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 \( V_{\text{OUT}} \) 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.

![Circuit Diagram](image)

**Figure 1. ADL5513 Logarithmic Detector and AD8368 VGA Providing 95 dB Dynamic Range at 120 MHz (Simplified Schematic), VPOS = 5 V**

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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 VOUT. 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 (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. The gain of the AD8368 varies by (0.5 × 1.5 V) ÷ (37.5 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 VOUT 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 VOUT.

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.

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