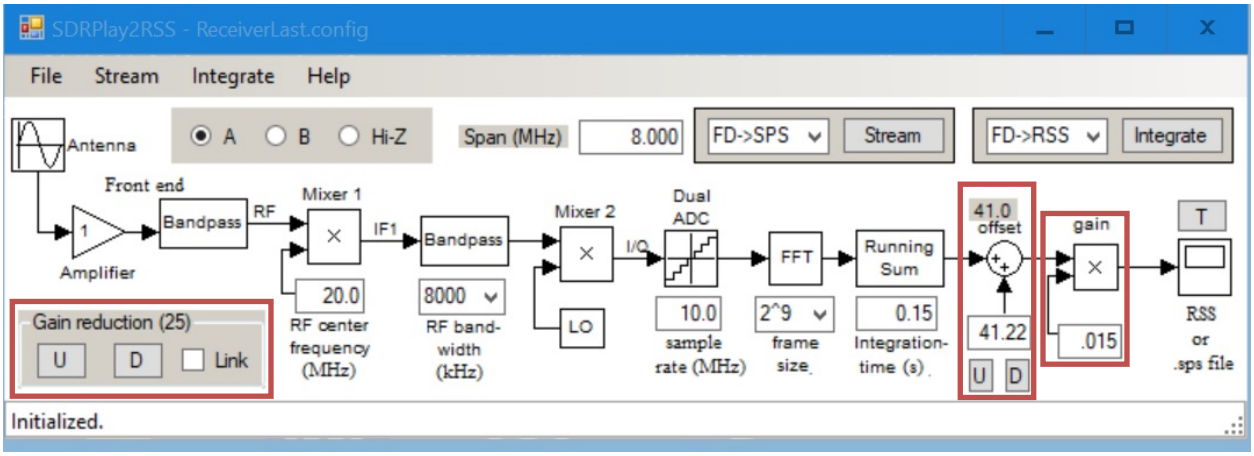
SDRPlay RSP2 Settings

Three important controls on the SDRPlay2RSS control panel are Gain Reduction, Offset, and Gain



Gain reduction is applied in the RF sections of the SDRPlay RSP2 while Offset and Gain are applied after the fast Fourier transform (FFT) has been computed. The digital output of Nathan Towne's SDRPlay2RSS is passed to Jim Sky's Radio Sky Spectrograph (RSS).

The RSS "Voltmeter"

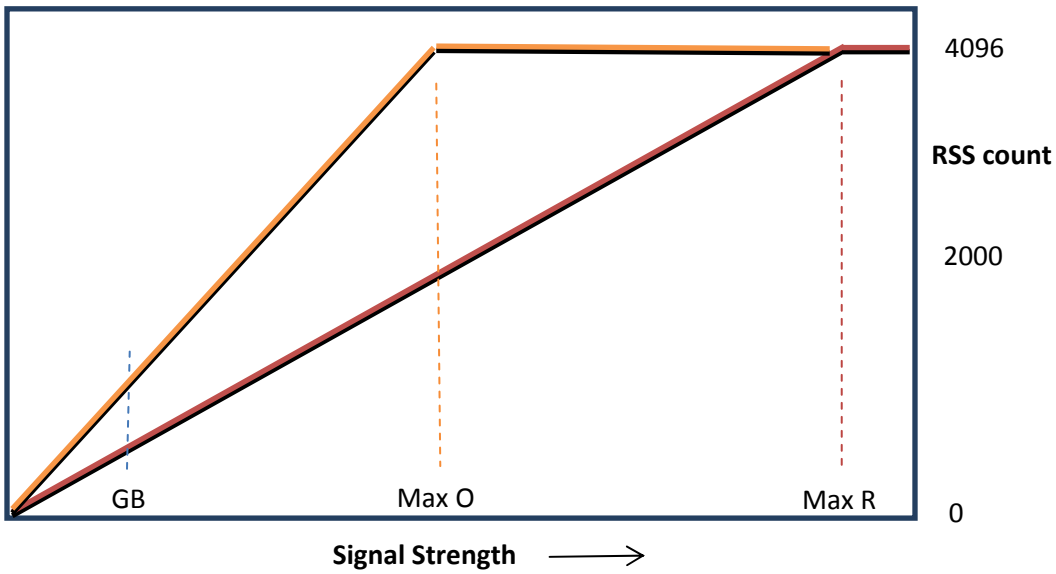
RSS supports a utility called Voltmeter (available under the View menu in RSS).

When used with SDRPlay2RSS the RSS "voltmeter" displays the magnitude of the digital signals in terms of a numerical count running from zero to 4096 (equal to 12 bit resolution). To use the meter, simply click at the desired frequency in the display area of the top RSS display panel. The "voltmeter" display will average data according to the number of sweeps selected under the RSS menu Spectrograph> Avg. Sweeps. (Avg. Sweeps can only be set in Stand Alone Mode, but the voltmeter works in both Stand Alone and Client modes.)

The range of raw data values from 0 to 4096 are represented by different colors in the RSS display, as determined by the RSS settings of Color Gain and Offset (these are the RSS controls, not the SDRPlay2RSS controls which are the topic of this paper).

With the raw RSS data range running from 0 to 4096 the galactic background should be at a low count with strong signals peaking out at 4096. This is seen in the following figure.

Response Curves



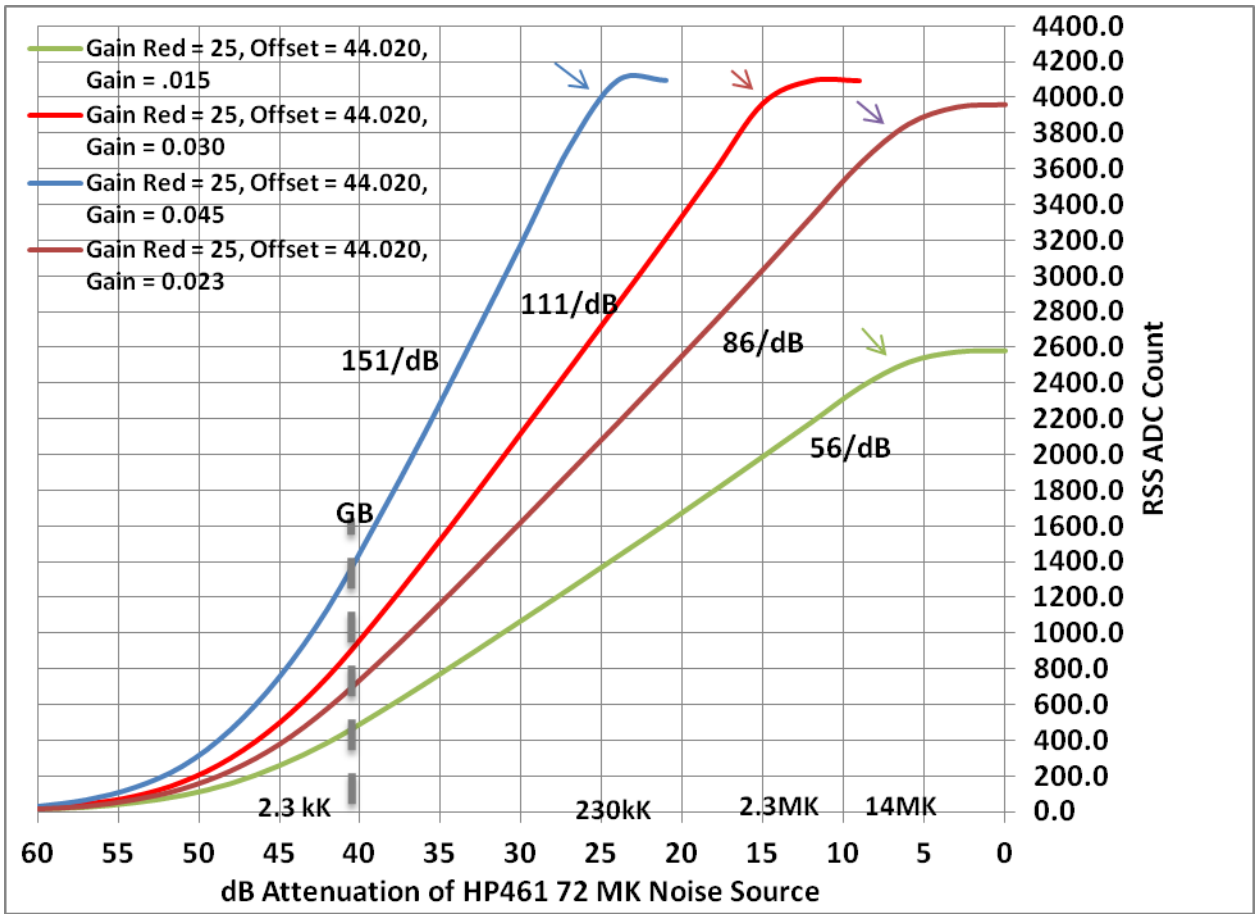
The horizontal axis is signal strength, increasing from below the galactic background (GB) toward the right. The RSS count is seen on the vertical axis. The diagonal red line is a response curve showing the output vs input for one theoretical setting of gains and offset in SDRPlay2RSS. The slope of that line indicates how quickly the counts change for a given change in input signal level. The orange line is a steeper response curve showing a more rapid change in counts for a given increase in signal strength. Both response curves increase up to the 4096 level and then go horizontal, indicating that the output will remain fixed at 4096 even if the input continues to increase in level. The knee of the response curve where it goes flat is called saturation.

The useful dynamic range for the red response settings is measured between the signal strength of the galactic background (GB) to the signal strength at (Max R). The orange response has a steeper slope and hence the output will change more for a given change in input signal than the red response. Small changes in signal amplitude will be more apparent. However, the orange dynamic range is clearly less than the red dynamic range, as (Max O) is closer to the GB level. The orange response goes into saturation at a lower signal level than the red response.

Generating Response Curves for the SDRPlay2

A Hewlett Packard HP-461 amplifier was used to generate broadband RF noise at an equivalent temperature of 72 MK. This signal was then passed thru a Kay step attenuator and fed into SDRPlay2 antenna port (A). The Kay was adjusted in 3 dB steps from 60 dB to 0 dB. At each setting of the attenuator five readings were taken using the RSS Voltmeter at 20 MHz. These readings were then averaged to obtain the RSS count for each signal level. It was determined that the optimum setting for

Gain Reduction was 25 with an Offset of 44.020. Four different response curves were generated using different values of Gain, running from 0.015 to 0.045. These response curves are seen below.



The horizontal axis shows dB attenuation of the 72 MK source and also equivalent temperature values. For example the attenuation of 45 dB is equivalent to 2.3kK, while 15 dB attenuation yields 2.3MK.

The galactic background level has been set close to 8kK taking into account the overall losses (see note 1) in a TFD antenna plus typical cable loss for a total of 8 dB attenuation of the 50 kK antenna temperature. Different amounts of cable loss, or using a multicoupler with 3 dB of gain will shift the GB temperature slightly on the horizontal axis.

For all four gain settings the galactic background temp is well above the system noise floor and up in the linear portion of the response curve (the straight portion of the curve). Gain was set a bit too low for the green curve (G=0.015), which only reached about 2,500 counts as it went into saturation. With the gain increased to 0.023 the brown response curve saturates near 3800 counts. Both green and brown responses go into saturation at about 7dB (14 MK) yielding a dynamic range of (40 -7 = 33dB). The brown curve with a slope of 86 counts per dB will produce a more sensitive display than the green curve with only 56 counts per dB.

By increasing the gain further to 0.030 we obtain the red curve with a slope of 111 counts/dB which goes into saturation at about 2.3 MK. This yields a dynamic range of (40 – 15 = 25 dB).

The blue curve, with a gain of 0.045 has a slope of 151 counts/dB and goes into saturation at about 230kK. The dynamic range is (40 - 25 = 15 dB). With the gain set to 0.045 we will see the most color change on the spectrograms for a given change in signal strength, but the instrument will have the most restricted dynamic range.

The following response data was obtained with Gain Reduction = 25 and Offset = 44.020

Gain	Slope (counts/dB)	Dynamic Range (dB)
0.015	56	33
0.023	86	33
0.030	111	25
0.045	151	15

Summary

Different SDRPlayRSP2 gain settings in SDRPlay2RSS will result in different responses as seen above.

By increasing the slope of the response curve (increasing the sensitivity) the dynamic range is decreased.

For solar observations, where large bursts may occur, a wide dynamic range is required. A gain setting of 0.023 is suggested. For Jupiter observations, higher gains are possible since the signals are weaker and require a smaller dynamic range. Gains between 0.030 and 0.045 are suggested. For strong S-bursts perhaps a wider dynamic range is appropriate indicating the lower gain (0.030).

The methodology for measuring the response of an SDRPlay unit has been outlined. It is suggested that any observer with access to a known hot noise source such as the HP461 and a calibrated step attenuator should generate their own response curves.

To date, SDRPlay has released three different models (RSP1, RSP1A, RSP2). Specifications suggest that each model has different gains and noise figures – making it all the more important for the observer to characterize their units so they can be set up for optimum performance.

Note 1 – The 24’ TFD has 4.3 dB of inefficiency plus 0.55 dB of loss in the balun for a total loss of 4.9 dB between the sky side of the antenna and the receiver side of the balun at 20 MHz. The 30’ TFD has 3.5 dB inefficiency plus 0.55 dB loss in the balun for a total loss of 4.1 dB at 20 MHz.

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