Sherwood Engineering HF Test Results

Model KX3 Serial # 0495 & 0121 Test Dates: 7/28/2012 & 05/24/2013

IF BW 2.5 –6 / -60 kHz	2.51/2.72 kHz	Ultimate	<110	dB
IF BW 500 –6 /-60 Hz	480 / 720 Hz	Ultimate	<130	dB

Dynamic Range with radio, no Preamp

Dynamic Range 20 kHz	105	dB	IP3	dBm
Dynamic Range 5 kHz	104	dB	IP3	dBm
Dynamic Range 2 kHz	104	dB	IP3	dBm

Dynamic Range 1 kHz was limited by opposite sideband rejection to about 60 dB
Note: The readings were NOT phase noise limited

Dynamic Range with radio, 20 dB Preamp

Dynamic Range 20 kHz	97	dB	IP3	dBm
Dynamic Range 5 kHz	97	dB	IP3	dBm
Dynamic Range 2 kHz	97	dB	IP3	dBm

Dynamic Range with radio, without optional receive filter

Dynamic Range 20 kHz	104	dB	IP3	dBm
Dynamic Range 5 kHz	96	dB	IP3	dBm
Dynamic Range 2 kHz	96	dB	IP3	dBm

Blocking above noise floor, 1uV signal @ 100 kHz, AGC On, 500 Hz BW 138* dB
* Blocking was noise limited. Noise went UP 3 dB at specified level.

Phase noise (normalized) at 2.5 kHz spacing:	No measured	dBc
Phase noise (normalized) at 5 kHz spacing:	-142	dBc
Phase noise (normalized) at 10 kHz spacing:	-144	dBc
Phase noise (normalized) at 20 kHz spacing:	-145	dBc
Phase noise (normalized) at 40 kHz spacing:	-146	dBc
Phase noise (normalized) at 80 kHz spacing:	-147	dBc
Phase noise (normalized) at 100 kHz spacing:	-147	dBc
Phase noise (normalized) at 200 kHz spacing:	-147	dBc
Phase noise (normalized) at 300 kHz spacing:	-148	dBc
Phase noise (normalized) at 400 kHz spacing:	-149	dBc
Phase noise (normalized) at 500 kHz spacing:	-149	dBc

S/N 0495

Noise floor, SSB bandwidth 14 MHz, no Preamp:	-117	dBm
Noise floor, SSB bandwidth 14 MHz, Preamp 20 dB preamp On:	-131	dBm

Sensitivity SSB at 14 MHz, no preamp	0.9	uV
Sensitivity SSB at 14 MHz, Preamp 20 dB Preamp On	0.09	uV

S/N 0495

Noise floor, 500 Hz, 14.2 MHz, no preamp	-123	dBm
Noise floor, 500 Hz, 14.2 MHz, 10 dB Preamp On	-127	dBm
Noise floor, 500 Hz, 14.2 MHz, 20 dB Preamp On	-138	dBm
Noise floor, 500 Hz, 14.2 MHz, 30 dB Preamp On	-141	dBm

S/N 0121

Noise floor, 500 Hz, 14.2 MHz, no preamp	-120	dBm
Noise floor, 500 Hz, 14.2 MHz, 10 dB Preamp On	-125	dBm
Noise floor, 500 Hz, 14.2 MHz, 20 dB Preamp On	-136	dBm
Noise floor, 500 Hz, 14.2 MHz, 30 dB Preamp On	-138	dBm

S/N 0121

Noise floor, SSB, 50.125 MHz, no preamp	-112	dBm
Noise floor, SSB, 50.125 MHz, 10 dB Preamp On	-117	dBm
Noise floor, SSB, 50.125 MHz, 20 dB Preamp On	-126	dBm
Noise floor, SSB, 50.125 MHz, 30 dB Preamp On	-128	dBm

S/N 0121

Sensitivity, SSB, 50.125 MHz, no preamp	1.8	uV
Sensitivity, SSB, 50.125 MHz, 10 dB Preamp On	1.0	uV
Sensitivity, SSB, 50.125 MHz, 20 dB Preamp On	0.31	uV
Sensitivity, SSB, 50.125 MHz, 30 dB Preamp On	0.26	uV

S/N 0121

Noise floor, 500 Hz, 50.125 MHz, no preamp	-116	dBm
Noise floor, 500 Hz, 50.125 MHz, 10 dB Preamp On	-123	dBm
Noise floor, 500 Hz, 50.125 MHz, 20 dB Preamp On	-133	dBm
Noise floor, 500 Hz, 50.125 MHz, 30 dB Preamp On	-137	dBm

S/N 0495

Signal for S9, no preamp	208	uV
Signal for S9, 10 dB Preamp	76	uV
Signal for S9, 20 dB Preamp	24	uV

Gain of preamp(s)

Preamp 1	10	dB
Preamp 2	20	dB
Preamp 3	30	dB

S/N 0495

AGC threshold at 3 dB, no Preamp (Threshold = 5)	12	uV
AGC threshold at 3 dB, 10 dB Preamp On (Threshold = 5)	4.4	uV
AGC threshold at 3 dB, 20 dB Preamp On (Threshold = 5)	1.3	uV

S/N 0495
AGC threshold, no Preamp with different Threshold settings:

Threshold = 4	6.7	uV
Threshold = 5	12	uV
Threshold = 6	21	uV
Threshold = 7	32	uV
Threshold = 8	68	uV

Notes:

Two different KX3s were tested. No 6 meter measurements were made on S/N 0495. Due to sample variation, 20 meter measurements for noise floor and sensitivity were also made on S/N 0121 for comparison. If no S/N is noted, the measurement was for 0495.

Enabling Receiver isolation amp degrades the noise floor on SSB by 3 dB. This also increases the current draw by 10 mA.

Enabling the Attenuator also increases the current draw by 10 mA. Both the preamp and the attenuator dramatically reduce the LO leakage out the antenna jack. This may be required to pass certain German or European receiver radiation tests.

Two receivers were tested, one with S/N 0121 and the newer one 0495. Measurement differences were approximately +/- 2 dB. Also many of the measurements were duplicated at Long Engineering by N0QO using the same HP test equipment.

Test equipment consisted of the following at each lab:
2 HP 8642A synthesized very low phase noise signal generators
1 HP 8662A low phase noise synthesized signal generator
2 HP 3586C level meters
2 HP 3400A RMS analog volt meters

Due to the low level headphone output level, an external audio amplifier was used to drive the Icom SP-20 speaker. This speaker has an output that is used to feed the RMS meter. No measurements were made using the ARRL 3-Hz blocking or dynamic range measurement method. Dynamic range measurements were NOT phase noise limited, thus it would make no difference whether the 3-Hz spectrum analyze was used. For blocking, that number is so high as to be a moot point whether the RMS meter or a spectrum analyzer with a 3 Hz filter was used.

Radio 0495 tested with firmware 1.06 and DSP 0.92

In late December the 0495 KX3 was updated to firmware version 1.30 and DSP 1.02. The opposite sideband null was adjusted, and exceeded 70 dB at the specified offset of 1.06 kHz. However the null width is narrow, and there was significant fly back to around 60 dB until the low pass filter took over.

The KX3 was used on December 30, 2012 during the Stew Perry W1BB CW contest on 160 meters. 12 watts output drove an Alpha 89 to about 300 watts output. The entire contest was run in the high power classification rather than backing things off to 100 watts. At no time was a lack of performance noted with the radio. It was operated in 0 IF mode with the low-pass roofing filter enabled.

Elecraft continues to excel in their ability to make the radio immune to single impulse noises, such as click, tick and pops. Virtually all other OEMs at this point have ignored this problem. All current Yaesu and Icom and most Ten-Tec radios have their AGCs captured by a single pulse, often driving the S meter to levels approaching S9. Classic analog radios are also immune to this problem, as their AGC don't charge up with a single pulse. Typical sources of impulse noise are electric fences, light switch opens or closures, rotor breaks opening or closing, ignition noise, and impulse noise skipping in with desired signals.

With the K3 and the KX3 one can turn pulse suppression off in the menu, which is a clear way to show how effective it is. With a lab generator providing a standard pulse, and the KX3 10 dB preamp ON, the AGC / S meter does not respond to a 1 PPS (pulse per second) signal. With pulse suppression OFF, the S meter reads S7.

My standard test is a 0.5 V. P-P signal (terminate into 50 ohms) with a pulse duration of around 300 nsec, and a rise time of 6 nsec. The pulse duration is not critical, but the fast rise time is necessary to propagate pulses throughout the HF spectrum.

There were two issues noted during the W1BB contest. My 28 ohm Sony ear phones needed more audio voltage drive than the KX3 could put out, so I used a pair of computer amplified speakers with the phones plugged into the ear phone jack. This allowed a good margin of gain without having to run the volume wide open and still be inadequate.

Surprisingly the QSK operation of the KX3 was not in the league of the K3. Much clicking was noted in full QSK mode. It did not matter whether I was driving the Alpha 89 linear or not. Having run a K3 in similar 160 meter CW contests in the past, I was not expecting inferior QSK operation.

AM Detection in Zero IF Elecraft KX3 vs. 8 kHz Offset

My first test was to check the effect of medium-wave standard AM broadcast signals with my 160 meter Marconi T antenna at my QTH 35 miles east of Ft. Collins Colorado. I had run the KX3 in the Stew Perry W1BB 160 meter CW contest December 30, 2012. It is likely I ran the ICE 402X high-pass filter during that contest to eliminate BC intermod on 160 meters. With the 10 dB preamp ON, (the preamp gain I use during the day during the contest), the worst case in-band 160 meter IMD is on 1820 kHz at my QTH. The intermod level is S4 without the ICE filter, while there is zero BC IMD with the ICE filter in the circuit. Except for the intermod on some multiples of 10 kHz, there was no observed AM detection without the high-pass filter when running in zero IF mode, the mode I use during the W1BB contest. AM detection generally does not tune. The signal levels from the broadcast band as measured with an HP 3585A spectrum analyzer are as strong as -10 dBm, the worst being on 760 kHz in Boulder, 50 miles away.

To test for AM detection with a signal generator, I used an HP 8642A generator set for 80% modulation at 1 kHz on 14.2 MHz. The harmonic distortion at 80% was better than 1% (lower than HP spec) for the second harmonic at -42 dB. The third modulation harmonic was about -50 dB, and fourth harmonic was down about 60 dB. The point is the HP isn't generating a lot of modulation products beyond the test frequency of 14.2 MHz.

The level fed into the KX3 was -33 dBm, which is S9 +40 dB on a properly calibrated receiver. On the KX3 S meter, with 10 dB preamp ON, the S meter read about S9 +35 dB. AM detection at -33 dBm was not noticed. There are spurious responses noted on the KX3, which with a test signal on 14.2 MHz are observed at 14.270 MHz and 14.290 MHz, modulated or not.

Listening for the AM detection, the radio was tuned from 14.225 MHz to 14.350 MHz. Offset from the 14.2 MHz test signal did not make any significant difference.   At -33 dBm there is no noticeable AM detection. At -23 dBm AM detection noticeable, and at -13 dBm there is lots of AM detection.   What is heard is the 1 kHz tone from the modulation envelope of the signal generator.

When switching to the alternate 8-kHz IF mode, the improvement was about 20 dB. Little AM detection occurs at -13 dBm, but at -3 dBm the AM detection is quite severe. If the test signal from the generator is unmodulated, a -3 dBm signal only produces some rise in background noise.

It is understandable that stations in Europe are bothered by AM detection with the KX3. Shortwave broadcasters run multi-megawatt transmitters, as 40 meter operators are well aware.

(AM detection information added May 27, 2013)

Rob, NC0B

Rev E