

Tangential Sensitivity of ADL5902-Based Receivers

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# Introduction

## Purpose

The ADL5902 is an RF power detector which has a linear-in-decibel output voltage to input power ratio. The following tangential sensitivity measurements will more accurately describe the usability of an ADL5902 based receiver by determining the lowest possible input power that produces a discernable pulse at the output.

## Scope

This report will define tangential sensitivity and outline the experiments performed.

# Related Documents and Drawings

## Applicable Documents

The following documents may not be directly referenced herein, but provide necessary context or supporting material.

|  |  |  |
| --- | --- | --- |
| **Ref. No.** | **Document Title** | **Rev/Doc. No.** |
| AD01 | ADL5902 Datasheet | [Filehost](file:///\\filehost\evla\techdocs\RFI\coopshare\remynguyen\SolarTelescope-ASWA\Solar-Telescope-Redesign\Datasheets\ADL5902.pdf), [Online](https://www.analog.com/media/en/technical-documentation/data-sheets/ADL5902.pdf) |
| AD02 | PMA2-63LN+ Datasheet | [Online](https://www.minicircuits.com/pdfs/PMA2-63LN+.pdf) |
| AD03 | PMA2-123LN+ Datasheet | [Online](https://www.minicircuits.com/pdfs/PMA2-123LN+.pdf) |

## Reference Documents

The following documents are referenced within this text:

|  |  |  |
| --- | --- | --- |
| **Ref. No.** | **Document Title** | **Rev/Doc. No.** |
| RD01 | The Criterion for the Tangential Sensitivity Measurement | [Hewlett Packard AN 956-1 (Filehost)](file:///\\filehost\evla\techdocs\RFI\coopshare\remynguyen\SolarTelescope-ASWA\Solar-Telescope-Redesign\Research\AN956-1.pdf), [Online](http://www.hp.woodshot.com/hprfhelp/4_downld/lit/diodelit/an956-1.pdf) |

# Procedure

Tangential signal sensitivity (TSS) is defined to be the power level of an input pulse to a receiver in which the output shows 8 dB of signal-to-noise ratio (SNR). By reading the output of the receiver on an oscilloscope, 8 dB of SNR can be determined by an RMS voltage ratio of 2.5[RD01]. In some cases, the TSS level is determined subjectively to be the input power level at which the bottom of the output signal waveform touches the top of the noise floor on an oscilloscope, as shown in Fig. 1.

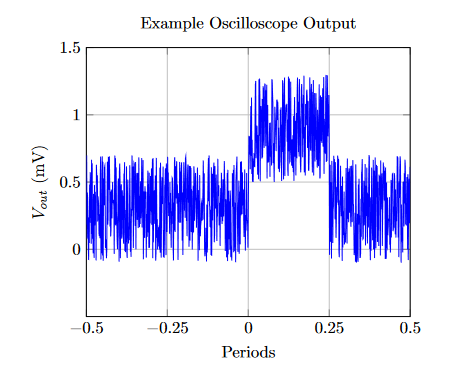


Figure : Receiver output where pulsed signal power sits just above the noise floor.

The setup to this experiment is shown in Fig. 2 and as follows: a signal generator is used to create a pulsed input signal at a given frequency and an oscilloscope is used to read the output of the receiver. Then, a step attenuator is used to tune the output trace to a 2.5:1 ratio of signal-to-noise RMS voltage. As attenuation increases, the RMS voltage of the output pulse decreases and vice versa.

In this case, a 1 kHz pulse with a 20% duty cycle was used; the output of each receiver setup when biased with no input signal measured roughly 400 µV, thus, an RMS signal voltage of 1 mV is desired for TSS.

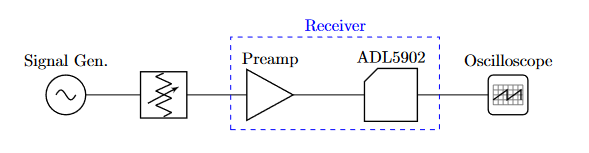


Figure : Test setup block diagram.

# Results

The ADL5902 evaluation board was used in each receiver although it has been slightly modified to increase the gain to approximately 86 mV/dB; R6 was replaced with a 1180Ω resistor and R2 was replaced with a 2kΩ resistor. The voltage-power curve in this configuration is shown in Fig. 3.

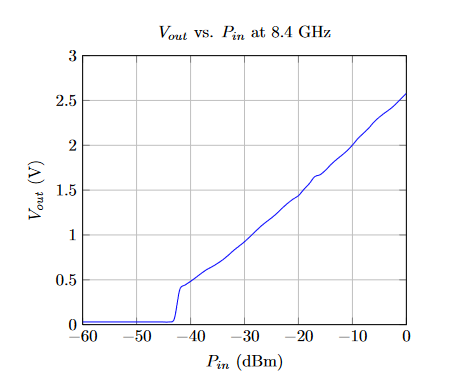


Figure : Power sweep of the ADL5902-EVALZ. R6 = 1180Ω and R2 = 2000Ω.

This V-P curve is a good baseline for systems utilizing the ADL5902 but shows a steep voltage slope immediately after the minimum power limit. Because of this, a more accurate measure of TSS would likely be possible with a precision step attenuator below 1 dB per step. In any case, TSS levels were measured across a frequency range of 2-10 GHz at various receiver configurations. All of these are outlined in Fig. 4.

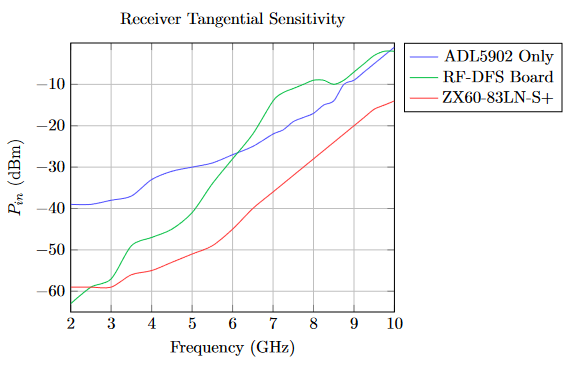


Figure : Tangential sensitivity of the ADL5902 with different preamplifiers.

The RF-DFS board used contains two PMA2-63LN+ amplifiers and a 1 dB attenuator in between. Because the RF-DFS LNAs are built for very low noise, the gain drops significantly after 6 GHz and although noise figure measurements from the datasheet only go up to 6 GHz, it is a fair assumption that noise performance also drops. Note that noise figure numbers were taken from the Mini-Circuits datasheets. The RF-DFS uses two PMA2-63LN+ amplifiers and thus will have a noise figure slightly higher than shown in Fig. 5.

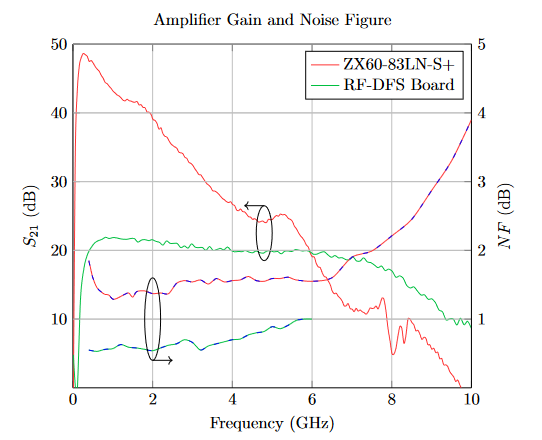


Figure : Power sweep of the ADL5902-EVALZ. R6 = 1180Ω and R2 = 2000Ω.

The poor performance of the RF-DFS board across frequency can likely be attributed to steep gain falloff even in the operating frequency. It’s possible the sub-2 GHz TSS would shown much better performance than the ZX60 LNA, but 2 GHz was the minimum output frequency on available signal generators at the time.

These tests primarily indicate two things: that a combination of low noise and high gain can increase receiver sensitivity, and give a baseline for systems utilizing the ADL5902. More in-depth testing could potentially determine how strongly gain or noise figure affect TSS independently, but a greater selection of LNAs is necessary.