Sherwood Engineering HF Test Results

Model Flex 6700			Test Date: 09/29/2014		
Serial# 2213-2088-6700-8347					
IF BW 6000 -6 / -60 Hz	6000/6200		Ultimate	115	dB
IF BW 2400 –6 / -60, Hz	2400/2500		Ultimate	115	dB
IF BW 500 –6 /-60, Hz	500/650		Ultimate	115	dB
Front End Selectivity (A – F)			Bandpass		B
First & second IF rejection +/- kHz			Does not apply		dB

Dynamic Range with radio, no preamp

Dynamic Range 20 kHz	99	dB	IP3^	dBm
Dynamic Range 5 kHz	99	dB	IP3^	dBm
Dynamic Range 2 kHz	99	dB	IP3^	dBm

Combination of phase noise and 3rd order product
* Consisted of phase noise only
^ Does not apply to direct sampling radios.

Dynamic Range with radio, Preamp 20 dB

Dynamic Range 20 kHz	108	dB	IP3^	dBm
Dynamic Range 5 kHz	108	dB	IP3^	dBm
Dynamic Range 2 kHz	108	dB	IP3^	dBm

Combination of phase noise and 3rd order product
* Consisted of phase noise only
^ Does not apply to direct sampling radios

Blocking above noise floor, 1uV signal @ 100 kHz, AGC On, 130 dB
Blocking is actually ADC overload.

Phase noise (normalized) at 2.5 kHz spacing:	143	dBc
Phase noise (normalized) at 5 kHz spacing:	143	dBc
Phase noise (normalized) at 10 kHz spacing:	145	dBc
Phase noise (normalized) at 20 kHz spacing:	148	dBc
Phase noise (normalized) at 30 kHz spacing:	152	dBc
Phase noise (normalized) at 40 kHz spacing:	153	dBc
Phase noise (normalized) at 50 kHz spacing:	155	dBc
Phase noise (normalized) at 80 kHz spacing:		dBc
Phase noise (normalized) at 100 kHz spacing:		dBc
Phase noise (normalized) at 200 kHz spacing:		dBc
Phase noise (normalized) at 300 kHz spacing:		dBc
Phase noise (normalized) at 400 kHz spacing:		dBc
Phase noise (normalized) at 500 kHz spacing:		dBc

NOTE: Phase noise measured on 10 MHz using a 8662A crystal oscillator timebase.

Noise floor, SSB bandwidth 14 MHz, no preamp	-111	dBm
Noise floor, SSB bandwidth 14 MHz, Preamp 1 On	-118	dBm
Noise floor, SSB bandwidth 14 MHz, Preamp 2 On	-128	dBm
Sensitivity SSB at 14 MHz, no preamp	2.0	uV
Sensitivity SSB at 14 MHz, Preamp 1 On	0.8	uV
Sensitivity SSB at 14 MHz, Preamp 2 On	0.25	uV
Noise floor, 500 Hz, 14.2 MHz, no preamp	-118	dBm
Noise floor, 500 Hz, 14.2 MHz, Preamp 1 On	-126	dBm
Noise floor, 500 Hz, 14.2 MHz, Preamp 2 On	-135	dBm
Noise floor, SSB, 50.125 MHz, no preamp		dBm
Noise floor, SSB, 50.125 MHz, Preamp 1		dBm
Noise floor, SSB, 50.125 MHz, Preamp 2		dBm
Sensitivity, SSB, 50.125 MHz, no preamp		uV
Sensitivity, SSB, 50.125 MHz, Preamp 1		uV
Sensitivity, SSB, 50.125 MHz, Preamp 2		uV
Noise floor, 500 Hz, 50.125 MHz, no preamp		dBm
Noise floor, 500 Hz, 50.125 MHz, Preamp 1 On		dBm
Noise floor, 500 Hz, 50.125 MHz, Preamp 2 On		dBm
Signal for S9, no preamp	50	uV
Signal for S9, Preamp 1	50	uV
Signal for S9, Preamp 2	50	uV
Gain of preamp(s)		
Preamp 1	10	dB
Preamp 2	20	dB
AGC threshold at 3 dB, no preamp	Any value can be set with AGC-T	uV
AGC threshold at 3 dB, Preamp 1 On		uV
AGC threshold at 3 dB, Preamp 2 On		uV

Notes:

This 6700 was updated by Flex with the change in the 1-volt power supply and the cooling improvement for the FPGA.

CQWW 160 meter CW contest in January 2014 was operated exclusively with a 6700 for over 16 hour of on-air time. A Flex Control was used for tuning, and logging was done with N1MM. Two computers were used since at that time the “return focus” feature had not been implemented in software for N1MM.

The 6700 drove an Alpha 89 with PIN diode T/R switching for QSK.

Most of the contest was run with a bandwidth filter setting between 200 and 150 Hz, using S&P mode, and with a typical bandscope span of 20 kHz. With this span, the bandscope resolution was on the order of 15 Hz. This made it possible to see signals that were too weak to copy. If a signal was approximately 5 dB above band noise, there was no point in trying to copy the signal. If the signal was approximately 10 dB above band noise, I could work the station. Working stations this weak generally applied to operation after sunrise or before sunset.

Receive audio was very clean with low fatigue. An external 8-watt amplifier was used to drive an Icom SP-20 speaker, with phones plugged into the headphone jack of the speaker.

The AGC-T (AGC threshold) was carefully set, depending on time of day, so band noise was about 6 dB below the threshold. This kept band noise from being as loud as a weak signal.

No preamp was used on 160 meters, and the strongest signals observed were around S9 +40 dB. Since A/D overload is in excess of combined signals with a PEP level of S9 +70 dB, the radio was never stressed.

I plan to run the 6700 again during the 2014/2015 160 meter CW contest season using a single Windows 7 PC, now that focus will no longer be an issue with N1MM.

The user should note that even though the dynamic range values (DR3) are higher with the preamp set to 20 dB, this should not be taken to imply that is how the radio should generally be run. Assuming one’s transmit antenna is being used for reception, and not a Beverage or similar negative gain antenna, the need for a preamp would generally only come into play on 17 meters and above at a quiet rural location.

Tests with three tones were done to see if external dither affected measurements of third-order dynamic range. A third signal of equal strength to the two normal test signals at random spacing did reduce the third-order product a few dB, but it added at least four additional distortion products equal to or greater than the original third-order products.

Thus I see no benefit in making measurements with a third tone. No attempt was made to do a four-tone dynamic-range test.

Note: With a three tone test, and the 20-dB preamp ON, the receiver was in modest overload at the -20 dBm level. (All three tones -20 dBm) Distortion products were all over the band at a level of -92 dBm +/- 3 dB. This level of distortion is significantly above band on 20 meters (around -110 dBm) (ITU / ARRL band noise data)

So while the nominal dynamic range of the radio is modestly higher with the 20 dB preamp enabled, I only recommend using the preamp when needed for weak signal reception on the higher HF bands. Generally the preamp would not be necessary on 20 meters since receiver noise is 8 dB lower than typical band noise. As one progresses to higher HF bands, the usefulness of the preamp will increase in quiet locations. Using the preamp on 40 meters would be totally ridiculous, considering the signal level of broadcast station above 7200 kHz.

Added comments from 2016/2017.

With the unusual increase in dynamic range with the preamp ON, vs. OFF, as measured by both Sherwood and the ARRL in 2014/2015, another sample was tested belonging to another ham in 2016. Additionally, a Flex 6500 was tested by the ARRL in February 2017. Neither the later production sample 6700 I tested, nor the 6500 tested by the League, showed this increase in dynamic range vs. preamp setting.

The only significance is the fact that the second 6700 sample on my website places lower than the first sample. Since any 6700 has excellent dynamic range, this is really a “numbers game” or “bragging rights” issue.

It was interesting that when using the IFSS (interference free signal strength) test method, the second 6700 (with 20 dB preamp ON) when tested on 10 meters, was edged out by a K3S with its preamp OFF. On the other hand, if the radios gains were setup for 40 meters, (no preamp Flex, 15 dB pad Elecraft), the 6700 edged out the K3S.

It has also been brought to my attention that Flex inserts a strong dither signal into its 6000 series radios to linearize the ADC. This may be why testing with a third test tone, (as done by the League), doesn’t make a significant difference on Flex products. On the other hand, an Apache ANAN-200D did show a significant improvement with a third test tone in my laboratory.

Because direct-sampling SDR (DS-SDR) radios have distortion products very different from analog radios, it is less precise to compare the dynamic range values between legacy radios and DS-SDR radios.

Rev E