United States of America Amateur Radio Station

WB8NUT

Cincinnati (Anderson Township), Ohio

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Digital Modes Information Page

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Communication technologies that are specifically designed to improve "live" HF keyboard operation can now be achieved which were previously only theory, too complex, or too costly to implement to be practical. Thanks to the generosity of radio amateurs (hams) with programming knowledge, and to the Internet, new and powerful communications tools are available to all hams. The evolution and wide spread use of the Personal Computer that include a digital sound card for Digital Signal Processing (DSP), is allowing radio amateurs to use these tools to develop new modes of digital communication. The distinguishing features of live HF digital operation today are the use of lower

power, compact or indoor antennas and courteous operating techniques. This reverses the trend of several years ago.

Confusion over band space is the obvious down-side as new and old modes compete for space on the HF bands. Crowding on a single band like 20 meters is partly to blame for this issue. Fortunately, the new modes like MFSK16, are designed to improve performance for a wide range of operating conditions. This should allow for increased amateur radio band usage to relieve crowding and extend contact opportunities as propagation changes to favor different bands. These are really exciting times for all radio amateurs the use and enjoy all these new digital modes!

An Overview of Digital HF Radio Operating Modes

TOR is an acronym for Teleprinting Over Radio. It is traditionally used to describe the three popular "error free" communication modes - AMTOR, PACTOR and G-TOR. The main method for error correction is from a technique called ARQ (Automatic Repeat Request) which is sent by the receiving station to verify any missed data. Since they share the same method of transmission (FSK), they can be economically provided together in one Terminal Node Controller (TNC) radio modem and easily operated with any modern radio transceiver. TOR methods that do not use the ARQ hand-shake can be easily operated with readily available software programs for personal computers. For the new and less complex digital modes, the TNC is replaced by an on-board sound card in the personal computer.

AMTOR is an FSK mode that is hardly used by radio amateurs in the 21st Century. While a robust mode, it only has 5 bits (as did its predecessor RTTY) and can not transfer extended ASCII or any binary data. With a set operating rate of 100 baud, it does not effectively compete with the speed and error correction of more modern ARQ modes like Pactor. The non-ARQ version of this mode is known as FEC, and known as SITOR-B by the Marine Information services.

To hear what an Amtor signal sounds like, click the icon 

PACTOR is an FSK mode and is a standard on modern Multi-Mode TNCs. It is designed with a combination of packet and Amtor Techniques. Although this mode is also fading in use, it is the most popular ARQ digital mode on amateur HF today and primarily used by amateurs for sending and receiving email over the radio. This mode is a major advancement over AMTOR, with its 200 baud operating rate, Huffman compression technique and true binary data transfer capability.

To hear what a Pactor signal sounds like, click the icon 

G-TOR (Golay -TOR) is an FSK mode that offers a fast transfer rate compared to Pactor. It incorporates a data inter-leaving system that assists in minimizing the effects of atmospheric noise and has the ability to fix garbled data. G-TOR tries to perform all transmissions at 300 baud but drops to 200 baud if difficulties are encountered and finally to 100 baud. (The protocol that brought back those good photos of Saturn and Jupiter from the Voyager space shots was devised by M.Golay and now adapted for ham radio use.) GTOR is a proprietary mode developed by Kantronics. Because it is only available with Kantronics multi-mode TNCs, it has never gained in popularity and is rarely used by radio amateurs.

To hear what a G-TOR signal sounds like, click the icon 

PACTOR II is a robust and powerful PSK mode which operates well under varying conditions. It uses strong logic, automatic frequency tracking; it is DSP based and as much as 8 times faster then Pactor. Both PACTOR and PACTOR-2 use the same protocol handshake, making the modes compatible. As with the original Pactor, it is rarely used by radio amateurs since the development of the new PC based sound card modes. Also, like GTOR, it is a proprietary mode owned by SCS and only available with their line of multi-mode TNC controllers.

To hear what a PactorII signal sounds like, click the icon 

CLOVER is a PSK mode which provides a full duplex simulation. It is well suited for HF operation (especially under good conditions), however, there are differences between CLOVER modems. The original modem was named CLOVER-I, the latest DSP based modem is named CLOVER-II. Clovers key characteristics are band-width efficiency with high error-corrected data rates. Clover adapts to conditions by constantly monitoring the received signal. Based on this monitoring, Clover determines the best modulation scheme to use.

To hear what a Clover signal sounds like, click the icon 

RTTY or "Radio Teletype" is a FSK mode that has been in use longer than any other digital mode (except for morse code). RTTY is a very simple technique which uses a five-bit code to represent all the letters of the alphabet, the numbers, some punctuation and some control characters. At 45 baud (typically) each bit is 1/45.45 seconds long, or 22 ms and corresponds to a typing speed of 60 WPM. There is no error correction provided in RTTY; noise and interference can have a seriously detrimental effect. Despite it's relative disadvantages, RTTY is still popular with many radio amateurs. This mode has now been implemented with commonly available PC sound card software.

To hear what a RTTY signal sounds like, click the icon 

PSK31 is the first new digital mode to find popularity on HF bands in many years. It combines the advantages of a simple variable length text code with a narrow bandwidth phase-shift keying (PSK) signal using DSP techniques. This mode is designed for "real time" keyboard operation and at a 31 baud rate is only fast enough to keep up with the typical amateur typist. PSK31 enjoys great popularity on the HF bands today and is presently the standard for live keyboard communications. Most of the ASCII characters are

supported. A second version having four (quad) phase shifts (QPSK) is available that provides Forward Error Correction (FEC) at the cost of reduced Signal to Noise ratio. Since PSK31 was one of the first new digital sound card modes to be developed and introduced, there are numerous programs available that support this mode - most of the programs available as "freeware".

To hear what a PSK31 signal sounds like, click the icon 

HF PACKET (300 baud) radio is a FSK mode that is an adaption of the very popular Packet radio used on VHF (1200 baud) FM amateur radio. Although the HF version of Packet Radio has a much reduced bandwidth due to the noise levels associated with HF operation, it maintains the same protocols and ability to "node" many stations on one frequency. Even with the reduced bandwidth (300 baud rate), this mode is unreliable for general HF ham communications and is mainly used to pass routine traffic and data between areas where VHF repeaters maybe lacking. HF and VHF Packet has recently enjoyed a resurgence in popularity since it is the protocol used by APRS - Automatic Position Reporting System mostly on 2 meter VHF and 30 meter HF.

To hear what a packet signal sounds like, click the icon 

HELLSCHREIBER is a method of sending and receiving text using facsimile technology. This mode has been around along time. It was actually developed by Germany prior to World War II! The recent use of PC sound cards as DSP units has increased the interest in Hellschreiber and many programs now support this new...well I mean, old mode. The single-tone version (Feld-Hell) is the method of choice for HF operation. It is an on-off keyed system with 122.5 dots/second, or about a 35 WPM text rate, with a narrow bandwidth (about 75 Hz). Text characters are "painted" on the screen, as apposed to being decoded and printed. Thus, many different fonts can be used for this mode including some basic graphic characters. A new "designer" flavor of this mode called PSK HELL has

some advantage for weak signal conditions. As with other "fuzzy modes" it has the advantage of using the "human processor" for error correction; making it the best overall mode for live HF keyboard communications. Feld-Hell also has the advantage of having a low duty cycle meaning your transmitter will run much cooler with this mode.

To hear what a Hellschreiber signal sounds like, click the icon 

MT63 is a new DSP based mode for sending keyboard text over paths that experience fading and interference from other signals. It is accomplished by a complex scheme to encode text in a matrix of 64 tones over time and frequency. This overkill method provides a "cushion" of error correction at the receiving end while still providing a 100 WPM rate. The wide bandwidth (1Khz for the standard method) makes this mode less desirable on crowded ham bands such as 20 meters. A fast PC (166 Mhz or faster) is needed to use all functions of this mode. MT63 is not commonly used by amateurs because of its large bandwidth requirement and the difficulty in tuning in an MT63 transmission.

To hear what a MT63 signal sounds like, click the icon 

THROB is yet another new DSP sound card mode that attempts to use Fast Fourier Transform technology (as used by waterfall displays). THROB is actually based on tone pairs with several characters represented by single tones. It is defined as a "2 of 8 +1 tone" system, or more simply put, it is based on the decode of tone pairs from a palette of 9 tones. The THROB program is an attempt to push DSP into the area where other methods fail because of sensitivity or propagation difficulties and at the same time work at a reasonable speed. The text speed is slower than other modes but the author (G3PPT) has been improving his MFSK (Multiple Frequency Shift Keying) program. Check his web site for the latest developments.

To hear what a Throb signal sounds like, click the icon 

MFSK16 is an advancement to the THROB mode and encodes 16 tones. The PC sound card for DSP uses Fast Fourier Transform technology to decode the ASCII characters, and Constant Phase Frequency Shift Keying to send the coded signal. Continuous Forward Error Correction (FEC) sends all data twice with an interleaving technique to reduce errors from impulse noise and static crashes. A new improved Varicode is used to increase the efficiency of sending extended ASCII characters, making it possible to transfer short data files between stations under fair to good conditions. The relatively wide bandwidth (316 Hz) for this mode allows faster baud rates (typing is about 42 WPM) and greater immunity to multi path phase shift. A second version called MFSK8 is available with a lower baud rate (8) but greater reliability for DXing when polar phase shift is a major problem. Both versions are available in a nice freeware Windows program created by IZ8BLY.

To hear what an MFSK16 signal sounds like, click the icon 

Download Digital Mode Soundcard Software

- **Digipan** - Great PSK31 Software (Freeware)
- **Hamscope** - PSK31, RTTY, ASCII, MFSK, Packet and CW (Freeware)
- **IZ8BLY Hellschreiber** - All popular Hell modes (Freeware)
- **MixW** - The soundcard based software that does all the modes! (Shareware - Reasonable)
- **Stream by IZ8BLY** for MFSK (Freeware)

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WB8NUT recommends the Donner Digital Interface -

Simple, Affordable, Easy to connect!

Works First Time - Every Time

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The Predominate USA HF Digital Frequencies Are:

10 Meter Band: 28.110 - 28.125 Mhz
12 Meter Band: 24.920 - 24.930 Mhz
15 Meter Band: 21.060 - 21.080 Mhz
17 Meter Band: 18.100 - 18.110 Mhz
20 Meter Band: 14.060 - 14.080 Mhz
30 Meter Band: 10.130 - 10.145 Mhz
40 Meter Band: 7.060 - 7.080 Mhz
80 Meter Band: 3.620 - 3.640 Mhz

email: duffy (at) wb8nut (dot) com