

ELECRAFT KX3 Application Note:

All-Band Receive Opposite Sideband and I.F. Image Nulling

Revision A8, January 24, 2013
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Background

The procedure described here can be used to improve the KX3's receive opposite sideband and I.F. image suppression. It applies to all modes, and can be done whether or not a KXFL3 roofing filter module is installed. The full procedure can take one to two hours or more to complete. (Elecraft can perform the procedure if you don't have the time or equipment to perform it yourself. Contact customer support for details.)

Some KX3s have already had the procedure done at the factory. See **Applicable KX3 Serial Numbers**, below.

Technical Details: Nulling of (rejecting or suppressing) the opposite sideband or 16-kHz image is achieved by slightly adjusting the gain and phase of one of the DSP's two I.F. channels in relation to the other. When the gain and phase are closely balanced, the DSP-based demodulator can suppress the unwanted sideband by 60-70 dB or more. Since the gain and phase change slightly with different filter settings and on different bands, the adjustments must be repeated on each band for each filter.

Note: KX3 firmware version 1.36 or later is required to perform this procedure.

Equipment Required

You'll need an RF signal source covering the 160-6 meter ham bands, with signal output in the range of about -73 to -33 dBm. An Elecraft XG3 is ideal for this purpose.

Applicable KX3 Serial Numbers

If you a KX3 with serial number 2324 or later (kit or factory assembled), then most of this all-band nulling procedure has already been completed. The only part not completed in this case is the second part of the MENU:RX SHFT=8.0 alignment, which nulls the 16-kHz I.F. image. To do only this part of the procedure, skip to the **RX SHFT=8.0 I.F. Image Nulling** section (page 5).

In all other cases the entire procedure should be completed.

Preparation for Receive Opposite Sideband and I.F. Image Nulling

The following steps prepare the KX3 for all-band nulling (RXSBNL*). These steps can be safely used prior to performing the Per-Filter procedure (with RX SHFT=NOR), as well as either of the RX SHFT=8.0 procedures.

1. Locate the TECH MD menu entry and set it to ON.
2. If you have a KXFL3 module installed, make sure the RX XFIL menu entry is set to NOR. If it was set to NOT INST, you must set it to NOR, exit the menu, then turn the KX3 off and back on.
3. **Set the KX3's power level (PWR) to 0.0.** This will prevent accidental damage to your signal source.
4. Switch to 160 meters, CW-normal mode. (If you are in CW reverse mode, with the LCD icons showing CW-R, hold the ALT switch to switch to CW normal.)
5. Hold the PITCH switch and adjust the knob above it to set the sidetone pitch to 550 Hz.
6. In the menu, set **DUAL RX** to OFF, **AGC MD** to ON and **ATU MD** to BYP (if applicable).
7. Exit the menu.
8. Look at the DSP filter graphic. If the two "wings" are not present at either end, NORMAlize the filter bandwidth by holding the PBT knob (sets bandwidth to 400 Hz in CW mode, with the passband centered). If you have a KXFL3 filter module installed, the FL3 icon will be on (otherwise, FL1). **Note:** Holding NORM alternates between the normalized passband and some other user-configured passband.
9. Turn on RIT and set the offset to -1.10 kHz. **Then turn RIT OFF** (for now).
10. Set up your all-band RF signal source for an output level between -73 dBm (S9) and -33 dBm (S9+40). (The signal source will be connected to the KX3 later.)
11. Set up your all-band RF signal source for the following target frequencies, +/- 50 Hz, within each band (160-6 meters): 1810, 3510, 5310, 7010, 10110, 14010, 18110, 21010, 24910, 28010, 50010. **Note:** These frequencies avoid band edges, where very weak system clock birdies may be present.
12. **If your the output of your RF signal source is higher than about S9+30 (-43 dBm), you'll need to turn the KX3's preamp OFF on every band (using the PRE switch). If lower than this level, turn the preamp ON. This will ensure a signal in the best range for the nulling steps that follow.**
13. (**Note: If you're setting up for the I.F. image nulling procedure on page 5, skip this step.**) Switch the KX3 to each band in turn, starting with 160 meters, and set VFO A to the frequencies noted above for the RF signal source.
14. Connect the signal source to the KX3's antenna jack. Set both the KX3 and the signal source to the first band to be aligned (160 m). Adjust the AF gain control for a comfortable listening level. **Note:** If you're preparing to null the RX SHFT=8.0 I.F. image, you may not hear any signal at this time since the VFO is offset from the signal source by 16 kHz. In all other cases you should hear a strong signal.

Per-Filter Opposite-Sideband Nulling (RX SHFT = NOR)

In this step, you will be nulling (rejecting) the unwanted audio opposite sideband signal for each of the KX3's three filter settings (or just for FL1 if you don't have a KXFL3 module installed). **Note:** You may need to tap a specified switch more than once in order to complete some steps.

1. Follow the **Preparation** steps on page 2 if you have not already done so. The VFO and signal source will be **on the same frequency** on each band as explained on page 2, step 13.
2. Locate the RX SHFT menu entry. Unlock the menu parameter by holding the KHZ switch for about 3 seconds. The lock icon will turn off. Set the RX SHFT parameter to NOR.
3. Tap BAND+, moving to 80 meters (3.5 MHz), then set the RX SHFT parameter for this band to NOR. Also set the mode to CW normal if it isn't already. Continue through 6 meters (50 MHz), tapping BAND+ each time, setting the parameter to NOR and the mode to CW normal. Exit the menu.
4. Locate the RXSBNL menu entry and unlock it.
5. If the menu entry name is RXSBNUL, tap CMP to change it to RXSBNL*. If it was already RXSBNL*, all or part of the all-band nulling procedure may have been completed earlier. It is OK to repeat the procedure.
6. **This step will initialize all per-band/per-filter RXSBNL* settings to default values:** Hold the CLR switch (1/2 second or longer).
7. Optimize gain and phase settings as follows:
 - a. Set both the signal source and KX3 to the target band (starting with 160 m, at 1810 kHz). Make sure you're in CW mode. (**Note:** You can change bands and modes from within the RXSBNUL menu entry.) You should hear a strong signal, and see an S-meter reading of between S9 and S9+30 dB. If not, adjust the preamp setting or the level of your signal source.
 - b. Turn on RIT if it isn't already on, and make sure the offset is set to -1.10 kHz; you'll now hear the *opposite sideband* signal, which should be considerably weaker.
 - c. Make sure the passband is NORMalized ("wings" showing at the ends of the DSP graphic). If you have a KXFL3 installed, FL3 should now be selected. Otherwise it will be FL1.
 - d. Tap the APF switch to automatically find the ideal GAIN and PHASE settings. This takes about 10-15 seconds. VFO A will show both gain (G) and phase (P) values during the automated search.
 - e. The depth of null should be entirely adequate—about 60-70 dB—with the automatically selected values. However, you can optionally adjust GAIN or PHASE manually to slightly deepen the null. To do this, tap PRE or ATTN to select GAIN or PHASE, respectively, then adjust VFO A.
 - f. If you have a KXFL3 module installed, increase the filter bandwidth using the PBT knob (function II, WIDTH) until the FL2 icon turns on. Then repeat steps (d) and (e). When this is completed, increase the bandwidth further until the FL1 icon turns on, then repeat steps (d) and (e) again.
 - g. Staying in the RXSBNL* menu entry, tap BAND+ to move to the next higher band. The band edge (not the actual VFO frequency) will be briefly flashed. Repeat steps (c) through (f) on this band.
 - h. Repeat step (g) on each band up through 6 meters (50 MHz).
6. **If you are not planning to do the RX SHFT=8.0 nulling procedures (pages 4 and 5),** restore your power level, CW sidetone pitch, and ATU mode (ATU MD menu entry).
7. **Do a Configuration Backup** (*KX3 Utility*). This will preserve changes made during this procedure.

RX SHFT=8.0 Opposite-Sideband Nulling

The KX3's RX SHFT=8.0 (kHz) menu setting can be used to improve the receiver's rejection of certain types of interference. If you use this setting, you should perform the nulling procedure. RX SHFT=8.0 nulling is done first for the audio opposite sideband signal (this section), then for the 16-kHz I.F. image (next section). The latter was added to the KX3 with firmware release 1.36.

Note: Prior to doing this part of the procedure, you should have completed Per-Filter nulling (page 3).

1. Follow the **Preparation** steps on page 2 if you have not already done so. The VFO and signal source will be on the same frequency on each band as explained in step 13 on that page.
2. Locate the RX SHFT menu entry. Unlock the menu parameter by holding the KHZ switch for about 3 seconds. The lock icon will turn off. Set the RX SHFT parameter to 8.0.
3. Tap BAND+, moving to 80 meters (3.5 MHz), and set the RX SHFT parameter for this band to 8.0. Also set the mode to CW normal if it isn't already. Continue through 6 meters (50 MHz), tapping BAND+ each time, setting the parameter to 8.0 and the mode to CW normal. Exit the menu.
4. Locate the RXSBNL* menu entry and unlock it. **The "FL1" icon should be flashing as reminder that RX SHFT is in effect. Note:** If the menu entry name is RXSBNUL, you may not have done the **Per-Filter** nulling procedure, which should be completed first
5. Optimize RX SHFT=8.0 gain and phase settings as follows:
 - a. Set both the signal source and KX3 to the target band (starting with 160 m, at 1810 kHz). Make sure you're in CW mode. (**Note:** You can change bands and modes from within the RXSBNUL menu entry.) You should hear a strong signal, and see an S-meter reading of between S9 and S9+30 dB. If not, adjust the preamp setting or the level of your signal source.
 - b. Turn on RIT if it isn't already on, and make sure the offset is set to -1.10 kHz; you'll now hear the *opposite sideband* signal, which should be considerably weaker.
 - c. Make sure the passband is NORMalized ("wings" showing at the ends of the DSP graphic).
 - d. Tap the APF switch to automatically find the ideal GAIN and PHASE settings. This takes about 10-15 seconds. VFO A will show both gain (G) and phase (P) values during the automated search.
 - e. The depth of null should be entirely adequate—about 60-70 dB—with the automatically selected values. However, you can optionally adjust GAIN or PHASE manually to slightly deepen the null. To do this, tap PRE or ATTN to select GAIN or PHASE, respectively, then adjust VFO A.
 - f. Staying in the RXSBNL* menu entry, tap BAND+ to move to the next higher band. The band edge will be briefly flashed. Repeat steps (c) through (e) on this band.
 - g. Repeat step (f) on each band up through 6 meters (50 MHz).
6. **If you are not planning to do the I.F. image nulling procedure (page 5),** restore your power level, CW sidetone pitch, and ATU mode (ATU MD menu entry).
7. **Do a Configuration Backup** (*KX3 Utility*). This will preserve changes made during this procedure.

RX SHFT=8.0 I.F. Image (16 kHz) Nulling

This portion of the procedure was added to the KX3 with firmware release 1.36. It allows you to further improve performance in the RX SHFT=8.0 case by nulling the 16-kHz I.F. image response.

Note: Prior to doing this part of the procedure, you should have completed Per-Filter nulling (page 3) and RX SHFT=8.0 Opposite Sideband Nulling (page 4).

1. Follow the **Preparation** steps on page 2 if you have not already done so, skipping step 13 as indicated.
2. For this portion of the procedure, the KX3's VFO must be set 16 kHz higher than the signal source on each band. Switch the KX3 to each band in turn, starting with 160 meters. **With RIT turned OFF on each band**, set VFO A to these frequencies: 1826, 3526, 5326, 7026, 10126, 14026, 18126, 21026, 24926, 28026, 50026.
3. Locate the RX SHFT menu entry. Unlock the menu parameter by holding the KHZ switch for about 3 seconds. The lock icon will turn off. Set the RX SHFT parameter to 8.0.
4. Tap BAND+, moving to 80 meters (3.5 MHz), and set the RX SHFT parameter for this band to 8.0. Also set the mode to CW normal if it isn't already. Continue through 6 meters (50 MHz), tapping BAND+ each time, setting the parameter to 8.0 and the mode to CW normal. Exit the menu.
5. Locate the RXSBNL* menu entry and unlock it. **The "FL1" icon should be flashing as reminder that RX SHFT is in effect.** **Note:** If the menu entry name is RXSBNUL, you may not have done the **Per-Filter** nulling procedure, which should be completed first.
6. Within the RXSBNL menu entry, tap SPOT to switch from AF sideband nulling (LCD shows **Gain/Phase**) to I.F. nulling (LCD shows **G-IF/P-IF**).
7. Optimize RX SHFT=8.0 I.F. image gain and phase settings as follows:
 - a. Set both the signal source and KX3 to the target band (starting with 160 m). Recall that the VFO should be set 16 kHz higher than the signal source. Make sure you're in CW mode. (**Note:** You can change bands and modes from within the RXSBNUL menu entry.) You should hear a strong signal, and see an S-meter reading of between S9 and S9+30 dB. If not, adjust the preamp setting or the RF source level.
 - b. Turn on RIT if it isn't already on, and make sure the offset is set to -1.10 kHz; you'll now hear the *I.F. image* signal, which should be considerably weaker.
 - c. Make sure the passband is NORMAlized ("wings" showing at the ends of the DSP graphic).
 - d. Tap the APF switch to automatically find the ideal G-IF and P-IF settings. This takes about 10-15 seconds. VFO A will show both gain (G) and phase (P) values during the automated search.
 - e. The depth of null should be entirely adequate—about 60-70 dB—with the automatically selected values. However, you can optionally adjust G-IF or P-IF manually to slightly deepen the null. To do this, tap PRE or ATTN to select GAIN or PHASE, respectively, then adjust VFO A.
 - f. Staying in the RXSBNL* menu entry, tap BAND+ to move to the next higher band. The band edge will be briefly flashed. Repeat steps (c) through (e) on this band.
 - g. Repeat step (f) on each band up through 6 meters (50 MHz).
8. Restore your power level, CW sidetone pitch, and ATU mode (ATU MD menu entry).
9. **Do a Configuration Backup (KX3 Utility).** This will preserve changes made during this procedure.