

Supporting High-Voltage or Bipolar Voltage Sensing with AMC67048



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Introduction

AMC67048 is a system guard device designed for minimal software fault detection and response preferred for high-channel density applications such as avionics or servers. AMC67048 contains a single ADC with up to 48 channels with programmable ranges of 0V to 2.5V or 0V to 5V. A fundamental requirement in power supply and communication line sensing applications is often the need to support high voltage or bipolar voltage sensing capabilities. To facilitate this, various strategies can be employed when integrating the AMC67048 into such systems.

AMC67048 uses a Successive Approximation Register (SAR) ADC. SAR ADCs use an internal 20pF capacitor for measurement; therefore, the input signal needs to contain enough current to charge the capacitor. For this reason, TI recommends using low-value resistors (below 10kΩ).

High Voltage

A pair of resistors (resistor divider) is one of the simplest and cost-effective ways to achieve such a requirement. The ratio between R_{TOP} and R_{BOTTOM} can be derived as follows:

$$\frac{R_{TOP}}{R_{BOTTOM}} = \frac{ADC_{MAXINPUT}}{V_{SENSEMAX}} \quad (1)$$

Where:

$ADC_{MAX INPUT}$ is maximum ADC input of AMC67048 (either 2.5V or 5V)

$V_{SENSE MAX}$ is highest voltage on the line being sensed.

For example, if 0V to 5V ADC range of AMC67048 is used and the power supply being monitored is from 0V to 24V, then resistor divider ratio needs to be $5/24=0.208$.

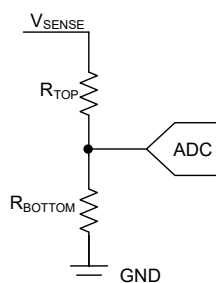


Figure 1. High Voltage Conversion using Resistor Divider

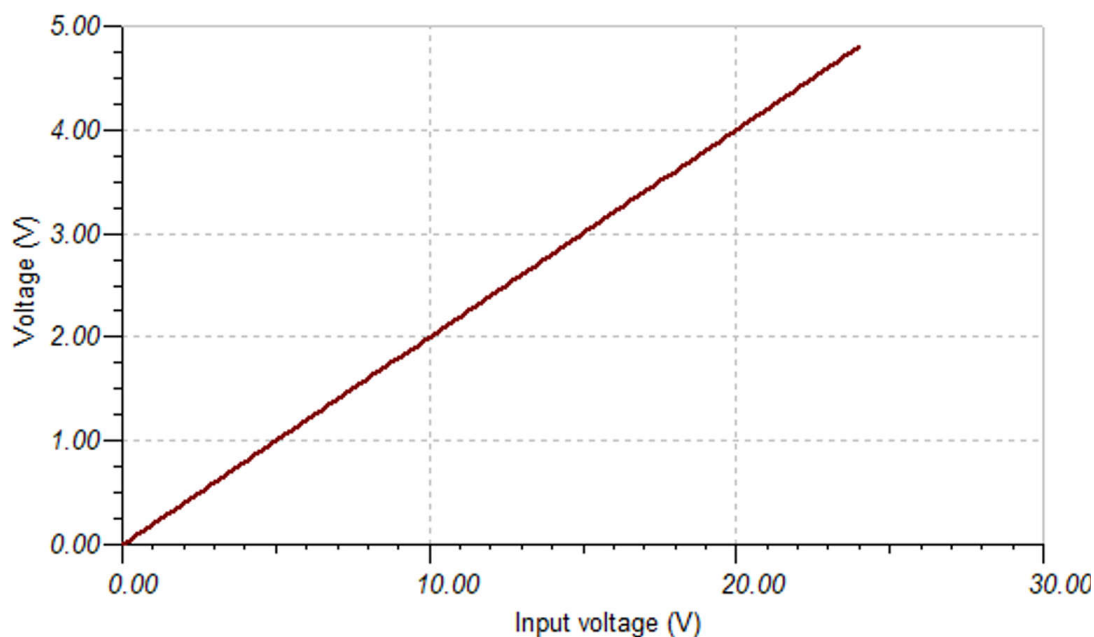


Figure 2. Resistor Divider Circuit Simulation

Bipolar Voltage

For bipolar voltage monitoring the input voltage must be normalized to 0V being the most negative VSENSE input, 5V the most positive VSENSE input, and 0V VSENSE translating to 2.5V input

Resistor Divider

A system of three resistor dividers and a reference voltage is a simple way to translate voltage from bipolar to the ADC input range.

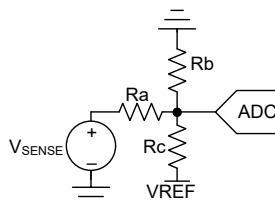


Figure 3. Bipolar Voltage to Unipolar Conversion

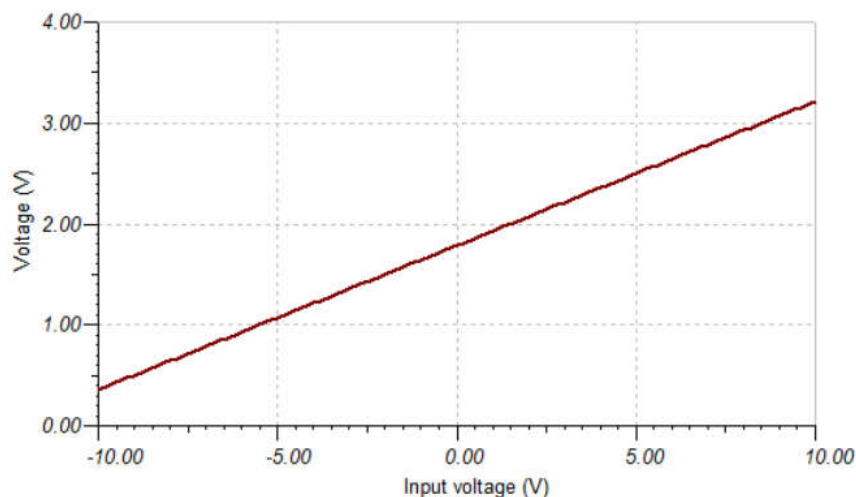


Figure 4. Bipolar Voltage to Unipolar Circuit Simulation

To achieve enough current required for the ADC to measure the voltage, TI recommends to use low value resistors. Operational amplifier such as OP328 can be used to increase the input current to required by the ADC value.

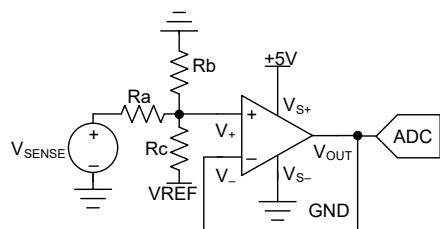


Figure 5. Bipolar Voltage to Unipolar Conversion With Op Amp

The steps of calculating the R_a , R_b , R_c including more information about the system can be found at [bipolar-to-unipolar level translation circuit white paper](#). Texas Instruments also offers an [analog engineer calculator](#) designed for calculating and simulating this circuit.

Noise

If V_{SENSE} has transient noise specifically around the range limits, additional protection is recommended at the ADC input to make sure that the ADC does not get damaged. The simplest way to protect the device is by using a voltage clamp diode pulled up to ground and V_{DD} . If the input voltage rises above the V_{DD} or drops below ground, the corresponding diode becomes active, and excessive current is drained, protecting the ADC.

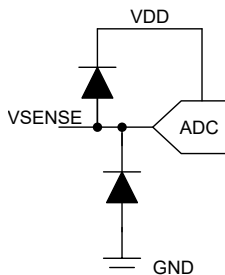


Figure 6. ADC Noise Protection

Fault Management and System Guard

The AMC67048 integrates multiple engines for fault management and detection. Each analog-to-digital converter (ADC) channel of the device can be independently configured via internal registers to set voltage threshold and hysteresis parameters. When any ADC channel exceeds the bound, the designer has various options available to respond.

An alarm can be triggered to notify a microcontroller unit (MCU) about the fault condition. Additionally, another alarm can be generated to disable the system that is malfunctioning. The digital-to-analog converter (DAC) channels are useful for tasks such as lighting an identification LED or controlling output from one DC/DC power supply or generating additional alarms.

All these responses and device behaviors are fully configurable via internal registers. A system example is shown in [Figure 7](#).

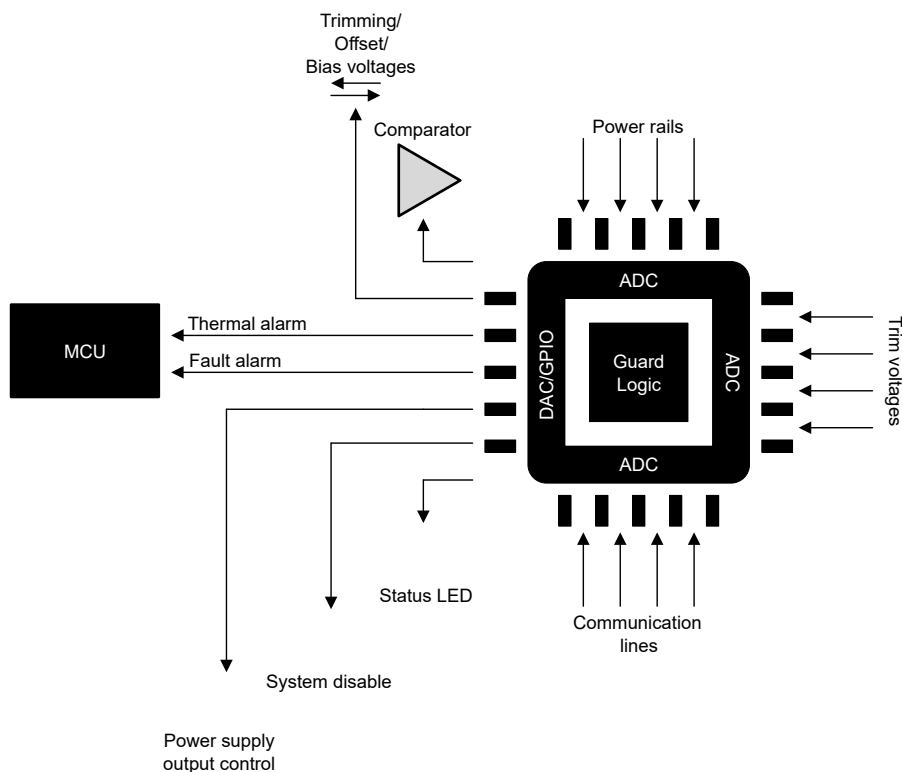


Figure 7. AMC67048 System Diagram Example

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Last updated 10/2025