Sherwood Engineering VHF/UHF Test Results

Model IC-9700 Serial # 12001078 Starting test Date: 04/10/2019

Firmware: 1.05 and later 1.06

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

Dynamic Range of radio, no preamp	2m	70cm	23cm	
Dynamic Range 20 kHz	74	75	75^	dB
Dynamic Range 10 kHz	74	75		dB
Dynamic Range 5 kHz	74	75		dB
Dynamic Range 2 kHz	74	75		dB
Dynamic Range of radio, Preamp ON				
Dynamic Range 20 kHz	71	76		dB
Dynamic Range 10 kHz	71	76		dB
Dynamic Range 5 kHz	71	76		dB
Dynamic Range 2 kHz	71	76		dB
Dynamic Range of radio, preamp ON, IP+ ON				
Dynamic Range 20 kHz, 2 meters			75*	dB

* IP+ has an inconsistent and minimal impact on third-order IMD.
^ Dynamic range phase noise limited on 23cm @ 20 kHz. See Notes

2 meter blocking above noise floor, 1uV signal @ 100 kHz, AGC ON, 111 dB
The blocking signal was registering on the S meter at this point.
This measurement was running into RMDR limits.

Note:
Approximate S meter reading on 70cm for the dynamic range measurements:
Preamp OFF: S9+30 dB
Preamp ON: S9+40 dB

Approximate S meter reading on 23cm for the phase-noise limited dynamic range measurement:
Preamp OFF: S9+28 dB

2 Meter reciprocal Mixing Dynamic Range (RMDR), Preamp OFF
Spacing kHz

2.5	95	dB
5	100	dB
10	103	dB
20	106	dB
30	108	dB
40	109	dB
50	111	dB
100	114	dB
200	116	dB
300	116	dB
400	114	dB
500	111	dB

Phase noise (normalized) at 2.5 kHz spacing:	122	dBc/Hz
Phase noise (normalized) at 5 kHz spacing:	127	dBc/Hz
Phase noise (normalized) at 10 kHz spacing:	130	dBc/Hz
Phase noise (normalized) at 20 kHz spacing:	133	dBc/Hz
Phase noise (normalized) at 30 kHz spacing:	135	dBc/Hz
Phase noise (normalized) at 40 kHz spacing:	136	dBc/Hz
Phase noise (normalized) at 50 kHz spacing:	138	dBc/Hz
Phase noise (normalized) at 100 kHz spacing:	141	dBc/Hz
Phase noise (normalized) at 200 kHz spacing:	143	dBc/Hz
Phase noise (normalized) at 300 kHz spacing:	143	dBc/Hz
Phase noise (normalized) at 400 kHz spacing:	141	dBc/Hz
Phase noise (normalized) at 500 kHz spacing:	138	dBc/Hz

Noise floor, 2.4 kHz, 144.2 MHz, no preamp	-126	dBm
Noise floor, 2.4 kHz, 144.2 MHz, no preamp, IP+	-125	dBm
Noise floor, 2.4 kHz, 144.2 MHz, Preamp ON	-139	dBm
Noise floor, 2.4 kHz, 144.2 MHz, Preamp ON, IP+	-137	dBm

Sensitivity SSB, 144.2 MHz, no preamp	0.35	uV
Sensitivity SSB, 144.2 MHz, no preamp, IP+	0.35	uV
Sensitivity SSB, 144.2 MHz, Preamp ON	0.082	uV
Sensitivity SSB, 144.2 MHz, Preamp ON, IP+	0.10	uV

Noise floor, 500 Hz, 144.2 MHz, no preamp	-131.5	dBm
Noise floor, 500 Hz, 144.2 MHz, no preamp, IP+	-131	dBm
Noise floor, 500 Hz, 144.2 MHz, Preamp ON	-145	dBm
Noise floor, 500 Hz, 144.2 MHz, Preamp ON, IP+	-143	dBm

Noise floor, SSB, 433 MHz, no preamp	-127	dBm
Noise floor, SSB, 433 MHz, Preamp ON	-137	dBm

Sensitivity, SSB, 433 MHz, no preamp	0.3	uV
Sensitivity, SSB, 433 MHz, Preamp ON	0.1	uV

Noise floor, 500 Hz, 433 MHz, no preamp	-132	dBm
Noise floor, 500 Hz, 433 MHz, Preamp ON	-144	dBm

Noise floor, SSB, 1240 MHz, no preamp	-133	dBm
Noise floor, SSB, 1240 MHz, Preamp ON	-138	dBm

Sensitivity, SSB, 1240 MHz, no preamp	0.14	uV
Sensitivity, SSB, 1240 MHz, Preamp ON	0.09	uF

Noise floor, 500 Hz, 1240 MHz, no preamp	-138 dBm
Noise floor, 500 Hz, 1240 MHz, Preamp ON	-144 dBm

Signal for S9, no preamp, 2 meters	15	uV
Signal for S9, Preamp ON, 2meters	3.8	uV

Gain of preamp

Preamp 2m	19.2#	dB
Preamp 70cm	19.8#	dB
Preamp 23dm	9.6#	dB

Preamp gain determined by the difference in OVF indicator.

2 meter AGC threshold at 3 dB, no preamp	0.7	uV
2 meter AGC threshold at 3 dB, Preamp ON	0.18	uV

Notes:

OVF, 2m, preamp OFF	-8.3	dBm
OVF, 2m, preamp ON	-27.5	dBm
OVF, 70cm, preamp OFF	-10.8	dBm
OVF, 70cm, preamp ON	-30.6	dBm
OVF, 23cm, preamp OFF	-22.3	dBm
OVF, 23cm, preamp ON	-31.9	dBm

Noise floor & sensitivity measured with HP 8662A and HP 8642A with good correlation.

2 meter RMDR measured with HP 8642A

Spurious responses on 2m:

I have looked for the spurs, and when I find one I swap synthesizers to be sure the spur is in the radio. The architecture of the HP 8662A and 8642A are completely different, and if a spur shows up on both, then it is in the radio. I have found three types of spurs with a test signal level of -25 dBm = S9+60 dB on 144.2 MHz. Preamp OFF.
Note: The S meter just starts to flicker at -107 dBm = 1 microvolt.

Three spurs have the following characteristics: The level is just below moving the S meter, but the S meter flickers as the spur is tuned in.
144.296 MHz, 145.250 MHz & 144.104 MHz

Two spurs have the following characteristics: Weak burbling spurs that sound like a switching power supply or a voltage converter source.
144.327 MHz & 144.073 MHz

One spur has the following characteristic, weak but clean & far below S0: 144.516 MHz.

Testing with a non-even signal frequency on 144.238 MHz did not materially affect the results as to the number or level of spurs.

Frequency Stability

There are frequency stability issues with the IC-9700 that affect both CW, SSB and weak signal digital modes such as those provided by WSJT X. Frequency drift on 2 meters through 23cm has been observed causing digital decoding to be seriously degraded or impossible.

IP+ is not providing any consistent improvement in third-order dynamic range that exists with the IC-7300 and IC-7610. At some test levels IP+ makes IMD worse.

At the end of this report are IFSS (Interference Free Signal Strength) input vs. third-order distortion curves. Notice there is almost no difference between IP+ OFF vs. IP+ ON.

Drift test summary:

The cooling fan is a major source of frequency drift in the IC-9700, affecting the TCXO master clock oscillator. While a 10 MHz accurate and stable frequency source can calibrate the TCXO, this internal clock cannot be phase locked to an external standard.

When operating on SSB on 2 meters, use of RIT of 10 or 20 Hz to compensate for drift, was required, if that level of frequency tuning error is of concern. On 70cm SSB, drift on the order of 50 Hz was definitely a problem. On SSB at the maximum 10 watt power level on the 23cm band, the cooling fan does come on if the transceiver is fully warmed up. The cooling fan always spins up on 23cm on modes other than SSB.

Frequency drift for WSPR transmissions is even a problem on 2 meters, let alone the higher frequency bands. Other WSJT modes are also affected, such as JT65 and QRA64, for example.

Drift tests were also run key down in CW mode to simulate what might happen when running digital WSJT modes. The key-down drift on 70cm was of the same order of magnitude as the SSB drift test.

With firmware 1.06 it was observed that changing the power level when transmitting a carrier, the fan speed smoothly increased or decreased as the power level was increased or decreased, but with a short time lag.

433 & 1296 MHz data Column 3 is a second run, & column 4 is second run.

Start	433.000 007 MHz	1296.000 002	432.999 997	1295.999 989
0.5	433.000 020	1296.000 026	433.000 012	1296.000 006
1.0	433.000 035	1296.000 055	433.000 024	1296.000 044
1.5	433.000 050	1296.000 075	433.000 032	1296.000 062
2.0	433.000 044	1296.000 097	433.000 042	1296.000 084
2.5	433.000 019	1296.000 114	433.000 049	1296.000 107
3.0	433.000 003	1296.000 133	433.000 051	1296.000 127
3.5	432.999 998	1296.000 141	433.000 051	1296.000 142
4.0	432.999 994	1296.000 142	433.000 050	1296.000 137
4.5	432.999 993	1296.000 136	433.000 050	1296.000 123
5.0	432.999 992	1296.000 127	433.000 050	1296.000 100
5.5		1296.000 117	433.000 050	1296.000 078
6.0		1296.000 109	433.000 051	1296.000 064
6.5		1296.000 103	433.000 051	1296.000 051
7.0		1296.000 096	433.000 051	1296.000 039
7.5		1296.000 092	433.000 051	1296.000 030
8.0		1296.000 089	433.000 051	1296.000 021

The two key-down drift tests on 70cm and 23cm show a significant drift consistent with the 3:1 frequency difference. Depending on the wait time between runs, maximum frequency excursing is similar, but the end frequency at 5 or 8 minutes may differ.

Observations on 23cm

Noise floor measurements were difficult to accurately make on 23cm due to leakage from the HP 8662A synthesizer and limitations in shielding of the radio and possibly common-mode pickup by the radio. Commercial double-shielded coax with N connectors were used, along with a 30 dB Narda 150-watt attenuator. Absolute errors could be on the order of a few dB.

The receiver is phase noise limited at times on 23cm. At times the 5th order IMD was stronger than the 3rd order IMD. The 3rd order IMD could increase or decrease if the two test signals were imbalanced by a few dB.

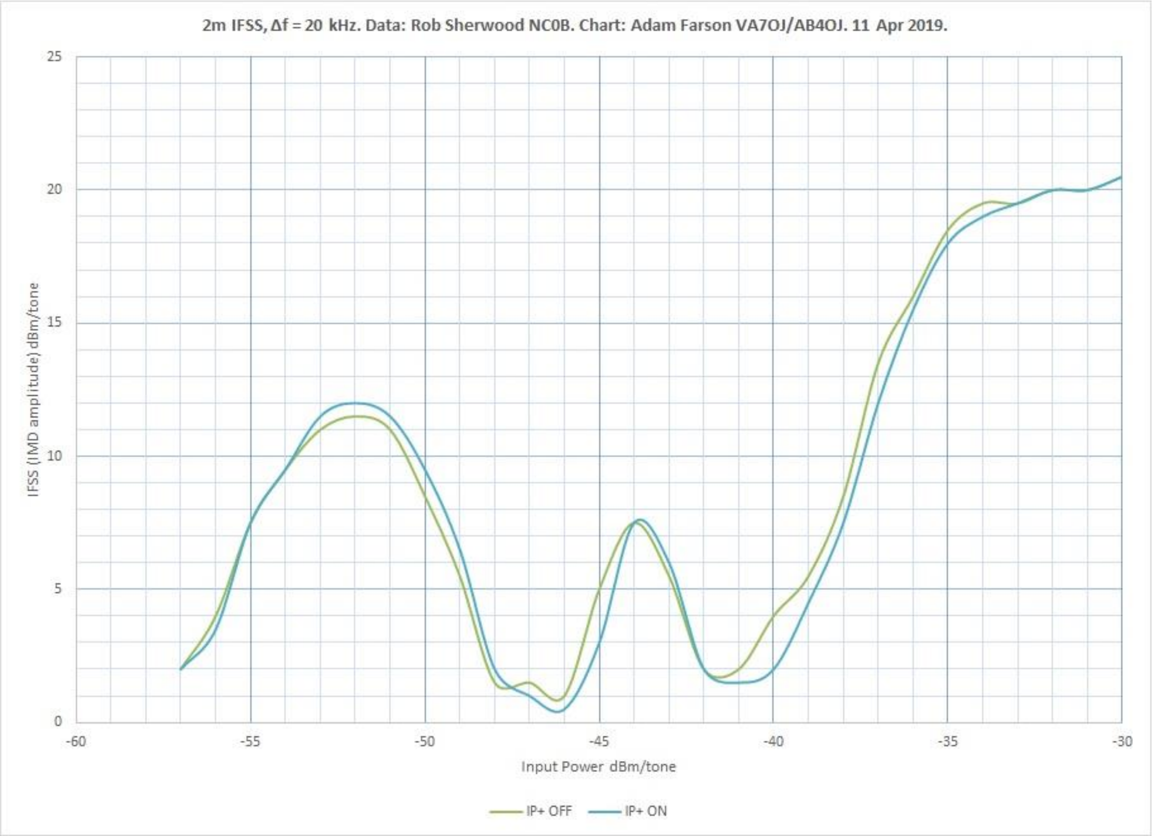
From a dynamic range standpoint, it is likely that phase noise will dominate over the intermodulation product. The level of phase noise only degrades a few dB at spacing closer than 20 kHz.

The test signals that produced the phase-noise limited measurement were on the order of -63 dBm. The S meter reading for the two test signals for at above -63 dBm level were S9+28 dB.

When measuring OVF at 100 kHz offset on 23cm, phase noise was reading upscale on the S meter as follows:

Preamp OFF, S meter read S6
Preamp ON, S meter read S4

IFSS curves



Transmit Composite Noise Icom IC-9700

144.2 MHz

Offset kHz	100 watts	30 watts
10	-121 dBc/Hz	-120 dBc/Hz
20	-122 dBc/Hz	-121 dBc/Hz
50	-125 dBc/Hz	-123 dBc/Hz
100	-129 dBc/Hz	-128 dBc/Hz

433.2 MHz

Offset kHz	75 watts	30 watts
10	-111 dBc/Hz	-112 dBc/Hz
20	-113 dBc/Hz	-113 dBc/Hz
50	-115 dBc/Hz	-116 dBc/Hz
100	-120 dBc/Hz	-120 dBc/Hz

Rev H