VISHAY INTERTECHNOLOGY, INC.

INTERACTIVE
data book

TRANSIENT VOLTAGE SUPPRESSORS

VISHAY GENERAL SEMICONDUCTOR

VSE-DB0002-1102

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

VISHAY INTERTECHNOLOGY, INC.

DATA BOOK

TRANSIENT VOLTAGE SUPPRESSORS

VISHAY GENERAL SEMICONDUCTOR

TRANSZORB® Transient Voltage Suppressors

PAR® Automotive Transient Voltage Suppressors

Power Voltage-Regulating Diodes

Special Function Transient Voltage Suppressors

www.vishay.com

SEMICONDUCTORS

RECTIFIERS
- Schottky (single, dual)
- Standard, Fast, and Ultra-Fast Recovery (single, dual)
- Bridge
- Superectifier®
- Sinterglass Avalanche Diodes

HIGH-POWER DIODES AND THYRISTORS
- High-Power Fast-Recovery Diodes
- Phase-Control Thyristors
- Fast Thyristors

SMALL-SIGNAL DIODES
- Schottky and Switching (single, dual)
- Tuner/Capacitance (single, dual)
- Bandswitching
- PIN

ZENER AND SUPPRESSOR DIODES
- Zener (single, dual)
- TVS (TransZorb®, Automotive, ESD, Arrays)

FETs
- Low-Voltage TrenchFET® Power MOSFETs
- High-Voltage TrenchFET® Power MOSFETs
- High-Voltage Planar MOSFETs
- JFETs

RF TRANSISTORS
- Bipolar Transistors (AF and RF)
- Dual Gate MOSFETs
- MOSMICs®

OPTOELECTRONICS
- IR Emitters and Detectors, and IR Receiver Modules
- Optocouplers and Solid-State Relays
- Optical Sensors
- LEDs and 7-Segment Displays
- Infrared Data Transceiver Modules
- Custom Products

ICs
- Power ICs
- Analog Switches
- RF Transceivers and Receiver Modules
- ICs for Optoelectronics

MODULES AND ASSEMBLIES
- Automotive Modules and Assemblies
- Power Modules (contain power diodes, thyristors, MOSFETs, IGBTs)
- DC/DC Converters

PASSIVE COMPONENTS

RESISTIVE PRODUCTS
- Foil Resistors
- Film Resistors
  - Metal Film Resistors
  - Thin Film Resistors
  - Thick Film Resistors
  - Metal Oxide Film Resistors
  - Carbon Film Resistors
- Wirewound Resistors
- Power Metal Strip® Resistors
- Chip Fuses
- Variable Resistors
  - Cermet Variable Resistors
  - Wirewound Variable Resistors
  - Conductive Plastic Variable Resistors
- Networks/Arrays
- Non-linear Resistors
  - NTC Thermistors
  - PTC Thermistors
  - Varistors

MAGNETICS
- Inductors
- Transformers

CAPACITORS
- Tantalum Capacitors
  - Molded Chip Tantalum Capacitors
  - Coated Chip Tantalum Capacitors
  - Solid Through-Hole Tantalum Capacitors
  - Wet Tantalum Capacitors
- Ceramic Capacitors
  - Multilayer Chip Capacitors
  - Disc Capacitors
- Film Capacitors
- Power Capacitors
- Heavy-Current Capacitors
- Aluminum Capacitors
- Silicon RF Capacitors

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Transient Voltage Suppressors

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Transient Voltage Suppressors

Introduction

Vishay Intertechnology, Inc., a Fortune 1000 Company listed on the NYSE, is one of the world's largest manufactures of discrete semiconductors (diodes, rectifiers, transistors, optoelectronics and power ICs) and passive electronic components (resistors, capacitors, inductors and transducers). With the acquisition of General Semiconductor, Vishay becomes the world's largest manufacturer of avalanche-type transient voltage suppressors (TVS), also known as Avalanche Breakdown Diodes (ABD). These include the TRANSZORB® TVS, PAR® Automotive TVS, Special Function TVS and Power Voltage-regulating Diodes (ABD). These products are used throughout the industry within the consumer electronics, telecommunications, electronic lighting ballast, computer, and automotive markets.

Vishay General Semiconductor's TVS products are offered in axial and surface-mount packages. The PAR Automotive TVS is also offered in the high-power surface-mount DO-218AB, wich is ideal for automotive load-dump protection. Recently the company has expanded the voltage range of its TRANSZORB TVS to be the widest in the industry. Efficient miniature surface mount packages including SMP, SMPC, and MicroSMP series are also introduced for use in more compact and hand held consumer/automotive electronic products. These ultra-miniature Transient Voltage Suppressor devices allow engineers to protect circuitry against harsh transients that have hither to demanded relatively large package dimensions to achieve sufficient power-dissipation capability. The peak surge-clamping power up to 100 W of MicroSMP is the highest available for this size of devices in market during time of its introduction.

MicroSMP, SMP and SMPC surface mount packages belong to the new eSMP™ series, which feature special wide bottom plate designs that enable better thermal performance than other industry packages of similar sizes. With excellent heat dissipation ability, the eSMP™ product series contribute to provide better device reliability.

Vishay General Semiconductors' strengths are the high performance and quality of its products, its strong worldwide sales and distribution channels, and the value-added manufacturing of its' worldwide operations, which enable Vishay General Semiconductor to effectively compete globally in all major end markets.

The information contained in this product catalog is intended to provide the necessary technical support data to assist the design engineer. It is our policy to maintain high standards of product design and manufacture. These high standards of quality assure reliable product performance for our customers. Vishay General Semiconductors' worldwide manufacturing facilities are ISO 9001 and ISO/TS16469 approved.

Not every application problem can be solved using a standard device; in this case we often develop special products to meet the customer's requirements. For further information, call your local sales office.

Additional information can be found on the Vishay website at **www.vishay.com**.

How to find the Products you are looking for

The book is divided into chapters for TRANSZORB® TVS, PAR® Automotive TVS, Power Voltage-Regulating Diodes and Special Function Transient Voltage Supprerssors. Within each chapter the products are arranged by increasing power ratings. Within a specific power rating they are arranged in alphanumeric order. At the beginning of each chapter there is an explanation of the part numbering system to aid in the search for the desired part.

If the desired functional type, package and/or specifications are known, the selector guides in this book can aid in finding the desired part number and datasheet. As with the chapters, these selector guides are arranged by type. These selector guides list the part numbers, major specifications, package type and the datasheet's page number. If the product type is not known, but the part number is known there is an alphanumeric index to help locate the part.

There is also a thru-hole/surface-mount cross-reference.

For the most current information, including new products, visit us on the web at **www.vishay.com**.

Transient Voltage Suppressors

Note

(1) Voltage range extended to 540 V for uni-directional only

Transient Voltage Suppressors

Note

(1) Voltage range extended to 540 V for uni-directional only

THRU-HOLE PART	DO-218AB	SMC	SMPC	SMB	SMA	SMP
1.5KA Series		TPSMC Series	TPC Series			
1.5KE Series ICTE Series		1.5SMC Series SM15T Series SMCJ Series				
6KA24	SM8A27 or SM8S24					
BZW04 Series P4KE Series					SMAJ Series P4SMA Series	SMP Series
P4KA Series					TPSMA Series	TPSMP Series
P6KA Series				TPSMB Series		
P6KE Series				P6SMB Series SM6T Series SMBJ Series		
TMPG06 Series					TPSMA Series	TPSMP Series

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INDEX OF SYMBOLS

α_{IR} .... Temperature coefficient of leakage current
α_{C} .... Temperature coefficient of capacitance
α_{VF} .... Temperature coefficient of forward voltage
α_{VZ} .... Temperature coefficient of Zener voltage
C_J .... Junction capacitance
I_F .... DC forward current
$I_{F(AV)}$ .... Average forward rectified current
I_D .... Stand-off reverse leakage current
I_{FSM} .... Peak forward surge current
I_O .... Main forward current
I_R .... Reverse leakage current
I_{PPM} .... Maximum peak impulse current
I_{RSM} .... Maximum non-repetitive reverse peak current
I_T .... On-state test current
I^2t .... Rating for fusing
I_Z .... Zener current
I_{ZT} .... Zener test current
I_{ZM} .... Maximum Zener current
$P_{M(AV)}$ ...... Maximum steady state power dissipation
P_{PM} .... Peak pulse power dissipation
P_{tot}, P_D .... Total power dissipation
r_{zj} .... Dynamic series resistance
$R_{\theta JA}$ .... Thermal resistance (juntion to ambient)
$R_{\theta JC}$ .... Thermal resistance (juntion to case)
$R_{\theta JL}$ .... Thermal resistance (juntion to lead)
T_A .... Ambient temperature
T_C .... Case temperature
t_d .... Time duration
T_J .... Junction temperature
T_L .... Lead temperature
T_S, T_{STG} .. Storage temperature
V_{BR} .... Reverse breakdown voltage
V_F .... Instantaneous forward voltage
V_{DC}, V_R ... DC reverse voltage
V_{RMS} .... RMS input voltage
V_{RRM} .... Peak repetitive reverse voltage
V_{RWM} ...... Working peak reverse voltage
V_C .... Clamping voltage
V_{WM} .... Working stand-off voltage
V_Z .... Zener voltage
Z_Z .... Dynamic Zener impedance
Z_{ZK} .... Zener impedance at I_{ZK}
Z_{ZT} .... Zener impedance at I_{ZT}

DRAWINGS

All dimensions are in inches and (millimeters) unless noted otherwise. Figures not necessarily drawn to scale.

PRO ELECTRON TYPE DESIGNATION CODES

The **first letter** gives information about the material used for the active part of the device, where “B” indicates silicon.

The **second letter** indicates the primary function of the device, where “A” is for low-power signal diodes, “Y” is for rectifying diodes, “Z” for voltage reference or regulator diodes (TVS if “W” follows “Z”), “C” is for low power bipolar transistors and “S” is for low power MOS transistors.

The **serial number** follows the first two letters. It may either be a number from 100 to 999 or a letter (e.g. W after Z indicates TVS) followed by a number from 10 to 99.

A **suffix** may be added to show V_{RRM} for a rectifier or V_{WM} for a TVS (Note: within the suffix a “V” is used instead of a decimal point). Examples: BZW04-8V5, BYW29-200.

JEDEC TYPE DESIGNATION CODES

The first number (which is followed by the letter “N”) indicates the number of leads minus 1. This is followed by the serial number. Example: 1N5817, 3N254

CHARACTERISTICS AND MAXIMUM RATINGS

The electrical performance of a semiconductor devise is usually expressed in terms of its characteristics and maximum ratings.

Characteristics are those which can be measured by use of suitable measuring instruments and circuits, and provide information on the performance of the device under specified operating conditions (at a given bias, for example). Depending on requirements, they are quoted either as typical (Typ.) values or guaranteed (Min., Max.) values.

Typical values are expressed as numbers or as one or more curves, and are subject to spread.

Maximum Ratings give the values which cannot be exceeded without risk of damage to the device. Changes in supply voltage and in the tolerances of other components in the circuit must also be taken into consideration. No single maximum rating should ever be exceeded, even when the device is operaated well within the other maximum ratings.

Selector Guides

TRANSZORB®
Transient Voltage Suppressors
•
PAR® Automotive
Transient Voltage Suppressors
•
Power Voltage-Regulating Diodes
•
Special Function
Transient Voltage Suppressors

Contents

TRANSZORB® AVALANCHE TRANSIENT VOLTAGE SUPPRESSORS							
P_{PPM} (1) (W)	DEVICE (2)	PACKAGE		V_{WM} RANGE (V)	V_{BR} RANGE (3) (V)	V_{BR} TOLERANCE (Suffix)	PAGE
		FAMILY	TYPE				
100	MSPxx(A) (5)	Surface Mount	MicroSMP	3.3 - 5.0	4.1 - 6.4	5 % (A)	19, 23
200	TGL41-nn(A) (5)	Surface Mount	MELF (DO-213AB)	81 - 171	100 - 200	5 % (A)/10 % (blank)	27
300	P4KE530 & P4KE550 (5)	Plastic Axial	DO-41 (DO-204AL)	477/495	530/550 (m)	N/A	32
	SMAJ530 & SMAJ550 (5)	Surface Mount	DO-214AC (SMA)	477/495	530/550 (m)	N/A	35
	P4SMAnnA (5)	Surface Mount	SMA (DO-214AC)	85.5 - 459	100 - 540	5 %	38
	P4SMAnnCA	Surface Mount	SMA (DO-214AC)	85.5 - 185	100 - 220	5 %	38
	SMAJxx(A) (5)	Surface Mount	SMA (DO-214AC)	85 - 188	94.4 - 209	5 % (A)/10 % (blank)	42
	SMAJxxC(A)	Surface Mount	SMA (DO-214AC)	85 - 188	94.4 - 209	5 % (A)/10 % (blank)	42
400	BZW04(P)-xx(B)	Plastic Axial	DO-41 (DO-204AL)	5.8 - 376	6.45 - 418	7 % (P)/5 % (blank)	47
	P4KEnn(A) (5)	Plastic Axial	DO-41 (DO-204AL)	5.5 - 459	6.8 - 540	5 % (A)/10 % (blank)	52
	P4KEnnC(A)	Plastic Axial	DO-41 (DO-204AL)	5.5 - 376	6.8 - 440	5 % (A)/10 % (blank)	52
	P4SMAnnA (5)	Surface Mount	SMA (DO-214AC)	5.8 - 77.8	6.8 - 91	5 %	38
	P4SMAnnCA	Surface Mount	SMA (DO-214AC)	5.8 - 77.8	6.8 - 91	5 %	38
	SMAJxx(A) (5)	Surface Mount	SMA (DO-214AC)	5.0 - 78	6.4 - 86.7	5 % (A)/10 % (blank)	42
	SMAJxxC(A)	Surface Mount	SMA (DO-214AC)	5.0 - 78	6.4 - 86.7	5 % (A)/10 % (blank)	42
	SMPxx(A)	Surface Mount	DO-220AA (SMP)	11 - 36	12.2 - 40.0	5 % (A)/10 % (blank)	57
	TGL41-nn(A) (5)	Surface Mount	MELF (DO-213AB)	5.5 - 77.8	6.8 - 91	5 % (A)/10 %(blank)	27
500	SAxx(A), C(A)	Plastic Axial	DO-15 (DO-204AC)	5.0 - 170	6.4 - 189	5 % (A)/10 % (blank)	60
	SMA5Jxx(A), C(A)	Surface Mount	SMA (DO-214AC)	5.0 - 40	6.4 - 44.4	5 % (A)/10 % (blank)	66
600	P6KEnn(A) (5)	Plastic Axial	DO-15 (DO-204AC)	5.5 - 459	6.8 - 540	5 % (A)/10 % (blank)	71
	P6KEnnC(A)	Plastic Axial	DO-15 (DO-204AC)	5.5 - 376	6.8 - 440	5 % (A)/10 % (blank)	71
	P6SMBnnA (5)	Surface Mount	SMB (DO-214AA)	5.8 - 459	6.8 - 540	5 %	77
	P6SMBnnCA	Surface Mount	SMB (DO-214AA)	5.8 - 185	6.8 - 220	5 %	77
	SM6TnnA, CA	Surface Mount	SMB (DO-214AA)	5.8 - 188	6.8 - 220	5 %	81
	SMA6J12A	Surface Mount	SMA (DO-214AC)	12	13.3 - 14.7	5 %	85
	SMBGxx(A), C(A)	Surface Mount	SMB (DO-215AA)	5.0 - 188	6.4 - 209	5 % (A)/10 % (blank)	88
	SMBJxx(A), C(A)	Surface Mount	SMB (DO-214AA)	5.0 - 188	6.4 - 209	5 % (A)/10 % (blank)	93
	SMBJ3V3	Surface Mount	SMB (DO-214AA)	3.3	4.1 Minimum		98
800	SMB8JxxC(A)	Surface Mount	SMB (DO-214AA)	5.0 - 40	6.4 - 44.4	5 % (A)/10 % (blank)	101
1000	SMB10Jxx(A) (5)	Surface Mount	SMB (DO-214AA)	5.0 - 40	6.4 - 44.4	5 % (A)/10 % (blank)	101
1500	1.5KEnn(A) (5)	Plastic Axial	1.5KE	5.5 - 459	6.8 - 540	5 % (A)/10 % (blank)	106
	1.5KEnnC(A)	Plastic Axial	1.5KE	5.5 - 376	6.8 - 440	5 % (A)/10 % (blank)	106
	1N6267 thru 1N6303 (5)	Plastic Axial	1.5KE	5.5 - 171	6.8 - 200	5 % (A)/10 % (blank)	106
	1.5SMCnnA (5)	Surface Mount	SMC (DO-214AB)	5.8 - 459	6.8 - 540	5 %	112
	1.5SMCnnCA	Surface Mount	SMC (DO-214AB)	5.8 - 185	6.8 - 220	5 %	112
	ICTE-xx (5)	Plastic Axial	1.5KE	5.0 - 18	6.0 - 21.2	N/A	116
	ICTE-xxC	Plastic Axial	1.5KE	8.0 - 18	9.4 - 21.2	N/A	116
	1N6373 thru 1N6378 (5)	Plastic Axial	1.5KE	5.0 - 18	6.0 - 21.2	N/A	116
	1N6382 thru 1N6386	Plastic Axial	1.5KE	8.0 - 18	9.4 - 21.2	N/A	116
	SM15TnnA, CA	Surface Mount	SMC (DO-214AB)	5.8 - 188	6.8 - 220	5 %	120
	SMCGxx(A), C(A)	Surface Mount	SMC (DO-215AB)	5.0 - 188	6.4 - 209	5 % (A)/10 % (blank)	124
	SMCJxx(A), C(A)	Surface Mount	SMC (DO-214AB)	5.0 - 188	6.4 - 209	5 % (A)/10 % (blank)	129
5000	5KPxx(A) (5)	Plastic Axial	P600	5.0 - 188	6.4 - 209	5 % (A)/10 % (blank)	134

Notes:

(1) Tested with 10/1000 µs pulse
(2) In part numbers, “xx” designates V_{WM} and “nn” designates nominal voltage
(3) Nominal voltages are specified for part numbers with “nn” and minimum voltages are specified for part numbers with “xx” or (m) footnote. Higher voltages are planned (up to 600 V). Contact local sales office for availability
(4) Types are offered in bi-directional polarity by adding suffix “C” (BZW04 use suffix “B”)
(5) Uni-directional polarity only
(6) Most Vishay TVS products have Underwriters Laboratory Recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B, and file number E136766 for both uni-directional and bi-directional devices. See the individual data sheets for specific information.

PAR® AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSORS							
P_{PPM} (1) (W)	DEVICE (2)	PACKAGE		V_{WM} RANGE (V)	V_{BR} RANGE (3) (V)	V_{BR} TOLERANCE (Suffix)	PAGE
		FAMILY	TYPE				
250	TPSMPnn(A)	Surface Mount	DO-220AA (SMP)	5.5 - 5.8	6.8	5 % (A)/10 % (blank)	142
300	TPSMPnn(A)	Surface Mount	DO-220AA (SMP)	6.05 - 10.2	7.5 - 12	5 % (A)/10 % (blank)	142
	TMPG06-nn(A)	Plastic Axial	MPG06	5.5 - 7.78	6.8 - 9.1	5 % (A)/10 % (blank)	146
400	TPSMPnn(A)	Surface Mount	DO-220AA (SMP)	10.5 - 36.8	13 - 43	5 % (A)/10 % (blank)	142
	TPSMAnn(A)	Surface Mount	SMA (DO-214AC)	5.5 - 36.8	6.8 - 43	5 % (A)/10 % (blank)	150
	TMPG06-nn(A)	Plastic Axial	MPG06	8.1 - 36.8	10 - 43	5 % (A)/10 % (blank)	146
	P4KAnn(A)	Plastic Axial	DO-41 (DO-204AL)	5.5 - 36.8	6.8 - 43	5 % (A)/10 % (blank)	154
600	TPSMBnn(A)	Surface Mount	SMB (DO-214AA)	5.5 - 36.8	6.8 - 43	5 % (A)/10 % (blank)	158
	P6KAnn(A)	Plastic Axial	DO-15 (DO-204AC)	5.5 - 36.8	6.8 - 43	5 % (A)/10 % (blank)	162
1500	TPCnn(A)	Surface Mount	SMPC (TO-277A)	5.5 - 36.8	6.8 - 43	5 % (A)/10 % (blank)	166
	TPSMCnn(A)	Surface Mount	SMC (DO-214AB)	5.5 - 40.2	6.8 - 47	5 % (A)/10 % (blank)	170
	1.5KAnn(A)	Plastic Axial	1.5KA	5.5 - 40.2	6.8 - 47	5 % (A)/10 % (blank)	174
3000	3KASMCnn(A)	Surface Mount	SMC (DO-214AB)	10 - 43	11.1 - 52.8	5 % (A)/10 % (blank)	178
3600 (4)	SM5A27	Surface Mount	DO-218AB	22	27	± 3 V	182
	SM5Sxx(A)	Surface Mount	DO-218AB	10 - 36	11.1 - 40	5 % (A)/10 % (blank)	186
4600 (4)	SM6A27	Surface Mount	DO-218AB	22	27	± 3 V	190
	SM6Sxx(A)	Surface Mount	DO-218AB	10 - 36	11.1 - 40	5 % (A)/10 %(blank)	193
6000	6KA24	Plastic Axial	P600	24	29.7	10 %	197
6600 (4)	SM8A27	Surface Mount	DO-218AB	22	27	± 3 V	200
	SM8Sxx(A)	Surface Mount	DO-218AB	10 - 43	11.1 - 47.8	5 % (A)/10 % (blank)	203

Notes:

(1) Tested with 10/1000 µs pulse
(2) In part numbers, “xx” designates V_{WM} and “nn” designates nominal voltage
(3) Nominal voltages are specified for part numbers with “nn” and minimum voltages are specified for part numbers with “xx”
(4) For 10 µs/10 ms load-dump pulse rating, see datasheet
(5) All automotive TVS are uni-directional polarity only
(6) All automotive TVS use the patended PAR process for superiour high-temperature performance
(7) Most Vishay TVS products have Underwriters Laboratory Recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B, and file number E136766 for both uni-directional and bi-directional devices. See the individual data sheets for specific information.

POWER VOLTAGE-REGULATING DIODES					
P_d (W)	DEVICE [1]	PACKAGE	ZENER VOLTAGE RANGE V_Z (V)	ZENER VOLTAGE TOLERANCES (SUFFIX)	PAGE
1.0	ZGL41-xxxy	MELF (DO-213AB)	100 - 200	5 % (A)/10 % (blank)	210
1.5	PTV5.1B - PTV36B	SMP (DO-220AA)	5.1 - 36	5 %	213
	SMAZ5919B - SMAZ5945B	SMAJ (DO-214AC)	5.6 - 68	5 %	216
	SMPZ3919B - SMPZ3940B	SMP (DO-220AA)	5.6 - 43	5 %	220
	SMZG3788 - SMZG3809(A), (B)	SMBG (DO-215AA)	9.1 - 68	5 % (B)/10 % (A)/20 % (blank)	224
	SMZJ3788 - SMZJ3809(A), (B)	SMBJ (DO-214AA)	9.1 - 68	5 % (B)/10 % (A)/20 % (blank)	227
	Z4KExxxy	DO-41 (DO-204AL)	100 - 200	5 % (A)/10 % (blank)	230
3.0	SMBZ5919B - SMBZ5945B	SMBJ (DO-214AA)	5.6 - 68	5 %	234

Notes:

(1) In part numbers, “xx” designates nominal V_Z and “y” designates the Zener voltage tolerance suffix

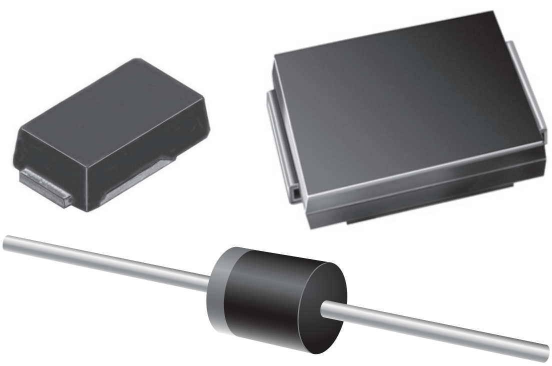
(2) Most Vishay TVS products have Underwriters Laboratory Recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B, and file number E136766 for both uni-directional and bi-directional devices. See the individual data sheets for specific information.

SPECIAL FUNCTION TRANSIENT VOLTAGE SUPPRESSORS							
P_{PPM} (1) (W)	DEVICE (2)	PACKAGE		V_{WM} RANGE (V)	V_{BR} RANGE (3) (V)	V_{BR} TOLERANCE (Suffix)	PAGE
		FAMILY	TYPE				
Low Capacitance Transient Voltage Suppressors							
500	SACxx (4)	Plastic Axial	DO-15 (DO-204AC)	5.0 - 50	7.6 - 55.5	N/A	242
1500	LCExx(A) (4)	Plastic Axial	1.5KE	6.05 - 28	7.22 - 31.1	5 % (A)/10 % (blank)	245
Low Forward Voltage Transient Voltage Suppressors							
600	LVB14A (4)	Surface Mount	SMB (DO-214AA)	12	13.2 - 14.8	5 %	249
Asymetric Transient Voltage Suppressors							
SMB30A300	30 V TVS	Surface Mount	SMB (DO-214AA)	25.6	28.5 - 31.5	5 %	252
	300 V Diode			243	270 - 360	10 %	

Notes:

(1) Tested with 10/1000 µs pulse
(2) In part numbers, “xx” designates V_{WM} and “nn” designates nominal voltage
(3) Nominal voltages are specified for part numbers with “nn” and minimum voltages are specified for part numbers with “xx” or (m) footnote
(4) Uni-directional polarity only
(5) Most Vishay TVS products have Underwriters Laboratory Recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B, and file number E136766 for both uni-directional and bi-directional devices. See the individual data sheets for specific information.

TRANSZORB®
Transient Voltage Suppressors



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Introduction to TRANSZORB® Transient Voltage Suppressors

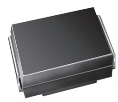
Vishay General Semiconductors delivers “state-of-the-art” Transient Voltage Suppressors (TVS) with the highest voltage range in the industry. Based on controlled avalanche technology, these voltage clamping devices utilize a specific soft solder construction and glass passivated die. This physical design enables these avalanche diodes to absorb large amounts of energy for short time durations without sustaining damage. When used within each component’s power handling capability, Vishay Generla Semiconductor’s TRANSZORB TVS products do not exhibit a wear out mechanism, as many MOV and similar technologies do. With extremely fast turn-on times and superior clamping characteristics, Vishay General Semiconductor’s TVS products are preferable option for your transient suppression needs compared to MOV’s.

Datasheets in this section are arranged by increasing power rating. Within a power rating they are listed in alphanumerical order.

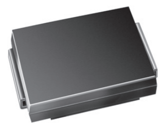
MicroSMP

DO-220AA (SMP)

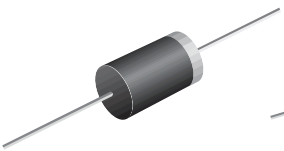
DO-214AC (SMA)



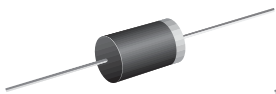
DO-214AA (SMB)



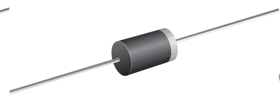
DO-214AB (SMC)



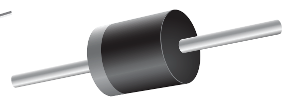
1.5KE



DO-204AC (DO-15)



DO-204AL (DO-41)



P600

TRANSZORB® Transient Voltage Suppressors Part Numbering System

1. AXIAL

a) TVS specified by Nominal Breakdown Voltage:

xxKEyyyd
xxK = Power Ratings
  P4K = 0.4 kW (i.e., 400 W)
  P6K = 0.6 kW (i.e., 600 W)
  1.5K = 1.5 kW (i.e., 1500 W)
E = Standard TVS designator: 400 W to 1.5 kW
  (original meaning: **E**poxy package)
yyy = Nominal breakdown voltage (in V)
d = Breakdown voltage tolerance/polarity
  "Blank" = ± 10 %/uni-directional
  A = ± 5 %/uni-directional
  C = ± 10 %/bi-directional
  CA = ± 5 %/bi-directional

b) TVS specified by Stand-off Voltage:

(1) 500 W
SAyyyd
SA = **S**urge **A**rrestor
yyy = Stand-off voltage (in V)
d = Breakdown voltage tolerance/polarity
  "Blank" = ± 10 %/uni-directional
  A = ± 5 %/uni-directional
  C = ± 10 %/bi-directional
  CA = ± 5 %/bi-directional

(2) 1500 W
ICTEyyd
ICT = **I**ntegrated **C**ircuit **T**VS
E = **E**poxy package
yy = Stand-off voltage (in V)
d = Polarity
  "Blank" = Standard
  C = Bi-directional

(3) 5000 W TVS
5KPyyd
5K = **5**000 W
P = High **P**ower TVS (5000 W)
yy = Stand-off voltage (in V)
d = Breakdown voltage tolerance
  "Blank" = ± 10 %
  A = ± 5 %

(4) "BZW04" Types
BZW04t-yyp
BZW = ProElectron designation for silicon TVS
04 = 400 W power rating
t = Breakdown voltage tolerance
  "Blank" = 5 %
  P = 7 %
yy = Stand-off voltage (in V)
  (Note: decimal points designated by "V")
p = polarity
  "Blank" = Uni-directional
  B = Bi-directional

c) High-voltage axial TVS:
(specified by minimum breakdown voltage)

P4KEyyy
P4KE = Case outline of standard P4KE series
  (i.e., DO-204AL)
yyy = Minimum breakdown voltage
  530 = 530 V
  550 = 550 V

2. SURFACE MOUNT

a) MELF:

TGL41-yyd
T =TVS
G = **G**lass passivated
L41 = **L**eadless “41” package (MELF/DO-213AB)
yy = Nominal breakdown voltage (in V)
d = Breakdown voltage tolerance/polarity
“Blank” = ± 10 %/uni-directional
A = ± 5 %/uni-directional

b) SMX specified by Stand-off Voltage:

SMxbyyyd
SMx = Surface mount package style
SMA =DO-214AC (J-bend)
SMB =DO-214AA (J-bend) or DO-215AA (gull-wing)
SMC =DO-214AB (J-bend) or DO-215AB (gull-wing)
SMP =DO-220AA
MSP =MicroSMP
SMA5J = DO-214AC (J-bend): 500 W
SMA6J = DO-214AC (J-bend): 600 W
SMB8J = DO-214AA (J-bend): 800 W
SMB10J = DO-214AA (J-bend): 1000 W
b = Lead form
J = **J**-bend
G = **G**ull-wing
yy = Stand-off voltage (in V)
d = Breakdown voltage tolerance/polarity
“Blank” = ± 10 %/uni-directional
A = ± 5 %/uni-directional
C = ± 10 %/bi-directional
CA = ± 5 %/bi-directional

c) SMX specified by Nominal Breakdown Voltage:

(1) aaSMxyyd
aa = Power ratings
P4 = 0.4 kW (i.e., 400 W)
P6 = 0.6 kW (i.e., 600 W)
1.5 = 1.5 kW (i.e., 1500 W)
SMx = Surface mount package style
SMA = DO-214AC (J-bend)
SMB = DO-214AA (J-bend)
SMC = DO-214AB (J-bend)
yy = Nominal breakdown voltage (in V)
d = Breakdown voltage tolerance/polarity
A = ± 5 %/uni-directional
CA = ± 5 %/bi-directional

Note:

- For explanations of JEDEC (“1N prefix”) part numbers, please see page 7.

(2) SMaaTyyd
SM = **S**urface **M**ount
aa = Power ratings
6 = 600 W
15 = 1500 W
T = TVS
yy = Nominal breakdown voltage (in V)
(Note: decimal points indicated by “V”)
d = Breakdown voltage tolerance/polarity
A = 5 %/uni-directional
CA = 5 %/bi-directional

d) High-Voltage SMX:
(specified by minimum breakdown voltage)

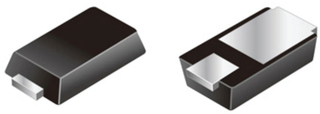
SMAJyyy
SMAJ =DO-214AC
yyy = Minimum breakdown voltage
530 = 530 V
550 = 550 V

Note:

- The P4SMA, P6SMB and 1.5SMC series (specified by nominal breakdown voltage) have been extended to 540 V (uni-directional only)

Surface Mount TRANSZORB® Transient Voltage Suppressors

eSMP™ Series



Top View **Bottom View**

MicroSMP

PRIMARY CHARACTERISTICS	
V_{WM}	3.3 V
P_{PPM}	100 W
I_{FSM}	25 A
T_J max.	150 °C

FEATURES

- Very low profile - typical height of 0.65 mm
- Ideal for automated placement
- Oxide planar chip junction
- Uni-directional polarity only
- Peak pulse power: 100 W (10/1000 µs)
- ESD capability: **15 kV (air), 8 kV (contact)**
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units specifically for protecting 3.3 V supplied sensitive equipment against transient overvoltages.

MECHANICAL DATA

Case: MicroSMP

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes the cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation (1)(2)	P_{PPM}	100	W
Peak pulse current with a 10/1000 µs waveform (Fig. 1)	I_{PPM}	13.7	A
Peak pulse current with a 8/20 µs waveform (Fig. 1)	I_{PPM}	75	A
Non repetitive peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	25	A
Power dissipation T_L = 120 °C (2)	P_D	1.0	W
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 1

(2) Mounted on 6.0 x 6.0 mm copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)											
DEVICE TYPE	**DEVICE MARKING CODE**	**BREAKDOWN VOLTAGE V_{BR} AT I_T MIN**		**MAXIMUM REVERSE LEAKAGE CURRENT I_R AT V_{WM} MAX**		**MAXIMUM CLAMPING VOLTAGE AT V_C AT I_{PPM} 10/1000 µs**		**MAXIMUM CLAMPING VOLTAGE AT V_C AT I_{PPM} 8/20 µs**		**TYPICAL TEMP. COEFFICIENT OF V_{BR}**	**TYPICAL JUNCTION CAPACITANCE C_J AT 0 V 1 MHz**
		V	**mA**	**µA**	**V**	**V**	**A**	**V**	**A**	**(10^{-4}/°C)**	**pF**
MSP3V3	KC	4.1	1.0	200	3.3	7.3	13.7	11.0	75	- 5.3	850

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance (1)	$R_{\theta JA}$ $R_{\theta JL}$	125 30	°C/W

Note:

(1) Thermal resistance from junction to ambient and junction to lead mounted on P.C.B. with 6.0 x 6.0 mm copper pad areas.
$R_{\theta JL}$ is measured at the terminal of cathode band.

IMMUNITY TO STATIC ELECTRICAL DISCHARGE TO THE FOLLOWING STANDARDS (T_A = 25 °C unless otherwise noted)					
STANDARD	**TEST TYPE**	**TEST CONDITIONS**	**SYMBOL**	**CLASS**	**VALUE**
AEC Q101-001	Human body model (contact mode)	C = 100 pF, R = 1.5 kΩ	V_C	H3B	> 8 kV
IEC-61000-4-2 (2)	Human body model (air discharge mode) (1)	C = 150 pF, R = 150 Ω		4	> 15 kV

Notes:

(1) Immunity to IEC-61000-4-2 air discharge mode has a typical performance > 30 kV

(2) System ESD standard

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
MSP3V3-E3/89A	0.006	89A	4500	7" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

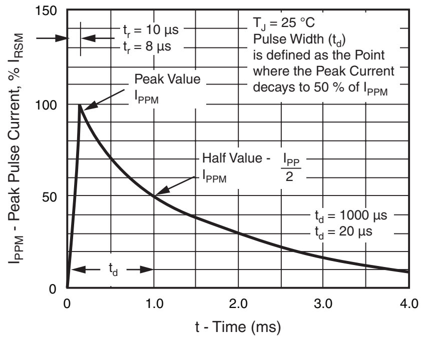


Figure 1. Pulse Waveform

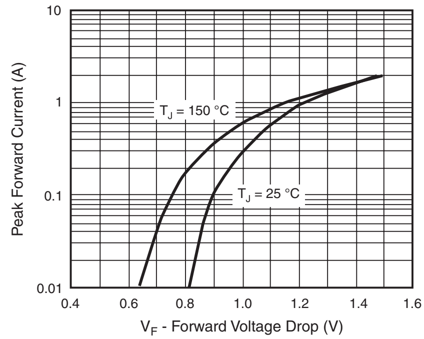


Figure 4. Typical Peak Forward Voltage Drop vs. Peak Forward Current

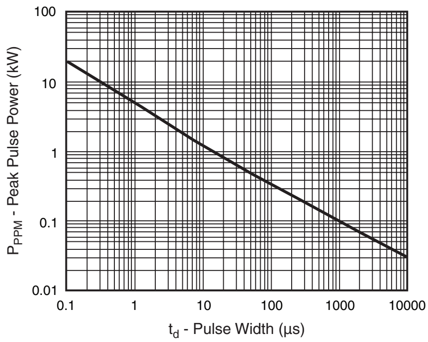


Figure 2. Peak Pulse Power Rating Curve

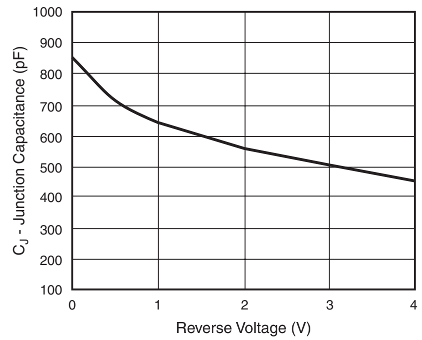


Figure 5. Typical Junction Capacitance

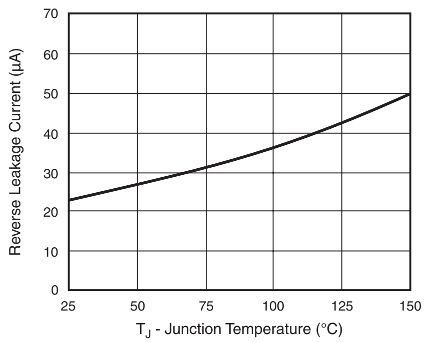


Figure 3. Relative Variation of Leakage Current vs. Junction Temperature

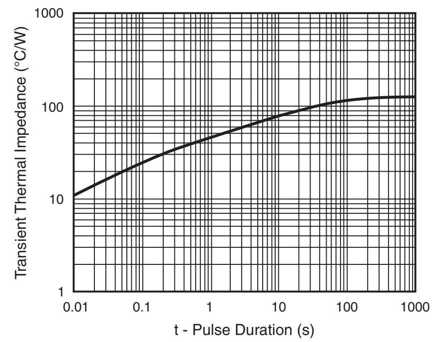
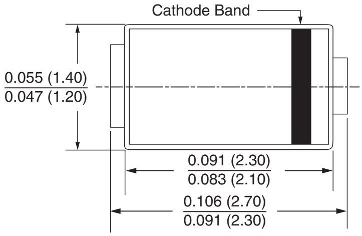
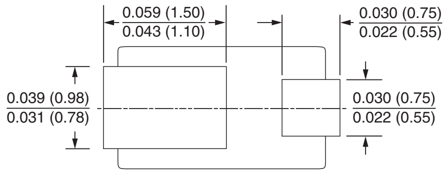


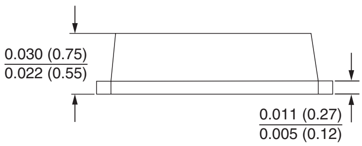
Figure 6. Typical Transient Thermal Impedance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

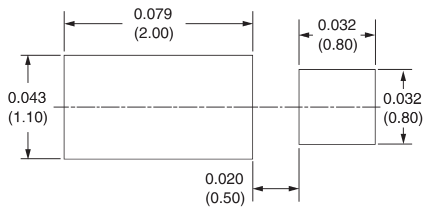
MicroSMP





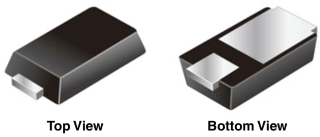


Mounting Pad Layout



Surface Mount TRANSZORB® Transient Voltage Suppressors

eSMP™ Series



MicroSMP

FEATURES

- Very low profile - typical height of 0.65 mm
- Ideal for automated placement
- Oxide planar chip junction
- Uni-directional polarity only
- Peak pulse power: 100 W (10/1000 µs)
- ESD capability: **15 kV (air), 8 kV (contact)**
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units specifically for protecting 5.0 V supplied sensitive equipment against transient overvoltages.

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V
P_{PPM}	100 W
I_{FSM}	25 A
T_J max.	150 °C

MECHANICAL DATA

Case: MicroSMP

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes the cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation (1)(2)	P_{PPM}	100	W
Peak pulse current with a 10/1000 µs waveform (Fig. 1)	I_{PPM}	10.9	A
Non repetitive peak forward surge current 10 ms single half sine-wave (2)	I_{FSM}	25	A
Power dissipation T_L = 120 °C (2)	P_D	1.0	W
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 1

(2) Mounted on 6.0 x 6.0 mm copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)										
DEVICE TYPE	DEVICE MARKING CODE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM CLAMPING VOLTAGE (2) V_C (V) AT I_{PPM} (A) 10/1000 µs		MAXIMUM CLAMPING VOLTAGE (2) V_C (V) AT I_{PPM} (A) 8/20 µs	
		MIN	MAX							
MSP5.0A	AE	6.40	7.07	10	5.0	100	9.2	10.9	14.5	57

Notes:
(1) Pulse test: $t_p \leq$ 50 ms
(2) Surge current waveform per Fig. 1 and derate per Fig. 2

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Typical thermal resistance (1)	$R_{\theta JA}$ $R_{\theta JL}$	125 30	°C/W

Note:
(1) Thermal resistance from junction to ambient and junction to lead mounted on P.C.B. with 6.0 x 6.0 mm copper pad areas. $R_{\theta JL}$ is measured at the terminal of cathode band.

IMMUNITY TO STATIC ELECTRICAL DISCHARGE TO THE FOLLOWING STANDARDS (T_A = 25 °C unless otherwise noted)					
STANDARD	TEST TYPE	TEST CONDITIONS	SYMBOL	CLASS	VALUE
AEC Q101-001	Human body model (contact mode)	C = 100 pF, R = 1.5 kΩ	V_C	H3B	> 8 kV
IEC-61000-4-2 (2)	Human body model (air discharge mode) (1)	C = 150 pF, R = 150 Ω		4	> 15 kV

Notes:
(1) Immunity to IEC-61000-4-2 air discharge mode has a typical performance > 30 kV
(2) System ESD standard

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
MSP5.0A-E3/89A	0.006	89A	4500	7" diameter plastic tape and reel

Document Number: 88487
Revision: 20-Sep-07

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

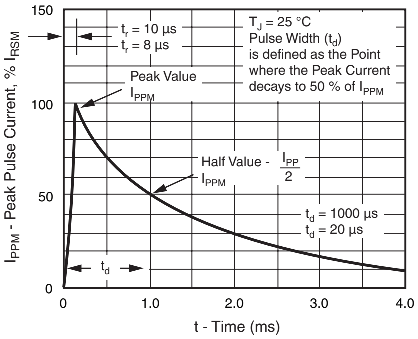


Figure 1. Pulse Waveform

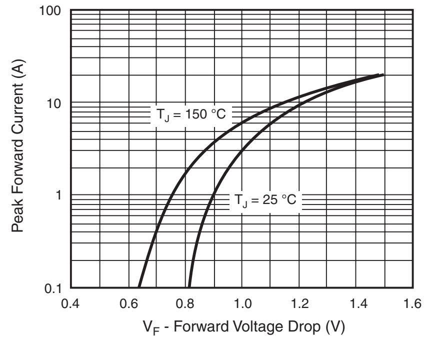


Figure 4. Typical Peak Forward Voltage Drop vs. Peak Forward Current

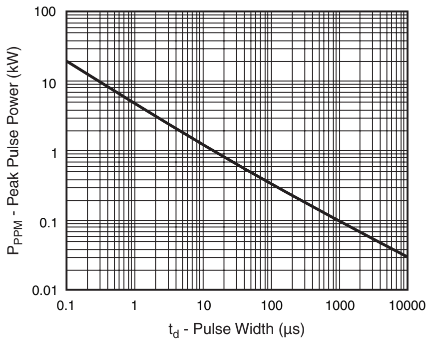


Figure 2. Peak Pulse Power Rating Curve

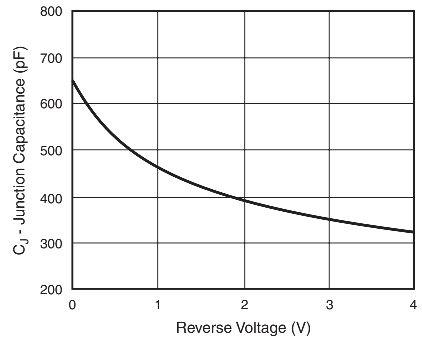


Figure 5. Typical Junction Capacitance

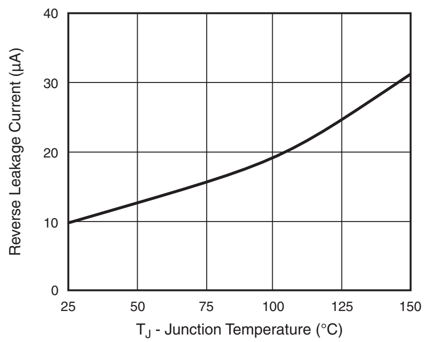


Figure 3. Relative Variation of Leakage Current vs. Junction Temperature

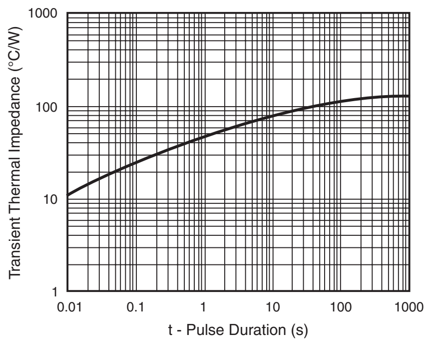
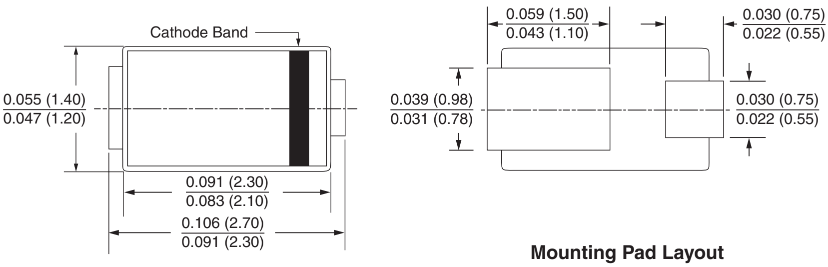
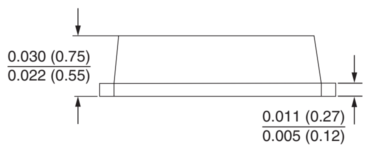


Figure 6. Typical Transient Thermal Impedance

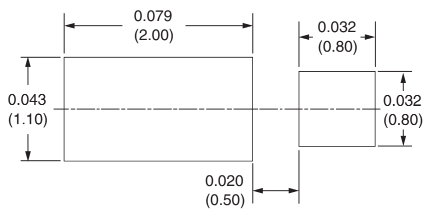
PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

MicroSMP

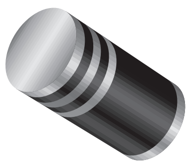




Mounting Pad Layout



Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-213AB (GL41)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 200 V
P_{PPM}	400 W, 200 W
P_D	1.0 W
I_{FSM}	40 A
T_J max.	150 °C

FEATURES

- Plastic MELF package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional polarity only
- 400 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 % (200 W above 91 V)
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 250 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: DO-213AB (GL41)
Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Blue band denotes the cathode which is positive with respect to the anode under normal TVS operation.

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBO	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1) (Fig. 1)	P_{PPM}	400	W
Power dissipation on infinite heatsink at T_L = 75 °C	P_D	1.0	W
Peak pulse current with a 10/1000 µs waveform (1) (Fig. 3)	I_{PPM}	See next table	A
Peak forward surge current, 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A for uni-directional only	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2. Rating is 200 W above 91 V

(2) Measured at 8.3 ms single half sine-wave or equivalent square wave duty cycle = 4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	**BREAKDOWN VOLTAGE V_{BR} (V) (1)**		**TEST CURRENT AT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)**	**MAXIMUM PEAK PULSE CURRENT I_{PPM} (A) (2)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**	**MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)**
	MIN	**MAX**						
TGL41-6.8	6.12	7.48	10	5.50	1000	37.0	10.8	0.060
TGL41-6.8A	6.45	7.14	10	5.80	1000	38.1	10.5	0.060
TGL41-7.5	6.75	8.25	10	6.05	500	34.2	11.7	0.064
TGL41-7.5A	7.13	7.88	10	6.40	500	35.4	11.3	0.064
TGL41-8.2	7.38	9.02	10	6.63	200	32.0	12.5	0.068
TGL41-8.2A	7.79	8.61	10	7.02	200	33.1	12.1	0.068
TGL41-9.1	8.19	10.0	1.0	7.37	50.0	29.0	13.8	0.071
TGL41-9.1A	8.65	9.55	1.0	7.78	50.0	29.9	13.4	0.071
TGL41 -10	9.00	11.0	1.0	8.10	10.0	26.7	15.0	0.076
TGL41 -10A	9.50	10.5	1.0	8.55	10.0	27.6	14.5	0.076
TGL41 -11	9.90	12.1	1.0	8.92	5.0	24.7	16.2	0.078
TGL41 -11A	10.5	11.6	1.0	9.40	5.0	25.6	15.6	0.078
TGL41-12	10.8	13.2	1.0	9.72	5.0	23.1	17.3	0.081
TGL41-12A	11.4	12.6	1.0	10.2	5.0	24.0	16.7	0.081
TGL41-13	11.7	14.3	1.0	10.5	5.0	21.1	19.0	0.084
TGL41-13A	12.4	13.7	1.0	11.1	5.0	22.0	18.2	0.084
TGL41-15	13.5	16.5	1.0	12.1	5.0	18.2	22.0	0.087
TGL41-15A	14.3	15.8	1.0	12.8	5.0	18.9	21.2	0.087
TGL41-16	14.4	17.6	1.0	12.9	5.0	17.0	23.5	0.089
TGL41-16A	15.2	16.8	1.0	13.6	5.0	17.8	22.5	0.089
TGL41-18	16.2	19.8	1.0	14.5	5.0	15.1	26.5	0.091
TGL41-18A	17.1	18.9	1.0	15.3	5.0	15.9	25.2	0.091
TGL41-20	18.0	22.0	1.0	16.2	5.0	13.7	29.1	0.093
TGL41-20A	19.0	21.0	1.0	17.1	5.0	14.4	27.7	0.093
TGL41-22	19.8	24.2	1.0	17.8	5.0	12.5	31.9	0.095
TGL41-22A	20.9	23.1	1.0	18.8	5.0	13.1	30.6	0.095
TGL41-24	21.6	26.4	1.0	19.4	5.0	11.5	34.7	0.097
TGL41-24A	22.8	25.2	1.0	20.5	5.0	12.0	33.2	0.097
TGL41-27	24.3	29.7	1.0	21.8	5.0	10.2	39.1	0.099
TGL41-27A	25.7	28.4	1.0	23.1	5.0	10.7	37.5	0.099
TGL41-30	27.0	33.0	1.0	24.3	5.0	9.2	43.5	0.100
TGL41-30A	28.5	31.5	1.0	25.6	5.0	9.7	41.4	0.100
TGL41-33	29.7	36.3	1.0	26.8	5.0	8.4	47.7	0.101
TGL41-33A	31.4	34.7	1.0	28.2	5.0	8.8	45.7	0.101
TGL41-36	32.4	39.6	1.0	29.1	5.0	7.7	52.0	0.102
TGL41-36A	34.2	37.8	1.0	30.8	5.0	8.0	49.9	0.102
TGL41-39	35.1	42.9	1.0	31.6	5.0	7.1	56.4	0.103
TGL41-39A	37.1	41.0	1.0	33.3	5.0	7.4	53.9	0.103
TGL41-43	38.7	47.3	1.0	34.8	5.0	6.5	61.9	0.104
TGL41-43A	40.9	45.2	1.0	36.8	5.0	6.7	59.3	0.104
TGL41-47	42.3	51.7	1.0	38.1	5.0	5.9	67.8	0.104
TGL41-47A	44.7	49.4	1.0	40.2	5.0	6.2	64.8	0.104
TGL41-51	45.9	56.1	1.0	41.3	5.0	5.4	73.5	0.105

Document Number: 88403
Revision: 04-Sep-07

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	**BREAKDOWN VOLTAGE V_{BR} (V) (1)**		**TEST CURRENT AT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)**	**MAXIMUM PEAK PULSE CURRENT I_{PPM} (A) (2)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**	**MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)**
	MIN	**MAX**						
TGL41-51A	48.5	53.6	1.0	43.6	5.0	5.7	70.1	0.105
TGL41-56	50.4	61.6	1.0	45.4	5.0	5.0	80.5	0.106
TGL41-56A	53.2	58.8	1.0	47.8	5.0	5.2	77.0	0.106
TGL41-62	55.8	68.2	1.0	50.2	5.0	4.5	89.0	0.107
TGL41-62A	58.9	65.1	1.0	53.0	5.0	4.7	85.0	0.107
TGL41-68	61.2	74.8	1.0	55.1	5.0	4.1	98.0	0.107
TGL41-68A	64.6	71.4	1.0	58.1	5.0	4.3	92.0	0.107
TGL41-75	67.5	82.5	1.0	60.7	5.0	3.7	108	0.108
TGL41-75A	71.3	78.8	1.0	64.1	5.0	3.9	103	0.108
TGL41-82	73.8	90.2	1.0	66.4	5.0	3.4	118	0.108
TGL41-82A	77.9	86.1	1.0	70.1	5.0	3.5	113	0.108
TGL41-91	81.9	100	1.0	73.7	5.0	3.1	131	0.109
TGL41-91A	86.5	95.5	1.0	77.8	5.0	3.2	125	0.109
TGL41-100	90.0	110	1.0	81.0	5.0	1.39	144	0.109
TGL41-100A	95.0	105	1.0	85.5	5.0	1.46	137	0.109
TGL41-110	99.0	121	1.0	89.2	5.0	1.27	158	0.110
TGL41-110A	105	116	1.0	94.0	5.0	1.32	152	0.110
TGL41-120	108	132	1.0	97.2	5.0	1.16	173	0.110
TGL41-120A	114	126	1.0	102	5.0	1.21	165	0.110
TGL41-130	117	143	1.0	105	5.0	1.07	187	0.110
TGL41-130A	124	137	1.0	111	5.0	1.12	179	0.110
TGL41-150	135	165	1.0	121	5.0	0.93	215	0.111
TGL41-150A	143	158	1.0	128	5.0	0.97	207	0.111
TGL41-160	144	176	1.0	130	5.0	0.87	230	0.111
TGL41-160A	152	168	1.0	136	5.0	0.91	219	0.111
TGL41-170	153	187	1.0	138	5.0	0.82	244	0.111
TGL41-170A	162	179	1.0	145	5.0	0.85	234	0.111
TGL41-180	162	198	1.0	146	5.0	0.78	258	0.111
TGL41-180A	171	189	1.0	154	5.0	0.81	246	0.111
TGL41-200	180	220	1.0	162	5.0	0.70	287	0.111
TGL41-200A	190	210	1.0	171	5.0	0.73	274	0.111

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
TGL41-6.8A-E3/96	0.134	96	1500	7" diameter plastic tape and reel
TGL41-6.8A-E3/97	0.134	97	5000	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise specified)

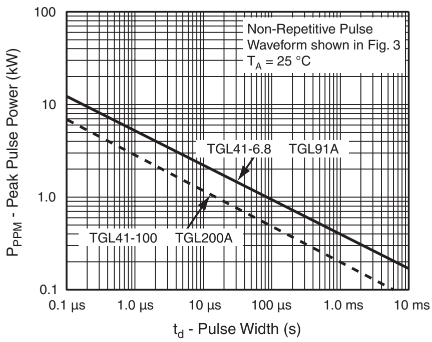


Figure 1. Peak Pulse Power Rating Curve

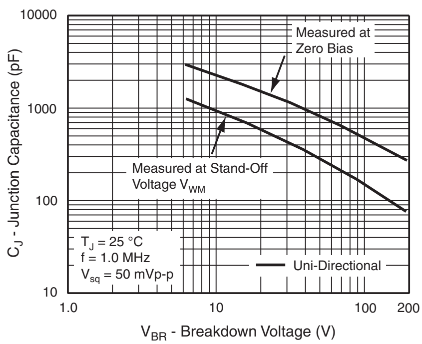


Figure 4. Typical Junction Capacitance

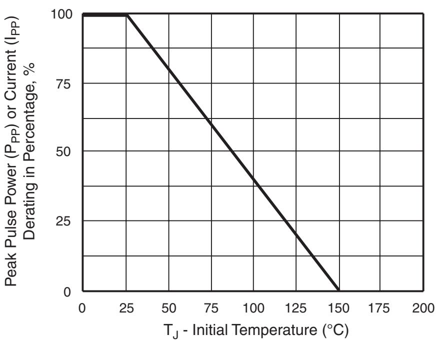


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

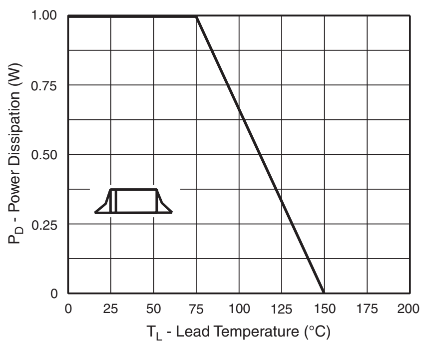


Figure 5. Power Derating Curve

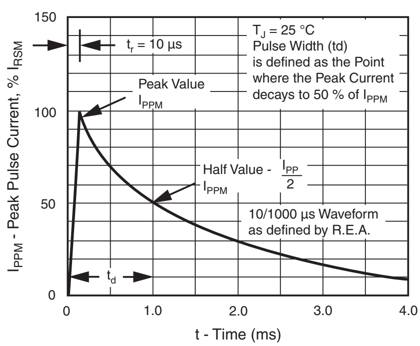


Figure 3. Pulse Waveform

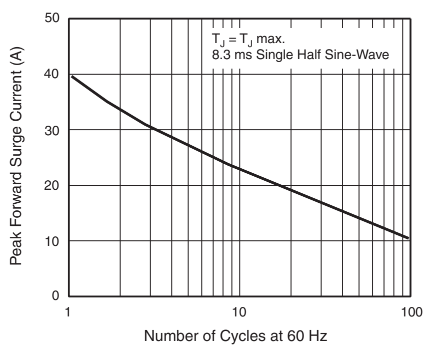
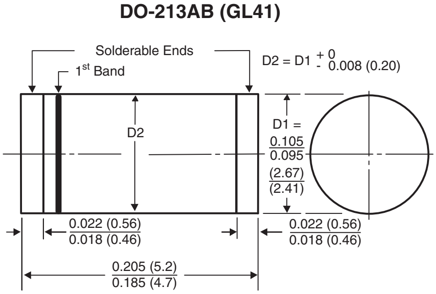
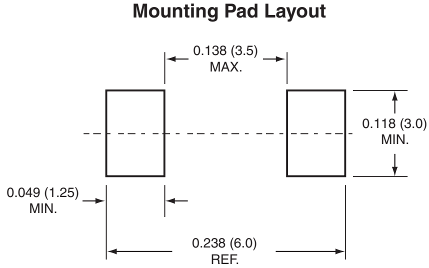


Figure 6. Maximum Non-Repetitive Peak Forward Surge Current
Uni-Directional Only

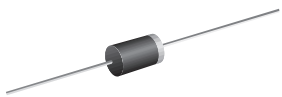
PACKAGE OUTLINE DIMENSIONS in inches (millimeters)



1st Band Denotes Type and Positive End (Cathode)



TRANSZORB® Transient Voltage Suppressors



DO-204AL (DO-41)

FEATURES

- Glass passivated chip junction
- Available in uni-directional only
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: DO-204AL, molded epoxy over passivated chip
Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes cathode end

PRIMARY CHARACTERISTICS	
V_{BR} uni-directional	530 V, 550 V
P_{PPM}	300 W
P_D	1.0 W
V_{WM}	477 V, 495 V
V_C	760 V
T_J max.	150 °C

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	P4KE530	P4KE550	UNIT
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 4)	P_D	1.0		W
Peak pulse power dissipation (1)(2) (Fig. 1)	P_{PPM}	300		W
Stand-off voltage	V_{WM}	477	495	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150		°C

Notes:

(1) Non repetitive current pulse per Fig. 3 and derated above 25 °C per Fig. 2

(2) Peak pulse power waveform is 10/1000 µs

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)					
PARAMETER	**TEST CONDITIONS**	**SYMBOL**	**P4KE530**	**P4KE550**	**UNIT**
Minimum breakdown voltage	at 100 µA	V_{BR}	530	550	V
Max. clamping voltage	at 400 mA, 10/1000 µs waveform	V_C	760		V
Maximum DC reverse leakage current	at V_{WM}	I_D	1.0		µA
Typical temperature coefficient	of V_{BR}		650		mV°C
Typical capacitance	at 1 MHz, V_R = 0 V	C_J	90		pF
	at 1 MHz, V_R = 200 V	C_J	7.5		pF

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)				
PARAMETER	**SYMBOL**	**P4KE530**	**P4KE550**	**UNIT**
Typical thermal resistance, junction to lead	$R_{\theta JL}$	75		°C/W
Typical thermal resistance, junction to ambient	$R_{\theta JA}$	125		°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
P4KE530-E3/54	0.350	54	4000	13" diameter paper tape and reel
P4KE550-E3/54	0.350	54	4000	13" diameter paper tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

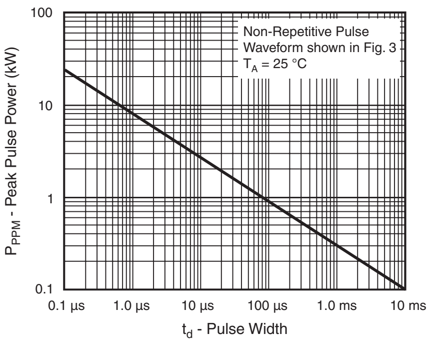


Figure 1. Peak Pulse Power Rating Curve

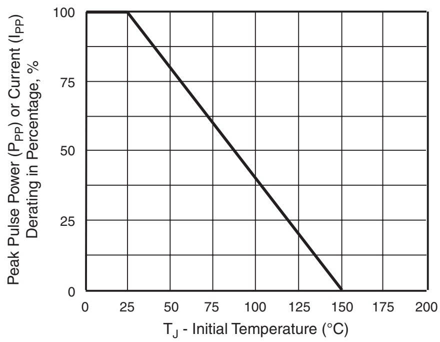


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

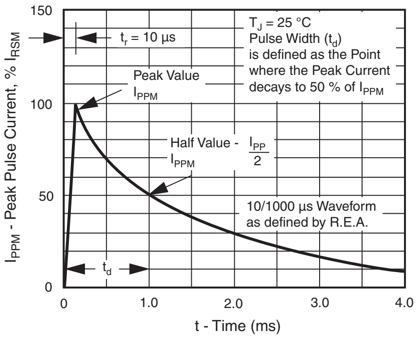


Figure 3. Pulse Waveform

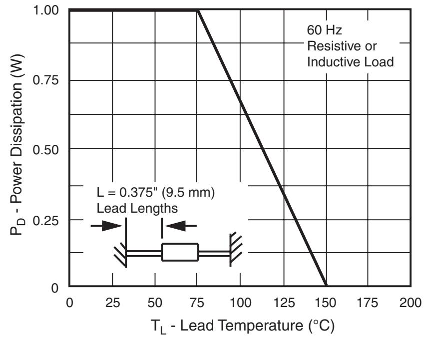
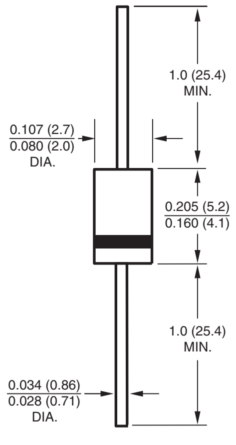


Figure 4. Pulse Derating Curve

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AL (DO-41)



APPLICATION NOTES

- Respect Thermal Resistance (PCB Layout) - as the temperature coefficient also contributes to the clamping voltage
- Select minimum breakdown voltage, so you get acceptable power dissipation and PCB tie point temperature. Devices with higher breakdown voltage will have a shorter conduction time and will dissipate less power
- Clamping voltage is influenced by internal resistance - design approximation is 7 V per 100 mA slope
- Keep temperature of TVS lower than TOPSwitch® as a recommendation
- Maximum current is determined by the maximum T_J and can be higher than 300 mA. Contact supplier for different clamping voltage/current arrangements
- Minimum breakdown voltage can be customized for other applications. Contact supplier
- TOPSwitch is a registered trademark of Power Integrations, Inc.

Surface Mount TRANSZORB® Transient Voltage Suppressors

DO-214AC (SMA)

PRIMARY CHARACTERISTICS	
V_{BR}	530 V, 550 V
P_{PPM}	300 W
P_D	2.5 W
I_{FSM}	40 A
T_J max.	150 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AC (SMA)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes cathode end

FEATURES

- Glass passivated chip junction
- Available in uni-directional polarity only
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

APPLICATION NOTES

- Respect thermal resistance (PCB Layout) - as the temperature coefficient also contributes to the clamping voltage
- Select minimum breakdown voltage, so you get acceptable power dissipation and PCB tie point temperature
- Devices with higher breakdown voltage will have a shorter conduction time and will dissipate less power
- Clamping voltage is influenced by internal resistance - design approximation is 7 V per 100 mA slope
- Keep temperature of TVS lower than TOPSwitch® as a recommendation
- Maximum current is determined by the maximum T_J and can be higher than 300 mA
- Contact supplier for different clamping voltage/ current arrangements
- Minimum breakdown voltage can be customized for other applications. Contact supplier
- TOPSwitch is a registered trademark of Power Integrations, Inc.

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	SMAJ530	SMAJ550	UNIT
Device marking code		HD	SB	
Power dissipation on infinite heatsink (3)	P_D	2.5		W
Peak pulse power dissipation (1)(2)(4) (Fig. 1)	P_{PPM}	300		W
Stand-off voltage	V_{WM}	477	495	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150		°C

Notes:

(1) Non repetitive current pulse per Fig. 3 and derated above 25 °C per Fig. 2

(2) Mounted on 5.0 mm^2 copper pads to each terminal

(3) Lead temperature at T_L = 75 °C

(4) Peak pulse power waveform is 10/1000 µs

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)					
PARAMETER	**TEST CONDITIONS**	**SYMBOL**	**SMAJ530**	**SMAJ550**	**UNIT**
Minimum breakdown voltage	at 100 µA	V_{BR}	530	550	V
Max. clamping voltage	at 400 mA, 10/1000 µs-waveform	V_C	760		V
Maximum DC reverse leakage current	at V_{WM}	I_D	1.0		µA
Typical temperature coefficient	of V_{BR}		650		mV/°C
Typical capacitance (1)	at 0 V	C_J	90		pF
	at 200 V	C_J	7.5		pF

Note:

(1) Measured at 1 MHz

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)				
PARAMETER	**SYMBOL**	**SMAJ530**	**SMAJ550**	**UNIT**
Typical thermal resistance, junction to lead	$R_{\theta JL}$	30		°C/W
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	120		°C/W

Note:

(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMAJ530-E3/61	0.064	61	1800	7" diameter plastic tape and reel
SMAJ530-E3/5A	0.064	5A	7500	13" diameter plastic tape and reel
SMAJ530HE3/61 (1)	0.064	61	1800	7" diameter plastic tape and reel
SMAJ530HE3/5A (1)	0.064	5A	7500	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

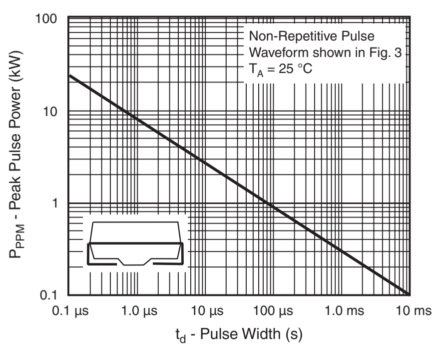


Figure 1. Peak Pulse Power Rating Curve

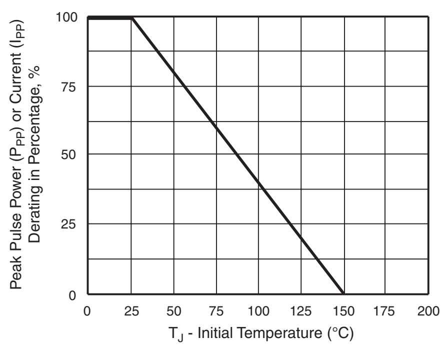


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

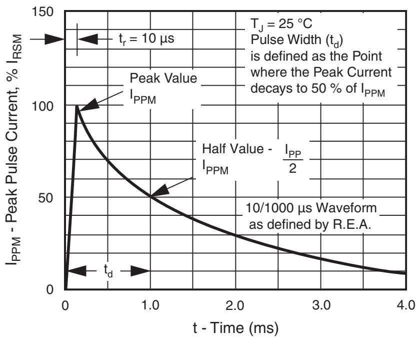
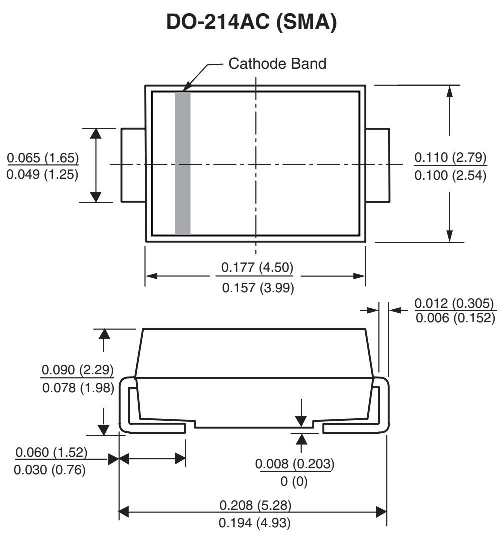
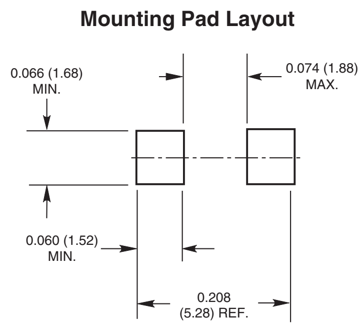


Figure 3. Pulse Waveform

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)





Surface Mount TRANSZORB® Transient Voltage Suppressors

DO-214AC (SMA)

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional 400 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 % (300 W above 91 V)
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

PRIMARY CHARACTERISTICS	
V_{BR} uni-directional	6.8 V to 540 V
V_{BR} bi-directional	6.8 V to 220 V
P_{PPM}	400 W, 300 W
P_D	3.3 W
I_{FSM} (uni-directional only)	40 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use CA suffix (e.g. P4SMA10CA).

Electrical characteristics apply in both directions.

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: DO-214AC (SMA)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	400	W
Peak pulse current with a 10/1000 µs waveform (1) (Fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink, T_A = 50 °C	P_D	3.3	W
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	40	A
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2. Rating is 300 W above 91 V

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)										
PART NUMBER	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (4) (μA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE OF V_{BR} (%/°C)
	UNI	BI	MIN	MAX						
P4SMA6.8A	6V8A	6V8C	6.45	7.14	10	5.80	1000	38.1	10.5	0.057
P4SMA7.5A	7V5A	7V5C	7.13	7.88	10	6.40	500	35.4	11.3	0.061
P4SMA8.2A	8V2A	8V2C	7.79	8.61	10	7.02	200	33.1	12.1	0.065
P4SMA9.1A	9V1A	9V1C	8.65	9.55	1.0	7.78	50.0	29.9	13.4	0.068
P4SMA10A	10A	10C	9.5	10.5	1.0	8.55	10.0	27.6	14.5	0.073
P4SMA11A	11A	11C	10.5	11.6	1.0	9.40	5.0	25.6	15.6	0.075
P4SMA12A	12A	12C	11.4	12.6	1.0	10.2	1.0	24.0	16.7	0.078
P4SMA13A	13A	13C	12.4	13.7	1.0	11.1	1.0	22.0	18.2	0.081
P4SMA15A	15A	15C	14.3	15.8	1.0	12.8	1.0	18.9	21.2	0.084
P4SMA16A	16A	16C	15.2	16.8	1.0	13.6	1.0	17.8	22.5	0.086
P4SMA18A	18A	18C	17.1	18.9	1.0	15.3	1.0	15.9	25.2	0.089
P4SMA20A	20A	20C	19.0	21.0	1.0	17.1	1.0	14.4	27.7	0.090
P4SMA22A	22A	22C	20.9	23.1	1.0	18.8	1.0	13.1	30.6	0.092
P4SMA24A	24A	24C	22.8	25.2	1.0	20.5	1.0	12.0	33.2	0.090
P4SMA27A	27A	27C	25.7	28.4	1.0	23.1	1.0	10.7	37.5	0.096
P4SMA30A	30A	30C	28.5	31.5	1.0	25.6	1.0	9.7	41.4	0.097
P4SMA33A	33A	33C	31.4	34.7	1.0	28.2	1.0	8.8	45.7	0.098
P4SMA36A	36A	36C	34.2	37.8	1.0	30.8	1.0	8.0	49.9	0.099
P4SMA39A	39A	39C	37.1	41.0	1.0	33.3	1.0	7.4	53.9	0.100
P4SMA43A	43A	43C	40.9	45.2	1.0	36.8	1.0	6.7	59.3	0.101
P4SMA47A	47A	47C	44.7	49.4	1.0	40.2	1.0	6.2	64.8	0.101
P4SMA51A	51A	51C	48.5	53.6	1.0	43.6	1.0	5.7	70.1	0.102
P4SMA56A	56A	56C	53.2	58.8	1.0	47.8	1.0	5.2	77.0	0.103
P4SMA62A	62A	62C	58.9	65.1	1.0	53.0	1.0	4.7	85.0	0.104
P4SMA68A	68A	68C	64.6	71.4	1.0	58.1	1.0	4.3	92.0	0.104
P4SMA75A	75A	75C	71.3	78.8	1.0	64.1	1.0	3.9	104	0.105
P4SMA82A	82A	82C	77.9	86.1	1.0	70.1	1.0	3.5	113	0.105
P4SMA91A	91A	91C	86.5	95.5	1.0	77.8	1.0	3.2	125	0.106
P4SMA100A	100A	100C	95.0	105	1.0	85.5	1.0	2.2	137	0.106
P4SMA110A	110A	110C	105	116	1.0	94.0	1.0	2.0	152	0.107
P4SMA120A	120A	120C	114	126	1.0	102	1.0	1.8	165	0.107
P4SMA130A	130A	130C	124	137	1.0	111	1.0	1.7	179	0.107
P4SMA150A	150A	150C	143	158	1.0	128	1.0	1.4	207	0.106
P4SMA160A	160A	160C	152	168	1.0	136	1.0	1.4	219	0.108
P4SMA170A	170A	170C	162	179	1.0	145	1.0	1.3	234	0.108
P4SMA180A	180A	180C	171	189	1.0	154	1.0	1.2	246	0.108
P4SMA200A	200A	200C	190	210	1.0	171	1.0	1.1	274	0.108
P4SMA220A	220A	220C	209	231	1.0	185	1.0	0.90	328	0.108
P4SMA250A	250A	-	237	263	1.0	214	1.0	0.87	344	0.110
P4SMA300A	300A	-	285	315	1.0	256	1.0	0.73	414	0.110
P4SMA350A	350A	-	333	368	1.0	300	1.0	0.62	482	0.110
P4SMA400A	400A	-	380	420	1.0	342	1.0	0.55	548	0.110
P4SMA440A	440A	-	418	462	1.0	376	1.0	0.50	602	0.110
P4SMA480A	480A	-	456	504	1.0	408	1.0	0.46	658	0.110
P4SMA510A	510A	-	485	535	1.0	434	1.0	0.43	698	0.110
P4SMA540A	540A	-	513	567	1.0	459	1.0	0.41	740	0.110

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE CA62.35

(4) For bi-directional types with V_R 10 V and less, the I_D limit is doubled

(5) V_F = 3.5 V at I_F = 25 A (uni-directional only)

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Thermal resistance, junction to ambient air (1)	$R_{\theta JA}$	120	°C/W
Thermal resistance, junction to leads	$R_{\theta JL}$	30	°C/W

Note:
(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
P4SMA6.8A-E3/61	0.064	61	1800	7" diameter plastic tape and reel
P4SMA6.8A-E3/5A	0.064	5A	7500	13" diameter plastic tape and reel
P4SMA6.8AHE3/61 (1)	0.064	61	1800	7" diameter plastic tape and reel
P4SMA6.8AHE3/5A (1)	0.064	5A	7500	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES
(T_A = 25 °C unless otherwise noted)

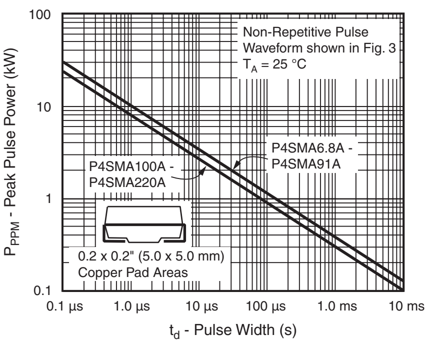


Figure 1. Peak Pulse Power Rating Curve

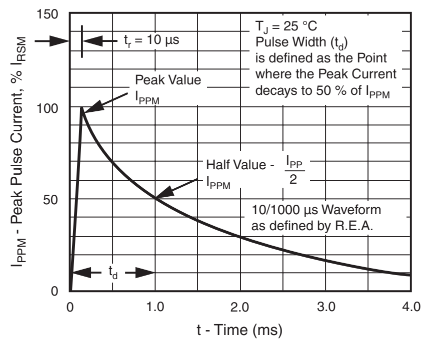


Figure 3. Pulse Waveform

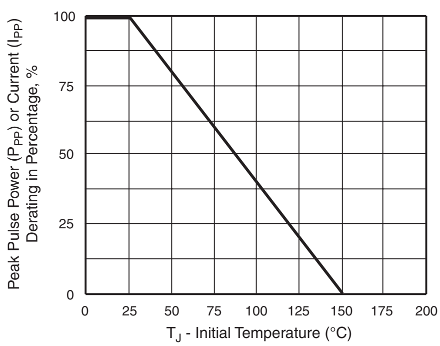


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

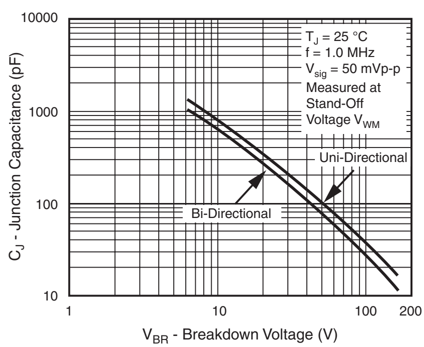


Figure 4. Typical Junction Capacitance

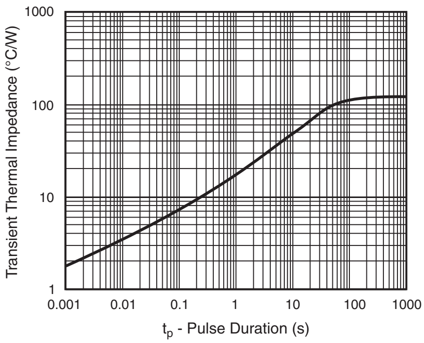


Figure 5. Typical Transient Thermal Impedance

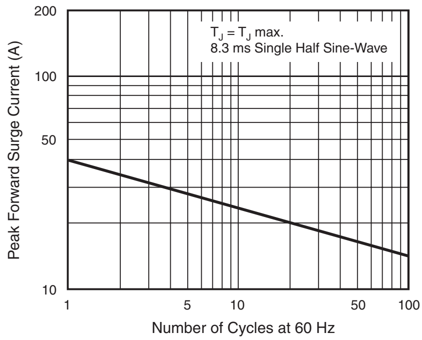
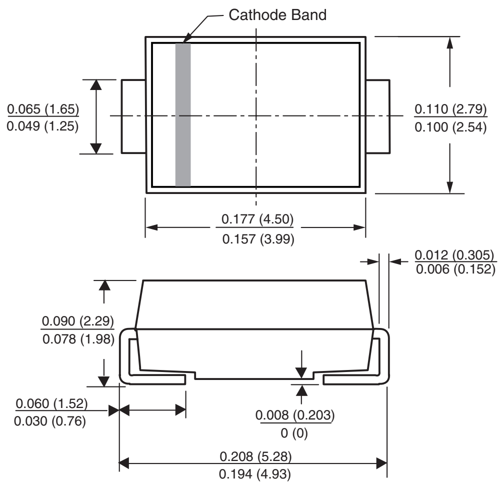


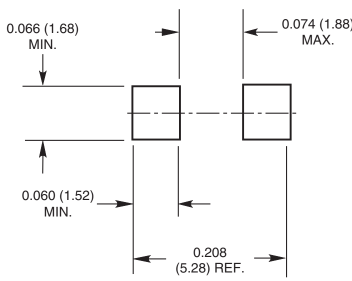
Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-214AC (SMA)



Mounting Pad Layout



Surface Mount TRANSZORB® Transient Voltage Suppressors

DO-214AC (SMA)

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 188 V
P_{PPM}	400 W, 300 W
I_{FSM}	40 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional use C or CA suffix (e.g. SMAJ10C, SMAJ10CA).

Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 400 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 % (300 W above 78 V)
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AC (SMA)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	400	W
Peak pulse current with a waveform (1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	40	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2. Rating is 300 W above 78 V

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

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

DEVICE TYPE	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
SMAJ5.0	AD	WD	6.40	7.82	10	5.0	800	41.7	9.6
SMAJ5.0A(5)	AE	WE	6.40	7.07	10	5.0	800	43.5	9.2
SMAJ6.0	AF	WF	6.67	8.15	10	6.0	800	35.1	11.4
SMAJ6.0A	AG	WG	6.67	7.37	10	6.0	800	38.8	10.3
SMAJ6.5	AH	WH	7.22	8.82	10	6.5	500	32.5	12.3
SMAJ6.5A	AK	WK	7.22	7.98	10	6.5	500	35.7	11.2
SMAJ7.0	AL	WL	7.78	9.51	10	7.0	200	30.1	13.3
SMAJ7.0A	AM	WM	7.78	8.60	10	7.0	200	33.3	12.0
SMAJ7.5	AN	WN	8.33	10.2	1.0	7.5	100	28.0	14.3
SMAJ7.5A	AP	WP	8.33	9.21	1.0	7.5	100	31.0	12.9
SMAJ8.0	AQ	WQ	8.89	10.9	1.0	8.0	50	26.7	15.0
SMAJ8.0A	AR	WR	8.89	9.83	1.0	8.0	50	29.4	13.6
SMAJ8.5	AS	WS	9.44	11.5	1.0	8.5	10	25.2	15.9
SMAJ8.5A	AT	WT	9.44	10.4	1.0	8.5	10	27.8	14.4
SMAJ9.0	AU	WU	10.0	12.2	1.0	9.0	5.0	23.7	16.9
SMAJ9.0A	AV	WV	10.0	11.1	1.0	9.0	5.0	26.0	15.4
SMAJ10	AW	WW	11.1	13.6	1.0	10	1.0	21.3	18.8
SMAJ10A	AX	WX	11.1	12.3	1.0	10	1.0	23.5	17.0
SMAJ11	AY	WY	12.2	14.9	1.0	11	1.0	19.9	20.1
SMAJ11A	AZ	WZ	12.2	13.5	1.0	11	1.0	22.0	18.2
SMAJ12	BD	XD	13.3	16.3	1.0	12	1.0	18.2	22.0
SMAJ12A	BE	XE	13.3	14.7	1.0	12	1.0	20.1	19.9
SMAJ13	BF	XF	14.4	17.6	1.0	13	1.0	16.8	23.8
SMAJ13A	BG	XG	14.4	15.9	1.0	13	1.0	18.6	21.5
SMAJ14	BH	XH	15.6	19.1	1.0	14	1.0	15.5	25.8
SMAJ14A	BK	XK	15.6	17.2	1.0	14	1.0	17.2	23.2
SMAJ15	BL	XL	16.7	20.4	1.0	15	1.0	14.9	26.9
SMAJ15A	BM	XM	16.7	18.5	1.0	15	1.0	16.4	24.4
SMAJ16	BN	XN	17.8	21.8	1.0	16	1.0	13.9	28.8
SMAJ16A	BP	XP	17.8	19.7	1.0	16	1.0	15.4	26.0
SMAJ17	BQ	XQ	18.9	23.1	1.0	17	1.0	13.1	30.5
SMAJ17A	BR	XR	18.9	20.9	1.0	17	1.0	14.5	27.6
SMAJ18	BS	XS	20.0	24.4	1.0	18	1.0	12.4	32.2
SMAJ18A	BT	XT	20.0	22.1	1.0	18	1.0	13.7	29.2
SMAJ20	BU	XU	22.2	27.1	1.0	20	1.0	11.2	35.8
SMAJ20A	BV	XV	22.2	24.5	1.0	20	1.0	12.3	32.4
SMAJ22	BW	XW	24.4	29.8	1.0	22	1.0	10.2	39.4
SMAJ22A	BX	XX	24.4	26.9	1.0	22	1.0	11.3	35.5
SMAJ24	BY	XY	26.7	32.6	1.0	24	1.0	9.3	43.0
SMAJ24A	BZ	XZ	26.7	29.5	1.0	24	1.0	10.3	38.9
SMAJ26	CD	YD	28.9	35.3	1.0	26	1.0	8.6	46.6
SMAJ26A	CE	YE	28.9	31.9	1.0	26	1.0	9.5	42.1
SMAJ28	CF	YF	31.1	38.0	1.0	28	1.0	8.0	50.0
SMAJ28A	CG	YG	31.1	34.4	1.0	28	1.0	8.8	45.4
SMAJ30	CH	YH	33.3	40.7	1.0	30	1.0	7.5	53.5
SMAJ30A	CK	YK	33.3	36.8	1.0	30	1.0	8.3	48.4
SMAJ33	CL	YL	36.7	44.9	1.0	33	1.0	6.8	59.0
SMAJ33A	CM	YM	36.7	40.6	1.0	33	1.0	7.5	53.3
SMAJ36	CN	YN	40.0	48.9	1.0	36	1.0	6.2	64.3
SMAJ36A	CP	YP	40.0	44.2	1.0	36	1.0	6.9	58.1
SMAJ40	CQ	YQ	44.4	54.3	1.0	40	1.0	5.6	71.4

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)										
DEVICE TYPE	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
SMAJ40A	CR	YR	44.4	49.1	1.0	40	1.0	6.2	64.5
SMAJ43	CS	YS	47.8	58.4	1.0	43	1.0	5.2	76.7
SMAJ43A	CT	YT	47.8	52.8	1.0	43	1.0	5.8	69.4
SMAJ45	CU	YU	50.0	61.1	1.0	45	1.0	5.0	80.3
SMAJ45A	CV	YV	50.0	55.3	1.0	45	1.0	5.5	72.7
SMAJ48	CW	YW	53.3	65.1	1.0	48	1.0	4.7	85.5
SMAJ48A	CX	YX	53.3	58.9	1.0	48	1.0	5.2	77.4
SMAJ51	CY	YY	56.7	69.3	1.0	51	1.0	4.4	91.1
SMAJ51A	CZ	YZ	56.7	62.7	1.0	51	1.0	4.9	82.4
SMAJ54	RD	ZD	60.0	73.3	1.0	54	1.0	4.2	96.3
SMAJ54A	RE	ZE	60.0	66.3	1.0	54	1.0	4.6	87.1
SMAJ58	RF	ZF	64.4	78.7	1.0	58	1.0	3.9	103
SMAJ58A	RG	ZG	64.4	71.2	1.0	58	1.0	4.3	93.6
SMAJ60	RH	ZH	66.7	81.5	1.0	60	1.0	3.7	107
SMAJ60A	RK	ZK	66.7	73.7	1.0	60	1.0	4.1	96.8
SMAJ64	RL	ZL	71.1	86.9	1.0	64	1.0	3.5	114
SMAJ64A	RM	ZM	71.1	78.6	1.0	64	1.0	3.9	103
SMAJ70	RN	ZN	77.8	95.1	1.0	70	1.0	3.2	125
SMAJ70A	RP	ZP	77.8	86.0	1.0	70	1.0	3.5	113
SMAJ75	RQ	ZQ	83.3	102	1.0	75	1.0	3.0	134
SMAJ75A	RR	ZR	83.3	92.1	1.0	75	1.0	3.3	121
SMAJ78	RS	ZS	86.7	106	1.0	78	1.0	2.9	139
SMAJ78A	RT	ZT	86.7	95.8	1.0	78	1.0	3.2	126
SMAJ85	RU	ZU	94.4	115	1.0	85	1.0	2.0	151
SMAJ85A	RV	ZV	94.4	104	1.0	85	1.0	2.2	137
SMAJ90	RW	ZW	100	122	1.0	90	1.0	1.9	160
SMAJ90A	RX	ZX	100	111	1.0	90	1.0	2.1	146
SMAJ100	RY	ZY	111	136	1.0	100	1.0	1.7	179
SMAJ100A	RZ	ZZ	111	123	1.0	100	1.0	1.9	162
SMAJ110	VD	VD	122	149	1.0	110	1.0	1.5	196
SMAJ110A	SE	VE	122	135	1.0	110	1.0	1.7	177
SMAJ120	SF	VF	133	163	1.0	120	1.0	1.4	214
SMAJ120A	VG	VG	133	147	1.0	120	1.0	1.6	193
SMAJ130	SH	VH	144	176	1.0	130	1.0	1.3	231
SMAJ130A	VK	VK	144	159	1.0	130	1.0	1.4	209
SMAJ150	SL	VL	167	204	1.0	150	1.0	1.1	268
SMAJ150A	VM	VM	167	185	1.0	150	1.0	1.2	243
SMAJ160	SN	VN	178	218	1.0	160	1.0	1.0	287
SMAJ160A	SP	VP	178	197	1.0	160	1.0	1.2	259
SMAJ170	SQ	VQ	189	231	1.0	170	1.0	0.99	304
SMAJ170A	SR	VR	189	209	1.0	170	1.0	1.09	275
SMAJ188	ST	VT	209	255	1.0	188	1.0	0.90	344
SMAJ188A	SS	VS	209	231	1.0	188	1.0	0.91	328

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(5) For the bi-directional SMAJ5.0CA, the maximum V_{BR} is 7.25 V

(6) V_F = 3.5 V at I_F = 25 A (uni-directional only)

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	120	°C/W
Typical thermal resistance, junction to lead	$R_{\theta JL}$	30	°C/W

Note:
(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SMAJ5.0A-E3/61	0.064	61	1800	7" diameter plastic tape and reel
SMAJ5.0A-E3/5A	0.064	5A	7500	13" diameter plastic tape and reel
SMAJ5.0AHE3/61 (1)	0.064	61	1800	7" diameter plastic tape and reel
SMAJ5.0AHE3/5A (1)	0.064	5A	7500	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES
(T_A = 25 °C unless otherwise noted)

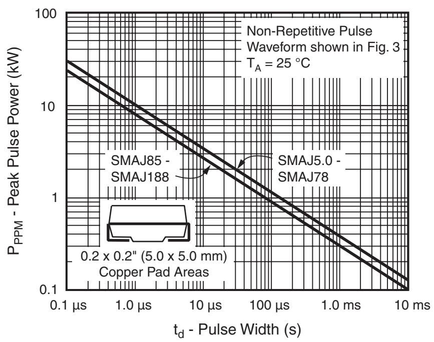


Figure 1. Peak Pulse Power Rating Curve

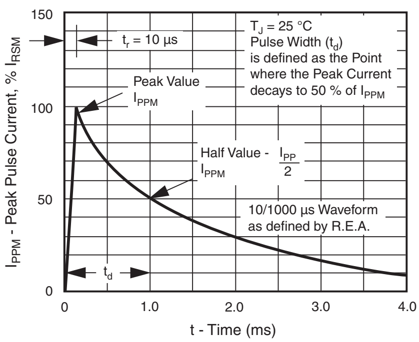


Figure 3. Pulse Waveform

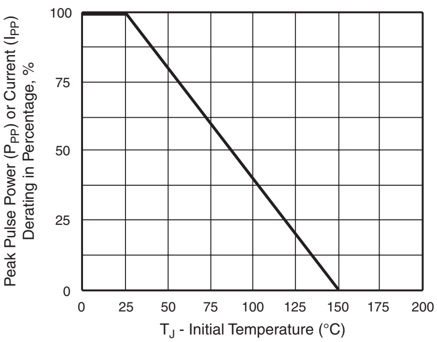


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

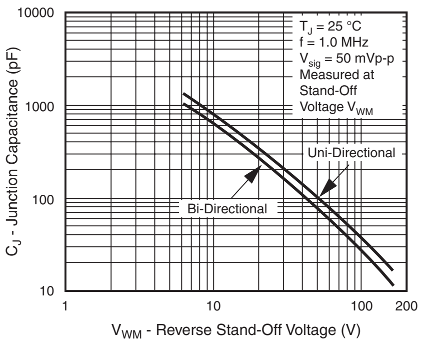


Figure 4. Typical Junction Capacitance

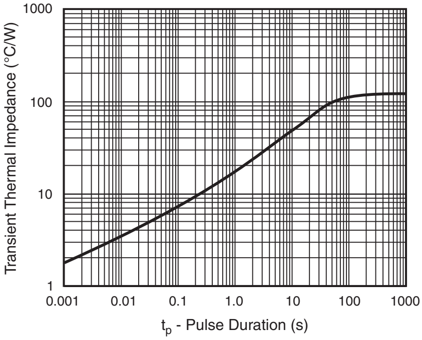


Figure 5. Typical Transient Thermal Impedance

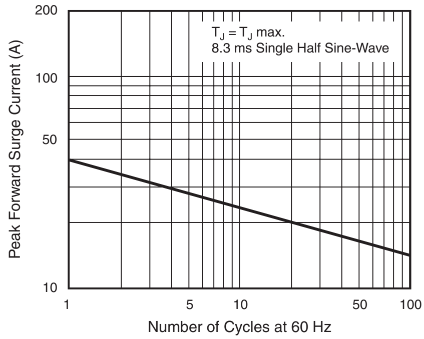
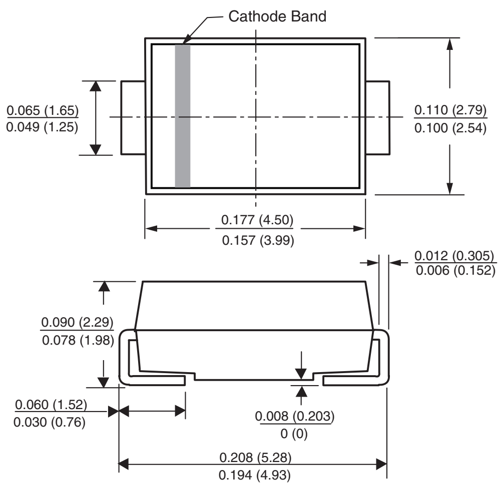


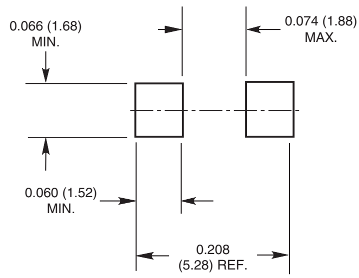
Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

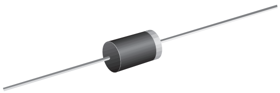
DO-214AC (SMA)



Mounting Pad Layout



TRANSZORB® Transient Voltage Suppressors



DO-204AL (DO-41)

PRIMARY CHARACTERISTICS	
V_{WM}	5.8 V to 376 V
P_{PPM}	400 W
P_D	1.5 W
I_{FSM} (uni-directional only)	40 A
T_J max.	175 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional types, use B suffix (e.g. BZW04P-6V4B).

Electrical characteristics apply in both directions.

FEATURES

- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 400 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: DO-204AL, molded epoxy over passivated chip

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the color band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS AND THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1) (Fig. 1)	P_{PPM}	400	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 5)	P_D	1.5	W
Peak forward surge current, 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A for uni-directional only (3)	V_F	3.5/5.0	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

(3) V_F = 3.5 V for BZW04P(-)188 and below; V_F = 5.0 V for BZW04P(-)213 and above

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
PART NUMBER		**BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)**		**TEST CURRENT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (4) (µA)**	**MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**	**MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)**
UNI-DIRECTIONAL	**BI-DIRECTIONAL**	**MIN**	**MAX**						
BZW04P5V8	BZW04P5V8B	6.45	7.48	10.0	5.80	1000	38.0	10.5	0.057
BZW04-5V8	BZW04-5V8B	6.45	7.14	10.0	5.80	1000	38.0	10.5	0.057
BZW04P6V4	BZW04P6V4B	7.13	8.25	10.0	6.40	500	35.4	11.3	0.061
BZW04-6V4	BZW04-6V4B	7.13	7.88	10.0	6.40	500	35.4	11.3	0.061
BZW04P7V0	BZW04P7V0B	7.79	9.02	10.0	7.02	200	33.0	12.1	0.065
BZW04-7V0	BZW04-7V0B	7.79	8.61	10.0	7.02	200	33.0	12.1	0.065
BZW04P7V8	BZW04P7V8B	8.65	10.0	1.0	7.78	50	30.0	13.4	0.068
BZW04-7V8	BZW04-7V8B	8.65	9.55	1.0	7.78	50	30.0	13.4	0.073
BZW04P8V5	BZW04P8V5B	9.50	11.0	1.0	8.55	10	27.6	14.5	0.07
BZW04-8V5	BZW04-8V5B	9.50	10.5	1.0	8.55	10	27.6	14.5	0.075
BZW04P9V4	BZW04P9V4B	10.5	12.1	1.0	9.4	5.0	25.7	15.6	0.075
BZW04-9V4	BZW04-9V4B	10.5	11.6	1.0	9.4	5.0	25.7	15.6	0.075
BZW0P10	BZW0P10B	11.4	13.2	1.0	10.2	5.0	24.0	16.7	0.078
BZW04-10	BZW04-10B	11.4	12.6	1.0	10.2	5.0	24.0	16.7	0.078
BZW04P11	BZW04P11B	12.4	14.3	1.0	11.1	5.0	22.0	18.2	0.081
BZW04-11	BZW04-11B	12.4	13.7	1.0	11.1	5.0	22.0	18.2	0.081
BZW04P13	BZW04P13B	14.3	16.5	1.0	12.8	5.0	19.0	21.2	0.084
BZW04-13	BZW04-13B	14.3	15.8	1.0	12.8	5.0	19.0	21.2	0.084
BZW04P14	BZW04P14B	15.2	17.6	1.0	13.6	1.0	17.8	22.5	0.086
BZW04-14	BZW04-14B	15.2	16.8	1.0	13.6	1.0	17.8	22.5	0.086
BZW04P15	BZW04P15B	17.1	19.8	1.0	15.3	1.0	16.0	25.2	0.088
BZW04-15	BZW04-15B	17.1	18.9	1.0	15.3	1.0	16.0	25.2	0.088
BZW04P17	BZW04P17B	19.0	22.0	1.0	17.1	1.0	14.5	27.7	0.090
BZW04-17	BZW04-17B	19.0	21.0	1.0	17.1	1.0	14.5	27.7	0.090
BZW04P19	BZW04P19B	20.9	24.2	1.0	18.8	1.0	13.0	30.6	0.092
BZW04-19	BZW04-19B	20.9	23.1	1.0	18.8	1.0	13.0	30.6	0.092
BZW04P20	BZW04P20B	22.8	26.4	1.0	20.5	1.0	12.0	33.2	0.094
BZW04-20	BZW04-20B	22.8	25.2	1.0	20.5	1.0	12.0	33.2	0.094
BZW04P23	BZW04P23B	25.7	29.7	1.0	23.1	1.0	10.7	37.5	0.096
BZW04-23	BZW04-23B	25.7	28.4	1.0	23.1	1.0	10.7	37.5	0.096
BZW04P26	BZW04P26B	28.5	33.0	1.0	25.6	1.0	9.6	41.5	0.097
BZW04-26	BZW04-26B	28.5	31.5	1.0	25.6	1.0	9.6	41.5	0.097
BZW04P28	BZW04P28B	31.4	36.3	1.0	28.2	1.0	8.8	45.7	0.098
BZW04-28	BZW04-28B	31.4	34.7	1.0	28.2	1.0	8.8	45.7	0.098
BZW04P31	BZW04P31B	34.2	39.6	1.0	30.8	1.0	8.0	49.9	0.099
BZW04-31	BZW04-31B	34.2	37.8	1.0	30.8	1.0	8.0	49.9	0.099
BZW04P33	BZW04P33B	37.1	42.9	1.0	33.3	1.0	7.4	53.9	0.100
BZW04-33	BZW04-33B	37.1	41.0	1.0	33.3	1.0	7.4	53.9	0.100
BZW04P37	BZW04P37B	40.9	47.3	1.0	36.8	1.0	6.7	59.3	0.101
BZW04-37	BZW04-37B	40.9	45.2	1.0	36.8	1.0	6.7	59.3	0.101
BZW04P40	BZW04P40B	44.7	51.7	1.0	40.2	1.0	6.2	64.8	0.101
BZW04-40	BZW04-40B	44.7	49.4	1.0	40.2	1.0	6.2	64.8	0.101
BZW04P44	BZW04P44B	48.5	56.1	1.0	43.6	1.0	5.7	70.1	0.102
BZW04-44	BZW04-44B	48.5	53.6	1.0	43.6	1.0	5.7	70.1	0.102
BZW04P48	BZW04P48B	53.2	61.6	1.0	47.8	1.0	5.2	77.0	0.103
BZW04-48	BZW04-48B	53.2	58.8	1.0	47.8	1.0	5.2	77.0	0.103
BZW04P53	BZW04P53B	58.9	68.2	1.0	53.0	1.0	4.7	85.0	0.104
BZW04-53	BZW04-53B	58.9	65.1	1.0	53.0	1.0	4.7	85.0	0.104
BZW04P58	BZW04P58B	64.6	74.8	1.0	58.1	1.0	4.3	92.0	0.104
BZW04-58	BZW04-58B	64.6	71.4	1.0	58.1	1.0	4.3	92.0	0.104
BZW04P64	BZW04P64B	71.3	82.5	1.0	64.1	1.0	3.9	103	0.105
BZW04-64	BZW04P64B	71.3	78.8	1.0	64.1	1.0	3.9	103	0.105

Document Number: 88316
Revision: 06-Sep-07

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
PART NUMBER		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (4) (μA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
UNI-DIRECTIONAL	BI-DIRECTIONAL	MIN	MAX						
BZW04P70	BZW04P70B	77.9	90.2	1.0	70.1	1.0	3.5	113	0.105
BZW04-70	BZW04-70B	77.9	86.1	1.0	70.1	1.0	3.5	113	0.105
BZW04P78	BZW04P78B	86.5	100	1.0	78.0	1.0	3.2	125	0.105
BZW04-78	BZW04-78B	86.5	95.5	1.0	78.0	1.0	3.2	125	0.105
BZW04P85	BZW04P85B	95.0	110	1.0	85.5	1.0	2.9	137	0.106
BZW04-85	BZW04-85B	95.0	105	1.0	85.5	1.0	2.9	137	0.106
BZW04P94	BZW04P94B	105	121	1.0	94.0	1.0	2.6	152	0.107
BZW04-94	BZW04-94B	105	116	1.0	94.0	1.0	2.6	152	0.107
BZW04P102	BZW04P102B	114	132	1.0	102	1.0	2.4	165	0.107
BZW04-102	BZW04-102B	114	126	1.0	102	1.0	2.4	165	0.107
BZW04P110	BZW04P110B	124	143	1.0	111	1.0	2.2	179	0.107
BZW04-110	BZW04-110B	124	137	1.0	111	1.0	2.2	179	0.107
BZW04P128	BZW04P128B	143	165	1.0	128	1.0	2.0	207	0.108
BZW04-128	BZW04-128B	143	158	1.0	128	1.0	2.0	207	0.108
BZW04P136	BZW04P136B	152	176	1.0	136	1.0	1.8	219	0.108
BZW404-136	BZW404-136B	152	168	1.0	136	1.0	1.8	219	0.108
BZW04P145	BZW04P145B	161	187	1.0	145	1.0	1.7	234	0.108
BZW04-145	BZW04-145B	161	179	1.0	145	1.0	1.7	234	0.108
BZW04P154	BZW04P154B	171	198	1.0	154	1.0	1.6	246	0.108
BZW04-154	BZW04-154B	171	189	1.0	154	1.0	1.6	246	0.108
BZW04P171	BZW04P171B	190	220	1.0	171	1.0	1.5	274	0.108
BZW04-171	BZW04-171B	190	210	1.0	171	1.0	1.5	274	0.108
BZW04P188	BZW04P188B	209	242	1.0	188	1.0	1.4	301	0.108
BZW04-188	BZW04-188B	209	231	1.0	188	1.0	1.4	301	0.108
BZW04P213	BZW04P213B	237	275	1.0	213	1.0	1.2	344	0.110
BZW04-213	BZW04-213B	237	263	1.0	213	1.0	1.2	344	0.110
BZW04P239	BZW04P239B	266	308	1.0	239	1.0	1.1	384	0.110
BZW04-239	BZW04-239B	266	294	1.0	239	1.0	1.1	384	0.110
BZW04P256	BZW04P256B	285	330	1.0	256	1.0	1.0	414	0.110
BZW04-256	BZW04-256B	285	315	1.0	256	1.0	1.0	414	0.110
BZW04P273	BZW04P273B	304	352	1.0	273	1.0	0.90	438	0.110
BZW04-273	BZW04-273B	304	336	1.0	273	1.0	0.90	438	0.110
BZW04P299	BZW04P299B	332	385	1.0	299	1.0	0.80	482	0.110
BZW04-299	BZW04-299B	332	368	1.0	299	1.0	0.80	482	0.110
BZW04P342	BZW04P342B	380	440	1.0	342	1.0	0.75	548	0.110
BZW04-342	BZW04-342B	380	420	1.0	342	1.0	0.75	548	0.110
BZW04P376	BZW04P376B	418	484	1.0	376	1.0	0.67	603	0.110
BZW04-376	BZW04-376B	418	462	1.0	376	1.0	0.67	603	0.110

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derated per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

(4) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
BZW04P10-E3/54	0.350	54	4000	13" diameter paper tape and reel
BZW04P10HE3/54 (1)	0.350	54	4000	13" diameter paper tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

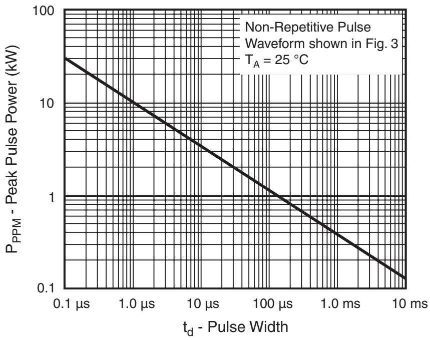


Figure 1. Peak Pulse Power Rating Curve

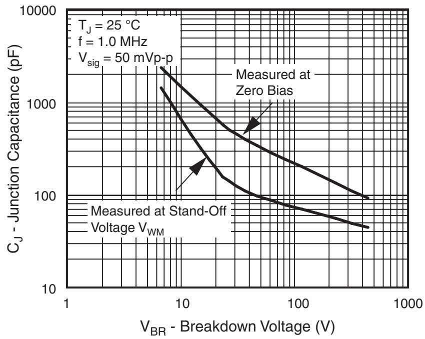


Figure 4. Typical Junction Capacitance

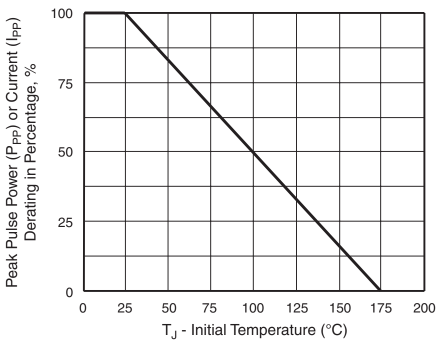


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

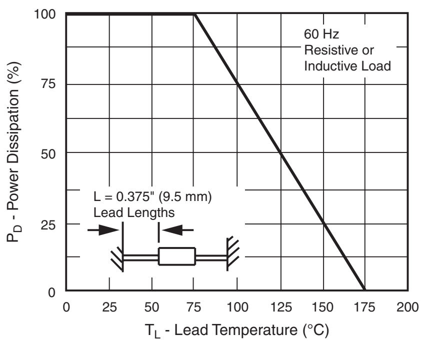


Figure 5. Power Derating Curve

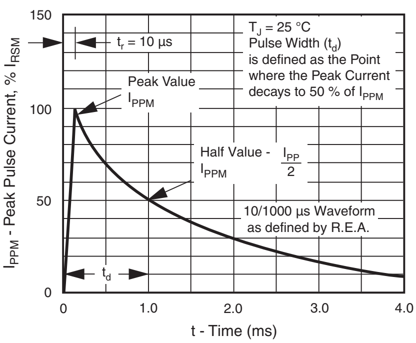


Figure 3. Pulse Waveform

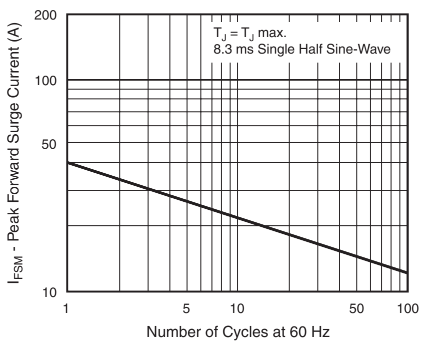
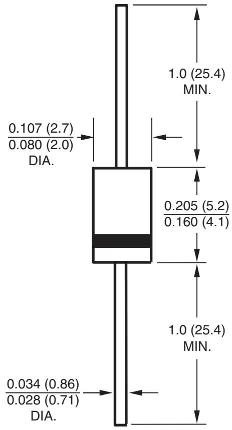


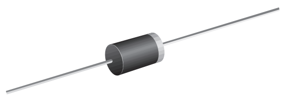
Figure 6. Max. Non-Repetitive Forward Surge Current
Uni-Directional Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AL (DO-41)



TRANSZORB® Transient Voltage Suppressors



DO-204AL (DO-41)

PRIMARY CHARACTERISTICS	
V_{BR} uni-directional	6.8 V to 540 V
V_{BR} bi-directional	6.8 V to 440 V
P_{PPM}	400 W
P_D	1.5 W
I_{FSM} (uni-directional only)	40 A
T_J max.	175 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-direction use C or CA suffix (e.g. P4KE440CA). Electrical characteristics apply in both directions.

FEATURES

- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 400 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-204AL, molded epoxy over passivated chip

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the color band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak power dissipation with a 10/1000 µs waveform (1) (Fig. 1)	P_{PPM}	400	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 5)	P_D	1.5	W
Peak forward surge current, 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A for uni-directional only (3)	V_F	3.5/5.0	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

(3) V_F = 3.5 V for P4KE220(A) and below; V_F = 5.0 V for P4KE250(A) and above

Document Number: 88365
Revision: 04-Sep-07

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

DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (3) (µA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
	MIN	MAX						
P4KE6.8	6.12	7.48	10	5.50	1000	37.0	10.8	0.057
P4KE6.8A	6.45	7.14	10	5.80	1000	38.1	10.5	0.057
P4KE7.5	6.75	8.25	10	6.05	500	34.2	11.7	0.061
P4KE7.5A	7.13	7.88	10	6.40	500	35.4	11.3	0.061
P4KE8.2	7.38	9.02	10	6.63	200	32.0	12.5	0.065
P4KE8.2A	7.79	8.61	10	7.02	200	33.1	12.1	0.06
P4KE9.1	8.19	10.0	1.0	7.37	50	29.0	13.8	0.068
P4KE9.1A	8.65	9.55	1.0	7.78	50	29.9	13.4	0.068
P4KE10	9.00	11.0	1.0	8.10	10	26.7	15.0	0.073
P4KE10A	9.50	10.5	1.0	8.55	10	27.6	14.5	0.073
P4KE11	9.90	12.1	1.0	8.92	5.0	24.7	16.2	0.075
P4KE11A	10.5	11.6	1.0	9.40	5.0	25.6	15.6	0.075
P4KE12	10.8	13.2	1.0	9.72	1.0	23.1	17.3	0.076
P4KE12A	11.4	12.6	1.0	10.2	1.0	24.0	16.7	0.078
P4KE13	11.7	14.3	1.0	10.5	1.0	21.1	19.0	0.081
P4KE13A	12.4	13.7	1.0	11.1	1.0	22.0	18.2	0.081
P4KE15	13.5	16.5	1.0	12.1	1.0	18.2	22.0	0.084
P4KE15A	14.3	15.8	1.0	12.8	1.0	18.9	21.2	0.084
P4KE16	14.4	17.6	1.0	12.9	1.0	17.0	23.5	0.086
P4KE16A	15.2	16.8	1.0	13.6	1.0	17.8	22.5	0.086
P4KE18	16.2	19.8	1.0	14.5	1.0	15.1	26.5	0.088
P4KE18A	17.1	18.9	1.0	15.3	1.0	15.9	25.2	0.088
P4KE20	18.0	22.0	1.0	16.2	1.0	13.7	29.1	0.090
P4KE20A	19.0	21.0	1.0	17.1	1.0	14.4	27.7	0.090
P4KE22	19.8	24.2	1.0	17.8	1.0	12.5	31.9	0.092
P4KE22A	20.9	23.1	1.0	18.8	1.0	13.1	30.6	0.092
P4KE24	21.6	26.4	1.0	19.4	1.0	11.5	34.7	0.094
P4KE24A	22.8	25.2	1.0	20.5	1.0	12.0	33.2	0.094
P4KE27	24.3	29.7	1.0	21.8	1.0	10.2	39.1	0.096
P4KE27A	25.7	28.4	1.0	23.1	1.0	10.7	37.5	0.096
P4KE30	27.0	33.0	1.0	24.3	1.0	9.2	43.5	0.097
P4KE30A	28.5	31.5	1.0	25.6	1.0	9.7	41.4	0.097
P4KE33	29.7	36.3	1.0	26.8	1.0	8.4	47.7	0.098
P4KE33A	31.4	34.7	1.0	28.2	1.0	8.8	45.7	0.098
P4KE36	32.4	39.6	1.0	29.1	1.0	7.7	52.0	0.099
P4KE36A	34.2	37.8	1.0	30.8	1.0	8.0	49.9	0.099
P4KE39	35.1	42.9	1.0	31.6	1.0	7.1	56.4	0.100
P4KE39A	37.1	41.0	1.0	33.3	1.0	7.4	53.9	0.100
P4KE43	38.7	47.3	1.0	34.8	1.0	6.5	61.9	0.101
P4KE43A	40.9	45.2	1.0	36.8	1.0	6.7	59.3	0.101
P4KE47	42.3	51.7	1.0	38.1	1.0	5.9	67.8	0.101
P4KE47A	44.7	49.4	1.0	40.2	1.0	6.2	64.8	0.101
P4KE51	45.9	56.1	1.0	41.3	1.0	5.4	73.5	0.102
P4KE51A	48.5	53.6	1.0	43.6	1.0	5.7	70.1	0.102
P4KE56	50.4	61.6	1.0	45.4	1.0	5.0	80.5	0.103
P4KE56A	53.2	58.8	1.0	47.8	1.0	5.2	77.0	0.103
P4KE62	55.8	68.2	1.0	50.2	1.0	4.5	89.0	0.104
P4KE62A	58.9	65.1	1.0	53.0	1.0	4.7	85.0	0.104
P4KE68	61.2	74.8	1.0	55.1	1.0	4.1	98.0	0.104
P4KE68A	64.6	71.4	1.0	58.1	1.0	4.3	92.0	0.104
P4KE75	67.5	82.5	1.0	60.7	1.0	3.7	108	0.105
P4KE75A	71.3	78.8	1.0	64.1	1.0	3.9	103	0.105

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	**BREAKDOWN VOLTAGE V_{BR} AT I_T(1) (V)**		**TEST CURRENT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (3) (μA)**	**MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**	**MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)**
	MIN	**MAX**						
P4KE82	73.8	90.2	1.0	66.4	1.0	3.4	118	0.105
P4KE82A	77.9	86.1	1.0	70.1	1.0	3.5	113	0.105
P4KE91	81.9	100	1.0	73.7	1.0	3.1	131	0.106
P4KE91A	86.5	95.5	1.0	77.8	1.0	3.2	125	0.106
P4KE100	90.0	110	1.0	81.0	1.0	2.8	144	0.106
P4KE100A	95.0	105	1.0	85.5	1.0	2.9	137	0.106
P4KE110	99.0	121	1.0	89.2	1.0	2.5	158	0.107
P4KE110A	105	116	1.0	94.0	1.0	2.6	152	0.107
P4KE120	108	132	1.0	97.2	1.0	2.3	173	0.107
P4KE120A	114	126	1.0	102	1.0	2.4	165	0.107
P4KE130	117	143	1.0	105	1.0	2.1	187	0.107
P4KE130A	124	137	1.0	111	1.0	2.2	179	0.107
P4KE150	135	165	1.0	121	1.0	1.9	215	0.108
P4KE150A	143	158	1.0	128	1.0	1.9	207	0.108
P4KE160	144	176	1.0	130	1.0	1.7	230	0.108
P4KE160A	152	168	1.0	136	1.0	1.8	219	0.108
P4KE170	153	187	1.0	138	1.0	1.6	244	0.108
P4KE170A	162	179	1.0	145	1.0	1.7	234	0.108
P4KE180	162	198	1.0	146	1.0	1.6	258	0.108
P4KE180A	171	189	1.0	154	1.0	1.6	246	0.108
P4KE200	180	220	1.0	162	1.0	1.4	287	0.108
P4KE200A	190	210	1.0	171	1.0	1.5	274	0.108
P4KE220	198	242	1.0	175	1.0	1.2	344	0.108
P4KE220A	209	231	1.0	185	1.0	1.2	328	0.108
P4KE250	225	275	1.0	202	1.0	1.1	360	0.110
P4KE250A	237	263	1.0	214	1.0	1.2	344	0.110
P4KE300	270	330	1.0	243	1.0	0.93	430	0.110
P4KE300A	285	315	1.0	256	1.0	1.0	414	0.110
P4KE350	315	385	1.0	284	1.0	0.79	504	0.110
P4KE350A	333	368	1.0	300	1.0	0.83	482	0.110
P4KE400	360	440	1.0	324	1.0	0.70	574	0.110
P4KE400A	380	420	1.0	342	1.0	0.73	548	0.110
P4KE440	396	484	1.0	356	1.0	0.63	631	0.110
P4KE440A	418	462	1.0	376	1.0	0.66	602	0.110
P4KE480	432	528	1.0	389	1.0	0.58	686	0.110
P4KE480A	456	504	1.0	408	1.0	0.61	658	0.110
P4KE510	459	561	1.0	413	1.0	0.55	729	0.110
P4KE510A	485	535	1.0	434	1.0	0.57	698	0.110
P4KE540	486	594	1.0	437	1.0	0.52	772	0.110
P4KE540A	513	567	1.0	459	1.0	0.54	740	0.110

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derated per Fig. 2

(3) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**LIMIT**	**UNIT**
Typical thermal resistance, junction to lead	$R_{\theta JL}$	66	°C/W
Typical thermal resistance, junction to ambient, L_{Lead} = 10 mm	$R_{\theta JA}$	100	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
P4KE6.8A-E3/54	0.350	54	4000	13" diameter paper tape and reel
P4KE6.8AHE3/54 (1)	0.350	54	4000	13" diameter paper tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

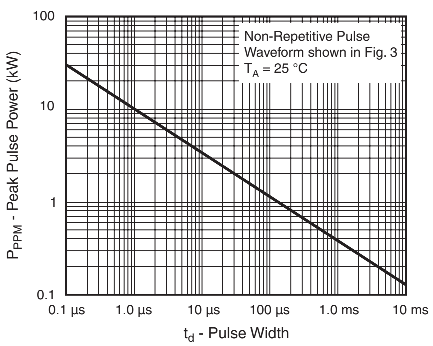


Figure 1. Peak Pulse Power Rating Curve

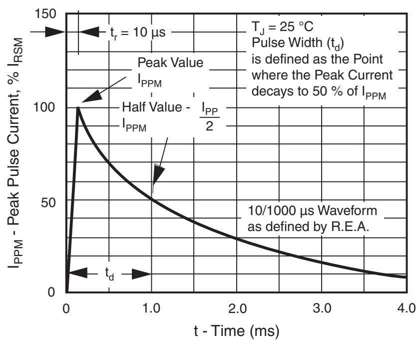


Figure 3. Pulse Waveform

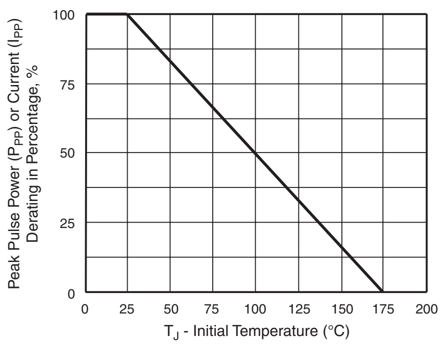


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

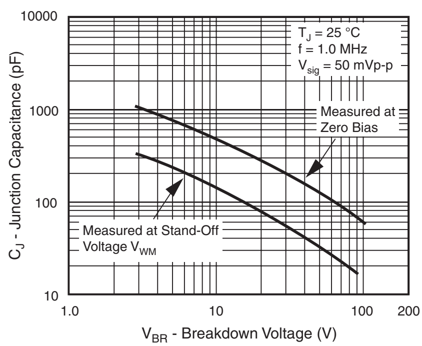


Figure 4. Typical Junction Capacitance Uni-Directional

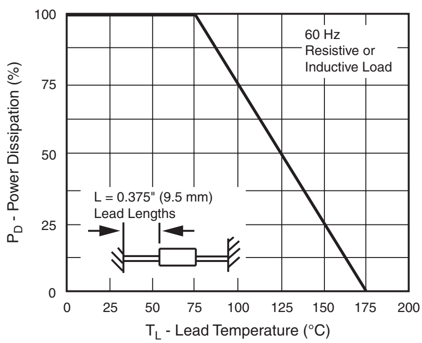


Figure 5. Power Derating Curve

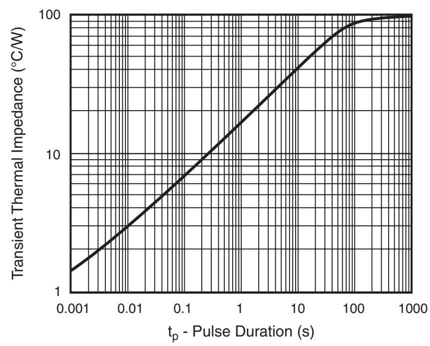


Figure 7. Typical Transient Thermal Impedance

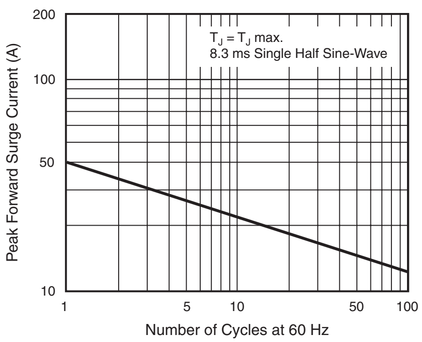
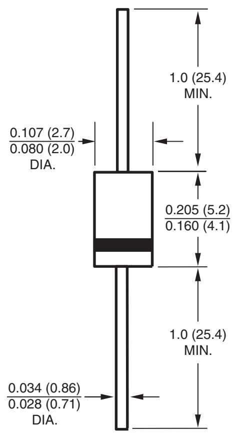


Figure 6. Max. Non-Repetitive Forward Surge Current
Uni-Directional Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AL (DO-41)



Surface Mount TRANSZORB® Transient Voltage Suppressors

eSMP™ Series

DO-220AA (SMP)

PRIMARY CHARACTERISTICS	
V_{WM}	11 V to 36 V
P_{PPM}	400 W
I_{FSM}	40 A
T_J max.	150 °C

FEATURES

- Very low profile - typical height of 1.0 mm
- Ideal for automated placement
- Available in uni-directional
- 400 W peak pulse power capability with a 10/1000 µs waveform
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-220AA (SMP)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	400	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See table next page	A
Peak forward surge current 10 ms single half sine-wave (2)	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A (3)	V_F	2.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

(3) Pulse test: 300 µs pulse width, 1 % duty cycle

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE	**DEVICE MARKING CODE**	**BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)**		**TEST CURRENT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA) (3)**	**MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**
		MIN	**MAX**					
SMP11	AY	12.2	14.9	1.0	11	1.0	19.9	20.1
SMP11A	AZ	12.2	13.5	1.0	11	1.0	22.0	18.2
SMP12	BD	13.3	16.3	1.0	12	1.0	18.2	22.0
SMP12A	BE	13.3	14.7	1.0	12	1.0	20.1	19.9
SMP13	BF	14.4	17.6	1.0	13	1.0	16.8	23.8
SMP13A	BG	14.4	15.9	1.0	13	1.0	18.6	21.5
SMP14	BH	15.6	19.1	1.0	14	1.0	15.5	25.8
SMP14A	BK	15.6	17.2	1.0	14	1.0	17.2	23.2
SMP15	BL	16.7	20.4	1.0	15	1.0	14.9	26.9
SMP15A	BM	16.7	18.5	1.0	15	1.0	16.4	24.4
SMP16	BN	17.8	21.8	1.0	16	1.0	13.9	28.8
SMP16A	BP	17.8	19.7	1.0	16	1.0	15.4	26.0
SMP17	BQ	18.9	23.1	1.0	17	1.0	13.1	30.5
SMP17A	BR	18.9	20.9	1.0	17	1.0	14.5	27.6
SMP18	BS	20.0	24.4	1.0	18	1.0	12.4	32.2
SMP18A	BT	20.0	22.1	1.0	18	1.0	13.7	29.2
SMP20	BU	22.2	27.1	1.0	20	1.0	11.2	35.8
SMP20A	BV	22.2	24.5	1.0	20	1.0	12.3	32.4
SMP22	BW	24.4	29.8	1.0	22	1.0	10.2	39.4
SMP22A	BX	24.4	26.9	1.0	22	1.0	11.3	35.5
SMP24	BY	26.7	32.6	1.0	24	1.0	9.3	43.0
SMP24A	BZ	26.7	29.5	1.0	24	1.0	10.3	38.9
SMP26	CD	28.9	35.3	1.0	26	1.0	8.6	46.6
SMP26A	CE	28.9	31.9	1.0	26	1.0	9.5	42.1
SMP28	CF	31.1	38.0	1.0	28	1.0	8.0	50.0
SMP28A	CG	31.1	34.4	1.0	28	1.0	8.8	45.4
SMP30	CH	33.3	40.7	1.0	30	1.0	7.5	53.5
SMP30A	CK	33.3	36.8	1.0	30	1.0	8.3	48.4
SMP33	CL	36.7	44.9	1.0	33	1.0	6.8	59.0
SMP33A	CM	36.7	40.6	1.0	33	1.0	7.5	53.3
SMP36	CN	40.0	48.9	1.0	36	1.0	6.2	64.3
SMP36A	CP	40.0	44.2	1.0	36	1.0	6.9	58.1

Notes:

(1) V_{BR} measured after I_T applied for 300 μs, I_T = square wave pulse or equivalent

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMP11A-E3/84A	0.024	84A	3000	7" diameter plastic tape and reel
SMP11A-E3/85A	0.024	85A	10000	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

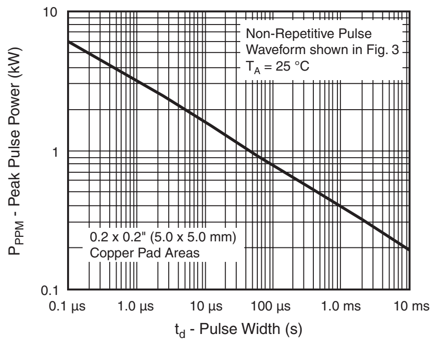


Figure 1. Peak Pulse Power Rating Curve

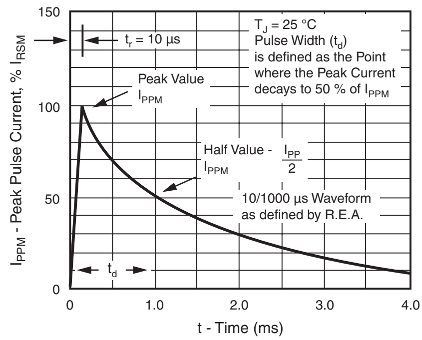


Figure 3. Pulse Waveform

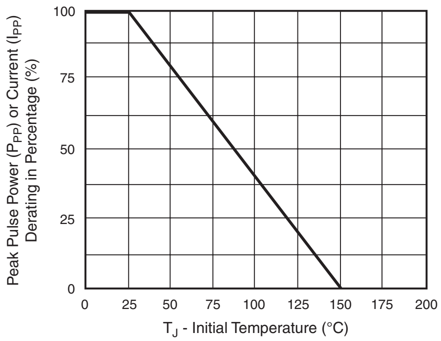


Figure 2. Pulse Derating Curve

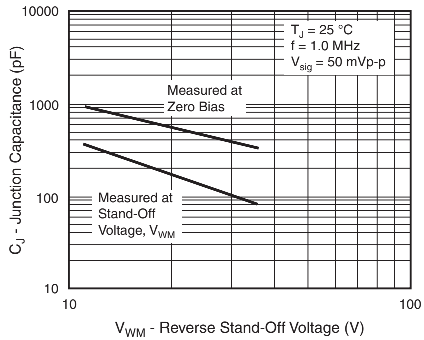
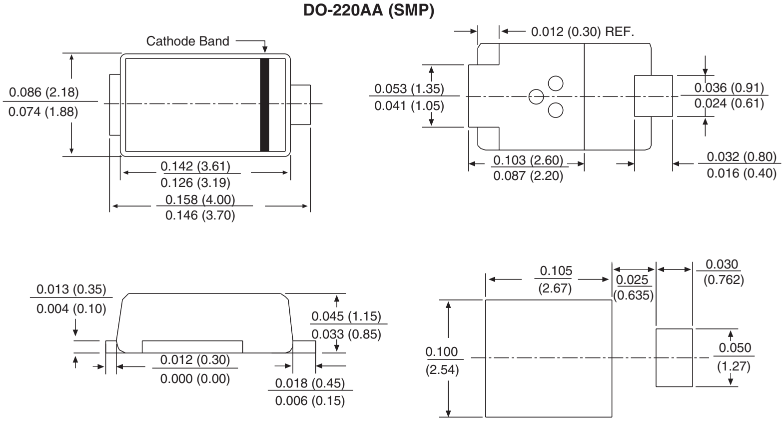


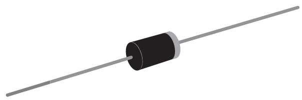
Figure 4. Typical Junction Capacitance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-220AA (SMP)



TRANSZORB® Transient Voltage Suppressors



DO-204AC (DO-15)

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 170 V
P_{PPM}	500 W
P_D	3.0 W
I_{FSM} (uni-directional only)	70 A
T_J max.	175 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional types, use C or CA suffix (e.g. SA5.0C, SA170CA).

Electrical characteristics apply in both directions.

FEATURES

- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 500 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: DO-204AC, molded epoxy over passivated chip

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the color band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1) (Fig. 1)	P_{PPM}	500	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_A = 75 °C (Fig. 5)	P_D	3.0	W
Peak forward surge current, 10 ms single half sine-wave uni-directional only	I_{FSM}	70	A
Maximum instantaneous forward voltage at 35 A for uni-directional only (2)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 per minute maximum

Document Number: 88378
Revision: 04-Sep-07

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (3) (µA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (mV/°C)
	MIN	MAX						
SA5.0	6.40	7.30	10	5.0	600	52.1	9.6	5.0
SA5.0A(4)	6.4	7.07	10	5.0	600	54.3	9.2	5.0
SA6.0	6.67	8.15	10	6.0	600	43.9	11.4	5.0
SA6.0A	6.67	7.37	10	6.0	600	48.5	10.3	5.0
SA6.5	7.22	8.82	10	6.5	400	40.7	12.3	5.0
SA6.5A	7.22	7.98	10	6.5	400	44.7	11.2	5.0
SA7.0	7.78	9.51	10	7.0	150	37.6	13.3	6.0
SA7.0A	7.78	8.60	10	7.0	150	41.7	12.0	6.0
SA7.5	8.33	10.2	1.0	7.5	50	35.0	14.3	7.0
SA7.5A	8.33	9.21	1.0	7.5	50	38.8	12.9	7.0
SA8.0	8.89	10.9	1.0	8.0	25	33.3	15.0	7.0
SA8.0A	8.89	9.83	1.0	8.0	25	36.8	13.6	7.0
SA8.5	9.44	11.5	1.0	8.5	10	31.4	15.9	8.0
SA8.5A	9.44	10.4	1.0	8.5	10	34.7	14.4	8.0
SA9.0	10.0	12.2	1.0	9.0	5.0	29.6	16.9	9.0
SA9.0A	10.0	11.1	1.0	9.0	5.0	32.5	15.4	9.0
SA10	11.1	13.6	1.0	10	1.0	26.6	18.8	10
SA10A	11.1	12.3	1.0	10	1.0	29.4	17.0	10
SA11	12.2	14.9	1.0	11	1.0	24.9	20.1	11
SA11A	12.2	13.5	1.0	11	1.0	27.5	18.2	11
SA12	13.3	16.3	1.0	12	1.0	22.7	22.0	12
SA12A	13.3	14.7	1.0	12	1.0	25.1	19.9	12
SA13	14.4	17.6	1.0	13	1.0	21.0	23.8	13
SA13A	14.4	15.9	1.0	13	1.0	23.3	21.5	13
SA14	15.6	19.1	1.0	14	1.0	19.4	25.8	14
SA14A	15.6	17.2	1.0	14	1.0	21.6	23.2	14
SA15	16.7	20.4	1.0	15	1.0	18.6	26.9	16
SA15A	16.7	18.5	1.0	15	1.0	20.5	24.4	16
SA16	17.8	21.8	1.0	16	1.0	17.4	28.8	19
SA16A	17.8	19.7	1.0	16	1.0	19.2	26.0	17
SA17	18.9	23.1	1.0	17	1.0	16.4	30.5	20
SA17A	18.9	20.9	1.0	17	1.0	18.1	27.6	19
SA18	20.0	24.4	1.0	18	1.0	15.5	32.2	21
SA18A	20.0	22.1	1.0	18	1.0	17.1	29.2	20
SA20	22.2	27.1	1.0	20	1.0	14.0	35.8	25
SA20A	22.2	24.5	1.0	20	1.0	15.4	32.4	23
SA22	24.4	29.8	1.0	22	1.0	22.7	39.4	28
SA22A	24.4	26.9	1.0	22	1.0	14.1	35.5	25
SA24	26.7	32.6	1.0	24	1.0	11.6	43.0	31
SA24A	26.7	29.5	1.0	24	1.0	12.9	38.9	28
SA26	28.9	35.3	1.0	26	1.0	10.7	46.6	31
SA26A	28.9	31.9	1.0	26	1.0	11.9	42.1	30
SA28	31.1	38.0	1.0	28	1.0	10.0	50.1	35
SA28A	31.1	34.4	1.0	28	1.0	11.0	45.4	31
SA30	33.3	40.7	1.0	30	1.0	9.3	53.5	39
SA30A	33.3	36.8	1.0	30	1.0	10.0	48.4	36
SA33	36.7	44.9	1.0	33	1.0	8.5	59.0	42
SA33A	36.7	40.6	1.0	33	1.0	9.4	53.3	39
SA36	40.0	48.9	1.0	36	1.0	7.8	64.3	46
SA36A	40.0	44.2	1.0	36	1.0	8.6	58.1	41

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

DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V) MIN	MAX	TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (3) (μA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (mV/°C)
SA40	44.4	54.3	1.0	40	1.0	7.0	71.4	51
SA40A	44.4	49.1	1.0	40	1.0	7.8	64.5	46
SA43	47.8	58.4	1.0	43	1.0	6.5	76.7	55
SA43A	47.8	52.8	1.0	43	1.0	7.2	69.4	50
SA45	50.0	61.1	1.0	45	1.0	6.2	80.3	58
SA45A	50.0	55.3	1.0	45	1.0	6.9	72.7	52
SA48	53.3	65.2	1.0	48	1.0	5.8	85.5	63
SA48A	53.3	58.9	1.0	48	1.0	6.5	77.4	56
SA51	56.7	69.3	1.0	51	1.0	5.5	91.1	66
SA51A	56.7	62.7	1.0	51	1.0	6.1	82.4	61
SA54	60.0	73.3	1.0	54	1.0	5.2	96.3	71
SA54A	60.0	66.3	1.0	54	1.0	5.7	87.1	65
SA58	64.4	78.7	1.0	58	1.0	4.9	103	78
SA58A	64.4	71.2	1.0	58	1.0	5.3	93.6	70
SA60	66.7	81.5	1.0	60	1.0	4.7	107	80
SA60A	66.7	73.7	1.0	60	1.0	5.2	96.8	71
SA64	71.1	86.9	1.0	64	1.0	4.4	114	86
SA64A	71.1	78.6	1.0	64	1.0	4.9	103	76
SA70	77.8	95.1	1.0	70	1.0	4.0	125	94
SA70A	77.8	86.0	1.0	70	1.0	4.4	113	85
SA75	83.3	102	1.0	75	1.0	3.7	134	101
SA75A	83.3	92.1	1.0	75	1.0	4.1	121	91
SA78	86.7	106	1.0	78	1.0	3.6	139	105
SA78A	86.7	95.8	1.0	78	1.0	4.0	126	95
SA85	94.4	115	1.0	85	1.0	3.3	151	114
SA85A	94.4	104	1.0	85	1.0	3.6	137	103
SA90	100	122	1.0	90	1.0	3.1	160	121
SA90A	100	111	1.0	90	1.0	3.4	146	110
SA100	111	136	1.0	100	1.0	2.8	179	135
SA100A	111	123	1.0	100	1.0	3.1	162	123
SA110	122	149	1.0	110	1.0	2.6	196	148
SA110A	122	135	1.0	110	1.0	2.8	177	133
SA120	133	163	1.0	120	1.0	2.3	214	162
SA120A	133	147	1.0	120	1.0	2.6	193	146
SA130	144	176	1.0	130	1.0	2.2	230	175
SA130A	144	159	1.0	130	1.0	2.4	209	158
SA150	167	204	1.0	150	1.0	1.9	268	203
SA150A	167	185	1.0	150	1.0	2.1	243	184
SA160	178	218	1.0	160	1.0	1.7	257	217
SA160A	178	197	1.0	160	1.0	1.9	259	196
SA170	189	231	1.0	170	1.0	1.6	304	230
SA170A	189	209	1.0	170	1.0	1.8	275	208

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types with V_{WM} of 10 V and less, the I_D limit is doubled

(4) For the bi-directional SA5.0CA, the maximum V_{BR} is 7.25 V

(5) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SA5.0A-E3/54	0.432	54	4000	13" diameter paper tape and reel
SA5.0AHE3/54 [(1)]	0.432	54	4000	13" diameter paper tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

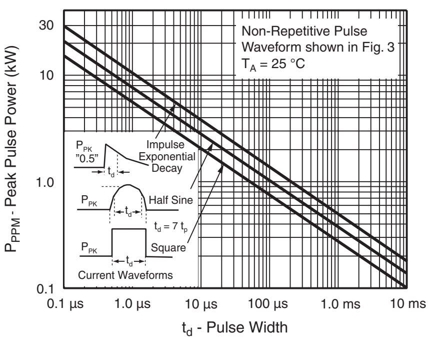


Figure 1. Peak Pulse Power Rating Curve

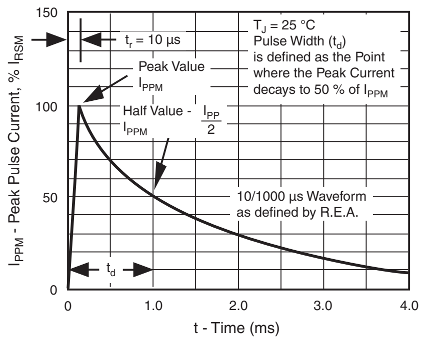


Figure 3. Pulse Waveform

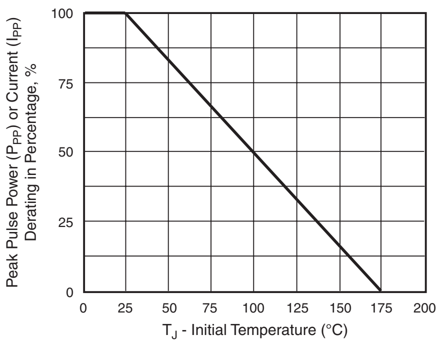


Figure 2. Pulse Derating Curve

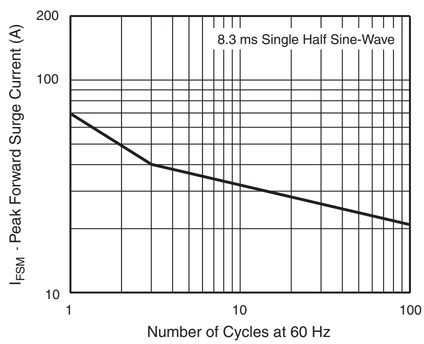


Figure 4. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Only

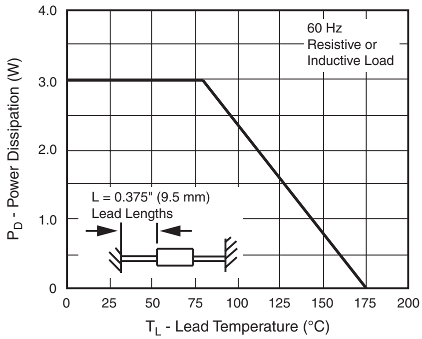


Figure 5. Steady State Power Derating Curve

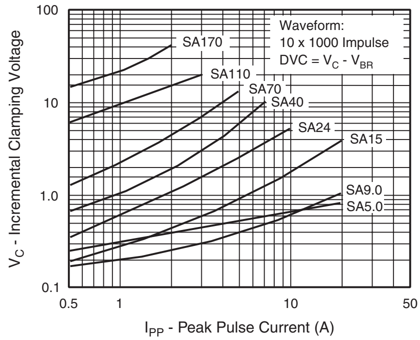


Figure 8. Incremental Clamping Voltage Curve Uni-Directional

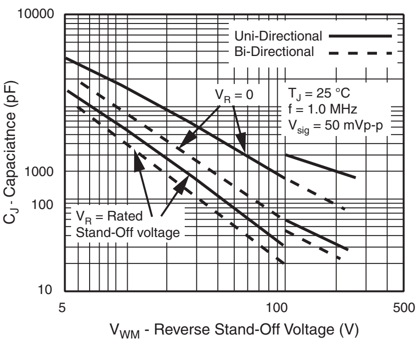


Figure 6. Capacitance

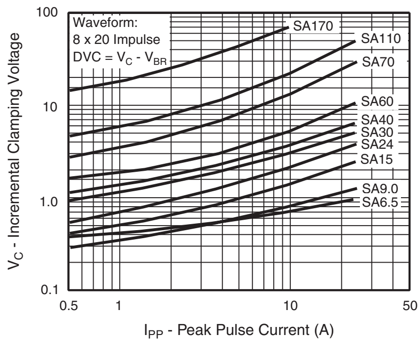


Figure 9. Incremental Clamping Voltage Curve Bi-Directional

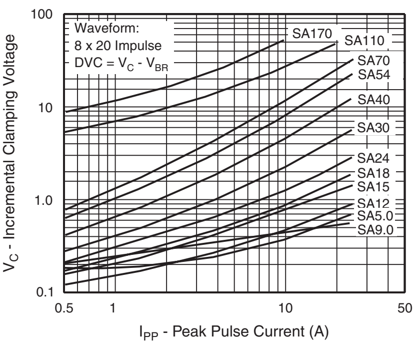


Figure 7. Incremental Clamping Voltage Curve Uni-Directional

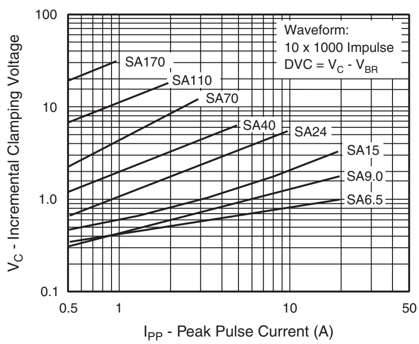


Figure 10. Incremental Clamping Voltage Curve Bi-Directional

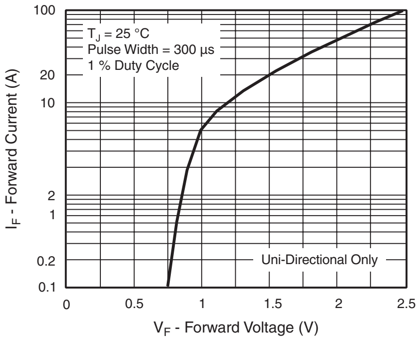


Figure 11. Typical Instantaneous Forward Voltage

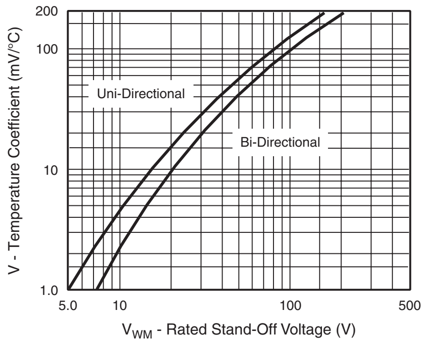
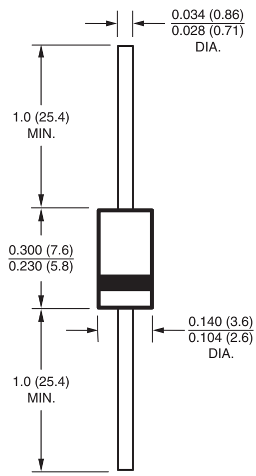


Figure 12. Breakdown Voltage Temperature Coefficient Curve

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AC (DO-15)



High Power Density Surface Mount TRANSZORB®
Transient Voltage Suppressors

DO-214AC (SMA)

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 40 V
P_{PPM}	500 W
I_{FSM} (uni-directional only)	40 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use C or CA suffix (e.g. SMA5J40CA).

Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AC (SMA)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	500	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	40	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2.

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)										
DEVICE TYPE	**DEVICE MARKING CODE**		**BREAKDOWN VOLTAGE V_{BR} (V)** (1)		**TEST CURRENT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)** (3)	**MAXIMUM PEAK PULSE CURRENT I_{PPM} (A)** (2)	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**
	UNI	**BI**	**MIN**	**MAX**					
SMA5J5.0	5AD	5AD	6.40	7.82	10	5.0	800	52.1	9.6
SMA5J5.0A (5)	5AE	5AE	6.40	7.07	10	5.0	800	54.3	9.2
SMA5J6.0	5AF	5AF	6.67	8.15	10	6.0	800	43.9	11.4
SMA5J6.0A	5AG	5AG	6.67	7.37	10	6.0	800	48.5	10.3
SMA5J6.5	5AH	5AH	7.22	8.82	10	6.5	500	40.7	12.3
SMA5J6.5A	5AK	5AK	7.22	7.98	10	6.5	500	44.6	11.2
SMA5J7.0	5AL	5AL	7.78	9.51	10	7.0	200	37.6	13.3
SMA5J7.0A	5AM	5AM	7.78	8.6	10	7.0	200	41.7	12.0
SMA5J7.5	5AN	5AN	8.33	10.2	1.0	7.5	100	35.0	14.3
SMA5J7.5A	5AP	5AP	8.33	9.21	1.0	7.5	100	38.8	12.9
SMA5J8.0	5AQ	5AQ	8.89	10.9	1.0	8.0	50	33.3	15.0
SMA5J8.0A	5AR	5AR	8.89	9.83	1.0	8.0	50	36.8	13.6
SMA5J8.5	5AS	5AS	9.44	11.5	1.0	8.5	10	31.4	15.9
SMA5J8.5A	5AT	5AT	9.44	10.4	1.0	8.5	10	34.7	14.4
SMA5J9.0	5AU	5AU	10.0	12.2	1.0	9.0	5.0	29.6	16.9
SMA5J9.0A	5AV	5AV	10.0	11.1	1.0	9.0	5.0	32.5	15.4
SMA5J10	5AW	5AW	11.1	13.6	1.0	10	1.0	26.6	18.8
SMA5J10A	5AX	5AX	11.1	12.3	1.0	10	1.0	29.4	17.0
SMA5J11	5AY	5AY	12.2	14.9	1.0	11	1.0	24.9	20.1
SMA5J11A	5AZ	5AZ	12.2	13.5	1.0	11	1.0	27.5	18.2
SMA5J12	5BD	5BD	13.3	16.3	1.0	12	1.0	22.7	22.0
SMA5J12A	5BE	5BE	13.3	14.7	1.0	12	1.0	25.1	19.9
SMA5J13	5BF	5BF	14.4	17.6	1.0	13	1.0	21.0	23.8
SMA5J13A	5BG	5BG	14.4	15.9	1.0	13	1.0	23.3	21.5
SMA5J14	5BH	5BH	15.6	19.1	1.0	14	1.0	19.4	25.8
SMA5J14A	5BK	5BK	15.6	17.2	1.0	14	1.0	21.6	23.2
SMA5J15	5BL	5BL	16.7	20.4	1.0	15	1.0	18.6	26.9
SMA5J15A	5BM	5BM	16.7	18.5	1.0	15	1.0	20.5	24.4
SMA5J16	6BN	5BN	17.8	21.8	1.0	16	1.0	17.4	28.8
SMA5J16A	5BP	5BP	17.8	19.7	1.0	16	1.0	19.2	26.0
SMA5J17	5BQ	5BQ	18.9	23.1	1.0	17	1.0	16.4	30.5
SMA5J17A	5BR	5BR	18.9	20.9	1.0	17	1.0	18.1	27.6
SMA5J18	5BS	5BS	20.0	24.4	1.0	18	1.0	15.5	32.2
SMA5J18A	5BT	5BT	20.0	22.1	1.0	18	1.0	17.1	29.2
SMA5J20	5BU	5BU	22.2	27.1	1.0	20	1.0	14.0	35.8
SMA5J20A	5BV	5BV	22.2	24.5	1.0	20	1.0	15.4	32.4
SMA5J22	5BW	5BW	24.4	29.8	1.0	22	1.0	12.7	39.4
SMA5J22A	5BX	5BX	24.4	26.9	1.0	22	1.0	14.1	35.5
SMA5J24	5BY	5BY	26.7	32.6	1.0	24	1.0	11.6	43.0

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE	**DEVICE MARKING CODE**		**BREAKDOWN VOLTAGE V_{BR} (V) (1)**		**TEST CURRENT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)**	**MAXIMUM PEAK PULSE CURRENT I_{PPM} (A) (2)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**
	UNI	**BI**	**MIN**	**MAX**					
SMA5J24A	5BZ	5BZ	26.7	29.5	1.0	24	1.0	12.9	38.9
SMA5J26	5CD	5CD	28.9	35.3	1.0	26	1.0	10.7	46.6
SMA5J26A	5CE	5CE	28.9	31.9	1.0	26	1.0	11.9	42.1
SMA5J28	5CF	5CF	31.1	38.0	1.0	28	1.0	10.0	50.0
SMA5J28A	5CG	5CG	31.1	34.4	1.0	28	1.0	11.0	45.4
SMA5J30	5CH	5CH	33.3	40.7	1.0	30	1.0	9.3	53.5
SMA5J30A	5CK	5CK	33.3	36.8	1.0	30	1.0	10.3	48.4
SMA5J33	5CL	5CL	36.7	44.9	1.0	33	1.0	8.5	59.0
SMA5J33A	5CM	5CM	36.7	40.6	1.0	33	1.0	9.4	53.3
SMA5J36	5CN	5CN	40.0	48.9	1.0	36	1.0	7.8	64.3
SMA5J36A	5CP	5CP	40.0	44.2	1.0	36	1.0	8.6	58.1
SMA5J40	5CQ	5CQ	44.4	54.3	1.0	40	1.0	7.0	71.4
SMA5J40A	5CR	5CR	44.4	49.1	1.0	40	1.0	7.8	64.5

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(5) For the bi-directional SMA5J5.0CA, the maximum V_{BR} is 7.25 V

(6) V_F = 3.5 V at I_F = 25 A (uni-directional only)

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Thermal resistance, junction to ambient (1)	$R_{\theta JA}$	80	°C/W
Thermal resistance, junction to leads	$R_{\theta JL}$	25	°C/W

Note:

(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMA5J5.0A-E3/61	0.064	61	1800	7" diameter plastic tape and reel
SMA5J5.0A-E3/5A	0.064	5A	7500	13" diameter plastic tape and reel
SMA5J5.0AHE3/61 (1)	0.064	61	1800	7" diameter plastic tape and reel
SMA5J5.0AHE3/5A (1)	0.064	5A	7500	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

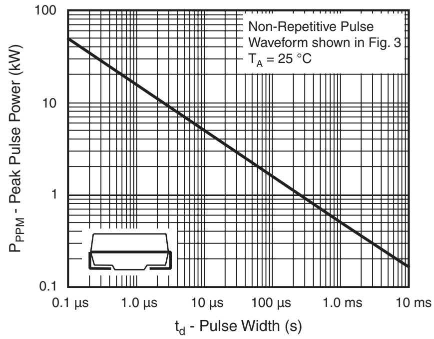


Figure 1. Peak Pulse Power Rating Curve

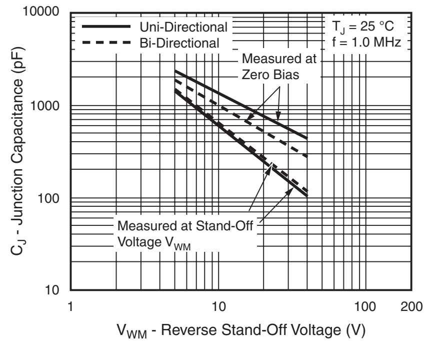


Figure 4. Typical Junction Capacitance

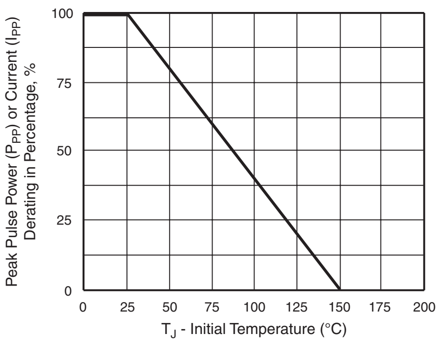


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

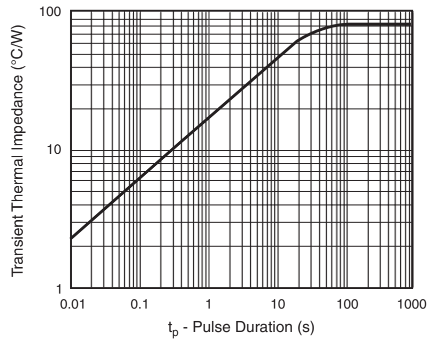


Figure 5. Typical Transient Thermal Impedance

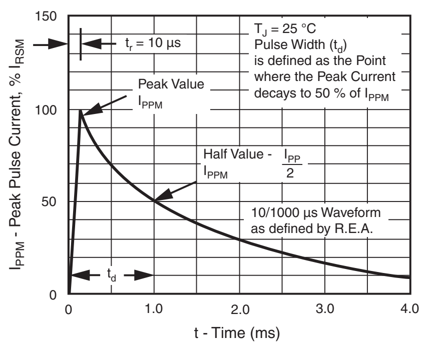


Figure 3. Pulse Waveform

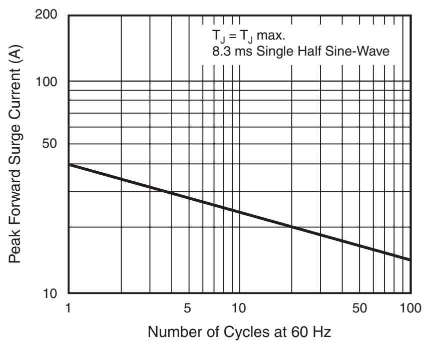
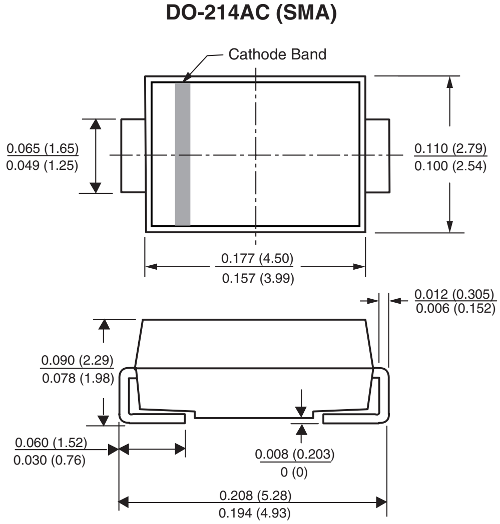
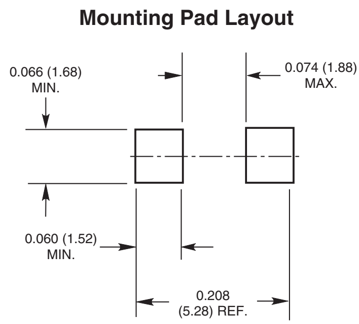


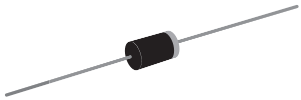
Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)





TRANSZORB® Transient Voltage Suppressors



DO-204AC (DO-15)

PRIMARY CHARACTERISTICS	
V_{BR} uni-directional	6.8 V to 540 V
V_{BR} bi-directional	6.8 V to 440 V
P_{PPM}	600 W
P_D	5.0 W
I_{FSM} (uni-directional only)	100 A
T_J max.	175 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional types, use C or CA suffix (e.g. P6KE440CA).

Electrical characteristics apply in both directions.

FEATURES

- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 600 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-204AC, molded epoxy over passivated chip

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the color band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak power dissipation with a 10/1000 µs waveform (1) (Fig. 1)	P_{PPM}	600	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 5)	P_D	5.0	W
Peak forward surge current, 8.3 ms single half sine-wave (2)	I_{FSM}	100	A
Maximum instantaneous forward voltage at 50 A for uni-directional only (3)	V_F	3.5/5.0	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 per minute maximum

(3) V_F = 3.5 V for P6KE220(A) and below; V_F = 5.0 V for P6KE250(A) and above

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} (3) I_D (µA)	PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
	MIN	MAX						
(+)P6KE6.8	6.12	7.48	10	5.50	1000	55.6	10.8	0.057
(+)P6KE6.8A	6.45	7.14	10	5.80	1000	57.1	10.5	0.057
(+)P6KE7.5	6.75	8.25	10	6.05	500	51.3	11.7	0.061
(+)P6KE7.5A	7.13	7.88	10	6.40	500	53.1	11.3	0.061
(+)P6KE8.2	7.38	9.02	10	6.63	200	48.0	12.5	0.065
(+)P6KE8.2A	7.79	8.61	10	7.02	200	49.6	12.1	0.065
(+)P6KE9.1	8.19	10.0	1.0	7.37	50	43.5	13.8	0.068
(+)P6KE9.1A	8.65	9.55	1.0	7.78	50	44.8	13.4	0.068
(+)P6KE10	9.00	11.0	1.0	8.10	10	40.0	15.0	0.073
(+)P6KE10A	9.50	10.5	1.0	8.55	10	41.4	14.5	0.073
(+)P6KE11	9.90	12.1	1.0	8.92	5.0	37.0	16.2	0.075
(+)P6KE11A	10.5	11.6	1.0	9.40	5.0	38.5	15.6	0.075
(+)P6KE12	10.8	13.2	1.0	9.72	5.0	34.7	17.3	0.078
(+)P6KE12A	11.4	12.6	1.0	10.2	5.0	35.9	16.7	0.078
(+)P6KE13	11.7	14.3	1.0	10.5	5.0	31.6	19.0	0.081
(+)P6KE13A	12.4	13.7	1.0	11.1	5.0	33.0	18.2	0.081
(+)P6KE15	13.5	16.5	1.0	12.1	1.0	27.3	22.0	0.084
(+)P6KE15A	14.3	15.8	1.0	12.8	1.0	28.3	21.2	0.084
(+)P6KE16	14.4	17.6	1.0	12.9	1.0	25.5	23.5	0.086
(+)P6KE16A	15.2	16.8	1.0	13.6	1.0	26.7	22.5	0.086
(+)P6KE18	16.2	19.8	1.0	14.5	1.0	22.6	26.5	0.088
(+)P6KE18A	17.1	18.9	1.0	15.3	1.0	23.8	25.2	0.088
(+)P6KE20	18.0	22.0	1.0	16.2	1.0	20.6	29.1	0.090
(+)P6KE20A	19.0	21.0	1.0	17.1	1.0	21.7	27.7	0.090
(+)P6KE22	19.8	24.2	1.0	17.8	1.0	18.8	31.9	0.092
(+)P6KE22A	20.9	23.1	1.0	18.8	1.0	19.6	30.6	0.092
(+)P6KE24	21.6	26.4	1.0	19.4	1.0	17.3	34.7	0.094
(+)P6KE24A	22.8	25.2	1.0	20.5	1.0	18.1	33.2	0.094
(+)P6KE27	24.3	29.7	1.0	21.8	1.0	15.3	39.1	0.096
(+)P6KE27A	25.7	28.4	1.0	23.1	1.0	16.0	37.5	0.096
(+)P6KE30	27.0	33.0	1.0	24.3	1.0	13.8	43.5	0.097
(+)P6KE30A	28.5	31.5	1.0	25.6	1.0	14.5	41.4	0.097
(+)P6KE33	29.7	36.3	1.0	26.8	1.0	12.6	47.7	0.098
(+)P6KE33A	31.4	34.7	1.0	28.2	1.0	13.1	45.7	0.098
(+)P6KE36	32.4	39.6	1.0	29.1	1.0	11.5	52.0	0.099
(+)P6KE36A	34.2	37.8	1.0	30.8	1.0	12.0	49.9	0.099
(+)P6KE39	35.1	42.9	1.0	31.6	1.0	10.6	56.4	0.100
(+)P6KE39A	37.1	41.0	1.0	33.3	1.0	11.1	53.9	0.100
(+)P6KE43	38.7	47.3	1.0	34.8	1.0	9.7	61.9	0.101
(+)P6KE43A	40.9	45.2	1.0	36.8	1.0	10.1	59.3	0.101
(+)P6KE47	42.3	51.7	1.0	38.1	1.0	8.8	67.8	0.101
(+)P6KE47A	44.7	49.4	1.0	40.2	1.0	9.3	64.8	0.101

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V) MIN	MAX	TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} (3) I_D (µA)	PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
(+)P6KE51	45.9	56.1	1.0	41.3	1.0	8.2	73.5	0.102
(+)P6KE51A	48.5	53.6	1.0	43.6	1.0	8.6	70.1	0.102
(+)P6KE56	50.4	61.6	1.0	45.4	1.0	7.5	80.5	0.103
(+)P6KE56A	53.2	58.8	1.0	47.8	1.0	7.8	77.0	0.103
(+)P6KE62	55.8	68.2	1.0	50.2	1.0	6.7	89.0	0.104
(+)P6KE62A	58.9	65.1	1.0	53.0	1.0	7.1	85.0	0.104
(+)P6KE68	61.2	74.8	1.0	55.1	1.0	6.1	98.0	0.104
(+)P6KE68A	64.6	71.4	1.0	58.1	1.0	6.5	92.0	0.104
(+)P6KE75	67.5	82.5	1.0	60.7	1.0	5.6	108	0.105
(+)P6KE75A	71.3	78.8	1.0	64.1	1.0	5.8	103	0.105
(+)P6KE82	73.8	90.2	1.0	66.4	1.0	5.1	118	0.105
(+)P6KE82A	77.9	86.1	1.0	70.1	1.0	5.3	113	0.105
(+)P6KE91	81.9	100	1.0	73.7	1.0	4.6	131	0.106
(+)P6KE91A	86.5	95.5	1.0	77.8	1.0	4.8	125	0.106
(+)P6KE100	90.0	110	1.0	81.0	1.0	4.2	144	0.106
(+)P6KE100A	95.0	105	1.0	85.5	1.0	4.4	137	0.106
(+)P6KE110	99.0	121	1.0	89.2	1.0	3.8	158	0.107
(+)P6KE110A	105	116	1.0	94.0	1.0	3.9	152	0.107
(+)P6KE120	108	132	1.0	97.2	1.0	3.5	173	0.107
(+)P6KE120A	114	126	1.0	102	1.0	3.6	165	0.107
(+)P6KE130	117	143	1.0	105	1.0	3.2	187	0.107
(+)P6KE130A	124	137	1.0	111	1.0	3.4	179	0.107
(+)P6KE150	135	165	1.0	121	1.0	2.8	215	0.108
(+)P6KE150A	143	158	1.0	128	1.0	2.9	207	0.108
(+)P6KE160	144	176	1.0	130	1.0	2.6	230	0.108
(+)P6KE160A	152	168	1.0	136	1.0	2.7	219	0.108
(+)P6KE170	153	187	1.0	138	1.0	2.5	244	0.108
(+)P6KE170A	162	179	1.0	145	1.0	2.6	234	0.108
(+)P6KE180	162	198	1.0	146	1.0	2.3	258	0.108
(+)P6KE180A	171	189	1.0	154	1.0	2.4	246	0.108
(+)P6KE200	180	220	1.0	162	1.0	2.1	287	0.108
(+)P6KE200A	190	210	1.0	171	1.0	2.2	274	0.108
(+)P6KE220	198	242	1.0	175	1.0	1.7	344	0.108
(+)P6KE220A	209	231	1.0	185	1.0	1.8	328	0.108
(+)P6KE250	225	275	1.0	202	1.0	1.7	360	0.110
(+)P6KE250A	237	263	1.0	214	1.0	1.7	344	0.110
(+)P6KE300	270	330	1.0	243	1.0	1.4	430	0.110
(+)P6KE300A	285	315	1.0	256	1.0	1.4	414	0.110
(+)P6KE350	315	385	1.0	284	1.0	1.2	504	0.110
(+)P6KE350A	333	368	1.0	300	1.0	1.2	482	0.110
(+)P6KE400	360	440	1.0	324	1.0	1.0	574	0.110
(+)P6KE400A	380	420	1.0	342	1.0	1.1	548	0.110

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} (3) I_D (μA)	PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
	MIN	MAX						
(+)P6KE440	396	484	1.0	356	1.0	0.95	631	0.110
(+)P6KE440A	418	462	1.0	376	1.0	1.00	602	0.110
P6KE480	432	528	1.0	389	1.0	0.88	686	0.110
P6KE480A	456	504	1.0	408	1.0	0.91	658	0.110
P6KE510	459	561	1.0	413	1.0	0.82	729	0.110
P6KE510A	485	535	1.0	434	1.0	0.86	698	0.110
P6KE540	486	594	1.0	437	1.0	0.78	772	0.110
P6KE540A	513	567	1.0	459	1.0	0.81	740	0.110

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types with V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(+) Underwriters laboratory recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B and file number E136766 for both uni-directional and bi-directional devices

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Typical thermal resistance, junction to lead	$R_{\theta JL}$	20	°C/W
Typical thermal resistance, junction to ambient	$R_{\theta JA}$	75	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
P6KE6.8A-E3/54	0.432	54	4000	13" diameter paper tape and reel
P6KE6.8AHE3/54 (1)	0.432	54	4000	13" diameter paper tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

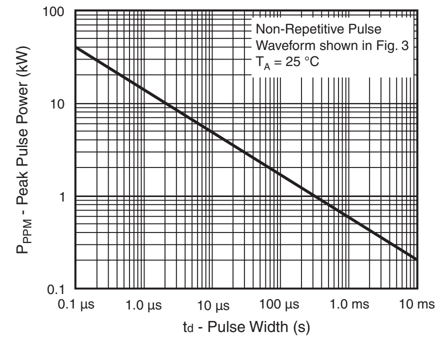


Figure 1. Peak Pulse Power Rating Curve

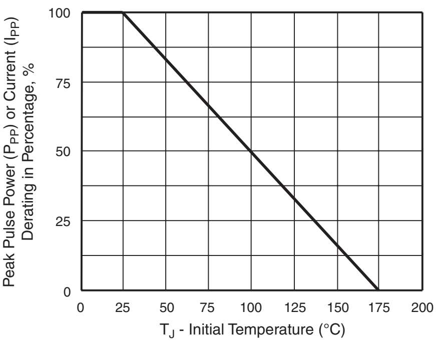


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

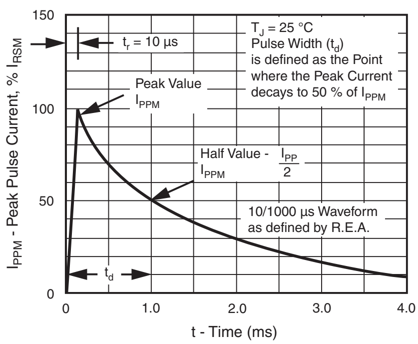


Figure 3. Pulse Waveform

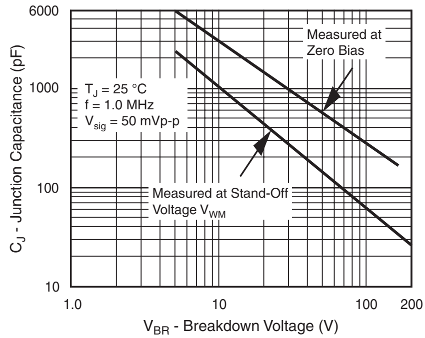


Figure 4. Typical Junction Capacitance Uni-Directional

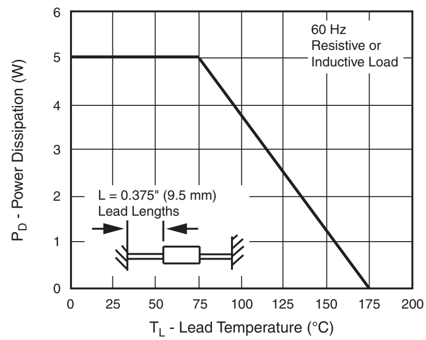


Figure 5. Power Derating Curve

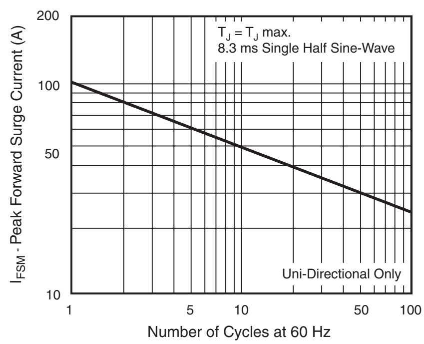


Figure 6. Maximum Non-Repetitive Forward Surge Current

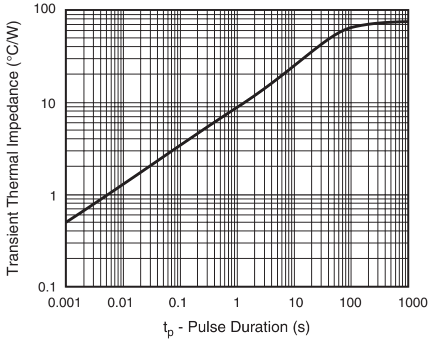
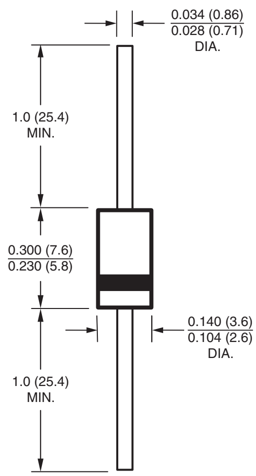


Figure 7. Typical Transient Thermal Impedance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AC (DO-15)



APPLICATION NOTE

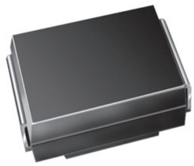
This P6KE TVS series is a low cost commercial product for use in applications where large voltage transients can permanently damage voltage-sensitive components.

The P6KE series device types are designed in a small package size where power and space is a consideration. They are characterized by their high surge capability, extremely fast response time, and low impedance, (R_{on}). Because of the unpredictable nature of transients, and the variation of the impedance with respect to these transients, impedance, per se, is not specified as a parametric value. However, a minimum voltage at low current conditions (BV) and a maximum clamping voltage (V_c) at a maximum peak pulse current is specified.

In some instances, the thermal effect (see V_c Clamping Voltage) may be responsible for 50 % to 70 %. of the observed voltage differential when subjected to high current pulses for several duty cycles, thus making a maximum impedance specification insignificant.

In case of a severe current overload or abnormal transient beyond the maximum ratings, the Transient Voltage Suppressor will initially fail 'short' thus tripping the system's circuit breaker or fuse while protecting the entire circuit. Curves depicting clamping voltage vs. various current pulses are available from the factory. Extended power curves vs. pulse time are also available.

Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-214AA (SMB)

PRIMARY CHARACTERISTICS	
V_{BR} uni-directional	6.8 V to 540 V
V_{BR} bi-directional	6.8 V to 220 V
P_{PPM}	600 W
P_D	5.0 W
I_{FSM} (uni-directional only)	100 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use CA suffix (e.g. P6SMB10CA).

Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 600 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: DO-214AA (SMB)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	600	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink T_A = 50 °C ,	P_D	5.0	W
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	100	A
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

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

GENERAL SEMICONDUCTOR PART NUMBER	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (3) (µA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMP. COEFFICIENT OF V_{BR} (%/°C)
	UNI	BI	MIN	MAX						
P6SMB6.8A	6V8A	6V8C	6.45	7.14	10	5.80	1000	57.1	10.5	0.057
P6SMB7.5A	7V5A	7V5C	7.13	7.88	10	6.40	500	53.1	11.3	0.061
P6SMB8.2A	8V2A	8V2C	7.79	8.61	10	7.02	200	49.6	12.1	0.065
P6SMB9.1A	9V1A	9V1C	8.65	9.55	1.0	7.78	50	44.8	13.4	0.068
P6SMB10A	10A	10C	9.50	10.5	1.0	8.55	10	41.4	14.5	0.073
P6SMB11A	11A	11C	10.5	11.6	1.0	9.40	5.0	38.5	15.6	0.075
P6SMB12A	12A	12C	11.4	12.6	1.0	10.2	5.0	35.9	16.7	0.078
P6SMB13A	13A	13C	12.4	13.7	1.0	11.1	5.0	33.0	18.2	0.081
P6SMB15A	15A	15C	14.3	15.8	1.0	12.8	1.0	28.3	21.2	0.084
P6SMB16A	16A	16C	15.2	16.8	1.0	13.6	1.0	26.7	22.5	0.086
P6SMB18A	18A	18C	17.1	18.9	1.0	15.3	1.0	23.8	25.2	0.088
P6SMB20A	20A	20C	19.0	21.0	1.0	17.1	1.0	21.7	27.7	0.090
P6SMB22A	22A	22C	20.9	23.1	1.0	18.8	1.0	19.6	30.6	0.092
P6SMB24A	24A	24C	22.8	25.2	1.0	20.5	1.0	18.1	33.2	0.094
P6SMB27A	27A	27C	25.7	28.4	1.0	23.1	1.0	16.0	37.5	0.096
P6SMB30A	30A	30C	28.5	31.5	1.0	25.6	1.0	14.5	41.4	0.097
P6SMB33A	33A	33C	31.4	34.7	1.0	28.2	1.0	13.1	45.7	0.098
P6SMB36A	36A	36C	34.2	37.8	1.0	30.8	1.0	12.0	49.9	0.099
P6SMB39A	39A	39C	37.1	41.0	1.0	33.3	1.0	11.1	53.9	0.100
P6SMB43A	43A	43C	40.9	45.2	1.0	36.8	1.0	10.1	59.3	0.101
P6SMB47A	47A	47C	44.7	49.4	1.0	40.2	1.0	9.3	64.8	0.101
P6SMB51A	51A	51C	48.5	53.6	1.0	43.6	1.0	8.6	70.1	0.102
P6SMB56A	56A	56C	53.2	58.8	1.0	47.8	1.0	7.8	77.0	0.103
P6SMB62A	62A	62C	58.9	65.1	1.0	53.0	1.0	7.1	85.0	0.104
P6SMB68A	68A	68C	64.6	71.4	1.0	58.1	1.0	6.5	92.0	0.104
P6SMB75A	75A	75C	71.3	78.8	1.0	64.1	1.0	5.8	103	0.105
P6SMB82A	82A	82C	77.9	86.1	1.0	70.1	1.0	5.3	113	0.105
P6SMB91A	91A	91C	86.5	95.5	1.0	77.8	1.0	4.8	125	0.106
P6SMB100A	100A	100C	95.0	105	1.0	85.5	1.0	4.4	137	0.106
P6SMB110A	110A	110C	105	116	1.0	94.0	1.0	3.9	152	0.107
P6SMB120A	120A	120C	114	126	1.0	102	1.0	3.6	165	0.107
P6SMB130A	130A	130C	124	137	1.0	111	1.0	3.4	179	0.107
P6SMB150A	150A	150C	143	158	1.0	128	1.0	2.9	207	0.108
P6SMB160A	160A	160C	152	168	1.0	136	1.0	2.7	219	0.108
P6SMB170A	170A	170C	162	179	1.0	145	1.0	2.6	234	0.108
P6SMB180A	180A	180C	171	189	1.0	154	1.0	2.4	246	0.108
P6SMB200A	200A	200C	190	210	1.0	171	1.0	2.2	274	0.108
P6SMB220A	220A	220C	209	231	1.0	185	1.0	1.8	328	0.108
P6SMB250A	250A	-	237	263	1.0	214	1.0	1.74	344	0.110
P6SMB300A	300A	-	285	315	1.0	256	1.0	1.45	414	0.110
P6SMB350A	350A	-	333	368	1.0	300	1.0	1.24	482	0.110
P6SMB400A	400A	-	380	420	1.0	342	1.0	1.10	548	0.110
P6SMB440A	440A	-	418	462	1.0	376	1.0	1.00	602	0.110
P6SMB480A	480A	-	456	504	1.0	408	1.0	0.91	658	0.110
P6SMB510A	510A	-	485	535	1.0	434	1.0	0.86	698	0.110
P6SMB540A	540A	-	513	567	1.0	459	1.0	0.81	740	0.110

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types with V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(5) V_F = 3 V at I_F = 50 A (uni-directional only)

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Revision: 04-Sep-07

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Thermal resistance, junction to ambient air (1)	$R_{\theta JA}$	100	°C/W
Thermal resistance, junction to leads	$R_{\theta JL}$	20	°C/W

Note:
(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
P6SMB6.8A-E3/52	0.096	52	750	7" diameter plastic tape and reel
P6SMB6.8A-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
P6SMB6.8AHE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
P6SMB6.8AHE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

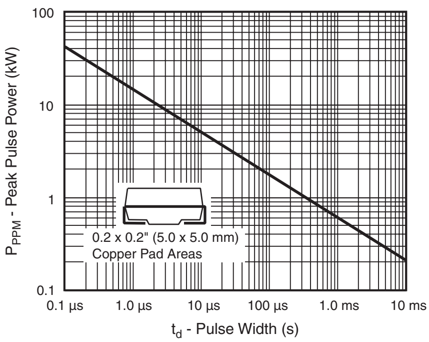


Figure 1. Peak Pulse Power Rating Curve

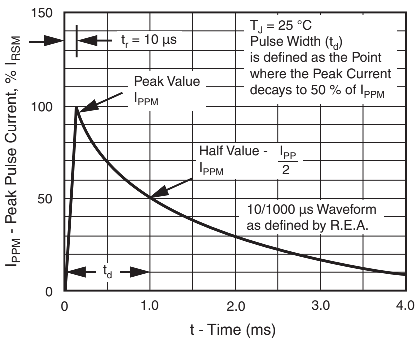


Figure 3. Pulse Waveform

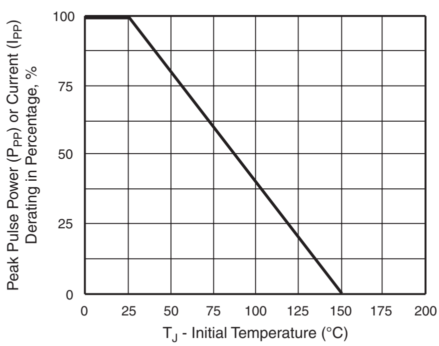


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

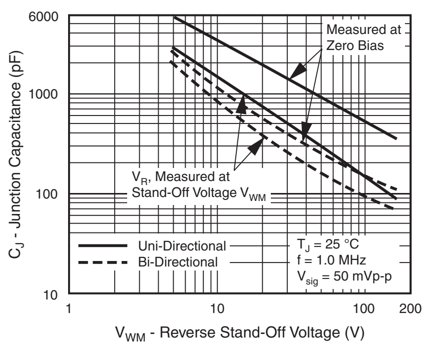


Figure 4. Typical Junction Capacitance

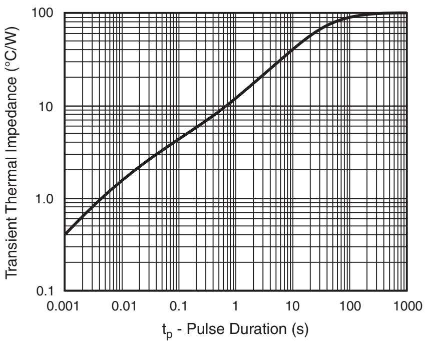


Figure 5. Typical Transient Thermal Impedance

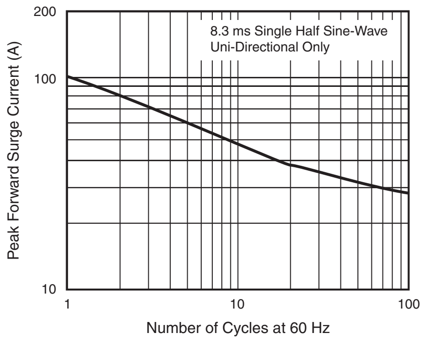
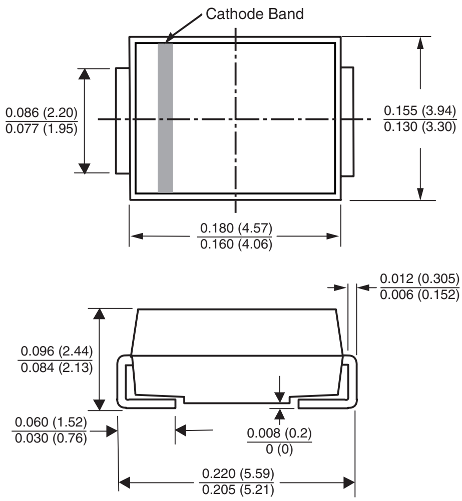


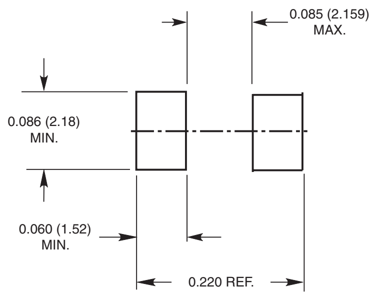
Figure 6. Maximum Non-Repetitive Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

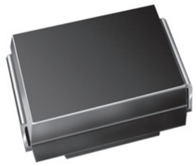
DO-214AA (SMB)



Mounting Pad Layout



Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-214AA (SMB)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 220 V
P_{PPM}	600 W
P_D	5.0 W
I_{FSM} (uni-directional only)	100 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use CA suffix (e.g. SM6T12CA).

Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- 600 W peak pulse power capability with a 10/1000 µs waveform
- Available in uni-directional and bi-directional
- Excellent clamping capability
- Low inductance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AA (SMB)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation on 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	600	W
Peak power pulse current with a 10/1000 µs waveform (1) (Fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink T_A = 50 °C	P_D	5.0	W
Peak forward surge current 10 ms single half sine-wave uni-directional only (2)	I_{FSM}	100	A
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to +150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)												
TYPE (1)	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (2) (V)		TEST CURRENT (mA)	STAND-OFF VOLTAGE V_{RM} (V)	LEAKAGE CURRENT (3) I_{RM} AT V_{RM} (μA)	CLAMPING VOLTAGE V_C AT I_{PP} 10/1000 μs		CLAMPING VOLTAGE V_C AT I_{PP} 8/20 μs		α_T Max 0^{-4}/°C
	UNI	BI	MIN	MAX				(V)	(A)	(V)	(A)	
SM6T6V8A	KE7	KE7	6.45	7.14	10	5.80	1000	10.5	57.0	13.4	298	5.7
SM6T7V5A	KK7	AK7	7.13	7.88	10	6.40	500	11.3	53.0	14.5	276	6.1
SM6T10A	KT7	AT7	9.50	10.5	1.0	8.55	10.0	14.5	41.0	18.6	215	7.3
SM6T12A	KX7	AX7	11.4	12.6	1.0	10.2	5.0	16.7	36.0	21.7	184	7.8
SM6T15A	LG7	LG7	14.3	15.8	1.0	12.8	1.0	21.2	28.0	27.2	147	8.4
SM6T18A	LM7	BM7	17.1	18.9	1.0	15.3	1.0	25.2	24.0	32.5	123	8.8
SM6T22A	LT7	BT7	20.9	23.1	1.0	18.8	1.0	30.6	20.0	39.3	102	9.2
SM6T24A	LV7	LV7	22.8	25.2	1.0	20.5	1.0	33.2	18.0	42.8	93	9.4
SM6T27A	LX7	BX7	25.7	28.4	1.0	23.1	1.0	37.5	16.0	48.3	83	9.6
SM6T30A	ME7	CE7	28.5	31.5	1.0	25.6	1.0	41.5	14.5	53.5	75	9.7
SM6T33A	MG7	MG7	31.4	34.7	1.0	28.2	1.0	45.7	13.1	59.0	68	9.8
SM6T36A	MK7	CK7	34.2	37.8	1.0	30.8	1.0	49.9	12.0	64.3	62	9.9
SM6T39A	MM7	CM7	37.1	41.0	1.0	33.3	1.0	53.9	11.1	69.7	57	10.0
SM6T68A	NG7	NG7	64.6	71.4	1.0	58.1	1.0	92.0	6.50	121	33	10.4
SM6T100A	NV7	NV7	95.0	105	1.0	85.5	1.0	137	4.40	178	22.5	10.6
SM6T150A	PK7	PK7	143	158	1.0	128	1.0	207	2.90	265	15	10.8
SM6T200A	PR7	PR7	190	210	1.0	171	1.0	274	2.20	353	11.3	10.8
SM6T220A	PR8	PR8	209	231	1.0	188	1.0	328	2.00	388	10.3	10.8

Notes:

(1) For bi-directional devices add suffix “CA”

(2) V_{BR} measured after I_T applied for 300 μs square wave pulse

(3) For bipolar devices with V_R = 10 V or under, the I_T limit is doubled

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Thermal resistance, junction to ambient air (1)	$R_{\theta JA}$	100	°C/W
Thermal resistance, junction to leads	$R_{\theta JL}$	20	°C/W

Note:

(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SM6T10A-E3/52	0.096	52	750	7" diameter plastic tape and reel
SM6T10A-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
SM6T10AHE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
SM6T10AHE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

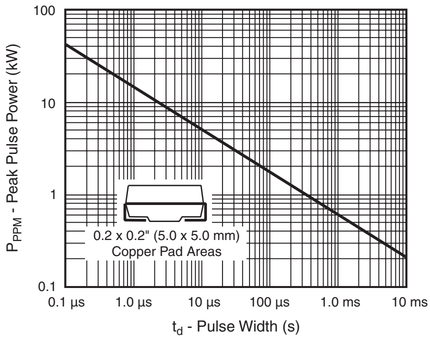


Figure 1. Peak Pulse Power Rating Curve

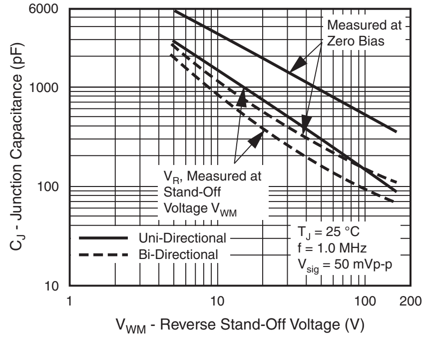


Figure 4. Typical Junction Capacitance

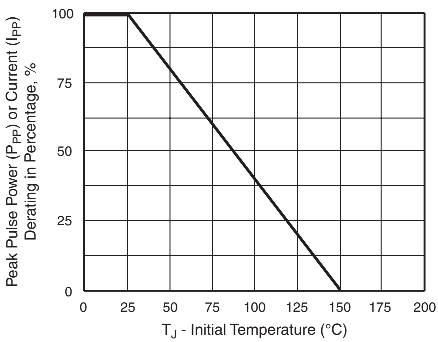


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

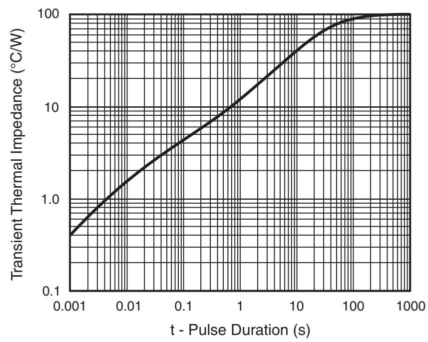


Figure 5. Typical Transient Thermal Impedance

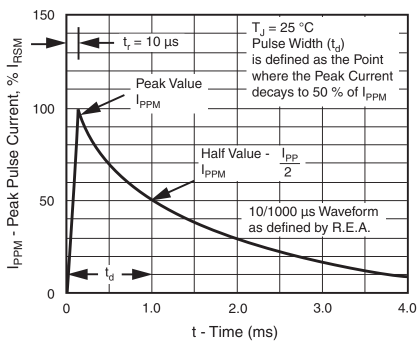


Figure 3. Pulse Waveform

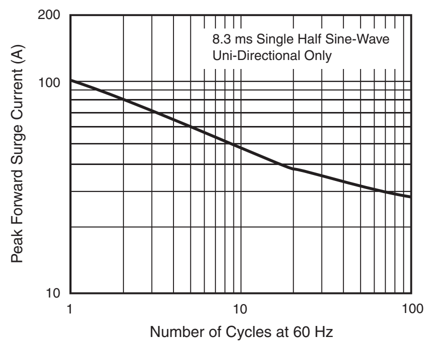
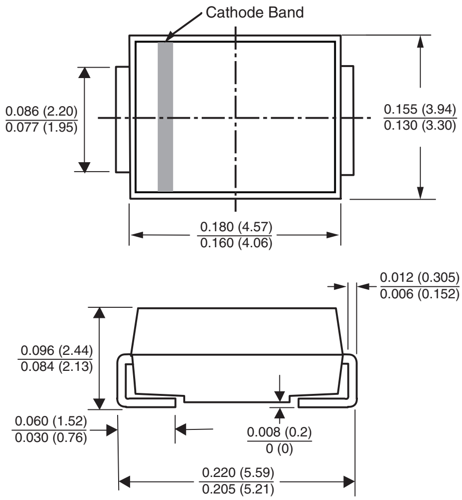


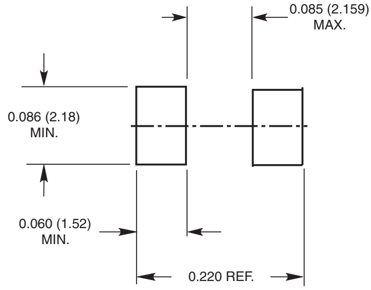
Figure 6. Maximum Non-Repetitive Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-214AA (SMB)



Mounting Pad Layout



Surface Mount Transient Voltage Suppressors

DO-214AC (SMA)

FEATURES

- Low profile package
- Ideal for automated placement
- 600 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Typical I_D less than 1.0 µA
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AC (SMA)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes cathode end

PRIMARY CHARACTERISTICS	
V_{WM}	12 V
P_{PPM}	600 W
I_{FSM}	50 A
T_J max.	150 °C

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 3)	P_{PPM}	600	W
Peak power pulse current with a 10/1000 µs waveform (1) (Fig. 1)	I_{PPM}	31	A
Peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	50	A
Maximum instantaneous forward voltage at 25 A (3)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 1 and derated above T_A = 25 °C per Fig. 2.

(2) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal

(3) Pulse test: 300 µs pulse width, 1 % duty cycle

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE	DEVICE MARKING CODE	BREAKDOWN VOLTAGE V_{BR} (V) (1)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN	MAX					
SMA6J12A	6BE	13.3	14.7	1.0	12	1.0	31	19.5

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SMA6J12A-E3/61	0.064	61	1800	7" diameter plastic tape and reel
SMA6J12A-E3/5A	0.064	5A	7500	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

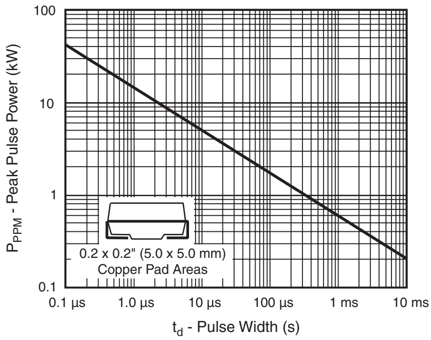


Figure 1. Peak Pulse Power Rating Curve

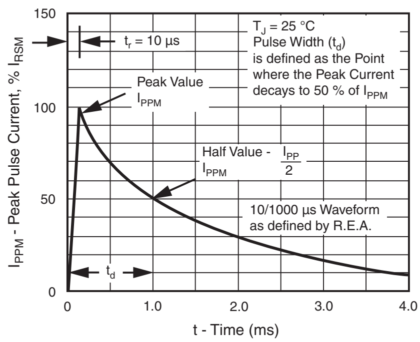


Figure 3. Pulse Waveform

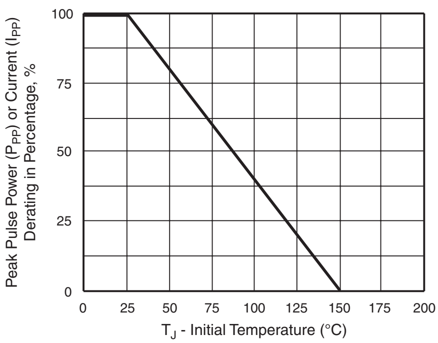
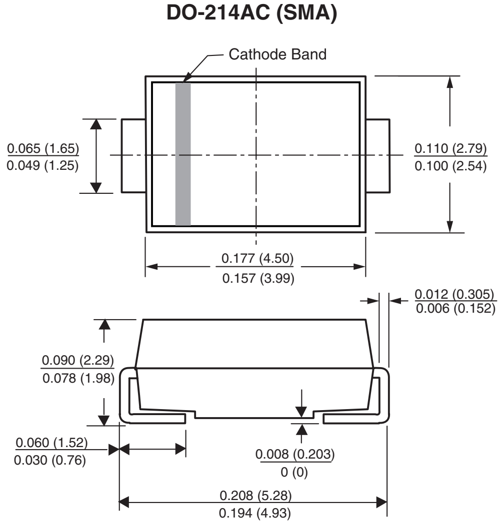
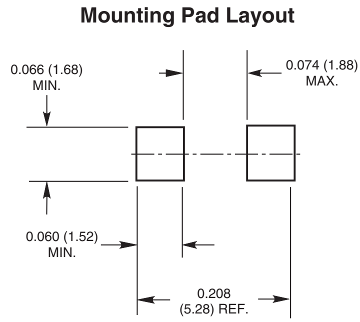


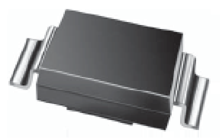
Figure 2. Pulse Power or Current vs. Initial Junction Temperature

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)





Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-215AA (SMBG)

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 188 V
P_{PPM}	600 W
I_{FSM} (uni-directional only)	100 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use C or CA suffix (e.g. SMBG10CA).

Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 600 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-215AA (SMBG)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	600	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	100	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE MODIFIED GULL WING	**DEVICE MARKING CODE**		**BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)**		**TEST CURRENT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)**	**MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**
	UNI	**BI**	**MIN**	**MAX**					
(+)SMBG5.0	KD	KD	6.40	7.82	10	5.0	800	62.5	9.6
(+)SMBG5.0A(5)	KE	KE	6.40	7.07	10	5.0	800	65.2	9.2
(+)SMBG6.0	KF	KF	6.67	8.15	10	6.0	800	52.6	11.4
(+)SMBG6.0A	KG	KG	6.67	7.37	10	6.0	800	58.3	10.3
(+)SMBG6.5	KH	AH	7.22	8.82	10	6.5	500	48.8	12.3
(+)SMBG6.5A	KK	AK	7.22	7.98	10	6.5	500	53.6	11.2
(+)SMBG7.0	KL	KL	7.78	9.51	10	7.0	200	45.1	13.3
(+)SMBG7.0A	KM	KM	7.78	8.60	10	7.0	200	50.0	12.0
(+)SMBG7.5	KN	AN	8.33	10.2	1.0	7.5	100	42.0	14.3
(+)SMBG7.5A	KP	AP	8.33	9.21	1.0	7.5	100	46.5	12.9
(+)SMBG8.0	KQ	AQ	8.89	10.9	1.0	8.0	50	40.0	15.0
(+)SMBG8.0A	KR	AR	8.89	9.83	1.0	8.0	50	44.1	13.6
(+)SMBG8.5	KS	AS	9.44	11.5	1.0	8.5	20	37.7	15.9
(+)SMBG8.5A	KT	AT	9.44	10.4	1.0	8.5	20	41.7	14.4
(+)SMBG9.0	KU	AU	10.0	12.2	1.0	9.0	10	35.5	16.9
(+)SMBG9.0A	KV	AV	10.0	11.1	1.0	9.0	10	39.0	15.4
(+)SMBG10	KW	AW	11.1	13.6	1.0	10	5.0	31.9	18.8
(+)SMBG10A	KX	AX	11.1	12.3	1.0	10	5.0	35.3	17.0
(+)SMBG11	KY	KY	12.2	14.9	1.0	11	5.0	29.9	20.1
(+)SMBG11A	KZ	KZ	12.2	13.5	1.0	11	5.0	33.0	18.2
(+)SMBG12	LD	BD	13.3	16.3	1.0	12	5.0	27.3	22.0
(+)SMBG12A	LE	BE	13.3	14.7	1.0	12	5.0	30.2	19.9
(+)SMBG13	LF	LF	14.4	17.6	1.0	13	1.0	25.2	23.8
(+)SMBG13A	LG	LG	14.4	15.9	1.0	13	1.0	27.9	21.5
(+)SMBG14	LH	BH	15.6	19.1	1.0	14	1.0	23.3	25.8
(+)SMBG14A	LK	BK	15.6	17.2	1.0	14	1.0	25.9	23.2
(+)SMBG15	LL	BL	16.7	20.4	1.0	15	1.0	22.3	26.9
(+)SMBG15A	LM	BM	16.7	18.5	1.0	15	1.0	24.6	24.4
(+)SMBG16	LN	LN	17.8	21.8	1.0	16	1.0	20.8	28.8
(+)SMBG16A	LP	LM	17.8	19.7	1.0	16	1.0	23.1	26.0
(+)SMBG17	LQ	LQ	18.9	23.1	1.0	17	1.0	19.7	30.5
(+)SMBG17A	LR	LR	18.9	20.9	1.0	17	1.0	21.7	27.6
(+)SMBG18	LS	BS	20.0	24.4	1.0	18	1.0	18.6	32.2
(+)SMBG18A	LT	BT	20.0	22.1	1.0	18	1.0	20.5	29.2
(+)SMBG20	LU	LU	22.2	27.1	1.0	20	1.0	16.8	35.8
(+)SMBG20A	LV	LV	22.2	24.5	1.0	20	1.0	18.5	32.4
(+)SMBG22	LW	BW	24.4	29.8	1.0	22	1.0	15.2	39.4
(+)SMBG22A	LX	BX	24.4	26.9	1.0	22	1.0	16.9	35.5
(+)SMBG24	LY	BY	26.7	32.6	1.0	24	1.0	14.0	43.0
(+)SMBG24A	LZ	BZ	26.7	29.5	1.0	24	1.0	15.4	38.9
(+)SMBG26	MD	CD	28.9	35.3	1.0	26	1.0	12.9	46.6
(+)SMBG26A	ME	CE	28.9	31.9	1.0	26	1.0	14.3	42.1
(+)SMBG28	MF	MF	31.1	38.0	1.0	28	1.0	12.0	50.0
(+)SMBG28A	MG	MG	31.1	34.4	1.0	28	1.0	13.2	45.4
(+)SMBG30	MH	CH	33.3	40.7	1.0	30	1.0	11.2	53.5
(+)SMBG30A	MK	CK	33.3	36.8	1.0	30	1.0	12.4	48.4
(+)SMBG33	ML	CL	36.7	44.9	1.0	33	1.0	10.2	59.0
(+)SMBG33A	MM	CM	36.7	40.6	1.0	33	1.0	11.3	53.3
(+)SMBG36	MN	CN	40.0	48.9	1.0	36	1.0	9.3	64.3
(+)SMBG36A	MP	CP	40.0	44.2	1.0	36	1.0	10.3	58.1
(+)SMBG40	MQ	CQ	44.4	54.3	1.0	40	1.0	8.4	71.4
(+)SMBG40A	MR	CR	44.4	49.1	1.0	40	1.0	9.3	64.5

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

DEVICE TYPE MODIFIED GULL WING	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
(+)SMBG43	MS	CS	47.8	58.4	1.0	43	1.0	7.8	76.7
(+)SMBG43A	MT	CT	47.8	52.8	1.0	43	1.0	8.6	69.4
(+)SMBG45	MU	MU	50.0	61.1	1.0	45	1.0	7.5	80.3
(+)SMBG45A	MV	MV	50.0	55.3	1.0	45	1.0	8.3	72.7
(+)SMBG48	MW	MW	53.3	65.1	1.0	48	1.0	7.0	85.5
(+)SMBG48A	MX	MX	53.3	58.9	1.0	48	1.0	7.8	77.4
(+)SMBG51	MY	MY	56.7	69.3	1.0	51	1.0	6.6	91.1
(+)SMBG51A	MZ	MZ	56.7	62.7	1.0	51	1.0	7.3	82.4
(+)SMBG54	ND	ND	60.0	73.3	1.0	54	1.0	6.2	96.3
(+)SMBG54A	NE	NE	60.0	66.3	1.0	54	1.0	6.9	87.1
(+)SMBG58	NF	NF	64.4	78.7	1.0	58	1.0	5.8	103
(+)SMBG58A	NG	NG	64.4	71.2	1.0	58	1.0	6.4	93.6
(+)SMBG60	NH	NH	66.7	81.5	1.0	60	1.0	5.6	107
(+)SMBG60A	NK	NK	66.7	73.7	1.0	60	1.0	6.2	96.8
(+)SMBG64	NL	NL	71.1	86.9	1.0	64	1.0	5.3	114
(+)SMBG64A	NM	NM	71.1	78.6	1.0	64	1.0	5.8	103
(+)SMBG70	NN	NN	77.8	95.1	1.0	70	1.0	4.8	125
(+)SMBG70A	NP	NP	77.8	86.0	1.0	70	1.0	5.3	113
(+)SMBG75	NQ	NQ	83.3	102	1.0	75	1.0	4.5	134
(+)SMBG75A	NR	NR	83.3	92.1	1.0	75	1.0	5.0	121
(+)SMBG78	NS	NS	86.7	106	1.0	78	1.0	4.3	139
(+)SMBG78A	NT	NT	86.7	95.8	1.0	78	1.0	4.8	126
(+)SMBG85	NU	NU	94.4	115	1.0	85	1.0	4.0	151
(+)SMBG85A	NV	NV	94.4	104	1.0	85	1.0	4.4	137
(+)SMBG90	NW	NW	100	122	1.0	90	1.0	3.8	160
(+)SMBG90A	NX	NX	100	111	1.0	90	1.0	4.1	146
(+)SMBG100	NY	NY	111	136	1.0	100	1.0	3.4	179
(+)SMBG100A	NZ	NZ	111	123	1.0	100	1.0	3.7	162
(+)SMBG110	PD	PD	122	149	1.0	110	1.0	3.1	196
(+)SMBG110A	PE	PE	122	135	1.0	110	1.0	3.4	177
(+)SMBG120	PF	PF	133	163	1.0	120	1.0	2.8	214
(+)SMBG120A	PG	PG	133	147	1.0	120	1.0	3.1	193
(+)SMBG130	PH	PH	144	176	1.0	130	1.0	2.6	231
(+)SMBG130A	PK	PK	144	159	1.0	130	1.0	2.9	209
(+)SMBG150	PL	PL	167	204	1.0	150	1.0	2.2	268
(+)SMBG150A	PM	PM	167	185	1.0	150	1.0	2.5	243
(+)SMBG160	PN	PN	178	218	1.0	160	1.0	2.1	287
(+)SMBG160A	PP	PP	178	197	1.0	160	1.0	2.3	259
(+)SMBG170	PQ	PQ	189	231	1.0	170	1.0	2.0	304
(+)SMBG170A	PR	PR	189	209	1.0	170	1.0	2.2	275
SMBG188	PT	PT	209	255	1.0	188	1.0	1.7	344
SMBG188A	PS	PS	209	231	1.0	188	1.0	2.0	328

Notes:

(1) Pulse test: $t_p \leq$ 50 ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(5) For the bi-directional SMBG/SMBJ5.0CA, the maximum V_{BR} is 7.25 V

(6) V_F = 3.5 V at I_F = 50 A (uni-directional only)

(+) Underwriters laboratory recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B and file number E136766 for both uni-directional and bi-directional devices

Document Number: 88456
Revision: 04-Sep-07

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	100	°C/W
Typical thermal resistance, junction to lead	$R_{\theta JL}$	20	°C/W

Note:
(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMBG5.0A-E3/52	0.096	52	750	7" diameter plastic tape and reel
SMBG5.0A-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
SMBG5.0AHE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
SMBG5.0AHE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

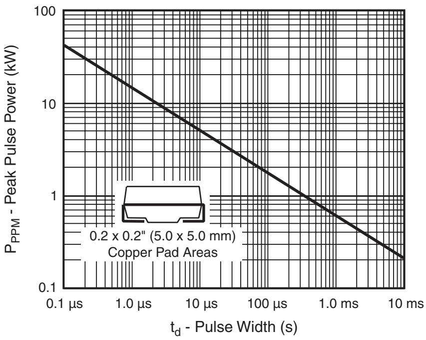


Figure 1. Peak Pulse Power Rating Curve

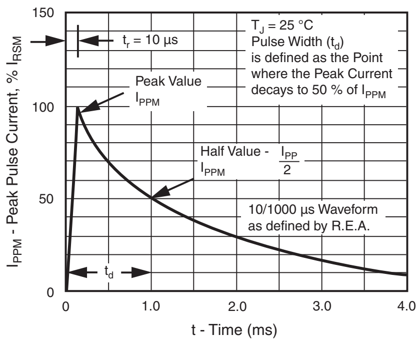


Figure 3. Pulse Waveform

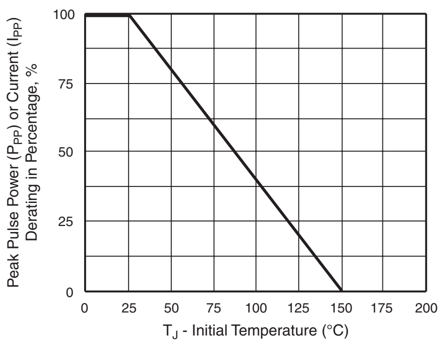


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

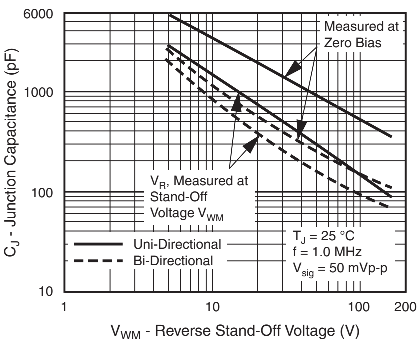


Figure 4. Typical Junction Capacitance

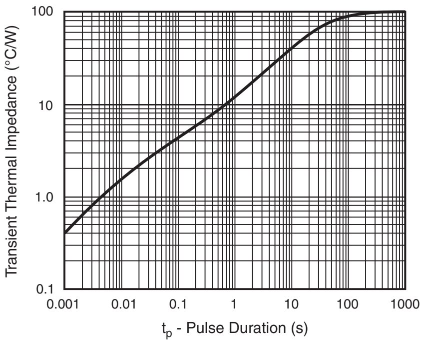


Figure 5. Typical Transient Thermal Impedance

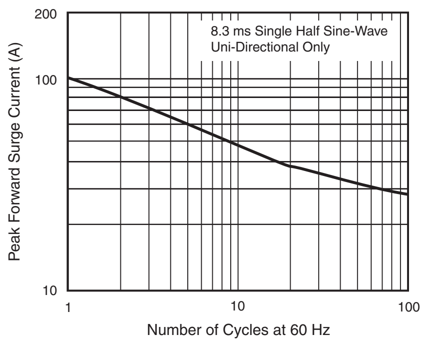
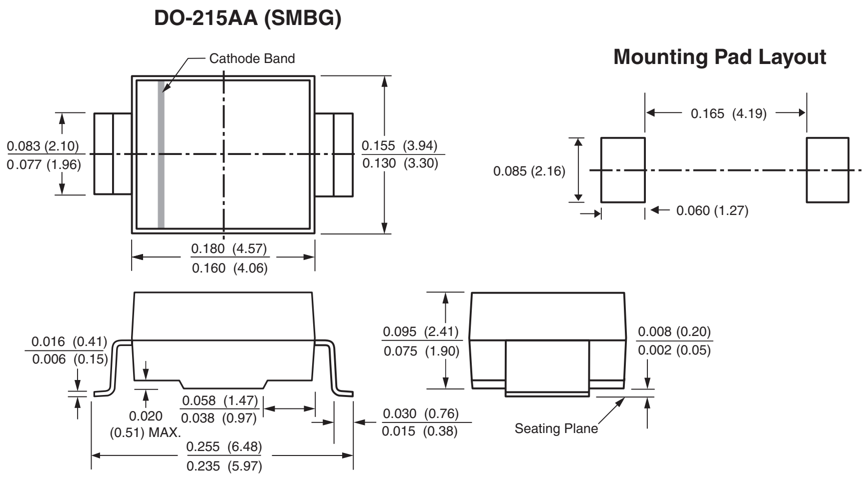
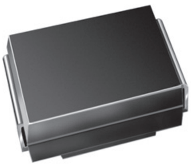


Figure 6. Maximum Non-Repetitive Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)



Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-214AA (SMB J-Bend)

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 600 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 188 V
P_{PPM}	600 W
I_{FSM} (uni-directional only)	100 A
T_J max.	150 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use C or CA suffix (e.g. SMBJ10CA).

Electrical characteristics apply in both directions.

MECHANICAL DATA

Case: DO-214AA (SMBJ)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	600	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	100	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE MODIFIED "J" BEND LEAD	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
(+)SMBJ5.0	KD	KD	6.40	7.82	10	5.0	800	62.5	9.6
(+)SMBJ5.0A (5)	KE	KE	6.40	7.07	10	5.0	800	65.2	9.2
(+)SMBJ6.0	KF	KF	6.67	8.15	10	6.0	800	52.6	11.4
(+)SMBJ6.0A	KG	KG	6.67	7.37	10	6.0	800	58.3	10.3
(+)SMBJ6.5	KH	AH	7.22	8.82	10	6.5	500	48.8	12.3
(+)SMBJ6.5A	KK	AK	7.22	7.98	10	6.5	500	53.6	11.2
(+)SMBJ7.0	KL	KL	7.78	9.51	10	7.0	200	45.1	13.3
(+)SMBJ7.0A	KM	KM	7.78	8.60	10	7.0	200	50.0	12.0
(+)SMBJ7.5	KN	AN	8.33	10.2	1.0	7.5	100	42.0	14.3
(+)SMBJ7.5A	KP	AP	8.33	9.21	1.0	7.5	100	46.5	12.9
(+)SMBJ8.0	KQ	AQ	8.89	10.9	1.0	8.0	50	40.0	15.0
(+)SMBJ8.0A	KR	AR	8.89	9.83	1.0	8.0	50	44.1	13.6
(+)SMBJ8.5	KS	AS	9.44	11.5	1.0	8.5	20	37.7	15.9
(+)SMBJ8.5A	KT	AT	9.44	10.4	1.0	8.5	20	41.7	14.4
(+)SMBJ9.0	KU	AU	10.0	12.2	1.0	9.0	10	35.5	16.9
(+)SMBJ9.0A	KV	AV	10.0	11.1	1.0	9.0	10	39.0	15.4
(+)SMBJ10	KW	AW	11.1	13.6	1.0	10	5.0	31.9	18.8
(+)SMBJ10A	KX	AX	11.1	12.3	1.0	10	5.0	35.3	17.0
(+)SMBJ11	KY	KY	12.2	14.9	1.0	11	5.0	29.9	20.1
(+)SMBJ11A	KZ	KZ	12.2	13.5	1.0	11	5.0	33.0	18.2
(+)SMBJ12	LD	BD	13.3	16.3	1.0	12	5.0	27.3	22.0
(+)SMBJ12A	LE	BE	13.3	14.7	1.0	12	5.0	30.2	19.9
(+)SMBJ13	LF	LF	14.4	17.6	1.0	13	1.0	25.2	23.8
(+)SMBJ13A	LG	LG	14.4	15.9	1.0	13	1.0	27.9	21.5
(+)SMBJ14	LH	BH	15.6	19.1	1.0	14	1.0	23.3	25.8
(+)SMBJ14A	LK	BK	15.6	17.2	1.0	14	1.0	25.9	23.2
(+)SMBJ15	LL	BL	16.7	20.4	1.0	15	1.0	22.3	26.9
(+)SMBJ15A	LM	BM	16.7	18.5	1.0	15	1.0	24.6	24.4
(+)SMBJ16	LN	LN	17.8	21.8	1.0	16	1.0	20.8	28.8
(+)SMBJ16A	LP	LM	17.8	19.7	1.0	16	1.0	23.1	26.0
(+)SMBJ17	LQ	LQ	18.9	23.1	1.0	17	1.0	19.7	30.5
(+)SMBJ17A	LR	LR	18.9	20.9	1.0	17	1.0	21.7	27.6
(+)SMBJ18	LS	BS	20.0	24.4	1.0	18	1.0	18.6	32.2
(+)SMBJ18A	LT	BT	20.0	22.1	1.0	18	1.0	20.5	29.2
(+)SMBJ20	LU	LU	22.2	27.1	1.0	20	1.0	16.8	35.8
(+)SMBJ20A	LV	LV	22.2	24.5	1.0	20	1.0	18.5	32.4
(+)SMBJ22	LW	BW	24.4	29.8	1.0	22	1.0	15.2	39.4
(+)SMBJ22A	LX	BX	24.4	26.9	1.0	22	1.0	16.9	35.5
(+)SMBJ24	LY	BY	26.7	32.6	1.0	24	1.0	14.0	43.0
(+)SMBJ24A	LZ	BZ	26.7	29.5	1.0	24	1.0	15.4	38.9
(+)SMBJ26	MD	CD	28.9	35.3	1.0	26	1.0	12.9	46.6
(+)SMBJ26A	ME	CE	28.9	31.9	1.0	26	1.0	14.3	42.1
(+)SMBJ28	MF	MF	31.1	38.0	1.0	28	1.0	12.0	50.0
(+)SMBJ28A	MG	MG	31.1	34.4	1.0	28	1.0	13.2	45.4
(+)SMBJ30	MH	CH	33.3	40.7	1.0	30	1.0	11.2	53.5
(+)SMBJ30A	MK	CK	33.3	36.8	1.0	30	1.0	12.4	48.4
(+)SMBJ33	ML	CL	36.7	44.9	1.0	33	1.0	10.2	59.0
(+)SMBJ33A	MM	CM	36.7	40.6	1.0	33	1.0	11.3	53.3
(+)SMBJ36	MN	CN	40.0	48.9	1.0	36	1.0	9.3	64.3
(+)SMBJ36A	MP	CP	40.0	44.2	1.0	36	1.0	10.3	58.1
(+)SMBJ40	MQ	CQ	44.4	54.3	1.0	40	1.0	8.4	71.4
(+)SMBJ40A	MR	CR	44.4	49.1	1.0	40	1.0	9.3	64.5

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE MODIFIED "J" BEND LEAD	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
(+)SMBJ43	MS	CS	47.8	58.4	1.0	43	1.0	7.8	76.7
(+)SMBJ43A	MT	CT	47.8	52.8	1.0	43	1.0	8.6	69.4
(+)SMBJ45	MU	MU	50.0	61.1	1.0	45	1.0	7.5	80.3
(+)SMBJ45A	MV	MV	50.0	55.3	1.0	45	1.0	8.3	72.7
(+)SMBJ48	MW	MW	53.3	65.1	1.0	48	1.0	7.0	85.5
(+)SMBJ48A	MX	MX	53.3	58.9	1.0	48	1.0	7.8	77.4
(+)SMBJ51	MY	MY	56.7	69.3	1.0	51	1.0	6.6	91.1
(+)SMBJ51A	MZ	MZ	56.7	62.7	1.0	51	1.0	7.3	82.4
(+)SMBJ54	ND	ND	60.0	73.3	1.0	54	1.0	6.2	96.3
(+)SMBJ54A	NE	NE	60.0	66.3	1.0	54	1.0	6.9	87.1
(+)SMBJ58	NF	NF	64.4	78.7	1.0	58	1.0	5.8	103
(+)SMBJ58A	NG	NG	64.4	71.2	1.0	58	1.0	6.4	93.6
(+)SMBJ60	NH	NH	66.7	81.5	1.0	60	1.0	5.6	107
(+)SMBJ60A	NK	NK	66.7	73.7	1.0	60	1.0	6.2	96.8
(+)SMBJ64	NL	NL	71.1	86.9	1.0	64	1.0	5.3	114
(+)SMBJ64A	NM	NM	71.1	78.6	1.0	64	1.0	5.8	103
(+)SMBJ70	NN	NN	77.8	95.1	1.0	70	1.0	4.8	125
(+)SMBJ70A	NP	NP	77.8	86.0	1.0	70	1.0	5.3	113
(+)SMBJ75	NQ	NQ	83.3	102	1.0	75	1.0	4.5	134
(+)SMBJ75A	NR	NR	83.3	92.1	1.0	75	1.0	5.0	121
(+)SMBJ78	NS	NS	86.7	106	1.0	78	1.0	4.3	139
(+)SMBJ78A	NT	NT	86.7	95.8	1.0	78	1.0	4.8	126
(+)SMBJ85	NU	NU	94.4	115	1.0	85	1.0	4.0	151
(+)SMBJ85A	NV	NV	94.4	104	1.0	85	1.0	4.4	137
(+)SMBJ90	NW	NW	100	122	1.0	90	1.0	3.8	160
(+)SMBJ90A	NX	NX	100	111	1.0	90	1.0	4.1	146
(+)SMBJ100	NY	NY	111	136	1.0	100	1.0	3.4	179
(+)SMBJ100A	NZ	NZ	111	123	1.0	100	1.0	3.7	162
(+)SMBJ110	PD	PD	122	149	1.0	110	1.0	3.1	196
(+)SMBJ110A	PE	PE	122	135	1.0	110	1.0	3.4	177
(+)SMBJ120	PF	PF	133	163	1.0	120	1.0	2.8	214
(+)SMBJ120A	PG	PG	133	147	1.0	120	1.0	3.1	193
(+)SMBJ130	PH	PH	144	176	1.0	130	1.0	2.6	231
(+)SMBJ130A	PK	PK	144	159	1.0	130	1.0	2.9	209
(+)SMBJ150	PL	PL	167	204	1.0	150	1.0	2.2	268
(+)SMBJ150A	PM	PM	167	185	1.0	150	1.0	2.5	243
(+)SMBJ160	PN	PN	178	218	1.0	160	1.0	2.1	287
(+)SMBJ160A	PP	PP	178	197	1.0	160	1.0	2.3	259
(+)SMBJ170	PQ	PQ	189	231	1.0	170	1.0	2.0	304
(+)SMBJ170A	PR	PR	189	209	1.0	170	1.0	2.2	275
SMBJ188	PT	PT	209	255	1.0	188	1.0	1.7	344
SMBJ188A	PS	PS	209	231	1.0	188	1.0	2.0	328

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(5) For the bi-directional SMBG/SMBJ5.0CA, the maximum V_{BR} is 7.25 V

(6) V_F = 3.5 V at I_F = 50 A (uni-directional only)

(+) Underwriters laboratory recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B and file number E136766 for both uni-directional and bi-directional devices

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	100	°C/W
Typical thermal resistance, junction to lead	$R_{\theta JL}$	20	°C/W

Note:
(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMBJ5.0A-E3/52	0.096	52	750	7" diameter plastic tape and reel
SMBJ5.0A-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
SMBJ5.0AHE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
SMBJ5.0AHE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

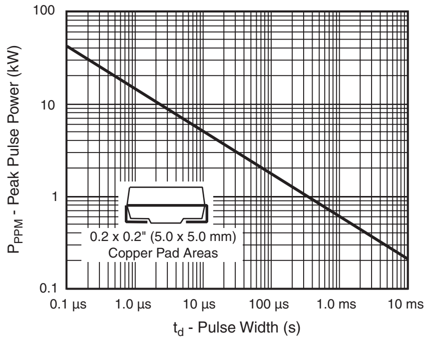


Figure 1. Peak Pulse Power Rating Curve

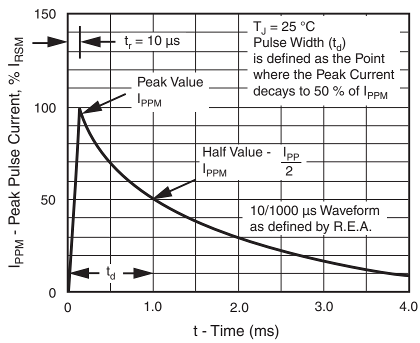


Figure 3. Pulse Waveform

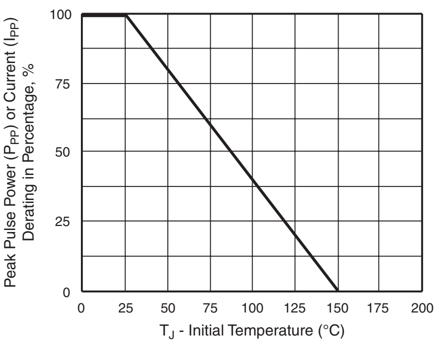


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

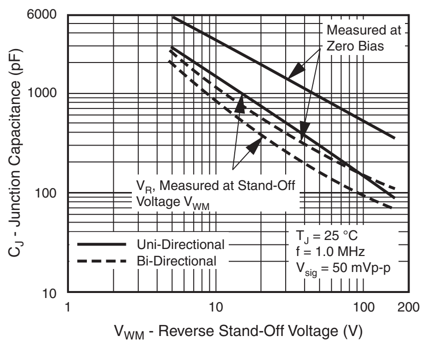


Figure 4. Typical Junction Capacitance

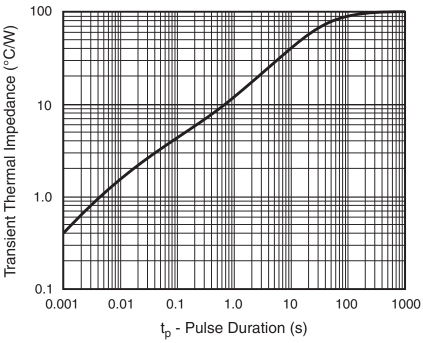


Figure 5. Typical Transient Thermal Impedance

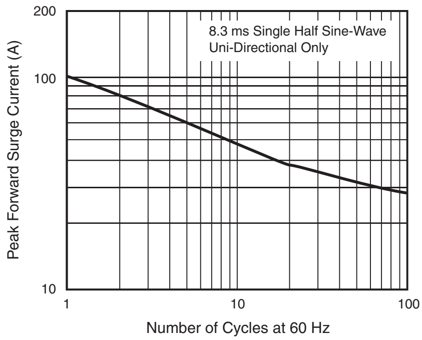
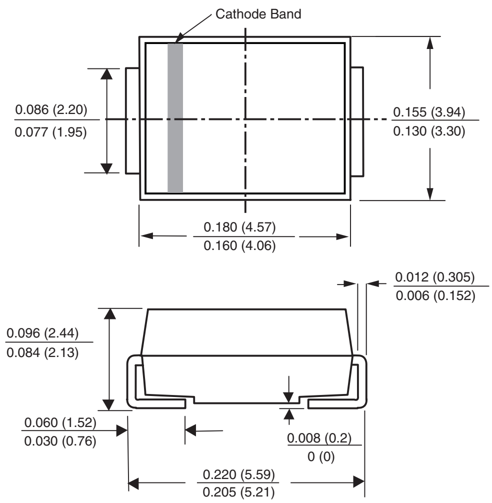


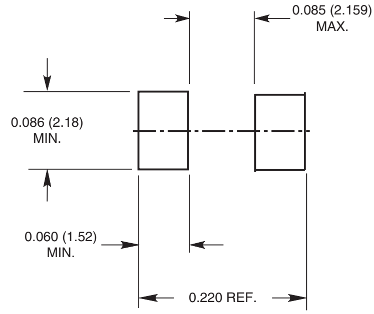
Figure 6. Maximum Non-Repetitive Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

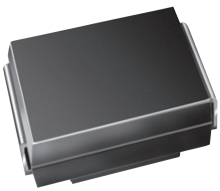
DO-214AA (SMB-J-Bend)



Mounting Pad Layout



Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-214AA (SMBJ)

FEATURES

- Uni-directional polarity only
- Peak pulse power: 600 W (10/1000 µs)
- Excellent clamping capability
- Very fast response time
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units specifically for protecting 3.3 V supplied sensitive equipment against transient overvoltages.

MECHANICAL DATA

Case: DO-214AA (SMBJ)
Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes cathode end

PRIMARY CHARACTERISTICS	
V_{WM}	3.3 V
P_{PPM}	600 W
I_{FSM}	60 A
T_J max.	175 °C

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation (1)(2)	P_{PPM}	600	W
Peak pulse current with a 10/1000 µs waveform (Fig. 1)	I_{PP}	50	A
Peak pulse current with a 8/20 waveform (Fig. 1)	I_{PPM}	200	A
Non repetitive peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	60	A
Power dissipation on infinite heatsink, T_L = 75 °C	P_D	5	W
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 1

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

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

DEVICE TYPE	DEVICE MARKING CODE	BREAKDOWN VOLTAGE V_{BR} AT I_T MIN		MAXIMUM REVERSE LEAKAGE CURRENT I_R AT V_{WM} MAX		MAXIMUM CLAMPING VOLTAGE V_C AT I_{PP} 10/1000 µs		MAXIMUM CLAMPING VOLTAGE V_C AT I_{PPM} 8/20 µs		TYPICAL TEMP. COEFFICIENT OF V_{BR}	TYPICAL JUNCTION CAPACITANCE C_J AT 0 V 1 MHz
		V	mA	µA	V	V	A	V	A	(10^{-4}/°C)	pF
SMBJ3V3	KC	4.1	1.0	200	3.3	7.3	50	10.3	200	- 5.3	5200

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to lead (1)	$R_{\theta JL}$	20	°C/W
Typical thermal resistance, junction to ambient (2)	$R_{\theta JA}$	100	

Notes:
(1) Thermal resistance from junction to lead - mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal
(2) Thermal resistance from junction to ambient - mounted on the recommended P.C.B. pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMBJ3V3-E3/52	0.096	52	750	7" diameter plastic tape and reel
SMBJ3V3-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
SMBJ3V3HE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
SMBJ3V3HE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

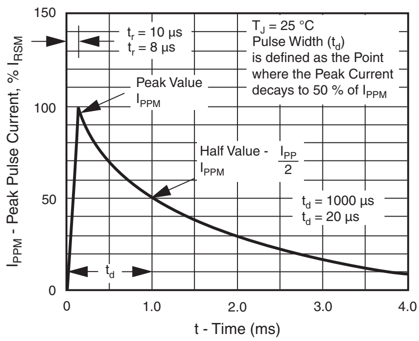


Figure 1. Pulse Waveform

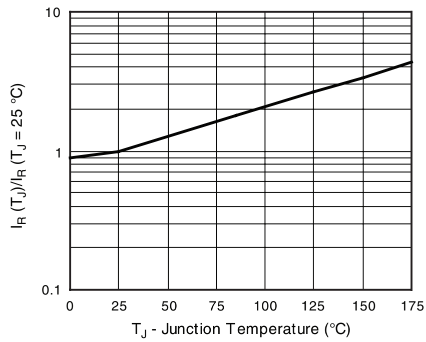


Figure 3. Relative Variation of Leakage Current vs. Junction Temperature

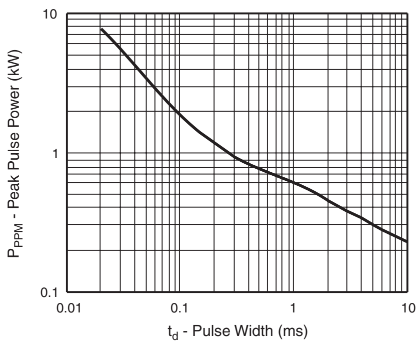


Figure 2. Peak Pulse Power Rating Curve

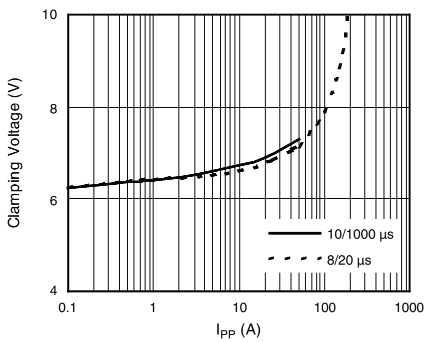


Figure 4. Clamping Voltage vs. Peak Pulse Current (T_J initial = 25 °C)

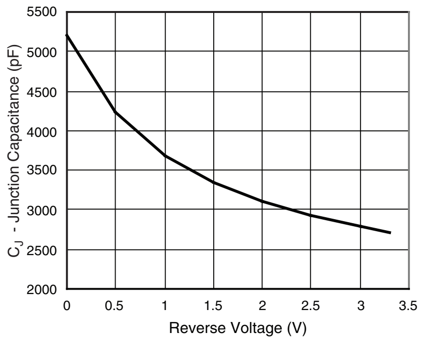


Figure 5. Typical Junction Capacitance

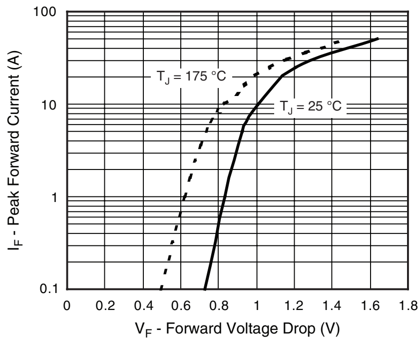


Figure 7. Typical Peak Forward Voltage Drop vs. Peak Forward Current

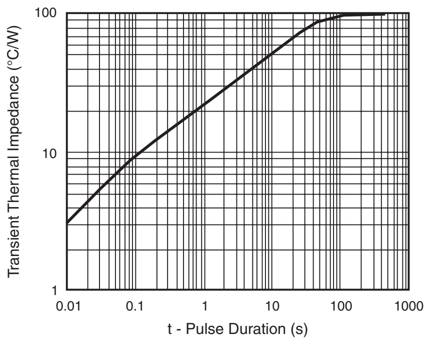
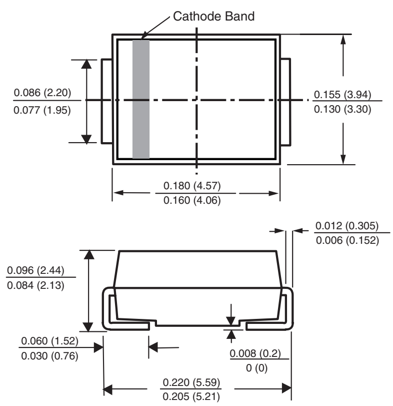


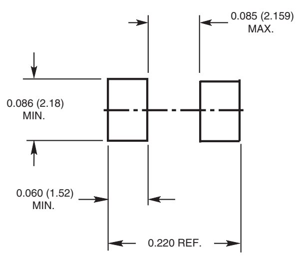
Figure 6. Typical Transient Thermal Impedance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

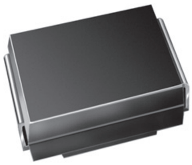
DO-214AA (SMB-J-Bend)



Mounting Pad Layout



High Power Density Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-214AA (SMB)

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AA (SMBJ)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the color band denotes cathode end, no marking on bi-directional types

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 40 V
P_{PPM} (uni-directional)	1000 W
P_{PPM} (bi-directional)	800 W
I_{FSM} (uni-directional only)	100 A
T_J max.	150 °C

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER		SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	uni-directional bi-directional	P_{PPM}	1000 800	W
Peak pulse current with a 10/1000 µs waveform (1)		I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)		I_{FSM}	100	A
Operating junction and storage temperature range		T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.2 x 0.2" (5.0 x 5.0 mm) copper pads to each terminal

UNI-DIRECTIONAL

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

DEVICE TYPE	DEVICE MARKING CODE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V) MIN	MAX	TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
SMB10J5.0	1AD	6.40	7.82	10	5.0	1000	104.2	9.6
SMB10J5.0A	1AE	6.40	7.07	10	5.0	1000	108.7	9.2
SMB10J6.0	1AF	6.67	8.15	10	6.0	1000	87.7	11.4
SMB10J6.0A	1AG	6.67	7.37	10	6.0	1000	97.1	10.3
SMB10J6.5	1AH	7.22	8.82	10	6.5	500	81.3	12.3
SMB10J6.5A	1AK	7.22	7.98	10	6.5	500	89.3	11.2
SMB10J7.0	1AL	7.78	9.51	10	7.0	200	75.2	13.3
SMB10J7.0A	1AM	7.78	8.60	10	7.0	200	83.3	12.0
SMB10J7.5	1AN	8.33	10.2	1.0	7.5	100	69.9	14.3
SMB10J7.5A	1AP	8.33	9.21	1.0	7.5	100	77.5	12.9
SMB10J8.0	1AQ	8.89	10.9	1.0	8.0	50	66.7	15.0
SMB10J8.0A	1AR	8.89	9.83	1.0	8.0	50	73.5	13.6
SMB10J8.5	1AS	9.44	11.5	1.0	8.5	20	62.9	15.9
SMB10J8.5A	1AT	9.44	10.4	1.0	8.5	20	69.4	14.4
SMB10J9.0	1AU	10.0	12.2	1.0	9.0	10	59.2	16.9
SMB10J9.0A	1AV	10.0	11.1	1.0	9.0	10	64.9	15.4
SMB10J10	1AW	11.1	13.6	1.0	10	5.0	53.2	18.8
SMB10J10A	1AX	11.1	12.3	1.0	10	5.0	58.8	17.0
SMB10J11	1AY	12.2	14.9	1.0	11	5.0	49.8	20.1
SMB10J11A	1AZ	12.2	13.5	1.0	11	5.0	54.9	18.2
SMB10J12	1BD	13.3	16.3	1.0	12	5.0	45.5	22.0
SMB10J12A	1BE	13.3	14.7	1.0	12	5.0	50.3	19.9
SMB10J13	1BF	14.4	17.6	1.0	13	1.0	42.0	23.8
SMB10J13A	1BG	14.4	15.9	1.0	13	1.0	46.5	21.5
SMB10J14	1BH	15.6	19.1	1.0	14	1.0	38.8	25.8
SMB10J14A	1BK	15.6	17.2	1.0	14	1.0	43.1	23.2
SMB10J15	1BL	16.7	20.4	1.0	15	1.0	37.2	26.9
SMB10J15A	1BM	16.7	18.5	1.0	15	1.0	41.0	24.4
SMB10J16	1BN	17.8	21.8	1.0	16	1.0	34.7	28.8
SMB10J16A	1BP	17.8	19.7	1.0	16	1.0	38.5	26.0
SMB10J17	1BQ	18.9	23.1	1.0	17	1.0	32.8	30.5
SMB10J17A	1BR	18.9	20.9	1.0	17	1.0	36.2	27.6
SMB10J18	1BS	20.0	24.4	1.0	18	1.0	31.1	32.2
SMB10J18A	1BT	20.0	22.1	1.0	18	1.0	34.2	29.2
SMB10J20	1BU	22.2	27.1	1.0	20	1.0	27.9	35.8
SMB10J20A	1BV	22.2	24.5	1.0	20	1.0	30.9	32.4
SMB10J22	1BW	24.4	29.8	1.0	22	1.0	25.4	39.4
SMB10J22A	1BX	24.4	26.9	1.0	22	1.0	28.2	35.5
SMB10J24	1BY	26.7	32.6	1.0	24	1.0	23.3	43.0
SMB10J24A	1BZ	26.7	29.5	1.0	24	1.0	25.7	38.9
SMB10J26	1CD	28.9	35.3	1.0	26	1.0	21.5	46.6
SMB10J26A	1CE	28.9	31.9	1.0	26	1.0	23.8	42.1
SMB10J28	1CF	31.1	38.0	1.0	28	1.0	20.0	50.0
SMB10J28A	1CG	31.1	34.4	1.0	28	1.0	22.0	45.4
SMB10J30	1CH	33.3	40.7	1.0	30	1.0	18.7	53.5
SMB10J30A	1CK	33.3	36.8	1.0	30	1.0	20.7	48.4
SMB10J33	1CL	36.7	44.9	1.0	33	1.0	16.9	59.0
SMB10J33A	1CM	36.7	40.6	1.0	33	1.0	18.8	53.3
SMB10J36	1CN	40.0	48.9	1.0	36	1.0	15.6	64.3
SMB10J36A	1CP	40.0	44.2	1.0	36	1.0	17.2	58.1
SMB10J40	1CQ	44.4	54.3	1.0	40	1.0	14.0	71.4
SMB10J40A	1CR	44.4	49.1	1.0	40	1.0	15.5	64.5

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

(4) V_F = 3.5 V at I_F = 50 A (uni-directional only)

BI-DIRECTIONAL

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

DEVICE TYPE	DEVICE MARKING CODE	BREAKDOWN VOLTAGE V_{BR} (1) (V) MIN	MAX	TEST CURRENT AT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
SMB8J5.0C	1AD	6.40	7.82	10	5.0	2000	83.3	9.6
SMB8J5.0CA	1AE	6.40	7.25	10	5.0	2000	87.0	9.2
SMB8J6.0C	1AF	6.67	8.15	10	6.0	2000	70.2	11.4
SMB8J6.0CA	1AG	6.67	7.37	10	6.0	2000	77.7	10.3
SMB8J6.5C	1AH	7.22	8.82	10	6.5	1000	65.0	12.3
SMB8J6.5CA	1AK	7.22	7.98	10	6.5	1000	71.4	11.2
SMB8J7.0C	1AL	7.78	9.51	10	7.0	400	60.2	13.3
SMB8J7.0CA	1AM	7.78	8.60	10	7.0	400	66.7	12.0
SMB8J7.5C	1AN	8.33	10.2	1.0	7.5	200	55.9	14.3
SMB8J7.5CA	1AP	8.33	9.21	1.0	7.5	200	62.0	12.9
SMB8J8.0C	1AQ	8.89	10.9	1.0	8.0	100	53.3	15.0
SMB8J8.0CA	1AR	8.89	9.83	1.0	8.0	100	58.8	13.6
SMB8J8.5C	1AS	9.44	11.5	1.0	8.5	40	50.3	15.9
SMB8J8.5CA	1AT	9.44	10.4	1.0	8.5	40	55.6	14.4
SMB8J9.0C	1AU	10.0	12.2	1.0	9.0	20	47.3	16.9
SMB8J9.0CA	1AV	10.0	11.1	1.0	9.0	20	51.9	15.4
SMB8J10C	1AW	11.1	13.6	1.0	10	10	42.6	18.8
SMB8J10CA	1AX	11.1	12.3	1.0	10	10	47.1	17.0
SMB8J11C	1AY	12.2	14.9	1.0	11	5.0	39.8	20.1
SMB8J11CA	1AZ	12.2	13.5	1.0	11	5.0	44.0	18.2
SMB8J12C	1BD	13.3	16.3	1.0	12	5.0	36.4	22.0
SMB8J12CA	1BE	13.3	14.7	1.0	12	5.0	40.2	19.9
SMB8J13C	1BF	14.4	17.6	1.0	13	1.0	33.6	23.8
SMB8J13CA	1BG	14.4	15.9	1.0	13	1.0	37.2	21.5
SMB8J14C	1BH	15.6	19.1	1.0	14	1.0	31.0	25.8
SMB8J14CA	1BK	15.6	17.2	1.0	14	1.0	34.5	23.2
SMB8J15C	1BL	16.7	20.4	1.0	15	1.0	29.7	26.9
SMB8J15CA	1BM	16.7	18.5	1.0	15	1.0	32.8	24.4
SMB8J16C	1BN	17.8	21.8	1.0	16	1.0	27.8	28.8
SMB8J16CA	1BP	17.8	19.7	1.0	16	1.0	30.8	26.0
SMB8J17C	1BQ	18.9	23.1	1.0	17	1.0	26.2	30.5
SMB8J17CA	1BR	18.9	20.9	1.0	17	1.0	29.0	27.6
SMB8J18C	1BS	20.0	24.4	1.0	18	1.0	24.8	32.2
SMB8J18CA	1BT	20.0	22.1	1.0	18	1.0	27.4	29.2
SMB8J20C	1BU	22.2	27.1	1.0	20	1.0	22.3	35.8
SMB8J20CA	1BV	22.2	24.5	1.0	20	1.0	24.7	32.4
SMB8J22C	1BW	24.4	29.8	1.0	22	1.0	20.3	39.4
SMB8J22CA	1BX	24.4	26.9	1.0	22	1.0	22.5	35.5
SMB8J24C	1BY	26.7	32.6	1.0	24	1.0	18.6	43.0
SMB8J24CA	1BZ	26.7	29.5	1.0	24	1.0	20.6	38.9
SMB8J26C	1CD	28.9	35.3	1.0	26	1.0	17.2	46.6
SMB8J26CA	1CE	28.9	31.9	1.0	26	1.0	19.0	42.1
SMB8J28C	1CF	31.1	38.0	1.0	28	1.0	16.0	50.0
SMB8J28CA	1CG	31.1	34.4	1.0	28	1.0	17.6	45.4
SMB8J30C	1CH	33.3	40.7	1.0	30	1.0	15.0	53.5
SMB8J30CA	1CK	33.3	36.8	1.0	30	1.0	16.5	48.4
SMB8J33C	1CL	36.7	44.9	1.0	33	1.0	13.6	59.0
SMB8J33CA	1CM	36.7	40.6	1.0	33	1.0	15.0	53.3
SMB8J36C	1CN	40.0	48.9	1.0	36	1.0	12.4	64.3
SMB8J36CA	1CP	40.0	44.2	1.0	36	1.0	13.8	58.1
SMB8J40C	1CQ	44.4	54.3	1.0	40	1.0	11.2	71.4
SMB8J40CA	1CR	44.4	49.1	1.0	40	1.0	12.4	64.5

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	72	°C/W
Typical thermal resistance, junction to lead	$R_{\theta JL}$	20	°C/W

Note:
(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMB10J5.0A-E3/52	0.106	52	750	7" diameter plastic tape and reel
SMB10J5.0A-E3/5B	0.106	5B	3200	13" diameter plastic tape and reel
SMB10J5.0AHE3/52 (1)	0.106	52	750	7" diameter plastic tape and reel
SMB10J5.0AHE3/5B (1)	0.106	5B	3200	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

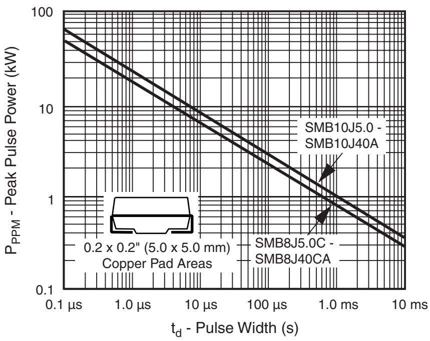


Figure 1. Peak Pulse Power Rating Curve

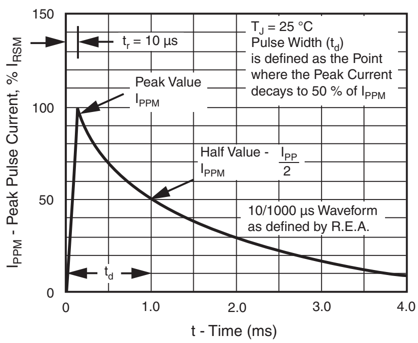


Figure 3. Pulse Waveform

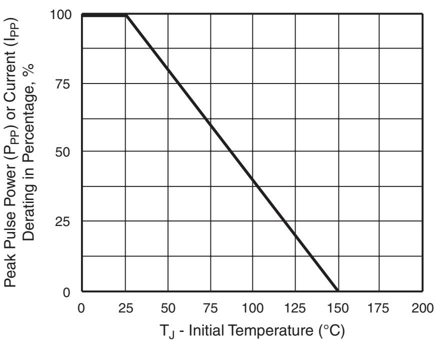


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

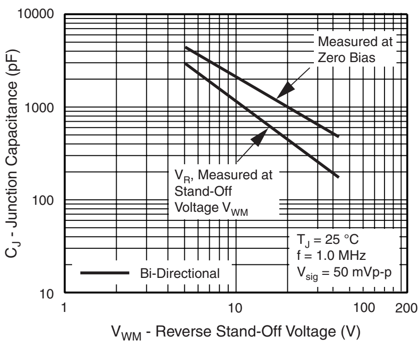


Figure 4. Typical Junction Capacitance

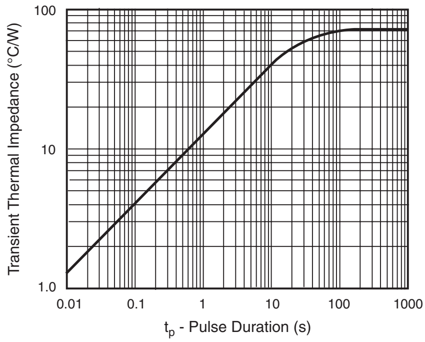


Figure 5. Typical Transient Thermal Impedance

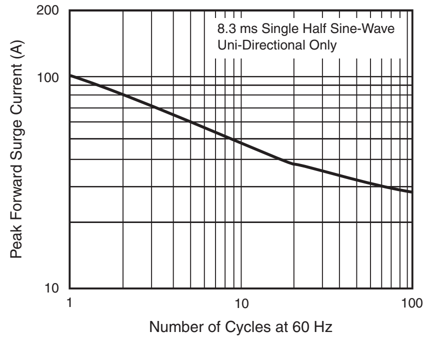
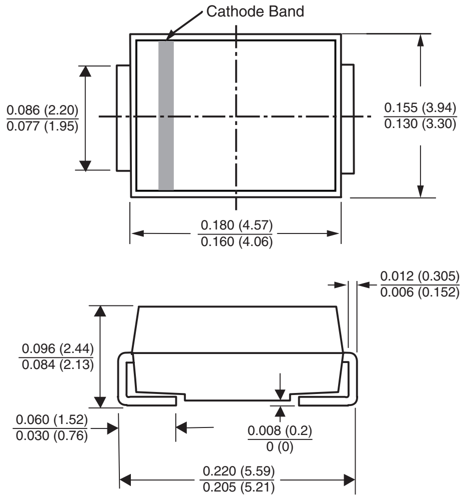


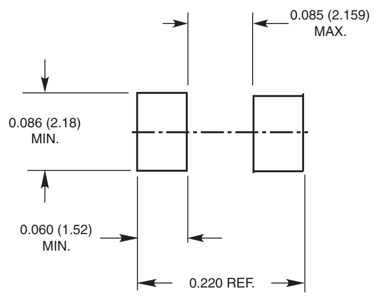
Figure 6. Maximum Non-Repetitive Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

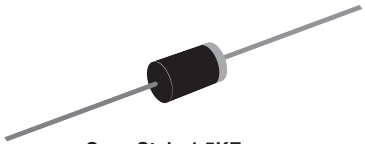
DO-214AA (SMB)



Mounting Pad Layout



TRANSZORB® Transient Voltage Suppressors



Case Style 1.5KE

PRIMARY CHARACTERISTICS	
V_{BR} uni-directional	6.8 V to 540 V
V_{BR} bi-directional	6.8 V to 440 V
P_{PPM}	1500 W
P_D	6.5 W
I_{FSM} (uni-directional only)	200 A
T_J max.	175 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional types, use C or CA suffix (e.g. 1.5KE440CA).

Electrical characteristics apply in both directions.

FEATURES

- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 1500 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder Dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: Molded epoxy body over passivated junction

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the color band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1) (Fig. 1)	P_{PPM}	1500	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 5)	P_D	6.5	W
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	200	A
Maximum instantaneous forward voltage at 100 A for uni-directional only (3)	V_F	3.5/5.0	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

(3) V_F = 3.5 V for 1.5KE220 (A) and below; V_F = 5.0 V for 1.5KE250(A) and above

Document Number: 88301
Revision: 20-Sep-07

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

JEDEC TYPE NUMBER	GENERAL SEMICONDUCTOR PART NUMBER	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (4) (μA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMP. COEFFICIENT OF V_{BR} (%/°C)
		MIN	MAX						
1N6267	(+)1.5KE6.8	6.12	7.48	10	5.50	1000	139	10.8	0.057
1N6267A	(+)1.5KE6.8A	6.45	7.14	10	5.80	1000	143	10.5	0.057
1N6268	(+)1.5KE7.5	6.75	8.25	10	6.05	500	128	11.7	0.061
1N6268A	(+)1.5KE7.5A	7.13	7.88	10	6.40	500	133	11.3	0.061
1N6269	(+)1.5KE8.2	7.38	9.02	10	6.63	200	120	12.5	0.065
1N6269A	(+)1.5KE8.2A	7.79	8.61	10	7.02	200	124	12.1	0.065
1N6270	(+)1.5KE9.1	8.19	10.0	1.0	7.37	50	109	13.8	0.068
1N6270A	(+)1.5KE9.1A	8.65	9.55	1.0	7.78	50	112	13.4	0.068
1N6271	(+)1.5KE10	9.00	11.0	1.0	8.10	10	100	15.0	0.073
1N6271A	(+)1.5KE10A	9.50	10.5	1.0	8.55	10	103	14.5	0.073
1N6272	(+)1.5KE11	9.90	12.1	1.0	8.92	5.0	92.6	16.2	0.075
1N6272A	(+)1.5KE11A	10.5	11.6	1.0	9.40	5.0	96.2	15.6	0.075
1N6273	(+)1.5KE12	10.8	13.2	1.0	9.72	5.0	86.7	17.3	0.076
1N6273A	(+)1.5KE12A	11.4	12.6	1.0	10.2	5.0	89.8	16.7	0.078
1N6274	(+)1.5KE13	11.7	14.3	1.0	10.5	5.0	78.9	19.0	0.081
1N6274A	(+)1.5KE13A	12.4	13.7	1.0	11.1	5.0	82.4	18.2	0.081
1N6275	(+)1.5KE15	13.5	16.5	1.0	12.1	1.0	68.2	22.0	0.084
1N6275A	(+)1.5KE15A	14.3	15.8	1.0	12.8	1.0	70.8	21.2	0.084
1N6276	(+)1.5KE16	14.4	17.6	1.0	12.9	1.0	63.8	23.5	0.086
1N6276A	(+)1.5KE16A	15.2	16.8	1.0	13.6	1.0	66.7	22.5	0.086
1N6277	(+)1.5KE18	16.2	19.8	1.0	14.5	1.0	56.6	26.5	0.088
1N6277A	(+)1.5KE18A	17.1	18.9	1.0	15.3	1.0	59.5	25.2	0.089
1N6278	(+)1.5KE20	18.0	22.0	1.0	16.2	1.0	51.5	29.1	0.090
1N6278A	(+)1.5KE20A	19.0	21.0	1.0	17.1	1.0	54.2	27.7	0.090
1N6279	(+)1.5KE22	19.8	24.2	1.0	17.8	1.0	47.0	31.9	0.092
1N6279A	(+)1.5KE22A	20.9	23.1	1.0	18.8	1.0	49.0	30.6	0.092
1N6280	(+)1.5KE24	21.6	26.4	1.0	19.4	1.0	43.2	34.7	0.094
1N6280A	(+)1.5KE24A	22.8	25.2	1.0	20.5	1.0	45.2	33.2	0.094
1N6281	(+)1.5KE27	24.3	29.7	1.0	21.8	1.0	38.4	39.1	0.096
1N6281A	(+)1.5KE27A	25.7	28.4	1.0	23.1	1.0	40.0	37.5	0.096
1N6282	(+)1.5KE30	27.0	33.0	1.0	24.3	1.0	34.5	43.5	0.097
1N6282A	(+)1.5KE30A	28.5	31.5	1.0	25.6	1.0	36.2	41.4	0.097
1N6283	(+)1.5KE33	29.7	36.3	1.0	26.8	1.0	31.4	47.7	0.098
1N6283A	(+)1.5KE33A	31.4	34.7	1.0	28.2	1.0	32.8	45.7	0.098
1N6284	(+)1.5KE36	32.4	39.6	1.0	29.1	1.0	28.8	52.0	0.099
1N6284A	(+)1.5KE36A	34.2	37.8	1.0	30.8	1.0	30.1	49.9	0.099
1N6285	(+)1.5KE39	35.1	42.9	1.0	31.6	1.0	26.6	56.4	0.100
1N6285A	(+)1.5KE39A	37.1	41.0	1.0	33.3	1.0	27.8	53.9	0.100
1N6286	(+)1.5KE43	38.7	47.3	1.0	34.8	1.0	24.2	61.9	0.101
1N6286A	(+)1.5KE43A	40.9	45.2	1.0	36.8	1.0	25.3	59.3	0.101
1N6287	(+)1.5KE47	42.3	51.7	1.0	38.1	1.0	22.1	67.8	0.101
1N6287A	(+)1.5KE47A	44.7	49.4	1.0	40.2	1.0	23.1	64.8	0.101
1N6288	(+)1.5KE51	45.9	56.1	1.0	41.3	1.0	20.4	73.5	0.102
1N6288A	(+)1.5KE51A	48.5	53.6	1.0	43.6	1.0	21.4	70.1	0.102
1N6289	(+)1.5KE56	50.4	61.8	1.0	45.4	1.0	18.6	80.5	0.103
1N6289A	(+)1.5KE56A	53.2	58.8	1.0	47.8	1.0	19.5	77.0	0.103
1N6290	(+)1.5KE62	55.8	68.2	1.0	50.2	1.0	16.9	89.0	0.104
1N6290A	(+)1.5KE62A	58.9	65.1	1.0	53.0	1.0	17.6	85.0	0.104
1N6291	(+)1.5KE68	61.2	74.8	1.0	55.1	1.0	15.3	98.0	0.104
1N6291A	(+)1.5KE68A	64.6	71.4	1.0	58.1	1.0	16.3	92.0	0.104
1N6292	(+)1.5KE75	67.5	82.5	1.0	60.7	1.0	13.9	109	0.105
1N6292A	(+)1.5KE75A	71.3	78.8	1.0	64.1	1.0	14.6	104	0.105

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

JEDEC TYPE NUMBER	GENERAL SEMICONDUCTOR PART NUMBER	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (4) (µA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMP. COEFFICIENT OF V_{BR} (%/°C)
		MIN	MAX						
1N6293	(+)1.5KE82	73.8	90.2	1.0	66.4	1.0	12.7	118	0.105
1N6293A	(+)1.5KE82A	77.9	86.1	1.0	70.1	1.0	13.3	113	0.105
1N6294	(+)1.5KE91	81.9	100.0	1.0	73.7	1.0	11.5	131	0.106
1N6294A	(+)1.5KE91A	86.5	95.5	1.0	77.8	1.0	12.0	125	0.106
1N6295	(+)1.5KE100	90.0	110	1.0	81.0	1.0	10.4	144	0.106
1N6295A	(+)1.5KE100A	95.0	105	1.0	85.5	1.0	10.9	137	0.106
1N6296	(+)1.5KE110	99.0	121	1.0	89.2	1.0	9.5	158	0.107
1N6296A	(+)1.5KE 110A	105	116	1.0	94.0	1.0	9.9	152	0.107
1N6297	(+)1.5KE120	108	132	1.0	97.2	1.0	8.7	173	0.107
1N6297A	(+)1.5KE120A	114	126	1.0	102	1.0	9.1	165	0.107
1N6298	(+)1.5KE130	117	143	1.0	105	1.0	8.0	187	0.107
1N6298A	(+)1.5KE130A	124	137	1.0	111	1.0	8.4	179	0.107
1N6299	(+)1.5KE150	136	165	1.0	121	1.0	7.0	215	0.108
1N6299A	(+)1.5KE150A	143	158	1.0	128	1.0	7.2	207	0.106
1N6300	(+)1.5KE160	144	176	1.0	130	1.0	6.5	230	0.106
1N6300A	(+)1.5KE160A	152	168	1.0	136	1.0	6.8	219	0.108
1N6301	(+)1.5KE170	153	187	1.0	138	1.0	6.1	244	0.108
1N6301A	(+)1.5KE170A	162	179	1.0	145	1.0	6.4	234	0.108
1N6302	1.5KE180	162	198	1.0	146	1.0	5.8	258	0.108
1N6302A	1.5KE180A	171	189	1.0	154	1.0	6.1	246	0.108
1N6303	1.5KE200	180	220	1.0	162	1.0	5.2	287	0.108
1N6303A	1.5KE200A*	190	210	1.0	171	1.0	5.5	274	0.108
	1.5KE220	198	242	1.0	175	1.0	4.4	344	0.108
	1.5KE220A*	209	231	1.0	185	1.0	4.6	328	0.108
	1.5KE250	225	275	1.0	202	1.0	4.2	360	0.110
	1.5KE250A	237	263	1.0	214	1.0	4.4	344	0.110
	1.5KE300	270	330	1.0	243	1.0	3.5	430	0.110
	1.5KE300A	285	315	1.0	256	1.0	3.6	414	0.110
	1.5KE350	315	385	1.0	284	1.0	3.0	504	0.110
	1.5KE350A	333	368	1.0	300	1.0	3.1	482	0.110
	1.5KE400	360	440	1.0	324	1.0	2.6	574	0.110
	1.5KE400A	380	420	1.0	342	1.0	2.7	548	0.110
	1.5KE440	396	484	1.0	356	1.0	2.4	631	0.110
	1.5KE440A	418	462	1.0	376	1.0	2.5	602	0.110
	1.5KE480	432	528	1.0	389	1.0	2.19	686	0.110
	1.5KE480A	456	504	1.0	408	1.0	2.28	658	0.110
	1.5KE510	459	561	1.0	413	1.0	2.06	729	0.110
	1.5KE510A	485	535	1.0	434	1.0	2.15	698	0.110
	1.5KE540	486	594	1.0	437	1.0	1.94	772	0.110
	1.5KE540A	513	567	1.0	459	1.0	2.03	740	0.110

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE CA62.35

(4) For bi-directional types with V_R 10 V and less the I_D limit is doubled

* Bi-directional versions are UL approved under component across the line protection, ULV1414 file number E108274 (1.5KE200CA, 1.5KE220CA)

(+) Underwriters laboratory recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B and file number E136766 for both uni-directional and bi-directional devices

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to ambient	$R_{\theta JA}$	75	°C/W
Typical thermal resistance, junction to lead	$R_{\theta JL}$	15.4	

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
1.5KE6.8A-E3/54	0.968	54	1400	13" diameter paper tape and reel
1.5KE6.8AHE3/54 (1)	0.968	54	1400	13" diameter paper tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

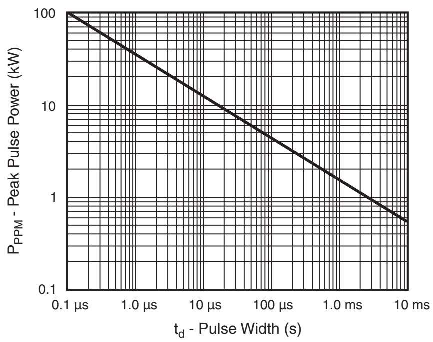


Figure 1. Peak Pulse Power Rating Curve

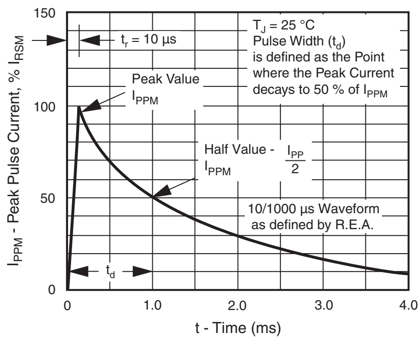


Figure 3. Pulse Waveform

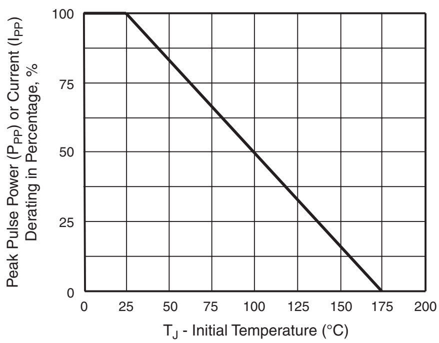


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

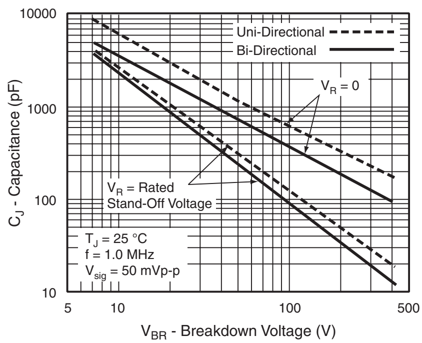


Figure 4. Typical Junction Capacitance

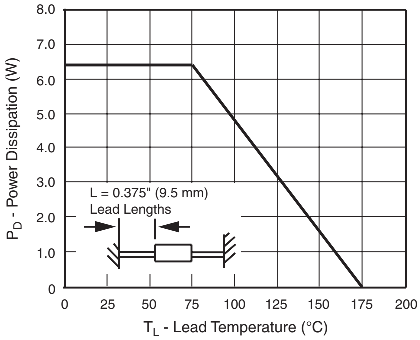


Figure 5. Power Derating Curve

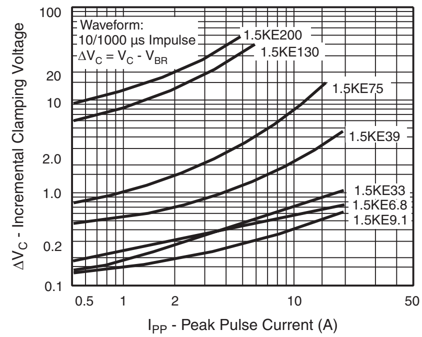


Figure 8. Incremental Clamping Voltage Curve (Uni-Directional)

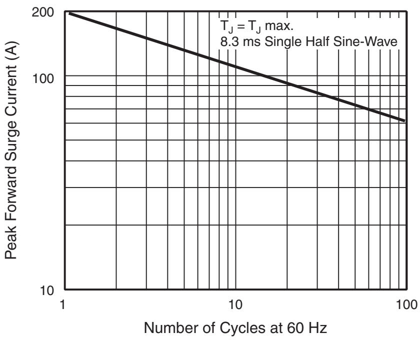


Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional only

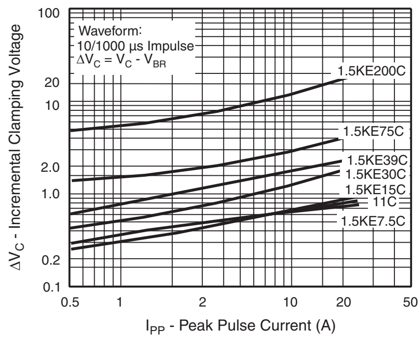


Figure 9. Incremental Clamping Voltage Curve (Bi-directional)

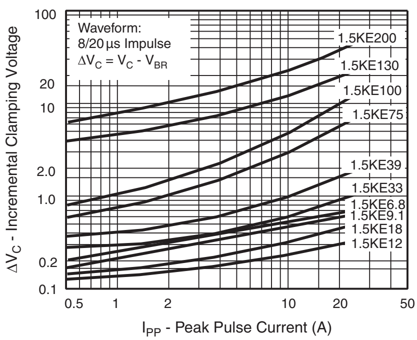


Figure 7. Incremental Clamping Voltage Curve (Uni-Directional)

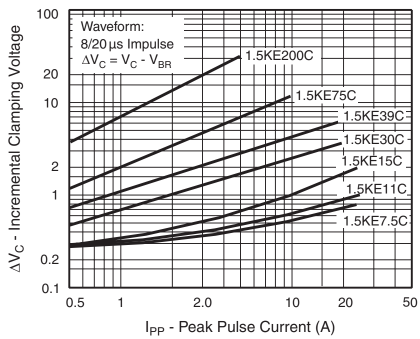


Figure 10. Incremental Clamping Voltage Curve (Bi-Directional)

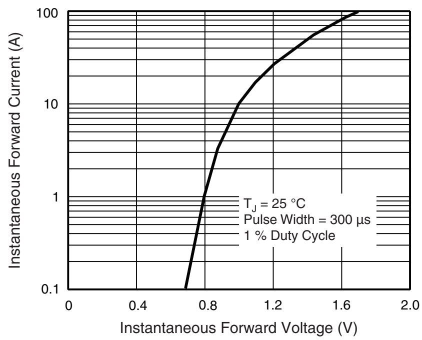


Figure 11. Instantaneous Forward Voltage Characteristics Curve

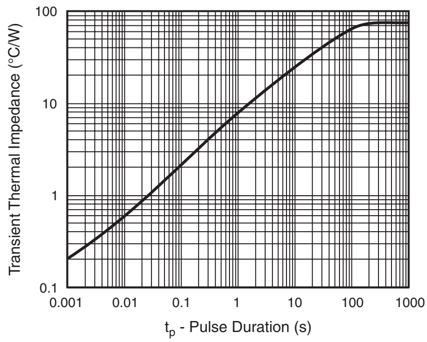
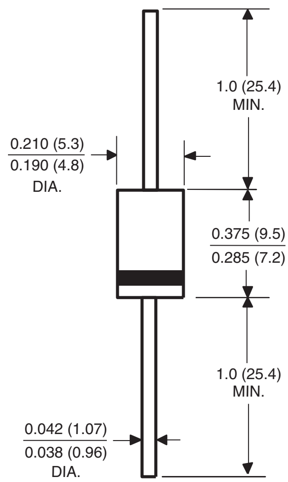


Figure 12. Typical Transient Thermal Impedance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

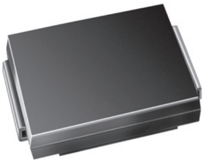
Case Style 1.5KE



APPLICATION NOTES

- This series of Silicon Transient Suppressors is used in applications where large voltage transients can permanently damage voltage-sensitive components.
- The TVS diode can be used in applications where induced lightning on rural or remote transmission lines presents a hazard to electronic circuitry (ref: R.E.A. specification P.E. 60).
- This Transient Voltage Suppressor diode has a pulse power rating of 1500 W for 1 ms. The response time of TVS diode clamping action is effectively instantaneous (1 x 10^{-9} s bi-directional); therefore, they can protect integrated circuits, MOS devices, hybrids, and other voltage sensitive semiconductors and components. TVS diodes can also be used in series or parallel to increase the peak power ratings.

Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-214AB (SMC)

PRIMARY CHARACTERISTICS	
V_{BR} uni-directional	6.8 V to 540 V
V_{BR} bi-directional	6.8 V to 220 V
P_{PPM}	1500 W
P_D	6.5 W
I_{FSM} (uni-directional only)	200 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use CA suffix (e.g. 1.5SMC220CA).

Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 1500 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AB (SMC)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	1500	W
Peak pulse current with a 10/1000 µs waveform (1) (Fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink T_A = 50 °C	P_D	6.5	W
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	200	A
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.31 x 0.31" (8.0 x 8.0 mm) copper pads to each terminal

Document Number: 88303
Revision: 08-May-07

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

GENERAL SEMICONDUCTOR PART NUMBER	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (4) (μA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMP. COEFFICIENT OF V_{BR} (%/°C)
	UNI	BI	MIN	MAX						
1.5SMC6.8A	6V8A	6V8C	6.45	7.14	10	5.80	1000	143	10.5	0.057
1.5SMC7.5A	7V5A	7V5C	7.13	7.88	10	6.40	500	133	11.3	0.061
1.5SMC8.2A	8V2A	8V2C	7.79	8.61	10	7.02	200	124	12.1	0.065
1.5SMC9.1A	9V1A	9V1C	8.65	9.55	1.0	7.78	50	112	13.4	0.068
1.5SMC10A	10A	10C	9.50	10.5	1.0	8.55	10	103	14.5	0.073
1.5SMC11A	11A	11C	10.5	11.6	1.0	9.40	5.0	96.2	15.6	0.075
1.5SMC12A	12A	12C	11.4	12.6	1.0	10.2	5.0	89.8	16.7	0.078
1.5SMC13A	13A	13C	12.4	13.7	1.0	11.1	5.0	82.4	18.2	0.081
1.5SMC15A	15A	15C	14.3	15.8	1.0	12.8	1.0	70.8	21.2	0.084
1.5SMC16A	16A	16C	15.2	16.8	1.0	13.6	1.0	66.7	22.5	0.086
1.5SMC18A	18A	18C	17.1	18.9	1.0	15.3	1.0	59.5	25.2	0.089
1.5SMC20A	20A	20C	19.0	21.0	1.0	17.1	1.0	54.2	27.7	0.090
1.5SMC22A	22A	22C	20.9	23.1	1.0	18.8	1.0	49.0	30.6	0.092
1.5SMC24A	24A	24C	22.8	25.2	1.0	20.5	1.0	45.2	33.2	0.09
1.5SMC27A	27A	27C	25.7	28.4	1.0	23.1	1.0	40.0	37.5	0.096
1.5SMC30A	30A	30C	28.5	31.5	1.0	25.6	1.0	36.2	41.4	0.097
1.5SMC33A	33A	33C	31.4	34.7	1.0	28.2	1.0	32.8	45.7	0.098
1.5SMC36A	36A	36C	34.2	37.8	1.0	30.8	1.0	30.1	49.9	0.099
1.5SMC39A	39A	39C	37.1	41.0	1.0	33.3	1.0	27.8	53.9	0.100
1.5SMC43A	43A	43C	40.9	45.2	1.0	36.8	1.0	25.3	59.3	0.101
1.5SMC47A	47A	47C	44.7	49.4	1.0	40.2	1.0	23.1	64.8	0.101
1.5SMC51A	51A	51C	48.5	53.6	1.0	43.6	1.0	21.4	70.1	0.102
1.5SMC56A	56A	56C	53.2	58.8	1.0	47.8	1.0	19.5	77.0	0.103
1.5SMC62A	62A	62C	58.9	65.1	1.0	53.0	1.0	17.6	85.0	0.104
1.5SMC68A	68A	68C	64.6	71.4	1.0	58.1	1.0	16.3	92.0	0.104
1.5SMC75A	75A	75C	71.3	78.8	1.0	64.1	1.0	14.6	104	0.105
1.5SMC82A	82A	82C	77.9	86.1	1.0	70.1	1.0	13.3	113	0.105
1.5SMC91A	91A	91C	86.5	95.5	1.0	77.8	1.0	12.0	125	0.106
1.5SMC100A	100A	100C	95.0	105	1.0	85.5	1.0	10.9	137	0.106
1.5SMC110A	110A	110C	105	116	1.0	94.0	1.0	9.9	152	0.107
1.5SMC120A	120A	120C	114	126	1.0	102	1.0	9.1	165	0.107
1.5SMC130A	130A	130C	124	137	1.0	111	1.0	8.4	179	0.107
1.5SMC150A	150A	150C	143	158	1.0	128	1.0	7.2	207	0.106
1.5SMC160A	160A	160C	152	168	1.0	136	1.0	6.8	219	0.108
1.5SMC170A	170A	170C	162	179	1.0	145	1.0	6.4	234	0.108
1.5SMC180A	180A	180C	171	189	1.0	154	1.0	6.1	246	0.108
1.5SMC200A	200A	200C	190	210	1.0	171	1.0	5.5	274	0.108
1.5SMC220A	220A	220C	209	231	1.0	185	1.0	4.6	328	0.108
1.5SMC250A	250A	-	237	263	1.0	214	1.0	4.4	344	0.110
1.5SMC300A	300A	-	285	315	1.0	256	1.0	3.6	414	0.110
1.5SMC350A	350A	-	333	368	1.0	300	1.0	3.1	482	0.110
1.5SMC400A	400A	-	380	420	1.0	342	1.0	2.7	548	0.110
1.5SMC440A	440A	-	418	462	1.0	376	1.0	2.5	602	0.110
1.5SMC480A	480A	-	456	504	1.0	408	1.0	2.28	658	0.110
1.5SMC510A	510A	-	485	535	1.0	434	1.0	2.15	698	0.110
1.5SMC540A	540A	-	513	567	1.0	459	1.0	2.03	740	0.110

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE CA62.35

(4) For bi-directional types with V_R 10 V and less, the I_D limit is doubled

(5) V_F = 3.5 V at I_F = 100 A (uni-directional only)

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Thermal resistance, junction to ambient air (1)	$R_{\theta JA}$	75	°C/W
Thermal resistance, junction to leads	$R_{\theta JL}$	15	°C/W

Note:
(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
1.5SMC6.8A-E3/57T	0.211	57T	850	7" diameter plastic tape and reel
1.5SMC6.8A-E3/9AT	0.211	9AT	3500	13" diameter plastic tape and reel
1.5SMC6.8AHE3/57T (1)	0.211	57T	850	7" diameter plastic tape and reel
1.5SMC6.8AHE3/9AT (1)	0.211	9AT	3500	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

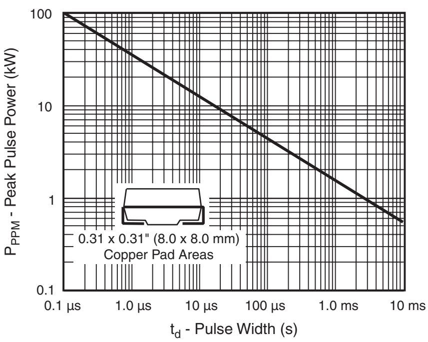


Figure 1. Peak Pulse Power Rating Curve

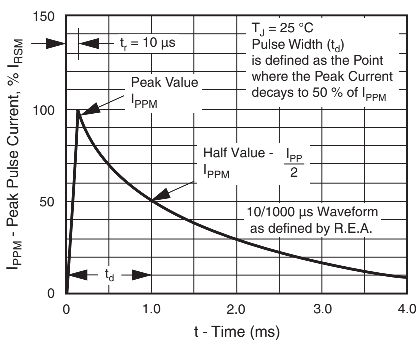


Figure 3. Pulse Waveform

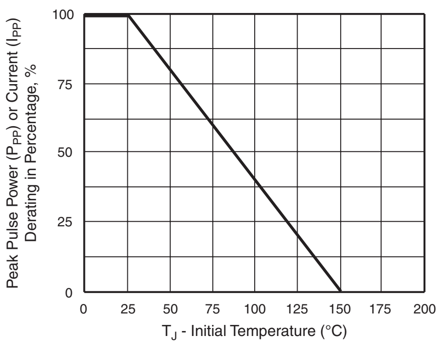


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

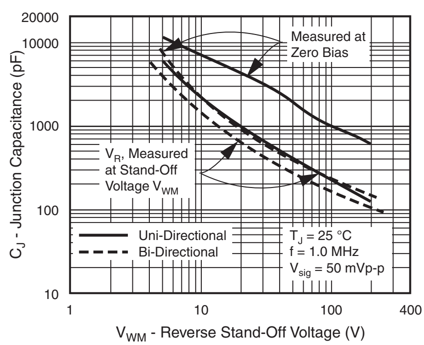


Figure 4. Typical Junction Capacitance Uni-Directional

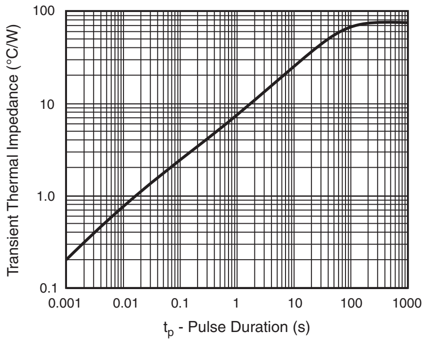


Figure 5. Typical Transient Thermal Impedance

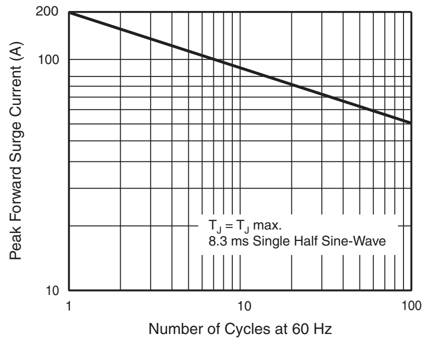
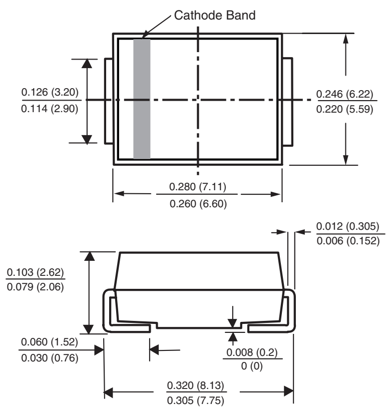


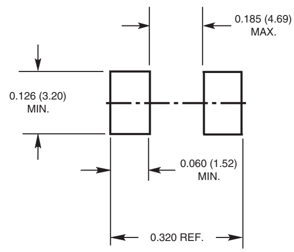
Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Use Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

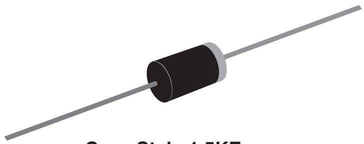
DO-214AB (SMC)



Mounting Pad Layout



TRANSZORB® Transient Voltage Suppressors



Case Style 1.5KE

FEATURES

- Glass passivated chip junction
- Available in uni-directional and bi-directional
- 1500 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 18 V
P_{PPM}	1500 W
P_D	6.5 W
I_{FSM}	200 A
T_J max.	175 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: Molded epoxy body over passivated junction

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the color band denotes cathode end, no marking on bi-directional types

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional types, use C suffix (e.g. ICTE-18C). Electrical characteristics apply in both directions.

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1) (Fig. 1)	P_{PPM}	1500	W
Peak pulse current with a 10/1000 µs waveform (1) (Fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 8)	P_D	6.5	W
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	200	A
Maximum instantaneous forward voltage at 100 A for uni-directional only	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) 8.3 ms single half sine-wave, duty cycle = 4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS (JEDEC REGISTERED DATA) (T_A = 25 °C unless otherwise noted)

JEDEC TYPE NUMBER	GENERAL SEMICONDUCTOR PART NUMBER	STAND-OFF VOLTAGE V_{WM} (V)	MINIMUM (3) BREAKDOWN VOLTAGE AT 1.0 mA V_{BR} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM CLAMPING VOLTAGE AT I_{PP} = 1.0 A V_C (V)	MAXIMUM CLAMPING VOLTAGE AT I_{PP} = 10 A V_C (V)	MAXIMUM PEAK PULSE CURRENT I_{PP} (A)
UNI-DIRECTIONAL TYPES							
1N6373 (2)	ICTE-5 (2)	5.0	6.0	300	7.1	7.5	160
1N6374	ICTE-8	8.0	9.4	25.0	11.3	11.5	100
1N6375	ICTE-10	10.0	11.7	2.0	13.7	14.1	90
1N6376	ICTE-12	12.0	14.1	2.0	16.1	16.5	70
1N6377	ICTE-15	15.0	17.6	2.0	20.1	20.6	60
1N6378	ICTE-18	18.0	21.2	2.0	24.2	25.2	50
BI-DIRECTIONAL TYPES							
1N6382	ICTE-8C	8.0	9.4	50.0	11.4	11.6	100
1N6383	ICTE-10C	10.0	11.7	2.0	14.1	14.5	90
1N6384	ICTE-12C	12.0	14.1	2.0	16.7	17.1	70
1N6385	ICTE-15C	15.0	17.6	2.0	20.8	21.4	60
1N6386	ICTE-18C	18.0	21.2	2.0	24.8	25.5	50

Notes:

(1) "C" Suffix indicates bi-directional

(2) ICTE-5 and 1N6373 are not available as bi-directional

(3) The minimum breakdown voltage as shown takes into consideration the ± 1 V tolerance normally specified for power supply regulation on most integrated circuit manufacturers data sheets. Please consult factory for devices that require reduced clamping voltages where tighter regulated power supply voltages are employed

(4) Clamping factor: 1.33 at full rated power; 1.20 at 50 % rated power; Clamping factor: the ratio of the actual V_C (Clamping Voltage) to the V_{BR} (Breakdown Voltage) as measured on a specific device

ORDERING INFORMATION (Example)

PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
ICTE-5-E3/54	0.968	54	1400	13" diameter paper tape and reel
ICTE-5HE3/54 (1)	0.968	54	1400	13" diameter paper tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

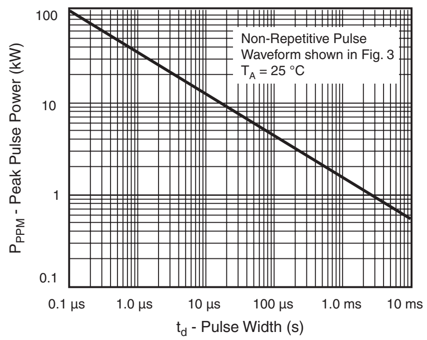


Figure 1. Peak Pulse Power Rating Curve

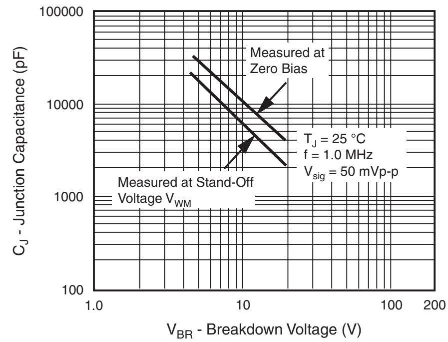


Figure 4. Typical Junction Capacitance Uni-Directional

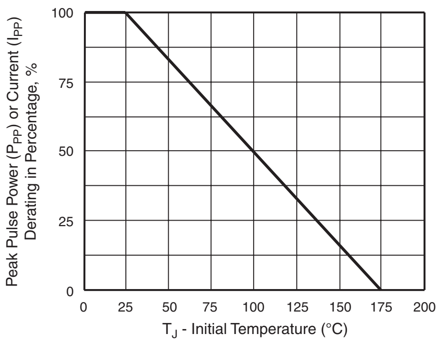


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

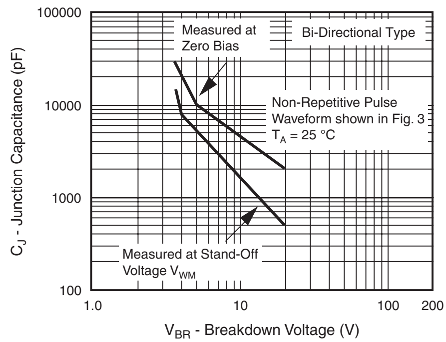


Figure 5. Typical Junction Capacitance

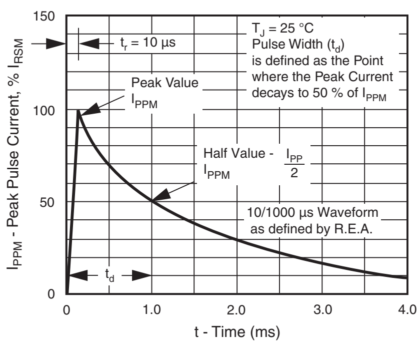


Figure 3. Pulse Waveform

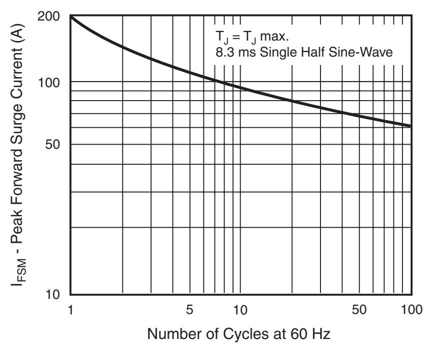


Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Only

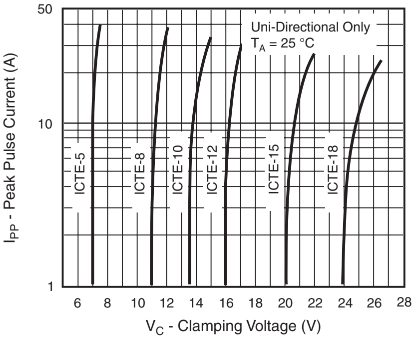


Figure 7. Typical Characteristics Clamping Voltage

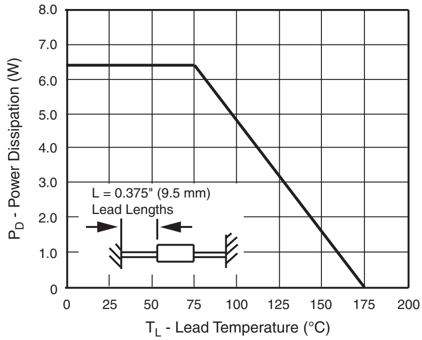
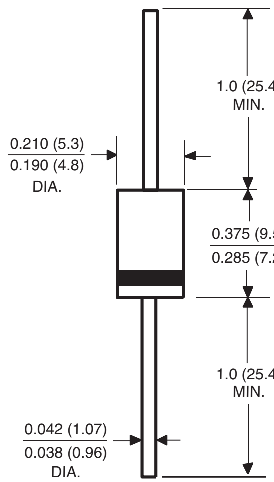


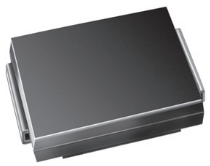
Figure 8. Power Derating Curve

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

Case Style 1.5KE



Surface Mount TRANSZORB® Transient Voltage Suppressors



DO-214AB (SMC)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 220 V
P_{PPM}	1500 W
P_D	6.5 W
I_{FSM} (uni-directional only)	200 A
T_J max.	150 °C

MECHANICAL DATA

Case: DO-214AB (SMC)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use CA suffix (e.g. SM15T12CA).
Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- 1500 W peak pulse power capability with a 10/1000 µs waveform
- Available in uni-directional and bi-directional
- Excellent clamping capability
- Low inductance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

APPLICATION NOTES

A 1500 W (SMC) device is normally selected when the threat of transients is from lightning induced transients, conducted via external leads or I/O lines. It is also used to protect against switching transients induced by large coils or industrial motors. Source impedance at component level in a system is usually high enough to limit the current within the peak pulse current (I_{PP}) rating of this series. In an overstress condition, the failure mode is a short circuit.

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (Fig. 1)	P_{PPM}	1500	W
Peak power pulse current with a 10/1000 µs waveform (1) (Fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink T_A = 50 °C	P_D	6.5	W
Peak forward surge current 10 ms single half sine-wave uni-directional only (2)	I_{FSM}	200	A
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.31 x 0.31" (8.0 x 8.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)												
TYPE (1)	**DEVICE MARKING CODE**		**STAND-OFF VOLTAGE V_{RM} (V)**	**LEAKAGE CURRENT** (3) **I_{RM} AT V_R**	**BREAKDOWN VOLTAGE V_{BR} AT I_T** (2) **(V)**		**TEST CURRENT I_T (mA)**	**CLAMPING VOLTAGE V_C AT I_{PP} (10/1000 µs)**		**CLAMPING VOLTAGE V_C AT I_{PP} (8/20 µs)**		**α_T Max 10^{-4}/°C**
	UNI	**BI**			**MIN**	**MAX**		**(V)**	**(A)**	**(V)**	**(A)**	
SM15T6V8A	GDE7	GDE7	5.80	1000	6.45	7.14	10	10.5	143	13.4	746	5.7
SM15T7V5A	GDK7	BDK7	6.40	500	7.13	7.88	10	11.3	132	14.5	690	6.1
SM15T10A	GDT7	BDT7	8.55	10.0	9.50	10.5	1.0	14.5	103	18.6	538	7.3
SM15T12A	GDX7	BDX7	10.2	5.0	11.4	12.6	1.0	16.7	90.0	21.7	461	7.8
SM15T15A	GEG7	GEG7	12.8	1.0	14.3	15.8	1.0	21.2	71.0	27.2	368	8.4
SM15T18A	GEM7	BEM7	15.3	1.0	17.1	18.9	1.0	25.2	59.5	32.5	308	8.8
SM15T22A	GET7	BET7	18.8	1.0	20.9	23.1	1.0	30.6	49.0	39.3	254	9.2
SM15T24A	GEV7	GEV7	20.5	1.0	22.8	25.2	1.0	33.2	45.0	42.8	234	9.4
SM15T27A	GEX7	BEX7	23.1	1.0	25.7	28.4	1.0	37.5	40.0	48.3	207	9.6
SM15T30A	GFE7	BFE7	25.6	1.0	28.5	31.5	1.0	41.5	36.0	53.5	187	9.7
SM15T33A	GFG7	GFG7	28.2	1.0	31.4	34.7	1.0	45.7	33.0	59.0	169	9.8
SM15T36A	GFK7	BFK7	30.8	1.0	34.2	37.8	1.0	49.9	30.0	64.3	156	9.9
SM15T39A	GFM7	BFM7	33.3	1.0	37.1	41.0	1.0	53.9	28.0	69.7	143	10.0
SM15T68A	GGG7	GGG7	58.1	1.0	64.6	71.4	1.0	92.0	16.3	121	83	10.4
SM15T100A	GGV7	GGV7	85.5	1.0	95.0	105	1.0	137	11.0	178	56	10.6
SM15T150A	GHK7	GHK7	128	1.0	143	158	1.0	207	7.20	265	38	10.8
SM15T200A	GHR7	GHR7	171	1.0	190	210	1.0	274	5.50	353	28	10.8
SM15T220A	GHR8	GHR8	188	1.0	209	231	1.0	328	4.60	388	26	10.8

Notes:

(1) For bi-directional devices add suffix "CA" instead of "A"

(2) V_{BR} measured after I_T applied for 300 µs square wave pulse

(3) For bipolar devices with V_R = 10 V or under, the I_T limit is doubled

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to ambient air (1)	$R_{\theta JA}$	75	°C/W
Typical thermal resistance, junction to leads	$R_{\theta JL}$	15	°C/W

Note:

(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SM15T10A-E3/57T	0.211	57T	850	7" diameter plastic tape and reel
SM15T10A-E3/9AT	0.211	9AT	3500	13" diameter plastic tape and reel
SM15T10AHE3/57T (1)	0.211	57T	850	7" diameter plastic tape and reel
SM15T10AHE3/9AT (1)	0.211	9AT	3500	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

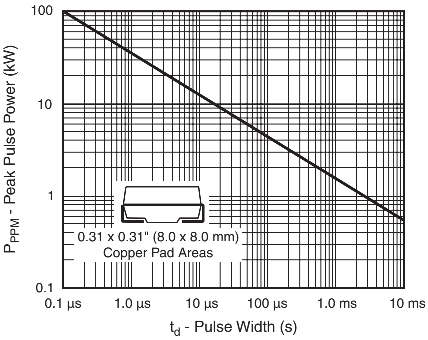


Figure 1. Peak Pulse Power Rating Curve

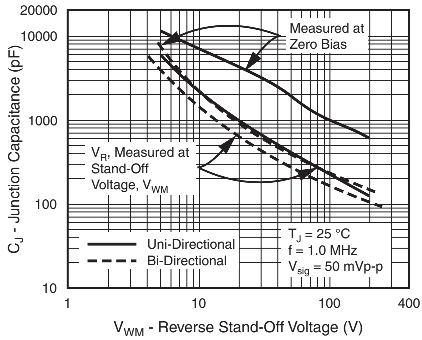


Figure 4. Typical Junction Capacitance Uni-Directional

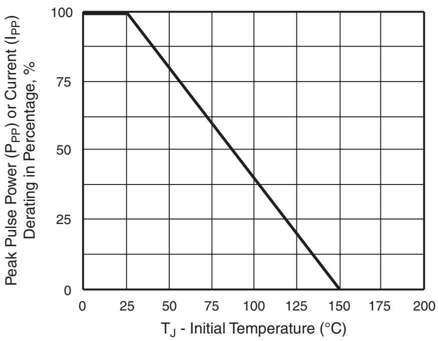


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

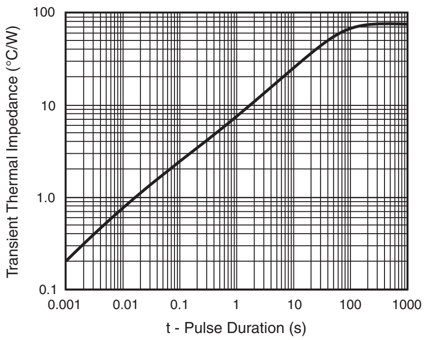


Figure 5. Typical Transient Thermal Impedance

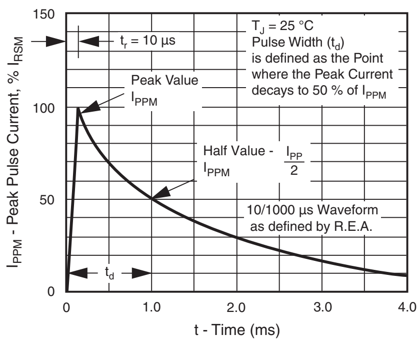


Figure 3. Pulse Waveform

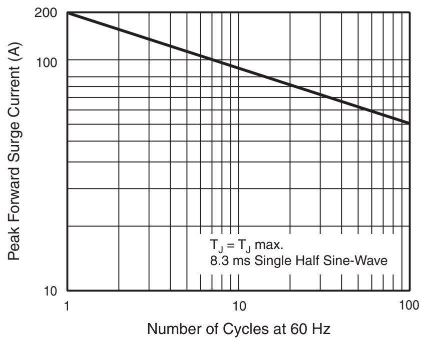
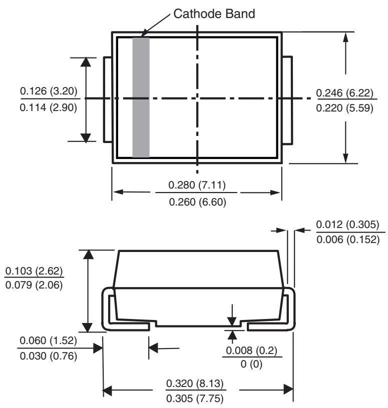


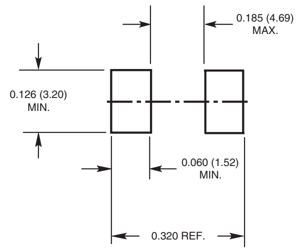
Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Use Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-214AB (SMC)



Mounting Pad Layout



Surface Mount TRANSZORB® Transient Voltage Suppressors

DO-215AB (SMCG)

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 188 V
P_{PPM}	1500 W
P_D	6.5 W
I_{FSM}	200 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use C or CA suffix (e.g. SMCG188CA).

Electrical characteristics apply in both directions.

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-215AB (SMCG)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2)	P_{PPM}	1500	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	200	A
Power dissipation on infinite heatsink, T_A = 50 °C	P_D	6.5	W
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.31 x 0.31" (8.0 x 8.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE MODIFIED GULL WING	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
(+)SMCG5.0	GDD	GDD	6.40	7.82	10.0	5.0	1000	156.3	9.6
(+)SMCG5.0A(5)	GDE	GDE	6.40	7.07	10.0	5.0	1000	163.0	9.2
(+)SMCG6.0	GDF	GDF	6.67	8.15	10.0	6.0	1000	131.6	11.4
(+)SMCG6.0A	GDG	GDG	6.67	7.37	10.0	6.0	1000	145.6	10.3
(+)SMCG6.5	GDH	BDH	7.22	8.82	10.0	6.5	500	122.0	12.3
(+)SMCG6.5A	GDK	BDK	7.22	7.98	10.0	6.5	500	133.9	11.2
(+)SMCG7.0	GDL	GDL	7.78	9.51	10.0	7.0	200	112.8	13.3
(+)SMCG7.0A	GDM	GDM	7.78	8.60	10.0	7.0	200	125.0	12.0
(+)SMCG7.5	GDN	BDN	8.33	10.2	1.0	7.5	100	104.9	14.3
(+)SMCG7.5A	GDP	BDP	8.33	9.21	1.0	7.5	100	116.3	12.9
(+)SMCG8.0	GDQ	BDG	8.89	10.9	1.0	8.0	50	100.0	15.0
(+)SMCG8.0A	GDR	BDR	8.89	9.83	1.0	8.0	50	110.3	13.6
(+)SMCG8.5	GDS	BDS	9.44	11.5	1.0	8.5	20	94.3	15.9
(+)SMCG8.5A	GDT	BDT	9.44	10.4	1.0	8.5	20	104.2	14.4
(+)SMCG9.0	GDU	BDU	10.0	12.2	1.0	9.0	10	88.8	16.9
(+)SMCG9.0A	GDV	BDV	10.0	11.1	1.0	9.0	10	97.4	15.4
(+)SMCG10	GDW	BDW	11.1	13.6	1.0	10	5.0	79.8	18.8
(+)SMCG10A	GDX	BDX	11.1	12.3	1.0	10	5.0	88.2	17.0
(+)SMCG11	GDY	GDY	12.2	14.9	1.0	11	5.0	74.6	20.1
(+)SMCG11A	GDZ	GDZ	12.2	13.5	1.0	11	5.0	82.4	18.2
(+)SMCG12	GED	BED	13.3	16.3	1.0	12	5.0	68.2	22.0
(+)SMCG12A	GEE	BEE	13.3	14.7	1.0	12	5.0	75.4	19.9
(+)SMCG13	GEF	GEF	14.4	17.6	1.0	13	1.0	63.0	23.8
(+)SMCG13A	GEG	GEG	14.4	15.9	1.0	13	1.0	69.8	21.5
(+)SMCG14	GEH	BEH	15.6	19.1	1.0	14	1.0	58.1	25.8
(+)SMCG14A	GEK	BEK	15.6	17.2	1.0	14	1.0	64.7	23.2
(+)SMCG15	GEL	BEL	16.7	20.4	1.0	15	1.0	55.8	26.9
(+)SMCG15A	GEM	BEM	16.7	18.5	1.0	15	1.0	61.5	24.4
(+)SMCG16	GEN	GEN	17.8	21.8	1.0	16	1.0	52.1	28.8
(+)SMCG16A	GEP	GEP	17.8	19.7	1.0	16	1.0	57.7	26.0
(+)SMCG17	GEQ	GEQ	18.9	23.1	1.0	17	1.0	49.2	30.5
(+)SMCG17A	GER	GER	18.9	20.9	1.0	17	1.0	54.3	27.6
(+)SMCG18	GES	BES	20.0	24.4	1.0	18	1.0	46.6	32.2
(+)SMCG18A	GET	BET	20.0	22.1	1.0	18	1.0	51.4	29.2
(+)SMCG20	GEU	BEU	22.2	27.1	1.0	20	1.0	41.9	35.8
(+)SMCG20A	GEV	BEV	22.2	24.5	1.0	20	1.0	46.3	32.4
(+)SMCG22	GEW	BEW	24.4	29.8	1.0	22	1.0	38.1	39.4
(+)SMCG22A	GEX	BEX	24.4	26.9	1.0	22	1.0	42.3	35.5
(+)SMCG24	GEY	BEY	26.7	32.6	1.0	24	1.0	34.9	43.0
(+)SMCG24A	GEZ	BEZ	26.7	29.5	1.0	24	1.0	38.6	38.9
(+)SMCG26	GFD	BFD	28.9	35.3	1.0	26	1.0	32.2	46.6
(+)SMCG26A	GFE	BFE	28.9	31.9	1.0	26	1.0	35.6	42.1
(+)SMCG28	GFF	BFF	31.1	38.0	1.0	28	1.0	30.0	50.0
(+)SMCG28A	GFG	BFG	31.1	34.4	1.0	28	1.0	33.0	45.4
(+)SMCG30	GFH	BFH	33.3	40.7	1.0	30	1.0	28.0	53.5
(+)SMCG30A	GFK	BFK	33.3	36.8	1.0	30	1.0	31.0	48.4
(+)SMCG33	GFL	BFL	36.7	44.9	1.0	33	1.0	25.4	59.0
(+)SMCG33A	GFM	BFM	36.7	40.6	1.0	33	1.0	28.1	53.3
(+)SMCG36	GFN	BFN	40.0	48.9	1.0	36	1.0	23.3	64.3
(+)SMCG36A	GFP	BFP	40.0	44.2	1.0	36	1.0	25.8	58.1
(+)SMCG40	GFQ	BFQ	44.4	54.3	1.0	40	1.0	21.0	71.4
(+)SMCG40A	GFR	BFR	44.4	49.1	1.0	40	1.0	23.3	64.5

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE MODIFIED GULL WING	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
(+)SMCG43	GFS	BFS	47.8	58.4	1.0	43	1.0	19.6	76.7
(+)SMCG43A	GFT	BFT	47.8	52.8	1.0	43	1.0	21.6	69.4
(+)SMCG45	GFU	GFU	50.0	61.1	1.0	45	1.0	18.7	80.3
(+)SMCG45A	GFV	GFV	50.0	55.3	1.0	45	1.0	20.6	72.7
(+)SMCG48	GFW	GFW	53.3	65.1	1.0	48	1.0	17.5	85.5
(+)SMCG48A	GFX	GFX	53.3	58.9	1.0	48	1.0	19.4	77.4
(+)SMCG51	GFY	GFY	56.7	69.3	1.0	51	1.0	16.5	91.1
(+)SMCG51A	GFZ	GFZ	56.7	62.7	1.0	51	1.0	18.2	82.4
(+)SMCG54	GGD	GGD	60.0	73.3	1.0	54	1.0	15.6	96.3
(+)SMCG54A	GGE	GGE	60.0	66.3	1.0	54	1.0	17.2	87.1
(+)SMCG58	GGF	GGF	64.4	78.7	1.0	58	1.0	14.6	103
(+)SMCG58A	GGG	GGG	64.4	71.2	1.0	58	1.0	16.0	93
(+)SMCG60	GGH	GGH	66.7	81.5	1.0	60	1.0	14.0	107
(+)SMCG60A	GGK	GGK	66.7	73.7	1.0	60	1.0	15.5	96
(+)SMCG64	GGL	GGL	71.1	86.9	1.0	64	1.0	13.2	114
(+)SMCG64A	GGM	GGM	71.1	78.6	1.0	64	1.0	14.6	103
(+)SMCG70	GGN	GGN	77.8	95.1	1.0	70	1.0	12.0	125
(+)SMCG70A	GGP	GGP	77.8	86.0	1.0	70	1.0	13.3	113
(+)SMCG75	GGQ	GGQ	83.3	102	1.0	75	1.0	11.2	134
(+)SMCG75A	GGR	GGR	83.3	92.1	1.0	75	1.0	12.4	121
(+)SMCG78	GGS	GGS	86.7	106	1.0	78	1.0	10.8	139
(+)SMCG78A	GGT	GGT	86.7	95.8	1.0	78	1.0	11.9	126
(+)SMCG85	GGU	GGU	94.4	115	1.0	85	1.0	9.9	151
(+)SMCG85A	GGV	GGV	94.4	104	1.0	85	1.0	10.9	137
(+)SMCG90	GGW	GGW	100	122	1.0	90	1.0	9.4	160
(+)SMCG90A	GGX	GGX	100	111	1.0	90	1.0	10.3	146
(+)SMCG100	GGY	GGY	111	136	1.0	100	1.0	8.4	179
(+)SMCG100A	GGZ	GGZ	111	123	1.0	100	1.0	9.3	162
(+)SMCG110	GHD	GHD	122	149	1.0	110	1.0	7.7	196
(+)SMCG110A	GHE	GHE	122	135	1.0	110	1.0	8.5	177
(+)SMCG120	GHF	GHF	133	163	1.0	120	1.0	7.0	214
(+)SMCG120A	GHG	GHG	133	147	1.0	120	1.0	7.8	193
(+)SMCG130	GHH	GHH	144	176	1.0	130	1.0	6.5	231
(+)SMCG130A	GHK	GHK	144	159	1.0	130	1.0	7.2	209
(+)SMCG150	GHL	GHL	167	204	1.0	150	1.0	5.6	268
(+)SMCG150A	GHM	GHM	167	185	1.0	150	1.0	6.2	243
(+)SMCG160	GHN	GHN	178	218	1.0	160	1.0	5.2	287
(+)SMCG160A	GHP	GHP	178	197	1.0	160	1.0	5.8	259
(+)SMCG170	GHQ	GHQ	189	231	1.0	170	1.0	4.9	304
(+)SMCG170A	GHR	GHR	189	209	1.0	170	1.0	5.5	275
SMCG188	GHT	GHT	209	255	1.0	188	1.0	4.4	344
SMCG188A	GHS	GHS	209	231	1.0	188	1.0	4.6	328

Notes:

(1) Pulse test: tp ≤ 50 ms

(2) Surge current waveform per Fig. 3 and derated per Fig. 2

(3) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(5) For the bi-directional SMCG5.0CA, the maximum V_{BR} is 7.25 V

(6) V_F = 3.5 V at I_F = 100 A (uni-directional only)

(+) Underwriters laboratory recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B and file number E136766 for both uni-directional and bi-directional devices

Document Number: 88457
Revision: 04-Sep-07

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	75	°C/W
Typical thermal resistance, junction to lead	$R_{\theta JL}$	15	°C/W

Note:
(1) Measured on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMCG5.0A-E3/57T	0.211	57T	850	7" diameter plastic tape and reel
SMCG5.0A-E3/9AT	0.211	9AT	3500	13" diameter plastic tape and reel
SMCG5.0AHE3/57T (1)	0.211	57T	850	7" diameter plastic tape and reel
SMCG5.0AHE3/9AT (1)	0.211	9AT	3500	13" diameter plastic tape and reel

Note:
(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES
(T_A = 25 °C unless otherwise noted)

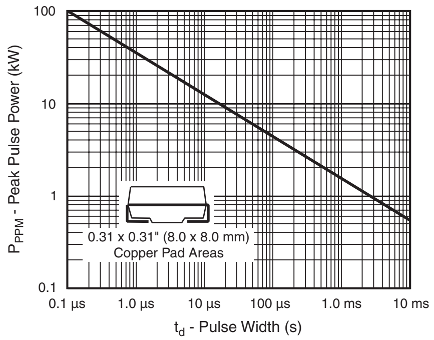


Figure 1. Peak Pulse Power Rating Curve

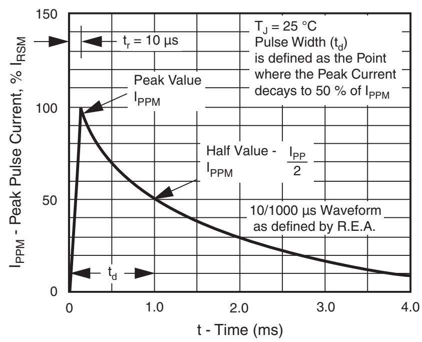


Figure 3. Pulse Waveform

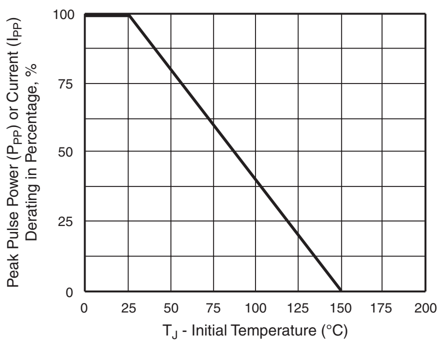


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

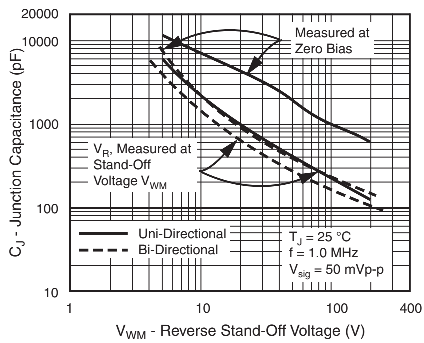


Figure 4. Typical Junction Capacitance Uni-Directional

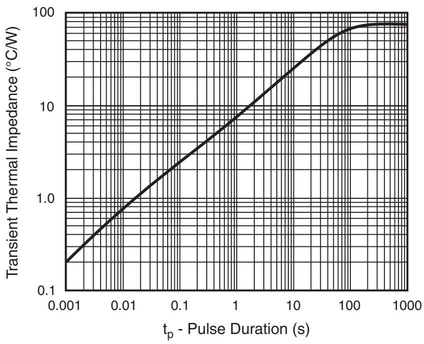


Figure 5. Typical Transient Thermal Impedance

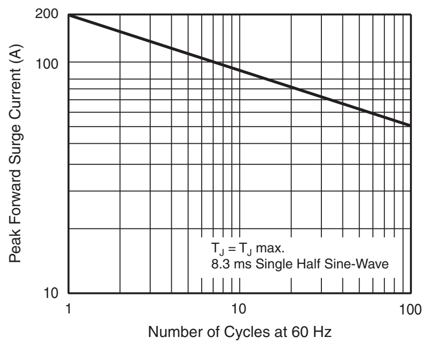
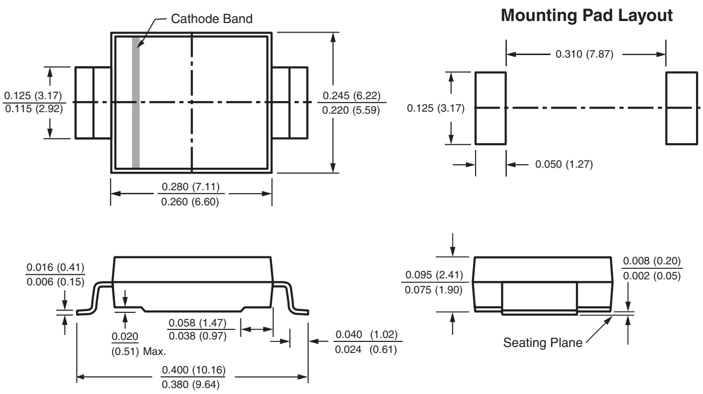


Figure 6. Maximum Non-Repetitive Forward Surge Current
Uni-Directional Use Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-215AB (SMCG)



Surface Mount TRANSZORB® Transient Voltage Suppressors

DO-214AB (SMC)

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 188 V
P_{PPM}	1500 W
P_D	6.5 W
I_{FSM} (uni-directional only)	200 A
T_J max.	150 °C

DEVICES FOR BI-DIRECTION APPLICATIONS

For bi-directional devices use C or CA suffix (e.g. SMCJ188CA).

Electrical characteristics apply in both directions.

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Available in uni-directional and bi-directional
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AB (SMCJ)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: For uni-directional types the band denotes cathode end, no marking on bi-directional types

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2)	P_{PPM}	1500	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave uni-directional only (2)	I_{FSM}	200	A
Power dissipation on infinite heatsink, T_A = 50 °C	P_D	6.5	W
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Mounted on 0.31 x 0.31" (8.0 x 8.0 mm) copper pads to each terminal

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE MODIFIED "J" BEND LEAD	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
(+)SMCJ5.0	GDD	GDD	6.40	7.82	10.0	5.0	1000	156.3	9.6
(+)SMCJ5.0A(5)	GDE	GDE	6.40	7.07	10.0	5.0	1000	163.0	9.2
(+)SMCJ6.0	GDF	GDF	6.67	8.15	10.0	6.0	1000	131.6	11.4
(+)SMCJ6.0A	GDG	GDG	6.67	7.37	10.0	6.0	1000	145.6	10.3
(+)SMCJ6.5	GDH	BDH	7.22	8.82	10.0	6.5	500	122.0	12.3
(+)SMCJ6.5A	GDK	BDK	7.22	7.98	10.0	6.5	500	133.9	11.2
(+)SMCJ7.0	GDL	GDL	7.78	9.51	10.0	7.0	200	112.8	13.3
(+)SMCJ7.0A	GDM	GDM	7.78	8.60	10.0	7.0	200	125.0	12.0
(+)SMCJ7.5	GDN	BDN	8.33	10.2	1.0	7.5	100	104.9	14.3
(+)SMCJ7.5A	GDP	BDP	8.33	9.21	1.0	7.5	100	116.3	12.9
(+)SMCJ8.0	GDQ	BDG	8.89	10.9	1.0	8.0	50	100.0	15.0
(+)SMCJ8.0A	GDR	BDR	8.89	9.83	1.0	8.0	50	110.3	13.6
(+)SMCJ8.5	GDS	BDS	9.44	11.5	1.0	8.5	20	94.3	15.9
(+)SMCJ8.5A	GDT	BDT	9.44	10.4	1.0	8.5	20	104.2	14.4
(+)SMCJ9.0	GDU	BDU	10.0	12.2	1.0	9.0	10	88.8	16.9
(+)SMCJ9.0A	GDV	BDV	10.0	11.1	1.0	9.0	10	97.4	15.4
(+)SMCJ10	GDW	BDW	11.1	13.6	1.0	10	5.0	79.8	18.8
(+)SMCJ10A	GDX	BDX	11.1	12.3	1.0	10	5.0	88.2	17.0
(+)SMCJ11	GDY	GDY	12.2	14.9	1.0	11	5.0	74.6	20.1
(+)SMCJ11A	GDZ	GDZ	12.2	13.5	1.0	11	5.0	82.4	18.2
(+)SMCJ12	GED	BED	13.3	16.3	1.0	12	5.0	68.2	22.0
(+)SMCJ12A	GEE	BEE	13.3	14.7	1.0	12	5.0	75.4	19.9
(+)SMCJ13	GEF	GEF	14.4	17.6	1.0	13	1.0	63.0	23.8
(+)SMCJ13A	GEG	GEG	14.4	15.9	1.0	13	1.0	69.8	21.5
(+)SMCJ14	GEH	BEH	15.6	19.1	1.0	14	1.0	58.1	25.8
(+)SMCJ14A	GEK	BEK	15.6	17.2	1.0	14	1.0	64.7	23.2
(+)SMCJ15	GEL	BEL	16.7	20.4	1.0	15	1.0	55.8	26.9
(+)SMCJ15A	GEM	BEM	16.7	18.5	1.0	15	1.0	61.5	24.4
(+)SMCJ16	GEN	GEN	17.8	21.8	1.0	16	1.0	52.1	28.8
(+)SMCJ16A	GEP	GEP	17.8	19.7	1.0	16	1.0	57.7	26.0
(+)SMCJ17	GEQ	GEQ	18.9	23.1	1.0	17	1.0	49.2	30.5
(+)SMCJ17A	GER	GER	18.9	20.9	1.0	17	1.0	54.3	27.6
(+)SMCJ18	GES	BES	20.0	24.4	1.0	18	1.0	46.6	32.2
(+)SMCJ18A	GET	BET	20.0	22.1	1.0	18	1.0	51.4	29.2
(+)SMCJ20	GEU	BEU	22.2	27.1	1.0	20	1.0	41.9	35.8
(+)SMCJ20A	GEV	BEV	22.2	24.5	1.0	20	1.0	46.3	32.4
(+)SMCJ22	GEW	BEW	24.4	29.8	1.0	22	1.0	38.1	39.4
(+)SMCJ22A	GEX	BEX	24.4	26.9	1.0	22	1.0	42.3	35.5
(+)SMCJ24	GEY	BEY	26.7	32.6	1.0	24	1.0	34.9	43.0
(+)SMCJ24A	GEZ	BEZ	26.7	29.5	1.0	24	1.0	38.6	38.9
(+)SMCJ26	GFD	BFD	28.9	35.3	1.0	26	1.0	32.2	46.6
(+)SMCJ26A	GFE	BFE	28.9	31.9	1.0	26	1.0	35.6	42.1
(+)SMCJ28	GFF	BFF	31.1	38.0	1.0	28	1.0	30.0	50.0
(+)SMCJ28A	GFG	BFG	31.1	34.4	1.0	28	1.0	33.0	45.4
(+)SMCJ30	GFH	BFH	33.3	40.7	1.0	30	1.0	28.0	53.5
(+)SMCJ30A	GFK	BFK	33.3	36.8	1.0	30	1.0	31.0	48.4
(+)SMCJ33	GFL	BFL	36.7	44.9	1.0	33	1.0	25.4	59.0
(+)SMCJ33A	GFM	BFM	36.7	40.6	1.0	33	1.0	28.1	53.3
(+)SMCJ36	GFN	BFN	40.0	48.9	1.0	36	1.0	23.3	64.3
(+)SMCJ36A	GFP	BFP	40.0	44.2	1.0	36	1.0	25.8	58.1
(+)SMCJ40	GFQ	BFQ	44.4	54.3	1.0	40	1.0	21.0	71.4
(+)SMCJ40A	GFR	BFR	44.4	49.1	1.0	40	1.0	23.3	64.5

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE MODIFIED "J" BEND LEAD	DEVICE MARKING CODE		BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA) (3)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (A) (2)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	UNI	BI	MIN	MAX					
(+)SMCJ43	GFS	BFS	47.8	58.4	1.0	43	1.0	19.6	76.7
(+)SMCJ43A	GFT	BFT	47.8	52.8	1.0	43	1.0	21.6	69.4
(+)SMCJ45	GFU	GFU	50.0	61.1	1.0	45	1.0	18.7	80.3
(+)SMCJ45A	GFV	GFV	50.0	55.3	1.0	45	1.0	20.6	72.7
(+)SMCJ48	GFW	GFW	53.3	65.1	1.0	48	1.0	17.5	85.5
(+)SMCJ48A	GFX	GFX	53.3	58.9	1.0	48	1.0	19.4	77.4
(+)SMCJ51	GFY	GFY	56.7	69.3	1.0	51	1.0	16.5	91.1
(+)SMCJ51A	GFZ	GFZ	56.7	62.7	1.0	51	1.0	18.2	82.4
(+)SMCJ54	GGD	GGD	60.0	73.3	1.0	54	1.0	15.6	96.3
(+)SMCJ54A	GGE	GGE	60.0	66.3	1.0	54	1.0	17.2	87.1
(+)SMCJ58	GGF	GGF	64.4	78.7	1.0	58	1.0	14.6	103
(+)SMCJ58A	GGG	GGG	64.4	71.2	1.0	58	1.0	16.0	93
(+)SMCJ60	GGH	GGH	66.7	81.5	1.0	60	1.0	14.0	107
(+)SMCJ60A	GGK	GGK	66.7	73.7	1.0	60	1.0	15.5	96
(+)SMCJ64	GGL	GGL	71.1	86.9	1.0	64	1.0	13.2	114
(+)SMCJ64A	GGM	GGM	71.1	78.6	1.0	64	1.0	14.6	103
(+)SMCJ70	GGN	GGN	77.8	95.1	1.0	70	1.0	12.0	125
(+)SMCJ70A	GGP	GGP	77.8	86.0	1.0	70	1.0	13.3	113
(+)SMCJ75	GGQ	GGQ	83.3	102	1.0	75	1.0	11.2	134
(+)SMCJ75A	GGR	GGR	83.3	92.1	1.0	75	1.0	12.4	121
(+)SMCJ78	GGS	GGS	86.7	106	1.0	78	1.0	10.8	139
(+)SMCJ78A	GGT	GGT	86.7	95.8	1.0	78	1.0	11.9	126
(+)SMCJ85	GGU	GGU	94.4	115	1.0	85	1.0	9.9	151
(+)SMCJ85A	GGV	GGV	94.4	104	1.0	85	1.0	10.9	137
(+)SMCJ90	GGW	GGW	100	122	1.0	90	1.0	9.4	160
(+)SMCJ90A	GGX	GGX	100	111	1.0	90	1.0	10.3	146
(+)SMCJ100	GGY	GGY	111	136	1.0	100	1.0	8.4	179
(+)SMCJ100A	GGZ	GGZ	111	123	1.0	100	1.0	9.3	162
(+)SMCJ110	GHD	GHD	122	149	1.0	110	1.0	7.7	196
(+)SMCJ110A	GHE	GHE	122	135	1.0	110	1.0	8.5	177
(+)SMCJ120	GHF	GHF	133	163	1.0	120	1.0	7.0	214
(+)SMCJ120A	GHG	GHG	133	147	1.0	120	1.0	7.8	193
(+)SMCJ130	GHH	GHH	144	176	1.0	130	1.0	6.5	231
(+)SMCJ130A	GHK	GHK	144	159	1.0	130	1.0	7.2	209
(+)SMCJ150	GHL	GHL	167	204	1.0	150	1.0	5.6	268
(+)SMCJ150A	GHM	GHM	167	185	1.0	150	1.0	6.2	243
(+)SMCJ160	GHN	GHN	178	218	1.0	160	1.0	5.2	287
(+)SMCJ160A	GHP	GHP	178	197	1.0	160	1.0	5.8	259
(+)SMCJ170	GHQ	GHQ	189	231	1.0	170	1.0	4.9	304
(+)SMCJ170A	GHR	GHR	189	209	1.0	170	1.0	5.5	275
SMCJ188	GHT	GHT	209	255	1.0	188	1.0	4.4	344
SMCJ188A	GHS	GHS	209	231	1.0	188	1.0	4.6	328

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) For bi-directional types having V_{WM} of 10 V and less, the I_D limit is doubled

(4) All terms and symbols are consistent with ANSI/IEEE C62.35

(5) For the bi-directional SMCJ5.0CA, the maximum V_{BR} is 7.25 V

(6) V_F = 3.5 V at I_F = 100 A (uni-directional only)

(+) Underwriters laboratory recognition for the classification of protectors (QVGQ2) under the UL standard for safety 497B and file number E136766 for both uni-directional and bi-directional devices

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to ambient air (1)	$R_{\theta JA}$	75	°C/W
Typical thermal resistance, junction to leads	$R_{\theta JL}$	15	°C/W

Note:

(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMCJ5.0A-E3/57T	0.211	57T	850	7" diameter plastic tape and reel
SMCJ5.0A-E3/9AT	0.211	9AT	3500	13" diameter plastic tape and reel
SMCJ5.0AHE3/57T (1)	0.211	57T	850	7" diameter plastic tape and reel
SMCJ5.0AHE3/9AT (1)	0.211	9AT	3500	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

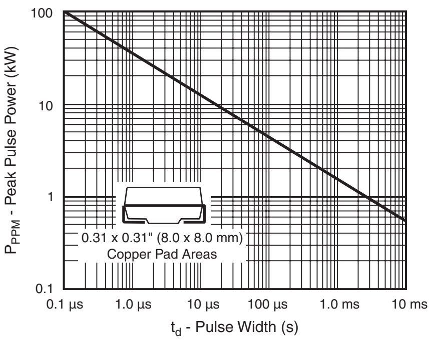


Figure 1. Peak Pulse Power Rating Curve

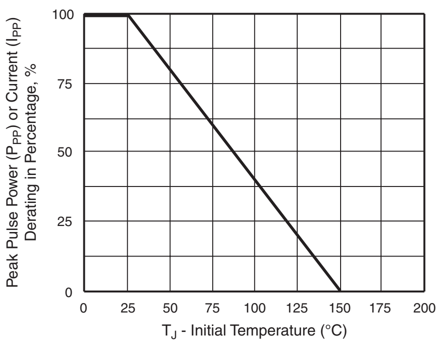


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

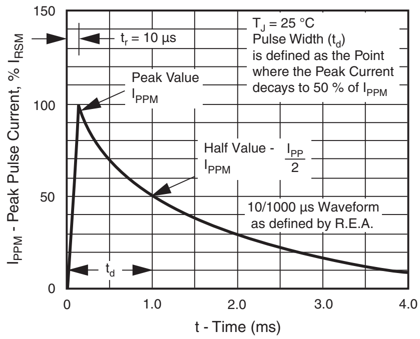


Figure 3. Pulse Waveform

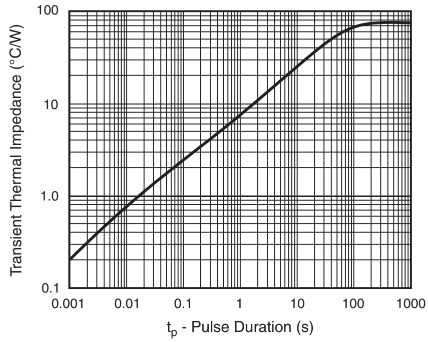


Figure 5. Typical Transient Thermal Impedance

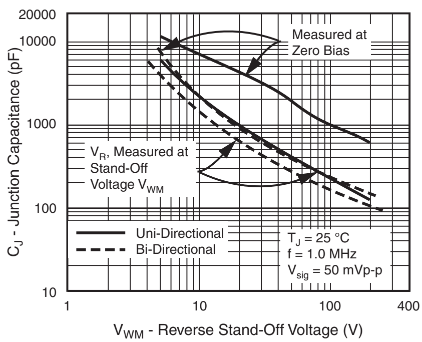


Figure 4. Typical Junction Capacitance Uni-Directional

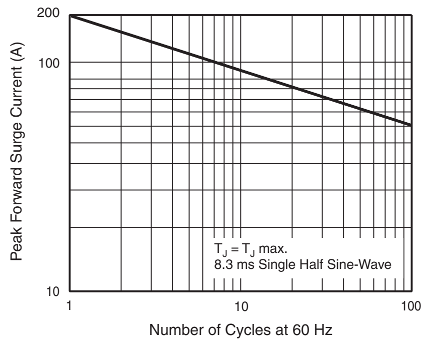
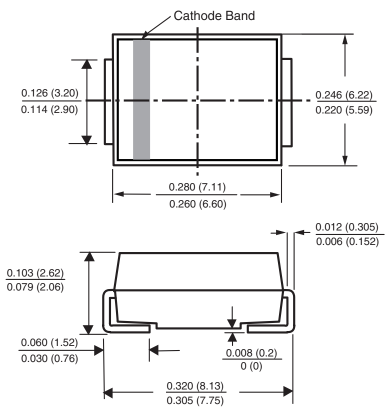


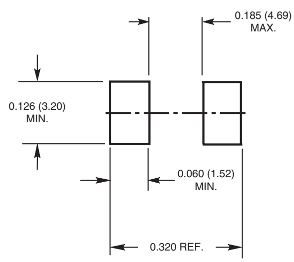
Figure 6. Maximum Non-Repetitive Forward Surge Current Uni-Directional Use Only

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-214AB (SMC J-Bend)



Mounting Pad Layout



TRANSZORB® Transient Voltage Suppressors

Case Style P600

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 188 V
P_{PPM}	5000 W
P_D	8.0 W
I_{FSM}	500 A
T_J max.	175 °C

FEATURES

- P600, glass passivated chip junction
- Available in uni-directional polarity only
- 5000 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: Molded epoxy body over passivated junction
Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)	P_{PPM}	5000	W
Peak pulse current with a 10/1000 µs waveform (1)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 5)	P_D	8.0	W
Peak forward surge current 8.3 ms single half sine-wave (Fig. 5)	I_{FSM}	600	A
Instantaneous forward voltage at 100 A (2)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} (V) (1)		TEST CURRENT AT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
	MIN	MAX						
5KP5.0	6.40	7.30	50	5.0	2000	521	9.6	0.057
5KP5.0A	6.40	7.00	50	5.0	2000	543	9.2	0.057
5KP6.0	6.67	8.15	50	6.0	5000	439	11.4	0.061
5KP6.0A	6.67	7.37	50	6.0	5000	485	10.3	0.061
5KP6.5	7.22	8.82	50	6.5	2000	407	12.3	0.065
5KP6.5A	7.22	7.98	50	6.5	2000	446	11.2	0.065
5KP7.0	7.78	9.51	50	7.0	1000	376	13.3	0.068
5KP7.0A	7.78	8.60	50	7.0	1000	417	12.0	0.068
5KP7.5	8.33	10.2	5.0	7.5	250	350	14.3	0.073
5KP7.5A	8.33	9.21	5.0	7.5	250	388	12.9	0.073
5KP8.0	8.89	10.9	5.0	8.0	150	333	15.0	0.075
5KP8.0A	8.89	9.83	5.0	8.0	150	368	13.6	0.075
5KP8.5	9.44	11.5	5.0	8.5	50	314	15.9	0.078
5KP8.5A	9.44	10.4	5.0	8.5	50	347	14.4	0.078
5KP9.0	10.0	12.2	5.0	9.0	20	296	16.9	0.081
5KP9.0A	10.0	11.1	5.0	9.0	20	325	15.4	0.081
5KP10	11.1	13.6	5.0	10.0	15	266	18.8	0.084
5KP10A	11.1	12.3	5.0	10.0	15	294	17.0	0.084
5KP11	12.2	14.9	5.0	11.0	10	249	20.1	0.086
5KP11A	12.2	13.5	5.0	11.0	10	275	18.2	0.086
5KP12	13.3	16.3	5.0	12.0	5.0	227	22.0	0.088
5KP12A	13.3	14.7	5.0	12.0	5.0	251	19.9	0.088
5KP13	14.4	17.6	5.0	13.0	2.0	210	23.8	0.090
5KP13A	14.4	15.9	5.0	13.0	2.0	233	21.5	0.090
5KP14	15.6	19.1	5.0	14.0	2.0	194	25.8	0.092
5KP14A	15.6	17.2	5.0	14.0	2.0	216	23.2	0.092
5KP15	16.7	20.4	5.0	15.0	2.0	186	26.9	0.094
5KP15A	16.7	18.5	5.0	15.0	2.0	205	24.4	0.094
5KP16	17.8	21.8	5.0	16.0	2.0	174	28.8	0.096
5KP16A	17.8	19.7	5.0	16.0	2.0	192	26.0	0.096
5KP17	18.9	23.1	5.0	17.0	2.0	164	30.5	0.097
5KP17A	18.9	20.9	5.0	17.0	2.0	181	27.6	0.097
5KP18	20.0	24.4	5.0	18.0	2.0	155	32.2	0.098
5KP18A	20.0	22.1	5.0	18.0	2.0	171	29.2	0.098
5KP20	22.2	27.1	5.0	20.0	2.0	140	35.8	0.099
5KP20A	22.2	24.5	5.0	20.0	2.0	154	32.4	0.099
5KP22	24.4	29.8	5.0	22.0	2.0	127	39.4	0.100
5KP22A	24.4	26.9	5.0	22.0	2.0	141	35.5	0.100
5KP24	26.7	32.6	5.0	24.0	2.0	116	43.0	0.101
5KP24A	26.7	29.5	5.0	24.0	2.0	129	38.9	0.101
5KP26	28.9	35.3	5.0	26.0	2.0	107	46.6	0.101
5KP26A	28.9	31.9	5.0	26.0	2.0	119	42.1	0.101
5KP26A	28.9	31.9	5.0	26.0	2.0	119	42.1	0.101
5KP28	31.1	38.0	5.0	28.0	2.0	100	50.1	0.102
5KP28A	31.1	34.4	5.0	28.0	2.0	110	45.4	0.102
5KP30	33.3	40.7	5.0	30.0	2.0	93.5	53.5	0.103
5KP30A	33.3	36.8	5.0	30.0	2.0	103	48.4	0.103
5KP33	36.7	44.9	5.0	33.0	2.0	84.7	59.0	0.104
5KP33A	36.7	40.6	5.0	33.0	2.0	93.8	53.3	0.104
5KP36	40.0	48.9	5.0	36.0	2.0	77.8	64.3	0.104
5KP36A	40.0	44.2	5.0	36.0	2.0	86.1	58.1	0.104

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} (V) (1) MIN	BREAKDOWN VOLTAGE V_{BR} (V) (1) MAX	TEST CURRENT AT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
5KP40	44.4	54.3	5.0	40.0	2.0	70.0	71.4	0.105
5KP40A	44.4	49.1	5.0	40.0	2.0	77.5	64.5	0.105
5KP43	47.8	58.4	5.0	43.0	2.0	65.2	76.7	0.105
5KP43A	47.8	52.8	5.0	43.0	2.0	72.0	69.4	0.105
5KP45	50.0	61.1	5.0	45.0	2.0	62.3	80.3	0.106
5KP45A	50.0	55.3	5.0	45.0	2.0	68.8	72.7	0.106
5KP48	53.3	65.2	5.0	48.0	2.0	58.5	85.5	0.106
5KP48A	53.3	58.9	5.0	48.0	2.0	64.6	77.4	0.106
5KP51	56.1	69.3	5.0	51.0	2.0	54.9	91.1	0.107
5KP51A	56.7	62.7	5.0	51.0	2.0	60.7	82.4	0.107
5KP54	60.0	73.3	5.0	54.0	2.0	51.9	96.3	0.107
5KP54A	60.0	66.3	5.0	54.0	2.0	57.4	87.1	0.107
5KP58	64.4	78.7	5.0	58.0	2.0	48.5	103	0.107
5KP58A	64.4	71.2	5.0	58.0	2.0	53.4	94	0.107
5KP60	66.7	81.5	5.0	60.0	2.0	46.7	107	0.108
5KP60A	66.7	73.7	5.0	60.0	2.0	51.7	97	0.108
5KP64	71.1	96.9	5.0	64.0	2.0	43.9	114	0.108
5KP64A	71.1	78.6	5.0	64.0	2.0	48.5	103	0.108
5KP70	77.6	95.1	5.0	70.0	2.0	40.0	125	0.108
5KP70A	77.8	86.0	5.0	70.0	2.0	44.2	113	0.108
5KP75	83.3	102	5.0	75.0	2.0	37.3	134	0.108
5KP75A	83.3	92.1	5.0	75.0	2.0	41.3	121	0.108
5KP78	86.7	106.0	5.0	78.0	2.0	36.0	139	0.108
5KP78A	86.7	95.8	5.0	78.0	2.0	39.7	126	0.108
5KP85	94.4	115	5.0	85.0	2.0	33.1	151	0.108
5KP85A	94.4	104	5.0	85.0	2.0	36.5	137	0.110
5KP90	100	122	5.0	90.0	2.0	31.3	160	0.110
5KP90A	100	111	5.0	90.0	2.0	34.2	146	0.110
5KP100	111	136	5.0	100	2.0	27.9	179	0.110
5KP100A	111	123	5.0	100	2.0	30.9	162	0.110
5KP110	122	149	5.0	110	2.0	25.5	196	0.112
5KP110A	122	135	5.0	110	2.0	28.2	177	0.112
5KP120	133	163	5.0	120	2.0	23.4	214	0.112
5KP120A	133	147	5.0	120	2.0	25.9	193	0.112
5KP130	144	176	5.0	130	2.0	21.6	230	0.112
5KP130A	144	159	5.0	130	2.0	23.9	209	0.112
5KP150	167	204	5.0	150	2.0	18.7	268	0.112
5KP150A	167	185	5.0	150	2.0	20.6	243	0.112
5KP160	178	218	5.0	160	2.0	17.4	287	0.112
5KP160A	178	197	5.0	160	2.0	19.3	259	0.112
5KP170	189	231	5.0	170	2.0	16.4	304	0.112
5KP170A	189	209	5.0	170	2.0	18.2	275	0.112
5KP188	209	255	5.0	188	2.0	14.5	344	0.112
5KP188A	209	231	5.0	188	2.0	15.2	328	0.112

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 3 and derate per Fig. 2

(3) All items and symbols are consistent with ANSI/IEEE C62.35

Document Number: 88308
Revision: 08-May-07

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
5KP5.0A-E3/54	2.776	54	800	13" diameter paper tape and reel
5KP5.0AHE3/54 (1)	2.776	54	800	13" diameter paper tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

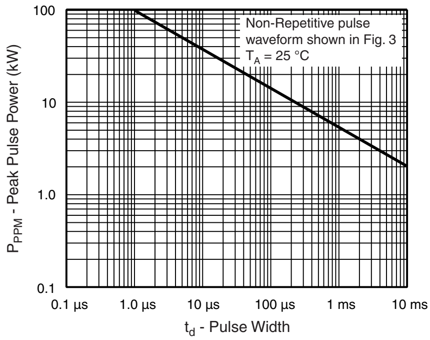


Figure 1. Peak Pulse Power Rating Curve

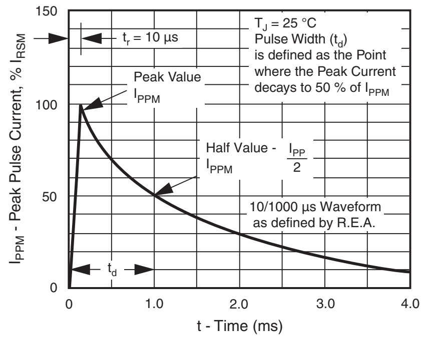


Figure 3. Pulse Waveform

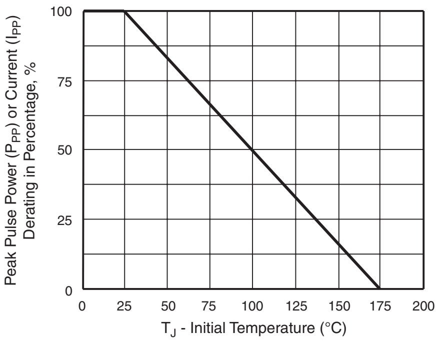


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

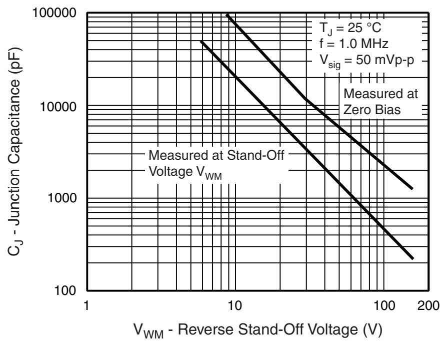


Figure 4. Typical Junction Capacitance

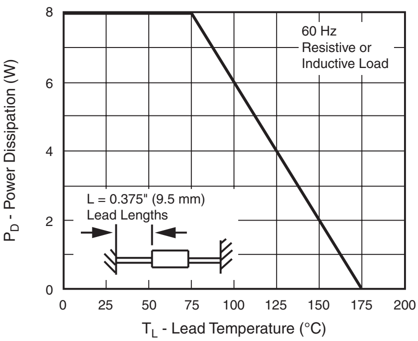


Figure 5. Power Derating Curve

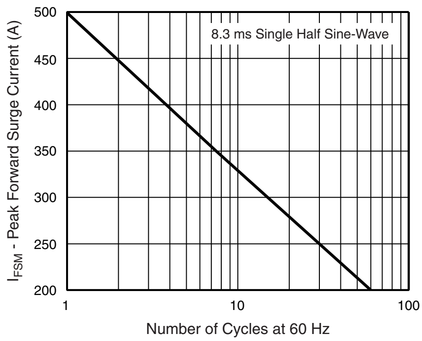
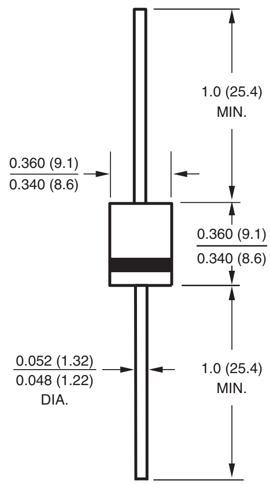


Figure 6. Maximum Non-repetitive Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

Case Style P600

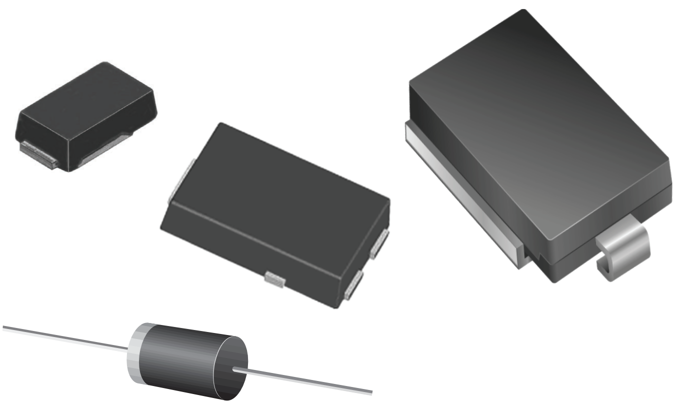


APPLICATION NOTE

The 5KP series of high power transient voltage suppressors were designed to be used on the output of switching power supplies. These devices may be used to replace crowbar circuits. Both the 5 % and 10 % voltage tolerances are referenced to the power supply output voltage level.

They are able to withstand high levels of peak current while allowing a circuit breaker to trip or a fuse blow before shorting. This will enable the user to reset the breaker or replace the fuse and continue operation. For this type operation, it is recommended that a sufficient mounting surface be used for dissipating the heat generated by the Transient Voltage Suppressor during the transient or over-voltage condition.

PAR®
Automotive Transient Voltage Suppressors



Contents

Introduction to Automotive Transient Voltage Suppressors

Transient Voltage Suppressors (TVS) fabricated with Vishay's exclusive PAR® process have superior stability and power handling capability over the entire automotive temperature range and beyond. This is the result of a unique combination of a thick passivation layer of grown silicon dioxide, together with a patented process designed to reduce the electric field intensity at the silicon surface, significantly reducing electric field stress on the passivating layer. The electrical characteristics are therefore dependent only on the properties of the bulk silicon crystal and unaffected by surface influences. This results in devices with lower reverse leakage current, the ability to operate at higher ambient temperatures and the capability to absorb large amounts of energy without damage or change of characteristics. For further information on PAR technology, see the Application Note "Transient Voltage Suppressors Ideally Suited for Automotive Environments."

Vishay is proud to introduce new series of surface mount load dump suppression components utilizing the PAR technology. These surface mount load dump TVS series are the SM5A27, SM5Sxx, SM6A27, SM6Sxx, SM8A27, SM8Sxx, and TPSMP series. Discrete load dump suppressors provide outstanding protection for vehicle electronics and exceptionally low reverse leakage in the new high-power surface mountable DO-218AB package.

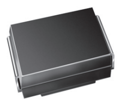
In addition to superior technology, Vishay's manufacturing facilities adhere to quality systems which meet automotive standards, and have gained QS-9000 and ISO-9001 certification. Vishay is committed to providing the products, quality, and services required by the world leading automakers.

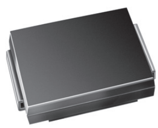
Datasheets in this section are arranged by increasing power rating. Within a power rating they are listed in alphanumeric order.

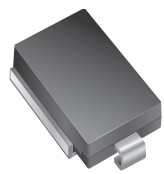

DO-220AA (SMP)

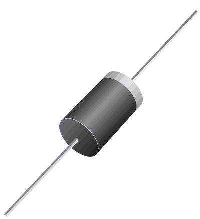

TO-277A (SMPC)

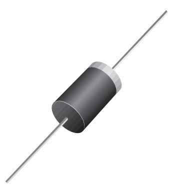

DO-214AC (SMA)

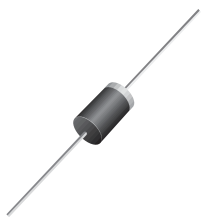

DO-214AA (SMB)

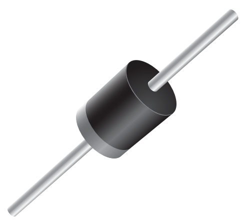

DO-214AB (SMC)


DO-218AB


1.5KE


DO-204AC (DO-15)


DO-204AL (DO-41)


P600


MPG06

Document Number: 88498
Revision: 20-Sep-07

Automotive Transient Voltage Suppressors Part Numbering System

1. AXIAL

a) TVS specified by Nominal Breakdown Voltage:

(1) Mini 400 W TVS
TMPG06-yyd
T = TVS
MPG06 = **M**ini **P**lastic **G**lass "06" package style
yy = Nominal breakdown voltage (in V)
d = Breakdown voltage tolerance
"Blank" = ± 10 %
A = ± 5 %

(2) 400 W to 1500 W
xxKAyyd
xxK = Power rating
P4K = 0.4 kW (i.e., 400 W)
P6K = 0.6 kW (i.e., 600 W)
1.5K = 1.5 kW (i.e., 1500 W)
A = **A**utomotive TVS designator
yy = Nominal breakdown voltage (in V)
d = Breakdown voltage tolerance
"Blank" = ± 10 %
A = ± 5 %

b) TVS specified by Stand-off Voltage:

6KA24
6K = 6000 W
A = Automotive TVS designator
24 = 24 V stand-off voltage (in V)

2. SURFACE MOUNT

a) SMX Package:

(1) TPSMxyyd
T = TVS
P = Automotive SMX designator
SMx = Surface mount package style
SMA = DO-214AC (J-bend): 400 W
SMB = DO-214AA (J-bend): 600 W
SMC = DO-214AB (J-bend): 1500 W
C = TO-277A (SMPC): 1500 W
SMP = DO-220AA: 250 W to 400 W
yy = Nominal breakdown voltage (in V)
d = Breakdown voltage tolerance
"Blank" = ± 10 %
A = ± 5 %

(2) 3KASMCyyd
3K = 3000 W
A = **A**utomotive TVS designator
SMC = DO-214AB (J-bend)
yy = Stand-off voltage (in V)
d = Breakdown voltage tolerance
"Blank" = ± 10 %
A = ± 5 %

b) Load-Dump DO-218AB:

(1) SMxA27
SM = Surface **M**ount (DO-218AB)
x = Steady state power
5 = 5 W
6 = 6 W
8 = 8 W
A = Automotive TVS designator (low V_F type)
27 = 27 V breakdown voltage

(2) SMxSyyd
SM = Surface **M**ount (DO-218AB)
x = Steady state power
5 = 5 W
6 = 6 W
8 = 8 W
S = Standard V_F type
yy = Stand-off voltage
d = Breakdown voltage tolerance
"Blank" = ± 10 %
A = ± 5 %

TPSMP6.8 thru TPSMP43A

Vishay General Semiconductor

High Power Density Surface Mount PAR® Transient Voltage Suppressors

eSMP™ Series

DO-220AA (SMP)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 43 V
P_{PPM} (for V_{BR} 6.8 V)	250 W
P_{PPM} (for V_{BR} 7.5 V to 12 V)	300 W
P_{PPM} (for V_{BR} 13 V to 43 V)	400 W
P_D	2.5 W
I_{FSM}	40 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Protection for ICs, drive transistors, signal lines of sensor units, and electronic units in consumer, computer, industrial and automotive applications.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Very low profile - typical height of 1.0 mm
- Ideal for automated placement
- Uni-direction only
- Excellent clamping capability
- Low incremental surge resistance
- Very fast response time
- Meets MSL level 1, per J-STD-020, LF maximum peak of 260 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC
- **Halogen-free according to IEC 61249-2-21 definition**

AUTOMOTIVE GRADE

RoHS COMPLIANT

HALOGEN FREE

MECHANICAL DATA

Case: DO-220AA (SMP)
Molding compound meets UL 94 V-0 flammability rating
Base P/NHM3 - halogen-free and RoHS compliant, automotive grade

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HM3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak power dissipation with a 10/1000 µs waveform (fig. 1 and 3) (1)(2)	P_{PPM}	See table next page	W
Peak power pulse current with a 10/1000 µs waveform (fig. 1) (1)	I_{PPM}	See table next page	A
Power dissipation on infinite heatsink, T_A = 75 °C	P_D	2.5	W
Peak forward surge current 10 ms single half sine-wave superimposed on rated load	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A (3)	V_F	2.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Mounted on PCB with 5.0 mm x 5.0 mm copper pads attached to each terminal
(3) Pulse test: 300 µs pulse width, 1 % duty cycle

For technical questions within your region, please contact one of the following:
DiodesAmericas@vishay.com, DiodesAsia@vishay.com, DiodesEurope@vishay.com
Document Number: 88471
Revision: 10-Feb-11

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 (A)	MAXIMUM REVERSE LEAKAGE AT V_{WM} T_J = 150 °C I_D (A)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
		MIN.	MAX.							
TPSMP6.8	ADP	6.12	7.48	10.0	5.50	300	1000	23.2	10.8	0.057
TPSMP6.8A	AEP	6.45	7.14	10.0	5.80	300	1000	23.8	10.5	0.057
TPSMP7.5	AFP	6.75	8.25	10.0	6.05	150	500	25.6	11.7	0.060
TPSMP7.5A	AGP	7.13	7.88	10.0	6.40	150	500	26.5	11.3	0.061
TPSMP8.2	AHP	7.38	9.02	10.0	6.63	50.0	200	24.0	12.5	0.065
TPSMP8.2A	AKP	7.79	8.61	10.0	7.02	50.0	200	24.8	12.1	0.065
TPSMP9.1	ALP	8.19	10.0	1.0	7.37	10.0	50.0	21.7	13.8	0.068
TPSMP9.1A	AMP	8.65	9.55	1.0	7.78	10.0	50.0	22.4	13.4	0.068
TPSMP10	ANP	9.00	11.0	1.0	8.10	5.0	20.0	20.0	15.0	0.073
TPSMP10A	APP	9.50	10.5	1.0	8.55	5.0	20.0	20.7	14.5	0.073
TPSMP11	AQP	9.90	12.1	1.0	8.92	2.0	10.0	18.5	16.2	0.075
TPSMP11A	ARP	10.5	11.6	1.0	9.40	2.0	10.0	19.2	15.6	0.075
TPSMP12	ASP	10.8	13.2	1.0	9.72	1.0	5.0	17.3	17.3	0.076
TPSMP12A	ATP	11.4	12.6	1.0	10.2	1.0	5.0	18.0	16.7	0.078
TPSMP13	AUP	11.7	14.3	1.0	10.5	1.0	5.0	21.1	19.0	0.081
TPSMP13A	AVP	12.4	13.7	1.0	11.1	1.0	5.0	22.0	18.2	0.081
TPSMP15	AWP	13.5	16.3	1.0	12.1	1.0	5.0	18.2	22.0	0.084
TPSMP15A	AXP	14.3	15.8	1.0	12.8	1.0	5.0	18.9	21.2	0.084
TPSMP16	AYP	14.4	17.6	1.0	12.9	1.0	5.0	17.0	23.5	0.086
TPSMP16A	AZP	15.2	16.8	1.0	13.6	1.0	5.0	17.8	22.5	0.086
TPSMP18	BDP	16.2	19.8	1.0	14.5	1.0	5.0	15.1	26.5	0.088
TPSMP18A	BEP	17.1	18.9	1.0	15.3	1.0	5.0	15.9	25.5	0.088
TPSMP20	BFP	18.0	22.0	1.0	16.2	1.0	5.0	13.7	29.1	0.090
TPSMP20A	BGP	19.0	21.0	1.0	17.1	1.0	5.0	14.4	27.7	0.090
TPSMP22	BHP	19.8	24.2	1.0	17.8	1.0	5.0	12.5	31.9	0.092
TPSMP22A	BKP	20.9	23.1	1.0	18.8	1.0	5.0	13.1	30.6	0.092
TPSMP24	BLP	21.6	26.4	1.0	19.4	1.0	5.0	11.5	34.7	0.094
TPSMP24A	BMP	22.8	25.2	1.0	20.5	1.0	5.0	12.0	33.2	0.094
TPSMP27	BNP	24.3	29.7	1.0	21.8	1.0	5.0	10.2	39.1	0.100
TPSMP27A	BPP	25.7	28.4	1.0	23.1	1.0	5.0	10.7	37.5	0.096
TPSMP30	BQP	27.0	33.0	1.0	24.3	1.0	5.0	9.2	43.5	0.097
TPSMP30A	BRP	28.5	31.5	1.0	25.6	1.0	5.0	9.7	41.4	0.097
TPSMP33	BSP	29.7	36.3	1.0	26.8	1.0	5.0	8.4	47.7	0.098
TPSMP33A	BTP	31.4	34.7	1.0	28.2	1.0	5.0	8.8	45.7	0.098
TPSMP36	BUP	32.4	39.6	1.0	29.1	1.0	5.0	7.7	52.0	0.099
TPSMP36A	BVP	34.2	37.8	1.0	30.8	1.0	5.0	8.0	49.9	0.099
TPSMP39	BWP	35.1	42.9	1.0	31.6	1.0	5.0	7.1	56.4	0.100
TPSMP39A	BXP	37.1	41.0	1.0	33.3	1.0	5.0	7.4	53.9	0.100
TPSMP43	BYP	38.7	47.3	1.0	34.8	1.0	5.0	6.5	61.9	0.101
TPSMP43A	BZP	40.9	45.2	1.0	36.8	1.0	5.0	6.7	59.3	0.101

Notes

(1) V_{BR} measured after I_T applied for 300 μs, I_T = square wave pulse or equivalent

(2) Surge current waveform per fig. 3 and derated per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

TPSMP6.8 thru TPSMP43A

Vishay General Semiconductor

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
TPSMP6.8AHM3/84A [(1)]	0.024	84A	3000	7" diameter plastic tape and reel
TPSMP6.8AHM3/85A [(1)]	0.024	85A	10 000	13" diameter plastic tape and reel

Note

[(1)] Automotive grade

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

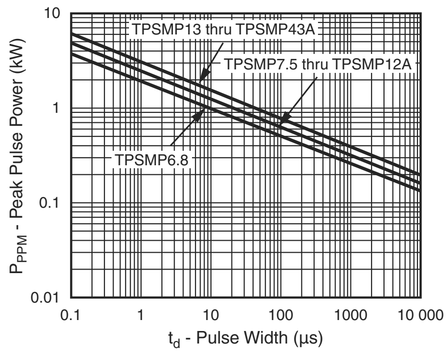


Fig. 1 - Peak Pulse Power Rating Curve

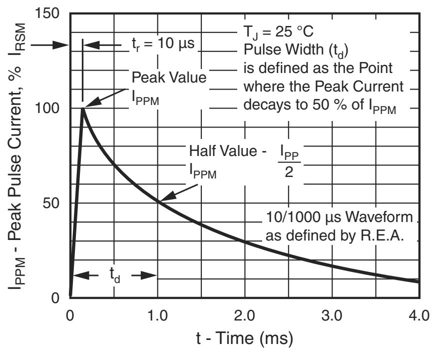


Fig. 3 - Pulse Waveform

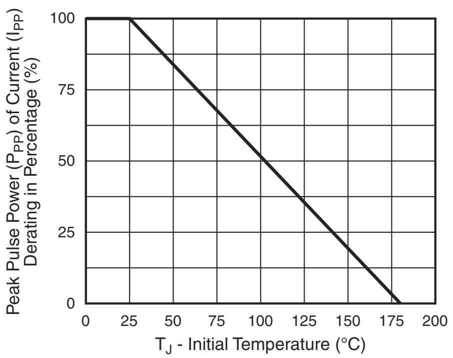


Fig. 2 - Pulse Derating Curve

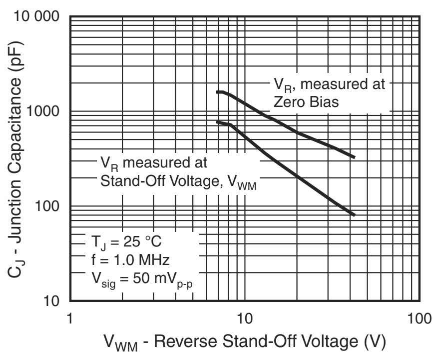


Fig. 4 - Typical Junction Capacitance

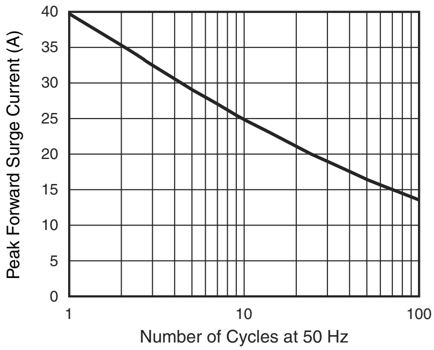


Fig. 5 - Maximum Peak Forward Surge Current

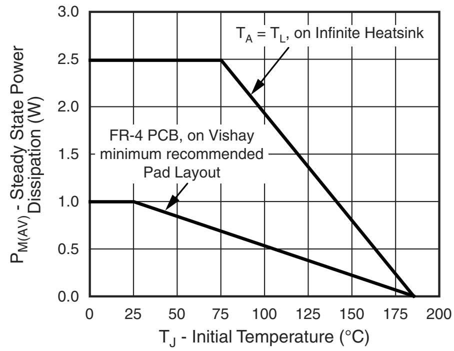
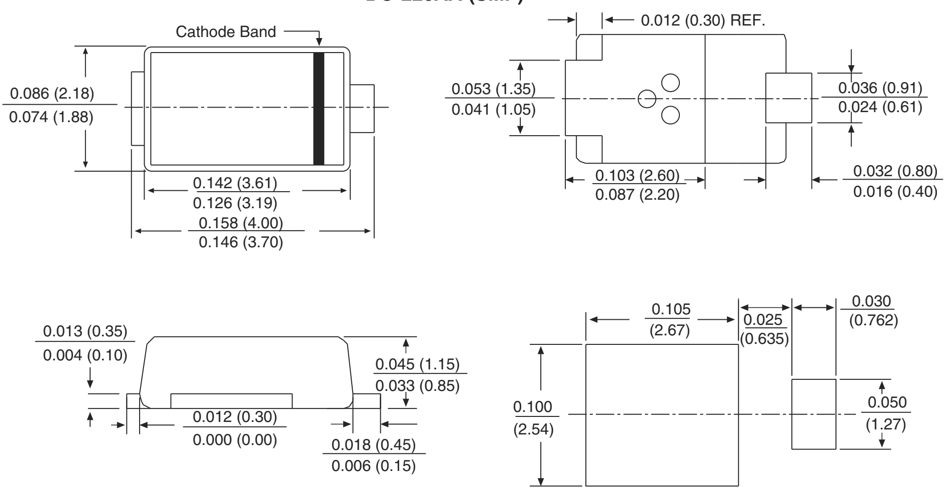


Fig. 6 - Steady State Power Derating Curve

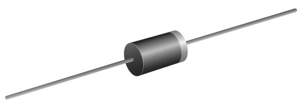
PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-220AA (SMP)



PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions



MPG06

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 43 V
P_{PPM}	400 W
P_D	1.0 W
I_{FSM}	40 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 400 W peak pulse power capability with a 10/1000 μs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 275 °C max. 10 s, per JESD 22-B106
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Pb e3 RoHS COMPLIANT

MECHANICAL DATA

Case: MPG06, molded epoxy over passivated junction
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak power dissipation with a 10/1000 μs waveform (1) (fig. 1)	P_{PPM}	400	W
Peak pulse current with a 10/1000 μs waveform (1)(2) (fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (fig. 5)	P_D	1.0	W
Peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A (2)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes:
(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE	MAXIMUM 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_D (µA)	REVERSE LEAKAGE AT V_{WM} T_J = 150 °C I_D (µA)	PEAK PULSE CURRENT I_{PPM} [(2)] (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMP. COEFFICIENT OF V_{BR} (%/°C)
	MIN.	MAX.							
TMPG06-6.8 [(4)]	6.12	7.48	10.0	5.50	300	1000	27.8	10.8	0.057
TMPG06-6.8A [(4)]	6.45	7.14	10.0	5.80	300	1000	28.6	10.5	0.057
TMPG06-7.5 [(4)]	6.75	8.25	10.0	6.05	150	500	25.6	11.7	0.060
TMPG06-7.5A [(4)]	7.13	7.88	10.0	6.40	150	500	26.5	11.3	0.061
TMPG06-8.2 [(4)]	7.38	9.02	10.0	6.63	50.0	200	24.0	12.5	0.065
TMPG06-8.2A [(4)]	7.79	8.61	10.0	7.02	50.0	200	24.8	12.1	0.065
TMPG06-9.1 [(4)]	8.19	10.0	1.0	7.37	10.0	50.0	21.7	13.8	0.068
TMPG06-9.1A [(4)]	8.65	9.55	1.0	7.78	10.0	50.0	22.4	13.4	0.068
TMPG06-10	9.00	11.0	1.0	8.10	5.0	20.0	26.7	15.0	0.073
TMPG06-10A	9.50	10.5	1.0	8.55	5.0	20.0	27.6	14.5	0.073
TMPG06-11	9.90	12.1	1.0	8.92	2.0	10.0	24.7	16.2	0.075
TMPG06-11A	10.5	11.6	1.0	9.40	2.0	10.0	25.6	15.6	0.075
TMPG06-12	10.8	13.2	1.0	9.72	1.0	5.0	23.1	17.3	0.076
TMPG06-12A	11.4	12.6	1.0	10.2	1.0	5.0	24.0	16.7	0.078
TMPG06-13	11.7	14.3	1.0	10.5	1.0	5.0	21.1	19.0	0.081
TMPG06-13A	12.4	13.7	1.0	11.1	1.0	5.0	22.0	18.2	0.081
TMPG06-15	13.5	16.3	1.0	12.1	1.0	5.0	18.2	22.0	0.084
TMPG06-15A	14.3	15.8	1.0	12.8	1.0	5.0	18.9	21.2	0.084
TMPG06-16	14.4	17.6	1.0	12.9	1.0	5.0	17.0	23.5	0.086
TMPG06-16A	15.2	16.8	1.0	13.6	1.0	5.0	17.8	22.5	0.086
TMPG06-18	16.2	19.8	1.0	14.5	1.0	5.0	15.1	26.5	0.088
TMPG06-18A	17.1	18.9	1.0	15.3	1.0	5.0	15.9	25.5	0.088
TMPG06-20	18.0	22.0	1.0	16.2	1.0	5.0	13.7	29.1	0.090
TMPG06-20A	19.0	21.0	1.0	17.0	1.0	5.0	14.4	27.7	0.090
TMPG06-22	19.8	24.2	1.0	17.8	1.0	5.0	12.5	31.9	0.092
TMPG06-22A	20.9	23.1	1.0	18.8	1.0	5.0	13.1	30.6	0.092
TMPG06-24	21.6	26.4	1.0	19.4	1.0	5.0	11.5	34.2	0.094
TMPG06-24A	22.8	25.2	1.0	20.5	1.0	5.0	12.0	33.2	0.094
TMPG06-27	24.3	29.7	1.0	21.8	1.0	5.0	10.2	39.1	0.096
TMPG06-27A	25.7	28.4	1.0	23.1	1.0	5.0	10.7	37.5	0.096
TMPG06-30	27.0	33.0	1.0	24.3	1.0	5.0	9.2	43.5	0.097
TMPG06-30A	28.5	31.5	1.0	25.6	1.0	5.0	9.7	41.4	0.097
TMPG06-33	29.7	36.3	1.0	26.8	1.0	5.0	8.4	47.7	0.098
TMPG06-33A	31.4	34.7	1.0	28.2	1.0	5.0	8.8	45.7	0.098
TMPG06-36	32.4	39.6	1.0	29.1	1.0	5.0	7.7	52.0	0.099
TMPG06-36A	34.2	37.8	1.0	30.8	1.0	5.0	8.0	49.9	0.099
TMPG06-39	35.1	42.9	1.0	31.6	1.0	5.0	7.1	56.4	0.100
TMPG06-39A	37.1	41.0	1.0	33.3	1.0	5.0	7.4	53.9	0.100
TMPG06-43	38.7	47.3	1.0	34.8	1.0	5.0	6.5	61.9	0.101
TMPG06-43A	40.9	45.2	1.0	36.8	1.0	5.0	6.7	59.3	0.101

Notes

(1) Pulse test: $t_p \leq$ 50 ms

(2) Surge current waveform per fig. 3 and derated per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

(4) TMPG06-6.8(A) thru TMPG06-9.1(A) not recommended for new design due to product be end of life on 31-May-11 per PCN-PDD-008-2010 Rev. 0

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
TMPG06-6.8AHE3/54 [(1)]	0.218	54	5500	13" diameter paper tape and reel

Note

(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

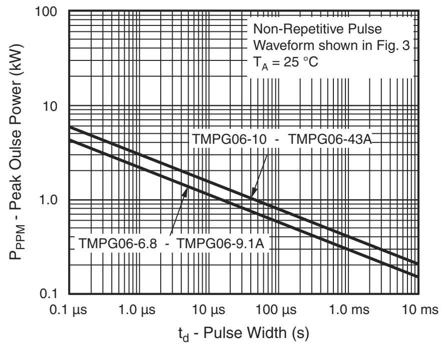


Figure 1. Peak Pulse Power Rating Curve

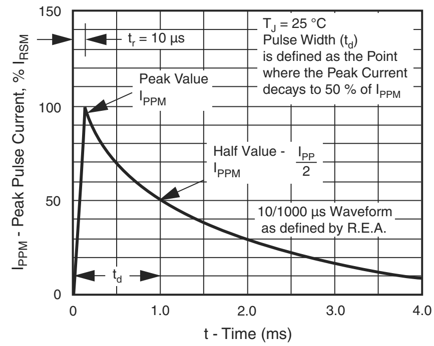


Figure 3. Pulse Waveform

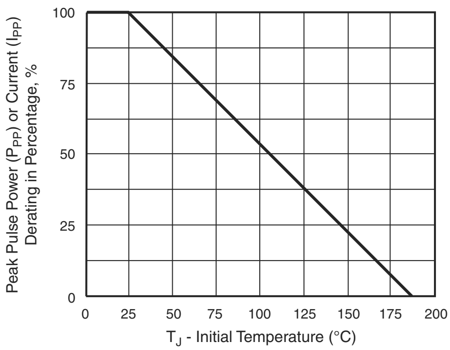


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

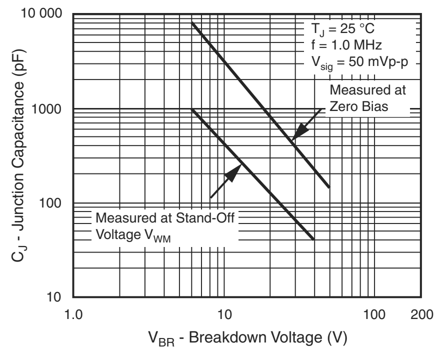


Figure 4. Typical Junction Capacitance

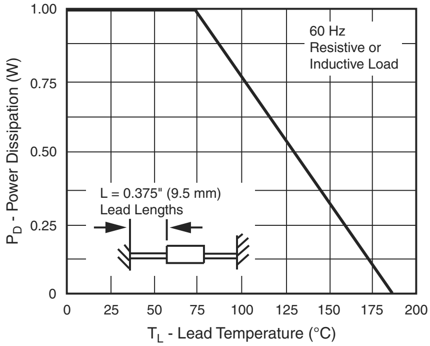


Figure 5. Power Derating Curve

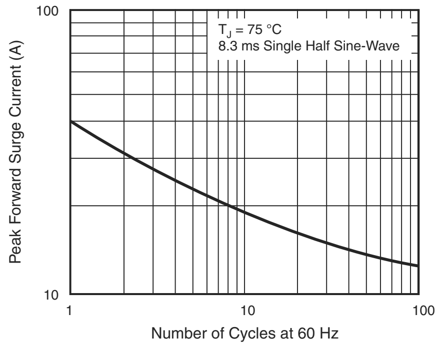
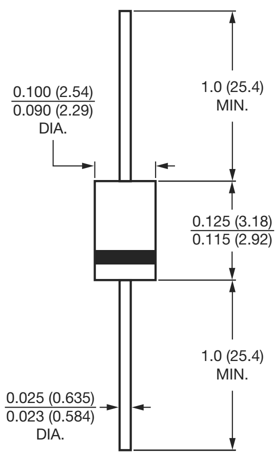


Figure 6. Maximum Non-Repetitive Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

MPG06



Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-214AC (SMA)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 43 V
P_{PPM}	400 W
P_D	1.0 W
I_{FSM}	40 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 400 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020, LF maximum peak of 260 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

MECHANICAL DATA

Case: DO-214AC (SMA)
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak power dissipation with a 10/1000 µs waveform (1)(2) (fig. 3)	P_{PPM}	400	W
Peak power pulse current with a 10/1000 µs waveform (1) (fig. 1)	I_{PPM}	See next table	A
Power dissipation at T_A = 25 °C (4)	P_D	1.0	W
Peak forward surge current 8.3 ms single half sine-wave (3)	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A (3)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Mounted on P.C.B. with 0.2" x 0.2" (5.0 mm x 5.0 mm) copper pads attached to each terminal
(3) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minutes maximum
(4) Mounted on minimum recommended pad layout

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE	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)	T_J = 150 °C MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN.	MAX.						
TPSMA6.8	ADP	6.12	7.48	10	5.50	300	1000	37.0	10.8
TPSMA6.8A	AEP	6.45	7.14	10	5.80	300	1000	38.1	10.5
TPSMA7.5	AFP	6.75	8.25	10	6.05	150	500	34.2	11.7
TPSMA7.5A	AGP	7.13	7.88	10	6.40	150	500	35.4	11.3
TPSMA8.2	AHP	7.38	9.02	10	6.63	50	200	32.0	12.5
TPSMA8.2A	AKP	7.79	8.61	10	7.02	50	200	33.1	12.1
TPSMA9.1	ALP	8.19	10.00	1.0	7.37	10	50	29.0	13.8
TPSMA9.1A	AMP	8.65	9.55	1.0	7.78	10	50	29.9	13.0
TPSMA10	ANP	9.00	11.00	1.0	8.10	5.0	20	26.7	15.0
TPSMA10A	APP	9.50	10.50	1.0	8.65	5.0	20	27.6	14.5
TPSMA11	AQP	9.90	12.10	1.0	8.92	1.0	5.0	24.7	16.2
TPSMA11A	ARP	10.50	11.60	1.0	9.40	1.0	5.0	25.6	15.6
TPSMA12	ASP	10.80	13.20	1.0	9.72	1.0	5.0	23.1	17.3
TPSMA12A	ATP	11.40	12.60	1.0	10.20	1.0	5.0	24.0	16.7
TPSMA13	AUP	11.70	14.30	1.0	10.50	1.0	5.0	21.1	19.0
TPSMA13A	AVP	12.40	13.70	1.0	11.10	1.0	5.0	22.0	18.2
TPSMA15	AWP	13.50	16.30	1.0	12.10	1.0	5.0	18.2	22.0
TPSMA15A	AXP	14.30	15.80	1.0	12.80	1.0	5.0	18.9	21.2
TPSMA16	AYP	14.40	17.60	1.0	12.90	1.0	5.0	17.0	23.5
TPSMA16A	AZP	15.20	16.80	1.0	13.60	1.0	5.0	17.8	22.0
TPSMA18	BDP	16.20	19.80	1.0	14.50	1.0	5.0	15.1	26.5
TPSMA18A	BEP	17.10	18.90	1.0	15.30	1.0	5.0	15.9	25.5
TPSMA20	BFP	18.00	22.00	1.0	16.20	1.0	5.0	13.7	29.1
TPSMA20A	BGP	19.00	21.00	1.0	17.10	1.0	5.0	14.4	27.7
TPSMA22	BHP	19.80	24.20	1.0	17.80	1.0	5.0	12.5	31.9
TPSMA22A	BKP	20.90	23.10	1.0	18.80	1.0	5.0	13.1	30.6
TPSMA24	BLP	21.60	26.40	1.0	19.40	1.0	5.0	11.5	34.7
TPSMA24A	BMP	22.80	25.20	1.0	20.50	1.0	5.0	12.0	33.2
TPSMA27	BNP	24.30	29.70	1.0	21.80	1.0	5.0	10.2	39.1
TPSMA27A	BPP	25.70	28.40	1.0	23.10	1.0	5.0	10.7	37.5
TPSMA30	BQP	27.00	33.00	1.0	24.30	1.0	5.0	9.2	43.5
TPSMA30A	BRP	28.50	31.50	1.0	25.60	1.0	5.0	9.7	41.4
TPSMA33	BSP	29.70	36.30	1.0	26.80	1.0	5.0	8.4	47.0
TPSMA33A	BTP	31.40	34.70	1.0	28.20	1.0	5.0	8.8	45.7
TPSMA36	BUP	32.40	39.60	1.0	29.10	1.0	5.0	7.7	52.0
TPSMA36A	BVP	34.20	37.80	1.0	30.80	1.0	5.0	8.0	49.9
TPSMA39	BWP	35.10	42.90	1.0	31.60	1.0	5.0	7.1	56.4
TPSMA39A	BXP	37.10	41.00	1.0	33.30	1.0	5.0	7.4	53.9
TPSMA43	BYP	38.70	47.30	1.0	34.80	1.0	5.0	6.5	61.9
TPSMA43A	BZP	40.90	45.20	1.0	36.80	1.0	5.0	6.7	59.3

Notes

(1) V_{BR} measured after I_T applied for 300 µs, I_T = square wave pulse or equivalent

(2) Surge current waveform per fig. 3 and derated per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
TPSMA6.8AHE3/61T [(1)]	0.064	61T	1800	7" diameter plastic tape and reel
TPSMA6.8AHE3/5AT [(1)]	0.064	5AT	7500	13" diameter plastic tape and reel

Note
(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

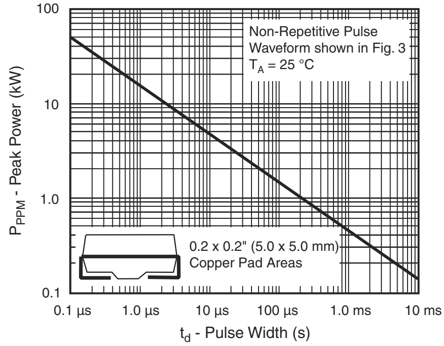


Figure 1. Peak Pulse Power Rating Curve

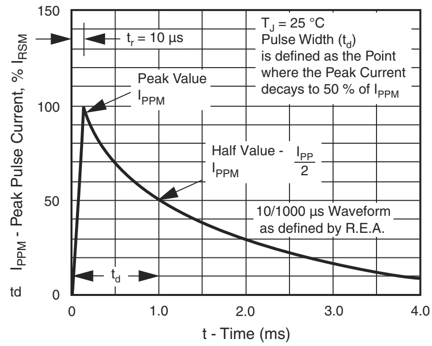


Figure 3. Pulse Waveform

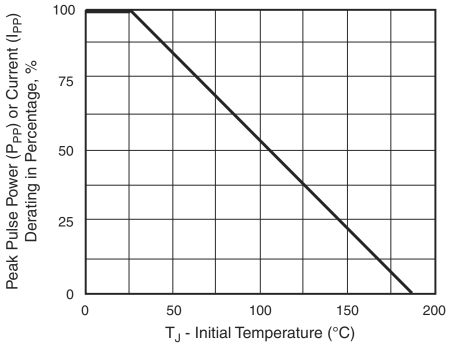


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

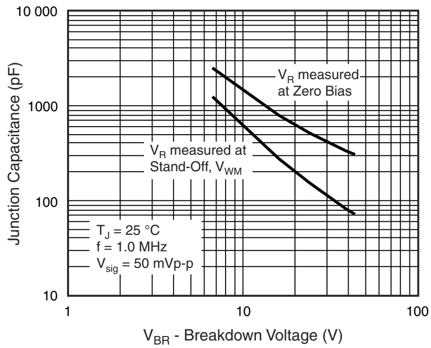


Figure 4. Typical Junction Capacitance

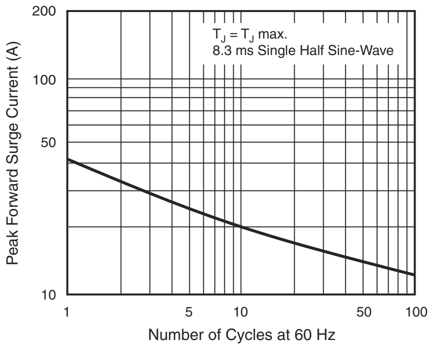
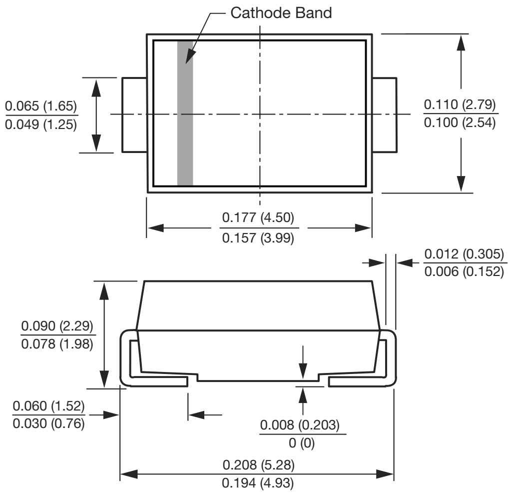


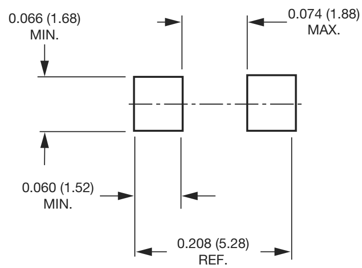
Figure 5. Maximum Non-Repetitive Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-214AC (SMA)

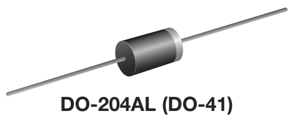


Mounting Pad Layout



PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions



DO-204AL (DO-41)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 43 V
P_{PPM}	400 W
P_D	1.5 W
I_{FSM}	40 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive, and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 400 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 275 °C max. 10 s, per JESD 22-B106
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Pb e3 RoHS COMPLIANT

MECHANICAL DATA

Case: DO-204AL, molded epoxy over passivated junction
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1) (fig. 1)	P_{PPM}	400	W
Peak pulse current with a 10/1000 µs waveform (1) (fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (fig. 5)	P_D	1.5	W
Peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	40	A
Maximum instantaneous forward voltage at 25 A	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) All terms and symbols are consistent with ANSI/IEEE C62.35

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE	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_D (μA)	T_J = 150 °C MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA)	MAXIMUM. PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMPERATURE COEFFICIENT OF V_{BR} (%/°C)
	MIN.	MAX.							
P4KA6.8	6.12	7.48	10	5.50	300	1000	37.0	10.8	0.057
P4KA6.8A	6.45	7.14	10	5.80	300	1000	38.1	10.5	0.057
P4KA7.5	6.75	8.25	10	6.05	150	500	34.2	11.7	0.060
P4KA7.5A	7.13	7.88	10	6.40	150	500	35.4	11.3	0.061
P4KA8.2	7.38	9.02	10	6.63	50	200	32.0	12.5	0.065
P4KA8.2A	7.79	8.61	10	7.02	50	200	33.1	12.1	0.065
P4KA9.1	8.19	10.0	1.0	7.37	10	50	29.0	13.8	0.068
P4KA9.1A	8.65	9.55	1.0	7.78	10	50	29.9	13.4	0.068
P4KA10	9.00	11.0	1.0	8.10	5.0	20	26.7	15.0	0.073
P4KA10A	9.50	10.5	1.0	8.55	5.0	20	27.6	14.5	0.073
P4KA11	9.90	12.1	1.0	8.92	1.0	5.0	24.7	16.2	0.075
P4KA11A	10.5	11.6	1.0	9.40	1.0	5.0	25.6	15.6	0.075
P4KA12	10.8	13.2	1.0	9.72	1.0	5.0	23.1	17.3	0.076
P4KA12A	11.4	12.6	1.0	10.2	1.0	5.0	24.0	16.7	0.078
P4KA13	11.7	14.3	1.0	10.5	1.0	5.0	21.1	19.0	0.081
P4KA13A	12.4	13.7	1.0	11.1	1.0	5.0	22.0	18.2	0.081
P4KA15	13.5	16.3	1.0	12.1	1.0	5.0	18.2	22.0	0.084
P4KA15A	14.3	15.8	1.0	12.8	1.0	5.0	18.9	21.2	0.084
P4KA16	14.4	17.6	1.0	12.9	1.0	5.0	17.0	23.5	0.086
P4KA16A	15.2	16.8	1.0	13.6	1.0	5.0	17.8	22.5	0.086
P4KA18	16.2	19.8	1.0	14.5	1.0	5.0	15.1	26.5	0.088
P4KA18A	17.1	18.9	1.0	15.3	1.0	5.0	15.9	25.5	0.088
P4KA20	18.0	22.0	1.0	16.2	1.0	5.0	13.7	29.1	0.090
P4KA20A	19.0	21.0	1.0	17.0	1.0	5.0	14.4	27.7	0.090
P4KA22	19.8	24.2	1.0	17.8	1.0	5.0	12.5	31.9	0.092
P4KA22A	20.9	23.1	1.0	18.8	1.0	5.0	13.1	30.6	0.092
P4KA24	21.6	26.4	1.0	19.4	1.0	5.0	11.5	34.2	0.094
P4KA24A	22.8	25.2	1.0	20.5	1.0	5.0	12.0	33.2	0.094
P4KA27	24.3	29.7	1.0	21.8	1.0	5.0	10.2	39.1	0.096
P4KA27A	25.7	28.4	1.0	23.1	1.0	5.0	10.7	37.5	0.096
P4KA30	27.0	33.0	1.0	24.3	1.0	5.0	9.2	43.5	0.097
P4KA30A	28.5	31.5	1.0	25.6	1.0	5.0	9.7	41.4	0.097
P4KA33	29.7	36.3	1.0	26.8	1.0	5.0	8.4	47.7	0.098
P4KA33A	31.4	34.7	1.0	28.2	1.0	5.0	8.8	45.7	0.098
P4KA36	32.4	39.6	1.0	29.1	1.0	5.0	7.7	52.0	0.099
P4KA36A	34.2	37.8	1.0	30.8	1.0	5.0	8.0	49.9	0.099
P4KA39	35.1	42.9	1.0	31.6	1.0	5.0	7.1	56.4	0.100
P4KA39A	37.1	41.0	1.0	33.3	1.0	5.0	7.4	53.9	0.100
P4KA43	38.7	47.3	1.0	34.8	1.0	5.0	6.5	61.9	0.101
P4KA43A	40.9	45.2	1.0	36.8	1.0	5.0	6.7	59.3	0.101

Notes

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per fig. 3 and derated per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
P4KA6.8AHE3/54 (1)	0.336	54	5500	13" diameter paper tape and reel

Note
(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

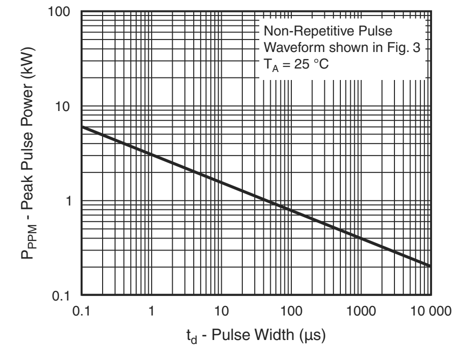


Figure 1. Peak Pulse Power Rating Curve

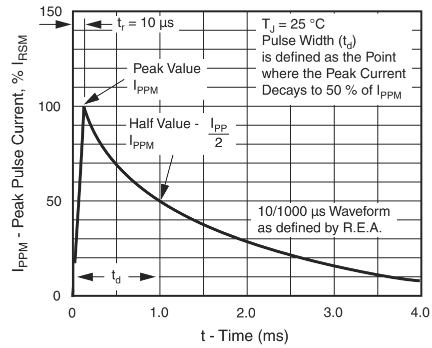


Figure 3. Pulse Waveform

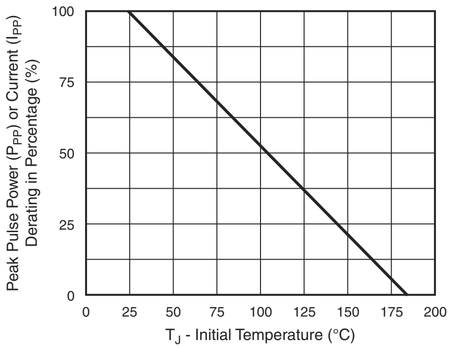


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

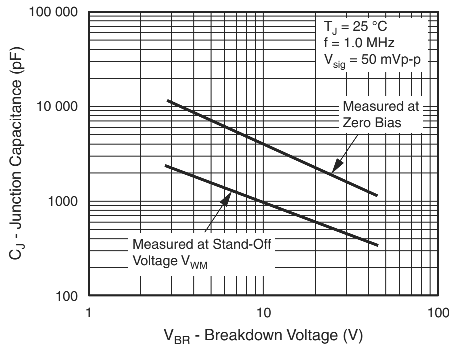


Figure 4. Typical Junction Capacitance

For technical questions within your region, please contact one of the following:
DiodesAmericas@vishay.com, DiodesAsia@vishay.com, DiodesEurope@vishay.com
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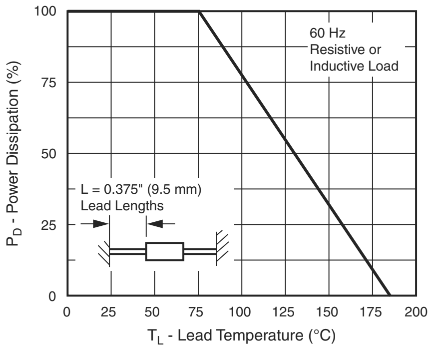


Figure 5. Power Derating Curve

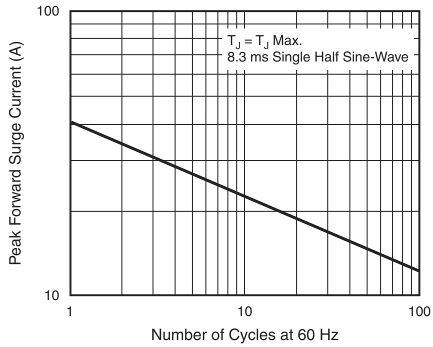
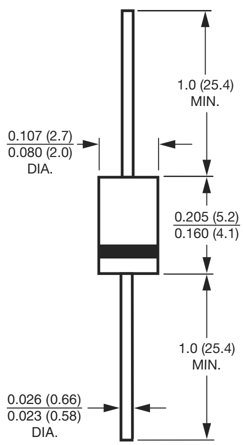


Figure 6. Maximum Non-Repetitive/Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

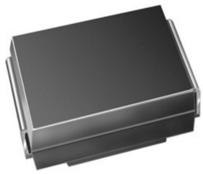
DO-204AL (DO-41)



Available in uni-directional only

Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions



DO-214AA (SMB)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 43 V
P_{PPM}	600 W
I_{FSM}	75 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 600 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020, LF maximum peak of 260 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS
COMPLIANT

MECHANICAL DATA

Case: DO-214AA (SMB)
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (fig. 1)	P_{PPM}	600	W
Peak pulse current with a 10/1000 µs waveform (1) (fig. 3)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave (2)(3)	I_{FSM}	75	A
Instantaneous forward voltage at 50 A (3)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes
(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Mounted on 0.2" x 0.2" (5.0 mm x 5.0 mm) land areas per figure
(3) Mounted on 8.3 ms single half sine-wave duty cycle = 4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)										
DEVICE	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_D (µA)	T_J = 150 °C MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} [(2)] (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN.	MAX.						
TPSMB6.8	KDP	6.12	7.48	10	5.50	500	1000	55.6	10.8
TPSMB6.8A	KEP	6.45	7.14	10	5.80	500	1000	57.1	10.5
TPSMB7.5	KFP	6.75	8.25	10	6.05	250	500	51.3	11.7
TPSMB7.5A	KGP	7.13	7.88	10	6.40	250	500	53.1	11.3
TPSMB8.2	KHP	7.38	9.02	10	6.63	100	200	48.0	12.5
TPSMB8.2A	KKP	7.79	8.61	10	7.02	100	200	49.6	12.1
TPSMB9.1	KLP	8.19	10.0	1.0	7.37	25.0	50.0	43.5	13.8
TPSMB9.1A	KMP	8.65	9.55	1.0	7.78	25.0	50.0	44.8	13.4
TPSMB10	KNP	9.00	11.0	1.0	8.10	5.0	20.0	40.0	15.0
TPSMB10A	KPP	9.50	10.5	1.0	8.55	5.0	20.0	41.4	14.5
TPSMB11	KQP	9.90	12.1	1.0	8.92	2.0	5.0	37.0	16.2
TPSMB11A	KRP	10.5	11.6	1.0	9.40	2.0	5.0	38.5	15.6
TPSMB12	KSP	10.8	13.2	1.0	9.72	2.0	5.0	34.7	17.3
TPSMB12A	KTP	11.4	12.6	1.0	10.2	2.0	5.0	35.9	16.7
TPSMB13	KUP	11.7	14.3	1.0	10.5	2.0	5.0	31.6	19.0
TPSMB13A	KVP	12.4	13.7	1.0	11.1	2.0	5.0	33.0	18.2
TPSMB15	KWP	13.5	16.5	1.0	12.1	1.0	5.0	27.3	22.0
TPSMB15A	KXP	14.3	15.8	1.0	12.8	1.0	5.0	28.3	21.2
TPSMB16	KYP	14.4	17.6	1.0	12.9	1.0	5.0	25.5	23.5
TPSMB16A	KZP	15.2	16.8	1.0	13.6	1.0	5.0	26.7	22.5
TPSMB18	LDP	16.2	19.8	1.0	14.5	1.0	5.0	22.6	26.5
TPSMB18A	LEP	17.1	18.9	1.0	15.3	1.0	5.0	23.8	25.2
TPSMB20	LFP	18.0	22.0	1.0	16.2	1.0	5.0	20.6	29.1
TPSMB20A	LGP	19.0	21.0	1.0	17.1	1.0	5.0	21.7	27.7
TPSMB22	LHP	19.8	24.2	1.0	17.8	1.0	5.0	18.8	31.9
TPSMB22A	LKP	20.9	23.1	1.0	18.8	1.0	5.0	19.6	30.6
TPSMB24	LLP	21.6	26.4	1.0	19.4	1.0	5.0	17.3	34.7
TPSMB24A	LMP	22.8	25.2	1.0	20.5	1.0	5.0	18.1	33.2
TPSMB27	LNP	24.3	29.7	1.0	21.8	1.0	5.0	15.3	39.1
TPSMB27A	LPP	25.7	28.4	1.0	23.1	1.0	5.0	16.0	37.5
TPSMB30	LQP	27.0	33.0	1.0	24.3	1.0	5.0	13.8	43.5
TPSMB30A	LRP	28.5	31.5	1.0	25.6	1.0	5.0	14.5	41.4
TPSMB33	LSP	29.7	36.3	1.0	26.8	1.0	5.0	12.6	47.7
TPSMB33A	LTP	31.4	34.7	1.0	28.2	1.0	5.0	13.1	45.7
TPSMB36	LUP	32.4	39.6	1.0	29.1	1.0	5.0	11.5	52.0
TPSMB36A	LVP	34.2	37.8	1.0	30.8	1.0	5.0	12.0	49.9
TPSMB39	LWP	35.1	42.9	1.0	31.6	1.0	5.0	10.6	56.4
TPSMB39A	LXP	37.1	41.0	1.0	33.3	1.0	5.0	11.1	53.9
TPSMB43	LYP	38.7	47.3	1.0	34.8	1.0	5.0	9.70	61.9
TPSMB43A	LZP	40.9	45.2	1.0	36.8	1.0	5.0	10.1	59.3

Notes

(1) V_{BR} measured after I_T applied for 300 µs, I_T = square wave pulse or equivalent
(2) Surge current waveform per fig. 3 and derated per fig. 2
(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
TPSMB6.8AHE3/52T [(1)]	0.096	52T	750	7" diameter plastic tape and reel
TPSMB6.8AHE3/5BT [(1)]	0.096	5BT	3200	13" diameter plastic tape and reel

Note

(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

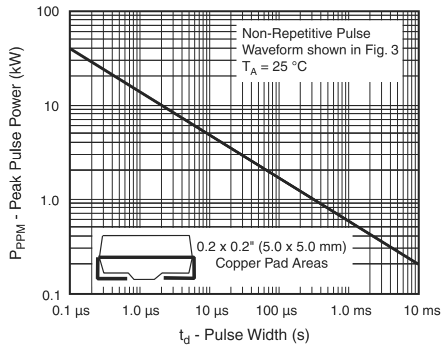


Figure 1. Peak Pulse Power Rating Curve

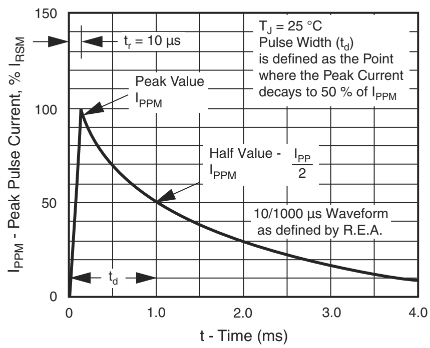


Figure 3. Pulse Waveform

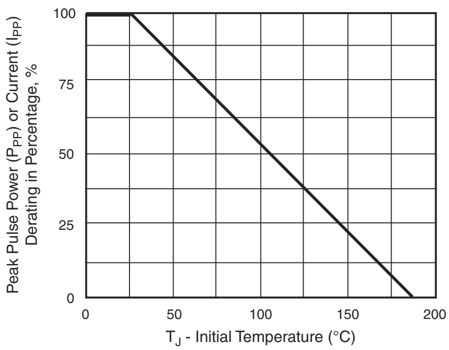


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

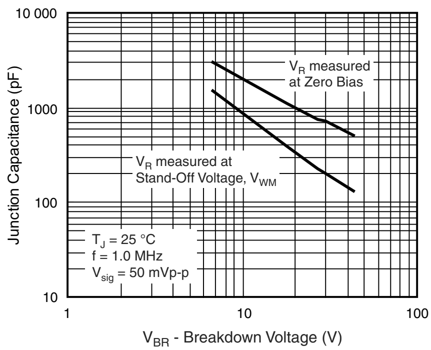


Figure 4. Typical Junction Capacitance

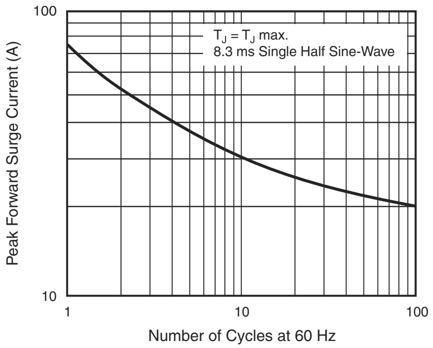
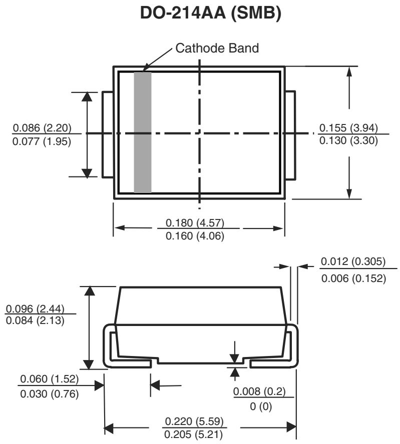
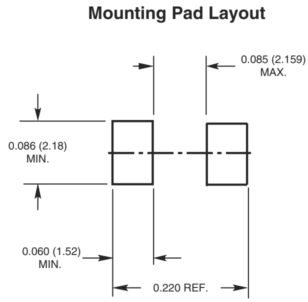


Figure 5. Maximum Non-Repetitive Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)





PAR® Transient Voltage Suppressors

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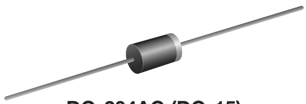


DO-204AC (DO-15)

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 43 V
P_{PPM}	600 W
P_D	5.0 W
I_{FSM}	75 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive, and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 600 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 275 °C max. 10 s, per JESD 22-B106
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Pb e3 RoHS COMPLIANT

MECHANICAL DATA

Case: DO-204AC, molded epoxy over passivated junction
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs (1) (fig. 1)	P_{PPM}	600	W
Pulse pulse current with a 10/1000 µs waveform (1) (fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (fig. 5)	P_D	5.0	W
Peak forward surge current, 8.3 ms single half sine-wave (2)	I_{FSM}	75	A
Maximum instantaneous forward voltage at 50 A (2)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 per minute maximum

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} [(1)] AT I_T (V)		TEST CURRENT I_T (A)	STAND-OFF VOLTAGE V_{WM} (V)	Maximum Reverse Leakage at V_{WM} I_D (µA)	T_J = 150 °C Maximum Reverse Leakage at V_{WM} I_D (µA)	PEAK PULSE CURRENT I_{PPM} [(2)] (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMP. COEFFICIENT OF V_{BR} (%/°C)
	MIN.	MAX.							
P6KA6.8	6.12	7.48	10	5.50	500	1000	55.6	10.8	0.057
P6KA6.8A	6.45	7.14	10	5.80	500	1000	57.1	10.5	0.057
P6KA7.5	6.75	8.25	10	6.05	250	500	51.3	11.7	0.061
P6KA7.5A	7.13	7.88	10	6.40	250	500	53.1	11.3	0.061
P6KA8.2	7.38	9.02	10	6.63	100	200	48.0	12.5	0.065
P6KA8.2A	7.79	8.61	10	7.02	100	200	49.6	12.1	0.065
P6KA9.1	8.19	10.0	1.0	7.37	25	50	43.5	13.8	0.068
P6KA9.1A	8.65	9.55	1.0	7.78	25	50	44.8	13.4	0.068
P6KA10	9.00	11.0	1.0	8.10	10	20	40.0	15.0	0.073
P6KA10A	9.50	10.5	1.0	8.55	10	20	41.4	14.5	0.073
P6KA11	9.90	12.1	1.0	8.92	5.0	5.0	37.0	16.2	0.075
P6KA11A	10.5	11.6	1.0	9.40	5.0	5.0	38.5	15.6	0.076
P6KA12	10.8	13.2	1.0	9.72	2.0	5.0	34.7	17.3	0.076
P6KA12A	11.4	12.6	1.0	10.2	2.0	5.0	35.9	16.7	0.078
P6KA13	11.7	14.3	1.0	10.5	2.0	5.0	31.6	19.0	0.081
P6KA13A	12.4	13.7	1.0	11.1	2.0	5.0	33.0	18.2	0.081
P6KA15	13.5	16.3	1.0	12.1	1.0	5.0	27.3	22.0	0.084
P6KA15A	14.3	15.8	1.0	12.8	1.0	5.0	28.3	21.2	0.084
P6KA16	14.4	17.6	1.0	12.9	1.0	5.0	25.5	23.5	0.086
P6KA16A	15.2	16.8	1.0	13.6	1.0	5.0	26.7	22.5	0.080
P6KA18	16.2	19.8	1.0	14.5	1.0	5.0	22.6	26.5	0.088
P6KA18A	17.1	18.9	1.0	15.3	1.0	5.0	23.8	25.2	0.088
P6KA20	18.0	22.0	1.0	16.2	1.0	5.0	20.6	29.1	0.090
P6KA20A	19.0	21.0	1.0	17.1	1.0	5.0	21.7	27.7	0.090
P6KA22	19.8	24.2	1.0	17.8	1.0	5.0	18.8	31.9	0.092
P6KA22A	20.9	23.1	1.0	18.8	1.0	5.0	19.6	30.6	0.092
P6KA24	21.6	26.4	1.0	19.4	1.0	5.0	17.3	34.7	0.094
P6KA24A	22.8	25.2	1.0	20.5	1.0	5.0	18.1	33.6	0.094
P6KA27	24.3	29.7	1.0	21.8	1.0	5.0	15.3	39.1	0.096
P6KA27A	25.7	28.4	1.0	23.1	1.0	5.0	16.0	37.5	0.096
P6KA30	27.0	33.0	1.0	24.3	1.0	5.0	13.8	43.5	0.097
P6KA30A	28.5	31.5	1.0	25.6	1.0	5.0	14.5	41.4	0.097
P6KA33	29.7	36.3	1.0	26.8	1.0	5.0	12.6	47.7	0.098
P6KA33A	31.4	34.7	1.0	28.2	1.0	5.0	13.1	45.7	0.098
P6KA36	32.4	39.6	1.0	29.1	1.0	5.0	11.5	52.0	0.099
P6KA36A	34.2	37.8	1.0	30.8	1.0	5.0	12.0	49.9	0.099
P6KA39	35.1	42.9	1.0	31.6	1.0	5.0	10.6	56.4	0.100
P6KA39A	37.1	41.0	1.0	33.3	1.0	5.0	11.1	53.9	0.100
P6KA43	38.7	47.3	1.0	34.8	1.0	5.0	9.7	61.9	0.101
P6KA43A	40.9	45.2	1.0	36.8	1.0	5.0	10.1	59.3	0.101

Notes

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per fig. 3 and derate per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
P6KA6.8AHE3/54 [(1)]	0.415	54	4000	13" diameter paper tape and reel

Note

(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

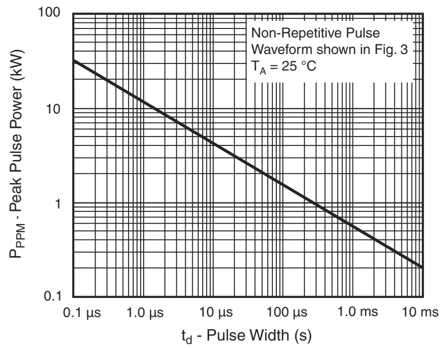


Figure 1. Peak Pulse Power Rating Curve

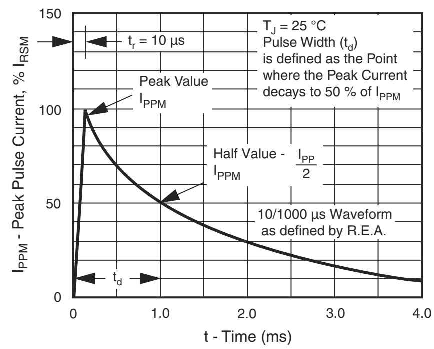


Figure 3. Pulse Waveform

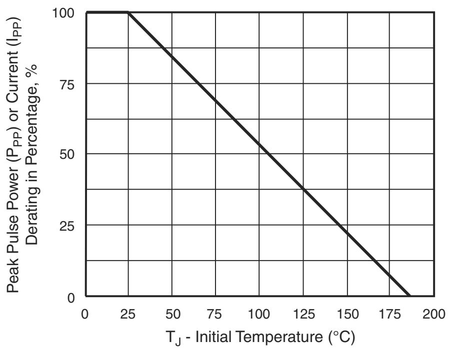


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

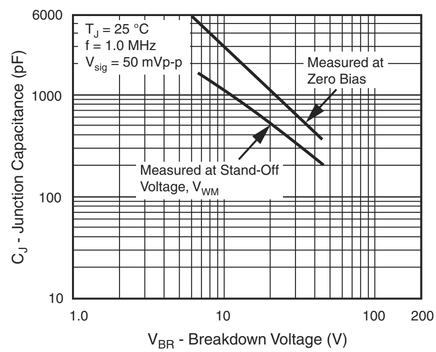


Figure 4. Typical Junction Capacitance

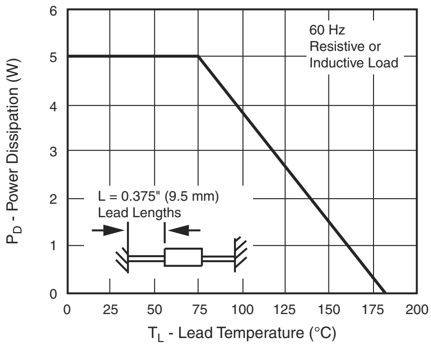


Figure 5. Power Derating Curve

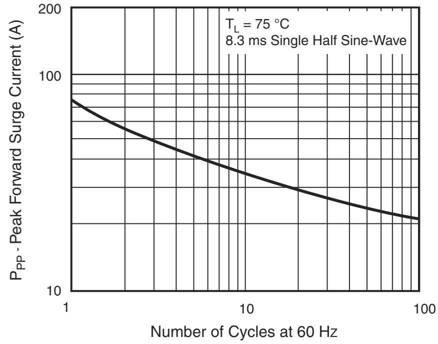
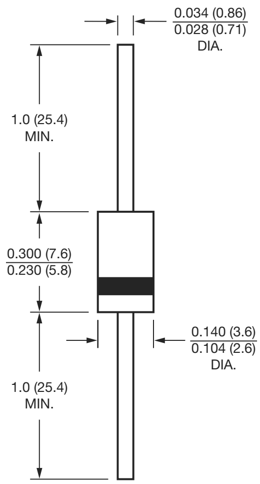


Figure 6. Maximum Non-Repetitive Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AC (DO-15)

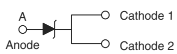


Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

eSMP™ Series

TO-277A (SMPC)



PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 43 V
P_{PPM}	1500 W
I_{FSM}	200 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Very low profile - typical height of 1.1 mm
- Ideal for automated placement
- Uni-direction only
- Excellent clamping capability
- Low incremental surge resistance
- Very fast response time
- Meets MSL level 1, per J-STD-020C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC
- **Halogen-free according to IEC 61249-2-21 definition**

MECHANICAL DATA

Case: TO-277A (SMPC)

Molding compound meets UL 94 V-0 flammability rating
Base P/NHM3 - halogen-free, RoHS compliant, and automotive grade

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HM3 suffix meets JESD 201 class 2 whisker test

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (fig. 3)	P_{PPM}	1500	W
Peak power pulse current with a 10/1000 µs waveform (1) (fig. 1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	200	A
Maximum instantaneous forward voltage at 100 A (3)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Measured on 8.3 ms single half sine-wave, or equivalent square wave, duty cycle = 4 pulses per minute maximum
(3) Pulse test: 300 µs pulse width, 1 % duty cycle

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)	T_J = 150 °C MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN.	MAX.						
TPC6.8	DDP	6.12	7.48	10.0	5.50	1500	10 000	139.0	10.8
TPC6.8A	DEP	6.45	7.14	10.0	5.80	1500	10 000	143.0	10.5
TPC7.5	DFP	6.75	8.25	10.0	6.05	500	5000	128.0	11.7
TPC7.5A	DGP	7.13	7.88	10.0	6.40	500	5000	133.0	11.3
TPC8.2	DHP	7.38	9.02	10.0	6.63	200	2000	120.0	12.5
TPC8.2A	DKP	7.79	8.61	10.0	7.02	200	2000	124.0	12.1
TPC9.1	DLP	8.19	10.0	1.0	7.37	50	500	109.0	13.8
TPC9.1A	DMP	8.65	9.55	1.0	7.78	50	500	112.0	13.4
TPC10	DNP	9.00	11.0	1.0	8.10	20	200	100.0	15.0
TPC10A	DPP	9.50	10.5	1.0	8.55	20	200	103.0	14.5
TPC11	DQP	9.90	12.1	1.0	8.92	5.0	50	92.6	16.2
TPC11A	DRP	10.5	11.6	1.0	9.40	5.0	50	96.2	15.6
TPC12	DSP	10.8	13.2	1.0	9.72	2.0	10	86.7	17.3
TPC12A	DTP	11.4	12.6	1.0	10.2	2.0	10	89.8	16.7
TPC13	DUP	11.7	14.3	1.0	10.5	2.0	10	78.9	19.0
TPC13A	DVP	12.4	13.7	1.0	11.1	2.0	10	82.4	18.2
TPC15	DWP	13.5	16.5	1.0	12.1	1.0	10	68.2	22.0
TPC15A	DXP	14.3	15.8	1.0	12.8	1.0	10	70.8	21.2
TPC16	DYP	14.4	17.6	1.0	12.9	1.0	10	63.8	23.5
TPC16A	DZP	15.2	16.8	1.0	13.6	1.0	10	66.7	22.5
TPC18	EDP	16.2	19.8	1.0	14.5	1.0	10	56.6	26.5
TPC18A	EEP	17.1	18.9	1.0	15.3	1.0	10	59.5	25.2
TPC20	EFP	18.0	22.0	1.0	16.2	1.0	10	51.5	29.1
TPC20A	EGP	19.0	21.0	1.0	17.1	1.0	10	54.2	27.7
TPC22	EHP	19.8	24.2	1.0	17.8	1.0	10	47.0	31.9
TPC22A	EKP	20.9	23.1	1.0	18.8	1.0	10	49.0	30.6
TPC24	ELP	21.6	26.4	1.0	19.4	1.0	10	43.2	34.7
TPC24A	EMP	22.8	25.2	1.0	20.5	1.0	10	45.2	33.2
TPC27	ENP	24.3	29.7	1.0	21.8	1.0	10	38.4	39.1
TPC27A	EPP	25.7	28.4	1.0	23.1	1.0	10	40.0	37.5
TPC30	EQP	27.0	33.0	1.0	24.3	1.0	10	34.5	43.5
TPC30A	ERP	28.5	31.5	1.0	25.6	1.0	10	36.2	41.4
TPC33	ESP	29.7	36.3	1.0	26.8	1.0	10	31.4	47.7
TPC33A	ETP	31.4	34.7	1.0	28.2	1.0	10	32.8	45.7
TPC36	EUP	32.4	39.6	1.0	29.1	1.0	15	28.8	52.0
TPC36A	EVP	34.2	37.8	1.0	30.8	1.0	15	30.1	49.9
TPC39	EWP	35.1	42.9	1.0	31.6	1.0	15	26.6	56.4
TPC39A	EXP	37.1	41.0	1.0	33.3	1.0	15	27.8	53.9
TPC43	EYP	38.7	47.3	1.0	34.8	1.0	20	24.2	61.9
TPC43A	EZP	40.9	45.2	1.0	36.8	1.0	20	25.3	59.3

Notes

(1) V_{BR} measured after I_T applied for 300 μs, I_T = square wave pulse or equivalent

(2) Surge current waveform per fig. 3 and derated per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
TPC10AHM3/86A (1)	0.10	86A	1500	7" diameter plastic tape and reel
TPC10AHM3/87A (1)	0.10	87A	6500	13" diameter plastic tape and reel

Note

(1) Automotive grade

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

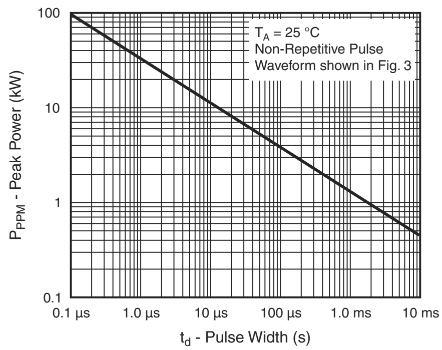


Figure 1. Peak Pulse Power Rating Curve

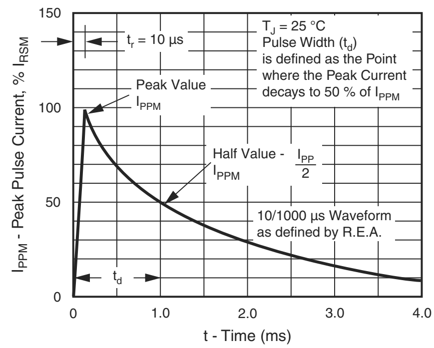


Figure 3. Pulse Waveform

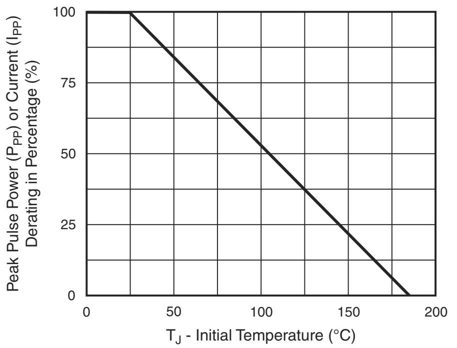


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

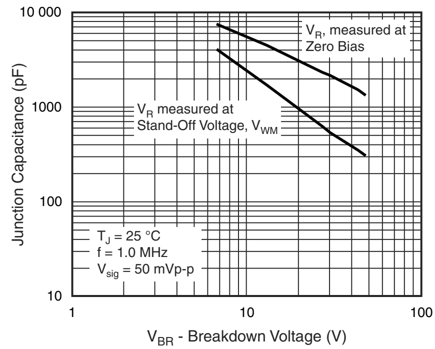
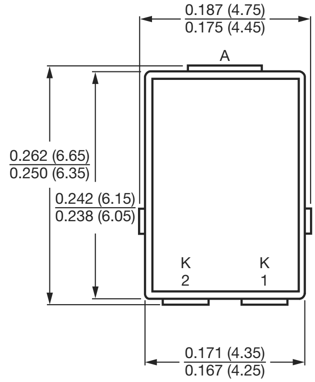
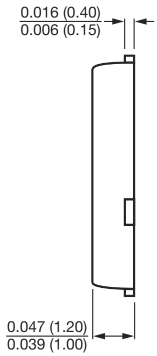


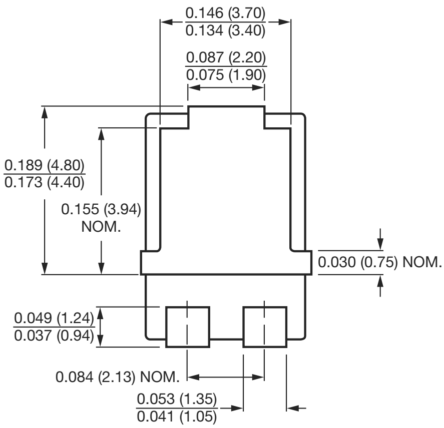
Figure 4. Typical Junction Capacitance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

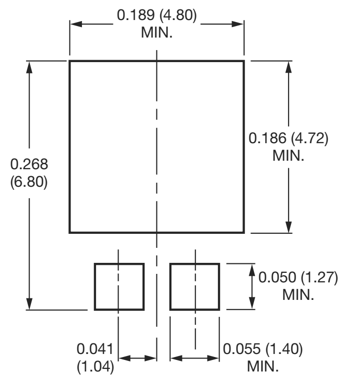
TO-277A (SMPC)







Mounting Pad Layout



Conform to JEDEC TO-277A

Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-214AB (SMC)

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 1500 W peak pulse power capability with a 10/1000 µs waveform
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020, LF maximum peak of 260 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 47 V
P_{PPM}	1500 W
I_{FSM}	200 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

MECHANICAL DATA

Case: DO-214AB (SMC)
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2) (fig. 3)	P_{PPM}	1500	W
Peak power pulse current with a 10/1000 µs waveform (1) (fig. 1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave (2)(3)	I_{FSM}	200	A
Maximum instantaneous forward voltage at 100 A (2)(3)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Mounted on 0.31" x 0.31" (8.0 mm x 8.0 mm) copper pads at each terminal
(3) Measured on 8.3 ms single half sine-wave, or equivalent square wave, duty cycle = 4 pulses per minute maximum

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)	T_J = 150 °C MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN.	MAX.						
TPSMC6.8	DDP	6.12	7.48	10.0	5.50	1000	10000	139.0	10.8
TPSMC6.8A	DEP	6.45	7.14	10.0	5.80	1000	10000	143.0	10.5
TPSMC7.5	DFP	6.75	8.25	10.0	6.05	500	5000	128.0	11.7
TPSMC7.5A	DGP	7.13	7.88	10.0	6.40	500	5000	133.0	11.3
TPSMC8.2	DHP	7.38	9.02	10.0	6.63	200	2000	120.0	12.5
TPSMC8.2A	DKP	7.79	8.61	10.0	7.02	200	2000	124.0	12.1
TPSMC9.1	DLP	8.19	10.0	1.0	7.37	50	500	109.0	13.8
TPSMC9.1A	DMP	8.65	9.55	1.0	7.78	50	500	112.0	13.4
TPSMC10	DNP	9.00	11.0	1.0	8.10	20	200	100.0	15.0
TPSMC10A	DPP	9.50	10.5	1.0	8.55	20	200	103.0	14.5
TPSMC11	DQP	9.90	12.1	1.0	8.92	5.0	50	92.6	16.2
TPSMC11A	DRP	10.5	11.6	1.0	9.40	5.0	50	96.2	15.6
TPSMC12	DSP	10.8	13.2	1.0	9.72	2.0	10	86.7	17.3
TPSMC12A	DTP	11.4	12.6	1.0	10.2	2.0	10	89.8	16.7
TPSMC13	DUP	11.7	14.3	1.0	10.5	2.0	10	78.9	19.0
TPSMC13A	DVP	12.4	13.7	1.0	11.1	2.0	10	82.4	18.2
TPSMC15	DWP	13.5	16.5	1.0	12.1	1.0	10	68.2	22.0
TPSMC15A	DXP	14.3	15.8	1.0	12.8	1.0	10	70.8	21.2
TPSMC16	DYP	14.4	17.6	1.0	12.9	1.0	10	63.8	23.5
TPSMC16A	DZP	15.2	16.8	1.0	13.6	1.0	10	66.7	22.5
TPSMC18	EDP	16.2	19.8	1.0	14.5	1.0	10	56.6	26.5
TPSMC18A	EEP	17.1	18.9	1.0	15.3	1.0	10	59.5	25.2
TPSMC20	EFP	18.0	22.0	1.0	16.2	1.0	10	51.5	29.1
TPSMC20A	EGP	19.0	21.0	1.0	17.1	1.0	10	54.2	27.7
TPSMC22	EHP	19.8	24.2	1.0	17.8	1.0	10	47.0	31.9
TPSMC22A	EKP	20.9	23.1	1.0	18.8	1.0	10	49.0	30.6
TPSMC24	ELP	21.6	26.4	1.0	19.4	1.0	10	43.2	34.7
TPSMC24A	EMP	22.8	25.2	1.0	20.5	1.0	10	45.2	33.2
TPSMC27	ENP	24.3	29.7	1.0	21.8	1.0	10	38.4	39.1
TPSMC27A	EPP	25.7	28.4	1.0	23.1	1.0	10	40.0	37.5
TPSMC30	EQP	27.0	33.0	1.0	24.3	1.0	10	34.5	43.5
TPSMC30A	ERP	28.5	31.5	1.0	25.6	1.0	10	36.2	41.4
TPSMC33	ESP	29.7	36.3	1.0	26.8	1.0	10	31.4	47.7
TPSMC33A	ETP	31.4	34.7	1.0	28.2	1.0	10	32.8	45.7
TPSMC36	EUP	32.4	39.6	1.0	29.1	1.0	15	28.8	52.0
TPSMC36A	EVP	34.2	37.8	1.0	30.8	1.0	15	30.1	49.9
TPSMC39	EWP	35.1	42.9	1.0	31.6	1.0	15	26.6	56.4
TPSMC39A	EXP	37.1	41.0	1.0	33.3	1.0	15	27.8	53.9
TPSMC43	EYP	38.7	47.3	1.0	34.8	1.0	20	24.2	61.9
TPSMC43A	EZP	40.9	45.2	1.0	36.8	1.0	20	25.3	59.3
TPSMC47	FDP	42.3	51.7	1.0	38.1	1.0	20	22.1	67.8
TPSMC47A	FEP	44.7	49.4	1.0	40.2	1.0	20	23.1	64.8

Notes

(1) V_{BR} measured after I_T applied for 300 µs, I_T = square wave pulse or equivalent
(2) Surge current waveform per fig. 3 and derated per fig. 2
(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
TPSMC6.8AHE3/57T [(1)]	0.211	57T	850	7" diameter plastic tape and reel
TPSMC6.8AHE3/9AT [(1)]	0.211	9AT	3500	13" diameter plastic tape and reel

Note

(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

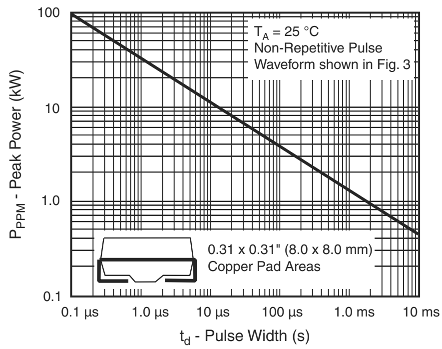


Figure 1. Peak Pulse Power Rating Curve

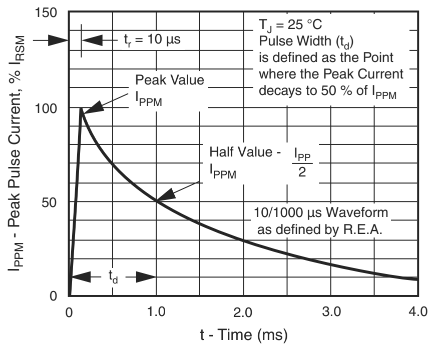


Figure 3. Pulse Waveform

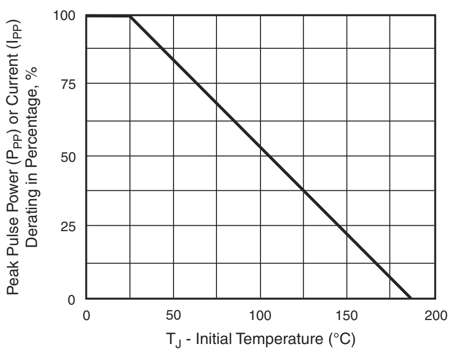


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

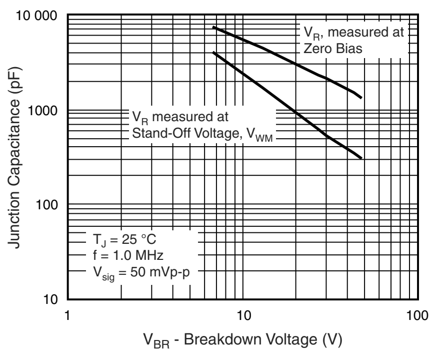


Figure 4. Typical Junction Capacitance

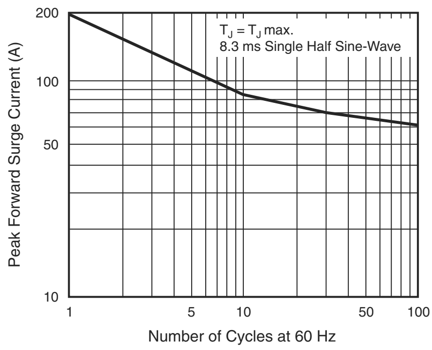
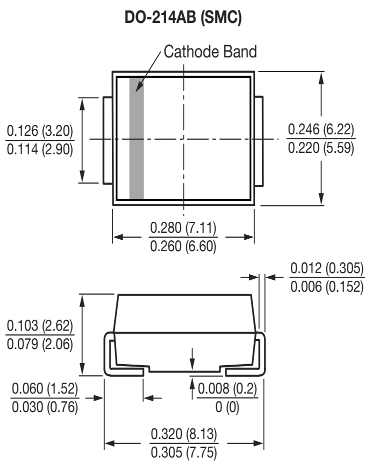
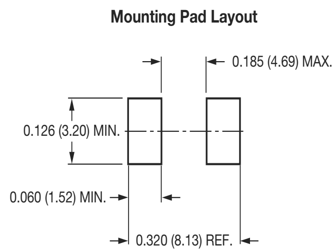


Figure 5. Maximum Non-Repetitive/Peak Forward Surge Current

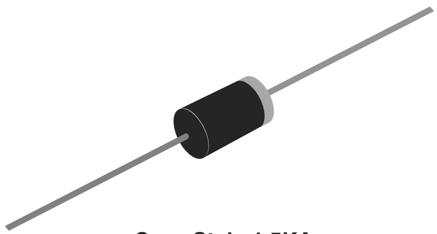
PACKAGE OUTLINE DIMENSIONS in inches (millimeters)





PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions



Case Style 1.5KA

PRIMARY CHARACTERISTICS	
V_{BR}	6.8 V to 47 V
P_{PPM}	1500 W
P_D	6.5 W
I_{FSM}	200 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 1500 W peak pulse power capability with a 10/1000 µs waveform
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 275 °C max. 10 s, per JESD 22-B106
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

MECHANICAL DATA

Case: Molded epoxy body over passivated junction
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1) (fig. 1)	P_{PPM}	1500	W
Peak pulse current at T_A = 25 °C with a 10/1000 µs waveform (1) (fig. 3)	I_{PPM}	See next table	A
Power dissipation on infinite heatsink at T_L = 75 °C (fig. 5)	P_D	6.5	W
Peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	200	A
Maximum instantaneous forward voltage at 100 A (2)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes
(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
DEVICE TYPE	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_D (µA)	T_J = 150 °C MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	PEAK PULSE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)	MAXIMUM TEMP. COEFFICIENT OF V_{BR} (%/°C)
	MIN.	MAX.							
1.5KA6.8	6.12	7.48	10	5.50	1000	10 000	139	10.8	0.057
1.5KA6.8A	6.45	7.14	10	5.80	1000	10 000	143	10.5	0.057
1.5KA7.5	6.75	8.25	10	6.05	500	5000	128	11.7	0.061
1.5KA7.5A	7.13	7.88	10	6.40	500	5000	133	11.3	0.061
1.5KA8.2	7.38	9.02	10	6.63	200	2000	120	12.5	0.065
1.5KA8.2A	7.79	8.61	10	7.02	200	2000	124	12.1	0.065
1.5KA9.1	8.19	10.0	1.0	7.37	50	500	109	13.8	0.068
1.5KA9.1A	8.65	9.55	1.0	7.78	50	500	112	13.4	0.068
1.5KA10	9.00	11.0	1.0	8.10	20	200	100	15.0	0.073
1.5KA10A	9.50	10.5	1.0	8.55	20	200	103	14.5	0.073
1.5KA11	9.90	12.1	1.0	8.92	5.0	50	92.6	16.2	0.075
1.5KA11A	10.5	11.6	1.0	9.40	5.0	50	96.2	15.6	0.076
1.5KA12	10.8	13.2	1.0	9.72	2.0	10	86.7	17.3	0.076
1.5KA12A	11.4	12.6	1.0	10.2	2.0	10	89.8	16.7	0.078
1.5KA13	11.7	14.3	1.0	10.5	2.0	10	78.9	19.0	0.081
1.5KA13A	12.4	13.7	1.0	11.1	2.0	10	82.4	18.2	0.081
1.5KA15	13.5	16.3	1.0	12.1	1.0	10	68.2	22.0	0.084
1.5KA15A	14.3	15.8	1.0	12.8	1.0	10	70.8	21.2	0.084
1.5KA16	14.4	17.6	1.0	12.9	1.0	10	63.8	23.5	0.086
1.5KA16A	15.2	16.8	1.0	13.6	1.0	10	66.7	22.5	0.086
1.5KA18	16.2	19.8	1.0	14.5	1.0	10	56.6	26.5	0.088
1.5KA18A	17.1	18.9	1.0	15.3	1.0	10	59.5	25.2	0.088
1.5KA20	18.0	22.0	1.0	16.2	1.0	10	51.5	29.1	0.090
1.5KA20A	19.0	21.0	1.0	17.1	1.0	10	54.2	27.7	0.090
1.5KA22	19.8	24.2	1.0	17.8	1.0	10	47.0	31.9	0.092
1.5KA22A	20.9	23.1	1.0	18.8	1.0	10	49.0	30.6	0.092
1.5KA24	21.6	26.4	1.0	19.4	1.0	10	43.2	34.7	0.094
1.5KA24A	22.8	25.2	1.0	20.5	1.0	10	45.2	33.2	0.094
1.5KA27	24.3	29.7	1.0	21.8	1.0	10	38.4	39.1	0.096
1.5KA27A	25.7	28.4	1.0	23.1	1.0	10	40.0	37.5	0.096
1.5KA30	27.0	33.0	1.0	24.3	1.0	10	34.5	43.5	0.097
1.5KA30A	28.5	31.5	1.0	25.6	1.0	10	36.2	41.4	0.097
1.5KA33	29.7	36.3	1.0	26.8	1.0	10	31.4	47.7	0.098
1.5KA33A	31.4	34.7	1.0	28.2	1.0	10	32.8	45.7	0.098
1.5KA36	32.4	39.6	1.0	29.1	1.0	10	28.8	52.0	0.099
1.5KA36A	34.2	37.8	1.0	30.8	1.0	10	30.1	49.9	0.099
1.5KA39	35.1	42.9	1.0	31.6	1.0	10	26.6	56.4	0.100
1.5KA39A	37.1	41.0	1.0	33.3	1.0	10	27.8	53.9	0.100
1.5KA43	38.7	47.3	1.0	34.8	1.0	20	24.2	61.9	0.101
1.5KA43A	40.9	45.2	1.0	36.8	1.0	20	25.3	59.3	0.101
1.5KA47	42.3	51.7	1.0	38.1	1.0	20	22.1	67.8	0.101
1.5KA47A	44.7	49.4	1.0	40.2	1.0	20	23.1	64.8	0.101

Notes

(1) V_{BR} measured after I_T applied for 300 µs = square wave pulse or equivalent

(2) Surge current waveform per fig. 3 and derate per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
1.5KA6.8AHE3/54 (1)	0.916	54	1400	13" diameter paper tape and reel

Note
(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

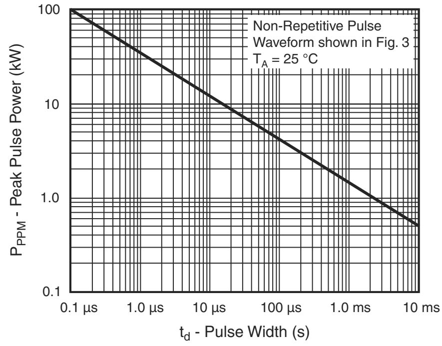


Figure 1. Peak Pulse Power Rating Curve

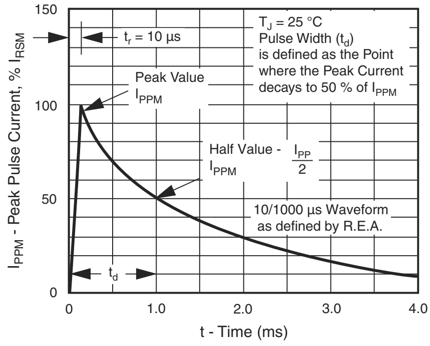


Figure 3. Pulse Waveform

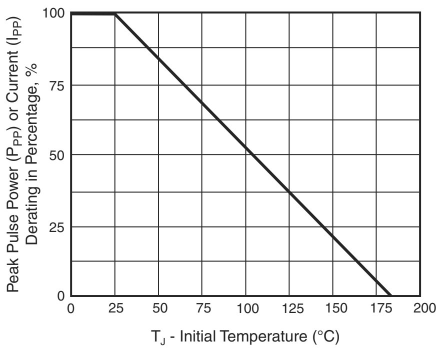


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

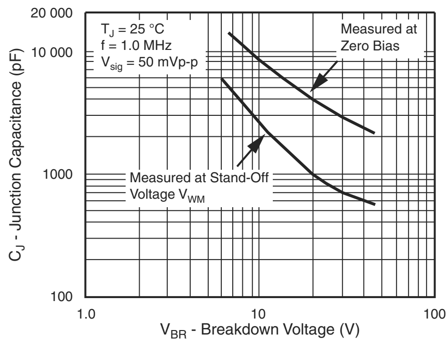


Figure 4. Typical Junction Capacitance Unidirectional

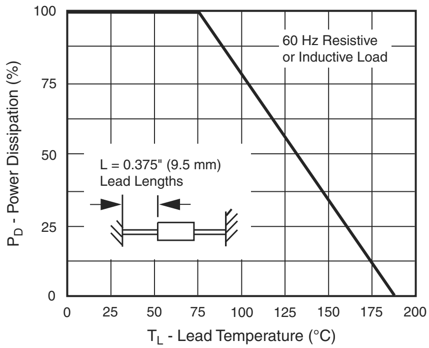


Figure 5. Power Derating Curve

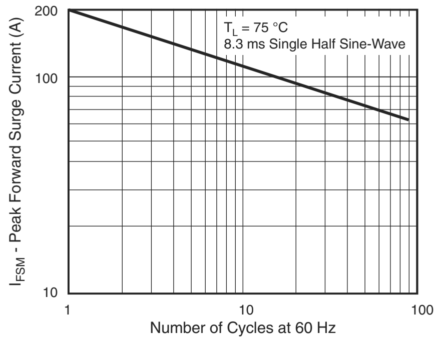
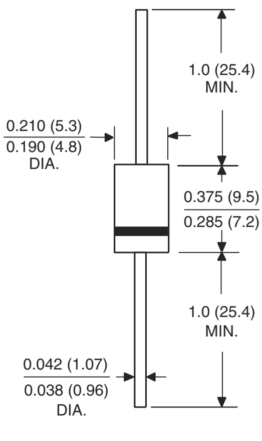


Figure 6. Maximum Non-Repetitive/Peak Forward Surge Current

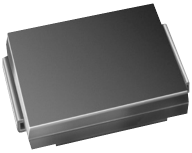
PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

Case Style 1.5KA



Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions



DO-214AB (SMC)

PRIMARY CHARACTERISTICS	
V_{WM}	10 V to 43 V
P_{PPM}	3000 W
P_D	6.0 W
I_{FSM}	200 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial, automotive and telecommunication.

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- 3000 W peak pulse power capability with a 10/1000 μs waveform
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Meets MSL level 1, per J-STD-020, LF maximum peak of 260 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

MECHANICAL DATA

Case: DO-214AB (SMC)
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with a 10/1000 μs waveform (1) (fig. 3)	P_{PPM}	3000	W
Peak power pulse current with a 10/1000 μs waveform (1) (fig. 1)	I_{PPM}	See next table	A
Peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	200	A
Power dissipation on infinite heatsink at T_L = 75 °C (fig. 6)	P_D	6.0	W
Maximum instantaneous forward voltage at 100 A (2)	V_F	3.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 3 and derated above T_A = 25 °C per fig. 2
(2) Measured on 8.3 ms single half sine-wave, or equivalent square wave, duty cycle = 4 pulses per minute maximum

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)	T_J = 150 °C MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN.	MAX.						
3KASMC10	3AW	11.1	13.6	1.0	10	5.0	50	160	18.8
3KASMC10A	3AX	11.1	12.3	1.0	10	5.0	50	177	17.0
3KASMC11	3AY	12.2	14.9	1.0	11	5.0	50	149	20.1
3KASMC11A	3AZ	12.2	13.5	1.0	11	5.0	50	165	18.2
3KASMC12	3BD	13.3	16.3	1.0	12	2.0	20	136	22.0
3KASMC12A	3BE	13.3	14.7	1.0	12	2.0	20	151	19.9
3KASMC13	3BF	14.4	17.6	1.0	13	2.0	20	126	23.8
3KASMC13A	3BG	14.4	15.9	1.0	13	2.0	20	140	21.5
3KASMC14	3BH	15.6	19.1	1.0	14	1.0	10	116	25.8
3KASMC14A	3BK	15.6	17.2	1.0	14	1.0	10	129	23.2
3KASMC15	3BL	16.7	20.4	1.0	15	1.0	10	112	26.9
3KASMC15A	3BM	16.7	18.5	1.0	15	1.0	10	123	24.4
3KASMC16	3BN	17.8	21.8	1.0	16	1.0	10	104	28.8
3KASMC16A	3BP	17.8	19.7	1.0	16	1.0	10	115	26.0
3KASMC17	3BQ	18.9	23.1	1.0	17	1.0	10	98.4	30.5
3KASMC17A	3BR	18.9	20.9	1.0	17	1.0	10	109	27.6
3KASMC18	3BS	20.0	24.4	1.0	18	1.0	10	93.2	32.2
3KASMC18A	3BT	20.0	22.1	1.0	18	1.0	10	103	29.2
3KASMC20	3BU	22.2	27.1	1.0	20	1.0	10	83.8	35.8
3KASMC20A	3BV	22.2	24.5	1.0	20	1.0	10	92.6	32.4
3KASMC22	3BW	24.4	29.8	1.0	22	1.0	10	76.1	39.4
3KASMC22A	3BX	24.4	26.9	1.0	22	1.0	10	84.5	35.5
3KASMC24	3BY	26.7	32.6	1.0	24	1.0	10	69.8	43.0
3KASMC24A	3BZ	26.7	29.5	1.0	24	1.0	10	77.1	38.9
3KASMC26	3CD	28.9	35.3	1.0	26	1.0	10	64.4	46.6
3KASMC26A	3CE	28.9	31.9	1.0	26	1.0	10	71.3	42.1
3KASMC28	3CF	31.1	38.0	1.0	28	1.0	10	60.0	50.0
3KASMC28A	3CG	31.1	34.4	1.0	28	1.0	10	66.1	45.4
3KASMC30	3CH	33.3	40.7	1.0	30	1.0	15	56.1	53.5
3KASMC30A	3CK	33.3	36.8	1.0	30	1.0	15	62.0	48.4
3KASMC33	3CL	36.7	44.9	1.0	33	1.0	15	50.8	59.0
3KASMC33A	3CM	36.7	40.6	1.0	33	1.0	15	56.3	53.3
3KASMC36	3CN	40.0	48.9	1.0	36	1.0	20	46.7	64.3
3KASMC36A	3CP	40.0	44.2	1.0	36	1.0	20	51.6	58.1
3KASMC40	3CQ	44.4	54.3	1.0	40	1.0	20	42.0	71.4
3KASMC40A	3CR	44.4	49.1	1.0	40	1.0	20	46.5	64.5
3KASMC43	3CS	47.8	58.4	1.0	43	1.0	20	39.1	76.7
3KASMC43A	3CT	47.8	52.8	1.0	43	1.0	20	43.2	69.4

Notes

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per fig. 3 and derated per fig. 2

(3) All terms and symbols are consistent with ANSI/IEEE C62.35

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Thermal resistance, junction to ambient air [(1)]	$R_{\theta JA}$	77.5	°C/W
Thermal resistance, junction to leads	$R_{\theta JL}$	18.3	

Note

(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
3KASMC10AHE3/57T [(1)]	0.211	57T	850	7" diameter plastic tape and reel
3KASMC10AHE3/9AT [(1)]	0.211	9AT	3500	13" diameter plastic tape and reel

Note

(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

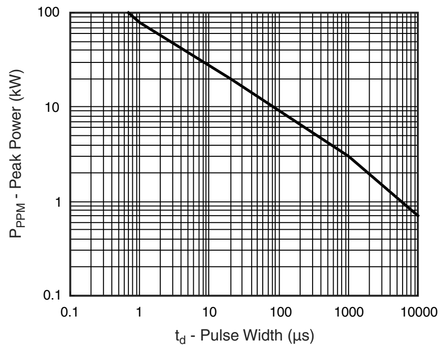


Figure 1. Peak Pulse Power Rating Curve

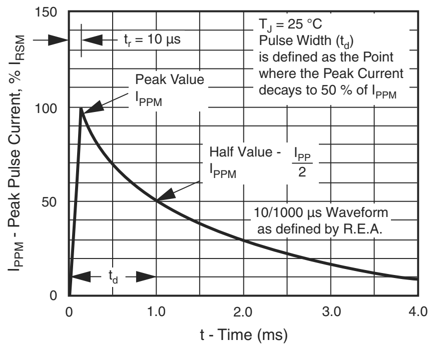


Figure 3. Pulse Waveform

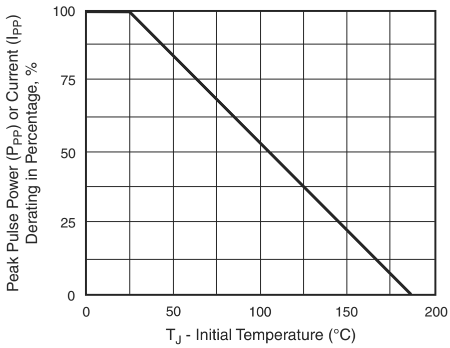


Figure 2. Pulse Power or Current vs. Initial Junction Temperature

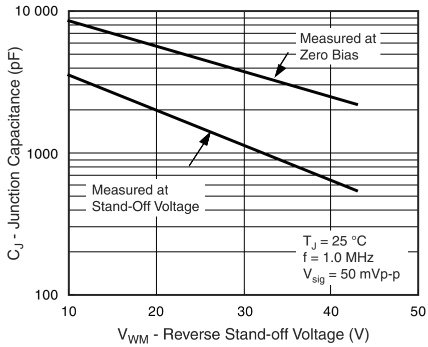


Figure 4. Typical Junction Capacitance

For technical questions within your region, please contact one of the following:
DiodesAmericas@vishay.com, DiodesAsia@vishay.com, DiodesEurope@vishay.com

Document Number: 88480
Revision: 09-Feb-11

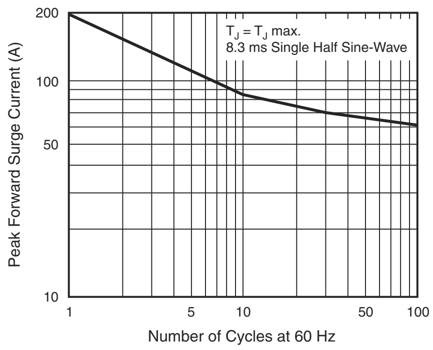


Figure 5. Maximum Non-Repetitive/Peak Forward Surge Current

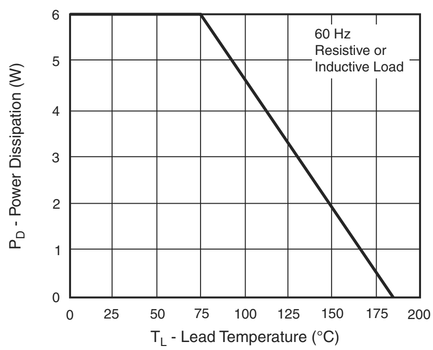
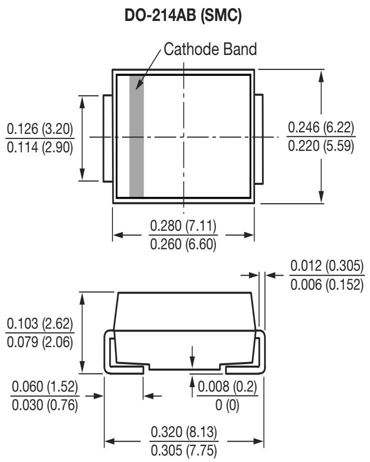
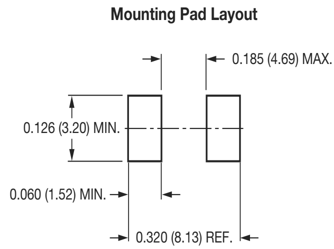


Figure 6. Power Derating Curve

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)





Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-218AB

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 175 °C capability suitable for high reliability and automotive requirement
- Low leakage current
- Low forward voltage drop
- High surge capability
- Meets ISO7637-2 surge specification
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

PRIMARY CHARACTERISTICS	
V_{BR}	27 V
P_{PPM} (10 x 1000 µs)	3600 W
P_D	5 W
I_{RSM}	70 A
I_{FSM}	500 A
T_J max.	175 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting, especially for automotive load dump protection application.

MECHANICAL DATA

Case: DO-218AB
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Heatsink is anode

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with 10/1000 µs waveform	P_{PPM}	3600	W
Power dissipation on infinite heatsink at T_C = 25 °C (fig. 1)	P_D	5.0	W
Non-repetitive peak reverse surge current for 10 µs/10 ms exponentially decaying waveform	I_{RSM}	70	A
Maximum working stand-off voltage	V_{WM}	22.0	V
Peak forward surge current 8.3 ms single half sine-wave	I_{FSM}	500	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)						
PARAMETER	**TEST CONDITIONS**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Reverse Zener voltage	I_Z = 10 mA	V_Z	24.0	-	30.0	V
Zener voltage temperature coefficient	I_Z = 10 mA	V_{ZTC}	-	-	36	mV/°C
Clamping voltage for 10 µs/10 ms exponentially decaying waveform	I_{PP} = 55 A	V_C	-	-	40.0	V
Instantaneous forward voltage	I_F = 6.0 A	V_F (1)	-	-	1.0	V
	I_F = 100 A		-	0.95	-	
Reverse leakage current	Rated V_{WM}, T_J = 25 °C	I_R	-	-	0.2	µA
	T_J = 175 °C		-	-	10.0	

Note
(1) Measured on a 300 µs square pulse width

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to case	$R_{\theta JC}$	1.0	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SM5A27HE3/2D (1)	2.505	2D	750	13" diameter plastic tape and reel, anode towards the sprocket hole

Note
(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

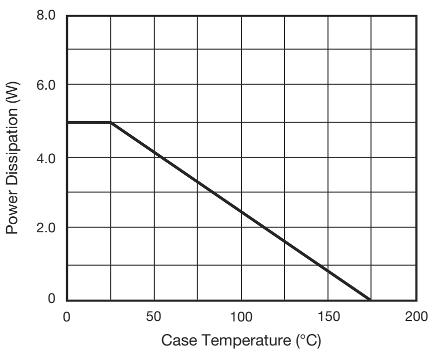


Fig. 1 - Power Derating Curve

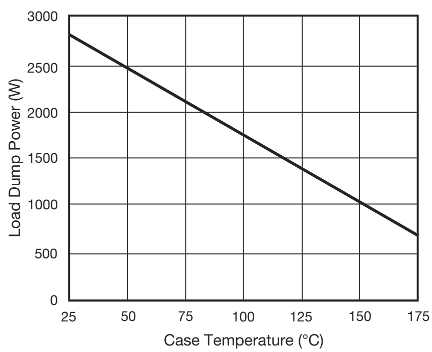


Fig. 2 - Load Dump Power Characteristics (10 ms Exponential Waveform)

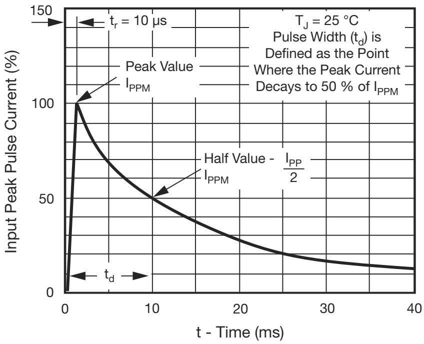


Fig. 3 - Pulse Waveform

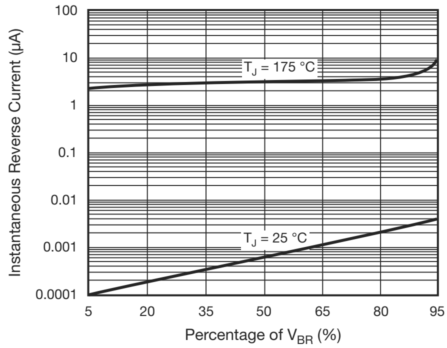


Fig. 6 - Typical Reverse Characteristics

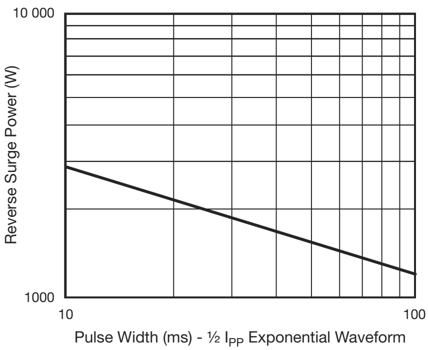


Fig. 4 - Reverse Power Capability

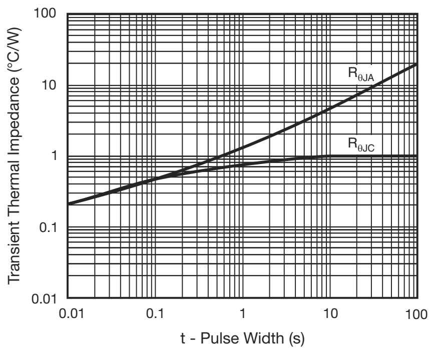


Fig. 7 - Typical Transient Thermal Impedance

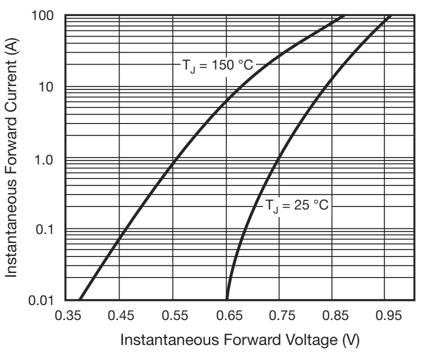
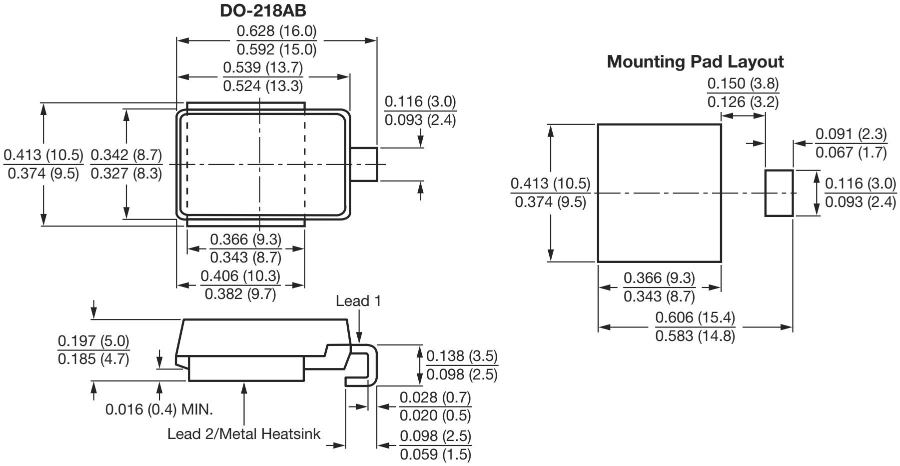


Fig. 5 - Typical Instantaneous Forward Characteristics

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)



Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-218AB

PRIMARY CHARACTERISTICS	
V_{WM}	10 V to 36 V
P_{PPM} (10 x 1000 μs)	3600 W
P_{PPM} (10 x 10 000 μs)	2800 W
P_D	5 W
I_{FSM}	500 A
T_J max.	175 °C

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 175 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- Low leakage current
- Low forward voltage drop
- High surge capability
- Meets ISO7637-2 surge specification (varied by test condition)
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS
COMPLIANT

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting, especially for automotive load dump protection application.

MECHANICAL DATA

Case: DO-218AB
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Heatsink is anode

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)				
PARAMETER		**SYMBOL**	**VALUE**	**UNIT**
Peak pulse power dissipation	with 10/1000 μs waveform	P_{PPM}	3600	W
	with 10/10 000 μs waveform		2800	
Power dissipation on infinite heatsink at T_C = 25 °C (fig. 1)		P_D	5.0	W
Peak pulse current with 10/1000 μs waveform		I_{PPM} (1)	See next table	A
Peak forward surge current 8.3 ms single half sine-wave		I_{FSM}	500	A
Operating junction and storage temperature range		T_J, T_{STG}	- 55 to + 175	°C

Note

(1) Non-repetitive current pulse at T_A = 25 °C

For technical questions within your region, please contact one of the following:
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Revision: 09-Feb-11

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} (V) MIN.	BREAKDOWN VOLTAGE V_{BR} (V) MAX.	TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM REVERSE LEAKAGE AT V_{WM} T_J = 175 °C I_D (µA)	MAX. PEAK PULSE CURRENT AT 10/1000 µs WAVEFORM (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
SM5S10	11.1	13.6	5.0	10.0	15	250	191	18.8
SM5S10A	11.1	12.3	5.0	10.0	15	250	212	17.0
SM5S11	12.2	14.9	5.0	11.0	10	150	179	20.1
SM5S11A	12.2	13.5	5.0	11.0	10	150	198	18.2
SM5S12	13.3	16.3	5.0	12.0	10	150	164	22.0
SM5S12A	13.3	14.7	5.0	12.0	10	150	181	19.9
SM5S13	14.4	17.6	5.0	13.0	10	150	151	23.8
SM5S13A	14.4	15.9	5.0	13.0	10	150	167	21.5
SM5S14	15.6	19.1	5.0	14.0	10	150	140	25.8
SM5S14A	15.6	17.2	5.0	14.0	10	150	155	23.2
SM5S15	16.7	20.4	5.0	15.0	10	150	134	26.9
SM5S15A	16.7	18.5	5.0	15.0	10	150	148	24.4
SM5S16	17.8	21.8	5.0	16.0	10	150	125	28.8
SM5S16A	17.8	19.7	5.0	16.0	10	150	138	26.0
SM5S17	18.9	23.1	5.0	17.0	10	150	118	30.5
SM5S17A	18.9	20.9	5.0	17.0	10	150	130	27.6
SM5S18	20.0	24.4	5.0	18.0	10	150	112	32.2
SM5S18A	20.0	22.1	5.0	18.0	10	150	123	29.2
SM5S20	22.2	27.1	5.0	20.0	10	150	101	35.8
SM5S20A	22.2	24.5	5.0	20.0	10	150	111	32.4
SM5S22	24.4	29.8	5.0	22.0	10	150	91	39.4
SM5S22A	24.4	26.9	5.0	22.0	10	150	101	35.5
SM5S24	26.7	32.6	5.0	24.0	10	150	84	43.0
SM5S24A	26.7	29.5	5.0	24.0	10	150	93	38.9
SM5S26	28.9	35.3	5.0	26.0	10	150	77	46.6
SM5S26A	28.9	31.9	5.0	26.0	10	150	86	42.1
SM5S28	31.1	38.0	5.0	28.0	10	150	72	50.1
SM5S28A	31.1	34.4	5.0	28.0	10	150	79	45.4
SM5S30	33.3	40.7	5.0	30.0	10	150	67	53.5
SM5S30A	33.3	36.8	5.0	30.0	10	150	74	48.4
SM5S33	36.7	44.9	5.0	33.0	10	150	61	59.0
SM5S33A	36.7	40.6	5.0	33.0	10	150	68	53.3
SM5S36	40.0	48.9	5.0	36.0	10	150	56	64.3
SM5S36A	40.0	44.2	5.0	36.0	10	150	62	58.1

Note

- For all types maximum V_F = 2.0 V at I_F = 100 A measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Typical thermal resistance, junction to case	$R_{\theta JC}$	1.0	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SM5S10AHE3/2D [(1)]	2.505	2D	750	13" diameter plastic tape and reel, anode towards the sprocket hole

Note
(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

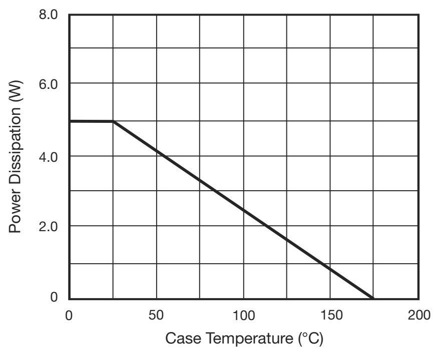


Fig. 1 - Power Derating Curve

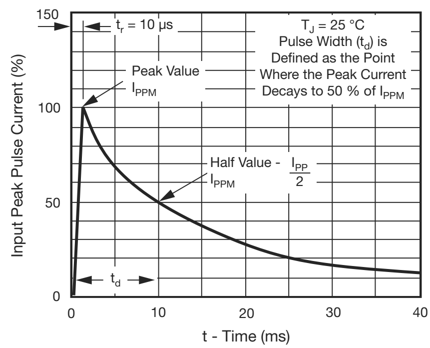


Fig. 3 - Pulse Waveform

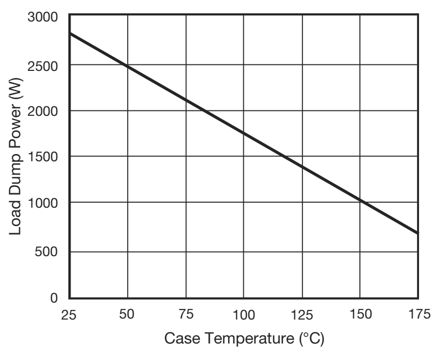


Fig. 2 - Load Dump Power Characteristics
(10 ms Exponential Waveform)

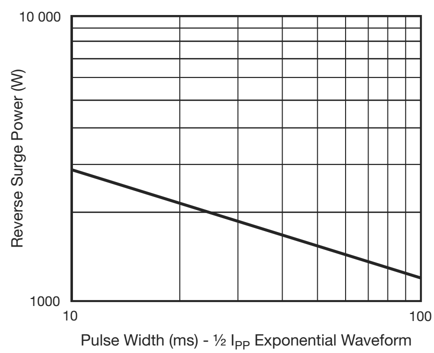


Fig. 4 - Reverse Power Capability

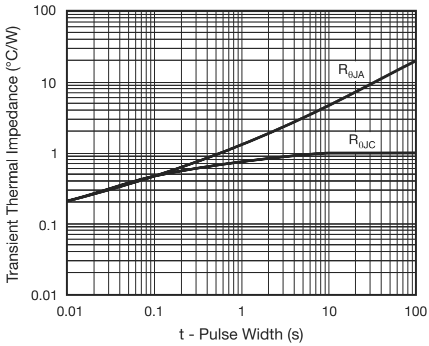
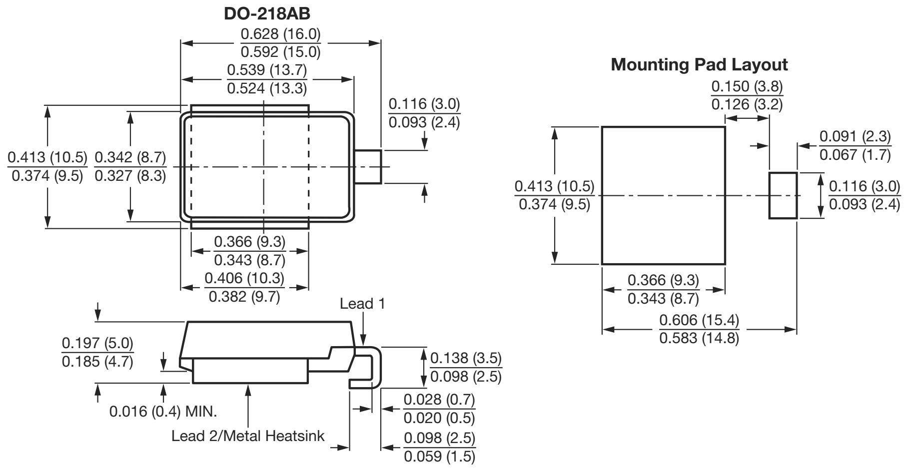


Fig. 5 - Typical Transient Thermal Impedance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)



Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-218AB

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 175 °C capability suitable for high reliability and automotive requirement
- Low leakage current
- Low forward voltage drop
- High surge capability
- Meets ISO7637-2 surge specification
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS
COMPLIANT

PRIMARY CHARACTERISTICS	
V_{BR}	27 V
P_{PPM} (10 x 1000 µs)	4600 W
P_D	6 W
I_{RSM}	90 A
I_{FSM}	600 A
T_J max.	175 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting, especially for automotive load dump protection application.

MECHANICAL DATA

Case: DO-218AB
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Heatsink is anode

MAXIMUM RATINGS (T_C = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with 10/1000 µs waveform	P_{PPM}	4600	W
Power dissipation on infinite heatsink at T_C = 25 °C (fig. 1)	P_D	6.0	W
Non-repetitive peak reverse surge current for 10 µs/10 ms exponentially decaying waveform	I_{RSM}	90	A
Maximum working stand-off voltage	V_{WM}	22.0	V
Peak forward surge current 8.3 ms single half sine-wave	I_{FSM}	600	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

ELECTRICAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)

PARAMETER	TEST CONDITIONS		SYMBOL	MIN.	TYP.	MAX.	UNIT
Reverse Zener voltage	I_Z = 10 mA		V_Z	24.0	-	30.0	V
Zener voltage temperature coefficient	I_Z = 10 mA		V_{ZTC}	-	-	36	mV/°C
Clamping voltage for 10 µs/10 ms exponentially decaying waveform	I_{PP} = 65 A		V_C	-	-	40.0	V
Instantaneous forward voltage	I_F = 6.0 A		V_F (1)	-	-	0.99	V
	I_F = 100 A			-	0.94	-	
Reverse leakage current	Rated V_{WM}	T_J = 25 °C	I_R	-	-	0.5	µA
		T_J = 175 °C		-	-	20.0	

Note

(1) Measured on a 300 µs square pulse width

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Typical thermal resistance, junction to case	$R_{\theta JC}$	0.95	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SM6A27HE3/2D [1]	2.550	2D	750	13" diameter plastic tape and reel, anode towards the sprocket hole

Note
[1] AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

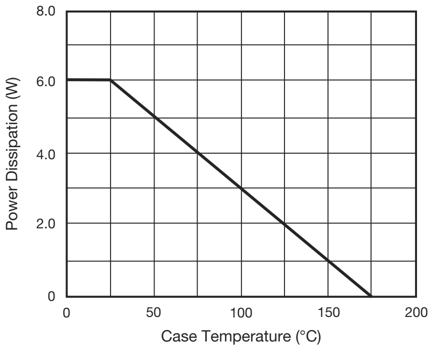


Fig. 1 - Power Derating Curve

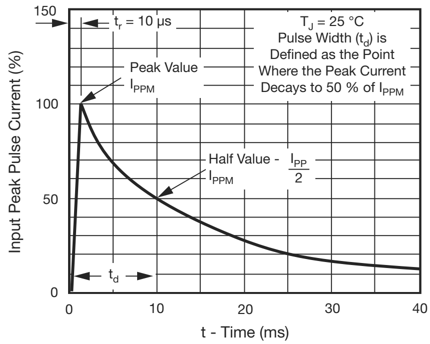


Fig. 3 - Pulse Waveform

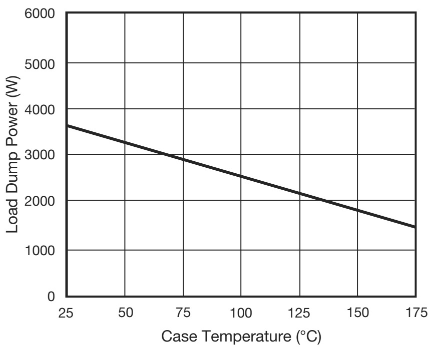


Fig. 2 - Load Dump Power Characteristics
(10 ms Exponential Waveform)

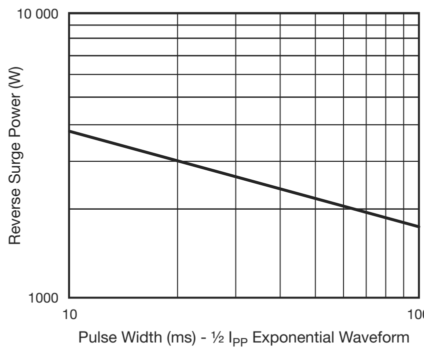


Fig. 4 - Reverse Power Capability

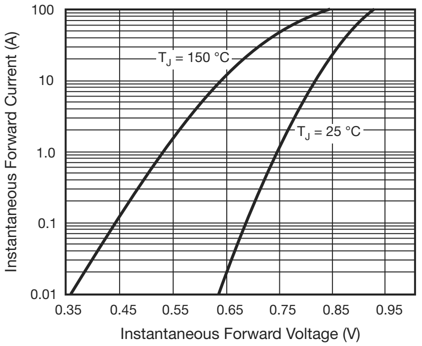


Fig. 5 - Typical Instantaneous Forward Characteristics

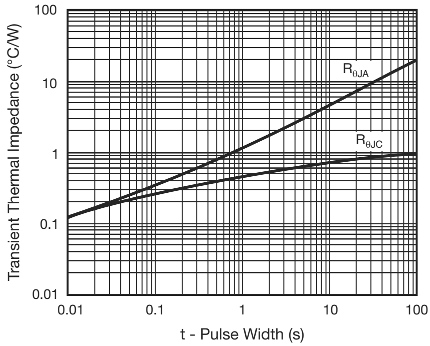


Fig. 7 - Typical Transient Thermal Impedance

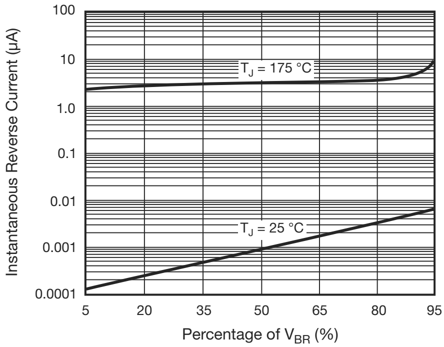
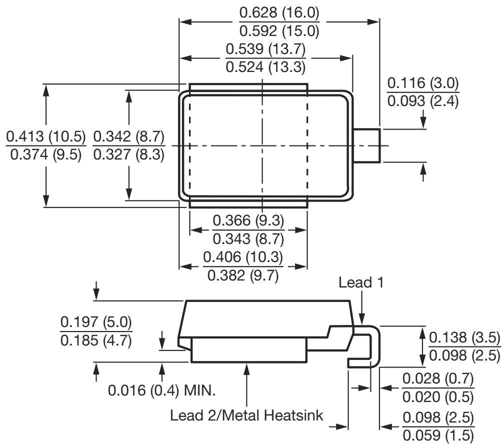


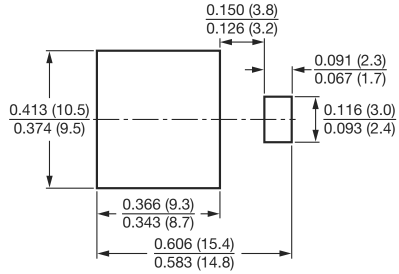
Fig. 6 - Typical Reverse Characteristics

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-218AB



Mounting Pad Layout



Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-218AB

PRIMARY CHARACTERISTICS	
V_{WM}	10 V to 36 V
P_{PPM} (10 x 1000 μs)	4600 W
P_{PPM} (10 x 10 000 μs)	3600 W
P_D	6 W
I_{FSM}	600 A
T_J max.	175 °C

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 175 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- Low leakage current
- Low forward voltage drop
- High surge capability
- Meets ISO7637-2 surge specification (varied by test condition)
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Pb e3 RoHS COMPLIANT

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting, especially for automotive load dump protection application.

MECHANICAL DATA

Case: DO-218AB
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Heatsink is anode

MAXIMUM RATINGS (T_C = 25 °C unless otherwise noted)

PARAMETER		SYMBOL	VALUE	UNIT
Peak pulse power dissipation	with 10/1000 μs waveform	P_{PPM}	4600	W
	with 10/10 000 μs waveform		3600	
Power dissipation on infinite heatsink at T_C = 25 °C (fig. 1)		P_D	6.0	W
Peak pulse current with 10/1000 μs waveform		I_{PPM} (1)	See next table	A
Peak forward surge current 8.3 ms single half sine-wave		I_{FSM}	600	A
Operating junction and storage temperature range		T_J, T_{STG}	- 55 to + 175	°C

Note

(1) Non-repetitive current pulse at T_A = 25 °C

ELECTRICAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)								
DEVICE TYPE	BREAKDOWN VOLTAGE V_{BR} (V)		TEST CURRENT I_T (mA)	STAND-OFF VOLTAGE V_{WM} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM REVERSE LEAKAGE AT V_{WM} T_J = 175 °C I_D (µA)	MAX. PEAK PULSE CURRENT AT 10/1000 µs WAVEFORM (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
	MIN.	MAX.						
SM6S10	11.1	13.6	5.0	10.0	15	250	245	18.8
SM6S10A	11.1	12.3	5.0	10.0	15	250	271	17.0
SM6S11	12.2	14.9	5.0	11.0	10	150	229	20.1
SM6S11A	12.2	13.5	5.0	11.0	10	150	253	18.2
SM6S12	13.3	16.3	5.0	12.0	10	150	209	22.0
SM6S12A	13.3	14.7	5.0	12.0	10	150	231	19.9
SM6S13	14.4	17.6	5.0	13.0	10	150	193	23.8
SM6S13A	14.4	15.9	5.0	13.0	10	150	214	21.5
SM6S14	15.6	19.1	5.0	14.0	10	150	178	25.8
SM6S14A	15.6	17.2	5.0	14.0	10	150	198	23.2
SM6S15	16.7	20.4	5.0	15.0	10	150	171	26.9
SM6S15A	16.7	18.5	5.0	15.0	10	150	189	24.4
SM6S16	17.8	21.8	5.0	16.0	10	150	160	28.8
SM6S16A	17.8	19.7	5.0	16.0	10	150	177	26.0
SM6S17	18.9	23.1	5.0	17.0	10	150	151	30.5
SM6S17A	18.9	20.9	5.0	17.0	10	150	167	27.6
SM6S18	20.0	24.4	5.0	18.0	10	150	143	32.2
SM6S18A	20.0	22.1	5.0	18.0	10	150	158	29.2
SM6S20	22.2	27.1	5.0	20.0	10	150	128	35.8
SM6S20A	22.2	24.5	5.0	20.0	10	150	142	32.4
SM6S22	24.4	29.8	5.0	22.0	10	150	117	39.4
SM6S22A	24.4	26.9	5.0	22.0	10	150	130	35.5
SM6S24	26.7	32.6	5.0	24.0	10	150	107	43.0
SM6S24A	26.7	29.5	5.0	24.0	10	150	118	38.9
SM6S26	28.9	35.3	5.0	26.0	10	150	99	46.6
SM6S26A	28.9	31.9	5.0	26.0	10	150	109	42.1
SM6S28	31.1	38.0	5.0	28.0	10	150	92	50.1
SM6S28A	31.1	34.4	5.0	28.0	10	150	101	45.4
SM6S30	33.3	40.7	5.0	30.0	10	150	86	53.5
SM6S30A	33.3	36.8	5.0	30.0	10	150	95	48.4
SM6S33	36.7	44.9	5.0	33.0	10	150	78	59.0
SM6S33A	36.7	40.6	5.0	33.0	10	150	86	53.3
SM6S36	40.0	48.9	5.0	36.0	10	150	72	64.3
SM6S36A	40.0	44.2	5.0	36.0	10	150	79	58.1

Note

- For all types maximum V_F = 1.9 V at I_F = 100 A measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

THERMAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	VALUE	UNIT
Typical thermal resistance, junction to case	$R_{\theta JC}$	0.95	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SM6S10AHE3/2D [1]	2.550	2D	750	13" diameter plastic tape and reel, anode towards the sprocket hole

Note
[1] AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

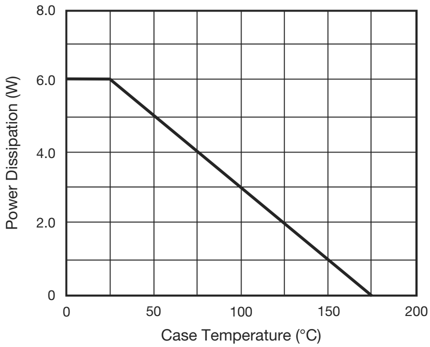


Fig. 1 - Power Derating Curve

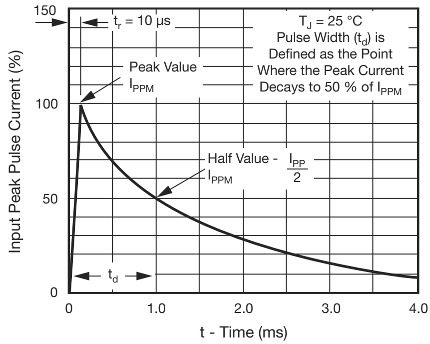


Fig. 3 - Pulse Waveform

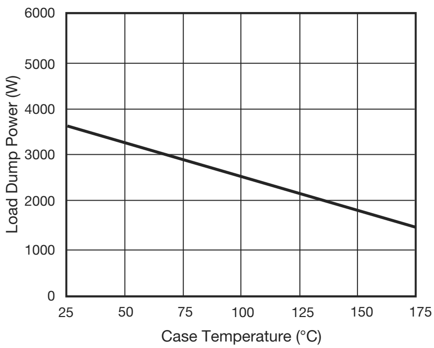


Fig. 2 - Load Dump Power Characteristics (10 ms Exponential Waveform)

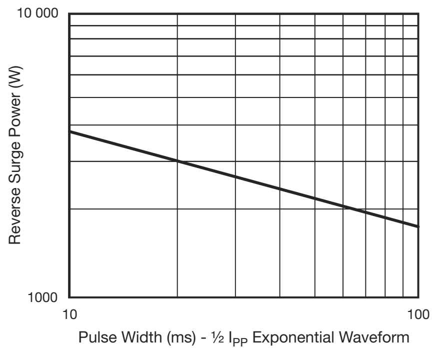


Fig. 4 - Reverse Power Capability

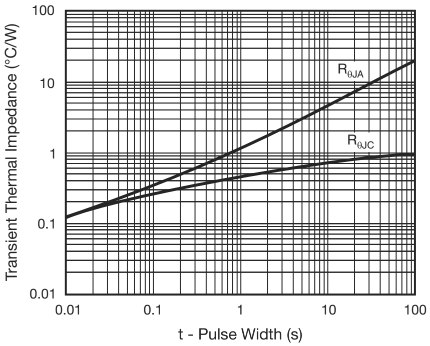
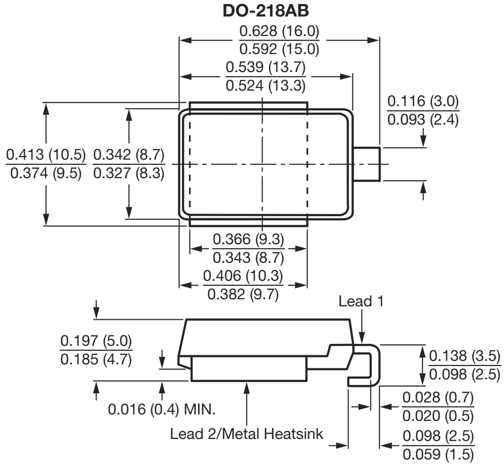
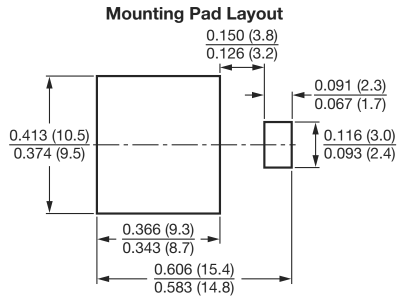


Fig. 5 - Typical Transient Thermal Impedance

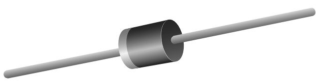
PACKAGE OUTLINE DIMENSIONS in inches (millimeters)





PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions



P600

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 185 °C capability suitable for high reliability and automotive requirement
- Excellent clamping capability
- Low leakage current
- High surge capability
- Solder dip 275 °C max. 10 s, per JESD 22-B106
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS COMPLIANT

PRIMARY CHARACTERISTICS	
V_{WM}	24 V
P_{PPM} (10 x 1000 µs)	6000 W
P_{PPM} (10 µs/50 ms)	2000 W
P_D	6.5 W
I_{RSM}	90 A
I_{FSM}	400 A
T_J max.	185 °C

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting, especially for automotive load dump protection application.

MECHANICAL DATA

Case: P600, molded epoxy over passivated junction
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER		SYMBOL	LIMIT	UNIT
Peak pulse power dissipation	with 10/1000 µs waveform (1) with 10 µs/50 ms waveform (2)	P_{PPM}	6000 2000	W
Power dissipation on infinite heatsink at T_L = 75 °C (fig. 3)		P_D	6.5	W
Maximum working stand-off voltage		V_{WM}	24	V
Peak forward surge current 8.3 ms single half sine-wave (3)		I_{FSM}	400	A
Operating junction and storage temperature range		T_J, T_{STG}	- 65 to + 185	°C

Notes

(1) Non-repetitive current pulse, per fig. 2, with a 10/1000 µs waveform
(2) Non-repetitive current pulse, per fig. 5, with a 10 µs/50 ms waveform
(3) Measured on 8.3 ms half sine-wave, or equivalent square wave, duty cycle = 4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)					
PARAMETER	TEST CONDITIONS		SYMBOL	LIMIT	UNIT
Maximum DC reverse leakage current	V_{WM} = 24 V,	T_A = 25 °C T_A = 150 °C	I_D	1.0 50	µA
Reverse breakdown voltage	100 mA,	T_A = 25 °C min. T_A = 25 °C max. T_A = 150 °C min. T_A = 150 °C max.	V_{BR}	26.7 32.6 29.7 36.7	V
Maximum clamping voltage	I_{PP} = 90 A (1)	T_A = 25 °C T_A = 150 °C	V_C	40 45	V
Maximum instantaneous forward voltage	100 A (2)		V_F	1.8	V

Notes
(1) Measured on 80 µs square pulse width
(2) Measured on 300 µs square pulse width

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
6KA24HE3/54 (1)	2.710	54	800	13" diameter paper tape and reel

Note
(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

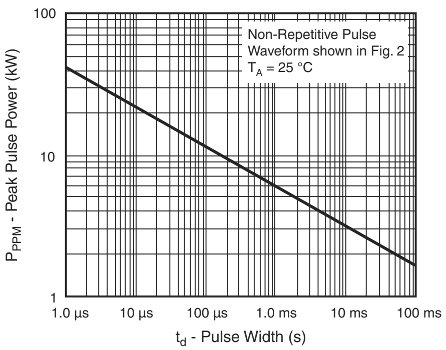


Figure 1. Peak Pulse Power Rating Curve

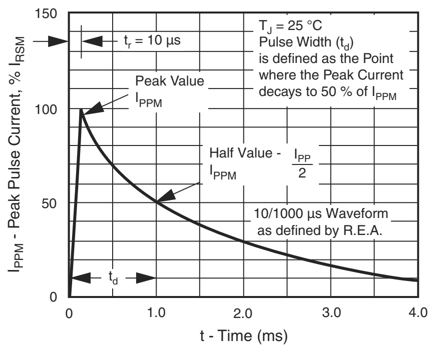


Figure 2. 10/1000 µs Pulse Waveform

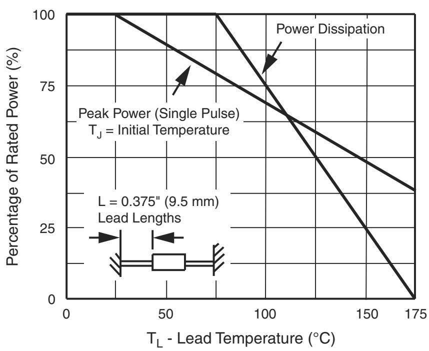


Figure 3. Pulse Derating Curve

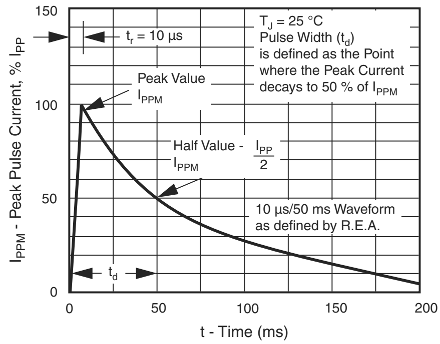


Figure 5. 10 µs/50 ms Pulse Waveform

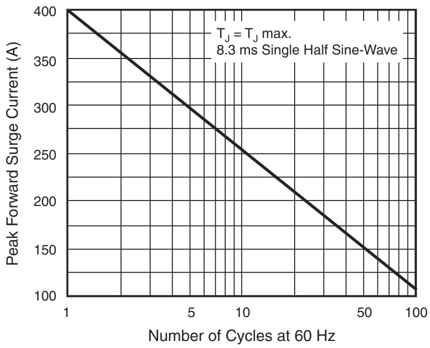
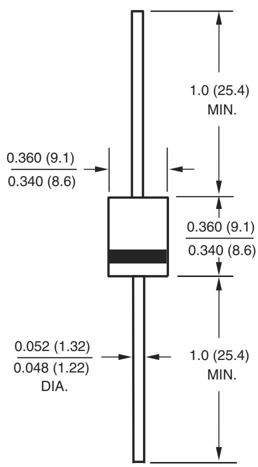


Figure 4. Maximum Non-Repetitive Peak Forward Surge Current

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

P600



Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-218AB

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 175 °C capability suitable for high reliability and automotive requirement
- Low leakage current
- Low forward voltage drop
- High surge capability
- Meets ISO7637-2 surge specification
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS
COMPLIANT

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting, especially for automotive load dump protection application.

MECHANICAL DATA

Case: DO-218AB
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Heatsink is anode

PRIMARY CHARACTERISTICS	
V_{BR}	27 V
P_{PPM} (10 x 1000 μs)	6600 W
P_D	8 W
I_{RSM}	130 A
I_{FSM}	700 A
T_J max.	175 °C

MAXIMUM RATINGS (T_C = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse power dissipation with 10/1000 μs waveform	P_{PPM}	6600	W
Power dissipation on infinite heatsink at T_C = 25 °C (fig. 1)	P_D	8.0	W
Non-repetitive peak reverse surge current for 10 μs/10 ms exponentially decaying waveform	I_{RSM}	130	A
Maximum working stand-off voltage	V_{WM}	22.0	V
Peak forward surge current 8.3 ms single half sine-wave	I_{FSM}	700	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

ELECTRICAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)

PARAMETER	TEST CONDITIONS		SYMBOL	MIN.	TYP.	MAX.	UNIT
Reverse Zener voltage	I_Z = 10 mA		V_Z	24.0	-	30.0	V
Zener voltage temperature coefficient	I_Z = 10 mA		V_{ZTC}	-	-	36	mV/°C
Clamping voltage for 10 μs/10 ms exponentially decaying waveform	I_{PP} = 75 A		V_C	-	-	40.0	V
Instantaneous forward voltage	I_F = 6.0 A		V_F (1)	-	-	0.98	V
	I_F = 100 A			-	0.93	-	
Reverse leakage current	Rated V_{WM}	T_J = 25 °C	I_R	-	-	1.0	μA
		T_J = 175 °C		-	-	50.0	

Note
(1) Measured on a 300 μs square pulse width

THERMAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to case	$R_{\theta JC}$	0.90	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SM8A27HE3/2D [(1)]	2.605	2D	750	13" diameter plastic tape and reel, anode towards the sprocket hole

Note
[(1)] AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

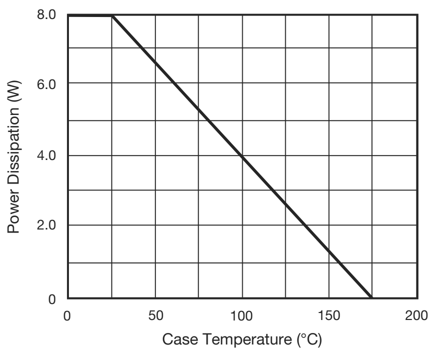


Fig. 1 - Power Derating Curve

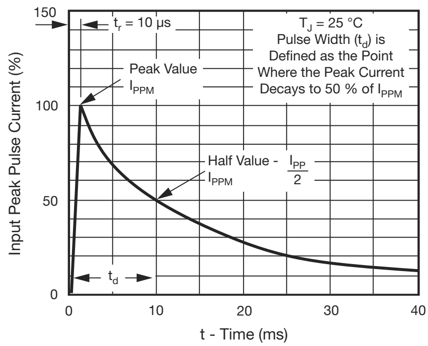


Fig. 3 - Pulse Waveform

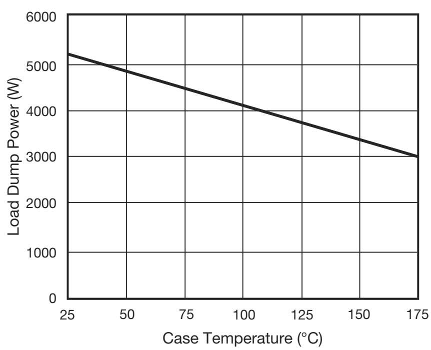


Fig. 2 - Load Dump Power Characteristics
(10 ms Exponential Waveform)

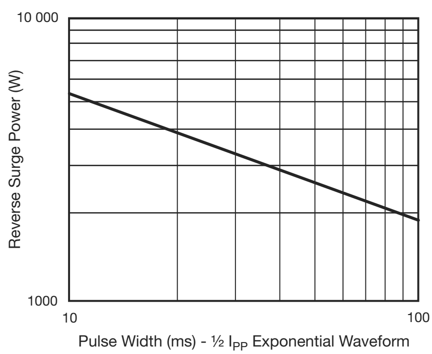


Fig. 4 - Reverse Power Capability

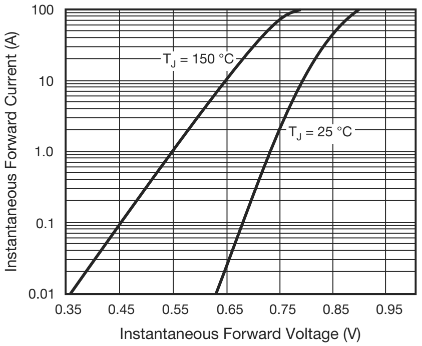


Fig. 5 - Typical Instantaneous Forward Characteristics

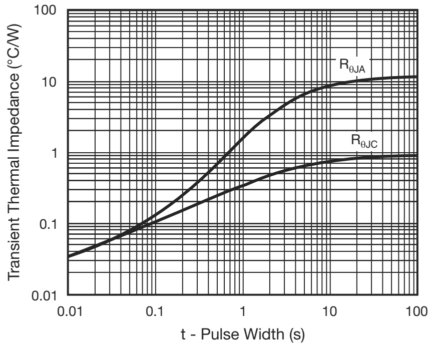


Fig. 7 - Typical Transient Thermal Impedance

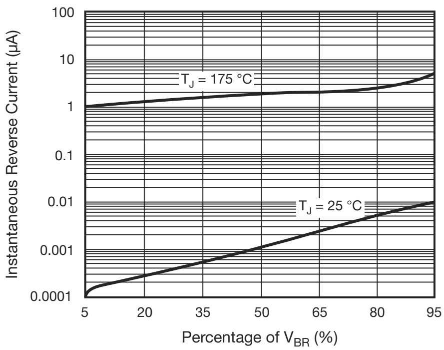
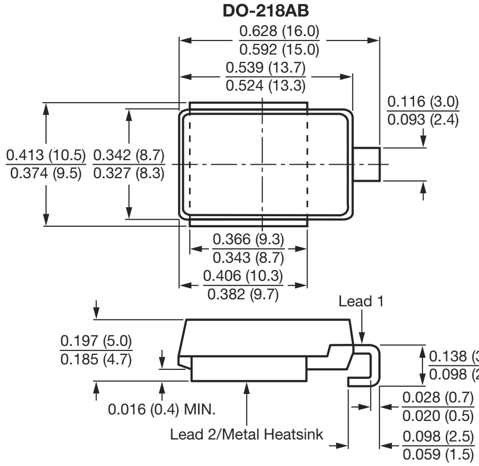


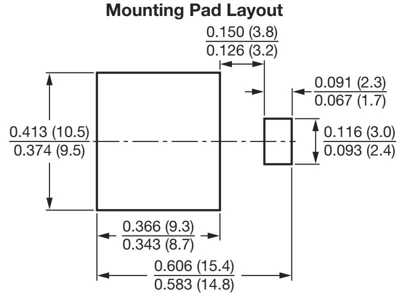
Fig. 6 - Typical Reverse Characteristics

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-218AB



Mounting Pad Layout



Surface Mount PAR® Transient Voltage Suppressors

High Temperature Stability and High Reliability Conditions

DO-218AB

PRIMARY CHARACTERISTICS	
V_{WM}	10 V to 43 V
P_{PPM} (10 x 1000 μs)	6600 W
P_{PPM} (10 x 10 000 μs)	5200 W
P_D	8 W
I_{FSM}	700 A
T_J max.	175 °C

FEATURES

- Junction passivation optimized design passivated anisotropic rectifier technology
- T_J = 175 °C capability suitable for high reliability and automotive requirement
- Available in uni-directional polarity only
- Low leakage current
- Low forward voltage drop
- High surge capability
- Meets ISO7637-2 surge specification (varied by test condition)
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- AEC-Q101 qualified
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

RoHS
COMPLIANT

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting, especially for automotive load dump protection application.

MECHANICAL DATA

Case: DO-218AB
Molding compound meets UL 94 V-0 flammability rating
Base P/NHE3 - RoHS compliant, AEC-Q101 qualified

Terminals: Matte tin plated leads, solderable per J-STD-002 and JESD 22-B102
HE3 suffix meets JESD 201 class 2 whisker test

Polarity: Heatsink is anode

MAXIMUM RATINGS (T_C = 25 °C unless otherwise noted)

PARAMETER		SYMBOL	VALUE	UNIT
Peak pulse power dissipation	with 10/1000 μs waveform	P_{PPM}	6600	W
	with 10/10 000 μs waveform		5200	
Power dissipation on infinite heatsink at T_C = 25 °C (fig. 1)		P_D	8.0	W
Peak pulse current with 10/1000 μs waveform		I_{PPM} (1)	See next table	A
Peak forward surge current 8.3 ms single half sine-wave		I_{FSM}	700	A
Operating junction and storage temperature range		T_J, T_{STG}	- 55 to + 175	°C

Note

(1) Non-repetitive current pulse derated above T_A = 25 °C

ELECTRICAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)								
DEVICE TYPE	**BREAKDOWN VOLTAGE V_{BR} (V)**		**TEST CURRENT I_T (mA)**	**STAND-OFF VOLTAGE V_{WM} (V)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)**	**MAXIMUM REVERSE LEAKAGE AT V_{WM} T_J = 175 °C I_D (µA)**	**MAX. PEAK PULSE CURRENT AT 10/1000 µs WAVEFORM (A)**	**MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)**
	MIN.	**MAX.**						
SM8S10	11.1	13.6	5.0	10.0	15	250	351	18.8
SM8S10A	11.1	12.3	5.0	10.0	15	250	388	17.0
SM8S11	12.2	14.9	5.0	11.0	10	150	328	20.1
SM8S11A	12.2	13.5	5.0	11.0	10	150	363	18.2
SM8S12	13.3	16.3	5.0	12.0	10	150	300	22.0
SM8S12A	13.3	14.7	5.0	12.0	10	150	332	19.9
SM8S13	14.4	17.6	5.0	13.0	10	150	277	23.8
SM8S13A	14.4	15.9	5.0	13.0	10	150	307	21.5
SM8S14	15.6	19.1	5.0	14.0	10	150	256	25.8
SM8S14A	15.6	17.2	5.0	14.0	10	150	284	23.2
SM8S15	16.7	20.4	5.0	15.0	10	150	245	26.9
SM8S15A	16.7	18.5	5.0	15.0	10	150	270	24.4
SM8S16	17.8	21.8	5.0	16.0	10	150	229	28.8
SM8S16A	17.8	19.7	5.0	16.0	10	150	254	26.0
SM8S17	18.9	23.1	5.0	17.0	10	150	216	30.5
SM8S17A	18.9	20.9	5.0	17.0	10	150	239	27.6
SM8S18	20.0	24.4	5.0	18.0	10	150	205	32.2
SM8S18A	20.0	22.1	5.0	18.0	10	150	226	29.2
SM8S20	22.2	27.1	5.0	20.0	10	150	184	35.8
SM8S20A	22.2	24.5	5.0	20.0	10	150	204	32.4
SM8S22	24.4	29.8	5.0	22.0	10	150	168	39.4
SM8S22A	24.4	26.9	5.0	22.0	10	150	186	35.5
SM8S24	26.7	32.6	5.0	24.0	10	150	153	43.0
SM8S24A	26.7	29.5	5.0	24.0	10	150	170	38.9
SM8S26	28.9	35.3	5.0	26.0	10	150	142	46.6
SM8S26A	28.9	31.9	5.0	26.0	10	150	157	42.1
SM8S28	31.1	38.0	5.0	28.0	10	150	132	50.1
SM8S28A	31.1	34.4	5.0	28.0	10	150	145	45.4
SM8S30	33.3	40.7	5.0	30.0	10	150	123	53.5
SM8S30A	33.3	36.8	5.0	30.0	10	150	136	48.4
SM8S33	36.7	44.9	5.0	33.0	10	150	112	59.0
SM8S33A	36.7	40.6	5.0	33.0	10	150	124	53.3
SM8S36	40.0	48.9	5.0	36.0	10	150	103	64.3
SM8S36A	40.0	44.2	5.0	36.0	10	150	114	58.1
SM8S40	44.4	54.3	5.0	40	10	150	92.4	71.4
SM8S40A	44.4	49.1	5.0	40	10	150	102	64.5
SM8S43	47.8	58.4	5.0	43	10	150	86	76.7
SM8S43A	47.8	52.8	5.0	43	10	150	95.1	69.4

Note

- For all types maximum V_F = 1.8 V at I_F = 100 A measured on 8.3 ms single half sine-wave or equivalent square wave, duty cycle = 4 pulses per minute maximum

THERMAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to case	$R_{\theta JC}$	0.90	°C/W

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SM8S10AHE3/2D [(1)]	2.605	2D	750	13" diameter plastic tape and reel, anode towards the sprocket hole

Note
(1) AEC-Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

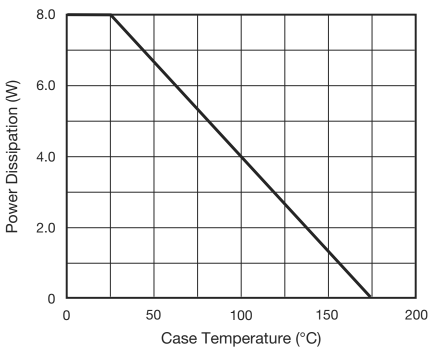


Fig. 1 - Power Derating Curve

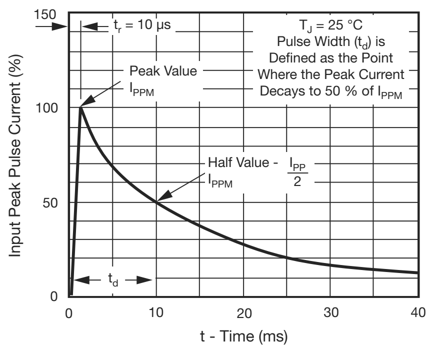


Fig. 3 - Pulse Waveform

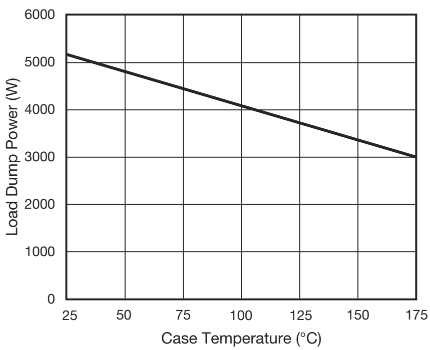


Fig. 2 - Load Dump Power Characteristics
(10 ms Exponential Waveform)

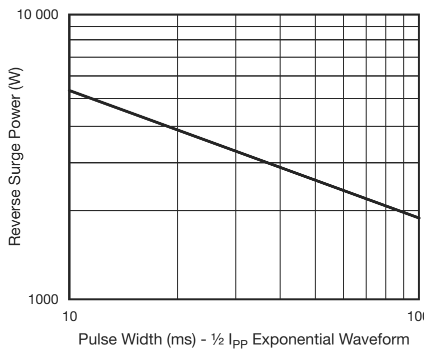


Fig. 4 - Reverse Power Capability

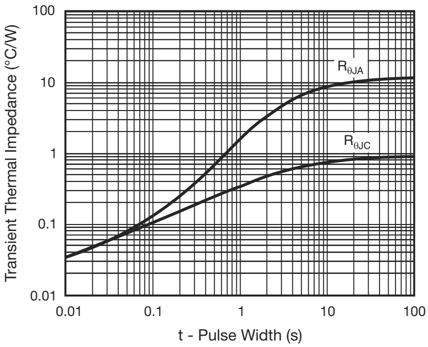


Fig. 5 - Typical Transient Thermal Impedance

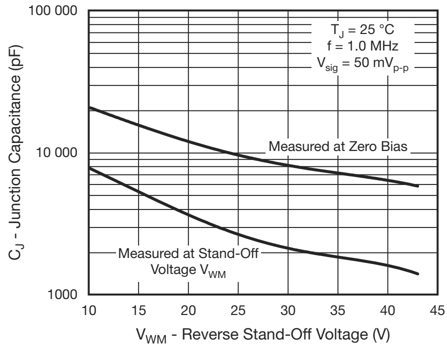
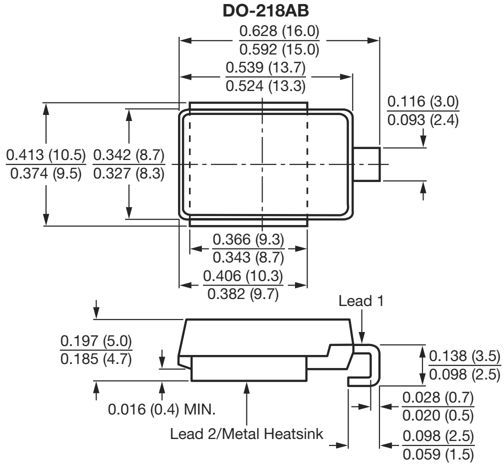


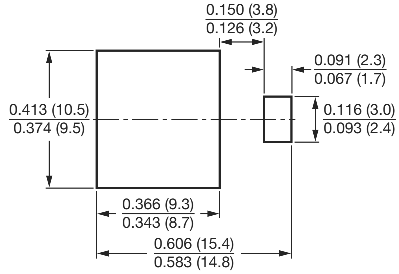
Fig. 6 - Typical Junction Capacitance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

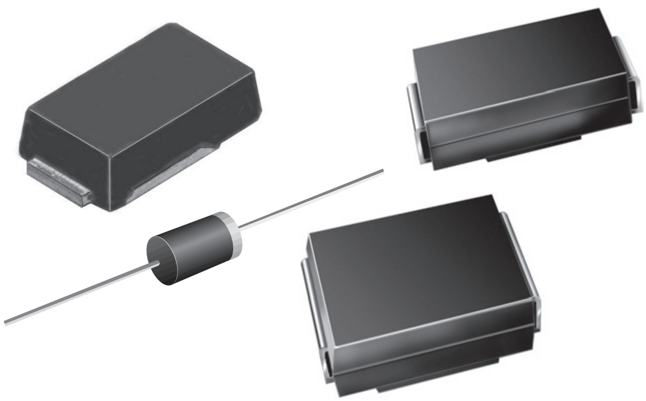
DO-218AB



Mounting Pad Layout



Power Voltage-Regulating Diodes



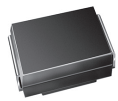
Contents

Introduction to Power Voltage-Regulating Diodes

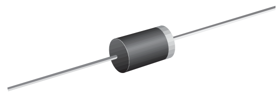
Vishay's Power Voltage-Regulating Diodes are used as voltage regulators, voltage references and voltage suppressors against ESD threats. Power ratings range from 1.0 W to 1.5 W and voltages range from 9.1 V to 200 V. Typical voltage tolerances are ± 5 %, but tighter tolerances such as ± 2 % are available. These diodes are available in the following packages: plastic MELF (DO-213AB), DO-204AL (DO-41), DO-214AC (SMA), DO-214AA (SMB) and DO-220AA (SMP).

DO-220AA (SMP)

DO-214AC (SMA)



DO-214AA (SMBJ)



DO-204AL (DO-41 Plastic)

Power Voltage-Regulating Diodes
Part Numbering System

1. AXIAL

a) Plastic DO-41:

Z4KExxxy
Z = Power voltage-regulationg diode
4KE = Indicates same structure as P4KE TVS series
xxx = Nominal Zener voltage (in V)
y = Zener voltage tolerance designator
"Blank" = ± 10 %
A = ± 5 %

2. SURFACE MOUNT

a) Plastic MELF (DO-213AB):

ZGL41-xxxy
Z = Power voltage-regulating diode
GL41 = Glass-passivated leadless "41" package
xxx = Nominal Zener voltage (in V)
y = Zener voltage tolerance designator
"Blank" = ± 10 %
A = ± 5 %

b) SMB:

SMZa3xxx
SM = Surface **M**ount
Z = Power voltage-regulating diode
a = Lead designator
G = Gullwing (DO-215AA)
J = J-bend (DO-214AA)
3xxx = JEDEC sequence (corresponding to the "1N3xxx" axial series)

c) SMxZ:

SMPZ39xxB
SMAZ59xxB
SMBZ59xxB
SM = Surface **M**ount
SMA = DO-214AC
SMB = DO-214AA
SMP = DO-220AA
Z = Power voltage-regulating diode

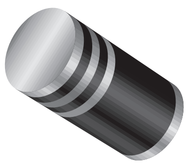
d) PTVyyB:

PTV = Power **V**oltage Regulator
yy = Minimum breakdown voltage
B = 5 %

Note:

- For additional explanation of JEDEC and ProElectron numbers, please refer to page 7.

Surface Mount Glass Passivated Power Voltage-Regulating Diodes



DO-213AB (GL41)

FEATURES

- Plastic MELF package
- Ideal for automated placement
- Glass passivated chip junction
- Low Zener impedance
- Low regulation factor
- Meets MSL level 1, per J-STD-020C, LF max peak of 250 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For general purpose regulation and protection applications.

PRIMARY CHARACTERISTICS	
V_Z	100 V to 200 V
P_D	1.0 W
I_R	1.0 µA
T_J max.	150 °C

MECHANICAL DATA

Case: DO-213AB (GL41)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Red band denotes Zener diode and positive (cathode)

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Document Number: 88409
Revision: 24-Sep-07

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
TYPE	NOMINAL ZENER VOLTAGE AT I_{ZT} (1) V_Z (V)	TEST CURRENT I_{ZT} (mA)	MAXIMUM ZENER DYNAMIC IMPEDANCE			MAXIMUM DC REVERSE LEAKAGE CURRENT AT V_R		MAXIMUM SURGE CURRENT (2) I_{RM} (mAdc)	MAX. INSTANTANEOUS FORWARD VOLTAGE AT 200 mA V_F (V)
			Z_{ZT} AT I_{ZT}	Z_{ZK} AT I_{ZK}		I_R	V_R		
			(Ω)	(Ω)	(mA)	(µA)	(V)		
ZGL41-100	100	3.7	250	3100	0.25	1.0	76.0	10.0	1.5
ZGL41-110	110	3.4	300	4000	0.25	1.0	83.6	9.1	1.5
ZGL41-120	120	3.1	380	4500	0.25	1.0	91.2	8.3	1.5
ZGL41-130	130	2.9	450	5000	0.25	1.0	98.8	7.7	1.5
ZGL41-140	140	2.7	525	5500	0.25	1.0	106.4	7.1	1.5
ZGL41-150	150	2.5	600	6000	0.25	1.0	114.0	6.7	1.5
ZGL41-160	160	2.3	700	6500	0.25	1.0	121.6	6.3	1.5
ZGL41-170	170	2.2	800	6750	0.25	1.0	129.2	5.9	1.5
ZGL41-180	180	2.1	900	7000	0.25	1.0	136.9	5.6	1.5
ZGL41-190	190	2.0	1050	7500	0.25	1.0	144.4	5.3	1.5
ZGL41-200	200	1.9	1200	8000	0.25	1.0	152.0	5.0	1.5

Notes:

(1) Standard voltage tolerance is ± 10 %, Suffix A = ± 5 %

(2) Surge current is a non-repetitive, 8.3 ms pulse width square wave or equivalent sine-wave superimposed on I_{ZT} per JEDEC Method

(3) Maximum steady state power dissipation is 1.0 W at T_L = 75 °C

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
ZGL41-100-E3/96	0.134	96	1500	7" diameter plastic tape and reel
ZGL41-100-E3/97	0.134	97	5000	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

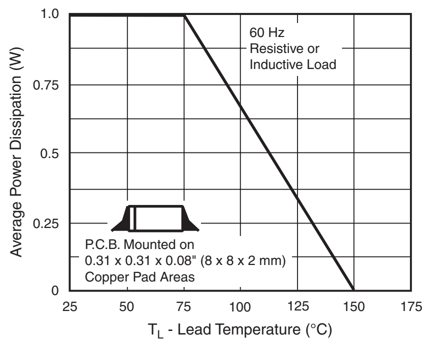


Figure 1. Maximum Continuous Power Dissipation

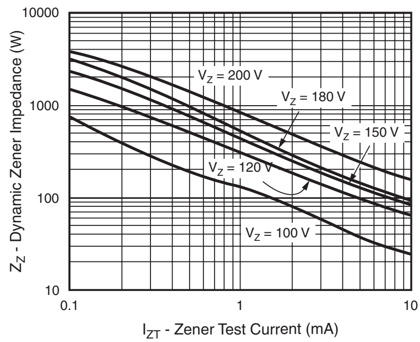


Figure 2. Typical Zener Impedance

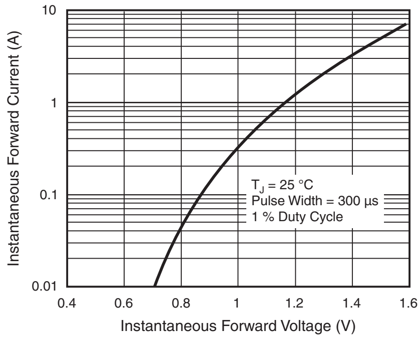


Figure 3. Typical Instantaneous Forward Characteristics

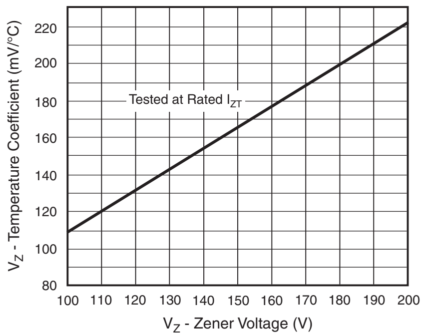


Figure 5. Steady State Power Derating Curve

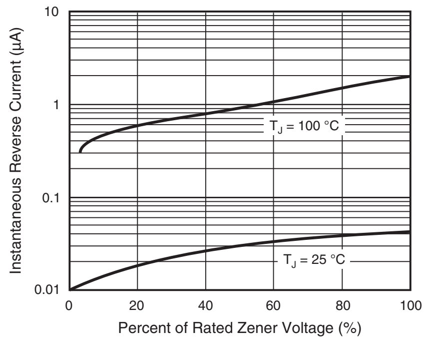


Figure 4. Typical Reverse Characteristics

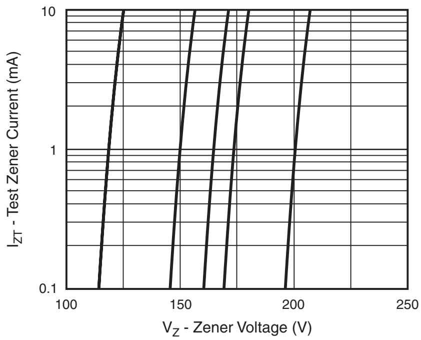
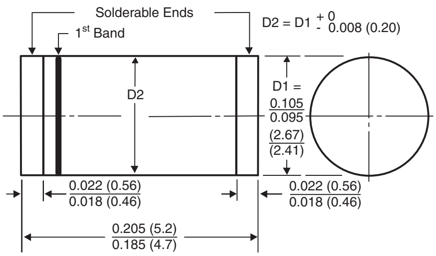


Figure 6. Typical Zener Voltage

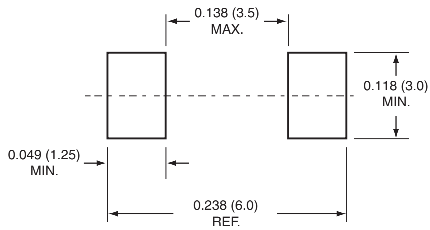
PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-213AB (GL41)



1st Band Denotes Type and Positive End (Cathode)

Mounting Pad Layout



Surface Mount Power Voltage-Regulating Diodes

eSMP™ Series

DO-220AA (SMP)

FEATURES

- Very low profile - typical height of 1.0 mm
- Ideal for automated placement
- Low Zener impedance
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For general voltage regulation, voltage limiting and voltage surge absorption.

PRIMARY CHARACTERISTICS	
V_Z	5.1 V to 36 V
P_D at T_L = 75 °C	1.5 W
P_D at T_A = 25 °C	0.6 W
T_J max.	150 °C

MECHANICAL DATA

Case: DO-220AA (SMP)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Power dissipation at T_L = 75 °C (Fig. 1) (1)	P_D	1.5	W
Power dissipation at T_A = 25 °C (Fig. 1) (2)	P_D	0.6	W
Maximum instantaneous forward voltage at 200 mA for all types (3)	V_F	1.5	V
Operating junction temperature	T_J	150	°C
Storage temperature range	T_{STG}	- 55 to + 150	°C

Notes:

(1) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal

(2) Mounted on minimum recommended pad layout

(3) Pulse test: 300 µs pulse width, 1 % duty circle

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)								
PART NUMBER	DEVICE MARKING CODE	ZENER VOLTAGE			MAXIMUM ZENER DYNAMIC IMPEDANCE		MAXIMUM REVERSE LEAKAGE CURRENT	
		V_Z (V)		I_{ZT} (mA)	Z_{ZT} (Ω)	I_{ZT} (mA)	I_R (µA)	V_R (V)
		MIN	MAX					
PTV 5.1B	VE	5.10	5.70	40	8	40	20	1.0
PTV 5.6B	VF	5.60	6.30	40	8	40	20	1.5
PTV 6.2B	VG	6.20	7.00	40	6	40	20	3.0
PTV 6.8B	VH	6.80	7.70	40	6	40	50	3.5
PTV 7.5B	VI	7.50	8.40	40	4	40	20	4.0
PTV 8.2B	VJ	8.20	9.30	40	4	40	20	5.0
PTV 9.1B	VK	9.10	10.2	40	6	40	20	6.0
PTV 10B	VL	10.0	11.2	40	6	40	10	7.0
PTV 11B	VM	11.0	12.3	20	8	20	10	8.0
PTV 12B	VN	12.0	13.5	20	8	20	10	9.0
PTV 13B	VO	13.3	15.0	20	10	20	10	10.0
PTV 15B	VP	14.7	16.5	20	10	20	10	11.0
PTV 16B	VQ	16.2	18.3	20	12	20	10	12.0
PTV 18B	VR	18.0	20.3	20	12	20	10	13.0
PTV 20B	VS	20.0	22.4	20	14	20	10	15.0
PTV 22B	VT	22.0	24.5	10	14	10	10	17.0
PTV 24B	VU	24.0	27.6	10	16	10	10	19.0
PTV 27B	VV	27.0	30.8	10	16	10	10	21.0
PTV 30B	VX	30.0	34.0	10	18	10	10	23.0
PTV 33B	VY	33.0	37.0	10	18	10	10	25.0
PTV 36B	VZ	36.0	40.0	10	20	10	10	27.0

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	LIMIT	UNIT
Typical thermal resistance, junction to lead (1)	$R_{\theta JL}$	50	°C/W
Typical thermal resistance, junction to ambient (2)	$R_{\theta JA}$	208	°C/W

Notes:

(1) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal

(2) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
PTV7.5B-E3/84A	0.024	84A	3000	7" diameter plastic tape and reel
PTV7.5B-E3/85A	0.024	85A	10000	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES
(T_A = 25 °C unless otherwise noted)

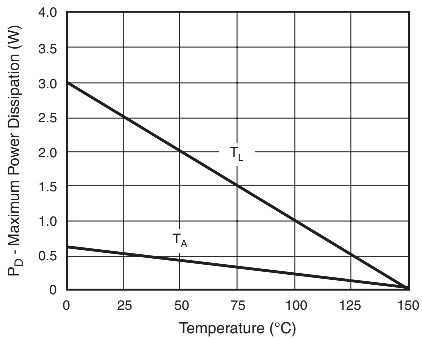


Figure 1. Steady State Power Durating

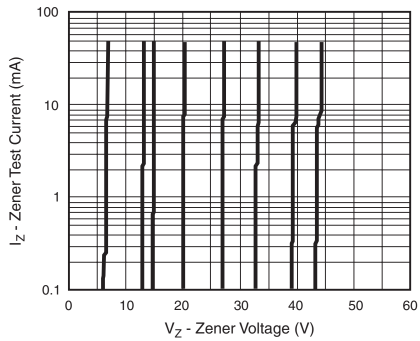


Figure 3. Typical Zener Voltage

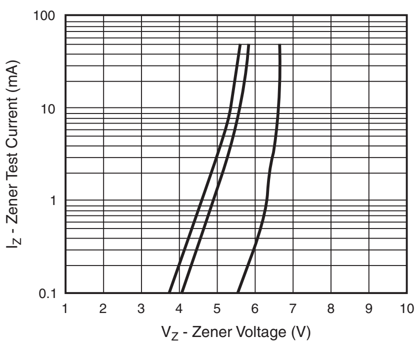
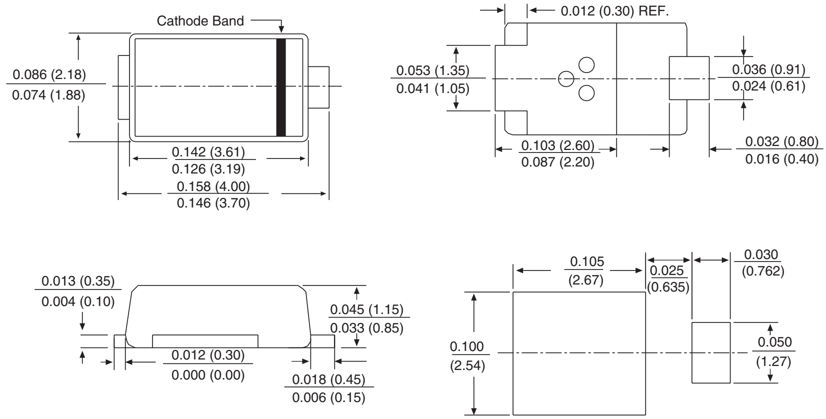


Figure 2. Typical Zener Voltage

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-220AA (SMP)



Surface Mount Power Voltage-Regulating Diodes

DO-214AC (SMA)

FEATURES

- Low profile package
- Ideal for automated placement
- Low Zener impedance
- Low regulation factor
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For general purpose regulation and protection applications.

PRIMARY CHARACTERISTICS	
V_Z	5.6 V to 68 V
P_D	1.5 W at T_L = 75 °C
P_D	0.5 W at T_A = 25 °C
T_J max.	150 °C

MECHANICAL DATA

Case: DO-214AC (SMA)
Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Power dissipation at T_L = 75 °C (Fig. 1) (1)	P_D	1.5	W
Power dissipation at T_A = 25 °C (Fig. 1) (2)	P_D	0.5	
Maximum instantaneous forward voltage at 200 mA for all types (3)	V_F	1.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 150	°C

Notes:

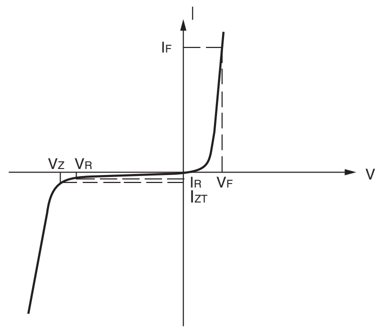
(1) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal

(2) Mounted on minimum recommended pad layout

(3) Pulse test: 300 µs pulse width, 1 % duty cycle

Document Number: 88488
Revision: 15-Aug-07

ELECTRICAL CHARACTERISTICS	
SYMBOL	**PARAMETER**
V_Z	Reverse Zener voltage at I_{ZT}
I_{ZT}	Reverse current
Z_{ZT}	Maximum Zener impedance at I_{ZT}
I_{ZK}	Reverse current
Z_{ZK}	Maximum Zener impedance at I_{ZK}
I_R	Reverse leakage current at V_R
V_R	Reverse voltage
I_F	Forward current
V_F	Forward voltage at I_F
I_{ZM}	Maximum DC Zener current



Zener Voltage Regulator

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

PART NUMBER	DEVICE MARKING CODE	ZENER VOLTAGE V_Z AT I_{ZT} (V)			TEST CURRENT I_{ZT} (mA)	MAXIMUM ZENER IMPEDANCE			MAXIMUM REVERSE LEAKAGE CURRENT I_R AT V_R		MAXIMUM ZENER CURRENT I_{ZM} (mA)
						Z_{ZT} AT I_{ZT}	Z_{ZK} AT I_{ZK}				
		MIN	NOM	MAX		(Ω)	(Ω)	(mA)	(µA)	(V)	
SMAZ5919B	19B	5.32	5.6	5.88	66.9	5	700	1	200	3	268
SMAZ5920B	20B	5.89	6.2	6.51	60.5	2	700	1	200	4	242
SMAZ5921B	21B	6.46	6.8	7.14	55.1	2.5	400	1	200	5.2	221
SMAZ5923B	23B	7.79	8.2	8.61	45.7	5.0	700	0.5	10	6.5	183
SMAZ5924B	24B	8.64	9.1	9.56	41.2	5.0	700	0.5	10	7.0	165
SMAZ5925B	25B	9.5	10	10.5	37.5	5.0	700	0.25	10	8.0	150
SMAZ5926B	26B	10.5	11	11.6	34.1	5.5	550	0.25	5	8.4	136
SMAZ5927B	27B	11.4	12	12.6	31.2	6.5	550	0.25	1	9.1	125
SMAZ5928B	28B	12.4	13	13.7	28.8	7.0	550	0.25	1	9.9	115
SMAZ5929B	29B	14.3	15	15.8	25.0	9.0	600	0.25	1	11.4	100
SMAZ5930B	30B	15.2	16	16.8	23.4	10.0	600	0.25	1	12.2	94
SMAZ5931B	31B	17.1	18	18.9	20.8	12.0	650	0.25	1	13.7	83
SMAZ5932B	32B	19.0	20	21.0	18.7	14.0	650	0.25	1	15.2	75
SMAZ5933B	33B	20.9	22	23.1	17.0	17.5	650	0.25	1	16.7	68
SMAZ5934B	34B	22.8	24	25.2	15.6	19.0	700	0.25	1	18.2	62
SMAZ5935B	35B	25.7	27	28.4	13.9	23.0	700	0.25	1	20.6	56
SMAZ5936B	36B	28.5	30	31.5	12.5	28.0	750	0.25	1	22.8	50
SMAZ5937B	37B	31.4	33	34.7	11.4	33.0	800	0.25	1	25.1	45
SMAZ5938B	38B	34.2	36	37.8	10.4	38.0	850	0.25	1	27.4	42
SMAZ5939B	39B	37.1	39	41.0	9.6	45.0	900	0.25	1	29.7	38
SMAZ5940B	40B	40.9	43	45.2	8.7	53.0	950	0.25	1	32.7	35
SMAZ5941B	41B	44.65	47	49.35	8.0	67	1000	0.25	1	35.8	32
SMAZ5942B	42B	48.45	51	53.55	7.3	70	1100	0.25	1	38.8	29
SMAZ5943B	43B	53.2	56	58.8	6.7	86	1300	0.25	1	42.6	27
SMAZ5944B	44B	58.9	62	65.1	6.0	100	1500	0.25	1	47.1	24
SMAZ5945B	45B	64.6	68	71.4	5.5	120	1700	0.25	1	51.7	22

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**LIMIT**	**UNIT**
Typical thermal resistance, junction to lead (1)	$R_{\theta JL}$	50	°C/W
Typical thermal resistance, junction to ambient (2)	$R_{\theta JA}$	250	°C/W

Notes:

(1) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal

(2) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMAZ5925B-E3/61	0.064	61	1800	7" diameter plastic tape and reel
SMAZ5925B-E3/5A	0.064	5A	7500	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

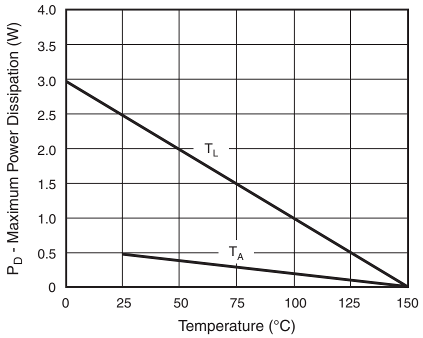


Figure 1. Steady State Power Durating

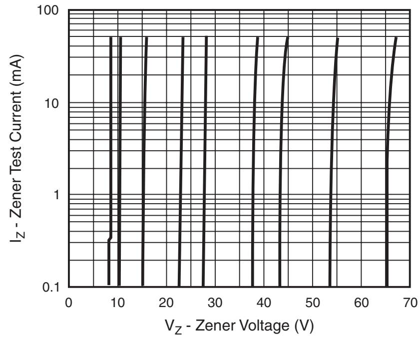


Figure 3. Typical Zener Voltage

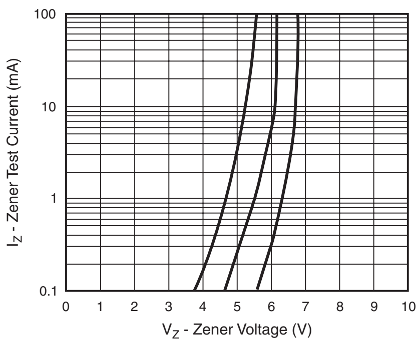


Figure 2. Typical Zener Voltage

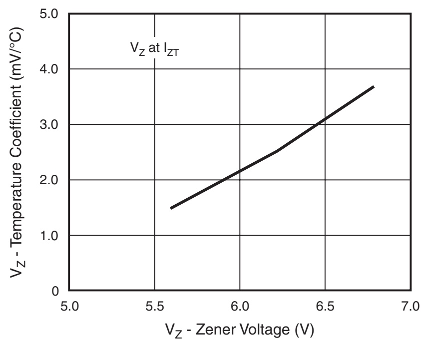


Figure 4. Typical Temperature Coefficients

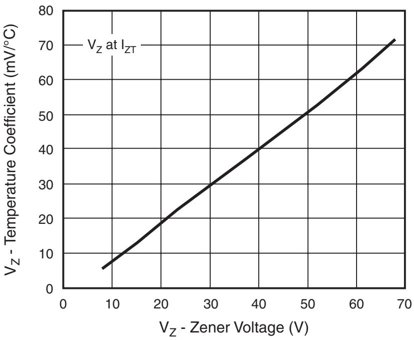


Figure 5. Typical Temperature Coefficients

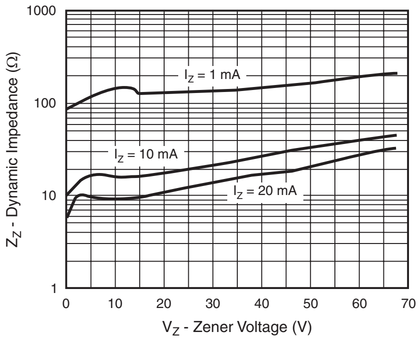


Figure 7. Typical Zener Impedance

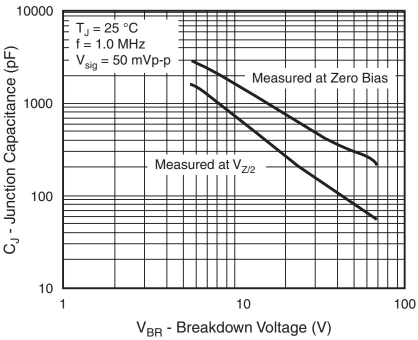
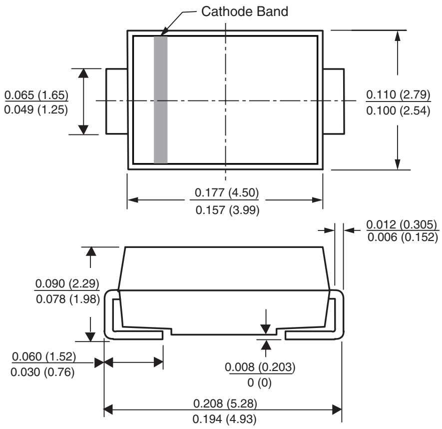


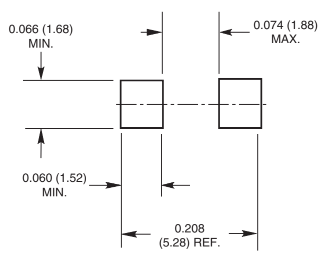
Figure 6. Typical Junction Capacitance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-214AC (SMA)



Mounting Pad Layout



Surface Mount Power Voltage-Regulating Diodes

eSMP™ Series

DO-220AA (SMP)

PRIMARY CHARACTERISTICS	
V_Z	5.6 V to 43 V
P_D	1.5 W at T_L = 75 °C
P_D	0.5 W at T_A = 25 °C
T_J max.	150 °C

FEATURES

- Very low profile - typical height of 1.0 mm
- Ideal for automated placement
- Low Zener impedance
- Low regulation factor
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For general purpose regulation and protection applications.

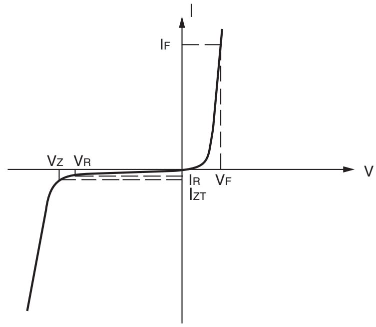
MECHANICAL DATA

Case: DO-220AA (SMP)
Epoxy meets UL 94V-0 flammability rating
Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade
Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Power dissipation at T_L = 75 °C (Fig. 1) (1)	P_D	1.5	W
Power dissipation at T_A = 25 °C (Fig. 1) (2)	P_D	0.5	W
Maximum instantaneous forward voltage at 200 mA for all types (3)	V_F	1.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 150	°C

Notes:
(1) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal
(2) Mounted on minimum recommended pad layout
(3) Pulse test: 300 µs pulse width, 1 % duty cycle

ELECTRICAL CHARACTERISTICS	
SYMBOL	**PARAMETER**
V_Z	Reverse Zener voltage at I_{ZT}
I_{ZT}	Reverse current
Z_{ZT}	Maximum Zener impedance at I_{ZT}
I_{ZK}	Reverse current
Z_{ZK}	Maximum Zener impedance at I_{ZK}
I_R	Reverse leakage current at V_R
V_R	Reverse voltage
I_F	Forward current
V_F	Forward voltage at I_F
I_{ZM}	Maximum DC Zener current



Zener Voltage Regulator

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

PART NUMBER	DEVICE MARKING CODE	ZENER VOLTAGE V_Z AT I_{ZT} (V)			TEST CURRENT I_{ZT} (mA)	MAXIMUM ZENER IMPEDANCE			MAXIMUM REVERSE LEAKAGE CURRENT I_R AT V_R		MAXIMUM ZENER CURRENT I_{ZM} (mA)
						Z_{ZT} AT I_{ZT}	Z_{ZK} AT I_{ZK}				
		MIN	NOM	MAX		(Ω)	(Ω)	(mA)	(μA)	(V)	
SMPZ3919B	19B	5.32	5.6	5.88	66.9	5.0	700	1.0	200	3.0	268
SMPZ3920B	20B	5.89	6.2	6.51	60.5	2.0	700	1.0	200	4.0	242
SMPZ3921B	21B	6.46	6.8	7.14	55.1	2.5	400	1.0	200	5.2	221
SMPZ3922B	22B	7.12	7.5	7.88	50.0	3.0	400	0.5	150	6.0	200
SMPZ3923B	23B	7.79	8.2	8.61	45.7	3.5	400	0.5	50	6.5	183
SMPZ3924B	24B	8.64	9.1	9.56	41.2	4.0	500	0.5	10	7.0	165
SMPZ3925B	25B	9.5	10	10.5	37.5	4.5	500	0.25	2.5	8.0	150
SMPZ3926B	26B	10.5	11	11.6	34.1	5.5	550	0.25	0.5	8.4	136
SMPZ3927B	27B	11.4	12	12.6	31.2	6.5	550	0.25	0.5	9.1	125
SMPZ3928B	28B	12.4	13	13.7	28.8	7.0	550	0.25	0.5	9.9	115
SMPZ3929B	29B	14.3	15	15.8	25.0	9.0	600	0.25	0.5	11.4	100
SMPZ3930B	30B	15.2	16	16.8	23.4	10.0	600	0.25	0.5	12.2	94
SMPZ3931B	31B	17.1	18	18.9	20.8	12.0	650	0.25	0.5	13.7	83
SMPZ3932B	32B	19.0	20	21.0	18.7	14.0	650	0.25	0.5	15.2	75
SMPZ3933B	33B	20.9	22	23.1	17.0	17.5	650	0.25	0.5	16.7	68
SMPZ3934B	34B	22.8	24	25.2	15.6	19.0	700	0.25	0.5	18.2	63
SMPZ3935B	35B	25.7	27	28.4	13.9	23.0	700	0.25	0.5	20.6	56
SMPZ3936B	36B	28.5	30	31.5	12.5	26.0	750	0.25	0.5	22.8	50
SMPZ3937B	37B	31.4	33	34.7	11.4	33.0	800	0.25	0.5	25.1	45
SMPZ3938B	38B	34.2	36	37.8	10.4	38.0	850	0.25	0.5	27.4	42
SMPZ3939B	39B	37.1	39	41.0	9.6	45.0	900	0.25	0.5	29.7	38
SMPZ3940B	40B	40.9	43	45.2	8.7	53.0	950	0.25	0.5	32.7	35

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Typical thermal resistance, junction to lead [(1)]	$R_{\theta JL}$	50	°C/W
Typical thermal resistance, junction to ambient [(2)]	$R_{\theta JA}$	250	°C/W

Notes:
(1) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal
(2) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMPZ3925B-E3/84A	0.024	84A	3000	7" diameter plastic tape and reel
SMPZ3925B-E3/85A	0.024	85A	10000	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

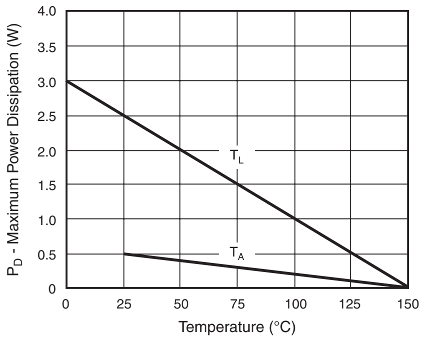


Figure 1. Steady State Power Durating

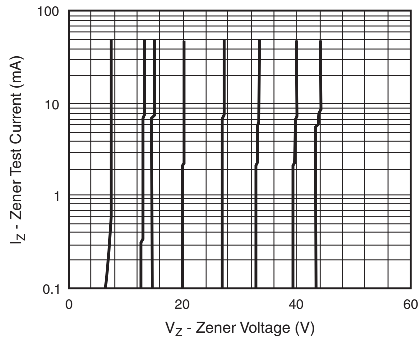


Figure 3. Typical Zener Voltage

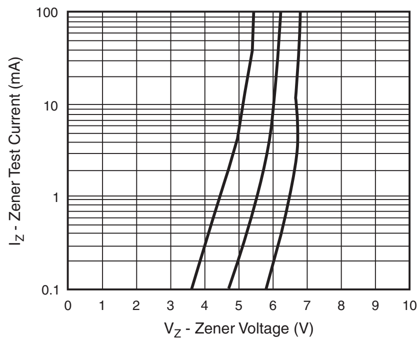


Figure 2. Typical Zener Voltage

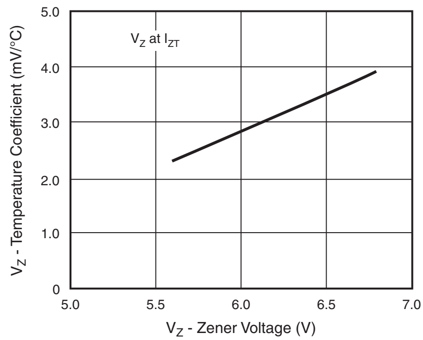


Figure 4. Typical Temperature Coefficients

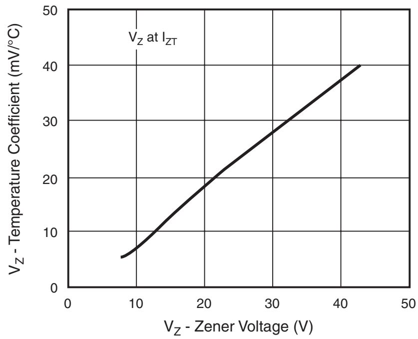


Figure 5. Typical Temperature Coefficients

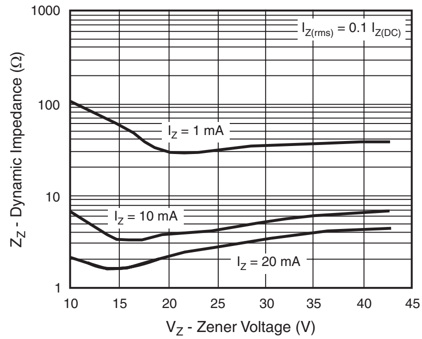


Figure 7. Typical Zener Impedance

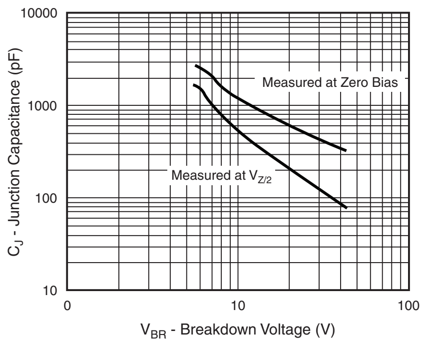
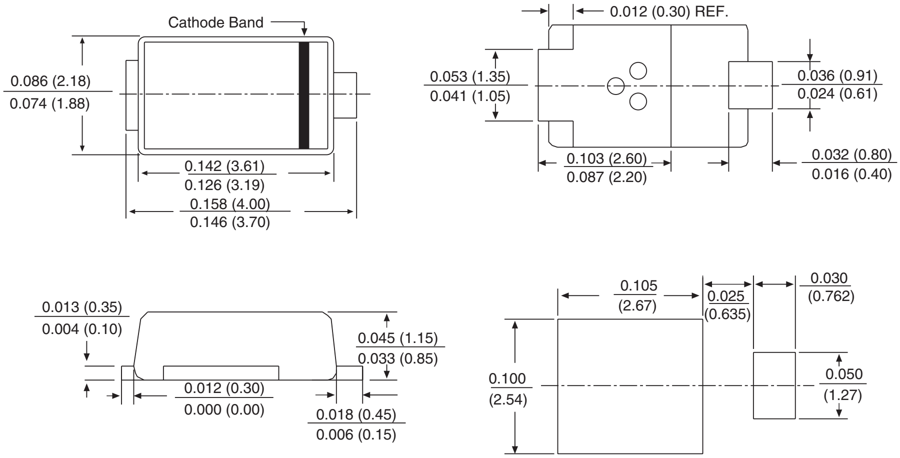


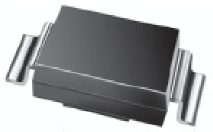
Figure 6. Typical Junction Capacitance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-220AA (SMP)



Surface Mount Power Voltage-Regulating Diodes



DO-215AA (SMBG)

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Low Zener impedance
- Low regulation factor
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For general purpose regulation and protection applications.

MECHANICAL DATA

Case: DO-215AA (SMBG)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes cathode end

PRIMARY CHARACTERISTICS	
V_Z	9.1 V to 68 V
P_D	1.5 W
I_R (V_Z > 12 V)	5.0 µA
T_J max.	150 °C

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Document Number: 88458
Revision: 20-Sep-07

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
PART NUMBER (1)	DEVICE MARKING CODE	NOMINAL ZENER VOLTAGE V_Z AT I_{ZT} (V)	TEST CURRENT I_{ZT} (mA)	MAX. ZENER IMPEDANCE LEAKAGE CURRENT			MAX. REVERSE CURRENT I_R AT V_R		MAX. ZENER CURRENT I_{ZM} (mA) (2)
				Z_{ZT} AT I_{ZT}	Z_{ZK} AT I_{ZK}				
				(Ω)	(Ω)	(mA)	(µA)	(V)	
SMZG3788A,B	VK,L	9.1	41.2	4.0	1000	0.50	50	7.0	140
SMZG3789A,B	WA,B	10	37.5	5.0	1000	0.25	50	7.6	125
SMZG3790A,B	WC,D	11	34.1	6.0	650	0.25	10	8.4	115
SMZG3791A,B	WE,F	12	31.2	7.0	550	0.25	5.0	9.1	105
SMZG3792A,B	WG,H	13	28.8	7.5	550	0.25	5.0	9.9	98
SMZG3793A,B	WI,J	15	25.0	9.0	600	0.25	5.0	11.4	85
SMZG3794A,B	WK,L	16	23.4	10	600	0.25	5.0	12.2	80
SMZG3795A,B	XA,B	18	20.8	12	650	0.25	5.0	13.7	70
SMZG3796A,B	XC,D	20	18.7	14	650	0.25	5.0	15.2	62
SMZG3797A,B	XE,F	22	17.0	17.5	650	0.25	5.0	16.7	56
SMZG3798A,B	XG,H	24	15.6	19	700	0.25	5.0	18.2	51
SMZG3799A,B	XI,J	27	13.9	23	700	0.25	5.0	20.6	46
SMZG3800A,B	XK,L	30	12.5	26	750	0.25	5.0	22.8	41
SMZG3801A,B	YA,B	33	11.4	33	800	0.25	5.0	25.1	38
SMZG3802A,B	YC,D	36	10.4	38	850	0.25	5.0	27.4	35
SMZG3803A,B	YE,F	39	9.6	45	900	0.25	5.0	29.7	31
SMZG3804A,B	YG,H	43	8.7	53	950	0.25	5.0	32.7	28
SMZG3805A,B	YI,J	47	8.0	67	1000	0.25	5.0	35.8	26
SMZG3806A,B	YK,L	51	7.3	70	1100	0.25	5.0	38.8	24
SMZG3807A,B	ZA,B	56	6.7	86	1300	0.25	5.0	42.6	22
SMZG3808A,B	ZC,D	62	6.0	100	1500	0.25	5.0	47.1	20
SMZG3809A,B	ZE,F	68	5.5	120	1700	0.25	5.0	51.7	18

Notes:

(1) Suffix “A” denotes ± 10 % and suffix “B” denotes ± 5 %

(2) Maximum steady state power dissipation is 1.5 W at T_L = 75 °C (Fig. 1)

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SMZG3788A-E3/52	0.096	52	750	7" diameter plastic tape and reel
SMZG3788A-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
SMZG3788AHE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
SMZG3788AHE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

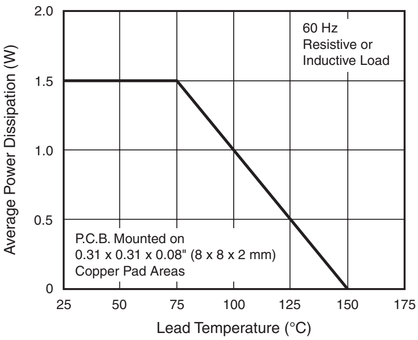


Figure 1. Maximum Continuous Power Dissipation

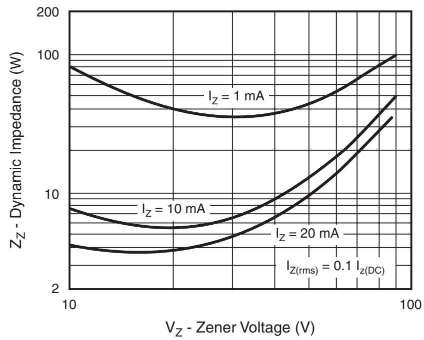


Figure 3. Typical Zener Impedance

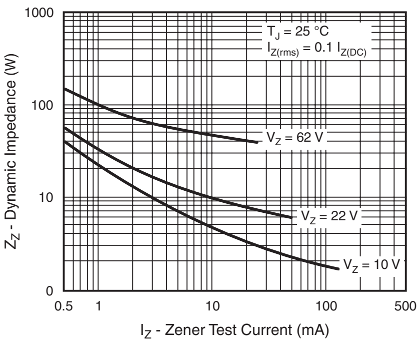


Figure 2. Typical Zener Impedance

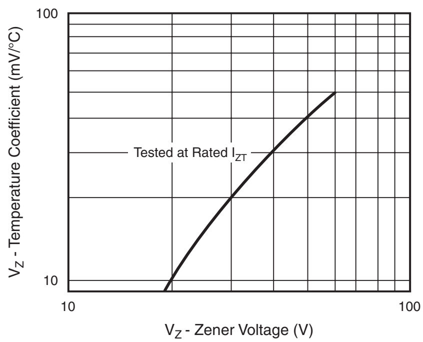
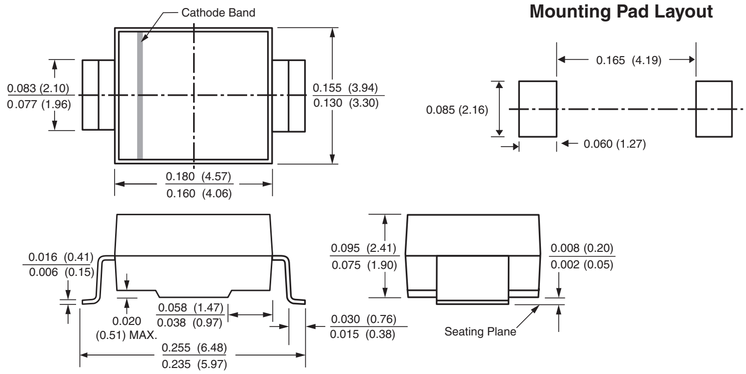


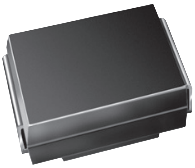
Figure 4. Typical Temperature Coefficients

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-215AA (SMBG)



Surface Mount Power Voltage-Regulating Diodes



DO-214AA (SMBJ)

FEATURES

- Low profile package
- Ideal for automated placement
- Glass passivated chip junction
- Low Zener impedance
- Low regulation factor
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

PRIMARY CHARACTERISTICS	
V_Z	9.1 V to 68 V
P_D	1.5 W
I_R ($V_Z \geq 12$ V)	5.0 µA
T_J max.	150 °C

TYPICAL APPLICATIONS

For general purpose regulation and protection applications.

MECHANICAL DATA

Case: DO-214AA (SMBJ)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
PART NUMBER	**DEVICE MARKING CODE**	**NOMINAL ZENER VOLTAGE V_Z AT I_{ZT} (V)**	**TEST CURRENT I_{ZT} (mA)**	**MAX. ZENER IMPEDANCE LEAKAGE CURRENT**			**MAX. REVERSE CURRENT I_R AT V_R**		**MAX. ZENER CURRENT I_{ZM} (mA)**
				Z_{ZT} AT I_{ZT}	**Z_{ZK} AT I_{ZK}**				
				(Ω)	**(Ω)**	**(mA)**	**(μA)**	**(V)**	
SMZJ3788A,B	VK,L	9.1	41.2	4.0	1000	0.50	50	7.0	140
SMZJ3789A,B	WA,B	10	37.5	5.0	1000	0.25	50	7.6	125
SMZJ3790A,B	WC,D	11	34.1	6.0	650	0.25	10	8.4	115
SMZJ3791A,B	WE,F	12	31.2	7.0	550	0.25	5.0	9.1	105
SMZJ3792A,B	WG,H	13	28.8	7.5	550	0.25	5.0	9.9	98
SMZJ3793A,B	WI,J	15	25.0	9.0	600	0.25	5.0	11.4	85
SMZJ3794A,B	WK,L	16	23.4	10.0	600	0.25	5.0	12.2	80
SMZJ3795A,B	XA,B	18	20.8	12.0	650	0.25	5.0	13.7	70
SMZJ3796A,B	XC,D	20	18.7	14.0	650	0.25	5.0	15.2	62
SMZJ3797A,B	XE,F	22	17.0	17.5	650	0.25	5.0	16.7	56
SMZJ3798A,B	XG,H	24	15.6	19.0	700	0.25	5.0	18.2	51
SMZJ3799A,B	XI,J	27	13.9	23.0	700	0.25	5.0	20.6	46
SMZJ3800A,B	XK,L	30	12.5	26.0	750	0.25	5.0	22.8	41
SMZJ3801A,B	YA,B	33	11.4	33.0	800	0.25	5.0	25.1	38
SMZJ3802A,B	YC,D	36	10.4	38.0	850	0.25	5.0	27.4	35
SMZJ3803A,B	YE,F	39	9.6	45.0	900	0.25	5.0	29.7	31
SMZJ3804A,B	YG,H	43	8.7	53.0	950	0.25	5.0	32.7	28
SMZJ3805A,B	YI,J	47	8.0	67.0	1000	0.25	5.0	35.8	26
SMZJ3806A,B	YK,L	51	7.3	70.0	1100	0.25	5.0	38.8	24
SMZJ3807A,B	ZA,B	56	6.7	86.0	1300	0.25	5.0	42.6	22
SMZJ3808A,B	ZC,D	62	6.0	100.0	1500	0.25	5.0	47.1	20
SMZJ3809A,B	ZE,F	68	5.5	120.0	1700	0.25	5.0	51.7	18

Notes:

(1) Suffix "A" denotes ± 10 % and suffix "B" denotes ± 5 %

(2) Maximum steady state power dissipation is 1.5 W at T_L = 75 °C (Fig. 1)

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMZJ3788A-E3/52	0.096	52	750	7" diameter plastic tape and reel
SMZJ3788A-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
SMZJ3788AHE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
SMZJ3788AHE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

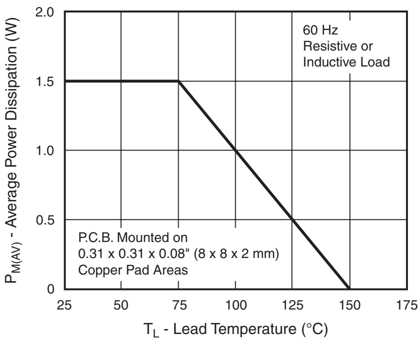


Figure 1. Maximum Continuous Power Dissipation

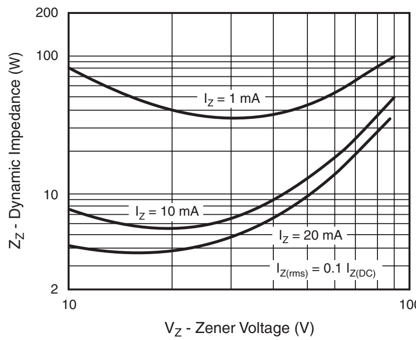


Figure 3. Typical Zener Impedance

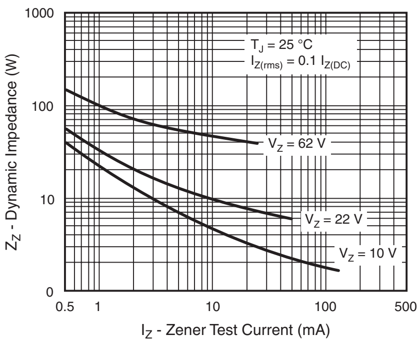


Figure 2. Typical Zener Impedance

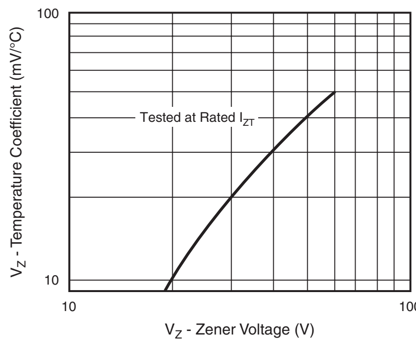
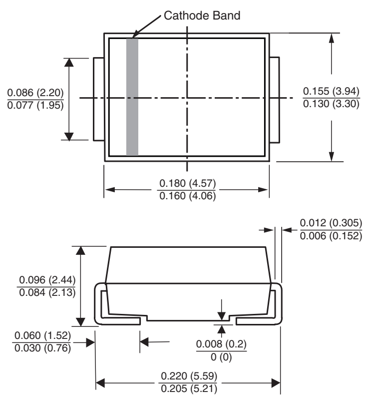


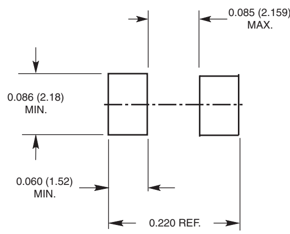
Figure 4. Typical Temperature Coefficients

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

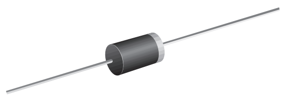
DO-214AA (SMB)



Mounting Pad Layout



Glass Passivated Power Voltage-Regulating Diodes



DO-204AL (DO-41)

PRIMARY CHARACTERISTICS	
V_Z	100 V to 200 V
P_D	1.5 W
I_R	0.5 µA
T_J max.	150 °C

FEATURES

- Plastic MELF package
- Ideal for automated placement
- Glass passivated chip junction
- Low Zener impedance
- Low regulation factor
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For general purpose regulation and protection applications.

MECHANICAL DATA

Case: DO-204AL (DO-41)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

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

TYPE	ZENER VOLTAGE AT 5.0 mA		MAXIMUM ZENER DYNAMIC IMPEDANCE				MAXIMUM DC REVERSE LEAKAGE CURRENT AT V_R			MAXIMUM INSTANTANEOUS FORWARD VOLTAGE AT 0.50 A	MAXIMUM CONTINUOUS REGULATOR CURRENT (2)
	V_Z (V)		I_{ZT}	Z_{ZT}	I_{ZK}	Z_{ZK}	V_R	I_R AT 25 °C	I_R AT 100 °C	V_{FM}	I_{ZM}
	MIN	MAX	(mA)	(Ω)	(mA)	(Ω)	(V)	(µA)	(µA)	(V)	(mA)
Z4KE100	90	110	5.0	500	0.25	5000	72.0	0.5	100	1.0	15.0
Z4KE100A	95	105	5.0	500	0.25	5000	76.0	0.5	100	1.0	15.0
Z4KE110	99	121	5.0	600	0.25	5000	79.2	0.5	100	1.0	13.0
Z4KE110A	104	116	5.0	600	0.25	5000	83.2	0.5	100	1.0	13.0
Z4KE120	108	132	5.0	700	0.25	5000	86.4	0.5	100	1.0	12.0
Z4KE120A	114	126	5.0	700	0.25	5000	91.2	0.5	100	1.0	12.0

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ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)											
TYPE	ZENER VOLTAGE AT 5.0 mA		MAXIMUM ZENER DYNAMIC IMPEDANCE				MAXIMUM DC REVERSE LEAKAGE CURRENT AT V_R			MAXIMUM INSTANTANEOUS FORWARD VOLTAGE AT 0.50 A	MAXIMUM CONTINUOUS REGULATOR CURRENT (2)
	V_Z (V)		I_{ZT}	Z_{ZT}	I_{ZK}	Z_{ZK}	V_R	I_R AT 25 °C	I_R AT 100 °C	V_{FM}	I_{ZM}
	MIN	MAX	(mA)	(Ω)	(mA)	(Ω)	(V)	(µA)	(µA)	(V)	(mA)
Z4KE130	117	143	5.0	800	0.25	5000	93.6	0.5	100	1.0	11.0
Z4KE130A	124	137	5.0	800	0.25	5000	99.2	0.5	100	1.0	11.0
Z4KE140	126	154	5.0	900	0.25	5000	100	0.5	100	1.0	10.7
Z4KE140A	133	147	5.0	900	0.25	5500	106.4	0.5	100	1.0	10.7
Z4KE150	135	165	5.0	1000	0.25	6000	108.0	0.5	100	1.0	10.0
Z4KE150A	142	158	5.0	1000	0.25	6000	113.6	0.5	100	1.0	10.0
Z4KE160	144	176	5.0	1100	0.25	6500	115.2	0.5	100	1.0	9.0
Z4KE160A	152	168	5.0	1100	0.25	6500	121.6	0.5	100	1.0	9.0
Z4KE170	153	187	5.0	1200	0.25	7000	122.4	0.5	100	1.0	8.8
Z4KE170A	162	179	5.0	1200	0.25	7000	129.6	0.5	100	1.0	8.0
Z4KE180	162	198	5.0	1300	0.25	7000	129.6	0.5	100	1.0	8.0
Z4KE180A	171	189	5.0	1300	0.25	7000	136.8	0.5	100	1.0	8.0
Z4KE190	171	209	5.0	1400	0.25	7500	136.8	0.5	100	1.0	7.9
Z4KE190A	180	200	5.0	1400	0.25	7500	144.0	0.5	100	1.0	7.9
Z4KE200	180	220	5.0	1500	0.25	8000	144.0	0.5	100	1.0	7.0
Z4KE200A	190	210	5.0	1500	0.25	8000	152.0	0.5	100	1.0	7.0

Notes:

(1) Standard voltage tolerance is ± 10 %, suffix “A” is ± 5 %

(2) Maximum power dissipation is 1.5 W at T_L = 75 °C with lead length 0.375" (9.5 mm)

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
Z4KE100-E3/54	0.350	54	4000	13" diameter paper tape and reel
Z4KE100HE3/54 (1)	0.350	54	4000	13" diameter paper tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES
(T_A = 25 °C unless otherwise noted)

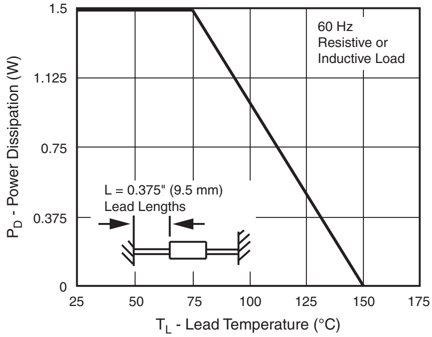


Figure 1. Power Derating Curve

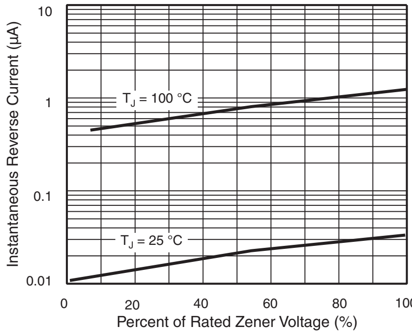


Figure 4. Typical Reverse Characteristics

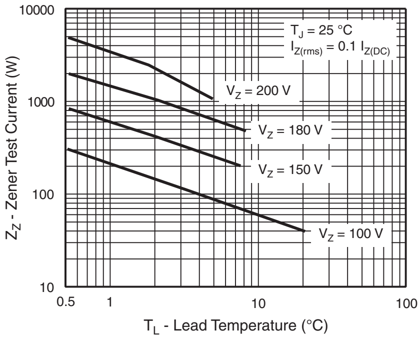


Figure 2. Typical Zener Impedance

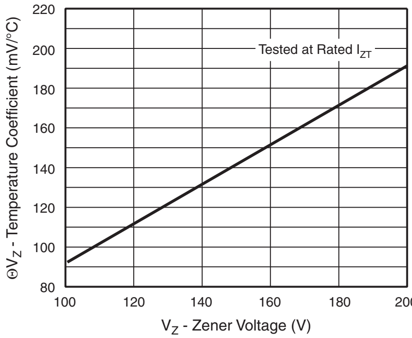


Figure 5. Typical Temperature Coefficients

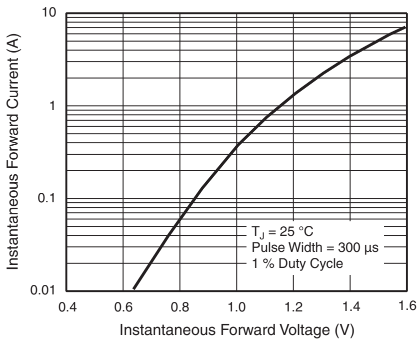


Figure 3. Typical Instantaneous Forward Characteristics

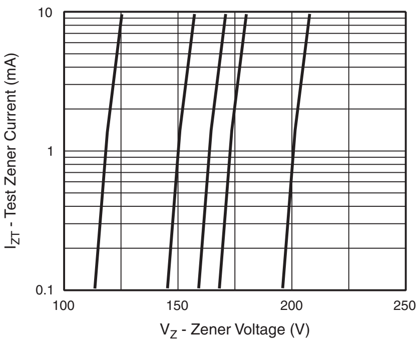
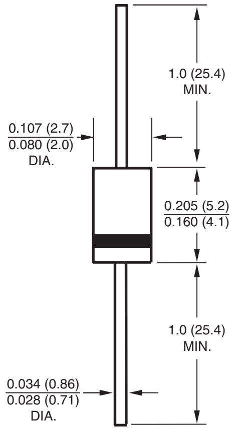


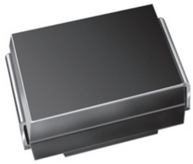
Figure 6. Typical Zener Voltage

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AL (DO-41)



Surface Mount Power Voltage-Regulating Diodes



DO-214AA (SMBJ)

PRIMARY CHARACTERISTICS	
V_Z	5.6 V to 68 V
P_D	3.0 W at T_L = 75 °C
P_D	550 mW at T_A = 25 °C
T_J max.	150 °C

FEATURES

- Low profile package
- Ideal for automated placement
- Low Zener impedance
- Low regulation factor
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For general purpose regulation and protection applications.

MECHANICAL DATA

Case: DO-214AA (SMBJ)
Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes cathode end

MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)

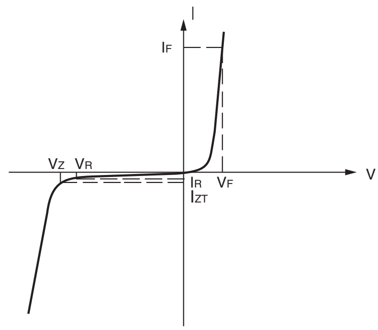
PARAMETER	SYMBOL	VALUE	UNIT
Maximum steady state power dissipation at T_L = 75 °C (Fig. 1)	P_D	3.0	W
Maximum steady state power dissipation at T_A = 25 °C (Fig. 1) (1)	P_D	550	mW
Maximum instantaneous forward voltage at 200 mA for all types (2)	V_F	1.5	V
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) Mounted on minimum recommended pad layout

(2) Pulse test: 300 µs pulse width, 1 % duty cycle

ELECTRICAL CHARACTERISTICS	
SYMBOL	**PARAMETER**
V_Z	Reverse Zener voltage at I_{ZT}
I_{ZT}	Reverse current
Z_{ZT}	Maximum Zener impedance at I_{ZT}
I_{ZK}	Reverse current
Z_{ZK}	Maximum Zener impedance at I_{ZK}
I_R	Reverse leakage current at V_R
V_R	Reverse voltage
I_F	Forward current
V_F	Forward voltage at I_F
I_{ZM}	Maximum DC Zener current



Zener Voltage Regulator

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

PART NUMBER	DEVICE MARKING CODE	ZENER VOLTAGE V_Z AT I_{ZT} (V)			TEST CURRENT I_{ZT} (mA)	MAXIMUM ZENER IMPEDANCE			MAXIMUM REVERSE LEAKAGE CURRENT I_R AT V_R		MAXIMUM ZENER CURRENT I_{ZM} (mA)
						Z_{ZT} AT I_{ZT}	Z_{ZK} AT I_{ZK}				
		MIN	NOM	MAX		(Ω)	(Ω)	(mA)	(µA)	(V)	
SMBZ5919B	19B	5.32	5.6	5.88	66.9	5	700	1	200	3	267
SMBZ5920B	20B	5.89	6.2	6.51	60.5	2	700	1	200	4	241
SMBZ5921B	21B	6.46	6.8	7.14	55.1	2.5	400	1	200	5.2	220
SMBZ5924B	24B	8.64	9.1	9.56	41.2	4.0	1000	0.5	25	7.0	164
SMBZ5925B	25B	9.5	10	10.5	37.5	4.5	1000	0.25	25	8.0	150
SMBZ5926B	26B	10.5	11	11.6	34.1	5.5	550	0.25	5	8.4	136
SMBZ5927B	27B	11.4	12	12.6	31.2	6.5	550	0.25	1	9.1	125
SMBZ5928B	28B	12.4	13	13.7	28.8	7.0	550	0.25	1	9.9	115
SMBZ5929B	29B	14.3	15	15.8	25.0	9.0	600	0.25	1	11.4	100
SMBZ5930B	30B	15.2	16	16.8	23.4	10.0	600	0.25	1	12.2	93
SMBZ5931B	31B	17.1	18	18.9	20.8	12.0	650	0.25	1	13.7	83
SMBZ5932B	32B	19.0	20	21.0	18.7	14.0	650	0.25	1	15.2	75
SMBZ5933B	33B	20.9	22	23.1	17.0	17.5	650	0.25	1	16.7	68
SMBZ5934B	34B	22.8	24	25.2	15.6	19.0	700	0.25	1	18.2	62
SMBZ5935B	35B	25.7	27	28.4	13.9	23.0	700	0.25	1	20.6	55
SMBZ5936B	36B	28.5	30	31.5	12.5	28.0	750	0.25	1	22.8	50
SMBZ5937B	37B	31.4	33	34.7	11.4	33.0	800	0.25	1	25.1	45
SMBZ5938B	38B	34.2	36	37.8	10.4	38.0	850	0.25	1	27.4	41
SMBZ5939B	39B	37.1	39	41.0	9.6	45.0	900	0.25	1	29.7	38
SMBZ5940B	40B	40.9	43	45.2	8.7	53.0	950	0.25	1	32.7	34
SMBZ5941B	41B	44.6	47	49.4	8.0	67	1000	0.25	1	35.8	31
SMBZ5942B	42B	48.4	51	53.6	7.3	70	1100	0.25	1	38.8	29
SMBZ5943B	43B	53.2	56	58.8	6.7	86	1300	0.25	1	42.6	26
SMBZ5944B	44B	58.9	62	65.1	6.0	100	1500	0.25	1	47.1	24
SMBZ5945B	45B	64.6	68	71.4	5.5	120	1700	0.25	1	51.7	22

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	SYMBOL	LIMIT	UNIT
Typical thermal resistance, junction to lead	$R_{\theta JL}$	25	°C/W
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	226	°C/W

Note:

(1) Mounted on minimum recommended pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SMBZ5935B-E3/52	0.096	52	750	7" diameter plastic tape and reel
SMBZ5935B-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

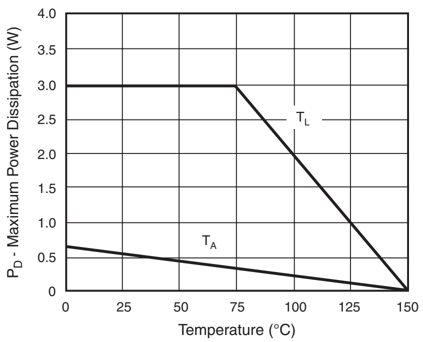


Figure 1. Steady State Power Durating

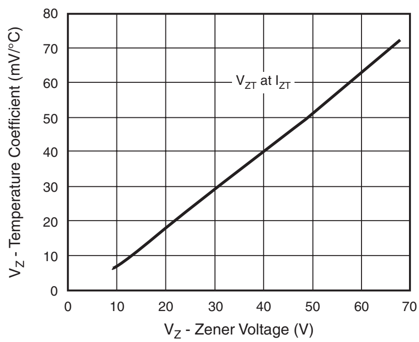


Figure 3. Typical Temperature Coefficients

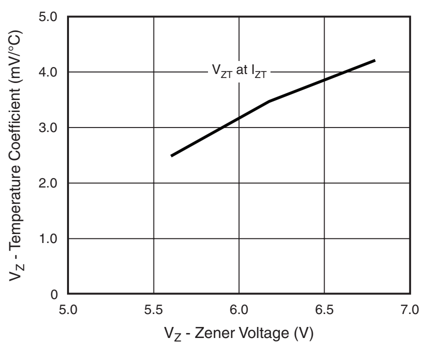


Figure 2. Typical Temperature Coefficients

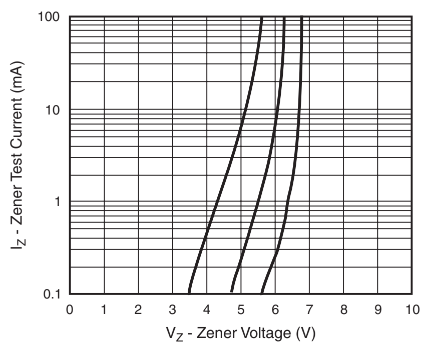


Figure 4. Typical Zener Voltage

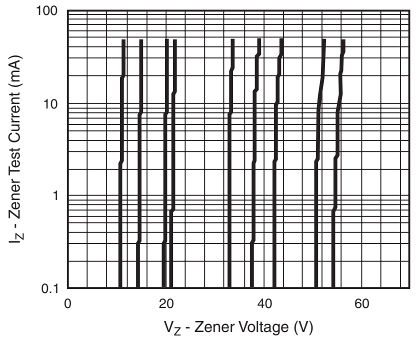


Figure 5. Typical Zener Voltage

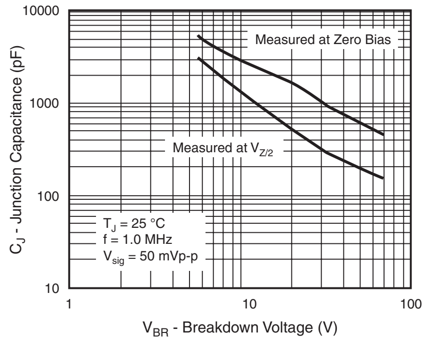


Figure 7. Typical Junction Capacitance

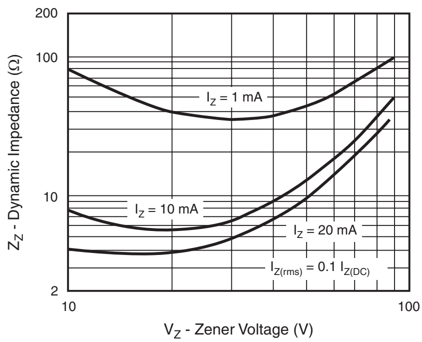
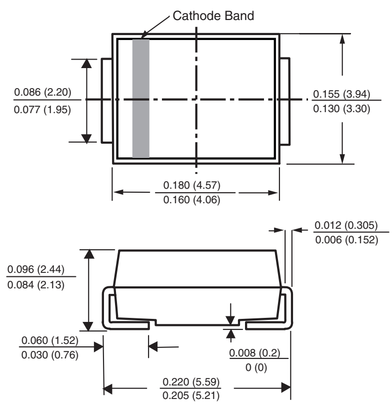


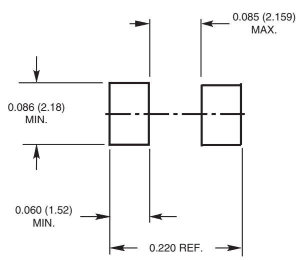
Figure 6. Typical Zener Impedance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

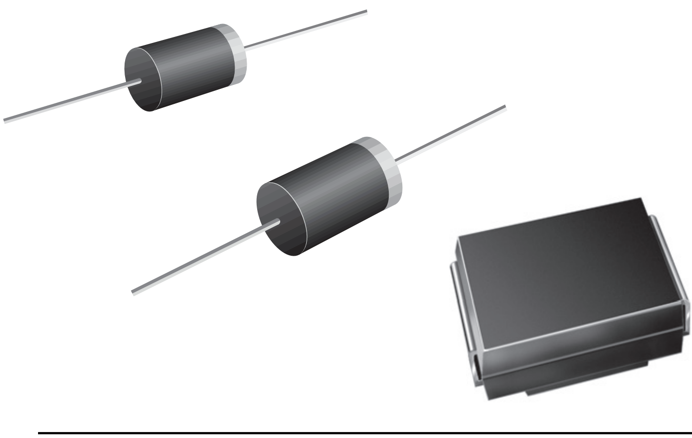
DO-214AA (SMB-J-Bend)



Mounting Pad Layout



Special Function Transient Voltage Suppressors

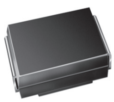


Contens

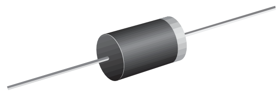
Introduction to Special Function Transient Voltage Suppressors

Vishay General Semiconductor also provides Special Function Transient Voltage Suppressors for varied special system requirements. Special Function TVS include: Asymmetric Transient Voltage Suppressors, Low Capacitance LCE and SAC series that are used to protect different Transient Voltages of power lines in telecom and automotive applications, Low Forward Voltage TVS products for hard disk drives. Asymmetric Transient Voltage Suppressors featured optimized design for automotive motor drive circuit, as in windshield wiper motor system. Voltages range from 30 V TVS to 300 V protection Diodes. The low V_F TVS series are used in reverse surge and polarity protections with low V_F < 0.5 V at 1 A.

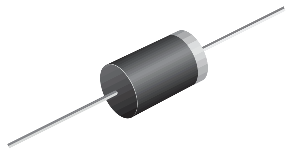
These diodes are available in the following packages: DO-214AA (SMB), DO-204AC (DO-15) and 1.5 KE.



DO-214AA (SMBJ)



DO-204AC (DO-15)



1.5KE

Special Function TVS Part Numbering System

1. AXIAL

a) <u>500 W:</u>

SACyy
SA = **S**urge **A**rrestor
C = Low capacitance (uni-directional only)
yy = Stand-off voltage (in V)

b) <u>1500 W:</u>

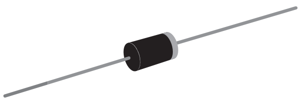
LCEyyd
LC = **L**ow **C**apacitance TVS (uni-directional only)
E = Epoxy package
yy = Stand-off voltage (in V)
d = Breakdown voltage tolerance/polarity
"Blank" = Standard
A = ± 5 %

2. SURFACE MOUNT

a) **LVByyd**
LV = Low forward voltage
B = SMB (DO-214AA)
yy = Nominal breakdown voltage (in V)
d = Breakdown voltage tolerance/polarity
"Blank" = ± 10 %/uni-directional
A = ± 5 %

b) **SMB30A300**
SMB = DO-214AA
30 = 30 V (TVS breakdown voltage)
A = ± 5 %/uni-directional
300 = 300 V (rectifier breakdown voltage)

Low Capacitance TRANSZORB® Transient Voltage Suppressors



DO-204AC (DO-15)

FEATURES

- Glass passivated chip junction
- Excellent clamping capability
- 500 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: DO-204AC, molded epoxy over passivated body

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes TVS cathode end

PRIMARY CHARACTERISTICS	
V_{WM}	5.0 V to 50 V
P_{PPM}	500 W
P_D	3.0 W
T_J max.	175 °C

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)	P_{PPM}	500	W
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 2)	P_D	3.0	W
Peak pulse power surge current with a 10/1000 µs waveform (Fig. 3) (1)	I_{PPM}	See next table	A
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 175	°C

Note:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)									
PART NUMBER	STAND-OFF VOLTAGE (1) V_{WM} (V)	MINIMUM BREAKDOWN VOLTAGE AT I_T = 1.0 mA V_{BR} (V)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM CLAMPING VOLTAGE AT I_{PP} = 5.0 A V_C (V)	MAXIMUM PEAK PULSE CURRENT PER FIG. 3 I_{PP} (A)	MAXIMUM JUNCTION CAPACITANCE AT 0 VOLTS (pF)	WORKING INVERSE BLOCKING VOLTAGE V_{WIB} (V)	INVERSE BLOCKING LEAKAGE CURRENT V_{WIB} I_{IB} (mA)	PEAK INVERSE BLOCKING VOLTAGE V_{PIB} (V)
SAC5.0	5	7.60	300	10.0	44	50	75	1.0	100
SAC6.0	6	7.90	300	11.2	41	50	75	1.0	100
SAC7.0	7	8.33	300	12.6	38	50	75	1.0	100
SAC8.0	8	8.89	100	13.4	36	50	75	1.0	100
SAC8.5	8.5	9.44	50	14.0	34	50	75	1.0	100
SAC10	10	11.10	5.0	16.3	29	50	75	1.0	100
SAC12	12	13.30	5.0	19.0	25	50	75	1.0	100
SAC15	15	16.70	5.0	23.6	20	50	75	1.0	100
SAC18	18	20.00	5.0	28.8	15	50	75	1.0	100
SAC22	22	24.40	5.0	35.4	14	50	75	1.0	100
SAC26	26	28.90	5.0	42.3	11.1	50	75	1.0	100
SAC30	30	33.30	5.0	48.6	10.0	50	75	1.0	100
SAC36	36	40.00	5.0	60.0	8.6	50	75	1.0	100
SAC45	45	50.00	5.0	77.0	6.8	50	150	1.0	200
SAC50	50	55.50	5.0	88.0	5.8	50	150	1.0	200

Note:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

ORDERING INFORMATION (Example)				
PREFERRED P/N	UNIT WEIGHT (g)	PREFERRED PACKAGE CODE	BASE QUANTITY	DELIVERY MODE
SAC5.0-E3/54	0.432	54	4000	13" diameter paper tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

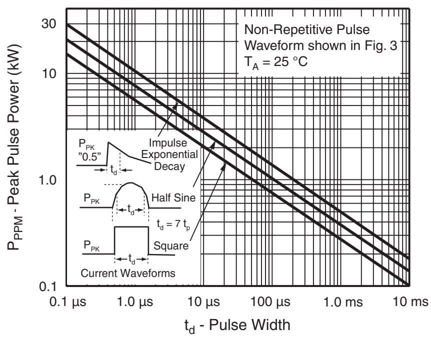


Figure 1. Peak Pulse Power Rating Curve

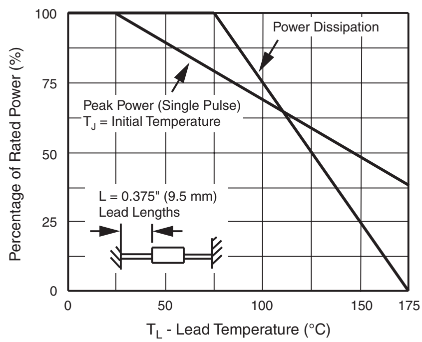


Figure 2. Power Derating Curve

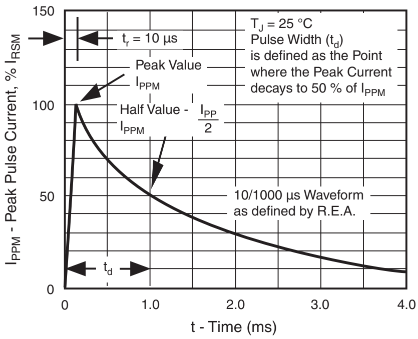
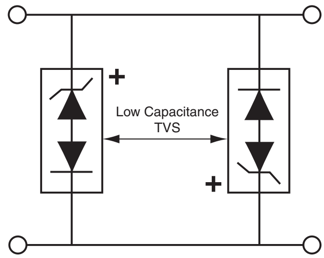


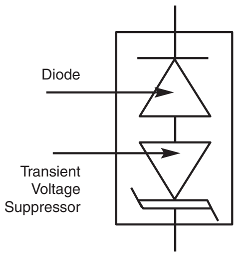
Figure 3. Pulse Waveform



Application Note: Device must be used with two units in parallel, opposite in polarity as shown in circuit for AC signal line protection.

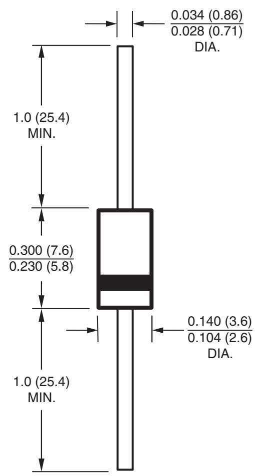
Figure 4. AC Line Protection Application

SCHEMATIC

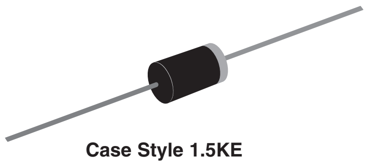


PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-204AC (DO-15)



Low Capacitance TRANSZORB® Transient Voltage Suppressors



Case Style 1.5KE

PRIMARY CHARACTERISTICS	
V_{WM}	6.5 V to 28 V
P_{PPM}	1500 W
P_D	6.5 W
T_J max.	175 °C

FEATURES

- Glass passivated chip junction
- 1500 W peak pulse power capability with a 10/1000 µs waveform, repetitive rate (duty cycle): 0.01 %
- Excellent clamping capability
- Very fast response time
- Low incremental surge resistance
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs, MOSFET, signal lines of sensor units for consumer, computer, industrial and telecommunication.

MECHANICAL DATA

Case: Molded epoxy body over passivated junction

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D
E3 suffix for commercial grade

Polarity: Color band denotes TVS cathode end

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Peak pulse power dissipation with a 10/1000 µs waveform (1)(2)	P_{PPM}	1500	W
Power dissipation on infinite heatsink at T_L = 75 °C (Fig. 2)	P_D	6.5	W
Peak power pulse surge current with a 10/1000 µs waveform (1)(3)	I_{PPM}	See next table	A
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 175	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A = 25 °C per Fig. 2

(2) See Fig. 1

(3) See Fig. 2

ELECTRICAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)												
PART NUMBER	STAND-OFF VOLTAGE V_{WM} (V)	BREAKDOWN VOLTAGE V_{BR} (V)		TEST CURRENT AT I_T mA	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (µA)	MAXIMUM CLAMPING VOLTAGE AT I_{PP} V_C (V)	MAXIMUM PEAK PULSE CURRENT (FIG 3) I_{PPM} (A)	MAXIMUM JUNCTION CAPACITANCE AT 0 (V) (pF)	WORKING INVERSE BLOCKING VOLTAGE V_{WIB} (V)	MAXIMUM INVERSE BLOCKING LEAKAGE CURRENT AT V_{WIB} I_D (mA)	MINIMUM PEAK INVERSE BLOCKING VOLTAGE V_{PIB} (V)
		MIN	MAX								
LCE6.5	6.5	7.22	8.82	10.0	1000	12.3	100	100	75	1.0	100
LCE6.5A	6.5	7.22	7.98	10.0	1000	11.2	100	100	75	1.0	100
LCE7.0	7.0	7.78	9.51	10.0	500	13.3	100	100	75	1.0	100
LCE7.0A	7.0	7.78	8.60	10.0	500	12.0	100	100	75	1.0	100
LCE7.5	7.5	8.33	10.2	10.0	250	14.3	100	100	75	1.0	100
LCE7.5A	7.5	8.33	9.21	10.0	250	12.9	100	100	75	1.0	100
LCE8.0	8.0	8.89	10.9	1.0	100	15.0	100	100	75	1.0	100
LCE8.0A	8.0	8.89	9.83	1.0	100	13.6	100	100	75	1.0	100
LCE8.5	8.5	9.44	11.5	1.0	50.0	15.9	94	100	75	1.0	100
LCE8.5A	8.5	9.44	10.4	1.0	50.0	14.4	100	100	75	1.0	100
LCE9.0	9.0	10.0	12.2	1.0	10.0	16.9	89	100	75	1.0	100
LCE9.0A	9.0	10.0	11.1	1.0	10.0	15.4	97	100	75	1.0	100
LCE10	10	11.1	13.6	1.0	5.0	18.8	80	100	75	1.0	100
LCE10A	10	11.1	12.3	1.0	5.0	17.0	88	100	75	1.0	100
LCE11	11	12.2	14.9	1.0	5.0	20.1	74	100	75	1.0	100
LCE11A	11	12.2	13.5	1.0	5.0	18.2	82	100	75	1.0	100
LCE12	12	13.3	16.3	1.0	5.0	22.0	68	100	75	1.0	100
LCE12A	12	13.3	14.7	1.0	5.0	19.9	75	100	75	1.0	100
LCE13	13	14.4	17.6	1.0	5.0	23.8	63	100	75	1.0	100
LCE13A	13	14.4	15.9	1.0	5.0	21.5	70	100	75	1.0	100
LCE14	14	15.6	19.1	1.0	5.0	25.8	58	100	75	1.0	100
LCE14A	14	15.6	17.2	1.0	5.0	23.2	65	100	75	1.0	100
LCE15	15	16.7	20.4	1.0	5.0	26.9	56	100	75	1.0	100
LCE15A	15	16.7	18.5	1.0	5.0	24.4	61	100	75	1.0	100
LCE16	16	17.8	21.8	1.0	5.0	28.8	52	100	75	1.0	100
LCE16A	16	17.8	19.7	1.0	5.0	26.0	57	100	75	1.0	100
LCE17	17	18.9	23.1	1.0	5.0	30.5	49	100	75	1.0	100
LCE17A	17	18.9	20.9	1.0	5.0	27.6	54	100	75	1.0	100
LCE18	18	20.0	24.4	1.0	5.0	32.2	46	100	75	1.0	100
LCE18A	18	20.0	22.1	1.0	5.0	29.2	51	100	75	1.0	100
LCE20	20	22.2	27.1	1.0	5.0	35.8	42	100	75	1.0	100
LCE20A	20	22.2	24.5	1.0	5.0	32.4	46	100	75	1.0	100
LCE22	22	24.4	29.8	1.0	5.0	39.4	38	100	75	1.0	100
LCE22A	22	24.4	26.9	1.0	5.0	35.5	42	100	75	1.0	100
LCE24	24	26.7	32.6	1.0	5.0	43.0	35	100	75	1.0	100
LCE24A	24	26.7	29.5	1.0	5.0	38.9	39	100	75	1.0	100
LCE26	26	28.9	35.3	1.0	5.0	46.6	32	100	75	1.0	100
LCE26A	26	28.9	31.9	1.0	5.0	42.1	36	100	75	1.0	100
LCE28	28	31.1	38.0	1.0	5.0	50.1	30	100	75	1.0	100
LCE28A	28	31.1	34.4	1.0	5.0	45.5	33	100	75	1.0	100

Note:

(1) All the above devices are UL listed for Telecom application protection 497B, file number E136766

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
LCE6.5-E3/54	0.968	54	1400	13" diameter paper tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

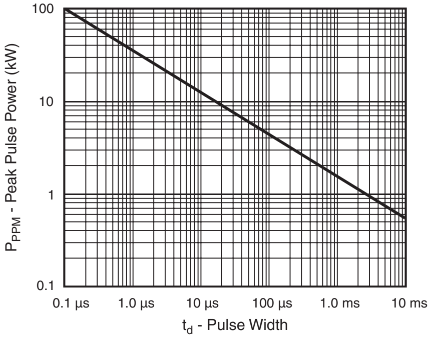


Figure 1. Peak Pulse Power Rating Curve

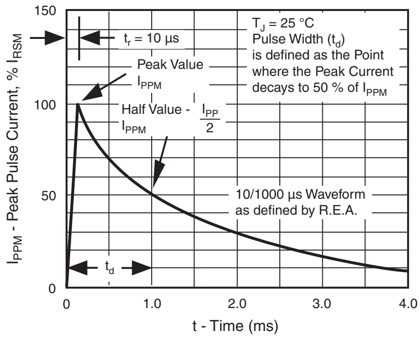


Figure 3. Pulse Waveform

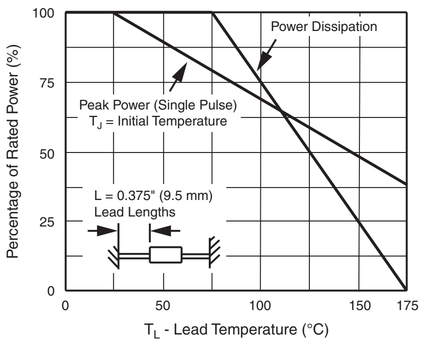
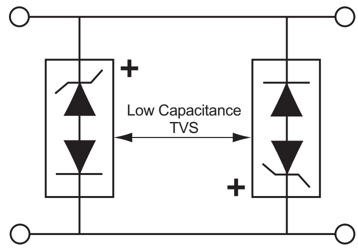


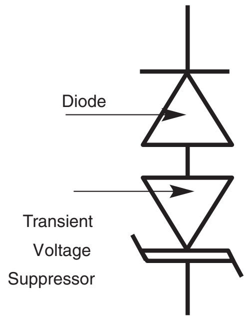
Figure 2. Power Derating Curve



Application Note: Device must be used with two units in parallel, opposite in polarity as shown in circuit for AC signal line protection.

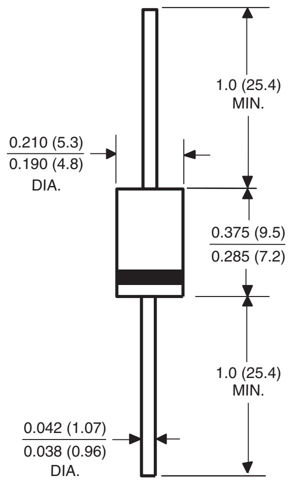
Figure 4. AC Line Protection Application

Schematic

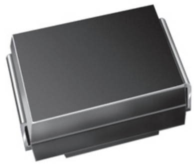


PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

Case Style 1.5KE



Low V_F Surface Mount Transient Voltage Suppressors



DO-214AA (SMB J-Bend)

FEATURES

- Uni-directional polarity only
- Peak pulse power: 600 W (10/1000 µs)
- Ideal for automated placement
- Low forward voltage
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

Use in sensitive electronics protection against voltage transients induced by inductive load switching and lighting on ICs sensor units specifically for protecting 12 V supplied sensitive equipment against transient overvoltages.

MECHANICAL DATA

Case: DO-214AA (SMBJ)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade

Polarity: Color band denotes cathode end

PRIMARY CHARACTERISTICS	
V_{BR}	13.2 - 14.8 V
I_{PPM} with 10 x 1000 µs	31 A
I_{PPM} with 1.4 x 6.5 µs	17.5 A
V_F at I_F = 1.0 A	0.35 V
I_{FSM}	100 A
T_J max.	150 °C

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Device marking code		L14	
Peak power pulse current with a 10/1000 µs waveform (Fig. 1) (1)(2)	I_{PPM}	31	A
Peak pulse current with a 1.4/6.5 µs waveform (Fig. 2)	I_{PPM}	17.5	A
Peak forward surge current 8.3 ms single half sine-wave (2)	I_{FSM}	100	A
Power dissipation on infinite heatsink, T_L = 50 °C	P_D	5	W
Operating junction and storage temperature range	T_J, T_{STG}	- 65 to + 150	°C

Notes:

(1) Non-repetitive current pulse, per Fig. 1 and derated above T_A = 25 °C per Fig. 1

(2) Mounted on P.C.B. with 5.0 x 5.0 mm copper pads attached to each terminal

ELECTRICAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted)						
PARAMETER	**TEST CONDITIONS**	**SYMBOL**	**TYP.**	**TYP.**	**MAX.**	**UNIT**
Breakdown voltage	at I_Z = 1 mA	V_{BR}	13.2	-	14.8	V
Max. clamping voltage with 10 x 1000 µs	at I_{PPM} = 31 A	V_C	-	-	19.5	V
Max. clamping voltage with 1.4 x 6.5 µs	at I_{PPM} = 17.5 A	V_C	-	-	15.8	V
Instantaneous forward voltage (1)	at I_F = 1.0 A T_J = 25 °C T_J = 125 °C	V_F	- -	0.45 0.35	0.5 -	V
Reverse leakage current (1)	at V_{WM} = 12.0 V	I_R	-	-	100	µA

Note:

(1) Measured on a 300 µs square pulse width

THERMAL CHARACTERISTICS (T_A = 25 °C unless otherwise noted)			
PARAMETER	**SYMBOL**	**VALUE**	**UNIT**
Typical thermal resistance, junction to lead	$R_{\theta JL}$	20	°C/W
Typical thermal resistance, junction to ambient (1)	$R_{\theta JA}$	100	

Note:

(1) Thermal resistance from junction to ambient - Mounted on the recommended P.C.B. pad layout

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
LVB14A-E3/52	0.096	52	750	7" diameter plastic tape and reel
LVB14A-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

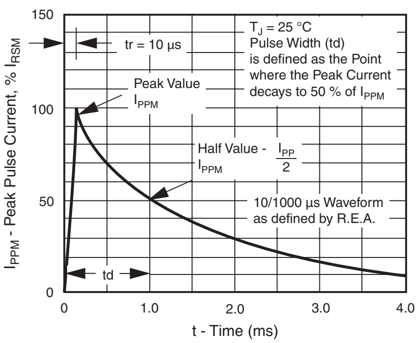


Figure 1. Pulse Waveform

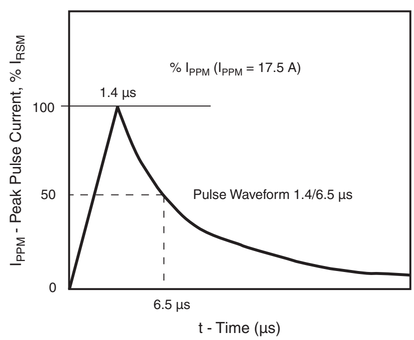


Figure 2. Pulse Waveform

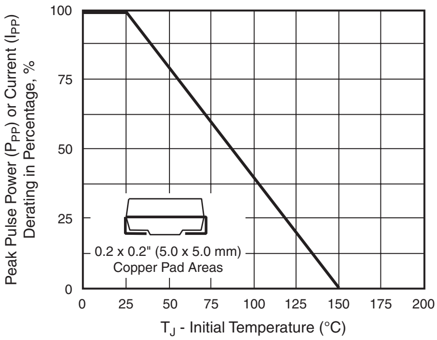


Figure 3. Pulse Poweror Current vs. Initial Junction Temperature

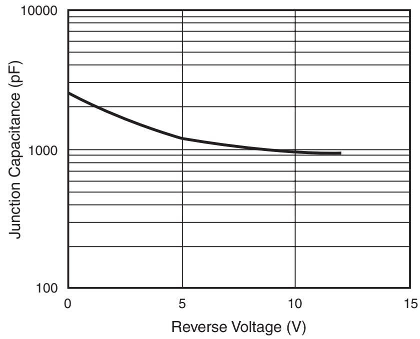


Figure 5. Typical Junction Capacitance

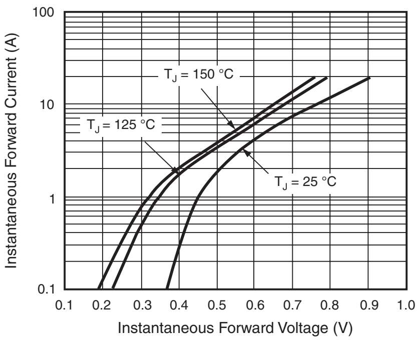
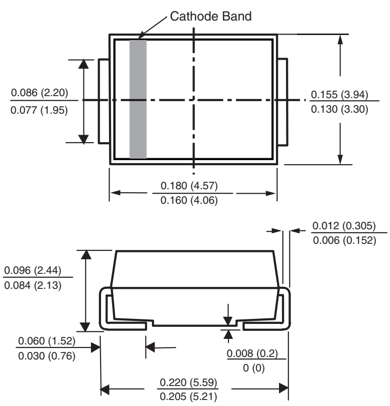


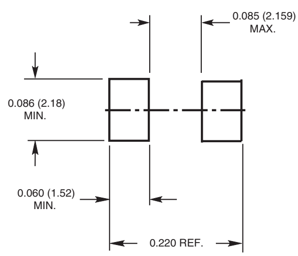
Figure 4. Typical Instantaneous Forward Characteristics

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

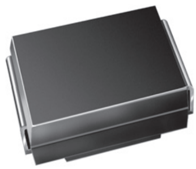
DO-214AA (SMB-J-Bend)



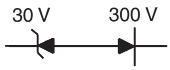
Mounting Pad Layout



Asymmetric Transient Voltage Suppressor



DO-214AA (SMB)



PRIMARY CHARACTERISTICS	
I_{PPM}	14.5 A
V_C	41.4 V
V_{BR} at TVS	30 V
V_{BR} at Diode	300 V
T_J max.	150 °C

FEATURES

- Glass passivated chip junction
- Ideal for automated placement
- Very fast response time
- Low incremental surge resistance, excellent clamping capability
- Meets MSL level 1, per J-STD-020C, LF max peak of 260 °C
- Solder dip 260 °C, 40 seconds
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC

TYPICAL APPLICATIONS

For use in wiper motor application, to replace varistor.

MECHANICAL DATA

Case: DO-214AA (SMB)

Epoxy meets UL 94V-0 flammability rating

Terminals: Matte tin plated leads, solderable per J-STD-002B and JESD22-B102D

E3 suffix for commercial grade, HE3 suffix for high reliability grade (AEC Q101 qualified)

Polarity: Color band denotes TVS 30 V cathode end, the cathode of 300 V is at the other terminal side

MAXIMUM RATINGS (T_A = 25 °C unless otherwise noted)

PARAMETER	SYMBOL	VALUE	UNIT
Peak pulse current with a 10/1000 µs waveform per (Fig. 1)	I_{PPM}	14.5	A
Maximum reverse current of 30 V TVS side at V_{WM} = 25.6 V (1)(2)	I_D	5.0	µA
Maximum reverse current of 300 V diode side at V_{WM} = 243 V (1)(2)	I_D	1.0	µA
Operating junction and storage temperature range	T_J, T_{STG}	- 55 to + 150	°C

Notes:

(1) All terms and symbols are consistant with ANSI/IEEE C62.35

(2) V_{WM} means stand-off voltage

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

DEVICE TYPE	DEVICE MARKING CODE	BREAKDOWN VOLTAGE V_{BR} AT I_T (1) (V)		TEST CURRENT I_T (mA)	TYPICAL JUNCTION CAPACITANCE AT 4.0 V, 1 MHz C_J (pF)	MAXIMUM PEAK PULSE SURGE CURRENT I_{PPM} (2) (A)	MAXIMUM CLAMPING VOLTAGE AT I_{PPM} V_C (V)
		MIN	MAX				
SMB30A300	30F						
30 V TVS		28.5	31.5	1.0	130	14.5	41.4
300 V Diode		270	360	1.0	72	-	-

Notes:

(1) Pulse test: $t_p \leq 50$ ms

(2) Surge current waveform per Fig. 1

ORDERING INFORMATION (Example)				
PREFERRED P/N	**UNIT WEIGHT (g)**	**PREFERRED PACKAGE CODE**	**BASE QUANTITY**	**DELIVERY MODE**
SMB30A300-E3/52	0.096	52	750	7" diameter plastic tape and reel
SMB30A300-E3/5B	0.096	5B	3200	13" diameter plastic tape and reel
SMB30A300HE3/52 (1)	0.096	52	750	7" diameter plastic tape and reel
SMB30A300HE3/5B (1)	0.096	5B	3200	13" diameter plastic tape and reel

Note:

(1) Automotive grade AEC Q101 qualified

RATINGS AND CHARACTERISTICS CURVES

(T_A = 25 °C unless otherwise noted)

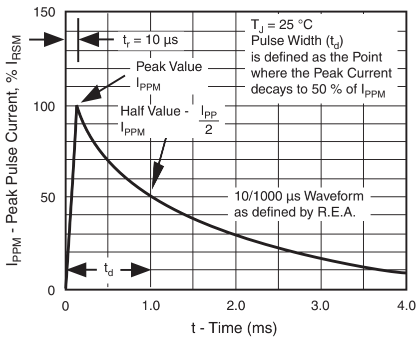


Figure 1. Pulse Waveform

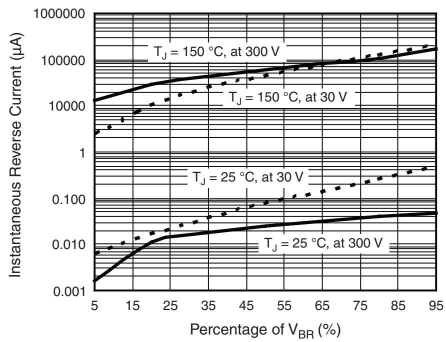


Figure 3. Typical Reverse Leakage Current

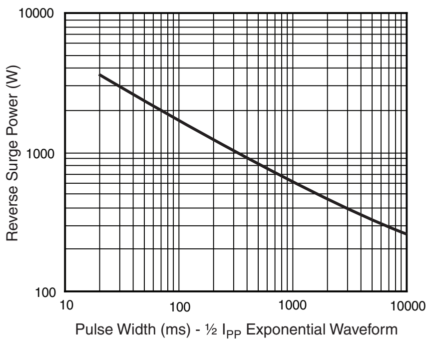


Figure 2. Reverse Power Capability for TVS

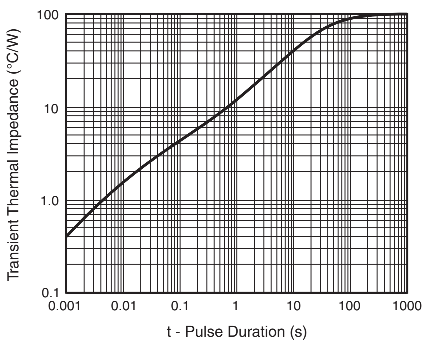
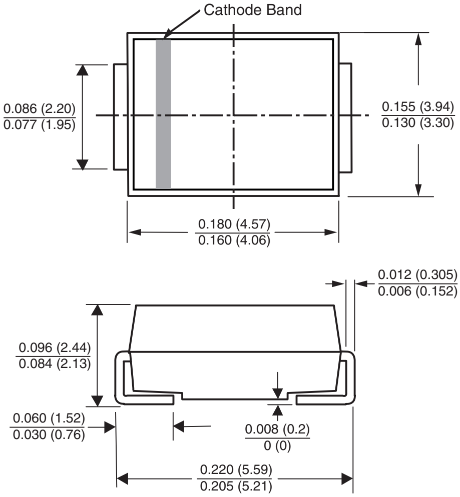


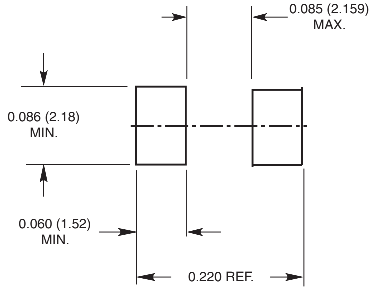
Figure 4. Typical Transient Thermal Impedance

PACKAGE OUTLINE DIMENSIONS in inches (millimeters)

DO-214AA (SMB)



Mounting Pad Layout



Application Notes

Contents

What is a Silicon Transient Voltage Suppressor and how does it work?

By Bruce Hartwig
Senior Automotive Applications Engineer

Transient Voltage Suppressors (TVS's) are devices used to protect vulnerable circuits from electrical overstress such as that caused by electrostatic discharge, inductive load switching and induced lightning. Within the TVS, damaging voltage spikes are limited by clamping or avalanche action of a rugged silicon pn junction which reduces the amplitude of the transient to a nondestructive level.

In a circuit, the TVS should be "invisible" until a transient appears. Electrical parameters such as breakdown voltage (V_{BR}), standby (leakage) current (I_D), and capacitance should have no effect on normal circuit performance.

The TVS breakdown voltage is usually 10 % above the reverse standoff voltage (V_R), which approximates the circuit operating voltage to limit standby current and to allow for variations in V_{BR} caused by the temperature coefficient of the TVS. When a transient occurs, the TVS clamps instantly to limit the spike voltage to a safe level, called the clamping voltage (V_C), while conducting potentially damaging current away from the protected component.

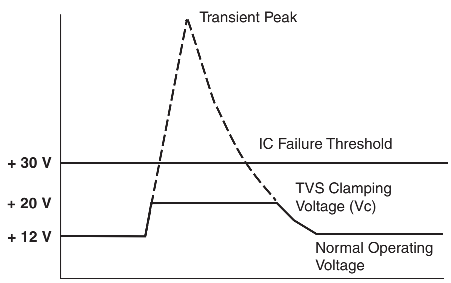


Figure 1. Transients of Several Thousand Volts can be "clamped" to a Safe Level by the TVS

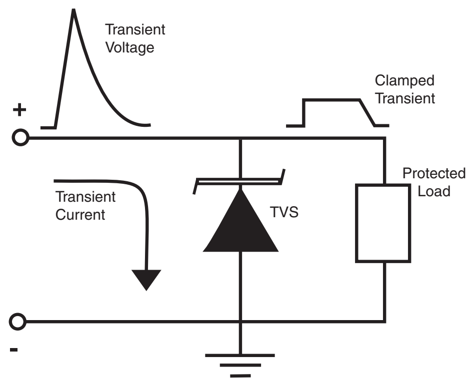


Figure 2. Transient Current is Diverted to Ground Through TVS; the Voltage Seen by the Protected Load is Limited to the Clamping Voltage Level of the TVS

TVS's are designed, specified and tested for transient voltage protection, while a Zener diode is designed and specified for voltage regulation. For transient protection, the designer's choice is a TVS.

The surge power and surge current capability of the TVS are proportional to its junction area. Surge ratings for silicon TVS families are normally specified in kilowatts of peak pulse power (P_{PP}) during a given waveform. Early devices were specified with a 10/1000 µs waveform (10 µs rise to peak and 1000 µs exponential decay to one half peak), while more recent product introductions are rated for an 8/20ìs test waveform. Power ratings range from 5 kW for 10/1000 µs, down to 400 W for 8/20 µs. This power is derived from the product of the peak voltage across the TVS and the peak current conducted through the device.

Packaging covers a broad spectrum according the need. Discrete axial leaded components are available in peak pulse power ratings of 400 W, 500 W, 600 W, 1.5 kW and 5 kW. The higher power devices are most frequently used across power buses.

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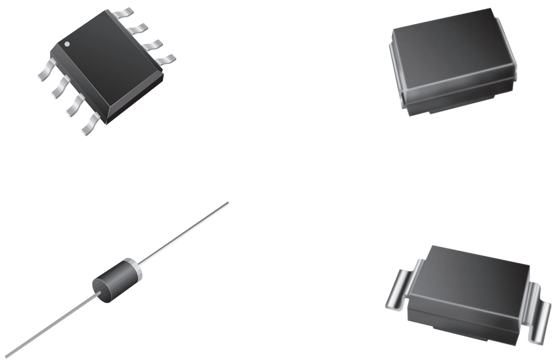


Figure 3. Transient Voltage Suppressors are Offered in Axial, Surface-Mount and Array Packages

For lower power, high density applications, suppressor arrays are available in both DIP and small outline surface mount configurations. Arrays are normally used across data lines for protecting I/O ports from static discharge. Specialized low capacitance TVSs are available for use in high data rate circuits to prevent signal attenuation.

TVSs have circuit operating voltages available in increments from 5 V up through 376 V for some types. Because of the broad range of voltages and power ratings available, (as well as the universal presence of transient voltages) TVSs are used in a remarkably wide variety of circuits and applications.

Integrated circuits normally feature on-chip protection which is usually provided by internal resistor-diode networks or SCR's. There is insufficient space on a microchip to provide more than minimal protection, so the higher power, external protection of a TVS should be added in those applications where damaging transient voltage threats exist.

The loss to U.S. industry due to transient voltages exceeds $ 10 billion per year. TVS devices are an important part of the solution.

Vishay General Semiconductor has become the world's leading supplier of silicon TVS protection.

Transient Voltage Suppressors (TVS) for Automotive Electronic Protection

By Soo Man (Sweetman) Kim,
Senior Application Manager

Vishay's Power Diodes Division offers leading automotive electronic TVS protection products under the renowned Vishay General Semiconductor brand.

I) IMPORTANT PARAMETERS OF TVS

Important TVS parameters include the power rating, the stand-off voltage, the breakdown voltage, and the maximum breakdown voltage.

Power Rating

The power rating of a TVS is its surge-absorbing capability under specific test or application conditions. Vishay's TVS products use the industrial-standard test condition of 10/1000 µs pulse form (Bellcore 1089 spec.), as shown in Figure 1. This test condition differs from the TVS ESD test condition of 8/20 µs pulse form, as shown in Figure 2.

The breakdown voltage, maximum breakdown voltage, and stand-off voltage are specified in the datasheet, as shown in Table 1.

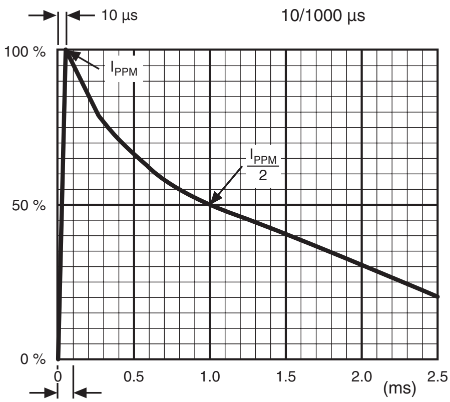


Figure 1. Test Waveform of TVS

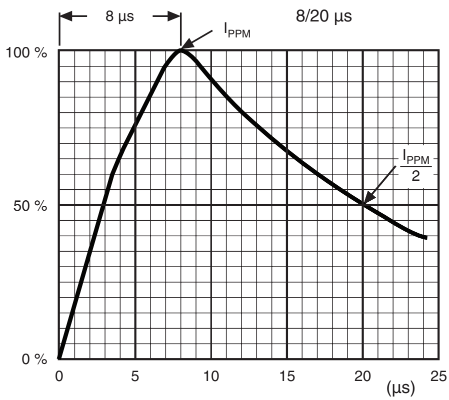


Figure 2. Test Waveform of TVS ESD

TABLE 1 - ELECTRICAL CHARACTERISTICS OF VISHAY'S SM6T SERIES
(Ratings at 25 °C ambient temperature unless otherwise specified)

Type	Device Marking Code		Breakdown Voltage V_{BR} at I_T I_T (V)		Test Current (mA)	Stand-off Voltage V_{RM} (V)	Leakage Current I_{RM} at V_{RM} (µA)	Clamping Voltage V_C at I_{PP} 10/1000 µs		Clamping Voltage V_C at I_{PP} 8/20 µs		T Max. 0^{-4}/°C
	Uni	Bi	Min	Max				(V)	(A)	(V)	(A)	
SM6T6V8A	KE7	KE7	6.45	7.14	10	5.80	1000	10.5	57.0	13.4	298	5.7
SM6T7V5A	KK7	AK7	7.13	7.88	10	6.40	500	11.3	53.0	14.5	276	6.1
SM6T10A	KT7	AT7	9.50	10.5	1.0	8.55	10.0	14.5	41.0	18.6	215	7.3
SM6T12A	KX7	AX7	11.4	12.6	1.0	10.2	5.0	16.7	36.0	21.7	184	7.8
SM6T15A	LG7	LG7	14.3	15.8	1.0	12.8	1.0	21.2	28.0	27.2	147	8.4

Breakdown Voltage (V_{BR})

The breakdown voltage is the voltage at which the device goes into avalanche breakdown, and is measured at a specified current on the datasheet. In Table 1, the SM6T6V8A has a 6.8 V breakdown characteristic with a 5 % tolerance at a 10 mA reverse current condition, and the SM6T10A has a 10 V breakdown characteristic at a 1 mA reverse current.

Maximum Breakdown Voltage (V_C: Clamping Voltage)

The clamping voltage appears across the TVS at the specified peak pulse current rating. The breakdown voltage of a TVS is measured at a very low current, such as 1 mA or 10 mA, which is different from the actual avalanche voltage in application conditions. Thus, semiconductor manufactures specify the typical or maximum breakdown voltage in large current. Table 1 shows the maximum clamping voltages in the 10/1000 µs and 8/20 µs waveforms.

Stand-Off Voltage (V_{WM}: Working Stand-Off Reverse Voltage)

The stand-off voltage indicates the maximum voltage of the TVS when not in breakdown, and is an important parameter of protection devices in circuits that do not operate under normal conditions.

In automotive applications, some regulation of the automotive electronics is provided by “jump-start protection”. This condition supplies 24 V_{DC} in 10 min to 12 V type electronics, and 36 V_{DC} in 10 min to 24 V type electronics without damage or malfunction of the circuit. Thus, the stand-off voltage is one of key parameters in TVS for automotive electronics.

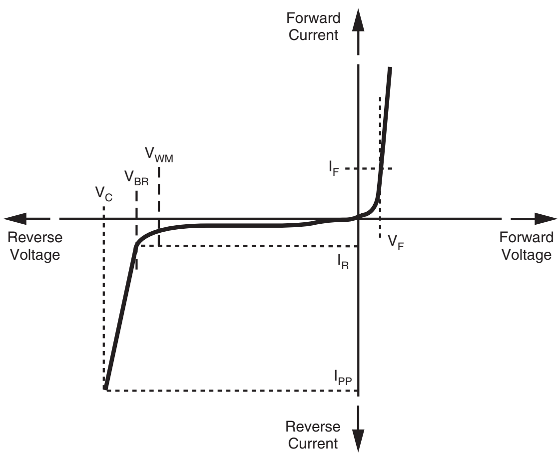


Figure 3. Parameters of voltage and current

II) PRIMARY PROTECTION OF THE AUTOMOTIVE POWER LINE (LOAD DUMP)

Automotive electronics, such as electronic control units, sensors, and entertainment systems, are connected to one power line. The power sources for these electronics are the battery and alternator, both of which have unstable output voltages that are subject to temperature, operating status, and other conditions.

Additionally, ESD, spike noise, and several kinds of transient and surge voltages are introduced into the power and signal line from automotive systems that use solenoid loads, such as fuel injection, valve, motor, electrical, and hydrolytic controllers.

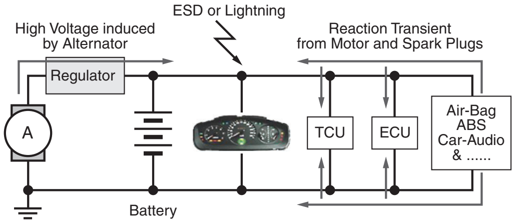


Figure 4. Typical Vehicle Power Bus

What is Load Dump?

The worst instances of surge voltage are generated when the battery is disconnected when the engine is in operation, and the alternator is supplying current to the power line of the vehicle. This condition is known as “load dump”, and most vehicle manufactures and industry associations specify a maximum voltage, line impedance, and time duration for this load dump status, as shown in Figure 5. Two well-known tests simulate this condition: the U.S.’s ISO-7637-2 Pulse 5, and Japan’s JASO A-1 for 14 V powertrains and JASO D-1 for 27 V powertrains. In this section we review the application of TVS for load dump in 14 V powertrains.

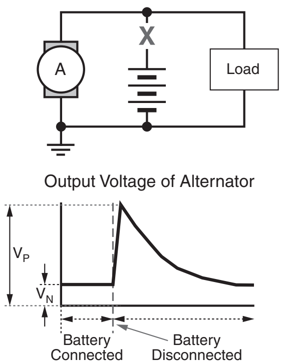


Figure 5. Output Voltage of Alternator in Load Dump Condition

As shown in Figure 6, Vishay’s high-power, silicon TRANSZORB® TVS is used to protect vulnerable electronic circuits from electrical overstress and to ensure high reliability. For primary protection, the TVS should absorb high energy under the load dump condition.

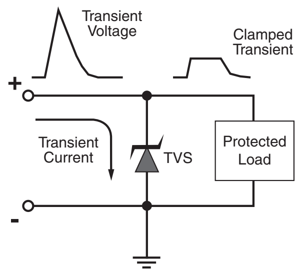


Figure 6. Typical Protection Circuit

DO-218AB

Specification and Results of Load Dump Tests

The U.S.'s ISO-7637-2 Pulse 5, and Japan's JASO A-1 test for 14 V powertrains, are simulated in Table 2. The voltage waveforms of both test conditions are shown in Figure 7.

TABLE 2 - MAJOR LOAD DUMP TEST CONDITIONS FOR 14 V POWERTRAINS

	V total (V_P) (V)	V_S (V)	V_A (V)	R_i (Ω)	TIME (ms)	CYCLE TIME
JASO A-1	70		12.0	0.8	200	1
	88		12.0	1.0	200	1
ISO 7637-2 Pulse 5	78.5 to 100.5	65 to 87	13.5	0.5 to 4.0	400	1

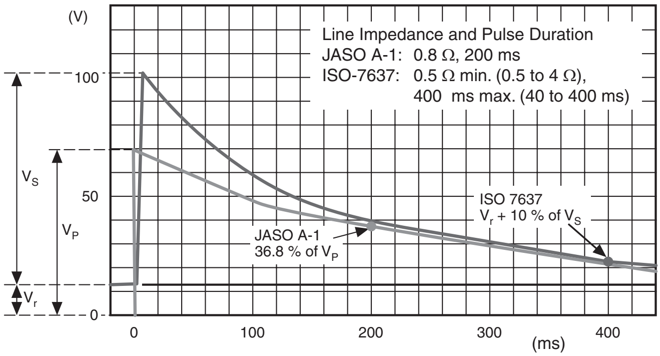


Figure 7. For ISO-7637-2 Test Conditions, the Standard Condition is a V_S Range of 65 V to 87 V, and R_i (Line Impedance) Range of 0.5 Ω to 4 Ω

Some vehicle manufactures apply different conditions for the load dump test based on ISO-7637-2 Pulse 5. The peak clamped current of the load dump TVS will be estimated by the following equation:

Calculation for peak clamping current

$$I_{PP} = (V_{in} - V_c)/R_i$$

I_{PP}: Peak clamping current
V_{in}: Input voltage
V_c: Clamping voltage
R_i: Line impedance

Table 3 shows the test results of Vishay's high-power silicon TVSs at different test specifications.

TABLE 3 - CLAMPED VOLTAGES OF VISHAY'S LOAD DUMP TVSs

	SPECIFICATION of V_C	JASO A-1	ISO-7637-2 Pulse 5
Test Condition	10/1000 µs waveform	V_P = 70 V, t = 200 ms, R_i = 1.5 Ω	V_S = 87 V, t = 300 ms, R_i = 0.75 Ω
SM5A27	40.0 V at I_{PP} = 55 A	34.1 V at I_{PP} = 47.4 A	36.5 V at I_{PP} = 59.4 A
SM5S24A	38.9 V at I_{PP} = 93 A	33.8 V at I_{PP} = 47.6 A	36.1 V at I_{PP} = 60.1 A
SM6A27	40.0 V at I_{PP} = 65 A	33.7 V at I_{PP} = 48.1 A	35.8 V at I_{PP} = 60.4 A
SM6S24A	38.9 V at I_{PP} = 118 A	33.5 V at I_{PP} = 48.3 A	35.8 V at I_{PP} = 60.4 A
SM8A27	40.0 V at I_{PP} = 75 A	33.2 V at I_{PP} = 48.4 A	34.9 V at I_{PP} = 61.1 A
SM8S24A	38.9 V at I_{PP} = 170 A	32.1 V at I_{PP} = 48.8 A	34.4 V at I_{PP} = 62.0 A

The clamped voltages of Vishay's high-power silicon TVSs in these tests are lower than 37 V, meeting the required maximum input voltage range of 37 V to 40 V for voltage regulators in automotive applications.

Figure 8a shows the current and voltage waveforms of the SM5A27 in the JASO A/1 test.

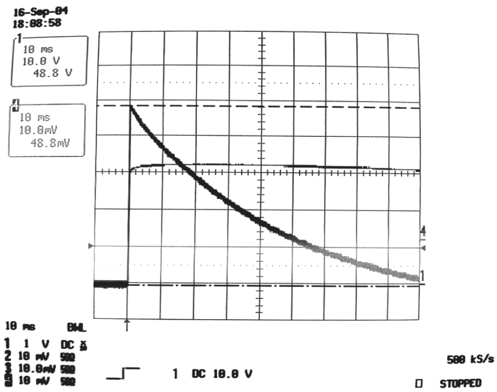


Figure 8a. Clamped Voltage and Current of SM5A27 in JASO A-1 Test

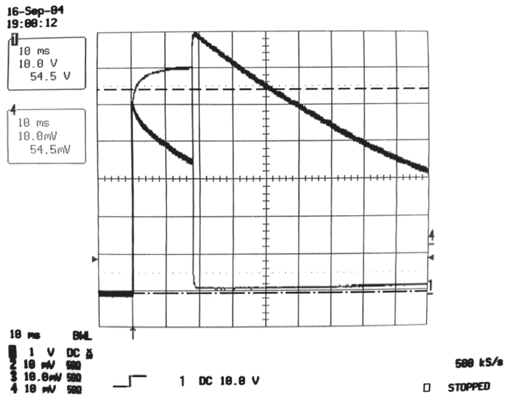


Figure 8b. Clamped Voltage and Current of Load Dump TVS Failures in ISO7637-2 Test

Figure 8b shows the clamped voltage and current of load dump TVS failures in the ISO-7637-2 test. The clamping voltage drops to near zero, and the current passed through the device is increased to the maximum allowed by the line impedance.

Table 4 shows the failed rate in various load dump test conditions of Vishay's load dump TVSs. The SM8S24A is the strongest device under the maximum ratings of ISO-7637-2 Pulse 5.

TABLE 4 - FAILED RATE IN VARIOUS LOAD DUMP TEST CONDITIONS

	JASO TEST			ISO-7637-2 Pulse 5			
	t = 200 ms, R_i = 0.8 Ω			t = 300 ms, R_i = 0.5 Ω			
Supply Voltage	**70 V**	**77 V**	**84 V**	**87 V**	**100 V**	**110 V/25 °C**	**110 V/85 °C**
SM5A27	20/0	20/0	20/0	20/0	20/0	20/20	-
SM5S22A	20/0	20/0	20/0	20/0	20/0	20/20	-
SM5A24A	20/0	20/0	20/0	20/0	20/0	20/20	-
SM6A27	20/0	20/0	20/0	20/0	20/0	20/20	-
SM6S24A	20/0	20/0	20/0	20/0	20/0	20/20	-
SM8A27	20/0	20/0	20/0	20/0	20/0	20/3	20/9
SM8S24A	20/0	20/0	20/0	20/0	20/0	20/0	20/0

The peak current in the maximum test conditions of ISO-76372 can calculated by the equation:

$$I_{PP} = (V_{in} - V_c)/R_i = (110 - 35)/0.5 = 150\ A$$

Two Groups of Vishay Load Dump TVS

Vishay has two kinds of load dump TVS for the primary protection of automotive electronics: EPI PAR TVS and Non-EPI PAR TVS. The product groups for the PAR TVSs are listed in Table 5.

TABLE 5 - PAR LOAD DUMP TVS PRODUCT GROUPS

PACKAGE TYPE	EPI PAR TVS	NON-EPI PAR TVS
Axial	6KA24	
Surface mount package	SM5A27	SM5S series
	SM6A27	SM6S series
	SM8A27	SM8S series

Both product groups have similar operating breakdown characteristics in reverse bias mode. The difference is that EPI-PAR TVSs have low V_F characteristics in forward mode, and non-EPI PAR TVSs have relatively high V_F under the same conditions, as shown in Table 6. This characteristic is important to the reverse voltage supplied to the power line.

TABLE 6 - PARAMETER OF PAR LOAD DUMP TVS

	V_F (TYPICAL) (0.3 MS PULSE WITH) V			STAND-OFF VOLTAGE AT REVERSE LEAKAGE CURRENT	BREAKDOWN VOLTAGE AT REVERSE CURRENT
	0.1 A	6 A	100 A		
SM5A27	0.70	0.93	0.95	22 V at 0.2 µA	27 V at 10 mA
SM6A27	0.70	0.91	0.94	22 V at 0.5 µA	27 V at 10 mA
SM8A27	0.70	0.89	0.93	22 V at 1.0 µA	27 V at 10 mA
SM5S24A	0.70	0.92	1.65	24 V at 10 µA	28 V at 5 mA
SM6S24A	0.70	0.88	1.50	24 V at 10 µA	28 V at 5 mA
SM8S24A	0.70	0.86	1.45	24 V at 10 µA	28 V at 5 mA

Most CMOS ICs and LSIs have very poor reverse voltage capabilities. The gates of MOSFETs are also weak in reverse voltage, at - 1 V or lower. In the reversed power input mode, the voltage of the power line is the same as the voltage of the TVS forward voltage drop (V_F). This reverse bias mode causes electronic circuit failure. The low forward voltage drop of EPI PAR TVSs is a good solution to this problem.

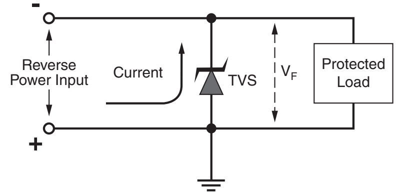


Figure 9. Reverse Bias Status

Another method to protect circuits from reversed power input is utilizing a polarity protection rectifier into the power line, as shown in Figure 9.

A polarity protection rectifier should have sufficient forward current ratings, and forward surge and reverse voltage capabilities.

Vishay has a wide range of standard rectifiers and Schottky rectifiers for polarity protection, with wide operating temperature ranges and superior electrical characteristics.

III) SECONDARY PROTECTION OF THE AUTOMOTIVE POWER LINE

The primary target of protection circuits in automotive systems is high surge voltages, but the clamped voltage is still high, as shown in Tables 2 and 7. Secondary protection is especially important in 24 V powertrains, such as found in trucks and vans. The main reason for this is the maximum input voltages for most regulators and dc-to-dc converter ICs for automotive applications are 45 V to 60 V.

The breakdown voltages of primary protection TVSs at 24 V test conditions are shown in Table 7. These result in high voltages to the regulator and the integrated circuits of instruments clusters and other electronics.

TABLE 7 - JASO D-1 LOAD DUMP TEST

P/N	JASO D-1			
	t = 400 ms, R_i = 1.5 Ω			
	V_P = 110 V		V_P = 130 V	
	V_C	I_{PP}	V_C	I_{PP}
SM5S36A	56 V	39.2 A	N/A	
SM6S36A	53 V	41.1 A	57 V	52 A
SM8S36A	52 V	42.0 A	55 V	53 A

For this kind of application, Vishay recommends using secondary protection, as shown in Figure 10.

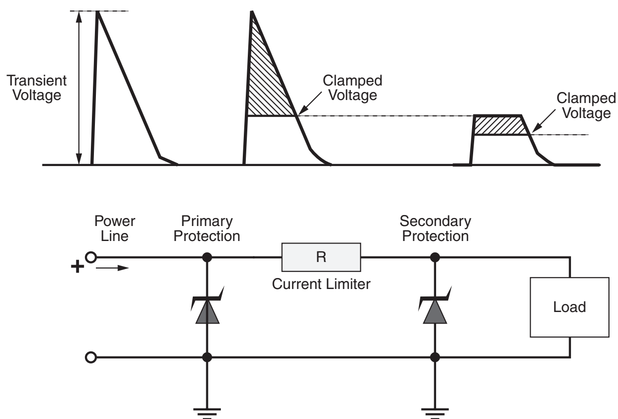


Figure 10. Secondary Protection Circuit

Adding resistor R onto the power line reduces the transient current, allowing smaller power-rating TVSs as the secondary protection. Current requirements for microprocessor and logic circuits in electronic units are 150 mA to 300 mA, and the minimum output voltage of a 12 V battery is 7.2 V at - 18 °C, or 14.4 V for a 24 V battery under the same conditions.

In a 24 V battery under the above conditions, the supply voltage at a 300 mA load is 8.4 V at R = 20 Ω, and 11.4 V at R = 10 Ω at a minimum voltage of battery of 14.4 V (24 V battery voltage in - 18 °C).

$$V_L = (V_{min}/(V_{min}/I_L)) \times ((V_{min}/I_L) - R)$$

V_L: Voltage to load
V_{min}: Minimum input voltage
I_L: Load current
R: Resistor value

Power rating of $R = I^2R$

This supply voltage is higher than the minimum input voltages for most voltage regulators and dc-to-dc converter ICs.

The clamping voltage of small- and medium-power TVSs for secondary protection in the JASO D-1 test (110 V, t = 400 ms, R_i = 1.5 Ω) for 24 V powertrains is shown in Table 8 with a current limiting resistor.

TABLE 8 - CLAMPED VOTLAGE OF SECONDARY PROTECTION TVS UNDER JASO D-1 TEST CONDITION

PRIMARY PROTECTION		SECONDARY PROTECTION				
P/N	Clamping voltage	P/N	Clamping voltage			
			R = 10 Ω, 2 W		R = 20 Ω, 2 W	
			V_C	I_{PP}	V_C	I_{PP}
SM8S36A	51.3 V	TPSMC39A	42.8 V	0.93 A	41.3 V	0.56 A
		TPSMB39A	44.9 V	0.85 A	42.2 V	0.50 A
		TPSMA39A	45.6 V	0.75 A	43.3 V	0.45 A
		TPSMC36A	40.3 V	1.25 A	37.8 V	0.70 A
		TPSMB36A	43.5 V	1.00 A	39.1 V	0.65 A
		TPSMA36A	44.0 V	0.90 A	40.6 V	0.60 A

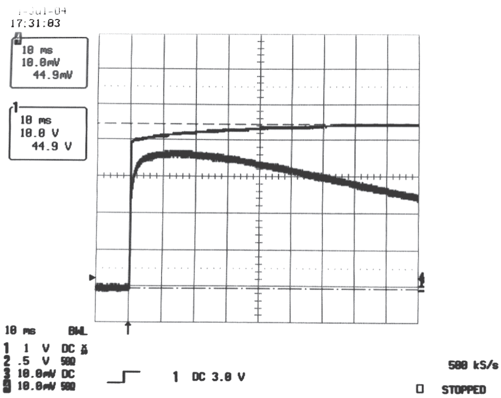


Figure 11. Clamped Voltage and Current Waveform under JASO D-1 Test

TPSMC36A with 20 Ω resistor
- V_C = 37.8 V
- I_{PP} = 0.7 A

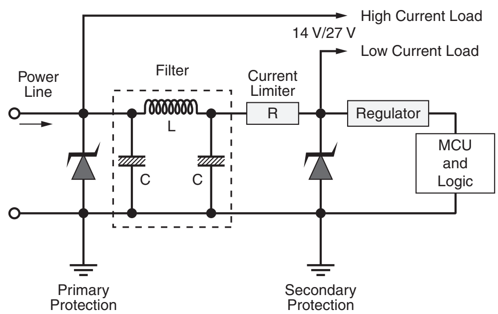


Figure 12. Secondary Protection Circuit with Noise Filter

Remark: All test data is typical value and has a tolerance of ± 5 %.

Typical TVS Applications

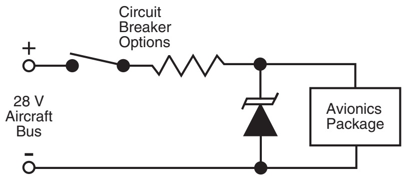


Figure 1. 28 V D.C. Supply Protection

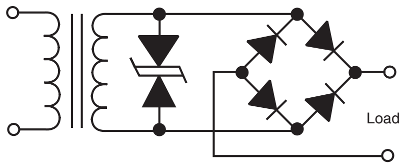


Figure 2. A.C. Supply Protection

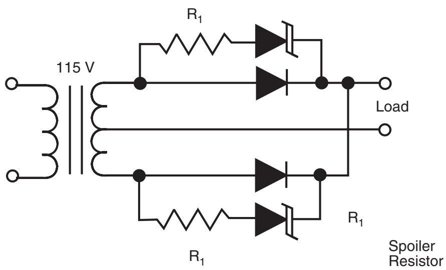


Figure 3. Breakdown Voltage Rectifier Protection

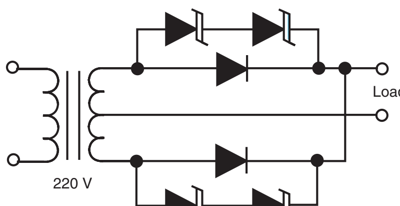


Figure 4. Breakdown Voltage Rectifier Protection

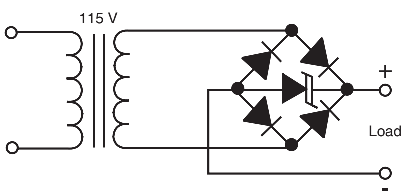


Figure 5. 115 V A.C. Supply Protection

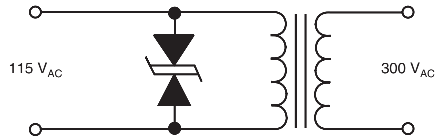


Figure 6. Circuit Protection from Overvoltage Supply

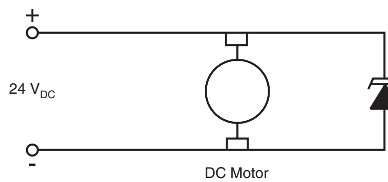


Figure 7. EMI limiting

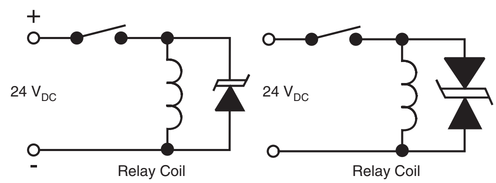
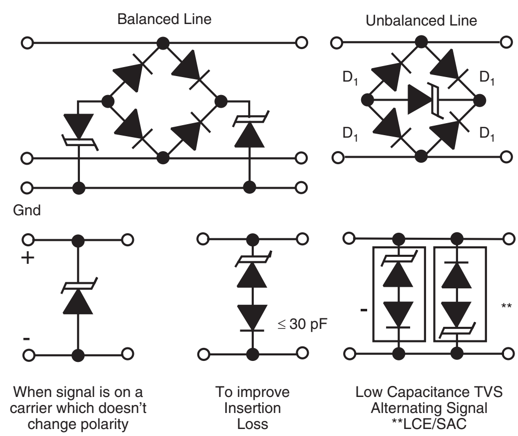


Figure 8. Relay and Contractor Transient Limiting



Failure Modes and Fusing of TVS Devices

INTRODUCTION

Transient Voltage Suppressors (TVS) will fail if they are subjected to conditions beyond their designed limits. It is, therefore, important to understand the types of failure modes of TVS devices before designing them into a circuit application. There are three basic types of failure modes: shorts, open and degraded (outside of the specification limits). Although the silicon avalanche junction Transient Voltage Suppressor (SAJTVS) will first fail short in most applications, there is always one transient event that will cause it to open initially. In this case, the transient energy is large and of short duration that the silicon chip itself explodes.

When a TVS device does short, follow-on operating current may cause the device to open. Fusing of the line is recommended in all applications. Shorted devices will start to conduct current away from the circuit or system affecting its performance. Open devices are transparent to the circuit/system and will not usually distribute circuit functions. In either case, it is difficult to determine if the TVS device is still functioning while in the circuit. Degraded TVS devices are most difficult to detect in the circuit. These can be devices with high leakage currents which may not adversely affect circuit performance, except under elevated operating temperatures. All three types of failure modes are discussed in this applications note along with the design practices for fusing the line when a device does fail.

With the thought that a TVS device can fail, there are some additional terms that designers would like to impose on the protector to ease this problem. One such term is a “Fail Safe” condition. The term “Fail Safe” implies some level of safety which cannot be used in connection with the TVS device. Due to the very nature of the unknown transient threat, there are no 100 % guarantees. “Fail Safe” is one of the most misunderstood terms regarding transient protection. It is important to define the term and discuss why it should not be used in reference to a TVS device.

Words have different meanings to different people which is the case with the term “Fail Safe.” A TVS device cannot assure a fail safe environment. By nature, a TVS device will fail when subjected to a transient beyond its designed capability. If the circuit or system is not properly fused, a shorted TVS device can become a safety hazard conducting operating currents through the return path. Even with the proper design-in and adherence to good engineering practices, this term should not be used in describing the function of the protection network. Quite often, the unknown transient threat along with some of the guess work regarding the sizing (Peak Pulse Power Rating) of the TVS device will suggest some level of risk in the overall protection system. The risk, in this case, is the trial and error method used to guarantee proper TVS device selection versus its location. This type of selection process may take some time to accomplish when the transient threat cannot be fully defined. “Fail Safe” may be used in conjunction with a complete systems approach, but not with a component such as a TVS device.

FAILURE MODES

TVS devices will fail in one of three modes. These are shorts, opens and degraded devices. In most applications, the preferred method of failure is a short. A short is defined when the TVS device has a resistance value of less than 1 Ω at a dc voltage of 0.1 V (ref. ANSI/IEEE C62.35). In the more practical world, a shorted device will start to conduct a significant amount of operating current to ground, Figure 1.

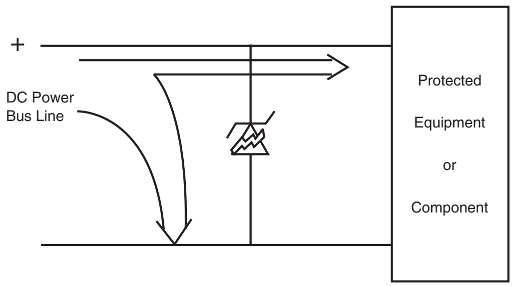


Figure 1. Current Path for Shorted Surge Protector

The actual current shunted to ground will depend upon the resistance in the line ahead of the TVS device. For the power line, this could mean a significant amount of current depending upon the available current from the power supply or source. With data lines, this can be somewhat limited but will depend upon the operating current of the circuit. Data lines operating in the milliampere range are more difficult to fuse. In either case, it is important to provide some type of fusing in the line to open up the circuit when a TVS device does short, Figure 2.

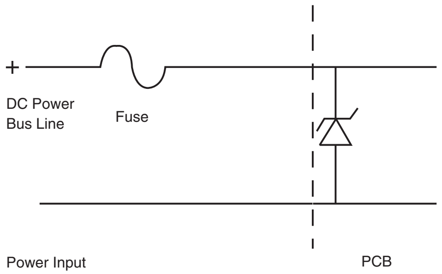


Figure 2. Fuse Location Relative to TVS Device

The fusing element must take into consideration two possibilities. First is the ability to handle the required transient current without interrupting the circuit functions. Second, it has to be able to open the line when the TVS device does short.

An open TVS device is defined as a diode that has a breakdown voltage V_{BR} greater than 150 % of the pretested value at an applied test current (I_P) (Ref. ANSI/IEEE C62.35). For this test, the unit must be taken out of the circuit for verification. An open device in the circuit will not exhibit any of the standard electrical characteristics such as leakage current or clamping voltage. Once out of the circuit, the TVS device can be tested on a curve tracer for verification of the open condition.

In an improperly fused circuit, a device that has been shorted can become open after an applied operating current is allowed to conduct through the device for a period of time. Figure 3 shows the fusing currents and time durations for each of the major axial lead type packages. When this occurs, there is usually some visible evidence in the form of a burn mark on or within the device indicating an open unit.

Devices that degrade are more difficult to detect. These types of failed devices will exhibit an increase in the reverse leakage current under normal operating voltages (equivalent to the stand-off voltage). According to ANSI/IEEE C62.35, a degraded failure mode has occurred when the avalanche junction surge suppressor has a stand-by current greater than the maximum specified. On the power bus line, this level of current reaches the upper limit of the power supply current or when the unit shorts from the increased current conduction. For data lines, this value may be much less due to the fact that there can be loss of data transmission of information. A device will act as a low impedance shunt path to ground.

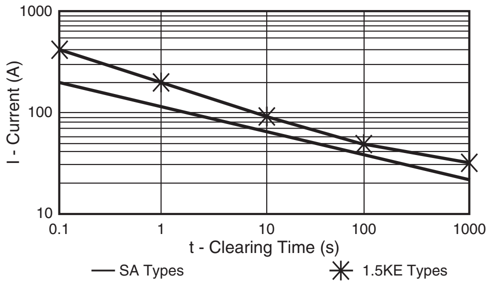


Figure 3. Clearing Time for Transient Voltage Suppressor Device - Fail Opened Condition

As discussed earlier, “Fail Safe” is discouraged in the description of a failure mode for TVS devices. For some, the term can be a desirable characteristic in that the unit will protect up to a specific level. To others it can mean that the device should provide protection because of the fail short or open condition. While both may be true, the TVS device should not be described as a fail safe product due to the fact that no one can guarantee a specific type of device failure mode. The transient threat and the location of the Transient Voltage Suppressor in the equipment will also have a major influence on the type of failure mode. In some applications, the transient currents and impulse waveform cannot be completely defined. As a result, the correct TVS device may not be designed in. In this case, the TVS device application is a trial and error method as suggested earlier. A TVS device is designed to withstand a specific level (power) of transient threat as defined by a peak pulse power rating versus pulse width curve, Figure 4.

Most manufacturers will provide a peak pulse power versus time curve on their individual product data sheets. This will provide the designer with the maximum power limit within a product family or series of devices. It is up to the circuit or system designer to translate this product information into the appropriate threat level. Threat levels should always be defined in terms of the peak current amplitude and impulse waveform rather than calculate the energy of the TVS device from the power curve. Energy is not a key parameter here due to the fact that the energy contained within the transient event is not the energy deposited in the TVS device. Equating the transient current threat to the peak pulse current rating of the TVS will ensure proper device selection and the continuous operation of the protector in the application. There will, however, be those applications in which the actual transient current cannot be defined. At best, the identification of the source of the threat is necessary; that is, lightning, switching, ESD or NEMP. From this information, the manufacturer can provide the direction for initial product selection.

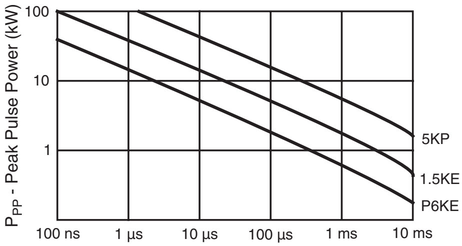


Figure 4. Peak Pulse Power vs. Pulse Time

Product selection begins by equating the circuit operating voltage to the stand-off voltage of the TVS device, Table 1.

TABLE 1 - AVALANCHE JUNCTION SELECTION PROCESS

DEVICE PARAMETERS		CONDITIONS
1) Stand-off voltage	>	Operating voltages
2) Peak pulse current	>	Transient current
3) Clamping voltage	>	Voltage protection

Next, as discussed above, it is necessary to equate the transient current to the peak pulse current of the TVS device. The transient current must always be less than the peak pulse current of the TVS for continuous operation. It is the transient current that will cause the TVS device to fail in a shorted mode. Device shorts can occur at the semiconductor chip junction surface interface or within the bulk material. This type of short will appear as a burn spot on the junction surface or as a dark spot on the top/bottom of the silicon chip. The bulk type of device short will be a function of the amount of transient current that was passed through the silicon chip. The burn spot can be as small as a pin hole in the die and as large as a funnel hole of a few millimeters in diameter. In both cases there is evidence of remelted semiconductor material. Its size will usually depend upon the current amplitude of the transient and any additional follow-up current that is present over a short period of time. Longer pulses will usually remelt the solder material which can bridge the silicon chip causing the shorted condition. In this case, removing the solder bridge will allow the TVS device to recover and appear as a good device.

Follow-on current after a TVS device has failed short can become a safety or circuit performance problem. For these reasons, it is suggested that a fuse or fusible link be inserted in the line ahead of the TVS device on both the power and data line applications. Selections well as location of a fusing element is important. From Figure 3, it is possible to determine the I^2t value necessary to select the fuse for any follow-on current. As this data is defined as the clearing time for a TVS device to open up for a continuous applied current, it is necessary to select a fuse with an I^2t characteristic below the device capability. Location of the fuse is best closest to the TVS device in the series line for board level protection, Figure 2. For equipment and high level systems protection, the fusing element can be a circuit breaker located at the point of power entry. At this location, the power and transient currents are terminated at the point of power entry input to the equipment preventing any additional problems such as safety hazard, data errors, or component damage.

One of the most difficult problems is the identification and, sometimes location of the failure. In-line tests are often used as the checkout procedure for the system/circuit's performance. With a Transient Voltage Suppressor, this may not be the best solution. The first step is the identification of problem area; that is, power bus or data line. The second step is to perform a visual inspection to locate the failed device or see evidence of a burn spot on a component. The third step is to apply power to the circuit for performance testing and test for any loss of data. If there are any major problems, tripping of a circuit breaker (CB) or a blown fuse will indicate some type of line problem. Trace the line to the problem area. When a CB or fuse does function, it's best not to reset the CB or replace the fuse but to locate the source of the problem. With data lines, this can be somewhat difficult if the fusing link does not function due to improper sizing.

Effect of Lead Wire Lengths on Protector Clamping Voltages

By O. Melville Clark and Joseph J. Pizzicaroli

Originally presented at the Federal Aviation Administration - Florida Institute of Technology Workshop on Grounding and Lightning Technology: March, 1979 - Melbourne, Florida

Abstract

Under high current pulse conditions, excessive lead lengths on suppressor components can be responsible for destruction of the protected circuit. This is caused by voltage build-up across the small but finite amount of inductance in the interconnecting leads of the protector. Some suppressor devices have been tested and observed to have more than twice the specified clamping voltage which was subsequently shown to be caused by inductive effects. Problems and corrective measures are illustrated and discussed in this paper.

SEMICONDUCTOR FAILURE THRESHOLDS

MOS and small area geometry semiconductors are particularly vulnerable to the effects of transient voltages. Unfortunately there has been very little information published on this subject. The work reported by Van Keuren [1] illustrates how fragile CMOS and TTL devices can be. Minimum failure pulse voltage thresholds are shown in Table 1.

TABLE 1 - MINIMUM FAILURE THRESHOLDS OF CMOS AND TTL

DEVICE TYPE	PULSE WIDTH					
	20 µs	2 µs	1 µs	0.02 µs	0.01 µs	0.025 µs
55107	22 V	16 V		22 V		
55109	36 V	38 V		60 V		
5404			30 V		50 V	120 V
54L30			20 V		50 V	90 V

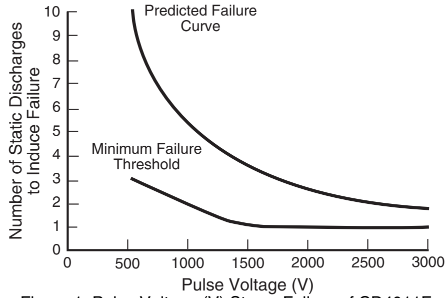


Figure 1. Pulse Voltage (V) Stress Failure of CD4011F

Electrostatic Discharge (ESD) failures of MOS microcircuits have been measured by Gallace and Pujol [2]. Comparisons among several suppliers indicate that failure levels can be a function of manufacturing technique. Repeated step stressing of a sample of 25 CD4011AF type devices shows that at a given stress level devices would eventually fail, as shown in Figure 1.

EQUIVALENT CIRCUIT OF PROTECTOR

The equivalent circuit of a silicon transient suppressor, such as the Transient Voltage Suppressor, is shown in Figure 2. All parameter values are fixed by manufacturing processes and device construction except L_1, the inductance resulting from the lead wires connecting the protector across the circuit for which protection is intended. Normal wiring practice results in lead lengths of the order of centimeters. In some power installations this has been observed to be of the order of feet.

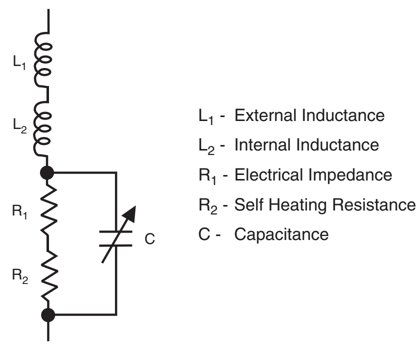


Figure 2. Pulse Voltage (V) Stress Failure of CD4011F

The inductance within an axial leaded part, as represented by L_2, is of the order of 10^{-8} H while the inductance within a modular assembly can be one to two orders of magnitude greater, depending on the design and the number of subcomponents. The capacitance of a silicon avalanche suppressor can vary over an order of magnitude, depending on the degree of reverse biasing.

TRANSIENT VOLTAGE RISE-TIMES

A. EMP: Voltage rise-times of EMP (Electromagnetic Pulse) transients, as generated by high altitude nuclear detonations, are 5 kV/ns. The presence of even a small amount of inductance in the protector circuit can have very profound results on the effectiveness of a protector device. This is illustrated with the oscillographs in Figure 3 and 4.

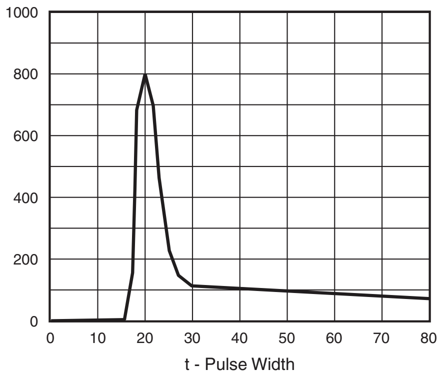


Figure 3. 7.5 cm Lead Wire

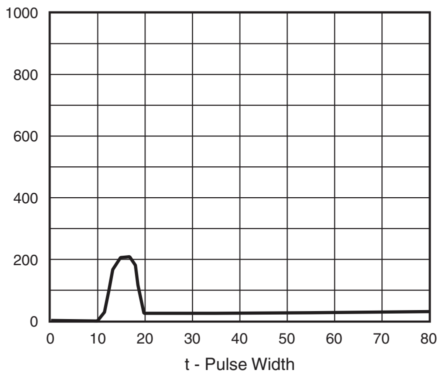


Figure 4. Zero Length Lead Wire

In Figure 3, a 30 V Transient Voltage Suppressor in the DO-13 package was pulsed with a 100 A 4 kV/ns rise-time transient. With 7.5 cm leads on each end, at which current was injected and voltage measured, the overshoot voltage is slightly greater than 800 V. The energy under this curve is calculated to be 70 mJ, sufficient energy to destroy most types of MOS and some TTL devices. By reducing the lead length to zero and repeating the pulsing, the overshoot voltage is reduced to about 200 V. The energy under this curve is less than 1 mJ, below the destruct threshold of MOS and TTL devices.

B. Lightning and Inductive Switching: From measurements made on 120 V_{AC} power systems, Martzloff [(3)] has proposed a waveform with a frequency of 100 kH. The lightning stroke, which is usually reported with current rise-times ranging from 1 to 3 ms has been more recently measured by Llewellyn [(4)] to be as low as 500 ns. Transients on shipboard AC power systems have been defined by MIL-STD-1339 as having transient rise-times of 1.5 ms.

Normal wiring practices are usually considered adequate for protection of electronic circuitry. “Normal” and “adequate” are relative terms and usually prevail under conditions in which equipment performance is acceptable. What is normal and adequate protection for vacuum tubes is not the same for power semiconductor devices. Protection for microcircuits is also quite different from power semiconductors. With increased usage of microprocessors and other small area geometry semiconductors, equipment is becoming more vulnerable to transient voltages, under both single pulse and repetitive pulse conditions.

INDUCTIVE EFFECTS IN COMPONENT LEADS

A. Calculation: The inductance in a straight wire appears, at first glance, to be very small and insignificant. Assuming a value of 1 mH/m for a straight wire, most lead wires have inductance values in the nH region. The voltage drop developed across an inductor under pulse conditions is expressed as:

$$V_{(t)} = L\frac{dI}{dt}$$

where L is inductance in henrys

$\frac{dI}{dt}$ is the rate change of current

For the fast rise-times of EMP as shown above, the associated problems are obvious; however, for the slower rise-time of switching and induced lightning the degree of exposure and protection required can be defined only after carefully studying all boundary conditions.

B. Case Study: In the following application, a silicon transient suppressor is being used to both regulate the voltage to power a telecommunications repeater and also provide transient suppression. The schematic is shown in Figure 5. This is one of two repeaters powered and protected by the same component.

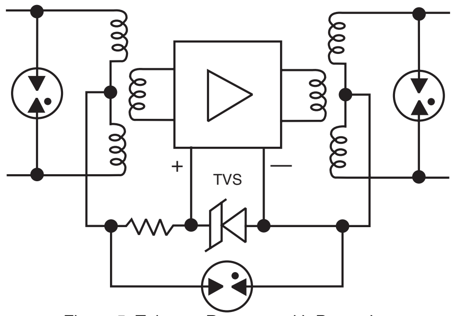


Figure 5. Telecom Repeater with Protection

The microcircuitry used in this equipment has some well defined failure levels; 20 V in the positive direction and 6.5 V in the negative direction. The suppressor has a well defined clamping voltage in the avalanche direction under a specified rise-time. The forward polarity measurements are specified at 100 A with an 8.4 ms, 1/2 sine wave pulse. To determine higher current capability, pulse tests were made with a 1.2 x 50 ms waveform.

During the process of taking data, small differences in lead length in the protection circuit were observed to have profound effect on the suppression capability of the device. Measurements extended over the range from 100 A to 500 A with lead lengths from the body of the device of zero, 1.0 cm and 2.0 cm. Tests were made on a molded 1.5 kW Transient Voltage Suppressor. The peak clamping voltage was plotted against pulse current as shown in Figure 6.

After tests were made with 0.0, 1.0 cm and 2.0 cm lead lengths, the plastic body was carefully cut away leaving only the cell containing the junction and the leads. Voltage measurements were then made across the cell, virtually eliminating inductance within the package. A lead length of 2 cm has a peak clamping voltage of 4 V at 100 A and 13.5 V at 500 A. By contrast, the cell only has a peak clamping voltage of 1.3 V at 100 A and 3 V at 500 A. Voltage probe placement for taking measurements is shown in Figure 7.

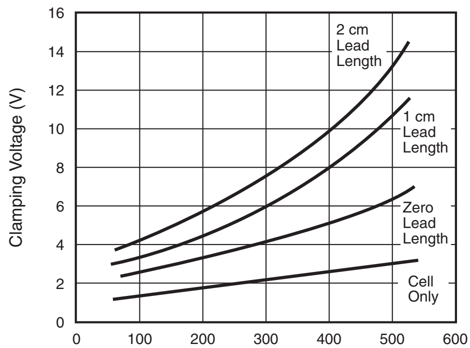
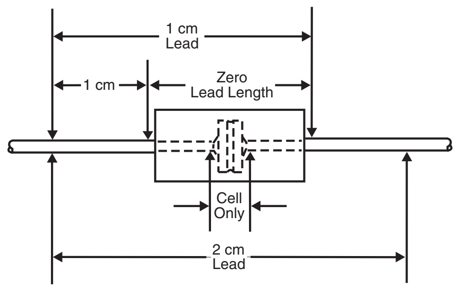


Figure 6. Clamping Voltage vs. Pulse Current



Voltage Probe Placement
Figure 7. Voltage Probe Placement

Voltage drops across the lead wires contributing to peak clamping voltage can be attributed to both resistive and inductive components. Calculations were made for both resistive and inductive voltage drops for a 1.0 cm 0.040" diameter copper wire at pulse current levels from 100 A to 500 A. Rise-time is 1.2 ms. This data is shown in Table 2.

Note that the calculated inductive voltage drop compares favorably with the measured voltage drop while the resistive component contributes less than 10 % of the total.

TABLE 2 - PULSE CURRENT LEVEL AND VOLTAGE DROP			
PULSE CURRENT (A)	MEASURED VOLTAGE DROP (V)	CALCULATED RESISTIVE VOLTAGE DROP (V)	CALCULATED INDUCTIVE VOLTAGE DROP (V)
100	0.75	0.019	0.83
200	1.3	0.038	1.66
350	2.3	0.066	2.91
500	3.3	0.095	4.16

CLAMPING VOLTAGE OF AC PROTECTOR

In power systems, it is quite easy to place a modular assembly protector in a convenient mounting location rather than the most effective one, especially in retrofit applications. These components are sometimes bulky and do not always conveniently fit the desired location. To illustrate reduced effectiveness in an AC power transient suppressor, a module was measured for peak clamping voltage having lead lengths of 24", 48", and 72". Pulse currents were 100 A, 200 A, 300 A and 400 A with a wave form of 1.2 x 50 ms. Lead length vs. additive peak clamping voltage plotted here, is that value above the normal clamping voltage with zero lead length.

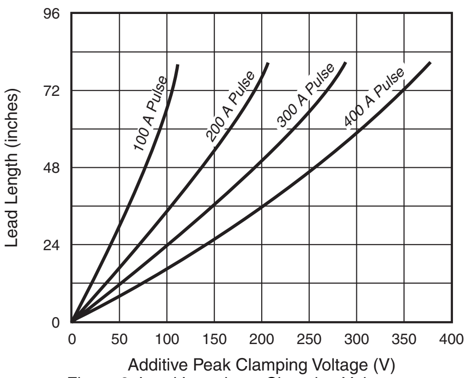


Figure 8. Lead Length vs. Clamping Voltage

Note that the additive clamping voltage can be down in the range of 35 V at 100 A for 24" leads extending up to 350 V at 400 A for 72" leads. An oscillograph depicting optimum protection at 100 A and 400 A is shown in Figure 9. The 100 A pulse is being clamped at about 215 V and 400 A pulse at 265 V. The peak clamping voltage is substantially increased by the inductive effects of 72" leads as shown in Figure 10. In this oscillograph, the 100 A pulse produced a peak of about 320 V and 400 A pulse produced a peak of about 615 V. The inductive overshoot illustrated in Figure 10 is quite profound by comparison with Figure 9.

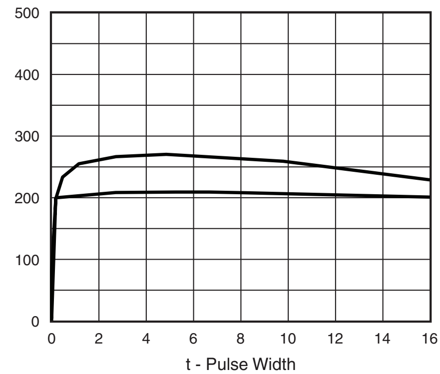


Figure 9. AC Protector, Optimum Protection

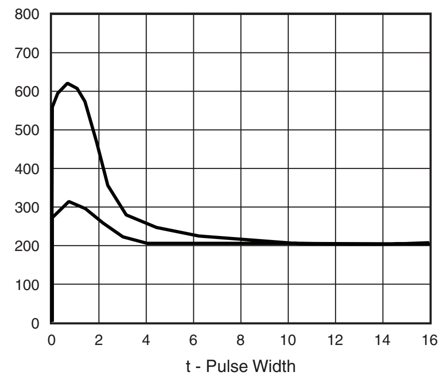


Figure 10. AC Protector, 72" Leads

CLAMPING VOLTAGE OF MICROCIRCUIT PROTECTOR

An ICT-5 type Transient Voltage Suppressor, designed for protecting low voltage logic circuits, was pulsed at levels of 100 A, 200 A, 300 A, 400 A and 500 A with a 1.2 x 50 ms waveform. Voltage drop was measured across the leads at distances of 0.0, 1.0 cm and 2.0 cm from the body of the package, adding a total of 4.0 cm 0.030 diameter straight wire contributing to inductance and subsequently adding to the peak clamping voltage. A graph plotting total lead length vs. peak clamping voltage is shown in Figure 11. These curves are plotted as additive above the breakdown voltage

(BV) at 1 mA, which was 6.3 V for the device tested. The clamping voltages increase with pulse current using zero lead length due both to the electrical impedance and thermal self-heating effect on the silicon pn junction. Observe that the clamping voltage covers a very broad range, from 3.6 V above BV to 24 V above BV depending on peak current and insertion method.

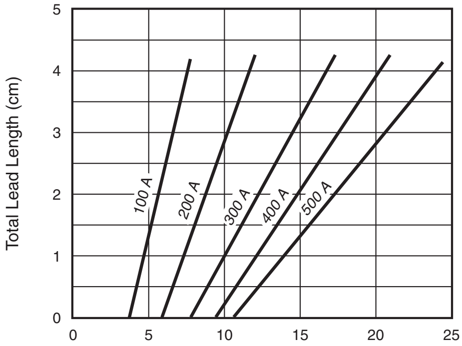


Figure 11. Lead Length vs. Peak Clamping Voltage

REDUCING INDUCTIVE EFFECTS

The most obvious method of reducing inductive effects and thus optimizing protector capability is to reduce lead wire lengths in the protector circuit. If it is not possible to reduce the conductor length, other options are available. Inductance in a given length of conductor can be reduced by replacing a small diameter wire with a wide strip conductor. On circuit boards, a ground plane on one or both sides of the board has been used by the author as a method for optimizing protector clamping.

Since voltage drop across the lead length is a function of the transient rise-time, it may be feasible to add series inductance between the transient source and the protector to reduce the risetime and subsequently the peak clamping voltage. A Transient Voltage Suppressor used for 5 V logic protection was tested with a 300 A pulse having a 1.2 x 50 ms waveform with voltage measurements made at 2.0 cm from each end of the body of the device. This is shown in Figure 12, peaking at 24 V. Placing a 12 mH choke ahead of the suppressor to reduce the rise-time, reduced the peak to 19 V and using 24 mH reduced the peak to 17 V. These curves are also shown in Figure 12.

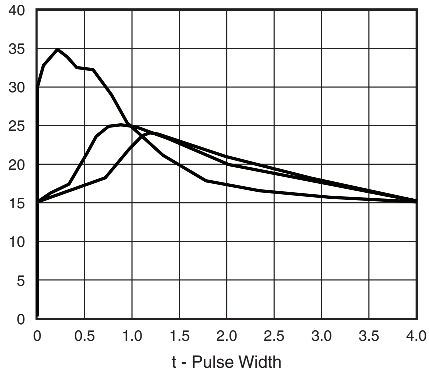


Figure 12. AC Protector, 72" Leads

CONCLUSION

Inductive effects can be, and often are, a source of abnormally high peak clamping voltages compared to the inherent capability of a Transient Voltage Suppressor. These high clamping voltages can cause failure of vulnerable electronic components; thus a suppressor capable of providing adequate protection can be rendered useless due to poor insertion methods. So it behooves the design engineers working on both mechanical layout and circuit design to be acutely aware of inductive effects and the problems which they can cause along with corrective measures in order to optimize transient voltage protector components.

References:

1. E. Van Keuren, “Effects of EMP Induced Transients on Integrated Circuits”, IEEE Electromagnetic Compatibility Symposium Record, October, 1975.
2. L. Gallace & H.J. Pujol, “The Evaluation of CMOS Static-Charge Protection Networks and Failure Mechanisms Associated With Overstress Conditions as Related to Device Life”, presented at the 1977 Reliability Physics Symposium. April, 1977.
3. F.D. Martzloff, “A Guidance on Transient Overvoltages in Low Voltage AC Power Circuits”. GE Report No. 77CRCD221, September, 1977.
4. Sigrid K. Llewellyn, “Broadband Magnetic Field Waveforms Radiated from Lightning”. Masters Thesis, Florida Institute of Technology, 1977.

Hardening Power Supplies to Line Voltage Transients

Originally presented at the Power Electronics Design Conference, October 1985, Anaheim, California
Also published in Power Conversion and Intelligent Motion, 6/86

Abstract

The power line transient environment is described. Transient voltages on the DC output of off-line rectifier/filter designs are shown. Protection schemes are discussed. An integrated rectifier/transient suppressor circuit is suggested as a cost-effective means of rendering the DC bus virtually immune to line transients.

INTRODUCTION

Unexpected line voltage transients are finally being recognized as a significant factor in the failure of Switching Mode Power Supplies (SMPS). As stated in a recent Navy publication [(1)]: "The most predominant power supply failure modes are caused by peak instantaneous transients and subtle factors within and external to the power supply...
The following is a list of key points to consider when designing and evaluating a switching-mode power supply design: (1) Put voltage transient protection on the input power lines".

Until the publication of IEEE Standard 587-1980 [(2)], now ANSI-IEEE C62.41, the designer of off-line SMPS was unsure of the AC line transient environment. Now switching power supplies can be designed to meet this standard and pulse generators are available which produce the waveform specified. The standard specifies that low impedances across the line in commercial and industrial environments should handle an 8/20 current waveshape (double exponential, 8 ms rise time, 20 ms decay to half of peak) having a peak amplitude of 3000 A.

It should be understood that lightning induced transients propagate through a system as a current source looking for a low impedance path to ground. It is unlikely that most designers make provision for the rectifier and filter system to handle pulse currents up to 3000 A, but a conservation design philosophy indicates that this should be done. The task is not easy, because component manufacturers do not generally consider this problem either.

A rectifier diode having a single-cycle 60 Hz surge current rating exceeding 300 A would most probably handle the 3000 A, 8/20 ms impulse specified in the standard, but the capability of rectifiers with lower ratings is questionable and needs to be verified. Rectifier diode surge capability will not be further addressed in this paper but clearly the rectifier must handle surge currents; the amount depends upon the protection scheme used.

In most off-line SMPS, the element which prevents excessive transient voltages from appearing across the DC bus and also bears the brunt of carrying the line to neutral transient pulse current is the filter capacitor. However, the charge delivered by the input transient and the voltage drop across the capacitor's ESL and ESR combine to develop a large overshoot voltage. This overshoot usually shorts the power switches connected to the DC output from the rectifier system.

Providing a network to limit voltage to a predetermined maximum rather than using higher voltage power switches offers a number of advantages to the power supply designer, independent of the choice of switching transistor (i.e., bipolar or FET). For a bipolar transistor of a given die area, lowering the breakdown voltage raises current gain and reduces all switching times. Reducing the breakdown voltage of a FET chip causes a marked decrease in on-state voltage - the principle determinant of power loss - because of the relationship $r_{DS(on)}$ of VB2.5. Alternately, a smaller size power switch chip could be used to achieve the same performance while realizing a significant cost savings [(3)].

CONDITIONS IN AN UNPROTECTED SYSTEM

Most SMPS have an input network as shown in Figure 1. The impedance is used to limit start-up inrush current without causing excessive power loss. The series impedance may be a thermistor or a resistor which is often shunted by a triac to reduce power loss after start-up.

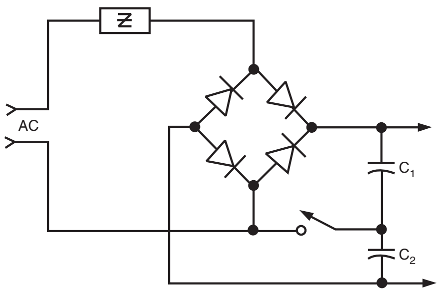


Figure 1. Basic Line Rectifier and Filter for SMPS Operating from 120/240 V Lines

It is not unusual to allow for a 20 % tolerance on a 120/240 V AC power line which puts the voltage crest at about 400 V. Added to the DC level is the overshoot caused by the 3000 A impulse. The usual switching power supply which operates from 120/240 V inputs has two capacitors as part of the voltage double arrangement. The capacitors are connected in series when used on 240 V.

Thus, the total DC bus voltage spikes up to twice the individual capacitor transients when used on 240 V. The voltage waveform of Figure 2 reveals the presence of three components of overshoot: 1) a fast rising step caused the di/dt of the wave flowing through the capacitors ESL, 2) an in-phase component caused by the current flow through capacitor ESL, and 3) a charge placed on the capacitor. Obviously, the transient voltage can be reduced by using a large valued capacitor having low ESL and ESR. The relationship is given in below Equation.

$$V_C = \frac{I}{C}\int idt + iRs + LS\frac{di}{dt}$$

where
C = Input filter capacitance
i = Pulse current
Rs = Capacitor equivalent series resistance (ESR)
Ls = Capacitor equivalent series inductance (ES)
di/dt = Rate of rise of transient current

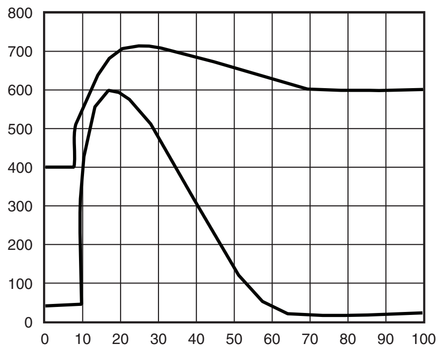


Figure 2. Capacitor Waveform Showing Spike Caused by Current, and Charge Placed on Capacitor ($C_1 = C_2 = 60$ mF; Upper: 10 V/div; Lower: 100 A/div; Time: 10 ms/div)

Measured voltage transients for some different capacitors when pulsed with 500 A in the circuit of Figure 1 are shown in Table 1. With a 3000 A pulse, overshoots of 6 times the values shown would occur. In all cases of 240 V input, the transient voltage exceeds the typical 250 V surge rating of a 200 V capacitor. Even worse, the DC bus - possibly at about 400 V because of high line, low load condition - is now up to at least 560 V! No wonder power switch failures occur in seemingly well designed systems.

TABLE 1 - TRANSIENT PERFORMANCE OF THE CIRCUIT OF FIGURE 1
(Peak Pulse Current = 500 A)

C_1, C_2	TYPE	INPUT	PEAK TRANSIENT VOLTAGE	CHARGE VOLTAGE
540 µF	Mepco/Electra 319DA541T250AMA1	120 V	39 V	30 V
		240 V	75 V	58 V
650 µF	Mepco/Electra 3120EA651T200BHA1	120 V	33 V	23 V
		240 V	65 V	46 V
2100 µF	General Electric 44A417052M21	120 V	12 V	7 V
		240 V	27 V	16 V

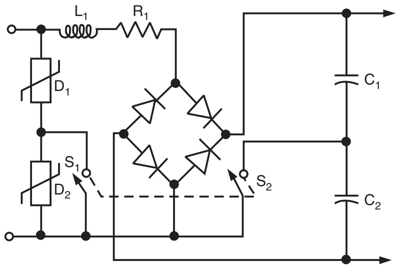


Figure 3. Basic Circuit with MOV Protection

The spike could be clipped by a suitable TVS device but the charge voltage persists for too long and is not easily eliminated. The best solution is to minimize the amount of transient current being fed to the capacitor.

TRANSIENT PROTECTION TECHNIQUES

General principles of powerline transient protection have been described in a paper by Jacobus [4]. Almost concurrently, a specific module designed using these same principles, which meets the 3000 A specification of ANSI-IEEE C62.41, was described by Roehr and Clark [5]. Both papers deal with providing transient protection downstream from susceptible equipment. However, in a power supply, components which must be present for rectification and filtering may be used as part of the transient suppression network.

TABLE 2 - TRANSIENT PERFORMANCE OF THE CIRCUIT OF FIGURE 3
(R_1 = 0.05 Ω, C_1 = C_2 = 540 µF, Peak Pulse Current = 2000 A)

R_1 - L_1	INPUT	S_1	PEAK TRANSIENT VOLTAGE	CHARGE VOLTAGE	PEAK CAPACITOR CURRENT
0.5 Ω - 0 µH	120 V	Open	77 V	54 V	1080 A
		Closed	24 V	21 V	440 A
	240 V	Open	106 V	78 V	780 A
0.5 Ω - 100 µH	120 V	Closed	18 V	10 V	190 A
	240 V	Open	74 V	47 V	440 A
1.0 Ω - 100 µH	120 V	Closed	12 V	7 V	130 A
	240 V	Open	53 V	34 V	300 A

When transient protection is used in a SMPS, it most often is nothing more than a single MOV across the line as shown in Figure 3. Table 2 shows test results taken in the circuit of Figure 3. Note that the worst transients occur in the 240 V position when both switches are open. However, unless the MOV voltage is adjusted to fit the lower line voltage when used on 120 V ac, (i.e., S_1 is closed), a very large capacitor current flows. For example, with only 0.5 Ω impedance the 77 V spike appears across only one capacitor; with 3000 A of input current the spike would increase to 115 V which could exceed the surge voltage rating of the capacitor. The 106 V transient increases to about 150 V when 3000 A is applied, bringing the bus voltage to 550 V.

To improve the transient suppression, the capacitor and/or the series impedance must be larger. The data in Table 2 taken with higher series impedances shows some improvement in lowering the transient levels, but the transients are still higher than desired. For very low power supplies, the circuit of Figure 3 would be satisfactory, if an appropriate series impedance and capacitor were chosen.

For example, the data of Table 1 shows that the 2100 mF capacitor allowed only 27 V of overshoot with a 500 A pulse. This capacitor would be satisfactory if used in Figure 3 with the 0.5 Ω - 100 mH input network.

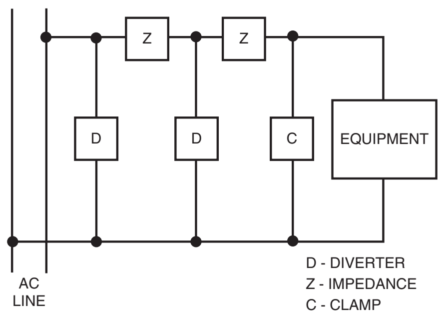


Figure 4. General Topology for a Protection Network

A general topology for transient protectors is shown in Figure 4 using the notations of Jacobus. The diverter devices handle high currents but do not offer a precise control of voltage; gas tubes and metal oxide varistors (MOVs) are typical diverting elements. The clamp devices have lower impedance than the diverters but have lower energy handling capabilities. A TRANSZORB™ Transient Voltage Suppressor (TVS) Diode is a typical clamping device. The series impedances shown semi-isolate the various diverter and clamp stages by causing a voltage drop between them. To meet the requirements of ANSI-IEEE C62.41, Category B, and provide low output voltage clamping, the topology of Figure 4 has proven to be quite effective.

AN INTEGRATED RECTIFIER/SUPPRESSOR CIRCUIT

After some experimentation, the network of Figure 4 has been found to work quite well when the first diverter is a MOV, the first impedance is composed of the inrush current limiting resistance and an inductor, the second diverter is a silicon Transient Voltage Suppressor and capacitor network, the second impedance is a series R - L circuit, and the clamping device is the filter capacitor.

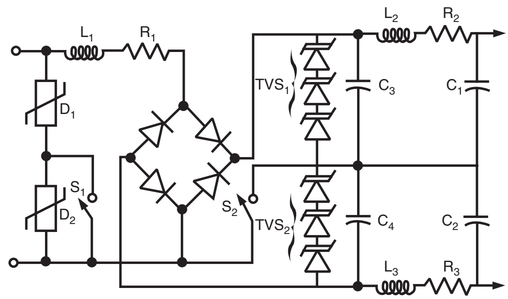


Figure 5. Circuit Providing a High Level of Protection

Figure 5 (patent pending) shows a practical implementation of the circuit of Figure 4, which is virtually immune to transients. The resulting T filter network also attenuates high frequency noise in both directions, thus easing EMI filter requirements. Performance is shown in Table 3 when pulsed with 2500 A. The resulting 25 V peak transient appearing at the output is low enough to allow the use of 450 V rated transistors in the power switching section.

TABLE 3 - TRANSIENT PERFORMANCE OF THE CIRCUIT OF FIGURE 5
(Pulse Current ≈ 2500 A, $L_1 = L_2 = L_3 = 100\ \mu H$, $R_1 = R_2 = R_3 = 0.5\ \Omega$ TVS Stack, 5KP60)

INPUT	PEAK TRANSIENT VOLTAGE	CHARGE VOLTAGE	PEAK CAPACITOR CURRENT
120 V	9 V	5 V	103 A
240 V	25 V	16 V	163 A

CONCLUSION

Only by ensuring a clean dc bus can a switching power supply be a reliable piece of equipment. Attention must be given to the lowly line rectifier and filter system to dramatically reduce line voltage transients. The circuit of Figure 5 provides a satisfactory clean DC level.

References:

1. “Navy Power Supply Reliability - Design and Manufacturing Guidelines”, NAVMAT P4855-1, Pg 27, NAVPUBFORCEN, 5801 Tabor Ave., Philadelphia, PA 19120
2. “IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits”, IEEE Standard 587-1980, Institute of Electrical and Electronic Engineers, 345 E. 47th St., NY, NY 10017
3. Jon D. Paul And Bill Roehr, “The Use of Transient Voltage Suppressor Diodes with Power Mosfets”, Official proceedings of the 9th International PCI ‘84 Conference, Intertec Communications, Inc. 2472 Eastman Ave., Unit 34, Ventura, CA 93003
4. N.M. Jacobus, “Designing Power Line Transient Protection Circuits”, Proceedings of Powercon 11, D-4 pp. 1-11, Power Concepts, Inc., P.O. Box 5226, Ventura, CA 93003
5. William D. Roehr and O. Melville Clark, “AC Power Line Protection for an IEEE 587 Class B Environment”, NASA Conference Publication 2356

Transient Suppressors, a Competitive Look

By Jon Schleisner, Senior Applications Engineer

Several different technologies share the transient suppressor marketplace. The energy capacity of these devices ranges from 0.1 J on up. Much of the new design work utilizing TVS components centers around data line protection on LAN systems and other industrial computer networks. Most of the systems are protected against lightning strikes and similarly large magnitude transient events entering the system via the power mains. This power input protection does nothing to protect the small geometry die within transceiver chips that transmit data from one terminal sight to another.

Typically, data lines are exposed to two specific surge events. Electrostatic discharge, and "ground bounce" dominate the field when it comes to stressing data ports electrically. Enter the two primary technologies vying for approval in this high volume design socket.

Zinc oxide varistors are manufactured by SMX chip capacitors vendors. The small physical dimensions of chip capacitors are ideally suited for low power ZnO style transient suppressor devices. The typical "zinc oxide (ZnO) based ceramic semiconductor device" uses an interleaved plate design made up of individual TVS cells in parallel to minimize inductance and enhance turn-on characteristics. This is a refined version of what is called a MOV (metal oxide varistor). MOV's have been produced in many shapes and sizes for at least the last thirty years. This recent adaptation of the technology is an excellent one.

The other technology of interest is the General Semiconductor "TVS" (Transient Voltage Suppressor). This component is constructed using an avalanche diode as the energy absorbing element. This approach to transient suppression is not a new one. Zener diodes have been used in this application for almost as long as MOV style protectors. The difference between the TVS manufactured by General Semiconductor (and others) and Zener diodes is construction. A Zener diode is primarily designed to handle steady state power. The Zener functions as a voltage regulator (shunt style) or voltage reference in a power supply system. While electrically similar, the TVS unit has a different construction and is designed to absorb large amounts of energy (joules) in a very short period of time (milliseconds).

MOV technology exhibits an inherent wear out mechanism within the structure. As the device absorbs transient energy (surges) the electrical characteristics tend to drift. IR (Leakage) and BVR (Breakdown voltage) can move away from their original specifications. The ZnO surface mount TVS performance is excellent in this respect. The other negative that the ZnO technology brings is an inferior clamping ratio, at least when compared to silicon avalanche technology.

The clamping ratio is a qualitative measure of a transient suppressor's performance. The clamping ratio is described mathematically in Figure 1. The best performance attainable is a clamping ratio of unity (1) which implies a transient suppressor with an "on" impedance of zero. In the real world this is impossible. All transient suppressors, regardless of technology, have some finite impedance.

Clamping Ratio at 20 A

$$\text{Clamping Ratio} = \frac{V_C \text{ at } 20\text{ A}}{B_{VR} \text{ at } 1\text{ mA}}$$

$$\text{Perfect Device} = \frac{V_C}{B_{VR}} = 1.0$$

A Clamping Ratio of 1 Implies Zero Impedance

Figure 1.

In Figure 2 the clamping ratio for 5 and 15 V protection components can be seen. The difference in clamping performance is obvious. The silicon based SMAJ05C and SMAJ15C exhibit clamping ratios in the range of 1.25 to 1.33. The ZnO technology shows clamping ratios approaching 2.0. From the standpoint of protecting the system behind the suppressor, the semiconductor (silicon avalanche) technology does a superior job.

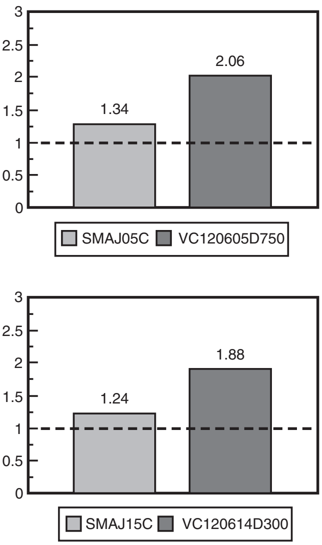


Figure 2.

Figures 3 and 4 show the actual clamping performance of the different devices under similar conditions.

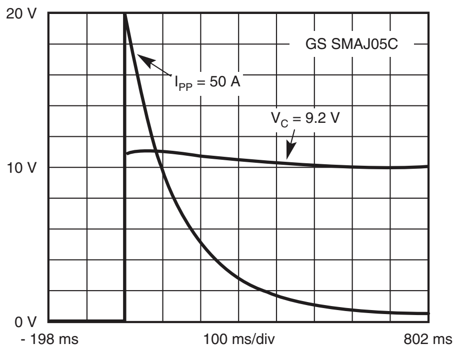


Figure 3.

To complete the picture it must be mentioned that the ZnO technology will handle more energy per unit area. This enables ZnO manufacturers to produce transient suppressors in the familiar SMX capacitor packages. The small size and high power per unit area of the ZnO technology are definite pluses. The poor clamping performance is not an asset. Table 1 shows the upside of each transient suppressor approach.

TABLE 1 - CONCLUSIONS: ZnO SUPPRESSOR vs. TVS
ZnO SUPPRESSOR:
• Handles more total power/energy • Smaller footprint • Very fast response for MOV type design • Negligible wearout within SOA
TVS:
• Exhibits much better clamping ratio • Better qualitiy protection • Faster turn-on response: 1 to 5 ns • No inherent wearout mechanism within SOA

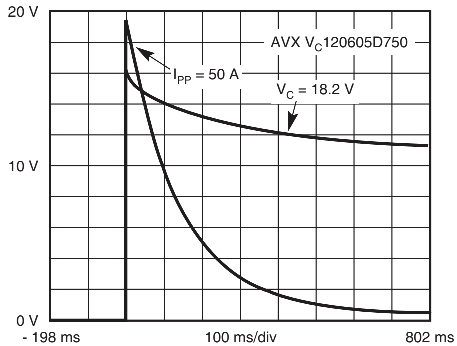


Figure 4.

Pulse Power Rating of Semiconductors

The admissible dissipation of diodes, rectifiers and Zener diodes which operate from sinusoidal supplies is based on the arithmetic mean value of junction temperature and power dissipation. Devices which handle pulses are capable of passing short-term currents far in excess of the maximum admissible static dissipation, and in this case it is admissible to exceed the continuous dissipation curve for the duration of each pulse. The magnitude of the admissible current is then inversely proportional to the pulse duty factor, because power is dissipated only intermittently, and the thermal capacity of the system and heat conduction prevent an undue rise in junction temperature. Some of the data sheets contain diagrams which allow the rating of a device operating under pulsed conditions to be determined.

In Figure 1, which applies to diodes and rectifiers, the maximum admissible pulse current amplitute is plotted as a function of pulse duration for an ambient (or case) temperature of + 25 °C. If the device is to operate at higher ambient temperatures, then it is necessary to derate the current values derived from this diagram in accordance with the “admissible dissipation versus temperature” curve.

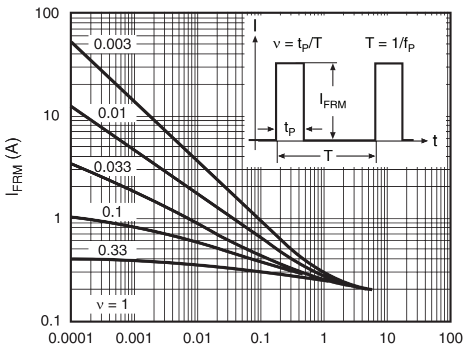


Figure 1.

For Zener diodes it is preferable to provide a plot which gives the terminal pulse resistance rather than the admissible current amplitude as a function of tp (the duration of the rectangular pulse which causes power to be dissipated), as shown in Figure 2. The operational junction temperature can then be calculated by use of the formula

$$T_J = T_{amb} + P_I \times rt_{hA},$$

or, if additional power PD is continuously dissipated, by use of the formula

$$T_J = T_{amb} + P_D \times R_{thA} + P_I \times r_{thA},$$

If the diode is fitted to a heat sink, then the equation becomes

$$T_J = T_{amb} + P_{tot} \times R_{thS} + P_I \times r_{thC},$$

where P_{tot} is the mean value of P_I (= pulse dissipation). If additional power is continuously dissipated, then the above equation must be extended to

$$T_J = T_{amb} + P_{tot} \times R_{thS} + P_D \times R_{thC} + P_I \times r_{thC},$$

where P_{tot} is the mean value of the total dissipated power.

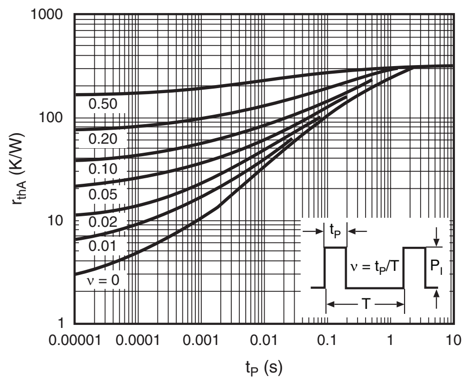


Figure 2.

HEAT REMOVAL FROM SEMICONDUCTOR COMPONENTS

The operation of any semiconductor device involves the dissipation of power with a consequent rise in junction temperature. Because the maximum admissible junction temperature must not be exceeded, careful circuit design with due regard not only to the electrical, but also the thermal performance of a semiconductor circuit is essential.

If the dissipated power is low, then sufficient heat is radiated from the surface of the case; if the dissipation is high, however, additional steps may have to be taken to promote this process by reducing the thermal resistance between the junction and the ambient air. This can be achieved either by pushing a star- or flag-shaped heat dissipator over the case, or by bolting the semiconductor device to a heat sink.

P, the power to be dissipated, T_j the junction temperature, and T_{amb}, the ambient temperature are related by the formula

$$P = \frac{T_J - T_{amb}}{R_{thA}} = \frac{T_J - T_{amb}}{R_{thA} + R_{thS}}$$

where R_{thA} is the total thermal resistance between junction and ambient air. The total thermal resistance in turn comprises an internal thermal resistance R_{thC} between the junction and the mounting base, and an outer thermal resistance R_{thS} between the case and the surrounding air (or any other cooling medium). It should be noted that only the outer thermal resistance is affected by the design of the heat sink. To determine the size of the heat sink required to meet given operating conditions, proceed as follows: First calculate the outer thermal resistance by use of the formula

$$R_{thS} < \frac{T_J - T_{amb}}{P} = R_{thC}$$

and then, by the use of the following diagrams, determine the size of the heat sink which provides the calculated R_{thS}-value. To determine the maximum admissible device dissipation and ambient temperature limit for a given heat sink, proceed in the reverse order to that described above.

The calculations are based on the following assumptions: Use of a squareshaped heat sink without any finish, mounted in a vertical position; semiconductor device located in the centre of the sink; heat sink operated in still air and not subjected to any additional heat radiation. The calculated area should be increased by a factor of 1.3 if the sink is mounted horizontally, and can be reduced by a factor of approximately 0.7 if a black finish is used.

The following curves give the thermal to ambient resistance of square vertical heat sinks as a function of side length. It is assumed that the heat is applied at the centre of the square.

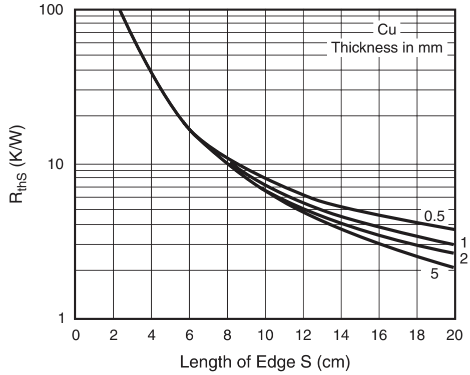


Figure 3. Copper Cooling Fin

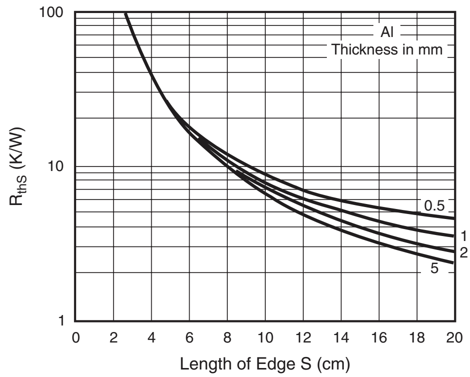


Figure 4. Aluminum Cooling Fin

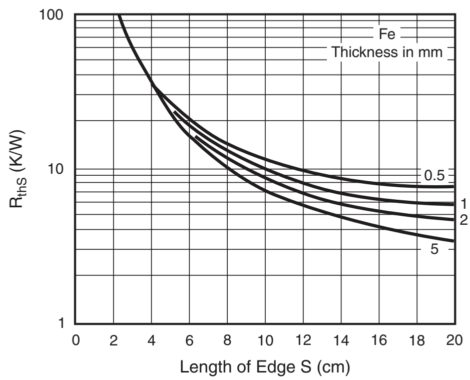


Figure 5. Steel Cooling Fin

Determining Clamping Voltage Levels for a Broad Range of Pulse Currents

By Bruce Hartwig
Senior Automotive Applications Engineer

In Transient Voltage Suppressor (TVS) data sheets, all clamping voltage (V_C) levels are specified at maximum rated peak pulse current (I_{PP}). How do you interpolate the V_C levels for transient currents (I_P) other than the rated maximum?

This figure is easily calculated using the parameters on the data sheet with the formula:

$$V_C = (I_P/I_{PP})(V_C \text{ max.} - V_{BR} \text{ max.}) + V_{BR} \text{ max.}$$

Where: I_P = test pulse current
I_{PP} = max rated pulse current
V_C max. = maximum specified clamping voltage
V_{BR} max. = upper limit of breakdown voltage

This calculation assumes a linear increase in V_C between V_{BR} and V_C max, which is realistic. Figure 1 illustrates the DVC vs DIP relationship for two voltage levels, 10 V and 64 V, in the SMB 600 W series between V_{BR} and V_C as determined by this formula. Results are linear as expected. V_{BR} max is used in this calculation as it is the upper limit of specified breakdown voltage.

In those instances where V_{BR} max is not given on the data sheet, it can be closely approximated. For “A” suffix parts, multiply the minimum V_{BR} by 1.11 and for non-suffix parts, multiply by 1.22 to obtain the maximum V_{BR}. The curves derived from measured data are compared with calculated values in Figure 1. Surge tests were performed for a 30 piece sample at 25 °C ambient with a 10/1000 µs waveform.

Note that the curves based on actual surge data have a more shallow slope than those from the calculation, indicating that the devices are conservatively rated and that the formula shown provides a sufficient level of confidence for worst-case design.

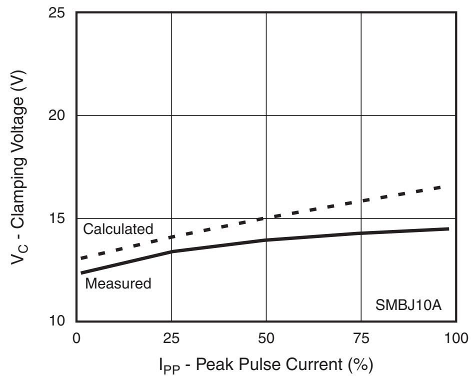


Figure 1. V_C vs IPP for SMBJ10A Calculated and Measured

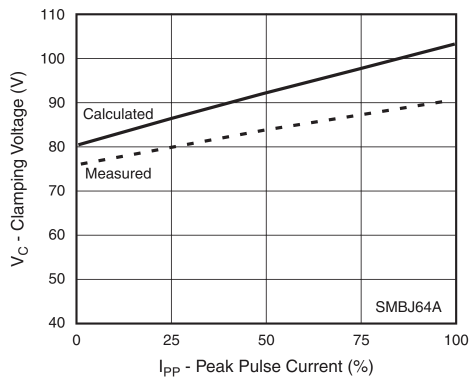


Figure 2. V_C vs IPP for SMBJ64A Calculated and Measured

Using the Power vs. Time Curve

By Bruce Hartwig
Senior Automotive Applications Engineer

How can the maximum transient power and current capability for silicon Transient Voltage Suppressors (TVS) be derived for conditions other than the 10/1000 µs pulse specified on data sheets?

Most Transient Voltage Suppressors are rated for 10/1000 ms non-repetitive pulse waveforms (10 ms being the front time and 1000 µs being the time from start to decay to one-half of the peak value), which is an early telecom transient waveform. Real world transients will have varying pulse widths depending on the source. Various standards describe other waveforms to reflect these origins. For example, IEC 801 - 5 describes a lightning threat to data lines approximating 1.2/50 ms.

The graph in Figure 1. relates peak pulse power with time for 600 W suppressors; similar curves exist for TVS's rated at other power levels. At 1000 ms the maximum pulse power (P_P) is 600 W, the rating condition of the device. The graph illustrates that at 50 µs, the rating is 2100 W and at 10 000 µs (10 ms), P_P rating is down to approximately 200 W. This applies to all devices in the 600 W series regardless of their operating voltage.

Under shorter pulse widths a TVS will sustain higher pulse currents (I_P). For a width of 50 ms, for example, a TVS will sustain 3.5 times its rated I_P at 1000 ms, 600 W. Thus the peak I_P of an SMBJ12A would increase from 30.2 A at 10/1000 ms to 105.7 A at 1.2/50 ms. The current rating of an SMBJ64A would increase from 5.8 A to 20.3 A.

Increasing the pulse width to 10 000 µs will reduce the I_P rating by a factor of 0.33 since the P_P is reduced to 200 W. An SMBJ12A with an I_P of 30.2 A at 1000 ms would be reduced to an I_P of 9.9 A for a 10 000 ms duration.

This method can be applied to derive the P_P and the I_P of a TVS from any other series (such as 400 W, 500 W, 1.5 kW, 5 kW), using its published power vs pulse time curve.

Most Transient Voltage Suppressors, including the examples shown here, are rated for 10/1000 ms double exponential waveforms. For one-half sine wave pulses, derate to 75 % of the exponential waveform value and for square wave pulses, derate to 66 %.

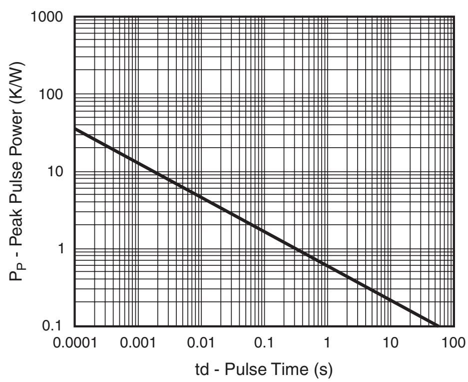


Figure 1. Peak Pulse Power vs. Pulse Time

Protecting Low Current Loads in Harsh Electrical Environments

By Bruce Hartwig
Senior Automotive Applications Engineer

Today's sophisticated electronic systems feature sensors, transducers and microcontrollers which are often placed in harsh environments having exposure to lightning, heavy load switching and other damaging transients.

To protect these vulnerable circuit elements from electrical overstress, high power silicon transient voltage suppressors (TVSs) are usually the first choice as illustrated in Figure 1.

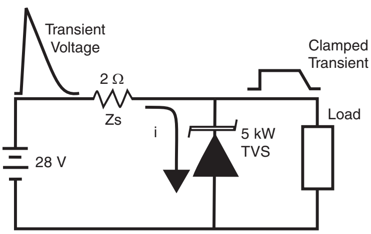


Figure 1. A 5 kW TVS is Required to Handle the High Surge Current

Consider as an example, a pressure transducer which operates at 28 V, placed in an environment in which it encounters a transient voltage of 140 V peak, having a source impedance of 2 Ω and a duration of 10/1000 µs. The failure threshold of the transducer is 40 V, therefore the TVS must clamp at 40 V or less. The current delivered by this transient is:

$$I = (140\ V - 40\ V)/2\ \Omega = 50\ A$$

Note that the voltage clamping action of the TVS results in a voltage divider whereby the open circuit level of the transient appears across the combination of the source impedance and the TVS device. Thus the TVS clamping voltage is subtracted from the transient voltage leaving a net source voltage of 100 V. When the clamping voltage is high compared to the transient peak voltage, the surge current is significantly reduced.

This circuit can be protected with a 5 kW rated suppression device such as the 5KP28A TVS which will easily sustain the surge current.

An alternate and more economical approach is to add a series resistor to effectively increase the source impedance thus limiting surge current as illustrated in Figure 2. Since the current drawn by the transducer under normal operation is small (< 20 mA typical), performance is not adversely affected by reduction in supply current.

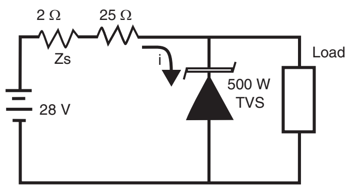


Figure 2. Series Resistor Reduces Transient Current Allowing a Much Smaller TVS to be Used

For a small load current, 10 mA, the voltage drop across the added resistance is minimal, about 0.25 V for a 0.25 Ω resistor. Adding this resistor reduces the surge current to:

$$I = (140\ V - 40\ V)/(2\ \Omega + 25\ \Omega) = 3.7\ A$$

This is less than one-tenth the surge current without the resistor. A TVS with lower power rating is able to handle the resulting current. In this case a 500 W suppressor, such as the SA28A TVS, replaces the 5 kW device, saving board space and cost.

An SA28A was chosen in this example since its current rating for a 10/1000 µs pulse is 11 A, easily withstanding the 3.7 A surge calculated above. Although the maximum clamping voltage for the SA28A is given on the data sheet as 45.4 V, the reduced surge current is 33 % of the suppressor's peak capability, hence the clamping voltage would be approximately 38 V, within our stated limit.

Carbon composition resistors are recommended for this application, as they have sufficient energy capability for the pulse condition. Steady state power dissipated by the resistor (E x I) is 0.25 W requiring a 0.5 W rated resistor for adequate margin. The examples given are for 25 °C ambient. For elevated temperatures, derate accordingly. Protected circuits derived within these guidelines should be fully evaluated under operating and threat conditions before use.

Protecting for Repetitive Transient Voltages

By Bruce Hartwig
Senior Automotive Applications Engineer

While lightning may not strike twice in the same place, in circuits which involve power switching, relays, or motor control, components may be continually subjected to very short transient voltages occurring at regular intervals. Transient Voltage Suppressor (TVS) will effectively limit the transient voltage to a safe level, but some guidelines are needed for selecting the TVS which must handle this repetitive stress.

The average steady state power which the TVS will dissipate can be calculated for recurring short pulse widths. This average power must be within the steady state power rating of the TVS selected for the application. For example, in a motor drive circuit, the switching of current through the inductance of the motor winding continuously generates a pulse which has a 4 ms duration and a 25 A peak current at a frequency of 120 Hz.

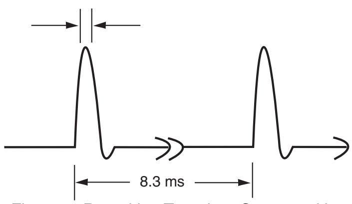


Figure 1. Repetitive Transient Generated by Motor Winding Inductance

In this application a surface mount TVS, part number SMBJ6.5A, is initially selected to protect the control inputs of the motor drive circuitry because it will clamp the single-pulse voltage to a maximum level of 11.2 V. But will this suppressor survive the continuous (120 times per second) application of this transient?

Pulse interval, the inverse of the frequency, is:

$$1/120 \text{ pulse/s} = 0.0083 \text{ s}$$

Peak pulse power is the clamping voltage multiplied by the pulse current:

$$P_{PP} = 11.2 \text{ V} \times 25 \text{ A} = 280 \text{ W}$$

Average power can be closely estimated by multiplying the peak power times the ratio of the pulse width to its interval:

$$P \text{ avg.} = 280 \text{ W} \times (0.000004/0.0083 \text{ s}) = 0.134 \text{ W}$$

The SMBJ6.5A will dissipate at least one watt steady state on a typical printed circuit board. Thus the calculation shows that the suppressor safely dissipates the average power generated in the motor drive, and clamps the transient voltage to a safe level. The SMAJ6.8A device is another option for this application.

Circuit board layout and engineering practices which provide adequate heat sinking for the suppressor should be observed. Higher power dissipation can be achieved by sizing mounting pads proportionately. Where this is not practical, or if calculation results in average dissipation greater than can be safely handled, a transient suppressor with a higher steady state power rating should be selected.

Derating must be observed for operation at elevated temperatures since all electrical ratings are normally specified at 25 °C. For the described electrical conditions an ambient temperature of 75 °C will provide 60 % of the rated steady state capability.

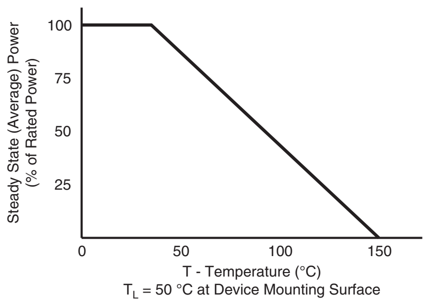


Figure 2. Temperature Derating for Steady-State Power Dissipation

The average power calculation shown here is generally valid for pulses up to 10 ms in duration, occurring at intervals in the range of 100 to 1000 ms. Longer pulse durations approaching 1 ms or more may be sustained only if the interval increases correspondingly.

It may not be possible to determine the exact conditions (current amplitude, pulse width, etc.) in repetitive pulse environments, so some experimentation may be required to optimize the suppressor selection.

TVS Placement
The Critical Path to the Leading Edge

By Jon Schleisner
Senior Applications Engineer

Reverse avalanche transient suppressors have excellent turn-on characteristics. Typically these devices turn on in sub-nano second time frames. When protecting small geometry integrated circuits it is important to "catch" the leading edge of transient surges with very steep rise times.

Parasitic inductance in the circuit configuration and component layout inhibit the suppressor's ability to catch the leading edge of an ESD surge or other very fast pulses.

The suppressor should be as physically close to the vulnerable component's ground return as possible (see Figure 1). The lower the parasitic inductance between the ground plane of the component to be protected and the TVS, the more effective the suppressor will be.

ESD can have rise times as steep as 64 kV/ms or 30 kA/ms. Though the total energy is minimal, the peak is easily capable of rupturing the gate oxide at the input stage of a data transceiver chip. Fortunately it is possible to use the parasitic inductance of the P.C.B. to your advantage.

In Figure 2 it is shown that the inductance inherent in the P.C.B. conductive traces can be used to slow down the leading edge of an incoming transient, thereby reducing the importance of the inductance between the TVS diode element and the critical ground path.

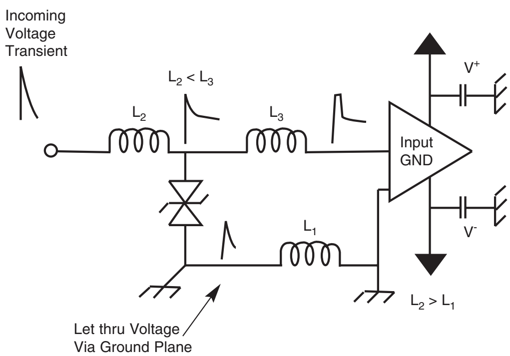


Figure 1.

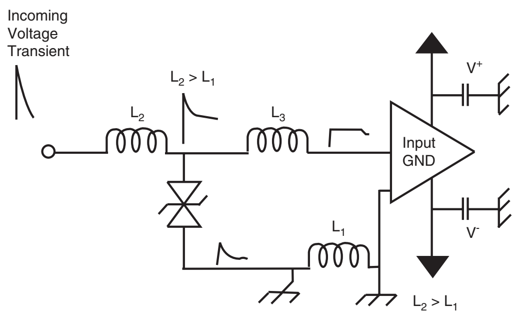


Figure 2.

For both Figure 1 and Figure 2:

L_1 = inductance of ground plane
L_2 = inductance of P.C.B. trace from input to TVS
L_3 = inductance of P.C.B. trace from TVS to transceiver into pin

Series Stacking of TVS for Higher Voltages and Power

By Bruce Hartwig
Senior Automotive Applications Engineer

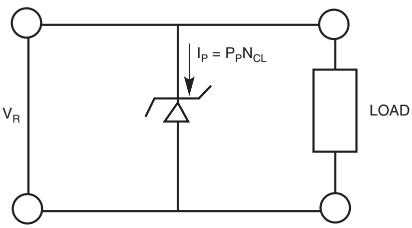
HIGHER VOLTAGES

In normal operation, a transient voltage suppressor should be invisible to the protected circuit. This is guaranteed by a very low leakage current at reverse stand-off voltage. As long as this voltage is not exceeded, the above mentioned feature is applicable. Some TVS applications require a very high stand-off voltage, which is beyond the highest available value for a certain TVS series. In the past, TVS voltages up to 440 V were available in axial parts. This was achieved by stacking chips inside the axial package.

In surface mount packages, this is no longer possible and the maximum available voltage is 170 V (working voltage). Applications requiring a working voltage that is higher than 170 V can be solved by putting TVS diodes in series.

When putting TVS diodes in series to obtain higher stand-off voltages, then the sum of the stand-off voltages of the single diodes should be equal to the desired value.

This sounds like a simple solution of the whole problem but current rating must also be taken into account. Preferably one uses devices with the same V_R rating for series stacking. Thus the I_{PP} rating is the same for each part. I_{PP} is the peak pulse current that can be reached with a corresponding clamping voltage V_{CL}, where I_{PP} x V_{CL} is the peak pulse power that the TVS device is capable of. If TVS diodes with different V_R ratings are used to get the desired voltage by series stacking, the I_{PP} for the combination is determined by the device with the lowest I_{PP} capability. V_F is something to observe at series stacking of TVS, as it will be multiplied by the number of devices.



Where: P_P = Power rating of used TVS
V_R = Reverse working voltages
I_P = Peak pulse current
V_R 1/2/3 = Reverse working voltages for single TVS
I_P max = Lowest I_P of the TVS diiodes put in series

HIGHER POWER

In applications with a fixed working and clamping voltage, a designer can increase the surge rating of his design by putting several lower voltage parts in series. Power handling capability is increased because lower voltage types tends to be limited, e.g. for a 1.5KE200 it is 5.2 A. The 5KP series is only available up to V_R 110 V. Some transients, however, have higher pulse currents.

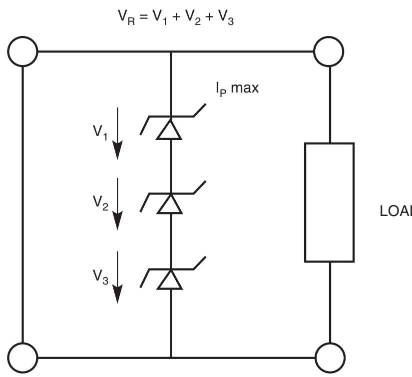
To keep the advantages of AJTVS, several TVS diodes can be put in series.

The designer needs to pay attention to the fact that the voltages need to be split equally. If all working voltages of the TVS devices put in series are equal, also the peak currents and power dissipated is equal.

In this case, the total power capability of the TVS diodes put in series is equal to the sum of each TVS diode.

AVAILABILITY AND PRICING

Another reason to consider series stacking of TVS diodes is availability and price of different types of TVS. If you have an application with a high working voltage and the total power is just over the wattage in Vishay General Semiconductor's range (400, 500, 600, 1500, 5000 W), it might be worth it to contact your Vishay General Semiconductor representative to discuss price and availability for a solution where diodes are put into a series.



Paralleling Transient Voltage Suppressors for Higher Power Capability

By Bruce Hartwig
Senior Automotive Applications Engineer

Silicon avalanche transient voltage suppressors (TVSs) offer a great deal of flexibility in circuit protection. These devices are available in voltages ranging from 5 through 400 V, and in power ratings from 300 through 6000 W.

In addition, they have been successfully used in higher voltage and power combinations, by configuring multiple TVSs in series (see "Series Stacking of TVS for Higher Voltages and Power"), or in parallel.

PARALLELING FOR HIGHER POWER – THE BASICS

Power ratings for individual TVSs are expressed in Watts, based on an industry standard pulse waveform, which has a 10 ms rise time, and an exponential decay to 1/2 its peak at 1000 µs. They can be derated for other pulse waveshapes in accordance with the power vs time graphs on datasheets (see "Using the Power vs Time Curve").

For an application in which known transient power exceeds these limits, it is possible (with appropriate cautions) to configure two or more TVSs in parallel. In this configuration, they will provide the same voltage response (reverse stand-off voltage and breakdown voltage) as a single unit. Leakage current will increase in proportion to the number of units paralleled. The primary advantage in paralleling TVSs in this manner is increased current and power handling capability.

The basic requirement is that they be matched in terms of clamping voltage, in order to share transient current equally.

CURRENT SHARING

As a first approximation, Figure 1 shows an example in which a 300 V transient of 150 A total current is divided among three TVSs (p/n 1.5KE15) in parallel. 150 A is greater than the rated capability of a single such TVS. However, by sharing the current equally, each TVS shunts 1/3 of the current or 50 A to ground. This value is within its rated capability, and the transient is safely clamped to 20 V, protecting the load from damage.

MATCHING

While all three TVSs in this example are of the same part number, each individual unit has its own value of breakdown voltage, reverse leakage and clamping voltage. These shifts are due to minor differences in dynamic impedance; all within the allowable specification. If close attention is not paid to matching these units, the device with the lowest breakdown voltage will typically conduct first and will be required to handle a disproportionate share of the transient current.

Matching of devices on the basis of clamping voltage under pulse conditions at a moderate current level is recommended. Rather than measuring low-current breakdown voltage only, this method provides accurate voltage matching by taking into account the dynamic effects under higher current. Each device is subjected to a known pulse level, such as a 1 A, 1 ms rectangular pulse. Clamping voltage is then monitored by a storage oscilloscope or peak reading voltmeter with sufficiently fast response. Units can then be sorted into groups of 1 % tolerance for best current sharing performance. In board layout, keep lead lengths and circuit board traces in the shunt path as short as possible.

Through proper selection and configuration, an effective transient suppressor combination can be achieved for almost any protection need.

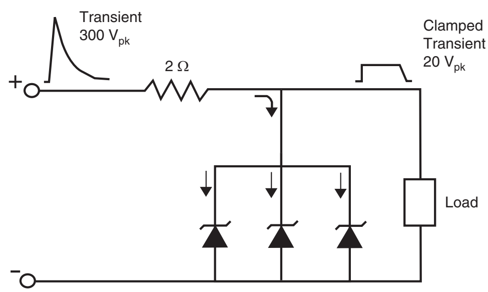


Figure 1.

Vishay: ISO/TS 16949:2002 Certified

Vishay is proud to have acquired ISO/TS 16949:2002 certification for all power diode manufacturing sites. This demonstrates our philosophy in quality management system deployment using the automotive "Process Approach" for example:

- Line-of-sight to the customer processes
- Value of product driven by efficient processes

Aligned with our common business practices and intrinsic technology, divisional processes are mapped into functional processes focusing on process interaction and performance linked to customer satisfaction.

Following are some common questions associated with ISO/TS 16949:2002.

WHAT IS ISO?

ISO (the international Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees (the ISO/TC).

WHAT IS ISO 9000?

ISO 9000 is a family of standards for quality management systems. ISO 9000 includes the following standards:

ISO 9000:2000, Quality management systems - Fundamentals and vocabulary
ISO 9001:2000, Quality management systems - Requirements
ISO 9004:2000, Quality management systems - Guidelines for performance improvements

A company or organization that has been independently audited and certified to be in conformance with ISO 9001 may publicly state that it is “ISO 9001 certified” or “ISO 9001 registered”. Certification to an ISO 9000 standard does not guarantee the compliance (and therefore the quality) of end products and services; rather, it certifies that consistent business processes are being applied.

WHAT IS ISO 9001:2000?

The last revision of ISO 9000 was ISO 9000:1994, (revised in 1994): The three 'models' for quality management systems being ISO 9001, ISO 9002 and ISO 9003. The current revision is ISO 9000:2000, (revised in 2000), and combines the three standards (9001, 9002 and 9003) into one, now called 9001. The ISO 9001:2000 promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements.

WHAT IS ISO/TS?

The main task of ISO technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document such as:

- An ISO Publicly Available Specification (ISO/PAS)
- An ISO Technical Specification (ISO/TS)

An ISO/PAS or ISO/TS is reviewed after three years to decide whether it should be confirmed for a further three years, revised to become an International Standard, or withdrawn.

WHAT IS ISO/TS 16949:2002?

The International Automotive Task Force (IATF) is a group of automotive manufacturers and their respective trade associations, formed to provide improved quality products to automotive customers worldwide. The ISO/TS 16949:2002 was jointly developed by IATF members and submitted to the ISO for approval and publication. The document is a common automotive quality system requirements catalog based on ISO 9001:2000, AVSQ (Italian), EAQF (French), QS-9000 (U.S.) and VDA6.1 (German) automotive catalogs. This document, coupled with customer-specific requirements defines quality system requirements for use in automotive supply chains.

Document Number: 88491
Revision: 14-Aug-07

WHICH ORGANIZATION CAN OBTAIN CERTIFICATION/REGISTRATION TO ISO/TS 16949:2002?

Any organization in the Automotive Supply Chain meeting the scope below (and its definition for Automotive, Site and Manufacturing) can obtain Certification to ISO/TS 16949:2002

- ISO/TS 16949:2002, in conjunction with ISO 9001:2000, defines the quality management system requirements for the design and development, production and, when relevant, installation and service of automotive-related products.
- ISO/TS 16949:2002 is applicable to sites of the organization where production and/or service parts specified by the customer are manufactured.

WHAT IS CUSTOMER SPECIFIC REQUIREMENTS (ISO/TS-16949) SEMICONDUCTOR COMMODITY?

The Automotive Electronics Council (AEC) revised the previous QS-9000 (2nd edition) Semiconductor Supplement to align with the ISO/TS 16949:2002 standard. The Semiconductor Supplement, Second Edition, coordinates its paragraph numbering with the base document.

The goal of this Semiconductor Supplement is to assist the semiconductor industry in the application of ISO/TS 16949:2002 for the development of fundamental quality systems that provide for continuous improvement, emphasizing defect prevention and the reduction of variation and waste in the semiconductor supply chain.

WHAT DOES ISO/TS 16949:2002 REGISTRATIONS MEAN TO VGS AND OUR CUSTOMERS?

Vishay is both, a direct and indirect supplier to the automotive industry. That is, product is supplied directly to these organizations, and also to other first tier suppliers of automotive electronics. ISO/TS16949 presents an opportunity to upgrade our existing certification at our manufacturing sites as part of our commitment to continuous improvement and total customer satisfaction. While ensuring the quality system can deliver the quality levels and improvements required by our automotive customers, it also benefits our customers in other end markets, by ensuring the highest quality products and services.

Vishay's certification under ISO/TS16949 and the Semiconductor Supplement is an achievement that our whole team is proud of. It underscores our commitment, as one of the leading suppliers of power semiconductors, to continuous improvement and total customer satisfaction.

General Product Information

Contents

TABLE 1 - PACKAGING ORDERING CODE

ANTI-STATIC PACKAGE CODE	PACKAGING DESCRIPTION
52	DO-214/215AA (SMB), 12 mm tape, 7" diameter plastic reel
2C	DO-214/215AA (SMB), 12 mm tape, 7" diameter paper reel
2D	DO-218AB (SM5-8A), 24 mm tape, 13" diameter paper reel, anode towards sprocket hole
2E	DO-218AB (SM5-8A), 24 mm tape, 13" diameter paper reel, cathode towards sprocket hole
2G	DO-214AC (SMA), 12 mm tape, 7" diameter paper reel
2M	Tube packaging for 5KP/6KA type lead formed components
53	26 mm horizontal taping and ammo box packaging
54	52.4 mm horizontal tape, 13" diameter paper reel class I
55	DO-214/215AA (SMB), 12 mm tape, 13" diameter paper reel
5A	DO-214AC (SMA), 12 mm tape, 13" diameter plastic reel
5B	DO-214/215AA (SMB), 12 mm tape, 13" diameter plastic reel
57	DO-214/215AB (SMC), 16 mm tape, 7" diameter plastic reel
58	Avisert, cathode up, cathode first out of ammo pack
59	DO-214/215AB (SMC), 16 mm tape, 13" diameter paper reel
9A	DO-214/215AB (SMC), 16 mm tape, 13" diameter plastic reel
9C	DO-214/215AB (SMC), 16 mm tape, 7" diameter paper reel
61	DO-214AC (SMA), 12 mm tape, 7" diameter plastic reel
63	DO-214AC (SMA), 12 mm tape, 13" diameter paper reel
72	Bulk pack for KBPM, GBL, GBU and special axial-leaded formed devices
73	52.4 mm horizontal tape and ammo box packaging, class I
75	DO-213AB (GL41), 12 mm tape, 7" diameter paper reel
76	DO-213AB (GL41), 12 mm tape, 13" diameter paper reel
84A	DO-220AA (SMP), 12 mm tape, 7" diameter plastic reel
85A	DO-220AA (SMP), 12 mm tape, 13" diameter plastic reel
86A	SMPC, 12 mm tape, 7" diameter plastic reel
87A	SMPC, 12 mm tape, 13" diameter plastic reel
89A	MicroSMP, 8 mm tape, 7" diameter plastic reel
94	52.4 mm horizontal tape, 13" diameter paper reel, 5 mm component, spacing for 1.5KA devices only
96	DO-213AB (GL41), 12 mm tape, 7" diameter plastic reel
97	DO-213AB (GL41), 12 mm tape, 13" diameter plastic reel
98	DO-213AA (GL34), 8 mm tape, 7" diameter plastic reel
100	MPG06 pseudo radial tape, cathode first out of ammo pack

Note:

- “T” suffix added to the packaging codes for SMA, SMB and SMC products indicates that the patented folded-frame construction is used. This does not apply to TRANSZORB® TVS in SMA and SMB

Document Number: 88460
Revision: 15-Aug-07

AXIAL-LEADED TAPE AND REEL PACKAGING

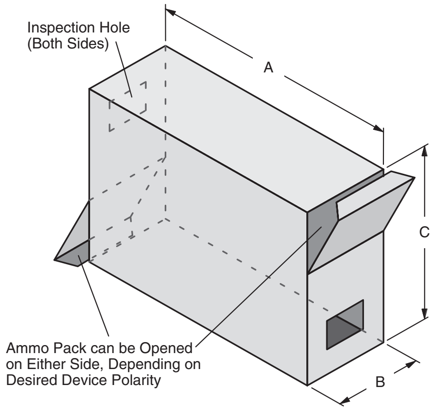


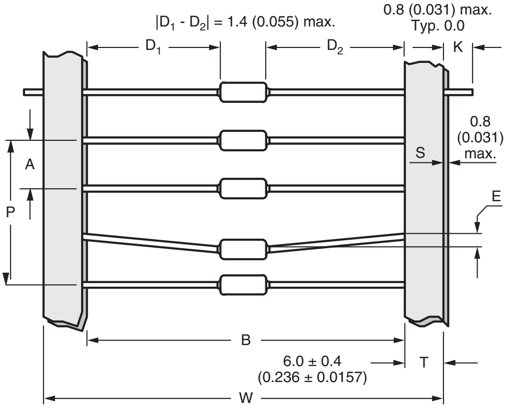
Figure 1.

TABLE 2 - AMMO PACK PACKAGING

PACKAGING	AVAILABLE PRODUCT OUTLINES	PREFFERED PACKAGE CODE	DIMENSION A	DIMENSION B	DIMENSION C	QUANTITY BOX
26 mm horizontal tape, ammo pack	DO-204AL (DO-41), TMPG06 DO-204AC	53 53	9.7" (247 mm)	1.7" (44 mm)	3.7" (95 mm)	3.0K 1.5K
52 mm horizontal tape, ammo pack	DO-204AL, TMPG06 DO-204AC DO-201AD, 1.5KE P600	73 73 73 73	10.0" (255 mm)	3.15" (80 mm)	4.53" (115 mm)	3.0K 2.0K 1.0K 0.3K
Pseudo/radial tape, ammo pack	TMPG06	100	13.4" (340 mm)	1.8" (47 mm)	7.9" (200 mm)	2.5K

AXIAL-LEADED TAPE AND REEL PACKAGING

All axial leaded devices are packed in accordance with EIA standard RS-296-E. The diagrams given below refer to these specifications.



Dimensions A, M, K, P, S and T apply to both sides

Figure 2.

DESCRIPTION	SYMBOL	
Component pitch	A	2, 3
Inside tape spacing	B	2, 3
Lead to lead eccentricity	$\|D_1 - D_2\|$	-
Lead extension	K	-
Lead bending	E	2
Cumulative pitch	P	3
Exposed adhesive	S	-
Tape width	T	-

Notes:

- All polarized components shall be oriented in the same direction
- All dimensions in millimeters (inches)

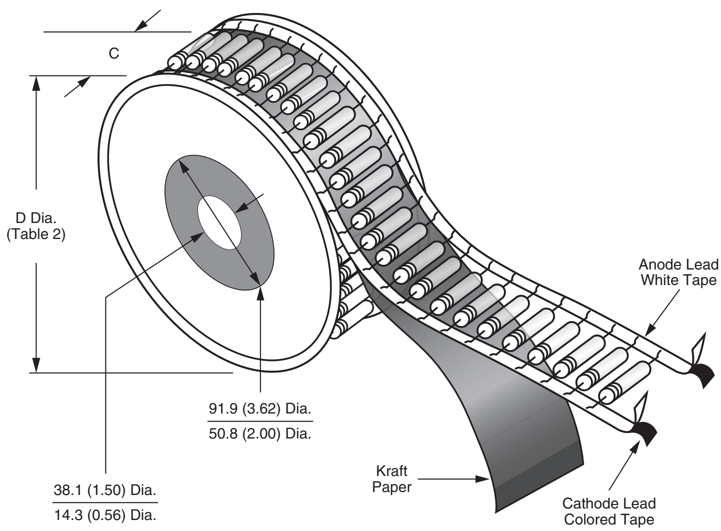


Figure 3.

The “C” dimension of Figure 3 is between flanges of the component reel and shall be 1.5 mm (0.059") to 8.00 mm (0.315") greater than the overall taped component width “W” (Figure 2). Where “W” dimension is 68.2 mm (2.68") max.

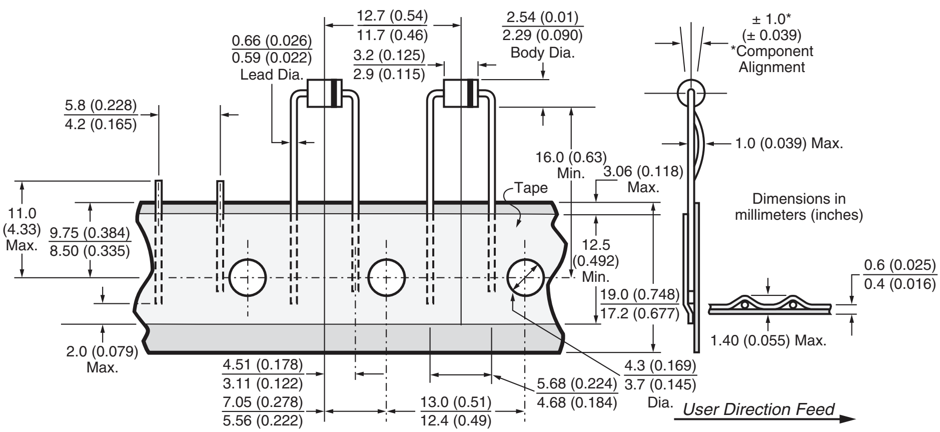
TABLE 3 - REEL AND AMMO PACK TAPING SPECIFICATIONS

COMPONENT CASE TYPE	PREFFERED PACKAGE CODE	UNITS PER REEL	COMPONENT PITH "A" FIGURE 2.		INSIDE TAPE SPACING "B" FIGURE 2.		REEL DIMENSION "D" FIGURE 3.		LEAD BENDING "E" FIGURE 2.		TYP. GROSS WEIGHT PER REEL	
		ea.	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kg
DO-204AC	54	4000	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	4.66	2.11
DO-204AL	54	5500	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	5.2	2.3
DO-213AB (GL41)	96/97	1500/5000	0.157	4.0	-	-	7.0/13.0	178/330	See Figure 8.		0.62/1.96	0.281/0.89
1.5KE	54	1400	0.395	10.0	2.06	52.4	13.0	330	0.047	1.2	4.9/3.8	2.22/1.76
MPG06	54	5500	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	3.8	1.71
P600	54	800	0.395	10.0	2.06	52.4	13.0	330	0.047	1.2	5.3	2.39
SMP	84A/85A	3000/10000	0.157	4.0	-	-	7.0/13.0	178/330	See Figure 8.		0.35/1.54	0.16/0.70
MicroSMP	89A	4500	0.157	4.0	-	-	7.0	178	See Figure 8.		0.29	0.13
SMPC	86A/87A	1500/6500	0.314	8.0	-	-	7.0/13.0	178/330	See Figure 8.		0.53/2.23	0.24/1.01
DO-214AC (SMA)	61, 61T, TR/5A, 5AT, TR3	1800/7500	0.157	4.0	-	-	7.0/13.0	178/330	See Figure 8.		0.24/0.99	0.11/0.45
DO-214AA (SMB)	52, 52T/5B, 5BT	750/3200	0.314	8.0	-	-	7.0/13.0	178/330	See Figure 8.		0.24/0.99	0.11/0.45
DO-214AB (SMC)	57T/9AT	850/3500	0.472	12.0	-	-	7.0/13.0	178/330	See Figure 8.		0.44/1.39	0.20/0.63
DO-218AB	2D	750	0.630	16.0	-	-	13.0	330	See Figure 8.		4.85	2.2

Note:
- Package codes, 61/5A, 52/5B are matrix-frame constructions for TRANSZORB® TVS in SMA and SMB only.

TABLE 4 - COMPONENT AND INSIDE HORIZONTAL TAPE SPACING

COMPONENT BODY DIAMETER	COMPONENT SPACING A (LEAD TO LEAD)	INDISE TAPE SPACING "B"	CUMULATIVE PITCH TOLERANCE
0 mm to 5 mm (0.0" to 0.197")	5.0 mm ± 0.5 mm (0.197" ± 0.020")	26 mm + 1.5 mm/- 0.0 mm (1.024" + 0.059"/- 0.0")	Not to exceed 1.5 mm (0.059") over 6 consecutive components
0 mm to 5 mm (0.0" to 0.197")	5.0 mm ± 0.5 mm (0.197" ± 0.020")	52.4 mm + 1.5 mm/- 0.4 mm (2.062" + 0.059"/- 0.016")	
5.01 mm to 10 mm (0.197" to 0.394")	10.0 mm ± 0.5 mm (0.394" ± 0.020")	52.4 mm + 1.5 mm/- 0.4 mm (2.062" + 0.059"/- 0.016")	



Available only for TMPG06 product in ammo pack in accordance with EIA Standard RS-468-A utilizing 0.61 mm (0.024") diameter leads. Maximum cumulative pitch tolerance: 1.0 mm (0.039")/20 pitch.

Figure 4.

SURFACE MOUNT TAPE AND REEL PACKAGING

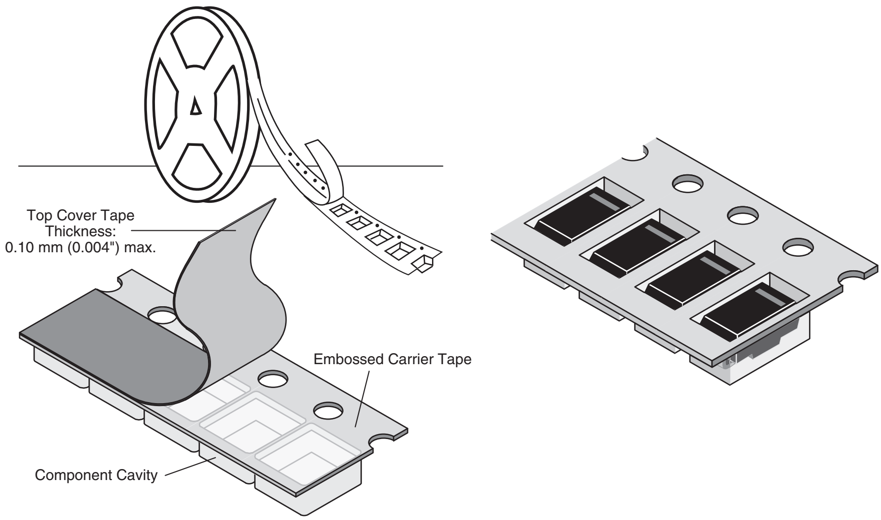


Figure 5.

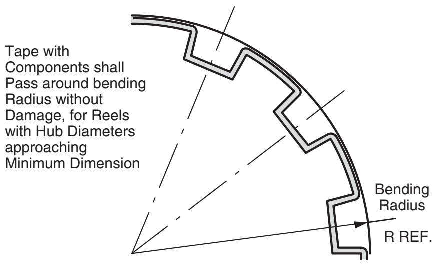


Figure 6.

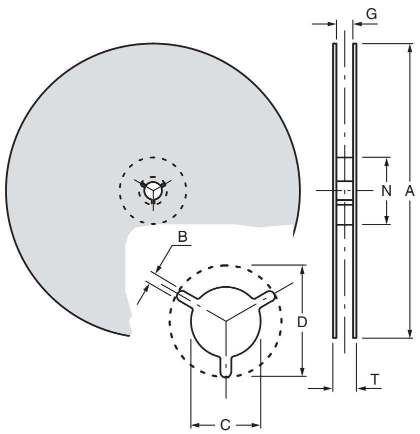
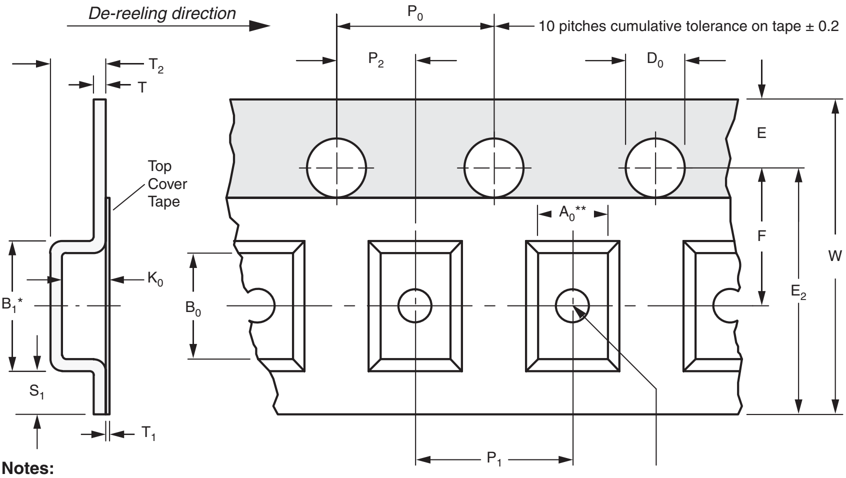
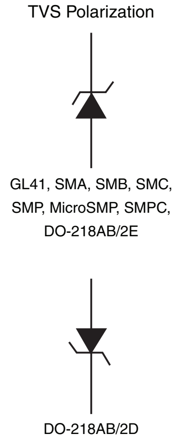


Figure 7.

TABLE 5 - DIMENSIONS in millimeters (inches)							
TAPE SIZE	**A MAX.**	**B MAX.**	**C**	**D MAX.**	**N MIN.**	**G MAX.**	**T MAX.**
8 (0.315)	330 ± 2.0 (13.0 ± 0.079) 178 ± 2.0 (7.0 ± 0.079)	1.5 (0.059)	13.0 ± 0.20 (0.51 ± 0.0008)	20.2 (0.795)	50 (1.97)	9.9 (0.389)	14.4 (0.567)
12 (0.472)	330 ± 2.0 (13.0 ± 0.079) 178 ± 2.0 (7.0 ± 0.079)	1.5 (0.059)	13.0 ± 0.20 (0.51 ± 0.0008)	20.2 (0.795)	50 (1.97)	14.4 (0.567)	18.4 (0.724)
16 (0.630)	330 ± 2.0 (13.0 ± 0.079) 178 ± 2.0 (7.0 ± 0.079)	1.5 (0.059)	13.0 ± 0.20 (0.51 ± 0.0008)	20.2 (0.795)	50 (1.97)	18.4 (0.724)	22.4 (0.802)
24 (0.945)	330 ± 2.0 (13.0 ± 0.079) 178 ± 2.0 (7.0 ± 0.079)	1.5 (0.059)	13.0 ± 0.20 (0.51 ± 0.0008)	20.2 (0.795)	50 (1.97)	26.4 (1.039)	30.4 (1.197)

SURFACE MOUNT TAPE AND REEL PACKAGING





Notes:

* For machine reference only, including draft and radii concentric around B_0

** See note 1 and table 6

Figure 8. 8, 12, 16, and 24 mm ebossed tape

<table>
<tr><th colspan="9">TABLE 6 - DIMENSIONS in millimeters (inches)</th></tr>
<tr><th>TAPE SIZE</th><th>D_0</th><th>E_1</th><th>P_0</th><th>P_2</th><th>A_0, B_0, K_0</th><th>S_1 MIN.</th><th>T Max.</th><th>T_1 Max.</th></tr>
<tr><td>8, 12 mm</td><td rowspan="2">1.5 ± 0.1
(0.059 ± 0.004)</td><td rowspan="2">1.75 ± 0.1
(0.069 ± 0.004)</td><td rowspan="2">4.0 ± 0.1
(0.157 ± 0.004)</td><td>2.0 ± 0.05
(0.79 ± 0.002)</td><td rowspan="2">See Note 1</td><td rowspan="2">0.6
(0.024)</td><td rowspan="2">0.6
(0.024)</td><td rowspan="2">0.1
(0.004)</td></tr>
<tr><td>16, 24 mm</td><td>2.0 ± 0.1
(0.79 ± 0.004)</td></tr>
</table>

<table>
<tr><th>CASE TYPE</th><th>TAPE SIZE</th><th>B_1 MAX.</th><th>D_1 MAX.</th><th>E_2 MAX.</th><th>F</th><th>P_1</th><th>R REF.</th><th>T_2 MAX.</th><th>W</th></tr>
<tr><td>MicroSMP</td><td>8
(0.315)</td><td>3.28
(0.129)</td><td>1.0
(0.039)</td><td>6.05
(0.238)</td><td>3.5 ± 0.05
(0.138 ± 0.002)</td><td></td><td>25
(0.984)</td><td>1.919
(0.076)</td><td>8.0 ± 0.30
(0.315 ± 0.012)</td></tr>
<tr><td>DO-213AB
(GL41)</td><td rowspan="5">12
(0.472)</td><td rowspan="3">8.2
(0.323)</td><td rowspan="7">1.5
(0.059)</td><td rowspan="5">10.25
(0.404)</td><td rowspan="5">5.5 ± 0.05
(0.217 ± 0.002)</td><td rowspan="3">4.0 ± 0.10
(0.157 ± 0.004)</td><td rowspan="7">30
(1.181)</td><td>4.5
(0.177)</td><td rowspan="4">12.0 ± 0.30
(0.472 ± 0.012)</td></tr>
<tr><td>DO-214AC
(SMA)</td><td>2.54 ± 0.10
(0.100 ± 0.004)</td></tr>
<tr><td>SMP</td><td>1.74 ± 0.10
(0.069 ± 0.004)</td></tr>
<tr><td>SMPC</td><td>7.0
(0.276)</td><td rowspan="3">8.0 ± 0.10
(0.315 ± 0.004)</td><td>1.33 ± 0.10
(0.052 ± 0.004)</td></tr>
<tr><td>DO-214/215
(SMB)</td><td>8.2
(0.323)</td><td>2.67 ± 0.10
(0.105 ± 0.004)</td><td rowspan="2">16.0 ± 0.20
(0.630 ± 0.008)</td></tr>
<tr><td>DO-214/215AB
(SMC)</td><td>16
(0.630)</td><td>12.1
(0.476)</td><td>14.25
(0.561)</td><td>7.5 ± 0.05
(0.295 ± 0.002)</td><td>2.5 ± 0.10
(0.100 ± 0.004)</td></tr>
<tr><td>DO-218AB</td><td>24
(0.945)</td><td>20.1
(0.791)</td><td>22.25
(0.876)</td><td>11.5 ± 0.10
(0.453 ± 0.004)</td><td>16.0 ± 0.10
(0.630 ± 0.004)</td><td>5.21 ± 0.10
(0.205 ± 0.004)</td><td>24.0 ± 0.20
(0.945 ± 0.008)</td></tr>
</table>

Notes:

- A_0, B_0 and K_0 are determined by the maximum dimensions of the component size. The clearance between the component and the cavity must be within 0.05 mm (0.002") min. to 0.5 mm (0.02") max. for 8 mm tape and 12 mm tape, 0.15 mm (0.066") min. to 0.90 mm (0.035") max. for 16 mm tape and 0.15 mm (0.006") min to 1.0 mm (0.039") max. for 24 mm tape.
- All surface mount components are packed in accordance with EIA standard 481-C.

VISHAY GENERAL SEMICONDUCTOR RECOMMENDED SOLDERING PROCESS FOR SURFACE MOUNTED AND AXIAL-LEADED COMPONENTS

RECOMMENDED WAVE SOLDERING PROFILE (Sn-Pb/Lead (Pb)-free)

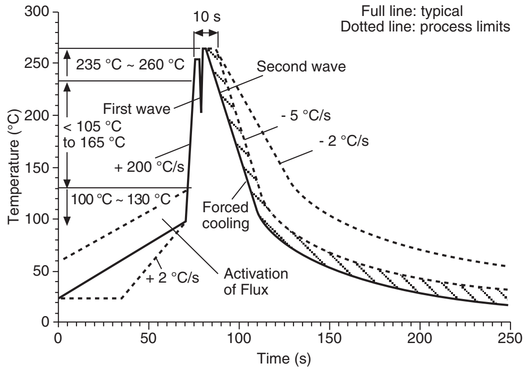


Figure 9.

Wave Soldering Notes

The profile illustrated above depends ultimately on the type of flux used with the solder paste. The peak temperature for this process should not exceed 265 °C for PC-board mounting.

REFLOW

TABLE 7 - CLASSIFICATION REFLOW PROFILE		
PROFILE FEATURE	**Sn-Pb EUTECTIC ASSEMBLY**	**LEAD (Pb)-FREE ASSEMBLY**
Preheat and soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	 100 °C 150 °C 60 to 120 s	 150 °C 200 °C 60 to 120 s
Average ramp-up rate (T_{Smax} to T_P)	3 °C/s maximum	
Liquidous temperature (T_L) Time to liquidous (t_L)	183 °C 60 to 150 s	217 °C 60 to 150 s
Peak package body temperature (T_P)*	See classification temp in Table 2	See classification temp in Table 3
Time (t_P)** with 5 °C of the specified classification temperature (T_C)	20 s**	30 s**
Average ramp-down rate (T_P to T_{smax})	6 °C/s maximum	
Time 25 °C to peak temperature	6 minutes maximum	8 minutes maximum

* Tolerance for peak profile temperature (T_P) is defined as a supplier minimum and a user maximum
** Tolerance for time at peak profile temperature (T_P) is defined as a supplier minimum and a user maximum

Note:

- All temperature refer to the center of the package, measured on the package body surface

REFLOW PROFILE

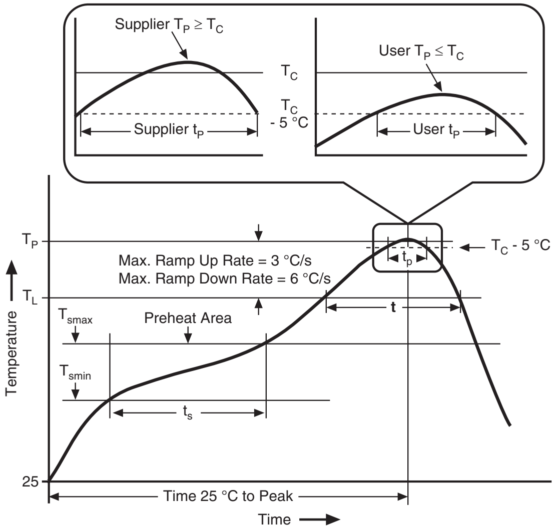


Figure 10.

TABLE 8 - Sn-Pb EUTECTIC PROCESS PACKAGE PEAK REFLOW TEMPERATURES		
PACKAGE THICKNESS	**VOLUME mm³ < 350**	**VOLUME mm³ ≥ 350**
< 2.5 mm	235 °C	220 °C
≥ 2.5 mm	220 °C	220 °C

TABLE 9 - LEAD (Pb)-FREE PROCESS PACKAGE CLASSIFICATION REFLOW TEMPERATURES			
PACKAGE THICKNESS	**VOLUME mm³ < 350**	**VOLUME mm³ 350 to 2000**	**VOLUME mm³ > 2000**
< 1.6 mm	260 °C	260 °C	260 °C
1.6 mm to 2.5 mm	260 °C	250 °C	245 °C
≥ 2.5 mm	250 °C	245 °C	245 °C

Tolerance: The device manufacturer/supplierer shall assure process compatibility up to and including the stated classfication temperature at the rated MSL level.

Notes:

- Package volume excludes external terminals (balls, bumps, lands, leads) and/or non-integral heatsinks.
- The maximum component temperature reached during reflow depends on package thickness and volume. The use of convection reflow processes reduces the thermal gradients between packages. However, thermal gradients due to differences in thermal mass of SMD packages may still exist.
- Recommended soldering process is accordance with J-STD-020D.

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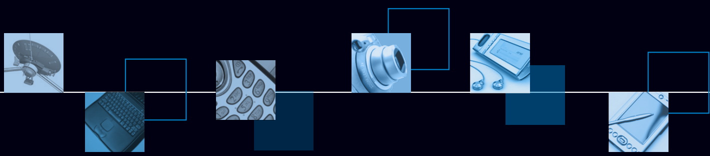

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