Elecraft KSYN3A Synthesizer Upgrade for the K3 HF/VHF Transceiver

Reviewed by Joel R. Hallas, W1ZR
QST *Contributing Editor*
w1zr@arrl.org

One of the major benefits of an Elecraft K3 transceiver is that its modular architecture allows it to be expanded or upgraded as interests, technology, or finances change. We have reviewed two versions of the K3 in the past, a "bare bones" 10 W transceiver built from a kit, and a fairly well equipped 100 W version with a second receiver.[2, 3] Since those reviews, we have reviewed a number of additional options and now we will review a major hardware upgrade, the KSYN3A frequency synthesizer board (part number KSYN3AUPG).

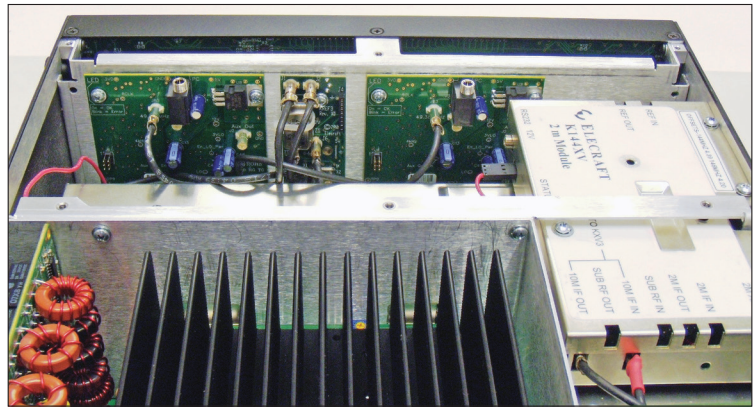

Figure 9 — Inside view from the rear of the author's dual-receiver 100 W K3 with new synthesizer boards installed.

When the K3 was introduced, it had one of the highest performance receivers and cleanest keying transmitters available at the time. While it is still as good now as it was then, since that time a number of transceivers have been made available with receivers that were better in the areas of close-in dynamic range — one of the key predictors of satisfactory operation in the presence of strong signals on adjacent channels.

According to Elecraft co-principal Wayne Burdick, N6KR, the new synthesizer came about because the design team found a way to dramatically reduce phase noise at close spacings. This can provide both improved receive and transmit performance. On the receive side, it prevents measurements from being noise limited, and also helps with reciprocal mixing dynamic range, often the limiting parameter. On transmit it makes the K3 signal even cleaner, particularly to those attempting to listen close to the K3 transmit frequency.

The new synthesizer has its own microcontroller to offload the main microcontroller during transmit-receive switching, resulting in less jitter in transmit-receive timing, making high-speed CW cleaner. This also provided an opportunity to add coverage of the upcoming 630 meter (472 – 479 kHz) band since the original synthesizer couldn't tune down that far. The new synthesizer tunes all the way down to 100 kHz and the transmitter can put out 1 mW on 630 meters as well.

In order to receive effectively on the lower frequencies, the K3 needs to have the general-coverage receive filter option (KBPF3) and the transverter interface option (KXV3) to allow connecting the antenna to the receive antenna (RX ANT IN) port or the transverter input (XVTR IN) port of the KXV3. The K3's regular antenna ports (ANT 1 or ANT 2) include a high-pass filter designed to eliminate strong broadcast signals that overload some receiver circuitry, but also attenuates desired signals in the new bands.

Any model of K3 transceiver shipped after January 23, 2015, (serial number 8801 or higher) comes equipped with the new synthesizers. If you have a second receiver installed in your K3, you will need a second KSYN3A for it.

Bottom Line

The Elecraft KSYN3A synthesizer upgrade for the K3 makes a dramatic improvement in local oscillator phase noise, resulting in improved receiver dynamic range and reduced transmit spurious output near the operating frequency.

Installing the Upgrade

The installation of the new board(s) is quite straightforward, and easier than many K3 modifications, since access is provided by just removing the K3's top cover. If a K144XV internal 2 meter transverter is installed, the stiffener bar will need to be removed and the transverter module shifted out of the way. Those with a single receiver have it particularly easy, because changing of a single board is all that is required. Not having the second receiver also provides additional visibility and connector access, but it isn't necessary to remove the second receiver if you have one.

The detailed instructions provide a number of cautions, especially that an electrostatic discharge (ESD) mat and wrist strap be used while handling the boards and that special care be taken to avoid losing two lockwashers into the radio's innards.

With a single receiver unit and no K144XV, the two synthesizer mounting screws are removed, the board unplugged, and the new one plugged in its place and new screws installed. One TMP terminated coax cable is shifted from the old to new board, and you're done. Having a K144XV with the optional reference phase lock adds one more cable.

In my K3, I have two receivers and the K144XV, so I had to do it all twice, as well as deal with an additional coax. The second receiver makes it a bit harder to get the second coax connector inserted, but it is, in my opinion, easier than removing the second receiver.

The whole operation took less than an hour and worked fine from the start. Figure 9 is an inside view of my K3 following the

[2]B. Prior, N7RR, "First Look: Elecraft K3 HF/6 Meter Transceiver," Product Review, *QST*, Apr 2008, pp 41 – 45.
[3]J. Hallas, W1ZR, "Elecraft K3/100 HF and 6 Meter Transceiver," Product Review, *QST*, Jan 2009, pp 43 – 49.

Table 5
Elecraft KSYN3A Synthesizer Upgrade for K3 — Receiver Tests

Test unit: Elecraft K3, s/n 431 with 400 Hz roofing filter and 400 Hz DSP bandwidth
Tests performed at 14.020 MHz before and after upgrade.

Minimum Discernible Signal (MDS)	
Before	*After*
Preamp off/on	*Preamp off/on*
–133/–139 dBm	–133/–139 dBm
MDS at 475 kHz (preamp off/on): –129/–122 dBm	
MDS at 137 kHz (preamp off): –44 dBm	

Blocking Gain Compression Dynamic Range	
Before	*After*
20 kHz offset	*20 kHz offset*
Preamp off/on	*Preamp off/on*
143/137 dB	143/138 dB
5/2 kHz offset	*5/2 kHz offset*
Preamp off	*Preamp off*
143/135 dB	143/143 dB

Reciprocal Mixing Dynamic Range	
Before	*After*
20/5/2 kHz offset	*20/5/2 kHz offset*
115/103/93 dB	119/118/115 dB

Two-Tone, Third-Order IMD Dynamic Range	
Before	*After*
20 kHz offset	*20 kHz offset*
Preamp off/on	*Preamp off/on*
106/102 dB	106/101 dB
5/2 kHz offset	*5/2 kHz offset*
Preamp off	*Preamp off*
106/103 dB	106/103 dB

change to the new boards, shown at the top of the photo, just inside the rear of the front panel.

Before and After Testing

My circa 2008 K3 was checked at Elecraft to get it up to snuff before we did a comparison of before-and-after measurements to make sure it was representative of current equipment. We tested the relevant performance parameters before and after the synthesizer replacement, with results shown in Table 5.

As expected, the performance parameters that tend to be limited by oscillator phase noise had the most dramatic changes. For receiver performance that is the reciprocal mixing dynamic range (RMDR), often the limiting factor in close in performance. The 2 kHz RMDR improved by 22 dB, to 115 dB at 2 kHz spacing — very impressive. In addition, all other 2 kHz spacing measures remained essentially the same or improved, with the blocking dynamic range increasing by 8 dB. It is important to note that these two parameters are those that can result from a single interfering signal, while the third-order dynamic range is only an issue with multiple interfering signals.

On the transmit side, the big news was the close in phase noise, often a major problem with multiple operators in the same band segment in close proximity, as happens in some contests and between neighbors with big stations. The transmitted phase noise on 20 meters at a spacing of 500 Hz was reduced by about 25 dB, while at 1 kHz it was down 12 dB. Figures 10 and 11 show the ARRL Lab transmitted phase noise data on 20 and 6 meters before and after the modification.

Expanded Frequency Coverage

Another big plus is the expansion of frequency coverage. The earlier synthesizers covered down to 500 kHz, which allowed coverage of the AM broadcast band (if the optional general coverage filter were added), as well as just down to the former marine CW calling and distress channel at 500 kHz. The new synthesizers cover down to 100 kHz.

With just the new synthesizers, general coverage module, and putting the antenna into one of the ports of the transverter module, the K3 will receive on the proposed 630 meter band with sensitivity comparable to that on other bands without the preamp, which is designed for higher frequencies. When 630 meter FCC operating authorization is received, Elecraft has announced plans to release a firmware revision that will permit transceive operation via the transverter ports at the 1 mW level. This means that an external amplifier and transmit receive antenna switching will be needed, but the K3 will then transmit and receive on 630 meters.

Because the original K3 design was not optimized for low frequency (LF) operation, it will take some modifications to the RF board and general coverage module for the transceiver to operate as well at the proposed 2200 meter band (135.7 – 137.8 kHz). Elecraft notes that current production K3s will leave the factory ready to go and that simple modification kits (part number KBPF3MDFT) are available for earlier transceivers. We did not install this modification, so the sensitivity at 137 kHz was quite low.

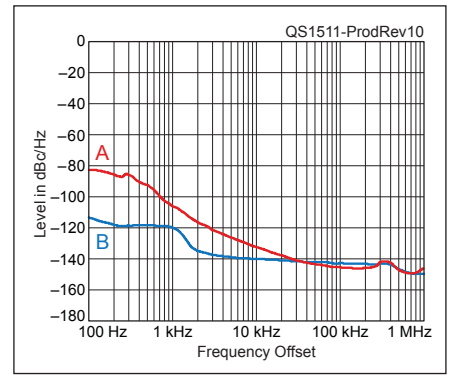

Figure 10 — Spectral display of the Elecraft K3 transmitter output during phase noise testing. Power output is 100 W on the 14 MHz band with the original synthesizer (line A) and after the synthesizer upgrade (line B). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dBc/Hz.

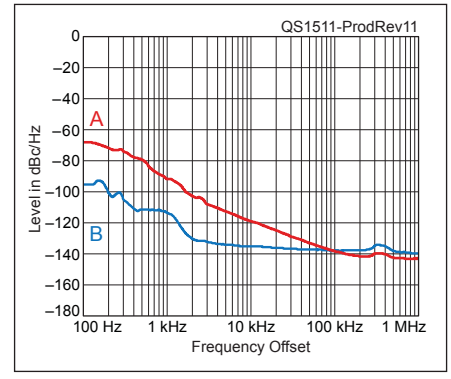

Figure 11 — Transmitted phase noise measurements for the K3 on the 50 MHz band with the original synthesizer (line A) and after the synthesizer upgrade (line B).

Documentation

Each KSYN3A synthesizer board comes with complete illustrated step-by-step installation instructions in a 19-page package. In addition, a single paragraph addendum is provided for the *K3 Operating Manual* that explains receiver operation below 500 kHz. I found the instructions complete and easy to follow. They are as lengthy as they are principally because Elecraft provides details for each K3 configuration that has different installation or cabling requirements. You can review the document on Elecraft's website.

Manufacturer: Elecraft, PO Box 69, Aptos, CA 95001; tel 831-662-8345; **www.elecraft.com**. Price: $220.