

PRODUCT REVIEW

TelePost LP-PAN Software Defined IQ Panadapter

Reviewed by Joel R. Hallas, W1ZR
Technical Editor, QST

The Elecraft K3/100, reviewed in January 2009 *QST*, includes the performance and most features hams think a modern top-shelf transceiver needs — except, perhaps, for a spectrum display.¹ Fortunately the K3, with the optional KXV3 transverter module, provides a wideband 8.215 MHz IF output suitable for panadapter or spectrum display use.

Larry Phipps, N8LP, principal of TelePost, has developed the LP-PAN, a dedicated software defined radio (SDR) receiver centered at 8.215 MHz. The LP-PAN is designed to plug into the K3 IF OUTPUT port and put I and Q quadrature audio signals into your PC sound system. This information is required to generate a panoramic display of the spectrum seen by the K3. The small LP-PAN box need not be accessed during operation, so it can be automatically powered on and off by the K3 AUX 12 V connector and located out of the way.

Although all of our testing was done with a K3, TelePost can configure the LP-PAN to work with some Kenwood (8.83 MHz IF) and Ten-Tec (9 MHz IF) radios. See the TelePost Web site for more information about supported radios.

1J. Hallas, W1ZR, "Elecraft K3/100 HF/6 Meter Transceiver," Product Review, *QST*, Jan 2009, pp 43-49. *QST* Product Reviews are available on the Web at www.arrl.org/members-only/prodrev/.



LP-PAN and PowerSDR-IF

The LP-PAN runs on a freely available version of *PowerSDR*, the open source software designed to drive the FlexRadio series of SDRs. This particular version (called *PowerSDR-IF*) was adapted by Scott McClements, WU2X, and is available without cost from the TelePost Web site. It's especially designed for use with software defined receivers used as IF processors. The software exchanges data with the K3 serial

port through an intermediate program, either *LP-Bridge* (described below) or the popular *Ham Radio Deluxe*.² Either intermediate program needs to be running and exchanging data with the K3 for *PowerSDR* to know what frequency you are on. The intermediate program can run in the background and does not need to appear on the display, leaving room for other software to be displayed concurrently.

The TelePost Web site indicates that LP-PAN can be operated using other SDR software such as *Rocky*, *SpectraVue*, *Spectrum Lab* or other similar systems. We only tested the LP-PAN using *PowerSDR*.

A Panadapter and More

The *PowerSDR* display system offers a

²Available at no cost from Simon Brown, HB9DRV, its developer, at www.ham-radio-deluxe.com.

Bottom Line

The LP-PAN and associated software add a high performance panadapter and interactive computer control to the Elecraft K3 at a reasonable cost for those with a radio connected PC and quality sound interface.

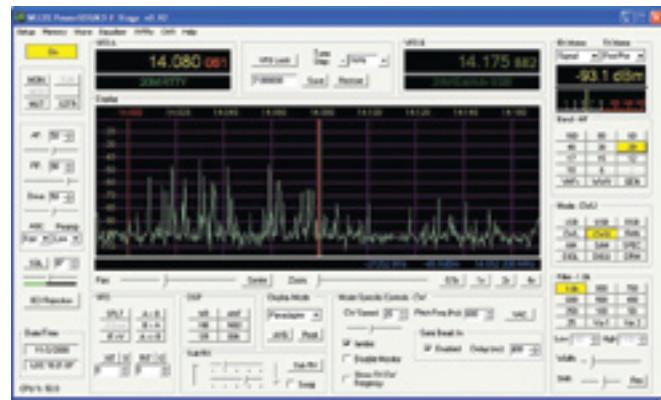


Figure 1 — Wideband panoramic view of the CW portion of 20 meters during the 2008 ARRL CW Sweepstakes.

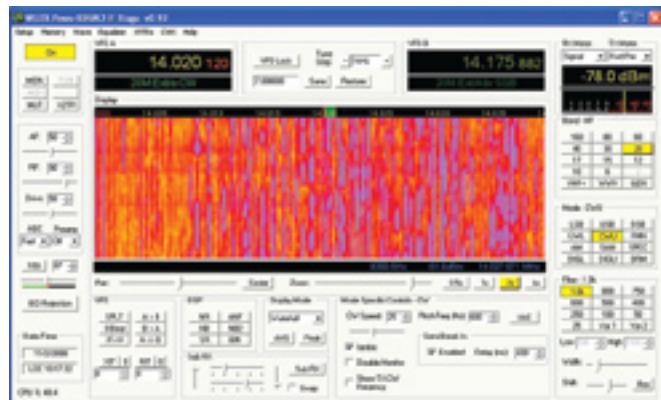


Figure 2 — Lower 40 kHz of 20 meters as a waterfall display.

number of display choices including, as you would expect, a classic panoramic display as shown in Figure 1. In addition, you can click to change to a colorful *waterfall* display as shown in Figure 2, or a number of other choices including an oscilloscope display. The width of the display can extend to 192 kHz, depending on sound interface sample rate — plenty wide enough for most band segments of interest. With most built-in PC sound systems, the performance is such that they only can sample fast enough to get to 48 kHz width. That width is okay for most operations, but built-in sound systems typically also have reduced dynamic range compared with high performance aftermarket devices.

The display width can be quickly reduced to a narrower region of interest using the ZOOM slider just below the display as shown in Figure 3. If reduced below the maximum, the PAN slider can be used to slide the display back and forth within the maximum display width.

In addition to its very capable panadapter display features, the LP-PAN system goes a step further with interactive control of the K3. Using either swept frequency display, the center frequency will follow your radio tuning, as you would expect. It can work the other way, too. You can change bands or modes with a click of the appropriate on-screen button. You also can move within a band by dragging the display scale wherever you want it. If you see a signal of interest, right-click the mouse to get a cursor, place it on the desired signal on the display, and one click tunes in that signal on your radio — pretty nifty.

There are a few mental adjustments required. If you are used to looking at the slow scan and high persistence display of the band scan functions in many radios, this *real time* display looks a bit different. In addition, the *PowerSDR* display system has many options and controls designed for use with the FlexRadio SDRs that are not applicable to IF panadapter use. Fortunately, most can be set up per Larry's instructions and then forgotten. I could imagine, one day, a dedicated version just for the LP-PAN and K3 that was a bit more specific. One feature that would be particularly useful is the ability to shrink the *PowerSDR* display while running other applications. In the current version you can only crop it, which offers some relief from the extra controls and allows for other applications to take up more of the screen.

The Sound System

As with many sound card applications, the performance of the LP-PAN and *PowerSDR* is drastically impacted by the performance of the computer sound system. While I was waiting to receive a sound inter-

Table 1
TelePost LP-PAN serial number 0206

Manufacturer's Specifications			Measured in ARRL Lab*		
Noise floor: -130 dBm with K3 preamp on.			-126 dBm preamp on, -115 dBm preamp off.		
Maximum input: +5 dBm with K3 attenuator on.			+2 dBm.		
Dynamic range: 115 dB, from noise floor to point of clipping.			108 dB preamp on, 109 dB preamp off.		
Image rejection: 60 dB typical with <i>PowerSDR</i> .			58 dB.		
Third order IMD: IP3 +23 dBm					
ARRL Lab Two-Tone IMD Testing					
<i>Band/Pream</i>	<i>Spacing</i>	<i>Input Level</i>	<i>Measured IMD Level</i>	<i>Measured IMD DR</i>	<i>Calculated IP3</i>
14 MHz/Off	20 kHz	-21 dBm -15 dBm	-115 dBm -97 dBm	94 dB	+26 dBm +26 dBm
14 MHz/On	20 kHz	-32 dBm -27 dBm	-126 dBm -97 dBm	94 dB	+15 dBm +16 dBm
14 MHz/Off	5 kHz	-32 dBm -15 dBm	-115 dBm -97 dBm	83 dB	+10 dBm +26 dBm
14 MHz/Off	2 kHz	-38 dBm -26 dBm	-115 dBm -97 dBm	77 dB	0 dBm +10 dBm
Total harmonic distortion (THD): ~0.005%.					
Local oscillator leakage: -110 dBm to -140 dBm at 8215 kHz.					
Output level: +2 dBV (1.27 V _{RMS} , 3.6 V _{PP}) nominal at maximum RF input, 600 Ω balanced or unbalanced.					
Power requirements: 11-16 V dc at 55 mA					
Price: LP-PAN kit with installed SMD components and enclosure, \$175; fully assembled and tested, \$225.					

*Measurements are a composite of K3, LP-PAN and sound card performance. Performance of an LP-PAN by itself would be higher. All measurements were made using *PowerSDR-IF* software and the TelePost recommended Creative Laboratories E-MU 0202 USB 2.0 external audio interface.

face from Larry's recommended list, I used the default on-board sound connections on my old PC. They did function, and I had a usable display, but my maximum display width was 48 kHz with limited dynamic range. In addition, I could not get proper image rejection with the old PC — a snap on a newer laptop loaned by my wife Nancy, W1NCY. The LP-PAN was still useful even with these limitations, and if I had to decide whether to get the LP-PAN first, or upgrade the sound card first, I'd go for the LP-PAN in a heartbeat and give it a try.

The TelePost Web site offers a list of suggested sound interfaces that will support full LP-PAN performance. As Larry notes, there are others that may work as well, so if you have an advanced sound card give it a try. If not, you should probably plan on upgrading at some point. We purchased the Creative Labs E-MU 0202 USB 2.0 Audio Interface, one on Larry's list, for about \$100. It is a USB connected external device, designed for USB-2 operation. For some reason, even though it showed improved dynamic range on my old PC with a USB-1 interface, I could not obtain proper image rejection

across the band. It worked fine on Nancy's USB-2 equipped laptop, as well as on the ARRL Lab's USB-2 desktop. I tried one of the recommended internal PCI sound cards, and that solved the problem with my old (Pentium III, 850 MHz) PC. An additional benefit of the internal sound interface is that they don't have manual gain controls that, on the E-MU can be easily bumped and throw off the calibration and image rejection.

For a thorough discussion of PC sound system performance issues, see the *QST* Product Review on the topic.³

A Problem — and a Solution

The K3 is designed to interface with your PC via a serial port. An optional USB-to-serial converter is also available from Elecraft or electronic retailers. Serial connections are designed to exchange data between the radio and a single application on the PC. If you want to run your contest logger and a PC based panadapter, and have the display

³J. Taylor, K1RFD, "Computer Sound Cards for Amateur Radio," Product Review, *QST*, May 2007, pp 63-70.



Figure 3 — Display of Figure 1 narrowed to show lower 40 kHz of the band.

keep track of both, you will have an address conflict. Generally the PC will throw up its many hands and either crash or not allow one of the applications to start. Larry has developed a software solution, available on the TelePost Web site, that cleverly works around this — *LP Bridge*.

LP Bridge acts like a packet router for serial data. In addition to the panadapter function, up to three virtual serial communication ports can be assigned to different programs running on your PC. *LP Bridge* will route the data from the single K3 port independently to each application — very clever!

One thing to keep in mind is that each added application increases the PC processing load. I didn't have a major problem, other than noted above, with my elderly 850 MHz Pentium III PC running the panadapter and N1MM logging software or *Ham Radio Deluxe*. During a logging operation, I did notice that the panadapter stuttered a bit on its updates. This is not a major concern and it caught up in less than a second, but if I planned to run all four possible applications at once I'd consider a faster PC. Figure 4 shows *PowerSDR* and the N1MM contest logging program running during the 2008 ARRL CW Sweepstakes contest. There is lots of activity on the band and the logging program is playing well with the panadapter such that both act as if the other program weren't there — at least while using W1NCY's more modern laptop PC.

Hooking it Up

The LP-PAN has a BNC connector for the IF input connection, so you will need a BNC-to-BNC jumper cable to connect with the K3 IF output. That connector is on the K3's optional KXV3 interface, so you need to get that first (\$100 from Elecraft). In addition, the LP-PAN has two audio outputs, one each $\frac{1}{8}$ inch jack for the I and Q channels. Those, and the coaxial power connector for a 12 V dc supply, make up the back panel.

From February 2009 QST © ARRL



Figure 4 — Demonstration of *LP-Bridge* providing simultaneous serial access to both *PowerSDR* and the N1MM contest logging program. Two other applications can also share the data from the K3 serial port without interfering with each other.

Unfortunately, many sound cards have a single $\frac{1}{8}$ inch stereo input, so I needed to fabricate a dual mono-to-stereo adapter to connect to the cable going to my audio card (that took \$7 of RadioShack parts). Note that the usual "Y adapter" that provides two plugs and a single socket has both sides in parallel and needs to be modified to have one channel connected to each side of the jack.

The E-MU 0202 has separate right and left line-level inputs using $\frac{1}{4}$ inch phone jacks, so I needed two more adapters to step up from my $\frac{1}{8}$ inch cable plugs. If you have the I and Q backward (just switch the plugs), when you make the image rejection adjustment the real signal will disappear instead of the image — been there, done that!

A few caveats are worth mentioning. To operate properly, a stereo LINE or MIC input is required on your PC sound system. Otherwise there will be no image rejection and each signal will appear on both sides of the center.

While Larry's clever *LP-Bridge*, described above, solves the problem of running multiple applications that want connectivity to the K3 serial port, there is no provision for sharing the PC sound inputs. If you want to run sound card digital modes or signal processing software, you will need to run two sound interfaces to do them at the same time. One good thing is that most sound card processes don't require the sample rate or dynamic range that you will want for optimum panadapter operation, so if you spring for a new one for LP-PAN use, the chances are you can use the old one for your digital modes — most PCs can support multiple sound devices. Some of Larry's recommended sound interface devices provide for two audio streams, another possible solution.

Performance

Once you have the PC, sound system and

software set up, you will have a very proficient system, as shown in Table 1. These measurements were taken using the usual ARRL Lab Product Review testing suite for receivers and includes the K3, not just the LP-PAN. I didn't use the audio output at my station. Note that the dynamic performance, while not quite up to the top performing (and much more expensive) software defined radio systems, is better than many current mid-priced transceivers. Of course the LP-PAN performance takes advantage of the K3's front end up to, but not including, the roofing filters that contribute significantly to the K3's excellent dynamic range.

The minimum discernable signal (MDS) is, however, comparable with that of the K3, so a signal that you can *hear* with the K3 is likely *visible* on the LP-PAN — just what you'd want, as long as your sound system has the required dynamic range. In fact, if you want to be sure to see everything, Larry offers instructions for a simple modification to the K3 IF buffer amplifier that increases the LP-PAN MDS another 6 to 8 dB. We elected not to modify our K3, but many have done so successfully.

Not to make excuses, but while this is indeed an SDR, the performance required to be a good panadapter is nowhere near that required by a primary receiver. Although you can listen to the audio output of the LP-PAN through the sound system, and some use it in place of a sub-receiver, for synchronous AM reception or to make use of the SDR's noise blinder. With the wide-as-a-barn-door input bandwidth needed for panadapter use, you will not be surprised to see the dynamic performance is not up to a receiver such as the K3 with its narrow roofing filters. If you see a cluster of strong signals on the PC display, you will likely want to use the super sharp K3 to sort them out, not the panadapter.



Figure 5 —
Inside view
of the LP-
PAN showing
construction
details.

Yet to Come

As with all SDRs, the LP-PAN can take on a new flavor each time a new flavor of *IF PowerSDR* software is made available. A version in test as we speak includes an additional display indication showing the spectrum around the K3's second receiver frequency — if on the same band.

Documentation

Larry has provided a very good documentation suite — both for the construction of his kit version and for the setup and operation of the assembled unit. You can review them on the Web site and decide if you want to build the kit or buy an assembled LP-PAN. Note that while the LP-PAN includes some surface mount components, the kit version has them all preinstalled, so just standard parts need be assembled. See Figure 5 for an inside view of the unit. The TelePost Web site also provides direct links to download all the required software and a list of suggested sound interfaces.

Manufacturer: TelePost Inc, 49100 Pine Hill Dr, Plymouth, MI 48170; tel 734-455-3716; www.telepostinc.com.