



One of the World's Largest
Manufacturers
of Discrete Semiconductors and Passive Components

VISHAY DIODES RECTIFIERS, ABD TVS and Zener Diodes

For Automotive Applications

June 2013

Automotive Applications

Rectifier Applications

Polarity protection

Signal line protection

Rectification

Freewheeling



ABD TVS Applications

Load dump

Second protection

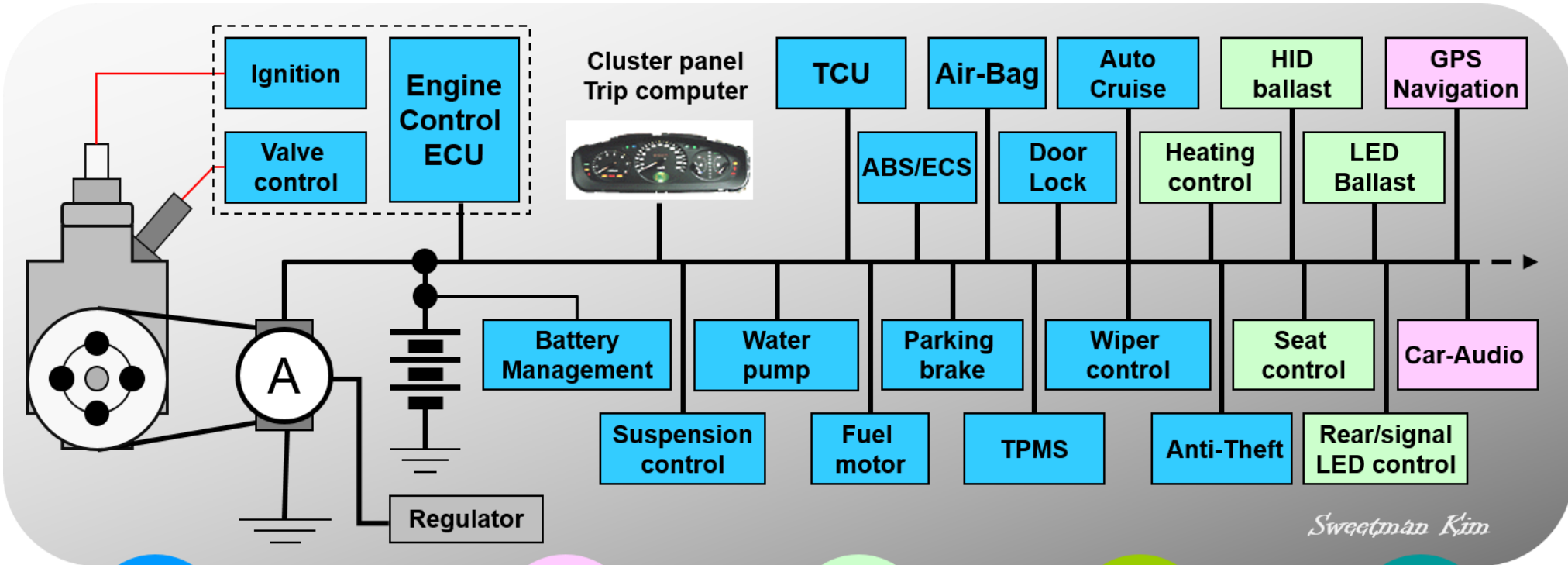
Freewheeling

Automotive Applications



Automotive Applications

- Vishay Diodes in Automotive



Load dump TVS
SMD / AXIAL TVS



Rectifier
SMD / AXIAL



Small Signal



Zener



Power module

Automotive Electronics and Test Standards

Conducted transient on power line

ISO 7637 - 2 : 2010

ISO 16750-2 : 2010

JASO D-001 : 94

SAE J1113-11

SAE J1455

Toyota TSC-7001

GM

Ford

Nissan

Honda

Renault

Peugeot

Chrysler

Mercedes

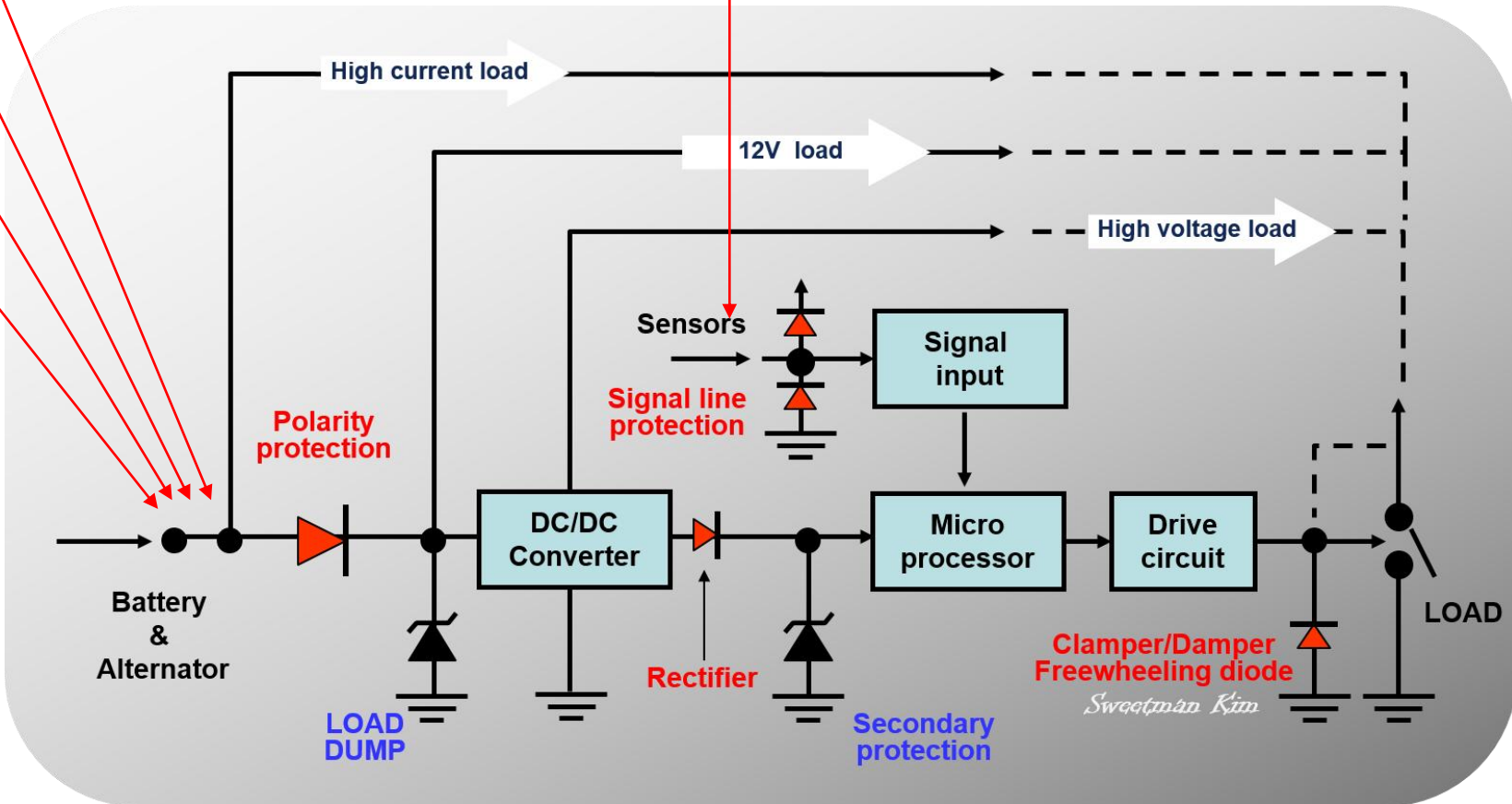
BMW

Volkswagen/Audi

Hyundai/Kia

Conducted transient on non-power line

ISO 7637 - 3 : 2010

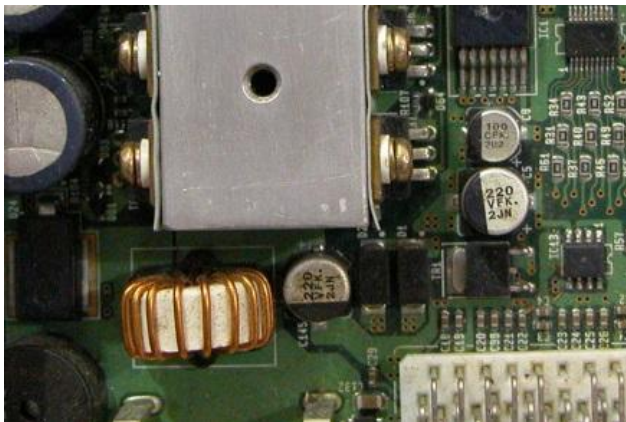


Rectifier Applications

Polarity protection

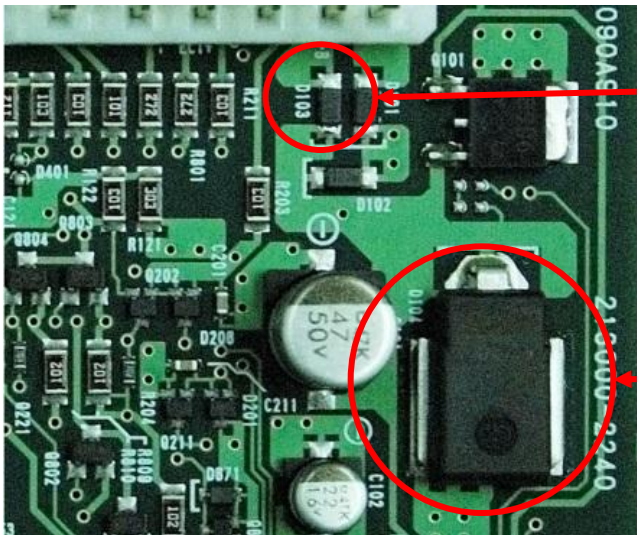
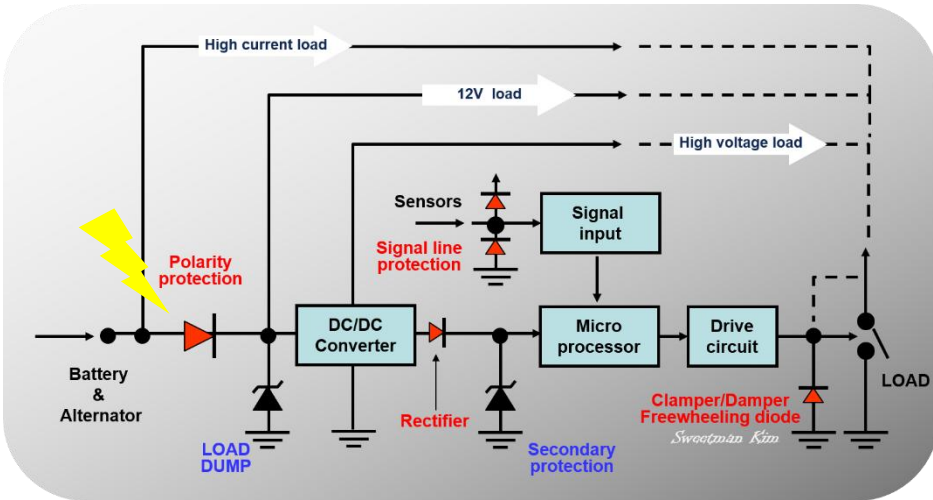
Signal line protection

Rectification



Freewheeling

Polarity Protection



Polarity protection

Load Dump TVS

Definition

- Protecting circuit from reverse polarity connection or hazardous reverse transient voltage penetration

Related test specifications

- ISO 7637-2 :2010 pulse 1 and pulse 3a
 - 100 V (pulse1) and -150 V (3a) for 12 V power train
 - 600 V (pulse1) and -200 V (3a) for 24 V power train
- JASO D001 : 94
 - type B-1(-80 V), B-2 (-260 V) for 12 V power train
 - type E (-320 V) for 24 V power train

Considerations

- Peak reverse voltage
- Continuous forward loading current
- Forward surge current at load dump operation

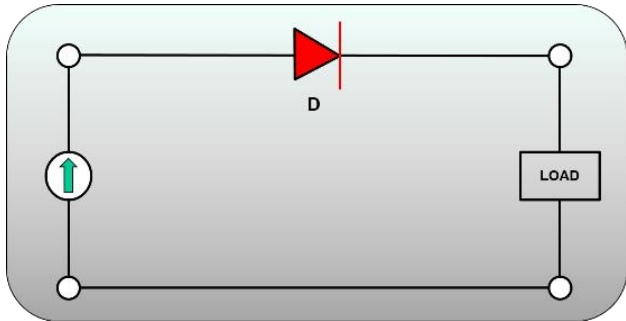
Products

- Standard rectifiers
- ESD capability standard rectifiers
- Standard avalanche rectifiers

Polarity Protection Circuits and Vishay Diodes

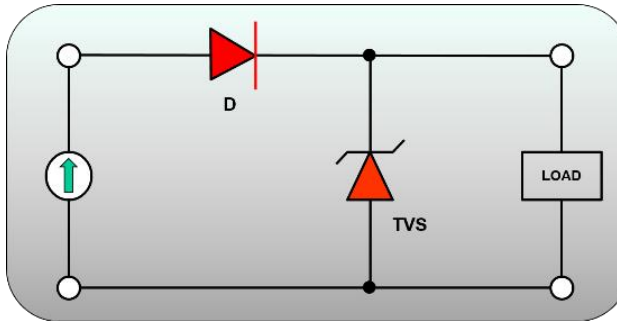
Serial connection

- For low-current and high-impedance load
- No protection of forward high voltage



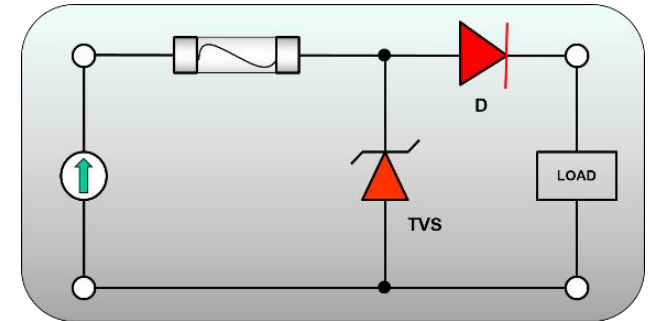
With load dump

- Common application
- For low-current load



With load dump

- For high-current load



Rectifier type	1 A	1.5 A	2 A	3 A	4 A	5 A
Standard	S1 , S07	S2	S1	S3		S5
ESD capability	MSE1P , SE10P	SE15P	SE20AFG	SE30AFG		
Avalanche	AS1P	BYG10		AS3BJ , AS3P	AS4P	

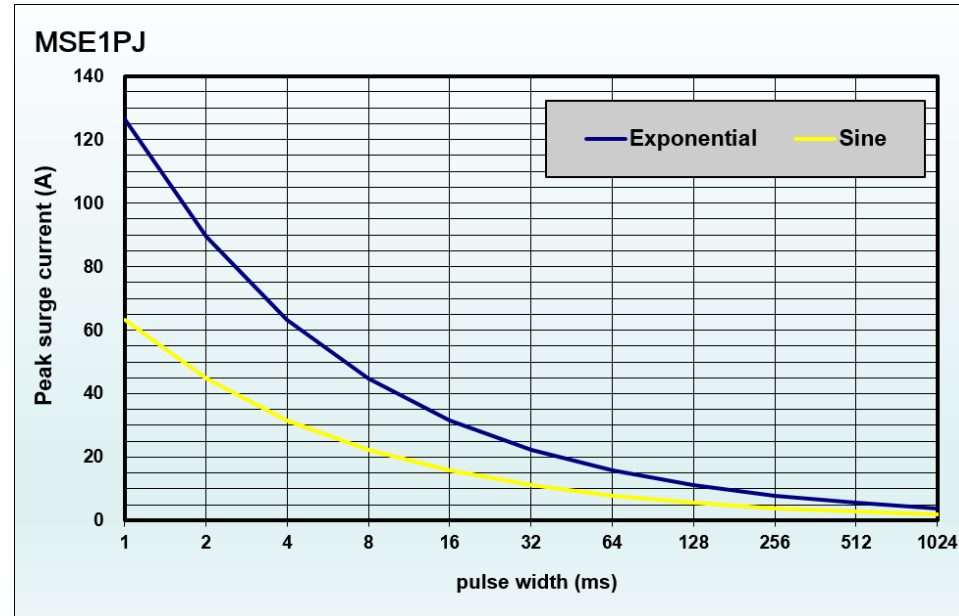
* 1 : SlimSMA package 1 mm height

Vishay Rectifiers for Polarity Protection

Product Groups	P/N	V_{RRM}	I_F (AVG)	I_{FSM}	Package	For ISO16750-2 Pulse 5a Ri max. (Ω) at 101 V, 25° C, 10 pulses	
		(V)	(A)	(A)		(40 ms)	(400 ms)
ESD capability	MSE1P	100 - 600	1	20	MicroSMP	2.4	8.3
	SE10P	100 - 600	1	25	DO-220AA	1.9	6.5
	SE15P	100 - 600	1.5	30	DO-220AA	1.6	5.5
	SE20AFG	400	2		DO-221AC		
	SE30AFG	400	3	40	DO-221AC	1.2	4.0
Standard	S07	100 - 1000	0.7	25	DO-219AB		
	S1P	50 - 1,000	1	30	DO-220AA	1.5	5.3
	S1	50 - 1,000	1	40	DO-214AC	1.3	4.1
	S2	50 - 1,000	1.5	50	DO-214AA	0.9	3.3
	S3	50 - 1,000	3	150	DO-214AB	0.5	1.1
	S4P	100 - 1,000	4	100	TO-277A	0.5	1.7
	S5	50 - 1,000	5	100	DO-214AB	0.5	1.7
Avalanche	AS1P	200 - 1,000	1	30	DO-220AA	1.6	5.5
	BYG10	200 - 1,600	1.5	30	DO-214AC	1.6	5.5
	AS3P	200 - 1,000	3	70	TO-277A	0.7	2.4
	AS3BJ	600	3	90	DO-214AA	0.5	1.8
	AS4P	200 - 1,000	4	100	TO-277A	0.5	1.6

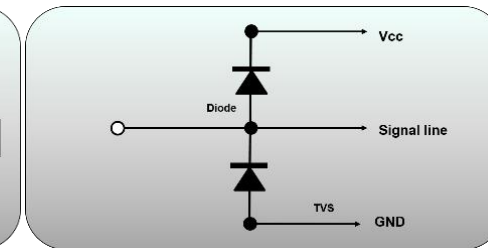
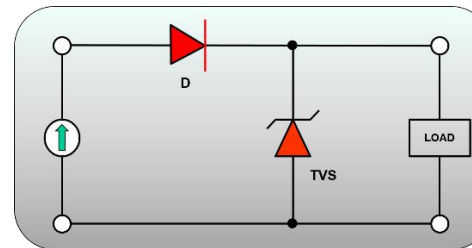
MSE1P Series MicroSMP ESD Capability Surface-mount Rectifier

- **High-current density** ESD capability rectifier
 - **1 A** forward current capability in MicroSMP package
 - **100 V to 600 V** V_{BR} and **25 KV ESD** capability
 - **20 A forward surge capability**
 - 10 ms sine wave non-repetitive single wave
 - - 55 to +175 °C wide operating temperature range
 - AEC-Q101 qualified
 - Pb-free, RoHS compliant and Halogen-free



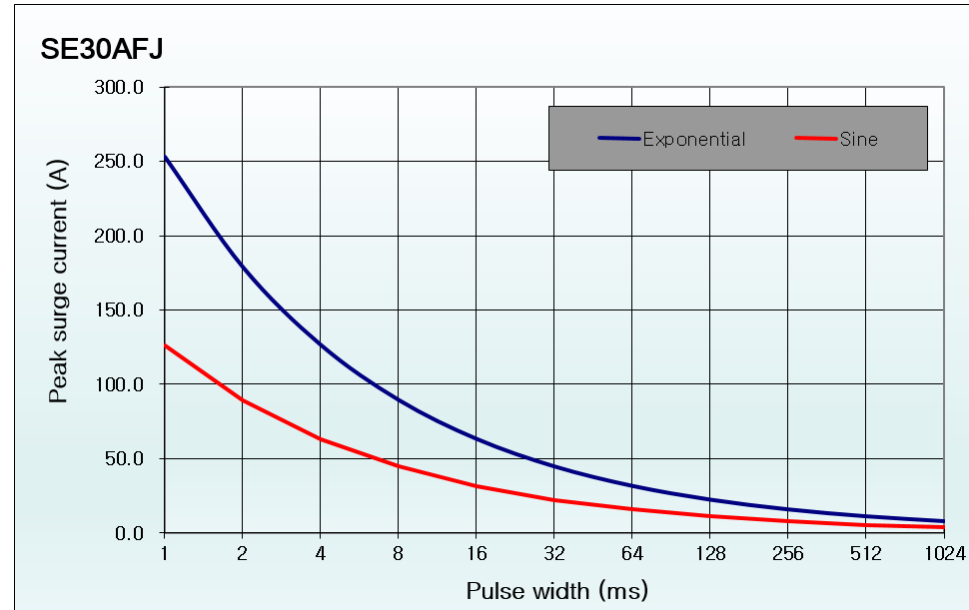
Applications

- Polarity protection for automotive electronics
- Signal line protection



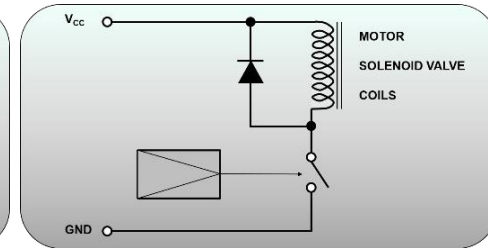
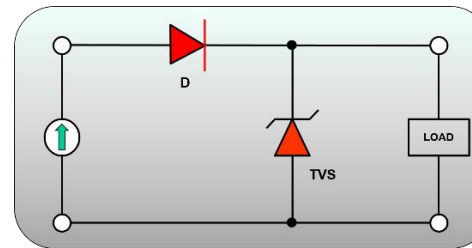
SE30AF Series SlimSMA™ ESD Capability Surface-mount Rectifier

- **High-current density ESD capability rectifier**
 - **3 A forward current capability in SlimSMA package**
 - **100 V to 600 V V_{BR} and 25 KV ESD capability**
 - **40 A forward surge capability**
 - 10 ms sine wave non-repetitive single wave
 - **- 55 to +175 °C wide operating temperature range**
 - **AEC-Q101 qualified**
 - **Pb-free, RoHS compliant and Halogen-free**



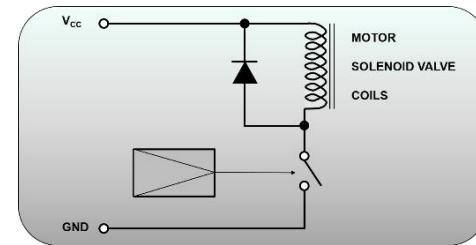
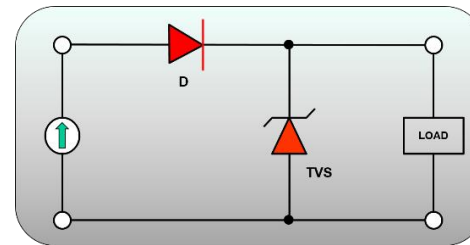
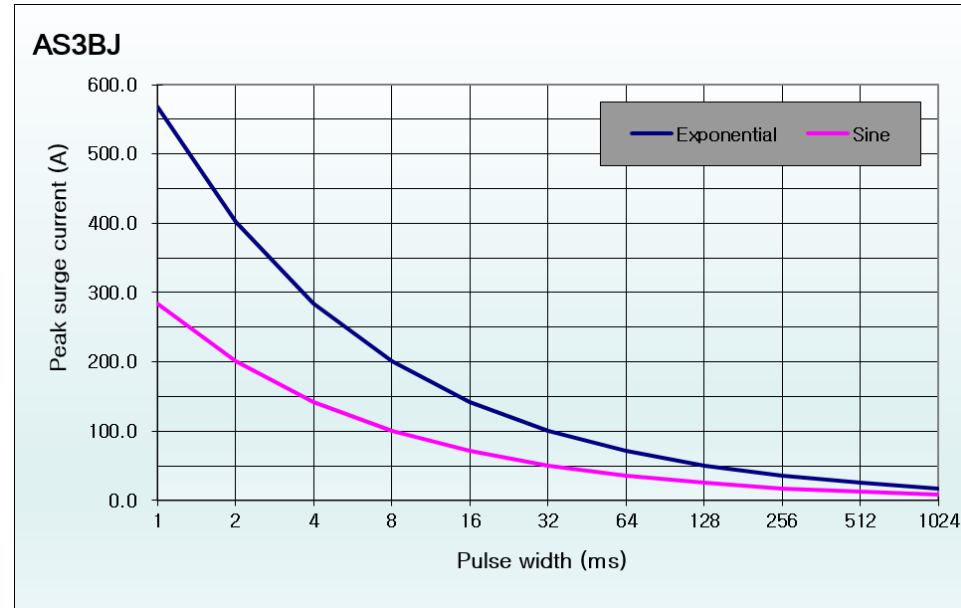
Applications

- **Polarity protection for automotive electronics**

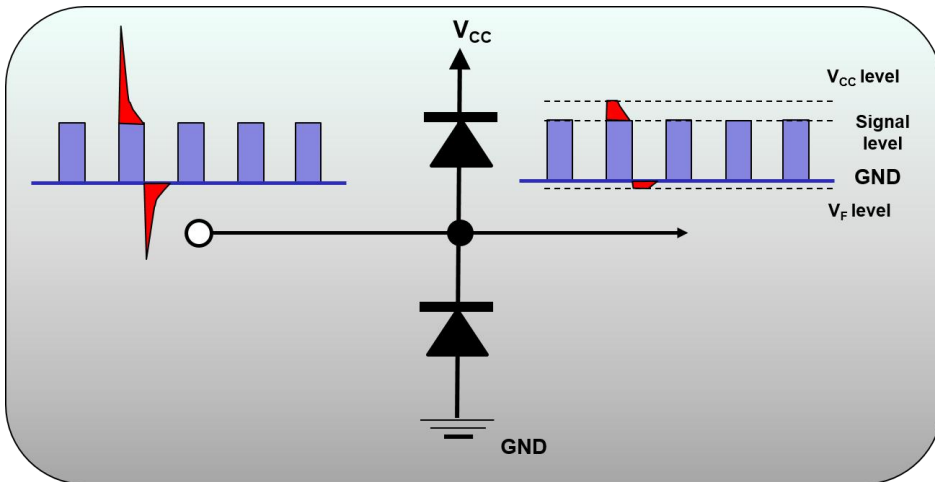
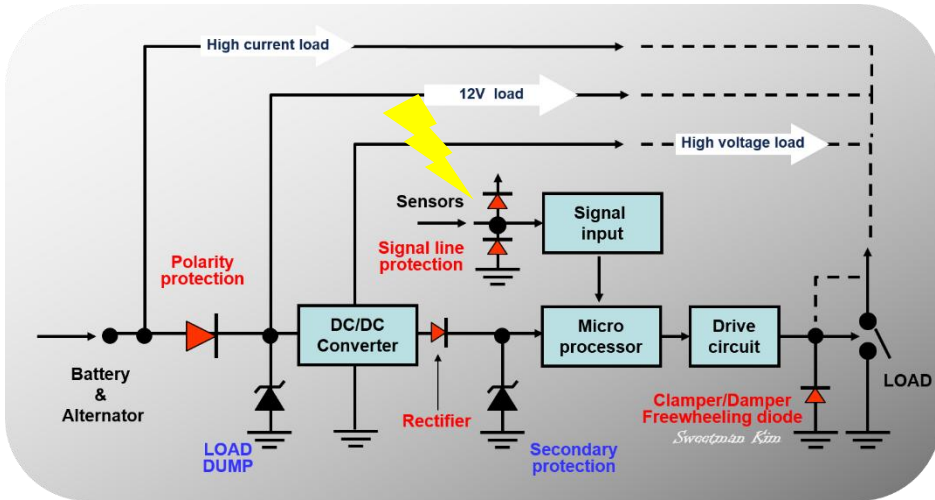


AS3BJ Avalanche Surface-mount Rectifier

- **High-current density avalanche rectifier**
 - **3 A** forward current capability in SMB package
 - **600 V** V_{BR} and **20 mJ** avalanche capability
 - passed 25 KV ESD test
 - **90 A** forward surge capability (**I^2T is 40 A²sec**)
 - 10 ms sine wave non-repetitive single wave
 - **-55 to +175 °C** wide operating temperature range
 - AEC-Q101 qualified
 - Pb-free, RoHS compliant and Halogen-free
- **Applications**
 - **Polarity protection** for automotive electronics
 - **Snubber / Clamp / Damper** for high-voltage inductive load drive



Signal Line Protection



■ Definition

- Protecting circuit from reverse polarity connection or hazardous reverse transient voltage penetration into signal lines

■ Related test specifications

- ISO 7637-3 :2010

■ Considerations

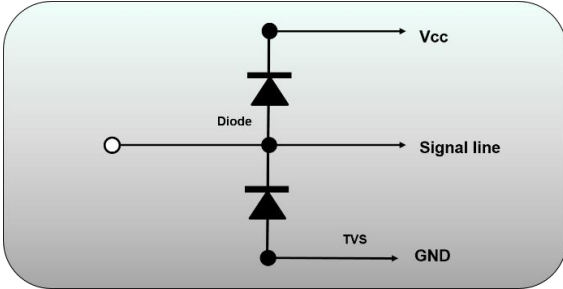
- Peak reverse voltage
- Forward surge current capability
- ESD capability

■ Products

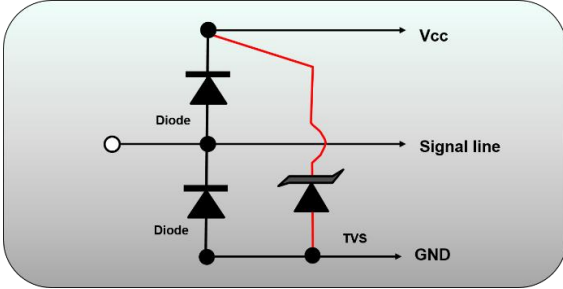
- Standard rectifiers
- ESD capability standard rectifiers
- Standard avalanche rectifiers

Signal Line Protection Circuits and Vishay Diodes

- Major application of 1 A, 400 V rectifiers in automotive electronics
- High-forward voltage on signal line over than V_{cc} will bypass to V_{cc} line
- Reverse voltage on signal line will bypass to ground line
- Medium power TVS is necessary when signal is directly connected to IC input and V_{cc} line as shown in Picture (2)
- Vishay rectifiers are AEC-Q101 qualified
- Lead frame structure of Vishay rectifiers offers better reliability in high-current forward surge current protection

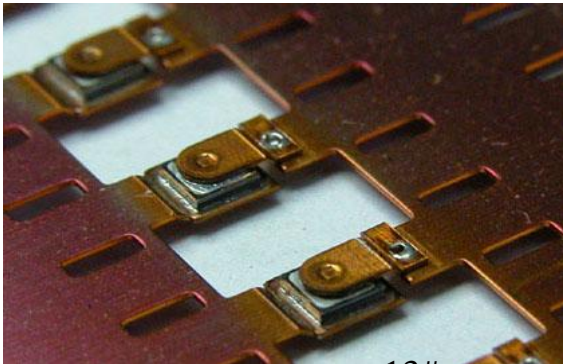


Picture (1) rail-to-rail protection

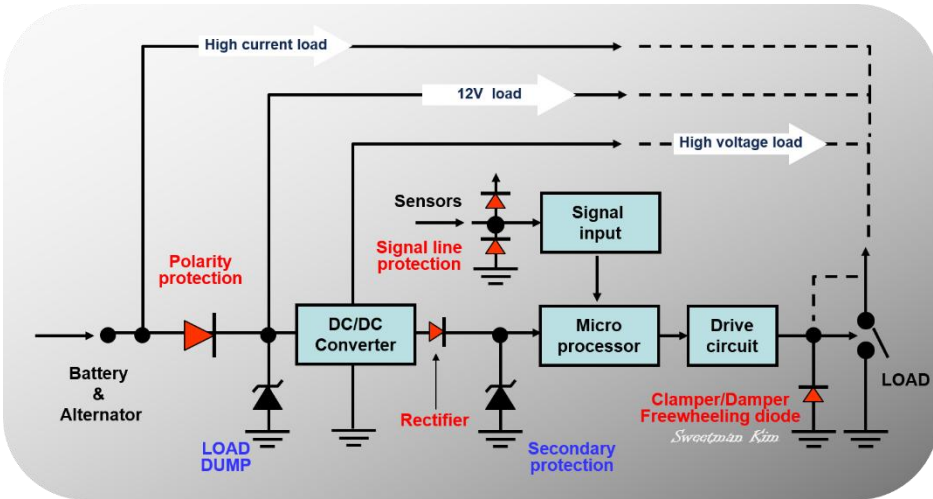


Picture (2) rail-to-rail protection with TVS

Product Groups	P/N	V_{RRM}	I_F (AVG)	I_{FSM}	Package
		(V)	(A)	(A)	
ESD capability	MSE1P	100 - 600	1	20	MicroSMP
	SE10P	100 - 600	1	25	DO-220AA
Standard	S07	100 - 1000	0.7	25	DO-219AB
	S1P	50 - 1,000	1	30	DO-220AA
	S1	50 - 1,000	1	40	DO-214AC
Avalanche	AS1P	200 - 1,000	1	30	DO-220AA



Rectification



■ Definition

- Rectifying diode for boost or buck type DC to DC converter or inverters
 - 12/24 V to 5 V voltage converting for microprocessors of most electronic units
 - 12/24 V to high voltages converting for air-bag igniter, engine ignition, LED, HID Ballast and Piezo injection

■ Related test specifications

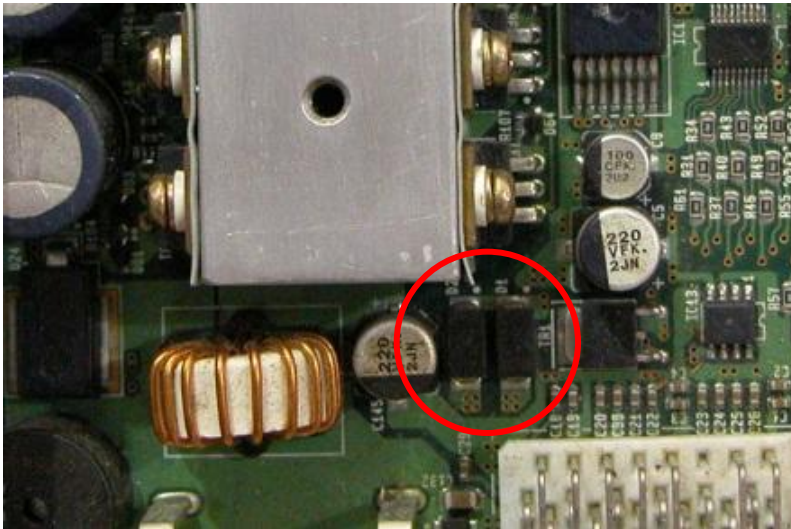
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■ Considerations

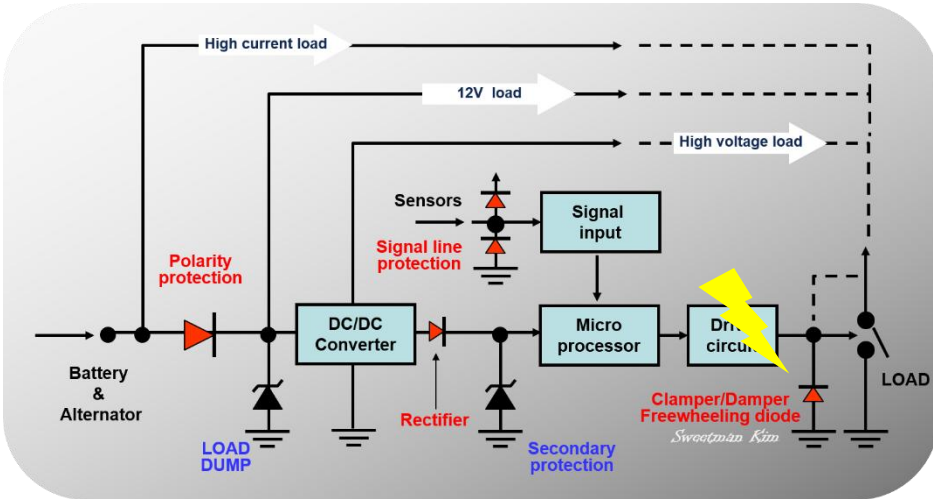
- Peak reverse voltage
- Continuous forward loading current
- Forward surge current at Load dump operation

■ Products

- Planar type or TMBS® Schottky rectifiers
- Ultrafast rectifiers
- FRED Pt® rectifiers
- Standard avalanche rectifiers



Freewheeling Diode



■ Definition

- Protecting circuits from induced high voltage by inductance load in operation

■ Related test specifications

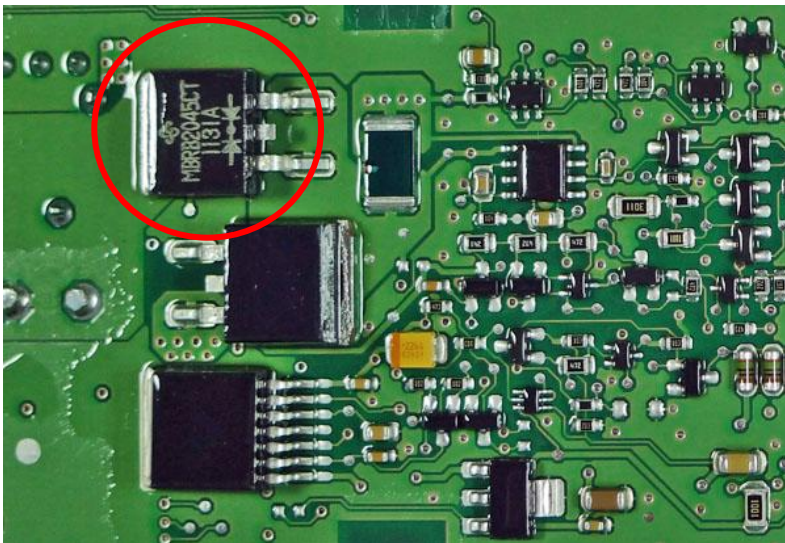
- N/A

■ Considerations

- Peak reverse voltage
- Forward surge current at freewheeling operation
- Avalanche capability

■ Products

- Planar type or TMBS® Schottky rectifiers
- Ultrafast rectifiers
- FRED Pt® rectifiers
- Standard avalanche rectifiers



Vishay Rectifiers for Rectification and Freewheeling

■ TMBS® Schottky Rectifiers

- High-current density : 5 to 60 A
- High voltage : 45 to 200 V V_{RRM}
- ESD capability improved
- SlimSMA™, TO-277A, TO-220AB, TO-220AC and D²PAK

AEC Q101 qualified

■ High-Performance and Planar Schottky Rectifiers

- High-current density : 1 to 30 A
- High voltage : 20 to 100V V_{RRM}
- High-Performance Schottky: ESD capability improved
- SlimSMA, TO-277A, DPAK, IPAK, TO-220AB, TO-220AC & D²PAK

■ FRED Pt® & Hexfred® Rectifiers

- High-current density : 6 to 150 A
- High voltage : 200 to 600 V V_{RRM}
- DPAK, IPAK, TO-220AB, TO-220AC, D²PAK, TO-247AC and PowerTab®

FRED Pt® & Hexfred®

Automotive Applications coverage

- Engine Control
- Automotive EV/ HEV: Main Inverter
 - On Board Charger
 - Battery Management
 - DC/DC Converter
- Braking
- Lighting

- Steering (1)
- Infotainment, Navigation, Audio (1)
- Heating, Ventilation, Air Conditioning (1)
- and safety (1)



Fred Pt[®] Hexfred[®] AEC Q101 Products

Target segment: Engine Control Unit

Technology: Fred Pt[®]

Part Number	Package	Config	I _F (A)	V _{RRM} (V)	T _{jmax}	Status
VS-4EWH02FNHM3	D-PAK (TO-252AA)	Single	4	200V	175°C	Active
VS-6CWH02FNHM3	D-PAK (TO-252AA)	dual	6	200V	175°C	Active
VS-MURD620CTHM3	D-PAK (TO-252AA)	dual	6	200V	175°C	Active
VS-8CWH02FNHM3	D-PAK (TO-252AA)	dual	8	200V	175°C	Active
VS-10CWH02FNHM3	D-PAK (TO-252AA)	dual	10	200V	175°C	Active

e-smp package option in development

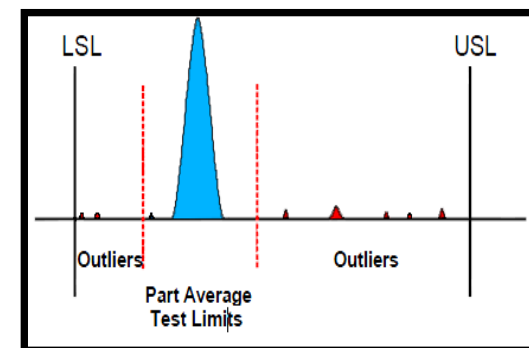
Technology: Fred Pt[®]

Part Number	Package	Config	I _F (A)	V _{RRM} (V)	T _{jmax}	Status
VS-1WFH02HM3	SMF	Single	1A	200V	175°C	samples available*
VS-2EJH03HM3	Slim SMA	Single	3	200V	175°C	samples available*
VS-3EJH03HM3	Slim SMA	Single	3	200V	175°C	samples available*
VS-4CSH02HM3	SMPC	dual	4	200V	175°C	samples available*
VS-4ESH02HM3	SMPC	Single	4	200V	175°C	samples available*
VS-6ESH02HM3	SMPC	Single	6	200V	175°C	samples available*
VS-6CSH02HM3	SMPC	dual	6	200V	175°C	samples available*
VS-8CSH02HM3	SMPC	dual	8	200V	175°C	samples available*

(*) contact factory for samples, technical info

Key Features:

- AEC Q101 qualified
- Limits based on PAT , 6s approach
- SYL : Statistical Yield limit
- **Soft recovery**
- **Low conduction losses**



▪ **ALL THE LINKED DIE CAN BE OFFERED AS BARE DIE CHIP**

Fred Pt[®] Hexfred[®] AEC Q101 Products

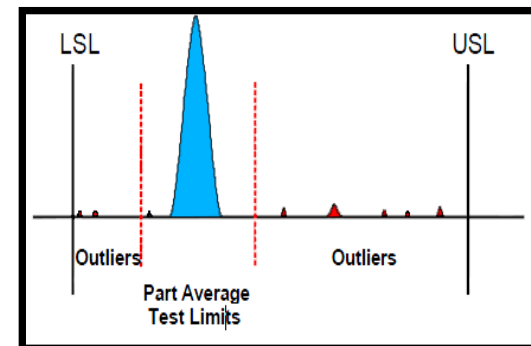
EV/HEV systems: . main inverter . on board chargers
 . battery management . DC-DC Converters

Key Features:

- AEC Q101 qualified
- Limits based on PAT , 6s approach
- SYL : Statistical Yield limit
- **Soft recovery**
- **Low conduction losses**

Technology: Fred Pt[®]
SMD package: D-Pak (TO-252AA), D2-Pak & TO-262

Part Number	Package	Config	I _F (A)	V _{RRM} (V)	T _{jmax}	Feature
VS-5EWH06FNxHM3	D-PAK (TO-	Single	5	600	175°C	Low Qrr
VS-6EWH06FNxHM3	D-PAK (TO-	Single	6	600	175°C	Low Qrr
VS-6EWX06FNxHM3	D-PAK (TO-	Single	6	600	175°C	Extreme Low
VS-8EWH06FNxHM3	D-PAK (TO-	Single	8	600	175°C	Low Qrr
VS-12EWH06FNxHM3	D-PAK (TO-	Single	12	600	175°C	Low Qrr
VS-15EWL06FNxHM3	D-PAK (TO-	Single	12	600	175°C	Low Vf
VS-15EWH06FNxHM3	D-PAK (TO-	Single	15	600	175°C	Low Qrr
VS-ETU1506SHM3	D2-Pak	Single	15	600	175°C	Low Vf
VS-ETH1506SxHM3	D2-Pak	Single	15	600	175°C	Low Qrr
VS-ETU3006SxHM3	D2-Pak	Single	30	600	175°C	Low Vf
VS-ETH3006SxHM3	D2-Pak	Single	30	600	175°C	Low Qrr
VS-ETU1506-1HM3	TO-262	Single	15	600	175°C	Low Vf
VS-ETH1506-1HM3	TO-262	Single	15	600	175°C	Low Qrr
VS-ETU3006-1HM3	TO-262	Single	30	600	175°C	Low Vf
VS-ETH3006-1HM3	TO-262	Single	30	600	175°C	Low Qrr



▪ **ALL THE LINKED DIE CAN BE OFFERED AS BARE DIE CHIP**

Fred Pt[®] Hexfred[®] AEC Q101 Products

EV/HEV systems: . main inverter . on board chargers
 . battery management . DC-DC Converters

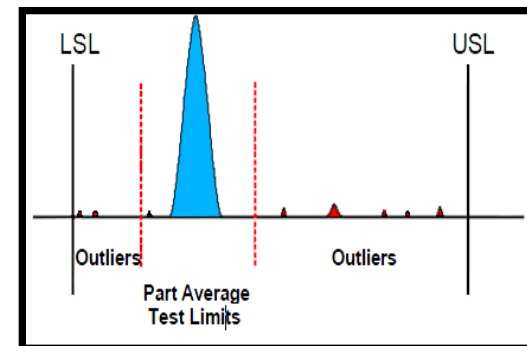
Key Features:

- AEC Q101 qualified
- Limits based on PAT , 6s approach
- SYL : Statistical Yield limit
- **Soft recovery**
- **Low conduction losses**

Technology: Fred Pt[®]

Through Hole package: TO-220, TO-247, Powertab

Part Number	Package	Config	I _F (A)	V _{RRM} (V)	Tjmax	Feature
VS-16CTU04HN3	TO-220	Dual	16A	400V	175°C	Low Vf
VS-8ETH06HN3	TO-220	Single	8A	600V	175°C	Low Qrr
VS-15ETL06HN3	TO-220	Single	15A	600V	175°C	Low Vf
VS-15ETH06HN3	TO-220	Single	15A	600V	175°C	Low Qrr
VS-APU3006HN3	TO-247	Single	30A	600V	175°C	Low Vf
VS-30EPH06HN3	TO-247	Single	30A	600V	175°C	Low Qrr
VS-60APU06HN3	TO-247	Single	60A	600V	175°C	Low Vf
VS-60EPU06HN3	TO-247	Single	60A	600V	175°C	Low Vf
VS-80EBU04HF4	Powertab	Single	80A	400V	175°C	Low Qrr
VS-150EBU04HF4	Powertab	Single	150A	400V	175°C	Low Qrr
VS-EBU8006HF4	Powertab	Single	80A	600V	175°C	Low Qrr
VS-EBU15006HF4	Powertab	Single	150A	600V	175°C	Low Qrr



■ **ALL THE LINKED DIE CAN BE OFFERED AS BARE DIE CHIP**

Fred Pt[®] Hexfred[®] AEC Q101 Products

Target segment:

EV/HEV systems: . main inverter . on board chargers
 . battery management . DC-DC Converters

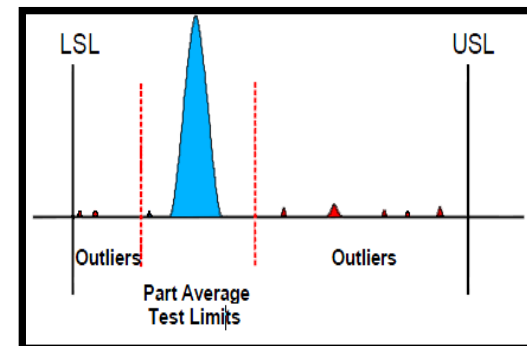
Silicon Technology: Hexfred[®]

Through Hole package: TO-220, TO-247

Part Number	Package	Config	I _F (A)	V _{RRM} (V)	T _{jmax}	Feature
VS-HFA06TB120HN3	TO-220	Single	6A	1200V	150°C	soft recovery
VS-HFA08TB120HN3	TO-220	Hexfred [®]	8A	1200V	150°C	soft recovery
VS-HFA25TB60HN3	TO-220	Hexfred [®]	25A	600V	150°C	soft recovery
VS-HFA30TA60CHN3	TO-220	Hexfred [®]	30A	600V	150°C	soft recovery
VS-HFA16PB120HN3	TO-247	Hexfred [®]	16A	1200V	150°C	soft recovery
VS-HFA30PB120HN3	TO-247	Hexfred [®]	30A	1200V	150°C	soft recovery

Key Features:

- AEC Q101 qualified
- Limits based on PAT , 6s approach
- SYL : Statistical Yield limit
- **Soft recovery**
- **Low conduction losses**



▪ **ALL THE LINKED DIE CAN BE OFFERED AS BARE DIE CHIP**

Fred Pt[®] Hexfred[®] AEC Q101 Products

Target segment: Breaking systems, lighting

Technology: Fred Pt[®]

Part Number	Package	Config	I _F (A)	V _{RRM} (V)	T _{jmax}
VS-6CWH02FNHM3	D-PAK (TO-	dual	6	200	175°C
VS-MURD620CTHM3	D-PAK (TO-	dual	6	200	175°C
VS-8CWH02FNHM3	D-PAK (TO-	dual	8	200	175°C
VS-6EWH06FNHM3	D-PAK (TO-	Single	6	600	175°C
VS-6EWX06FNHM3	D-PAK (TO-	Single	6	600	175°C
VS-8EWH06FNHM3	D-PAK (TO-	Single	8	600	175°C

e-smp package option in development

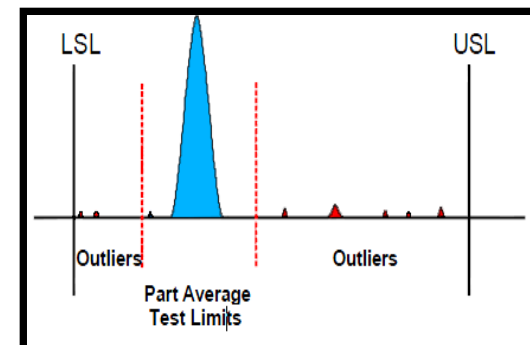
Technology: Fred Pt[®]

Part Number	Package	Config	I _F (A)	V _{RRM} (V)	T _{jmax}
VS-6CSH02HM3	SMPC	Single	6	200	175°C
VS-6ESH06HM3	SMPC	Single	6	600	175°C
VS-6ESX06HM3	SMPC	Single	6	600	175°C
VS-8ESH06HM3	SMPC	dual	8	600	175°C

(*) contact factory for samples, technical info

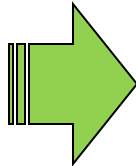
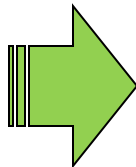
Key Features:

- AEC Q101 qualified
- Limits based on PAT , 6s approach
- SYL : Statistical Yield limit
- **Soft recovery**
- **Low conduction losses**



▪ **ALL THE LINKED DIE CAN BE OFFERED AS BARE DIE CHIP**

I _F (A)	Part#	Config	V _{RRM} (V)
4	VS-4EWH02FNx-M3	Single	200
6	VS-6CWH02FNx-M3	Dual	200
6	VS-MURD620CTx-M3	Dual	200
8	VS-8CWH02FNx-M3	Dual	200
8	VS-8EWH02FNx-M3	Single	200
10	VS-10CWH02FN-M3	Dual	200
5	VS-5EWL06FNx-M3	Single	600
5	VS-5EWH06FNx-M3	Single	600
5	VS-5EWX06FNx-M3	Single	600
6	VS-6EWL06FNx-M3	Single	600
6	VS-6EWH06FNx-M3	Single	600
6	VS-6EWX06FNx-M3	Single	600
8	VS-8EWL06FNx-M3	Single	600
8	VS-8EWH06FNx-M3	Single	600
8	VS-8EWX06FNx-M3	Single	600
12	VS-12EWH06FNx-M3	Single	600
15	VS-15AWL06FNx-M3	Single	600
15	VS-15EWL06FNx-M3	Single	600
15	VS-15EWH06FNx-M3	Single	600
15	VS-15EWX06FNx-M3	Single	600



**12-15A
INDUSTRY
FIRST in
the market**

Automotive Grade PN's
VS-4EWH02FNxHM3
VS-6CWH02FNxHM3
VS-MURD620CTxHM3
VS-8CWH02FNxHM3
VS-8EWH02FNxHM3
VS-10CWH02FNHM3
VS-5EWL06FNxHM3
VS-5EWH06FNxHM3
VS-5EWX06FNxHM3
VS-6EWL06FNxHM3
VS-6EWH06FNxHM3
VS-6EWX06FNxHM3
VS-8EWL06FNxHM3
VS-8EWH06FNxHM3
VS-8EWX06FNxHM3
VS-12EWH06FNxHM3
VS-15AWL06FNxHM3
VS-15EWL06FNxHM3
VS-15EWH06FNxHM3
VS-15EWX06FNxHM3

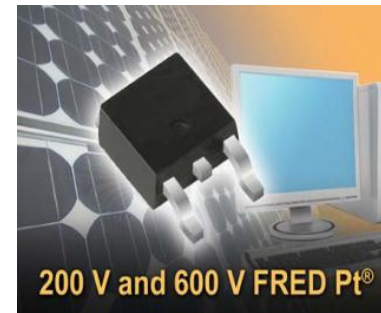
Key Features Fred Pt[®]

- Voltage: 200V-600V - Current : 4-15Amp
- Tjmax=175°C , Low leakage (Pt Doping)
- Optimized Fv/ Qrr ratio
- "X" series offers Qrr 20nQ (at rated I)

Target segment:

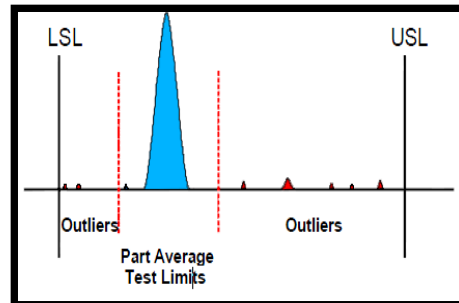
- Low Voltage high frequency inverter
- Freewheeling and polarity protection
- HID Lighting

Using dual gage I/frame
for Low Rthj-c



⁽¹⁾x tube(none) or T&R

⁽²⁾Industry first



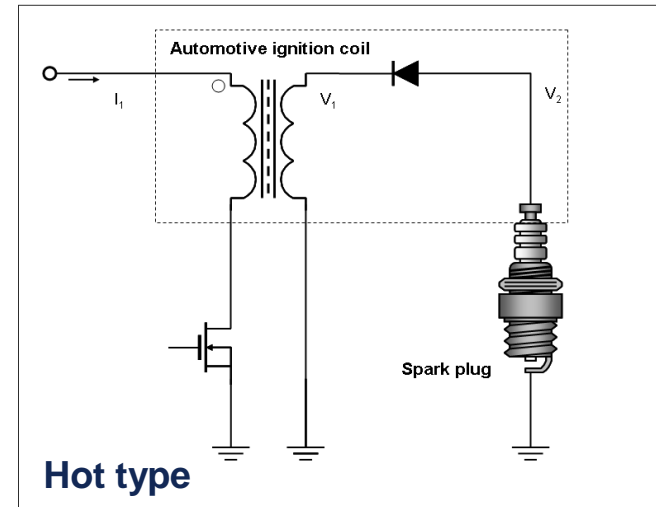
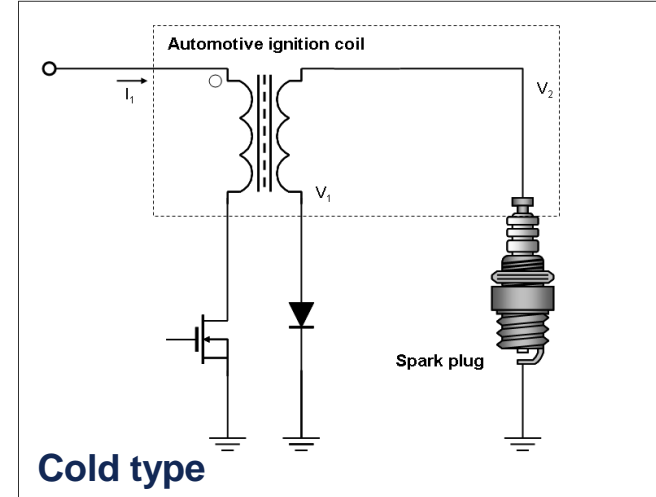
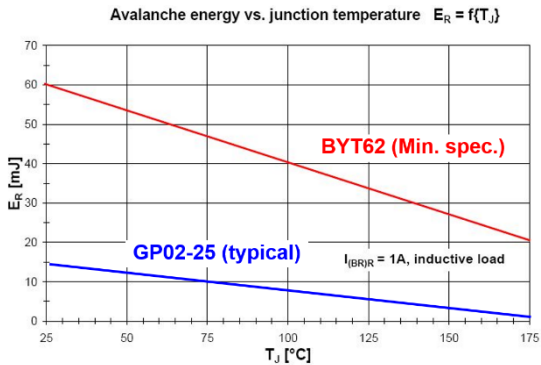
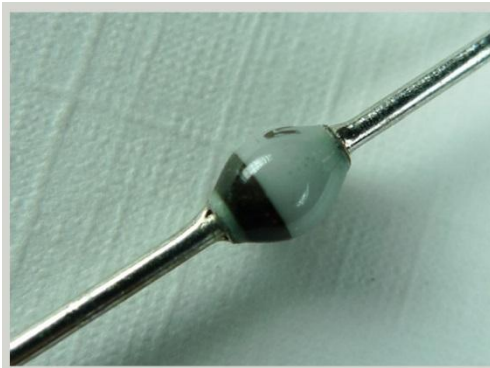
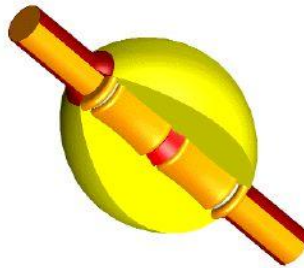
RoHS
COMPLIANT



HALOGEN
FREE

BYT62 Avalanche Diode for Ignition

- ◆ Reverse peak pulse protection in Automotive ignition systems
- ◆ 2400V reverse voltage
- ◆ 60mJ reverse avalanche capability
- ◆ 175°C junction temperature
- ◆ 190°C storage temperature
- ◆ low leakage current & stable break through characteristics
- ◆ hermetically sealed glass envelope & passivation
- ◆ Two mesa Chips connected in series in one Sinterglass Package for highest reliability
- ◆ dedicated for potted applications
- ◆ preference of origin Europe available



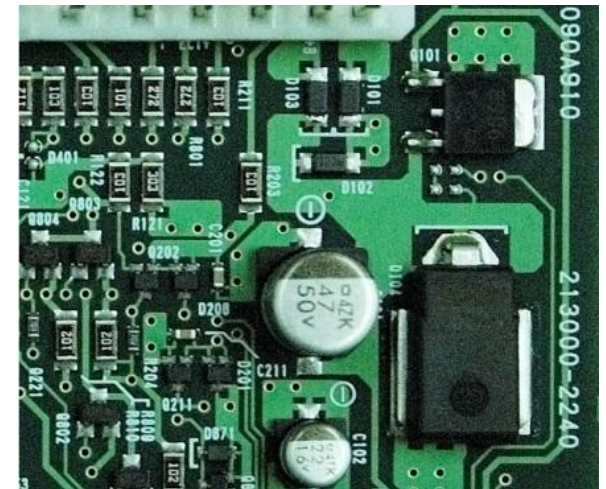
ABD TVS Applications

Load dump
protection

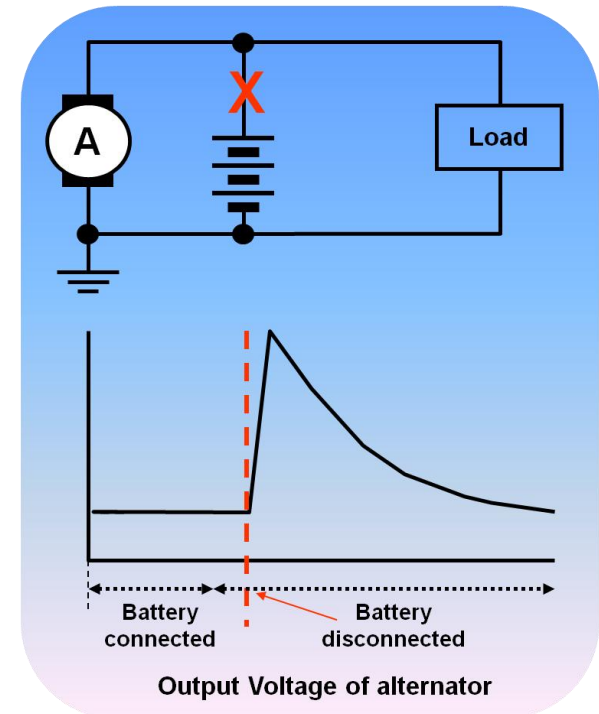
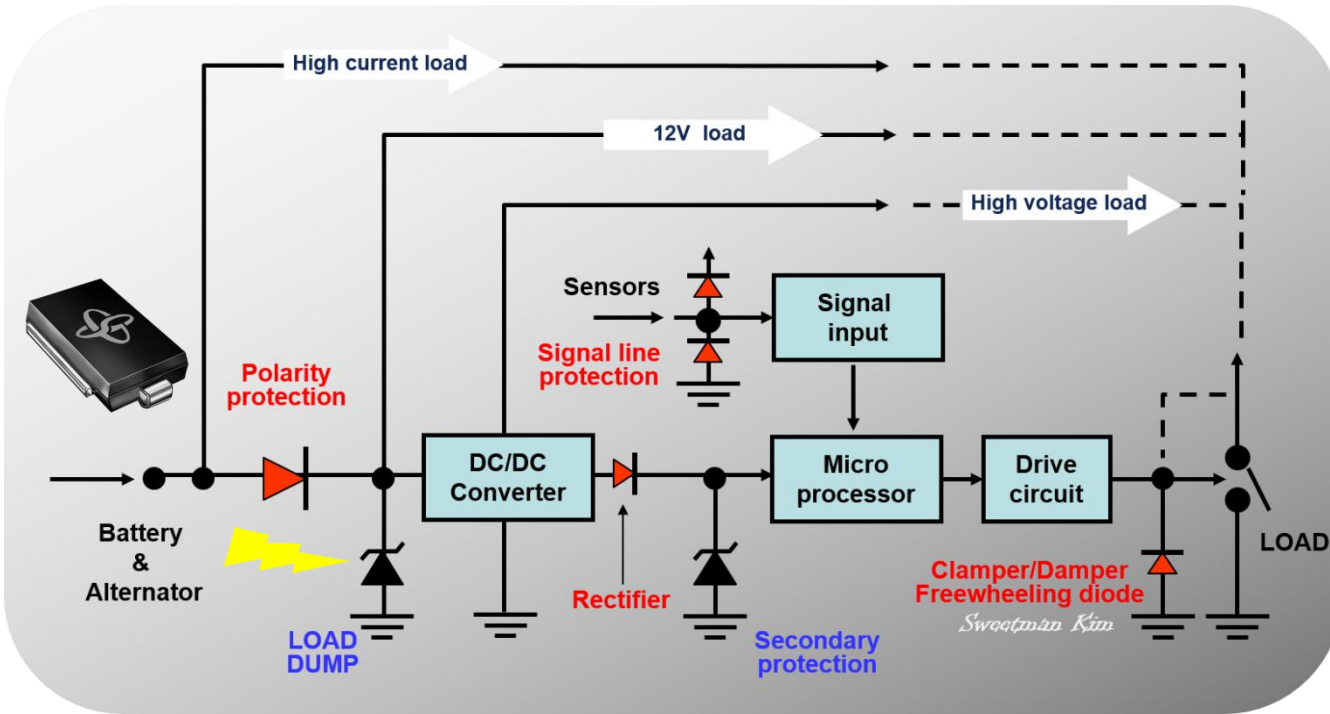


Freewheeling

Second
protection



Load Dump Protection Circuits and Conditions



Load Dump Protection Circuits

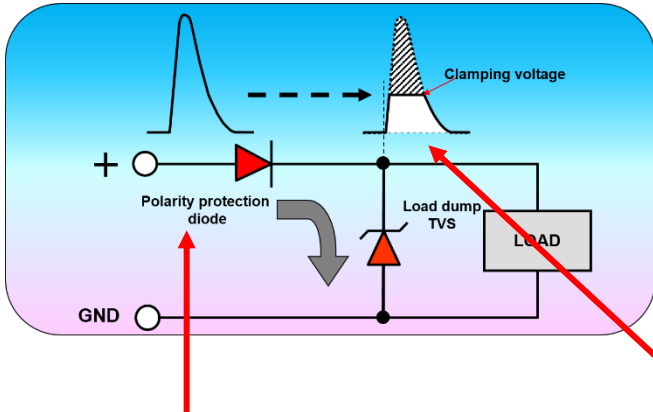
Load dump TVS is the main protection device of automotive electronics and clamping surge voltage to acceptable low voltage to protect vulnerable electronic circuits.

This load dump function is required for almost all automotive electronics; all vehicle manufacturers test to rules: ISO 7637 : 2004, ISO 16750-2 : 2010, JASO and Toyota TSC7001.

Load Dump Conditions

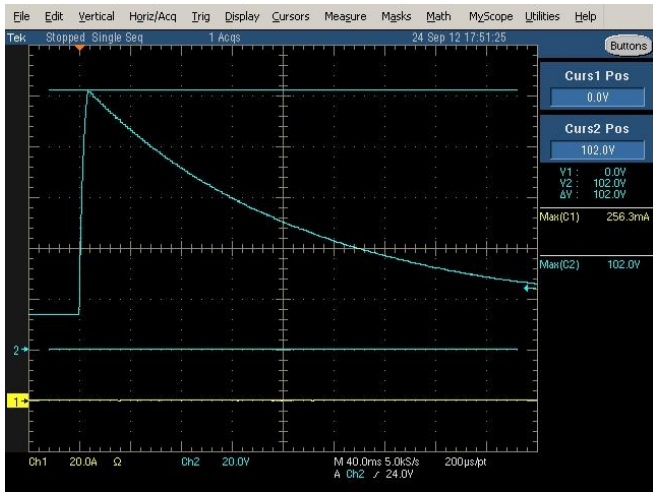
Surge voltage is generated by alternator when battery is disconnected in engine operating status (alternator is supplying electricity).

Operation of Load Dump TVS

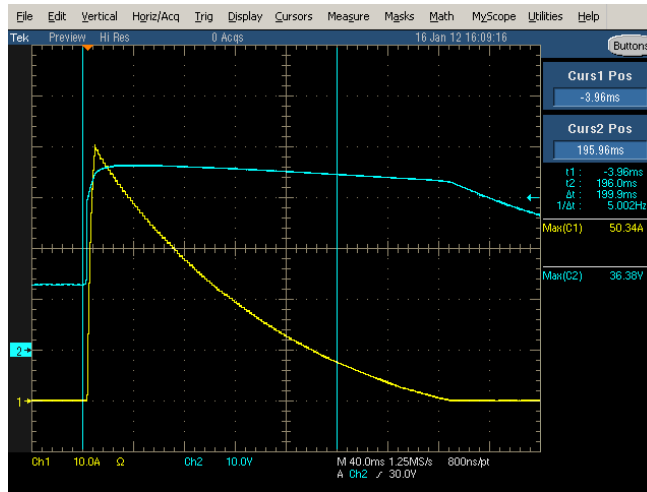


Load dump TVS clamps the surge voltage and bypasses the energy through the device to protect vulnerable electronic circuits.

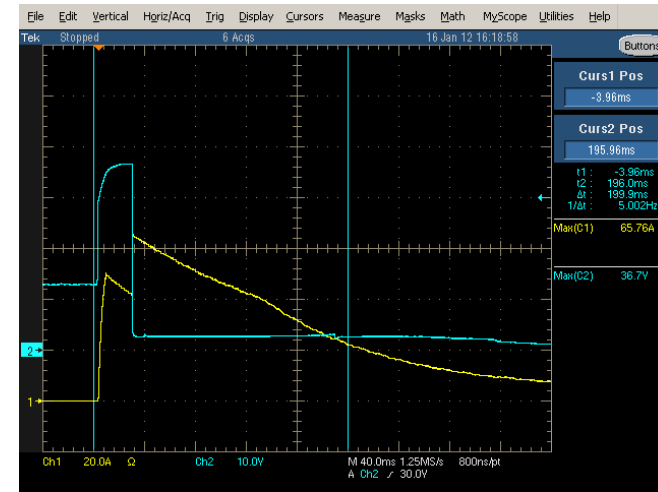
Vishay has several kinds of load dump ABD TVS (Avalanche Breakdown Diode Transient Voltage Suppressor) for various surge and transient conditions.



Test rule input
101 V U_s / 400 ms pulse width



Normal operating
Clamping voltage : 36.4 V / 400 ms Pw
 R_i : 1.25 Ω

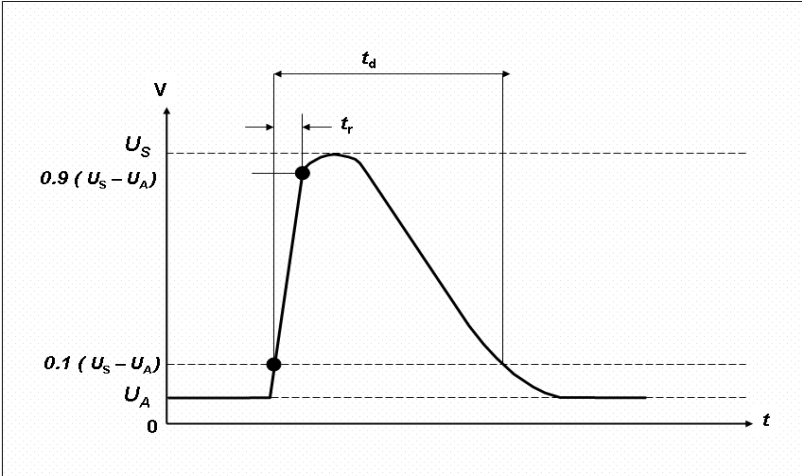


Device failed
Device destroyed at clamping operation
101 V U_s $R_i=1 \Omega$ / failed at 5th pulse

ISO-16750-2 : 2010 Load Dump Test Pulse A

Pulse A

Parameter	Type of system		Minimum test requirements
	$U_A=12\text{ V}$	$U_A=24\text{ V}$	
U_s (V)	79 to 101	151 to 202	10 pulses at intervals of 1 min.
R_i (Ohm)	0.5 to 4	1 to 8	
t_d (ms)	40 to 400	100 to 350	
t_r (ms)	10 / +0 / -5	10 / +0 / -5	



ISO 16750-2 : 2010 Test pulse A

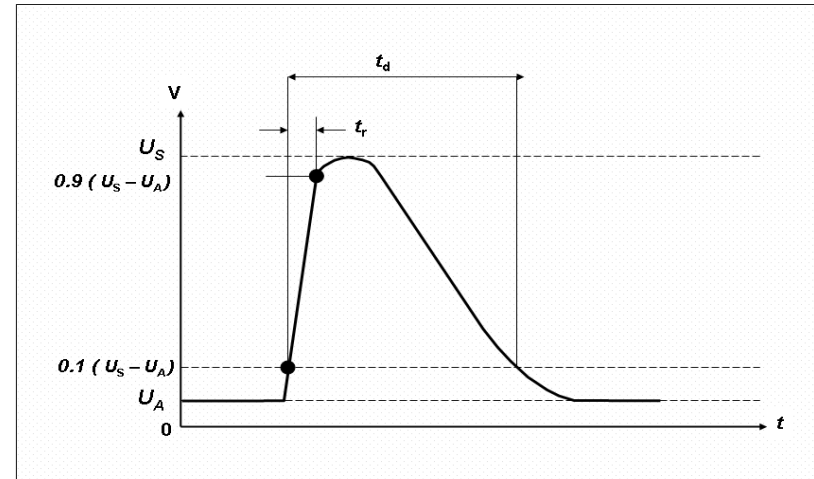
- ◆ New test condition for **Non-central load dump type alternator equipped vehicles**
- ◆ Replaced ISO7637-2 pulse 5a
- ◆ Requires high power load dump protection device for clamping large current
- ◆ Clamping current is as;

$$I_{\text{clamping}} = (U_s - V_{\text{clamping}}) / R_i$$

That's new! ISO-16750-2 : 2010 Load Dump Test

Pulse A

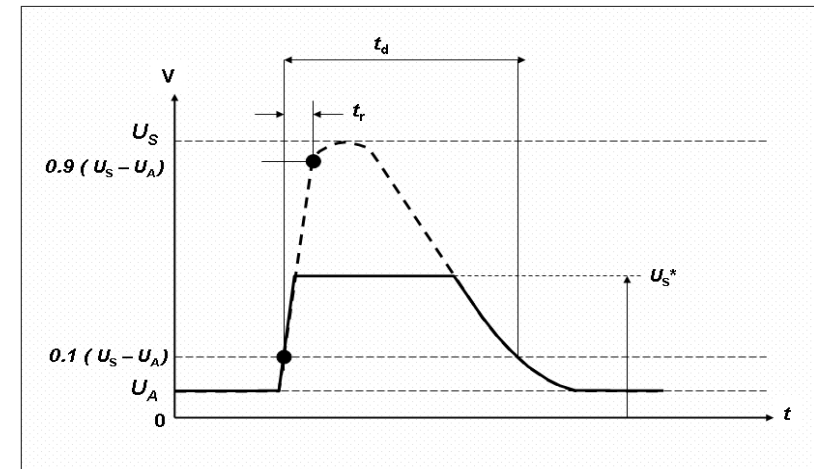
Parameter	Type of system		Minimum test requirements
	$U_A=12\text{ V}$	$U_A=24\text{ V}$	
U_S (V)	79 to 101	151 to 202	10 pulses at intervals of 1 min.
R_i (Ohm)	0.5 to 4	1 to 8	
t_d (ms)	40 to 400	100 to 350	
t_r (ms)	10 / +0 / -5	10 / +0 / -5	



ISO 16750-2 : 2010 Test pulse A

Pulse B

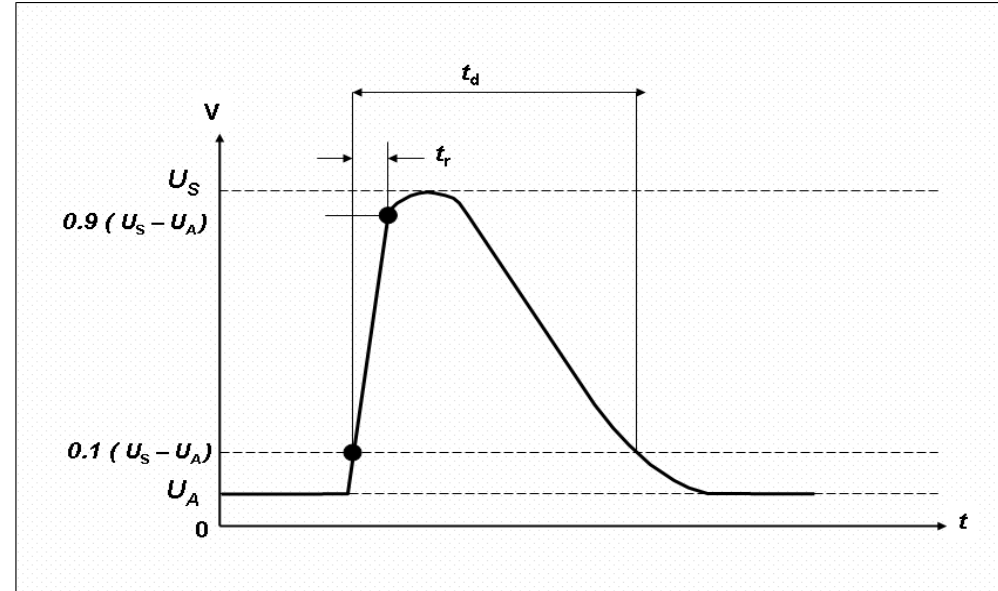
Parameter	Type of system		Minimum test requirements
	$U_A=12\text{ V}$	$U_A=24\text{ V}$	
U_S (V)	79 to 101	151 to 202	5 pulses at intervals of 1 min.
U_S^* (V)	35	65	
R_i (Ohm)	0.5 to 4	1 to 8	
t_d (ms)	40 to 400	100 to 350	
t_r (ms)	10 / +0 / -5	10 / +0 / -5	



ISO 16750-2 : 2010 Test pulse B

Differences of ISO7637-2 vs. ISO 16750-2 Load Dump Test

	ISO7637-2 : 2004	ISO16750-2 : 2010
U_A (V)	12 V	
U_S (V)	$79 < U_S < 101$	$79 < U_S < 101$
R_i (Ohm)	$0.5 < R_i < 4$	$0.5 < R_i < 4$
t_d (ms)	$40 < t_d < 400$	$40 < t_d < 400$
t_r (ms)	10 (+0/-5)	10 (+0/-5)
Pulses	1 pulse	10 pulses in 10 min.



ISO 16750-2 : 2010 Test pulse A

- ◆ New condition of 10 continuous pulses in 10 minutes is highly stressful to load dump protection device and polarity protection device.
- ◆ **Device's capability Junction temperature of load dump** device and polarity devices are escalated continuously

Key Parameters of Load Dump TVS

■ Clamping voltage

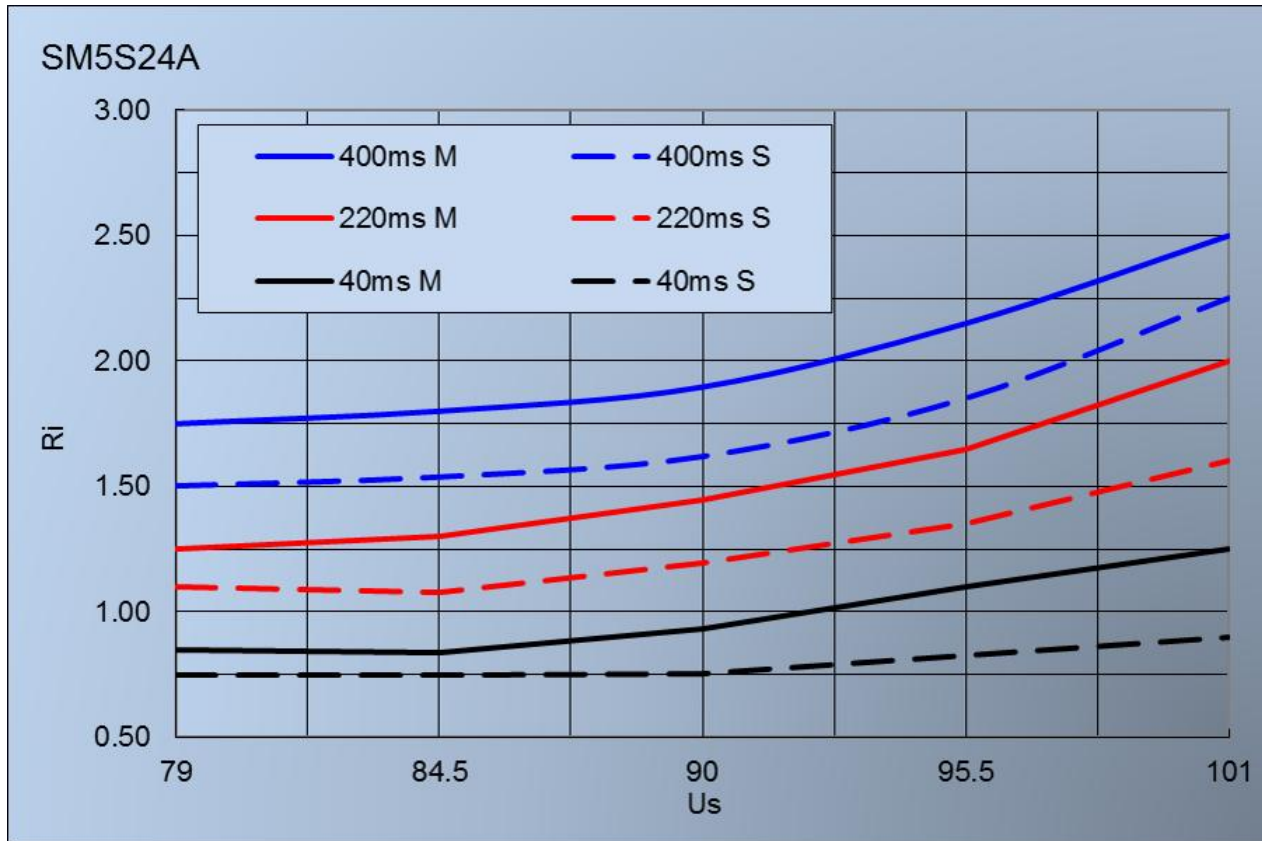
- Clamping voltage of load dump TVS relative to SOA (Safety Operation Area) of protected load and test specifications of electronic units in load dump conditions
- Load dump TVS **should clamp to lower voltage than maximum input voltage of regulator** and/or customer's test specification from high surge input voltage in load dump conditions
- Maximum input voltage of voltage regulators
 - Linear type : 37 – 40 V
 - DC-DC converter IC : 40 – 60 V
 - › **Customer's design guide line : 10% margin required**

■ Stand-off voltage

- Stand-off voltage of load dump TVS relative to SOA (Safety Operation Area) of protected load and test specifications of electronic units in battery jump conditions
- Load dump TVS should not clamp to specified voltage range and/or customer's test specification in "with-stand conditions"
- Test specification of **with-stand condition**
 - 24 V for 14 V power train
 - 36 V for 27 V power train

SM5S24A

Ri limit in various voltage and pulse width conditions



For ISO16750-2 :2010 Pulse A

- 400 ms M : 400 ms pulse width
- 220 ms M : 220 ms pulse width
- 40 ms M : 40 ms pulse width
- 10 pulses in 10 minutes

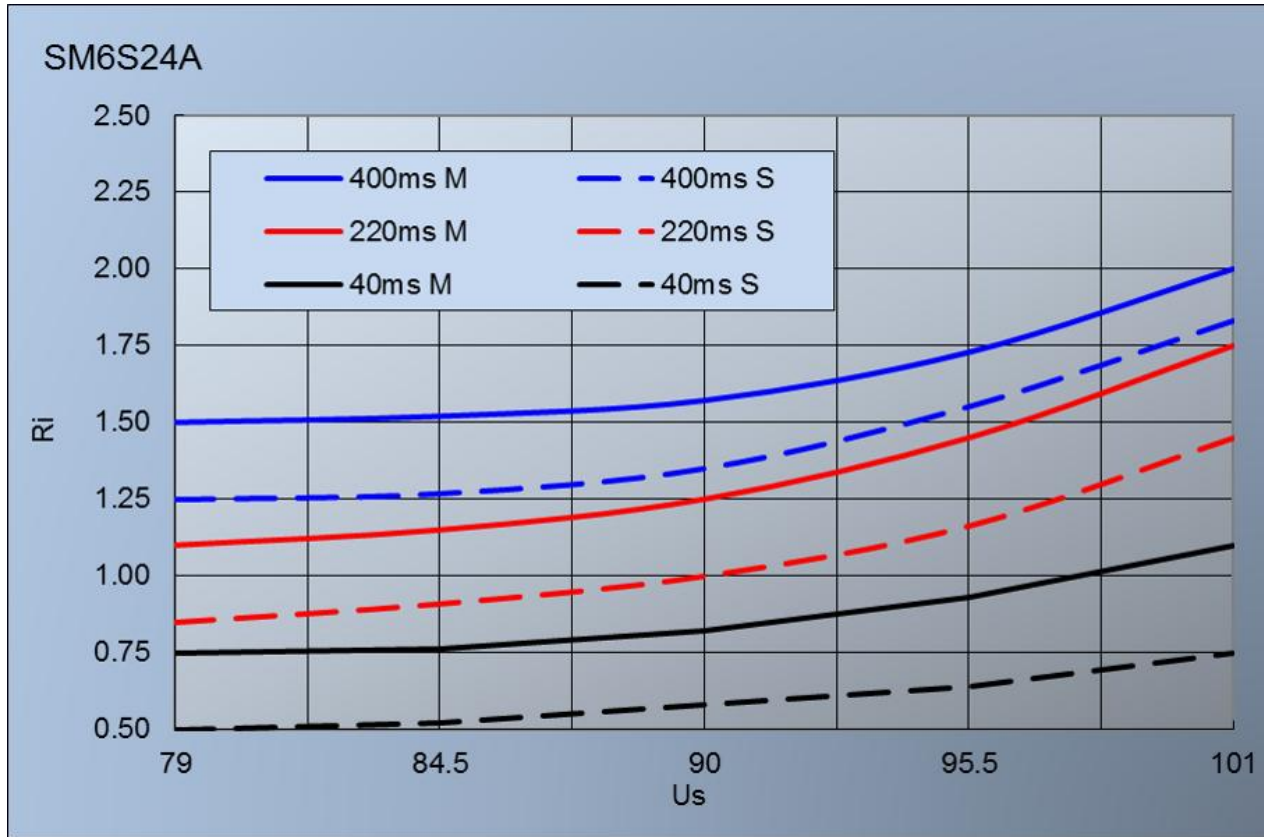
For ISO7637-2 :2004 Pulse 5a

- 400 ms S : 400 ms pulse width
- 220 ms S : 220 ms pulse width
- 40 ms S : 40 ms pulse width
- Single pulse

Ex) R_i should be higher than 2.5 Ω at 101 V U_s , 400 ms pulse width and 10 multiple pulses by ISO16750-2 pulse A condition

SM6S24A

Ri limit in various voltage and pulse width conditions



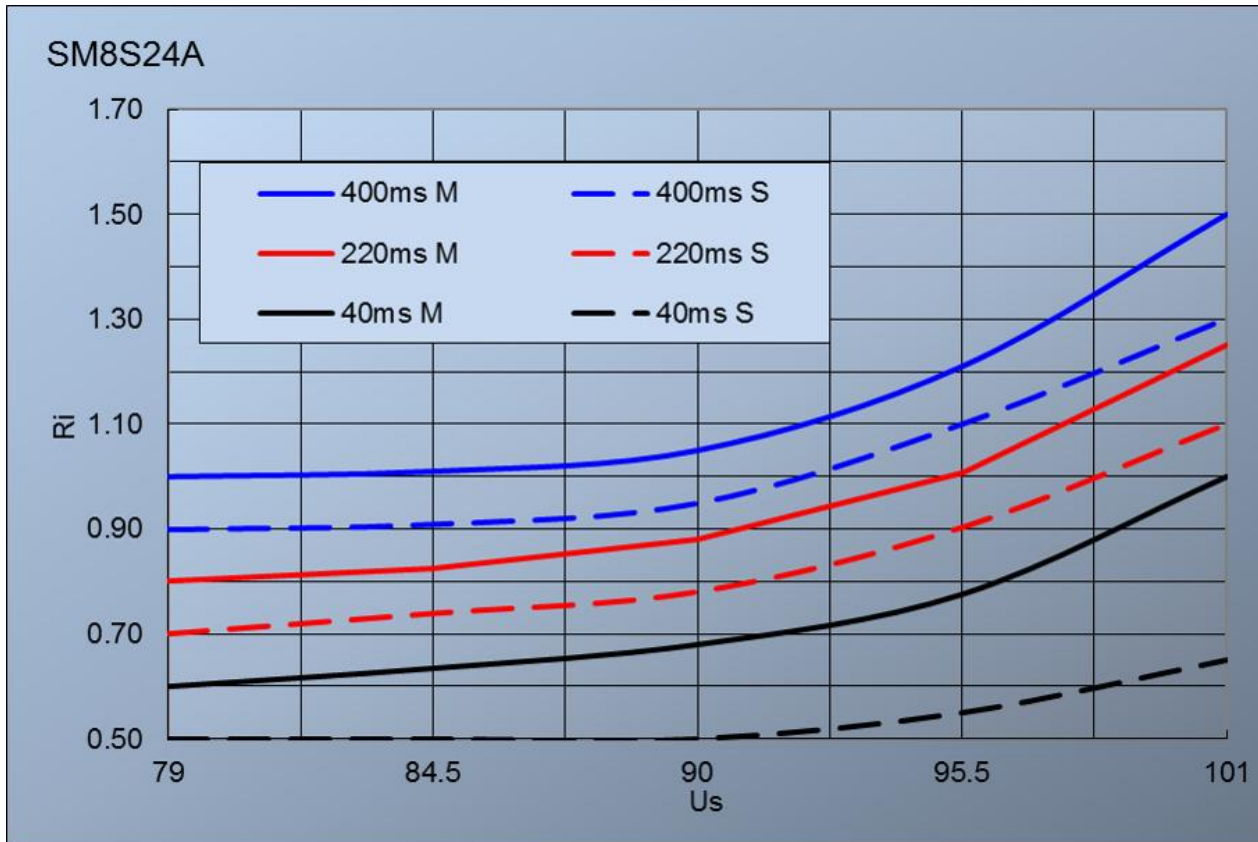
For ISO16750-2 :2010 Pulse A
 - 400 ms M : 400 ms pulse width
 - 220 ms M : 220 ms pulse width
 - 40 ms M : 40 ms pulse width
 10 pulses in 10 minutes

For ISO7637-2 :2004 Pulse 5a
 - 400 ms S : 400 ms pulse width
 - 220 ms S : 220 ms pulse width
 - 40 ms S : 40 ms pulse width
 Single pulse

Ex) R_i should be higher than 2.0 Ω at 101 V U_s , 400 ms pulse width and 10 multiple pulses by ISO16750-2 pulse A condition

SM8S24A

Ri limit in various voltage and pulse width conditions



For ISO16750-2 : 2010 Pulse A

- 400 ms M : 400 ms pulse width
- 220 ms M : 220 ms pulse width
- 40 ms M : 40 ms pulse width

10 pulses in 10 minutes

For ISO7637-2 : 2004 Pulse 5a

- 400 ms S : 400 ms pulse width
- 220 ms S : 220 ms pulse width
- 40 ms S : 40 ms pulse width

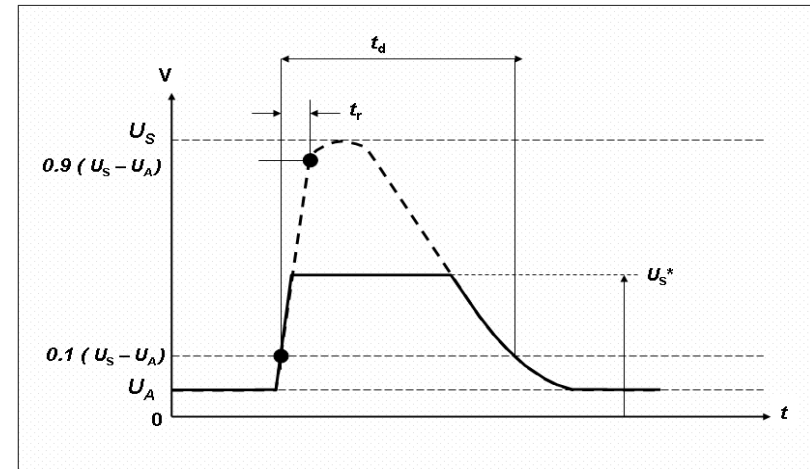
Single pulse

Ex) R_i should be higher than 1.5 Ω at 101 V U_s , 400 ms pulse width and 10 multiple pulses by ISO16750-2 pulse A condition

For ISO16750-2 : 2010 Pulse B

Pulse B

Parameter	Type of system		Minimum test requirements
	$U_A=12\text{ V}$	$U_A=24\text{ V}$	
U_S (V)	79 to 101	151 to 202	5 pulses at intervals of 1 min.
U_S^* (V)	35	65	
R_i (Ohm)	0.5 to 4	1 to 8	
t_d (ms)	40 to 400	100 to 350	
t_r (ms)	10 / +0 / -5	10 / +0 / -5	



ISO 16750-2 : 2010 Test pulse B

- ◆ New test condition for **central load dump type alternator equipped vehicles**
- ◆ Replaced ISO7637-2 pulse 5b
- ◆ Requires low or medium power load dump protection device for clamping large current
 - Clamping current is $I_{clamping} = (U_S - V_{clamping}) / R_i$
- ◆ Vishay products for Pulse B : [TPSMC27A](#), [3KASMC24A](#) or [5KASMC24A](#)
 - Depends on clamping voltage and input voltage margin

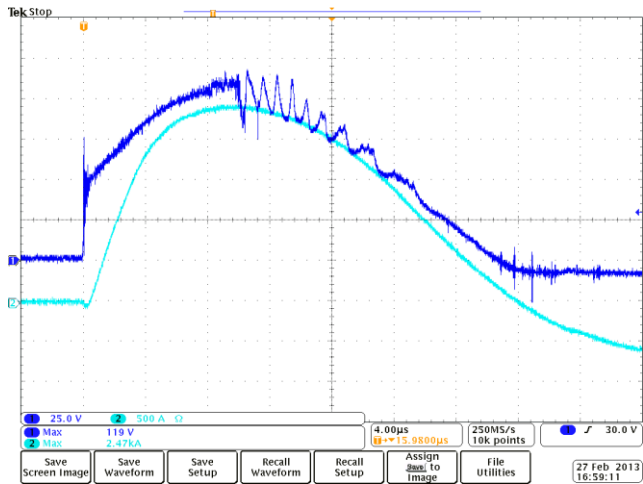
ISO7637 : 2010 Pulse1 , 2a, 2b,3a and 3b

Powertrain	test pulse	Peak Voltage Us	Ri	Td	T	Repeat
		V	Ω	us	us	pulses
12V	1	-75 to -100	10	2,000.00	500,000.00	5,000
	2a	35 to 50	2	50.00	200,000.00	5,000
	3a	-112 to -150	50	0.10	10.00	1 HR
	3b	75 to 100	50	0.10	10.00	1 HR
24V	1	-450 to -600	10	2,000.00	500,000.00	5,000
	2a	37 to 50	2	50.00	200,000.00	5,000
	3a	-150 to -200	50	0.10	10.00	1 HR
	3b	150 to 200	50	0.10	10.00	1 HR

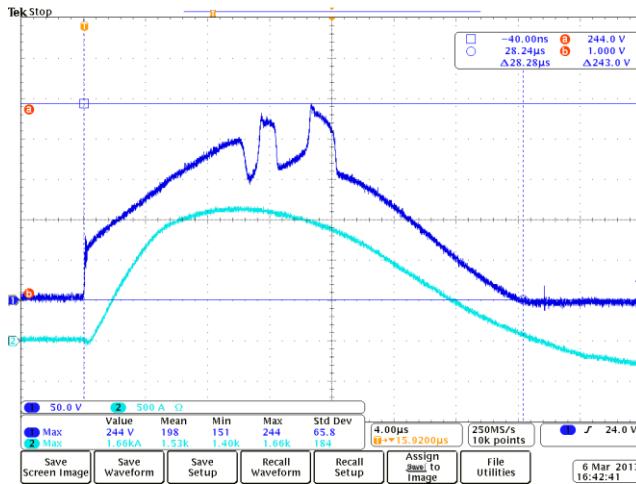
- ◆ Pulse 1 and 3a related to polarity protection diode
- ◆ Vishay products for above test pulses:
 - Without polarity protection diode, above 1000 W: 27 to 30 V type TVS
 - With polarity protection diode, above 600 W: 27 to 30 V type TVS

Vishay Load Dump Series at Lightning Test

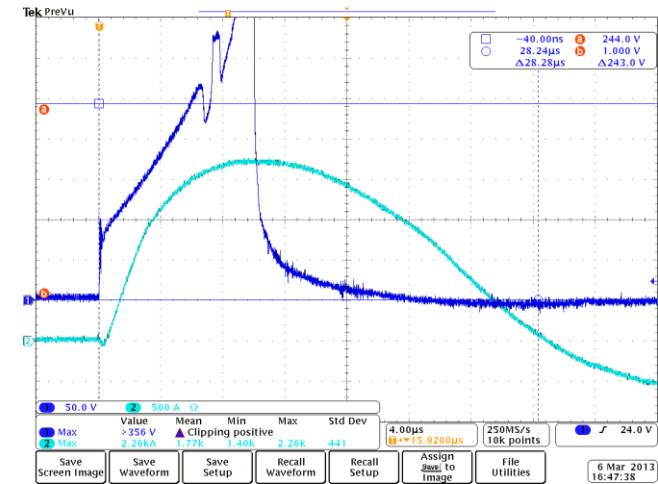
- [SM5S24A](#), [SM6S24A](#) and [SM8S24A](#) passed at 6 KV, 8x20 us, 2 Ω (3 KA) test
- [SM5S36A](#), [SM6S36A](#) and [SM8S36A](#) passed at 4 KV, 8x20 us, 2 Ω (2 KA) test
- [SM5S36A](#) failed at 5 KV, 8x20 us, 2 Ω (2.5 KA) test
- [SM5S36A](#) failed at 5.5 KV, 8x20 us, 2 Ω (2.7 KA) test
- [SM5S36A](#) failed at 6 KV, 8x20 us, 2 Ω (3 KA) test



SM5S24A passed at
6 KV, 8x20 us transient pulse
Ri = 2 Ω



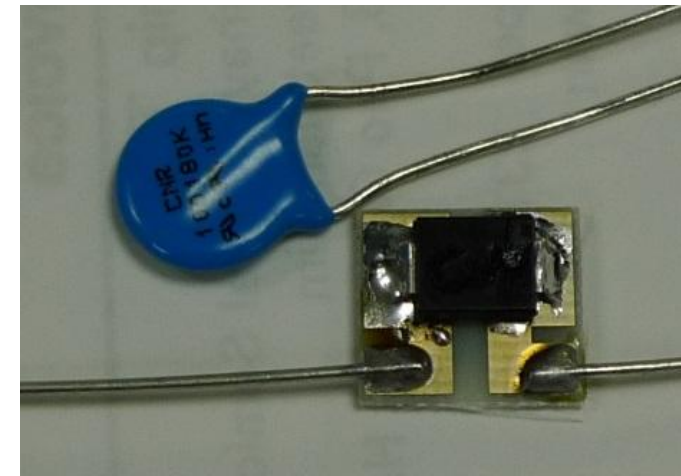
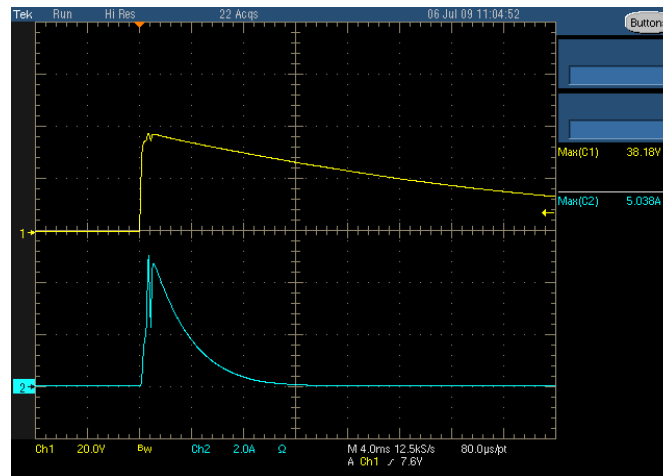
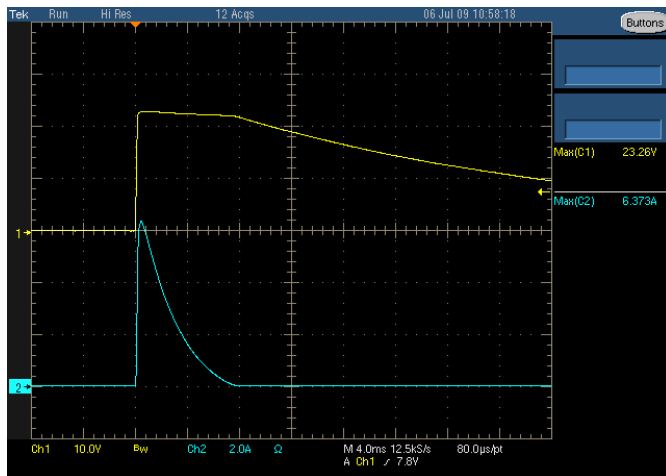
SM5S36A passed at
4 KV, 8x20 us transient pulse
Ri = 2 Ω



SM5S36A failed at
6 KV, 8x20 us transient pulse
Ri = 2 Ω

ABD TVS vs. MOV (Metal Oxided Varistor)

- ABD TVS has
 - Narrow clamping ratio at low current and high current
 - Fast response
 - No wear out



3KASMC18A

70 V, 10x10,000 us transient pulse
 $R_i = 5 \Omega$
 Clamping voltage : 23.3 V

18 V MOV

70 V, 10x10,000 us transient pulse
 $R_i = 5 \Omega$
 Clamping voltage : 38.2 V

New packages for automotive application

SMF
(DO-219AB)

SlimSMA
(DO-221AC)

SMPC
(DO-277AA)

SMPD

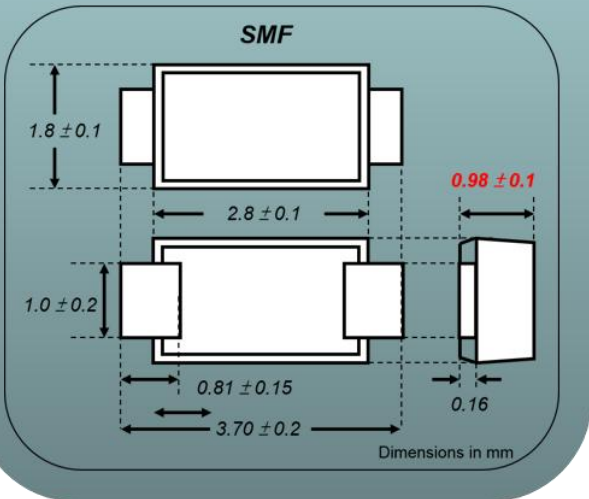
NEW SMF (DO-219AB) series



- High power density as 2 A in SOD-123 compatible package
- Low profile package as 1mm device height
- AEC-Q101 qualified
- Wide junction temperature range as -55°C to +175°C *1

Product name with **red** is new products in plan

Categories	Product series	V _{RRM} (V)	I _O (A)	I _{FSM} (A)	Application
Standard	SE10FG / SE10FJ	400 / 600	1	30	Signal line protection Polarity protection
	SE20FG / SE20FJ	400 / 600	2	40	
	S07B ~ S07M	100 ~ 1,000	0.7		
Schottky barrier	SS1F4 / SS1F6	40 / 60	1	50	Signal line protection Polarity protection High Freq. output rectifier Flywheel diode
	SS2F6	60	2	50	
	SL02 / SL04	20 / 40	0.7		
Ultrafast	VS-1EFH02HM3	200	1		
	ES07B / ES07D	100 / 200	0.7		
TVS	TA4F	5.6 to 43V 400W TVS			
ESD protection	SMF5V0 A~ SMF51A	5.0 to 51V 200W TVS / ESD protection			
Zener	BZD27C	3.6 to 200V zener diode			

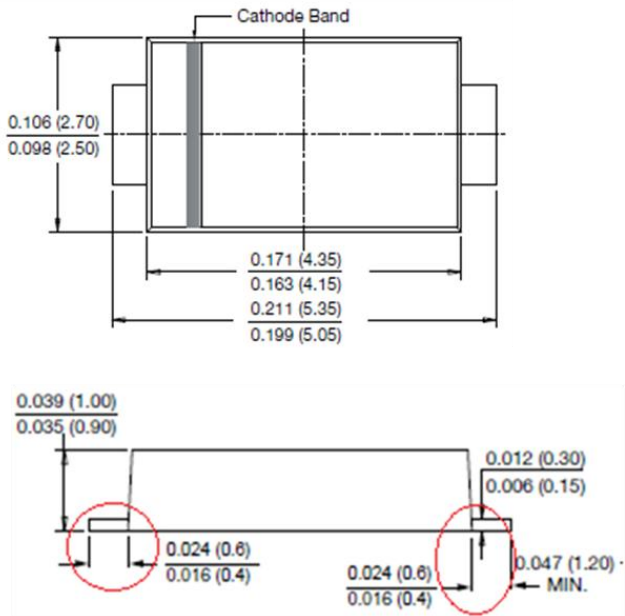
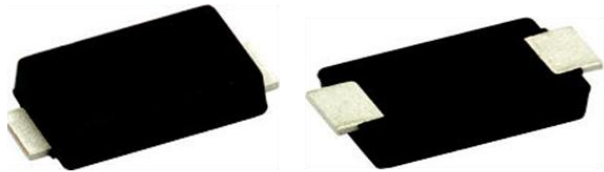


*1 Refer to datasheet

NEW SlimSMA (DO-221AC) series



- High power density as 2 A in DO-214AC (SMA) footprint package
- Low profile package as **1mm** device height (SMA is 2.1mm)
- AEC-Q101 qualified
- Wide junction temperature range as -55°C to +175°C *1



Product name with **blue** is new products

Categories	Product series	V _{RRM} (V)	I _O (A)	I _{FSM} (A)	Application
Standard (ESD capa.)	SE20AFG / SE20AFJ	400 / 600	2	40	Signal line protection Polarity protection
	SE30AFG / SE30AFJ	400 / 600	3	40	
Schottky barrier	VSSAF3L45	45	3		Signal line protection Polarity protection High Freq. output rectifier Flywheel diode
	VSSAF5L45	45	5		
Ultrafast	VS-2EJH02HM3	200	2		Polarity protection High Freq. output rectifier Flywheel diode Parallel diode of valve control IC
	VS-3EJH02HM3	200	3		
	VS-2EJH06HM3	600	2		
	VS-3EJH06HM3	600	3		
TVS	TA6F	6.8 to 51V, 600W			
	Bi-TA6F *2	6.8 to 51V, 600W Bi-directional			

*1 Refer to datasheet

*2 Release in 2014

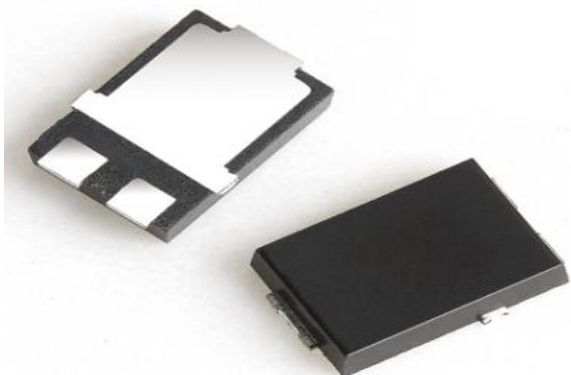
NEW Fred Pt in SMPC series



- High power density footprint package
- Very small 1.1 mm height and 4.8 mm by 6.7 mm footprint
- AEC-Q101 qualified
- Wide junction temperature range as -55°C to $+175^{\circ}\text{C}$ *1

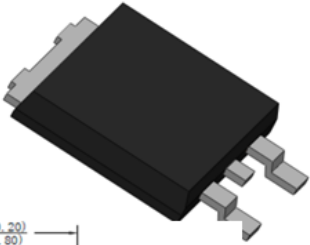
Product name with red is under release

Categories	Product series	V_{RRM} (V)	I_o (A)	I_{FSM} (A)	Application
Fred Pt	VS-4CSH02HM3	200	2x2		ECU
	VS-4ESH02HM3	200	4		
	VS-6CSH02HM3	200	2x3		HID Lighting ABS system
	VS-6ESH02HM3	200	6		
	VS-8CSH02HM3	200	2x4		ABS system
	VS-10CSH02HM3	200	2x5		
	VS-6ESU06HM3	600	6		
	VS-8ESU06HM3	600	8		



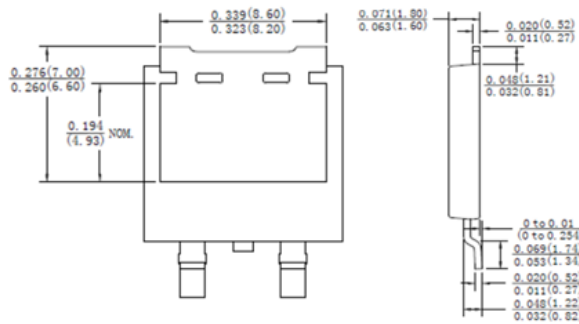
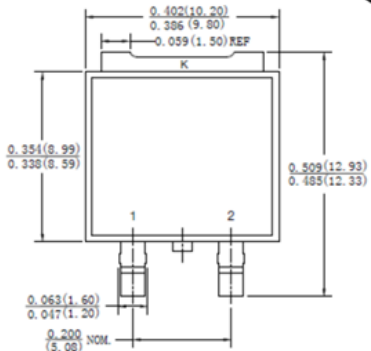
Release Q4 2013

NEW SMPD series



- High power density as 40 A in TO-263AB footprint package
- Low profile package as **1.8mm** device height (To-263AB is 4.5mm)
- AEC-Q101 qualified
- Wide junction temperature range as -55°C to +175°C *1

Product name with **red** is new products in plan(Q3 2013)



Package Size: 12.6 x 10 x **1.7mm**
RthJM= RthJM=2.0 °C/W

Categories	Product series	V _{RRM} (V)	I _o (A)	I _{FSM} (A)	Application
TMBS Schottky barrier	V10D45C / V10D60C	45 / 60	10		Polarity protection
	V30D45C / V30D60C	45 / 60	30		High Freq. output rectifier
	V40D100C	100	40		Flywheel diode
	V40DM120C	120	40		
Fred Pt	V30D200C	200	30		EV/HEV DC-DC converters On board chargers Main inverter
	VS-16CDU06HM3	600	16		
	VS-10CDU06HM3	600	10		
	VS-16EDU06HM3	600	16		
	VS-30DU06HM3	600	30		

*1 Refer to datasheet