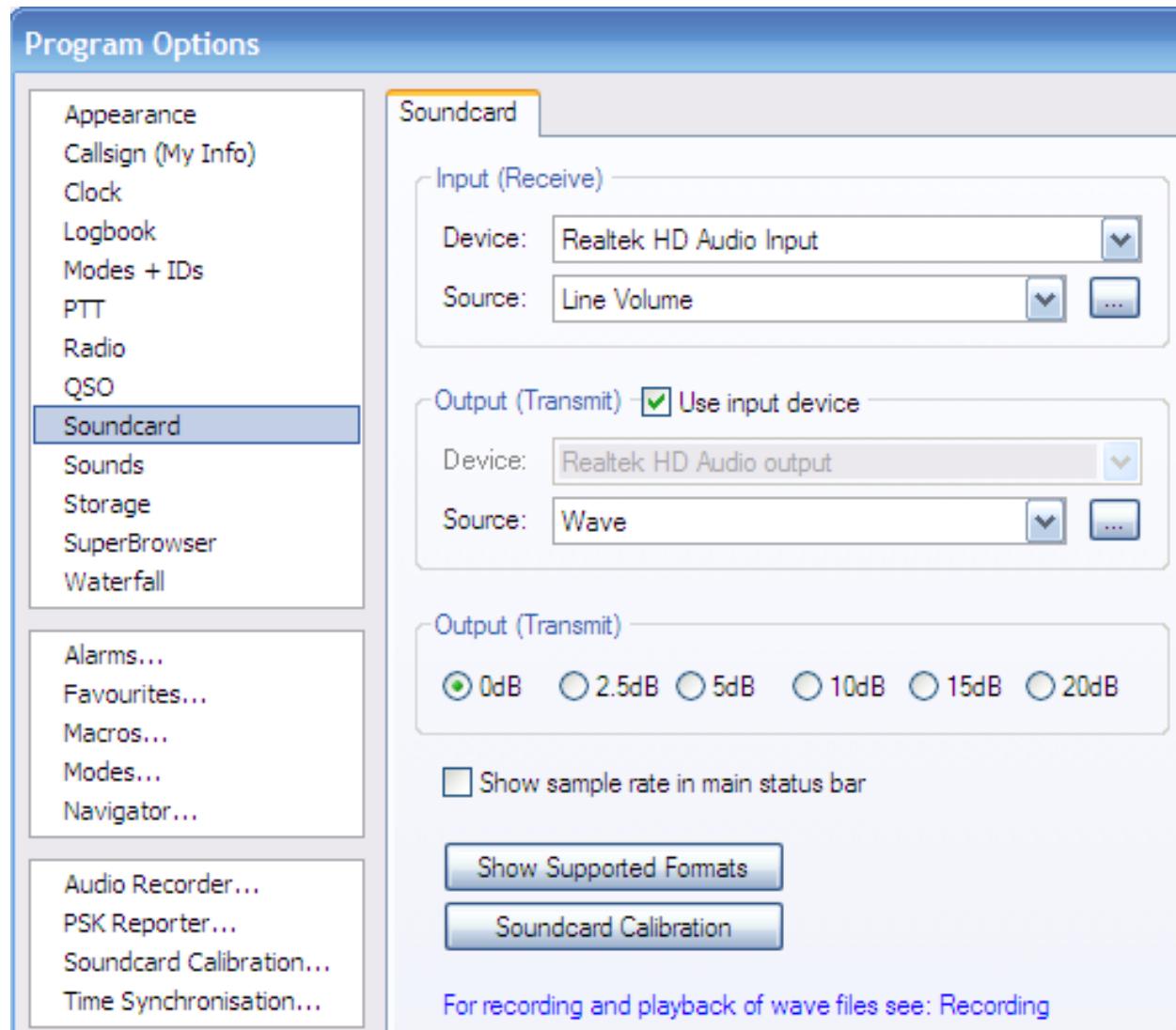
The first information you should enter is on the screen you can access by clicking “Program options” on the DM780 toolbar and selecting the “Callsign (My info)” entry.



Enter your call sign, handle, and other information about your station.

Configuring your sound card

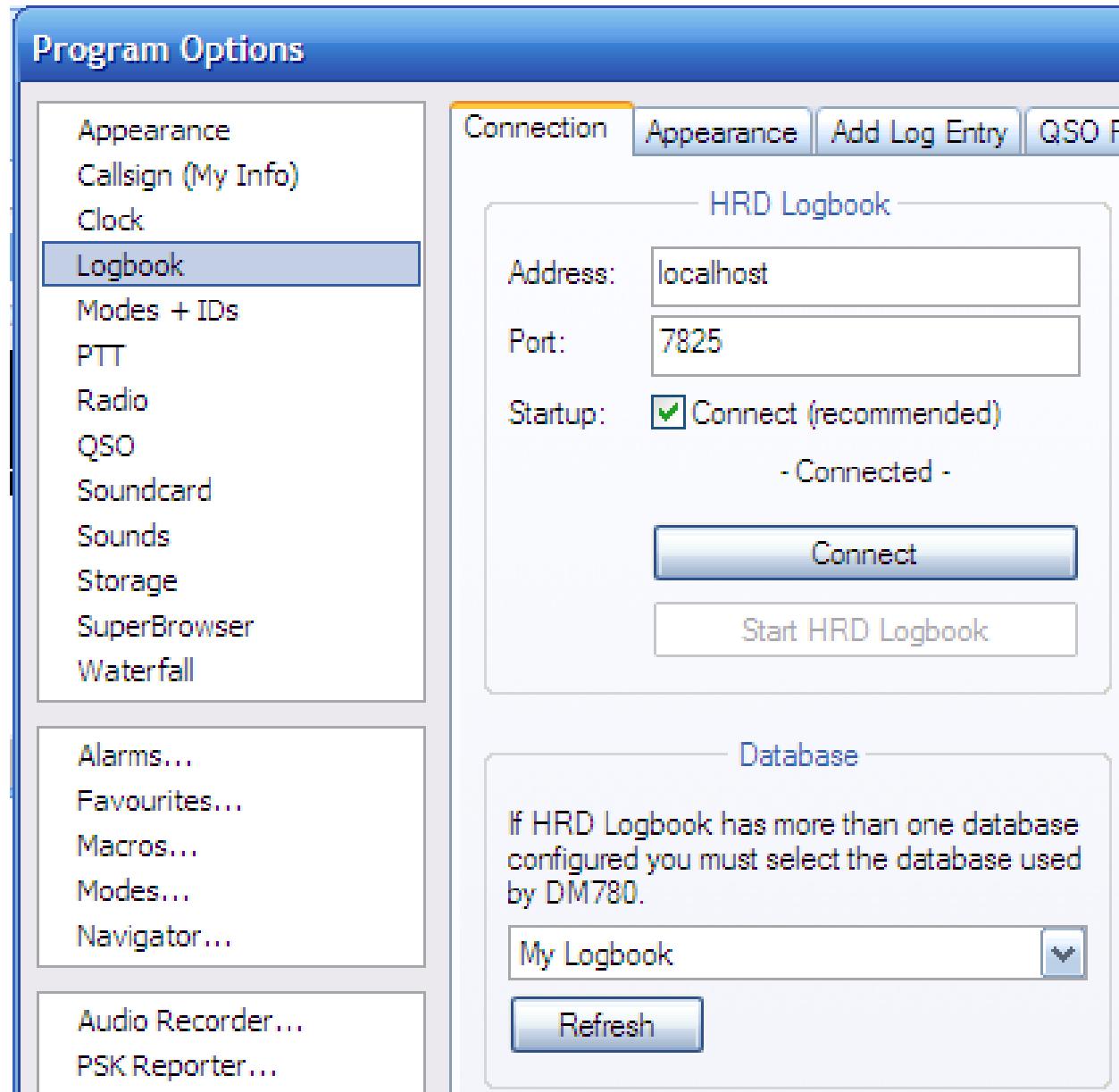
Once you finish filling in your station information, select the “Soundcard” entry on the Program options screen (see above). The soundcard setup screen will be displayed:



Select the soundcard that is connected to your radio. If you are using a SignaLink interface, the soundcard will be “USB audio device”.

Configuring the logbook connection

DM780 talks to the main HRD module for radio control, and it talks to the logbook module to look up and log QSOs. To configure the connection, click the “Logbook” entry on the Program Options screen.

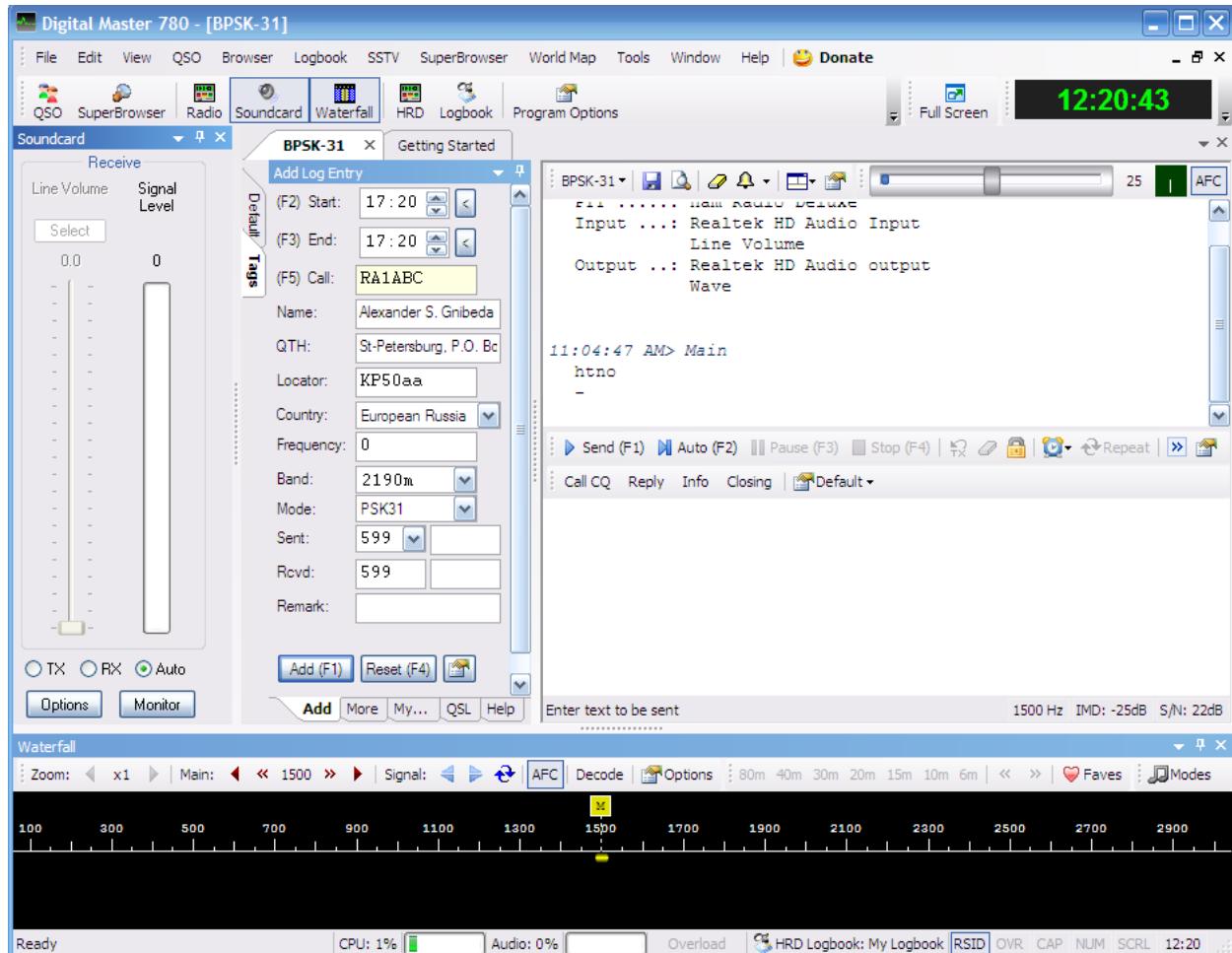


The connection screen will probably already be set up properly. Confirm that the fields are shown above. Make sure the “Connect” box is checked so that DM780 will connect automatically to the logbook each time it is started.

You can now close the Program Options screen.

The DM780 main screen

The DM780 screen has a number of panels:



Soundcard panel

The left panel has soundcard information. While receiving, a vertical bar will be displayed in the “Signal Level” field showing the audio level. You should adjust the RX control on the SignalLink to get the high of the bar near the middle of the graph.

QSO entry panel

The QSO entry panel is shown to the right of the soundcard panel. Normally, information in this panel is filled in automatically using a technique that will be described below. When you are ready to add an entry to your log, click the “Add” button shown at the bottom of the QSO panel, or press the F1 key. Important note: **The QSO panel is enabled only when the HRD logbook module is running.** So you should open the logbook and leave it open while using DM780.

Receive text panel

The upper right panel displays decoded text as it is received. When you transmit, the upper panel will display your text as it is being sent.

Outgoing text panel

The lower right panel displays text that is ready to be sent or which is currently being sent. During the sending process, a line is drawn through the text to show the current sending point. You can compose a message to be sent by typing it in this field.

“Waterfall” panel

The bottom panel is called the “waterfall”. It displays “tracks” corresponding to signals being received. Click on a track to select it and start displaying the decoded text in the upper panel.

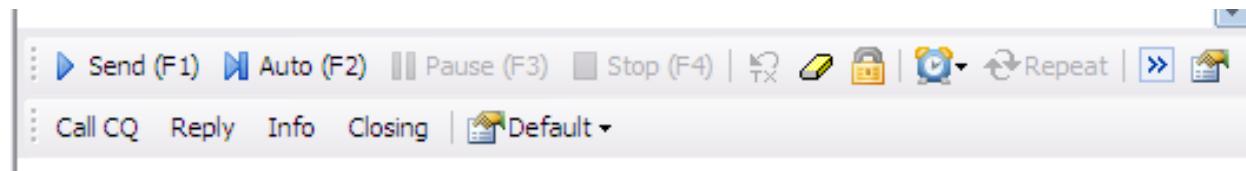
Configuring macros

A “macro” is a stored text string that is transmitted when you click a button. Macros are very convenient, because they allow you to quickly send standard information such as your call sign, QTH, station description, and 73 signoff without having to type them each time. Stations who are receiving your information will appreciate getting it at full speed rather than having to wait for your hunt-and-peck typing.

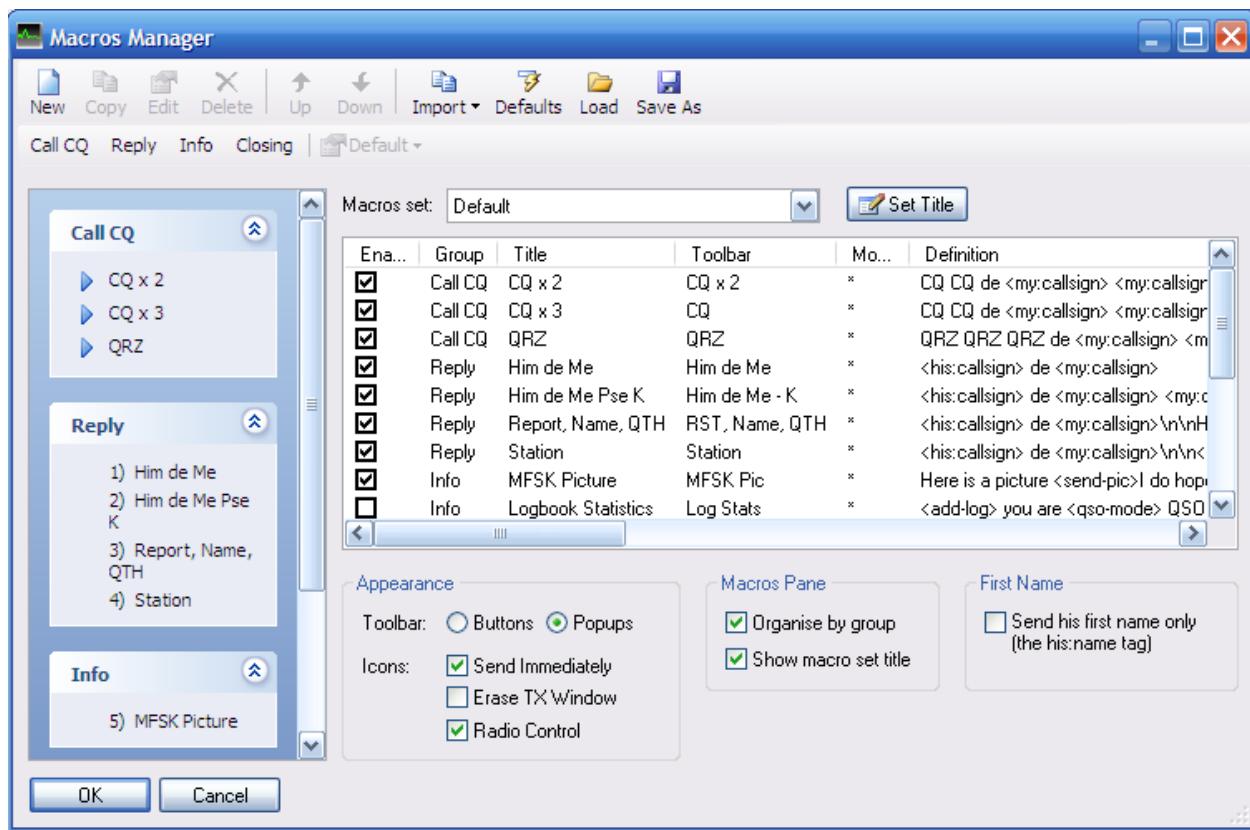
Macros are more than just canned text; they also can contain substitution operators that insert information into the text when the macro is invoked. For example, your call sign and the call sign of the station you are working can be inserted automatically.

DM780 comes with a standard set of macros that will get you off to a good start. I recommend reviewing the standard macros and doing some initial customization. As you work other stations and see what information they send, you can continue to improve your macros.

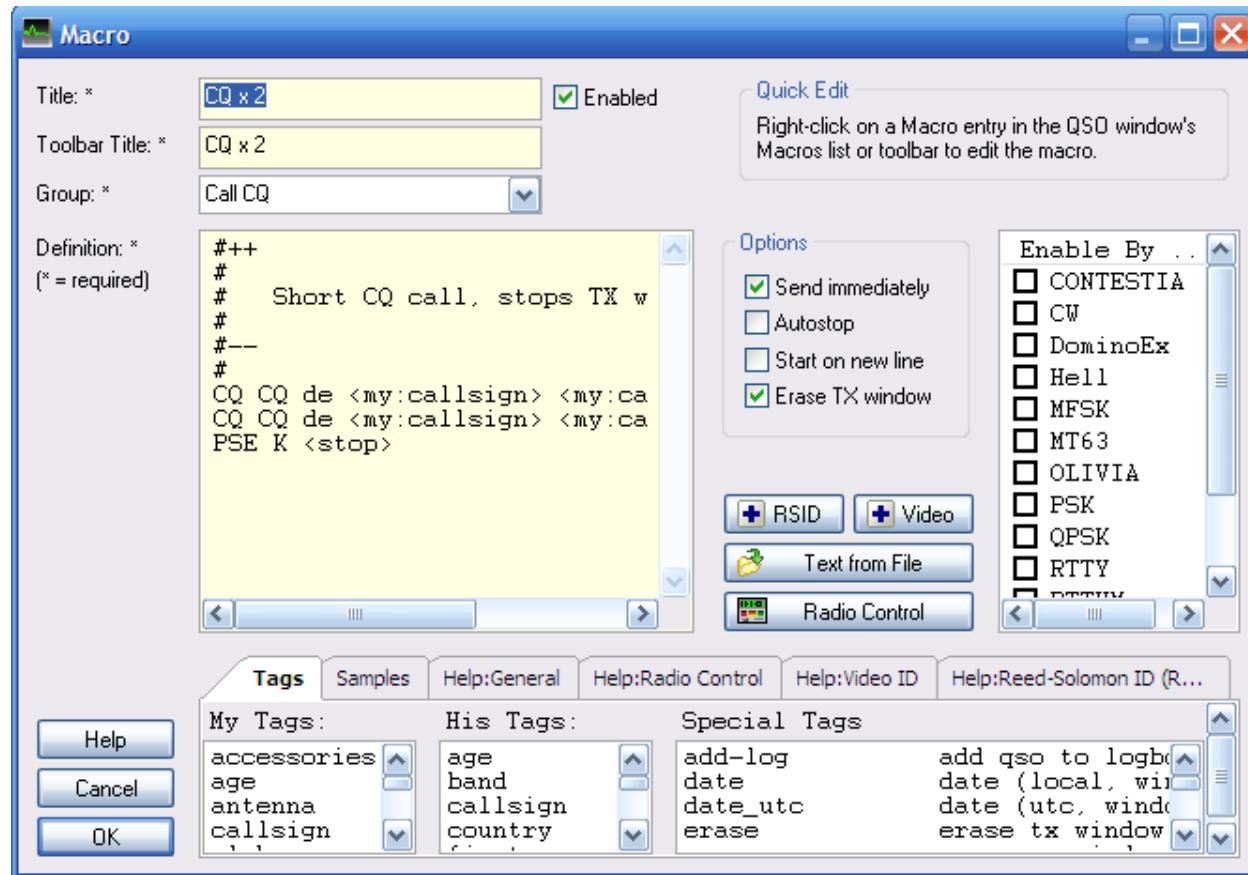
If you look between the upper receive-text panel and the lower send-text panel, you will see a bar with macro control items:



The “Call CQ”, “Reply”, “Info”, and “Closing” items are buttons you can click to open macro groups. Click the “Defaults” button, and select “Manager” to get into the macro manager screen:



To examine and/or modify a macro, double click it's entry in the list. For example, double click "CQx2" and you should see a screen like this:



The contents of the macro are shown the main left field. Note the item "<my:callsign>". This is a **substitution entry** (or "**tag**") that is replaced by your call sign when the macro is invoked. There are many substitution entries available.

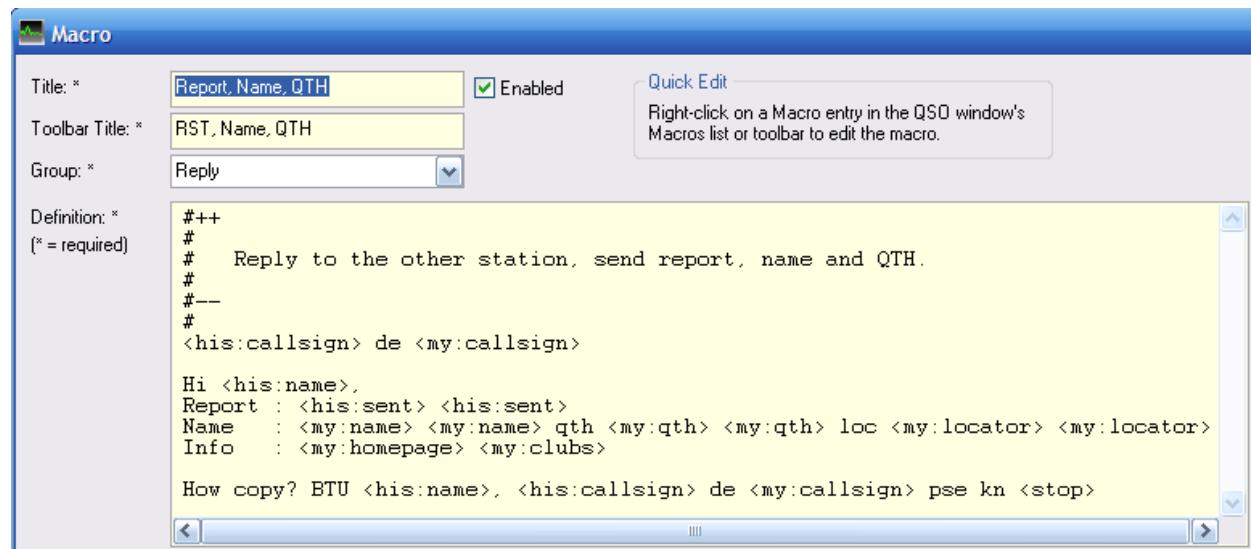
Look at the items in the "Options" group near the middle of the screen. You can check or uncheck boxes to control how the macro is handled when you click its name.

- **Send immediately** – If you check this, then the macro begins to be transmitted as soon as you click its name on the DM780 macro bar. If you uncheck this, the macro is expanded and placed in the send-panel, but you must click the "Auto" button or press the F2 key to begin sending it. It's convenient to select send immediately for macros like CQ that usually aren't edited, but you may want to uncheck this option for macros like the RST reply which you may want to edit before transmitting.

- **Autostop** – If checked, this option causes transmission to stop automatically at the end of the macro. The “<stop>” entry in the body of a macro also does this.
- **Start on a new line** – If checked, the macro text is inserted on a new line in the send window.
- **Erase TX window** – If sent, the contents of the send window are cleared before this macro is inserted into it.

Click “OK” to close the macro entry and save changes, or click “Cancel” to discard any changes.

Let's look at a more complex macro. Double click the entry for “Report, name, QTH”, and a screen like this should be displayed:



There are several substitution operators:

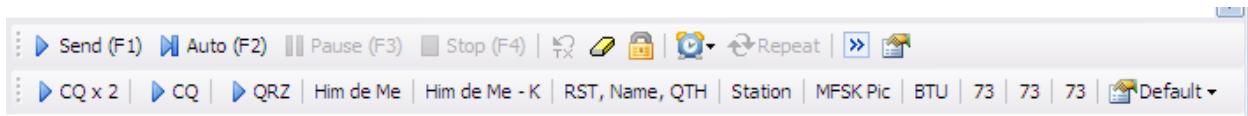
- **<my:callsign>** -- Inserts your call sign.
- **<his:callsign>** -- Inserts the call sign of the station you're working.
- **<his:name>** -- Inserts the name of the other ham as downloaded from QRZ.com
- **<his:sent>** -- Inserts the signal report which defaults to “59”.
- **<my:name>** -- Inserts your name as you entered it when you configured your station information.

- <my:qth>, <my:locator>, <my:homepage>, <my:clubs> -- Insert your QTH, your grid locator, your homepage URL, and list of clubs from your DM780 configuration.
- <stop> -- Stops transmission and shifts into receive mode.
- <add-log> -- Writes the information in your QSO panel to your logbook. If you prefer to have more control over when QSOs are logged, remove this from the macro, and click the “Add” button on the QSO screen to log the QSO.

After you finish examining and/or modifying the RST macro, click “OK” or “Cancel” to close it.

Back on the main macro manager screen (shown above), I recommend clicking the radio button labeled “Buttons” in the “Appearance” group. This will cause the names of the macros to be displayed as separate items on the macro bar in DM780 rather than as popup groups.

Click “OK” to close the macro manager and return to the main DM780 screen. The macro bar should now look like this:



Each macro entry is a separate button which you can click to invoke the macro.

Common digital abbreviations

To save time, many common phrases are shortened into a few characters (similar to Q-codes or “prosigns” in Morse code). Here are the most common ones you’ll encounter:

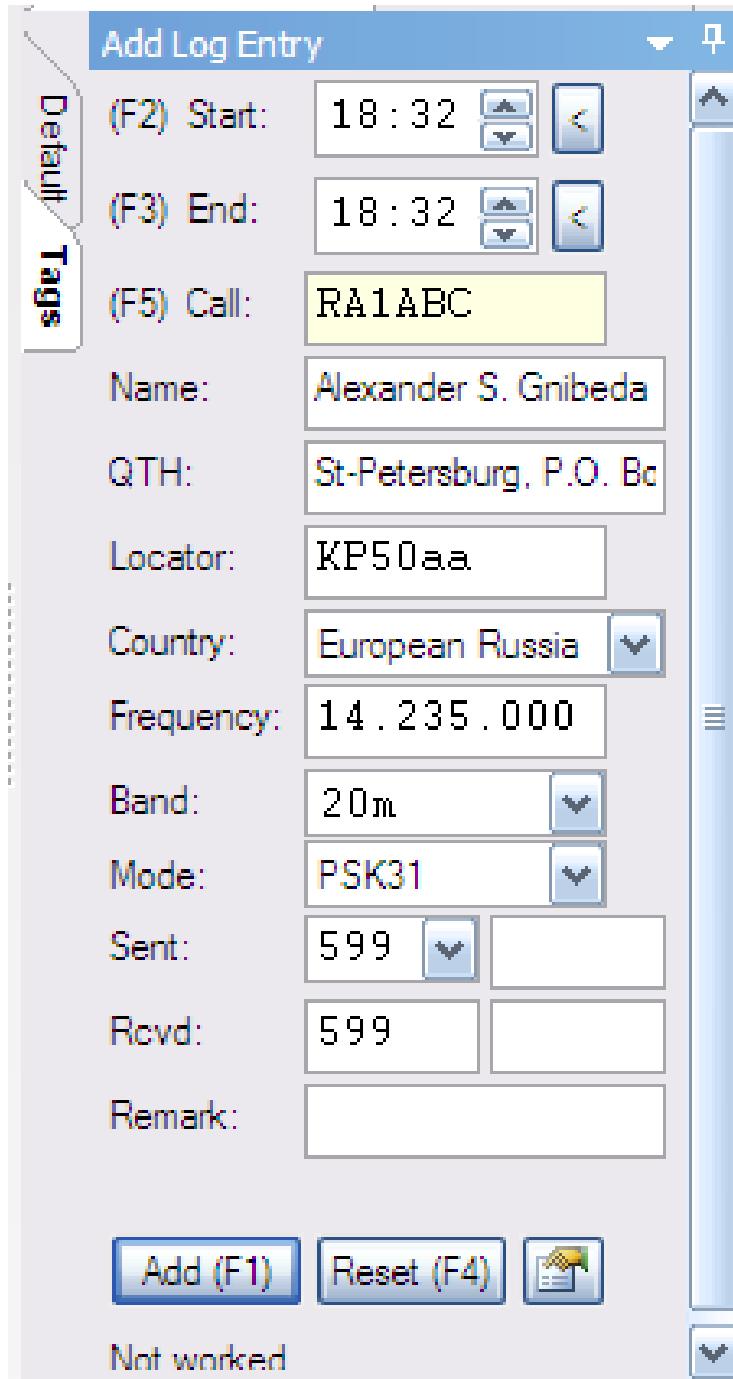
- “**de**” – Short for “from”. For example “de W4PHS” means the message is from W4PHS.
- “**k**” – Over to you. Technically, “**k**” means over to anyone, and “**kn**” means over to the person whose call sign you specify. So a CQ would end with “**k**” whereas an exchange in an ongoing conversation with someone would end with “**kn**”.
- **BTU** – Back to you.
- “**sk**” – End of QSO. This is the end of my final transmission.
- **pse** – Please

- **TU** – Thank you
- **agn** – “again”; please repeat.

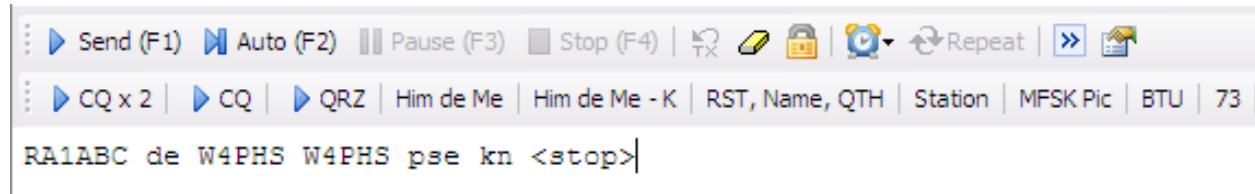
Experimenting with macros

Before going live, let's play around with macros a little.

Type "RA1ABC" (a Russian call sign) into the "Call" field of the "Add log entry panel", and press the Tab key. DM780 should talk to the HRD logbook module, look up the call sign on QRZ.com, and fill in the QSO panel fields like this:

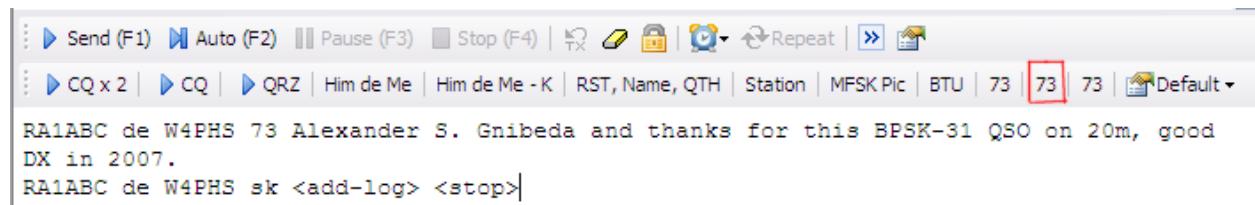


Now that we have a call sign set up, we can invoke macros and see the information inserted into them. Click the “Him de me – K” macro button on the line between the right upper and lower panels, and the send panel should be filled in with text similar to this:



This translates to “RA1ABC from W4PHS please go ahead”. This is the normal type of message you will send when responding to someone’s CQ.

Now go back to the macro control bar and notice that there are three “73” buttons. Click the middle one to expand that version of the 73 macro, and you should see a screen like this:



Notice that the other ham’s call sign and name were inserted along with the operating mode (“BPSK-31”) and the band (“20m”).

Try expanding various macros by clicking their buttons to see what they will look like. Take note of which ones you will use to (1) respond to a CQ, (2) send your RST, and (3) send 73 to end the QSO. If you’re just getting started, you may want to write them down.

Caution: The “CQ” macro was set to send immediately. So when you click it, you will immediately begin transmitting. You can press F4 or click the “Stop” button above the macro bar to abort a transmission.

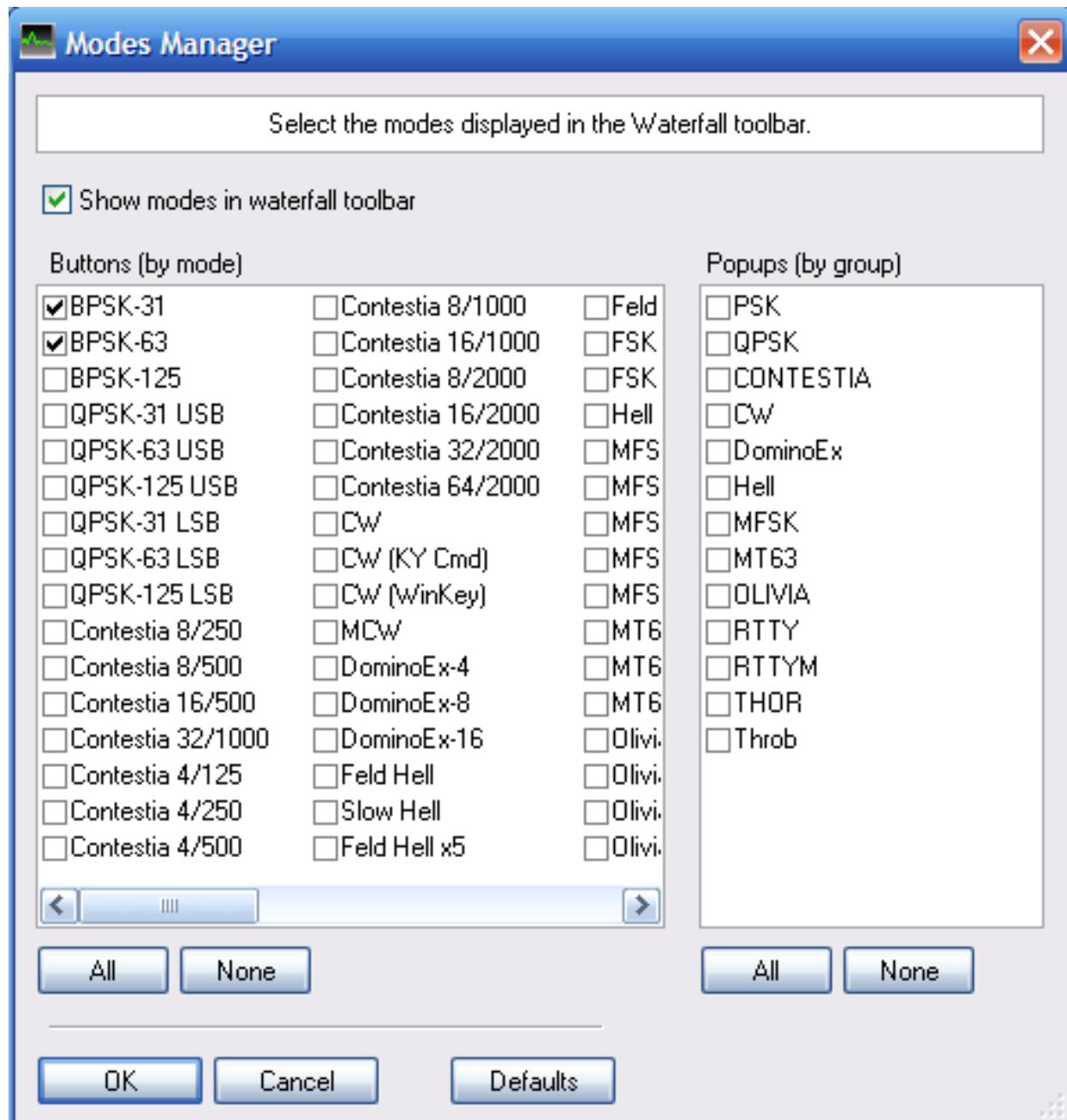
Macros that are not set for immediate transmission are expanded into the send panel, but transmission does not begin until you click the “Auto” button or press F2.

Selecting modes, bands, and frequencies

DM780 supports dozens of digital modes. Following the standard band plan, some modes normally operate on some frequencies and other modes use different frequencies. To prevent you from having to remember the appropriate frequency for

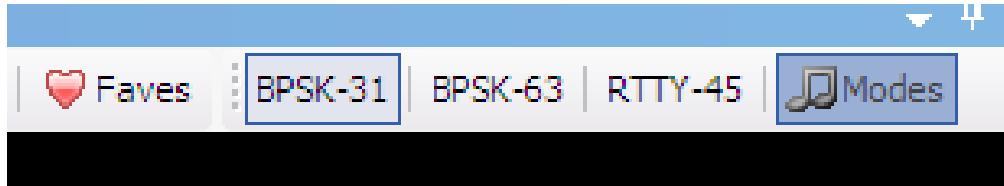
each mode and band, DM780 has them built into it. To use this facility you need to set up the mode menu bar.

Look at the right end of the menu bar immediately above the waterfall panel, and you should see an entry for “Modes” with a musical chord icon. Click “Modes”, and this screen should be displayed:



This screen has a list of all of the digital modes DM780 supports, and it allows you to select your favorite modes which will have buttons on the modes menu bar. Click the

box at the top “Show modes in waterfall toolbar”, then select the modes you want to create buttons for. For now, click “BPSK-32”, “BPSK-63”, and “RTTY-45” (use the horizontal scroll bar to get to “RTTY-45”). Then click “OK”. The bar above the waterfall should have buttons for these modes and look like this:



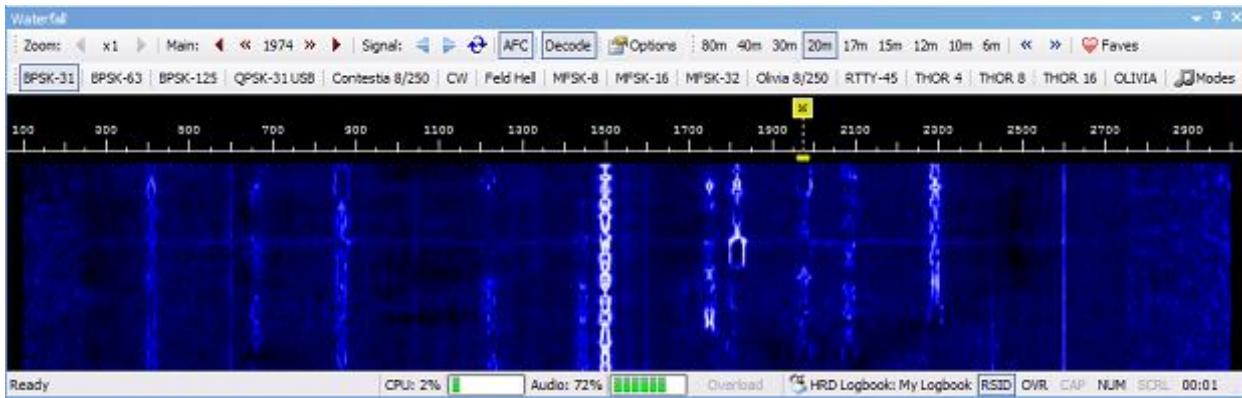
Click the button for “BPSK-31” to select the standard PSK-31 mode.

Now that you’ve selected the mode (PSK-31), DM780 can show you the standard frequencies for that mode on each band. Look near the middle of the waterfall menu bar and you should see a set of bands. Click on the “20m” button and select “14.070” from the drop-down list.



14.070 is the standard operating frequency for PSK-31 on the 20 meter band. If your radio is properly connected to your computer, DM780 will command your radio to tune to this band and frequency. Check it now. Also check to make sure the radio is in USB (upper side band) mode. In digital modes, USB is used on all bands. Use the same method to select other digital modes and find the appropriate frequencies within each band.

If the SignaLink sound interface is properly connected, it is likely that some PSK-31 signals will start to be received, and their tracks will appear on the waterfall screen:



Position your mouse cursor over one of the stronger tracks and left click on it. DM780 should lock onto that PSK-31 signal and display a yellow bar above it at the top of the waterfall. If the signal is being properly received, DM780 will start to decode it and display the received text in the upper receive panel:

Before jumping into your first QSO, spend some time monitoring various transmissions to get a feel for the typical exchange.

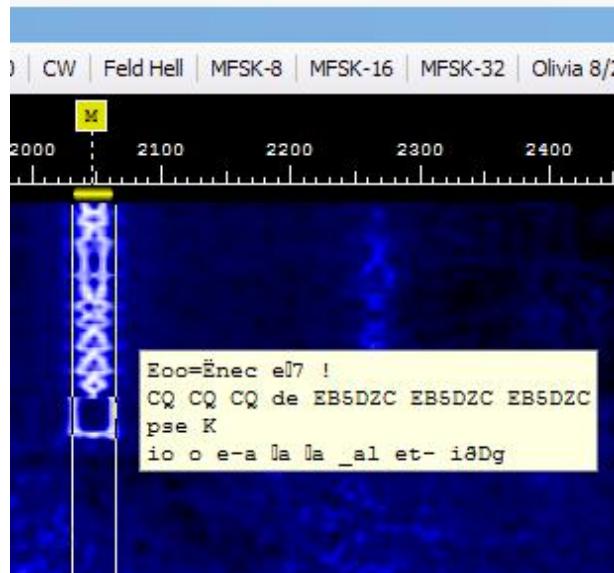
Preparing for your first QSO

We are very close to being ready to start our first QSO, but we need to run down a checklist:

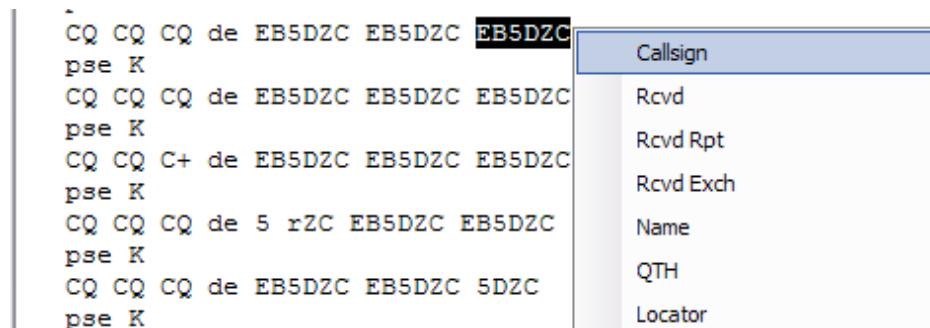
1. Confirm that your radio is tuned to a frequency appropriate for the digital mode you're using, and make sure it's in USB (upper side band) mode. USB is used on *all* bands (including 40m and 80m) when operating in digital modes.
2. Turn off any audio compression in your radio.
3. Select a receive filter that is at least 3 kHz wide.
4. Set your radio power to a reduced level. The usual power level for PSK-31 is in the range of 15 to 40 watts, so let's start out at 25 watts. RTTY and the other modes with wider bandwidth may be operated at higher power.
5. Review the macro buttons that you will use for a QSO, and make notes about which one to click at each stage – call, RST, 73.

Answering a CQ

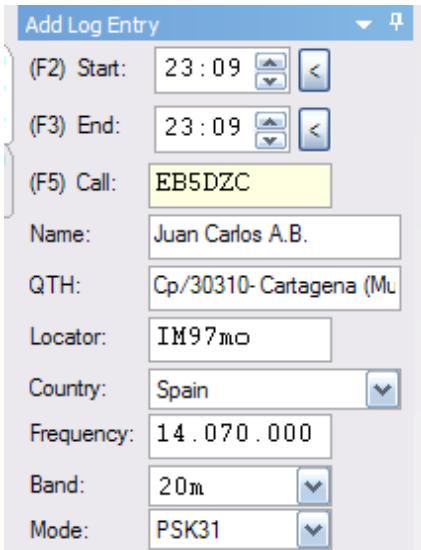
Click on PSK-31 tracks in the waterfall panel, and monitor the decoded text until you find someone calling CQ.



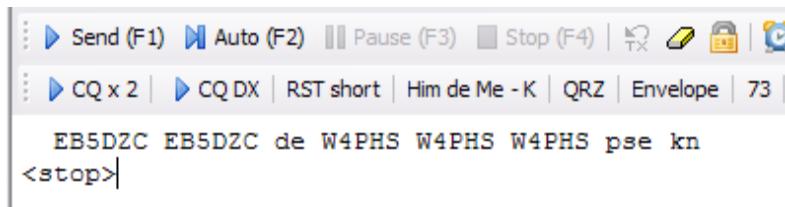
Next, move your mouse cursor over the calling station's call sign in the upper receive panel, and click on it. DM780 will display a popup menu with various options. Click on the top entry in the list which is "Callsign".



The call sign of the station should appear in the "Call" field of the QSO entry panel, and in a second or two DM780 should retrieve information about the station from QRZ.com and fill in the other fields.



Once the QSO entry panel has been filled in, the macro substitution operators can insert it into the text of the macro. Try clicking the button for the “Him de me – K” macro. The expanded macro should appear in the send screen:



Since this macro does not have the “Send Immediately” option set, you have a chance to look at what is going to be sent before sending it. To send the macro, click the “Auto” button or press the F2 key. Don’t start sending until he finishes his transmission and the track on the waterfall ends.

Here is the normal sequence of macros when responding to a CQ:

1. *Him:* “**CQ**” – He solicits a call.
2. *You:* “**Him de me – kn**” -- Send his call, your call sign, and “kn” asking him to respond.
3. *Him:* “[**your call**] de [**his call**] kn” – He tells you to go ahead.
4. *You:* “**RST report**” – Send his signal report and information about your station.
5. *Him:* He sends you his **signal report** and station information

6. You: “**73**” – Use the “73” macro to finish the QSO.

Calling CQ

Calling CQ is just like responding to a CQ except that you use the “CQx2” macro to send the CQ message. Note, if the CQ macro is set for immediate transmission, it will start to transmit when you click its button.

Logging a QSO in DM780

Once you finish a QSO, you can write it to your HRD logbook by clicking the “Add” button on the QSO entry screen or by pressing the F1 key.

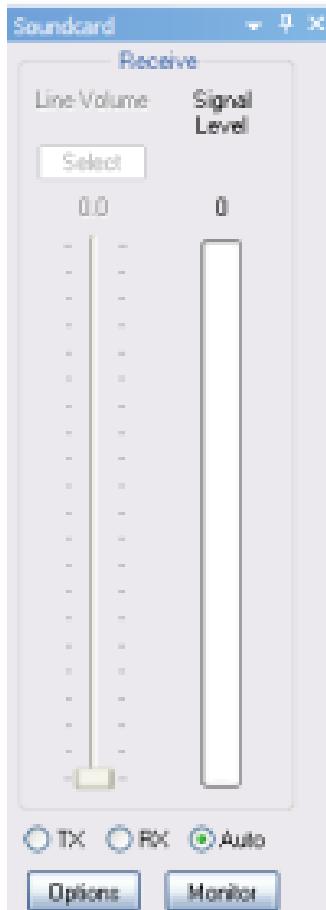
Add Log Entry

(F2) Start:	14 : 55		
(F3) End:	14 : 55		
(F5) Call:	RA1ABC		
Name:	Alexander S. Gnibeda		
QTH:	St-Petersburg, P.O. Bc		
Locator:	KP50aa		
Country:	European Russia		
Frequency:	14 . 235 . 000		
Band:	20m		
Mode:	PSK31		
Sent:	599		
Rcvd:	599		
Remark:			

Add (F1) **Reset (F4)**

Adjusting SignaLink audio levels

If the Soundcard panel isn't open in the DM780 screen, click the "Soundcard" toolbar icon to open it. You should see a panel like this:



The "Signal Level" shows a vertical bar graph with the received signal level. You should adjust the RX level on the SignaLink until the bar reaches approximately the midpoint of the chart.

The SignaLink TX level should be set so that the automatic gain control (AGC) in your radio's menus shows about 25% from the bottom. Basically, you want TX set as low as possible but high enough that your radio can deliver its full power.

Popular digital operating modes

There are *many* digital modes. DM780 supports about 85, and there are others beyond that. Some modes are very popular, and you can have QSOs almost any time. Other modes are very rare, and it may be hard to find someone to work. This introductory guide will discuss only the most popular modes.

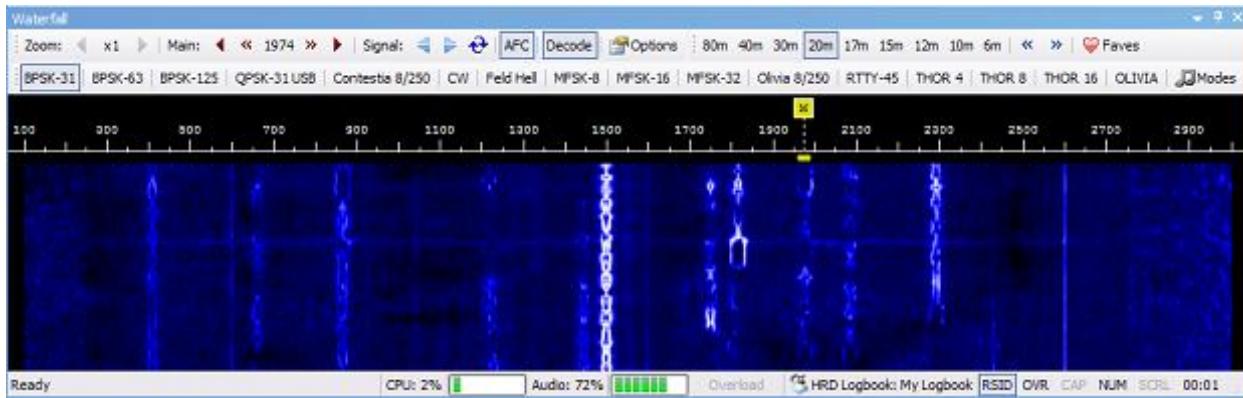
PSK-31, PSK-63, and PSK-125

By far, the most popular digital mode today is PSK-31. You will find people using it almost any time and day. PSK-31 is popular because it's easy to use, it provides the full ASCII character set with both upper and lower-case letters, and it uses a very narrow bandwidth allowing many stations to share the same RF frequency. Because of its narrow bandwidth, low power or even QRP stations can make DX contacts. The typical operating power for PSK-31 is 10 to 40 watts. I have had error-free PSK-31 contacts with people hundreds of miles away who were running 2 watts.

PSK stands for Phase Shift Keying which is the type of modulation used for the signal. There are three variants of PSK that use the same type of modulation but which use different bandwidths and have different speeds. PSK-31 transmits at a rate of 31.25 baud (bits per second); PSK-63 transmits at 62.5 baud, and PSK-125 transmits at 125 baud.

PSK-31 uses an amazingly small bandwidth of only 32 Hz. In contrast, RTTY uses about 175 Hz, and SSB phone uses 2500 to 3000 Hz. PSK-31 requires less bandwidth than even CW (Morse code). The narrow bandwidth has two primary benefits: (1) concentrating the RF signal into a narrow bandwidth allows a low-power signal to propagate as well as a much stronger wideband signal, and (2) it allows many PSK-31 communications to share a small section on the frequency spectrum. PSK-63 and PSK-125 offer faster speed, and they use proportionally wider bandwidths; but they are still very narrow compared with other modes.

Here is an image of the DM780 waterfall showing at least 11 PSK-31 tracks:



Some people describe PSK-31 tracks as looking like railroad tracks because of their parallel lines and what looks like crossties.

In the picture shown above, note that all of the PSK-31 tracks are within a single 3 KHz bandwidth. In other words, all of them are contained in the same space occupied by a single SSB phone conversation. Each band has one or possibly two frequencies that are usually used for PSK-31; on 20m, this is 14.070 MHz (USB). When you tune your radio to that frequency and look at the waterfall, and you can monitor and work many PSK-31 conversations. The PSK-31 signals are separated by shifting the *audio* frequency (not RF frequency) within the 3 kHz RF bandwidth. Near the center of the image you can see a strong PSK-31 track near 1500 Hz. This track appears to be using audio frequencies in the range of 1480 to 1512 Hz riding on an RF carrier at 14.070 MHz. Further to the right there is a PSK-31 track around 2300 Hz; its audio signal appears to be varying between 2280 and 2312 Hz. PSK-31 programs like DM780 generate different audio frequencies within a single 3 kHz RF frequency range. The same bandwidth required for a single SSB phone conversation can contain many PSK-31 conversations.

By far, the most common form of PSK-31 is **BPSK**. As described above, BPSK is bandwidth and power efficient and has proven itself to be an excellent performer. However, there is no error correction capability with BPSK. If a noise burst or QSB occurs, you may lose some characters or get some corrupted characters. It is customary in PSK-31 QSOs to say something like “I’m getting 95% copy” in addition to sending the RST signal report.

There is a variant of PSK-31 that provides error correction: that is the **QPSK** protocol (Quaternary Phase Shift Keying). By using a clever 4-phase encoding, QPSK manages to add error correction while maintaining the same bandwidth and speed as BPSK. However, the penalty is a 3 dB reduction in signal-to-noise and a requirement for much

tighter tuning – no more than 4 Hz difference. Because BPSK works so well, you rarely encounter anyone using QPSK.

Like Morse code, PSK-31 uses variable length character encoding. That is, fewer bits are used to encode the most common characters like ‘e’, and more characters are required to encode less common symbols. Lower case characters are more common than upper case characters, so they are encoded with fewer bits, and they can be transmitted faster than upper case.

RTTY – Radio Teletype

The second most popular digital mode after PSK-31 is RTTY. RTTY used to be the most common digital mode, but for the last decade or so there has been a strong shift to PSK-31. RTTY is still widely used for digital contests and by DXpeditions, but on a typical night you will find *many* more hams using PSK-31.

With RTTY, text is sent using Baudot code with five bits for each character. Five bits can encode 32 unique characters which is sufficient for the upper-case alphabet. A *shift* character is sent in the RTTY stream to select a second set of 32 characters for the digits and punctuation characters.

RTTY can be transmitted at several speeds, but RTTY-45 (45 baud) is the most common one used by ham radio.

The bandwidth required for an RTTY signal is about 170 Hz. This is the difference between the *mark* and *space* frequencies used to denote each bit.

RTTY can be transmitted using either **FSK** (RF Frequency Shift Keying) or **AFSK** (Audio Frequency Shift Keying). To use FSK, you must have a connection from your computer to the FSK input on your radio (assuming your radio supports FSK). An on/off signal is sent through the connection, and this causes the radio to shift the RF carrier signal between the *mark* and *space* frequencies (typically 170 Hz apart). With AFSK encoding, the radio carrier remains on the same frequency, but an audio encoded signal is transmitted that has audio tones for *mark* and *space* (also 170 Hz apart). If you use DM790 with a SignaLink to send/receive RTTY messages, you will operate in AFSK mode. The important thing to understand is that **FSK and AFSK signals are compatible, and a station using FSK has no problem communicating with one using AFSK.**

RTTY was invented before World War II, and the original Teletype machines were large mechanical contraptions such as shown below:

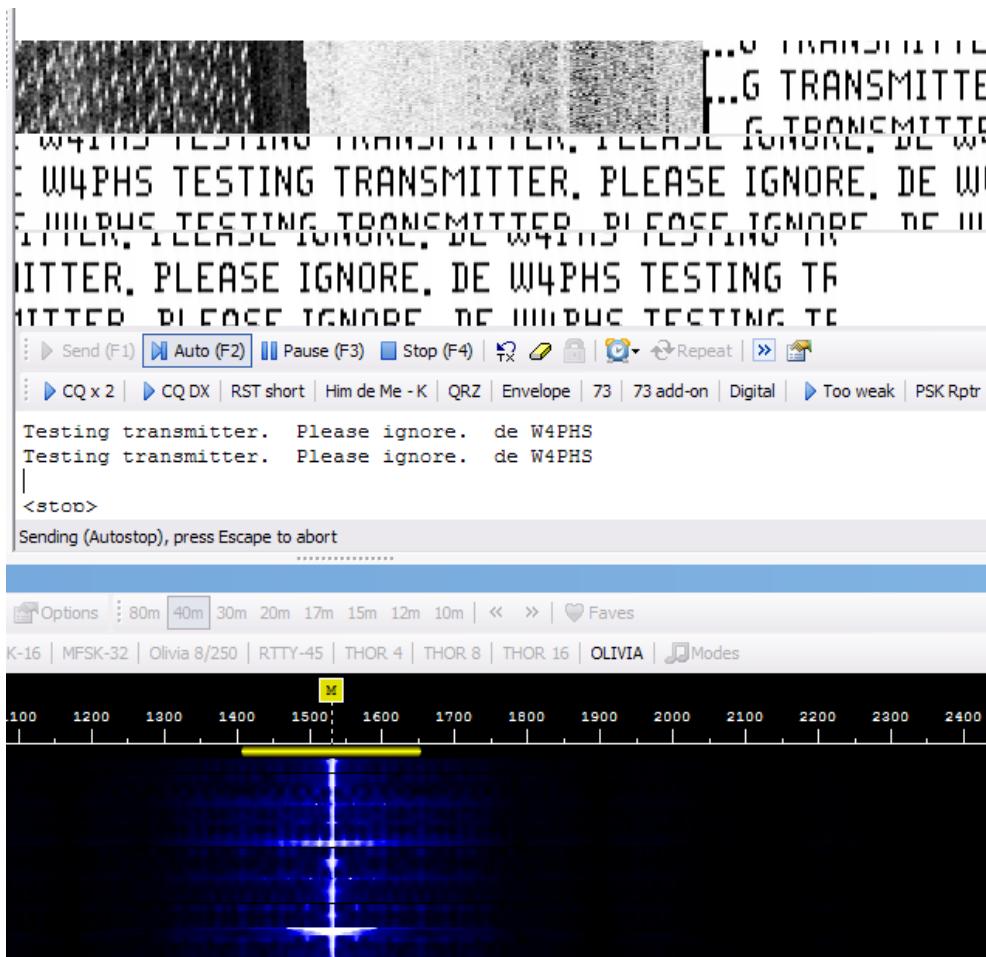


Hellshreiber and Feld-Hell

Hellshreiber is different from PSK-31 and RTTY in that characters are not encoded as a set of bits; instead, they are sent as images like a FAX machine.

There are variants of Hellshreiber encoding, but Feld-Hell is the most popular. DM780 fully supports Feld-Hell. With Feld-Hell, each character is painted on the screen using a dot matrix similar to a dot-matrix printer. Characters are transmitted at a rate of 150 per minute which works out to 2.5 per second. By comparison, five-bit RTTY characters are transmitted at 45 baud or 9 characters per second (45/5).

Here is an example of a Feld-Held message being received and a view of the signal on the waterfall:



MFSK16

MFSK (Multiple Frequency Shift Keying) is similar to PSK-31 and RTTY in that characters are encoded as a set of bits. However, unlike PSK-31 and RTTY which use two tones, MFSK uses multiple audio tones for each symbol being transmitted. MFSK transmissions are relatively insensitive to noise and multipath timing errors. Some of the MFSK methods include error correction.

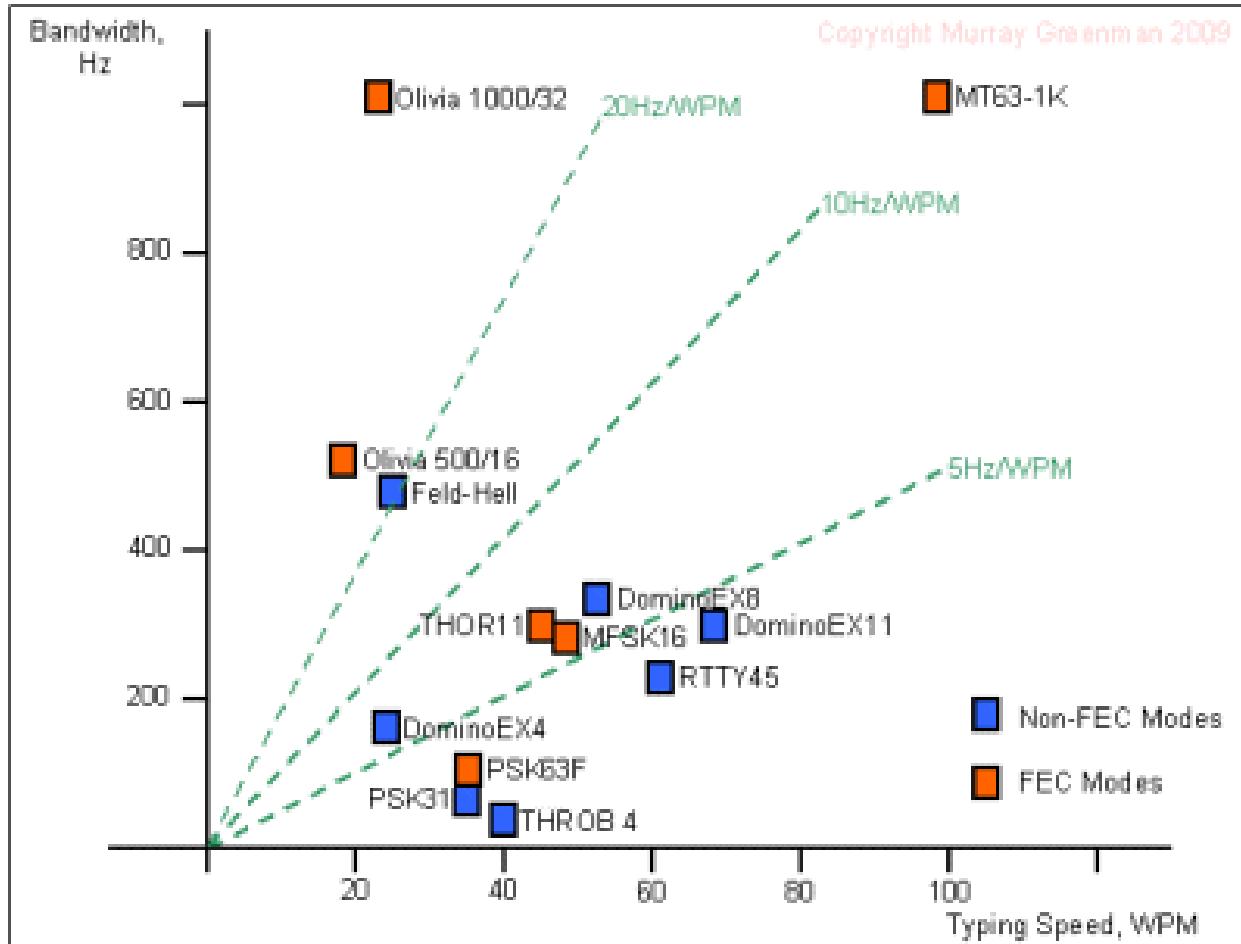
Variants of MFSK can use a different number of tones for each symbol. The most common variety is MFSK16 which uses 16 tones, but DM780 also supports MFSK4, MFSK8, MFSK32, and MFSK64.

MFSK16 has a bandwidth of 316 Hz (versus 32 Hz for PSK-31 and 170 Hz for RTTY), and the transmission speed is 62.5 baud.

Other variants of MFSK that you may occasionally encounter include Olivia, Domino, and Throb. These modes include error correction, and they are very robust over long distances. Surprisingly, they are used rarely compared with PSK-31 and RTTY.

Speed/bandwidth comparison of text digital modes

Here is a chart from <http://www.qsl.net/zl1bpu/MFSK/> showing the speed and bandwidth required by various digital modes. (Permission to use graciously granted by Murray Greenman, ZL1BPU.)



SSTV – Slow Scan TV

Slow scan TV (SSTV) can send pictures via radio over ham bands. Here is a Christmas greeting with a picture of my grandson that I sent last year:

Merry Christmas



de W4PHS

Received image quality is subject to signal strength, QRN, and other factors. Here's an example of a received SSTV image:



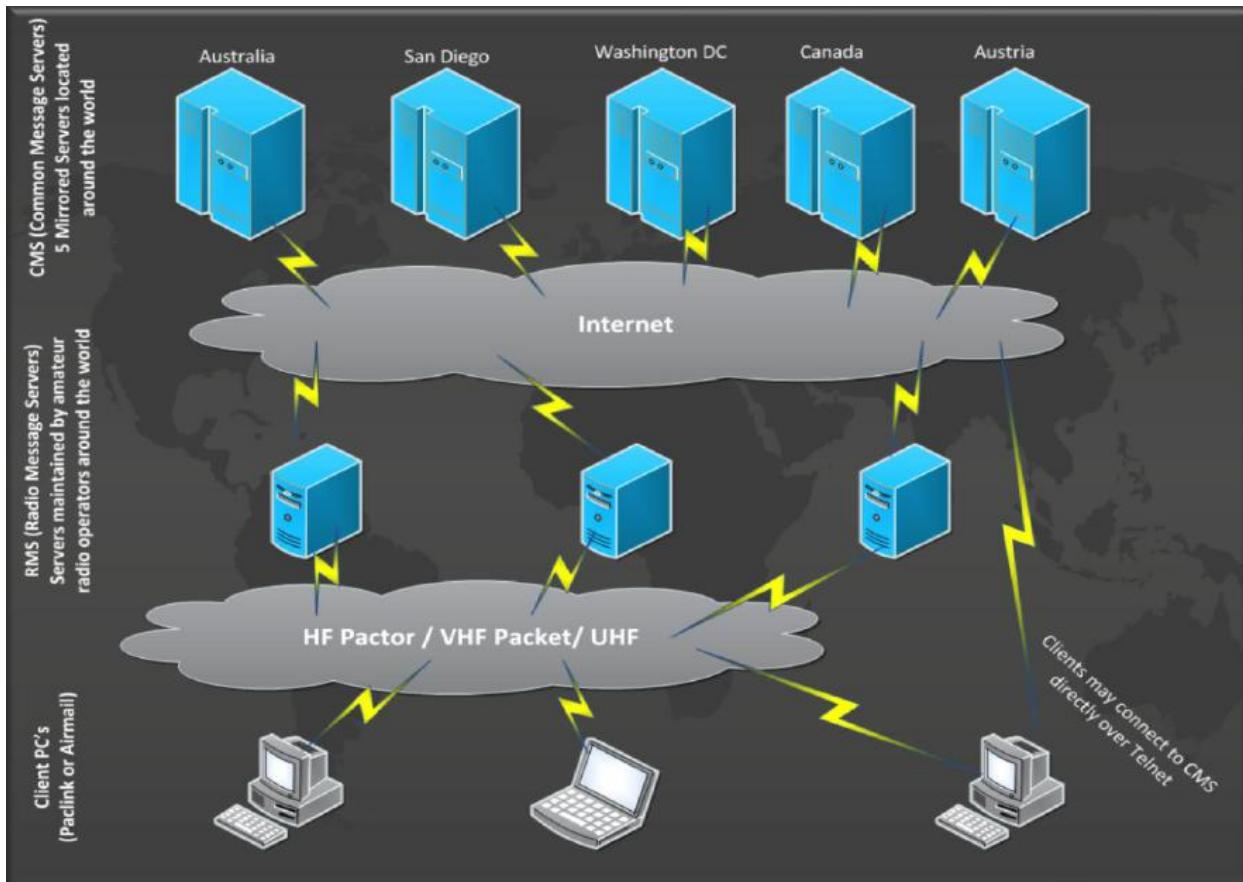
DM780 has excellent support for SSTV. To get into the SSTV section of DM780, click “SSTV” on the DM780 menu bar and select “Display” from the drop-down menu. The DM780 SSTV screen has a number of fields.



Using the DM780 SSTV module, you can upload pictures, edit pictures to insert your call sign and messages, build up a library of pictures, send pictures, receive pictures, store received pictures, and log SSTV QSOs. It is a very complete system. It would take too much space in this document to describe the SSTV system, so I'm just going to have to refer you to the DM780 documentation if you are interested in SSTV.

Winlink 2000

Winlink 2000™ (www.Winlink.org) is a worldwide system for sending and receiving e-mail over radio. Since the connection from the client computer to the Winlink server does not depend on the Internet, Winlink is widely used by mariners, RV campers, missionaries, and various agencies who need to communicate when the Internet is not available.



The Winlink system consists of a group of Common Message Servers (CMS) placed at various locations around the world. These servers connect via the Internet to Radio Message Servers (RMS) in many geographic locations to form a star network configuration. The Radio Message Servers are the VHF, UHF, or HF RF gateway into the Winlink system. The final component is the client computer (i.e., your computer) which runs software to send/receive messages through your radio.

Like regular e-mail, Winlink messages are sent to a specific address, and they may contain file attachments such as pictures, weather maps, spreadsheets, ICS forms, etc. E-mails can be sent between Winlink stations and normal SMTP/POP3 e-mail servers like gmail.com.

Because of its importance, I have written a separate guide to *Getting Started with Winlink 2000*. Please use this URL to access it:

http://www.dtreg.com/Getting_Started_with_Winlink_and_WINMOR.pdf

APRS

Officially, APRS stands for Automatic Packet Reporting System; however, because it is so frequently used for position reporting, it is commonly referred to as Automatic Position Reporting System. APRS was developed in the late 1970's by Bob Bruninga, WB4APR. His goal was to develop a tactical, real-time information distribution system.

APRS is a network for transporting packets from a sending site to one or more receiving sites. These packets also can be passed on to Internet sites that display global information about APRS reports. APRS packets can be used to send telemetry information, weather conditions, status and emergency signals, short text messages, and even short e-mails. However, the overwhelming majority of APRS sites transmit position reports. Now days, the position information is usually collected from GPS receivers, but it is possible to manually enter positions and use other navigation devices.

For our purpose, APRS is an excellent vehicle tracking system. This is very important in a real emergency scenario or during public service events.

Equipment needed to use APRS

A basic APRS setup consists of a 2 meter radio, GPS receiver, a TNC which encodes the position, and the associated cables. Some of the higher priced dual band radios such as the Kenwood D-700 and D-710 and the Yaesu FT-350 have a built-in APRS TNC position encoder. But the least expensive approach is to purchase a GPS receiver and APRS TNC and connect them to a radio you pick up at a hamfest or eBay.

There are two primary vendors that have reasonably priced GPS receivers and TNC position encoders. One is Byonics, www.byonics.com, and the two products of interest are the TinyTrak3Plus and the TinyTrak4. The other company is Argent Data Systems, www.argentdata.com, and the unit they have is the Tracker2. Assembled and tested APRS GPS-TNC units can be purchased for about \$110 (less if you can build a kit).

APRS packet transmission

Within the United States, the standard frequency for all APRS packet transmissions is 144.39 (simplex). If you monitor 144.39, you will hear APRS packets. However, it is possible to use an alternate frequency to set up a local APRS network. Since all stations are transmitting on the same frequency, consideration must be given to the possibility of having packet collisions. TNCs monitor incoming signals and hold off on transmitting their own packets if they hear another APRS packet coming in. However, even with this technique, collisions do occur, and one or more packets are corrupted and lost. The assumption is that stations will transmit updated information in a short while, so when packets are lost they are not retransmitted until the next scheduled time. Unlike TCP/IP Internet connections, APRS does not provide delivery guarantee with retry of lost packets for position reports.

APRS also supports two-way, semi-reliable text messaging. You can send a short text message to a specific station, and that station, upon receipt of the message, will send back a delivery acknowledgement. The sending station will retransmit the message several times (typically 5) until a delivery acknowledgement is received.

Digipeaters: APRS repeaters

It is possible to directly receive APRS packets from the originating stations and display the packet information on a computer screen. Similar to voice repeaters, digipeaters are used to expand the coverage of APRS areas. However, unlike a voice repeater, a digipeater retransmits the packet on the same frequency it received it.

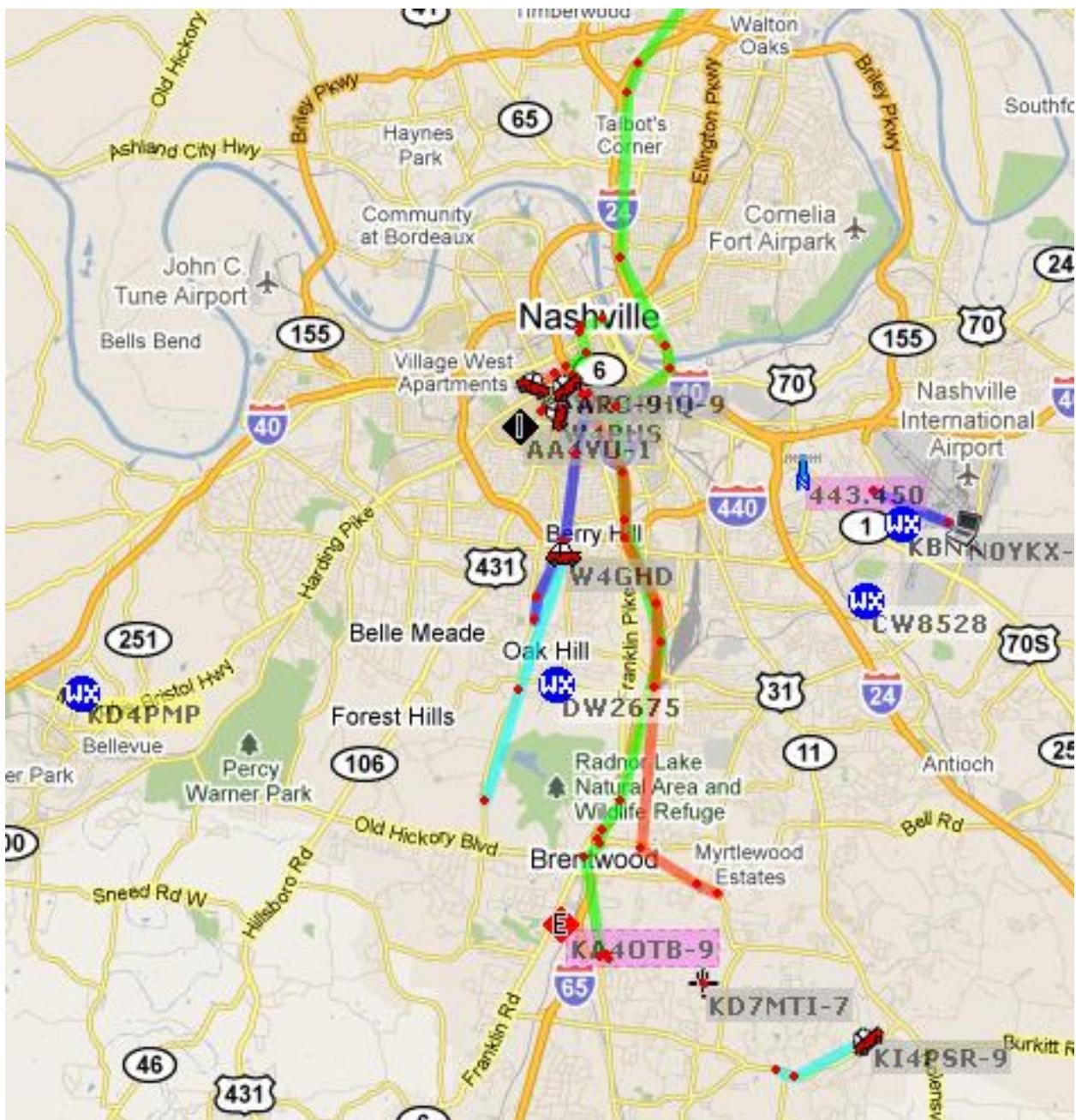
By convention, there are two classes of digipeaters: (1) fill-in digipeaters that have limited coverage, and (2) wide area digipeaters that have the height and power to cover a large area.

I-Gates and Internet sites

Some digipeaters are connected to I-Gates which pass incoming APRS packets on to APRS Internet servers ("APRS-IS"). If you have an Internet connection, you can view the positions of APRS-equipped vehicles anywhere in the world by connecting to these servers. In addition to displaying vehicle positions, most APRS servers display other useful information such as repeater frequency/tone, WINLink nodes, weather information, etc. A popular APRS server is <http://aprs.fi>. You can tell it to search for a specific call sign, or you can enter a zip code or city name, and it will display all vehicles in that area.

If you would like to see the actual APRS traffic around your area right now, go to <http://www.aprs.fi>. On the right side of the screen, in the "Show Last" field, select whatever time frame you would like cover. I would suggest 1 hour for a start. In the

"Address" field, type in your zip code. After you make both of these entries then click on "Search". The screen will now display any mobile stations and a "bread trail" of their movements for the last hour. If you put your cursor over a station, it will draw a line to the digipeter that is hearing the station and then to the I-Gate. If you would like to search for just one station, then put their call in the "Track callsign" field and select Search. Here is an example of a map displayed by aprs.fi:



TNC: Terminal Node Controllers

The "brains" of an APRS system is the TNC (Terminal Node Controller). The TNC accepts position information from a GPS receiver, creates APRS packets, and uses the attached radio to transmit them.).

TNCs can be divided into two groups: (1) transmit-only, and (2) transmit and receive. A transmit-only TNC is well suited for installation in a car, a weather station, or other telemetry applications. As the name implies, it transmits position or other information, but it does not receive or decode incoming APRS packets. A TNC that can transmit and receive decodes the incoming APRS packets and passes them to a computer or a specialized display unit such as a Garmin Nuvi 350 GPS unit. Software on the computer (such as UI-View").) can then display the position of vehicles whose packets are received. Transmit-Receive TNCs also can function as digipeaters.

APRS Transmission paths

When configuring a TNC, one of the parameters is the APRS packet "path".). The path specifies what type of digipeaters should relay the packets and how many hops should be permitted. Only two types of entries are routinely used with path specifications: "WIDE1", which denotes a local area digipeater, and "WIDE2" which denotes a wide-area digipeater. The number of hops requested is specified using a dash and a digit following the digipeater type.). For example, WIDE2-2 requests that wide-area digipeaters relay the packet up to two times. Each time a digipeater relays a packet, it decrements the hop count in the outgoing packet. For urban locations, the recommended path is WIDE1-1,WIDE2-1. For rural areas, the recommended path is WIDE1-1,WIDE2-2.

Index

1

144.39 APRS frequency, 52

A

Advantages of digital, 5

AFSK, 44

APRS, 51

APRS.fi, 53

Argent Data Systems, 52

Automatic Position Reporting System, 51

Autostop macro control, 29

B

BPSK, 43

Byonics, 51

C

Call sign lookup, 13

CMS, 50

COM port, 10

Common message server, 50

CQ, 39

D

Digipeater, 52

Digital abbreviations, 30

Digital Master 780, 21

Digital modes manager, 34

Digital power, 5

DM780, 21

Domino, 47

DX cluster, 15

E

E-mail via radio, 51

eQSL.cc, 19

Erase TX window macro control, 29

F

Feld-Hell, 45

FSK, 44

H

Ham Radio Deluxe, 9

Hardware requirements, 6

Hellshreiber, 45

I

I-Gate, 52

L

Logbook connection configuration, 24

Logging a QSO, 17

M

Macros, 26

MFSK16, 46

Modes manager, 34

O

Olivia, 47

P

Packet modes, 6

Pactor 3, 6, 50

Path for APRS, 55

Prosigns, 30

PSK-31, 42

Q

QPSK, 43

QRZ.com, 14

R

Radio message server, 50

RMS, 50

RTTY, 44

S

Send-immediately macro control, 28

SignaLink RX/TX controls, 7
SignaLink sound interface, 6
Slow Scan TV, 48
Soundcard configuration, 23
Speed/Bandwidth chart, 47
Spotting list, 15
SSTV, 48
Start-on-a-new-line macro control, 29

UI-View, 55
U
Vehicle tracking, 51
V

T
Throb, 47
Tigertronics, 6
TinyTrak APRS, 52
TNC for APRS, 54
Tracker2 APRS, 52

Waterfall, 43
Waterfall panel, 26
WIDE APRS path, 55
Winlink, 50
WINMOR, 6, 50

W