# 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.

From a performance standpoint, dynamic range (DR3) or reciprocal mixing (RMDR), wide-spaced performance is similar to the IC-9100. Close-in, however, the performance is significantly better.

Dynamic range, unfortunately, is dominated by RMDR performance. While the synthesized conversion local oscillators (LOs) are cleaner close-in than past HF to UHF radios, the dramatic improvement observed at HF 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 as 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 8642A generators are the same model, the Mini-Circuits buffer amps and in-line pads and 15 MHz low-pass filters are 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 variations in the ADC used in the receiver.

I do not consider this a significant issue. 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. On the other hand, the IC-7300 demonstrates a noise-floor degradation in the range of 11 to 13 dB with IP+ ON.

Considering the price of its predecessors, The R9000 or the 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 be operated in a mobile or portable environment. Neither of the Icom power supplies were tested, as both units were run off of commercial linear regulated power supplies.

Combined Rev C