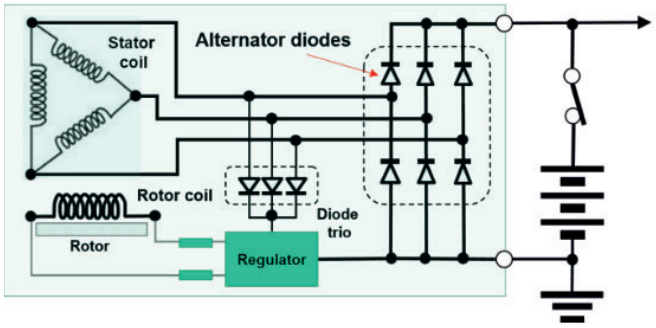
TVS Diodes for 12 V Powertrains With Centralized Load Dump Suppression-Type Alternators

By Kim Sweetman

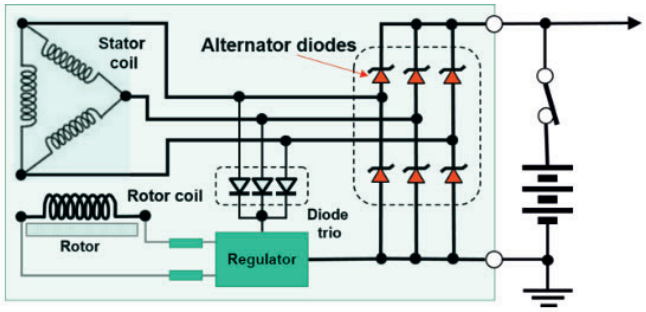
DEFINITION OF CENTRALIZED LOAD DUMP SUPPRESSION-TYPE ALTERNATORS

Conventional powertrains use a standard-type alternator diode and regulator to control the output voltage for normal operations.

The regulator controls output voltage in normal rotor operations and does not suppress high voltages in load dump situations.



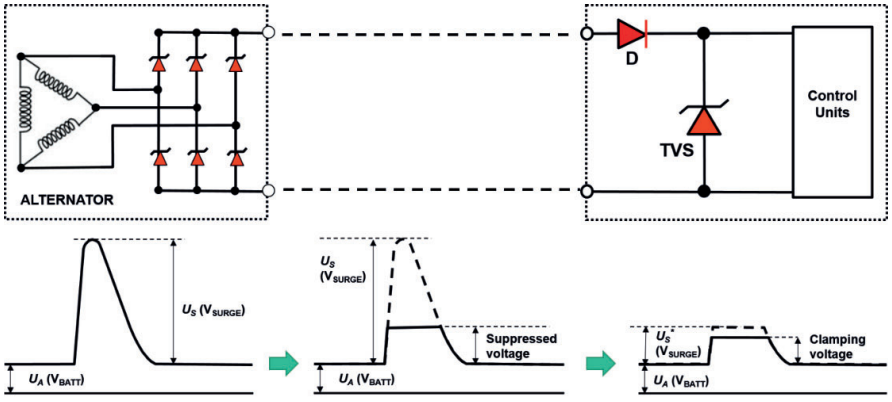
Conventional-Type Alternator



Centralized Load Dump Suppression-Type Alternator

A centralized load dump suppression-type alternator is different than a traditional powertrain in that it suppresses high voltages when it reaches load dump status to lower them to a specified voltage range, thus ensuring normal operation.

Most central load dump suppression-type alternators use Zener alternator diodes to suppress high voltages.



TECHNICAL NOTE

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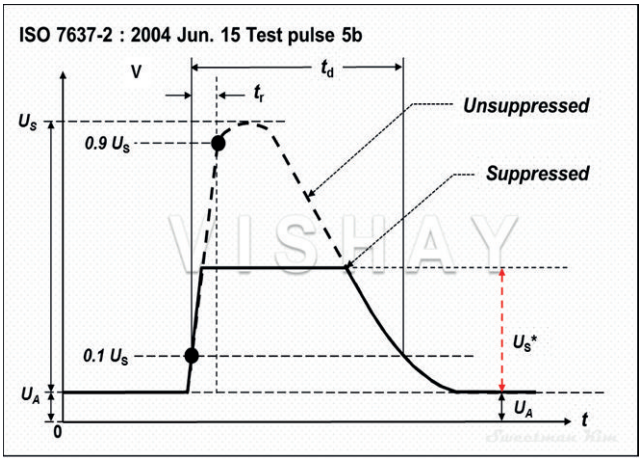
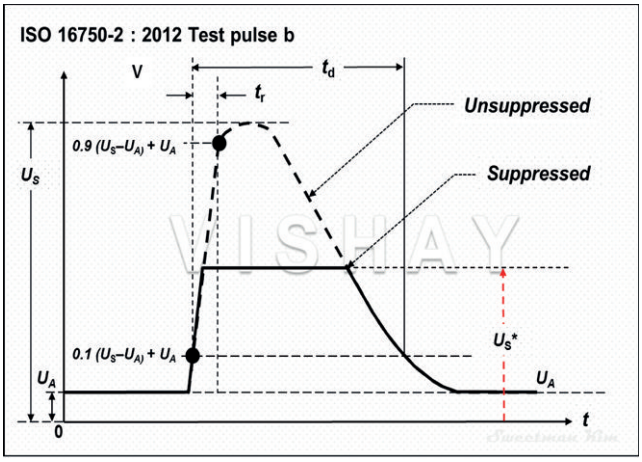
TEST SPECIFICATIONS FOR 12 V POWERTRAINS WITH CENTRALIZED LOAD DUMP SUPPRESSION-TYPE ALTERNATORS

Below are test conditions for centralized load dump suppression:



PARAMETER	VALUE
$U_A/(U_N)$	13.5 V
U_S	65 V ≤ U_S ≤ 87 V
U_S*	As specified by customer
R_i	0.5 Ω ≤ R_i; ≤ 4.0 Ω
t_d	40 ms ≤ t_d ≤ 400 ms
T_r	10 ms (+0/-5 ms)
Pulses	1 pulse: ISO 7637-2 : 2004



PARAMETER	VALUE
$U_A/(U_N)$	13.5 V
$U_S{}^A$	79 V ≤ U_S ≤ 101 V
U_S*	35 V
R_i	0.5 Ω ≤ R_i; ≤ 4.0 Ω
t_d	40 ms ≤ t_d ≤ 400 ms
T_r	10 ms (+0/-5 ms)
Pulses	5 pulses at intervals of 1 min

Some vehicle manufacturers use other standards to specify suppressed voltage, pulse width, and internal resistance (R_i).

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LOAD DUMP PROTECTION DEVICES FOR CENTRALIZED LOAD DUMP SUPPRESSION POWERTRAINS

Guidelines for selecting load dump protection devices for use in vehicles include:

1. The stand-off voltage is more than 24 V for 12 V powertrains, as determined by withstand test or jumper-start test conditions
2. The maximum clamping voltage for ISO 7637-2: 2004 June 15 at pulse 1, 2a, 2b, 3a, 3b, and 5b, or ISO 16750-2: 2010 at pulse b, is lower than the target clamping voltage
3. Select the appropriate protection device based on target clamping voltage, input surge voltage, pulse width, and internal resistance (R_i)

Most clamping-type protection devices have a clamping ratio, which is the difference in the breakdown voltage and clamping voltage at low and high surge energy conditions.

ELECTRICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)

DEVICE TYPE	DEVICE MARKING CODE	BREAKDOWN VOLTAGE V_{BR} (1) AT I_T (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_R (µA)	MAXIMUM REVERSE LEAKAGE AT V_{WM} T_J = 150 °C I_D (µA)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN.	MAX.						
TPSMC24A	EMP	22.8	25.2	1	20.5	1	10	45.2	33.2
TPSMC27A	EPP	25.7	28.4	1	23.1	1	10	40	37.5
TPSMC30A	ERP	28.5	31.5	1	25.6	1	10	36.2	41.4

For example, the maximum voltage from a centralized load dump suppression-type alternator generates 54 V at load dump status; however, the maximum allowed input voltage for this circuit is 35 V. The protection device will clamp at a minimum of 19 V from the input voltage, preventing the circuit from malfunctioning.

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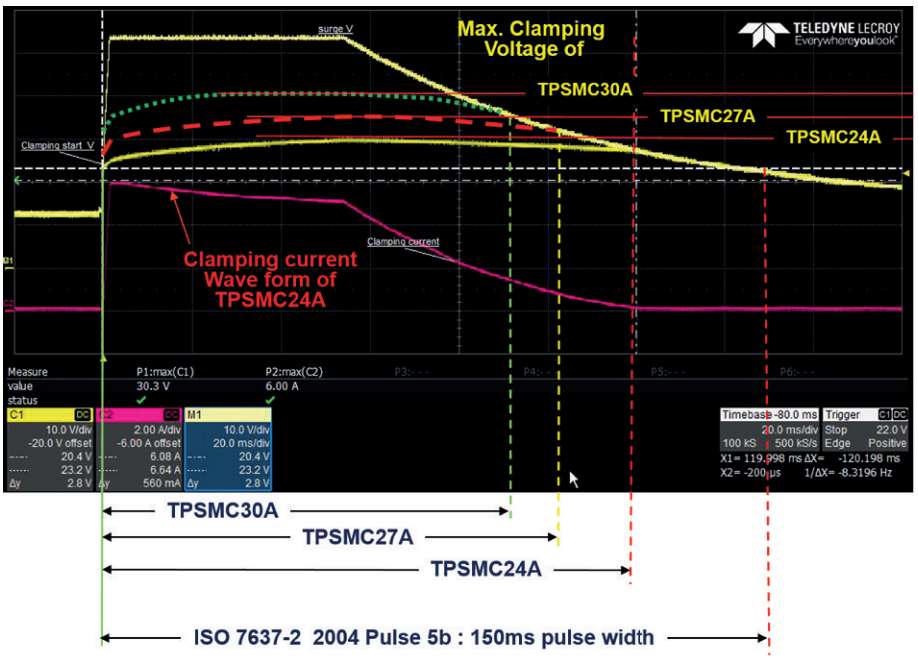

CLAMPING CHARACTERISTICS AT ISO 7637-2 PULSE 5b TEST						
	INPUT		CLAMPING			
	U_S*	R_I	START VOLTAGE	PEAK VOLTAGE	PEAK CURRENT	CLAMPING OP. TIME
	V	Ω	V	V	A	ms
TPSMC24A	54.0	4.5	23.2	30.3	6.0	120.0
TPSMC27A	54.0	4.0	25.7	33.6	5.9	105.0
TPSMC30A	54.0	3.5	28.9	36.3	5.3	90.0

Each part number in the TPSMC Series has different maximum clamping voltages at the same surge pulse condition.

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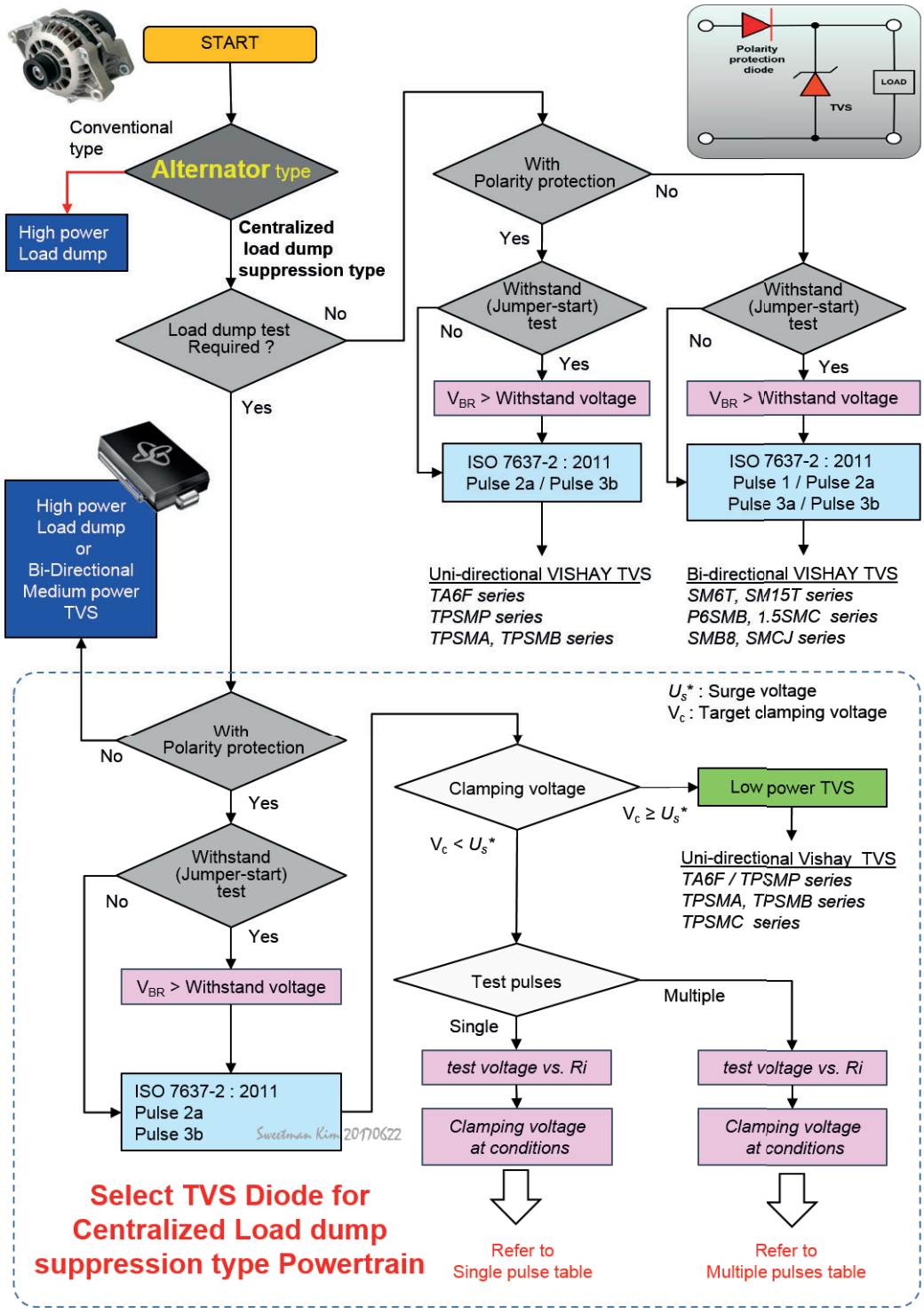
FLOWCHART OF TVS DIODES FOR CENTRAL LOAD DUMP PROTECTION APPLICATIONS



TECHNICAL NOTE

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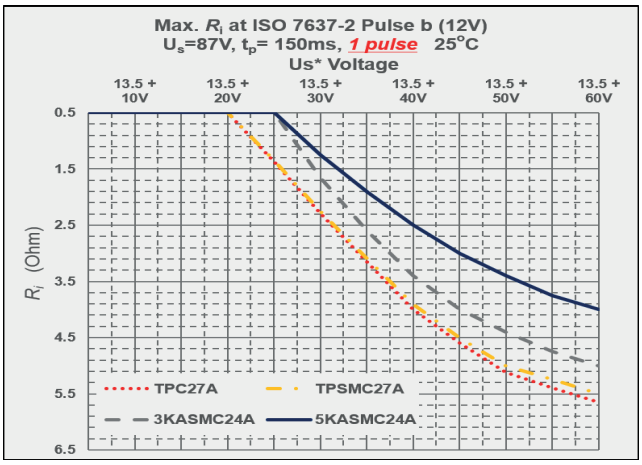
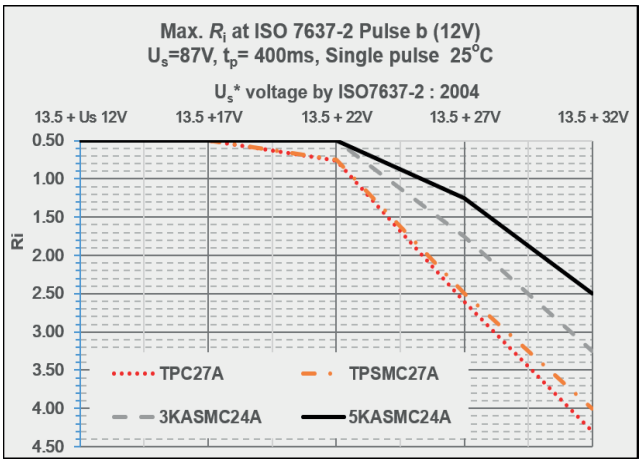
TVS DIODES WITH MEDIUM CURRENT SURGE CAPABILITY FOR CENTRALIZED LOAD DUMP PROTECTION POWERTRAINS

Vishay offers several TVS diode devices for centralized load dump protection powertrains. Most devices have a surge capability of 1500 W to 5000 W.

SINGLE PULSE TEST WITH TPC27A, TPSMC27A, 3KASMC24A, AND 5KASMC24A

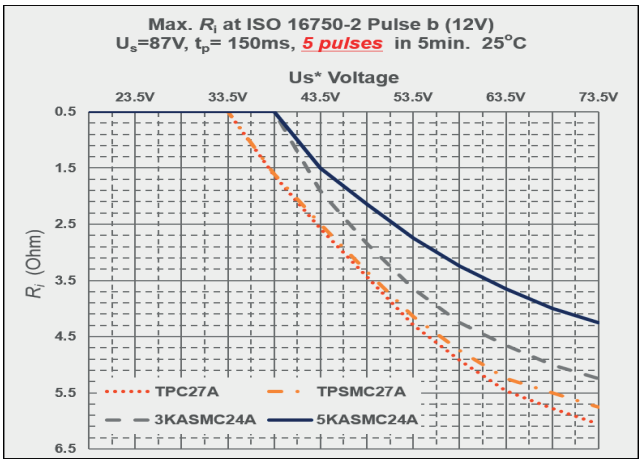
The following graphs show the maximum internal resistance (R_i) at different input surge voltages for these commonly used TVS diodes in single pulse test conditions.

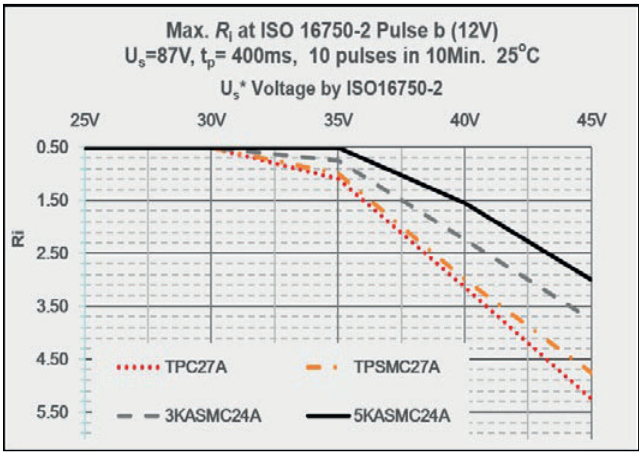




MULTIPLE PULSE TEST FOR TPC27A, TPSMC27A, 3KASMC24A, AND 5KASMC24A

The following graphs show the maximum internal resistance (R_i) at different input surge voltages for these commonly used TVS diodes in multiple pulse test conditions.





Vishay offers a range of low to medium power TVS diodes in high power density miniature packages to protect electronic units in vehicles against load dump surges and transient voltages from motors, ignition circuits, and other transient sources in powertrains.

For technical questions within your region: DiodesAmericas@vishay.com, DiodesAsia@vishay.com, DiodesEurope@vishay.com