

Devices Connected/Referenced

ADL5513	1 MHz to 4 GHz , 80 dB Logarithmic Detector/Controller
AD8368	800 MHz Linear-in-dB Variable Gain Amplifier (VGA)

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

CIRCUIT FUNCTION AND BENEFITS

This circuit provides a solution for increasing the dynamic range of the ADL5513 logarithmic detector. This is accomplished by adding an AD8368 variable gain amplifier (VGA) at the input of the ADL5513. The 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. Using this approach, the dynamic range of the circuit is increased to 95 dB with excellent temperature stability (see Figure 2). The output voltage is linear in dB with respect to the input signal.

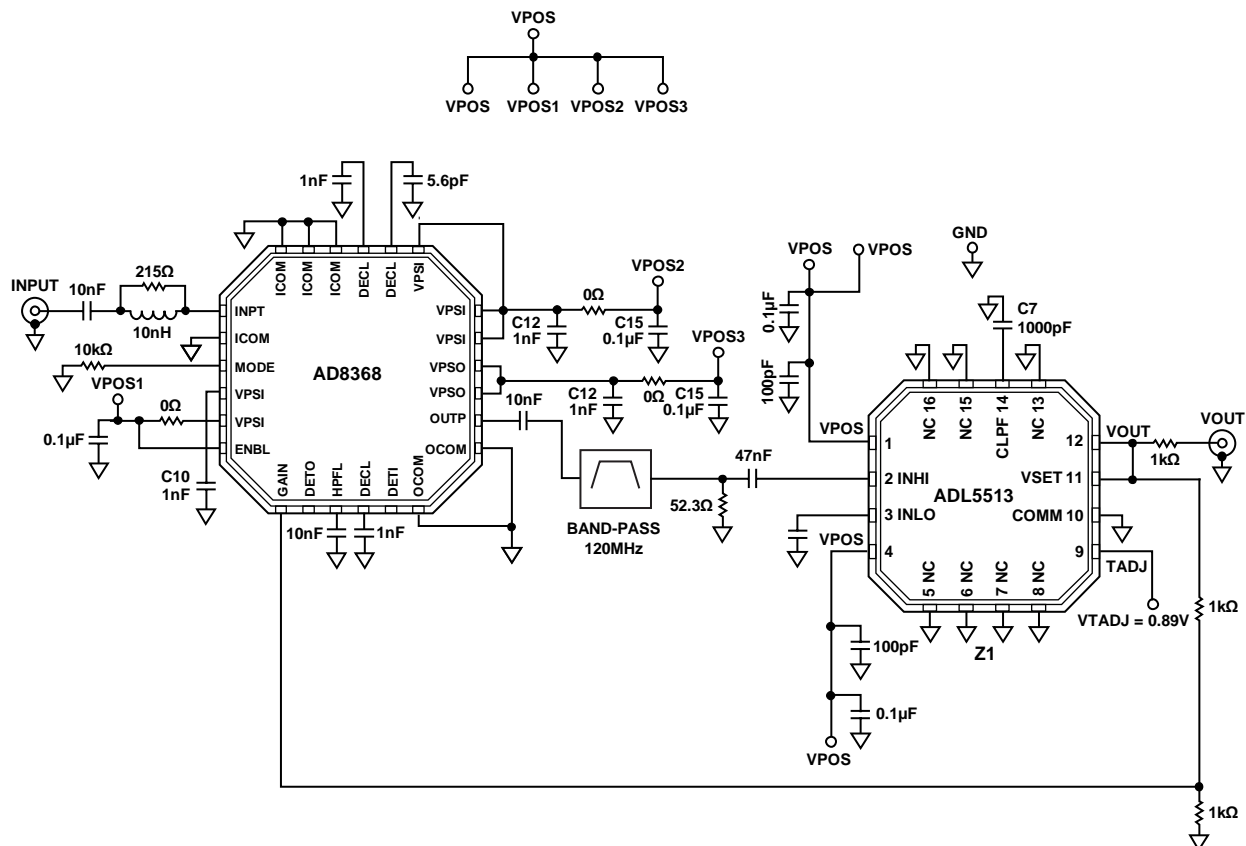


Figure 1. ADL5513 Logarithmic Detector and AD8368 VGA Providing 95 dB Dynamic Range at 120 MHz (Simplified Schematic)
 Note: $V_{POS} = +5V$

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CIRCUIT DESCRIPTION

The ADL5513 logarithmic detector dynamic range can be extended by adding a separate VGA whose gain control input is derived directly from V_{OUT} . This 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 needs only a single 5.0 V supply and is capable of generating a single-ended output. All of these conditions are met by the AD8368. Figure 1 shows the simplified schematic. Using the inverse gain mode (MODE pin low) of the AD8368, its gain decreases on a slope of 37.5 mV/dB to a minimum value of -12 dB for a gain voltage (VGAIN) of 1.0 V. The voltage, VGAIN, 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. Over the 1.5 V range from 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. Combined with the 75 dB gain span (at 120 MHz) of the ADL5513, this results in a 1.5 V change in V_{OUT} for a 95 dB change at the input to the AD8368.

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, better than 90 dB sensitivity 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 PC board that has at least one layer for the ground plane. Each IC 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 ESL) for extremely high frequencies. The “0 Ω ” resistors on the schematic represent optional small resistor values (less than 10 Ω) or ferrite beads that may be added for more decoupling. The data sheets for the ADL5513 and the AD8368 show the optimal layouts of the respective evaluation boards.

On the underside of both the ADL5513 and the AD8368 chip scale package there is an exposed paddle. This paddle is internally connected to the ground of the chip. Solder the paddle to the low impedance ground plane on the PCB to ensure specified electrical performance and to provide thermal relief. It is also recommended that the ground planes on all layers under the paddle be stitched together with vias to reduce thermal impedance.

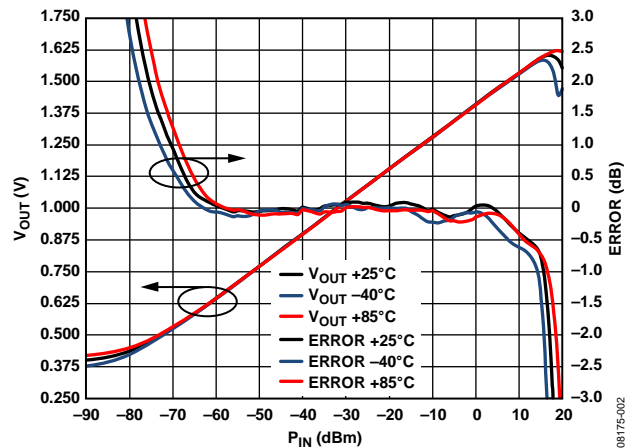


Figure 2. Output and Conformance for the AD8368/ADL5513 Extended Dynamic Range Circuit at 120 MHz

COMMON VARIATIONS

The application circuit described here can be modified for any IF frequency 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 also requires an inverter between the ADL5330 gain pin and the gain control voltage from the ADL5513. A single-supply operational amplifier such as the AD8061 can be configured for use as an inverter in this application.

LEARN MORE

[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.

Data Sheets

[AD8061 Data Sheet.](#)

[AD8368 Data Sheet.](#)

[ADL5330 Data Sheet.](#)

[ADL5513 Data Sheet.](#)

REVISION HISTORY

7/09—Revision 0: Initial Version

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