Phase Shift Keying (PSK) Radio

Dr. John A. Allocca, WB2LUA
19 Lorraine Court, Northport, NY 11768
(631) 757-3919
john@allocca.com
July 2003

PSK31 (Phase Shift Keying) is a data mode that uses a personal computer and sound card to communicate. Packet is primarily designed for communications between two people or bulletin board. PSK31 is designed for multiple users like the voice nets. Anyone listening can see what everyone else is sending. PSK31 had many advantages over other modalities, such as requiring lower transmit power and more immunity from noise and interference (QRM). It uses an alphabet that has a text speed of 50 wpm. It does not require any handshaking with a second station. Roundtable communications are common in PSK31 mode. PSK31 was developed by Peter Martinez G3PLX.

The information in PSK31 is transmitted in patterns of reversed-polarities or 180-degree phase shifts. Phase modulation has several advantages over CW, which uses on-off keying. In a noisy or distorted propagation environment, the amplitude of CW will shift and vary much more than the phase of a signal.

The baud rate is 31.25 and the bandwidth is 31 Hz using narrow CW filters. The normal bandwidth of other modes is approximately 300-500 Hz. PSK31 can used with lower signal levels in a crowded digital band. PSK31 operates in a much narrower bandwidth than FSK (Frequency Shift Keying).

PSK63 is a variation of PSK31. It has a bandwidth of 63 Hz. and a speed of 100 wpm. RTTY has a speed of 60 wpm. PSK63 has improved polar path performance over PSK31.

The difference between a CW filter of 500 Hz and the bandwidth of PSK31 of 31 Hz (10*log(500/31) db = 12 db) is 12 db, which demonstrates that a CW transmitter must transmit 16 times more power than a PSK31 transmitter to achieve the same signal to noise ratio. Therefore, a PSK31 station can operate at 16 times less power than a CW station.

PSK creates a problem of key-clicks. The solution for eliminating key-clicks is to filter the output or to shape the envelope amplitude of each bit. The same problem of key-clicks may appear at the receiving end. PSK31 can eliminate this problem by filtering the receive signal or by shaping the envelope of the received bit. If a simple cosine wave is used at the receiver, a signal from one receive bit may be spread into the next bit. At the receive end, 4 bits are shaped at a time. The transmit and receive filters must be matched to each other. Over-driving the audio can create intermodulation products if it is not linear. So, it is important to not over-drive the audio.

BPSK (Binary PSK) mode that does not have forward error correction but is probably the most common mode on the bands. It can be identified by its two vertical lines in the "Vector" signal view window.

QPSK (Quadrature PSK) is another mode whereby instead of phase reversals (180 degree phase shifts), and additional pair of 90 and 270 degree phase-shifts are possible. It is like having two PSK (BPSK) transmitter on the same frequency, but, 90 degrees out of phase with each other. The result is twice the bit rate and 3 db less signal-to-noise ratio. QPSK mode has forward error correction but is a little harder to tune. It can be identified by its two vertical lines and two horizontal lines in the "Vector" signal view window. It is also sideband sensitive. Sometimes lower sideband is used.

PSK uses a personal computer and a 16 bit computer sound card. The audio output from the sound card is connected to the audio input of the transceiver with a 100:1 voltage divider to reduce the voltage from the sound card audio output to the transceiver audio input. Some interfaces use transformer isolation and some use opto-isolation. There a number of radio sound card interfaces available commercially. Most include a microphone connector, wire with microphone plug, bypass switches, a computer RS232 connector, and audio inputs and outputs.

Software

There are a number of software programs that can be used for PSK. This author used the highly recommended WinPSKse. It is freeware available at http://www.psk31.com along with various article and technical information on PSK31. WinPSKse is an adaptation of AE4JY's fine WinPSK program expertly crafted by Dave Knight, KA1DT. WinPSKse has the ability to display and read two PSK31 signals at the same time, in an easy to read and interpret presentation. This has a much improved user interface. For example, it has an amazing new simultaneous spectrum/waterfall display.

Some PSK31 calling frequencies

BPSK primarily uses upper side band mode.

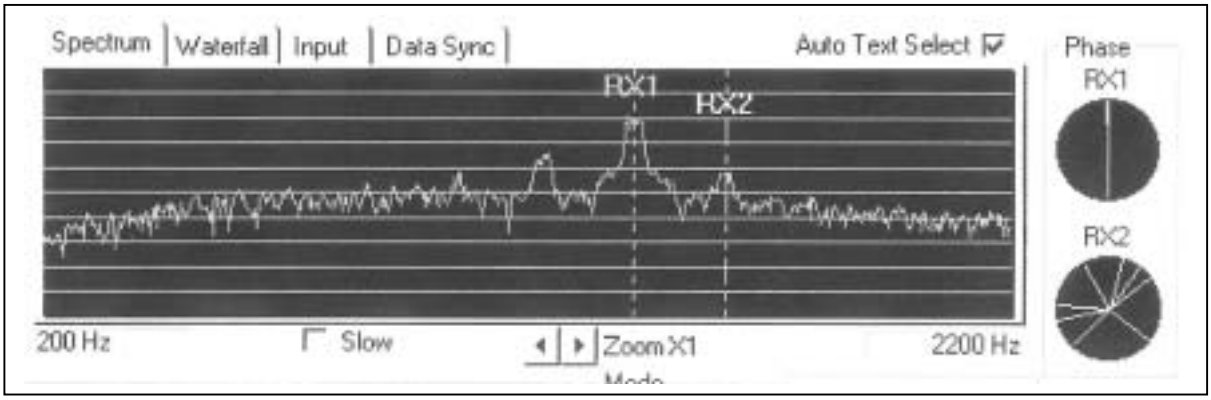
1,838.150 kHz
3,580.150 kHz to 3.620 kHz
7,035.150 kHz for region 1 and region 3, and 7080.15 for region 2 (the Americas)
10,142.150 kHz
14,070.150 kHz (Primary calling frequency)
18,100.150 kHz
21,080.150 kHz 150 (although most activity can be found 10 kHz lower)
24,920.150 kHz
28,120.150 kHz
145,550 kHz

Receive Audio Input Level

Tune the radio to a loud signal or carrier at 14,070.150 kHz. Display the soundcard's mixer program (or use the one that comes with Windows). Set the mixer's LINE IN setting to mid way. Adjust the volume control on the radio while viewing the INPUT signal display in the software program. The volume should be adjusted for a good signal level that is not too high and not too low.

Tuning in a PSK31 Signal

In the spectrum display view, look for peaks. Click the mouse on a peak to change the receive frequency marker position. If the display is not showing anything, adjust the soundcard Recorder mixer volume control or the volume control of the radio. Below is a typical PSK31 signal (RX1).



Transmit Audio Level Adjustment

Transmit level is more complicated to adjust than the receive level because the actual signal spectrum coming out of the transmitter cannot be seen at the transmitter. Adjust the mixer's VOLUME setting to adjust the transmit audio level The best method is to guess at a good level (mid way), then get a critical signal report over the air. The correct setting will vary from radio to radio. It is better to under-drive the radio until a clean signal is clean is obtained. In general never drive the transmitter anywhere near its rated power at first.

Operation Hints and Tips

The actual Transmit/Receive frequency is the USB radio dial frequency plus the audio frequency displayed in software. If using LSB, subtract the audio frequency from the radio dial setting. For example if the transceiver is in the USB mode and reads 14070.00 KHz and the audio frequency is 1500 Hz, then the actual transmit/receive frequency is 14071.50 KHz.

The TX and RX frequencies are limited between 200 and 3500 Hz. It is best to avoid the edges because transmitters may have some frequency limitations as well as some soundcards.

Don't send all text as UPPER CASE letters. PSK31 was designed to send the most commonly used letters such as 'e' and 't' much faster than letters such as 'z' that are used less frequencly. Uppercase letters take much longer to send and slow down the transmission. Capitalize letters as needed. A common practice is to send callsigns in upper case.

Make sure the PC time and date are set correctly.

Try using the QPSK mode when conditions get rough. In many circumstances, using QPSK will greatly improve reception due to its error correcting capability.