# QSY Society Field Day 2011 PSK31 Training
# By KC2QFR - Fred Lauricella

## *Introduction:*

The Digital mode PSK31 was the creation of Peter Martinez. Introduced in a 1998 RSGB article by G3PLX in the societies RADCOM JournalG3PLX. Peter is also the developer of AMTOR.

The "PSK" stands for Phase Shift Keying, the modulation method that is used to generate the signal; "31" is the bit rate, but the bit rate is really 31.25, which is easily derived from the sound card's 8000 Hz.

Peter devised a new code named *Varicode* because a varying number of bits are used for each character. He allocated the shorter codes to the letters that appeared most often in standard English text. This results in sending the least number of bits possible during a given transmission. For example: E is a very popular letter on the English alphabet hit parade, so it gets a Varicode of 11. Z sees relatively little use, so its Varicode becomes 111010101.

- Speed with mostly lower case characters provides 50wpm,
- Very good copy under low Eb/No numbers and is suitable for QRP,
- BPSK has No error correction.
- Software is available for free for Windows and Linux systems.,
- Audio from SSB Rig goes to digital sound card for DSP. decoding DSP encoded Audio from the PC goes to the SSB rig transmission.

To reduce the bandwidth of the PSK signal, the signal is shaped so that phase transitions occur only when the signal amplitude is zero

A "0" (space) is a 180 degree phase shift

A "1" (mark) is no phase shift.

The DSP capabilities of the PC and common computer sound card are used to create an audio signal that shifted its phase 180° in sync with the 31.25 bit-per-second data stream. In Peter's scheme, a 0 bit in the data stream generates an audio phase shift, but a 1 does not. The technique of using phase shifts (and the lack thereof) to represent binary data is known as Binary Phase-Shift Keying, or *BPS*K..If you apply a BPSK audio signal to an SSB transceiver, you end up with BPSK modulated RF. At this data rate the resulting PSK31 RF signal is only 31.25 Hz wide, which narrower than the typical CW signal!

Concentrating RF into a narrow bandwidth significantly improves reception as it does in CW.

10 *log (500/31) dB = 12 dB, reveals that a CW transmitter must put out 15 to 18 times more power than a PSK31 transmitter to achieve the same signal to noise ratio at the PSK31 receiving station.

If a 100 W signal provides a 20 dB S/N ratio at the receiver using SSB, the same S/N ratio is achieved with 8W using RTTY and only **1W** using PSK-31!

The phase transitions are easier to identify--even when they are deep in the noise--if your pc knows when to expect them. The receiving station automatically synchronizes with the transmitting station. Every PSK31 transmission begins with a short "idle" string of 0s. This allows the receive software to quickly sync. Varicode enables mathematically predictable phase transitions so the digital mode software can quickly synchronize itself when a signal is selected or after a momentarily lose signal.

## *Frequencies to Use*

**PSK-31** activity standard frequencies:

1.83815 MHz

3.580

7.035 MHz

14.07 MHz

18.100 MHz

21.070 MHz

24.920 MHz

28.120 MHz

50.290 MHz

## *Tips and Things to Keep in Mind When operation PSK:*

- Use the center of your waterfall or you will loose signal strength at the band pass edges.
- Set your rig's volume to an optimum level and adjust your waterfall and soundcard levels for a good contrast. Do not overdrive your soundcard! The background noise and the transmit trace should be well defined and separate. How the waterfall looks does not impact decoding, but it is harder to work a station if you can't see it.
- Use UPPER CASE characters sparingly. Lower case text in PSK31 varicode transmits fewer bits of data. It will result in increased transmit speed and improve the likelihood of proper decoding on the other end of the QSO. For example, the difference of a lowercase e and an uppercase E is five times more bits! (e=11 vs. E=1101101101)
- Use Data Mode on your RIG if it is supported, otherwise USB.
- Use Roofing filter if there are nearby strong signals that can desensitize your receiver.
- Try to enable your RF Attenuation and increase the volume. This helps keep a strong signal from wiping out the weaker ones and by reducing the noise level, the signal readability improves.
- AGC (auto gain control) does not help bring out a weak signal and can have negative effects on weak signal reception.
- Keep your ALC reading during transmit to as close to zero as possible. This will keep your signal clean and your IMD at an acceptable level of > 20db.
- Power Output of around 35 - 50W is enough to work the world, and your fellow CQs will appreciate the courtesy. Higher power will wipe-out the band for others
- Turn off Compression and RIG DSP functions when using digital modes.
- Ask for an RSQ (readability, strength, quality) report! When in a QSO, send just a tone and ask for your IMD and a report on how your trace looks.

- (S/N) ratio: A comparison of the signal levels to the relative noise level. Ideally, a perfect signal would have no noise, but realistically, you'll want a S/N ratio well within the tolerances of the mode you're using. PSK31 tolerates about a 10dB S/N ratio.
- ***IMD*** (Intermodulation Distortion): The ratio, in dB, used to determine the quality of your transmission. Unwanted 'products' or signals reduces IMD levels. More power does not mean better copy! Overdrive: Turning the volume of your radio up so high that you risk damage to the soundcard, or cause signal 'splatter'. Similar to maintaining your ALC levels.
- ***RSQ*** (Readability, Strength, Quality): Much like the familiar 'RST' reports, using a 599type
- **Reporting scheme:** Instead of 'Tone' (Morse Code), use 'Quality'. 95%+ readable, with a very strong waterfall trace, and a clean (no splatter) signal would warrant a 599 report.
- ***Waterfall***: A visual display of radio signals (and other sounds) found on the tuned frequency.
- To aid in detecting weak signals in the presence of stronger signals, turn OFF the receiver's AGC feature. This will allow the receiver to operate at full linearity and not reduce gain when a strong signal is present. Adding some attenuation to the front-end and using a narrow IF filter is advisable. Without receiver AGC your S-meter will not function and some strong signals may appear to be distorted, but with a sensitive waterfall display and a radio with good dynamic range, you will still be able to decode the weaker signals.
- Operate at the power level needed to produce good printing. Operate PSK31 mode at half (or less) the rated power of the transceiver. Operate all digital modes at a level that produces no ALC voltage to the PA.
- Multi-path QSB (flutter) will cause serious difficulty for PSK31 mode! Switch to other modes such as MFSK16 to eliminate this problem.
- Use BPSK mode for calling and all normal PSK31 operation. Try QPSK mode if the print quality drops to 80% due to static or noisy band conditions.
- Using lower case letters instead of all caps, will increase PSK31 speed and reduce TX time.
- Space QSOs at least 100hz apart.
- The power in a PSK-31 signal is concentrated in a 31 Hz bandwidth, versus 250 Hz for RTTY and 3300 Hz for SSB; the PSK-31 signal is brighter (3.2 W/Hz vs 30 mW/Hz for SSB)
- If a 100 W signal provides a 20 dB S/N ratio at the receiver using SSB, the same S/N ratio is achieved with 8W using RTTY and only **1W** using PSK-31!
- The transmit level should be set using the level controls in the software or sound card interface so that the ALC level is in the desired range
- The receive level should be adjusted to a level that does not overdrive the sound card.

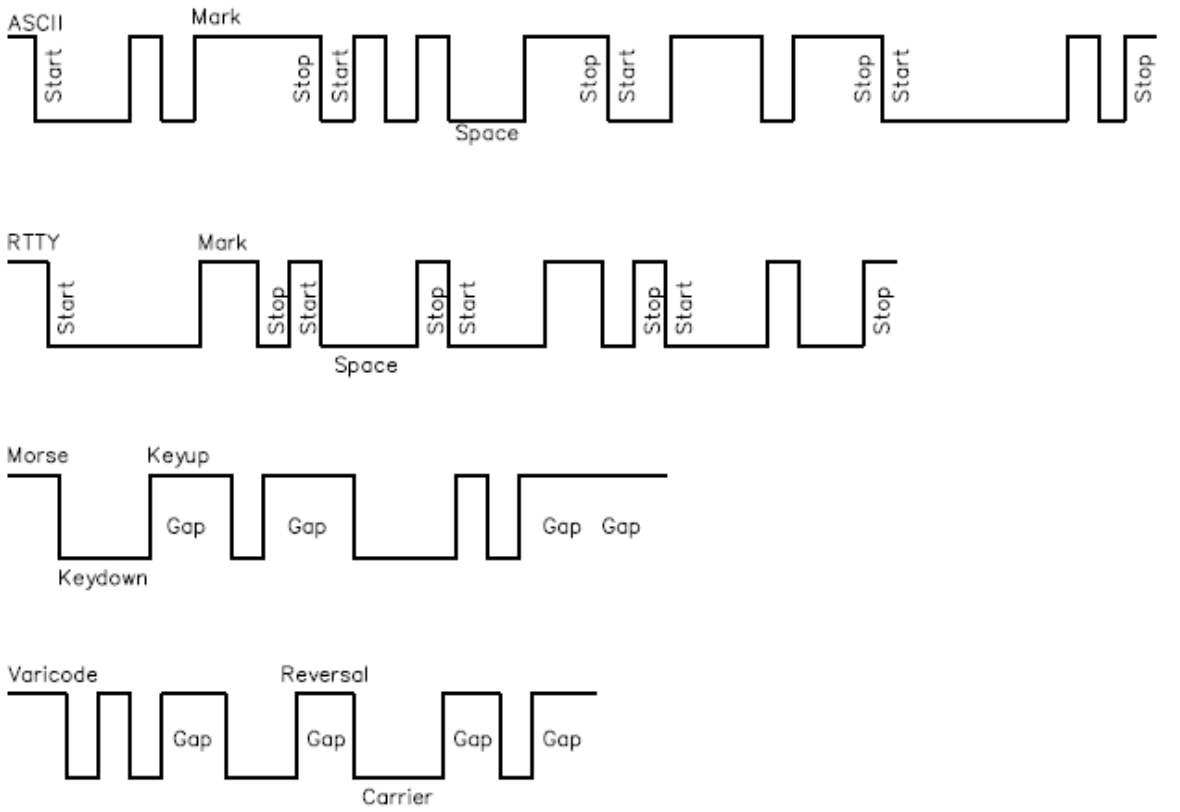



**Fig 1—The word "ten" in ASCII, RTTY, Morse and Varicode.**

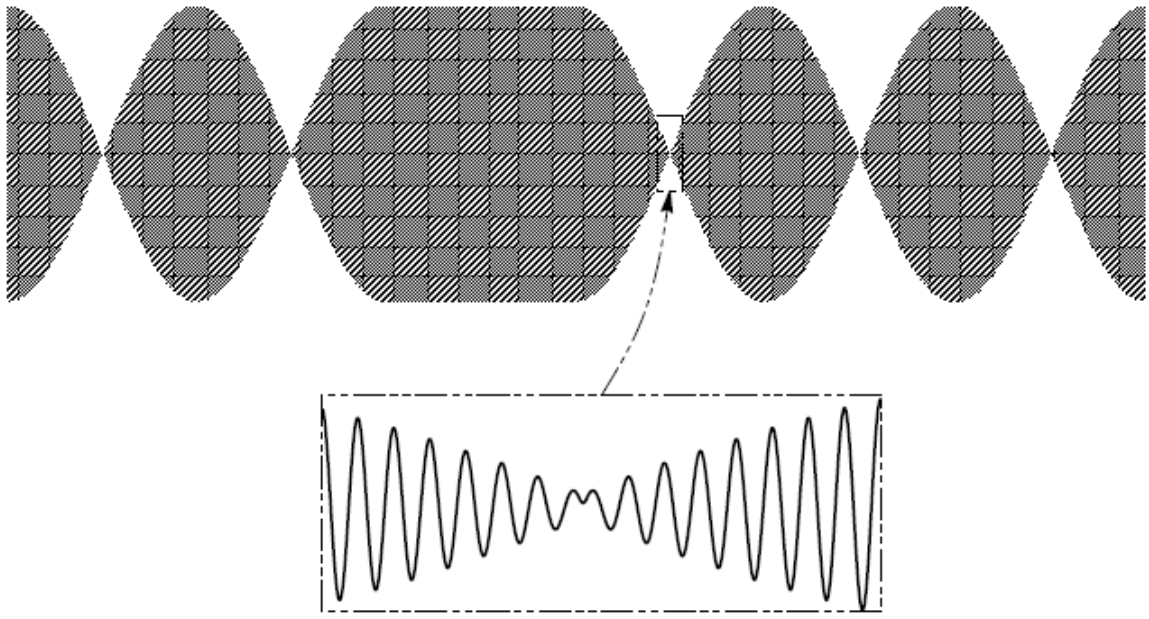


**Fig 2—The waveform of BPSK sending the Varicode space symbol., with a close-up of the detail during a phase reversal.**

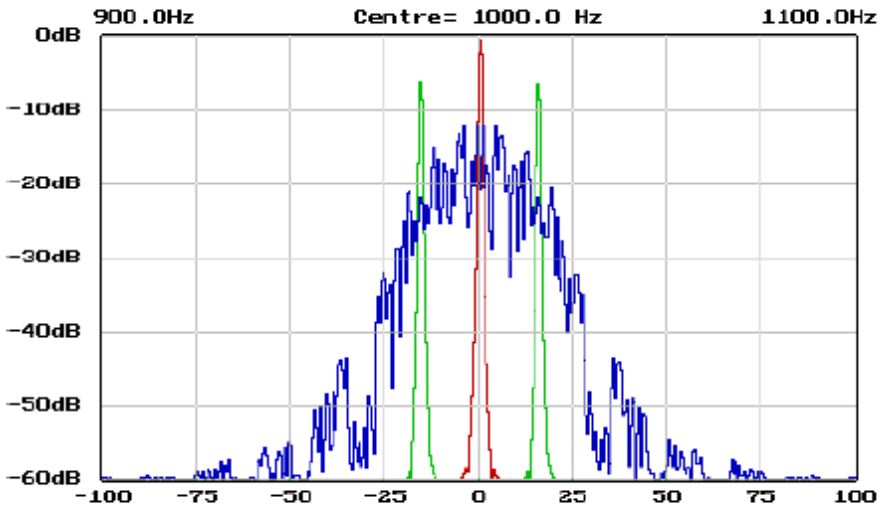



**Fig 4—The spectrum of a BPSK signal, idling and sending data, compared with an unmodulated carrier at the same signal level. The carrier is the center pip; the smaller pips are the PSK31 reversals, and the large, ragged hump is noise shaped by the filter.**

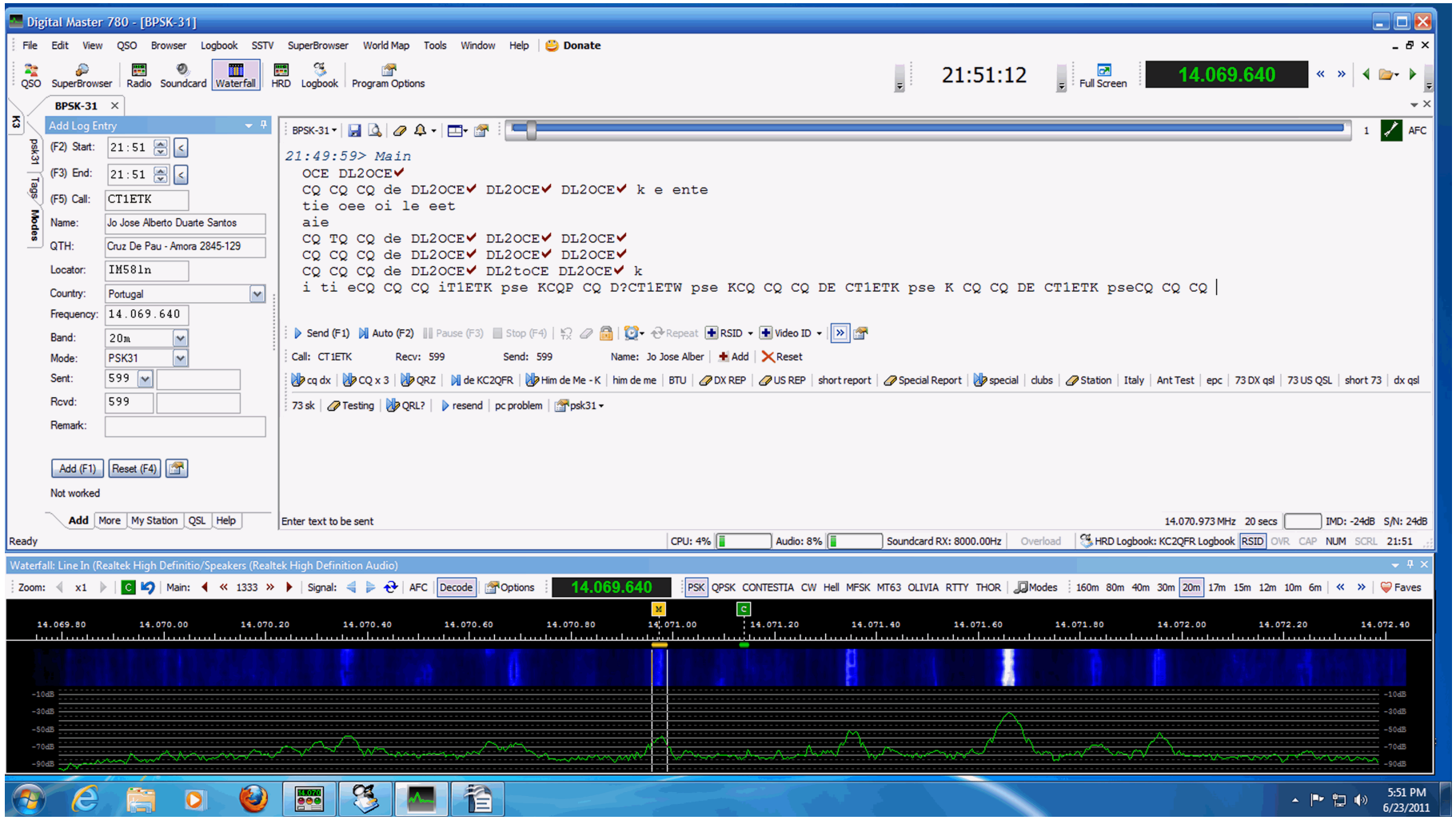
Search for PSK31 and Digital modes and you will find a wealth of knowledge.

Today we will use the popular Ham Radio Deluxe (HRD). a suite of free Windows programs providing computer control for commonly used transceivers and receivers. HRD also includes mapping, satellite tracking and the digital mode program Digital Master 780 (DM780).

HRD is designed for Windows 2000 or higher (XP, Vista, 7), also Internet Explorer 6.0 (or higher) is required. It may work with Windows 98 but this is not supported. The policy is to support Windows versions which are supported by Microsoft.

http://www.ham-radio-deluxe.com

Macros make sending routine text quick and easy. We will use macros for our Field Day psk31 operations.


Digital Master 780 - [BPSK-31]
File Edit View QSO Browser Logbook SSTV SuperBrowser World Map Tools Window Help Donate
QSO SuperBrowser Radio Soundcard Waterfall HRD Logbook Program Options
21:51:12
Full Screen
14.069.640
BPSK-31
Add Log Entry
(F2) Start: 21:51
(F3) End: 21:51
(F5) Call: CT1ETK
Name: Jo Jose Alberto Duarte Santos
QTH: Cruz De Pau - Amora 2845-129
Locator: IM58ln
Country: Portugal
Frequency: 14.069.640
Band: 20m
Mode: PSK31
Sent: 599
Rcvd: 599
Remark:
Add (F1) Reset (F4)
Not worked
Add More My Station QSL Help
21:49:59> Main
OCE DL2OCE✔
CQ CQ CQ de DL2OCE✔ DL2OCE✔ DL2OCE✔ k e ente
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Send (F1) Auto (F2) Pause (F3) Stop (F4) Repeat RSID Video ID
Call: CT1ETK Recv: 599 Send: 599 Name: Jo Jose Alber Add Reset
cq dx CQ x 3 QRZ de KC2QFR Him de Me - K him de me BTU DX REP US REP short report Special Report special clubs Station Italy Ant Test epc 73 DX qsl 73 US QSL short 73 dx qsl
73 sk Testing QRL? resend pc problem psk31
Enter text to be sent
14.070.973 MHz 20 secs IMD: -24dB S/N: 24dB
Ready
CPU: 4% Audio: 8% Soundcard RX: 8000.00Hz Overload HRD Logbook: KC2QFR Logbook RSID OVR CAP NUM SCRL 21:51
Waterfall: Line In (Realtek High Definitio/Speakers (Realtek High Definition Audio)
Zoom: x1 Main: 1333 Signal: AFC Decode Options 14.069.640
PSK QPSK CONTESTIA CW Hell MFSK MT63 OLIVIA RTTY THOR Modes 160m 80m 40m 30m 20m 17m 15m 12m 10m 6m Faves
14.069.80 14.070.00 14.070.20 14.070.40 14.070.60 14.070.80 14.071.00 14.071.20 14.071.40 14.071.60 14.071.80 14.072.00 14.072.20 14.072.40
-10dB -30dB -50dB -70dB -90dB
5:51 PM
6/23/2011

***Sources:***

American Radio Relay League: http://www.arrl.org

RSGB- Radio Society of Great Britain *January '99 issues of their journal,* RadCom*. By Peter Martinez*

*http://www.buxcomm.com/pdfzips/2011-BUXCOMM_Digital-handbook.pdf by Buck Rogers K4ABT and BUX Comm*

http://aintel.bi.ehu.es/psk31.html