Newcomers and Elmers Net: Exploring Digital Modes   Robert AK3Q 07.02.17

Digital Modes on HF
With the marriage of computers and radios over the last several decades, there are more digital signals than you can imagine, and most of them are in the HF frequency range.
-- Amateur radio folks as well as commercial, military and governments use modes like PSK31, RTTY, MFSK, Olivia, Hellschreiber, SSTV, digital voice and more.
-- I want to introduce the topic here and talk a bit about the hardware required for these modes. Your computer's soundcard can be put into service for receiving these digital signals along with software packages to decode the text.
-- Several programs such as [fldigi](), [DM780](), and [DxLab]() give a lot of options for receiving various digital modes.
-- Strictly speaking, you do not have to have your radio connected to a computer to get digital modes to work, but you will get better results.

Computer/Audio Connections
There are several options for this depending on the radio you have and how you use it.
-- Standard portable radios or desktop radios without a computer interface/CAT connection will need to be connected through a "Line Out" connection or through a speaker/headphone connection.
-- Depending on how your radio is designed, usually a line out connection is the best way to go if available, as these typically have a steady output level which can then be manipulated as needed using the computer volume controls.
-- If you only have a headphone jack or a speaker jack then the output will be controlled by your radio volume control, and sometimes this can overwhelm a computer input connection.
-- Speaking of the computer input, here you have several options as well, usually a "Line In" connection or and/or a "Mic" connection.
-- "Line In" typically works best, but if there is not one available, you can use the "Mic" input. It will be more sensitive than the "Line In", but quite usable.
-- If you have no way to go directly from your radio to a computer input, another method is to record the audio from your radio and then play it back into a computer's built-in microphone, such as one on a laptop or tablet running digital mode software.
-- (An audio recorder might also be handy to record signals for later playback when you are not able to have a computer handy.)

Assuming you have a computer/CAT interface connector on your radio you can get the appropriate data cable to go into either a serial or USB interface on the computer.
-- This can get a bit tricky if your cable only comes with a serial port connector and your modern computer does not have a serial port!

This came up at the field day I attended as I was setting up for working some digital modes
-- the club radio had a serial port connector and my laptop did not; even though I did not need to control the radio from the laptop, the software I wanted to use and had prepared for use would not run without the CAT interface
-- so I quickly changed software to another program I had installed which fortunately did not need CAT control and it worked out fine
-- In these cases where there is no serial port you will need a USB/serial port converter cable with the appropriate drivers to create a "virtual" serial port.
-- This is not as difficult as it sounds, but it does create some headaches if the drivers/chipset combination does not work with your operating system. -
-- There is plenty of information on the Internet about these issues, so do some research before purchasing your cables.
-- Just keep in mind since the serial port is created in software rather than being actual hardware, the virtual driver can get corrupted in memory more easily, so sometimes a computer reboot is in order.
-- Once everything is set up and working properly you really won't have many issues unless you change your configuration or change USB ports for the connection.
-- Depending on the driver/software combination changing USB ports between uses could change the communications port number as the computer loads a new virtual port.

Sound In and Out
The best radio/computer option, but more expensive, would be to have a dedicated audio card for the digital modes, such as a Rigblaster, SignaLink USB, or similar device.
-- The advantage here is that the soundcards are designed to have adequate signal processing capabilities, taking some of the load off the computer's internal soundcard, and they are accessible since these units are external devices.
-- Where things can get a bit tricky is in the audio settings of your computer's operating system.
-- Follow the manufacturer's recommendations closely if using an external soundcard, and if using a computer soundcard with line inputs or mic inputs, get familiar with how to adjust these settings in the advanced menus.

-- Some software/hardware combinations can be difficult to get set just right. Fortunately this is usually a one-time thing unless you change something, but don't be surprised if things take a bit of tweaking.
-- Also almost all of the software and hardware out there have extensive user-bases, and plenty of help is available online.

One of the things I have found with Windows 10 is that it can switch configurations without warning
  - Typically we set a default sound card for system sounds and then when adding a sound card interface the driver is only used when the appropriate software/hardware is run
  - -- what sometimes happens now in Windows 10 is that the sound card interface, usually called something like USBCodec becomes the default and system sounds are played out of this driver also, causing problems with a given digital mode

Digital HF Modes
Digital modes on HF frequencies are varied and plentiful.
-- One of the more exciting features of digital modes is that they do not need high power to work around the world
-- 30-35 watts is usually all that is required; in fact, much more than this and your signal gets distorted, causing problems for others
-- While a relatively new field as far as radio goes, there have been a number of modes developed which are considered old standards, with many other new modes coming almost daily.
-- This will in no way be an exhaustive listing, but I will cover some of the more common and/or user-friendly modes to get you started.

RTTY
RTTY, or radioteletype, was the primary means of digital communications from the 1940s until the 1980s, and is still in use today.
-- While the technology of digital modes has come a long way since RTTY, it is still considered a very robust mode for long-distance communication.
-- Many governments, military, and amateur radio operators still use the mode, and the Coast Guard and other weather services still use it as well.
-- There are regular RTTY contest weekends, and some amateur radios still come with RTTY decoders built in for listening purposes.

One RTTY weather service is the German Meteorological Service, on the following frequencies:

Callsign	Frequency	speed/shift
DDH47	147.3 kHz	50 baud/85 Hz
DDK2	4583 kHz	50 baud/450 Hz

DDH7   7646 kHz   50 baud/450 Hz
DDK9   10100.8 kHz 50 baud/450 Hz
DDH9   11039 kHz   50 baud/450 Hz
DDH8   14467.3 kHz 50 baud/450 Hz
Table Courtesy Wikipedia

PSK31

Without getting into all of the technical details of PSK31, this is a very robust mode which has become extremely popular for amateur radio work
-- The bandwidth requirements are quite small, but accuracy is quite good.
-- *PSK* stands for phase-shift keying, referring to the modulation method, and 31.25 is the bit rate.
-- The software on the receiving end must synchronize with the transmitting software so that it knows what to expect.
-- All of this is done through the software and is transparent to the user.

One of the reasons for the popularity of PSK31 has been the development of the waterfall (or panoramic) view of signals.
-- Early PSK software was somewhat difficult to tune because the bandwidth of the mode is so narrow.
-- By using a panoramic view of the audio (much like a spectrum analyzer) one need only "point and click" to adjust tuning to receive the signal.

PSK31 Frequencies

Frequency	Amateur Band
1.838 MHz	160 meters
3.580 MHz	80 meters
7.040 MHz	40 meters *(region 1)*
7.035 MHz	40 meters *(regions 2,3)*
10.142 MHz	30 meters
14.070 MHz	20 meters
18.100 MHz	17 meters
21.080 MHz	15 meters
24.920 MHz	12 meters
28.120 MHz	10 meters
50.290 MHz	6 meters

Table and image Courtesy of Wikipedia

There are numerous variations of PSK31 for specialized uses and higher speeds, but the most widely used is still PSK31.
-- If 100% copy is necessary, PSK31-F incorporates forward error-correction, meaning it checks itself to ensure all characters have been received properly before moving on to the next block.
-- This ensures the complete message is copied, assuming the signal can make it through.

Like almost all of the digital modes, the greatest strength of using a computer to send signals is the computer's amazing ability to recognize signal patterns far below levels distinguishable by the human ear.
-- What we only hear as static, synchronized software can process signals well into the noise and still get a clean copy.
-- In this way digital modes have surpassed Morse Code for sheer ability to be heard under difficult conditions, but Morse Code is still supreme in terms of allowing the human ear to process the signal without a computer.

PSK31 on HF – A Typical Session
-- get software installed and audio connections set
-- set the radio to USB; set filters to voice (or wide)
-- tune radio to 14.070 (day) or 7.035 (night) and listen for whistles; if all you hear is normal static, there could be a lull or something is not set right with the audio
-- run the software—should see a waterfall display with yellow lines with a light blue background (typically—some software may be different)
-- click on one of the lines with the mouse and then read the text in the test window
-- practice just receiving and getting comfortable with the controls of the software, and learn the flow of conversations
--you will notice common abbreviations like "BTU" for Back to You, and PSE K to indicate you are finished sending your text
-- also people usually send important information twice to ensure it gets through in case of static or other interruptions e.g. AK3Q de AB3XYZ AK3Q de AB3XYZ; or CQCQCQ de AK3Q CQCQCQ de AK3Q PSE K
-- when ready to transmit make sure power is set to 35 watts or so, and make sure you understand how your software options for sending the test—it may send as you type, or allow you to type and then send; most people send as they type so the other person knows you are still there
-- most of the software also allows you to put repetitious information in a macro/keyboard shortcut which makes things more efficient and easier

This would be the first mode I would start with since it is popular, relatively easy, and a lot of information is available for various software packages to make sure you have things setup correctly

-- don't worry about making mistakes – I have told people many times I am new to this or that mode, and people are very understanding
-- most folks are very welcoming into the digital club, regardless of mode

PACTOR
PACTOR is known as a *burst-mode* protocol, meaning that data is sent in bursts rather than in a continuous stream.
-- By sending the data in bursts, analyzing it for errors, and then sending back an acknowledgement code, PACTOR can be virtually error-free. It is highly sophisticated and, therefore, trusted by governments and military groups.
-- There are four versions of PACTOR (I,II,III, IV), and while there is soundcard software to decode basic PACTOR I, extra hardware is needed for the advanced modes or to transmit any version of PACTOR.
-- Another interesting feature of PACTOR is its integration with the Internet, allowing stations to use a combination of strategies to get the signal to its intended destination.

For listening purposes, software such as *MixW* can receive PACTOR 1, but PACTOR II and III & IV need specialized hardware from a company called *SCS* out of Germany.
-- These modems are fairly expensive, so most folks do not use them unless they have a specific need for the faster versions of PACTOR.
-- One common use of PACTOR is the messaging program *WinLink 2000* which is capable of sending E-mail, binary files, and weather bulletins around the world using linked radios and Internet hubs.
-- Since there are a number of HF stations around the world, at least one station should be reachable by radio for sending a message, and then the Internet forwarding capabilities of the system can forward it around the world to the receiving station, or hold it until the person retrieves it.

MFSK16
MFSK16 is an excellent long-distance mode, particularly for lower bands like 40 and 80 meters.
-- In addition to standard text handling, MFSK16 can also send simple images.
-- Recently the Voice of America (VOA) and other large radio broadcast stations have been experimenting with digital modes, and VOA tests have found MFSK16 to be the most reliable and readable across a wide spectrum of testers around the world.
-- I have been able to participate in some of these tests, and I have to say it is a lot of fun! (The idea behind the tests is a serious one: stations like VOA want to have emergency capabilities to get information out when propagation conditions might be poor for one reason or another, and digital

modes offer the best chance of getting the signals through the interference and/or normal propagation restrictions.)
-- FLDigi is an excellent program for MFSK16, as is MixW and MultiPSK.

Hellschreiber

Hellschreiber (or Hell for short) is actually an old mode of communication, much like a facsimile image, but it is indeed a digital mode.
-- It was developed in the 1920s, used extensively in WWII, and was used for commercial landline services until around 1980.
-- Today it is used by amateur radio folks in several iterations, the most popular being Feld-Hell, and found between 14.077 and 14.082 MHz, and the digital portion of 40 meters.
-- While not all that common, if you have software which will decode Hell you might enjoy trying it out.
-- Unlike other text modes, Hell looks a bit odd, more like a blurry image of the text rather than crisp letters
-- When there is interference Hell can be difficult to read, but it has something of its own error correction built in, in that each character is sent twice.

Part of the fun of the digital modes is trying them and seeing how well things can copy. For regular use if you decide to transmit in the digital modes, you no doubt will find one or two favorites.
-- For receiving purposes and for really using your radio to its fullest, you will want to try all of the modes you can, so have fun with Hellschreiber and RTTY and experience a modern take on a bit of history!

SSTV

Slow-Scan Television (SSTV) is an excellent mode to experiment with since there is regular activity daily on 14.230 MHz (analog signals) or 14.233 MHz (digital signals), both using Upper Sideband.
-- SSTV can be either an analog or a digital radio mode for sending still images, much like a fax machine, but with color. Depending on the quality of the signal the images can be pretty clear, or a bit grainy.
-- Sometimes they look like old scattered TV images (now almost a nostalgic thought since Digital TV has changed everything!), but if propagation is good, the images will be as well.

Analog modes rely on audio frequency shifting to send picture and color information, while digital imaging modes use DRM-type technology (Digital Radio Mondiale) and the JPEG2000 format.

-- Software such as [EasyPAL](#) and [DIGTRX](#) can translate these digital images, while many digital software suites will include software to render the analog images.
-- There are a number of programs able to decode these images, and it is fun watching them develop on the screen.
-- The only real hiccup in the process is identifying in which mode the analog images are being sent—Scottie is by far the most popular, but there are several common modes.
-- Sometimes the person sending the image will alert the receiving person concerning the mode, but often not. A little experimentation will usually hit on the right mode.

Olivia, Throb, and MT63
These three modes have also be a part of the VOA testing I mentioned above, and they are used sporadically around the amateur bands.
-- Olivia is a very robust mode, but not particularly fast, while MT63 is a very wide signal (almost as wide as voice SSB) but with really good forward error correction.
-- You can hear MARS groups using MT63 regularly outside of the amateur bands, as well as on the low bands.

So Many Ways to Run Digital Modes
Raspberry Pi, Tablets, Cell Phones numerous other processor/hardware combinations running Linux, Windows, Apple software and more can be configured for digital modes

VHF/UHF
"Digital" Modes like APRS (Automatic Packet Reporting System), WSJT for moonbounce and meteor scatter, ALE (Automatic Link Establishment) and others are common on VHF and above frequencies, and most can be run without a lot of extra equipment/cost.

Most digital work on VHF/UHF tends to be on SSB because FM modulation is not an efficient use of bandwidth, since most of the digital modes common on HF are quite narrow.