

Efficient 12 V Reverse Battery Protection of Down Stream Circuit with Asymmetric TVS Diodes

Overview

Automotive battery management systems and MOSFET controllers are exposed to positive-voltage transients, such as motor inductive kickback, load dump events, and charger-induced surges. These circuits also experience negative transients caused by phenomena such as ground bounce and inductive ringing. Effective protection against both types of transients is essential to ensure system stability, component longevity, and overall vehicle safety.

The TPSMB Asymmetrical TVS Diodes (TPSMBxx1xCA) deliver a compact, single-component solution for protecting anti-reverse MOSFETs, diodes, and DC/DC converter ICs from both positive and negative voltage surges. Its asymmetrical clamping design provides significantly lower clamping voltage during negative surges, enabling the use of lower-rated MOSFETs or diodes. This helps reduce conduction losses, simplifies circuit design, and lowers overall BOM costs—making it an ideal choice for high-efficiency and reliable automotive system protection.



Features

- Asymmetrical protection with low positive clamping (24–30 V) and low negative clamping (12–18 V).
- High performance: 600 W peak pulse power, <1 ns response time, and up to 30 kV ESD dissipation.
- Automotive qualified: AEC-Q101 compliant with a wide -65°C to 175°C junction temperature range.

Benefits

- Single device replaces multiple Zeners/TVS diodes, streamlining PCB design.
- Allows the use of lower-voltage MOSFETs or diodes, which helps reduce conduction losses, streamline circuit design, and lower BOM costs—while still maintaining reliable system-level protection.

Table 1. Electrical Characteristics for Asymmetric TVS Diodes ($T_A = 25\text{ }^\circ\text{C}$ unless otherwise noted)

Part Number	Marking	K to A							A to K						
		Maximum Reverse Leakage $I_{R1} @ V_{R1}$ (μA)	Stand off Voltage V_{R1} (V)	Breakdown Voltage $V_{BR} @ I_{T1}$ (V)		Maximum Clamping Voltage $V_{C1} @ I_{PP1}$ (V)	Maximum Peak Pulse Current I_{PP1} (A)	Test Current I_{T1} (mA)	Maximum Reverse Leakage $I_{R2} @ V_{R2}$ (μA)	Stand off Voltage V_{R2} (V)	Breakdown Voltage V_{BR} (V) @ I_{T2}		Maximum Clamping Voltage $V_{C2} @ I_{PP2}$ (V)	Maximum Peak Pulse Current I_{PP2} (A)	Test Current I_{T2} (mA)
				Min	Max						Min	Max			
TPSMB2412CA	2412	1	24	26.6	29.4	38.9	15.5	1	1	12	13.3	14.7	19.9	30.2	1
TPSMB2616CA	2616	1	26	28.9	31.9	39.5	14.3	1	1	16	17.8	19.7	26.0	23.1	1
TPSMB2818CA	2818	1	28	31.1	34.4	42.5	13.3	1	1	18	20.0	22.1	29.2	20.6	1
TPSMB3018CA	3018	1	30	33.3	36.8	48.4	12.4	1	1	18	20.0	22.1	29.2	20.6	1

The TPSMB Asymmetrical Series is ideal for a broad range of automotive applications requiring 12V battery anti-reverse protection, including Domain and zonal controllers, Body control modules (BCMs), Infotainment and lighting systems, ECUs and power seats, Motor pre-tensioner safety belts, and ADAS systems, etc.

Figure 1. 12V Anti-reverse Battery Protection

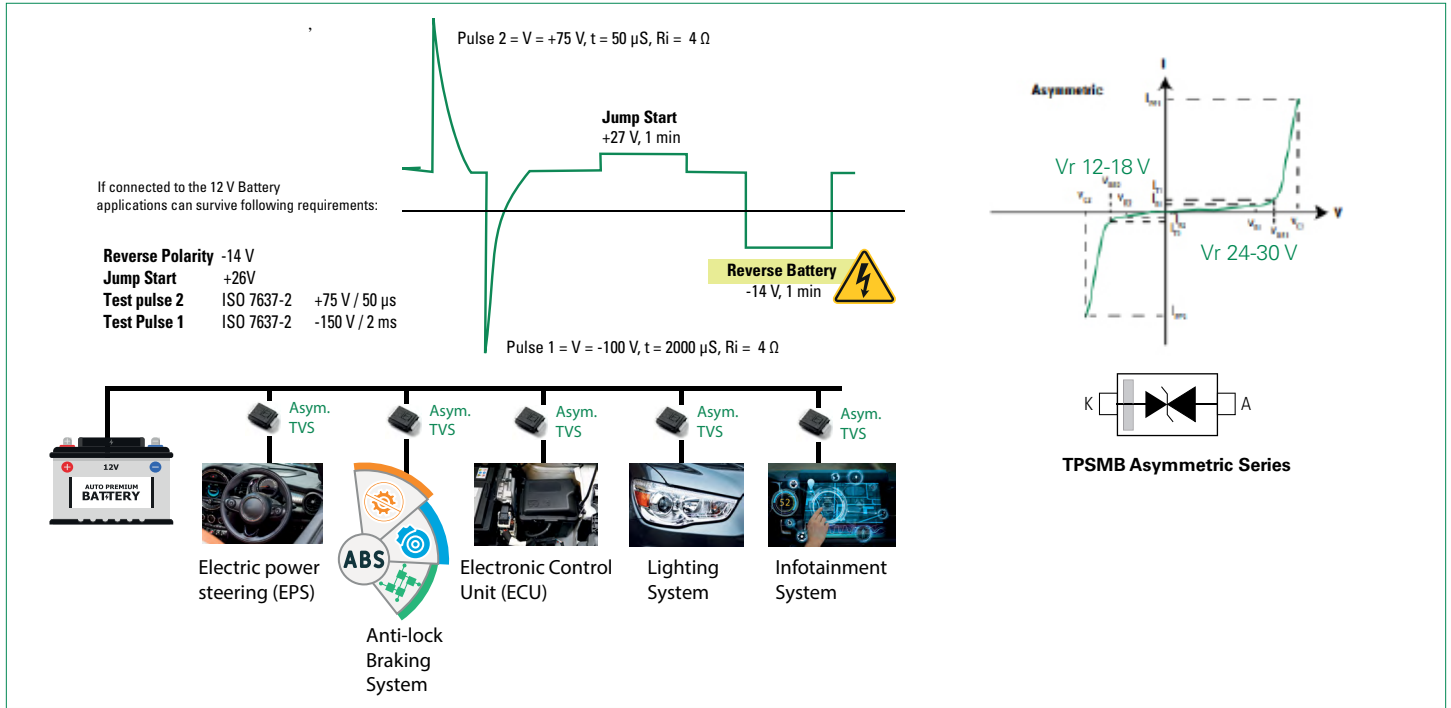
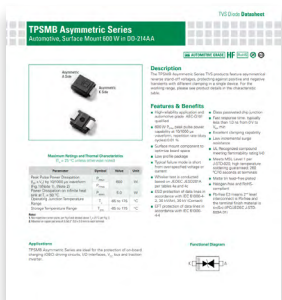


Figure 2. Application Diagram of Reverse Battery Protection (using TPSMB2616CA)

Symmetrical TVS diodes are commonly used in reverse-polarity protection circuits. In this case, the asymmetrical TPSMB2616 offers a more efficient solution.

When a positive pulse (e.g., ISO7637-2 Pulse 2) is applied, the TPSMB2616 clamps the voltage to below 40 V, effectively protecting the downstream load. During negative pulses (e.g., ISO7637-2 Pulse 1), it ensures that the source-drain voltage (V_{SD}) of the P-MOS transistor is limited to 26 V—safely below its rated voltage of 30 V.

This approach allows designers to use a standard 30 V P-MOS instead of a higher-voltage alternative, reducing component costs. Additionally, the asymmetrical TVS diode can replace two series-connected TVS diodes, saving valuable PCB space and simplifying the circuit design.



For more information about [TPSMB Asymmetric TPSMBxx1xCA](https://www.littelfuse.com/tpsmb), please reference the product datasheet on [Littelfuse.com](https://www.littelfuse.com).