Kiwi-SDR Direct-Sampling Receiver Test Report

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The following tests were planned:

1. MDS (Minimum Discernible Signal)
2. RMDR (Reciprocal Mixing Dynamic Range
3. NPR (Noise Power Ratio
4. IFSS (Interference-Free Signal Strength), i.e. front-end IMD3 over a wide range of input levels

A background on the author's SDR test methodology can be found in the following presentation given at Ham Radio Friedrichshafen SDR Academy in 2016:

http://www.ab4oj.com/sdr/sdrtest2.pdf "A New Look at SDR Testing"

The following comprehensive article describes NPR testing of HF receivers:

http://www.ab4oj.com/test/docs/npr_test.pdf

The test results are presented below, with the exception of RMDR which could not be tested due to apparent blocking or overload in the ADC driver.

Table 1: KIWI-SDR MDS

Mode/Bandwidth	3600 kHz	14100 kHz	28100 kHz	kHz
CW/500 Hz	-124	-124	-124	dBm
SSB/2.4 kHz	-120	-120	-119	dBm

Test configuration: Marconi 2018A signal generator, 20 dB pad between sig gen output and DUT input.

Table 2a. Kiwi-SDR HF NPR. SSB, B = 2.4 kHz.

BSF kHz	BLF kHz	Mode	P_{TOT} dBm	NPR dB	Theor. NPR dB
1940	60-2044	LSB	-25	51	74.8
3886	60-4100	LSB	-25	51	71.7
4650	60-5600	USB	-25	50	70.3
5340	60-5600	USB	-26	50	70.3
7600	12-8160	LSB	-26	49	68.7
11700	316-12360	USB	-25	50	67.0
16400	316-17300	USB	-25	50	65.4

Table 2b. Kiwi-SDR LF/MF NPR. SSB (USB), B = 2.4 kHz.

BSF kHz	BLF kHz	P_{TOT} dBm	NPR dB	Theor. NPR dB
16	6-108	-24	55	88
34		-24	55	88
70		-24	52	88
240	12-552	-23	51	80.6
534		-23	55	80.6
1248	60-1296	-23	53	86.8

The theoretical NPR was calculated according to the following procedure:

http://www.ab4oj.com/test/docs/16bit_npr.pdf

There is a possibility that blocking in the ADC driver is degrading NPR as well. By contrast, the Perseus (which also uses a 14-bit ADC) has measured NPR values in the 70 dB range. (Measured NPR was read off the spectrum scope; displayed notch depth = NPR). This bears further investigation.

Test configuration: Wandel & Goltermann RS-25 (HF) and RS-50 (LF/MF) with bandstop (BSF) and band-limiting (BLF) filters as per Tables 2a and 2b.

IFSS (Interference-Free Signal Strength).

Using two test signals f_1 and f_2 with 2 kHz spacing, the IMD3 product amplitude (the average of $2f - f_1$ and $2 f_1 - f_2$) is recorded over a range of per-tone input power levels from a maximum (usually -1 dBFS) to the noise floor, and a curve drawn. Horizontal lines across the chart represent the ITU-R P.372 band noise at the frequency of interest and at typical urban, rural and quiet rural sites. If the curve is below the band noise at the site, the IMD3 products will not interfere with audible signals. Here f_1 = 14010 kHz and f_2 = 14012 kHz. The IMD3 products are 14008 and 14014 kHz.

The IFSS curves for the KIWI-SDR and for the Perseus are attached. The IFSS curve for the Perseus with dither on is monotonic, and crosses the -109 dBm ITU-R Rural band noise line at -15 dBm/tone input level (-7 dBFS). The curve crosses the Quiet Rural line (-122 dBm) at -30 dBm/tone input level. Thus, IMD products are of no consequence below the band noise line for the operating frequency (14.1 MHz) and site.

By contrast, the KIWI curve crosses the Rural noise line at -54 dBm/tone and the Quiet Rural line at -80 dBm/tone. Also, the top of the curve is noise-limited at -37 dBm/tone input level. The curve sits very high in the chart. This suggests fairly severe blocking or overloading in the ADC driver IC, because the problem arises long before the ADC clips. It was not possible to increase the input level to anywhere near -1 dBFS because the IMD products were noise-limited at -36 dBm/tone and disappeared into the elevated noise pedestal.

IFSS test configuration: Test fixture as described in “A New Look at SDR Testing”, Slide 9.

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Figure 1: Kiwi-SDR IFSS Chart.