Solid-State Relays | White Paper

High Voltage Isolation Measurement in EVs Using the VORA1150

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INTRODUCTION

Electric vehicles (EVs) rely on accurate **isolation measurement** to ensure driver safety and comply with functional safety standards (e.g., ISO 6469-1, ISO 26262). As EV battery voltages rise - often exceeding 800 V - the need for **high voltage switching solutions** in isolation monitoring circuits is growing.

To meet this need, we are introducing our new **VORA1150 1500 V solid-state relay (SSR), as shown in Fig. 1**, which is specifically optimized for **isolation resistance measurement** in high voltage EV systems.

Fig. 1 - VORA1150, 1500 V SSR

ISOLATION MEASUREMENT IN EVs

During normal operation or charging, an isolation monitoring device (IMD) checks the resistance between the high voltage battery system and chassis ground. If this isolation degrades or there is a short, the IMD must detect and report it to the battery management system (BMS) to trigger protective measures.

A switching element - typically a **solid-state relay** - is required to connect the IMD to the HV+ or HV- rails during testing and isolate it afterwards.

WHY USE A SOLID-STATE RELAY?

Compared to electromechanical relays, SSRs are ideal for high voltage, high reliability automotive applications:

- **Fast switching** for real-time diagnostics
- **No mechanical wear**, enabling long life even with frequent test cycles
- **Silent and arc-free operation**, suitable for enclosed environments
- **Compact footprint**, allowing easy integration into power distribution units (PDUs) or BMS boards

INTRODUCTION OF A NEW 1500 V SSR

Our newly developed **VORA1150 solid-state relay** is designed specifically for EV isolation measurement applications. Key features include:

- **Rated voltage:** up to 1500 V_{DC}
- **2.4 kV high pot pulse width:** 5 s
- **Current handling:** up to 50 mA
- **Avalanche current:** 0.9 mA
- **Leakage current:** < 100 nA at 1500 V
- **Working voltage:** up to 1000 V_{DC}
- **Fast switching time:** < 250 µs
- **AEC-Q102 qualified** for automotive applications
- **Ambient temperature:** up to 125 °C

TYPICAL APPLICATION CIRCUIT

In a typical case, the VORA1150 is controlled by the BMS and switches the HV+ or HV- bus to the IMD input. Once the measurement is complete, it safely disconnects the IMD, preventing leakage currents or damage during operation, as shown in Fig. 2.

CONCLUSION

The VORA1150 solid-state relay offers the high voltage rating, low leakage, and fast switching needed for **safe and reliable isolation monitoring** in modern EVs.

Its robust design and Automotive Grade qualification make it a dependable choice for designers looking to meet strict safety standards in high voltage applications.

For more information or design support, contact our applications engineering team at optocoupleranswers@vishay.com, or download the full VORA1150 datasheet.

WHITE PAPER

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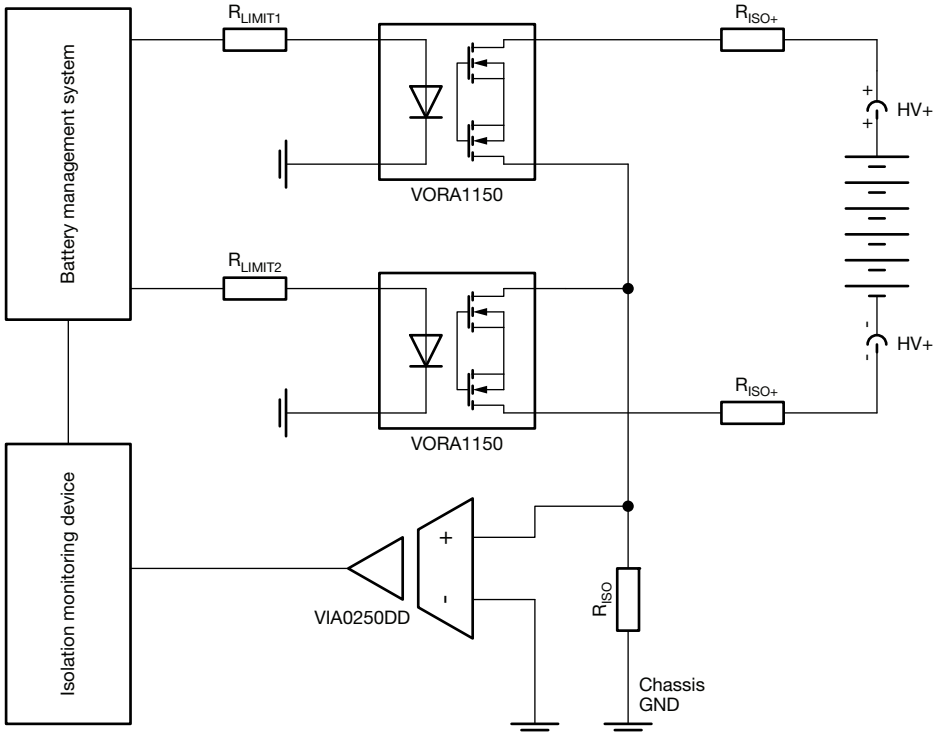

Fig. 2 - Isolation Measurement With the VORA1150 in EVs

R_{ISO} CALCULATION

To protect the VORA1150, R_{ISO} must be calculated to limit the current in an overvoltage condition and depends on the applied overvoltage. For example, during a HiPot test of 2500 V for 5 s, the VORA1150 will clamp the voltage to 1500 V and the rest is the voltage drop over the resistor. To keep the current below 0.9 mA, a 1.111 MΩ resistor is required. A standard value such as 1.2 MΩ (resulting in ≈0.83 mA) provides sufficient protection.

$$R_{ISO} = (V_{HIGHPOT} - V_{BREAK})/I_{AVA} = (2500\ V - 1500\ V)/0.9\ mA \geq 1.111\ M\Omega\ (1.2\ M\Omega)$$

TEST VOLTAGE	R_{ISO} FOR 5 s TEST
2000 V	560 kΩ
2500 V	1.2 MΩ
3000 V	1.8 MΩ
3500 V	2.4 MΩ