ELECRAFT

How to Set Up and Interpret the P3 Display

(Oct 11, 2010)

There are several options to customize the layout of your P3 display. The DISPLAY key switches between a spectrum-only and spectrum-plus-waterfall display. The height of the waterfall can be adjusted with the *Waterfall* entry in the MENU. The FN key labels appear at the bottom of the screen by default. You can hide them to maximize the screen area by holding the LABELS key. The FN keys remain active even when the labels are hidden. Another trick to maximize viewing area is to choose a smaller type font via the *Font* selection in the MENU.

Spectrum Display

The spectrum display on a panadapter is similar to the display on a laboratory spectrum analyzer. The horizontal axis is frequency and signal strength is represented by the vertical height of each signal. The P3's spectrum display is similar to most in that the signal height is proportional to the logarithm of the amplitude, represented in decibels (dB). Each 3 dB represents a doubling of power and 10 dB means ten times the power.

The vertical scale at the left edge of the spectrum display is in dBm, which means dB with respect to one milliwatt. 0 dBm is one milliwatt, +10 dBm is 10 milliwatts, -10 dBm is 1/10 milliwatt and so on. An S9 signal is normally considered to be 50 microvolts into 50 ohms, which is -73 dBm, an easy number for a ham to remember! Assuming the standard 6 dB per S-unit, the following table applies.

S-units	**Signal level**	
S9	-73 dBm	50 µV
S8	-79 dBm	25 µV
S7	-85 dBm	12.5 µV
S6	-91 dBm	6.25 µV
S5	-97 dBm	3.13 µV
S4	-103 dBm	1.56 µV
S3	-109 dBm	0.78 µV
S2	-115 dBm	0.39 µV
S1	-121 dBm	0.20 µV

The REF LVL control on the P3 shifts all the signals up or down. The "reference level" that you are adjusting is the signal level at the bottom of the display, measured in dBm. The SCALE control is used to expand or contract the vertical scale. Think of it as a vertical gain control. The "scale" is defined as the dB difference between the top and the bottom of the display. For example, if the reference level is -100 dBm and the scale is 20 dB, then a signal at the top of the display is at -80 dBm. For both REF LVL and SCALE, turning the knob clockwise makes the signals taller.

The P3 automatically compensates for the preamplifier and attenuator in the K3. When you turn them on or off, the signal levels on the P3 should stay the same. If the IF output modification has been done on the K3 (page 5), the indicated dBm level should be the signal level at the K3 antenna input. Perhaps counter-intuitively, this means that if you turn on the preamplifier in the K3, the noise level displayed on the P3 may decrease, rather than increase. That is because the P3 automatically reduces its gain when the K3 preamplifier is turned on, in order to keep the signal levels the same.

Waterfall Display

The waterfall allows you to see a history of band activity for the past few seconds. Like the spectrum display, the horizontal axis is frequency but in this case the vertical axis is time. Signal amplitude is represented by colors, from dark blue for weak signals, then brighter blue as signals increase in strength, through shades of green, yellow and red for the strongest signals. Each horizontal line represents one update of the spectrum display. As each new line is written the old ones are shifted down, creating a waterfall effect.

While the spectrum display is better at accurately displaying signal strength and the shape of a signal's modulation, it can only show what is happening right now. The waterfall is better for showing transient signals, such as a DX station running a pileup who only transmits for a few seconds at a time. Often, you can easily see a weak fading signal on the waterfall that is invisible on the spectrum display.

The scaling of the waterfall is the same as for the spectrum. That is, the bottom of the spectrum display corresponds to dark blue on the waterfall and the top corresponds to bright red. For maximum visibility of signals on the waterfall, it is best to set the REF LVL so that the noise level is right at the bottom of the spectrum display and then expand the SCALE as much as possible while keeping signals of interest below the top of the spectrum display. That improves the color contrast on the waterfall and makes weak signals appear to pop out of the noise.

Averaging and Peak Hold

Another way to make weak signals more visible is averaging. Because noise is random in nature, averaging reduces the jaggedness of the noise spectrum trace, making signals easier to pick out. The more averaging, the better the noise reduction, but at the expense of a slower response. To turn on averaging and adjust the averaging time, hold the AVERAGE key and then turn the knob. The averaging time is in units of the spectrum update rate, typically about 50 ms. You can apply averaging to the waterfall as well by setting the MENU *Wfall Avg* selection to "ON".

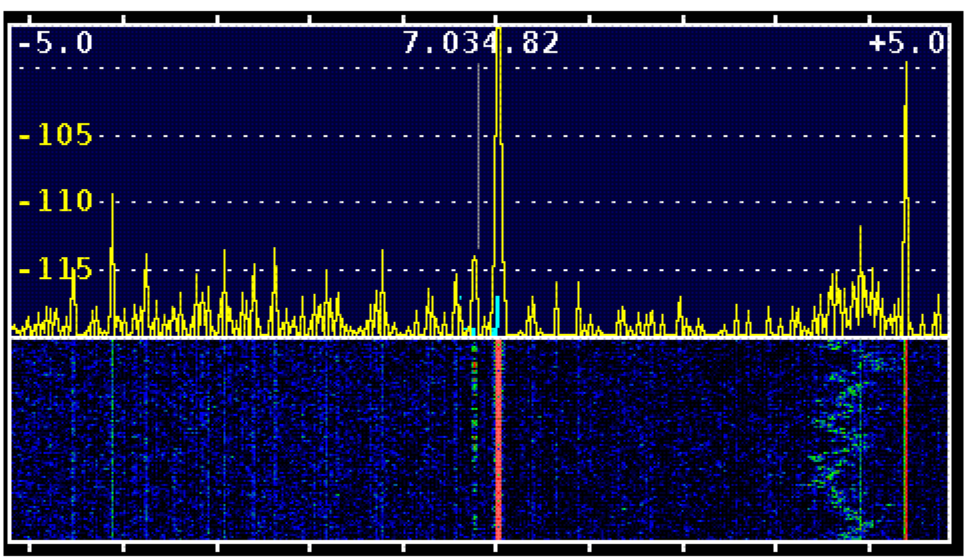
Peak hold is a way to display a memory of past signals on the spectrum display. It shows the strongest signals that have appeared at each frequency since the last time peak mode was enabled. To reset the peak trace, simply disable peak hold and then re-enable it. This mode is most useful if you assign the *Peak* selection in the menu to a FN key so you can turn it on and off at the touch of a button.

One use for peak hold is to monitor a dead band for activity while you are away from the operating position. If you glance at the display every now and then you can see if any signals have appeared in the meantime. Peak hold is also useful to see the shape of a modulation spectrum. Since the sidebands are continually changing with modulation, the peak is a better indication of the spectrum than the instantaneous value.

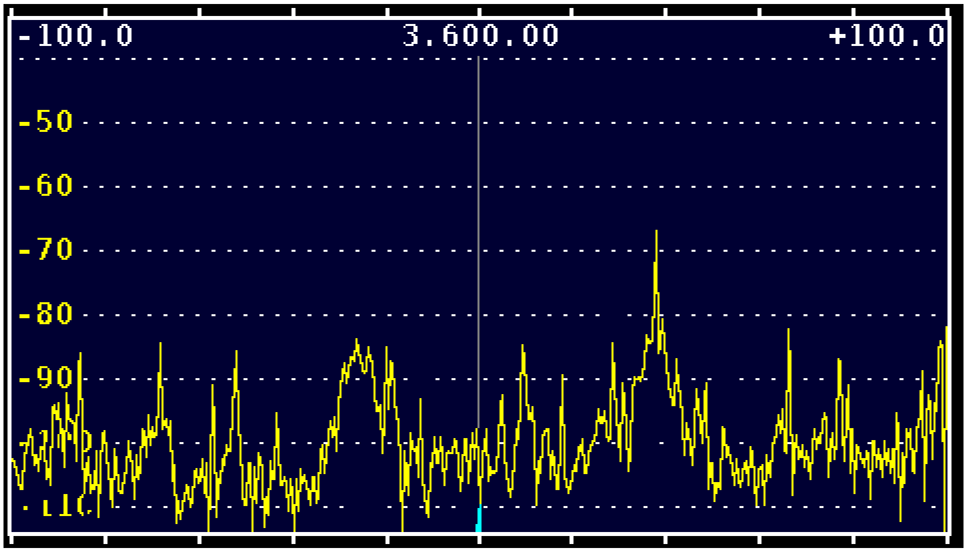
Span
Adjusting the span is yet another way to make weak signals more visible. As you narrow the span, there is less noise within the range of each frequency display point. That reduces the apparent noise level while the signal levels stay the same, which increases the signal-to-noise ratio. At narrow spans, signals that are difficult or impossible to hear become visible, especially on the waterfall.

As mentioned before, it is useful to keep the noise level right at the bottom of the display. The P3 can automatically keep the noise level constant as you adjust the span by setting the menu *SpanScale* value to "REF LVL only". If you would also like the level at the top of the screen to remain constant as you adjust the span, set *SpanScale* to "REF LVL & SCALE".

Typical Spectra
Below is a typical screen shot of the 40 meter band during the day. At the center is a weak CW signal that was inaudible on the K3 transceiver during fades. It is hard to see on the spectrum display at the top but is clearly visible on the waterfall. Just to the right of that is a strong interfering carrier. At the far right is another steady carrier and just to the left of that is a spurious emission, probably from a switching power supply, that is wavering back and forth in frequency. A panadapter is a powerful tool for tracking down interference.

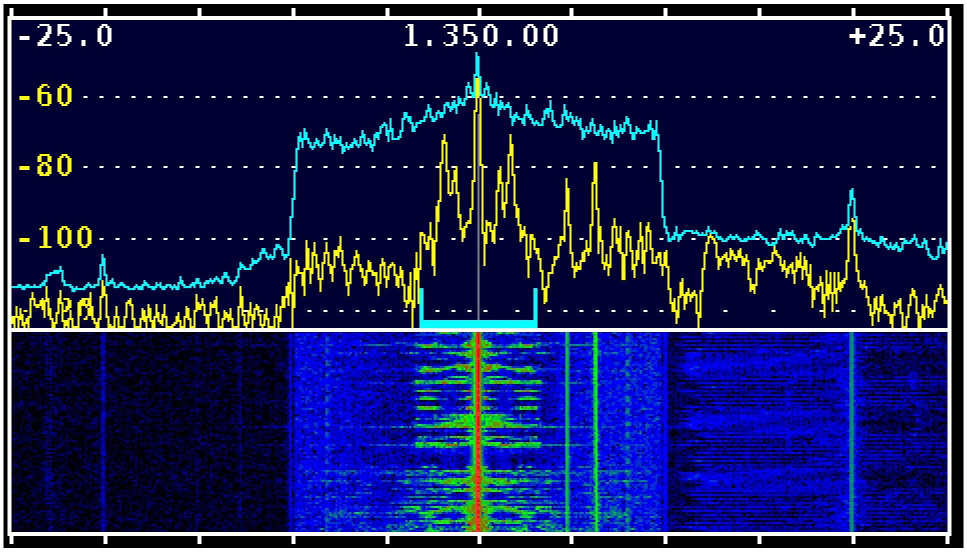


This is another example of interference, this time from a LAN router. The QRM includes both wideband noise as well as discrete carriers and is constantly heaving and writhing as the processor in the router executes different portions of its software routines.



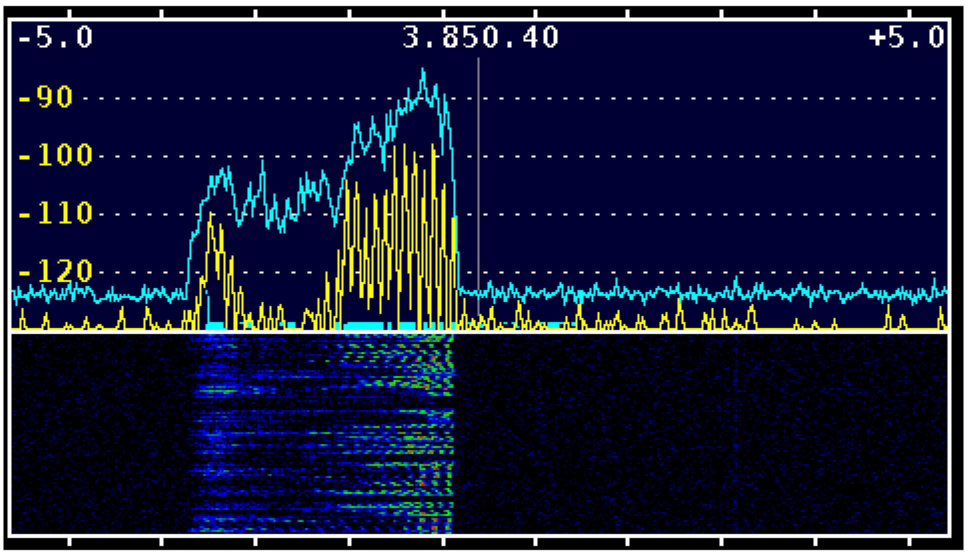
Spurious signals generated in the transceiver are sometimes visible as well. As you tune the transceiver you may see carriers that scroll across the screen much faster than other signals, sometimes tuning in the opposite direction. These are created by high-order harmonics of the VFO, BFO and other signal sources in the transceiver. They are typically not noticeable in normal operation. Since they tune so rapidly you don't hear them unless you happen to be tuned to exactly the right (wrong) frequency, but they are easy to see on the panadapter display because of its much wider bandwidth.

This is a shot of a local AM broadcast station, illustrating the use of peak hold to show the shape of the modulation spectrum, which extends to plus and minus 10 kHz from the carrier and then drops off abruptly to meet FCC regulations.



Normally the P3 display is frozen while the K3 is transmitting. However if you temporarily disconnect the RS232 cable between the P3 and K3, that function is disabled and it is possible to view your own transmissions for test purposes. The signal level is rather weak as it depends on random leakage in the K3's IF chain, so you may need to experiment with the REF LVL on the P3 and the power level and frequency band on the K3 to get an adequate signal. Also, the frequency may not be exactly centered on the display due to the effect of crystal filter offsets in the K3.

The following image shows a typical LSB spectrum obtained in this way. Peak hold is enabled in order to get a better view of the spectrum shape. Notice that the low audio frequencies (on the right) are much stronger than the high audio frequencies. A flatter spectrum is considered desirable to improve the signal's "punch" in the presence of noise and interference, especially when speech compression is used. The P3 is a handy tool for adjusting the transmit equalizer in the K3.



The previous image also illustrates an important point when using markers. On SSB, the frequency that is shown on the display of the K3 transceiver is the suppressed carrier frequency. When you QSY the transceiver using MKR A or MKR B on the P3, that is the frequency the K3 will go to. So on bands where LSB is used, you should place the marker just above the spectrum of the SSB signal you are trying to net (approximately in the center of the above display) and for USB, place the marker just below the spectrum.