Sherwood Engineering HF Test Results

Sample #1
Model IC-R8600 Serial # 02001177 Test Date: 11/02, 09 & 18 / 2017

Sample #2
Model IC-R8600 Serial # 04001188 Test Date: 11/15/2017

Note: Data is from sample #1 unless noted as sample #2

IF BW 2400 –6 / -60, Hz / Ultimate dB
IF BW 500 –6 /-60, Hz / Ultimate dB

Front End Selectivity (A – F)
First IF rejection +/- kHz dB

Sample #1	Lab #2		Lab #1	
Dynamic Range, 20m, Preamp OFF, IP+ OFF				
Dynamic Range 20 kHz	88	dB	88	dB
Dynamic Range 10 kHz	88	dB	88	dB
Dynamic Range 5 kHz	88	dB	88	dB
Dynamic Range 2 kHz	88	dB	88	dB
Dynamic Range, 20m, Preamp OFF, IP+ ON				
Dynamic Range 20 kHz	109	dB	109	dB
Dynamic Range 10 kHz	108	dB	109	dB
Dynamic Range 5 kHz	108	dB	108	dB
Dynamic Range 2 kHz	105	dB	107	dB
Sample #2				
Dynamic Range of radio, Preamp OFF, IP+ OFF				
Dynamic Range 20 kHz			78	dB
Dynamic Range 10 kHz			78	dB
Dynamic Range 5 kHz			78	dB
Dynamic Range 2 kHz			78	dB
Dynamic Range of radio, Preamp OFF, IP+ ON				
Dynamic Range 20 kHz			98	dB
Dynamic Range 10 kHz			97.5	dB
Dynamic Range 5 kHz			97.5	dB
Dynamic Range 2 kHz			97.5	dB

Blocking above noise floor, 1uV signal @ 100 kHz, AGC On, Blocking occurs at -7 dBm when OVF lights.		-7	dBm
Phase noise performance, 20m	RMDR	dBc/Hz	
Phase noise (normalized) at 2.5 kHz spacing:	111 dB	138	dBc
Phase noise (normalized) at 5 kHz spacing:	114 dB	141	dBc
Phase noise (normalized) at 10 kHz spacing:	117 dB	144	dBc
Phase noise (normalized) at 20 kHz spacing:	119 dB	146	dBc
Phase noise (normalized) at 30 kHz spacing:	120 dB	147	dBc
Phase noise (normalized) at 40 kHz spacing:	120 dB	147	dBc
Phase noise (normalized) at 50 kHz spacing:	121 dB	148	dBc
Phase noise (normalized) at 80 kHz spacing:	122 dB	149	dBc
Phase noise (normalized) at 100 kHz spacing:	OVF	OVF	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

Noise floor, SSB bandwidth 14 MHz, Preamp OFF, IP+ OFF	-124	dBm
Noise floor, SSB bandwidth 14 MHz, Preamp ON, IP+ OFF	-135	dBm
Noise floor, SSB bandwidth 14 MHz, Preamp OFF, IP+ ON	-123	dBm
Sensitivity SSB at 14 MHz, Preamp OFF, IP+ OFF	0.40	uV
Sensitivity SSB at 14 MHz, Preamp ON, IP+ OFF	0.12	uV
Sensitivity SSB at 14 MHz, Preamp OFF, IP+ ON	0.49	uV
Sample #1		
Noise floor, 500 Hz, 14.2 MHz, Preamp OFF, IP+ OFF	-131	dBm
Noise floor, 500 Hz, 14.2 MHz, Preamp ON, IP+ OFF	-142	dBm
Noise floor, 500 Hz, 14.2 MHz, Preamp OFF, IP+ ON	-130	dBm
Sample #2		
Noise floor, 500 Hz, 14.2 MHz, Preamp OFF, IP+ OFF	-132	dBm
Noise floor, 500 Hz, 14.2 MHz, Preamp ON, IP+ OFF	-142	dBm
Noise floor, 500 Hz, 14.2 MHz, Preamp OFF, IP+ ON	-130.5	dBm

VHF and UHF measurements sample #1, sample #2 when noted:	#1	#2	Value
Noise floor, 500 Hz, 144.2 MHz, Preamp OFF, IP+ ON	-130	-131	dBm
Noise floor, 500 Hz, 144.2 MHz, Preamp ON, IP+ ON	-139	-139	dBm
Noise floor, 500 Hz, 440 MHz, Preamp OFF, IP+ ON	-128	-129	dBm
Noise floor, 500 Hz, 440 MHz, Preamp ON, IP+ ON	-138	-139	dBm
Noise floor, 500 Hz, 1049.9 MHz, Preamp OFF, IP+ ON	-126	-128	dBm
Noise floor, 500 Hz, 1279.9 MHz, Preamp OFF, IP+ ON	-130	-131	dBm
Noise floor, 500 Hz, 1279.9 MHz, Preamp ON, IP+ ON	-140	-138	dBm

Signal for S9, Preamp OFF	-72	dBm	53	uV
Signal for S9, Preamp ON	-83	dBm	15	uV

S9 and below, 1 S unit = 3.5 dB

Signal in dBm instead of S units
Absolute accuracy within 1 dB. Linearity within 1 dB
Range: -120 dBm to 0 dBm preamp OFF, -130 dBm to 0 dB preamp ON

Gain of preamp:	10	dB
AGC threshold at 3 dB, Preamp OFF	2.4	uV
AGC threshold at 3 dB, Preamp ON	0.67	uV

RMDR in dB on VHF and UHF bands

Sample #	#1	#2	#1	#2	#1	#1
kHz offset	2m	2m	70cm	70cm	28cm	23cm
2.5	84	86	82	83	84	77
5	86	88	84	85	86	80
10	88	89	86	86	86	82
20	88	89	86	86	86	83
50	88	89	86	86	86	83
100	90	91	88	88	88	84

Dynamic Range in dB VHF and UHF, third-order DR3. (* = phase noise limited)

kHz offset	2m	70cm	28 cm	23cm
20	85	81*	82*	79*
10	84*	81*	82*	79*
5	84*	81*	82*	78*
2	82*	78*	78*	74*

Note: 20 kHz DR3 measured at 19 kHz due to spurious at 20 kHz spacing when driven hard enough to overcome reciprocal mixing noise.

General comments:

The R8600 is very easy to use, having an interface similar to the IC-7300. Frequency entry is quickly entered by touching a MHz digit, using the touch screen, digits and decimal point if desired, plus enter.

VHF/UHF dynamic range (DR3) and reciprocal mixing (RMDR) wide-spaced performance is similar to the IC-9100. Close-in, however, the performance is significantly better. HF performance 10 kHz – 30 MHz is state-of-the-art.

VHF/UHF Dynamic range is dominated by RMDR limitations. While the synthesized conversion local oscillators (LOs) are cleaner close-in than past HF to UHF radios, the dramatic improvement observed at HF through 6m is not yet available at VHF and UHF.

Looking forward in respect to the IC-9700 concept radio shown in Japan recently, the question would appear to be whether the 9700 will be general coverage or ham band only. If ham band only, it is conceivable that cleaner fixed-frequency conversion oscillators could mix down to HF direct sampling frequencies and provide an additional 10 to 20-dB improvement.

Comments on sample #2, and other published data

Measurements by Adam Farson, VA7OJ and the ARRL were lower than sample #1.
Mike Frye, KM6AB, was kind enough to supply sample #2 on a loaner basis.
Sample #1 has been retested to confirm the 20 meter data. See a few paragraphs below.

Dynamic range had very minimal variation with signal spacing, as is normal with a direct-sampling radio. The following table lists the current data sets at 20 kHz spacing in a 20 kHz bandwidth

Data Set	DR3 IP+ OFF	DR3 IP+ ON	
Sherwood sample #1	88 dB	109 dB	
Sherwood sample #2	78 dB	98 dB	
Farson	71 dB*	95 dB*	
ARRL	60 dB	103 dB	
Sherwood IC-7300	81 dB	103 dB	(For comparison)

* (Date was at 2 kHz spacing)

The data scatter on the direct-sampling frequencies (10 kHz to 30 MHz) is more than we have observed in the past on different samples of the IC-7300. A full dynamic-range test on 20 meters, with and without IP+, was run again on sample #1 at my second lab, noted as lab #2 in the report above.

The equipment is identical, except a 2-port hybrid combiner was used instead of a 4-port combiner.

The HP generators are the same low phase noise 8642A model. The Mini-Circuits buffer amps, in-line pads and 15-MHz low-pass filters are also the same. The performance run at lab #2 on sample #1 is virtually identical to data taken at lab #1.

At this point, the only conclusion I can make is there are minor variations in production samples of the ADC used in the receiver.

I do not consider this a significant problem. With IP+ ON, we are splitting hairs in respect to a 100 dB dynamic-range radio. IP+ in the R8600 only degrades receiver noise floor between 1 and 1.5 dB. Early IC-7300s demonstrates noise-floor degradation in the range of 11 to 13 dB with IP+ ON. A year later IP+ only degraded noise floor 1 dB.

Considering the price of its predecessors, the R9000 or R9500, the R8600 has many improved features at a fraction of the cost of the earlier units. In addition, the receiver is quite small, and runs cool. The spectrum scope, while small, has greatly improved resolution compared to legacy Icom radios.

Since the R8600 runs on an external 13.8 volt supply, the receiver could be easily operated in a mobile or portable environment. Neither of the Icom power supplies were initially tested, as both R8600 samples were run off of commercial HP or Astron linear regulated power supplies.

Later in normal use, my R8600 is powered by the Icom power supply that looks like a laptop charger. Since my antennas are far from the shack, I don’t notice an RFI from the switching power supply.

Combined Rev E