Sherwood Engineering HF Test Results

Model: R9500	Serial # 0601015		Test Date: 06/30/2007		
6.0 kHz IF BW -6 / -60 kHz	6.3/10.3		Ultimate 70	noise	dB
2.4 kHz IF BW -6 / -60 kHz	2.5/3.8		Ultimate 80	noise	dB
500 Hz IF BW -6 / -40 Hz	500/620		Ultimate 50	noise	dB
500 Hz IF BW -6 / -60 kHz	500/1700		Ultimate 78	noise	dB
Front End Selectivity (A – F)			½ octave		B
IF Rejection, 10 MHz @	10.7	kHz IF	>100		dB
First IF Rejection @	58.7	MHz IF	>110		dB
Dynamic Range 100 kHz	110	dB	IP3	+38	dBm
Dynamic Range 20 khz	110	dB	IP3	+38	dBm
Dynamic Range 5 kHz	100	dB	IP3	+23	dBm
Dynamic Range 2 kHz	**85**	**dB**	**IP3**	**0**	**dBm**
(All were phase noise limited)					
Blocking above noise floor at 100 kHz spacing			119		dB
Phase noise (normalized) at 10 kHz spacing:			134		dBc
Noise floor, SSB bandwidth 29 MHz			-120		dBm
Sensitivity at 29 MHz			0.7		uV
Noise floor, CW bandwidth 14 MHz			-127		dBm
Noise floor, SSB bandwidth 14 MHz			-120		dBm
Sensitivity at 14 MHz, preamp OFF			0.7		uV
Sensitivity at 14 MHz, preamp 1 ON			0.2		uV
Sensitivity at 14 MHz, preamp 2 ON			0.11		uV
Noise floor, SSB, 10 MHz			-120		dBm
Sensitivity 10 MHz			0.7		uV
Noise floor, SSB, 5 MHz			-120		dBm
Sensitivity 5 MHz			0.7		uV
Noise floor, SSB, 2 MHz			-120		dBm
Sensitivity, 2 MHz			0.7		uV
Noise floor, SSB, 1 MHz			-120		dBm
Sensitivity, 1 MHz			0.7		uV
Noise floor, SSB, 200 kHz			-120		dBm
Sensitivity, 200 kHz			0.7		uV

AGC threshold at -3 dB, preamp OFF	1.1	uV
AGC threshold at -3 dB, preamp 1 ON	0.25	uV
AGC threshold at -3 dB, preamp 2 ON	0.16	uV

Preamp 1 gain:	13.0	dB
Preamp 2 gain:	17.5	dB
Attenuators: 6/12/18/24/30		dB

Notch: Auto notch	55	dB
Manual notch 1 & 2	40 to 65	dB

Drift	1	Hz

Distortion:	SSB	AM	AM Sync
100 Hz	<0.3 %	0.5 %	0.5 %
200 Hz	<0.3 %	0.3 %	0.3 %
400 Hz	<0.3 %	0.4 %	0.4 %
1 kHz	<0.3 %	0.4 %	0.4 %
2 kHz	0.3 %	<0.3 %	0.3 %
3 kHz	0.5 %	<0.3 %	<0.3 %

Comments and Observations:

The R9500 is the companion receiver to the IC-7800 transceiver, replacing the R9000 and its companion IC-781. Both the earlier units were designed about 20 years ago. The basic design of the receiver is taken from the IC-7800, with, of course, expanded coverage to 3.3 GHz, and with wide-band FM demodulation capabilities.

The obvious changes in 20 years consist of an LCD display instead of a CRT, expanded UHF coverage from 2 GHz to 3.3 GHz, DSP IF filtering, and switchable roofing filters. In addition, there are two manual notches instead of one, and the auto-notch can handle multiple heterodynes effortlessly.

Strangely, while the earlier R9000 had flip-up feet to tilt the radio for a better viewing angle, the R9500 has no such feature. I used a VHS tape to tilt the radio for better viewing of the LCD, which while having a good viewing angle, cannot rival the 160+ degree viewing angle of the older CRT.

Some weak points observed in the IC-7800 carry over to the R9500, with the exception of insertion-loss issues with the roofing filters. The 9500 has extra gain in the roofing filter chain to maintain the total gain of the receiver, measured within 1.3 dB when switching between the 50 kHz, 15 kHz, 6 kHz or 3 kHz roofing filters. Of course a 240 kHz roofing filter is used in wide-band FM mode, non-selectable. Additionally the abysmally high AGC threshold in the 7800 of 7 uV with the 3 kHz roofing filter enabled has been

completely fixed, with an excellent value of 1.1 uV for the 9500, with the preamp OFF! Even though the gain among filters is equalized, there is a 3-dB degradation in the noise floor of the radio with the 3 kHz roofing filter, compared to the 15 kHz unit. This is expected, and unavoidable.

Flexibility is the high point of the new design, with the user able to easily program in three filter bandwidths per mode available at the touch of a button. As has been the case with Icom for decades, the user interface is top notch, with little need to dig into the manual. Unfortunately, if one has to adjust an obscure setting, finding the answer in the manual is a tedious job, with no overall index.

The dynamic range is outstanding, being 110 dB wide spaced (20 kHz) and 100 dB narrow spaced (5 kHz). Even at 2 kHz, a value of significance for CW operation only, the DR3 comes in at 84 dB. All values were limited by phase noise, not intermodulation.

Sensitivity is perfectly balanced among preamp off, preamp 1 or preamp 2 settings. Except for people with a wet noodle for an antenna, the need for preamp 2 is questionable. One would hope that anyone who can afford a $14,000 radio will also mate it with a good outdoor antenna. That being said, if in a temporary setup with a 30 foot piece of wire, the extra gain of preamp 2 might be useful.

Distortion is very low on SSB, AM and AM Sync. However, enabling the radio's sync detector results in only a subtle difference in received audio. Under heavy fading, the SYNC legend on the display occasionally blinks off, and distortion is heard. Under modest fading, some fades result in a fuzzy distortion that is somewhat different from the standard envelope detector, but not significantly better. As with the R75, the SYNC mode is a non-performer.

The 9500 has both two manual notches and an auto-notch feature. Manual nulling on SSB was measured between 40 and 65 dB. When an S9 carrier was manually nulled, the AGC opens up, placing the noise of the filter passband above the notched signal. Normally one would be listening to a signal that would control the AGC, and manually nulling the heterodyne would not affect the receiver gain. In auto-notch mode, all you have to do is push a button, and the heterodyne goes away. The radio auto-notched the "het" to the noise floor of the filter passband, or about 55 dB for an S9 test signal. As multiple "hets" were injected into the receiver, the auto-notch handled them with aplomb, with only a modest reduction in notch depth. Up to 4 "hets" were nulled in a lab environment, with the annoying tones reduced to within 10 dB of the filter passband noise floor. With multiple "hets" being notched, there was the expected "flanging" effect on the desired signal.

There are a couple areas where the R9500 takes a step backwards to the older R9000, and that involves how the radio sounds in static (QRN), and when there is impulse noise interference. Of course QRN is also an impulse noise, though different in sound to a noise from an electric livestock fence. Most radios designed in the past few years, that are highly digital, exaggerate the detrimental effects of impulse noise. An impulse that

may be virtually ignored by the AGC of a 10, 20 or even older radio, captures the AGC of most new designs. Thus an impulse can "poke a hole" in a signal until the AGC decays, a quite annoying effect when listening to weak S1 to S5 signals on a quiet band. Additionally, modest S5 QRN was noticeably more objectionable when listening to weak SSB signals on 20 meters than with the older analog R9000.

The other area where new technology has not resulted in an improvement is in the spectrum scope feature. Icom virtually invented the spectrum scope for consumer radios, with the IC-781, R9000 and the follow-on ham tranceivers in the 756 line. Under certain conditions, the value of a spectrum scope cannot be overrated when it comes to locating weak signals on a quiet band. With the R9000, a 1 uV signal is 1 division out of 6 on the scope, against a perfectly flat (noiseless) baseline, of the 60 dB on-screen display range. Assuming a quiet location on frequencies 12 MHz and above, a 1 uV signal is 100% copyable. You cannot miss a 1 uV, 1 division signal on the R9000, yet you can barely imagine seeing that same signal on the R9500 band scope due to baseline "grass" noise. (+/- 25 kHz span, R9500 set to 500 Hz resolution) Even a 0.5 uV signal is perfectly and obviously visible on the older R9000, at ½ division on the graticule. Forget weak-signal sleuthing with the R9500 band scope, as it takes a 2 uV signal at two divisions on the scope to be noticeable above the 1.5 divisions of noise "grass" on the scope.

If sleuthing weak signals with a band scope is of prime importance, the R9500 provides the requisite IF output at 10.7 MHz for an external spectrum analyzer. An HP 3585A analyzer was used in conjunction with the R9500, completely solving the lack of weak signal visibility. A 1 uV signal produces a blip on the HP that is about 12 dB above the noise floor of the spectrum analyzer. It is a shame that same level of performance is not produced by the internal spectrum display. An HP 8568B analyzer was also successfully mated with the Icom.

Whether one is searching for utility signals, or normal shortwave AM stations, a great band scope is hard to give up, once one has used one on a regular basis. An example of its value would be searching for HF commercial airline traffic flying in our northern latitudes. These signals pop on and off, and being able to see a "see" a 50 kHz swath of the aircraft bands makes locating airline chatter much easier. If one assumes signals in excess of a few microvolts, the internal display will fill the bill for most listeners.

The R9500 uses a dedicated DSP chip for the scope, while the R9000 is a classical analog swept spectrum analyzer. The skirt selectivity of the DSP filters in the R9500 is superior to the older R9000 design, but the 9500 sweep speed is slower. Additionally, phase noise in the 9500 scope limits the useful on-screen dynamic range to about 55 dB, problem that does not exist on the R9000.

The S meter on the R9500 is very flexible, being able to display as a normal S meter, the level in dBm, or two dBV scales. The dBm accuracy is supurb, making absolute measurements of signals a snap. In dBm mode, there is a "signal level" reading, plus a bar graph. If one accuates either the attenuator or the preamps, the "signal level" stays constant. The bar graph changes scale, but still shows the proper level in dBm. This

feature has rarely been seen in consumer shortwave or amateur radio gear. The level accuracy of the receiver is maintained through out its frequency range, to 1280 MHz, the limit of our HP 8662A generator. The only odd thing in "S meter" mode, the low signal levels are rather "wimpy". An 8 uV signal reads S6 on the older R9000 S meter, but barely moves the S meter to S1 on the R9500. This same anomaly exists on the companion IC-7800 transceiver.

Overall, the R9500 is likely the Cadillac of receivers, in features and ease of use. Unfortunately its performance under QRN and impulse interference is a step down from the R9000, as is the spectrum scope. Beyond that, there is little more one could ask for out of a receiver that covers DC to Light. The receiver is not so heavy at 44 pounds to be impractical to put on the back seat of your car and transport it to a vacation home.

Last revision made 7/11/2007