

## VISHAY SEMICONDUCTORS

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## **Isolation Amplifiers**

White Paper

# Isolation Amplifier for Current Sensing and High Voltage Monitoring

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### ABSTRACT

Accurate current and voltage measurement is critical in electronic systems like inverters, converters, and motor drivers. This white paper explores the application of the <u>VIA0050DD</u>, <u>VIA0250DD</u>, and <u>VIA2000SD</u> isolation amplifiers, combined with shunt resistors and voltage dividers, to achieve precise and safe measurements. The proposed solution offers significant advantages in terms of safety, accuracy, and broadness.



#### INTRODUCTION

This white paper presents a solution integrating isolation amplifiers with shunt resistors for current sensing and with voltage dividers for voltage monitoring to enhance measurement performance.

To reduce power losses over the shunt resistor, low resistor values and therefore low voltage drop levels must be evaluated. The VIA0050DD, with its very sensitive input range of  $\pm$  50 mV, is ideally suited for this application. Due to its bipolar input range, current sensing in both directions is possible.

In contrast, voltage monitoring is done via high ohmic voltage dividers to reduce power losses. The measurement signal is only given by the resistance ratio and can be adapted to voltage levels, which can be measured more easily. The VIA2000SD, with its wide input voltage range up to 2 V and its high input impedance, is the ideal component for this DC voltage measurement.

The VIA0250DD with a bipolar input voltage range of  $\pm$  250 mV can be used for both applications and for AC voltage monitoring.

## **TECHNICAL BACKGROUND**

Isolation amplifiers are designed to provide electrical isolation between their input and output, preventing high voltage from reaching sensitive components and ensuring user safety. By isolating the input from the output, they also help to eliminate ground loops and reduce noise, enhancing the overall signal integrity.

Shunt resistors, known for their low resistance and precision, are used to measure current by detecting the voltage drop across them. When a current flows through a shunt resistor, it produces a small voltage proportional to the current. This voltage can then be measured and used to calculate the current using Ohm's law.

Voltage dividers, on the other hand, scale down high voltages to manageable levels for accurate measurement. A voltage divider consists of two resistors connected in series across a voltage source. The output voltage, taken between two resistors, is a fraction of the high voltage determined by the ratio of the resistances.

## APPLICATION SOLUTION

In the proposed system, an isolation amplifier is used in combination with a shunt resistor for current measurement, as shown in Fig. 1, and a voltage divider for high voltage monitoring, as shown in Fig. 2 and Fig. 3. The isolation amplifier ensures that the signals are accurately transmitted to the measuring equipment without interference from high voltage or noise.



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White Paper

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Fig. 2 - Divider-Based AC Voltage Monitoring With the VIA0250DD



Fig. 3 - Divider-Based High DC Voltage Monitoring With the VIA2000SD

#### **REFERENCE DESIGNS**

Our new reference designs provide optimized solutions for three key applications: current sensing, AC voltage monitoring, and DC voltage monitoring.

The current sensing reference design leverages a shunt resistor and isolation amplifier for accurate, interferencefree measurement of electrical currents. For AC and DC voltage monitoring, dedicated voltage divider circuits are utilized, each configured to safely scale down high voltage inputs, ensuring compatibility with control units.

#### FORMULAS AND EQUATIONS

For current measurement, formula 1 is used, where I<sub>L</sub> is the load current flowing through the connected load, V<sub>SHUNT</sub> is the voltage across the shunt resistor and the input voltage for the VIA0050DD, and R<sub>SHUNT</sub> is the resistance. Voltage across the shunt should not exceed  $\pm$  50 mV.

$$V_{SHUNT} = I_{L} \times R_{SHUNT}$$
(1)

For AC voltage measurement, the voltage divider formula 2 is applied, where V<sub>IN</sub> is the input voltage for the VIA0250DD, V<sub>peak</sub> is the peak voltage on the primary side, and R<sub>SENSE1</sub> and R<sub>SENSE2</sub> are the resistances of the voltage divider. The input voltage should not exceed 250 mV.

$$V_{IN} = V_{peak} \times \frac{R_{SENSE2}}{R_{SENSE1} + R_{SENSE2}}$$
(2)

For DC voltage measurement, the voltage divider formula 3 is applied, where V<sub>IN</sub> is the input voltage for the VIA2000SD, V<sub>+HV</sub> is the high voltage on the primary side, and R<sub>SENSE1</sub> and R<sub>SENSE2</sub> are the resistances of the voltage divider. The input voltage should not exceed 2.0 V.

$$V_{IN} = V_{+HV} \times \frac{R_{SENSE2}}{R_{SENSE1} + R_{SENSE2}}$$
(3)

## CONCLUSION

Isolated amplifiers offer an effective solution for accurate current sensing and voltage monitoring in various electronic systems. By providing electrical isolation, these amplifiers mitigate the challenges associated with ground loops, noise interference, and safety concerns. As technology advances and demands for precision measurement increase, the role of isolated amplifiers in current sensing and voltage monitoring applications is poised to become even more significant.