

Extending the Dynamic Range of the **ADL5513** Logarithmic Detector Using the **AD8368** Variable Gain Amplifier

CIRCUIT FUNCTION AND BENEFITS

The circuit shown in Figure 1 provides a solution for increasing the dynamic range of the **ADL5513** logarithmic detector. To accomplish this increase, add an **AD8368** variable gain amplifier (VGA) at the input of the **ADL5513**. The output voltage (V_{OUT}) signal from the **ADL5513** is attenuated and fed back to the gain

control input of the **AD8368**, providing precise control of the power at the input of the **ADL5513**. This approach increases the dynamic range of the circuit to 95 dB with temperature stability (see Figure 2). The output voltage is linear in dB with respect to the input signal.

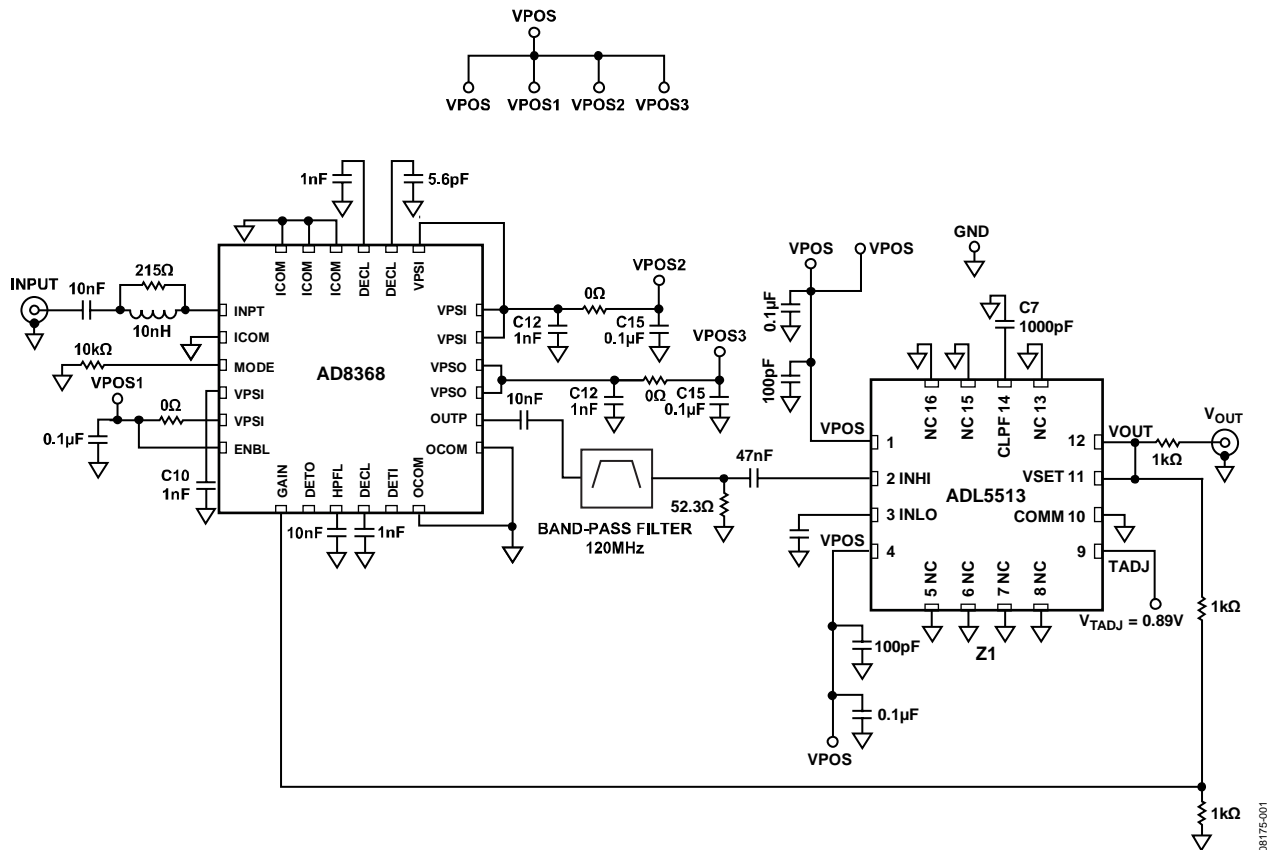


Figure 1. **ADL5513** Logarithmic Detector and **AD8368** VGA Providing 95 dB Dynamic Range at 120 MHz (Simplified Schematic), $V_{POS} = 5\text{ V}$

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REVISION HISTORY

1/2018—Rev. 0 to Rev. A

Document Title Changed from CN0072 to AN-1523 Universal
Changes to Figure 1..... 1

7/2009—Revision 0: Initial Version

CIRCUIT DESCRIPTION

The [ADL5513](#) logarithmic detector dynamic range can be extended by adding a separate VGA that has a gain control input derived directly from V_{OUT} . This configuration extends the dynamic range by the gain control range of the VGA. For the overall measurement to remain linear in dB, the VGA must provide a linear in dB (exponential) gain control function. The VGA gain must decrease with an increase in its gain bias in the same way as the [ADL5513](#). Alternatively, an inverting op amp with suitable level shifting can be used. It is convenient to select a VGA that only needs a single 5.0 V supply and is capable of generating a single-ended output. The [AD8368](#) meets all of these conditions. Figure 1 shows the simplified schematic. Using the inverse gain mode (MODE pin low) of the [AD8368](#), the gain decreases on a slope of 37.5 mV/dB to a minimum value of -12 dB for a gain voltage (V_{GAIN}) of 1.0 V. The voltage, V_{GAIN} , required by the [AD8368](#) is 50% of the output of the [ADL5513](#). To scale this voltage, it is necessary to insert a voltage divider at the output of the [ADL5513](#). The gain of the [AD8368](#) varies by $(0.5 \times 1.5 \text{ V}) \div (37.5 \text{ mV/dB})$, or 20 dB over the 1.5 V range from the output of the [ADL5513](#). This gain variation results in a 1.5 V change in V_{OUT} for a 95 dB change at the input to the [AD8368](#) when combined with the 75 dB gain span (at 120 MHz) of the [ADL5513](#).

Due to the amplification of out of band noise by the [AD8368](#), a band-pass filter is used between the [AD8368](#) and [ADL5513](#) to increase the low signal sensitivity. The VGA amplifies low power signals and attenuates high power signals to fit them in the detectable range of the [ADL5513](#). If an amplifier with higher gain and lower noise figure is used, sensitivity greater than 90 dB can be achieved for use in a receive signal strength indicator (RSSI) application.

Figure 2 shows the data results of the extended dynamic range at 120 MHz and the corresponding error in V_{OUT} .

Due to the high frequencies and wide dynamic ranges involved, the circuit must be constructed on a multilayer printed circuit board (PCB) that has at least one layer for the ground plane. Each IC input power pin must be decoupled with a 0.1 μF low inductance ceramic capacitor as shown in Figure 1. Some power pins have an additional smaller value decoupling capacitor (low effective series inductance) for extremely high frequencies. The 0 Ω resistors on the schematic represent optional small resistor values (<10 Ω) or ferrite beads that can be added for more decoupling.

See the [ADL5513](#) and the [AD8368](#) data sheets for the optimal layouts of the [EVAL-ADL5513](#) and [EVAL-AD8368](#) evaluation boards.

There are exposed paddles on the undersides of the [ADL5513](#) and the [AD8368](#) chip scale packages. These paddles are internally connected to the ground of the chips. Solder the paddles to the low impedance ground planes on the PCB to ensure specified electrical performance and to provide thermal relief. It is recommended that the ground planes on all layers under the paddles be stitched together with vias to reduce thermal impedance.

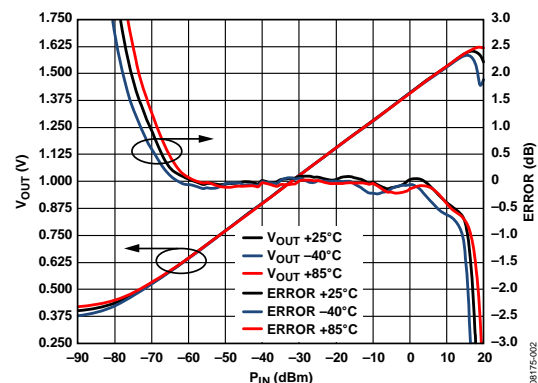


Figure 2. Output and Conformance for the [AD8368/ADL5513](#) Extended Dynamic Range Circuit at 120 MHz

COMMON VARIATIONS

The application circuit described in this application note can be modified for any intermediate frequency (IF) within the operating range of the [AD8368](#) and [ADL5513](#) by selecting the appropriate band-pass filter. For operation above 800 MHz, the [ADL5330](#) can be used in place of the [AD8368](#). The [ADL5330](#) VGA can be used at frequencies between 10 MHz and 3 GHz. Using the [ADL5330](#) requires an inverter between the [ADL5330](#) GAIN pin and the [ADL5513](#) gain control voltage. The [AD8061](#) single-supply op amp can be configured for use as an inverter in this application.

REFERENCES

- MT-073 Tutorial. *High Speed Variable Gain Amplifiers (VGAs)*. Analog Devices.
- MT-077 Tutorial. *Log Amp Basics*. Analog Devices.
- MT-078 Tutorial. *High Frequency Log Amps*. Analog Devices.
- MT-101 Tutorial. *Decoupling Techniques*. Analog Devices.