Product Overview

INA600: Small-Size Voltage Monitoring Design with High Attenuation Ratios for Up to 85V Systems

As system voltages in EV chargers, solar inverters, and energy-storage systems continue to rise, engineers need compact and precise designs to monitor rails up to 85V directly into low-voltage analog-to-digital converters (ADCs). The INA600 has an input range well beyond supply rails, allowing for direct interfacing between high-voltage signals up to 85V with low-voltage ADCs. With multiple attenuation options, the INA600 is a device designed for a variety of voltage monitoring systems. Below are frequently asked questions about the INA600.

Why Choose the INA600 for High-Voltage Monitoring?

Low-cost, discrete (resistor divider + op amp) voltage monitoring performance is degraded in noisy environments, where ground bouncing (common in these systems) creates errors in the measured signal. Discrete difference amplifiers overcome some of this; however, integrated difference amplifiers provide benefit through higher precision, better resistor matching, lower board space, and a simpler bill of materials (BOM), all while being equivalent in cost. Table 1 below compares some key specifications between different voltage monitoring designs shown in Figure 1.

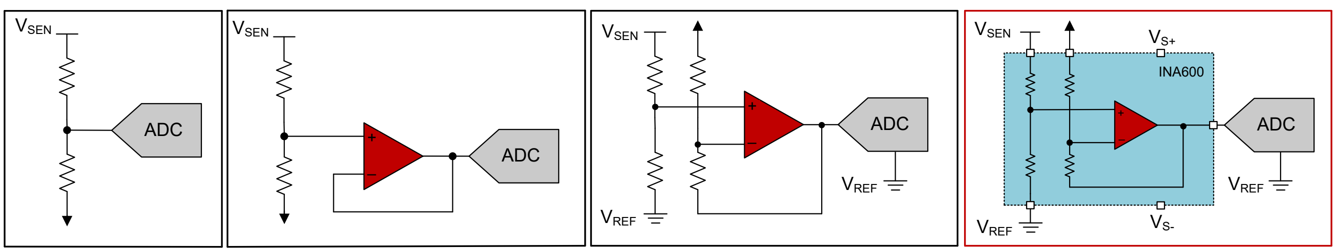

Figure 1. Common Voltage Monitoring Designs

Table 1. Comparing Common Voltage Monitoring Designs

Key Specs	Discrete Resistor Ladder (1% tol. Resistors)	Discrete Resistor Ladder + Op Amp (1% tol. Resistors)	Discrete Diff. Amp (0.1% tol. Resistors)	Integrated Diff Amp (INA600)
Max Gain Error	~1.5%	~1.5%	~0.15%	~0.1%
Max Gain Drift	~100ppm/°C	~100ppm/°C	~50-100ppm/°C	10-20ppm/°C
Min. CMRR	< 5dB	< 5dB	~56dB	75dB to 85dB
Cost	$	$	$$	$$

Target Applications and Sub-Systems for the INA600

Energy Infrastructure:

- EV charging: DC-fast charging, wallbox chargers, DC-DC converters
- Energy storage system: power conversion systems
- Solar energy: microinverters

Test and Measurement:

- Battery formation and test equipment: 12/24/48V lead acid batteries

What Problem is the INA600 Solving? How is that Problem Solved?

The INA600 rejects the ground bounce and switching noise which are the common-mode noise associated with the power rails, and loads which affect the voltage monitoring accuracy. This is particularly relevant with the trend of higher voltages and switching frequencies associated with GaN and SiC architectures. INA600 also maintains lower gain error and drift versus discrete based voltage monitoring, where integrated, precision (ratio-metrically) matched resistors are used to set the according gain ratios.

Figure 2 below shows that the INA600 has the unique ability to monitor voltages beyond the power supply of the amplifier, as the input voltage of operational amplifiers is generally limited by the supply range. In this example, an attenuating difference amplifier is used to measure a 24V battery with an attenuation ratio of 1/5 to interface with a 5V ADC. If a large ground bouncing event occurs, the input voltage absolute maximum rating of the device can be violated. Typically to mitigate this issue, one increases the attenuation ratio of the difference amplifier. This approach compromises the accuracy of the ADC readings, as the full-scale range is not fully utilized. The INA600 circumvents this issue, due to having a larger input range compared to a standard difference amplifier, regardless of the device's attenuation ratio.

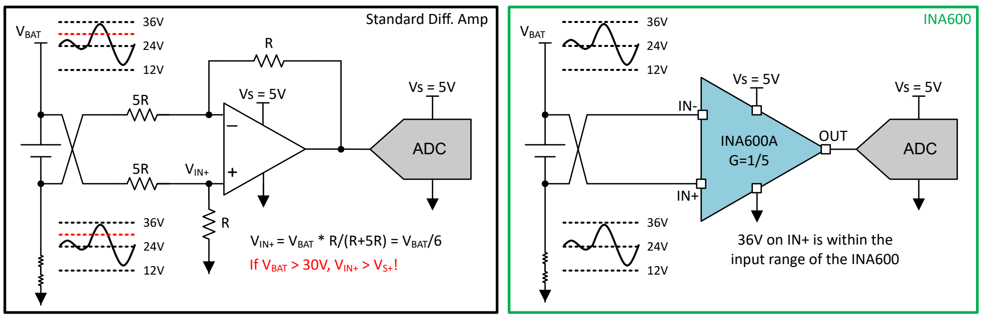

Figure 2. Extended Input Range of the INA600

How is the INA600 Different from What is Already on the Market?

The INA600 is an industry first general-purpose difference amplifier with high attenuation ratios, as most difference amplifiers in the market today have gain ratios of 1/2 V/V up to 2 V/V. Refer to the different attenuation ratios in Table 2 and Table 3 below.

Table 2. INA600 Gain Ratios (V_{REF} = 0V)

Orderable Part Number	Gain Ratio	Input Ranges (V_s = 3.3V)	Input Ranges (V_s = 5V)
INA600**A**IDBVR	1/5	44V to -8V	74V to -18V
INA600**B**IDBVR	1/10	56V to -7V	85V to -17V
INA600**F**IDBVR	1/36	85V to 3V	85V to -10V

Table 3. INA600 Gain Ratios (V_{REF} = V_S/2)

Orderable Part Number	Gain Ratio	Input Ranges (V_s = 3.3V)	Input Ranges (V_s = 5V)
INA600**A**IDBVR	1/5	36V to -20V	62V to -30V
INA600**B**IDBVR	1/10	40V to -24V	70V to -43V
INA600**F**IDBVR	1/36	61V to -40V	85V to -40V

Learn More

- Texas Instruments, *INA600 Low-Power, 2.7V to 40V Attenuating Difference Amplifier With >1MΩ Input Impedance for Cost-Optimized Designs* datasheet.
- Needing to monitor a 12V and under rail? Check out the *INA500* with gain options of 1/4, 1/2, and 1.

EVM and Samples Order Info

- *Universal Difference Amplifier Evaluation Module*
- You can order samples and EVMs through *samples.ti.com*.

For additional assistance, ask questions to TI engineers on the *TI E2E™ Amplifiers Support Forum*.