

# Diving Into the Alphabet Soup

## An Update on Popular Digital Modes, With a 'Sound Show,' to Boot

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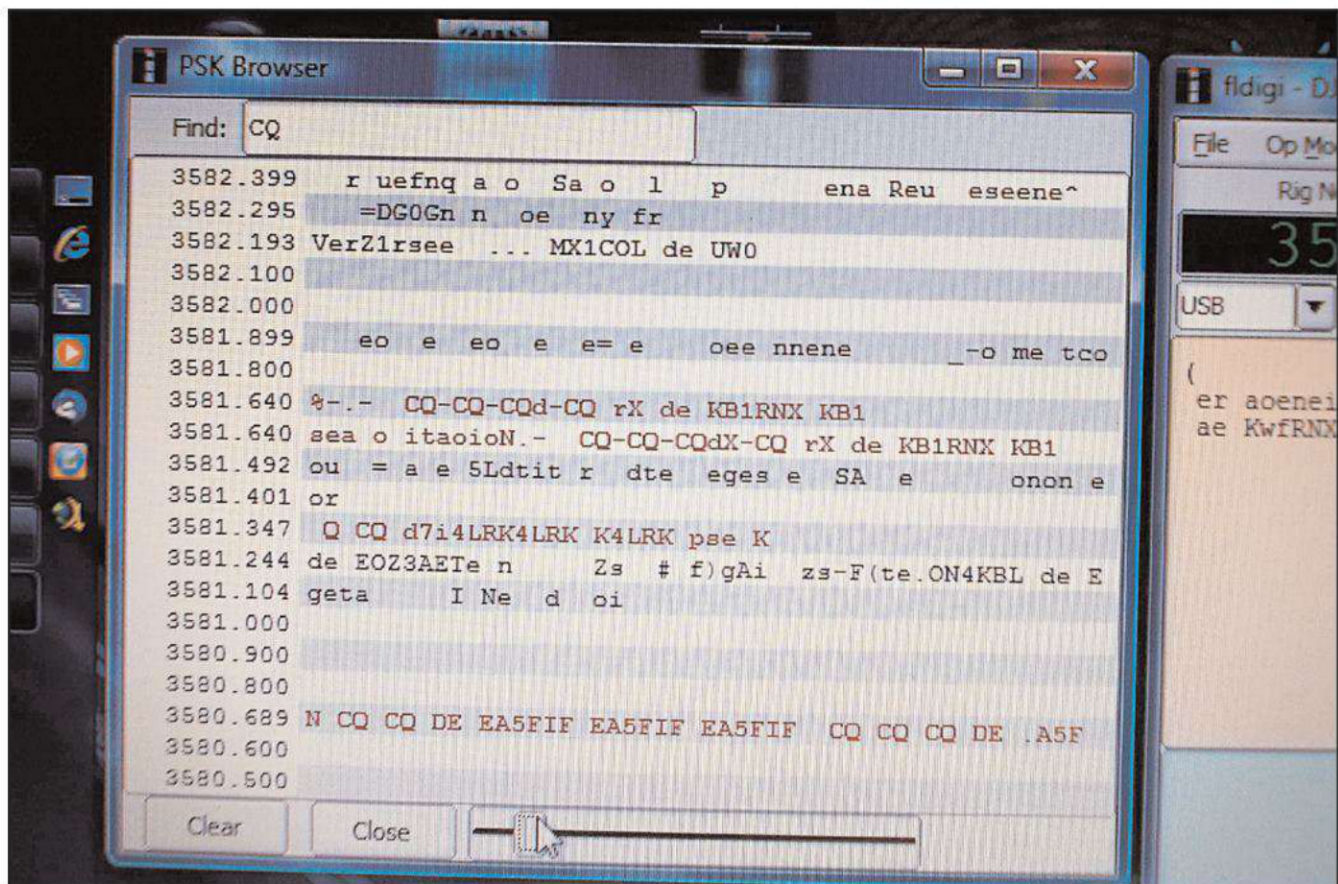
Communication technologies that are specifically designed to improve "live" HF keyboard operation that were previously only theory, too complex, or too costly to implement to be practical, can now be achieved. Thanks to the generosity of radio amateurs with programming knowledge, and to the Internet, new and powerful communications tools are available to all hams.

The evolution and widespread 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 downside 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 propaga-



**Photo A.** PSK31 marries a simple variable-length-text code with a narrow-bandwidth phase-shift keying (PSK) signal using DSP techniques. Many operators don't fully grasp the intricacies of how this mode works, but thoroughly enjoy contacting fellow PSK31 users around the world. (Courtesy of Wikimedia Commons)

## ON THE COVER

### KP4JRS: RTTY is My Passion!



Jose Rivera-Salaman, KP4JRS

Jose Rivera-Salaman, KP4JRS, of Trujillo Alto, Puerto Rico, operated NP3U, the Mi Casita Contest Club in San Juan during the CQ WPX RTTY Contest, **Photos B through G**.

He was part of a multioperator team in the competition the weekend of February 9-10, <<http://www.qrz.com/db/NP3U>>.

The station is owned by Carlos Colon WP4U. The team set up the cluster system that was used during the contest.

Jose has been a radio amateur since the age of 15 and held the callsign WP4JDS until 2000 when he upgraded to General and opted for KP4JRS.

His family members are amateur radio operators as well: His father Jose Rivera Carrasquillo is KP4JFR, and in recent years his sister Vilmarie also joined the ranks as NP3YL. The three have in common their favorite operating mode: RTTY. They participate in various contests — many times being the only amateurs to submit their logs representing their native Puerto Rico.

In addition to his studies, Jose works in a university as a computer consultant. He is the trustee of WP4WW <<http://www.qrz.com/db/WP4WW>>, as well.

KP4JRS is a member of the ARRL, 10-10 International, 30-Meter Digital Group, EPC, DMC, and Army MARS (ACM4KS). "My favorite mode is RTTY, but I also like chasing DX on SSB and CW," Jose said.

— Angel Santana-Diaz, WP3GW

tion changes to favor different bands. These are really exciting times for all radio amateurs that use and enjoy all these new digital modes.

### Setting the Digital Table

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 handshake can be easily operated with readily available software programs for personal computers.

For the new and less complex digital modes, an onboard sound card in the personal computer replaces the TNC.



**Photo B.** Among the equipment at Jose Rivera-Salaman, KP4JRS's, RTTY-oriented amateur station in Trujillo Alto, Puerto Rico, is an ICOM-756 Pro II transceiver, MFJ Super Antenna Tuner, Fluidmotion Stepp IR antenna controller and Alpha 78 linear amplifier. (Courtesy of KP4JRS)



**Photo C.** The blue Puerto Rican sky is a beautiful backdrop for KP4JRS's two-element Stepp IR antenna. (Courtesy of KP4JRS)





**Photo D.** Towering amateur radio antennas dot the hillside around the home of the Mi Casita Contest Club, NP3U, in Puerto Rico. (*Internet screen grab*)

We'll start with a digital mode that has been wildly popular for many years — PSK31 — then work through many others that have found a niche, or are emerging.

## An Overview of Digital HF Radio Operating Modes

*At the end of each segment, please click on the link in LISTEN to hear a sample of each mode as it sounds over the air.*

**PSK31, Photo A**, 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 operation 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 are available as “freeware.”

*(LISTEN: To PSK31 at <<http://wb8nut.com/resources/psk31.wav>>)*

**AMTOR** is an FSK mode that is hardly used by radio amateurs in the 21<sup>st</sup> Century. While a robust mode, it only has 5 bits (as did its predecessor RTTY) and cannot 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 SITOP-B by the Marine Information services.

*(LISTEN: To AMTOR at <<http://wb8nut.com/resources/amtpr.wav>>)*

**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

## Popular U.S. HF Digital Frequencies

10 meters: 28.110 – 28.125 MHz  
 12 meters: 24.920 – 24.930 MHz  
 15 meters: 21.060 – 21.080 MHz  
 17 meters: 18.100 – 18.110 MHz  
 20 meters: 14.060 – 14.080 MHz  
 30 meters: 10.130 – 10.145 MHz  
 40 meters: 7.060 – 7.080 MHz  
 80 meters: 3.620 – 3.640 MHz

**Figure 1.**

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.

*(LISTEN: To PACTOR at <<http://wb8nut.com/resources/pactor1.wav>>)*

**G-TOR (Golay-TOR)** is an FSK mode that offers a fast transfer rate compared to PACTOR. It incorporates a data interleaving 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 nice photographs of Saturn and Jupiter from the Voyager spacecraft was devised by M. Golay and now adapted for ham radio use.)

G-TOR is a proprietary mode developed by Kantronics. Because it is only available with Kantronics multimode TNCs, it has never gained in popularity and is rarely used by radio amateurs.

*(LISTEN: To G-TOR at <<http://wb8nut.com/resources/gtor.wav>>)*

**PACTOR II** is a robust and powerful PSK mode that operates well under varying conditions. It uses strong logic, automatic frequency tracking; it is DSP based and as much as eight times faster than PACTOR.

Both PACTOR and PACTOR-II 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 G-TOR, it is a proprietary mode owned by SCS and only available with its line of multimode TNC controllers.

*(LISTEN: To PACTOR II at <<http://wb8nut.com/resources/pac2.wav>>)*

**CLOVER** is a PSK mode that 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.

CLOVER's key characteristics are bandwidth 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. *(LISTEN: To CLOVER at <<http://wb8nut.com/resources/clover.wav>>)*



**Photo E.** An Elecraft transceiver is the centerpiece of the operating position at NP3U. (*Internet screen grab*)

**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 utilizing 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 its relative disadvantages, RTTY is still popular with many radio amateurs. This mode has now been implemented with commonly available PC sound card software.

(**LISTEN:** To RTTY at <<http://wb8nut.com/resources/rtty.wav>>)

**HF PACKET** (300 baud) radio is a FSK mode that is an adaptation of the very popular PACKET radio used on VHF (1,200 baud) FM amateur radio. Although the HF version of PACKET Radio has a 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.

(**LISTEN:** To PACKET at <<http://wb8nut.com/resources/packet.wav>>)

**HELLSCHREIBER** is a method of sending and receiving text using facsimile technology. This mode has been around a long 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 opposed 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 cooler with this mode.

(**LISTEN:** To HELLSCHREIBER at <<http://wb8nut.com/resources/hell.wav>>)

**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 (1 kHz 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 of tuning in an MT63 transmission.

(**LISTEN:** To MT63 at <<http://wb8nut.com/resources/mt63.wav>>)

**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 nine 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



**Photo F.** Members of the Trujillo-Alto Contest Club, WP4WW, include, from left, Jose Rivera-Salaman, KP4JRS; Tomas Gerena-Rivera, WP4BH; Nestor Alonso-Vega, SR, WP4BL; and Angel Santana-Diaz, WP4GW. Digital operation is part of the club’s formula for success. (*Internet screen grab*)