CONTENTS

ZENER DIODES & TRANSIENT VOLTAGE SUPPRESSORS

INTRODUCTION

General Semiconductor is a world leader in the design, manufacture, and sale of low-to-medium power rectifiers, transient voltage suppressors, small signal diodes, zener diodes and transistors in axial, bridge and surface mount packages. These products are used throughout industry to condition current and voltage, to protect electrical circuits from power surges, to amplify small electrical signals and to regulate voltage levels in circuits. The increased demand for electronic functions, global sourcing, and higher levels of reliability within the consumer electronics, telecommunications, electronic lighting ballast, computer, and automotive markets is helping to drive the growth of General Semiconductor's business worldwide.

As a result of the acquisition of the discrete semiconductor business of ITT Industries, Inc., General Semiconductor now offers small signal diodes, transistors (bipolar and DMOS), and Zeners. These exciting new products, as well as the complete product offerings, can be found on the General Semiconductor website at **www.gensemi.com**.

General Semiconductor's strengths are the quality of its' products, its' strong worldwide sales and distribution channels, and the value-added manufacturing of its' worldwide operations which enable 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. The General Semiconductor symbol ensures that every component reaches the highest level of quality, reliability and performance. These high standards of quality assure reliable product performance for our customers. In addition, all of General Semiconductor's worldwide manufacturing facilities are ISO 9001 approved.

The success of General Semiconductor is the result of a group of people working worldwide, all firmly committed to Total Customer Satisfaction. General Semiconductor's goal is to exceed the needs and wishes of our customers.

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 or our applications engineering laboratory

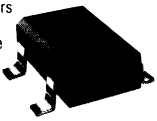
GENERAL SEMICONDUCTOR®

We Power the Products that Empower Your Life™

PRODUCT PORTFOLIO

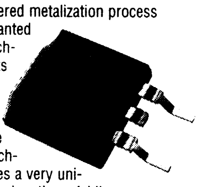
Bridge Rectifiers

Bridge rectifiers are essential for any electronic equipment which requires full wave rectification of an AC power source. The bridge rectifier is comprised of four separate rectifier components configured into a "bridge" arrangement in a single package. The bridge rectifier converts alternating current (AC) into direct current (DC). General Semiconductor manufactures a complete line of bridge rectifiers which can meet the power and case style requirements of almost all electronic equipment.



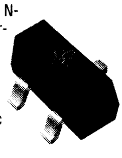
Schottky Rectifiers

General Semiconductor's Schottky Rectifier is the ideal product for high speed and low power loss applications. Their metal-silicon junctions and majority carrier condition results in extremely fast recovery times (less than 10ns) and very low forward voltage drops. General Semiconductor's unique sputtered metalization process and ion implanted guardring technology results in a highly reliable Schottky product. The sputtering technique provides a very uniform Schottky junction, yielding a well controlled barrier height distribution. Ion implantation provides consistency to the PN junction guardring, resulting in unsurpassed reverse energy handling capability. We offer a unique opportunity to our customers by providing flexibility of different barrier heights to best suit their end applications.



Small Signal Transistors

General Semiconductor's Small Signal Transistors further diversifies our product portfolio. The two prime circuit applications for small signal transistors are amplification and switching. Bipolar transistors are offered in both NPN and PNP polarities. DMOS FETs are also offered in both N-Channel and P-Channel polarities. Package options are through hole TO-92 and the surface mount SOT-23. Small Signal Transistors are used in virtually all electronic products.



SUPERECTIFIERS®

General Semiconductor's SUPERECTIFIER® is exactly that: a super rectifier. There is nothing else in the world like it. This is the most cost effective and highly reliable device on the market which is the result of the combination of patented technologies.

No other 0.25 to 3.0 Ampere rectifiers of any kind - plastic, glass or metal - can match (or even approach) SUPERECTIFIER's combination of features... the result of General Semiconductor's unique glass-plastic construction.

Plastic Rectifiers

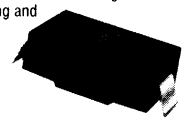
General Semiconductor has produced Plastic Rectifiers successfully for many years. The key factor in the production of the Plastic Rectifiers is the double nail head construction concept. This manufacturing technique locks the nail head into the plastic to reduce stress on the chip from external forces.

Glass Rectifiers

The Glass Passivated Rectifier is a hermetically sealed, cavity free, diffused junction rectifier with unsurpassed operating and surge capabilities at high temperatures. An extremely pure, specially developed glass applied in direct contact with the silicon junction, creates an ideal cavity-free passivating medium.

Small Signal Schottky Diodes

A lower power extension of our Schottky Rectifier family with forward currents of less than 1 Amp. Packaging available in DO-35 axial, MiniMELF, SOT-23 single and dual, SOD-123 and SOD-323. The low forward voltage drop and fast switching make these diodes ideal for protection of MOS integrated circuits, steering, biasing and coupling for fast switching and low logic level applications.

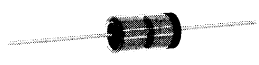


Transient Voltage Suppressors

General Semiconductor delivers "state of the art" Transient Voltage Suppressors (TVS). Based on controlled avalanche technology, these voltage clamping devices utilize a specific soft solder construction. 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, GS TVS' do not exhibit a wear out mechanism, as many MOV and similar technologies do. With sub-nanosecond turn-on times and superior clamping characteristics as compared to MOV's, GS TVS' are the preferable option for your transient suppression needs.

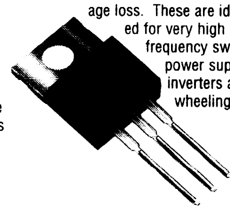
Small Signal Switching Diodes

Utilized for signal blocking, routing, switching, and handling a myriad of functions at lower currents, General Semiconductor's Small Signal Switching Diodes fit a diverse range of applications. Product usage includes: telecommunications equipment, P.C. motherboards, automotive systems, power supplies, and more.



Fast Efficient Rectifiers

General Semiconductor's Fast Efficient Rectifiers (FER) are a natural extension of our Schottky product portfolio. This is accomplished by offering very fast reverse recovery times (as low as 25 nanoseconds) and voltage levels as high as 1000 Volts and still maintain the efficiencies of a lower forward voltage loss. These are ideally suited for very high frequency switching power supplies, inverters and freewheeling diodes.

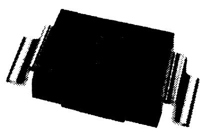


Automotive TVS

General Semiconductor is a leading supplier of discrete semiconductor components to the automotive electronics industry. GS has developed a number of products specifically to meet the demands of the severe automotive environment.

Zener Diodes

General Semiconductor's Zener product line provides a wide variety of specialized functions for complex electronic circuits. These devices are used as voltage regulators, voltage references, voltage suppressors against ESD threats and assorted clipping and clamping circuits. Available in various power ratings from 300mW through 2W and Zener voltages from 2.4V to 200V. Typical voltage tolerances are +/- 5%, but tighter tolerances, such as +/- 2% are available.



ZENER DIODES & TRANSIENT VOLTAGE SUPPRESSORS INDEX

Note: For a complete listing of General Semiconductor part numbers, refer to the Master Data Book Index on pages 5-9.

ALPHANUMERICAL LIST OF ALL GENERAL SEMICONDUCTOR TYPES

Note: Listed below are General Semiconductor's part numbers, along with the Data Book in which they appear. For Zener/TVS page references, see the Page Index on page 4 of this book.

ALPHANUMERICAL LIST OF ALL GENERAL SEMICONDUCTOR TYPES

Note: Listed below are General Semiconductor's part numbers, along with the Data Book in which they appear. For Zener/TVS page references, see the Page Index on page 4 of this book.

BAT54C	Small Signal
BAT54S	Small Signal
BAT54WS	Small Signal
BAT85	Small Signal
BAT86	Small Signal
BAV100	Small Signal
BAV101	Small Signal
BAV102	Small Signal
BAV103	Small Signal
BAV19	Small Signal
BAV19WS	Small Signal
BAV20	Small Signal
BAV20W	Small Signal
BAV21	Small Signal
BAV21W	Small Signal
BAV70	Small Signal
BAV99	Small Signal
BAW56	Small Signal
BAW75/76	Small Signal
BB721	Small Signal
BB721S	Small Signal
BB729	Small Signal
BB729S	Small Signal
BB731	Small Signal
BB731S	Small Signal
BC327-16,-25,-40	Small Signal
BC328-16,-25,40	Small Signal
BC337-16,-25,-40	Small Signal
BC338-16,-25,-40	Small Signal
BC546-A,-B	Small Signal
BC547-A,-B,-C	Small Signal
BC548-A,-B,-C	Small Signal
BC549-B,-C	Small Signal
BC556-A,-B	Small Signal
BC557-A,-B,-C	Small Signal
BC558-A,-B,-C	Small Signal
BC559-A,-B,-C	Small Signal
BC807-16,-25,-40	Small Signal
BC808-16,-25,-40	Small Signal
BC817-16,-25,-40	Small Signal
BC818-16,-25,-40	Small Signal
BC846-A,-B	Small Signal
BC847-A,-B,-C	Small Signal
BC848-A,-B,-C	Small Signal
BC849-B,-C	Small Signal
BC856-A,-B	Small Signal
BC857-A,-B,-C	Small Signal
BC858-A,-B,-C	Small Signal
BC859-A,-B,-C	Small Signal
BS170	Small Signal
BS250	Small Signal
BS850	Small Signal
BS870	Small Signal
BY228	Rectifier
BY229X	Rectifier
BY396P thru BY399P	Rectifier
BY500-100 thru BY500-800	Rectifier
BYM10-50 thru BYM10-1000	Rectifier
BYM11-50 thru BYM11-1000	Rectifier
BYM12	Rectifier
BYM12-50 thru BYM12-400	Rectifier
BYM13-20 thru BYM13-60	Rectifier
BYV26D and BYV26E	Rectifier
BYV27-50 thru BYV27-200	Rectifier
BYV28-50 thru BYV28-200	Rectifier
BYV32-50 thru BYV32-200	Rectifier
BYV95 and BYV96 Series	Rectifier
BYVB32-50 thru BYVB32-200	Rectifier
BYW29-50 thru BYW29-200	Rectifier
BYW32 thru BYW36	Rectifier
BYW72T thru BYW76 Series	Rectifier
BYWB29-50 thru BYWB28-200	Rectifier
BZT52 Series	Zener/TVS
BZV55 Series	Zener/TVS
BZW04 Series	Zener/TVS
BZX384 Series	Zener/TVS
BZX55 Series	Zener/TVS
BZX79 Series	Zener/TVS
BZX84 Series	Zener/TVS
BZX85 Series	Zener/TVS
BZY97 Series	Zener/TVS
CG1 and DG1	Rectifier
CG2 and DG2	Rectifier
CG3 and DG3	Rectifier
DF005M thru DF10M	Rectifier
DF005S thru DF10S	Rectifier
DZ23 Series	Zener/TVS
EDF1AM thru EDF1DM	Rectifier
EDF1AS thru EDF1DS	Rectifier
EGF1A thru EGF1D	Rectifier
EGF1A thru EGF1D	Rectifier
EGL34A thru EGL34G	Rectifier
EGL41A thru EGL41G	Rectifier
EGP10A thru EGP10G	Rectifier

ALPHANUMERICAL LIST OF ALL GENERAL SEMICONDUCTOR TYPES

Note: Listed below are General Semiconductor's part numbers, along with the Data Book in which they appear. For Zener/TVS page references, see the Page Index on page 4 of this book.

Part Numbers	Data Book
EGP20A thru EGP20G	Rectifier
EGP30A thru EGP30G	Rectifier
EGP50A thru EGP50G	Rectifier
ES1A thru ES1D	Rectifier
ES2A thru ES2D	Rectifier
ES2F thru ES2G	Rectifier
ES3A thru ES3D	Rectifier
ES3F thru ES3G	Rectifier
FE1A thru FE1D	Rectifier
FE2A thru FE2D	Rectifier
FE3A thru FE3D	Rectifier
FE5A thru FE5D	Rectifier
FE6A thru FE6D	Rectifier
FEP16AT thru FEP16JT	Rectifier
FEP30AP thru FEP30JP	Rectifier
FEP6AT thru FEP6DT	Rectifier
FEPB16AT thru FEPB16JT	Rectifier
FEPB6AT thru FEPB6DT	Rectifier
FES16AT thru FES16JT	Rectifier
FES8AT thru FES8JT	Rectifier
FESB16AT thru FESB16JT	Rectifier
FESB8AT thru FESB8JT	Rectifier
G1A thru G1M	Rectifier
G2A thru G2M	Rectifier
G2SBA20 AND G2SBA60	Rectifier
G3A thru G3M	Rectifier
G3SBA20 AND G3SBA60	Rectifier
G4A thru G4J	Rectifier
G5SBA20 AND G5SBA60	Rectifier
GBL005 thru GBL10	Rectifier
GBPC1005 thru GBPC110	Rectifier
GBPC12, 15, 25, and 35 Series	Rectifier
GBPC6005 thru GBPC610	Rectifier
GBU4A thru GBU4M	Rectifier
GBU6A thru GBU6M	Rectifier
GBU8A thru GBU8M	Rectifier
GF1A thru GF1M	Rectifier
GI1001 thru GI1004	Rectifier
GI1101 thru GI1104	Rectifier
GI1-1200 thru GI1-160	Rectifier
GI1401 thru GI1404	Rectifier
GI2401 thru GI2404	Rectifier
GI250-1 thru GI250-4	Rectifier
GI500 thru GI510	Rectifier
GI750 thru GI758	Rectifier
GI810 thru GI818	Rectifier
GI820 thru GI828	Rectifier
GI850 thru GI858	Rectifier
GI910 thru GI917	Rectifier
GIB1401 thru GIB1404	Rectifier
GIB2401 thru GIB2404	Rectifier
GL34A thru GL34J	Rectifier
GL41A thru GL41Y	Rectifier
GLL4735 thru GLL4763A	Zener/TVS
GP02-20 thru GP02-40	Rectifier
GP08A thru GP08J	Rectifier
GP10A thru GP10Y	Rectifier
GP15A thru GP15M	Rectifier
GP20A thru GP20J	Rectifier
GP30A thru GP30M	Rectifier
ICTE Series	Zener/TVS
IDB31	Small Signal
IMBD4148	Small Signal
IMBD4448	Small Signal
KBL005 thru KBL10	Rectifier
KBPxxM	Rectifier
KBU4A thru KBU4M	Rectifier
KBU6A thru KBU6M	Rectifier
KBU8A thru KBU8M	Rectifier
LCE Series	Zener/TVS
LL1.5	Zener/TVS
LL101A	Small Signal
LL101B	Small Signal
LL101C	Small Signal
LL103A	Small Signal
LL103B	Small Signal
LL103C	Small Signal
LL2	Zener/TVS
LL2.4	Zener/TVS
LL41	Small Signal
LL4148	Small Signal
LL4150	Small Signal
LL4151	Small Signal
LL42	Small Signal
LL43	Small Signal
LL4448	Small Signal
LL46	Small Signal
LL48	Small Signal
LL5711and LL6263	Small Signal
M100A thru M100M	Rectifier
MB2M thru MB6M	Rectifier
MB2S thru MB6S	Rectifier
MBR1035 thru MBR1060	Rectifier
MBR1535CT thru MBR1560CT	Rectifier

ALPHANUMERICAL LIST OF ALL GENERAL SEMICONDUCTOR TYPES

Note: Listed below are General Semiconductor's part numbers, along with the Data Book in which they appear. For Zener/TVS page references, see the Page Index on page 4 of this book.

Type	Data Book
MBR1635 thru MBR1660	Rectifier
MBR2035CT thru MBR2060CT	Rectifier
MBR2535CT thru MBR2560CT	Rectifier
MBR3035PT thru MBR3060PT	Rectifier
MBR4035PT thru MBR4060PT	Rectifier
MBR735 thru MBR760	Rectifier
MBRB1035 thru MBRB1060	Rectifier
MBRB1535CT thru MBRB1560CT	Rectifier
MBRB1635 thru MBRB1660	Rectifier
MBRB2035CT thru MBRB2060CT	Rectifier
MBRB2535CT thru MBRB2560CT	Rectifier
MBRB735 thru MBRB760	Rectifier
MBRF1035 thru MBRF1060	Rectifier
MBRF1535CT thru MBRF1560CT	Rectifier
MBRF1635 thru MBRF1660	Rectifier
MBRF2035CT thru MBRF2060CT	Rectifier
MBRF2535CT thru 2560CT	Rectifier
MBRF735 thru MBRF760	Rectifier
MMBD914	Small Signal
MMBT3904	Small Signal
MMBT3906	Small Signal
MMBTA06	Small Signal
MMBTA56	Small Signal
MMBZ4617 thru MMBZ4627	Zener/TVS
MMBZ4681 thru MMBZ4717	Zener/TVS
MMBZ5225 thru MMBZ5267	Zener/TVS
MMSZ4681 thru MMSZ4717	Zener/TVS
MMSZ5225 thru MMSZ5267	Zener/TVS
MPG06A thru MPG06M	Rectifier
MPSA06	Small Signal
MPSA56	Small Signal
NS8AT thru NS8MT	Rectifier
NSB8AT thru NSB8MT	Rectifier
NSF8AT thru NSF8MT	Rectifier
P300A thru P300M	Rectifier
P4KA Series	Zener/TVS
P4KE Series	Zener/TVS
P4KE530 and P4KE550	Zener/TVS
P600A thru P600M	Rectifier
P6KA Series	Zener/TVS
P6KE Series	Zener/TVS
RG1A thru RG1M	Rectifier
RG2A thru RG2M	Rectifier
RG3A thru RG3M	Rectifier
RG4A thru RG4J	Rectifier
RGF1A thru RGF1M	Rectifier
RGL34A thru RGL34J	Rectifier
RGL41A thru RGL41M	Rectifier
RGP02-12E thru RGP02-20E	Rectifier
RGP10A thru RGP10M	Rectifier
RGP15A thru RGP15M	Rectifier
RGP20A thru RGP20J	Rectifier
RGP25A thru RGP25M	Rectifier
RGP30A thru RGP30M	Rectifier
RMB2S thru RMB6S	Rectifier
RMPG06	Rectifier
RS1	Rectifier
RS2	Rectifier
RS3	Rectifier
S1A thru S1M	Rectifier
S2A thru S2M	Rectifier
S3A and S3M	Rectifier
SA5.0 thru SA170CA	Zener/TVS
SAC5.0 thru SAC50 Series	Zener/TVS
SB020 thru SB040	Rectifier
SB120 thru SB160	Rectifier
SB320 thru SB360	Rectifier
SB520 thru SB560	Rectifier
SBL1030 and SBL1040	Rectifier
SBL1030CT and SBL1040CT	Rectifier
SBL1630CT and SBL1640CT	Rectifier
SBL2030CT and SBL2040CT	Rectifier
SBL2030PT and SBL2040PT	Rectifier
SBL25L20CT and SBL25L30CT	Rectifier
SBL3030PT and SBL3040PT	Rectifier
SBL4030PT thru SBL4040PT	Rectifier
SBLB1030 and SBLB1040	Rectifier
SBLB1030CT and SBLB1040CT	Rectifier
SBLB1630CT and SBLB1640CT	Rectifier
SBLB2030CT and SBLB2040CT	Rectifier
SBLB25L20CT thru SBLB25L25CT	Rectifier
SBLF1030 and SBLF1040	Rectifier
SBLF1030CT and SBLF1040CT	Rectifier
SBLF1630CT and SBLF1640CT	Rectifier
SBLF2030CT and SBLF2040CT	Rectifier
SBLF25L20CT thru SBLFL30CT	Rectifier
SBYV27-50 thru SBYV27-200	Rectifier
SBYV28-50 thru SBYV28-200	Rectifier
SD101A	Small Signal
SD101AW	Small Signal
SD101B	Small Signal
SD101BW	Small Signal
SD101C	Small Signal
SD101CW	Small Signal

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Note: Listed below are General Semiconductor's part numbers, along with the Data Book in which they appear. For Zener/TVS page references, see the Page Index on page 4 of this book.

ZENER DIODE SERIES SUMMARY

Pmax (mW)	Device	Package	Zener Voltage Range (Volts)	Zener Voltage Tolerances 10%	5%	3%	2%	Page
200	**BZX384-yxx**	SOD-323	2.4 ... 75		C		B	18
300	AZ23-yxx *	TO-236AB (SOT-23)	2.4 ... 51		C			152
	DZ23-yxx **	TO-236AB (SOT-23)	2.4 ... 51		C			160
	MMBZ5225-MMBZ5267	TO-236AB (SOT-23)	2.4 ... 75		B		C	26
350	BZX84-yxx	TO-236AB (SOT-23)	2.4 ... 75		C		B	28
	MMBZ4617-MMBZ4627++	TO-236AB (SOT-23)	2.4 ... 6.2		std.			36
	MMBZ4681-MMBZ4717++	TO-236AB (SOT-23)	2.4 ... 43		std.			38
410	BZT52-yxx	SOD-123	2.4 ... 75		C		B	40
500	**1N4681-1N4717++**	DO-204AH (DO-35 Glass)	2.4 ... 43		std.			48
	1N5225-1N5267	DO-204AH (DO-35 Glass)	2.4 ... 75		B		C	50
	1N746-1N759	DO-204AH (DO-35 Glass)	3.3 ... 12		A			53
	1N957-1N978	DO-204AH (DO-35 Glass)	6.8 ... 91		B			55
	BZV55-yxx	SOD-80C (Mini-MELF Glass)	2.4 ... 75		C	F	B	57
	BZX55-yxx	DO-204AH (DO-35 Glass)	0.8, 2.4... 75		C		B	64
	BZX79-yxx	DO-204AH (DO-35 Glass)	2.4 ... 75		C	F	B	70
	MMSZ4681-MMSZ4717++	SOD-123	2.4 ... 43		std.			77
	MMSZ5225-MMSZ5267	SOD-123	2.4 ... 75		B		C	79
	ZMM1 - ZMM75	SOD-80C (Mini-MELF Glass)	1.0, 2.4... 75		std.		***	81
	ZMM5225-ZMM5267	SOD-80C (Mini-MELF Glass)	3.0 ... 75		B			89
	ZPDxx	DO-204AH (DO-35 Glass)	1.0, 2.4... 75		std.		***	92
1000	1N4728-1N4764	DO-204AL (DO-41 Glass)	3.3 ... 100	std.	A			100
	GLL4735-GLL4763	DO-213AB (Plastic MELF)	6.2 ... 91	std.	A			103
	ZGL41-xxy	DO-213AB (Plastic MELF)	100 ... 200	std.	A			105
	SML4735-SML4763	DO-214AC (SMA)	6.2 ... 91	std.	A			107
	ZM4728-ZM4764	Glass MELF	3.3 ... 100		A			109
	ZMUxxx	Glass MELF	100 ... 180	std.				112
	ZMYxx	Glass MELF	1.0, 3.3... 100		std.		***	115
1300	BZX85-yxx	DO-204AL (DO-41 Glass)	3.6 ... 62		C		B	120
	ZPUxxx	DO-204AL (DO-41 Glass)	100 ... 180	std.				125
	ZPYxx	DO-204AL (DO-41 Glass)	1.0, 3.9... 100		std.		***	129
1500	BZY97-yxx	DO-204AL (DO-41 Plastic)	11 ... 68		C			134
	SMZG3789-SMZG3809	DO-215AA (SMB - Gullwing)	10 ... 68	A+	B			139
	SMZJ3789-SMZJ3809	DO-214 AA (SMB)	10 ... 68	A+	B			139
	Z4KExxxy	DO-204AL (DO-41Plastic)	100 ... 200	std.	A			141
2000	ZYxx	DO-204AL (DO-41 Plastic)	11 ... 68		std.			143

New Products are in bold
* = Dual Common Anode
** = Dual-Common Cathode
*** = 2% tolerance available as a special at or below 62 V
y = Zener voltage tolerance designator
+ = 20% tolerance standard (no suffix)
std. = Indicates standard tolerance, where there is no letter for the designator
++ = Advanced Information available in 1999

VOLTAGE STABILIZER DIODES

Package		Operating voltage at Iz = 5mA(1) Vz(V)	Dynamic resistance at Iz = 5mA rzjΩ	Permissable operating current Iz max. (mA)	Page
DO-204AH (Glass DO-35)	SOD-80C (Mini-MELF Glass)				
	LL1.5	1.35 ... 1.55	13(<20)	120(2)	170
	LL2	2.0 ... 2.3	18(<30)	120(2)	170
	LL2.4	2.2 ... 2.56	14(<20)	120(2)	170
ZTE1.5		1.35 ... 1.55	13(<20)	120(3)	174
ZTE2		2.0 ... 2.3	18(<30)	120(3)	174
ZTE2.4		2.2 ... 2.56	14(<20)	120(3)	174
ZTK6.8		6.4 ... 7.1	10(<25)	36(4)	178
ZTK9		8.0 ... 10	10(<25)	27(4)	178
ZTK11		10 ... 12	10(<25)	19(4)	178
ZTK18		16 ... 20	11(<25)	13(4)	178
ZTK22		20 ... 24	11(<25)	10(4)	178
ZTK27		24 ... 30	12(<25)	8(4)	178
ZTK33A		30 ... 32	12(<25)	7(4)	178
ZTK33B		32 ... 34	12(<25)	7(4)	178
ZTK33C		34 ... 36	12(<25)	7(4)	178

NOTES:

(1) Tested with pulses t_p=5ms

(2) Valid provided that electrodes are kept at ambient temperature, T_{amb} = 25°C

(3) Valid provided that leads are kept at ambient temperature at a distance of 8mm from case, T_{amb} = 25°C

(4) Valid provided that leads are kept at ambient temperature at a distance of 8mm from case, T_{amb} = 45°C

TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSORS

P_{PM}[1] (W)	Device[2] [6]	Package Family[8]	Package Type	V_{WM} Range (V)	$V_{(BR)}$[4] Range (V)	Standard $V_{(BR)}$ Tolerance	Page
300	SMAJxx	surface mount	DO-214AC (SMA)	5.0 - 170[3]	6.4 - 189	10%[5]	182
	P4KE530 & P4KE550 *	plastic axial	DO-204AL (DO-41)	477 - 495	530 - 550[m]	NA	186
	SMAJ530 & SMAJ550 *	surface mount	DO-214AC (SMA)	477 - 495	530 - 550[m]	NA	188
400	BZW04P-xx / BZW04-xx	plastic axial	DO-204AL (DO-41)	5.8 - 376	6.45 - 418	7%(P)/5%(blank)	190
	P4KEnn	plastic axial	DO-204AL (DO-41)	5.5 - 376	6.8 - 440	10%[5]	194
	TGL41-nn	surface mount	DO-213AB (MELF)	5.5 - 171	6.8 - 200	10%[5]	198
500	SAxx	plastic axial	DO-204AC (DO-15)	5.0 - 170	6.4 - 189	10%[5]	202
	SACxx *	plastic axial[7]	DO-204AC (DO-15)	5.0 - 50	7.6 - 55.5	NA	208
600	P6KEnn	plastic axial	DO-204AC (DO-15)	5.5 - 376	6.8 - 440	10%[5]	210
	SM6Tnn	surface mount	DO-214AA (SMB)	5.0 - 170[3]	6.4 - 189	5%	214
	SMBJxx	surface mount	DO-214AA (SMB)	5.0 - 170[3]	6.4 - 189	10%[5]	217
	SMBGxx	surface mount	DO-215AA (SMB)	5.0 - 170[3]	6.4 - 189	10%[5]	217
1500	1.5KEnn	plastic axial	1.5KE	5.5 - 376	6.8 - 440	10%[5]	221
	1N6267 - 1N6303	plastic axial	1.5KE	5.5 - 171	6.8 - 200	10%[5]	221
	ICTE-xx	plastic axial	1.5KE	5.0 - 15	6.0 - 17.6	±1V	227
	1N6373 - 1N6385	plastic axial	1.5KE	5.0 - 15	6.0 - 17.6[m]	±1V	227
	LCExx *	plastic axial[7]	1.5KE	6.5 - 28.0	7.22 - 31.1	10%[5]	231
	SM15Tnn	surface mount	DO-214AB (SMC)	5.8 - 188	6.8 - 220	5%	233
	SMCJxx	surface mount	DO-214AB (SMC)	5.0 - 170[3]	6.4 - 189	10%[5]	236
	SMCGxx	surface mount	DO-215AB (SMC)	5.0 - 170[3]	6.4 - 189	10%[5]	236
5000	5KPxx *	plastic axial	P600	5.0 - 110	6.4 - 122	10%[5]	240

NOTES:
(1) Measured with 10/1000us pulse.
(2) In the part number, "xx" designates the V_{WM} and "nn" designates nominal $V_{(BR)}$.
(3) For higher voltages consult regional sales office for availability.
(4) Nominal voltages are specified for part numbers designated with "nn" and minimum voltages are specified for part numbers with "xx" or [m] footnote.
(5) Also available with 5% $V_{(BR)}$ tolerance by adding suffix "A".
(6) Offered in bidirectional polarity by adding suffix "C" (BZW04 uses suffix "B"). Types only offered as unidirectional are designated with " * ". Bidirectional devices with 5% $V_{(BR)}$ tolerance have suffix "CA" (except BZW04).
(7) Low capacitance.
(8) All TVS products use glass passivated die.
(9) New Products are in bold

AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSORS

P_{PM}[2] (W)	Device[1][4]	Package Family[9]	Package Type	V_{WM} Range (V)	$V_{(BR)}$[5] Range (V)	$V_{(BR)}$ Tolerance	Page
400	TMPG06-nn	plastic axial	MPG06	5.50 - 36.8	6.8 - 43.0	10%[6]	246
	P4KAnn	plastic axial	DO-204AL	5.50 - 36.8	6.8 - 43.0	10%[6]	250
	TPSMAnn	surface mount	DO-214AC (SMA)	5.50 - 36.8	6.8 - 43.0	10%[6]	254
600	P6KAnn	plastic axial	DO-204AC	5.50 - 36.8	6.8 - 43.0	10%[6]	258
	TPSMBnn	surface mount	DO-214AA (SMB)	5.50 - 36.8	6.8 - 43.0	10%[6]	262
1500	1.5KAnn	plastic axial	1.5KA	5.50 - 36.8	6.8 - 43.0	10%[6]	266
	TPSMCnn	surface mount	DO-214AB (SMC)	5.50 - 36.8	6.8 - 43.0	10%[6]	270
3600[3]	**SM5A27**	surface mount	DO-218 (POWERBLOCK™)	22	27	±3V	274
	SM5Sxx	surface mount	DO-218 (POWERBLOCK™)	9.0 - 36	10 - 40	10%[6]	NOTE 7
	AS30nn	alternator	Leaded POWERBLOCK™	18 & 20	28 & 32	±4V	NOTE 8
4600[3]	**SM6A27**	surface mount	DO-218 (POWERBLOCK™)	22	27	±3V	276
	SM6Sxx	surface mount	DO-218 (POWERBLOCK™)	9.0 - 36	10 - 40	10%[6]	NOTE 7
	AS35nn	alternator	Leaded POWERBLOCK™	18 & 20	28 & 32	±4V	NOTE 8
6000	6KA24	plastic axial	P600	24	29.7	10%	280
6600[3]	**SM8A27**	surface mount	DO-218 (POWERBLOCK™)	22	27	±3V	278
	SM8Sxx	surface mount	DO-218 (POWERBLOCK™)	9.0 - 36	10 - 40	10%[6]	NOTE 7
	AS40nn	alternator	Leaded POWERBLOCK™	18 & 20	28 & 32	±4V	NOTE 8

NOTES:

(1) **Bold Text = New Products.**
(2) Measured with 10/1000us pulse, unless otherwise noted.
(3) For 10ms load dump specification, refer to datasheets.
(4) In the part number, "xx" designates the V_{WM} and "nn" designates nominal $V_{(BR)}$.
(5) Nominal Voltages are specified for part numbers designated with "nn" and minimum voltages are specified with "xx"
(6) Also available with 5% tolerance by adding suffix "A".
(7) Available in Q1-99. Please contact sales office for specifications and availability.
(8) For detailed specifications of Avalanche Alternator Rectifiers, please contact regional sales office.
(9) All automotive TVS products use the patented PAR™ die process, which includes oxide passivation.

GENERAL SEMICONDUCTOR®

www.gensemi.com

Surface Mount Product Guide

Package	Zener Diode	TVS	Schottky Rectifier	Standard Rectifier	Bridge Rectifier	Recovery Rectifier	FER Rectifier	Small Signal Diode	Schottky Diode	Tuner Diode	Stabilizer Diode	Small Signal Transistor	Small Signal DMOS
	Products Available												
SOD-323	X							X	X	X	X		
SOD-123	X	X						X	X	X			
SMA (DO-214AC)	X	X	X	X		X	X						
SMB (DO-214AA)	X	X	X	X		X	X						
SMC (DO-214AB)			X	X		X	X						
GF1 (DO-214BA)				X		X							
MINI-MELF (SOD-80C)	X							X	X				
GL34 (DO-213AA)				X		X	X						
GL41 (DO-213AB)	X	X	X	X		X	X						
MELF (GLASS)	X												
SOT-23 (TO-236AB)	X							X	X			X	X
POWERBLOCK™ (ASC)		X		X									
POWERBLOCK™ (DO-218AA)		X											
D^2 PAK (TO-263AB)			X	X		X	X						
DFS					X								
MBS (TO-269AA)					X								

9/98

X=Available Products & Packages

INDEX OF SYMBOLS

α_{IR} .... Temperature coefficient of leakage current
α_{C} .... Temperature coefficent 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
$I_{(AV)}$ .... Average Forward Rectified Current
I_D .... Stand-Off Reverse Leakage Current
I_{FSM} .... Peak Forward Surge Current
I_O .... Mean Forward Current
I_R .... Reverse Leakage Current
I_{PPM} .... Maximum Peak Impulse Current
I_{RSM} .... Maximum Non-Repetitive Reverse Peak Current
I_T .... Test Current
I^2t .... Rating for Fusing
$P_{M(AV)}$ ..... Maximum Steady State Power Dissipation
P_{PM} .... Peak Pulse Power Dissipation
$R_{\Theta JA}$ ...... Thermal Resistance (Junction to Ambient)
$R_{\Theta JC}$ ...... Thermal Resistance (Junction to Case)
$R_{\Theta JL}$ .... Thermal Resistance (Junction 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_{WM} .... 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}

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, and "Z" is for voltage reference or regulator diodes. (TVS if W follows Z), "C" is for low power transistor, and "S" is for low power switching MOS transistor.

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, BYV32-150

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

"All technical information mentioned in this Product Catalog is intended for representative use and application guidance and never indicates that we will guarantee or make approval of ownership right by ourselves or a third party."

ZENER DIODES

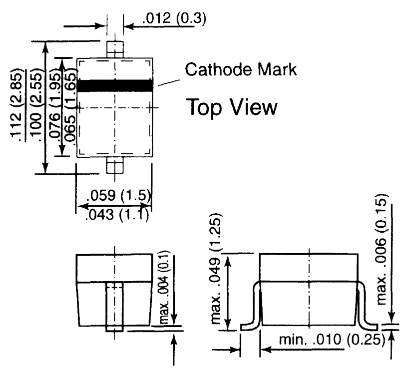
General Semiconductor's Zener Diodes are used as voltage regulators, voltage references and voltage suppressors against ESD threats. Power ratings range from 300mW to 2W and voltages range from 2.4V to 200 V. Typical voltage tolerances are ±5%, but tighter tolerances such as ±2% are available. These diodes are available in the following packages: DO-35 and DO-41 axial; MELF, mini-MELF, SOD-123, SOD-323, SMA, SMB and SOT-23 (single & dual) surface mount packages.

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

BZX384-C2V4 THRU BZX384-C75

ZENER DIODES

SOD-323



Dimensions are in inches and (millimeters)

FEATURES

- Silicon Planar Power Zener Diodes
- The Zener voltages are graded according to the international E 24 standard. Standard Zener voltage tolerance is ±5%. Replace "C" with "B" for ±2% tolerance. Other voltage tolerances and other Zener voltages are available upon request.

MECHANICAL DATA

Case: SOD-323 Plastic Package
Weight: approx. 0.004 g

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current	I_{ZM}	250	mA
Power Dissipation at T_{amb} = 25°C	P_{tot}	200[1)]	mW
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +175	°C

NOTES:
(1) Device on fiberglass substrate, see layout.

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	650[1)]	K/W
Forward Voltage at I_F = 10 mA	–	–	–	0.9	Volts

NOTES:
(1) Valid provided that electrodes are kept at ambient temperature

BZX384-C2V4 THRU BZX384-C75

ELECTRICAL CHARACTERISTICS

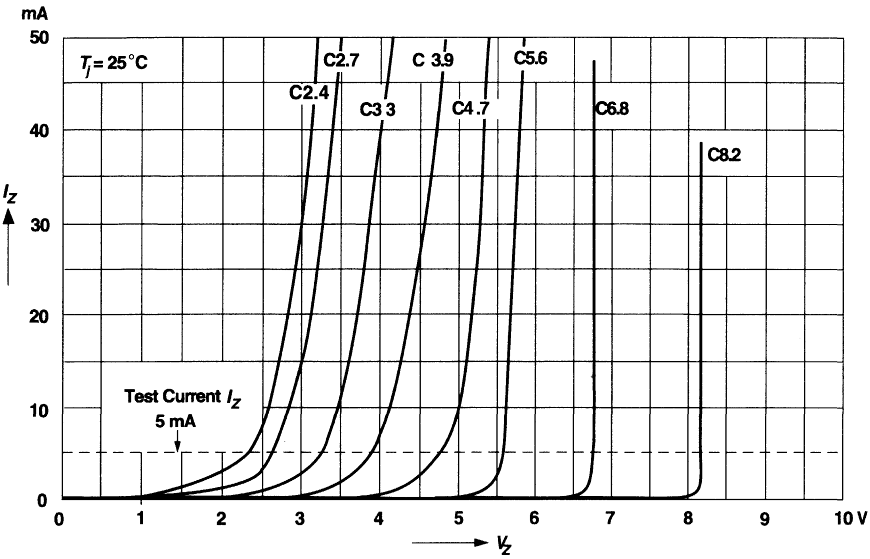
Ratings at 25°C ambient temperature unless otherwise specified.

Type	Marking	Zener Voltage(1) at I_{ZT1}	Dynamic Resistance at I_{ZT1}	Temp. Coefficient of Zener Voltage at I_{ZT1}	Test Current	Dynamic Resistance at I_{ZT2}	Test Current	Reverse Leakage Current	
		V_Z (V)	r_{zj} (Ω)	α_{VZ} (10^{-4}/K)	I_{ZT1} (mA)	r_{zj} (Ω)	I_{ZT2} (mA)	I_R (μA)	at V_R (V)
BZX384-C2V4	W1	2.20 ... 2.60	70 (≤100)	−3.5 ... 0.0	5	275	1.0	50.0	1.0
BZX384-C2V7	W2	2.50 ... 2.90	75 (≤100)	−9.0 ... −4.0	5	300 (≤600)	1.0	20.0	1.0
BZX384-C3	W3	2.80 ... 3.20	80 (≤95)	−9.0 ... −3.0	5	325 (≤600)	1.0	10.0	1.0
BZX384-C3V3	W4	3.10 ... 3.50	85 (≤95)	−8.0 ... −3.0	5	350 (≤600)	1.0	5.00	1.0
BZX384-C3V6	W5	3.40 ... 3.80	85 (≤90)	−8.0 ... −3.0	5	375 (≤600)	1.0	5.00	1.0
BZX384-C3V9	W6	3.70 ... 4.10	85 (≤90)	−7.0 ... −3.0	5	400 (≤600)	1.0	3.00	1.0
BZX384-C4V3	W7	4.00 ... 4.60	80 (≤90)	−6.0 ... −1.0	5	410 (≤600)	1.0	3.00	1.0
BZX384-C4V7	W8	4.40 ... 5.00	50 (≤80)	−5.0 ... +2.0	5	425 (≤500)	1.0	3.00	2.0
BZX384-C5V1	W9	4.80 ... 5.40	40 (≤60)	−3.0 ... +4.0	5	400 (≤480)	1.0	2.00	2.0
BZX384-C5V6	WA	5.20 ... 6.00	15 (≤40)	−2.0 ... +6.0	5	80 (≤400)	1.0	1.00	2.0
BZX384-C6V2	WB	5.80 ... 6.60	6.0 (≤10)	−1.0 ... +7.0	5	40 (≤150)	1.0	3.00	4.0
BZX384-C6V8	WC	6.40 ... 7.20	6.0 (≤15)	+2.0 ... +7.0	5	30 (≤80)	1.0	2.00	4.0
BZX384-C7V5	WD	7.00 ... 7.90	6.0 (≤15)	+3.0 ... +7.0	5	30 (≤80)	1.0	1.00	5.0
BZX384-C8V2	WE	7.70 ... 8.70	6.0 (≤15)	+4.0 ... +7.0	5	40 (≤80)	1.0	0.70	5.0
BZX384-C9V1	WF	8.50 ... 9.60	6.0 (≤15)	+5.0 ... +8.0	5	40 (≤100)	1.0	0.50	6.0
BZX384-C10	WG	9.40 ... 10.6	8.0 (≤20)	+5.0 ... +8.0	5	50 (≤150)	1.0	0.20	7.0
BZX384-C11	WH	10.4 ... 11.6	10 (≤20)	+5.0 ... +9.0	5	50 (≤150)	1.0	0.10	8.0
BZX384-C12	WI	11.4 ... 12.7	10 (≤25)	+6.0 ... +9.0	5	50 (≤150)	1.0	0.10	8.0
BZX384-C13	WK	12.4 ... 14.1	10 (≤30)	+7.0 ... +9.0	5	50 (≤170)	1.0	0.10	8.0
BZX384-C15	WL	13.8 ... 15.6	10 (≤30)	+7.0 ... +9.0	5	50 (≤200)	1.0	0.05	0.7 $V_{Znom.}$
BZX384-C16	WM	15.3 ... 17.1	10 (≤40)	+8.0 ... +9.5	5	50 (≤200)	1.0	0.05	0.7 $V_{Znom.}$
BZX384-C18	WN	16.8 ... 19.1	10 (≤45)	+8.0 ... +9.5	5	50 (≤225)	1.0	0.05	0.7 $V_{Znom.}$
BZX384-C20	WO	18.8 ... 21.2	15 (≤55)	+8.0 ... +10	5	60 (≤225)	1.0	0.05	0.7 $V_{Znom.}$
BZX384-C22	WP	20.8 ... 23.3	20 (≤55)	+8.0 ... +10	5	60 (≤250)	1.0	0.05	0.7 $V_{Znom.}$
BZX384-C24	WR	22.8 ... 25.6	25 (≤70)	+8.0 ... +10	5	60 (≤250)	1.0	0.05	0.7 $V_{Znom.}$
BZX384-C27	WS	25.1 ... 28.9	25 (≤80)	+8.0 ... +10	2	65 (≤300)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C30	WT	28.0 ... 32.0	30 (≤80)	+8.0 ... +10	2	70 (≤300)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C33	WU	31.0 ... 35.0	35 (≤80)	+8.0 ... +10	2	75 (≤325)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C36	WW	34.0 ... 38.0	35 (≤90)	+8.0 ... +10	2	80 (≤350)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C39	WX	37.0 ... 41.0	40 (≤130)	+10.0 ... +12	2	80 (≤350)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C43	WY	40.0 ... 46.0	45 (≤150)	+10.0 ... +12	2	85 (≤375)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C47	WZ	44.0 ... 50.0	50 (≤170)	+10.0 ... +12	2	85 (≤375)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C51	X1	48.0 ... 54.0	60 (≤180)	+10.0 ... +12	2	85 (≤400)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C56	X2	52.0 ... 60.0	70 (≤200)	+9.0 ... +11	2	100 (≤425)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C62	X3	58.0 ... 66.0	80 (≤215)	+9.0 ... +12	2	100 (≤450)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C68	X4	64.0 ... 72.0	90 (≤240)	+10.0 ... +12	2	150 (≤475)	0.5	0.05	0.7 $V_{Znom.}$
BZX384-C75	X5	70.0 ... 79.0	95 (≤255)	+10.0 ... +12	2	170 (≤500)	0.5	0.05	0.7 $V_{Znom.}$

NOTES:
(1) Measured with pulses t_p = 5 ms

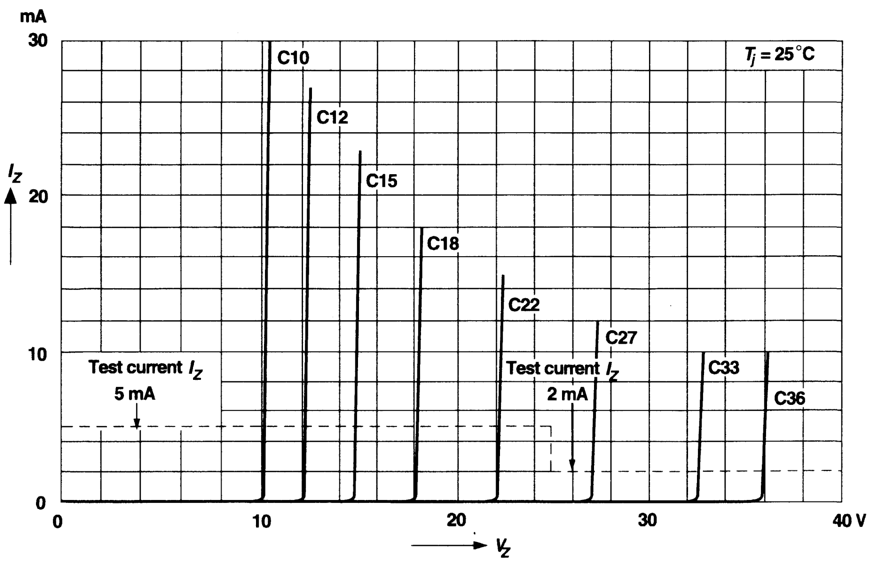
Breakdown characteristics

T_j = constant (pulsed)



Breakdown characteristics

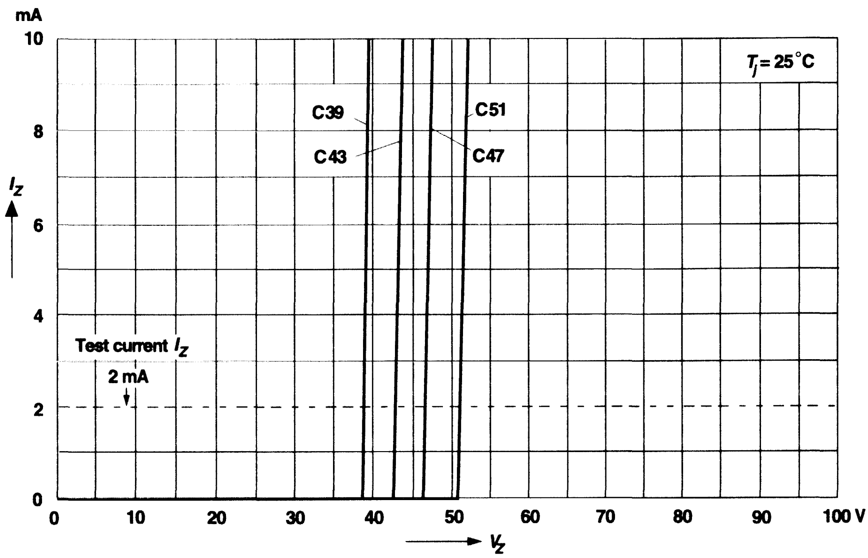
T_j = constant (pulsed)



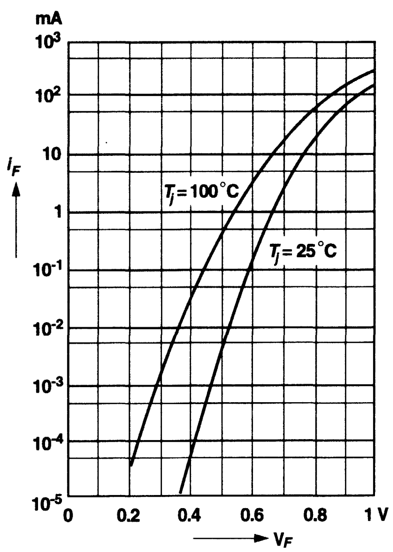
RATINGS AND CHARACTERISTICS CURVES BZX384-C2V4 THRU BZX384-C75

Breakdown characteristics

T_j = constant (pulsed)

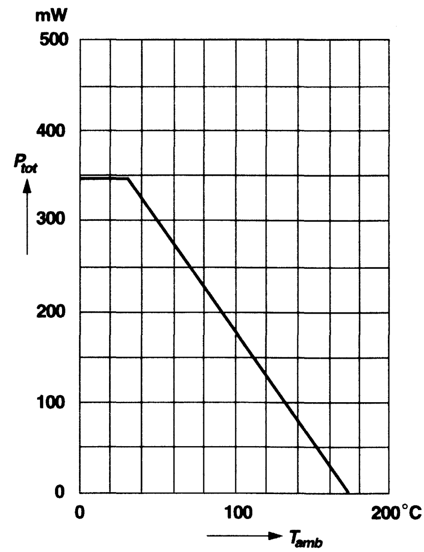


Forward characteristics



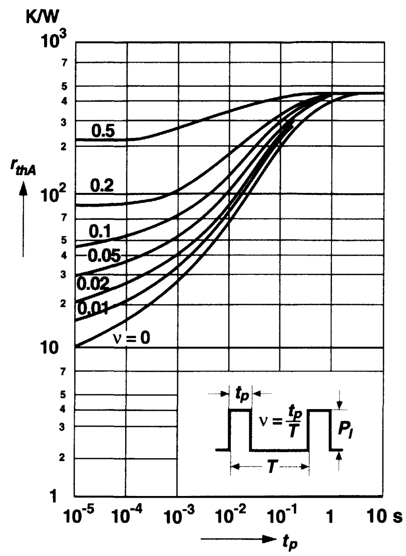
Admissible power dissipation versus ambient temperature

For conditions, see footnote in table "Absolute Maximum Ratings"

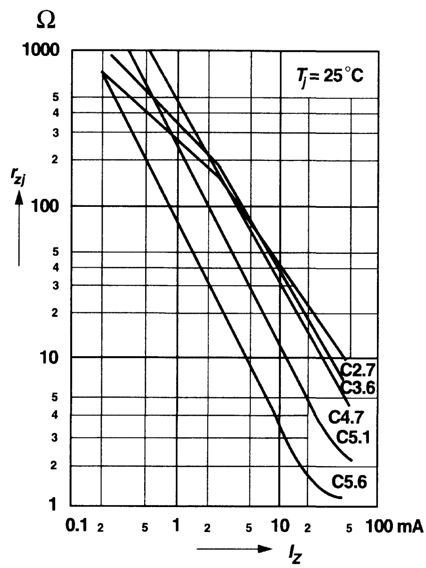


Pulse thermal resistance versus pulse duration

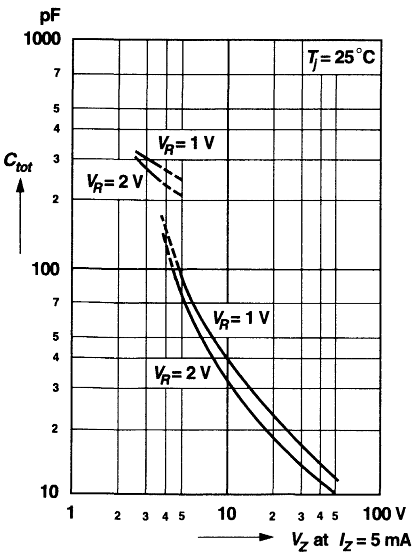
For conditions, see footnote in table "Absolute Maximum Ratings"



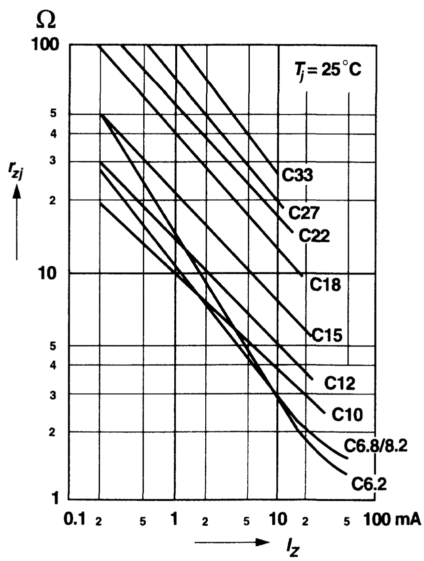
Dynamic resistance versus Zener current



Capacitance versus Zener voltage

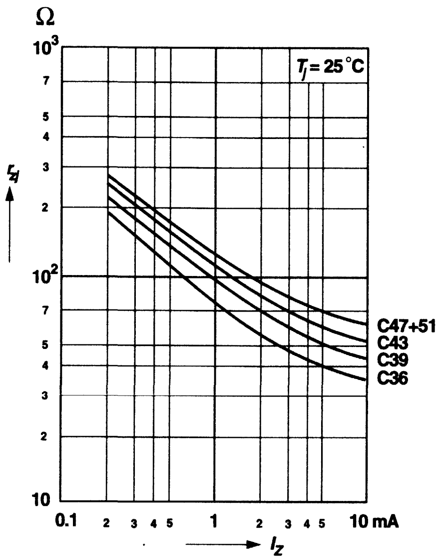


Dynamic resistance versus Zener current



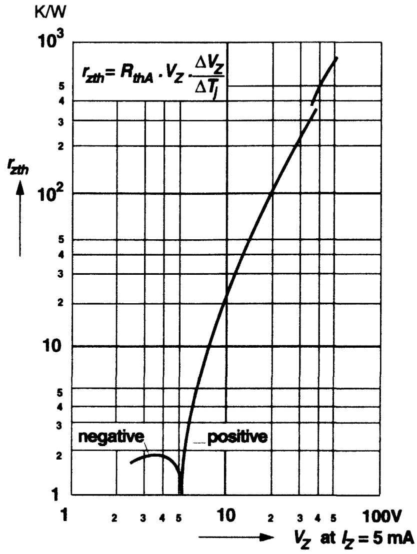
RATINGS AND CHARACTERISTICS CURVES BZX384-C2V4 THRU BZX384-C75

Dynamic resistance versus Zener current

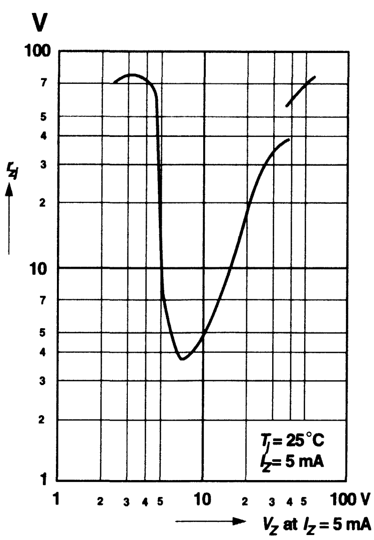


Thermal differential resistance versus Zener voltage

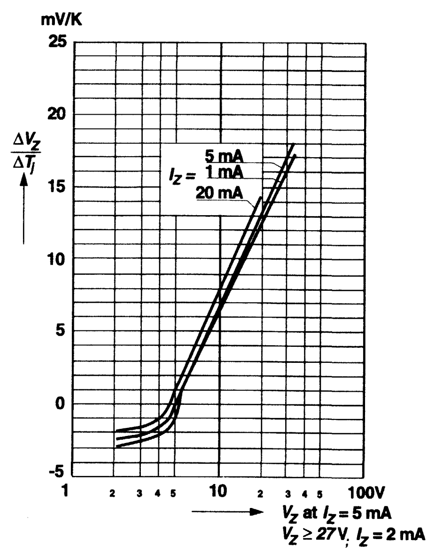
For conditions, see footnote in table "Absolute Maximum Ratings"



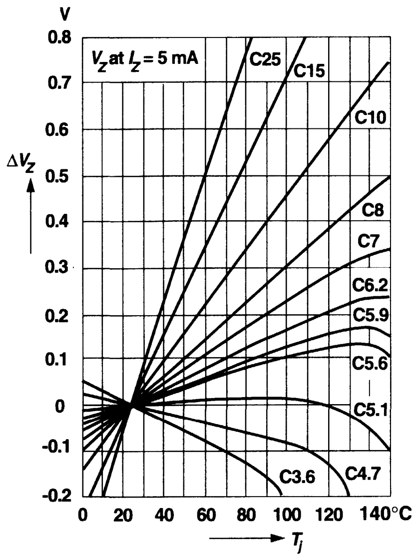
Dynamic resistance versus Zener voltage



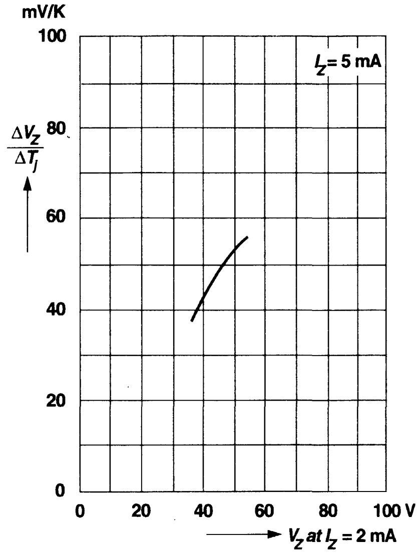
Temperature dependence of Zener voltage versus Zener voltage



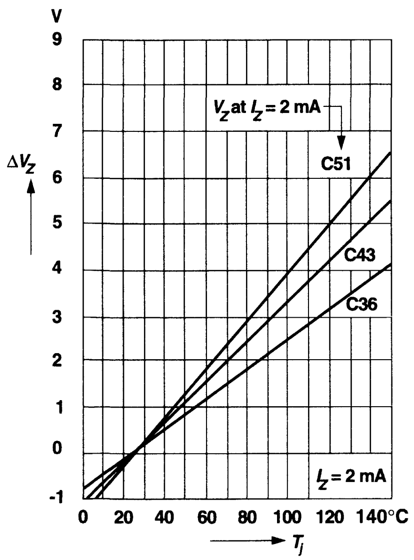
Change of Zener voltage versus junction temperature



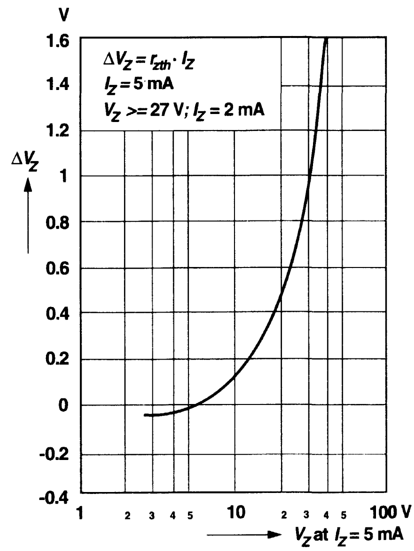
Temperature dependence of Zener voltage versus Zener voltage



Change of Zener voltage versus junction temperature

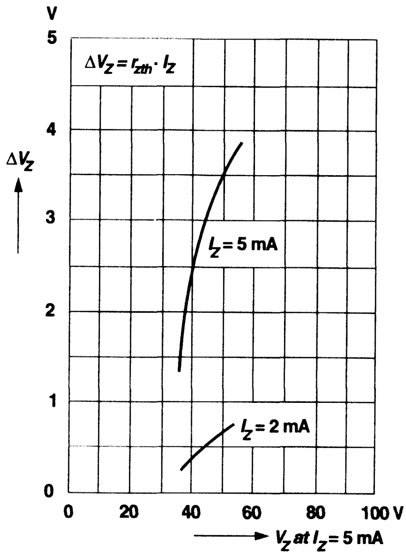


Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



RATINGS AND CHARACTERISTICS CURVES BZX384-C2V4 THRU BZX384-C75

Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage

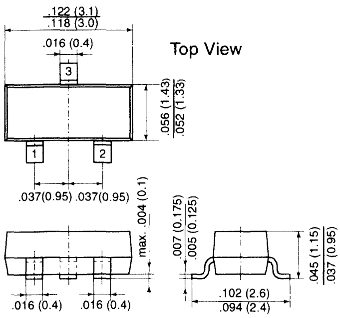


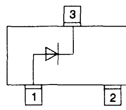
NEW PRODUCT **NEW PRODUCT** **NEW PRODUCT**

MMBZ5225 THRU MMBZ5267

ZENER DIODES

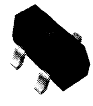
SOT-23





Dimensions in inches and (millimeters)

FEATURES



- ♦ Silicon Planar Power Zener Diodes
- ♦ Standard Zener voltage tolerance is ±5% tolerance with a "B" suffix. Other tolerances are available upon request
- ♦ These diodes are also available in Mini-MELF case with the type designation ZMM5225 ... ZMM5267, DO-35 case with the type designation 1N5225 ... 1N5267 and SOD-123 case with the type designation MMSZ5225 ... MMSZ5267

MECHANICAL DATA

Case: SOT-23 Plastic Package
Weight: approx. 0.008 g

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current see Table "Characteristics"			
Power Dissipation at T_A = 25°C	P_{tot}	225(1) 300(2)	mW
Maximum Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	–65 to +175	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	556(1)	°C/W
Forward Voltage at I_F = 10 mA	V_F	–	–	0.9	Volts

NOTES:
(1) On FR-5 board using recommended solder pad layout.
(2) On alumina substrate.

1/21/99

GENERAL SEMICONDUCTOR®

MMBZ5225 THRU MMBZ5267

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Marking Code	Nominal Zener voltage(3) at I_{ZT} V_Z(V)	Test current I_{ZT}(mA)	Maximum Zener impedance(2)		Typical temperture coefficient αV_Z (%/K)	Maximum reverse leakage current	
				at I_{ZT} $Z_{ZT}(\Omega)$	at I_{ZK} = 0.25 mA $Z_{ZK}(\Omega)$		I_R (µA)	Test Voltage V_R (Volts)
MMBZ5225	18E	3.0	20	30	1600	-0.075	50	1.0
MMBZ5226	8A	3.3	20	28	1600	-0.070	25	1.0
MMBZ5227	8B	3.6	20	24	1700	-0.065	15	1.0
MMBZ5228	8C	3.9	20	23	1900	-0.060	10	1.0
MMBZ5229	8D	4.3	20	22	2000	-0.055	5	1.0
MMBZ5230	8E	4.7	20	19	1900	±0.030	5	2.0
MMBZ5231	8F	5.1	20	17	1600	±0.030	5	2.0
MMBZ5232	8G	5.6	20	11	1600	+0.038	5	3.0
MMBZ5233	8H	6.0	20	7	1600	+0.038	5	3.5
MMBZ5234	8J	6.2	20	7	1000	+0.045	5	4.0
MMBZ5235	8K	6.8	20	5	750	+0.050	3	5.0
MMBZ5236	8L	7.5	20	6	500	+0.058	3	6.0
MMBZ5237	8M	8.2	20	8	500	+0.062	3	6.5
MMBZ5238	8N	8.7	20	8	600	+0.065	3	6.5
MMBZ5239	8P	9.1	20	10	600	+0.068	3	7.0
MMBZ5240	8Q	10	20	17	600	+0.075	3	8.0
MMBZ5241	8R	11	20	22	600	+0.076	2	8.4
MMBZ5242	8S	12	20	30	600	+0.077	1	9.1
MMBZ5243	8T	13	9.5	13	600	+0.079	0.5	9.9
MMBZ5244	8U	14	9.0	15	600	+0.082	0.1	10
MMBZ5245	8V	15	8.5	16	600	+0.082	0.1	11
MMBZ5246	8W	16	7.8	17	600	+0.083	0.1	12
MMBZ5247	8X	17	7.4	19	600	+0.084	0.1	13
MMBZ5248	8Y	18	7.0	21	600	+0.085	0.1	14
MMBZ5249	8Z	19	6.6	23	600	+0.086	0.1	14
MMBZ5250	81A	20	6.2	25	600	+0.086	0.1	15
MMBZ5251	81B	22	5.6	29	600	+0.087	0.1	17
MMBZ5252	81C	24	5.2	33	600	+0.087	0.1	18
MMBZ5253	81D	25	5.0	35	600	+0.089	0.1	19
MMBZ5254	81E	27	4.6	41	600	+0.090	0.1	21
MMBZ5255	81F	28	4.5	44	600	+0.091	0.1	21
MMBZ5256	81G	30	4.2	49	600	+0.091	0.1	23
MMBZ5257	81H	33	3.8	58	700	+0.092	0.1	25
MMBZ5258	81J	36	3.4	70	700	+0.093	0.1	27
MMBZ5259	81K	39	3.2	80	800	+0.094	0.1	30
MMBZ5260	18F	43	3.0	93	900	+0.095	0.1	33
MMBZ5261	81M	47	2.7	105	1000	+0.095	0.1	36
MMBZ5262	81N	51	2.5	125	1100	+0.096	0.1	39
MMBZ5263	81P	56	2.2	150	1300	+0.096	0.1	43
MMBZ5264	81Q	60	2.1	170	1400	+0.097	0.1	46
MMBZ5265	81R	62	2.0	185	1400	+0.097	0.1	47
MMBZ5266	81S	68	1.8	230	1600	+0.097	0.1	52
MMBZ5267	81T	75	1.7	270	1700	+0.098	0.1	56

NOTES:

(1) The Zener Impedance is derived from the 1kHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}. Zener Impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units.

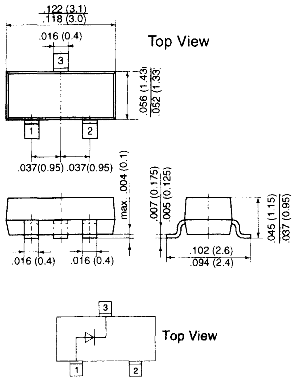
(2) Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature.

(3) Measured with a pulse test current.

BZX84-C2V4 THRU BZX84-C75

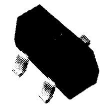
ZENER DIODES

SOT-23



Dimensions are in inches and (millimeters)

FEATURES



- ♦ Silicon Planar Power Zener Diodes
- ♦ The Zener voltages are graded according to the international E 24 standard. Standard Zener voltage tolerance is ±5%. Replace "C" with "B" for ±2% tolerance. Other voltage tolerances and other Zener voltages are available upon request.
- ♦ These diodes are also available in other case styles and other configurations including: the SOD-123 case with type designation BZT52 series, the dual zener diode common anode configuration in the SOT-23 case with type designation AZ23 series and the dual zener diode common cathode configuration in the SOT-23 case with type designation DZ23 series.

MECHANICAL DATA

Case: SOT-23 Plastic Package
Weight: approx. 0.008 g

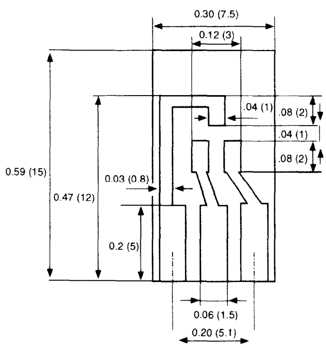
MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current	I_{ZM}	250	mA
Power Dissipation at T_{amb} = 25°C	P_{tot}	350(1)	mW
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +150	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	420(1)	K/W
Forward Voltage at I_F = 10 mA	V_F	–	–	0.9	Volts

NOTES:
(1) Device on fiberglass substrate, see layout.



Layout for $R_{\Theta JA}$ test
Thickness: Fiberglass 0.059 in (1.5mm)
Copper leads 0.012 in (0.3mm)

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GENERAL SEMICONDUCTOR®

BZX84-C2V4 THRU BZX84-C75

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

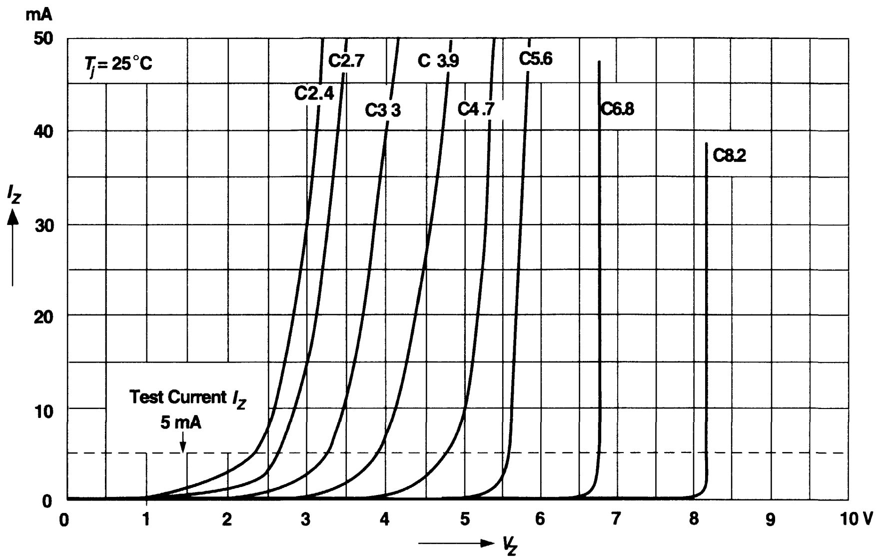
Type	Marking Code	Zener Voltage[1] at I_{ZT1} V_Z (V)	Dynamic Resistance at I_{ZT1} r_{zj} (Ω)	Temp. Coefficient of Zener Voltage at I_{ZT1} α_{VZ} (10^{-4}/K)	Test Current I_{ZT1} (mA)	Dynamic Resistance at I_{ZT2} r_{zj} (Ω)	Test Current I_{ZT2} (mA)	Reverse Leakage Current I_R (µA)	Reverse Leakage Current at V_R (V)
BZX84-C2V4	Z11	2.20 … 2.60	70 (≤100)	–3.5 … 0.0	5	275	1.0	50	1.0
BZX84-C2V7	Z12	2.50 … 2.90	75 (≤100)	–9.0 … –4.0	5	300 (≤600)	1.0	20	1.0
BZX84-C3	Z13	2.80 … 3.20	80 (≤95)	–9.0 … –3.0	5	325 (≤600)	1.0	10	1.0
BZX84-C3V3	Z14	3.10 … 3.50	85 (≤95)	–8.0 … –3.0	5	350 (≤600)	1.0	5.0	1.0
BZX84-C3V6	Z15	3.40 … 3.80	85 (≤90)	–8.0 … –3.0	5	375 (≤600)	1.0	5.0	1.0
BZX84-C3V9	Z16	3.70 … 4.10	85 (≤90)	–7.0 … –3.0	5	400 (≤600)	1.0	3.0	1.0
BZX84-C4V3	Z17	4.00 … 4.60	80 (≤90)	–6.0 … –1.0	5	410 (≤600)	1.0	3.0	1.0
BZX84-C4V7	Z1	4.40 … 5.00	50 (≤80)	–5.0 … +2.0	5	425 (≤500)	1.0	3.0	2.0
BZX84-C5V1	Z2	4.80 … 5.40	40 (≤60)	–3.0. … +4.0	5	400 (≤480)	1.0	2.0	2.0
BZX84-C5V6	Z3	5.20 … 6.00	15 (≤40)	–2.0 … +6.0	5	80 (≤400)	1.0	1.0	2.0
BZX84-C6V2	Z4	5.80 … 6.60	6.0 (≤10)	–1.0 … +7.0	5	40 (≤150)	1.0	3.0	4.0
BZX84-C6V8	Z5	6.40 … 7.20	6.0 (≤15)	+2.0 … +7.0	5	30 (≤80)	1.0	2.0	4.0
BZX84-C7V5	Z6	7.00 … 7.90	6.0 (≤15)	+3.0 … +7.0	5	30 (≤80)	1.0	1.0	5.0
BZX84-C8V2	Z7	7.70 … 8.70	6.0 (≤15)	+4.0 … +7.0	5	40 (≤80)	1.0	0.7	5.0
BZX84-C9V1	Z8	8.50 … 9.60	6.0 (≤15)	+5.0 … +8.0	5	40 (≤100)	1.0	0.5	6.0
BZX84-C10	Z9	9.40 … 10.6	8.0 (≤20)	+5.0 … +8.0	5	50 (≤150)	1.0	0.2	7.0
BZX84-C11	Y1	10.4 … 11.6	10 (≤20)	+5.0 … +9.0	5	50 (≤150)	1.0	0.1	8.0
BZX84-C12	Y2	11.4 … 12.7	10 (≤25)	+6.0 … +9.0	5	50 (≤150)	1.0	0.1	8.0
BZX84-C13	Y3	12.4 … 14.1	10 (≤30)	+7.0 … +9.0	5	50 (≤170)	1.0	0.1	8.0
BZX84-C15	Y4	13.8 … 15.6	10 (≤30)	+7.0 … +9.0	5	50 (≤200)	1.0	0.05	0.7 $V_{Znom.}$
BZX84-C16	Y5	15.3 … 17.1	10 (≤40)	+8.0 … +9.5	5	50 (≤200)	1.0	0.05	0.7 $V_{Znom.}$
BZX84-C18	Y6	16.8 … 19.1	10 (≤45)	+8.0 … +9.5	5	50 (≤225)	1.0	0.05	0.7 $V_{Znom.}$
BZX84-C20	Y7	18.8 … 21.2	15 (≤55)	+8.0 … +10	5	60 (≤225)	1.0	0.05	0.7 $V_{Znom.}$
BZX84-C22	Y8	20.8 … 23.3	20 (≤55)	+8.0 … +10	5	60 (≤250)	1.0	0.05	0.7 $V_{Znom.}$
BZX84-C24	Y9	22.8 … 25.6	25 (≤70)	+8.0 … +10	5	60 (≤250)	1.0	0.05	0.7 $V_{Znom.}$
BZX84-C27	Y10	25.1 … 28.9	25 (≤80)	+8.0 … +10	2	65 (≤300)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C30	Y11	28.0 … 32.0	30 (≤80)	+8.0 … +10	2	70 (≤300)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C33	Y12	31.0 … 35.0	35 (≤80)	+8.0 … +10	2	75 (≤325)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C36	Y13	34.0 … 38.0	35 (≤90)	+8.0 … +10	2	80 (≤350)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C39	Y14	37.0 … 41.0	40 (≤130)	+10 … +12	2	80 (≤350)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C43	Y15	40.0 … 46.0	45 (≤150)	+10 … +12	2	85 (≤375)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C47	Y16	44.0 … 50.0	50 (≤170)	+10 … +12	2	85 (≤375)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C51	Y17	48.0 … 54.0	60 (≤180)	+10 … +12	2	85 (≤400)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C56	Y18	52.0 … 60.0	70 (≤200)	+9.0 … +11	2	100 (≤425)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C62	Y19	58.0 … 66.0	80 (≤215)	+9.0 … +12	2	100 (≤450)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C68	Y20	64.0 … 72.0	90 (≤240)	+10 … +12	2	150 (≤475)	0.5	0.05	0.7 $V_{Znom.}$
BZX84-C75	Y21	70.0 … 79.0	95 (≤255)	+10 … +12	2	170 (≤500)	0.5	0.05	0.7 $V_{Znom.}$

NOTES:

(1) Measured with pulses t_p = 5 ms

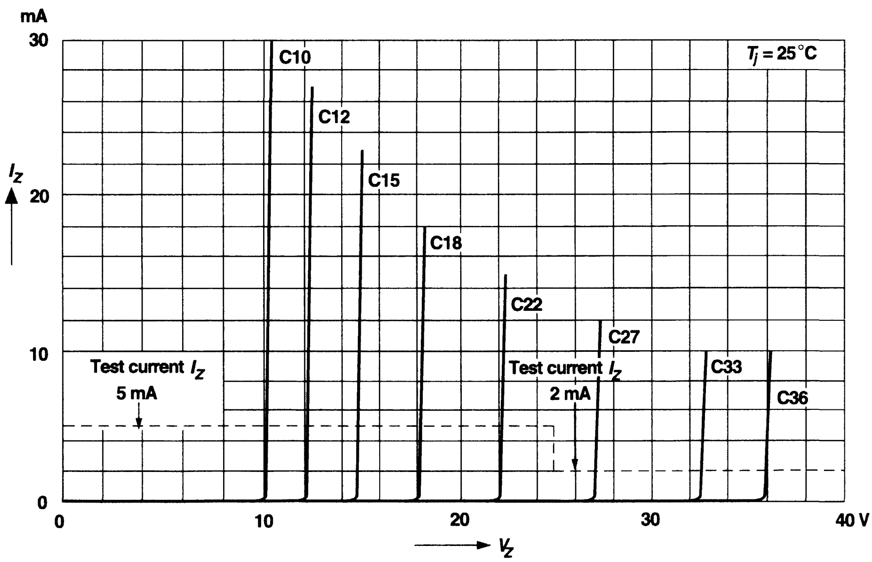
Breakdown characteristics

T_j = constant (pulsed)



Breakdown characteristics

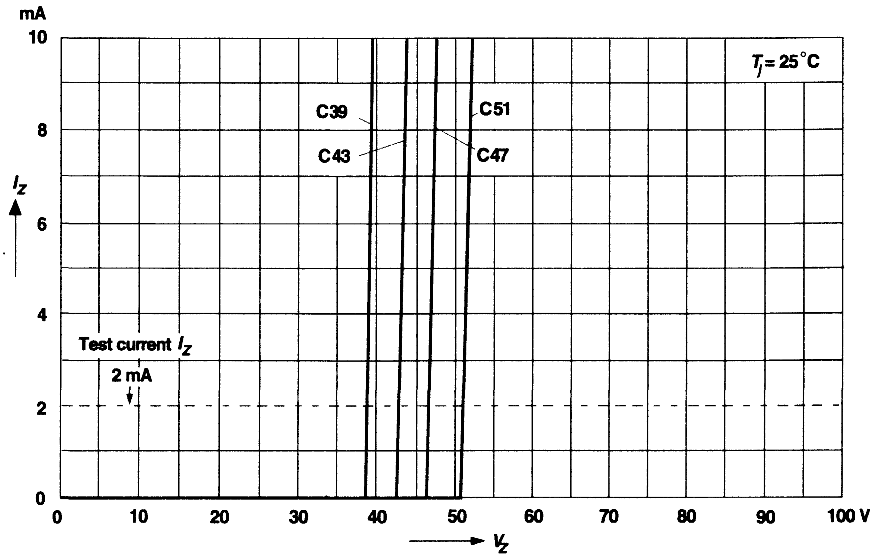
T_j = constant (pulsed)



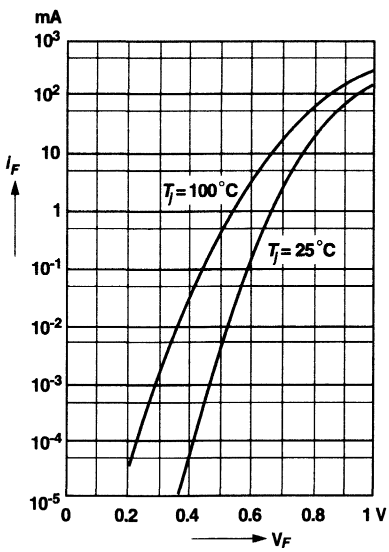
RATINGS AND CHARACTERISTIC CURVES BZX84-C2V4 THRU BZX84-C75

Breakdown characteristics

T_j = constant (pulsed)

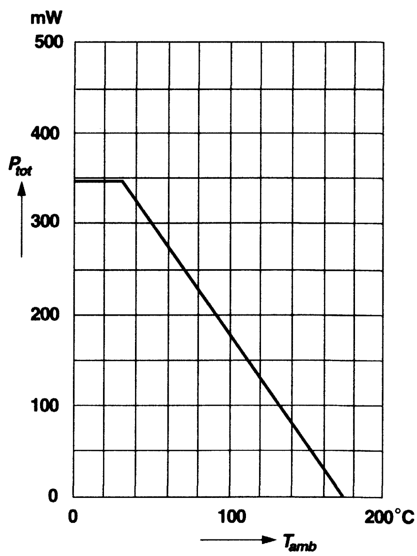


Forward characteristics



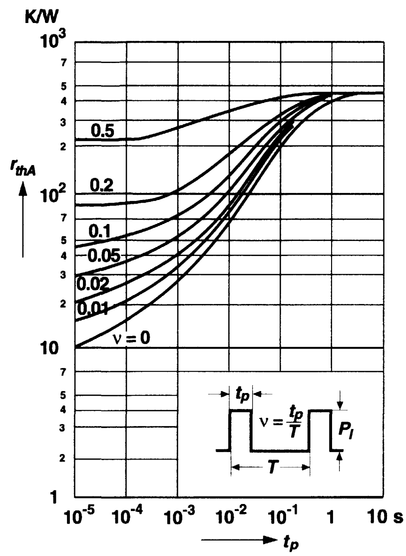
Admissible power dissipation versus ambient temperature

For conditions, see footnote in table "Absolute Maximum Ratings"

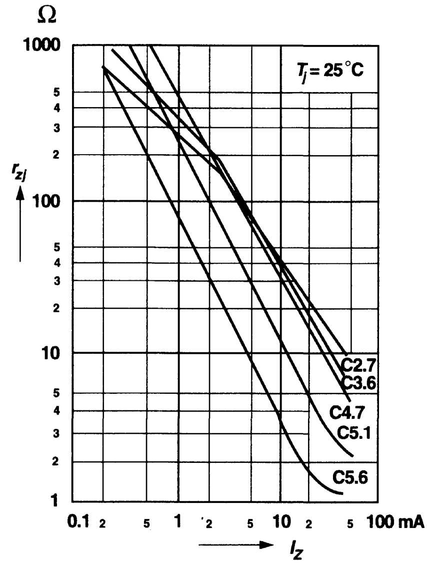


Pulse thermal resistance versus pulse duration

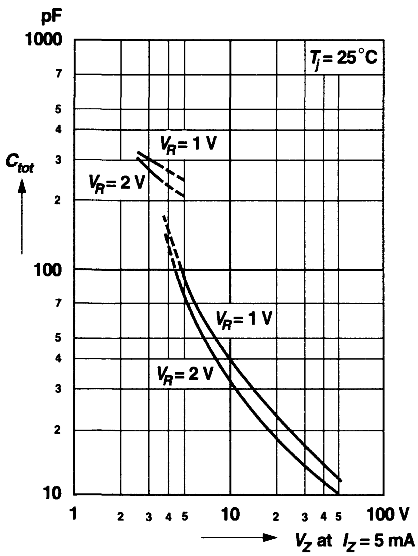
For conditions, see footnote in table "Absolute Maximum Ratings"



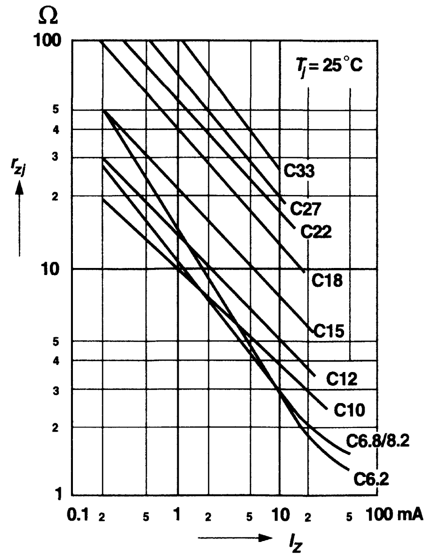
Dynamic resistance versus Zener current



Capacitance versus Zener voltage

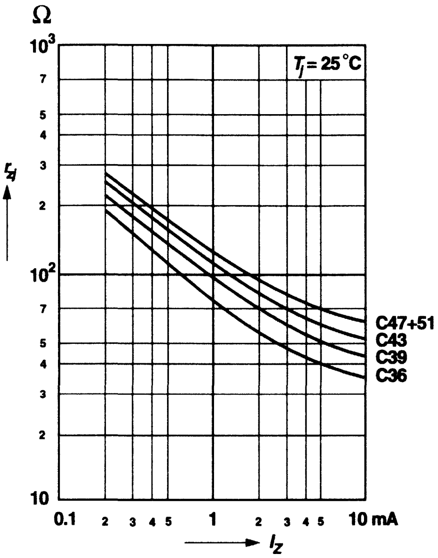


Dynamic resistance versus Zener current



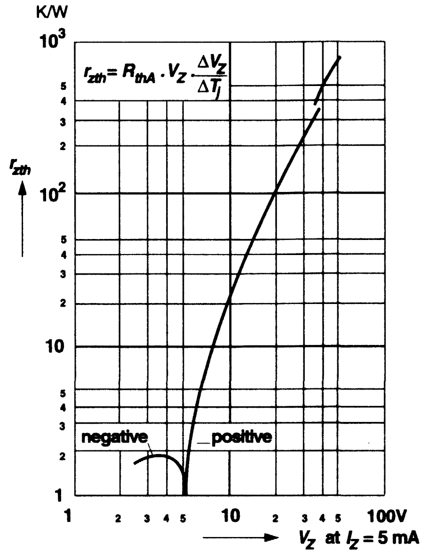
RATINGS AND CHARACTERISTICS CURVES BZX84-C2V4 THRU BZX84-C75

Dynamic resistance versus Zener current

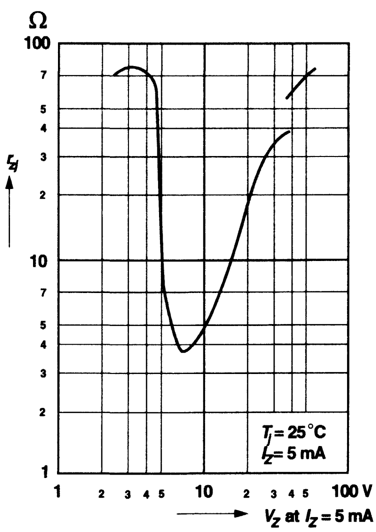


Thermal differential resistance versus Zener voltage

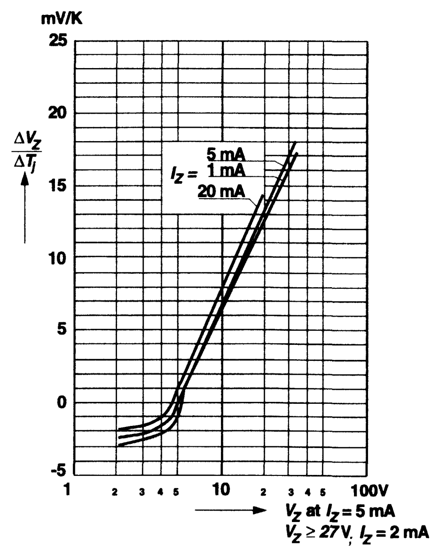
For conditions, see footnote in table "Absolute Maximum Ratings"



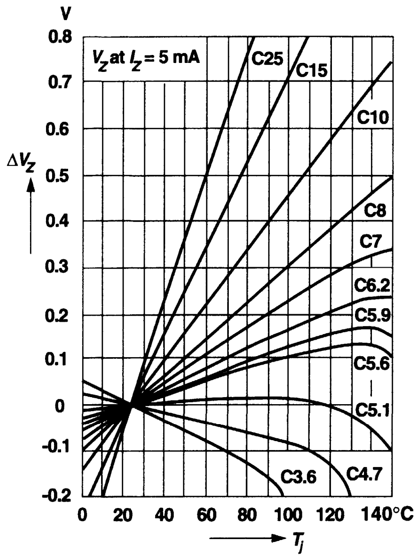
Dynamic resistance versus Zener voltage



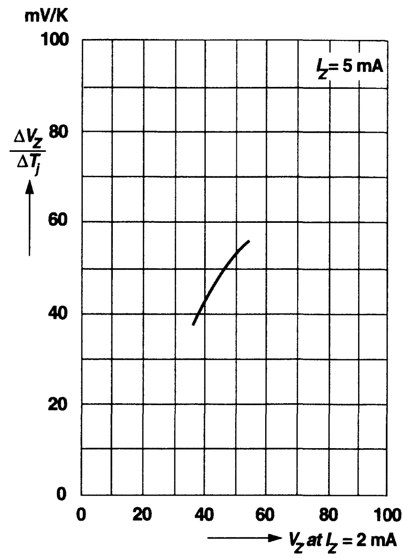
Temperature dependence of Zener voltage versus Zener voltage



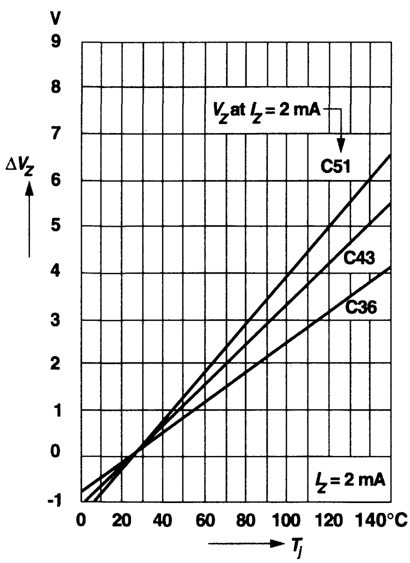
Change of Zener voltage versus junction temperature



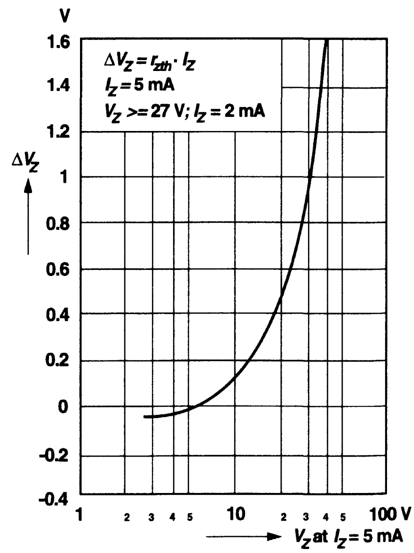
Temperature dependence of Zener voltage versus Zener voltage



Change of Zener voltage versus junction temperature

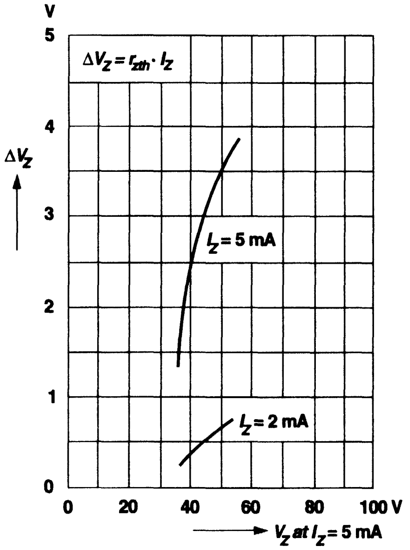


Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



RATINGS AND CHARACTERISTICS CURVES BZX84-C2V4 THRU BZX84-C75

Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage

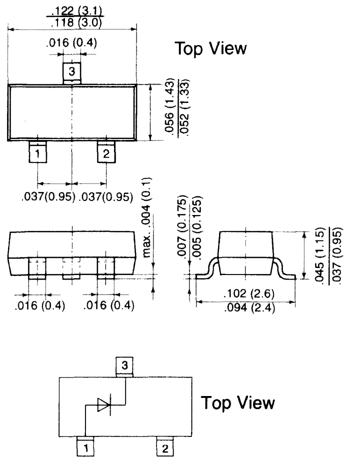


ADVANCED INFORMATION

MMBZ4617 THRU MMBZ4627

ZENER DIODES

SOT-23



Dimensions in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Low Noise Zener Diodes
- ♦ 350mW high quality voltage regulator designed for low leakage, low current and low noise applications
- ♦ 5% Tolerance on V_Z
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals.

MECHANICAL DATA

Case: SOT-23 Plastic Package
Weight: approx. 0.008 g
Terminals: Solderable per MIL-STD-750, method 2026.

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

		SYMBOL	*VALUE*	*UNIT*
Power Dissipation		P_{tot}	350(1)	mW
Forward Voltage at I_F = 200 mA	Maximum Typical	V_F	1.1 0.97	Volts
Maximum Junction Temperature		T_j	150	°C
Storage Temperature Range		T_S	–55 to +150	°C
Thermal Resistance Junction to Ambient		$R_{\Theta JA}$	420(1)	°C/W

NOTES:
(1) On FR-5 board using recommended solder pad layout.

MMBZ4617 THRU MMBZ4627

ELECTRICAL CHARACTERISTICS

(T_A = 25°C unless otherwise noted)

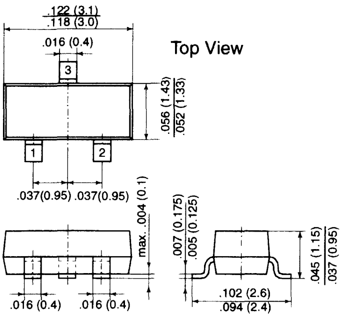
Part Number	Marking Code	Zener[1] Voltage V_Z @ I_{ZT}	Test Current I_{ZT}	Max. Zener Impedance Z_{ZT} @ I_{ZT}	Max. Reverse Leakage Current I_R @ V_R		Max. Zener Current I_{ZM}	Max. Noise Density N_D @ I_{ZT} = 250μA
		Volts	μA	Ω	μA	Volts	mA	$\frac{\mu V}{\sqrt{Hz}}$
MMBZ4617	G17	2.4	250	1400	2.0	1.0	95	1.0
MMBZ4618	G18	2.7	250	1500	1.0	1.0	90	1.0
MMBZ4619	G19	3.0	250	1600	0.8	1.0	85	1.0
MMBZ4620	G20	3.3	250	1650	7.5	1.5	80	1.0
MMBZ4621	G21	3.6	250	1700	7.5	2.0	75	1.0
MMBZ4622	G22	3.9	250	1650	5.0	2.0	70	1.0
MMBZ4623	G23	4.3	250	1600	4.0	2.0	65	1.0
MMBZ4624	G24	4.7	250	1550	10	3.0	60	1.0
MMBZ4625	G25	5.1	250	1500	10	3.0	55	2.0
MMBZ4626	G26	5.6	250	1400	10	4.0	50	4.0
MMBZ4627	G27	6.2	250	1200	10	5.0	45	5.0

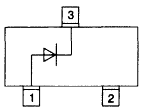
NOTES:
(1) V_Z tested with 5ms pulse.

MMBZ4681 THRU MMBZ4717

ZENER DIODES

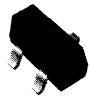
SOT-23





Dimensions in inches and (millimeters)

FEATURES



- ♦ Silicon Planar Zener Diodes
- ♦ Standard Zener voltage tolerance is ±5%. Other tolerances are available upon request
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals.
- ♦ These diodes are also available in DO-35 case with the type designation 1N4681 ... 1N4717 and SOD-123 case with the type designation MMSZ4681 ... MMSZ4717.

MECHANICAL DATA

Case: SOT-23 Plastic Package
Weight: approx. 0.008 g
Terminals: Solderable per MIL-STD-750, method 2026.

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_A = 25°C	P_{tot}	350(1)	mW
Maximum Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	–55 to +150	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	420(1)	°C/W
Forward Voltage at I_F = 10 mA	V_F	–	–	0.9	Volts

NOTES:
(1) On FR-5 board using recommended solder pad layout.

MMBZ4681 THRU MMBZ4717

ELECTRICAL CHARACTERISTICS

(T_A = 25°C unless otherwise noted)

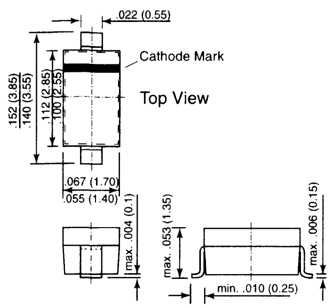
Type	Marking Code	Zener Voltage[1] V_Z @ I_{ZT} - 50μA (Volts)			Max Reverse Current I_R (μA)	Test Voltage V_R (Volts)
		Norm[1]	Min	Max		
MMBZ4681	CF	2.4	2.28	2.52	2.0	1.0
MMBZ4682	CH	2.7	2.57	2.84	1.0	1.0
MMBZ4683	CJ	3.0	2.85	3.15	0.8	1.0
MMBZ4684	CK	3.3	3.14	3.47	7.5	1.5
MMBZ4685	CM	3.6	3.42	3.78	7.5	2.0
MMBZ4686	CN	3.9	3.71	4.10	5.0	2.0
MMBZ4687	CP	4.3	4.09	4.52	4.0	2.0
MMBZ4688	CT	4.7	4.47	4.94	10.0	3.0
MMBZ4689	CU	5.1	4.85	5.36	10.0	3.0
MMBZ4690	CV	5.6	5.32	5.88	10.0	4.0
MMBZ4691	CA	6.2	5.89	6.51	10.0	5.0
MMBZ4692	CX	6.8	6.46	7.14	10.0	5.1
MMBZ4693	CY	7.5	7.13	7.88	10.0	5.7
MMBZ4694	CZ	8.2	7.79	8.61	1.0	6.2
MMBZ4695	DC	8.7	8.27	9.14	1.0	6.6
MMBZ4696	DD	9.1	8.65	9.56	1.0	6.9
MMBZ4697	DE	10.0	9.50	10.5	1.0	7.6
MMBZ4698	DF	11.0	10.50	11.6	0.05	8.4
MMBZ4699	DH	12.0	11.40	12.6	0.05	9.1
MMBZ4700	DJ	13.0	12.40	13.7	0.05	9.8
MMBZ4701	DK	14.0	13.30	14.7	0.05	10.6
MMBZ4702	DM	15.0	14.30	15.8	0.05	11.4
MMBZ4703	DN	16.0	15.20	16.8	0.05	12.1
MMBZ4704	DP	17.0	16.20	17.9	0.05	12.9
MMBZ4705	DT	18.0	17.10	18.9	0.05	13.6
MMBZ4706	DU	19.0	18.10	20.0	0.05	14.4
MMBZ4707	DV	20.0	19.00	21.0	0.01	15.2
MMBZ4708	DA	22.0	20.90	23.1	0.01	16.7
MMBZ4709	DZ	24.0	22.80	25.2	0.01	18.2
MMBZ4710	DY	25.0	23.80	26.3	0.01	19.0
MMBZ4711	EA	27.0	25.70	28.4	0.01	20.4
MMBZ4712	EC	28.0	26.60	29.4	0.01	21.2
MMBZ4713	ED	30.0	28.50	31.5	0.01	22.8
MMBZ4714	EE	33.0	31.40	34.7	0.01	25.0
MMBZ4715	EF	36.0	34.20	37.8	0.01	27.3
MMBZ4716	EH	39.0	37.10	41.0	0.01	29.6
MMBZ4717	EJ	43.0	40.90	45.2	0.01	32.6

NOTES:
(1) Tested with pulse test current

BZT52-C2V4 THRU BZT52-C75

ZENER DIODES

SOD-123



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ The Zener voltages are graded according to the international E 24 standard. Standard Zener voltage tolerance is ±5%. Replace suffix "C" with "B" for ±2% tolerance. Other tolerances and other Zener voltages are available upon request.

- ♦ These diodes are also available in other case styles and other configurations including: the SOT-23 case with type designation BZX84 series, the dual zener diode common anode configuration in the SOT-23 case with type designation AZ23 series and the dual zener diode common cathode configuration in the SOT-23 case with type designation DZ23 series.

MECHANICAL DATA

Case: SOD-123 Plastic Case
Weight: approx. 0.01 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at Tamb = 25°C	P_{tot}	410[1]	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 65 to +150	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	300[2]	°C/W

NOTES:
(1) Diode on Ceramic Substrate 0.7mm; 2.5mm^2 area
(2) Valid provided that electrodes are kept at ambient temperature

12/10/98

GENERAL SEMICONDUCTOR®

BZT52-C2V4 THRU BZT52-C75

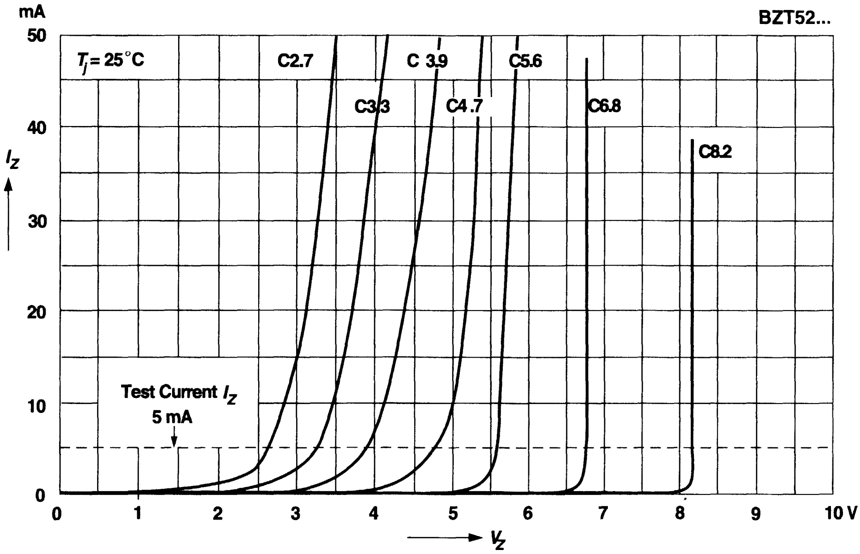
ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

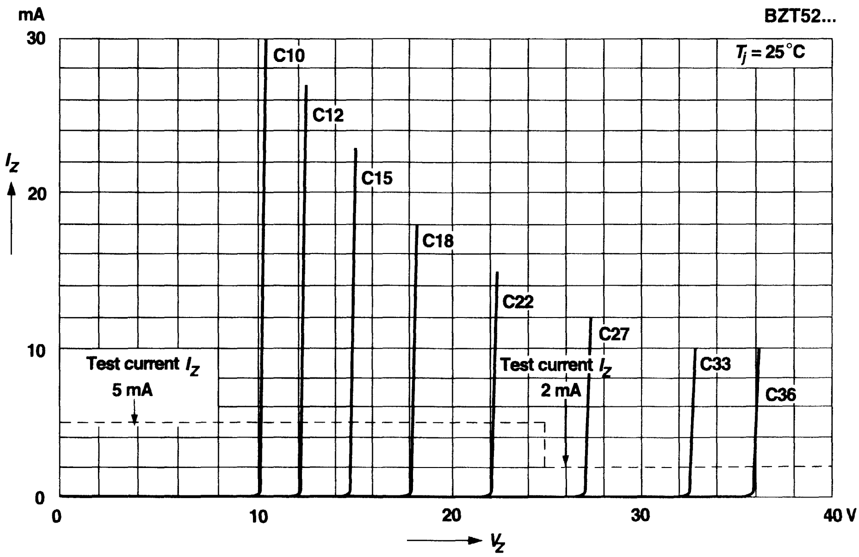
Type	Zener Voltage[1] at I_Z = 5 mA V_Z V	Dynamic Resistance		Temp. Coeff. of Zener Voltage at I_Z = 5 mA $\alpha_{VZ} 10^{-4}/K$	Reverse Voltage at I_R = 100 nA V_R V	Admissable Zener current[4]	
		at I_Z = 5 mA f = 1 kHz r_{zj} Ω	at I_Z = 1 mA f = 1 kHz r_{zj} Ω			at T_{amb} = 45°C I_Z mA	at T_{amb} = 25°C I_Z mA
BZT52-C2V4	2.28 ... 2.56	85	600	typ. −1.8	–	–	–
BZT52-C2V7	2.5 ... 2.9	75 (< 83)	< 500	− 9 ... − 4	–	113	134
BZT52-C3	2.8 ... 3.2	80 (< 95)	< 500	− 9 ... − 3	–	98	118
BZT52-C3V3	3.1 ... 3.5	80 (< 95)	< 500	− 8 ... − 3	–	92	109
BZT52-C3V6	3.4 ... 3.8	80 (< 95)	< 500	− 8 ... − 3	–	85	100
BZT52-C3V9	3.7 ... 4.1	80 (< 95)	< 500	− 7 ... − 3	–	77	92
BZT52-C4V3	4.0 ... 4.6	80 (< 95)	< 500	− 6 ... − 1	–	71	84
BZT52-C4V7	4.4 ... 5.0	70 (< 78)	< 500	− 5 ... +2	–	64	76
BZT52-C5V1	4.8 ... 5.4	30 (< 60)	< 480	− 3 ... +4	> 0.8	56	67
BZT52-C5V6	5.2 ... 6.0	10 (< 40)	< 400	− 2 ... +6	> 1	50	59
BZT52-C6V2	5.8 ... 6.6	4.8 (< 10)	< 200	− 1 ... +7	> 2	45	54
BZT52-C6V8	6.4 ... 7.2	4.5 (< 8)	< 150	+2 ... +7	> 3	41	49
BZT52-C7V5	7.0 ... 7.9	4 (< 7)	< 50	+3 ... +7	> 5	37	44
BZT52-C8V2	7.7 ... 8.7	4.5 (< 7)	< 50	+4 ... +7	> 6	34	40
BZT52-C9V1	8.5 ... 9.6	4.8 (< 10)	< 50	+5 ... +8	> 7	30	36
BZT52-C10	9.4 ... 10.6	5.2 (< 15)	< 70	+5 ... +8	> 7.5	28	33
BZT52-C11	10.4 ... 11.6	6 (< 20)	< 70	+5 ... +9	> 8.5	25	30
BZT52-C12	11.4 ... 12.7	7 (< 20)	< 90	+6 ... +9	> 9	23	28
BZT52-C13	12.4 ... 14.1	9 (< 25)	< 110	+7 ... +9	> 10	21	25
BZT52-C15	13.8 ... 15.6	11 (< 30)	< 110	+7 ... +9	> 11	19	23
BZT52-C16	15.3 ... 17.1	13 (< 40)	< 170	+8 ... +9.5	> 12	17	20
BZT52-C18	16.8 ... 19.1	18 (< 50)	< 170	+8 ... +9.5	> 14	15	18
BZT52-C20	18.8 ... 21.2	20 (< 50)	< 220	+8 ... +10	> 15	14	17
BZT52-C22	20.8 ... 23.3	25 (< 55)	< 220	+8 ... +10	> 17	13	16
BZT52-C24	22.8 ... 25.6	28 (< 80)	< 220	+8 ... +10	> 18	11	13
BZT52-C27	25.1 ... 28.9	30 (< 80)	< 250	+8 ... +10	> 20	10	12
BZT52-C30	28 ... 32	35 (< 80)	< 250	+8 ... +10	> 22.5	9	10
BZT52-C33	31 ... 35	40 (< 80)	< 250	+8 ... +10	> 25	8	9
BZT52-C36	34 ... 38	40 (< 90)	< 250	+8 ... +10	> 27	8	9
BZT52-C39	37 ... 41	50 (< 90)	< 300	+10 ... +12	> 29	7	8
BZT52-C43	40 ... 46	60 (< 100)	< 700	+10 ... +12	> 32	6	7
BZT52-C47	44 ... 50	70 (< 100)	< 750	+10 ... +12	> 35	5	6
BZT52-C51	48 ... 54	70 (< 100)	< 750	+10 ... +12	> 38	5	6
BZT52-C56	52.0 ... 60.0[2]	< 135[2]	< 1000[3]	typ. +10[2]	–	–	–
BZT52-C62	58.0 ... 66.0[2]	< 150[2]	< 1000[3]	typ. +10[2]	–	–	–
BZT52-C68	64.0 ... 72.0[2]	< 200[2]	< 1000[3]	typ. +10[2]	–	–	–
BZT52-C75	70.0 ... 79.0[2]	< 250[2]	< 1500[3]	typ. +10[2]	–	–	–

NOTES:
(1) Tested with pulses t_p = 5 ms
(2) at I_Z = 2.5 mA
(3) at I_Z = 0.5 mA
(4) Valid provided that electrodes are kept at ambient temperature

Breakdown characteristics
T_j = constant (pulsed)



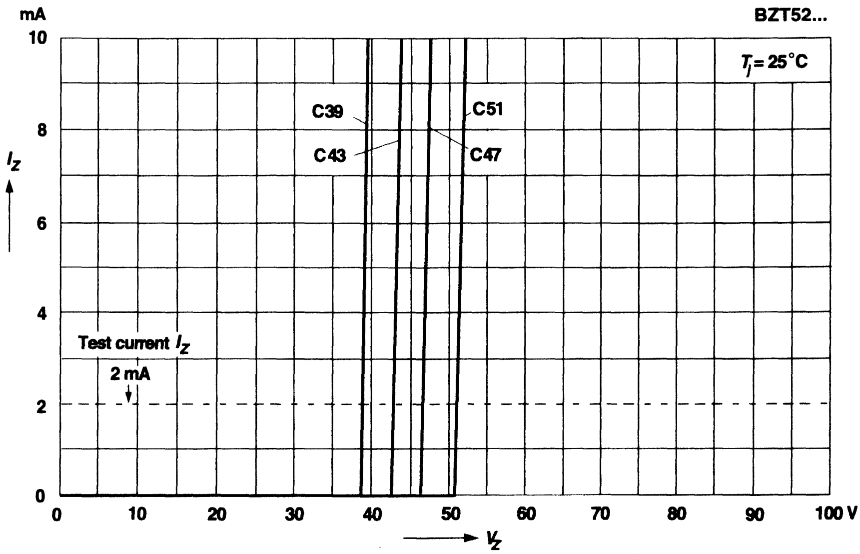
Breakdown characteristics
T_j = constant (pulsed)



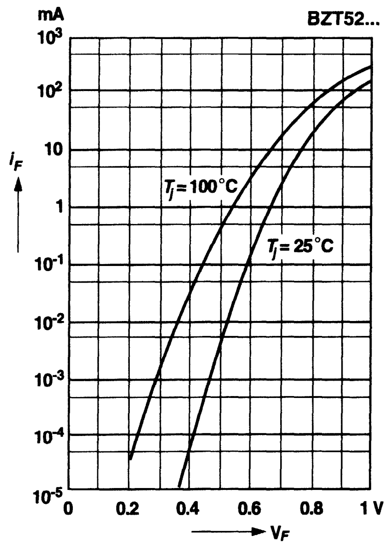
RATINGS AND CHARACTERISTIC CURVES BZT52-C2V4 THRU BZT52-C75

Breakdown characteristics

T_j = constant (pulsed)

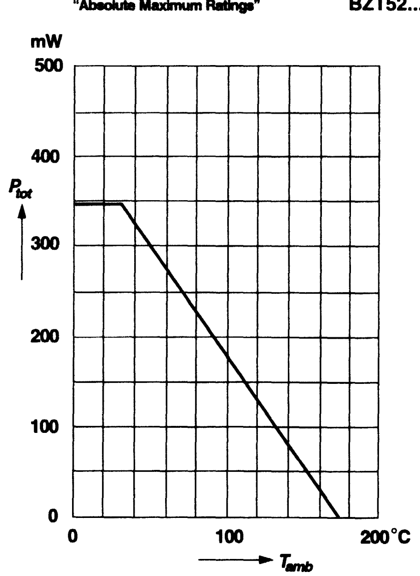


Forward characteristics



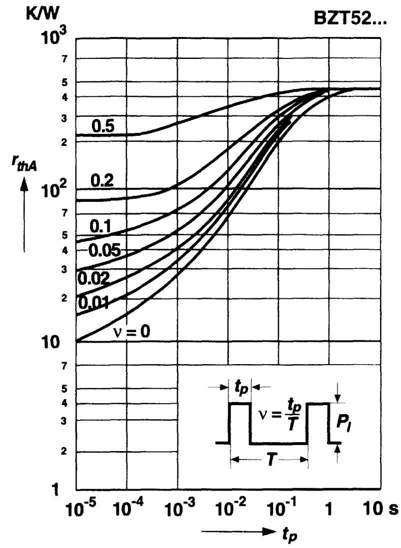
Admissible power dissipation versus ambient temperature

For conditions, see footnote in table "Absolute Maximum Ratings"

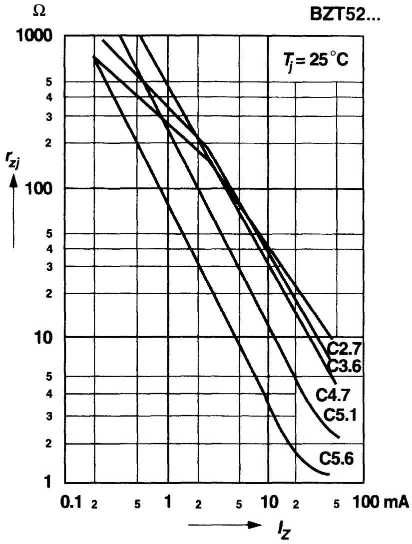


Pulse thermal resistance versus pulse duration

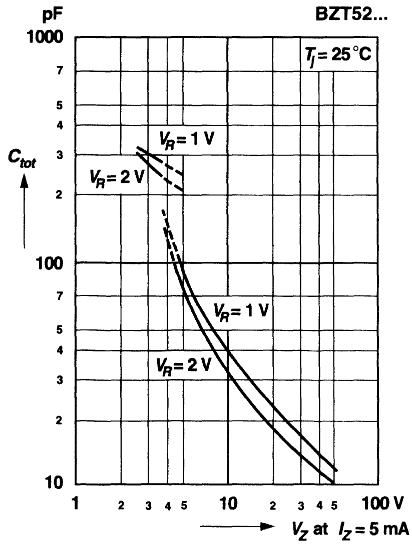
For conditions, see footnote in table "Absolute Maximum Ratings"



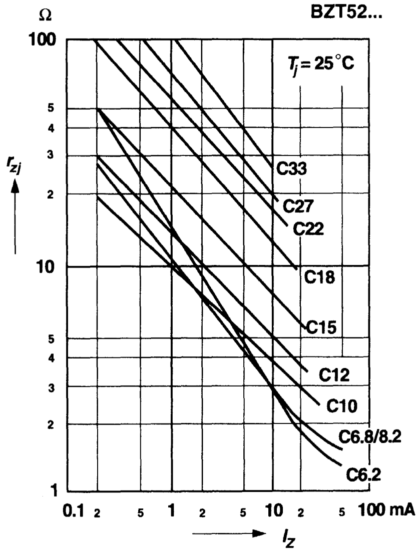
Dynamic resistance versus Zener current



Capacitance versus Zener voltage

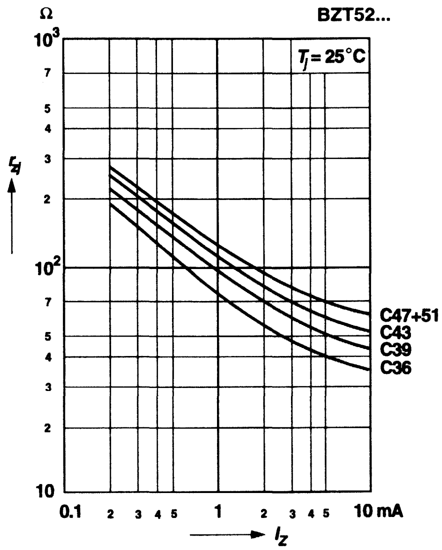


Dynamic resistance versus Zener current



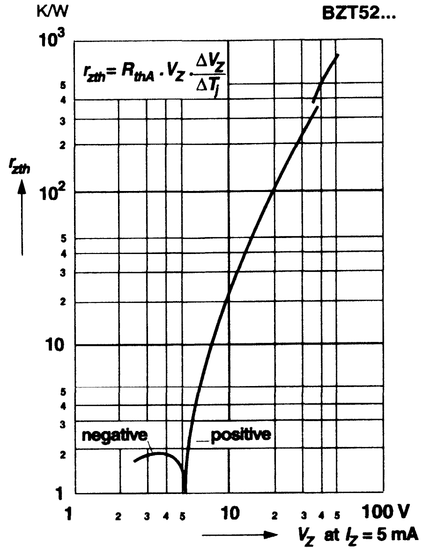
RATINGS AND CHARACTERISTIC CURVES BZT52-C2V4 THRU BZT52-C75

Dynamic resistance versus Zener current

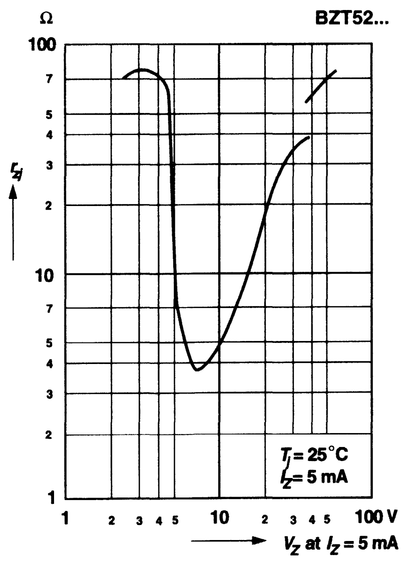


Thermal differential resistance versus Zener voltage

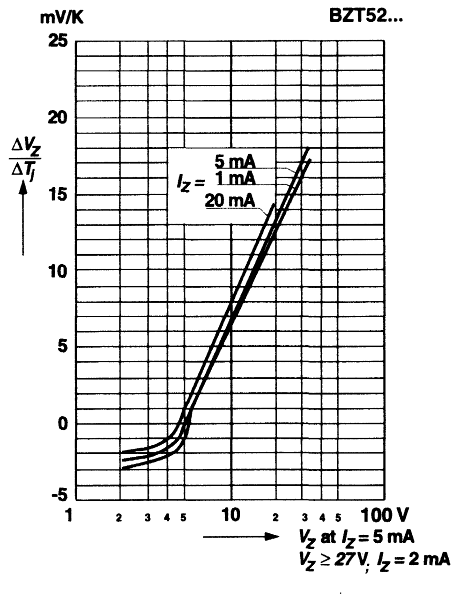
For conditions, see footnote in table "Absolute Maximum Ratings"



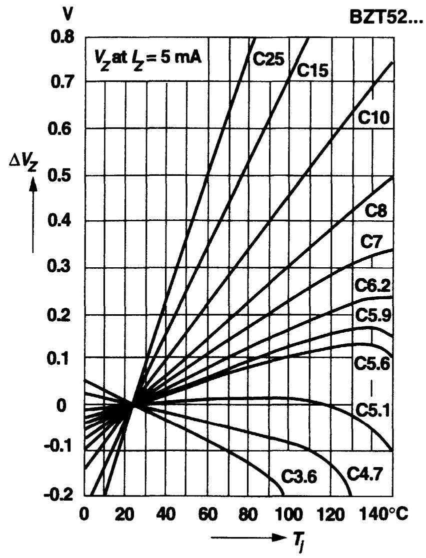
Dynamic resistance versus Zener voltage



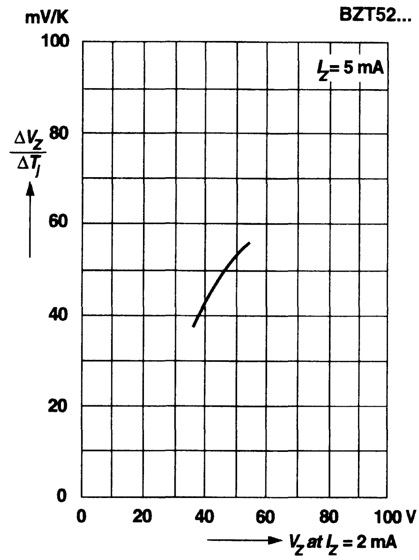
Temperature dependence of Zener voltage versus Zener voltage



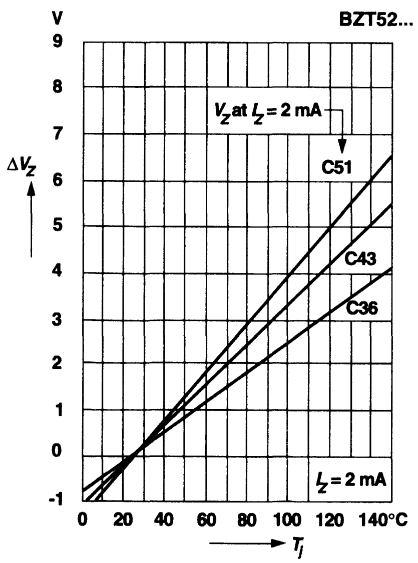
Change of Zener voltage versus junction temperature



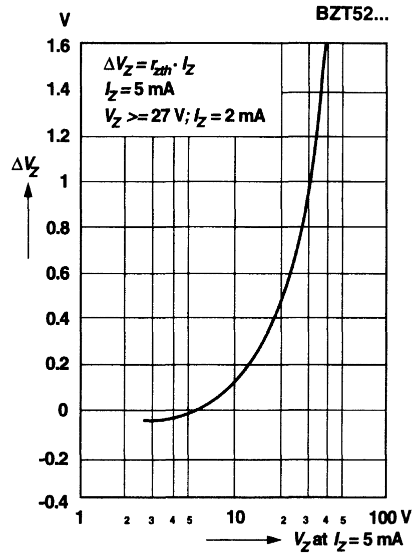
Temperature dependence of Zener voltage versus Zener voltage



Change of Zener voltage versus junction temperature

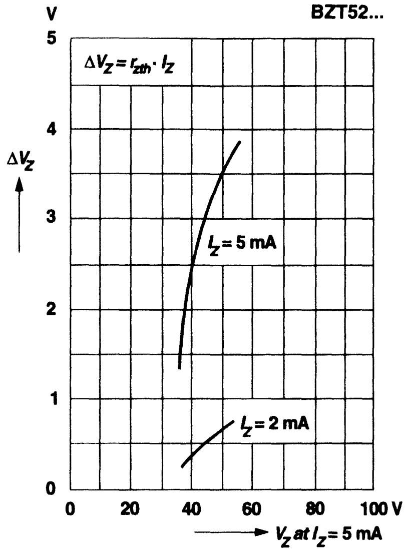


Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



RATINGS AND CHARACTERISTIC CURVES BZT52-C2V4 THRU BZT52-C75

Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage

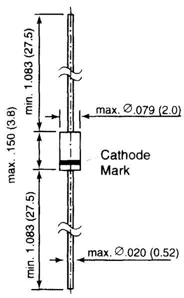


ADVANCED INFORMATION

1N4681 THRU 1N4717

ZENER DIODES

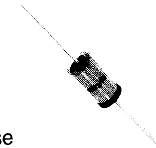
DO-35



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Zener Diodes
- ♦ Standard Zener voltage tolerance is ± 5%. Other tolerances are available upon request.
- ♦ High temperature soldering guaranteed: 250°C/10 seconds, 0.375" (9.5mm) lead length.
- ♦ These diodes are also available in SOD-123 case with the type designation MMSZ4681...MMSZ4717 and SOT-23 case with the type designation MMBZ4681...MMBZ4717.



MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g
Terminals: Solderable, per MIL-STD-750, method 2026.

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Zener Current (see Table "Characteristics")			
Power Dissipation at T_L = 75°C, 3/8" from case	P_{tot}	500	mW
Maximum Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +175	°C

	SYMBOL	MIN.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	300(1)	°C/W
Forward Voltage at I_F = 100 mA	V_F	–	1.5	Volts

NOTES:
(1) Valid provided that leads at a distance of 3/8" mm from case are kept at ambient temperature.

12/2/98

GENERAL SEMICONDUCTOR®

1N4681 THRU 1N4717

ELECTRICAL CHARACTERISTICS

(T_A = 25°C, unless otherwise specified.)

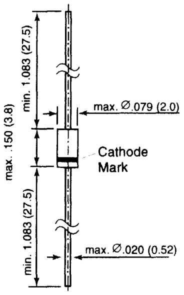
Type	Zener Voltage(1) V_Z @ I_Z = 50μA (Volts) Nominal	Min	Max	Max Reverse Current I_R (μA)	Test Voltage V_R (Volts)	Max Zener Current I_{ZM} (mA)	Max Voltage Change ΔV_Z (Volts)(2)
1N4678	1.8	1.71	1.89	7.5	1.0	120	0.70
1N4679	2.0	1.90	2.10	5.0	1.0	110	0.70
1N4680	2.2	2.09	2.31	4.0	1.0	100	0.75
1N4681	2.4	2.28	2.52	2.0	1.0	95.0	0.80
1N4682	2.7	2.57	2.84	1.0	1.0	90.0	0.85
1N4683	3.0	2.85	3.15	0.8	1.0	85.0	0.90
1N4684	3.3	3.14	3.47	7.5	1.5	80.0	0.95
1N4685	3.6	3.42	3.78	7.5	2.0	75.0	0.95
1N4686	3.9	3.71	4.10	5.0	2.0	70.0	0.97
1N4687	4.3	4.09	4.52	4.0	2.0	65.0	0.99
1N4688	4.7	4.47	4.94	10.0	3.0	60.0	0.99
1N4689	5.1	4.85	5.36	10.0	3.0	55.0	0.97
1N4690	5.6	5.32	5.88	10.0	4.0	50.0	0.96
1N4691	6.2	5.89	6.51	10.0	5.0	45.0	0.95
1N4692	6.8	6.46	7.14	10.0	5.1	35.0	0.90
1N4693	7.5	7.13	7.88	10.0	5.7	31.8	0.75
1N4694	8.2	7.79	8.61	1.0	6.2	29.0	0.50
1N4695	8.7	8.27	9.14	1.0	6.6	27.4	0.10
1N4696	9.1	8.65	9.56	1.0	6.9	26.2	0.08
1N4697	10	9.50	10.5	1.0	7.6	24.8	0.10
1N4698	11	10.5	11.6	0.05	8.4	21.6	0.11
1N4699	12	11.4	12.6	0.05	9.1	20.4	0.12
1N4700	13	12.4	13.7	0.05	9.8	19.0	0.13
1N4701	14	13.3	14.7	0.05	10.6	17.5	0.14
1N4702	15	14.3	15.8	0.05	11.4	16.3	0.15
1N4703	16	15.2	16.8	0.05	12.1	15.4	0.16
1N4704	17	16.2	17.9	0.05	12.9	14.5	0.17
1N4705	18	17.1	18.9	0.05	13.6	13.2	0.18
1N4706	19	18.1	20.0	0.05	14.4	12.5	0.19
1N4707	20	19.0	21.0	0.01	15.2	11.9	0.20
1N4708	22	20.9	23.1	0.01	16.7	10.8	0.22
1N4709	24	22.8	25.2	0.01	18.2	9.9	0.24
1N4710	25	23.8	26.3	0.01	19.0	9.5	0.25
1N4711	27	25.7	28.4	0.01	20.4	8.8	0.27
1N4712	28	26.6	29.4	0.01	21.2	8.5	0.28
1N4713	30	28.5	31.5	0.01	22.8	7.9	0.30
1N4714	33	31.4	34.7	0.01	25.0	7.2	0.33
1N4715	36	34.2	37.8	0.01	27.3	6.6	0.36
1N4716	39	37.1	41.0	0.01	29.6	6.1	0.39
1N4717	43	40.9	45.2	0.01	32.6	5.5	0.43

NOTES:
(1) Tested with pulses, t_p = 5ms
(2) ΔV_Z is the difference between V_Z at 100μA and at 10μA.

1N5225 THRU 1N5267

ZENER DIODES

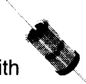
DO-35



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ Standard Zener voltage tolerance is ± 5% with a "B" suffix. Other tolerances are available upon request.
- ♦ These diodes are also available in Mini-MELF case with the type designation ZMM5225 ... ZMM5267, SOT-23 case with the type designation MMBZ5265 ... MMBZ5267 and SOD-23 case with the types designation MMSZ5225 ... MMSZ5267.



MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 75°C	P_{tot}	500(1)	mW
Maximum Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +175	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	300(1)	°C/W
Forward Voltage at I_F = 200 mA	V_F	–	–	1.1	Volts

NOTES:
Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature.

1N5225 THRU 1N5267

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Nominal Zener Voltage(3) at I_{ZT} V_Z (V)	Test Current I_{ZT} (mA)	Maximum Zener impedance(1)		Typical Temperature Coefficient α_{VZ} (% / K)	Maximum Reverse Leakage Current		Maximum Regulator Current(2) I_{ZM} (mA)
			at I_{ZT} Z_{ZT} (Ω)	at I_{ZK}=0.25mA Z_{ZK} (Ω)		I_R (μA)	Test Voltage V_R (V)	
1N5225	3.0	20	29	1600	– 0.075	50	1.0	152
1N5226	3.3	20	28	1600	–0.070	25	1.0	138
1N5227	3.6	20	24	1700	–0.065	15	1.0	126
1N5228	3.9	20	23	1900	–0.060	10	1.0	115
1N5229	4.3	20	22	2000	–0.055	5.0	1.0	106
1N5230	4.7	20	19	1900	±0.030	5.0	2.0	97
1N5231	5.1	20	17	1600	±0.030	5.0	2.0	89
1N5232	5.6	20	11	1600	+0.038	5.0	3.0	81
1N5233	6.0	20	7	1600	+0.038	5.0	3.5	76
1N5234	6.2	20	7	1000	+0.045	5.0	4.0	73
1N5235	6.8	20	5	750	+0.050	3.0	5.0	67
1N5236	7.5	20	6	500	+0.058	3.0	6.0	61
1N5237	8.2	20	8	500	+0.062	3.0	6.5	55
1N5238	8.7	20	8	600	+0.065	3.0	6.5	52
1N5239	9.1	20	10	600	+0.068	3.0	7.0	50
1N5240	10	20	17	600	+0.075	3.0	8.0	45
1N5241	11	20	22	600	+0.076	2.0	8.4	41
1N5242	12	20	30	600	+0.077	1.0	9.1	38
1N5243	13	9.5	13	600	+0.079	0.5	9.9	35
1N5244	14	9.0	15	600	+0.082	0.1	10	32
1N5245	15	8.5	16	600	+0.082	0.1	11	30
1N5246	16	7.8	17	600	+0.083	0.1	12	28
1N5247	17	7.4	19	600	+0.084	0.1	13	27
1N5248	18	7.0	21	600	+0.085	0.1	14	25
1N5249	19	6.6	23	600	+0.086	0.1	14	24
1N5250	20	6.2	25	600	+0.086	0.1	15	23
1N5251	22	5.6	29	600	+0.087	0.1	17	21
1N5252	24	5.2	33	600	+0.087	0.1	18	19.1
1N5253	25	5.0	35	600	+0.089	0.1	19	18.2
1N5254	27	4.6	41	600	+0.090	0.1	21	16.8
1N5255	28	4.5	44	600	+0.091	0.1	21	16.2
1N5256	30	4.2	49	600	+0.091	0.1	23	15.1
1N5257	33	3.8	58	700	+0.092	0.1	25	13.8
1N5258	36	3.4	70	700	+0.093	0.1	27	12.6
1N5259	39	3.2	80	800	+0.094	0.1	30	11.6
1N5260	43	3.0	93	900	+0.095	0.1	33	10.6
1N5261	47	2.7	105	1000	+0.095	0.1	36	9.7
1N5262	51	2.5	125	1100	+0.096	0.1	39	8.9
1N5263	56	2.2	150	1300	+0.096	0.1	43	–
1N5264	60	2.1	170	1400	+0.097	0.1	46	–
1N5265	62	2.0	185	1400	+0.097	0.1	47	–
1N5266	68	1.8	230	1600	+0.097	0.1	52	–
1N5267	75	1.7	270	1700	+0.098	0.1	56	–

NOTES:

(1) The Zener impedance is derived from the 1 kHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}. Zener impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units

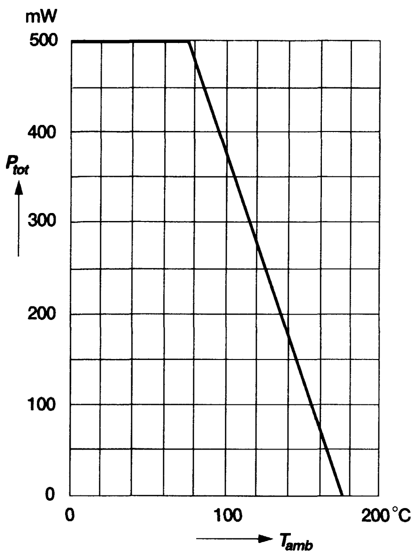
(2) Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature

(3) Measured with device junction in thermal equilibrium

GENERAL SEMICONDUCTOR®

Admissible power dissipation versus ambient temperature

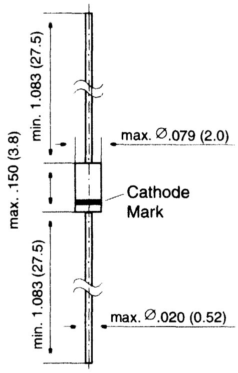
Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature



1N746 THRU 1N759

ZENER DIODES

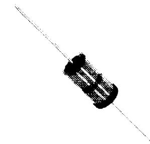
DO-35



Dimensions are in inches and (millimeters)

FEATURES

- Silicon Planar Power Zener Diodes
- Standard Zener voltage tolerance is ±5% for "A" suffix. Other tolerances are available upon request.



MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Zener Current (see Table "Characteristics")			
Power Dissipation at T_L = 75°C	P_{tot}	500[1]	mW
Maximum Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +175	°C

NOTES:
(1) T_L is measured 3/8" from body.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	300[1]	°C/W
Forward Voltage at I_F = 200 mA	V_F	–	–	1.5	Volts

NOTES:
(1) Valid provided that leads at a distance of 3/8" from case are kept at ambient temperature.

1N746 THRU 1N759

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type Number	Nominal Zener Voltage V_Z @ I_{ZT}(3) (Volts)	Test Current I_{ZT} (mA)	Maximum Zener Impedance Z_{ZT} @ I_{ZT}(1) (Ω)	Maximum Regulator Current I_{ZM}(2) (mA)	Maximum Reverse Leakage Current	
					T_A = 25°C I_R @ V_R = 1V (μA)	T_A = 150°C I_R @ V_R = 1V (μA)
1N746A	3.3	20	28	110	10	30
1N747A	3.6	20	24	100	10	30
1N748A	3.9	20	23	95	10	30
1N749A	4.3	20	22	85	2	30
1N750A	4.7	20	19	75	2	30
1N751A	5.1	20	17	70	1	20
1N752A	5.6	20	11	65	1	20
1N753A	6.2	20	7	60	0.1	20
1N754A	6.8	20	5	55	0.1	20
1N755A	7.5	20	6	50	0.1	20
1N756A	8.2	20	8	45	0.1	20
1N757A	9.1	20	10	40	0.1	20
1N758A	10	20	17	35	0.1	20
1N759A	12	20	30	30	0.1	20

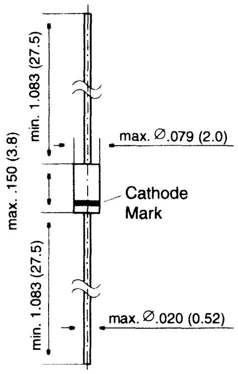
NOTES:

(1) The Zener Impedance is derived from the 1 KHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT}) is superimposed on I_{ZT}. Zener Impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units.
(2) Valid provided that leads at a distance of 3/8" from case are kept at ambient temperature.
(3) Measured with device junction in thermal equilibrium.

1N957 THRU 1N979

ZENER DIODES

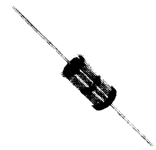
DO-35



Dimensions are in inches and (millimeters)

FEATURES

- Silicon Planar Power Zener Diodes
- Standard Zener voltage tolerance is ±5% for "B" suffix. Other tolerances are available upon request.



MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Zener Current (see Table "Characteristics")			
Power Dissipation at T_L = 75°C	P_{tot}	500(1)	mW
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +175	°C

NOTES:
(1) T_L is measured 3/8" from body.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	300(1)	°C/W
Forward Voltage at I_F = 200 mA	V_F	–	–	1.5	Volts

NOTES:
(1) Valid provided that leads at a distance of 3/8" from case are kept at ambient temperature.

1N957 THRU 1N979

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type Number	Nominal Zener Voltage V_Z(3) (Volts)	Test Current I_{ZT} (mA)	Maximum Zener Impedance(1)			Maximum Regulator Current I_{ZM}(2) (mA)	Maximum Reverse Current	
			Z_{ZT} @ I_{ZT} (Ω)	Z_{ZK} @ I_{ZK} (Ω)	I_{ZK} (mA)		I_R Maximum (μA)	Test Voltage Vdc (Volts)
1N957B	6.8	18.5	4.5	700	1	47	150	5.2
1N958B	7.5	16.5	5.5	700	0.5	42	75	5.7
1N959B	8.2	15	6.5	700	0.5	38	50	6.2
1N960B	9.1	14	7.5	700	0.5	35	25	6.9
1N961B	10	12.5	8.5	700	0.25	32	10	7.6
1N962B	11	11.5	9.5	700	0.25	28	5	8.4
1N963B	12	10.5	11.5	700	0.25	26	5	9.1
1N964B	13	9.5	13	700	0.25	24	5	9.9
1N965B	15	8.5	16	700	0.25	21	5	11.4
1N966B	16	7.8	17	700	0.25	19	5	12.2
1N967B	18	7	21	750	0.25	17	5	13.7
1N968B	20	6.2	25	750	0.25	15	5	15.2
1N969B	22	5.6	29	750	0.25	14	5	16.7
1N970B	24	5.2	33	750	0.25	13	5	18.2
1N971B	27	4.6	41	750	0.25	11	5	20.6
1N972B	30	4.2	49	1000	0.25	10	5	22.8
1N973B	33	3.8	58	1000	0.25	9.2	5	25.1
1N974B	36	3.4	70	1000	0.25	8.5	5	27.4
1N975B	39	3.2	80	1000	0.25	7.8	5	29.7
1N976B	43	3	93	1500	0.25	7	5	32.7
1N977B	47	2.7	105	1500	0.25	6.4	5	35.8
1N978B	51	2.5	125	1500	0.25	5.9	5	38.8
1N979B	56	2.2	150	2000	0.25	5.4	5	42.6

NOTES:

(1) The Zener Impedance is derived from the 1 KHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT}) is superimposed on I_{ZT}. Zener Impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units.

(2) Valid provided that leads at a distance of 3/8" from case are kept at ambient temperature.

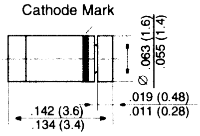
(3) Measured with device junction in thermal equilibrium.

NEW PRODUCT **NEW PRODUCT** **NEW PRODUCT**

BZV55 SERIES

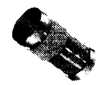
ZENER DIODES

Mini-MELF



Dimensions are in inches and (millimeters)

FEATURES



- ♦ Silicon Planar Power Zener Diodes
- ♦ For use as low voltage stabilizer or voltage reference.
- ♦ The Zener voltages are graded according to the international E 24 standard. Higher Zener voltages and 1% tolerance available on request.
- ♦ Diodes available in these tolerance series: ±2% BZV55-B, ±3% BZV55-F, ±5% BZV55-C.

MECHANICAL DATA

Case: Mini-MELF Glass Case (SOD-80)
Weight: approx. 0.05 g
Cathode band color: Blue

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current see Table "Characteristics"			
Power Dissipation at T_{flange} = 50°C	P_{tot}	500	mW
Power Dissipation at T_A = 50°C	P_{tot}	400 [1]	mW
Junction Temperature	T_j	–65 to +200	°C
Storage Temperature Range	T_S	–65 to +200	°C
Continuous Forward Current	I_F	250	mA
Peak reverse power disipation (non-repetitive) tp=100μs	P_{ZSM}	30 [2]	W

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}			0.38 [1]	K/mW
Thermal Resistance Junction to Lead	R_{thJL}			0.30	K/mW
Forward Voltage at I_F = 10 mA	V_F			0.9	V

NOTES:
1) Mounted on ceramic substrate 10mm x 10mm x 0.6mm
2) T_j = 150°C

BZV55 SERIES

ELECTRICAL CHARACTERISTICS

Type y=B for ±2%Vz y=F for ±3%Vz y=C for ±5%Vz	Dynamic Resistance at Iz = 5 mA f=1 kHz r_{zj} (Ω) max.	Dynamic Resistance at Iz = 1 mA f=1 kHz r_{zj} (Ω) max.	Temp. coefficient of Zener Voltage at Iz = 5 mA αvz (%/K) min.	max.	Reverse leakage current at T_{amb} = 25°C at I_R (μA)	V_R (V)
BZV55-y2V4	100	600	−0.08	−0.06	50	1
BZV55-y2V7	100	600	−0.08	−0.06	20	1
BZV55-y3V0	95	600	−0.08	−0.06	10	1
BZV55-y3V3	95	600	−0.08	−0.05	5	1
BZV55-y3V6	90	600	−0.08	−0.04	5	1
BZV55-y3V9	90	600	−0.07	−0.03	3	1
BZV55-y4V3	90	600	−0.04	−0.01	3	1
BZV55-y4V7	80	500	−0.03	+0.01	3	2
BZV55-y5V1	60	480	−0.02	+0.05	2	2
BZV55-y5V6	40	400	−0.01	+0.06	1	2
BZV55-y6V2	10	150	0	+0.07	3	4
BZV55-y6V8	15	80	+0.01	+0.08	2	4
BZV55-y7V5	15	80	+0.01	+0.09	1	5
BZV55-y8V2	15	80	+0.01	+0.09	0.7	5
BZV55-y9V1	15	100	+0.02	+0.10	0.5	6
BZV55-y10	20	150	+0.03	+0.11	0.2	7
BZV55-y11	20	150	+0.03	+0.11	0.1	8
BZV55-y12	25	150	+0.03	+0.11	0.1	8
BZV55-y13	30	170	+0.03	+0.11	0.1	8
BZV55-y15	30	200	+0.03	+0.11	0.05	10
BZV55-y16	40	200	+0.03	+0.11	0.05	11
BZV55-y18	45	225	+0.03	+0.11	0.05	13
BZV55-y20	55	225	+0.03	+0.11	0.05	14
BZV55-y22	55	250	+0.03	+0.11	0.05	15
BZV55-y24	70	250	+0.04	+0.12	0.05	17
BZV55-y27	80(3)	300(4)	+0.04(3)	+0.12 (3)	0.05	19
BZV55-y30	80(3)	300(4)	+0.04(3)	+0.12 (3)	0.05	21
BZV55-y33	80(3)	325(4)	+0.04(3)	+0.12 (3)	0.05	23
BZV55-y36	90(3)	350(4)	+0.04(3)	+0.12 (3)	0.05	25
BZV55-y39	130(3)	350(4)	+0.04(3)	+0.12 (3)	0.05	27
BZV55-y43	150(3)	375(4)	+0.04(3)	+0.12 (3)	0.05	30
BZV55-y47	170(3)	375(4)	+0.04(3)	+0.12 (3)	0.05	33
BZV55-y51	180(3)	400(4)	+0.04(3)	+0.12 (3)	0.05	36
BZV55-y56	200(3)	425(4)	typ. +0.1(3)		0.05	39
BZV55-y62	215(3)	450(4)	typ. +0.1(3)		0.05	43
BZV55-y68	240(3)	475(4)	typ. +0.1(3)		0.05	48
BZV55-y75	255(3)	500(4)	typ. +0.1(3)		0.05	53

(1) Tested with pulses tp = 5 ms.
(2) Valid provided that electrodes are kept at ambient temperature.
(3) at Iz = 2.0 mA
(4) at Iz = 0.5 mA
y = Zener voltage tolerance designator

BZV55 SERIES

ELECTRICAL CHARACTERISTICS

Type ±5% Tol.	Zener Voltage range[1] at Iz = 5 mA Vz V min.	 max.
BZV55-C2V4	2.20	2.60
BZV55-C2V7	2.50	2.90
BZV55-C3V0	2.80	3.20
BZV55-C3V3	3.10	3.50
BZV55-C3V6	3.40	3.80
BZV55-C3V9	3.70	4.10
BZV55-C4V3	4.00	4.60
BZV55-C4V7	4.40	5.00
BZV55-C5V1	4.80	5.40
BZV55-C5V6	5.20	6.00
BZV55-C6V2	5.80	6.60
BZV55-C6V8	6.40	7.20
BZV55-C7V5	7.00	7.90
BZV55-C8V2	7.70	8.70
BZV55-C9V1	8.50	9.60
BZV55-C10	9.40	10.60
BZV55-C11	10.40	11.60
BZV55-C12	11.40	12.70
BZV55-C13	12.40	14.10
BZV55-C15	13.80	15.60
BZV55-C16	15.30	17.10
BZV55-C18	16.80	19.10
BZV55-C20	18.80	21.20
BZV55-C22	20.80	23.30
BZV55-C24	22.80	25.60
BZV55-C27	25.10	28.90[3]
BZV55-C30	28.00	32.00[3]
BZV55-C33	31.00	35.00[3]
BZV55-C36	34.00	38.00[3]
BZV55-C39	37.00	41.00[3]
BZV55-C43	40.00	46.00[3]
BZV55-C47	44.00	50.00[3]
BZV55-C51	48.00	54.00[3]
BZV55-C56	52.00	60.00[3]
BZV55-C62	58.00	66.00[3]
BZV55-C68	64.00	72.00[3]
BZV55-C75	70.00	79.00[3]

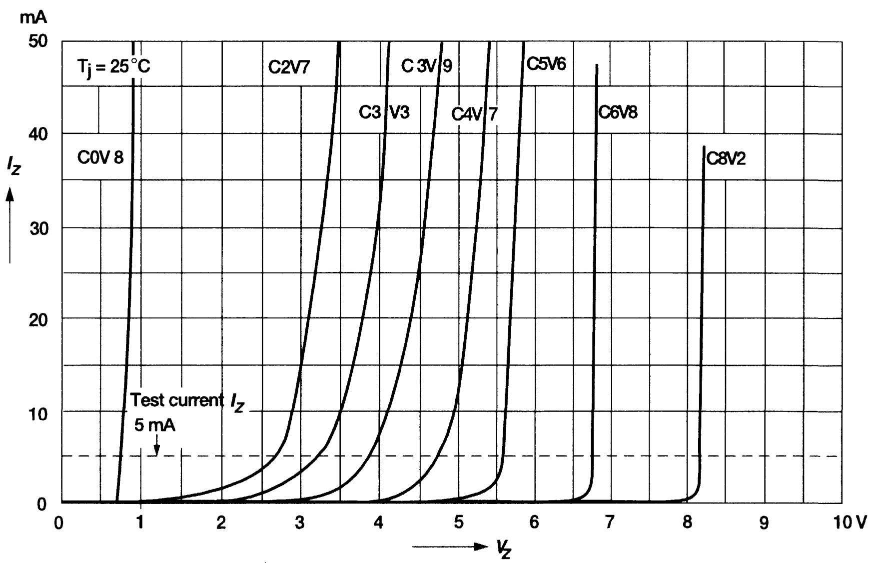
Type ±3% Tol.	Zener Voltage range[1] at Iz = 5 mA Vz V min.	 max.
BZV55-F2V4	2.33	2.47
BZV55-F2V7	2.62	2.78
BZV55-F3V0	2.91	3.09
BZV55-F3V3	3.20	3.40
BZV55-F3V6	3.49	3.71
BZV55-F3V9	3.78	4.02
BZV55-F4V3	4.17	4.43
BZV55-F4V7	4.56	4.84
BZV55-F5V1	4.95	5.25
BZV55-F5V6	5.43	5.77
BZV55-F6V2	6.01	6.39
BZV55-F6V8	6.60	7.00
BZV55-F7V5	7.28	7.72
BZV55-F8V2	7.95	8.45
BZV55-F9V1	8.83	9.37
BZV55-F10	9.70	10.30
BZV55-F11	10.67	11.33
BZV55-F12	11.64	12.36
BZV55-F13	12.61	13.39
BZV55-F15	14.55	15.45
BZV55-F16	15.50	16.50
BZV55-F18	17.50	18.50
BZV55-F20	19.40	20.60
BZV55-F22	21.30	22.70
BZV55-F24	23.30	24.70
BZV55-F27	26.20	27.80[3]
BZV55-F30	29.10	30.90[3]
BZV55-F33	32.00	34.00[3]
BZV55-F36	34.90	37.10[3]
BZV55-F39	37.80	40.20[3]
BZV55-F43	41.70	44.30[3]
BZV55-F47	45.60	48.40[3]
BZV55-F51	49.50	52.50[3]
BZV55-F56	54.30	57.70[3]
BZV55-F62	60.10	63.90[3]
BZV55-F68	66.00	70.00[3]
BZV55-F75	72.80	77.20[3]

Type ±2% Tol.	Zener Voltage range[1] at Iz = 5 mA Vz V min.	 max.
BZV55-B2V4	2.35	2.45
BZV55-B2V7	2.65	2.75
BZV55-B3V0	2.94	3.06
BZV55-B3V3	3.23	3.37
BZV55-B3V6	3.53	3.67
BZV55-B3V9	3.82	3.98
BZV55-B4V3	4.21	4.39
BZV55-B4V7	4.61	4.79
BZV55-B5V1	5.00	5.20
BZV55-B5V6	5.49	5.71
BZV55-B6V2	6.08	6.32
BZV55-B6V8	6.66	6.94
BZV55-B7V5	7.35	7.65
BZV55-B8V2	8.04	8.36
BZV55-B9V1	8.92	9.28
BZV55-B10	9.80	10.20
BZV55-B11	10.80	11.20
BZV55-B12	11.80	12.20
BZV55-B13	12.70	13.30
BZV55-B15	14.70	15.30
BZV55-B16	15.70	16.30
BZV55-B18	17.60	18.40
BZV55-B20	19.60	20.40
BZV55-B22	21.60	22.40
BZV55-B24	23.50	24.50
BZV55-B27	26.50	27.50[3]
BZV55-B30	29.40	30.60[3]
BZV55-B33	32.30	33.70[3]
BZV55-B36	35.30	36.70[3]
BZV55-B39	38.20	39.80[3]
BZV55-B43	42.10	43.90[3]
BZV55-B47	46.10	47.90[3]
BZV55-B51	50.00	52.00[3]
BZV55-B56	54.90	57.10[3]
BZV55-B62	60.80	63.20[3]
BZV55-B68	66.60	69.40[3]
BZV55-B75	73.50	76.50[3]

(1) Tested with pulses tp = 5 ms.
(2) Valid provided that electrodes are kept at ambient temperature.
(3) at Iz = 2.0 mA
See BZV55-y table for all characteristics other than zener voltage range.

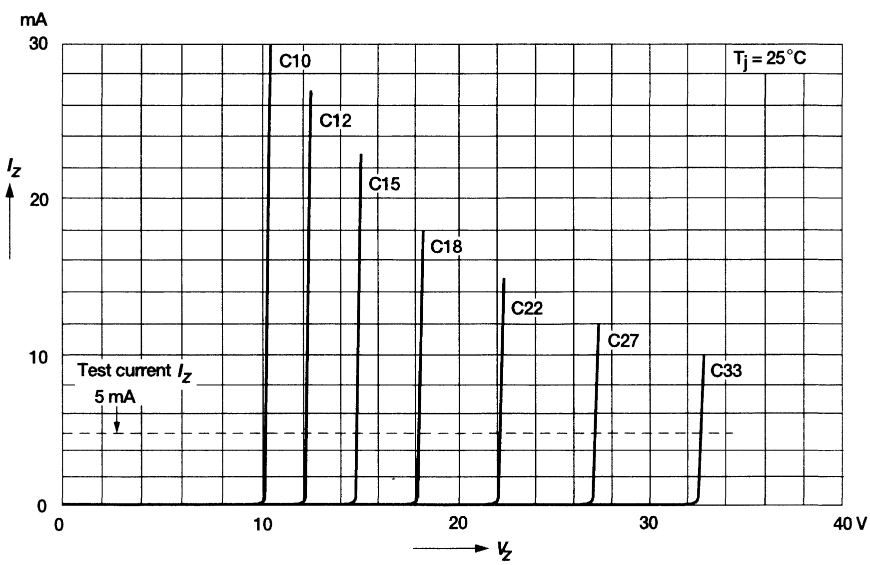
Breakdown characteristics

at T_j = constant (pulsed)



Breakdown characteristics

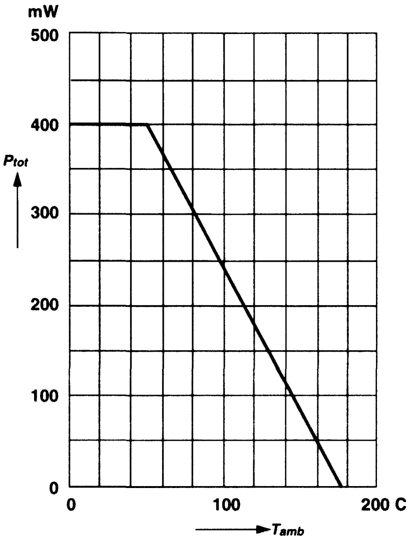
at T_j = constant (pulsed)



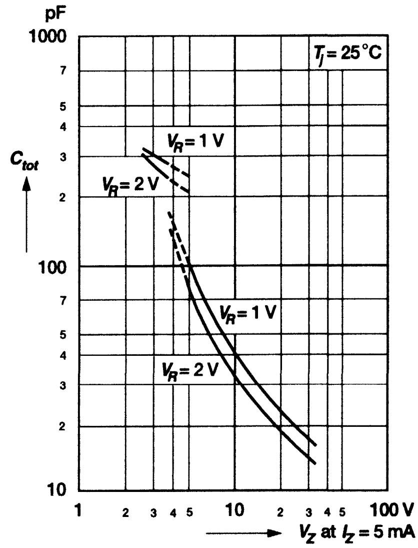
RATINGS AND CHARACTERISTIC CURVES BZV55 Series

Admissible power dissipation versus ambient temperature

Valid provided that leads are kept ambient temperature.

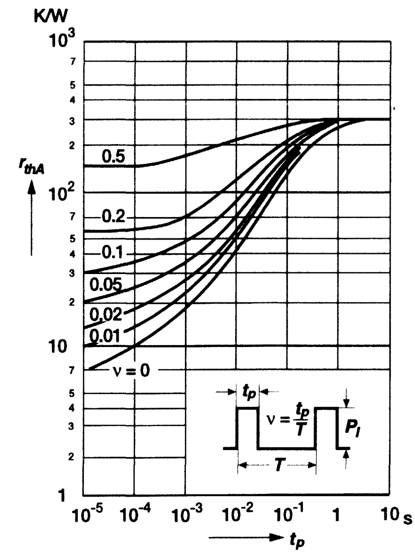


Capacitance versus Zener voltage

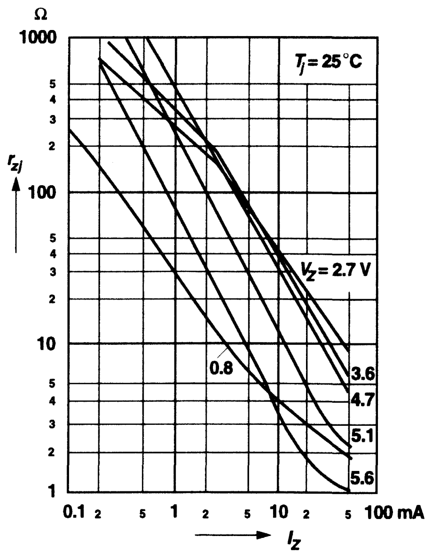


Pulse thermal resistance versus pulse duration

Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case.



Dynamic resistance versus Zener current



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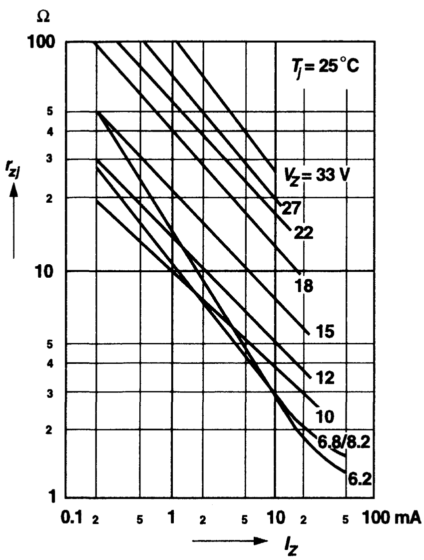
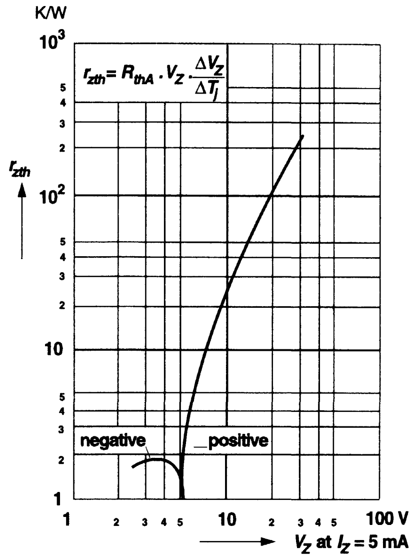
Dynamic resistance versus Zener current

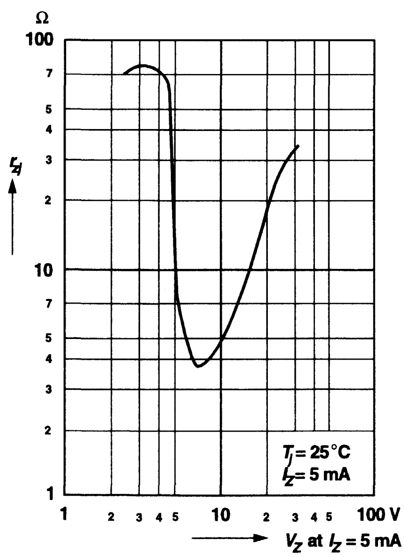


Thermal differential resistance versus Zener voltage

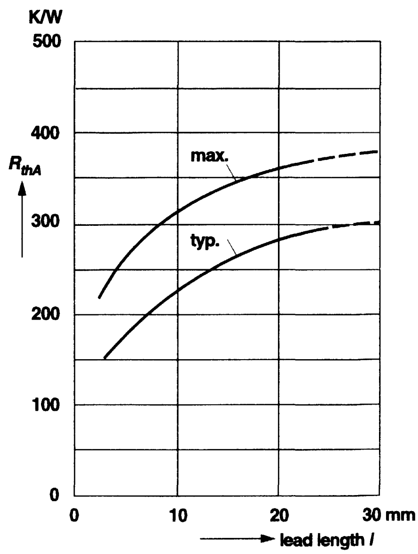
Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case.



Dynamic resistance versus Zener voltage

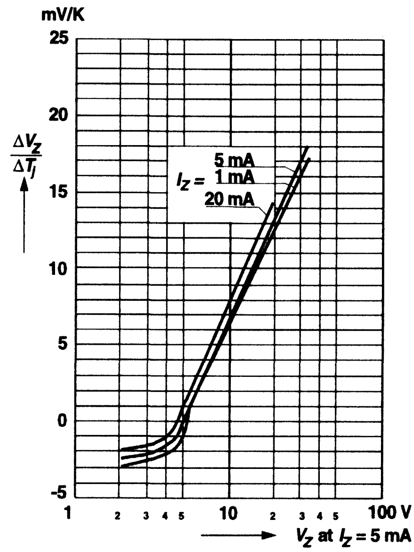


Thermal resistance versus lead length

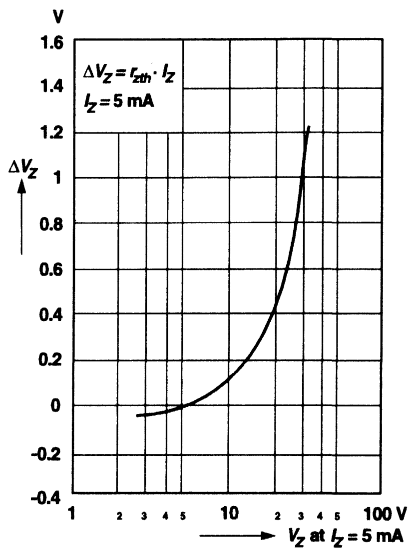


RATINGS AND CHARACTERISTIC CURVES BZV55 Series

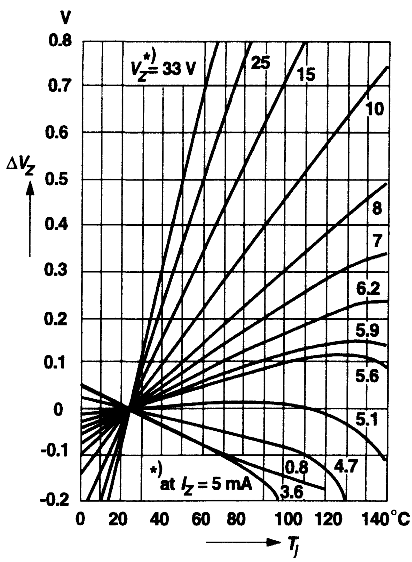
Temperature dependence of Zener voltage versus Zener voltage



Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



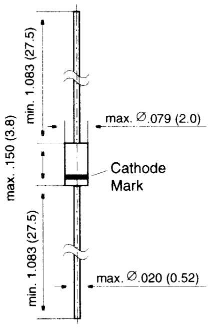
Change of Zener voltage versus junction temperature



BZX55-C0V8 THRU BZX55-C75

ZENER DIODES

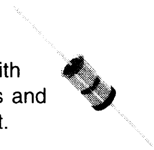
DO-35



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ The Zener voltages are graded according to the international E 24 standard. Standard Zener voltage tolerance is ±5%. Replace suffix “C” with “B” for ±2% tolerance. Other voltage tolerances and other Zener voltages are available upon request.



MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Zener Current (see Table “Characteristics”)			
Power Dissipation at Tamb = 25°C	P_{tot}	500(1)	mW
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 55 to +175	°C

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	300(1)	°C/W
Forward Voltage at I_F = 100 mA	V_F	–	–	1.0	Volts

NOTES:
(1) Valid provided that leads at a distance of 8 mm from case are kept at ambient temperature.

BZX55-C0V8 THRU BZX55-C75

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener Voltage range(1) at Iz = 5 mA	Dynamic resistance		Temp. coefficient of Zener Voltage at Iz = 5 mA αVz %/K		Reverse leakage current			Admissible Zener current(2)
		at Iz = 5 mA f = 1 kHz	at Iz = 1mA f = 1 kHz			at Tamb = 25°C	at Tamb = 150°C	at	
	Vz V	rzj Ω	rzj Ω	min	max	IR nA	IR µA	VR V	IZM mA
BZX55 – C0V8(3)	0.73 … 0.83	< 8	< 600	– 0.25	–	–	–	–	–
BZX55 – C2V7	2.5 … 2.9	< 85	< 600	– 0.08	– 0.06	< 10000	< 50	1	135
BZX55 – C3V0	2.8 … 3.2	< 85	< 600	– 0.08	– 0.06	< 4000	< 40	1	125
BZX55 – C3V3	3.1 … 3.5	< 85	< 600	– 0.08	– 0.05	< 2000	< 40	1	115
BZX55 – C3V6	3.4 … 3.9	< 85	< 600	– 0.08	– 0.04	< 2000	< 40	1	105
BZX55 – C3V9	3.7 … 4.1	< 85	< 600	– 0.07	– 0.03	< 2000	< 40	1	95
BZX55 – C4V3	4.0 … 4.6	< 75	< 600	– 0.04	– 0.01	< 1000	< 20	1	90
BZX55 – C4V7	4.4 … 5.0	< 60	< 600	– 0.03	+0.01	< 500	< 10	1	85
BZX55 – C5V1	4.8 … 5.4	< 35	< 550	– 0.02	+0.05	< 100	< 2	1	80
BZX55 – C5V6	5.2 … 6.0	< 25	< 450	– 0.01	+0.06	< 100	< 2	1	70
BZX55 – C6V2	5.8 … 6.6	< 10	< 200	0	+0.07	< 100	< 2	2	64
BZX55 – C6V8	6.4 … 7.2	< 8	< 150	+0.01	+0.08	< 100	< 2	3	58
BZX55 – C7V5	7.0 … 7.9	< 7	< 50	+0.01	+0.09	< 100	< 2	5	53
BZX55 – C8V2	7.7 … 8.7	< 7	< 50	+0.01	+0.09	< 100	< 2	6	47
BZX55 – C9V1	8.5 … 9.6	< 10	< 50	+0.02	+0.10	< 100	< 2	7	43
BZX55 – C10	9.4 … 10.6	< 15	< 70	+0.03	+0.11	< 100	< 2	7.5	40
BZX55 – C11	10.4 … 11.6	< 20	< 70	+0.03	+0.11	< 100	< 2	8.5	36
BZX55 – C12	11.4 … 12.7	< 20	< 90	+0.03	+0.11	< 100	< 2	9	32
BZX55 – C13	12.4 … 14.1	< 26	< 110	+0.03	+0.11	< 100	< 2	10	29
BZX55 – C15	13.8 … 15.6	< 30	< 110	+0.03	+0.11	< 100	< 2	11	27
BZX55 – C16	15.3 … 17.1	< 40	< 170	+0.03	+0.11	< 100	< 2	12	24
BZX55 – C18	16.8 … 19.1	< 50	< 170	+0.03	+0.11	< 100	< 2	14	21
BZX55 – C20	18.8 … 21.2	< 55	< 220	+0.03	+0.11	< 100	< 2	15	20
BZX55 – C22	20.8 … 23.3	< 55	< 220	+0.03	+0.11	< 100	< 2	17	18
BZX55 – C24	22.8 … 25.6	< 80	< 220	+0.04	+0.12	< 100	< 2	18	16
BZX55 – C27	25.1 … 28.9	< 80	< 220	+0.04	+0.12	< 100	< 2	20	14
BZX55 – C30	28 … 32	< 80	< 220	+0.04	+0.12	< 100	< 2	22	13
BZX55 – C33	31 … 35	< 80	< 220	+0.04	+0.12	< 100	< 2	24	12
BZX55 – C36	34 … 38	< 80	< 220	+0.04	+0.12	< 100	< 2	27	11
BZX55 – C39	37 … 41(4)	< 90(4)	< 500(5)	+0.04	+0.12	< 100	< 5	28	10
BZX55 – C43	40 … 46(4)	< 90(4)	< 600(5)	+0.04	+0.12	< 100	< 5	32	9.2
BZX55 – C47	44 … 50(4)	< 110(4)	< 700(5)	+0.04	+0.12	< 100	< 5	35	8.5
BZX55 – C51	48 … 54(4)	< 125(4)	< 700(5)	+0.04	+0.12	< 100	< 10	38	7.8
BZX55-C56	52.0 … 60.0(4)	< 135(4)	< 1000(5)	typ. +0.1(4)		< 100	< 10	42	7.0
BZX55-C62	58.0 … 66.0(4)	< 150(4)	< 1000(5)	typ. +0.1(4)		< 100	< 10	47	6.4
BZX55-C68	64.0 … 72.0(4)	< 200(4)	< 1000(5)	typ. +0.1(4)		< 100	< 10	51	5.9
BZX55-C75	70.0 … 79.0(4)	< 250(4)	< 1000(5)	typ. +0.1(4)		< 100	< 10	56	5.3

NOTES:

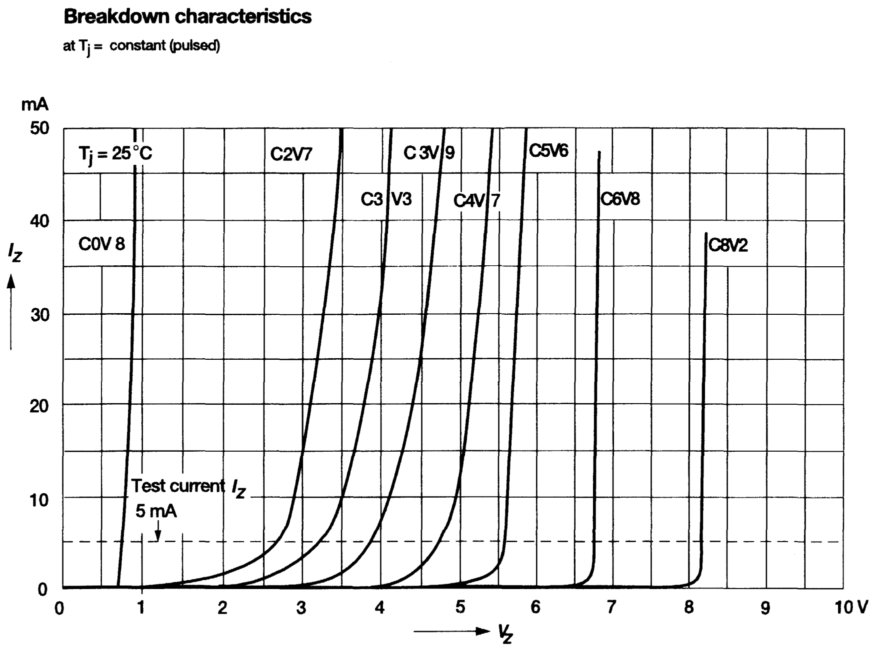
(1) Tested with pulses t_p = 5 ms

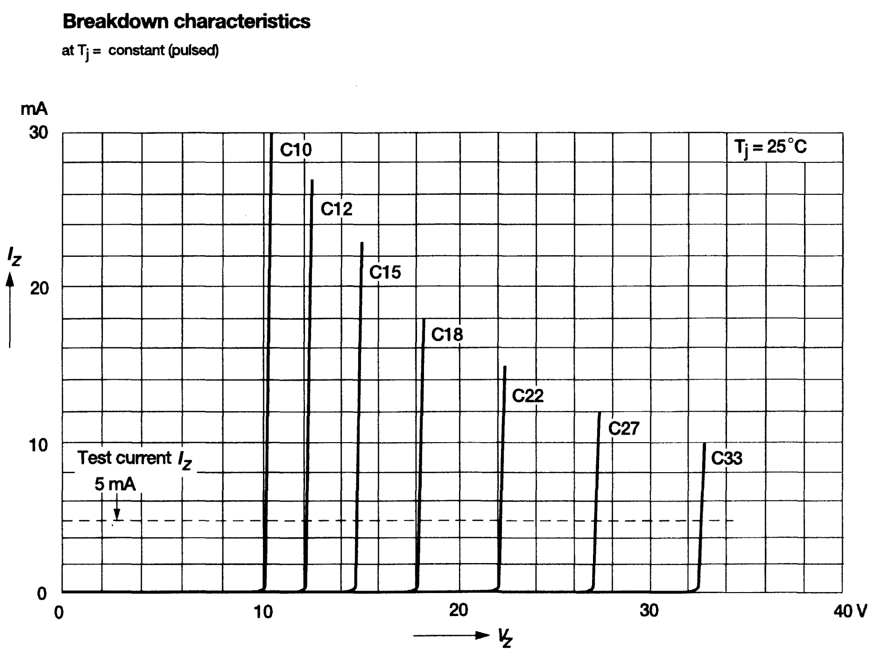
(2) Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case

(3) The BZX55–C0V8 is a silicon diode with operation in forward direction. Hence, the index of all parameters should be "F" instead of "Z". Connect the cathode lead to the negative pole

(4) at Iz = 2.5 mA

(5) at Iz = 0.5 mA

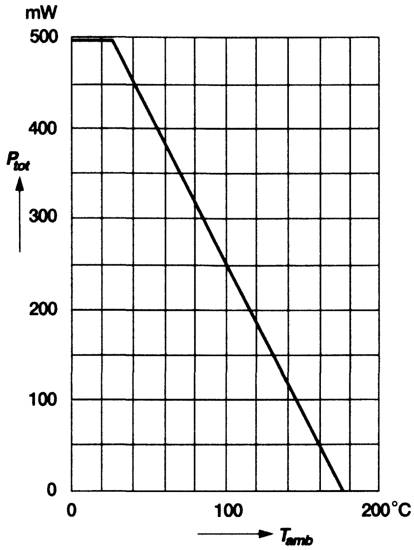

Breakdown characteristics
at T_j = constant (pulsed)
mA
50
40
30
20
10
0
I_Z
T_j = 25°C
C0V 8
C2V7
C3V3
C3V9
C4V7
C5V6
C6V8
C8V2
Test current I_Z
5 mA
0
1
2
3
4
5
6
7
8
9
10 V
V_Z


Breakdown characteristics
at T_j = constant (pulsed)
mA
30
20
10
0
I_Z
T_j = 25°C
C10
C12
C15
C18
C22
C27
C33
Test current I_Z
5 mA
0
10
20
30
40 V
V_Z

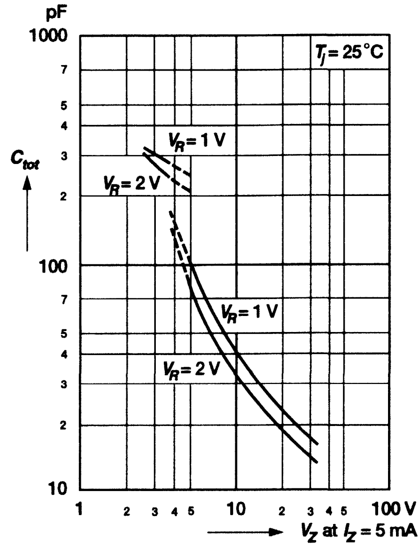
RATINGS AND CHARACTERISTIC CURVES BZX55-C0V8 THRU BZX55-C75

Admissible power dissipation versus ambient temperature

Valid provided that leads are kept ambient temperature at a distance of 8 mm from case.

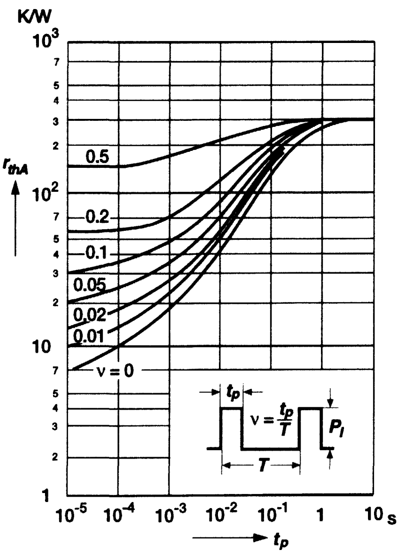


Capacitance versus Zener voltage

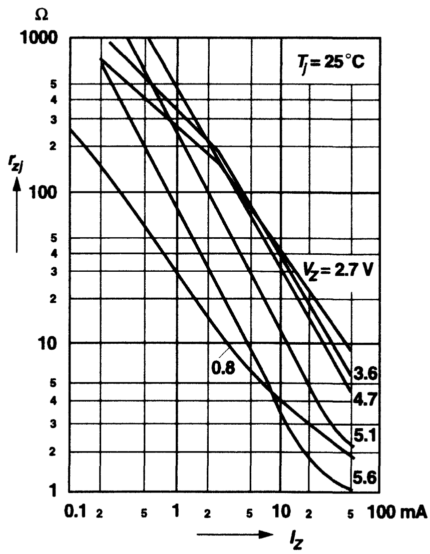


Pulse thermal resistance versus pulse duration

Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case.

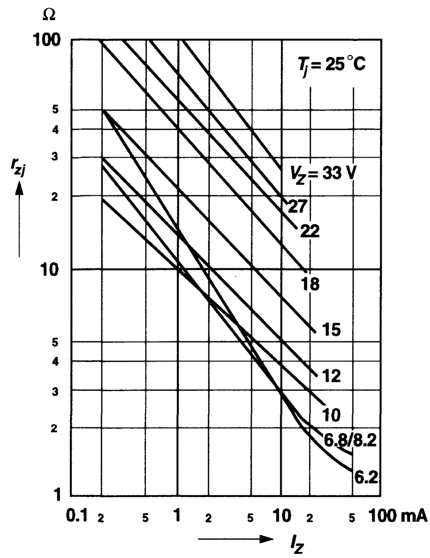


Dynamic resistance versus Zener current



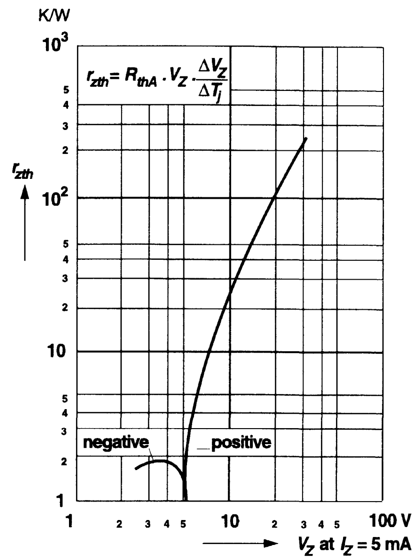
General Semiconductor®

Dynamic resistance versus Zener current

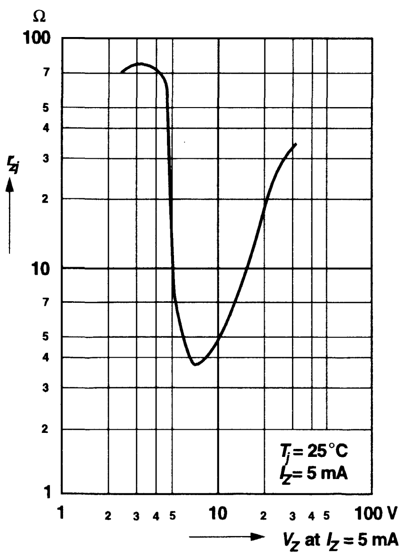


Thermal differential resistance versus Zener voltage

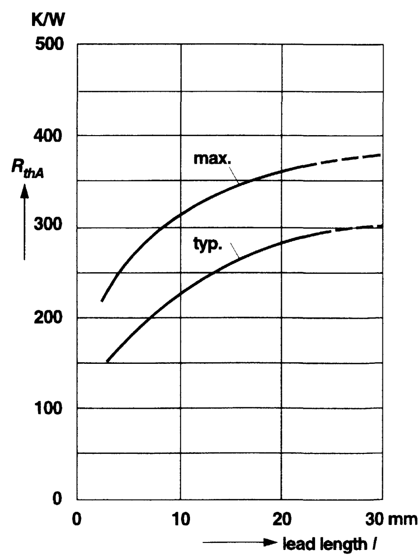
Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case.



Dynamic resistance versus Zener voltage

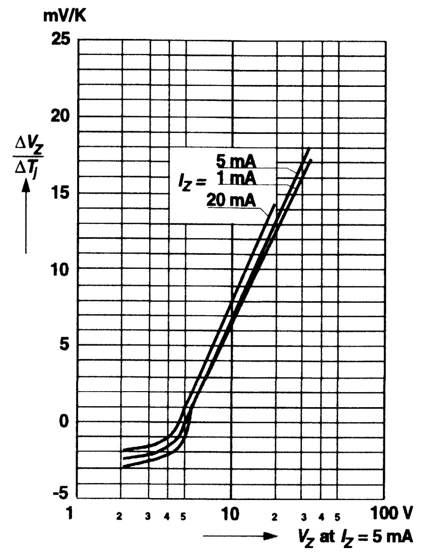


Thermal resistance versus lead length

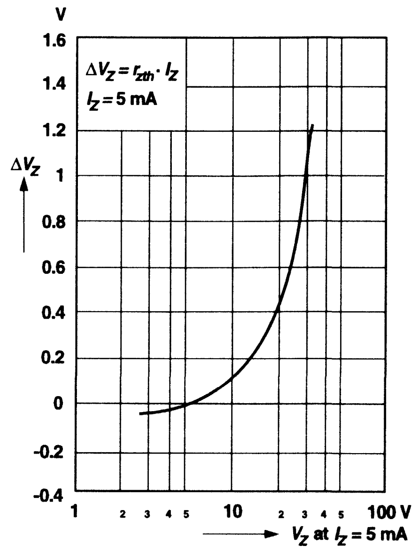


RATINGS AND CHARACTERISTIC CURVES BZX55-C0V8 THRU BZX55-C75

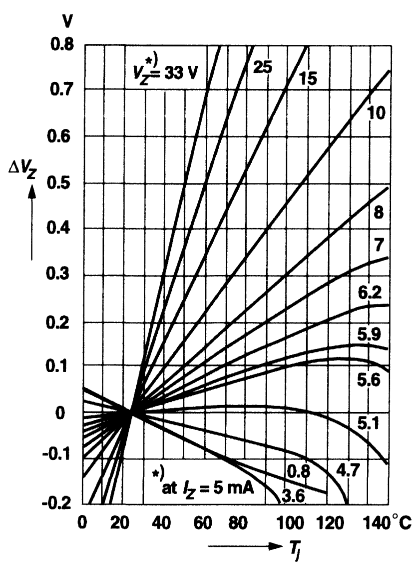
Temperature dependence of Zener voltage versus Zener voltage



Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



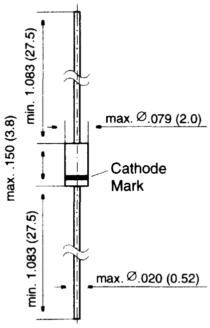
Change of Zener voltage versus junction temperature



BZX79 SERIES

SILICON PLANAR ZENER DIODES

DO-35

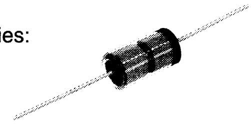


Dimensions in inches and (millimeters)

FEATURES

The Zener voltages are graded according to the international E 24 standard. Higher Zener voltages and 1% tolerance available on request.

Diodes available in these tolerance series:



±2% BZX79-B
±3% BZX79-F
±5% BZX79-C

MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature 8unless otherwise specified

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table “Characteristics”)			
Power Dissipation at T_{amb} = 25°C	P_{tot}	500(1)	mW
Junction Temperature	T_j	-65 to 200	°C
Storage Temperature Range	T_S	-65 to + 200	°C
Continuous Forward Current	I_F	250	mA
Peak reverse power dissipation (non-repetitive) t_p=100ms, square wave	P_{ZSM}	40	Watts

Characteristics at Tamb = 25°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	0.3(1)	°C/W
Forward Voltage at I_F = 10 mA	V_F	–	–	0.9	Volts

NOTES:
(1) Valid provided that leads are kept at ambient temperature at a distance of 8mm from case.

BZX79 SERIES

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type y = B for ±2%Vz y = F for ±3%Vz y = C for ±5%Vz	Dynamic resistance at Iz = 5 mA f = 1 kHz r_{zj} Ω max.	Dynamic resistance at Iz = 1 mA f = 1 kHz r_{zj} Ω max	Temp coefficient of Zener Voltage at Iz = 5 mA ∝ mvz %/K min.	Temp coefficient of Zener Voltage max.	Reverse leakage Current I_R nA	Reverse leakage Current at V_R V	Admissible Zener current[(2)] Iz (mA)	Capacitance V_R =0 f=1 MHz (pF) max.	Non-Repetitive Peak Reverse Currrent at t_p = 100μs I_{ZSM} (A)
BZX79 – y2V4	100	< 600	– 0.08	– 0.06	50,000	1	167	450	6.0
BZX79 – y2V7	100	< 600	– 0.08	– 0.06	20,000	1	135	450	6.0
BZX79 – y3V0	95	< 600	– 0.08	– 0.06	10,000	1	125	450	6.0
BZX79 – y3V3	95	< 600	– 0.08	– 0.05	5,000	1	115	450	6.0
BZX79 – y3V6	90	< 600	– 0.08	– 0.04	5,000	1	105	450	6.0
BZX79 – y3V9	90	< 600	– 0.07	– 0.03	3,000	1	95	450	6.0
BZX79 – y4V3	90	< 600	– 0.04	– 0.01	3,000	1	90	450	6.0
BZX79 – y4V7	80	500	– 0.03	+0.01	3,000	1	85	300	6.0
BZX79 – y5V1	60	480	– 0.02	+0.05	2,000	1	80	300	6.0
BZX79 – y5V6	40	400	– 0.01	+0.06	1,000	1	70	300	6.0
BZX79 – y6V2	10	150	0	+0.07	3,000	2	64	200	6.0
BZX79 – y6V8	15	80	+0.01	+0.08	2,000	3	58	200	6.0
BZX79 – y7V5	15	80	+0.01	+0.09	1,000	5	53	150	4.0
BZX79 – y8V2	15	80	+0.01	+0.09	700	6	47	150	4.0
BZX79 – y9V1	15	100	+0.02	+0.10	500	7	43	150	3.0
BZX79 – y10	20	150	+0.03	+0.11	200	7.5	40	90	3.0
BZX79 – y11	20	150	+0.03	+0.11	100	8.5	36	85	2.5
BZX79 – y12	25	150	+0.03	+0.11	100	9	32	85	2.5
BZX79 – y13	30	170	+0.03	+0.11	100	10	29	80	2.5
BZX79 – y15	30	200	+0.03	+0.11	50	11	27	75	2.0
BZX79 – y16	40	200	+0.03	+0.11	50	12	24	75	1.5
BZX79 – y18	45	225	+0.03	+0.11	50	14	21	70	1.5
BZX79 – y20	55	225	+0.03	+0.11	50	15	20	60	1.5
BZX79 – y22	55	250	+0.03	+0.11	50	17	18	60	1.3
BZX79 – y24	70	250	+0.04	+0.12	50	18	16	55	1.3
BZX79 – y27	80[(3)]	300[(4)]	+0.04[(3)]	+0.12	50	20	14	50	1.0
BZX79 – y30	80[(3)]	300[(4)]	+0.04[(3)]	+0.12	50	22	13	50	1.0
BZX79 – x33	80[(3)]	325[(4)]	+0.04[(3)]	+0.12	50	24	12	45	0.9
BZX79 – x36	90[(3)]	350[(4)]	+0.04[(3)]	+0.12	50	27	11	45	0.8
BZX79 – x39	130[(3)]	350[(4)]	+0.04[(3)]	+0.12	50	28	10	45	0.7
BZX79 – x43	150[(3)]	375[(4)]	+0.04[(3)]	+0.12	50	32	9.2	40	0.6
BZX79 – x47	170[(3)]	375[(4)]	+0.04[(3)]	+0.12	50	35	8.5	40	0.5
BZX79 – x51	180[(3)]	400[(4)]	+0.04[(3)]	+0.12	50	38	7.8	40	0.4
BZX79 – x56	200[(3)]	425[(4)]	typ. +0.1[(3)]		50	39	7.1	40	0.3
BZX79 – x62	215[(3)]	450[(4)]	typ. +0.1[(3)]		50	43	6.4	35	0.3
BZX79 – x68	240[(3)]	475[(4)]	typ. +0.1[(3)]		50	48	5.8	35	0.3
BZX79 – x75	255[(3)]	500[(4)]	typ. +0.1[(3)]		50	53	5.3	35	0.2

NOTES:
(1) Tested with pulses t_p = 5 ms.
(2) Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case.
(3) at I_Z = 2.0 mA
(4) at I_Z = 0.5 mA
Y = Zener voltage tolerance designator

BZX79 SERIES

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener Voltage range[1] at Iz = 5 mA Vz V	
±5% Tol.	min.	max.
BZX79 – C2V4	2.20	2.60
BZX79 – C2V7	2.50	2.90
BZX79 – C3V0	2.80	3.20
BZX79 – C3V3	3.10	3.50
BZX79 – C3V6	3.40	3.80
BZX79 – C3V9	3.70	4.10
BZX79 – C4V3	4.00	4.60
BZX79 – C4V7	4.40	5.00
BZX79 – C5V1	4.80	5.40
BZX79 – C5V6	5.20	6.00
BZX79 – C6V2	5.80	6.60
BZX79 – C6V8	6.40	7.20
BZX79 – C7V5	7.00	7.90
BZX79 – C8V2	7.70	8.70
BZX79 – C9V1	8.50	9.60
BZX79 – C10	9.40	10.60
BZX79 – C11	10.40	11.60
BZX79 – C12	11.40	12.70
BZX79 – C13	12.40	14.10
BZX79 – C15	13.80	15.60
BZX79 – C16	15.30	17.10
BZX79 – C18	16.80	19.10
BZX79 – C20	18.80	21.20
BZX79 – C22	20.80	23.30
BZX79 – C24	22.80	25.60
BZX79 – C27	25.10	28.90[3]
BZX79 – C30	28.00	32.00[3]
BZX79 – C33	31.00	35.00[3]
BZX79 – C36	34.00	38.00[3]
BZX79 – C39	37.00	41.00[3]
BZX79 – C43	40.00	46.00[3]
BZX79 – C47	44.00	50.00[3]
BZX79 – C51	48.00	54.00[3]
BZX79 – C56	52.00	60.00[3]
BZX79 – C62	58.00	66.00[3]
BZX79 – C68	64.00	72.00[3]
BZX79 – C75	70.00	79.00[3]

Type	Zener Voltage range[1] at Iz = 5 mA Vz V	
±3% Tol.	min.	max.
BZX79 – F2V4	2.33	2.47
BZX79 – F2V7	2.62	2.78
BZX79 – F3V0	2.91	3.09
BZX79 – F3V3	3.20	3.40
BZX79 – F3V6	3.49	3.71
BZX79 – F3V9	3.78	4.02
BZX79 – F4V3	4.17	4.43
BZX79 – F4V7	4.56	4.84
BZX79 – F5V1	4.95	5.25
BZX79 – F5V6	5.43	5.77
BZX79 – F6V2	6.01	6.39
BZX79 – F6V8	6.60	7.00
BZX79 – F7V5	7.28	7.72
BZX79 – F8V2	7.95	8.45
BZX79 – F9V1	8.83	9.37
BZX79 – F10	9.70	10.30
BZX79 – F11	10.67	11.33
BZX79 – F12	11.64	12.36
BZX79 – F13	12.61	13.39
BZX79 – F15	14.55	15.45
BZX79 – F16	15.50	16.50
BZX79 – F18	17.50	18.50
BZX79 – F20	19.40	20.60
BZX79 – F22	21.30	22.70
BZX79 – F24	23.30	24.70
BZX79 – F27	26.20	27.80[3]
BZX79 – F30	29.10	30.90[3]
BZX79 – F33	32.00	34.00[3]
BZX79 – F36	34.90	37.10[3]
BZX79 – F39	37.80	40.20[3]
BZX79 – F43	41.70	44.30[3]
BZX79 – F47	45.60	48.40[3]
BZX79 – F51	49.50	52.50[3]
BZX79 – F56	54.30	57.70[3]
BZX79 – F62	60.10	63.90[3]
BZX79 – F68	66.00	70.00[3]
BZX79 – F75	72.80	77.20[3]

Type	Zener Voltage range[1] at Iz = 5 mA Vz V	
±2% Tol.	min.	max.
BZX79 B2V4	2.35	2.45
BZX79 B2V7	2.65	2.75
BZX79B3V0	2.94	3.06
BZX79B3V3	3.23	3.37
BZX79 B3V6	3.53	3.67
BZX79B3V9	3.82	3.98
BZX79B4V3	4.21	4.39
BZX79B4V7	4.61	4.79
BZX79B5V1	5.00	5.20
BZX79 B5V6	5.49	5.71
BZX79B6V2	6.08	6.32
BZX79B6V8	6.66	6.94
BZX79B7V5	7.35	7.65
BZX79B8V2	8.04	8.36
BZX79B9V1	8.92	9.28
BZX79B10	9.80	10.20
BZX79B11	10.80	11.20
BZX79B12	11.80	12.20
BZX79B13	12.70	13.30
BZX79B15	14.70	15.30
BZX79B16	15.70	16.30
BZX79B18	17.60	18.40
BZX79B20	19.60	20.40
BZX79B22	21.60	22.40
BZX79B24	23.50	24.50
BZX79B27	26.50	27.50[3]
BZX79B30	29.40	30.60[3]
BZX79B33	32.30	33.70[3])
BZX79B36	35.30	36.70[3]
BZX79B39	38.20	39.80[3]
BZX79B43	42.10	43.90[3]
BZX79B47	46.10	47.90[3]
BZX79B51	50.00	52.00[3]
BZX79B56	54.90	57.10[3]
BZX79B62	60.80	63.20[3]
BZX79B68	66.60	69.40[3]
BZX79B75	73.50	76.50[3]

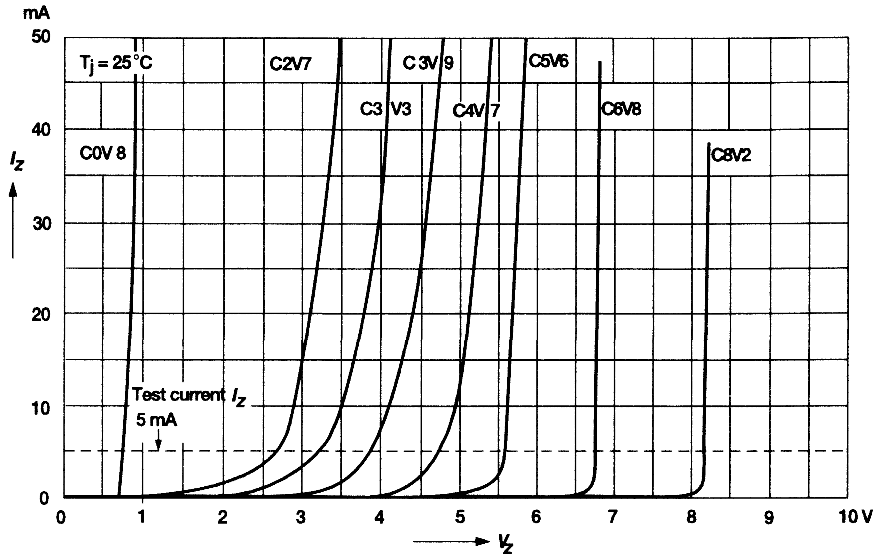
See BZX79-y table for all characteristics other than zener voltage range.

BZX79 SERIES

ELECTRICAL CHARACTERISTICS

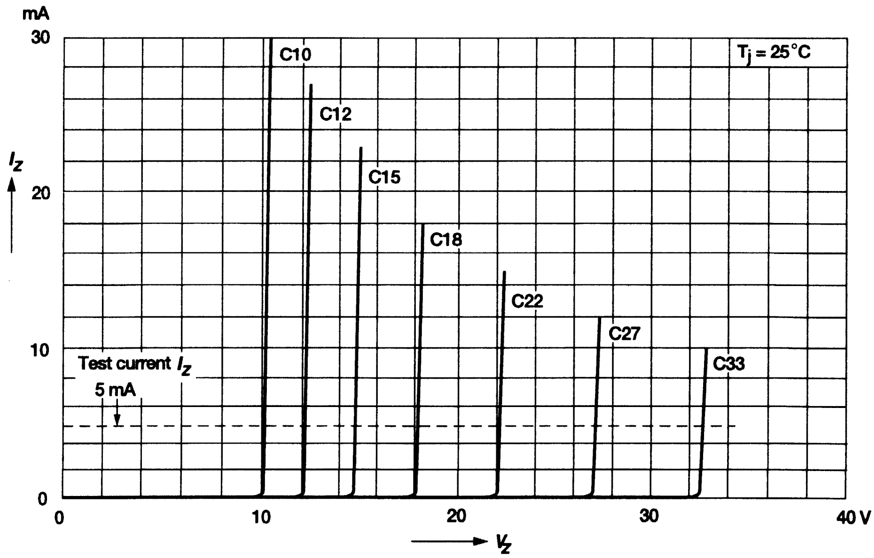
Breakdown characteristics

at T_j = constant (pulsed)



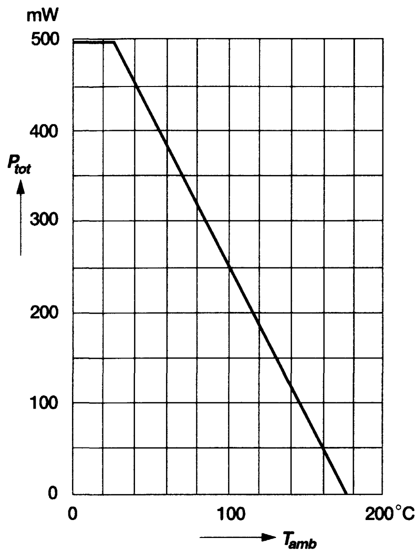
Breakdown characteristics

at T_j = constant (pulsed)

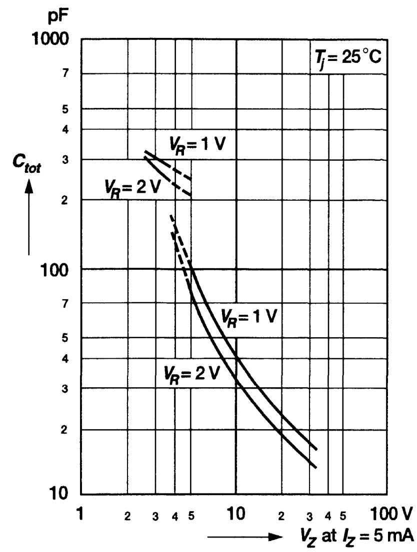


Admissible power dissipation versus ambient temperature

Valid provided that leads are kept ambient temperature at a distance of 8 mm from case.

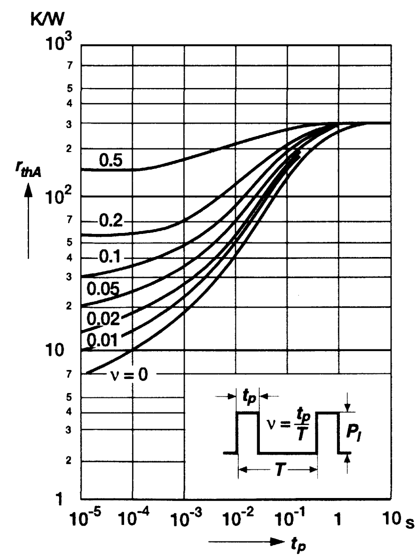


Capacitance versus Zener voltage

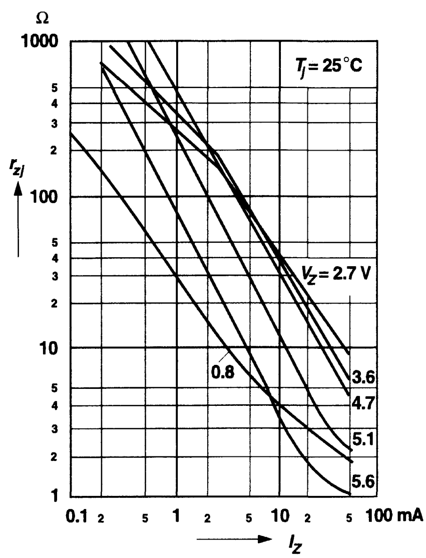


Pulse thermal resistance versus pulse duration

Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case.



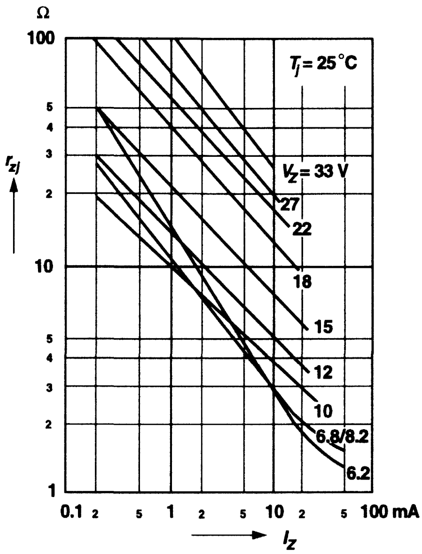
Dynamic resistance versus Zener current



GENERAL SEMICONDUCTOR®

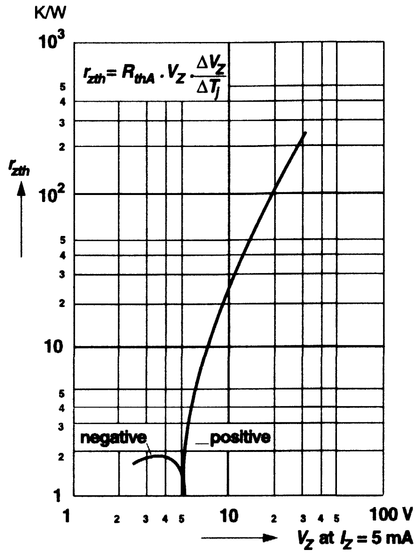
RATINGS AND CHARACTERISTIC CURVES BZX79 SERIES

Dynamic resistance versus Zener current

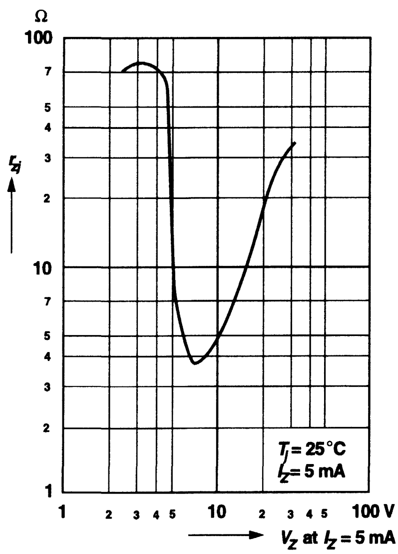


Thermal differential resistance versus Zener voltage

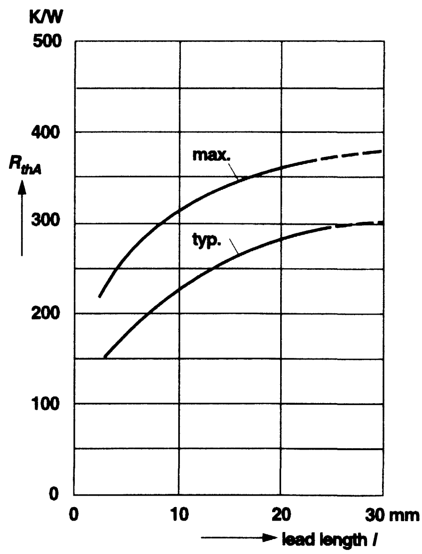
Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case.



Dynamic resistance versus Zener voltage

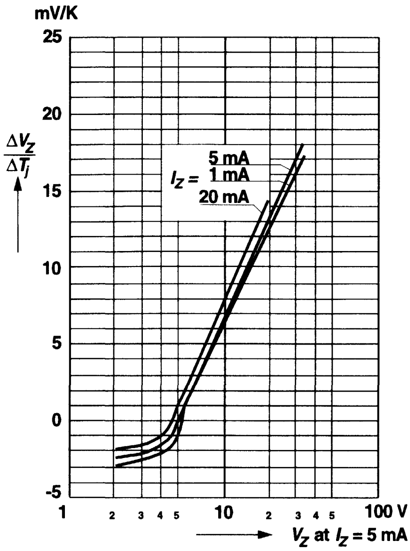


Thermal resistance versus lead length

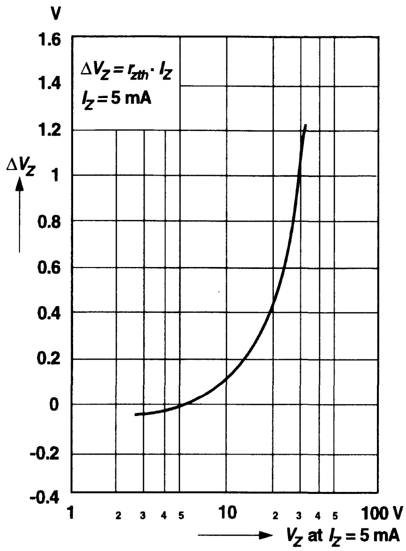


GENERAL SEMICONDUCTOR®

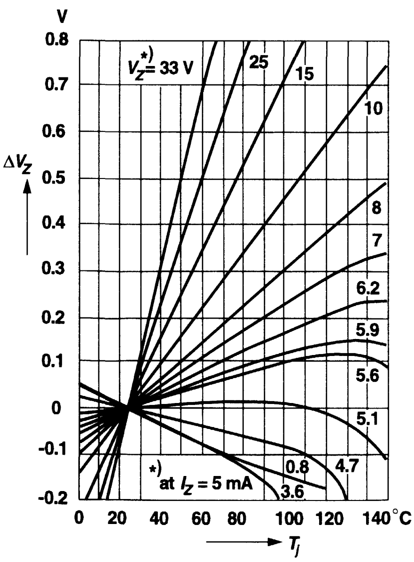
Temperature dependence of Zener voltage versus Zener voltage



Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



Change of Zener voltage versus junction temperature

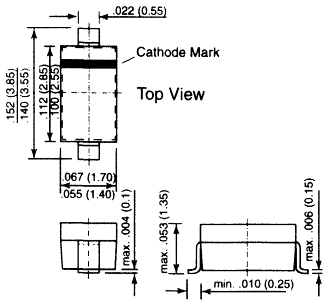


ADVANCED INFORMATION

MMSZ4681 THRU MMSZ4717

ZENER DIODES

SOD-123



Dimensions in inches and (millimeters)

FEATURES

- Silicon Planar Zener Diodes
- Standard Zener voltage tolerance is ± 5%. Other tolerances are available upon request.
- High temperature soldering guaranteed: 250°C/10 seconds set terminals.
- These diodes are also available in DO-35 case with type designation 1N4681 ... 1N4717 and SOT-23 case with the type designation MMBZ4681 ... MMBZ4717.

MECHANICAL DATA

Case: SOD-123 Plastic Case
Weight: approx. 0.01 g
Terminals: Solderable per MIL-STD-750, method 2026.

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Zener Current (see Table "Characteristics")			
Power Dissipation at T_L = 75°C	P_{tot}	500[(1)]	mW
Maximum Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	-55 to +150	°C

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	340[(1)]	°C/W
Forward Voltage at I_F = 10 mA	V_F	–	–	0.9	Volts

NOTES:
(1) FR-4 or FR-5 board with minimum recommended solder pad layout.

MMSZ4681 THRU MMSZ4717

ELECTRICAL CHARACTERISTICS

T_A = 25°C unless otherwise specified

Type	Marking Code	Zener Voltage[1] V_Z @ I_{ZT} - 50μA (Volts)			Max Reverse Current I_R (μA)	Test Voltage V_R (Volts)
		Nominal	Min	Max		
MMSZ4681	CF	2.4	2.28	2.52	2.00	1.0
MMSZ4682	CH	2.7	2.57	2.84	1.00	1.0
MMSZ4683	CJ	3.0	2.85	3.15	0.80	1.0
MMSZ4684	CK	3.3	3.14	3.47	7.50	1.5
MMSZ4685	CM	3.6	3.42	3.78	7.50	2.0
MMSZ4686	CN	3.9	3.71	4.10	5.00	2.0
MMSZ4687	CP	4.3	4.09	4.52	4.00	2.0
MMSZ4688	CT	4.7	4.47	4.94	10.0	3.0
MMSZ4689	CU	5.1	4.85	5.36	10.0	3.0
MMSZ4690	CV	5.6	5.32	5.88	10.0	4.0
MMSZ4691	CA	6.2	5.89	6.51	10.0	5.0
MMSZ4692	CX	6.8	6.46	7.14	10.0	5.1
MMSZ4693	CY	7.5	7.13	7.88	10.0	5.7
MMSZ4694	CZ	8.2	7.79	8.61	1.00	6.2
MMSZ4695	DC	8.7	8.27	9.14	1.00	6.6
MMSZ4696	DD	9.1	8.65	9.56	1.00	6.9
MMSZ4697	DE	10.0	9.50	10.5	1.00	7.6
MMSZ4698	DF	11.0	10.5	11.6	0.05	8.4
MMSZ4699	DH	12.0	11.4	12.6	0.05	9.1
MMSZ4700	DJ	13.0	12.4	13.7	0.05	9.8
MMSZ4701	DK	14.0	13.3	14.7	0.05	10.6
MMSZ4702	DM	15.0	14.3	15.8	0.05	11.4
MMSZ4703	DN	16.0	15.2	16.8	0.05	12.1
MMSZ4704	DP	17.0	16.2	17.9	0.05	12.9
MMSZ4705	DT	18.0	17.1	18.9	0.05	13.6
MMSZ4706	DU	19.0	18.1	20.0	0.05	14.4
MMSZ4707	DV	20.0	19.0	21.0	0.01	15.2
MMSZ4708	DA	22.0	20.9	23.1	0.01	16.7
MMSZ4709	DZ	24.0	22.8	25.2	0.01	18.2
MMSZ4710	DY	25.0	23.8	26.3	0.01	19.0
MMSZ4711	EA	27.0	25.7	28.4	0.01	20.4
MMSZ4712	EC	28.0	26.6	29.4	0.01	21.2
MMSZ4713	ED	30.0	28.5	31.5	0.01	22.8
MMSZ4714	EE	33.0	31.4	34.7	0.01	25.0
MMSZ4715	EF	36.0	34.2	37.8	0.01	27.3
MMSZ4716	EH	39.0	37.1	41.0	0.01	29.6
MMSZ4717	EJ	43.0	40.9	45.2	0.01	32.6

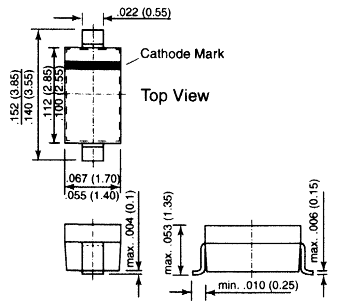
NOTES:
(1) Measured with device junction in thermal equilibrium

NEW PRODUCT **NEW PRODUCT** **NEW PRODUCT**

MMSZ5225 THRU MMSZ5267

ZENER DIODES

SOD-123



Dimensions in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ Standard Zener voltage tolerance is ± 5% with a "B" suffix. Other tolerances are available upon request.
- ♦ These diodes are also available in Mini-MELF case with the designation ZMM5225 ... ZMM5267, DO-35 case with type designation 1N5225 ... 1N5267 and SOT-23 case with the type designation MMBZ5225 ... MMBZ5267.

MECHANICAL DATA

Case: SOD-123 Plastic Case
Weight: approx. 0.01 g

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_L = 75°C	P_{tot}	500[(1)]	mW
Maximum Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	-65 to +175	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	340[(1)]	°C/W
Forward Voltage at I_F = 10 mA	V_F	–	–	0.9	Volts

NOTES:
(1) FR-4 or FR-5 board with minimum recommended solder pad layout.

MMSZ5225 THRU MMSZ5267

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Marking Code	Nominal Zener voltage[3] at I_{ZT} V_Z (V)	Test current I_{ZT} (mA)	Maximum Zener impedance[1]		Typical Temperture Coefficient α_{VZ} (%/K)	Maximum Reverse Leakage Current	
				at I_{ZT} Z_{ZT} (Ω)	at I_{ZK} = 0.25 mA Z_{ZK} (Ω)		I_R (μA)	Test Voltage V_R (V)
MMSZ5225	C5	3.0	20	30	1600	-0.075	50	1.0
MMSZ5226	D1	3.3	20	28	1600	-0.070	25	1.0
MMSZ5227	D2	3.6	20	24	1700	-0.065	15	1.0
MMSZ5228	D3	3.9	20	23	1900	-0.060	10	1.0
MMSZ5229	D4	4.3	20	22	2000	-0.055	5.0	1.0
MMSZ5230	D5	4.7	20	19	1900	±0.030	5.0	2.0
MMSZ5231	E1	5.1	20	17	1600	±0.030	5.0	2.0
MMSZ5232	E2	5.6	20	11	1600	+0.038	5.0	3.0
MMSZ5233	E3	6.0	20	7	1600	+0.038	5.0	3.5
MMSZ5234	E4	6.2	20	7	1000	+0.045	5.0	4.0
MMSZ5235	E5	6.8	20	5	750	+0.050	3.0	5.0
MMSZ5236	F1	7.5	20	6	500	+0.058	3.0	6.0
MMSZ5237	F2	8.2	20	8	500	+0.062	3.0	6.5
MMSZ5238	F3	8.7	20	8	600	+0.065	3.0	6.5
MMSZ5239	F4	9.1	20	10	600	+0.068	3.0	7.0
MMSZ5240	F5	10	20	17	600	+0.075	3.0	8.0
MMSZ5241	H1	11	20	22	600	+0.076	2.0	8.4
MMSZ5242	H2	12	20	30	600	+0.077	1.0	9.1
MMSZ5243	H3	13	9.5	13	600	+0.079	0.5	9.9
MMSZ5244	H4	14	9.0	15	600	+0.082	0.1	10
MMSZ5245	H5	15	8.5	16	600	+0.082	0.1	11
MMSZ5246	J1	16	7.8	17	600	+0.083	0.1	12
MMSZ5247	J2	17	7.4	19	600	+0.084	0.1	13
MMSZ5248	J3	18	7.0	21	600	+0.085	0.1	14
MMSZ5249	J4	19	6.6	23	600	+0.086	0.1	14
MMSZ5250	J5	20	6.2	25	600	+0.086	0.1	15
MMSZ5251	K1	22	5.6	29	600	+0.087	0.1	17
MMSZ5252	K2	24	5.2	33	600	+0.087	0.1	18
MMSZ5253	K3	25	5.0	35	600	+0.089	0.1	19
MMSZ5254	K4	27	4.6	41	600	+0.090	0.1	21
MMSZ5255	K5	28	4.5	44	600	+0.091	0.1	21
MMSZ5256	M1	30	4.2	49	600	+0.091	0.1	23
MMSZ5257	M2	33	3.8	58	700	+0.092	0.1	25
MMSZ5258	M3	36	3.4	70	700	+0.093	0.1	27
MMSZ5259	M4	39	3.2	80	800	+0.094	0.1	30
MMSZ5260	M5	43	3.0	93	900	+0.095	0.1	33
MMSZ5261	N1	47	2.7	105	1000	+0.095	0.1	36
MMSZ5262	N2	51	2.5	125	1100	+0.096	0.1	39
MMSZ5263	N3	56	2.2	150	1300	+0.096	0.1	43
MMSZ5264	N4	60	2.1	170	1400	+0.097	0.1	46
MMSZ5265	N5	62	2.0	185	1400	+0.097	0.1	47
MMSZ5266	P1	68	1.8	230	1600	+0.097	0.1	52
MMSZ5267	P2	75	1.7	270	1700	+0.098	0.1	56

NOTES:

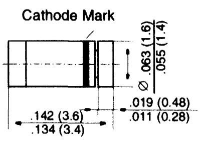
(1) The Zener Impedance is derived from the 1kHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}. Zener Impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units.

(2) Measured with device junction in thermal equilibrium.

ZMM1 THRU ZMM75

ZENER DIODES

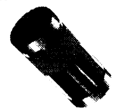
Mini-MELF



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Zener Diodes
- ♦ In Mini-MELF case especially for automatic insertion.
- ♦ The Zener voltages are graded according to the international E 24 standard. Smaller voltage tolerances and other Zener voltages are available upon request.
- ♦ These diodes are also available in DO-35 case with the type designation ZPD1 ... ZPD51.



MECHANICAL DATA

Case: Mini-MELF Glass Case (SOD-80)
Weight: approx. 0.05 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	500(1)	mW
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 55 to +175	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	0.3(1)	°C/W

NOTES:
(1) Valid provided that electrodes are kept at ambient temperature.

ZMM1 THRU ZMM75

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener Voltage[(1)] at I_Z = 5 mA V_Z V	Dynamic Resistance at I_Z = 5 mA f = 1 kHz r_{zj} Ω	Dynamic Resistance at I_Z = 1 mA f = 1 kHz r_{zj} Ω	Temp. Coeff. of Zener Voltage at I_Z = 5 mA α_{VZ} 10^{-4}/K	Reverse Voltage at I_R = 100 nA V_R V	Admissable Zener current[(2)] at T_{amb} = 45°C I_Z = mA	Admissable Zener current[(2)] at T_{amb} = 25°C I_Z = mA
ZMM1[(3)]	0.7 ... 0.8	6.5 (< 8)	< 50	– 26 ... – 23	–	280	340
ZMM2.7	2.5 ... 2.9	75 (< 83)	< 500	– 9 ... – 4	–	135	160
ZMM3	2.8 ... 3.2	80 (< 95)	< 500	– 9 ... – 3	–	117	140
ZMM3.3	3.1 ... 3.5	80 (< 95)	< 500	– 8 ... – 3	–	109	130
ZMM3.6	3.4 ... 3.8	80 (< 95)	< 500	– 8 ... – 3	–	101	120
ZMM3.9	3.7 ... 4.1	80 (< 95)	< 500	– 7 ... – 3	–	92	110
ZMM4.3	4.0 ... 4.6	80 (< 95)	< 500	– 6 ... – 1	–	85	100
ZMM4.7	4.4 ... 5.0	70 (< 78)	< 500	– 5 ... +2	–	76	90
ZMM5.1	4.8 ... 5.4	30 (< 60)	< 480	– 3 ... +4	> 0.8	67	80
ZMM5.6	5.2 ... 6.0	10 (< 40)	< 400	– 2 ... +6	> 1	59	70
ZMM6.2	5.8 ... 6.6	4.8 (< 10)	< 200	– 1 ... +7	> 2	54	64
ZMM6.8	6.4 ... 7.2	4.5 (< 8)	< 150	+2 ... +7	> 3	49	58
ZMM7.5	7.0 ... 7.9	4 (< 7)	< 50	+3 ... +7	> 5	44	53
ZMM8.2	7.7 ... 8.7	4.5 (< 7)	< 50	+4 ... +7	> 6	40	47
ZMM9.1	8.5 ... 9.6	4.8 (< 10)	< 50	+5 ... +8	> 7	36	43
ZMM10	9.4 ... 10.6	5.2 (< 15)	< 70	+5 ... +8	> 7.5	33	40
ZMM11	10.4 ... 11.6	6 (< 20)	< 70	+5 ... +9	> 8.5	30	36
ZMM12	11.4 ... 12.7	7 (< 20)	< 90	+6 ... +9	> 9	28	32
ZMM13	12.4 ... 14.1	9 (< 25)	< 110	+7 ... +9	> 10	25	29
ZMM15	13.8 ... 15.6	11 (< 30)	< 110	+7 ... +9	> 11	23	27
ZMM16	15.3 ... 17.1	13 (< 40)	< 170	+8 ... +9.5	> 12	20	24
ZMM18	16.8 ... 19.1	18 (< 50)	< 170	+8 ... +9.5	> 14	18	21
ZMM20	18.8 ... 21.2	20 (< 50)	< 220	+8 ... +10	> 15	17	20
ZMM22	20.8 ... 23.3	25 (< 55)	< 220	+8 ... +10	> 17	16	18
ZMM24	22.8 ... 25.6	28 (< 80)	< 220	+8 ... +10	> 18	13	16
ZMM27	25.1 ... 28.9	30 (< 80)	< 250	+8 ... +10	> 20	12	14
ZMM30	28 ... 32	35 (< 80)	< 250	+8 ... +10	> 22.5	10	13
ZMM33	31 ... 35	40 (< 80)	< 250	+8 ... +10	> 25	9	12
ZMM36	34 ... 38	40 (< 90)	< 250	+8 ... +10	> 27	9	11
ZMM39	37 ... 41	50 (< 90)	< 300	+10 ... +12	> 29	8	10
ZMM43	40 ... 46	60 (< 100)	< 700	+10 ... +12	> 32	7	9.2
ZMM47	44 ... 50	70 (< 100)	< 750	+10 ... +12	> 35	6	8.5
ZMM51	48 ... 54	70 (< 100)	< 750	+10 ... +12	> 38	6	7.8
ZMM56	52.0 ... 60.0[(4)]	<135[(4)]	<1000[(5)]	typ. +10[(4)]	–	–	–
ZMM62	58.0 ... 66.0[(4)]	<150[(4)]	<1000[(5)]	typ. +10[(4)]	–	–	–
ZMM68	64.0 ... 72.0[(4)]	<200[(4)]	<1000[(5)]	typ. +10[(4)]	–	–	–
ZMM75	70.0 ... 79.0[(4)]	<250[(4)]	<1500[(5)]	typ. +10[(4)]	–	–	–

NOTES:

(1) Tested with pulses t_p = 5 ms

(2) Valid provided that electrodes are kept at ambient temperature

(3) The ZMM1 is a silicon diode operated in forward direction. Hence, the index of all parameters should be "F" instead of "Z"
Connect the cathode electrode to the negative pole

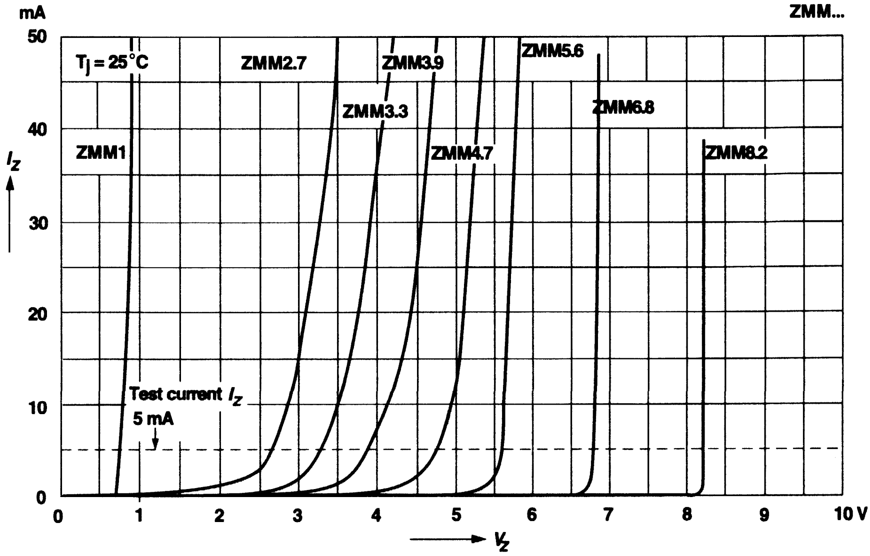
(4) at I_Z = 2.5 mA

(5) at I_Z = 0.5 mA

RATINGS AND CHARACTERISTIC CURVES ZMM1 THRU ZMM75

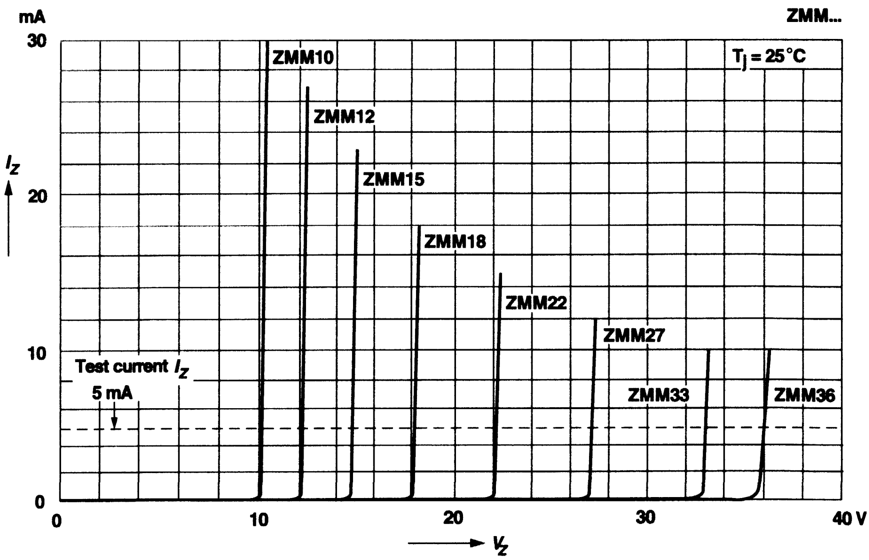
Breakdown characteristics

T_j = constant (pulsed)



Breakdown characteristics

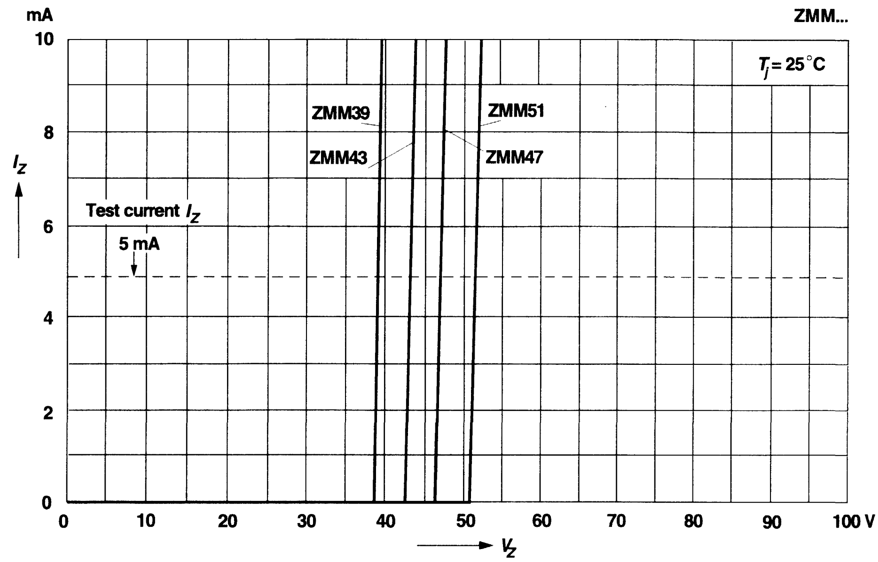
T_j = constant (pulsed)



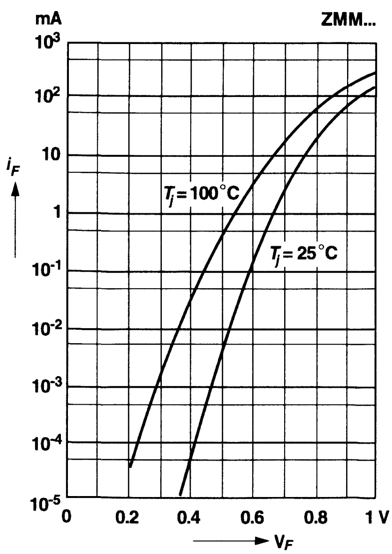
GENERAL SEMICONDUCTOR®

Breakdown characteristics

T_j = constant (pulsed)

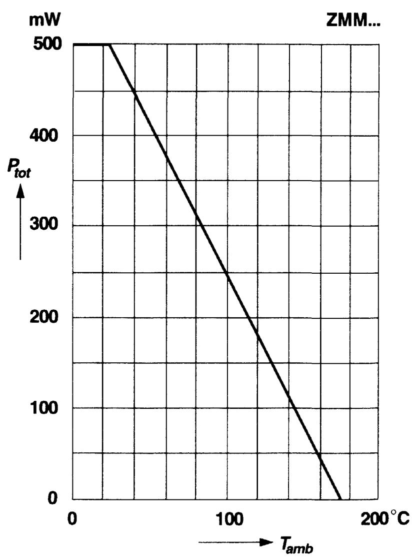


Forward characteristics



Admissible power dissipation versus ambient temperature

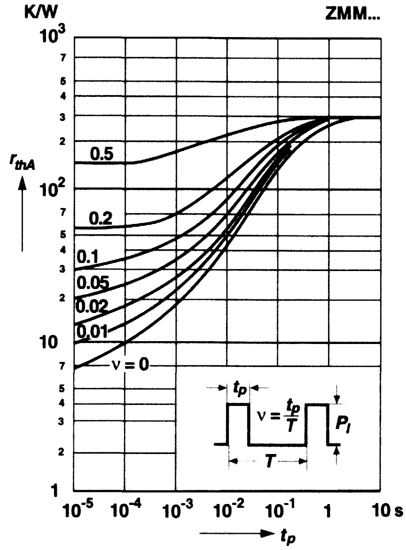
Valid provided that electrodes are kept at ambient temperature



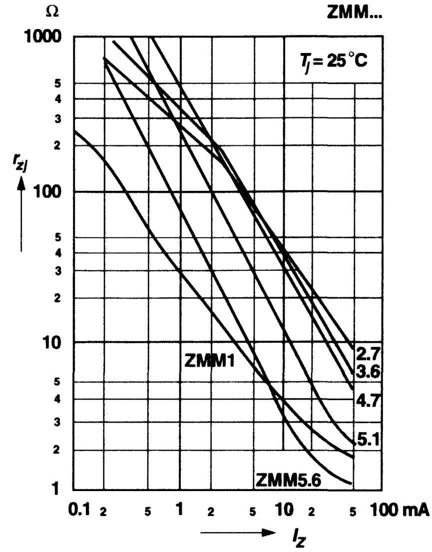
RATINGS AND CHARACTERISTIC CURVES ZMM1 THRU ZMM75

Pulse thermal resistance versus pulse duration

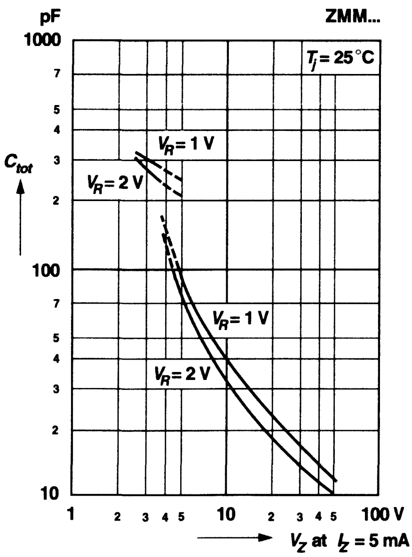
Valid provided that the electrodes are kept at ambient temperature



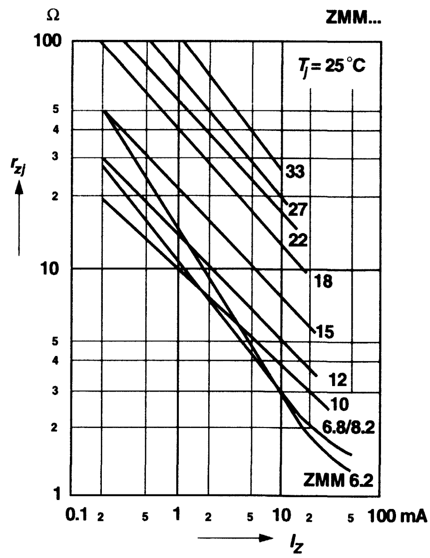
Dynamic resistance versus Zener current



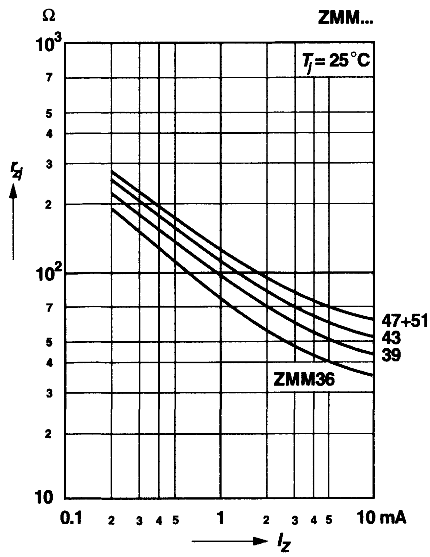
Capacitance versus Zener voltage



Dynamic resistance versus Zener current

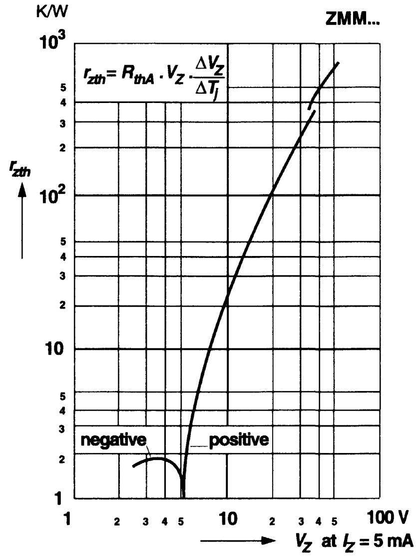


Dynamic resistance versus Zener current

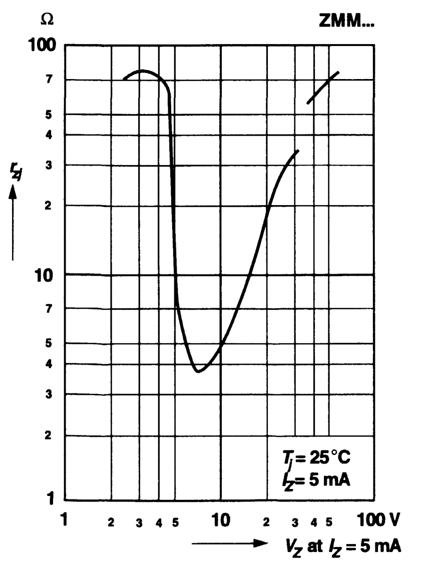


Thermal differential resistance versus Zener voltage

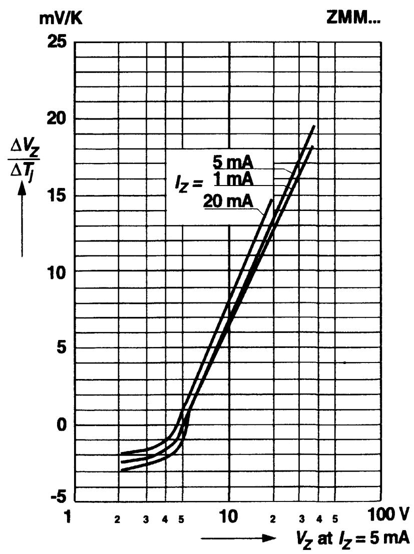
Valid provided that electrodes are kept at ambient temperature



Dynamic resistance versus Zener voltage

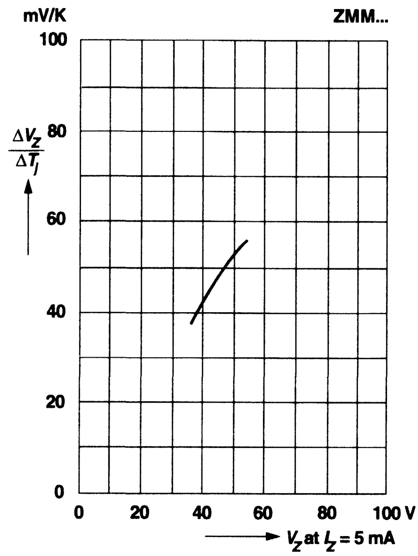


Temperature dependence of Zener voltage versus Zener voltage

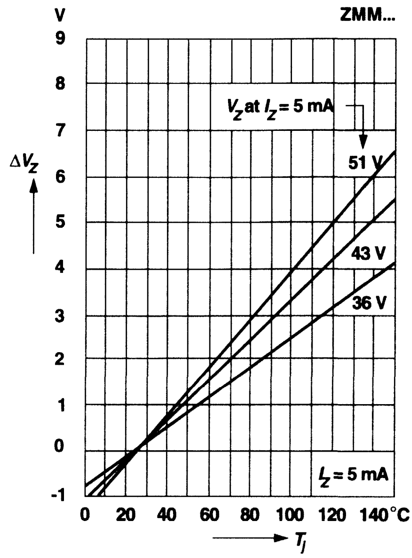


RATINGS AND CHARACTERISTIC CURVES ZMM1 THRU ZMM75

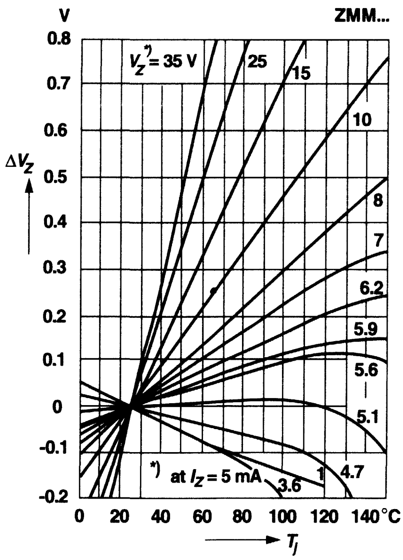
Temperature dependence of Zener voltage versus Zener voltage



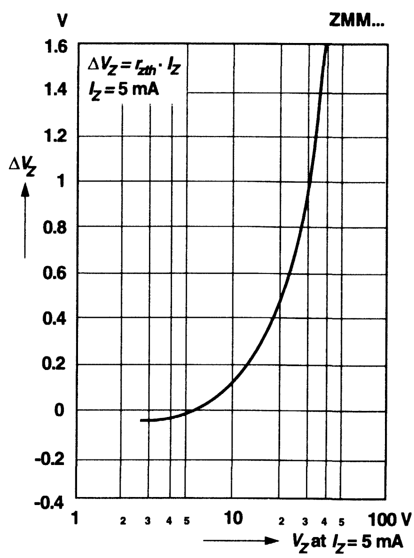
Change of Zener voltage versus junction temperature



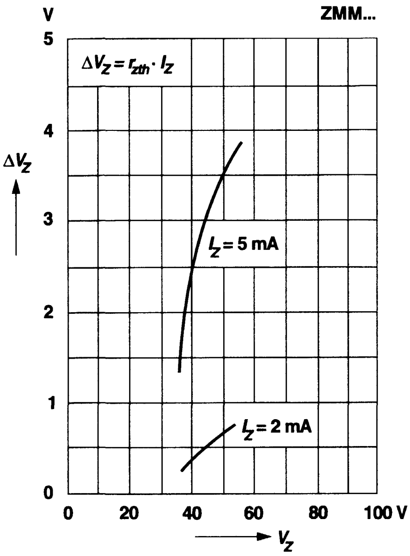
Change of Zener voltage versus junction temperature



Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



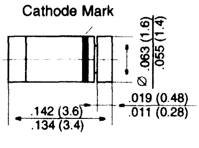
Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



ZMM5225 THRU ZMM5267

ZENER DIODES

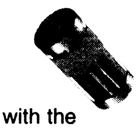
Mini-MELF



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ Standard Zener voltage tolerance is ± 5% with a "B" suffix. Other tolerances are available upon request.



- ♦ These diodes are also available in the DO-35 case with the type designation 1N5225 ... 1N5267, SOT-23 case with the type designation MMBZ5225 ... MMBZ5267 and SOD-123 case with type designation MMSZ5225 ... MMSZ5267.

MECHANICAL DATA

Case: Mini-MELF Glass Case (SOD-80)
Weight: approx. 0.05 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 75°C	P_{tot}	500(1)	mW
Maximum Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +150	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	–	–	300(1)	°C/W
Forward Voltage at I_F = 200 mA	V_F	–	–	1.1	Volts

NOTES
(1) Valid provided that electrodes are kept at ambient temperature.

ZMM5225 THRU ZMM5267

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Nominal Zener Voltage[3] at I_{ZT} V_Z(V)	Test current I_{ZT} (mA)	Maximum Zener impedance[1]		Typical Temperature Coefficient α_{VZ} (%/K)	Maximum Reverse Leakage Current		Maximum regulator current[2] I_{ZM} (mA)
			at I_{ZT} Z_{ZT} (Ω)	at I_{ZK}=0.25mA Z_{ZK} (Ω)		I_R (μA)	Test Voltage V_R (V)	
ZMM5225	3.0	20	29	1600	– 0.075	50	1.0	152
ZMM5226	3.3	20	28	1600	– 0.070	25	1.0	138
ZMM5227	3.6	20	24	1700	– 0.065	15	1.0	126
ZMM5228	3.9	20	23	1900	– 0.060	10	1.0	115
ZMM5229	4.3	20	22	2000	– 0.055	5.0	1.0	106
ZMM5230	4.7	20	19	1900	±0.030	5.0	2.0	97
ZMM5231	5.1	20	17	1600	±0.030	5.0	2.0	89
ZMM5232	5.6	20	11	1600	+0.038	5.0	3.0	81
ZMM5233	6.0	20	7	1600	+0.038	5.0	3.5	76
ZMM5234	6.2	20	7	1000	+0.045	5.0	4.0	73
ZMM5235	6.8	20	5	750	+0.050	3.0	5.0	67
ZMM5236	7.5	20	6	500	+0.058	3.0	6.0	61
ZMM5237	8.2	20	8	500	+0.062	3.0	6.5	55
ZMM5238	8.7	20	8	600	+0.065	3.0	6.5	52
ZMM5239	9.1	20	10	600	+0.068	3.0	7.0	50
ZMM5240	10	20	17	600	+0.075	3.0	8.0	45
ZMM5241	11	20	22	600	+0.076	2.0	8.4	41
ZMM5242	12	20	30	600	+0.077	1.0	9.1	38
ZMM5243	13	9.5	13	600	+0.079	0.5	9.9	35
ZMM5244	14	9.0	15	600	+0.082	0.1	10	32
ZMM5245	15	8.5	16	600	+0.082	0.1	11	30
ZMM5246	16	7.8	17	600	+0.083	0.1	12	28
ZMM5247	17	7.4	19	600	+0.084	0.1	13	27
ZMM5248	18	7.0	21	600	+0.085	0.1	14	25
ZMM5249	19	6.6	23	600	+0.086	0.1	14	24
ZMM5250	20	6.2	25	600	+0.086	0.1	15	23
ZMM5251	22	5.6	29	600	+0.087	0.1	17	21
ZMM5252	24	5.2	33	600	+0.087	0.1	18	19.1
ZMM5253	25	5.0	35	600	+0.089	0.1	19	18.2
ZMM5254	27	4.6	41	600	+0.090	0.1	21	16.8
ZMM5255	28	4.5	44	600	+0.091	0.1	21	16.2
ZMM5256	30	4.2	49	600	+0.091	0.1	23	15.1
ZMM5257	33	3.8	58	700	+0.092	0.1	25	13.8
ZMM5258	36	3.4	70	700	+0.093	0.1	27	12.6
ZMM5259	39	3.2	80	800	+0.094	0.1	30	11.6
ZMM5260	43	3.0	93	900	+0.095	0.1	33	10.6
ZMM5261	47	2.7	105	1000	+0.095	0.1	36	9.7
ZMM5262	51	2.5	125	1100	+0.096	0.1	39	8.9
ZMM5263	56	2.2	150	1300	+0.096	0.1	43	–
ZMM5264	60	2.1	170	1400	+0.097	0.1	46	–
ZMM5265	62	2.0	185	1400	+0.097	0.1	47	–
ZMM5266	68	1.8	230	1600	+0.097	0.1	52	–
ZMM5267	75	1.7	270	1700	+0.098	0.1	56	–

NOTES

(1) The Zener impedance is derived from the 1kHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}. Zener impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units

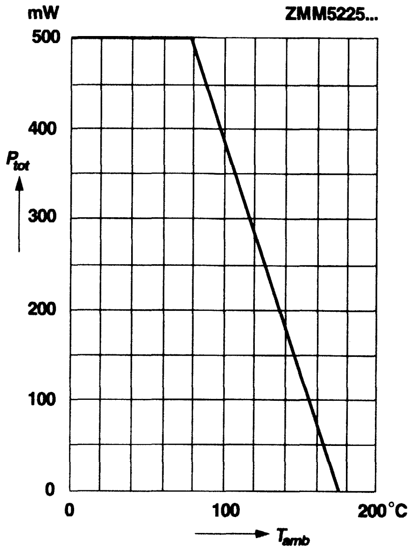
(2) Valid provided that electrodes are kept at ambient temperature

(3) Tested under thermal equilibrium and DC test conditions

RATINGS AND CHARACTERISTIC CURVES ZMM5225 THRU ZMM5267

Admissible power dissipation versus ambient temperature

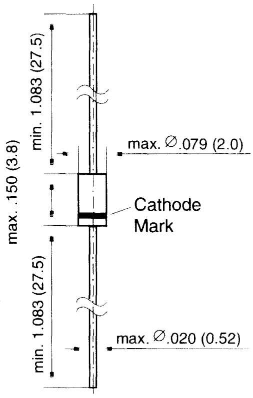
Valid provided that electrodes are kept at ambient temperature



ZPD1 THRU ZPD75

ZENER DIODES

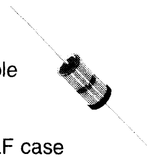
DO-35



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Zener Diodes
- ♦ The Zener voltages are graded according to the international E 12 standard. Smaller voltage tolerances and other Zener voltages are available upon request.
- ♦ These diodes are also available in the Mini-MELF case with the type designation ZMM1 ... ZMM75.



MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	500[1]	mW
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 55 to +175	°C

NOTES:
(1) Valid provided that leads at a distance of 8 mm from case are kept at ambient temperature.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	0.3[1]	°C/W

NOTES:
(1) Valid provided that leads at a distance of 4 mm from case are kept at ambient temperature.

ZPD1 THRU ZPD75

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener Voltage[1] at I_Z = 5 mA V_Z (V)	Dynamic Resistance		Temp. Coeff. of Zener Voltage at I_Z = 5 mA α_{VZ} (10^{-4}/K)	Reverse Voltage at I_R = 100 nA V_R (V)	Admissible Zener current[2]	
		at I_Z = 5 mA f = 1 kHz r_{zj} (Ω)	at I_Z = 1 mA f = 1 kHz r_{zj} (Ω)			at T_{amb} = 45°C I_Z (mA)	at T_{amb} = 25°C I_Z (mA)
ZPD1[3]	0.7 ... 0.8	6.5 (< 8)	< 50	−26 ... −23	–	280	340
ZPD2.7	2.5 ... 2.9	75 (< 83)	< 500	−9 ... −4	–	135	160
ZPD3	2.8 ... 3.2	80 (< 95)	< 500	−9 ... −3	–	117	140
ZPD3.3	3.1 ... 3.5	80 (< 95)	< 500	−8 ... −3	–	109	130
ZPD3.6	3.4 ... 3.8	80 (< 95)	< 500	−8 ... −3	–	101	120
ZPD3.9	3.7 ... 4.1	80 (< 95)	< 500	−7 ... −3	–	92	110
ZPD4.3	4.0 ... 4.6	80 (< 95)	< 500	−6 ... −1	–	85	100
ZPD4.7	4.4 ... 5.0	70 (< 78)	< 500	−5 ... +2	–	76	90
ZPD5.1	4.8 ... 5.4	30 (< 60)	< 480	−3 ... +4	> 0.8	67	80
ZPD5.6	5.2 ... 6.0	10 (< 40)	< 400	−2 ... +6	> 1	59	70
ZPD6.2	5.8 ... 6.6	4.8 (< 10)	< 200	−1 ... +7	> 2	54	64
ZPD6.8	6.4 ... 7.2	4.5 (< 8)	< 150	+2 ... +7	> 3	49	58
ZPD7.5	7.0 ... 7.9	4 (< 7)	< 50	+3 ... +7	> 5	44	53
ZPD8.2	7.7 ... 8.7	4.5 (< 7)	< 50	+4 ... +7	> 6	40	47
ZPD9.1	8.5 ... 9.6	4.8 (< 10)	< 50	+5 ... +8	> 7	36	43
ZPD10	9.4 ... 10.6	5.2 (< 15)	< 70	+5 ... +8	> 7.5	33	40
ZPD11	10.4 ... 11.6	6 (< 20)	< 70	+5 ... +9	> 8.5	30	36
ZPD12	11.4 ... 12.7	7 (< 20)	< 90	+6 ... +9	> 9	28	32
ZPD13	12.4 ... 14.1	9 (< 25)	< 110	+7 ... +9	> 10	25	29
ZPD15	13.8 ... 15.6	11 (< 30)	< 110	+7 ... +9	> 11	23	27
ZPD16	15.3 ... 17.1	13 (< 40)	< 170	+8 ... +9.5	> 12	20	24
ZPD18	16.8 ... 19.1	18 (< 50)	< 170	+8 ... +9.5	> 14	18	21
ZPD20	18.8 ... 21.2	20 (< 50)	< 220	+8 ... +10	> 15	17	20
ZPD22	20.8 ... 23.3	25 (< 55)	< 220	+8 ... +10	> 17	16	18
ZPD24	22.8 ... 25.6	28 (< 80)	< 220	+8 ... +10	> 18	13	16
ZPD27	25.1 ... 28.9	30 (< 80)	< 250	+8 ... +10	> 20	12	14
ZPD30	28 ... 32	35 (< 80)	< 250	+8 ... +10	> 22.5	10	13
ZPD33	31 ... 35	40 (< 80)	< 250	+8 ... +10	> 25	9	12
ZPD36	34 ... 38	40 (< 90)	< 250	+8 ... +10	> 27	9	11
ZPD39	37 ... 41	50 (< 90)	< 300	+10 ... +12	> 29	8	10
ZPD43	40 ... 46	60 (< 100)	< 700	+10 ... +12	> 32	7	9.2
ZPD47	44 ... 50	70 (< 100)	< 750	+10 ... +12	> 35	6	8.5
ZPD51	48 ... 54	70 (< 100)	< 750	+10 ... +12	> 38	6	7.8
ZPD56	52.0 ... 60.0[4]	< 135[4]	< 1000[5]	typ. +10[4]	–	–	–
ZPD62	58.0 ... 66.0[4]	< 150[4]	< 1000[5]	typ. +10[4]	–	–	–
ZPD68	64.0 ... 72.0[4]	< 200[4]	< 1000[5]	typ. +10[4]	–	–	–
ZPD75	70.0 ... 79.0[4]	< 250[4]	< 1500[5]	typ. +10[4]	–	–	–

NOTES:

(1) Tested with pulses t_p = 5 ms

(2) Valid provided that leads at a distance of 4 mm from case are kept at ambient temperature

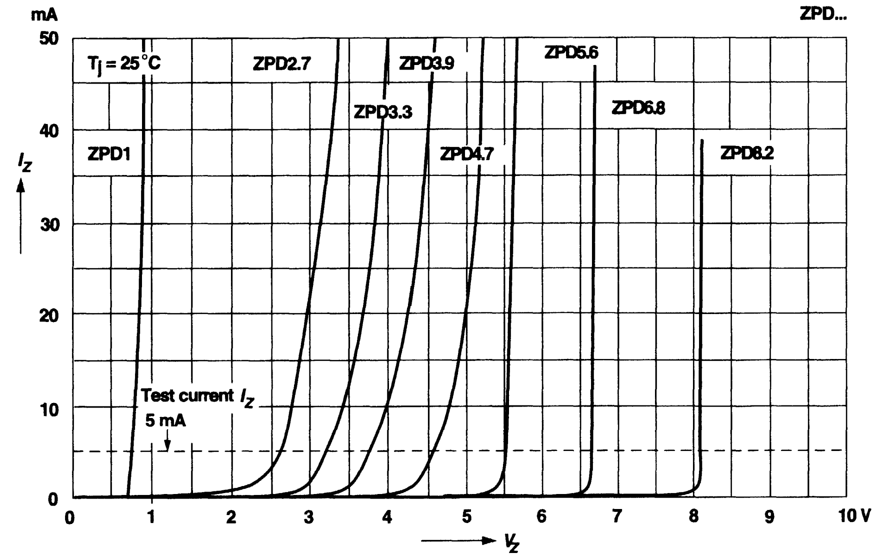
(3) The ZPD1 is a silicon diode operated in forward direction. Hence, the subscript of all parameters should be "F" instead of "Z". Connect the cathode terminal to the negative pole

(4) at I_Z = 2.5 mA

(5) at I_Z = 0.5 mA

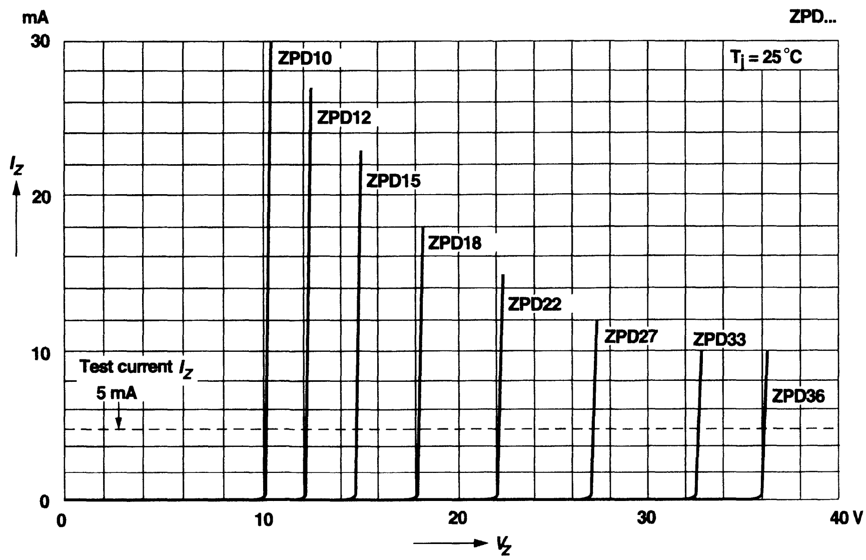
Breakdown characteristics

T_j = constant (pulsed)



Breakdown characteristics

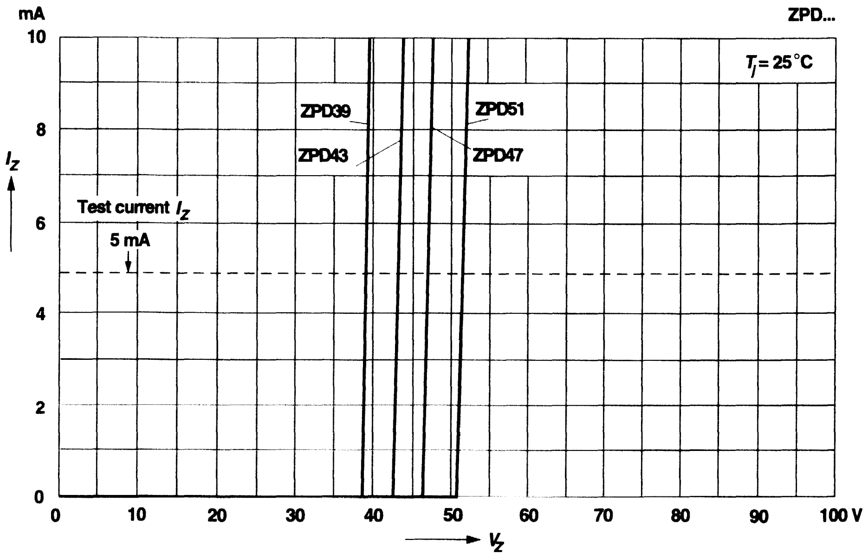
T_j = constant (pulsed)



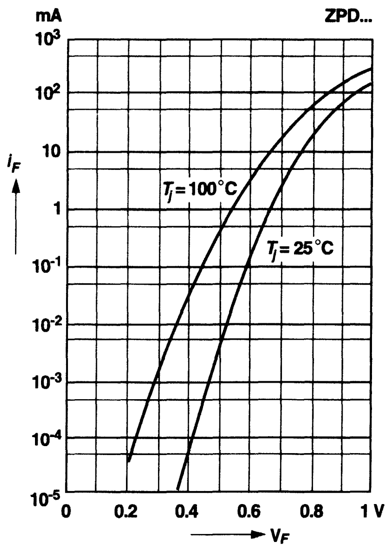
RATINGS AND CHARACTERISTIC CURVES ZPD1 THRU ZPD75

Breakdown characteristics

T_j = constant (pulsed)

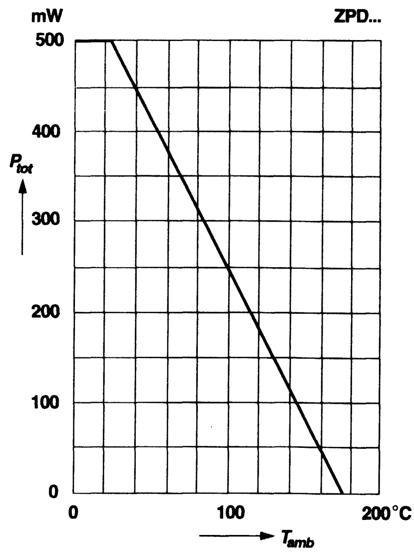


Forward characteristics



Admissible power dissipation versus ambient temperature

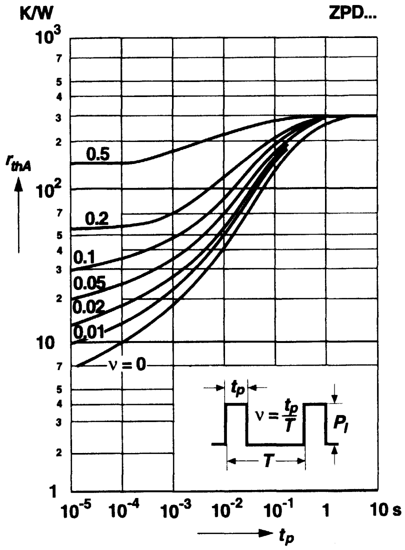
Valid provided that leads at a distance of 4 mm from case are kept at ambient temperature



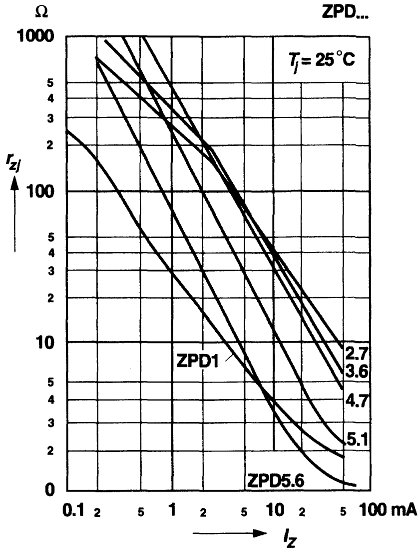
GENERAL SEMICONDUCTOR®

Pulse thermal resistance versus pulse duration

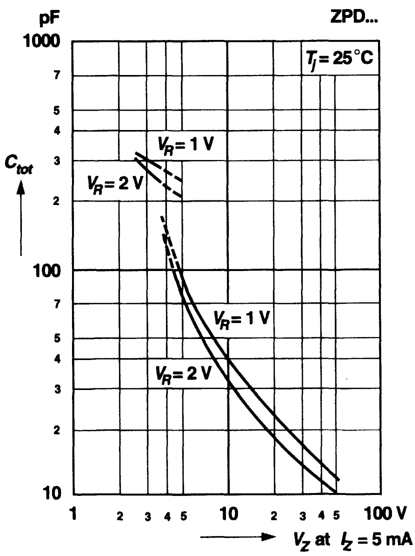
Valid provided that leads at a distance of 4 mm from case are kept at ambient temperature



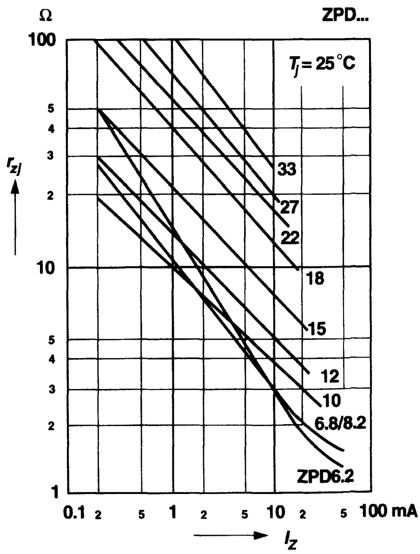
Dynamic resistance versus Zener current



Capacitance versus Zener voltage

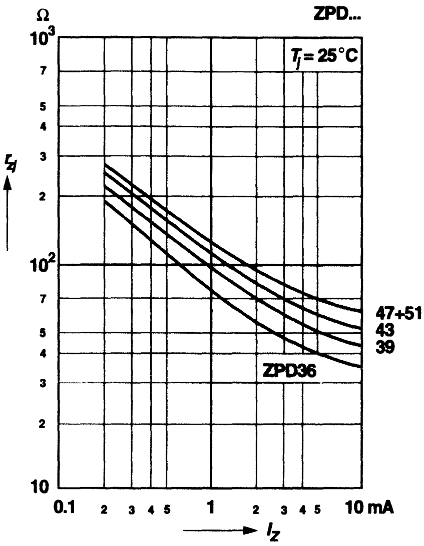


Dynamic resistance versus Zener current



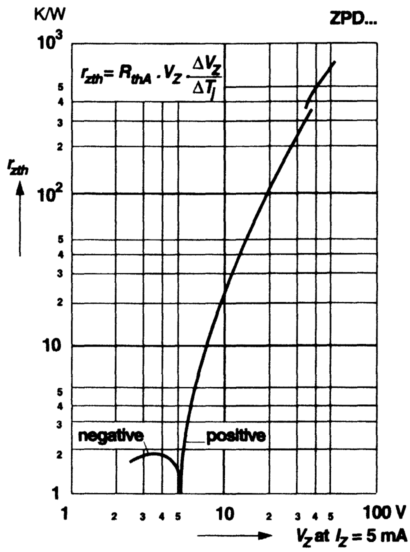
RATINGS AND CHARACTERISTIC CURVES ZPD1 THRU ZPD75

Dynamic resistance versus Zener current

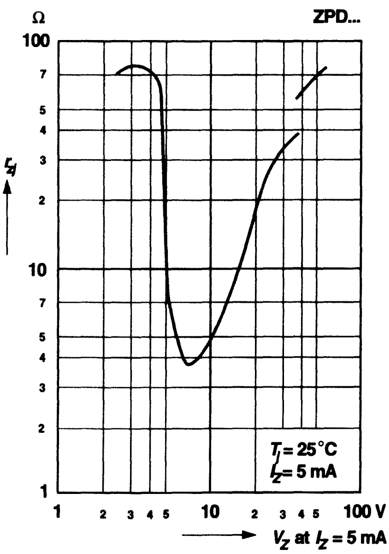


Thermal differential resistance versus Zener voltage

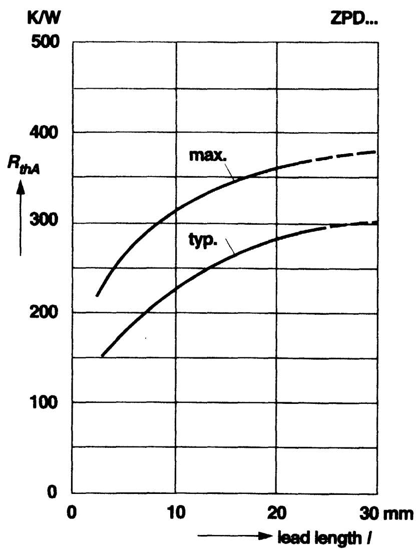
Valid provided that leads at a distance of 4 mm from case are kept at ambient temperature



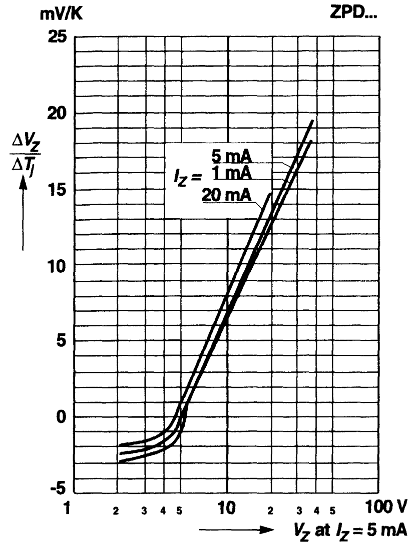
Dynamic resistance versus Zener voltage



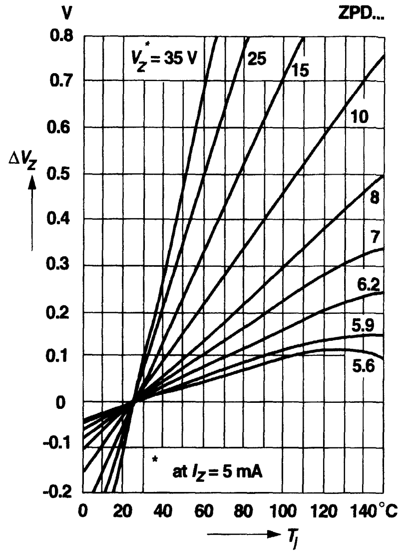
Thermal resistance versus lead length



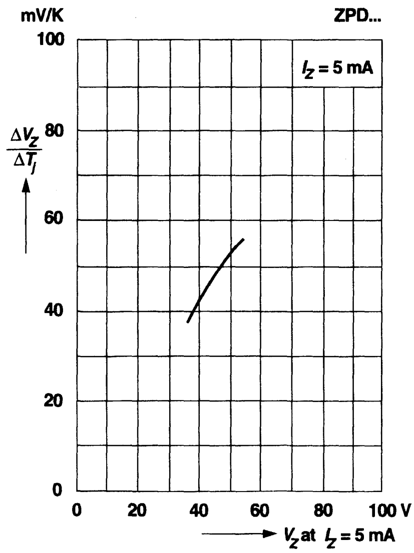
Temperature dependence of Zener voltage versus Zener voltage



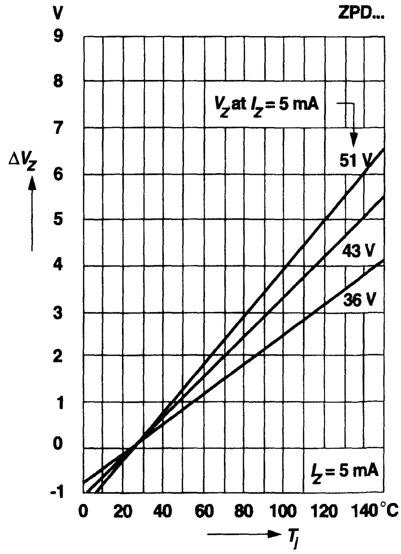
Change of Zener voltage versus junction temperature



Temperature dependence of Zener voltage versus Zener voltage

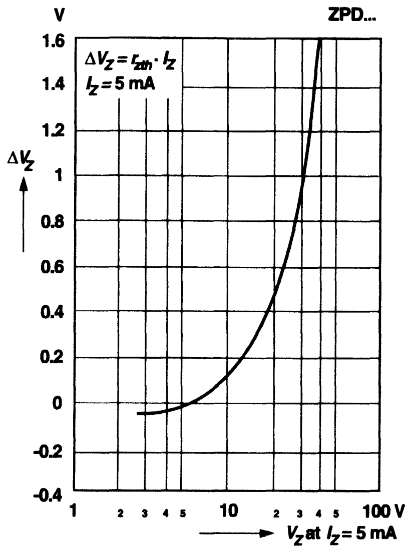


Change of Zener voltage versus junction temperature

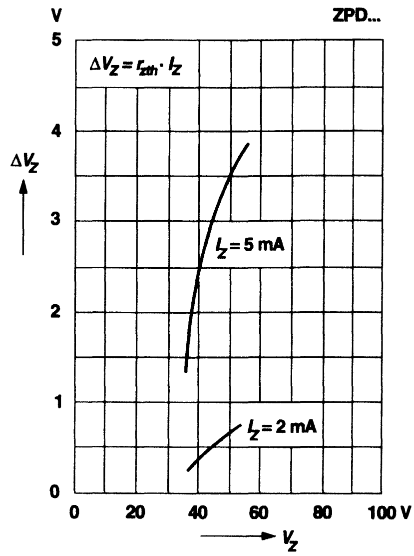


RATINGS AND CHARACTERISTIC CURVES ZPD1 THRU ZPD75

Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



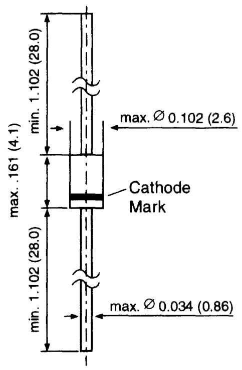
Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



1N4728 THRU 1N4764

ZENER DIODES

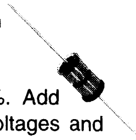
DO-41 Glass



Dimensions in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with high power rating.
- ♦ Standard Zener voltage tolerance is ±10%. Add suffix "A" for ±5% tolerance. Other Zener voltages and tolerances are available upon request.
- ♦ These diodes are also available in the MELF case with type designation ZM4728 thru ZM4764



MECHANICAL DATA

Case: DO-41 Glass Case
Weight: approx. 0.35 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	1.0[1]	Watts
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 65 to +175	°C

Characteristics at Tamb = 25 °C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	170[1]	°C/W
Forward Voltage at I_F = 200 mA	V_F	–	–	1.2	Volts

NOTES:
(1) Valid provided that electrodes at a distance of 10mm from case are kept at ambient temperature

1N4728 THRU 1N4764

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Nominal Zener voltage[3] at I_{ZT} V_Z V	Test current I_{ZT} mA	Maximum Zener impedance[1]			Maximum reverse leakage current		Surge current at T_A = 25°C I_R mA	Maximum regulator current[2] I_{ZM} mA
			Z_{ZT} at I_{ZT} Ω	Z_{ZK} Ω	at I_{ZK} mA	I_R µA	at V_R V		
1N4728	3.3	76	10	400	1.0	100	1	1380	276
1N4729	3.6	69	10	400	1.0	100	1	1260	252
1N4730	3.9	64	9	400	1.0	50	1	1190	234
1N4731	4.3	58	9	400	1.0	10	1	1070	217
1N4732	4.7	53	8	500	1.0	10	1	970	193
1N4733	5.1	49	7	550	1.0	10	1	890	178
1N4734	5.6	45	5	600	1.0	10	2	810	162
1N4735	6.2	41	2	700	1.0	10	3	730	146
1N4736	6.8	37	3.5	700	1.0	10	4	660	133
1N4737	7.5	34	4.0	700	0.5	10	5	605	121
1N4738	8.2	31	4.5	700	0.5	10	6	550	110
1N4739	9.1	28	5.0	700	0.5	10	7	500	100
1N4740	10	25	7	700	0.25	10	7.6	454	91
1N4741	11	23	8	700	0.25	5	8.4	414	83
1N4742	12	21	9	700	0.25	5	9.1	380	76
1N4743	13	19	10	700	0.25	5	9.9	344	69
1N4744	15	17	14	700	0.25	5	11.4	304	61
1N4745	16	15.5	16	700	0.25	5	12.2	285	57
1N4746	18	14	20	750	0.25	5	13.7	250	50
1N4747	20	12.5	22	750	0.25	5	15.2	225	45
1N4748	22	11.5	23	750	0.25	5	16.7	205	41
1N4749	24	10.5	25	750	0.25	5	18.2	190	38
1N4750	27	9.5	35	750	0.25	5	20.6	170	34
1N4751	30	8.5	40	1000	0.25	5	22.8	150	30
1N4752	33	7.5	45	1000	0.25	5	25.1	135	27
1N4753	36	7.0	50	1000	0.25	5	27.4	125	25
1N4754	39	6.5	60	1000	0.25	5	29.7	115	23
1N4755	43	6.0	70	1500	0.25	5	32.7	110	22
1N4756	47	5.5	80	1500	0.25	5	35.8	95	19
1N4757	51	5.0	95	1500	0.25	5	38.8	90	18
1N4758	56	4.5	110	2000	0.25	5	42.6	80	16
1N4759	62	4.0	125	2000	0.25	5	47.1	70	14
1N4760	68	3.7	150	2000	0.25	5	51.7	65	13
1N4761	75	3.3	175	2000	0.25	5	56.0	60	12
1N4762	82	3.0	200	3000	0.25	5	62.2	55	11
1N4763	91	2.8	250	3000	0.25	5	69.2	50	10
1N4764	100	2.5	350	3000	0.25	5	76.0	45	9

NOTES:

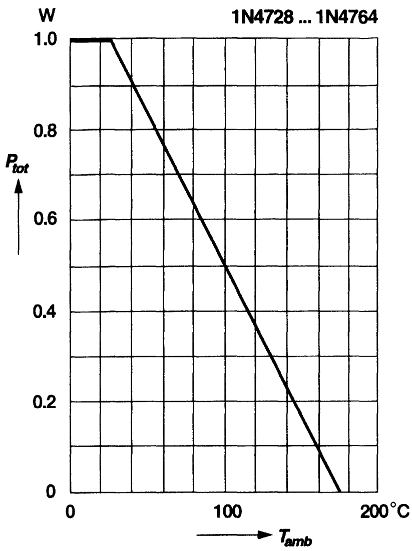
(1) The Zener impedance is derived from the 1KHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}. Zener impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units

(2) Valid provided that electrodes at a distance of 10mm from case are kept at ambient temperature

(3) Measured under thermal equilibrium and DC test conditions

Admissible power dissipation versus ambient temperature

Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case

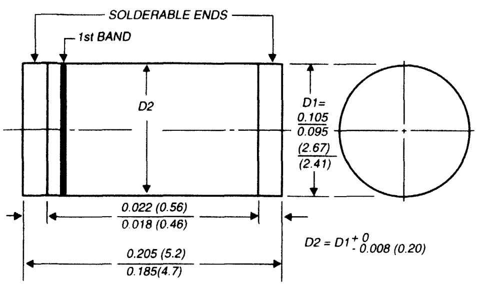


GLL4735 THRU GLL4763A

SURFACE MOUNT GLASS PASSIVATED ZENER

Zener Voltage *- 6.2 to 91.0 Volts* ***Steady State Power*** *- 1.0 Watt*

DO-213AB



1st band denotes type and positive end (cathode)

Dimensions are in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ For surface mounted applications
- ♦ Glass passivated chip junction
- ♦ Low zener impedance
- ♦ Low regulation factor
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-213AB molded plastic over passivated junction
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: Red band denotes Zener diode and positive end (cathode)
Mounting Position: Any
Weight: 0.0046 ounce, 0.116 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE: T_J, T_{STG}: -55°C to +150°C

TYPE	NOMINAL ZENER VOLTAGE AT I_{ZT} (NOTE 1) V_Z (Volts)	TEST CURRENT I_{ZT} (mA)	MAXIMUM DYNAMIC IMPEDANCE Z_{ZT} at I_{ZT} (Ohms)	Z_{ZK} at I_{ZK} (Ohms)	I_{ZK} (mA)	MAXIMUM DC REVERSE LEAKAGE CURRENT I_R (μA)	V_R (Volts)	MAXIMUM ZENER CURRENT (NOTE 2) I_{ZM} (mApk)	MAXIMUM FORWARD VOLTAGE at 200mA V_F (Volts)
GLL4735	6.2	41.0	2.0	700	1.0	50.0	3.0	730.0	1.2
GLL4736	6.8	37.0	3.5	700	1.0	10.0	4.0	660.0	1.2
GLL4737	7.5	34.0	4.0	700	0.5	10.0	5.0	605.0	1.2
GLL4738	8.2	31.0	4.5	700	0.5	10.0	6.0	550.0	1.2
GLL4739	9.1	28.0	5.0	700	0.5	10.0	7.0	500.0	1.2
GLL4740	10	25.0	7.0	700	0.25	10.0	7.6	454.0	1.2
GLL4741	11	23.0	8.0	700	0.25	5.0	8.4	414.0	1.2
GLL4742	12	21.0	9.0	700	0.25	5.0	9.1	380.0	1.2
GLL4743	13	19.0	10.0	700	0.25	5.0	9.9	344.0	1.2
GLL4744	15	17.0	14.0	700	0.25	5.0	11.4	305.0	1.2
GLL4745	16	15.5	16.0	700	0.25	5.0	12.2	285.0	1.2
GLL4746	18	14.0	20.0	750	0.25	5.0	13.7	250.0	1.2
GLL4747	20	12.5	22.0	750	0.25	5.0	15.2	225.0	1.2
GLL4748	22	11.5	23.0	750	0.25	5.0	16.7	205.0	1.2
GLL4749	24	10.5	25.0	750	0.25	5.0	18.2	190.0	1.2
GLL4750	27	9.5	35.0	750	0.25	5.0	20.6	170.0	1.2
GLL4751	30	8.5	40.0	1000	0.25	5.0	22.8	150.0	1.2
GLL4752	33	7.5	45.0	1000	0.25	5.0	25.1	135.0	1.2
GLL4753	36	7.0	50.0	1000	0.25	5.0	27.4	125.0	1.2
GLL4754	39	6.5	60.0	1000	0.25	5.0	29.7	115.0	1.2
GLL4755	43	6.0	70.0	1500	0.25	5.0	32.7	110.0	1.2
GLL4756	47	5.5	80.0	1500	0.25	5.0	35.8	95.0	1.2
GLL4757	51	5.0	95.0	1500	0.25	5.0	38.8	90.0	1.2
GLL4758	56	4.5	110.0	2000	0.25	5.0	42.6	80.0	1.2
GLL4759	62	4.0	125.0	2000	0.25	5.0	47.1	70.0	1.2
GLL4760	68	3.7	150.0	2000	0.25	5.0	51.7	65.0	1.2
GLL4761	75	3.3	175.0	2000	0.25	5.0	56.0	60.0	1.2
GLL4762	82	3.0	200.0	3000	0.25	5.0	62.2	55.0	1.2
GLL4763	91	2.0	250.0	3000	0.25	5.0	69.2	50.0	1.2

NOTES:
(1) Standard voltage tolerance is ±10%, Suffix A = ±5%
(2) Surge current is a non-repetitive, 8.3ms pulse width square wave or equivalent sine-wave superimposed on I_{ZT} per JEDEC Method
(3) Maximum steady state power dissipation is 1.0 watt at T_T=75°C

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FIG. 1 - MAXIMUM CONTINUOUS POWER DISSIPATION

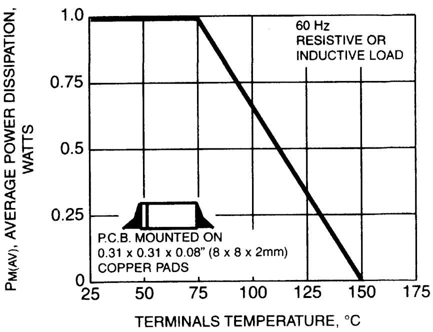


FIG. 2 - TYPICAL ZENER IMPEDANCE

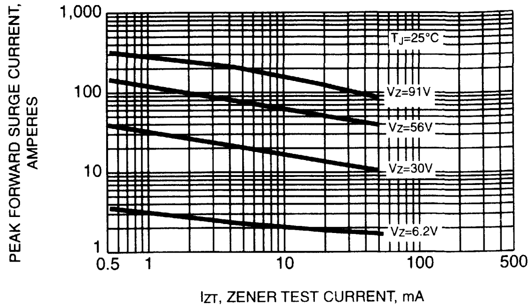


FIG. 3 - TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS FOR GLL4763

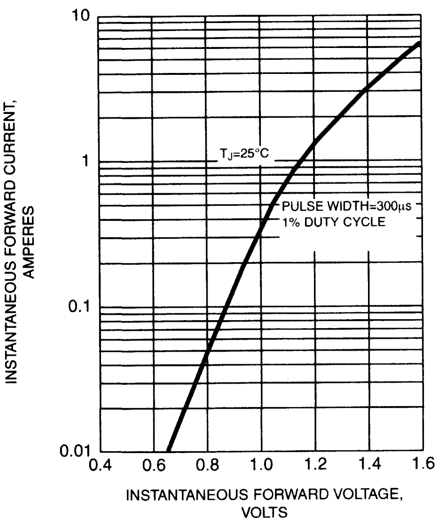


FIG. 4 - TYPICAL REVERSE CHARACTERISTICS

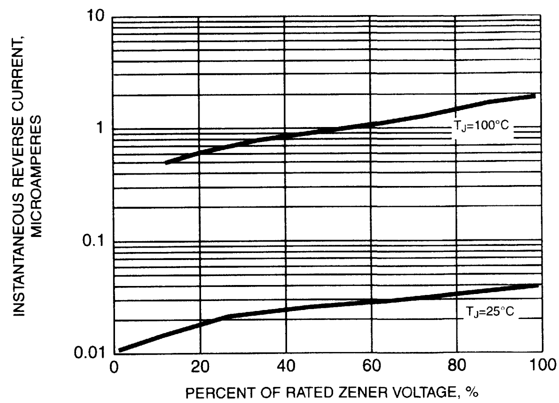
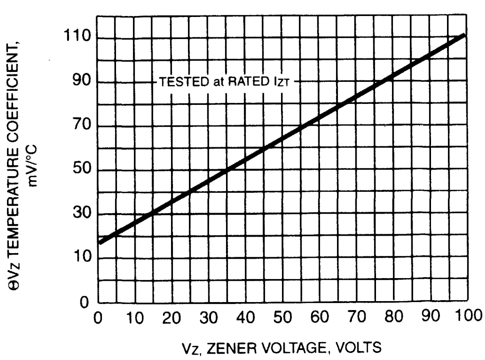


FIG. 5 - TYPICAL TEMPERATURE COEFFICIENTS

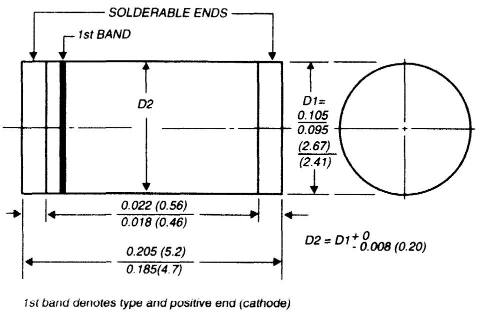


ZGL41-100 THRU ZGL41-200A

SURFACE MOUNT GLASS PASSIVATED ZENER

***Zener Voltage** - 100 to 200 Volts* ***Steady State Power** - 1.0 Watt*

DO-213AB



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ For surface mount applications
- ♦ Glass passivated junction
- ♦ Low Zener impedance
- ♦ Low regulation factor
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-213AB molded plastic body over passivated junction
Terminals: Solder plated solderable per MIL-STD-750, Method 2026
Polarity: Red band denotes Zener diode and positive end (cathode)
Mounting Position: Any
Weight: 0.0046 ounce, 0.116 grams

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE: T_J, T_{STG}: -55°C to +150°C

TYPE	NOMINAL ZENER VOLTAGE at I_{ZT} (NOTE 1) (V_Z)	TEST CURRENT (I_{ZT})	MAXIMUM ZENER DYNAMIC IMPEDANCE Z_{ZT} at I_{ZT}	Z_{ZK} at	I_{ZK}	MAXIMUM DC REVERSE LEAKAGE CURRENT at V_R (I_R)	(V_R)	MAXIMUM SURGE CURRENT (NOTE 2) (I_{RM})	MAXIMUM INSTANTANEOUS FORWARD VOLTAGE at 200mA (V_F)
	(Volts)	(mA)	(Ohms)	(Ohms)	(mA)	(μA)	(Volts)	(mAdc)	(VOLTS)
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, 8.3ms pulse width square wave or equivalent sine-wave superimposed on I_{ZT} per JEDEC Method
(3) Maximum steady state power dissipation is 1.0 watt at T_T=75°C

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FIG. 1 - MAXIMUM CONTINUOUS POWER DISSIPATION

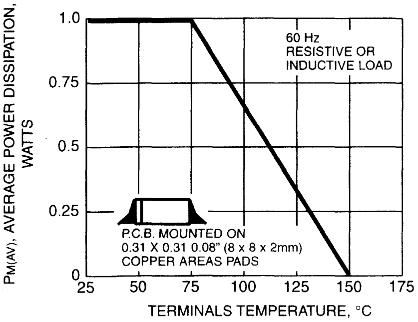


FIG. 2 - TYPICAL ZENER IMPEDANCE

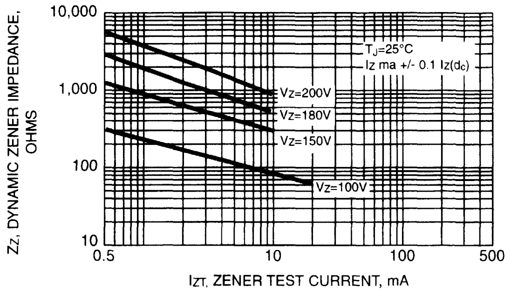


FIG. 3 - TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS

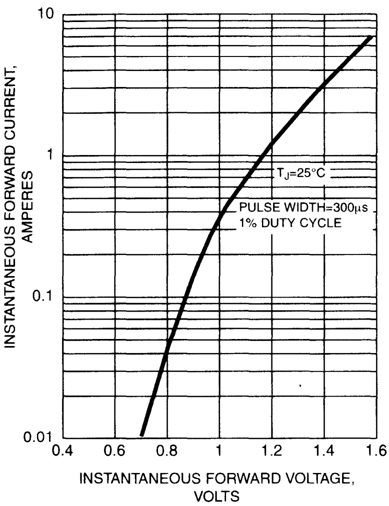


FIG. 4 - TYPICAL REVERSE CHARACTERISTICS

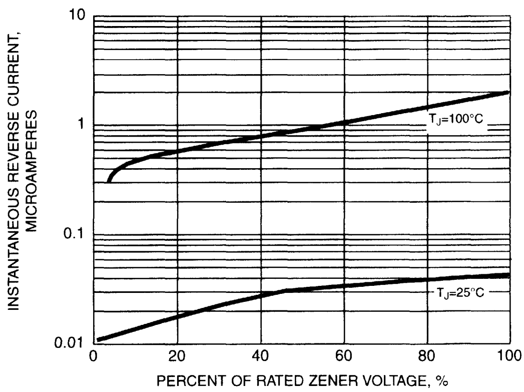


FIG. 5 - TYPICAL TEMPERATURE COEFFICIENTS

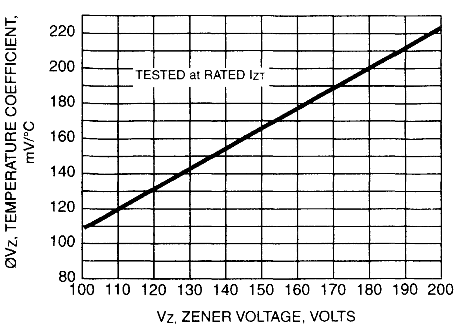
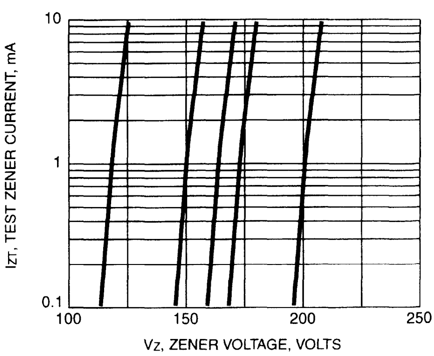


FIG. 6 - TYPICAL ZENER VOLTAGE

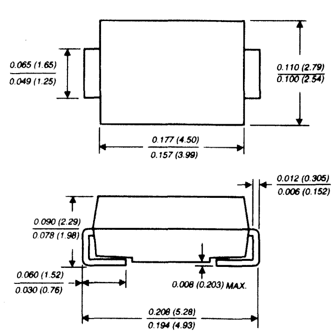


SML4735 THRU SML4763A

SURFACE MOUNT GLASS PASSIVATED ZENER

***Zener Voltage** - 6.2 to 91.0 Volts* ***Steady State Power** - 1.0 Watt*

DO-214AC



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ For surface mounted applications
- ♦ Glass passivated chip junction
- ♦ Low Zener impedance
- ♦ Low regulation factor
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-214AC molded plastic over passivated junction
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.002 ounce, 0.064 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE: T_J, T_{STG}: -55°C to +150°C

TYPE	DEVICE MARKING CODE	NOMINAL ZENER VOLTAGE at I_{ZT} V_Z (NOTE 1) (Volts)	TEST CURRENT I_{ZT} (mA)	MAXIMUM DYNAMIC IMPEDANCE			MAXIMUM DC REVERSE LEAKAGE CURRENT		MAXIMUM SURGE CURRENT (NOTE 2) I_{RM} (mApk)	MAXIMUM FORWARD VOLTAGE at 200mA V_F (Volts)
				Z_{ZT} at I_{ZT} (Ohms)	Z_{ZK} at I_{ZK} (Ohms)	(NOTE 1) I_{ZK} (mA)	I_R (μA)	V_R (Volts)		
SML4735	6P2	6.2	41.0	2.0	700	1.0	50.0	3.0	730.0	1.2
SML4736	6P8	6.8	37.0	3.5	700	1.0	20.0	4.0	660.0	1.2
SML4737	7P5	7.5	34.0	4.0	700	0.5	10.0	5.0	605.0	1.2
SML4738	8P2	8.2	31.0	4.5	700	0.5	10.0	6.0	550.0	1.2
SML4739	9P1	9.1	28.0	5.0	700	0.5	10.0	7.0	500.0	1.2
SML4740	10	10	25.0	7.0	700	0.25	10.0	7.6	454.0	1.2
SML4741	11	11	23.0	8.0	700	0.25	5.0	8.4	414.0	1.2
SML4742	12	12	21.0	9.0	700	0.25	5.0	9.1	380.0	1.2
SML4743	13	13	19.0	10.0	700	0.25	5.0	9.9	344.0	1.2
SML4744	15	15	17.0	14.0	700	0.25	5.0	11.4	305.0	1.2
SML4745	16	16	15.5	16.0	700	0.25	5.0	12.2	285.0	1.2
SML4746	18	18	14.0	20.0	750	0.25	5.0	13.7	250.0	1.2
SML4747	20	20	12.5	22.0	750	0.25	5.0	15.2	225.0	1.2
SML4748	22	22	11.5	23.0	750	0.25	5.0	16.7	205.0	1.2
SML4749	24	24	10.5	25.0	750	0.25	5.0	18.2	190.0	1.2
SML4750	27	27	9.5	35.0	750	0.25	5.0	20.6	170.0	1.2
SML4751	30	30	8.5	40.0	1000	0.25	5.0	22.8	150.0	1.2
SML4752	33	33	7.5	45.0	1000	0.25	5.0	25.1	135.0	1.2
SML4753	36	36	7.0	50.0	1000	0.25	5.0	27.4	125.0	1.2
SML4754	39	39	6.5	60.0	1000	0.25	5.0	29.7	115.0	1.2
SML4755	43	43	6.0	70.0	1500	0.25	5.0	32.7	110.0	1.2
SML4756	47	47	5.5	80.0	1500	0.25	5.0	35.8	95.0	1.2
SML4757	51	51	5.0	95.0	1500	0.25	5.0	38.8	90.0	1.2
SML4758	56	56	4.5	110.0	2000	0.25	5.0	42.6	80.0	1.2
SML4759	62	62	4.0	125.0	2000	0.25	5.0	47.1	70.0	1.2
SML4760	68	68	3.7	150.0	2000	0.25	5.0	51.7	65.0	1.2
SML4761	75	75	3.3	175.0	2000	0.25	5.0	56.0	60.0	1.2
SML4762	82	82	3.0	200.0	3000	0.25	5.0	62.2	55.0	1.2
SML4763	91	91	2.0	250.0	3000	0.25	5.0	69.2	50.0	1.2

NOTES:

(1) Standard voltage tolerance is 10%, Suffix A ± 5%
(2) Surge current is a non-repetitive, 8.3ms pulse width square wave or equivalent sine-wave superimposed on I_{ZT} per JEDEC Method
(3) Maximum steady state power dissipation is 1.0 watt at T_T=75°C

FIG. 1 - MAXIMUM CONTINUOUS POWER DISSIPATION

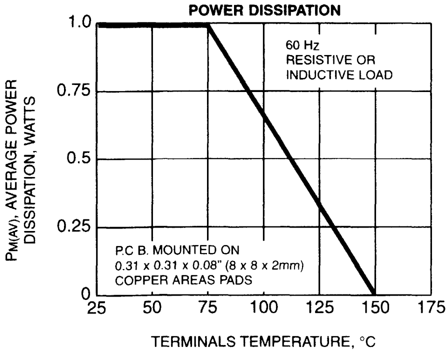


FIG. 2 - TYPICAL ZENER IMPEDANCE

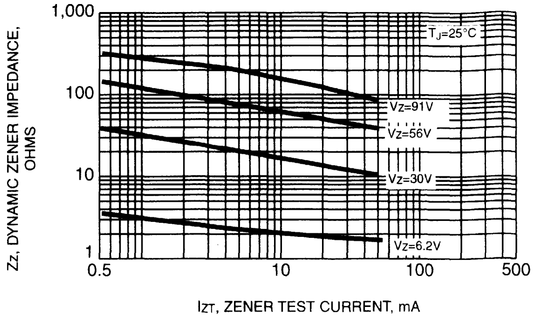


FIG. 3 - TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS FOR SML4763

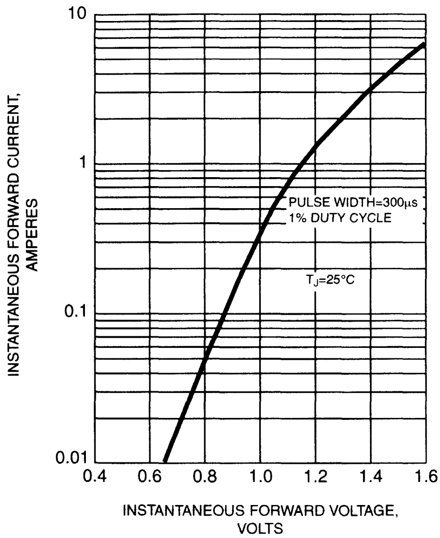


FIG. 4 - TYPICAL REVERSE CHARACTERISTICS

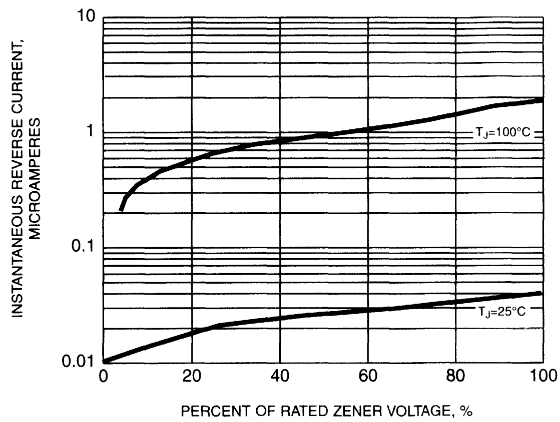
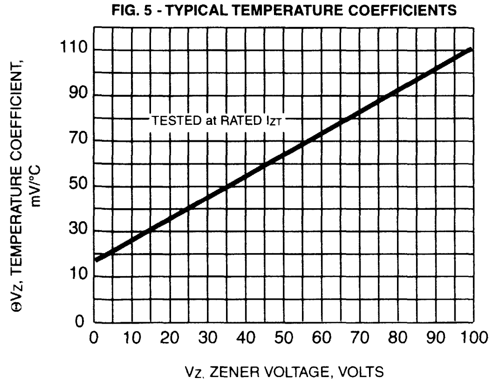


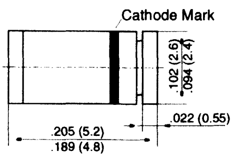
FIG. 5 - TYPICAL TEMPERATURE COEFFICIENTS



ZM4728 THRU ZM4764

ZENER DIODES

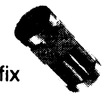
MELF



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with high power rating.
- ♦ Standard Zener voltage tolerance is ±10%. Add suffix "A" for ±5% tolerance. Other Zener voltages and tolerances are available upon request.
- ♦ These diodes are also available in DO-41 case with the type designation 1N4728 ... 1N4764.



MECHANICAL DATA

Case: MELF Glass Case
Weight: approx. 0.25 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	1.0(1)	Watts
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 65 to +150	°C

Characteristics at Tamb = 25 °C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	170(1)	°C/W
Forward Voltage at I_F = 200 mA	V_F	–	–	1.2	Volts

NOTES:
(1) Valid provided that electrodes are kept at ambient temperature

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ZM4728 THRU ZM4764

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Nominal Zener voltage(3) at I_{ZT} V_Z (V)	Test current I_{ZT} (mA)	Maximum Zener impedance(1) Z_{ZT} at I_{ZT} (Ω)	Z_{ZK} (Ω)	at I_{ZK} (mA)	Maximum reverse leakage current I_R (μA)	at V_R (V)	Surge current at T_A = 25°C I_R (mA)	Maximum regulator current(2) I_{ZM} (mA)
ZM4728	3.3	76	10	400	1.0	100	1.0	1380	276
ZM4729	3.6	69	10	400	1.0	100	1.0	1260	252
ZM4730	3.9	64	9	400	1.0	50	1.0	1190	234
ZM4731	4.3	58	9	400	1.0	10	1.0	1070	217
ZM4732	4.7	53	8	500	1.0	10	1.0	970	193
ZM4733	5.1	49	7	550	1.0	10	1.0	890	178
ZM4734	5.6	45	5	600	1.0	10	2.0	810	162
ZM4735	6.2	41	2	700	1.0	10	3.0	730	146
ZM4736	6.8	37	3.5	700	1.0	10	4.0	660	133
ZM4737	7.5	34	4.0	700	0.5	10	5.0	605	121
ZM4738	8.2	31	4.5	700	0.5	10	6.0	550	110
ZM4739	9.1	28	5.0	700	0.5	10	7.0	500	100
ZM4740	10	25	7	700	0.25	10	7.6	454	91
ZM4741	11	23	8	700	0.25	5	8.4	414	83
ZM4742	12	21	9	700	0.25	5	9.1	380	76
ZM4743	13	19	10	700	0.25	5	9.9	344	69
ZM4744	15	17	14	700	0.25	5	11.4	304	61
ZM4745	16	15.5	16	700	0.25	5	12.2	285	57
ZM4746	18	14	20	750	0.25	5	13.7	250	50
ZM4747	20	12.5	22	750	0.25	5	15.2	225	45
ZM4748	22	11.5	23	750	0.25	5	16.7	205	41
ZM4749	24	10.5	25	750	0.25	5	18.2	190	38
ZM4750	27	9.5	35	750	0.25	5	20.6	170	34
ZM4751	30	8.5	40	1000	0.25	5	22.8	150	30
ZM4752	33	7.5	45	1000	0.25	5	25.1	135	27
ZM4753	36	7.0	50	1000	0.25	5	27.4	125	25
ZM4754	39	6.5	60	1000	0.25	5	29.7	115	23
ZM4755	43	6.0	70	1500	0.25	5	32.7	110	22
ZM4756	47	5.5	80	1500	0.25	5	35.8	95	19
ZM4757	51	5.0	95	1500	0.25	5	38.8	90	18
ZM4758	56	4.5	110	2000	0.25	5	42.6	80	16
ZM4759	62	4.0	125	2000	0.25	5	47.1	70	14
ZM4760	68	3.7	150	2000	0.25	5	51.7	65	13
ZM4761	75	3.3	175	2000	0.25	5	56.0	60	12
ZM4762	82	3.0	200	3000	0.25	5	62.2	55	11
ZM4763	91	2.8	250	3000	0.25	5	69.2	50	10
ZM4764	100	2.5	350	3000	0.25	5	76.0	45	9

NOTES:

(1) The Zener impedance is derived from the 1KHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}. Zener impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units

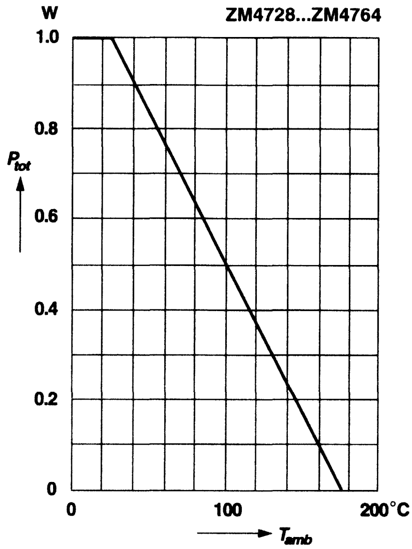
(2) Valid provided that electrodes at a distance of 10mm from case are kept at ambient temperature

(3) Measured under thermal equilibrium and DC test conditions

RATINGS AND CHARACTERISTIC CURVES ZM4728 THRU ZM4764

Admissible power dissipation versus ambient temperature

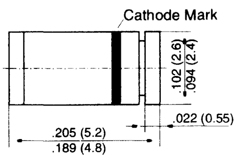
Valid provided that electrodes are kept at ambient temperature



ZMU100 THRU ZMU180

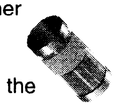
ZENER DIODES

MELF



Dimensions are in inches and (millimeters)

FEATURES



- ♦ Silicon Planar Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with higher power rating.
- ♦ The Zener voltages are graded according to the international E 12 standard. Smaller voltage tolerances are available upon request.
- ♦ These diodes are also available in the DO-41 case with the type designation ZPU100 ... ZPU180.

MECHANICAL DATA

Case: MELF Glass Case
Weight: approx. 0.25 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	1.0[1)]	Watts
Junction Temperature	T_j	150	°C
Storage Temperature Range	Ts	– 55 to +150	°C

NOTES:
(1) Valid provided that electrodes are kept at ambient temperature.

ZMU100 THRU ZMU180

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	170[1)]	°C/W

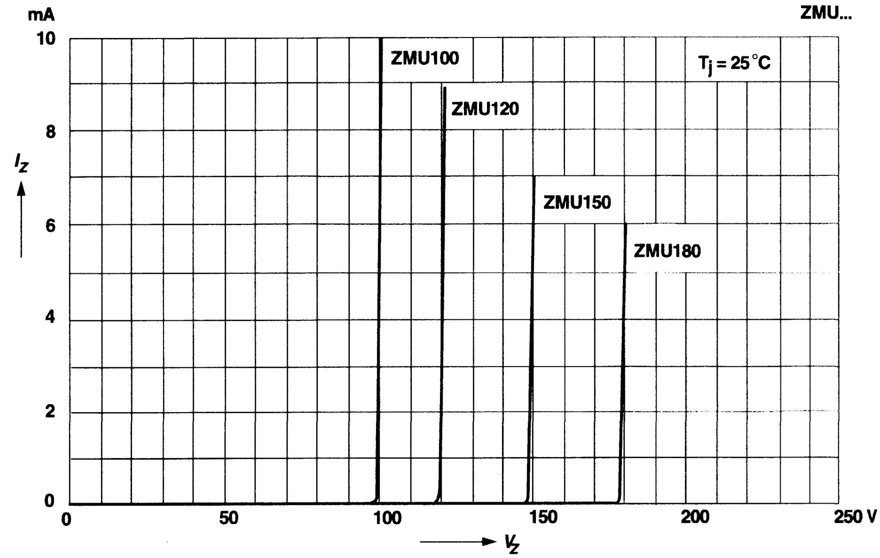
NOTES:
(1) Valid provided that electrodes are kept at ambient temperature.

Type	Zener voltage[(1)] at I_{ZT} V_Z (V)	Dynamic Resistance at I_{ZT} f = 1 kHz r_{zj} (Ω)	Temp. Coeff. of Zener Voltage at I_{ZT} α_{VZ} (10^{-4}/K)	Test current I_{ZT} (mA)	Reverse Voltage at I_R = .5 µA V_R (V)	Admissible Zener current[(2)] at T_{amb} = 25°C I_Z (mA)
ZMU100	88 ... 110	140 (< 300)	+9 ... +13	5	> 75	7
ZMU120	107 ... 134	170 (< 330)	+9 ... +13	5	> 90	6
ZMU150	130 ... 165	200 (< 360)	+9 ... +13	5	> 112	5
ZMU180	160 ... 200	220 (< 380)	+9 ... +13	5	> 134	4

NOTES:
(1) Tested with pulses t_p = 5 ms
(2) Valid provided that electrodes are kept at ambient temperature

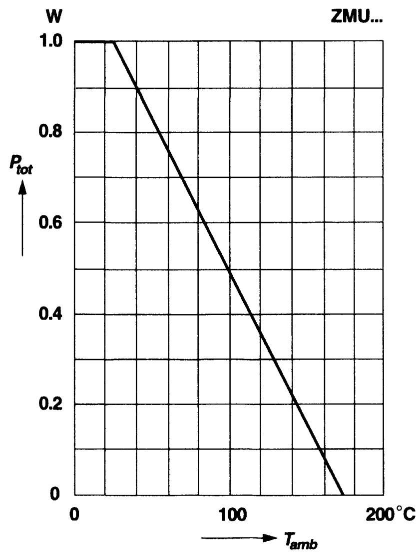
Breakdown characteristics

T_j = constant (pulsed)



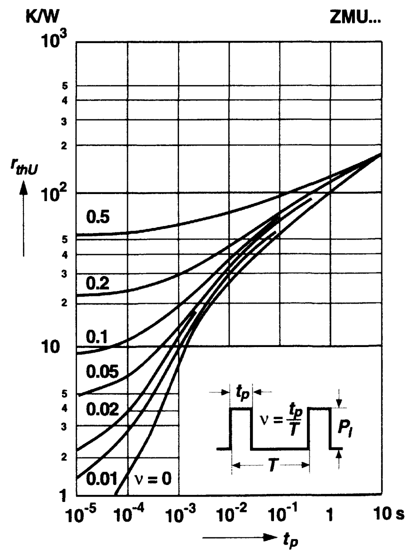
Admissible power dissipation versus ambient temperature

Valid provided that electrodes are kept at ambient temperature



Pulse thermal resistance versus pulse duration

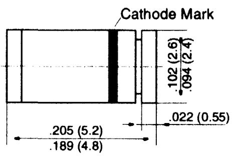
Valid provided that electrodes are kept at ambient temperature



ZMY1 THRU ZMY100

ZENER DIODES

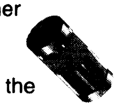
MELF



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with higher power rating.
- ♦ The Zener voltages are graded according to the international E24 standard. Smaller voltage tolerances and other Zener voltages are available upon request.
- ♦ These diodes are also available in the DO-41 case with the type designation ZPY1 ... ZPY100.



MECHANICAL DATA

Case: MELF Glass Case
Weight: approx. 0.25 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	1.0[1]	W
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 55 to +150	°C

Characteristics at Tamb = 25 °C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	170[1]	°C/W

NOTES:
(1) Valid provided that electrodes are kept at ambient temperature.

ZMY1 THRU ZMY100

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener voltage[2] at I_{ZT} min. max. V_Z (V)	Dynamic resistance at I_{ZT} f = 1 kHz max r_{zj} (Ω)	Temp. coeff. of Zener volt. at I_{ZT} α_{VZ} (10^{-4}/K)	Test current I_{ZT} (mA)	Reverse voltage at I_R= 0.5μA V_R (V)	Admissible Zener current[1] at T_{amb} = 25°C I_Z (mA)
ZMY1[3]	0.65 … 0.75	6.5 (< 8)	−26 … −23	5	–	406
ZMY3.9	3.7 … 4.1	4 (< 7)	−7 … +2	100	–	203
ZMY4.3	4.0 … 4.6	4 (< 7)	−7 … +3	100	–	182
ZMY4.7	4.4 … 5.0	4 (< 7)	−7 … +4	100	–	165
ZMY5.1	4.8 … 5.4	2 (< 5)	−6 … +5	100	> 0.7	150
ZMY5.6	5.2 … 6.0	1 (< 2)	−3 … +5	100	> 1.5	135
ZMY6.2	5.8 … 6.6	1 (< 2)	−1 … +6	100	> 2.0	128
ZMY6.8	6.4 … 7.2	1 (< 2)	0 … +7	100	> 3.0	110
ZMY7.5	7.0 … 7.9	1 (< 2)	0 … +7	100	> 5.0	100
ZMY8.2	7.7 … 8.7	1 (< 2)	+3 … +8	100	> 6.0	89
ZMY9.1	8.5 … 9.6	2 (< 4)	+3 … +8	50	> 7.0	82
ZMY10	9.4 … 10.6	2 (< 4)	+5 … +9	50	> 7.5	74
ZMY11	10.4 … 11.6	3 (< 7)	+5 … +10	50	> 8.5	66
ZMY12	11.4 … 12.7	3 (< 7)	+5 … +10	50	> 9.0	60
ZMY13	12.4 … 14.1	4 (< 9)	+5 … +10	50	> 10	55
ZMY15	13.8 … 15.8	4 (< 9)	+5 … +10	50	> 11	49
ZMY16	15.3 … 17.1	5 (< 10)	+7 … +11	25	> 12	44
ZMY18	16.8 … 19.1	5 (< 11)	+7 … +11	25	> 14	40
ZMY20	18.8 … 21.2	6 (< 12)	+7 … +11	25	> 15	36
ZMY22	20.8 … 23.3	7 (< 13)	+7 … +11	25	> 17	34
ZMY24	22.8 … 25.6	8 (< 14)	+7 … +12	25	> 18	29
ZMY27	25.1 … 28.9	9 (< 15)	+7 … +12	25	> 20	27
ZMY30	28 … 32	10 (< 20)	+7 … +12	25	> 22.5	25
ZMY33	31 … 35	11 (< 20)	+7 … +12	25	> 25	22
ZMY36	34 … 38	25 (< 60)	+7 … +12	10	> 27	20
ZMY39	37 … 41	30 (< 60)	+8 … +12	10	> 29	18
ZMY43	40 … 46	35 (< 80)	+8 … +13	10	> 32	17
ZMY47	44 … 50	40 (< 80)	+8 … +13	10	> 35	15
ZMY51	48 … 54	45 (< 100)	+8 … +13	10	> 38	14
ZMY56	52 … 60	50 (< 100)	+8 … +13	10	> 42	13
ZMY62	58 … 66	60 (< 130)	+8 … +13	10	> 47	11
ZMY68	64 … 72	65 (< 130)	+8 … +13	10	> 51	10
ZMY75	70 … 79	70 (< 160)	+8 … +13	10	> 56	9
ZMY82	77 … 88	80 (< 160)	+8 … +13	10	> 61	8
ZMY91	85 … 96	120 (< 250)	+9 … +13	5	> 68	7.5
ZMY100	94 … 106	130 (< 250)	+9 … +13	5	> 75	7

NOTES:

(1) Valid provided that electrodes are kept at ambient temperature

(2) Tested with pulses t_p = 5 ms

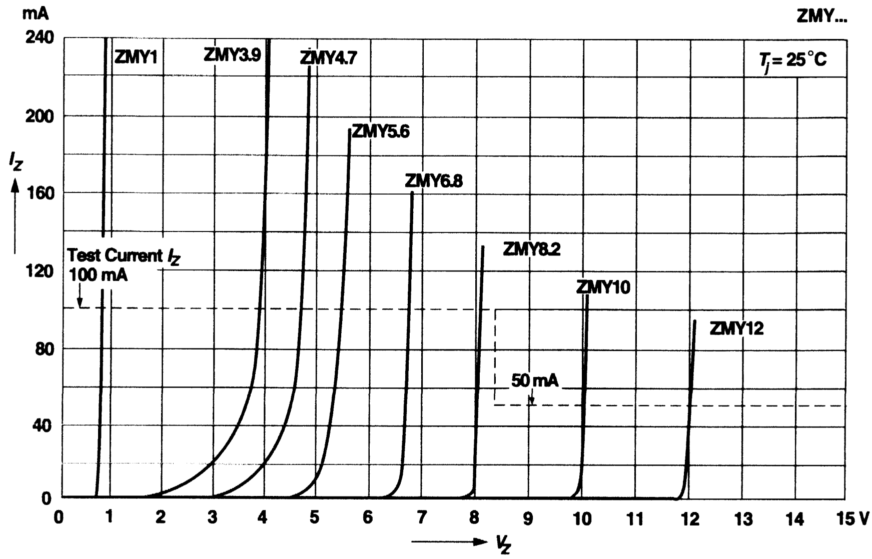
(3) The ZMY1 is a silicon diode operated in forward direction. Hence, the index of all characteristics and maximum ratings should be "F" instead of "Z". Connect the cathode terminal to the negative pole

For devices in glass case MELF with higher Zener voltage but same power dissipation see types ZMU100 … ZMU180

RATINGS AND CHARACTERISTIC CURVES ZMY1 THRU ZMY100

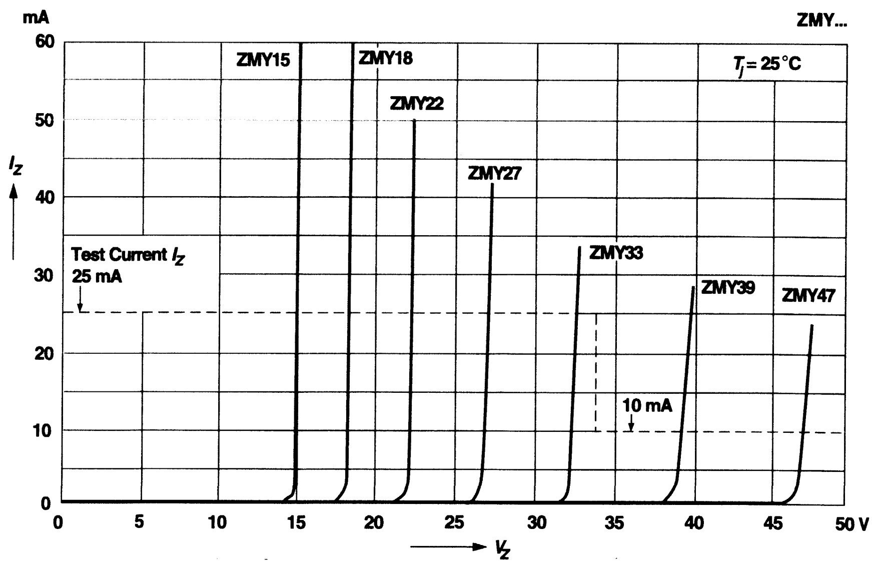
Breakdown characteristics

T_j = constant (pulsed)



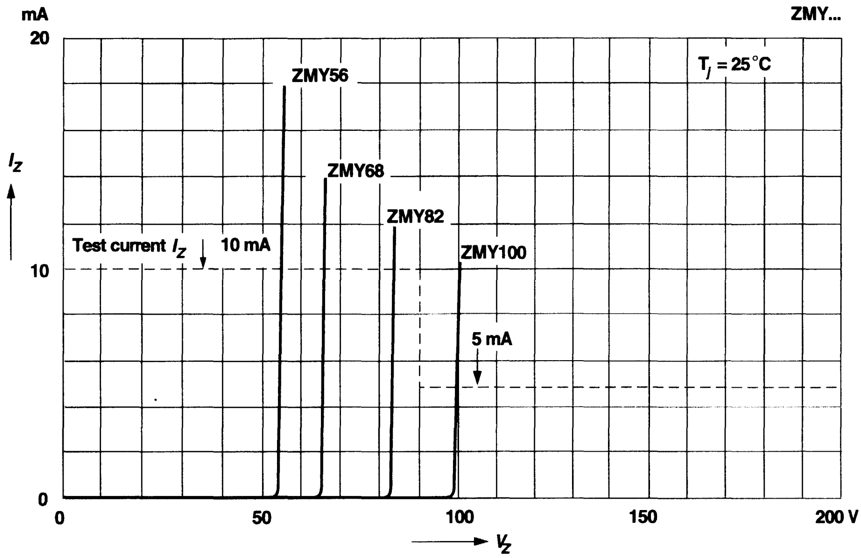
Breakdown characteristics

T_j = constant (pulsed)



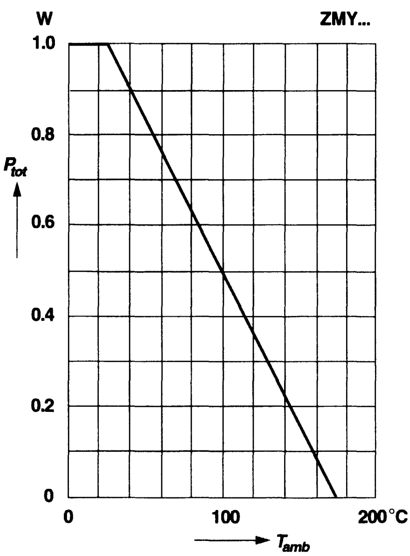
Breakdown characteristics

T_j = constant (pulsed)



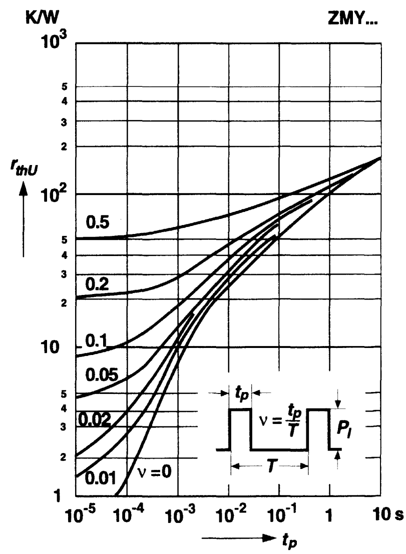
Admissible power dissipation versus ambient temperature

Valid provided that electrodes are kept at ambient temperature



Pulse thermal resistance versus pulse duration

Valid provided that electrodes are kept at ambient temperature



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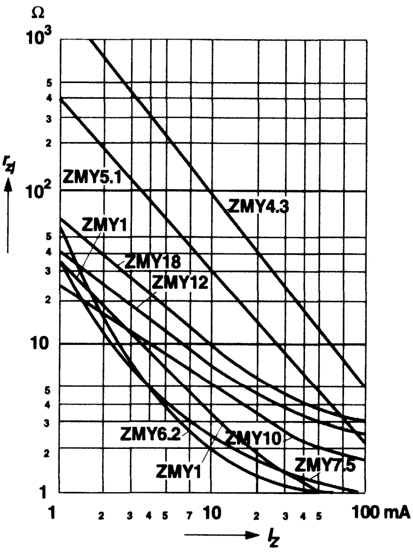
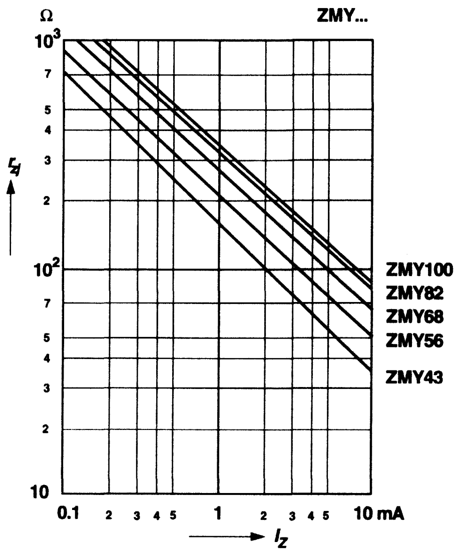
RATINGS AND CHARACTERISTIC CURVES ZMY1 THRU ZMY100

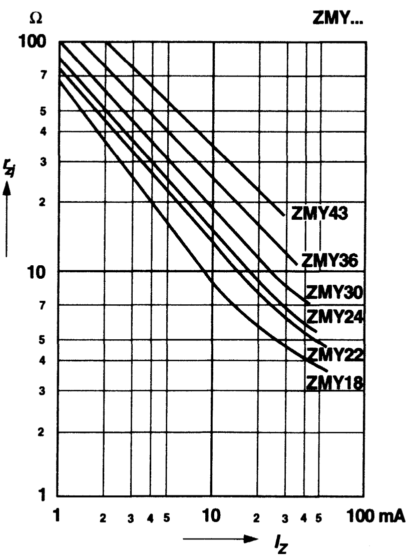
Dynamic resistance versus Zener current



Dynamic resistance versus Zener current



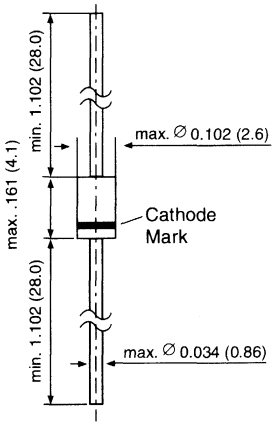
Dynamic resistance versus Zener current



BZX85-C3V6 THRU BZX85-C62

ZENER DIODES

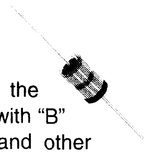
DO-41 Glass



Dimensions in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with high power rating.
- ♦ The Zener voltages are graded according to the international E 24 standard. Replace suffix "C" with "B" for ±2% tolerance. Other voltage tolerances and other Zener voltages are available upon request.



MECHANICAL DATA

Case: DO-41 Glass Case
Weight: approx. 0.35 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	1.3[1]	Watts
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 55 to +175	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	130[1]	°C/W
Forward Voltage at I_F = 200 mA	V_F	–	–	1.0	Volts

NOTES:
(1) Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature.

BZX85-C3V6 THRU BZX85-C62

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener Voltage range[1] at $I_Z = I_{ZT}$	Dynamic resistance				Temp. coefficient of Zener Voltage at $I_Z = I_{ZT}$ α_{VZ} %/K		Reverse leakage current		Admissable Zener current[2]	
	V_Z V	r_{zj} Ω	at f=1 kHz I_{ZT} mA	r_{zj} Ω	at f =1 kHz I_{ZT} mA	min.	max.	at I_R µA	at V_R V	I_Z mA	at t_p=10 ms I_{ZSM} mA
BZX85 – C3V6	3.4 ... 3.8	< 15	60	< 500	1	– 0.08	– 0.05	< 20	1	290	2660
BZX85 – C3V9	3.7 ... 4.1	< 15	60	< 500	1	– 0.07	– 0.02	< 10	1	280	2540
BZX85 – C4V3	4.0 ... 4.6	< 13	50	< 500	1	– 0.05	+0.01	< 3	1	250	2440
BZX85 – C4V7	4.4 ... 5.0	< 13	45	< 600	1	– 0.03	+0.04	< 3	1	215	2320
BZX85 – C5V1	4.8 ... 5.4	< 10	45	< 500	1	– 0.01	+0.04	< 1	1.5	200	2200
BZX85 – C5V6	5.2 ... 6.0	< 7	45	< 400	1	0	+0.045	< 1	2	190	2080
BZX85 – C6V2	5.8 ... 6.6	< 4	35	< 300	1	+0.01	+0.055	< 1	3	170	1960
BZX85 – C6V8	6.4 ... 7.2	< 3.5	35	< 300	1	+0.015	+0.06	< 1	4	155	1800
BZX85 – C7V5	7.0 ... 7.9	< 3	35	< 200	0.5	+0.02	+0.065	< 1	4.5	140	1620
BZX85 – C8V2	7.7 ... 8.7	< 5	25	< 200	0.5	+0.03	+0.07	< 1	6.2	130	1520
BZX85 – C9V1	8.5 ... 9.6	< 5	25	< 200	0.5	+0.035	+0.075	< 1	6.8	120	1340
BZX85 – C10	9.4 ... 10.6	< 7	25	< 200	0.5	+0.04	+0.08	< 0.5	7.5	105	1200
BZX85 – C11	10.4 ... 11.6	< 8	20	< 300	0.5	+0.045	+0.08	< 0.5	8.2	97	1100
BZX85 – C12	11.4 ... 12.7	< 9	20	< 350	0.5	+0.045	+0.085	< 0.5	9.1	88	1000
BZX85 – C13	12.4 ... 14.1	< 10	20	< 400	0.5	+0.05	+0.085	< 0.5	10	79	900
BZX85 – C15	13.8 ... 15.6	< 10	15	< 500	0.5	+0.055	+0.09	< 0.5	11	71	760
BZX85 – C16	15.3 ... 17.1	< 15	15	< 500	0.5	+0.055	+0.09	< 0.5	12	66	700
BZX85 – C18	16.8 ... 19.1	< 20	15	< 500	0.5	+0.06	+0.09	< 0.5	13	62	600
BZX85 – C20	18.8 ... 21.2	< 24	10	< 600	0.5	+0.06	+0.09	< 0.5	15	56	540
BZX85 – C22	20.8 ... 23.3	< 25	10	< 600	0.5	+0.06	+0.095	< 0.5	16	52	500
BZX85 – C24	22.8 ... 25.6	< 25	10	< 600	0.5	+0.06	+0.095	< 0.5	18	47	450
BZX85 – C27	25.1 ... 28.9	< 30	8	< 750	0.25	+0.06	+0.095	< 0.5	20	41	400
BZX85 – C30	28 ... 32	< 30	8	< 1000	0.25	+0.06	+0.095	< 0.5	22	36	380
BZX85 – C33	31 ... 35	< 35	8	< 1000	0.25	+0.06	+0.095	< 0.5	24	33	350
BZX85 – C36	34 ... 38	< 40	8	< 1000	0.25	+0.06	+0.095	< 0.5	27	30	320
BZX85 – C39	37 ... 41	< 50	6	< 1000	0.25	+0.06	+0.095	< 0.5	30	28	296
BZX85 – C43	40 ... 46	< 50	6	< 1000	0.25	+0.06	+0.095	< 0.5	33	26	270
BZX85 – C47	44 ... 50	< 90	4	< 1500	0.25	+0.06	+0.095	< 0.5	36	23	246
BZX85 – C51	48 ... 54	< 115	4	< 1500	0.25	+0.06	+0.095	< 0.5	39	21	226
BZX85 – C56	52 ... 60	< 120	4	< 2000	0.25	+0.06	+0.095	< 0.5	43	19	208
BZX85 – C62	58 ... 66	< 125	4	< 2000	0.25	+0.06	+0.095	< 0.5	47	16	186

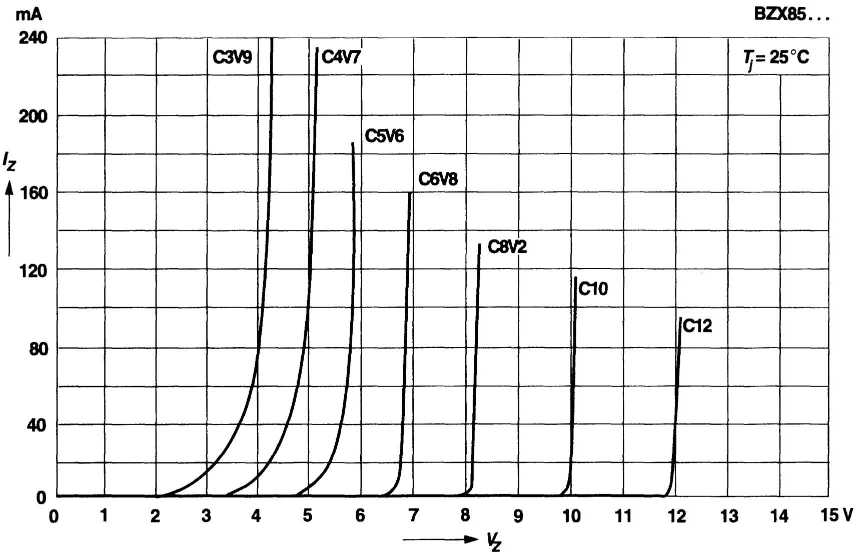
NOTES:

(1) Measured with pulses t_p = 5 ms

(2) Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case

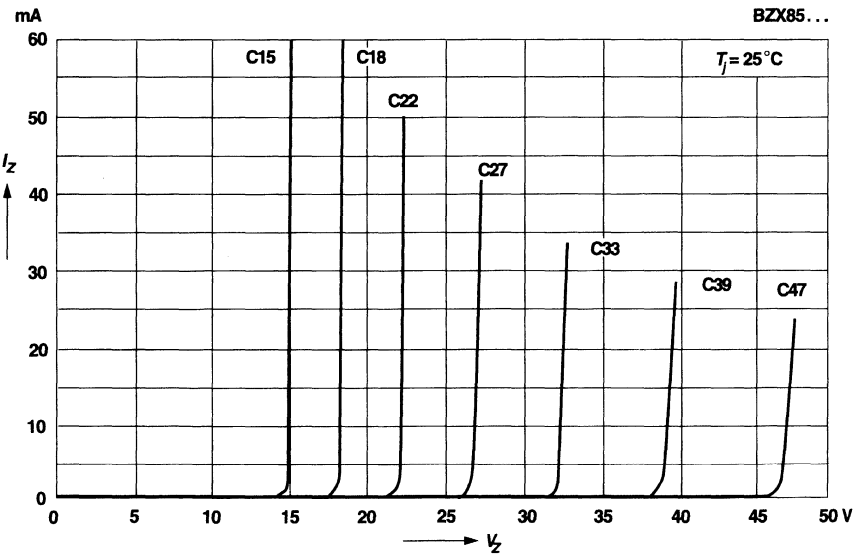
Breakdown characteristics

at T_j = constant (pulsed)



Breakdown characteristics

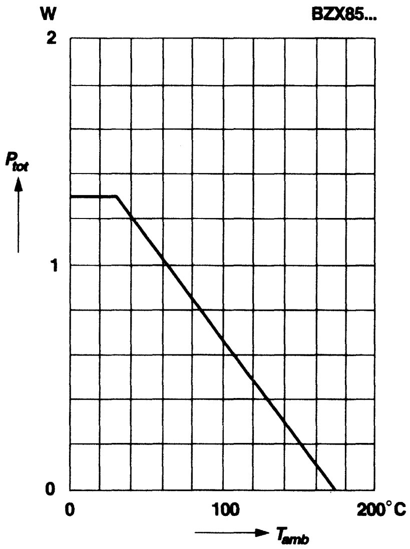
at T_j = constant (pulsed)



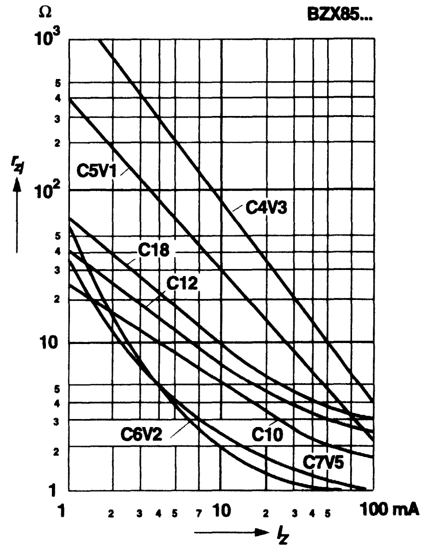
RATINGS AND CHARACTERISTIC CURVES BZX85-C3V6 THRU BZX85-C62

Admissible power dissipation versus ambient temperature

Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case

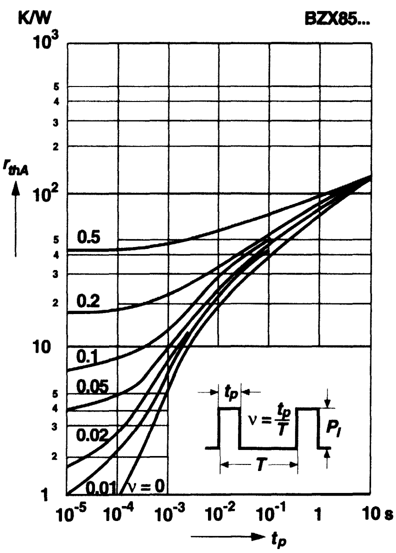


Dynamic resistance versus Zener current

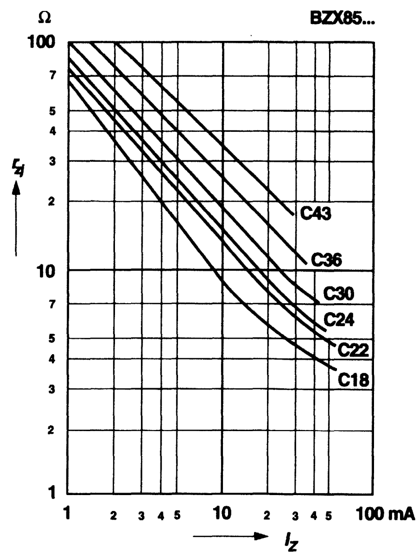


Pulse thermal resistance versus pulse duration

Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case.



Dynamic resistance versus Zener current



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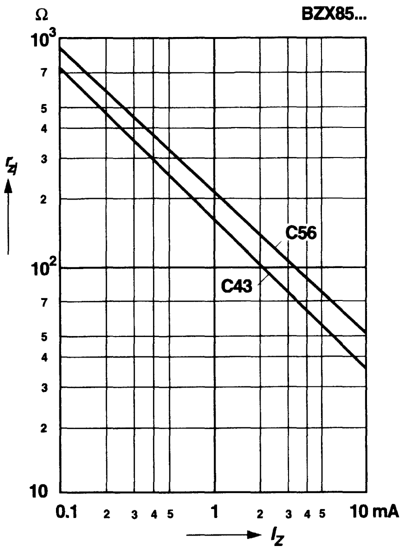
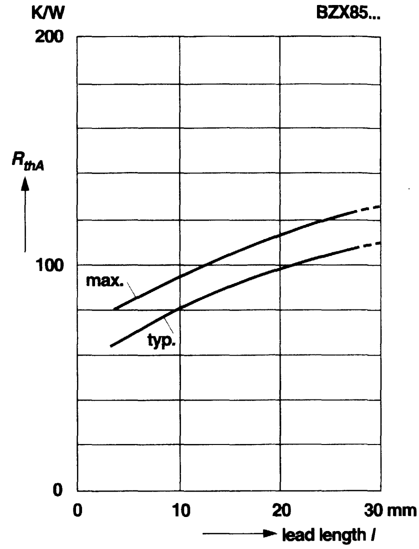
Dynamic resistance versus Zener current



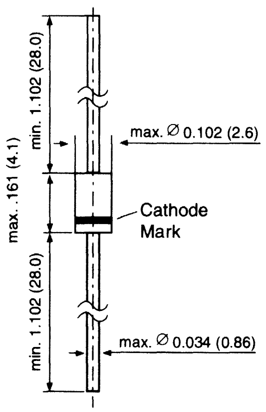
Thermal resistance versus lead length



ZPU100 THRU ZPU180

ZENER DIODES

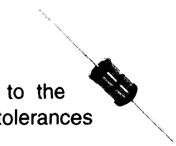
DO-41 Glass



Dimensions in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Zener Diodes
- ♦ For use in stabilizing and clipping circuits with higher power rating.
- ♦ The Zener voltages are graded according to the international E 12 standard. Smaller voltage tolerances are available upon request.
- ♦ These types are also available in MELF case with the type designation ZMU100 ... ZMU180.



MECHANICAL DATA

Case: DO-41 Glass Case
Weight: approx. 0.35 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	1.3[1]	W
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 55 to +175	°C

NOTES:
(1) Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature.

ZPU100 THRU ZPU180

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	130[1]	°C/W

NOTES:
(1) Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature.

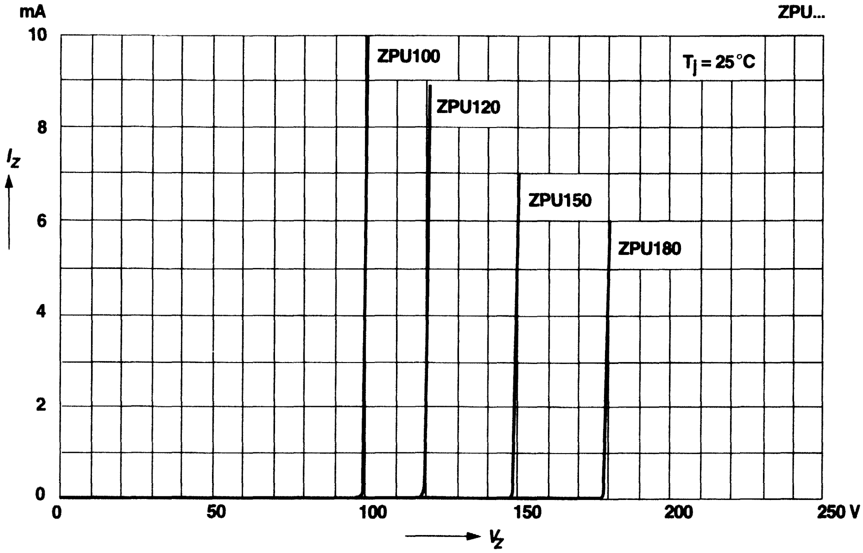
Type	Zener voltage[2] at I_{ZT} V_Z (V)	Dynamic Resistance at I_{ZT} f = 1 kHz r_{zj} (Ω)	Temp. Coeff. of Zener Voltage at I_{ZT} α_{VZ} 10^{-4}/K	Test current I_{ZT} (mA)	Reverse Voltage at I_R = 0.5 μA V_R (V)	Admissible Zener current[1] at T_{amb} = 25°C I_Z (mA)
ZPU100	88 ... 110	140 (< 300)	+9 ... +13	5	> 75	10
ZPU120	107 ... 134	170 (< 330)	+9 ... +13	5	> 90	8.5
ZPU150	130 ... 165	200 (< 360)	+9 ... +13	5	> 112	7
ZPU180	160 ... 200	220 (< 380)	+9 ... +13	5	> 134	5.5

NOTES:
(1) Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case
(2) Tested with pulses t_p = 5 ms

RATINGS AND CHARACTERISTIC CURVES ZPU100 THRU ZPU180

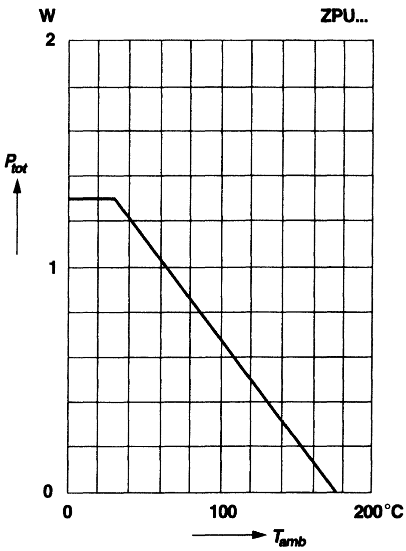
Breakdown characteristics

T_j = constant (pulsed)



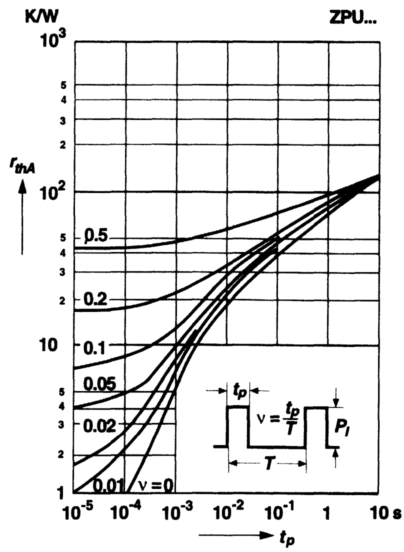
Admissible power dissipation versus ambient temperature

Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case

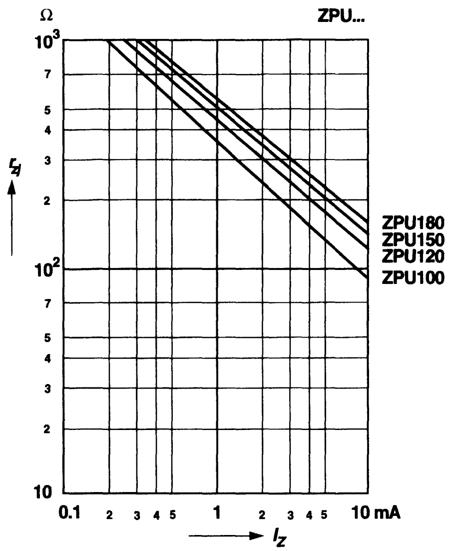


Pulse thermal resistance versus pulse duration

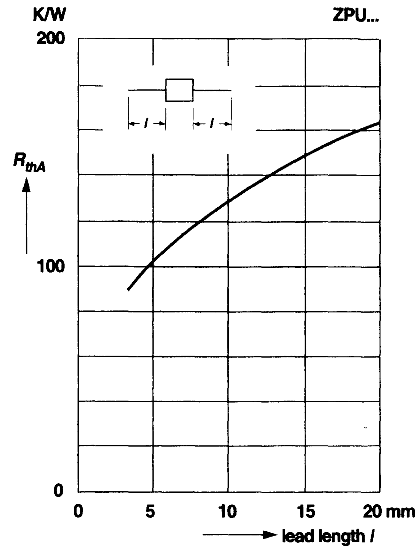
Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case.



Dynamic resistance versus Zener current



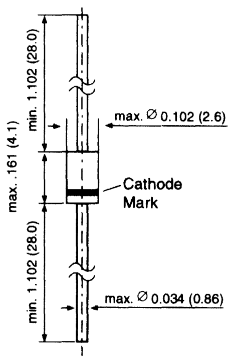
Thermal resistance versus lead length



ZPY1 THRU ZPY100

ZENER DIODES

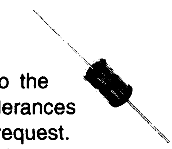
DO-41 Glass



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Planar Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with high power rating
- ♦ The Zener voltages are graded according to the international E12 standard. Smaller voltage tolerances and other Zener voltages are available upon request.
- ♦ These diode are also available in the MELF case with type designation ZMY1 ... ZMY100.



MECHANICAL DATA

Case: DO-41 Glass Case
Weight: approx. 0.35 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} = 25°C	P_{tot}	1.3[1)]	Watts
Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	– 55 to +175	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	130[1)]	°C/W

NOTES:
(1) Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature.

ZPY1 THRU ZPY100

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener voltage(2) at I_{ZT} V_Z (V)	Dynamic resistance at I_{ZT} f = 1 kHz max r_{zj} (Ω)	Temp. coeff. of Zener volt. at I_{ZT} α_{VZ} (10^{-4}/K)	Test current I_{ZT} (mA)	Reverse voltage at I_R= 0.5μA V_R (V)	Admissible Zener current(1) at T_{amb} = 25°C I_Z (mA)
ZPY1(3)	0.65 ... 0.75	6.5 (< 8)	– 26 ... – 23	5	–	580
ZPY3.9	3.7 ... 4.1	4 (< 7)	– 7 ... +2	100	–	290
ZPY4.3	4.0 ... 4.6	4 (< 7)	– 7 ... +3	100	–	260
ZPY4.7	4.4 ... 5.0	4 (< 7)	– 7 ... +4	100	–	235
ZPY5.1	4.8 ... 5.4	2 (< 5)	– 6 ... +5	100	> 0.7	215
ZPY5.6	5.2 ... 6.0	1 (< 2)	– 3 ... +5	100	> 1.5	193
ZPY6.2	5.8 ... 6.6	1 (< 2)	– 1 ... +6	100	> 2.0	183
ZPY6.8	6.4 ... 7.2	1 (< 2)	0 ... +7	100	> 3.0	157
ZPY7.5	7.0 ... 7.9	1 (< 2)	0 ... +7	100	> 5.0	143
ZPY8.2	7.7 ... 8.7	1 (< 2)	+3 ... +8	100	> 6.0	127
ZPY9.1	8.5 ... 9.6	2 (< 4)	+3 ... +8	50	> 7.0	117
ZPY10	9.4 ... 10.6	2 (< 4)	+5 ... +9	50	> 7.5	105
ZPY11	10.4 ... 11.6	3 (< 7)	+5 ... +10	50	> 8.5	94
ZPY12	11.4 ... 12.7	3 (< 7)	+5 ... +10	50	> 9.0	85
ZPY13	12.4 ... 14.1	4 (< 9)	+5 ... +10	50	> 10	78
ZPY15	13.8 ... 15.8	4 (< 9)	+5 ... +10	50	> 11	70
ZPY16	15.3 ... 17.1	5 (< 10)	+7 ... +11	25	> 12	63
ZPY18	16.8 ... 19.1	5 (< 11)	+7 ... +11	25	> 14	57
ZPY20	18.8 ... 21.2	6 (< 12)	+7 ... +11	25	> 15	52
ZPY22	20.8 ... 23.3	7 (< 13)	+7 ... +11	25	> 17	48
ZPY24	22.8 ... 25.6	8 (< 14)	+7 ... +12	25	> 18	42
ZPY27	25.1 ... 28.9	9 (< 15)	+7 ... +12	25	> 20	38
ZPY30	28 ... 32	10 (< 20)	+7 ... +12	25	> 22.5	35
ZPY33	31 ... 35	11 (< 20)	+7 ... +12	25	> 25	31
ZPY36	34 ... 38	25 (< 60)	+7 ... +12	10	> 27	29
ZPY39	37 ... 41	30 (< 60)	+8 ... +12	10	> 29	26
ZPY43	40 ... 46	35 (< 80)	+8 ... +13	10	> 32	24
ZPY47	44 ... 50	40 (< 80)	+8 ... +13	10	> 35	22
ZPY51	48 ... 54	45 (< 100)	+8 ... +13	10	> 38	20
ZPY56	52 ... 60	50 (< 100)	+8 ... +13	10	> 42	18
ZPY62	58 ... 66	60 (< 130)	+8 ... +13	10	> 47	16
ZPY68	64 ... 72	65 (< 130)	+8 ... +13	10	> 51	14
ZPY75	70 ... 79	70 (< 160)	+8 ... +13	10	> 56	13
ZPY82	77 ... 88	80 (< 160)	+8 ... +13	10	> 61	12
ZPY91	85 ... 96	120 (< 250)	+9 ... +13	5	> 68	11
ZPY100	94 ... 106	130 (< 250)	+9 ... +13	5	> 75	10

NOTES:

(1) Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case

(2) Tested with pulses t_p = 5 ms

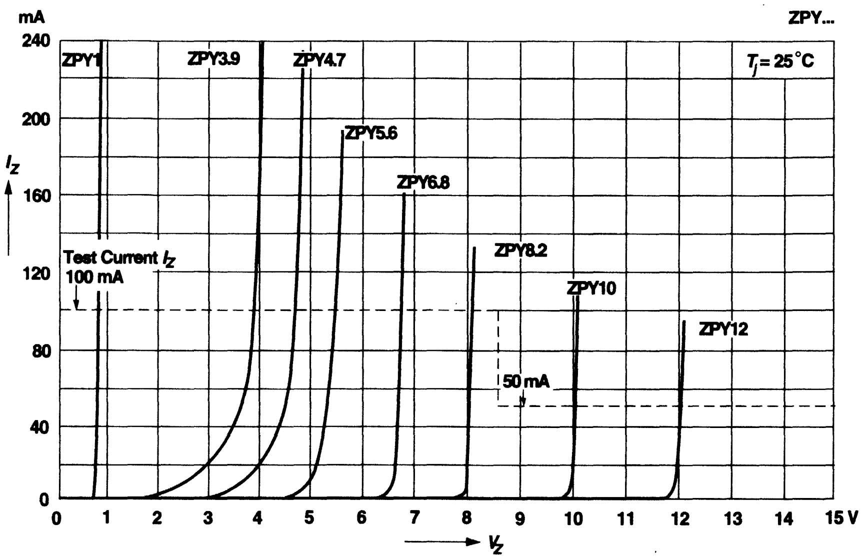
(3) The ZPY1 is a silicon diode operated in forward direction. Hence, the index of all characteristics and maximum ratings should be "F" instead of "Z"
Connect the cathode terminal to the negative pole

For devices in glass case DO-41 with higher Zener voltage but same power dissipation see types ZPU100 ... ZPU180

RATINGS AND CHARACTERISTIC CURVES ZPY1 THRU ZPY100

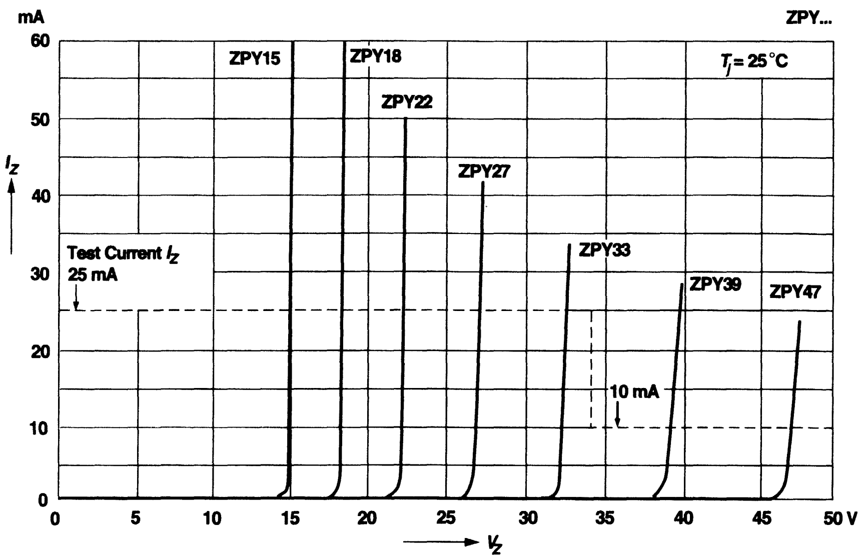
Breakdown characteristics

T_j = constant (pulsed)



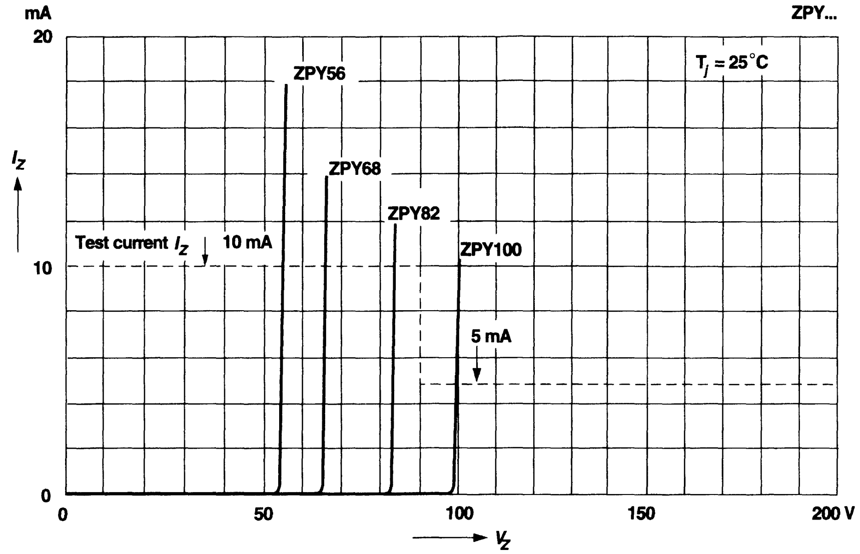
Breakdown characteristics

T_j = constant (pulsed)



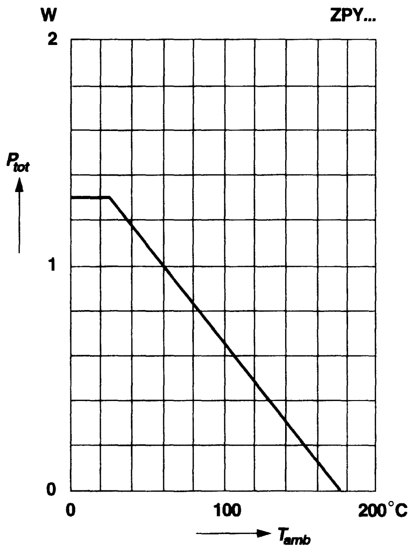
Breakdown characteristics

T_j = constant (pulsed)



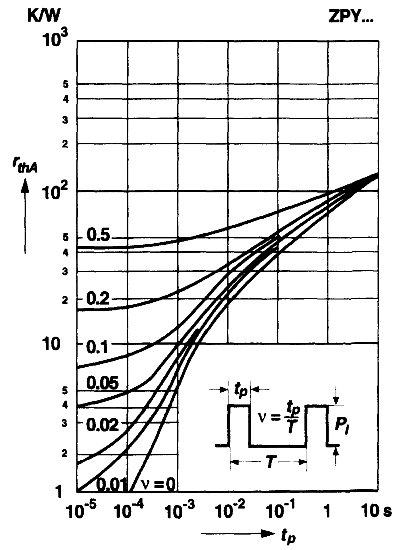
Admissible power dissipation versus ambient temperature

Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case



Pulse thermal resistance versus pulse duration

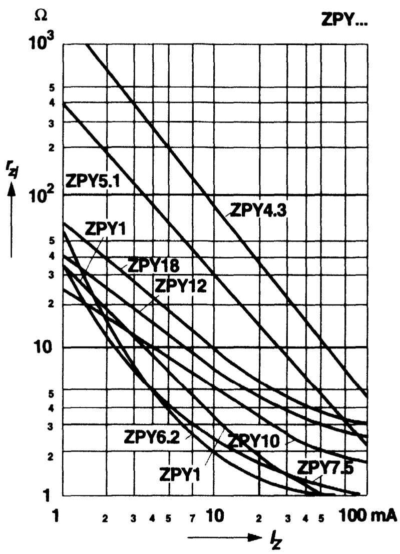
Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case



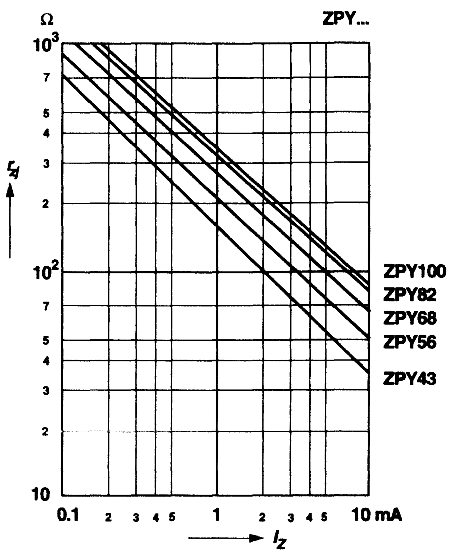
GENERAL SEMICONDUCTOR®

RATINGS AND CHARACTERISTIC CURVES ZPY1 THRU ZPY100

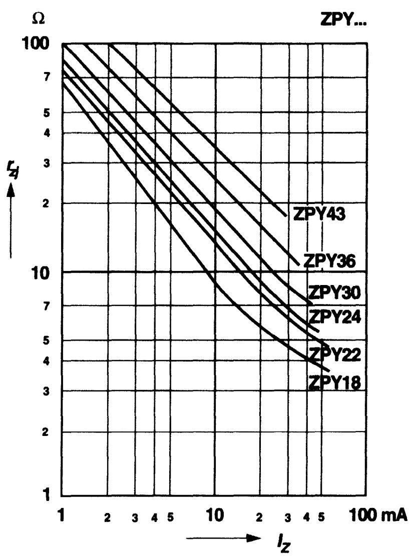
Dynamic resistance versus Zener current



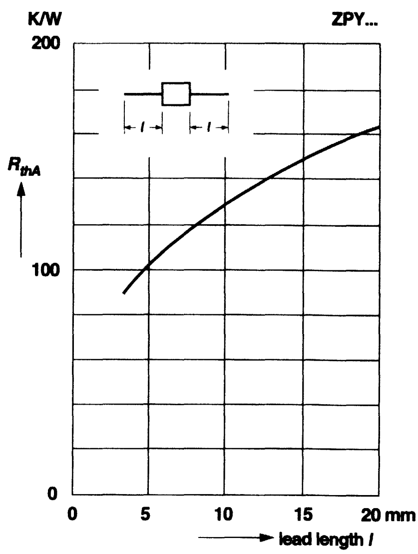
Dynamic resistance versus Zener current



Dynamic resistance versus Zener current



Thermal resistance versus lead length

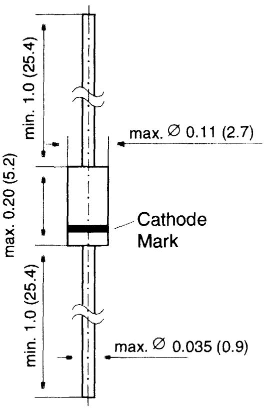


GENERAL SEMICONDUCTOR®

BZY97-C11 THRU BZY97-C68

ZENER DIODES

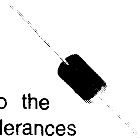
DO-41 Plastic



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with high power rating.
- ♦ The Zener voltages are graded according to the international E 24 standard. Smaller voltage tolerances are available upon request.



MECHANICAL DATA

Case: DO-41 Plastic Case
Weight: approx. 0.34 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at T_{amb} =60°C	P_{tot}	1.5[1)]	Watts
Junction Temperature	T_j	150	°C
Storage Temperature Range	Ts	– 55 to +150	°C

Characteristics at Tamb = 25 °C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	60[1)]	°C/W

NOTES:
(1) Valid provided that leads at a distance of 10 mm from case are kept at ambient temperature.

BZY97-C11 THRU BZY97-C68

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

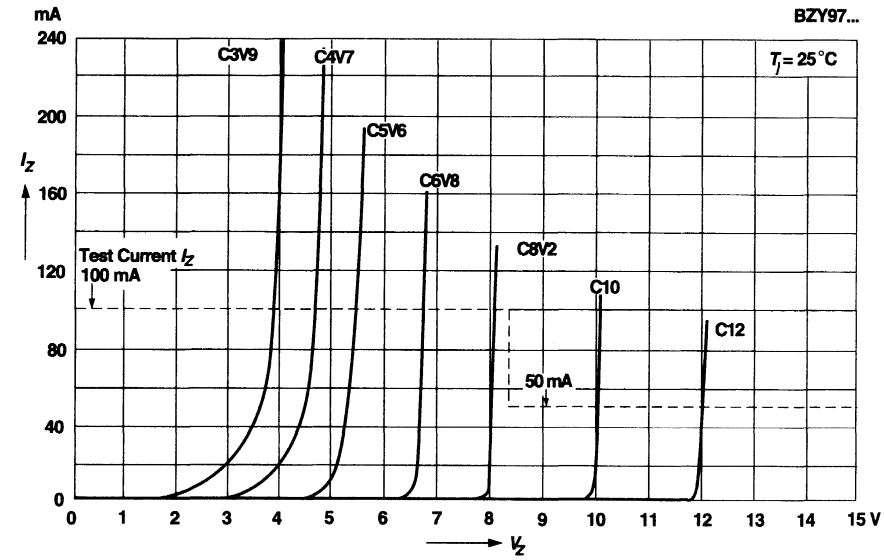
Type	Zener voltage(1) at I_{ZT} min. max. V_Z (V)	Dynamic resistance at $-I_{ZT}$ f = 1 kHz max r_{zj} (Ω)	Temp. coeff. of Zener volt. at I_{ZT} α_{VZ} (10^{-4}/K)	Test current I_{ZT} (mA)	Leakage current I_R (μA)	Reverse voltage V_R (V)	Admissible Zener current at T_{amb} = 60°C I_Z (mA)	I_{ZSM} t_p = 10 ms (A)
BZY97 – C11	10.4 ... 11.6	7	+5 ... +10	50	0.5	5	129	1.3
BZY97 – C12	11.4 ... 12.7	7	+5 ... +10	50	0.5	7	118	1.2
BZY97 – C13	12.4 ... 14.1	10	+5 ... +10	50	0.5	7	106	1.1
BZY97 – C15	13.8 ... 15.6	10	+5 ... +10	50	0.5	10	96	1.0
BZY97 – C16	15.3 ... 17.1	15	+6 ... +11	25	0.5	10	88	0.90
BZY97 – C18	16.8 ... 19.1	15	+6 ... +11	25	0.5	10	79	0.81
BZY97 – C20	18.8 ... 21.2	15	+6 ... +11	25	0.5	10	71	0.73
BZY97 – C22	20.8 ... 23.3	15	+6 ... +11	25	0.5	12	64	0.66
BZY97 – C24	22.8 ... 25.6	15	+6 ... +11	25	0.5	12	59	0.60
BZY97 – C27	25.1 ... 28.9	15	+6 ... +11	25	0.5	14	52	0.53
BZY97 – C30	28 ... 32	15	+6 ... +11	25	0.5	14	47	0.48
BZY97 – C33	31 ... 35	15	+6 ... +11	25	0.5	17	43	0.44
BZY97 – C36	34 ... 38	40	+6 ... +11	10	0.5	17	40	0.40
BZY97 – C39	37 ... 41	40	+6 ... +11	10	0.5	20	37	0.38
BZY97 – C43	40 ... 46	45	+7 ... +12	10	0.5	20	33	0.33
BZY97 – C47	44 ... 50	45	+7 ... +12	10	0.5	24	30	0.31
BZY97 – C51	48 ... 54	60	+7 ... +12	10	0.5	24	28	0.28
BZY97 – C56	52 ... 60	60	+7 ... +12	10	0.5	28	25	0.26
BZY97 – C62	58 ... 66	80	+7 ... +12	10	0.5	28	23	0.23
BZY97 – C68	64 ... 72	80	+7 ... +12	10	0.5	34	21	0.21

NOTES:

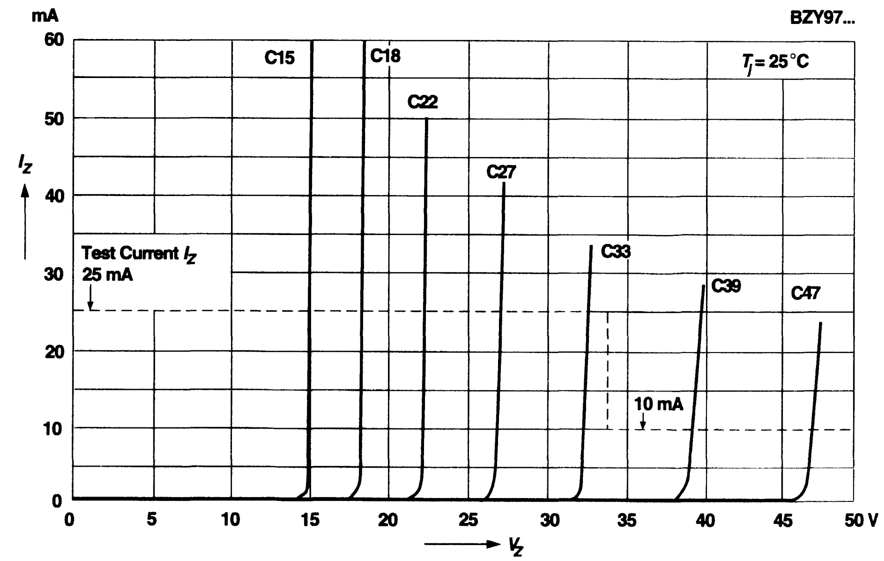
(1) Tested with pulses t_p = 5 ms

(2) Consult factory for voltages above 68V

Breakdown characteristics
T_j = constant (pulsed)



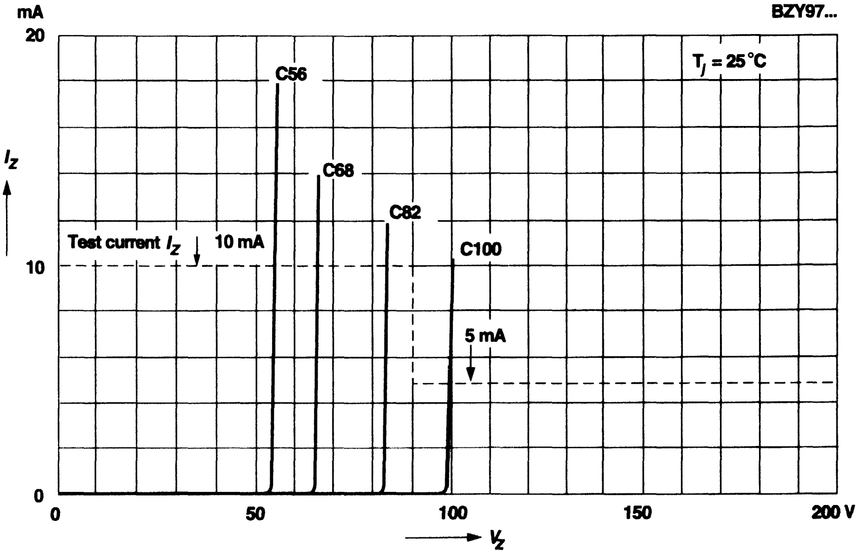
Breakdown characteristics
T_j = constant (pulsed)



RATINGS AND CHARACTERISTIC CURVES BZY97-C11 THRU BZY97-C68

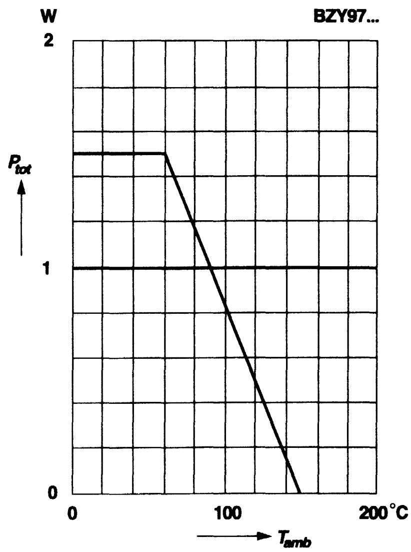
Breakdown characteristics

T_j = constant (pulsed)



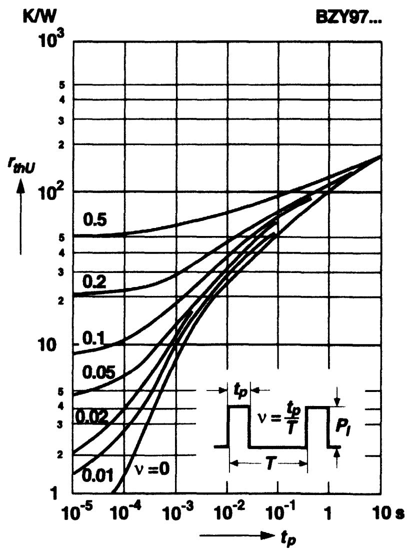
Admissible power dissipation versus ambient temperature

For conditions, see footnote in table "Absolute Maximum Ratings"

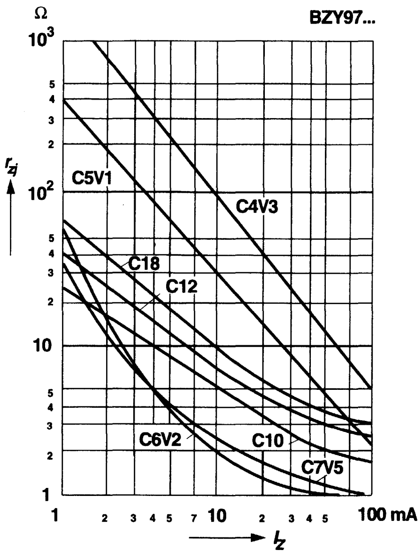


Pulse thermal resistance versus pulse duration

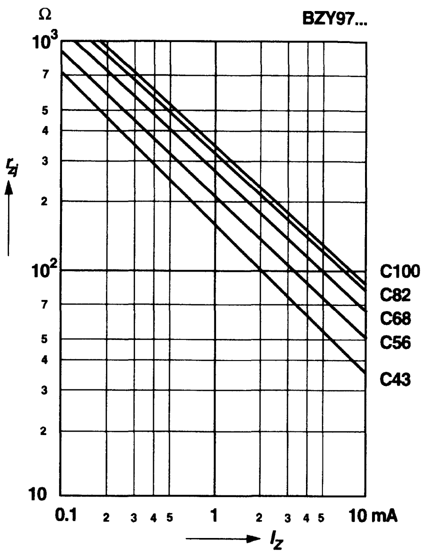
For conditions, see footnote in table "Absolute Maximum Ratings"



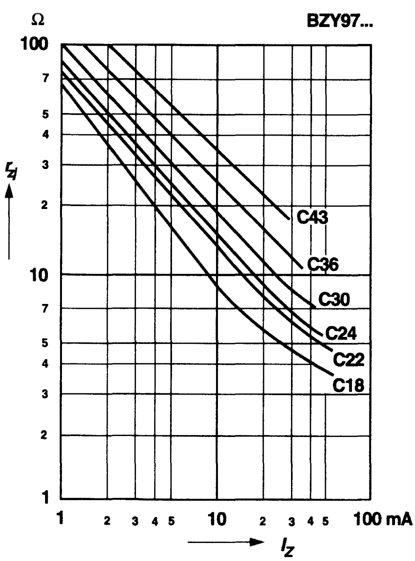
Dynamic resistance versus Zener current



Dynamic resistance versus Zener current



Dynamic resistance versus Zener current

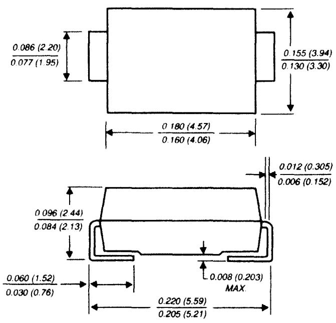


SMZG AND SMZJ 3789 THRU 3809B

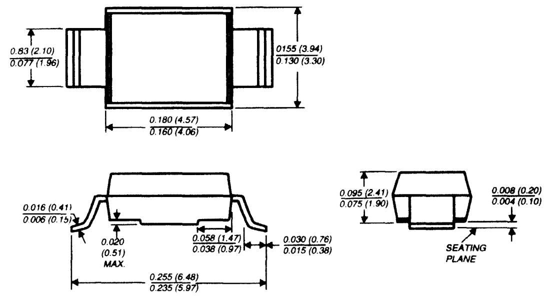
SURFACE MOUNT ZENER DIODE

***Zener Voltage** - 10 to 68 Volts* ***Steady State Power** - 1.5 Watts*

DO-214AA
MODIFIED J-BEND



DO-215AA



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ For surface mount applications
- ♦ Glass passivated chip junction
- ♦ Low Zener impedance
- ♦ Low regulation factor
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-214/DO215AA molded plastic over passivated junction
Terminals: Solder plated, solderable per MIL STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.003 ounce , 0.093 gram

OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE: T_J, T_{STG}: -55°C to +150°C

MAXIMUM ELECTRICAL CHARACTERISTICS

PART NUMBER		DEVICE MARKING CODE	NOMINAL ZENER VOLTAGE V_Z at I_{ZT} (Volts)	TEST CURRENT I_{ZT} (mA)	MAX. ZENER IMPEDANCE			MAX. REVERSE LEAKAGE CURRENT I_R at V_R		MAX. ZENER CURRENT I_{ZM} (mA)
GULL-WING	MODIFIED J-BEND				Z_{ZT} at I_{ZT} (Ohms)	Z_{ZK} at I_{ZK} (Ohms)	(mA)	(µA)	(Volts)	
SMZG3789A,B	SMZJ3789A,B	WA,B	10.0	37.5	5.0	1000	0.25	50.0	7.6	125
SMZG3790A,B	SMZJ3790A.B	WC,D	11.0	34.1	6.0	650	0.25	10.0	8.4	115
SMZG3791A,B	SMZJ3791A,B	WE,F	12.0	31.2	7.0	550	0.25	5.0	9.1	105
SMZG3792A,B	SMZJ3792A,B	WG,H	13.0	28.8	7.5	550	0.25	5.0	9.9	98
SMZG3793A,B	SMZJ3793A,B	WI,J	15.0	25.0	9.0	600	0.25	5.0	11.4	85
SMZG3794A,B	SMZJ3794A,B	WK,L	16.0	23.4	10.0	600	0.25	5.0	12.2	80
SMZG3795A,B	SMZJ3795A,B	XA,B	18.0	20.8	12.0	650	0.25	5.0	13.7	70
SMZG3796A,B	SMZJ3796A,B	XC,D	20.0	18.7	14.0	650	0.25	5.0	15.2	62
SMZG3797A,B	SMZJ3797A,B	XE,F	22.0	17.0	17.5	650	0.25	5.0	16.7	56
SMZG3798A,B	SMZJ3798A,B	XG,H	24.0	15.6	19.0	700	0.25	5.0	18.2	51
SMZG3799A,B	SMZJ3799A,B	XI,J	27.0	13.9	23.0	700	0.25	5.0	20.6	46
SMZG3800A,B	SMZJ3800A,B	XK,L	30.0	12.5	26.0	750	0.25	5.0	22.8	41
SMZG3801A,B	SMZJ3801A,B	YA,B	33.0	11.4	33.0	800	0.25	5.0	25.1	38
SMZG3802A,B	SMZJ3802A,B	YC,D	36.0	10.4	38.0	850	0.25	5.0	27.4	35
SMZG3803A,B	SMZJ3803A,B	YE,F	39.0	9.6	45.0	900	0.25	5.0	29.7	31
SMZG3804A,B	SMZJ3804A,B	YG,H	43.0	8.7	53.0	950	0.25	5.0	32.7	28
SMZG3805A.B	SMZJ3805A,B	YI,J	47.0	8.0	67.0	1000	0.25	5.0	35.8	26
SMZG3806A,B	SMZJ3806A,B	YK,L	51.0	7.3	70.0	1100	0.25	5.0	38.8	24
SMZG3807A,B	SMZJ3807A,B	ZA,B	56.0	6.7	86.0	1300	0.25	5.0	42.6	22
SMZG3808A,B	SMZJ3808A,B	ZC,D	62.0	6.0	100.0	1500	0.25	5.0	47.1	20
SMZG3809A,B	SMZJ3809A,B	ZE,F	68.0	5.5	120.0	1700	0.25	5.0	51.7	18

NOTES:
(1) Standard voltage tolerance is ±20%, suffix "A" denotes ±10% and suffix "B" denotes ±5%
(2) Maximum steady state power dissipation is 1.5 watts at T_L=75°C (SEE FIG. 1)

FIG. 1 - MAXIMUM CONTINUOUS POWER DISSIPATION

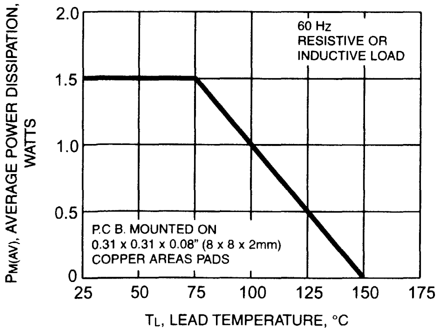


FIG. 2 - TYPICAL ZENER IMPEDANCE

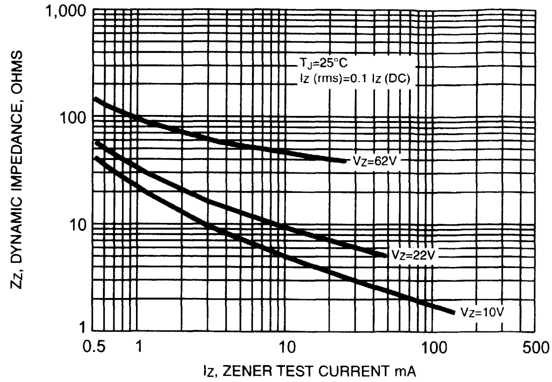


FIG. 3 - TYPICAL ZENER IMPEDANCE

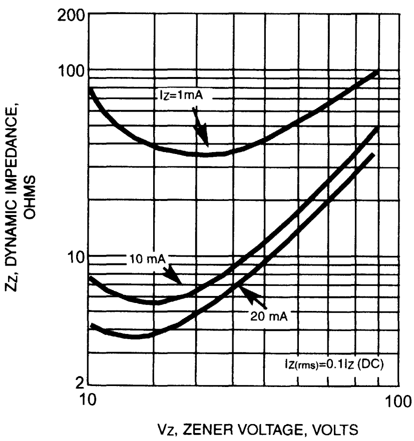
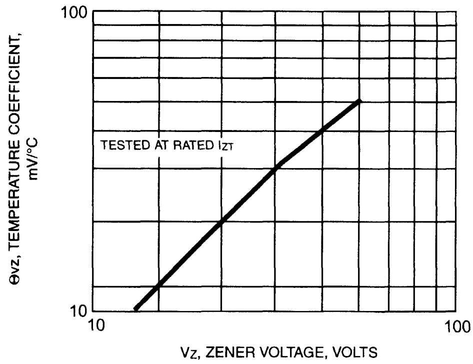


FIG. 4 - TYPICAL TEMPERATURE COEFFICIENTS

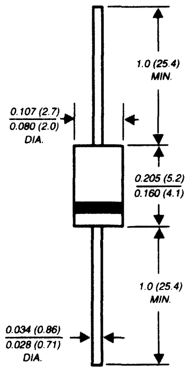


Z4KE100 THRU Z4KE200A

GLASS PASSIVATED ZENER

Zener Voltage *- 100 to 200 Volts* ***Steady State Power*** *- 1.5 Watts*

DO-204AL



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Low Zener impedance
- ♦ Low regulation factor
- ♦ Glass passivated junction
- ♦ High temperature soldering guaranteed: 260°C/10 seconds 0.375" (9.5mm) lead length, 5 lbs. (2.3kg) tension

MECHANICAL DATA

Case: JEDEC DO-204AL molded plastic over passivated junction
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.012 ounce, 0.3 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

OPERATING JUNCTION AND STORAGE TEMPERATURE RANGE: T_J, T_{STG}: -55°C to +150°C

TYPE	ZENER VOLTAGE at 5.0mA		MAXIMUM ZENER DYNAMIC IMPEDANCE				MAXIMUM DC REVERSE LEAKAGE CURRENT AT V_R			MAXIMUM INSTANTANEOUS FORWARD VOLTAGE at 0.50A	MAXIMUM CONTINUOUS REGULATOR CURRENT (1)
	V_Z (Volts)		I_{ZT} (mA)	Z_{ZT} (Ohms)	I_{ZK} (mA)	Z_{ZK} (Ohms)	V_R (Volts)	I_R @ 25°C (µA)	I_R 100°C (µA)	V_{FM} (Volts)	I_{ZM} (µA)
	MIN	MAX									
Z4KE100	90	110	5.0	500	0.25	5000	72.0	0.5	100.0	1.0	15.0
Z4KE100A	95	105	5.0	500	0.25	5000	76.0	0.5	100.0	1.0	15.0
Z4KE110	99	121	5.0	600	0.25	5000	79.2	0.5	100.0	1.0	13.0
Z4KE110A	104	116	5.0	600	0.25	5000	83.2	0.5	100.0	1.0	13.0
Z4KE120	108	132	5.0	700	0.25	5000	86.4	0.5	100.0	1.0	12.0
Z4KE120A	114	126	5.0	700	0.25	5000	91.2	0.5	100.0	1.0	12.0
Z4KE130	117	143	5.0	800	0.25	5000	93.6	0.5	100.0	1.0	11.0
Z4KE130A	124	137	5.0	800	0.25	5000	99.2	0.5	100.0	1.0	11.0
Z4KE140	126	154	5.0	900	0.25	5000	100	0.5	100.0	1.0	10.7
Z4KE140A	133	147	5.0	900	0.25	5500	106.4	0.5	100.0	1.0	10.7
Z4KE150	135	165	5.0	1000	0.25	6000	108.0	0.5	100.0	1.0	10.0
Z4KE150A	142	158	5.0	1000	0.25	6000	113.6	0.5	100.0	1.0	10.0
Z4KE160	144	176	5.0	1100	0.25	6500	115.2	0.5	100.0	1.0	9.0
Z4KE160A	152	168	5.0	1100	0.25	6500	121.6	0.5	100.0	1.0	9.0
Z4KE170	153	187	5.0	1200	0.25	7000	122.4	0.5	100.0	1.0	8.8
Z4KE170A	162	179	5.0	1200	0.25	7000	129.6	0.5	100.0	1.0	8.0
Z4KE180	162	198	5.0	1300	0.25	7000	129.6	0.5	100.0	1.0	8.0
Z4KE180A	171	189	5.0	1300	0.25	7000	136.8	0.5	100.0	1.0	8.0
Z4KE190	171	209	5.0	1400	0.25	7500	136.8	0.5	100.0	1.0	7.9
Z4KE190A	180	200	5.0	1400	0.25	7500	144.0	0.5	100.0	1.0	7.9
Z4KE200	180	220	5.0	1500	0.25	8000	144.0	0.5	100.0	1.0	7.0
Z4KE200A	190	210	5.0	1500	0.25	8000	152.0	0.5	100.0	1.0	7.0

NOTES:
(1) Standard voltage tolerance is ±10%, suffix "A" is ± 5%
(2) Temperature rating at specified regulator current is T_L=30°C
(3) Maximum steady state power dissipation is 1.5 watts at T_L=75°C with lead length 0.375" (9.5mm)

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FIG.1 - MAXIMUM CONTINUOUS POWER DISSIPATION

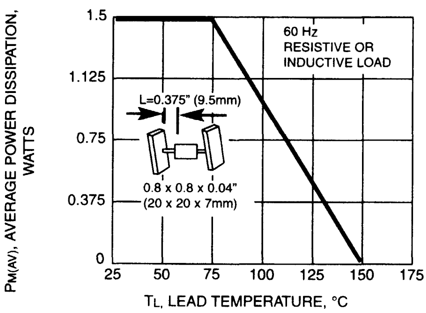


FIG. 2 - TYPICAL ZENER IMPEDANCE

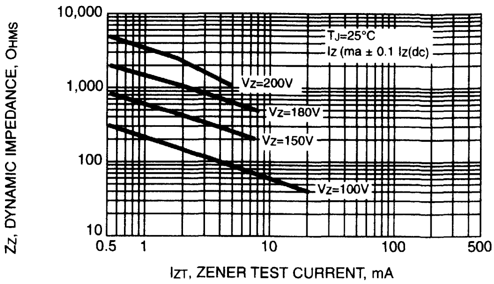


FIG. 3 - TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS

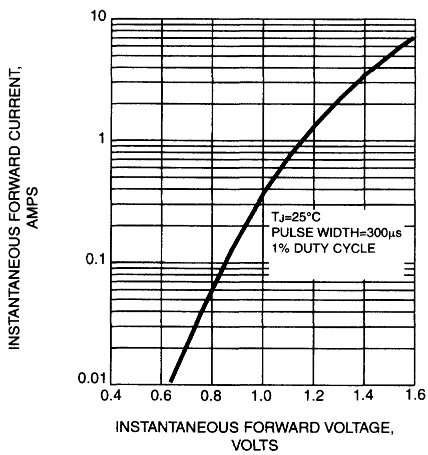


FIG. 4 - TYPICAL REVERSE CHARACTERISTICS

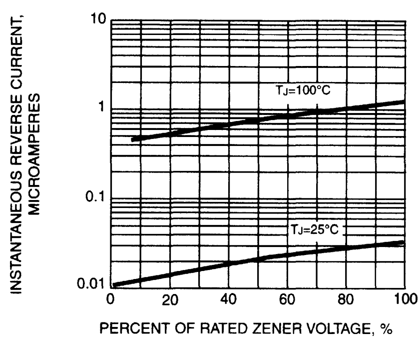


FIG. 5 - TYPICAL TEMPERATURE COEFFICIENTS

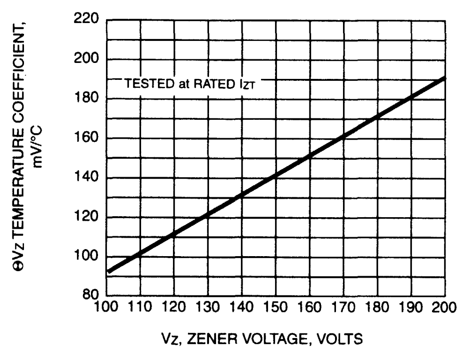
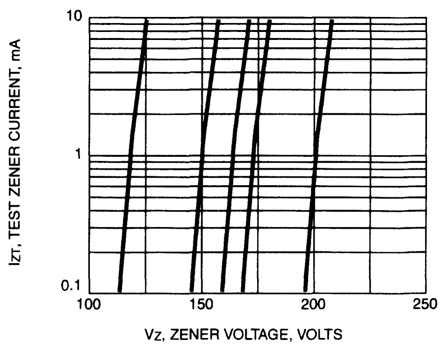


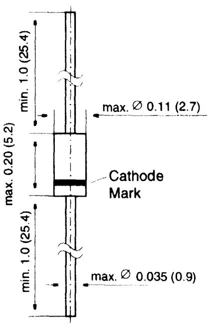
FIG. 6 - TYPICAL ZENER VOLTAGE



ZY1, ZY11 THRU ZY200

ZENER DIODES

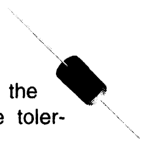
DO-41 Plastic



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Silicon Power Zener Diodes
- ♦ For use in stabilizing and clipping circuits with high power rating
- ♦ The Zener voltages are graded according to the international E 24 standard. Smaller voltage tolerances are available upon request.



MECHANICAL DATA

Case: DO-41 Plastic Case
Weight: approx. 0.34 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Zener Current (see Table "Characteristics")			
Power Dissipation at Tamb = 25°C	P_{tot}	2.0[1)]	Watts
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 55 to +150	°C

	SYMBOL	*MIN.*	*TYP.*	*MAX.*	*UNIT*
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	60[1)]	°C/W

NOTES:
(1) Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case.

ZY1, ZY11 THRU ZY200

ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

Type	Zener voltage(2) at I_{ZT} V_Z (V)	Dynamic resistance at I_{ZT} f = 1 kHz max r_{zj} (Ω)	Temp. coeff. of Zener volt. at I_{ZT} α_{VZ} (10^{-4}/K)	Test current I_{ZT} (mA)	Reverse voltage at I_R= 0.5μA V_R (V)	Admissible Zener current(1) at T_{amb} = 25°C I_Z (mA)
ZY1(3)	0.71 ... 0.82	0.5 (< 1)	-26 ... -16	100	–	1000
ZY11	10.4 ... 11.6	4 (< 7)	+5 ... +10	50	> 9.2	135
ZY12	11.4 ... 12.7	4 (< 7)	+5 ... +10	50	> 10	120
ZY13	12.4 ... 14.1	5 (< 10)	+5 ... +10	50	> 10.7	110
ZY15	13.8 ... 15.8	5 (< 10)	+5 ... +10	50	> 12	98
ZY16	15.3 ... 17.1	6 (< 15)	+6 ... +11	25	> 13.3	90
ZY18	16.8 ... 19.1	6 (< 15)	+6 ... +11	25	> 14.7	80
ZY20	18.8 ... 21.2	6 (< 15)	+6 ... +11	25	> 16.5	72
ZY22	20.8 ... 23.3	6 (< 15)	+6 ... +11	25	> 18.3	66
ZY24	22.8 ... 25.6	7 (< 15)	+6 ... +11	25	> 20.1	60
ZY27	25.1 ... 28.9	7 (< 15)	+6 ... +11	25	> 22.5	53
ZY30	28 ... 32	8 (< 15)	+6 ... +11	25	> 25.1	48
ZY33	31 ... 35	8 (< 15)	+6 ... +11	25	> 27.8	44
ZY36	34 ... 38	21 (< 40)	+6 ... +11	10	> 30.2	40
ZY39	37 ... 41	21 (< 40)	+6 ... +11	10	> 32.9	37
ZY43	40 ... 46	24 (< 45)	+7 ... +12	10	> 35.6	33
ZY47	44 ... 50	24 (< 45)	+7 ... +12	10	> 39.2	30
ZY51	48 ... 54	25 (< 60)	+7 ... +12	10	> 42.8	27
ZY56	52 ... 60	25 (< 60)	+7 ... +12	10	> 47.3	25
ZY62	58 ... 66	25 (< 80)	+8 ... +13	10	> 51.7	21
ZY68	64 ... 72	25 (< 80)	+8 ... +13	10	> 57.1	20
ZY75	70 ... 79	30 (< 100)	+8 ... +13	10	> 63.2	18
ZY82	77 ... 88	30 (< 100)	+8 ... +13	10	> 68.6	16
ZY91	85 ... 96	60 (< 200)	+9 ... +13	5	> 75.7	15
ZY100	94 ... 106	60 (< 200)	+9 ... +13	5	> 83.7	13
ZY110	104 ...116	80 (< 250)	+9 ... +13	5	> 92.6	12
ZY120	114 ... 127	80 (< 250)	+9 ... +13	5	> 101.6	11
ZY130	124 ... 141	110 (< 300)	+9 ... +13	5	> 110.5	10
ZY150	138 ... 156	110 (< 300)	+9 ... +13	5	> 123	9
ZY160	153 ...171	150 (< 350)	+9 ... +13	5	>136	8.5
ZY180	168 ... 191	150 (< 350)	+9 ... +13	5	> 149	8
ZY200	188 ... 212	150 (< 350)	+9 ... +13	5	> 167	7.5

NOTES:

(1) Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case

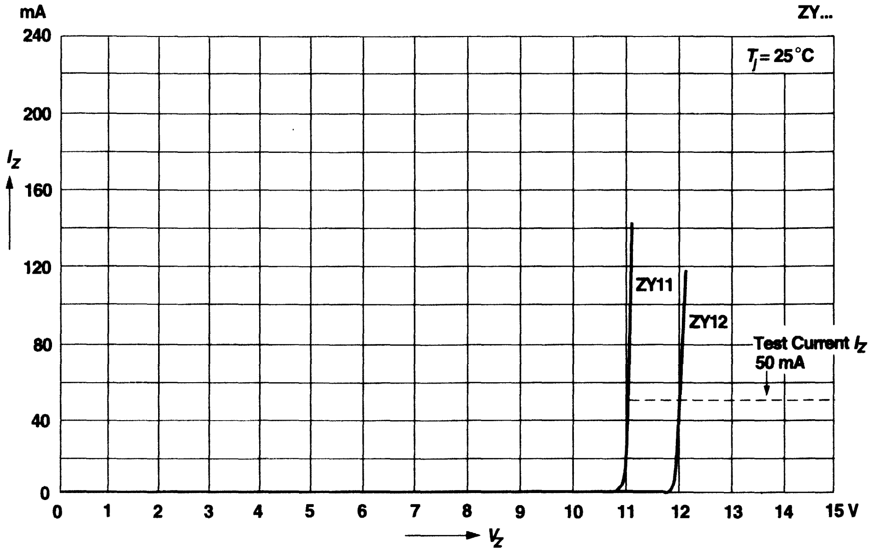
(2) Tested with pulses t_p = 5 ms

(3) The ZY1 is a silicon diode operated in forward direction. Hence, the index of all parameters ratings should be "F" instead of "Z". Connect the cathode lead to the negative pole

RATINGS AND CHARACTERISTIC CURVES ZY1, ZY11 THRU ZY200

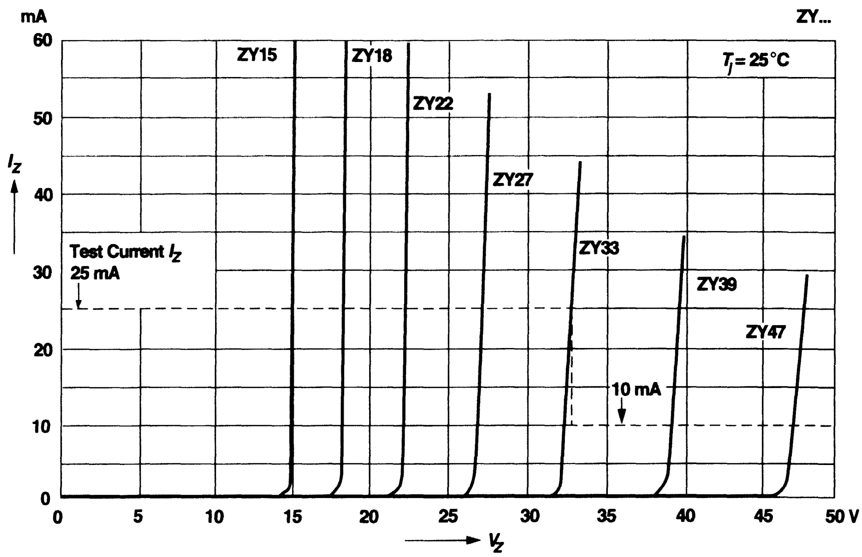
Breakdown characteristics

T_j = constant (pulsed)



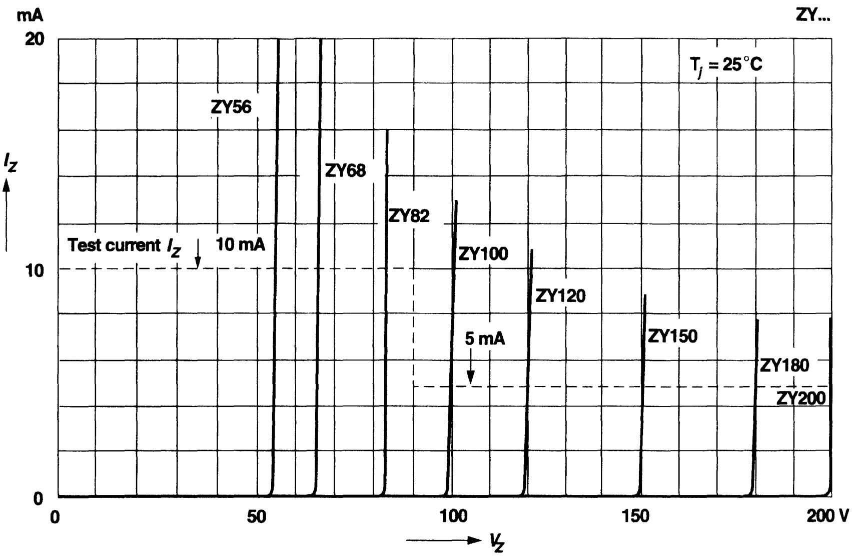
Breakdown characteristics

T_j = constant (pulsed)



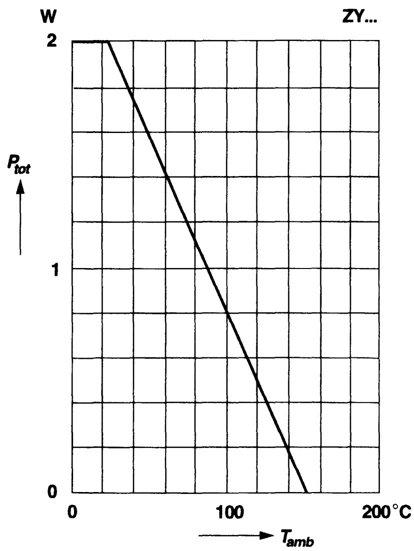
Breakdown characteristics

T_j = constant (pulsed)

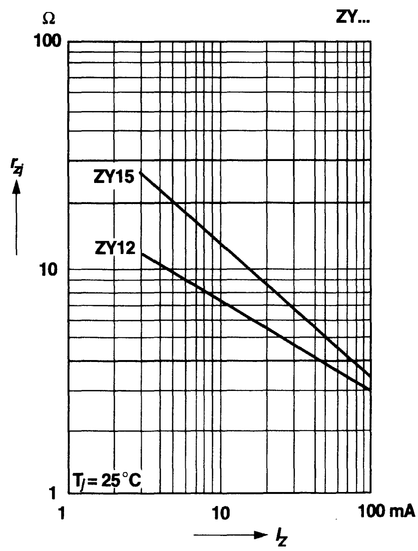


Admissible power dissipation versus ambient temperature

Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case

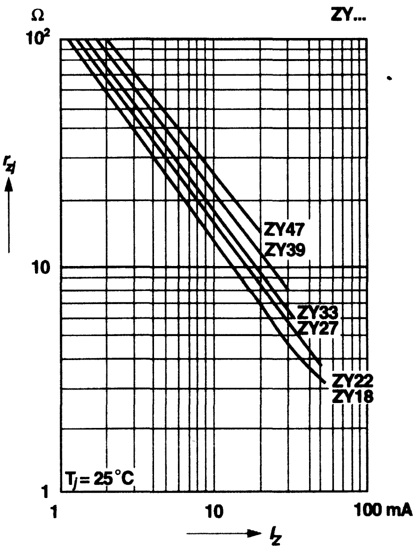


Dynamic resistance versus Zener current



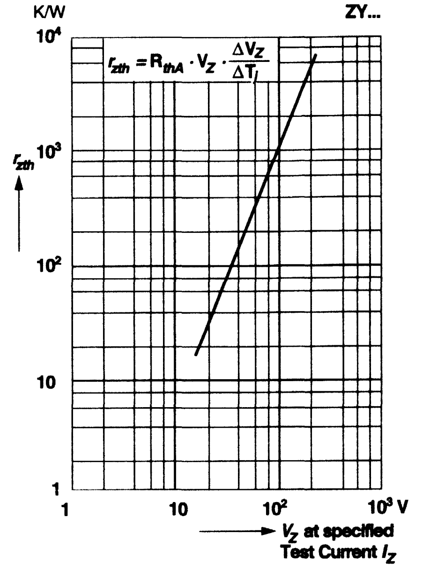
RATINGS AND CHARACTERISTIC CURVES ZY1, ZY11 THRU ZY200

Dynamic resistance versus Zener current

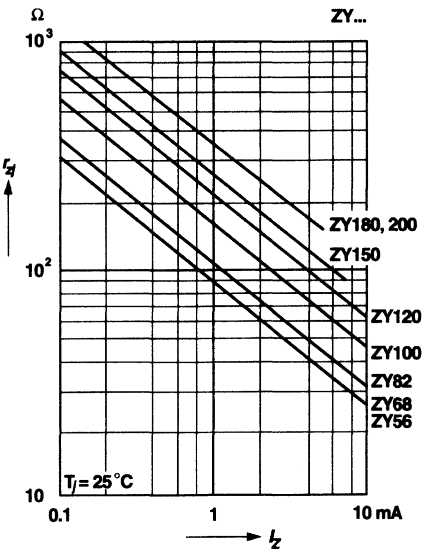


Thermal differential resistance versus Zener voltage

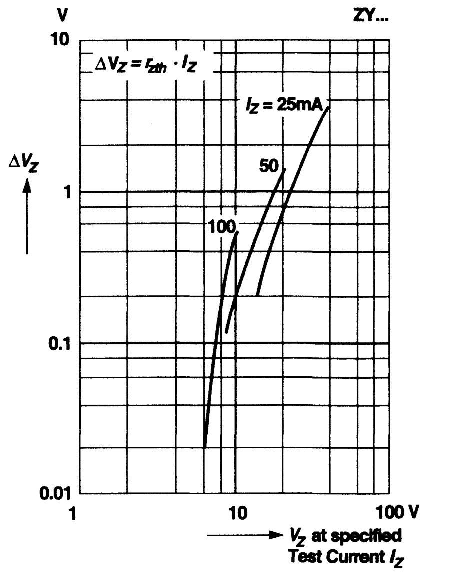
Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case



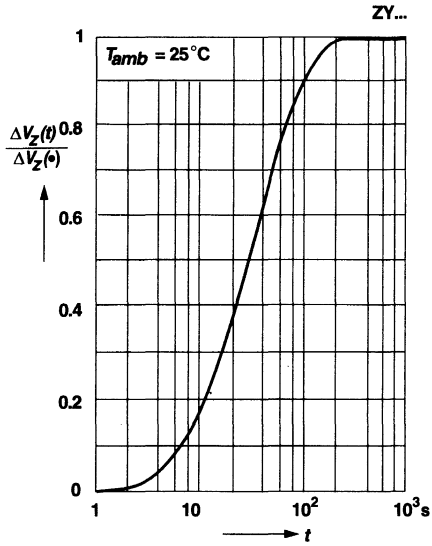
Dynamic resistance versus Zener current



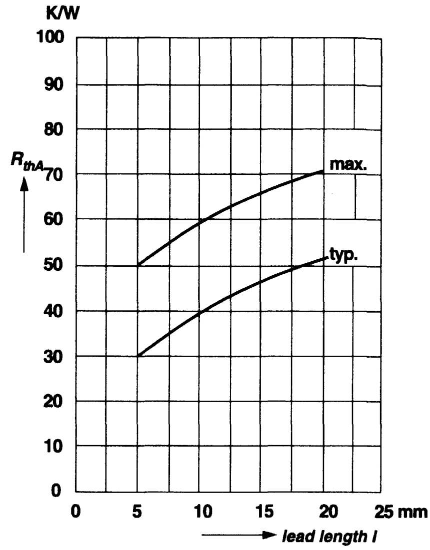
Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener Voltage



Relative change of Zener voltage versus turn-on time

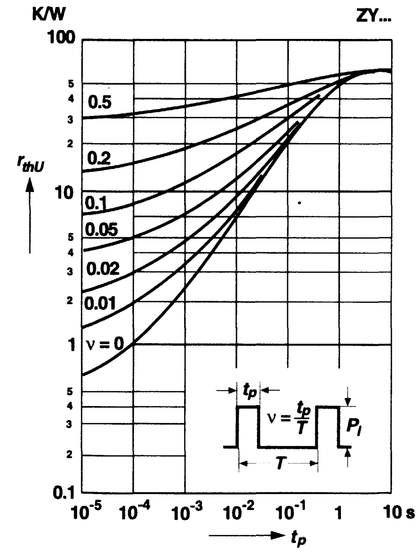


Thermal resistance versus lead length



Pulse thermal resistance versus pulse duration

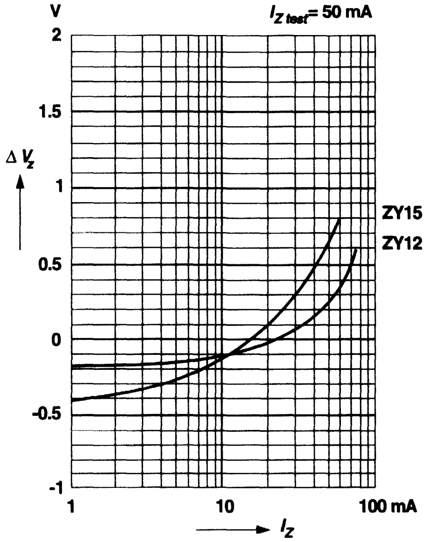
Valid provided that leads are kept at ambient temperature at a distance of 10 mm from case



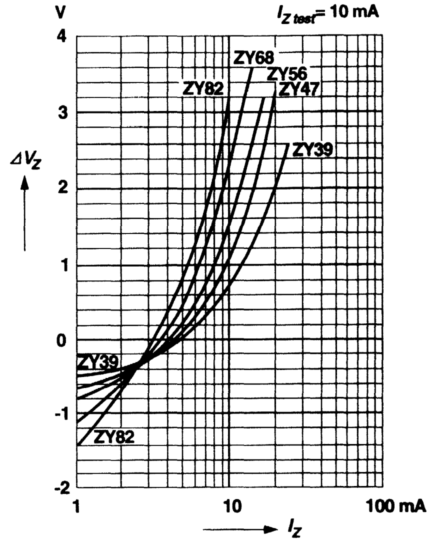
GENERAL SEMICONDUCTOR®

RATINGS AND CHARACTERISTIC CURVES ZY1, ZY11 THRU ZY200

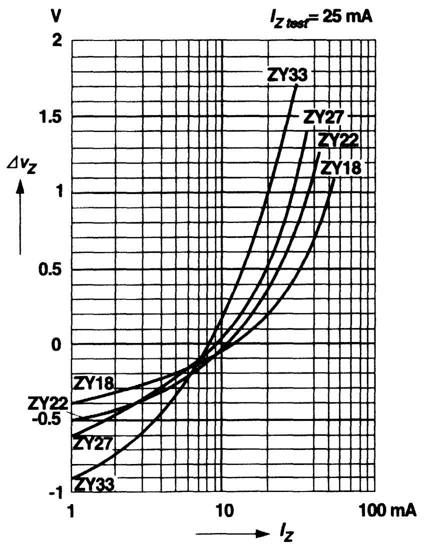
Difference between Zener voltage at test current pulses less than 1 s duration and Zener voltage at the point of thermal equilibrium versus Zener current



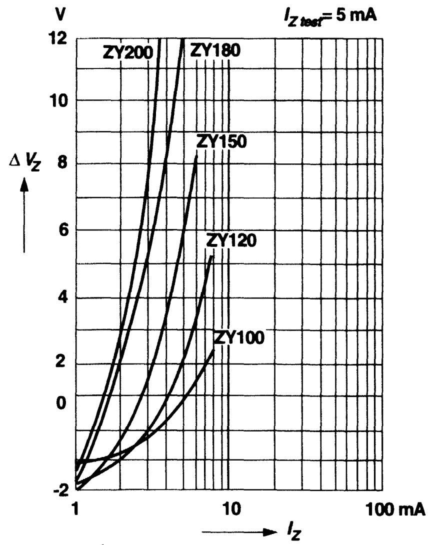
Difference between Zener voltage at test current pulses less than 1 s duration and Zener voltage at the point of thermal equilibrium versus Zener current



Difference between Zener voltage at test current pulses less than 1 s duration and Zener voltage at the point of thermal equilibrium versus Zener current



Difference between Zener voltage at test current pulses less than 1 s duration and Zener voltage at the point of thermal equilibrium versus Zener current



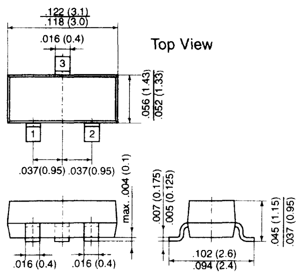
DUAL ZENER DIODES

General Semiconductor's Zener Diodes are used as voltage regulators, voltage references and voltage suppressors against ESD threats. Power ratings range from 300mW to 2W and voltages range from 2.4V to 200 V. Typical voltage tolerances are ±5%, but tighter tolerances such as ±2% are available. These diodes are available in the following packages: DO-35 and DO-41 axial; MELF, mini-MELF, SOD-123, SOD-323, SMA, SMB and SOT-23 (single & dual) surface mount packages.

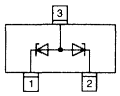
AZ23-C2V7 THRU AZ23-C51

DUAL ZENER DIODES

SOT-23



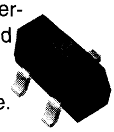
Dimensions in inches and (millimeters)



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Dual Silicon Planar Zener Diodes, Common Anode
- ♦ The Zener voltages are graded according to the international E 24 standard. Other voltage tolerances and other Zener voltages are available upon request.
- ♦ The parameters are valid for both diodes in one case. ΔV_Z and Δr_{zj} of the two diodes in one case is ≤ 5%.
- ♦ This diode is also available in other case styles and configurations including: the dual diode common cathode configuration with type designation DZ23, the single diode SOT-23 case with the type designation BZX84C, and the single diode SOD-123 case with the type designation BZT52C.



MECHANICAL DATA

Case: SOT-23 Plastic Package
Weight: approx. 0.008 g

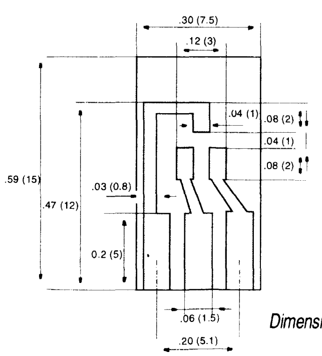
MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Power Dissipation at T_{amb} = 25°C	P_{tot}	300(1)	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 65 to +150	°C

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	420(1)	°C/W

NOTES:
Device on fiberglass substrate, see layout



Dimensions in inches (millimeters)

Layout for R_{thJA} test
Thickness: Fiberglass 0.059 in (1.5 mm)
Copper leads 0.012 in (0.3 mm)

AZ23-C2V7 THRU AZ23-C51

ELECTRICAL CHARACTERISTICS

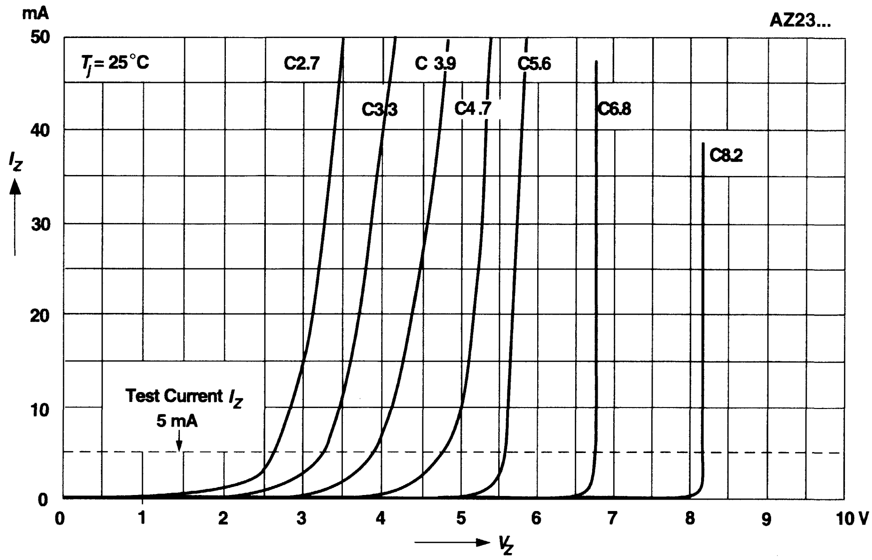
Ratings at 25°C ambient temperature unless otherwise specified.

Type	Marking	Zener Voltage(1) at Iz = 5 mA Vz (V)	Dynamic Resistance at Iz = 5 mA f = 1 kHz rzj (Ω)	Dynamic Resistance at Iz = 1 mA f = 1 kHz rzj (Ω)	Temp. Coeff. of Zener Voltage at Iz = 5 mA αvz (10^{-4}/K)	Reverse Voltage at IR = 100 nA VR (V)
AZ23-C2V7	D1	2.5 ... 2.9	75 (<83)	<500	−9 ... −4	–
AZ23-C3	D2	2.8 ... 3.2	80 (<95)	<500	−9 ... −3	–
AZ23-C3V3	D3	3.1 ... 3.5	80 (<95)	<500	−8 ... −3	–
AZ23-C3V6	D4	3.4 ... 3.8	80 (<95)	<500	−8 ... −3	–
AZ23-C3V9	D5	3.7 ... 4.1	80 (<95)	<500	−7 ... −3	–
AZ23-C4V3	D6	4.0 ... 4.6	80 (<95)	<500	−6 ... −1	–
AZ23-C4V7	D7	4.4 ... 5.0	70 (<78)	<500	−5 ... +2	–
AZ23-C5V1	D8	4.8 ... 5.4	30 (<60)	<480	−3 ... +4	>0.8
AZ23-C5V6	D9	5.2 ... 6.0	10 (<40)	<400	−2 ... +6	>1
AZ23-C6V2	D10	5.8 ... 6.6	4.8 (<10)	<200	−1 ... +7	>2
AZ23-C6V8	D11	6.4 ... 7.2	4.5 (<8)	<150	+2 ... +7	>3
AZ23-C7V5	D12	7.0 ... 7.9	4 (<7)	<50	−3 ... +7	>5
AZ23-C8V2	D13	7.7 ... 8.7	4.5 (<7)	<50	+4 ... +7	>6
AZ23-C9V1	D14	8.5 ... 9.6	4.8 (<10)	<50	+5 ... +8	>7
AZ23-C10	D15	9.4 ... 10.6	5.2 (<15)	<70	+5 ... +8	>7.5
AZ23-C11	D16	10.4 ... 11.6	6 (<20)	<70	+5 ... +9	>8.5
AZ23-C12	D17	11.4 ... 12.7	7 (<20)	<90	+6 ... +9	>9
AZ23-C13	D18	12.4 ... 14.1	9 (<25)	<110	+7 ... +9	>10
AZ23-C15	D19	13.8 ... 15.6	11 (<30)	<110	+7 ... +9	>11
AZ23-C16	D20	15.3 ... 17.1	13 (<40)	<170	+8 ... +9.5	>12
AZ23-C18	D21	16.8 ... 19.1	18 (<50)	<170	+8 ... +9.5	>14
AZ23-C20	D22	18.8 ... 21.2	20 (<50)	<220	+8 ... +10	>15
AZ23-C22	D23	20.8 ... 23.3	25 (<55)	<220	+8 ... +10	>17
AZ23-C24	D24	22.8 ... 25.6	28 (<80)	<220	+8 ... +10	>18
AZ23-C27	D25	25.1 ... 28.9	30 (<80)	<250	+8 ... +10	>20
AZ23-C30	D26	28 ... 32	35 (<80)	<250	+8 ... +10	>22.5
AZ23-C33	D27	31 ... 35	40 (<80)	<250	+8 ... +10	>25
AZ23-C36	D28	34 ... 38	40 (<90)	<250	+8 ... +10	>27
AZ23-C39	D29	37 ... 41	50 (<90)	<300	+10 ... +12	>29
AZ23-C43	D30	40 ... 46	60 (<100)	<700	+10 ... +12	>32
AZ23-C47	D31	44 ... 50	70 (<100)	<750	+10 ... +12	>35
AZ23-C51	D32	48 ... 54	70 (<100)	<750	+10 ... +12	>38

NOTES:
(1) Tested with pulses t_p = 3 ms

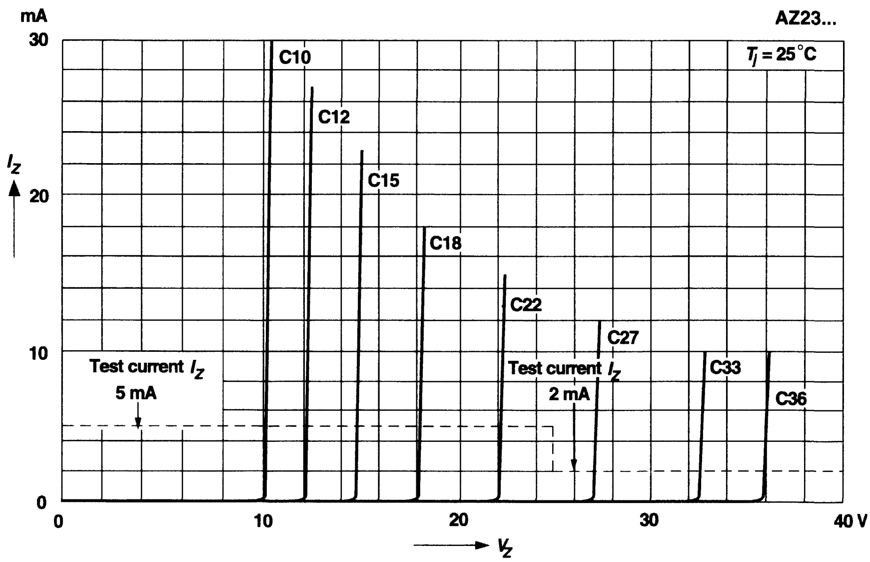
Breakdown characteristics

T_j = constant (pulsed)



Breakdown characteristics

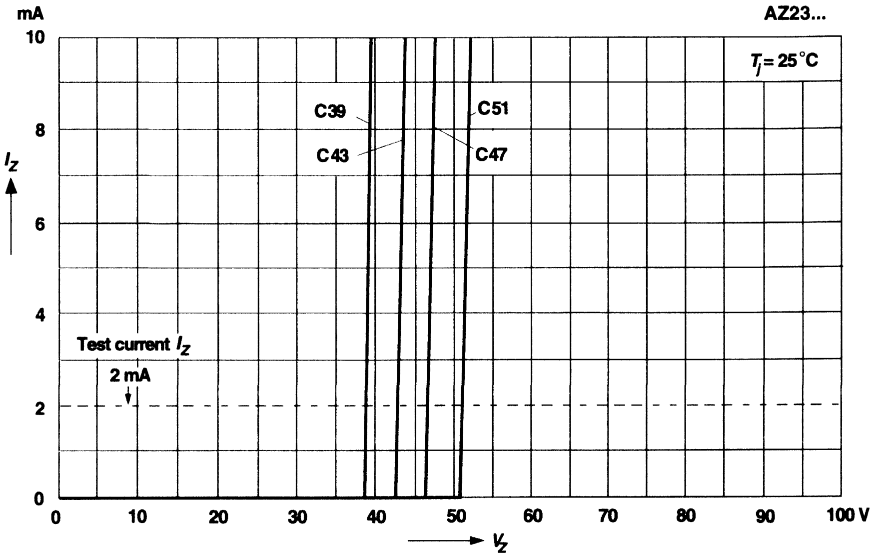
T_j = constant (pulsed)



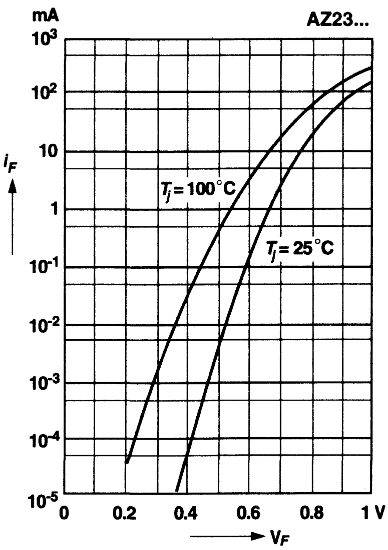
RATINGS AND CHARACTERISTIC CURVES AZ23-C2V7 THRU AZ23-C51

Breakdown characteristics

T_j = constant (pulsed)

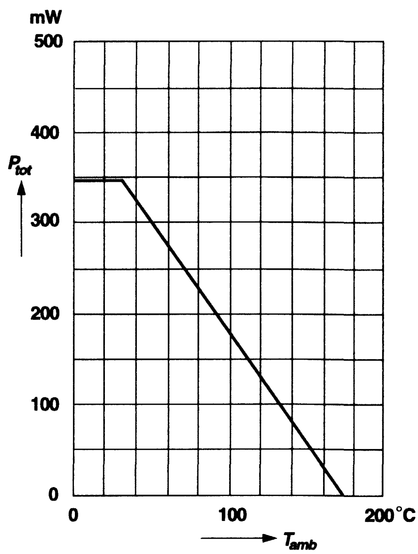


Forward characteristics



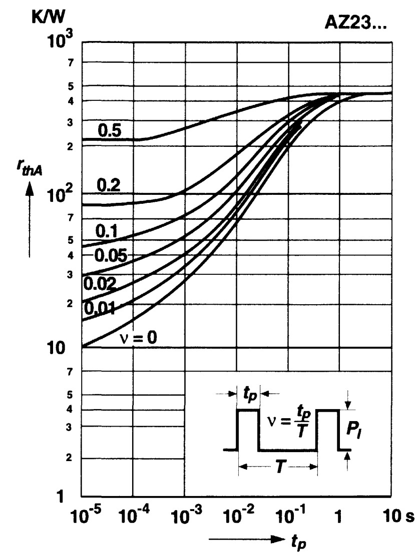
Admissible power dissipation versus ambient temperature

For conditions, see footnote in table "Absolute Maximum Ratings"

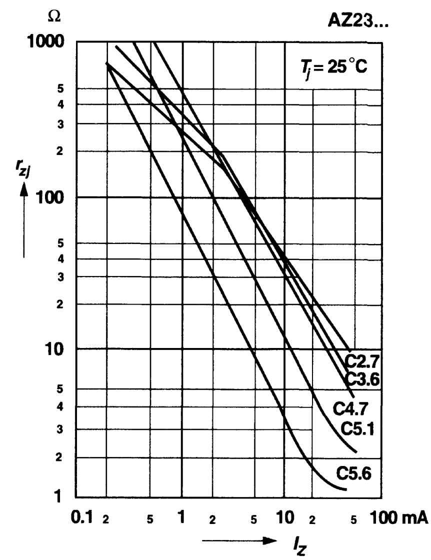


Pulse thermal resistance versus pulse duration

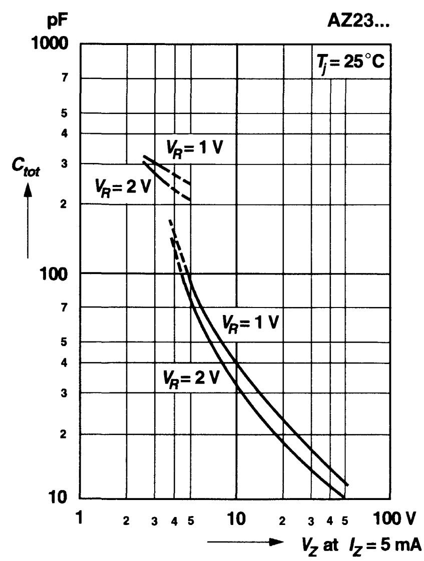
For conditions, see footnote in table "Absolute Maximum Ratings"



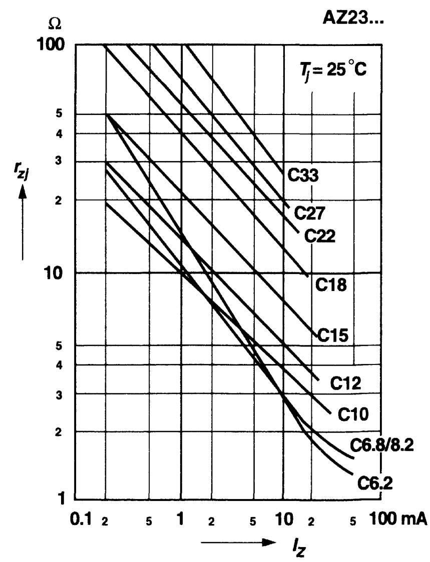
Dynamic resistance versus Zener current



Capacitance versus Zener voltage

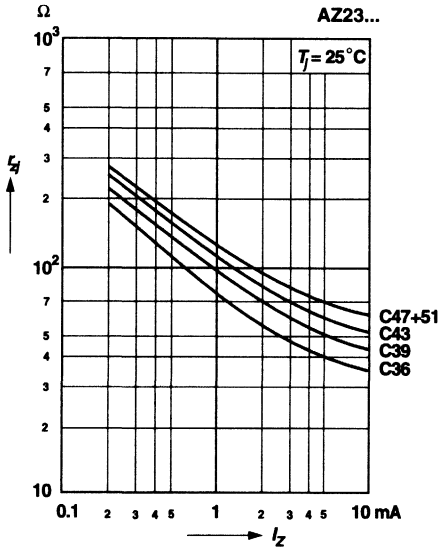


Dynamic resistance versus Zener current



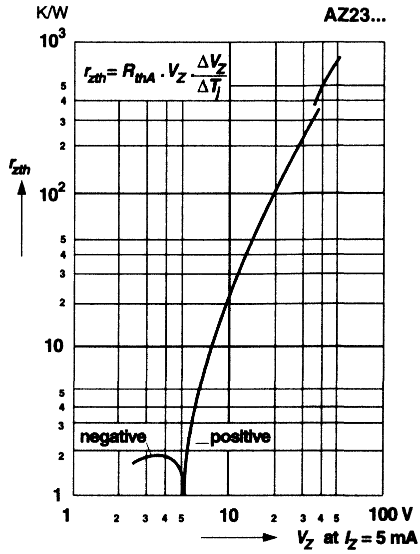
RATINGS AND CHARACTERISTIC CURVES AZ23-C2V7 THRU AZ23-C51

Dynamic resistance versus Zener current

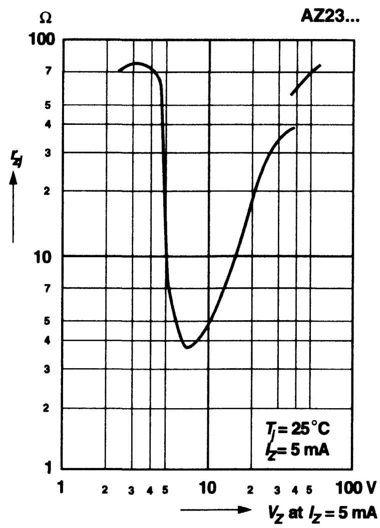


Thermal differential resistance versus Zener voltage

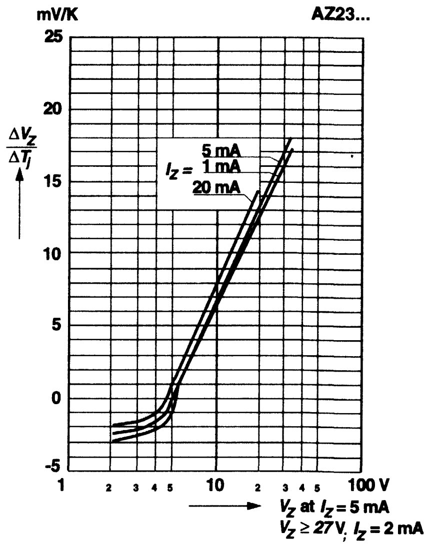
For conditions, see footnote in table "Absolute Maximum Ratings"



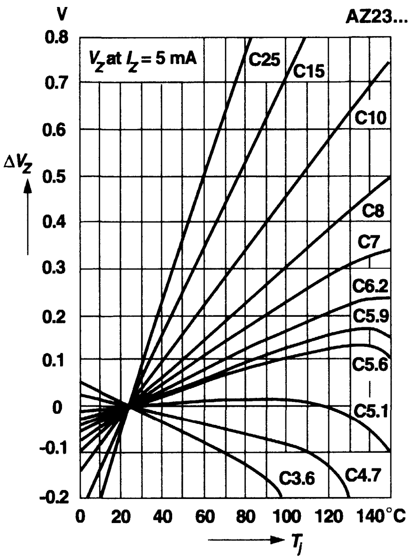
Dynamic resistance versus Zener voltage



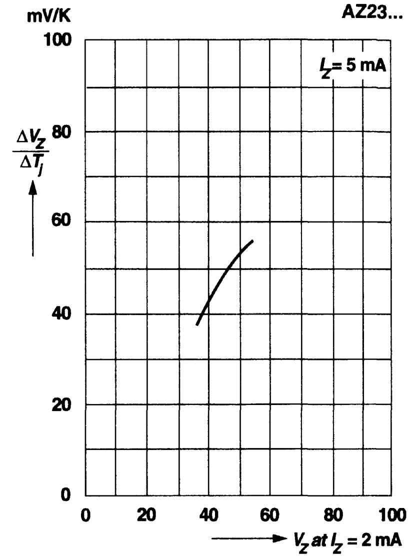
Temperature dependence of Zener voltage versus Zener voltage



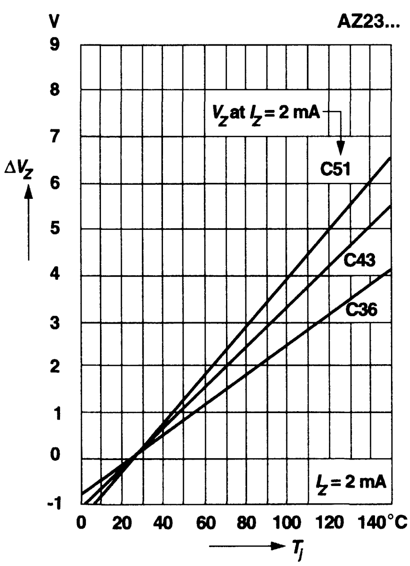
Change of Zener voltage versus junction temperature



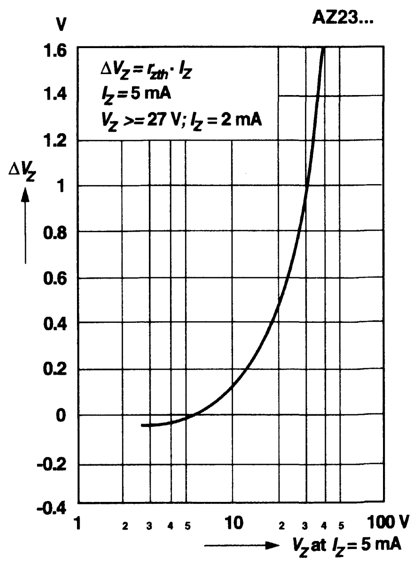
Temperature dependence of Zener voltage versus Zener voltage



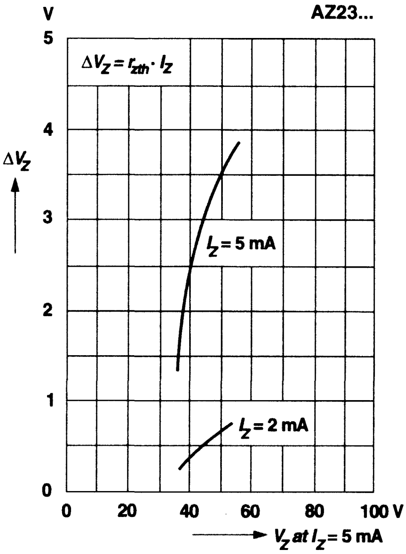
Change of Zener voltage versus junction temperature



Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



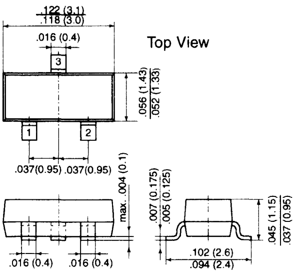
Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



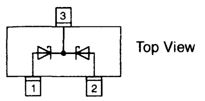
DZ23-C2V7 THRU DZ23-C51

DUAL ZENER DIODES

SOT-23

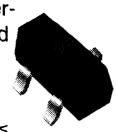


Dimensions in inches and (millimeters)



Dimensions are in inches and (millimeters)

FEATURES



- ♦ Dual Silicon Planar Zener Diodes, Common Cathode
- ♦ The Zener voltages are graded according to the international E 24 standard. Other voltage tolerances and other Zener voltages are available upon request.
- ♦ The parameters are valid for both diodes in one case. ΔV_Z and Δr_{zj} of the two diodes in one case is $\leq$ 5%.
- ♦ This diode is also available in other case styles and configurations including: the dual diode common cathode configuration with type designation AZ23, the single diode SOT-23 case with the type designation BZX84C, and the single diode SOD-123 case with the type designation BZT52C.

MECHANICAL DATA

Case: SOT-23 Plastic Package
Weight: approx. 0.008 g

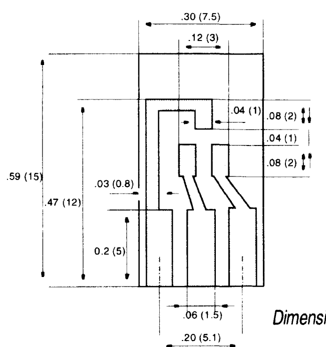
MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNIT
Power Dissipation at T_{amb} = 25°C	P_{tot}	300$^{(1)}$	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 65 to +150	°C

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	420$^{(1)}$	°C/W

NOTES:
(1) Device on fiberglass substrate, see layout



Dimensions in inches (millimeters)

Layout for R_{thJA} test
Thickness: Fiberglass 0.059 in (1.5 mm)
Copper leads 0.012 in (0.3 mm)

DZ23-C2V7 THRU DZ23-C51

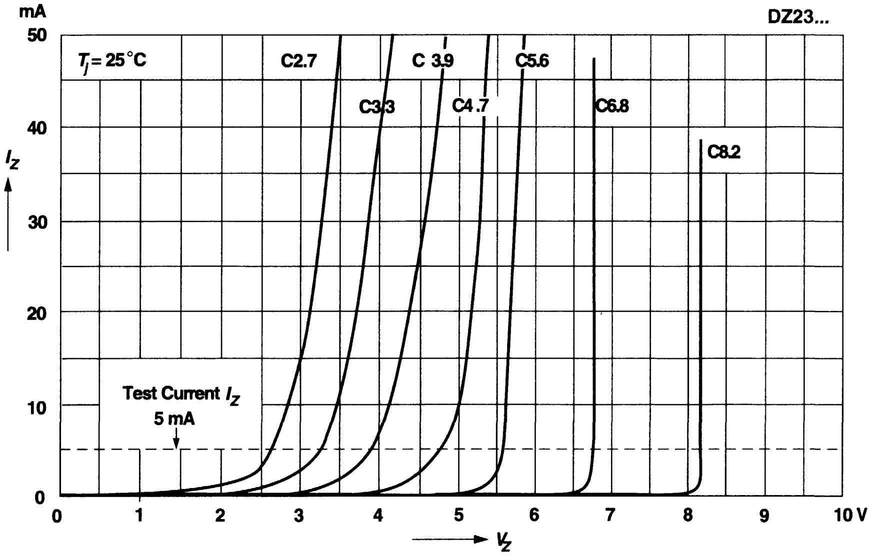
ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

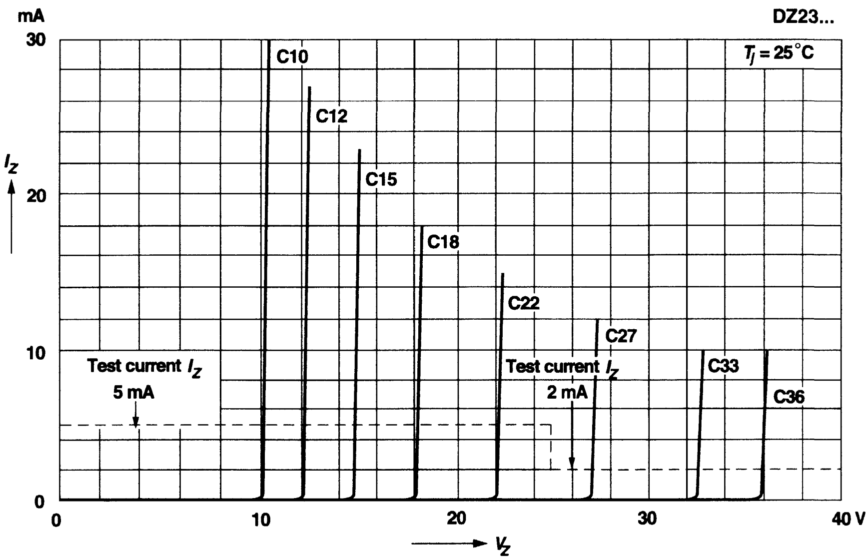
Type	Marking	Zener Voltage(1) at Iz = 5 mA Vz (V)	Dynamic Resistance at Iz = 5 mA f = 1 kHz rzj (Ω)	Dynamic Resistance at Iz = 1 mA f = 1 kHz rzj (Ω)	Temp. Coeff. of Zener Voltage at Iz = 5 mA αvz (10^{-4}/K)	Reverse Voltage at IR = 100 nA VR (V)
DZ23-C2V7	V1	2.5 ... 2.9	75 (<83)	<500	−9 ... −4	–
DZ23-C3	V2	2.8 ... 3.2	80 (<95)	<500	−9 ... −3	–
DZ23-C3V3	V3	3.1 ... 3.5	80 (<95)	<500	−8 ... −3	–
DZ23-C3V6	V4	3.4 ... 3.8	80 (<95)	<500	−8 ... −3	–
DZ23-C3V9	V5	3.7 ... 4.1	80 (<95)	<500	−7 ... −3	–
DZ23-C4V3	V6	4.0 ... 4.6	80 (<95)	<500	−6 ... −1	–
DZ23-C4V7	V7	4.4 ... 5.0	70 (<78)	<500	−5 ... +2	–
DZ23-C5V1	V8	4.8 ... 5.4	30 (<60)	<480	−3 ... +4	>0.8
DZ23-C5V6	V9	5.2 ... 6.0	10 (<40)	<400	−2 ... +6	>1
DZ23-C6V2	V10	5.8 ... 6.6	4.8 (<10)	<200	−1 ... +7	>2
DZ23-C6V8	V11	6.4 ... 7.2	4.5 (<8)	<150	+2 ... +7	>3
DZ23-C7V5	V12	7.0 ... 7.9	4 (<7)	<50	−3 ... +7	>5
DZ23-C8V2	V13	7.7 ... 8.7	4.5 (<7)	<50	+4 ... +7	>6
DZ23-C9V1	V14	8.5 ... 9.6	4.8 (<10)	<50	+5 ... +8	>7
DZ23-C10	V15	9.4 ... 10.6	5.2 (<15)	<70	+5 ... +8	>7.5
DZ23-C11	V16	10.4 ... 11.6	6 (<20)	<70	+5 ... +9	>8.5
DZ23-C12	V17	11.4 ... 12.7	7 (<20)	<90	+6 ... +9	>9
DZ23-C13	V18	12.4 ... 14.1	9 (<25)	<110	+7 ... +9	>10
DZ23-C15	V19	13.8 ... 15.6	11 (<30)	<110	+7 ... +9	>11
DZ23-C16	V20	15.3 ... 17.1	13 (<40)	<170	+8 ... +9.5	>12
DZ23-C18	V21	16.8 ... 19.1	18 (<50)	<170	+8 ... +9.5	>14
DZ23-C20	V22	18.8 ... 21.2	20 (<50)	<220	+8 ... +10	>15
DZ23-C22	V23	20.8 ... 23.3	25 (<55)	<220	+8 ... +10	>17
DZ23-C24	V24	22.8 ... 25.6	28 (<80)	<220	+8 ... +10	>18
DZ23-C27	V25	25.1 ... 28.9	30 (<80)	<250	+8 ... +10	>20
DZ23-C30	V26	28 ... 32	35 (<80)	<250	+8 ... +10	>22.5
DZ23-C33	V27	31 ... 35	40 (<80)	<250	+8 ... +10	>25
DZ23-C36	V28	34 ... 38	40 (<90)	<250	+8 ... +10	>27
DZ23-C39	V29	37 ... 41	50 (<90)	<300	+10 ... +12	>29
DZ23-C43	V30	40 ... 46	60 (<100)	<700	+10 ... +12	>32
DZ23-C47	V31	44 ... 50	70 (<100)	<750	+10 ... +12	>35
DZ23-C51	V32	48 ... 54	70 (<100)	<750	+10 ... +12	>38

NOTES:
(1) Tested with pulses t_p = 3 ms

Breakdown characteristics
T_j = constant (pulsed)

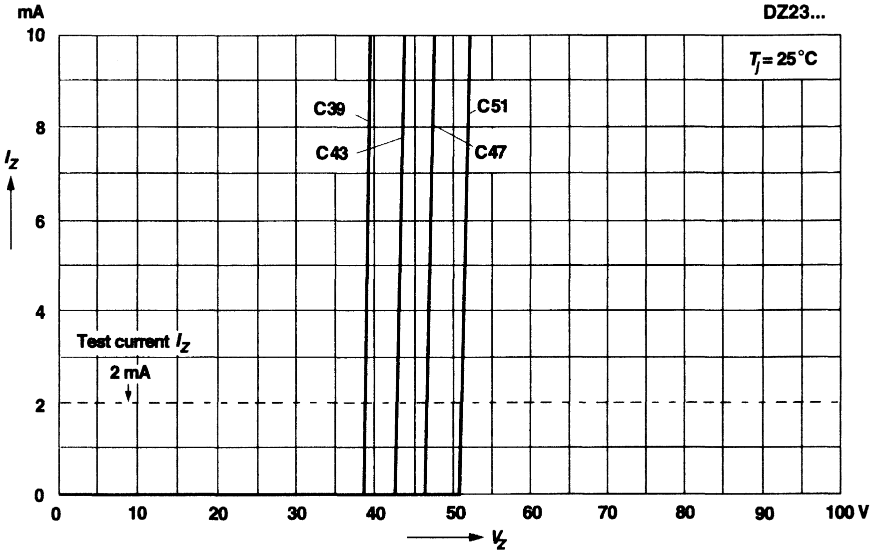


Breakdown characteristics
T_j = constant (pulsed)

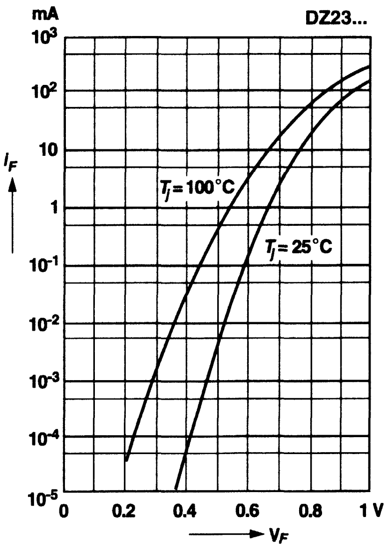


Breakdown characteristics

T_j = constant (pulsed)

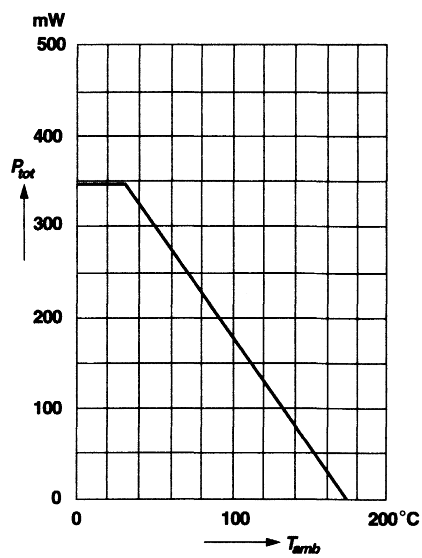


Forward characteristics



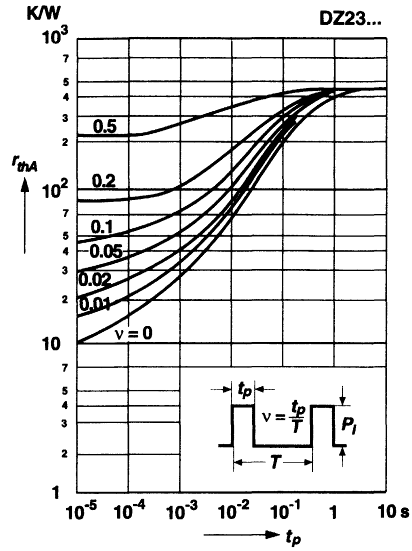
Admissible power dissipation versus ambient temperature

For conditions, see footnote in table "Absolute Maximum Ratings"

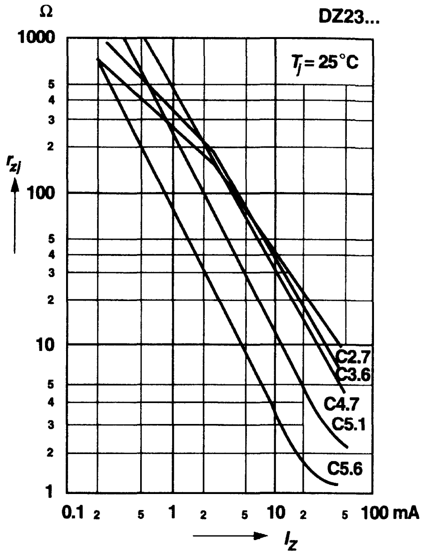


Pulse thermal resistance versus pulse duration

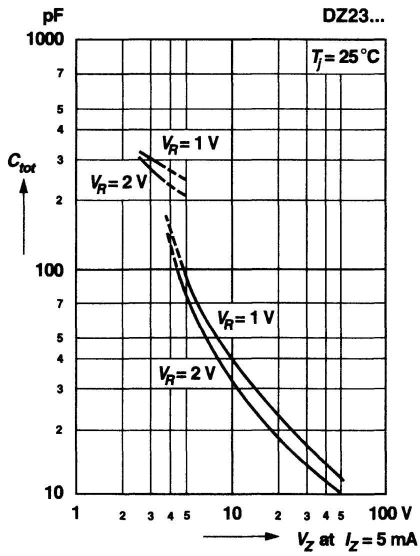
For conditions, see footnote in table "Absolute Maximum Ratings"



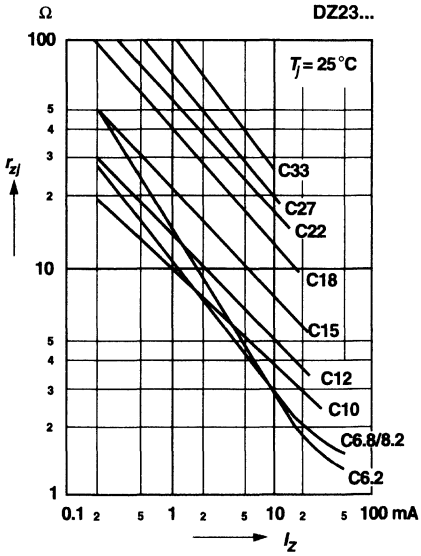
Dynamic resistance versus Zener current



Capacitance versus Zener voltage

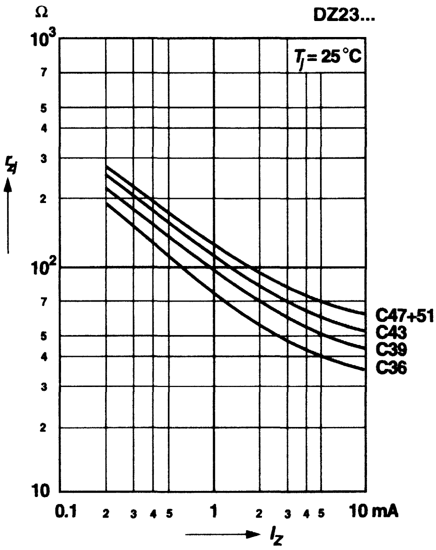


Dynamic resistance versus Zener current



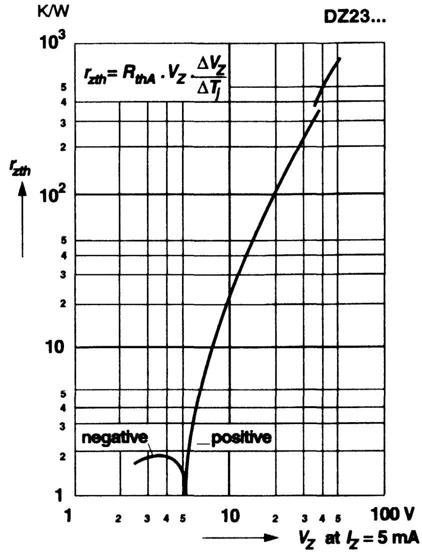
RATINGS AND CHARACTERISTIC CURVES DZ23-C2V7 THRU DZ23-C51

Dynamic resistance versus Zener current

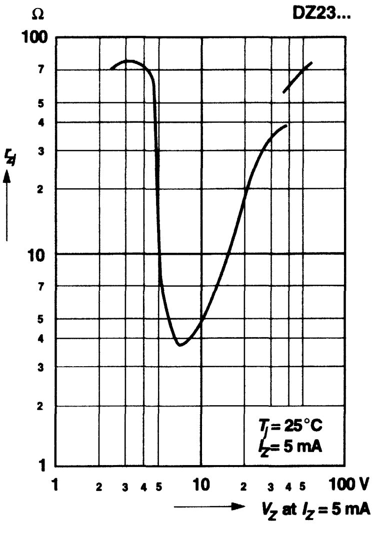


Thermal differential resistance versus Zener voltage

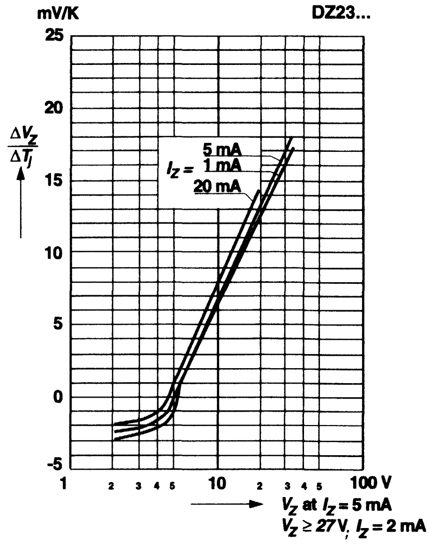
For conditions, see footnote in table "Absolute Maximum Ratings"



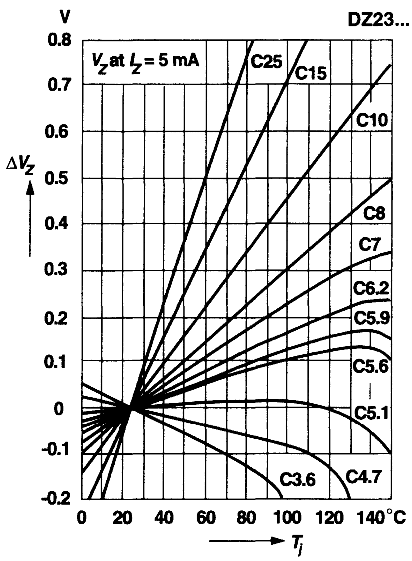
Dynamic resistance versus Zener voltage



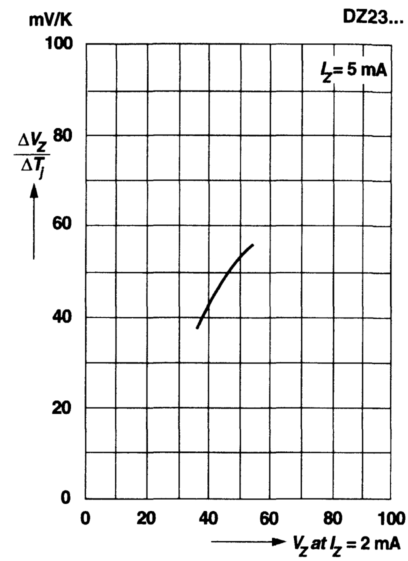
Temperature dependence of Zener voltage versus Zener voltage



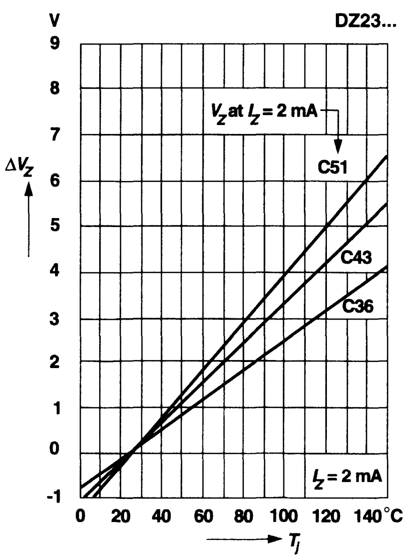
Change of Zener voltage versus junction temperature



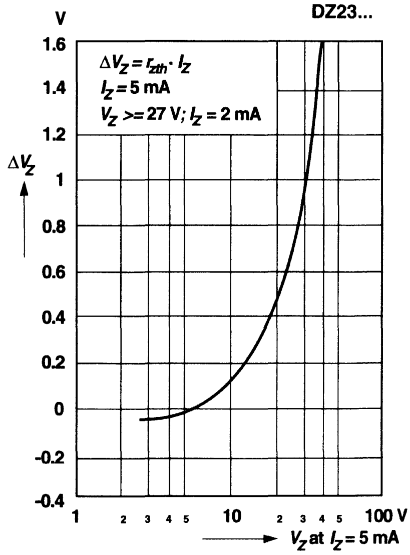
Temperature dependence of Zener voltage versus Zener voltage



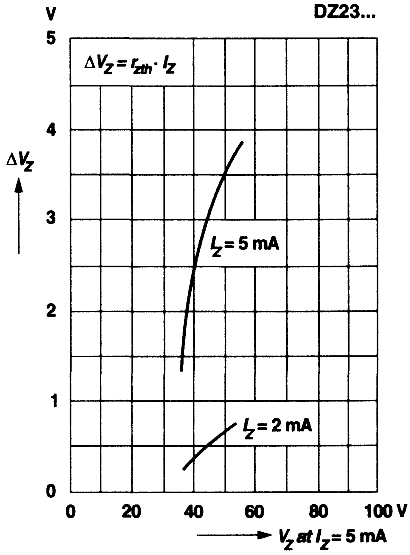
Change of Zener voltage versus junction temperature



Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



Change of Zener voltage from turn-on up to the point of thermal equilibrium versus Zener voltage



VOLTAGE STABILIZERS

Designed for small power stabilizer and limitation circuits, providing low dynamic resistance and high quality stabilization performance, as well as low noise.

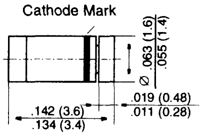
Temperature-compensated stabilizers of the ZTK series exhibit extremely short thermal run-in time producing a constant temperature compensated voltage. They are particularly suitable for stabilizing the tuning voltage in radio and TV tuners employing voltage-variable capacitance diodes.

Datasheets in this section are listed in alphanumerical order.

LL1.5 THRU LL2.4

VOLTAGE STABILIZERS

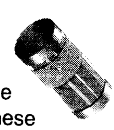
Mini-MELF



Dimensions are in inches and (millimeters)

FEATURES

- Silicon Planar Stabilizer Diodes
- Monolithic integrated analog circuits in Mini-MELF case, designed for small power stabilizer and limitation circuits, providing low dynamic resistance and high-quality stabilization performance as well as low noise. In the reverse direction, these devices show the behavior of forward-biased silicon diodes.



- The end of the device marked with the cathode ring is to be connected:
  LL1.5 and LL 2 to the negative pole of the supply voltage
  LL 2.4 to the positive pole of the supply voltage
- These diodes are also available in DO-35 case with the type designation ZTE1.5 ... ZTE 2.4.

MECHANICAL DATA

Case: Mini-MELF Glass Case (SOD-80)
Weight: approx. 0.05 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Operating Current (see Table "Characteristics")			
Inverse Current	I_F	100	mA
Power Dissipation at T_{amb} = 25°C	P_{tot}	300[1)]	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 55 to +150	°C

NOTES:
(1) Valid provided that electrodes are kept at ambient temperature.

LL1.5 THRU LL2.4

ELECTRICAL AND THERMAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Forward Voltage at I_F = 10 mA	V_F	–	–	1.1	Volts
Temperature Coefficient of the stabilized voltage at I_Z = 5 mA **LL1.5, LL2**	α_{VZ}	–	–26	–	10^{-4}/K
LL2.4	α_{VZ}	–	–34	–	10^{-4}/K
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	0.4[1)]	°C/W

NOTES:
(1) Valid provided that electrodes are kept at ambient temperature.

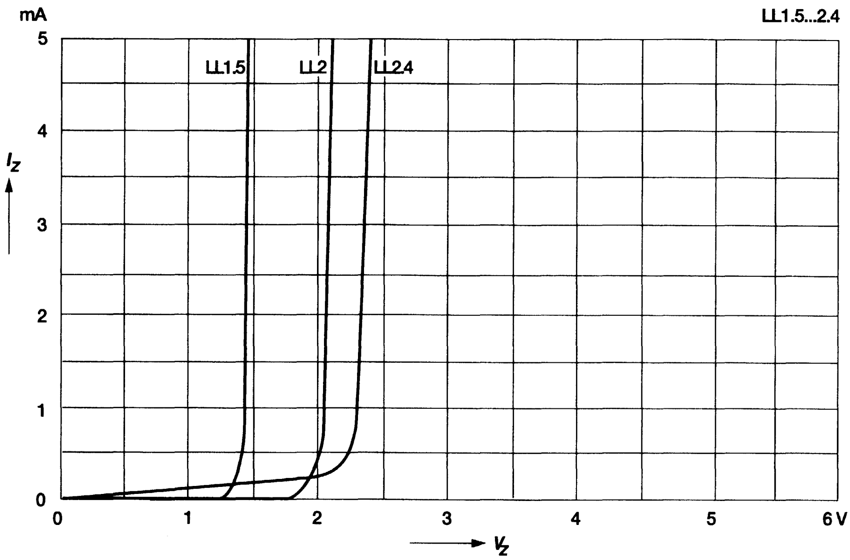
Voltage Stabilizers

Type	Operating voltage at I_Z = 5mA[(1)] V_Z (V)	Dynamic resistance at I_Z = 5mA r_{zj} (Ω)	Permissable operating current at T_{amb} = 25°C[(2)] I_Z max. (mA)
LL1.5	1.35 ... 1.55	13(<20)	120
LL2	2.0 ... 2.3	18(<30)	120
LL2.4	2.2 ... 2.56	14(<20)	120

NOTES:
(1) Tested with pulses t_p=5ms
(2) Valid provided that electrodes are kept at ambient temperature

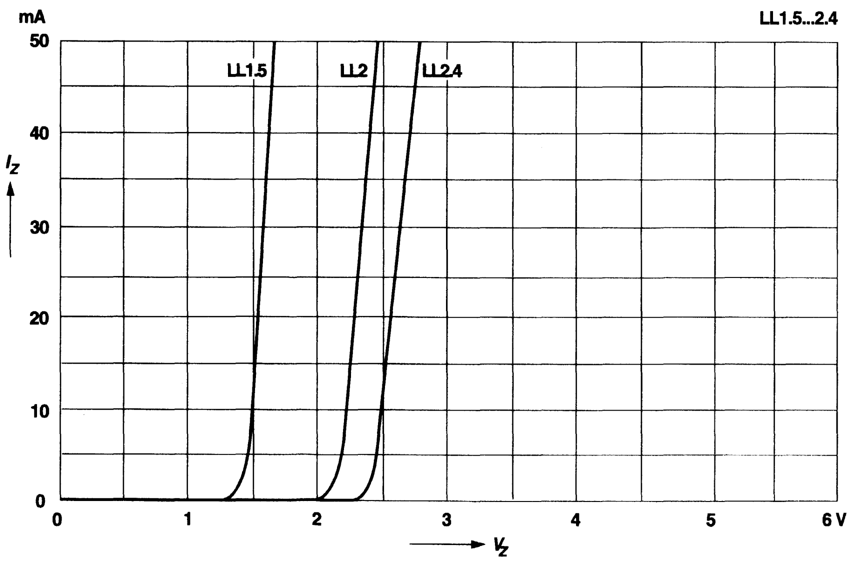
Breakdown characteristics

T_j = constant (pulsed)



Breakdown characteristics

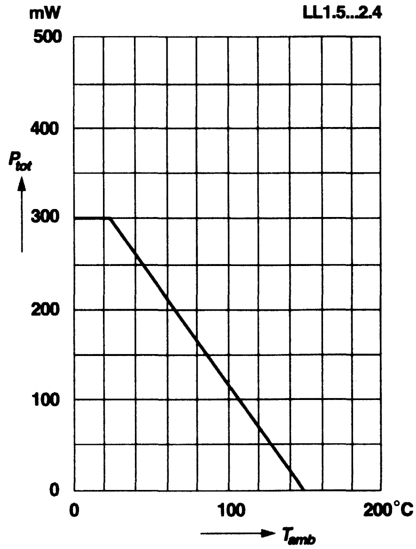
T_j = constant (pulsed)



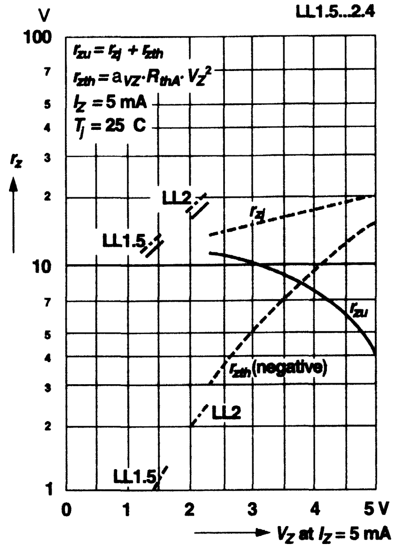
RATINGS AND CHARACTERISTIC CURVES LL1.5 THRU LL2.4

Admissible power dissipation versus ambient temperature

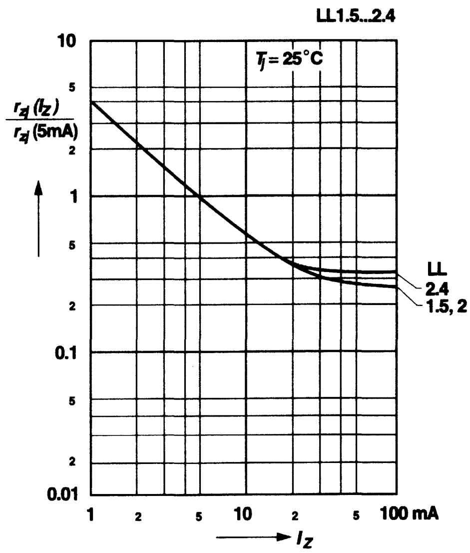
Valid provided that electrodes are kept at ambient temperature.



Dynamic resistance versus operating voltage



Dynamic resistance versus operating current, normalized

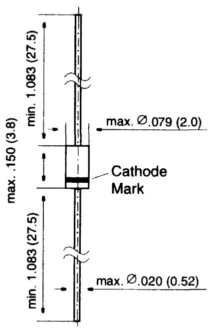


Voltage Stabilizers

ZTE1.5 THRU ZTE2.4

VOLTAGE STABILIZERS

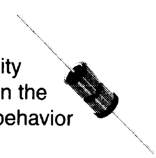
DO-35



Dimensions are in inches and (millimeters)

FEATURES

- Silicon Stabilizer Diodes
- Monolithic integrated analog circuits, designed for small power stabilizer and limitation circuits, providing low dynamic resistance and high-quality stabilization performance as well as low noise. In the reverse direction, these devices show the behavior of forward-biased silicon diodes.



- The end of the ZTE device marked with the cathode ring is to be connected:
  ZTE1.5 & ZTE2 to the negative pole of the supply voltage
  ZTE2.4 to the positive pole of the supply voltage
- These diodes are also available in Mini-MELF case with the type designation LL1.5 ... LL2.4.

MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Operating Current (see Table "Characteristics")			
Inverse Current	I_F	100	mA
Power Dissipation at T_{amb} = 25°C	P_{tot}	300[1)]	mW
Junction Temperature	T_j	150	°C
Storage Temperature Range	T_S	– 55 to +150	°C

NOTES:
(1) Valid provided that leads are kept at ambient temperature at a distance of 8 mm.

ZTE1.5 THRU ZTE2.4

ELECTRICAL AND THERMAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Forward Voltage at I_F = 10 mA	V_F	–	–	1.1	Volts
Temperature Coefficient of the stabilized voltage at I_Z = 5 mA **ZTE1.5, ZTE2**	α_{VZ}	–	–26	–	10^{-4}/K
ZTE2.4	α_{VZ}	–	–34	–	10^{-4}/K
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	0.4[1)]	°C/W

NOTES:
(1) Valid provided that leads are kept at ambient temperature at a distance of 8 mm.

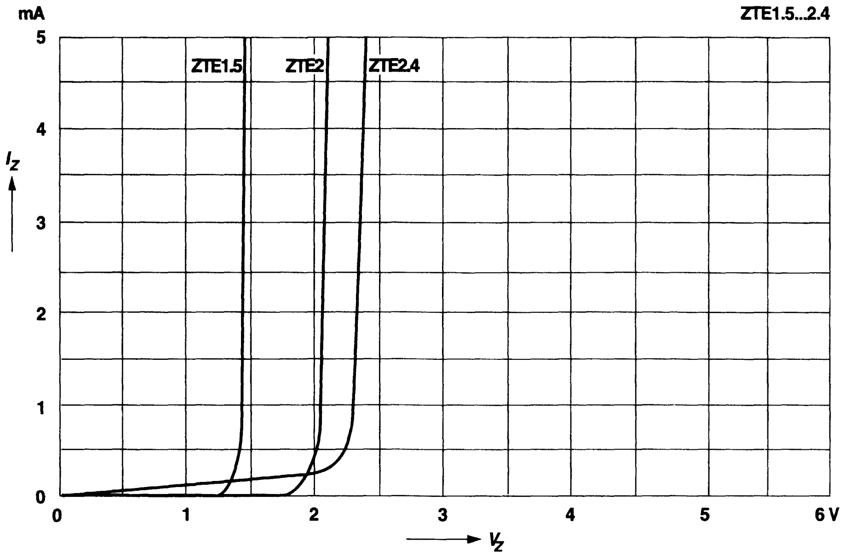
Voltage Stabilizers

Type	Operating voltage at I_Z = 5mA[(1)] V_Z (V)	Dynamic resistance at I_Z = 5mA r_{zj} (Ω)	Permissable operating current at T_{amb} = 25°C[(2)] I_Z max. (mA)
ZTE1.5	1.35 ... 1.55	13(<20)	120
ZTE2	2.0 ... 2.3	18(<30)	120
ZTE2.4	2.2 ... 2.56	14(<20)	120

NOTES:
(1) Tested with pulses t_p=5ms
(2) Valid provided that leads are kept at ambient temperature at a distance of 8mm from case

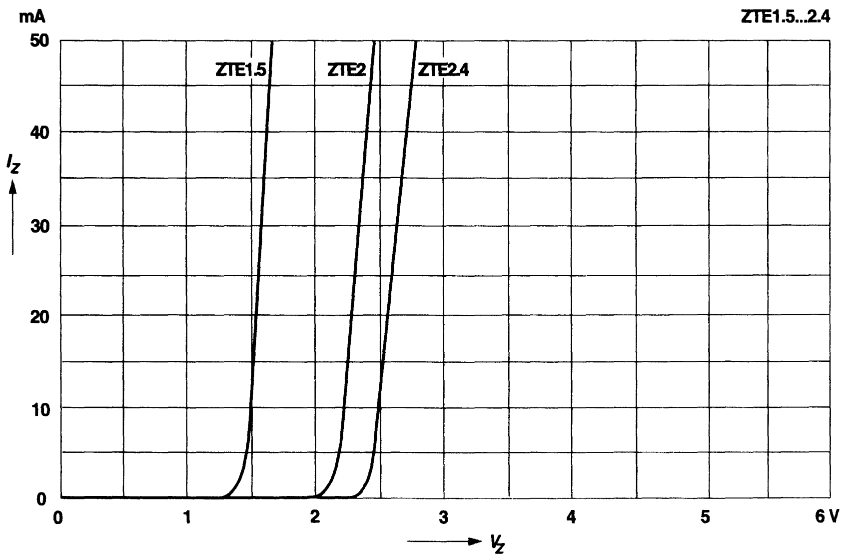
Breakdown characteristics

T_j = constant (pulsed)



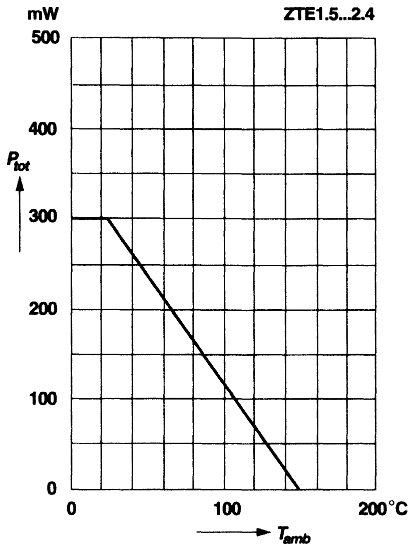
Breakdown characteristics

T_j = constant (pulsed)

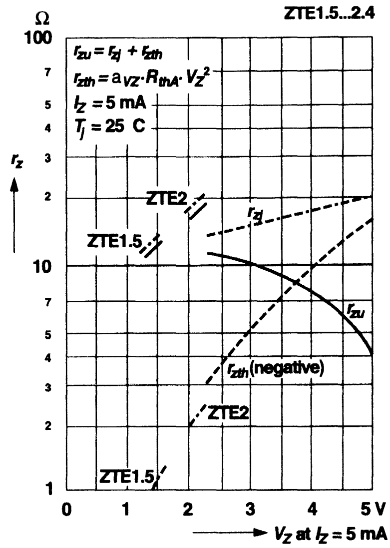


Admissible power dissipation versus ambient temperature

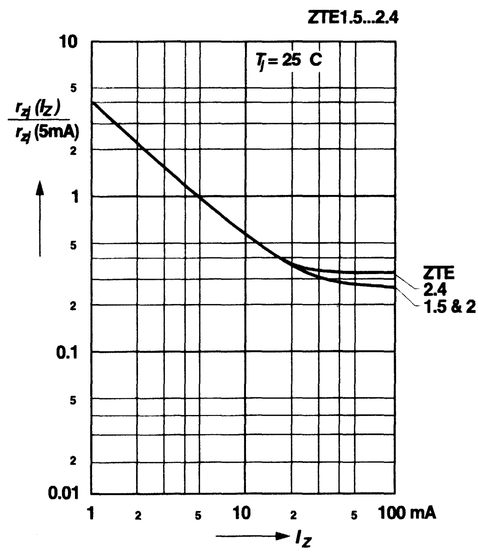
Valid provided that leads at a distance of 8 mm from case are kept at ambient temperature



Dynamic resistance versus operating voltage



Dynamic resistance versus operating current, normalized



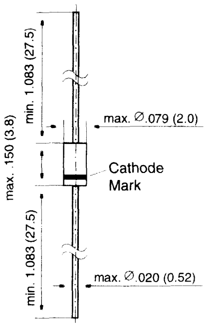
GENERAL SEMICONDUCTOR®

Voltage Stabilizers

ZTK6.8 THRU ZTK33

VOLTAGE STABILIZERS

DO-35



Dimensions are in inches and (millimeters)

FEATURES

- Temperature-Compensated Stabilizing Circuits
- Monolithic linear integrated circuits with extremely short thermal run-in time producing a constant temperature-compensated voltage. They are particularly suitable for stabilizing the tuning voltage in radio and TV tuners employing voltage-variable capacitance diodes.

MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Operating Current (see Table "Characteristics")			
Junction Temperature	T_j	150	°C
Storage Temperature Range	Ts	– 20 to +150	°C

ZTK6.8 THRU ZTK33

ELECTRICAL AND THERMAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	MIN.	TYP.	MAX.	UNIT
Temperature Coefficient of the Operating Voltage at I_Z = 5 mA ±0.5 mA in the range of T_{amb} = 20 to 60°C	α_{VZ}	–10	–2	+5[1)]	10^{-5}/K
Thermal Run-In-Time	t_{th}	–	20[2)]	–	s
Thermal Resistance Junction to Ambient Air	R_{thJA}	–	–	0.4	°C/W

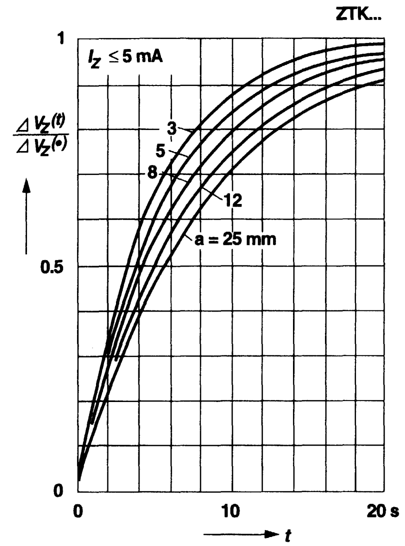
NOTES:
(1) Valid provided that leads are kept at ambient temperature at a distance of 8mm from case.
(2) At the end of this time ΔV_Z has reached 90% of its final value $\Delta V_{Z\ max}$.
$\Delta V_{Z\ max} = V_Z(a) - V_Z(0)$, where $V_Z(0) = V_Z$ in the instant of turn-on and $V_Z(a) = V_Z$ at thermal equilibrium.

Voltage Stabilizers

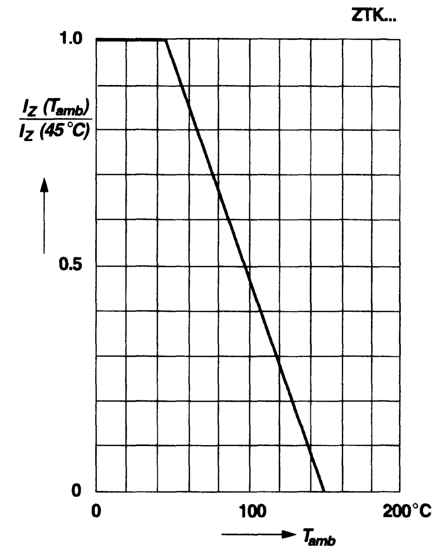
Type	Operating voltage at I_Z = 5mA[(1)] V_Z(V)	Dynamic resistance at I_Z = 5mA r_{zj}(Ω)	Permissable operating current at T_{amb} = 45°C[(2)] I_Z max. (mA)
ZTK6.8	6.4 ... 7.1	10(<25)	36
ZTK9	8 ... 10	10(<25)	27
ZTK11	10 ... 12	10(<25)	19
ZTK18	16 ... 20	11(<25)	13
ZTK22	20 ... 24	11(<25)	10
ZTK27	24 ... 30	12(<25)	8
ZTK33A	30 ... 32	12(<25)	7
ZTK33B	32 ... 34	12(<25)	7
ZTK33C	34 ... 36	12(<25)	7

NOTES:
(1) Tested with pulses t_p=5ms
(2) Valid provided that leads are kept at ambient temperature at a distance of 8mm from case

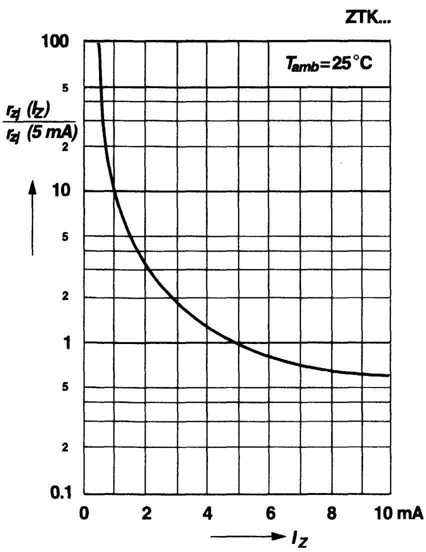
Time dependence of ΔV_Z after turn-on for different distances between case and point of ambient temperature on the leads



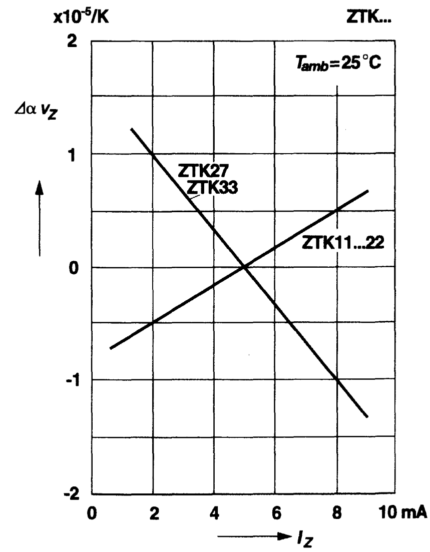
Permissible operating current versus ambient temperature
Valid provided that leads are kept at ambient temperature at a distance of 8 mm from case



Dynamic resistance versus operating current



Change of temperature coefficient versus operating current



GENERAL SEMICONDUCTOR®

TransZorb™

TRANSIENT VOLTAGE SUPPRESSORS

General Semiconductor delivers "state-of-the-art" Transient Voltage Suppressors (TVS). Based on controlled avalanche technology, these voltage clamping devices utilize a specific soft solder construction. 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, General Semiconductor's TransZorb™ TVS products do not exhibit a wear out mechanism, as many MOV and similar technologies do. With sub-nanosecond turn-on times and superior clamping characteristics, General Semiconductor's TVS products are the preferable option for your transient suppression needs compared to MOV's.

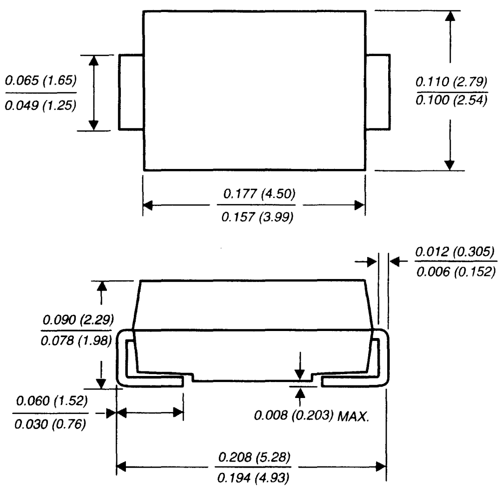
Datasheets in this section are arranged by increasing power rating.

SMAJ5.0 THRU SMAJ170CA

SURFACE MOUNT TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 5.0 to 170 Volts* ***Peak Pulse Power** - 300 Watts*

DO-214AC



Dimensions in inches and (millimeters)

FEATURES

- ♦ Optimized for LAN protection applications
- ♦ Ideal for ESD protection of data lines in accordance with IEC 1000-4-2 (IEC801-2)
- ♦ Ideal for EFT protection of data lines in accordance with IEC1000-4-4 (IEC801-4)
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ min.
- ♦ 300W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-214AC molded plastic body over passivated chip
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types the color band denotes the cathode, which is postitive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.002 ounces, 0.064 gram

DEVICES FOR BIDIRECTIONAL APPLICATIONS

For bi-directional use suffix C or CA for types SMAJ5.0 thru SMAJ170 (e.g. SMAJ5.0C, SMAJ170CA)
Electrical characteristics apply in both directions.

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, 2, FIG.1)	P_{PM}	Minimum 300	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTES 2, 3) - unidirectional only	I_{FSM}	40.0	Amps
Maximum instantaneous forward voltage at 25A (NOTE 3)	V_F	3.5	Volts
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 5.0mm) copper pads to each terminal
(3) Measured on 8.3ms single half sine-wave. For uni-directional devices only.

ELECTRICAL CHARACTERISTICS (T_A=25°C unless otherwise noted) TABLE 1

Device	Device Marking Code UNI	Device Marking Code BI	Breakdown Voltage $V_{(BR)}$ (Volts) at I_T (NOTE 1) Min.	Breakdown Voltage $V_{(BR)}$ (Volts) at I_T (NOTE 1) Max.	Test Current I_T (mA)	Working Peak Reverse Voltage V_{WM} (Volts)	Maximum Reverse Leakage a V_{WM} (NOTE 3) I_D (μA)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)
SMAJ5.0	AD	WD	6.4	7.82	10	5.0	800	31.3	9.6
SMAJ5.0A	AE	WE	6.4	7.07	10	5.0	800	32.6	9.2
SMAJ6.0	AF	WF	6.67	8.15	10	6.0	800	26.3	11.4
SMAJ6.0A	AG	WG	6.67	7.37	10	6.0	800	29.1	10.3
SMAJ6.5	AH	WH	7.22	8.82	10	6.5	500	24.4	12.3
SMAJ6.5A	AK	WK	7.22	7.98	10	6.5	500	26.8	11.2
SMAJ7.0	AL	WL	7.78	9.51	10	7.0	200	22.6	13.3
SMAJ7.0A	AM	WM	7.78	8.6	10	7.0	200	25.0	12.0
SMAJ7.5	AN	WN	8.33	10.3	1.0	7.5	100	21.0	14.3
SMAJ7.5A	AP	WP	8.33	9.21	1.0	7.5	100	23.3	12.9
SMAJ8.0	AQ	WQ	8.89	10.9	1.0	8.0	50.0	20.0	15.0
SMAJ8.0A	AR	WR	8.89	9.83	1.0	8.0	50.0	22.1	13.6
SMAJ8.5	AS	WS	9.44	11.5	1.0	8.5	10.0	18.9	15.9
SMAJ8.5A	AT	WT	9.44	10.4	1.0	8.5	10.0	20.8	14.4
SMAJ9.0	AU	WU	10.0	12.2	1.0	9.0	5.0	17.8	16.9
SMA J9.0A	AV	WV	10.0	11.1	1.0	9.0	5.0	19.5	15.4
SMAJ10	AW	WW	11.1	13.6	1.0	10.0	5.0	16.0	18.8
SMAJ10A	AX	WX	11.1	12.3	1.0	10.0	5.0	17.6	17.0
SMAJ11	AY	WY	12.2	14.9	1.0	11.0	5.0	14.9	20.1
SMAJ11A	AZ	WZ	12.2	13.5	1.0	11.0	5.0	16.5	18.2
SMAJ12	BD	XD	13.3	16.3	1.0	12.0	5.0	13.6	22.0
SMAJ12A	BE	XE	13.3	14.7	1.0	12.0	5.0	15.1	19.9
SMAJ13	BF	XF	14.4	17.6	1.0	13.0	5.0	12.6	23.8
SMAJ13A	BG	XG	14.4	15.9	1.0	13.0	5.0	14.0	21.5
SMAJ14	BH	XH	15.6	19.1	1.0	14.0	5.0	11.6	25.8
SMAJ14A	BK	XK	15.6	17.2	1.0	14.0	5.0	12.9	23.2
SMAJ15	BL	XL	16.7	20.4	1.0	15.0	5.0	11.2	26.9
SMAJ15A	BM	XM	16.7	18.5	1.0	15.0	5.0	12.3	24.4
SMAJ16	BN	XN	17.8	21.8	1.0	16.0	5.0	10.4	28.8
SMAJ16A	BP	XP	17.8	19.7	1.0	16.0	5.0	11.5	26.0
SMAJ17	BQ	XQ	18.9	23.1	1.0	17.0	5.0	9.8	30.5
SMAJ17A	BR	XR	18.9	20.9	1.0	17.0	5.0	10.9	27.6
SMAJ18	BS	XS	20.0	24.4	1.0	18.0	5.0	9.3	32.2
SMAJ18A	BT	XT	20.0	22.1	1.0	18.0	5.0	10.3	29.2
SMAJ20	BU	XU	22.2	27.1	1.0	20.0	5.0	8.4	35.8
SMAJ20A	BV	XV	22.2	24.5	1.0	20.0	5.0	9.3	32.4
SMAJ22	BW	XW	24.4	29.8	1.0	22.0	5.0	7.6	39.4
SMAJ22A	BX	XX	24.4	26.9	1.0	22.0	5.0	8.5	35.5
SMAJ24	BY	XY	26.7	32.6	1.0	24.0	5.0	7.0	43.0
SMAJ24A	BZ	XZ	26.7	29.5	1.0	24.0	5.0	7.7	38.9
SMAJ26	CD	YD	28.9	35.3	1.0	26.0	5.0	6.4	46.6
SMAJ26A	CE	YE	28.9	31.9	1.0	26.0	5.0	7.1	42.1
SMAJ28	CF	YF	31.1	38.0	1.0	28.0	5.0	6.0	50.0
SMAJ28A	CG	YG	31.1	34.4	1.0	28.0	5.0	6.6	45.4
SMAJ30	CH	YH	33.3	40.7	1.0	30.0	5.0	5.6	53.5
SMAJ30A	CK	YK	33.3	36.8	1.0	30.0	5.0	6.2	48.4
SMAJ33	CL	YL	36.7	44.9	1.0	33.0	5.0	5.1	59.0
SMAJ33A	CM	YM	36.7	40.6	1.0	33.0	5.0	5.6	53.3
SMAJ36	CN	YN	40.0	48.9	1.0	36.0	5.0	4.7	64.3
SMAJ36A	CP	YP	40.0	44.2	1.0	36.0	5.0	5.2	58.1
SMAJ40	CQ	YQ	44.4	54.3	1.0	40.0	5.0	4.2	71.4
SMAJ40A	CR	YR	44.4	49.1	1.0	40.0	5.0	4.7	64.5
SMAJ43	CS	YS	47.8	58.4	1.0	43.0	5.0	3.9	76.7
SMAJ43A	CT	YT	47.8	52.8	1.0	43.0	5.0	4.3	69.4
SMAJ45	CU	YU	50.0	61.1	1.0	45.0	5.0	80.3	3.7
SMAJ45A	CV	YV	50.0	55.3	1.0	45	5.0	72.7	4.1
SMAJ48	CW	YW	53.3	65.1	1.0	48	5.0	85.5	3.5
SMAJ48A	CX	YX	53.3	58.9	1.0	48	5.0	77.4	3.9
SMAJ51	CY	YY	56.7	69.3	1.0	51	5.0	91.1	3.3
SMAJ51A	CZ	YZ	56.7	62.7	1.0	51	5.0	82.4	3.6

ELECTRICAL CHARACTERISTICS (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device	Device Marking Code		Breakdown Voltage $V_{(BR)}$ (Volts) at I_T (NOTE 1)		Test Current I_T (mA)	Working Peak Reverse Voltage V_{WM} (Volts)	Maximum Reverse Leakage a V_{WM} (NOTE 3) I_D (µA)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} Vc (Volts)
	UNI	BI	Min.	Max.					
SMAJ54	RD	ZD	60.0	73.3	1.0	54	5.0	96.3	3.1
SMAJ54A	RE	ZE	60.0	66.3	1.0	54	5.0	87.1	3.4
SMAJ58	RF	ZF	64.4	78.7	1.0	58	5.0	103	2.9
SMAJ58A	RG	ZG	64.4	71.2	1.0	58	5.0	93.6	3.2
SMAJ60	RH	ZH	66.7	81.5	1.0	60	5.0	107	2.8
SMAJ60A	RK	ZK	66.7	73.7	1.0	60	5.0	96.8	3.1
SMAJ64	RL	ZL	71.1	86.4	1.0	64	5.0	114	2.6
SMAJ64A	RM	ZM	71.1	78.6	1.0	64	5.0	103	2.9
SMAJ70	RN	ZN	77.8	95.1	1.0	70	5.0	125	2.4
SMAJ70A	RP	ZP	77.8	86	1.0	70	5.0	113	2.7
SMAJ75	RQ	ZQ	83.3	102	1.0	75	5.0	134	2.2
SMAJ75A	RR	ZR	83.3	92.1	1.0	75	5.0	121	2.5
SMAJ78	RS	ZS	86.7	106	1.0	78	5.0	139	2.2
SMAJ78A	RT	ZT	86.7	95.8	1.0	78	5.0	126	2.4
SMAJ85	RU	ZU	94.4	115	1.0	85	5.0	151	2
SMAJ85A	RV	ZV	94.4	104	1.0	85	5.0	137	2.2
SMAJ90	RW	ZW	100	122	1.0	90	5.0	160	1.9
SMAJ90A	RX	ZX	100	111	1.0	90	5.0	146	2.1
SMAJ100	RY	ZY	111	136	1.0	100	5.0	179	1.7
SMAJ100A	RZ	ZZ	111	123	1.0	100	5.0	162	1.9
SMAJ110	SD	VD	122	149	1.0	110	5.0	196	1.5
SMAJ110A	SE	VE	122	135	1.0	110	5.0	177	1.7
SMAJ120	SF	VF	133	163	1.0	120	5.0	214	1.4
SMAJ120A	SG	VG	133	147	1.0	120	5.0	193	1.6
SMAJ130	SH	VH	144	176	1.0	130	5.0	231	1.3
SMAJ130A	SK	VK	144	159	1.0	130	5.0	209	1.4
SMAJ150	SL	VL	167	204	1.0	150	5.0	268	1.1
SMAJ150A	SM	VM	167	185	1.0	150	5.0	243	1.2
SMAJ160	SN	VN	178	218	1.0	160	5.0	287	1.0
SMAJ160A	SP	VP	178	197	1.0	160	5.0	259	1.2
SMAJ170	SQ	VQ	189	231	1	170	5.0	304	0.99
SMAJ170A	SR	VR	189	209	1.0	170	5.0	275	1.09

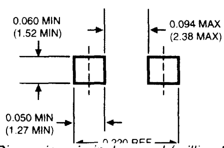
NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300µs square wave pulse or equivalent
(2) Surge current waveform per Fig. 3 and derate per Fig. 2
(3) For bi-directional types having V_{WM} of 10 Volts and less, the I_D limit is doubled
(4) For the bi-directional SMAJ5.0CA, the maximum $V_{(BR)}$ is 7.25V.
(5) All terms and symbols are consistent with ANSI/IEEE C62.35

APPLICATION NOTES

RECOMMENDED PAD LAYOUT

The pad dimensions should be 0.010" (2.5mm) longer than the contact size in the lead axis. This allows a solder fillet to form, see figure below. Contact factory for soldering methods.

MODIFIED J-BEND



Dimensions in inches and (millimeters)

This device is designed specifically for transient voltage suppression from threats generated by ESD for board level load switching components.

The wide leads assure a large surface contact for good heat dissipation, and a low resistance path for surge current flow to ground.

This series is designed to optimize board space and for use with surface mount technology automated assembly equipment.

They can be easily mounted on printed circuit boards and ceramic substrates to protect sensitive components from transient voltage damage.

FIG. 1 - PEAK PULSE POWER RATING CURVE

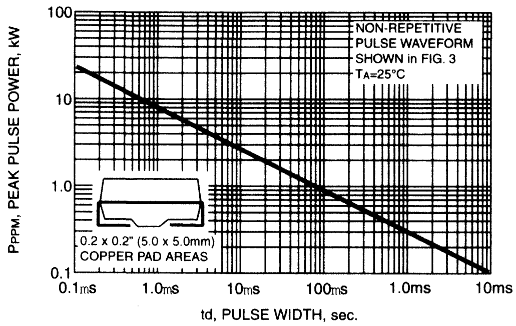


FIG. 2 - PULSE DERATING CURVE

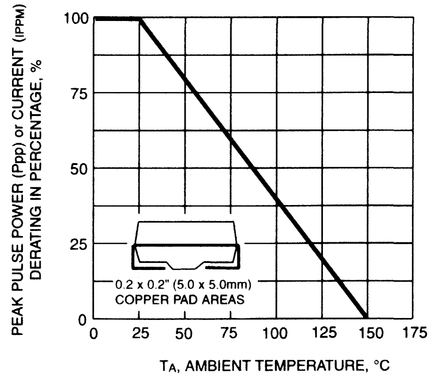


FIG. 3 - PULSE WAVEFORM

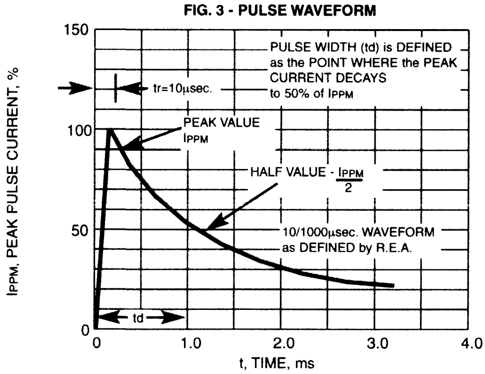
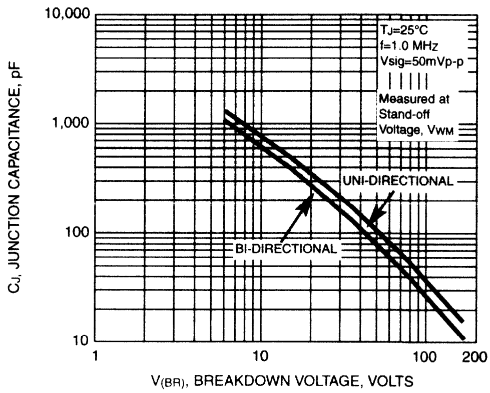


FIG. 4 - TYPICAL JUNCTION CAPACITANCE



TRANSZORB™ TVS

FIG. 5- Typical Response to 8KV Positive Going ESD Pulse Per IEC1000 - 4-2 (IEC801-2)

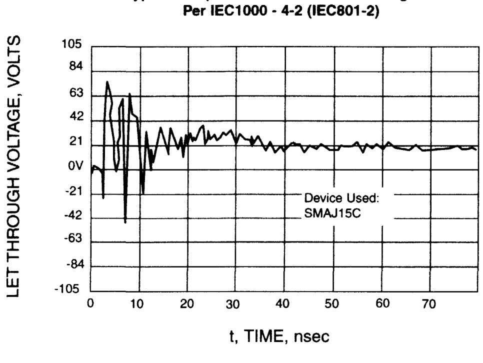
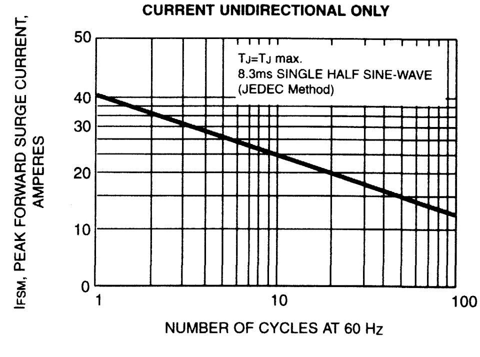


FIG. 6 - MAXIMUM NON-REPETITIVE FORWARD SURGE CURRENT UNIDIRECTIONAL ONLY



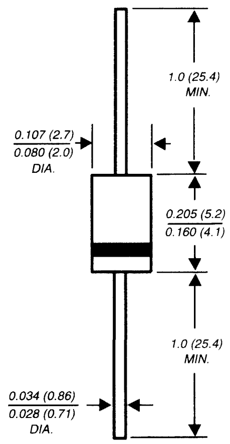
ADVANCED INFORMATION

P4KE530 AND P4KE550

TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Steady State Power** - 1 Watt* ***Reverse Voltage** - 530, 550 Volts*

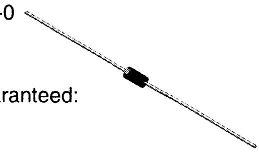
DO-204AL



Dimensions are in inches and (millimeters)

Available in uni-directional only

FEATURES



- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Protects TOPSwitch®
- ♦ Glass Passivated Junction
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals
- ♦ Exellent Clamping capability
- ♦ Available in unidirectional only

MECHANICAL DATA

Case: JEDEC DO-204AL molded plastic body over passivated junction
Terminals: Axial leads, solderable per MIL-STD-750, Method 2026
Polarity: The color band denotes the cathode, which is positive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.012 ounce, 0.3 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

		SYMBOLS	*P4KE530*	*P4KE550*	*UNITS*
Steady state power dissipation (NOTE 3)		$P_{M(AV)}$	1.0		Watts
Peak pulse power dissipation (NOTE 1,2, FIG.1)		P_{PPM}	Minimum 300		Watts
Minimum breakdown voltage at 100μA		$V_{(BR)}$	530	550	Volts
Maximum clamping voltage at 300mA, 10/1000 μs-waveform		V_C	660		Volts
Stand-off voltage		V_{WM}	477	495	Volts
Maximum DC reverse leakage current at V_{WM}		I_D	5.0		μA
Typical temperature coefficient of $V_{(BR)}$			650		mV°C
Typical capacitance (NOTE 4)	at 0V at 200V	C_J	75 45		pF
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 10/100μS
(3) Lead temperature at 75°C=T_L
(4) Measured at 1MHz

MAXIMUM RATINGS AND CHARACTERISTIC CURVES P4KE530 AND P4KE550

FIG. 1 - PEAK PULSE POWER RATING CURVE

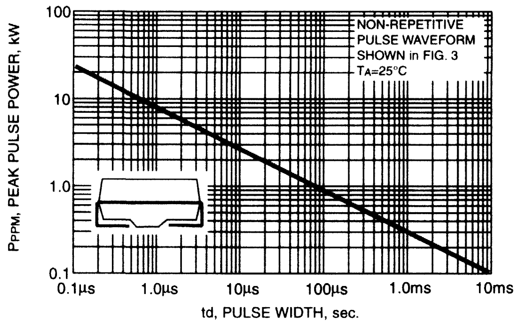


FIG. 2 - PULSE DERATING CURVE

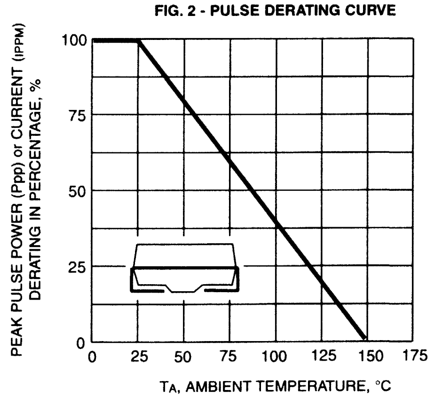
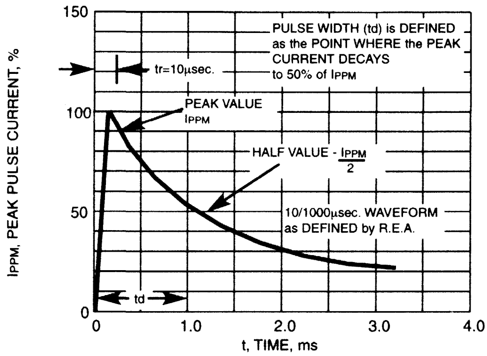


FIG. 3 - PULSE WAVEFORM



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 7V per 100mA 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 300mA. Contact supplier for different clamping voltage / current arrangements.
- Minimum breakdown voltage can be customized for other applications. Contact supplier.

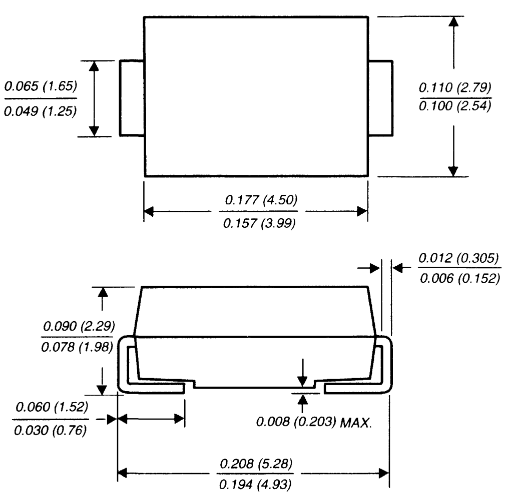
ADVANCED INFORMATION

SMAJ530 AND SMAJ550

SURFACE MOUNT TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Steady State Power** - 1 Watt* ***Reverse Voltage** - 530, 550 Volts*

DO-214AC



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Protects TOPSwitch®
- ♦ Glass Passivated Junction
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals
- ♦ Exellent Clamping capability
- ♦ Available in unidirectional only

MECHANICAL DATA

Case: JEDEC DO-214AC molded plastic body over passivated chip
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: The color band denotes the cathode, which is positive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.002 ounces, 0.064 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	SMAJ530	SMAJ550	UNITS
Device marking code		HD	SB	
Steady state power dissipation (NOTE 3)	$P_{M(AV)}$	1.0		Watts
Peak pulse power dissipation (NOTE 1,2,5, FIG.1)	P_{PPM}	Minimum 300		Watts
Minimum breakdown voltage at 100μA	$V_{(BR)}$	530	550	Volts
Maximum clamping voltage at 300mA, 10/1000 μs-waveform	V_C	660		Volts
Stand-off voltage	V_{WM}	477	495	Volts
Maximum DC reverse leakage current at V_{WM}	I_D	5.0		μA
Typical thermal resistance	$R_{\Theta JL}$	27		°C/W
Typical thermal resistance	$R_{\Theta JA}$	75		°C/W
Typical temperature coefficient of $V_{(BR)}$		650		mV°C
Typical capacitance (NOTE 4) at 0V at 200V	C_J	75 45		pF
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 5.0mm′ copper pads to each terminal
(3) Lead temperature at 75°C=T_L per Fig. 5
(4) Measured at 1MHz
(5) Peak pulse power waveform is 10/100μS

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GENERAL SEMICONDUCTOR®

MAXIMUM RATINGS AND CHARACTERISTIC CURVES SMAJ530 AND SMAJ550

FIG. 1 - PEAK PULSE POWER RATING CURVE

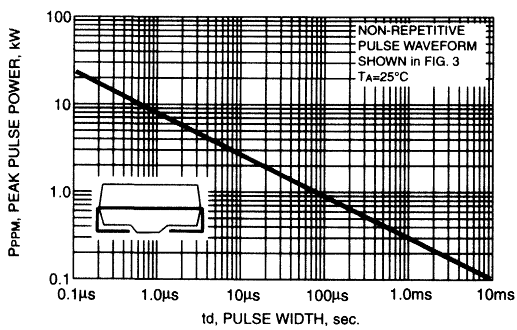


FIG. 2 - PULSE DERATING CURVE

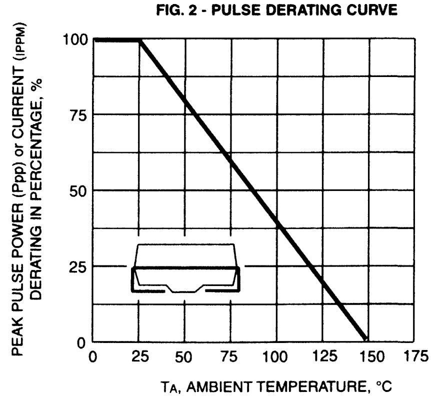
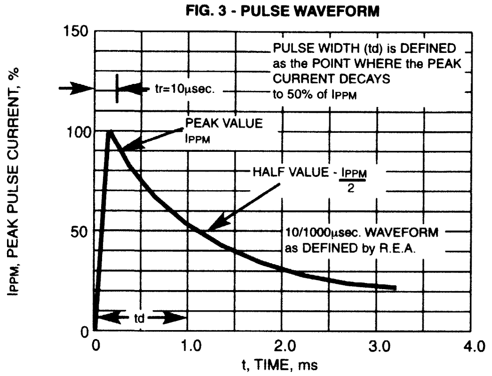


FIG. 3 - PULSE WAVEFORM



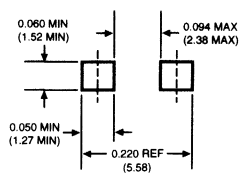
TransZorb™ TVS

APPLICATION NOTES

RECOMMENDED PAD LAYOUT

The pad dimensions should be 0.010" (2.5mm) longer than the contact size in the lead axis. This allows a solder fillet to form, see figure below. Contact factory for soldering methods.

MODIFIED J-BEND



Dimensions in inches and (millimeters)

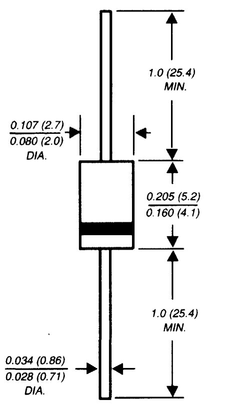
- Respect Thermal Resistance (PCB Layout) - as the temperature coefficient also contributes to the clamping voltage.
- Select minimum breakdown voltage, so you get acceptable power dissipation and PCB tie point temperature. Devices with higher breakdown voltage will have a shorter conduction time and will dissipate less power.
- Clamping voltage is influenced by internal resistance - design approximation is 7V per 100mA 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 300mA. Contact supplier for different clamping voltage / current arrangements.
- Minimum breakdown voltage can be customized for other applications. Contact supplier.

BZW04P-5V8 THRU BZW04-376

TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 5.8 to 376 Volts* ***Peak Pulse Power** - 400 Watts*

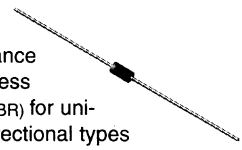
DO204AL



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated chip junction
- ♦ 400W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0 ps from 0 Volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional types
- ♦ Typical I_D less than 1μA above 10V rating
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: JEDEC DO-204AL molded plastic over passivated junction
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: For unidirectional types the color band denotes the cathode, which is postitive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.012 ounce, 0.3 gram

DEVICES FOR BIDIRECTIONAL APPLICATIONS

For bi-directional use add suffix Letter "B" (e.g. BZW04P-6V4B).
Electrical characteristics apply in both directions.

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 400	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths, 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	1.0	Watts
Peak forward surge current, 8.3ms single half Sine-wave superimposed on rated load (JEDEC Method) (NOTE 3) unidirectional only	I_{FSM}	40.0	Amps
Maximum instantaneous forward voltage at 25A (NOTE 4) uni-directional only	V_F	3.5/5.0	Volts
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) Mounted on copper pad area of 1.6 x 1.6" (40 x 40mm) per Fig. 5
(3) 8.3ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum
(4) V_F=3.5V max. for devices of $V_{(BR)} \leq 220V$ and V_F=5.0 Volt max. for devices of $V_{(BR)} > 220V$

1/20/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1)		Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (µA) (NOTE4)	Maximum Peak Pulse Current I_{PPM} (Amps) (NOTE 2)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / C)
	MIN	MAX						
BZW04P5V8	6.45	7.48	10.0	5.80	1000	38.0	10.5	0.057
BZW04-5V8	6.45	7.14	10.0	5.80	1000	38.0	10.5	0.057
BZW04P6V4	7.13	8.25	10.0	6.40	500	35.4	11.3	0.061
BZW04-6V4	7.13	7.88	10.0	6.40	500	35.4	11.3	0.061
BZW04P7V0	7.79	9.02	10.0	7.02	200	33.0	12.1	0.065
BZW04-7V0	7.79	8.61	10.0	7.02	200	33.0	12.1	0.065
BZW04P7V8	8.65	10.0	1.0	7.78	50.0	30.0	13.4	0.068
BZW04-7V8	8.65	9.55	1.0	7.78	50.0	30.0	13.4	0.073
BZW04P8V5	9.50	11.0	1.0	8.55	10.0	27.6	14.5	0.073
BZW04-8V5	9.50	10.5	1.0	8.55	10.0	27.6	14.5	0.075
BZW04P9V4	10.5	12.1	1.0	9.4	5.0	25.7	15.6	0.075
BZW04-9V4	10.5	11.6	1.0	9.4	5.0	25.7	15.6	0.075
BZW0P10	11.4	13.2	1.0	10.2	5.0	24.0	16.7	0.078
BZW04-10	11.4	12.6	1.0	10.2	5.0	24.0	16.7	0.078
BZW04P11	12.4	14.3	1.0	11.1	5.0	22.0	18.2	0.081
BZW04-11	12.4	13.7	1.0	11.1	5.0	22.0	18.2	0.081
BZW04P13	14.3	16.5	1.0	12.8	5.0	19.0	21.2	0.084
BZW04-13	14.3	15.8	1.0	12.8	5.0	19.0	21.2	0.084
BZW04P14	15.2	17.6	1.0	13.6	5.0	17.8	22.5	0.086
BZW04-14	15.2	16.8	1.0	13.6	5.0	17.8	22.5	0.086
BZW04P15	17.1	19.8	1.0	15.3	5.0	16.0	25.2	0.088
BZW04-15	17.1	18.9	1.0	15.3	5.0	16.0	25.2	0.088
BZW04P17	19.0	22.0	1.0	17.1	5.0	14.5	27.7	0.090
BZW04-17	19.0	21.0	1.0	17.1	5.0	14.5	27.7	0.090
BZW04P19	20.9	24.2	1.0	18.8	5.0	13.0	30.6	0.092
BZW04-19	20.9	23.1	1.0	18.8	5.0	13.0	30.6	0.092
BZW04P20	22.8	26.4	1.0	20.5	5.0	12.0	33.2	0.094
BZW04-20	22.8	25.2	1.0	20.5	5.0	12.0	33.2	0.094
BZW04P23	25.7	29.7	1.0	23.1	5.0	10.7	37.5	0.096
BZW04-23	25.7	28.4	1.0	23.1	5.0	10.7	37.5	0.096
BZW04P26	28.5	33.0	1.0	25.6	5.0	9.6	41.5	0.097
BZW04-26	28.5	31.5	1.0	25.6	5.0	9.6	41.5	0.097
BZW04P28	31.4	36.3	1.0	28.2	5.0	8.8	45.7	0.098
BZW04-28	31.4	34.7	1.0	28.2	5.0	8.8	45.7	0.098
BZW04P31	34.2	39.6	1.0	30.8	5.0	8.0	49.9	0.099
BZW04-31	34.2	37.8	1.0	30.8	5.0	8.0	49.9	0.099
BZW04P33	37.1	42.9	1.0	33.3	5.0	7.4	53.9	0.100
BZW04-33	37.1	41.0	1.0	33.3	5.0	7.4	53.9	0.100
BZW04P37	40.9	47.3	1.0	36.8	5.0	6.7	59.3	0.101
BZW04-37	40.9	45.2	1.0	36.8	5.0	6.7	59.3	0.101
BZW04P40	44.7	51.7	1.0	40.2	5.0	6.2	64.8	0.101
BZW04-40	44.7	49.4	1.0	40.2	5.0	6.2	64.8	0.101
BZW04P44	48.5	56.1	1.0	43.6	5.0	5.7	70.1	0.102
BZW04-44	48.5	53.6	1.0	43.6	5.0	5.7	70.1	0.102
BZW04P48	53.2	61.6	1.0	47.8	5.0	5.2	77.0	0.103
BZW04-48	53.2	58.8	1.0	47.8	5.0	5.2	77.0	0.103

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA) (NOTE4)	Maximum Peak Pulse Current I_{PPM} (Amps) (NOTE 2)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / C)
BZW04P53	58.9	68.2	1.0	53.0	5.0	4.7	85.0	0.104
BZW04-53	58.9	65.1	1.0	53.0	5.0	4.7	85.0	0.104
BZW04P58	64.6	74.8	1.0	58.1	5.0	4.3	92.0	0.104
BZW04-58	64.6	71.4	1.0	58.1	5.0	4.3	92.0	0.104
BZW04P64	71.3	82.5	1.0	64.1	5.0	3.9	103	0.105
BZW04-64	71.3	78.8	1.0	64.1	5.0	3.9	103	0.105
BZW04P70	77.9	90.2	1.0	70.1	5.0	3.5	113	0.105
BZW04-70	77.9	86.1	1.0	70.1	5.0	3.5	113	0.105
BZW04P78	86.5	100	1.0	78.0	5.0	3.2	125	0.105
BZW04-78	86.5	95.5	1.0	78.0	5.0	3.2	125	0.105
BZW04P85	95.0	110	1.0	85.5	5.0	2.9	137	0.106
BZW04-85	95.0	105	1.0	85.5	5.0	2.9	137	0.106
BZW04P94	105	121	1.0	94.0	5.0	2.6	152	0.107
BZW04-94	105	116	1.0	94.0	5.0	2.6	152	0.107
BZW04P102	114	132	1.0	102	5.0	2.4	165	0.107
BZW04-102	114	126	1.0	102	5.0	2.4	165	0.107
BZW04P110	124	143	1.0	111	5.0	2.2	179	0.107
BZW04-110	124	137	1.0	111	5.0	2.2	179	0.107
BZW04P128	143	165	1.0	128	5.0	2.0	207	0.108
BZW04-128	143	158	1.0	128	5.0	2.0	207	0.108
BZW04P136	152	176	1.0	136	5.0	1.8	219	0.108
BZW404-136	152	168	1.0	136	5.0	1.8	219	0.108
BZW04P145	161	187	1.0	145	5.0	1.7	234	0.108
BZW04-145	161	179	1.0	145	5.0	1.7	234	0.108
BZW04P154	171	198	1.0	154	5.0	1.6	246	0.108
BZW04-154	171	189	1.0	154	5.0	1.6	246	0.108
BZW04P171	190	220	1.0	171	5.0	1.5	274	0.108
BZW04-171	190	210	1.0	171	5.0	1.5	274	0.108
BZW04P188	209	242	1.0	188	5.0	1.4	301	0.108
BZW04-188	209	231	1.0	188	5.0	1.4	301	0.108
BZW04P213	237	275	1.0	213	5.0	1.5	344	0.110
BZW04-213	237	263	1.0	213	5.0	1.5	344	0.110
BZW04P239	266	308	1.0	239	5.0	1.5	384	0.110
BZW04-239	266	294	1.0	239	5.0	1.5	384	0.110
BZW04P256	285	330	1.0	256	5.0	1.2	414	0.110
BZW04-256	285	315	1.0	256	5.0	1.2	414	0.110
BZW04P273	304	352	1.0	273	5.0	1.2	438	0.110
BZW04-273	304	336	1.0	273	5.0	1.2	438	0.110
BZW04P299	332	385	1.0	299	5.0	0.90	482	0.110
BZW04-299	332	368	1.0	299	5.0	0.90	482	0.110
BZW04P342	380	440	1.0	342	5.0	0.90	548	0.110
BZW04-342	380	420	1.0	342	5.0	0.90	548	0.110
BZW04P376	418	484	1.0	376	5.0	0.80	603	0.110
BZW04-376	418	462	1.0	376	5.0	0.80	603	0.110

NOTES:

(1) $V_{(BR)}$ measured after I_T applied for 300μs 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
(4) For bi-directional devices with V_{WM} of 10 Volts and less, the I_D limit is doubled

FIG. 1 - PEAK PULSE POWER RATING CURVE

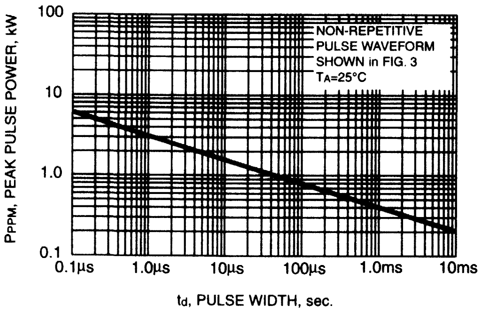


FIG. 2 - PULSE DERATING CURVE

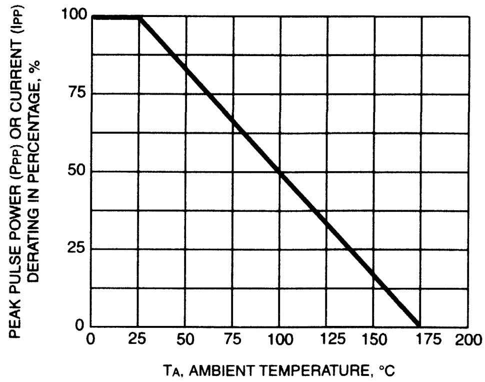


FIG. 3 - PULSE WAVEFORM

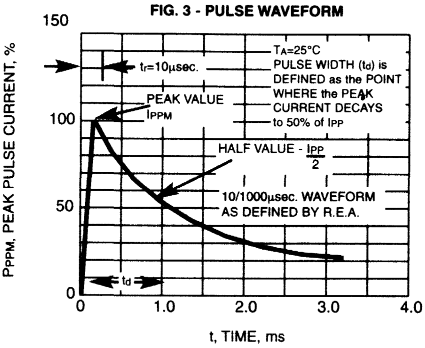


FIG. 4 - TYPICAL JUNCTION CAPACITANCE UNIDIRECTIONAL

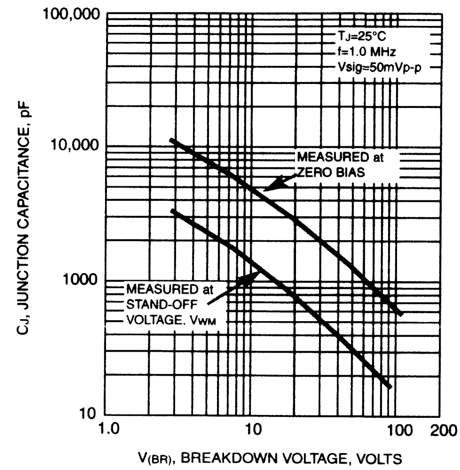


FIG. 5 - STEADY STATE POWER DERATING CURVE

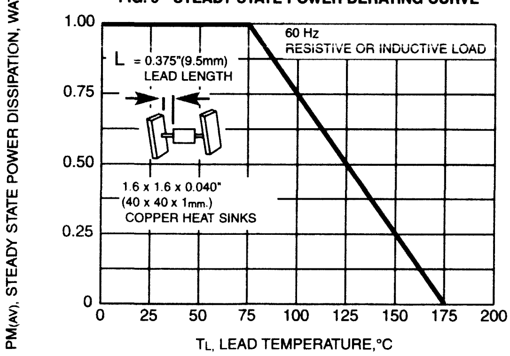


FIG. 6 - MAXIMUM NON-REPETITIVE FORWARD SURGE CURRENT UNIDIRECTIONAL

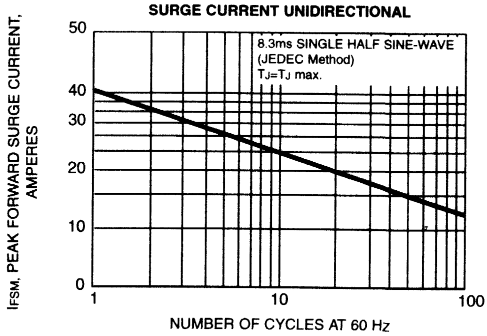
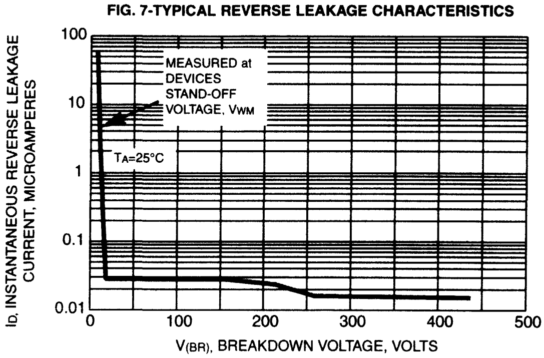


FIG. 7-TYPICAL REVERSE LEAKAGE CHARACTERISTICS



TRANSZORB™ TVS

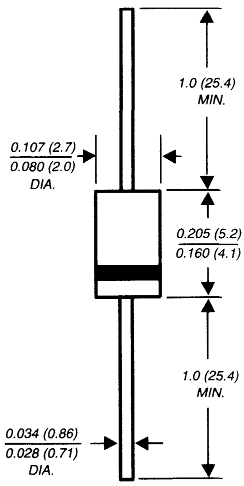
GENERAL SEMICONDUCTOR®

P4KE6.8 THRU P4KE440CA

TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 440 Volts* ***Peak Pulse Power** - 400 Watts*

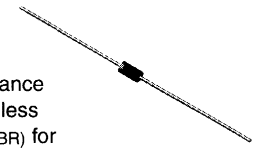
DO-204AL



Dimensions are in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ 400W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional types
- ♦ Devices with $V_{(BR)} \geq 10V$ I_D are typically I_D less than 1.0μA
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: JEDEC DO-204AL molded plastic body over passivated junction
Terminals: Axial leads, solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types the color band denotes the cathode, which is postitive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.012 ounce, 0.3 gram

DEVICES FOR BIDIRECTIONAL APPLICATIONS

For bi-directional use C or CA suffix for types P4KE7.5 thru types P4KE440 (e.g. P4KE7.5CA, P4KE440CA). Electrical characteristics apply in both directions.

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNITS*
Peak power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 400	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	1.0	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	40.0	Amps
Maximum instantaneous forward voltage at 25A for unidirectional only (NOTE 4)	V_F	3.5/5.0	Volts
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) Mounted on copper pad area of 1.6 x 1.6" (40 x 40mm) per Fig. 5
(3) Measured on 8.3ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum
(4) V_F=3.5 Volt max. for devices of $V_{(BR)} \leq 220V$, and V_F=5.0 Volt max. for devices of $V_{(BR)} > 220V$

1/20/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (NOTE3) (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
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	5.0	23.1	17.3	0.076
P4KE12A	11.4	12.6	1.0	10.2	5.0	24.0	16.7	0.078
P4KE13	11.7	14.3	1.0	10.5	5.0	21.1	19.0	0.081
P4KE13A	12.4	13.7	1.0	11.1	5.0	22.0	18.2	0.081
P4KE15	13.5	16.5	1.0	12.1	5.0	18.2	22.0	0.084
P4KE15A	14.3	15.8	1.0	12.8	5.0	18.9	21.2	0.084
P4KE16	14.4	17.6	1.0	12.9	5.0	17.0	23.5	0.086
P4KE16A	15.2	16.8	1.0	13.6	5.0	17.8	22.5	0.086
P4KE18	16.2	19.8	1.0	14.5	5.0	15.1	26.5	0.088
P4KE18A	17.1	18.9	1.0	15.3	5.0	15.9	25.2	0.088
P4KE20	18.0	22.0	1.0	16.2	5.0	13.7	29.1	0.090
P4KE20A	19.0	21.0	1.0	17.1	5.0	14.4	27.7	0.090
P4KE22	19.8	24.2	1.0	17.8	5.0	12.5	31.9	0.092
P4KE22A	20.9	23.1	1.0	18.8	5.0	13.1	30.6	0.092
P4KE24	21.6	26.4	1.0	19.4	5.0	11.5	34.7	0.094
P4KE24A	22.8	25.2	1.0	20.5	5.0	12.0	33.2	0.094
P4KE27	24.3	29.7	1.0	21.8	5.0	10.2	39.1	0.096
P4KE27A	25.7	28.4	1.0	23.1	5.0	10.7	37.5	0.096
P4KE30	27.0	33.0	1.0	24.3	5.0	9.2	43.5	0.097
P4KE30A	28.5	31.5	1.0	25.6	5.0	9.7	41.4	0.097
P4KE33	29.7	36.3	1.0	26.8	5.0	8.4	47.7	0.098
P4KE33A	31.4	34.7	1.0	28.2	5.0	8.8	45.7	0.098
P4KE36	32.4	39.6	1.0	29.1	5.0	7.7	52.0	0.099
P4KE36A	34.2	37.8	1.0	30.8	5.0	8.0	49.9	0.099
P4KE39	35.1	42.9	1.0	31.6	5.0	7.1	56.4	0.100
P4KE39A	37.1	41.0	1.0	33.3	5.0	7.4	53.9	0.100
P4KE43	38.7	47.3	1.0	34.8	5.0	6.5	61.9	0.101
P4KE43A	40.9	45.2	1.0	36.8	5.0	6.7	59.3	0.101
P4KE47	42.3	51.7	1.0	38.1	5.0	5.9	67.8	0.101
P4KE47A	44.7	49.4	1.0	40.2	5.0	6.2	64.8	0.101
P4KE51	45.9	56.1	1.0	41.3	5.0	5.4	73.5	0.102
P4KE51A	48.5	53.6	1.0	43.6	5.0	5.7	70.1	0.102
P4KE56	50.4	61.6	1.0	45.4	5.0	5.0	80.5	0.103
P4KE56A	53.2	58.8	1.0	47.8	5.0	5.2	77.0	0.103

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (NOTE3) (µA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
P4KE62	55.8	68.2	1.0	50.2	5.0	4.5	89.0	0.104
P4KE62A	58.9	65.1	1.0	53.0	5.0	4.7	85.0	0.104
P4KE68	61.2	74.8	1.0	55.1	5.0	4.1	98.0	0.104
P4KE68A	64.6	71.4	1.0	58.1	5.0	4.3	92.0	0.104
P4KE75	67.5	82.5	1.0	60.7	5.0	3.7	108	0.105
P4KE75A	71.3	78.8	1.0	64.1	5.0	3.9	103	0.105
P4KE82	73.8	90.2	1.0	66.4	5.0	3.4	118	0.105
P4KE82A	77.9	86.1	1.0	70.1	5.0	3.5	113	0.105
P4KE91	81.9	100	1.0	73.7	5.0	3.1	131	0.106
P4KE91A	86.5	95.5	1.0	77.8	5.0	3.2	125	0.106
P4KE100	90.0	110	1.0	81.0	5.0	2.8	144	0.106
P4KE100A	95.0	105	1.0	85.5	5.0	2.9	137	0.106
P4KE110	99.0	121	1.0	89.2	5.0	2.5	158	0.107
P4KE110A	105	116	1.0	94.0	5.0	2.6	152	0.107
P4KE120	108	132	1.0	97.2	5.0	2.3	173	0.107
P4KE120A	114	126	1.0	102	5.0	2.4	165	0.107
P4KE130	117	143	1.0	105	5.0	2.1	187	0.107
P4KE130A	124	137	1.0	111	5.0	2.2	179	0.107
P4KE150	135	165	1.0	121	5.0	1.9	215	0.108
P4KE150A	143	158	1.0	128	5.0	1.9	207	0.108
P4KE160	144	176	1.0	130	5.0	1.7	230	0.108
P4KE160A	152	168	1.0	136	5.0	1.8	219	0.108
P4KE170	153	187	1.0	138	5.0	1.6	244	0.108
P4KE170A	162	179	1.0	145	5.0	1.7	234	0.108
P4KE180	162	198	1.0	146	5.0	1.6	258	0.108
P4KE180A	171	189	1.0	154	5.0	1.6	246	0.108
P4KE200	180	220	1.0	162	5.0	1.4	287	0.108
P4KE200A	190	210	1.0	171	5.0	1.5	274	0.108
P4KE220	198	242	1.0	175	5.0	1.2	344	0.108
P4KE220A	209	231	1.0	185	5.0	1.2	328	0.108
P4KE250	225	275	1.0	202	5.0	1.1	360	0.110
P4KE250A	237	263	1.0	214	5.0	1.2	344	0.110
P4KE300	270	330	1.0	243	5.0	0.93	430	0.110
P4KE300A	285	315	1.0	256	5.0	1.0	414	0.110
P4KE350	315	385	1.0	284	5.0	0.79	504	0.110
P4KE350A	333	368	1.0	300	5.0	0.83	482	0.110
P4KE400	360	440	1.0	324	5.0	0.70	574	0.110
P4KE400A	380	420	1.0	342	5.0	0.73	548	0.110
P4KE440	396	484	1.0	356	5.0	0.63	631	0.110
P4KE440A	418	462	1.0	376	5.0	0.66	602	0.110

NOTES:

(1) $V_{(BR)}$ measured after I_T applied for 300µs, I_T=square wave pulse or equivalent
(2) Surge current waveform per Fig. 3 and derated per Fig. 2
(3) For bidirectional types having V_{WM} of 10 volts and less, the I_D limit is doubled
(4) All terms and symbols are consistent with ANSI/IEEE C62.35

FIG. 1 - PEAK PULSE POWER RATING CURVE

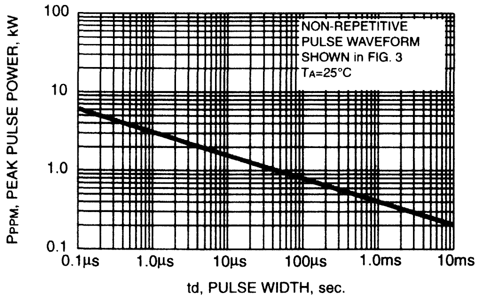


FIG. 2 - PULSE DERATING CURVE

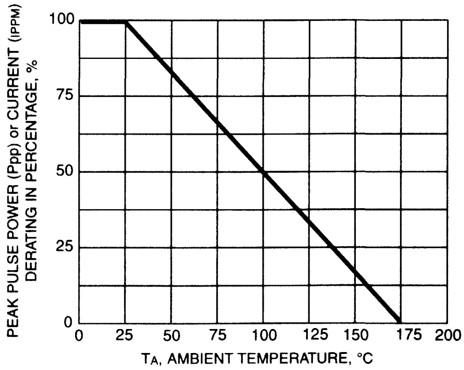


FIG. 3 - PULSE WAVEFORM

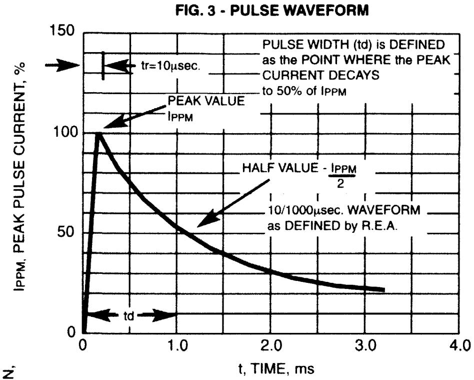


FIG. 4 - TYPICAL JUNCTION CAPACITANCE UNIDIRECTIONAL

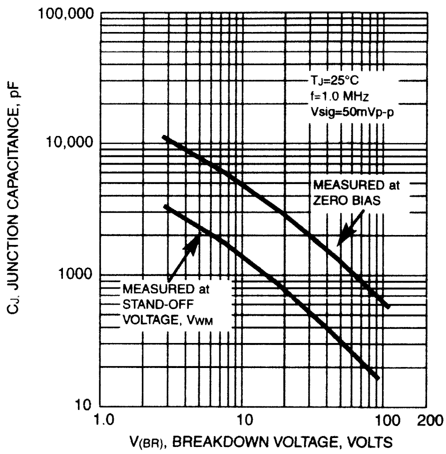


FIG. 5 - STEADY STATE POWER DERATING CURVE

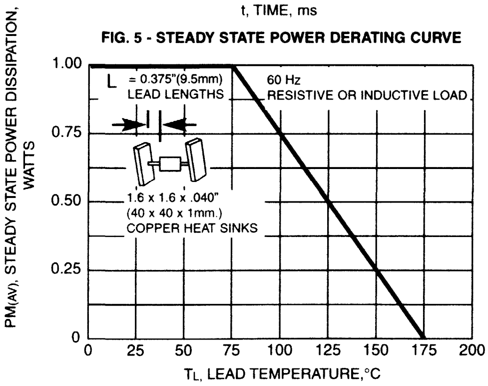


FIG. 6 - MAXIMUM NON-REPETITIVE FORWARD SURGE CURRENT UNIDIRECTIONAL ONLY

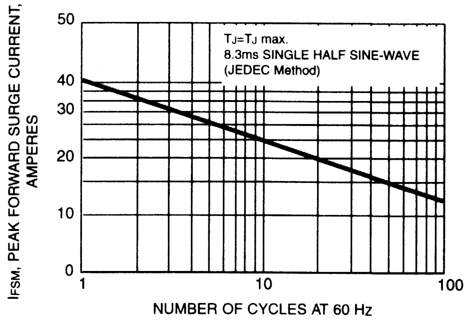
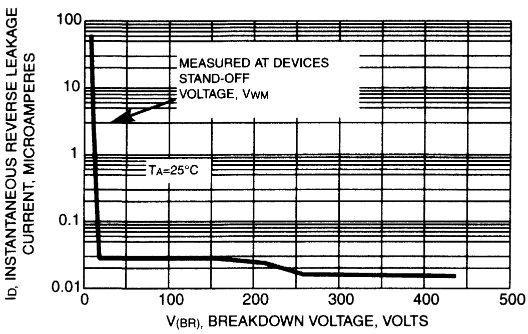


FIG. 7 - TYPICAL REVERSE LEAKAGE CHARACTERISTICS



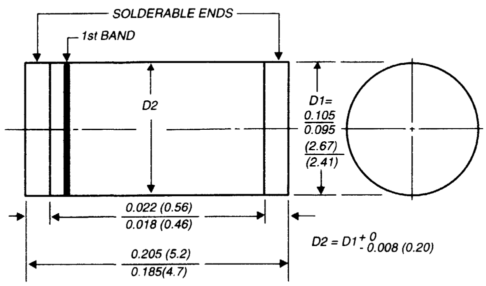
TRANSZORB™ TVS

TGL41-6.8 THRU TGL41-200A

SURFACE MOUNT TransZorb™ TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 200 Volts* ***Peak Pulse Power** - 400 Watts*

DO-213AB



1st band denotes type and positive end (cathode)

Dimensions in inches and (millimeters)

Available in uni-directional only

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ For surface mounted applications
- ♦ Glass passivated junction
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time typically less than 1.0ps from 0 Volts to $V_{(BR)}$
- ♦ 400W peak pulse capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ For devices with $V_{(BR)} \geq 10V$, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-213AB molded plastic body over passivated junction
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: Blue bands denotes the cathode which is positive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.116 gram, 0.0046 ounce

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

RATINGS	*SYMBOL*	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 400	Watts
Steady state power dissipation at T_L=75°C (NOTE 2)	$P_{M(AV)}$	1.0	Watt
Peak pulse current with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load for unidirectional only (JEDEC Method) (NOTE 3)	I_{FSM}	40.0	Amps
Maximum instantaneous forward voltage at 25A for unidirectional only	V_F	3.5	Volts
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 copper pads to each terminal of 0.31 in² (8.0 mm²) per Fig. 5
(3) Measured at 8.3ms single half sine-wave or equivalent square wave duty cycle=4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1)		Test Current at I_T (mA)	Stand-off Voltage V_{WM} (NOTE 4) (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA) (NOTE 4)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	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

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
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
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	100.0	1.0	73.7	5.0	3.1	131	0.109
TGL41-91A	86.5	95.50	1.0	77.8	5.0	3.2	125	0.109
TGL41-100	90.0	110.0	1.0	81.0	5.0	1.39	144	0.109
TGL41-100A	95.0	105.0	1.0	85.5	5.0	1.46	137	0.109
TGL41-110	99.0	121.0	1.0	89.2	5.0	1.27	158	0.110
TGL41-110A	105.0	116.0	1.0	94.0	5.0	1.32	152	0.110
TGL41-120	108.0	132.0	1.0	97.2	5.0	1.16	173	0.110
TGL41-120A	114.0	126.0	1.0	102.0	5.0	1.21	165	0.110
TGL41-130	117.0	143.0	1.0	105.0	5.0	1.07	187	0.110
TGL41-130A	124.0	137.0	1.0	111.0	5.0	1.12	179	0.110
TGL41-150	135.0	165.0	1.0	121.0	5.0	0.93	215	0.111
TGL41-150A	143.0	158.0	1.0	128.0	5.0	0.97	207	0.111
TGL41-160	144.0	176.0	1.0	130.0	5.0	0.87	230	0.111
TGL41-160A	152.0	168.0	1.0	136.0	5.0	0.91	219	0.111
TGL41-170	153.0	187.0	1.0	138.0	5.0	0.82	244	0.111
TGL41-170A	162.0	179.0	1.0	145.0	5.0	0.85	234	0.111
TGL41-180	162.0	198.0	1.0	146.0	5.0	0.78	258	0.111
TGL41-180A	171.0	189.0	1.0	154.0	5.0	0.81	246	0.111
TGL41-200	180.0	220.0	1.0	162.0	5.0	0.70	287	0.111
TGL41-200A	190.0	210.0	1.0	171.0	5.0	0.73	274	0.111

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300μs square wave pulse or equivalent
(2) Surge current waveform per Figure 3 and derate per Fig.2
(3) All terms and symbols are consistent with ANSI/IEEE C62.35

RATINGS AND CHARACTERISTIC CURVES TGL41-6.8A THRU TGL41-200A

FIG. 1 - PEAK PULSE POWER RATING CURVE

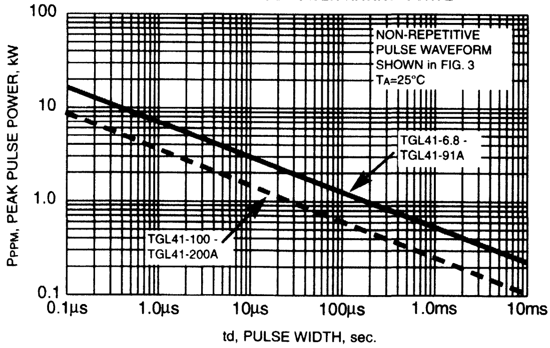


FIG. 2 - PULSE DERATING CURVE

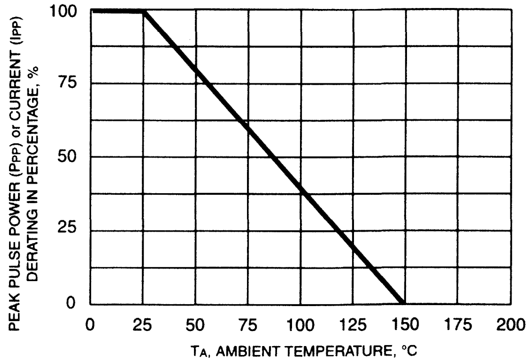


FIG. 3 - PULSE WAVEFORM

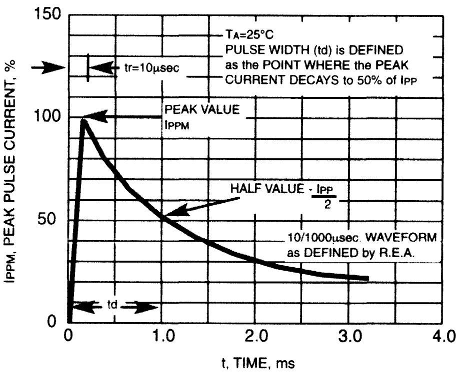


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

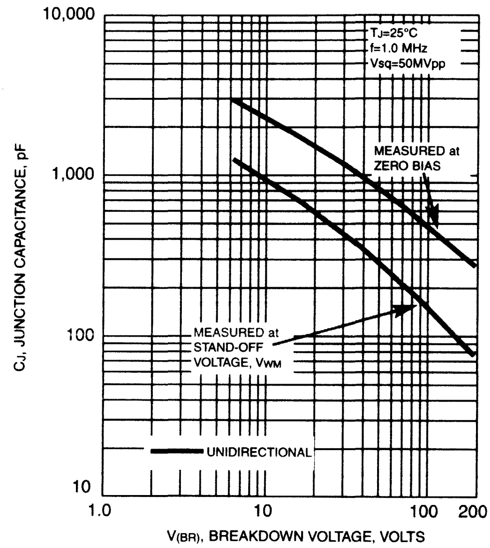


FIG. 5 - STEADY STATE POWER DERATING CURVE

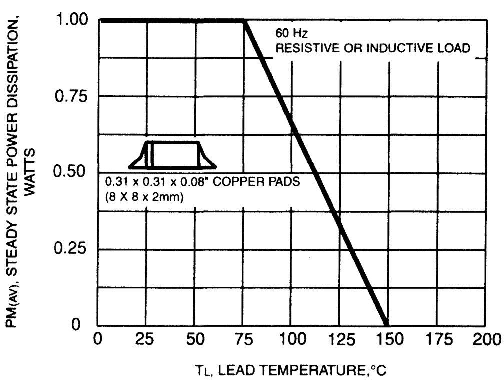
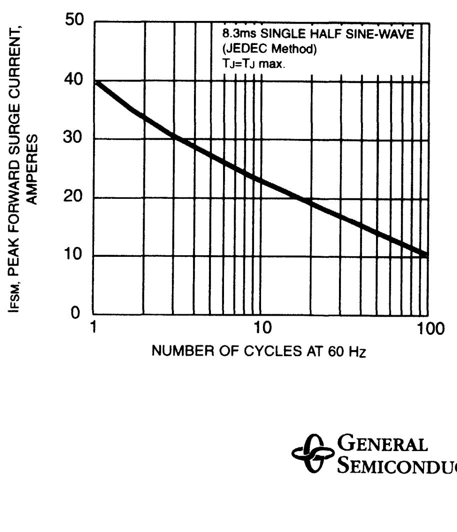


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT UNIDIRECTIONAL ONLY



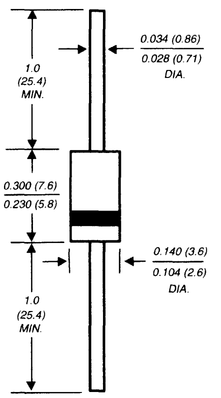
TRANSZORB™ TVS

SA5.0 THRU SA170CA

TransZorb™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 5.0 to 170 Volts*   ***Peak Pulse Power** - 500 Watts*

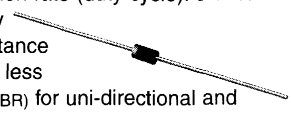
DO-204AC



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ 500W peak pulse power surge capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional types
- ♦ For devices with $V_{(BR)} \geq 10V$, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 265°C/10 seconds 0.375" (9.5mm) lead length, 5lbs (2.3 kg) tension



MECHANICAL DATA

Case: JEDEC DO-204AC molded plastic body over passivated junction
Terminals: Solder plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types the color band denotes the cathode, which is positive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.015 ounce, 0.4 gram

DEVICES FOR BIDIRECTIONAL APPLICATIONS

For bi-directional use C or CA Suffix. (e.g. SA5.0C, SA170CA).
Electrical characteristics apply in both directions.

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

	SYMBOL	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 500	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	3.0	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load, unidirectional only (JEDEC Method) (NOTE 3)	I_{FSM}	70	Amps
Maximum instantaneous forward voltage at 35A for unidirectional only	V_F	3.5	Volts
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) Mounted on copper pad area of 1.6 x 1.6" (40 x 40mm) per Fig. 5
(3) 8.3ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum

1/25/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1)		Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (NOTE3) (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	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	6.40	7.00	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	10.0	1.0	26.6	18.8	10.0
SA10A	11.1	12.3	1.0	10.0	1.0	29.4	17.0	10.0
SA11	12.2	14.9	1.0	11.0	1.0	24.9	20.1	11.0
SA11A	12.2	13.5	1.0	11.0	1.0	27.5	18.2	11.0
SA12	13.3	16.3	1.0	12.0	1.0	22.7	22.0	12.0
SA12A	13.3	14.7	1.0	12.0	1.0	25.1	19.9	12.0
SA13	14.4	17.6	1.0	13.0	1.0	21.0	23.8	13.0
SA13A	14.4	15.9	1.0	13.0	1.0	23.3	21.5	13.0
SA14	15.6	19.1	1.0	14.0	1.0	19.4	25.8	14.0
SA14A	15.6	17.2	1.0	14.0	1.0	21.6	23.2	14.0
SA15	16.7	20.4	1.0	15.0	1.0	18.6	26.9	16.0
SA15A	16.7	18.5	1.0	15.0	1.0	20.5	24.4	16.0
SA16	17.8	21.8	1.0	16.0	1.0	17.4	28.8	19.0
SA16A	17.8	19.7	1.0	16.0	1.0	19.2	26.0	17.0
SA17	18.9	23.1	1.0	17.0	1.0	16.4	30.5	20.0
SA17A	18.9	20.9	1.0	17.0	1.0	18.1	27.6	19.0
SA18	20.0	24.4	1.0	18.0	1.0	15.5	32.2	21.0
SA18A	20.0	22.1	1.0	18.0	1.0	17.1	29.2	20.0
SA20	22.2	27.1	1.0	20.0	1.0	14.0	35.8	25.0
SA20A	22.2	24.5	1.0	20.0	1.0	15.4	32.4	23.0
SA22	24.4	29.8	1.0	22.0	1.0	22.7	39.4	28.0
SA22A	24.4	26.9	1.0	22.0	1.0	14.1	35.5	25.0
SA24	26.7	32.6	1.0	24.0	1.0	11.6	43.0	31.0
SA24A	26.7	29.5	1.0	24.0	1.0	12.9	38.9	28.0
SA26	28.9	35.3	1.0	26.0	1.0	10.7	46.6	31.0
SA26A	28.9	31.9	1.0	26.0	1.0	11.9	42.1	30.0
SA28	31.1	38.0	1.0	28.0	1.0	10.0	50.1	35.0
SA28A	31.1	34.4	1.0	28.0	1.0	11.0	45.4	31.0
SA30	33.3	40.7	1.0	30.0	1.0	9.3	53.5	39.0
SA30A	33.3	36.8	1.0	30.0	1.0	10	48.4	36.0
SA33	36.7	44.9	1.0	33.0	1.0	8.5	59.0	42.0
SA33A	36.7	40.6	1.0	33.0	1.0	9.4	53.3	39.0
SA36	40.0	48.9	1.0	36.0	1.0	7.8	64.3	46.0
SA36A	40.0	44.2	1.0	36.0	1.0	8.6	58.1	41.0
SA40	44.4	54.3	1.0	40.0	1.0	7.0	71.4	51.0
SA40A	44.4	49.1	1.0	40.0	1.0	7.8	64.5	46.0

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (NOTE3) (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (mV / °C)
SA43	47.8	58.4	1.0	43.0	1.0	6.5	76.7	55.0
SA43A	47.8	52.8	1.0	43.0	1.0	7.2	69.4	50.0
SA45	50.0	61.1	1.0	45.0	1.0	6.2	80.3	58.0
SA45A	50.0	55.3	1.0	45.0	1.0	6.9	72.7	52.0
SA48	53.3	65.2	1.0	48.0	1.0	5.8	85.5	63.0
SA48A	53.3	58.9	1.0	48.0	1.0	6.5	77.4	56.0
SA51	56.7	69.3	1.0	51.0	1.0	5.5	91.1	66.0
SA51A	56.7	62.7	1.0	51.0	1.0	6.1	82.4	61.0
SA54	60.0	73.3	1.0	54.0	1.0	5.2	96.3	71.0
SA54A	60.0	66.3	1.0	54.0	1.0	5.7	87.1	65.0
SA58	64.4	78.7	1.0	58.0	1.0	4.9	103	78.0
SA58A	64.4	71.2	1.0	58.0	1.0	5.3	93.6	70.0
SA60	66.7	81.5	1.0	60.0	1.0	4.7	107	80.0
SA60A	66.7	73.7	1.0	60.0	1.0	5.2	96.8	71.0
SA64	71.1	86.9	1.0	64.0	1.0	4.4	114	86.0
SA64A	71.1	78.6	1.0	64.0	1.0	4.9	103	76.0
SA70	77.8	95.1	1.0	70.0	1.0	4.0	125	94.0
SA70A	77.8	86.0	1.0	70.0	1.0	4.4	113	85.0
SA75	83.3	102	1.0	75.0	1.0	3.7	134	101
SA75A	83.3	92.1	1.0	75.0	1.0	4.1	121	91.0
SA78	86.7	106	1.0	78.0	1.0	3.6	139	105
SA78A	86.7	95.8	1.0	78.0	1.0	4.0	126	95.0
SA85	94.4	115	1.0	85.0	1.0	3.3	151	114
SA85A	94.4	104	1.0	85.0	1.0	3.6	137	103
SA90	100	122	1.0	90.0	1.0	3.1	160	121
SA90A	100	111	1.0	90.0	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) $V_{(BR)}$ measured after I_T applied for 300μs. I_T=square wave pulse or equivalent
(2) Surge current waveform per Fig. 3 and derate per Fig. 2
(3) For bidirectional types with V_{WM} of 10 Volts and less, the I_D limit is doubled.
(4) All terms and symbols are consistent with ANSI/IEEE C62.35

FIG. 1 - PEAK PULSE POWER RATING CURVE

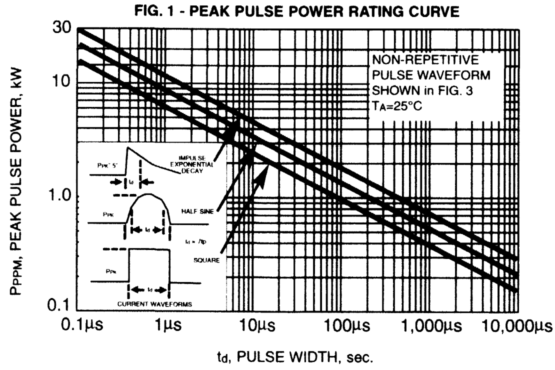


FIG. 2 - PULSE DERATING CURVE

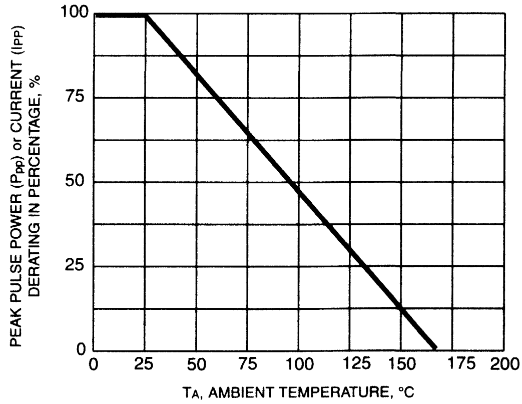


FIG. 3 - PULSE WAVEFORM

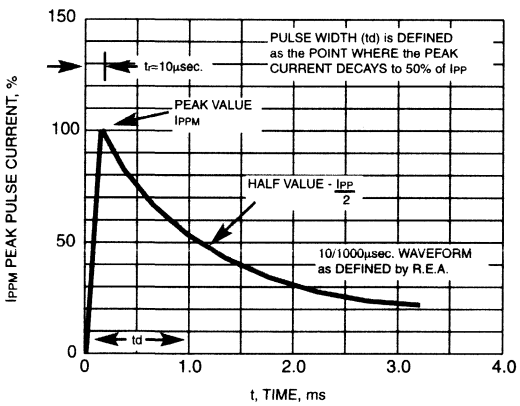


FIG. 4 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT UNIDIRECTIONAL ONLY

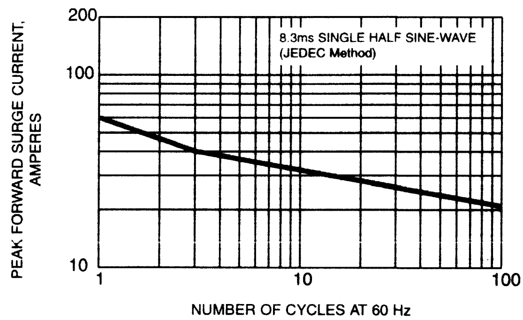


FIG. 5 - STEADY STATE POWER DERATING CURVE

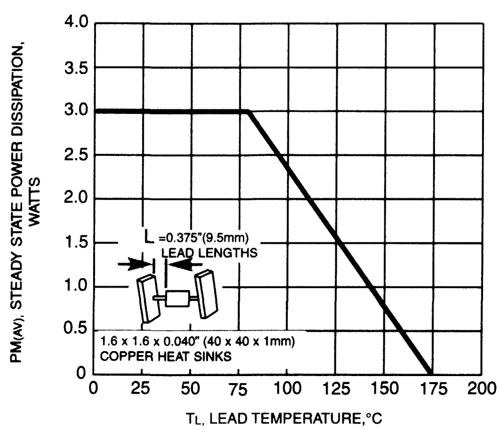
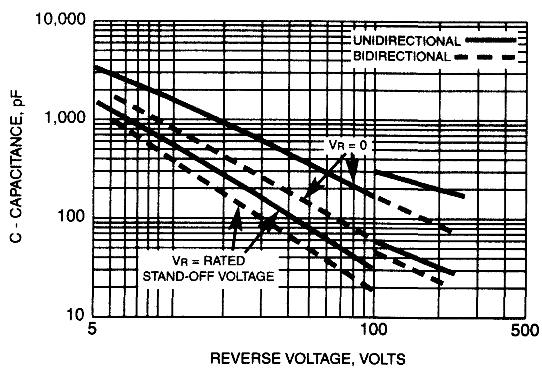


FIG. 6 - CAPACITANCE



TRANSZORB™ TVS

GENERAL SEMICONDUCTOR®

FIG. 7 - INCREMENTAL CLAMPING VOLTAGE CURVE UNIDIRECTIONAL

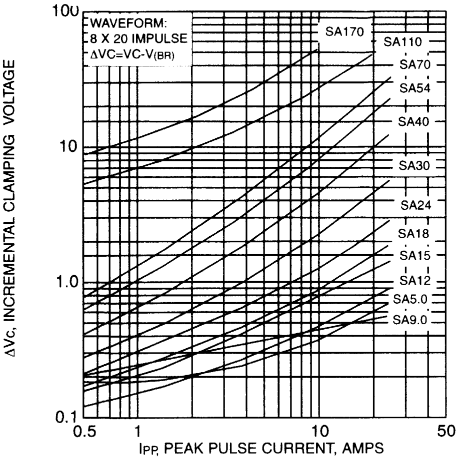


FIG. 8 - INCREMENTAL CLAMPING VOLTAGE CURVE UNIDIRECTIONAL

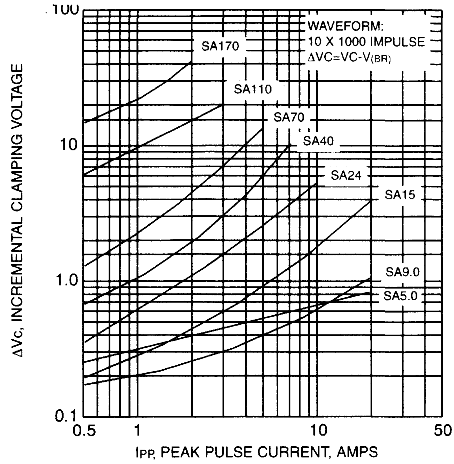


FIG. 9 - INCREMENTAL CLAMPING VOLTAGE CURVE BIDIRECTIONAL

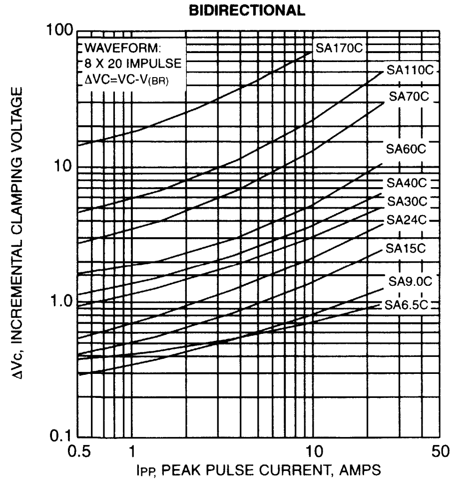
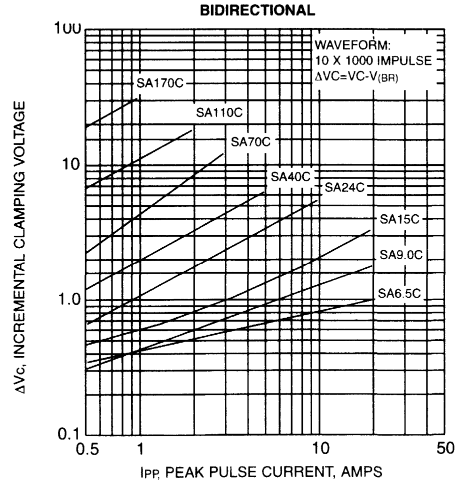


FIG. 10 - INCREMENTAL CLAMPING VOLTAGE CURVE BIDIRECTIONAL



RATINGS AND CHARACTERISTIC CURVES SA5.0 THRU SA170CA

FIG. 11 - TYPICAL INSTANTANEOUS FORWARD VOLTAGE CHARACTERISTICS CURVE

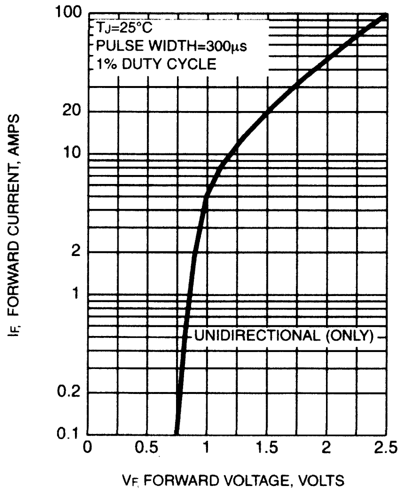
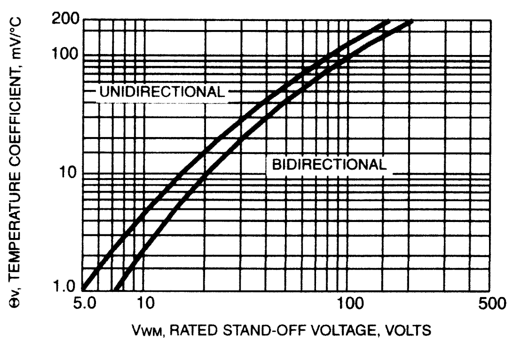


FIG. 12 - BREAKDOWN VOLTAGE TEMPERATURE COEFFICIENT CURVE



APPLICATIONS

This TVS series is a low cost, 500 watt commercial and industrial product for use in applications where space is a premium and where large voltage transients can permanently damage voltage-sensitive components.

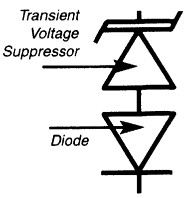
The response time of TVS clamping action is 1.0ns for uni-directional and 5.0ns for bi-directional; therefore, they can protect integrated circuits, MOS devices, hybrids, and other voltage-sensitive semiconductor components.

SAC5.0 THRU SAC50 SERIES

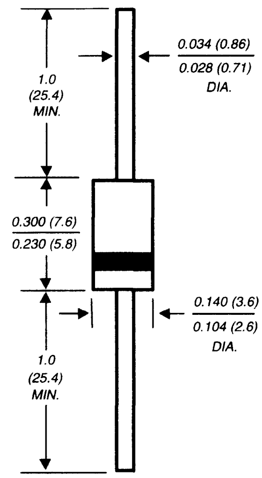
LOW CAPACITANCE TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 5.0 to 50 Volts* ***Peak Pulse Power** - 500 Watts*

Schematic



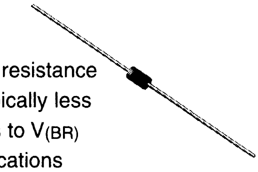
DO-204AC



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junctions
- ♦ 500W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ns from 0 Volts to $V_{(BR)}$
- ♦ Ideal for data line applications
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: JEDEC DO-204AC molded plastic over a passivated junction

Terminals: Solder plated axial leads, solderable per MIL-STD-750, Method 2026

Polarity: Color band denotes positive end (cathode)

Mounting Position: Any

Weight: 0.015 ounce, 0.4 gram

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1)	P_{PPM}	Minimum 500	Watts
Steady state power dissipation at T_L=75°C with lead lengths or 0.375" (9.5mm)	$P_{M(AV)}$	3.0	Watts
Peak pulse power surge current with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
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

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Part Number	Stand-off Voltage (NOTE 1) V_{WM} (VOLTS)	Minimum Breakdown Voltage at I_T = 1.0mA $V_{(BR)}$ (VOLTS)	Maximum Reverse Leakage at V_{WM} I_D (uA)	Maximum Clamping Voltage at I_{PP}=5.0A V_C (VOLTS)	Maximum Peak Pulse Current per FIG. 3 I_{PP} (AMPS)	Maximum Junction Capacitance at 0 VOLTS (pF)	Working Inverse Blocking Voltage V_{WIB} (VOLTS)	Inverse Blocking Leakage Current at V_{WIB} I_{IB} (mA)	Peak Inverse Blocking Voltage V_{PIB} (VOLTS)
SAC5.0	5.0	7.60	300	10.0	44	50	75	1.0	100
SAC6.0	6.0	7.90	300	11.2	41	50	75	1.0	100
SAC7.0	7.0	8.33	300	12.6	38	50	75	1.0	100
SAC8.0	8.0	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

RATINGS AND CHARACTERISTIC CURVES SAC5.0 THRU SAC50 SERIES

FIG. 1 - PEAK PULSE POWER RATING CURVE

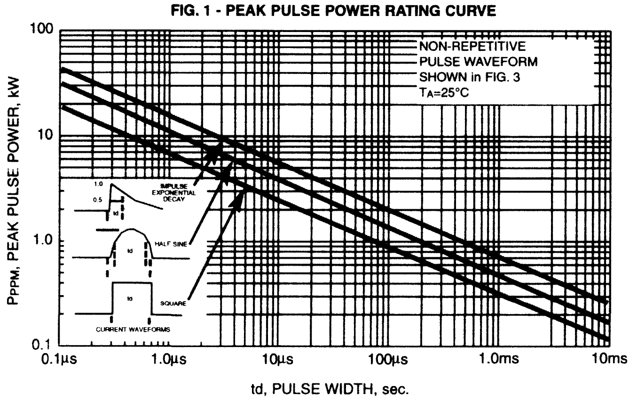


FIG. 2 - POWER DERATING CURVE

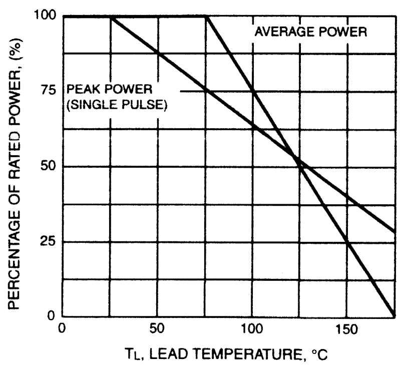


FIG. 3 - PULSE WAVEFORM

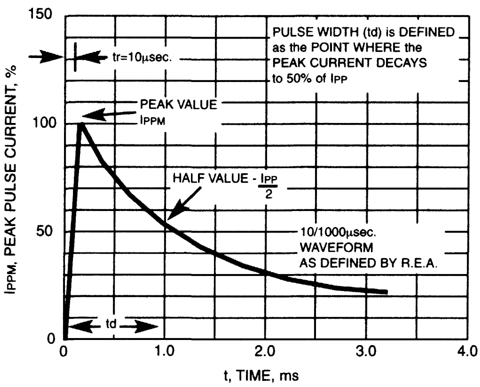
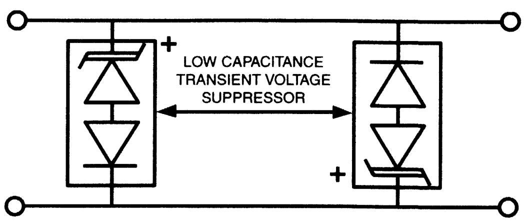


FIG. 4 - AC LINE PROTECTION APPLICATION



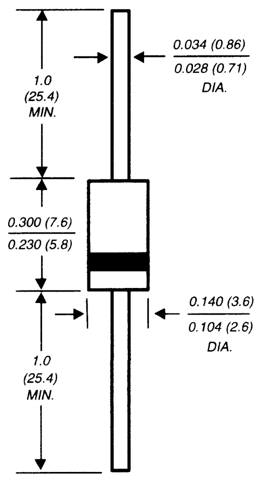
APPLICATION NOTE: Device must be used with two units in parallel, opposite in polarity as shown in circuit for AC signal line protection

P6KE6.8 THRU P6KE440CA

TransZorb™ TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 440 Volts* ***Peak Pulse Power-** 600 Watts*

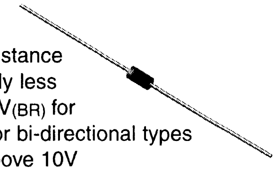
DO-204AC



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ 600W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional types
- ♦ Typical I_D less than 1μA above 10V
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: JEDEC DO-204AC molded plastic body over passivated junction
Terminals: Solder plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types the color band denotes the cathode, which is postitive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.015 ounce, 0.4 gram

DEVICES FOR BIDIRECTIONAL APPLICATIONS

For bi-directional use C or CA Suffix for types P6KE6.8 thru types P6KE440 (e.g. P6KE6.8C, P6KE440CA). Electrical characteristics apply in both directions.

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 600	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths, 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	5.0	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) unidirectional only (NOTE 3)	I_{FSM}	100.0	Amps
Maximum instantaneous forward voltage at 50.0A for unidirectional only (NOTE 4)	V_F	3.5/5.0	Volts
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) Mounted on copper pad area of 1.6 x 1.6" (40 x 40mm) per Fig. 5
(3) Measured on 8.3ms single half sine-wave or equivalent square wave duty cycle=4 pulses per minute maximum
(4) V_F=3.5 Volt max. for devices of $V_{(BR)}\leq$220V, and V_F=5.0V for devices of $V_{(BR)}$>220V

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1)		Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA) (NOTE3)	Maximum Peak Pulse Current I_{PPM} (Amps) (NOTE 2)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	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	5.0	27.3	22.0	0.084
+P6KE15A	14.3	15.8	1.0	12.8	5.0	28.3	21.2	0.084
+P6KE16	14.4	17.6	1.0	12.9	5.0	25.5	23.5	0.086
+P6KE16A	15.2	16.8	1.0	13.6	5.0	26.7	22.5	0.086
+P6KE18	16.2	19.8	1.0	14.5	5.0	22.6	26.5	0.088
+P6KE18A	17.1	18.9	1.0	15.3	5.0	23.8	25.2	0.088
+P6KE20	18.0	22.0	1.0	16.2	5.0	20.6	29.1	0.090
+P6KE20A	19.0	21.0	1.0	17.1	5.0	21.7	27.7	0.090
+P6KE22	19.8	24.2	1.0	17.8	5.0	18.8	31.9	0.092
+P6KE22A	20.9	23.1	1.0	18.8	5.0	19.6	30.6	0.092
+P6KE24	21.6	26.4	1.0	19.4	5.0	17.3	34.7	0.094
+P6KE24A	22.8	25.2	1.0	20.5	5.0	18.1	33.2	0.094
+P6KE27	24.3	29.7	1.0	21.8	5.0	15.3	39.1	0.096
+P6KE27A	25.7	28.4	1.0	23.1	5.0	16.0	37.5	0.096
+P6KE30	27.0	33.0	1.0	24.3	5.0	13.8	43.5	0.097
+P6KE30A	28.5	31.5	1.0	25.6	5.0	14.5	41.4	0.097
+P6KE33	29.7	36.3	1.0	26.8	5.0	12.6	47.7	0.098
+P6KE33A	31.4	34.7	1.0	28.2	5.0	13.1	45.7	0.098
+P6KE36	32.4	39.6	1.0	29.1	5.0	11.5	52.0	0.099
+P6KE36A	34.2	37.8	1.0	30.8	5.0	12.0	49.9	0.099
+P6KE39	35.1	42.9	1.0	31.6	5.0	10.6	56.4	0.100
+P6KE39A	37.1	41.0	1.0	33.3	5.0	11.1	53.9	0.100
+P6KE43	38.7	47.3	1.0	34.8	5.0	9.7	61.9	0.101
+P6KE43A	40.9	45.2	1.0	36.8	5.0	10.1	59.3	0.101
+P6KE47	42.3	51.7	1.0	38.1	5.0	8.8	67.8	0.101
+P6KE47A	44.7	49.4	1.0	40.2	5.0	9.3	64.8	0.101
P6KE51	45.9	56.1	1.0	41.3	5.0	8.2	73.5	0.102
P6KE51A	48.5	53.6	1.0	43.6	5.0	8.6	70.1	0.102
P6KE56	50.4	61.6	1.0	45.4	5.0	7.5	80.5	0.103
P6KE56A	53.2	58.8	1.0	47.8	5.0	7.8	77.0	0.103
P6KE62	55.8	68.2	1.0	50.2	5.0	6.7	89.0	0.104
P6KE62A	58.9	65.1	1.0	53.0	5.0	7.1	85.0	0.104
P6KE68	61.2	74.8	1.0	55.1	5.0	6.1	98.0	0.104
P6KE68A	64.6	71.4	1.0	58.1	5.0	6.5	92.0	0.104
P6KE75	67.5	82.5	1.0	60.7	5.0	5.6	108	0.105
P6KE75A	71.3	78.8	1.0	64.1	5.0	5.8	103	0.105
P6KE82	73.8	90.2	1.0	66.4	5.0	5.1	118	0.105
P6KE82A	77.9	86.1	1.0	70.1	5.0	5.3	113	0.105
P6KE91	81.9	100	1.0	73.7	5.0	4.6	131	0.106

+UL listed for Telecom application protection 497B, file number E136766 for both uni-directional and bi-directional devices

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA) (NOTE3)	Maximum Peak Pulse Current I_{PPM} (Amps) (NOTE 2)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / C)
P6KE91A	86.5	95.5	1.0	77.8	5.0	4.8	125	0.106
P6KE100	90.0	110	1.0	81.0	5.0	4.2	144	0.106
P6KE100A	95.0	105	1.0	85.5	5.0	4.4	137	0.106
P6KE110	99.0	121	1.0	89.2	5.0	3.8	158	0.107
P6KE110A	105	116	1.0	94.0	5.0	3.9	152	0.107
P6KE120	108	132	1.0	97.2	5.0	3.5	173	0.107
P6KE120A	114	126	1.0	102	5.0	3.6	165	0.107
P6KE130	117	143	1.0	105	5.0	3.2	187	0.107
P6KE130A	124	137	1.0	111	5.0	3.4	179	0.107
P6KE150	135	165	1.0	121	5.0	2.8	215	0.108
P6KE150A	143	158	1.0	128	5.0	2.9	207	0.108
P6KE160	144	176	1.0	130	5.0	2.6	230	0.108
P6KE160A	152	168	1.0	136	5.0	2.7	219	0.108
P6KE170	153	187	1.0	138	5.0	2.5	244	0.108
P6KE170A	162	179	1.0	145	5.0	2.6	234	0.108
P6KE180	162	198	1.0	146	5.0	2.3	258	0.108
P6KE180A	171	189	1.0	154	5.0	2.4	246	0.108
P6KE200	180	220	1.0	162	5.0	2.1	287	0.108
P6KE200A	190	210	1.0	171	5.0	2.2	274	0.108
P6KE220	198	242	1.0	175	5.0	1.7	344	0.108
P6KE220A	209	231	1.0	185	5.0	1.8	328	0.108
P6KE250	225	275	1.0	202	5.0	1.7	360	0.110
P6KE250A	237	263	1.0	214	5.0	1.7	344	0.110
P6KE300	270	330	1.0	243	5.0	1.4	430	0.110
P6KE300A	285	315	1.0	256	5.0	1.4	414	0.110
P6KE350	315	385	1.0	284	5.0	1.2	504	0.110
P6KE350A	333	368	1.0	300	5.0	1.2	482	0.110
P6KE400	360	440	1.0	324	5.0	1.0	574	0.110
P6KE400A	380	420	1.0	342	5.0	1.1	548	0.110
P6KE440	396	484	1.0	356	5.0	0.95	631	0.110
P6KE440A	418	462	1.0	376	5.0	1.0	602	0.110

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300μs, I_T=square wave pulse or equivalent
(2) Surge current waveform per Fig. 3 and derate per Fig. 2
(3) For bidirectional types with V_{WM} of 10 volts and less, the I_D limit is doubled
(4) All terms and symbols are consistent with ANSI/IEEE C62.35
+UL listed for Telecom application protection 497B, file number E136766 for both uni-directional and bi-directional devices

DESCRIPTION

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 (Vc) at a maximum peak pulse current is specified.

In some instances, the thermal effect (see Vc 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.

FIG. 1 - PEAK PULSE POWER RATING CURVE

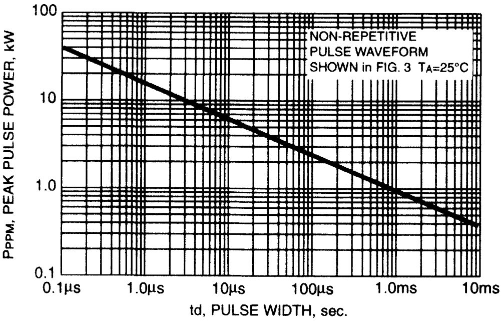


FIG. 2 - PULSE DERATING CURVE

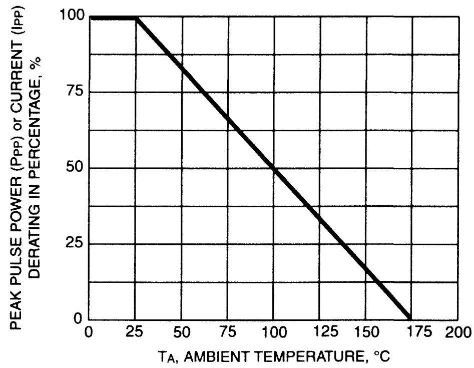


FIG. 3 - PULSE WAVEFORM

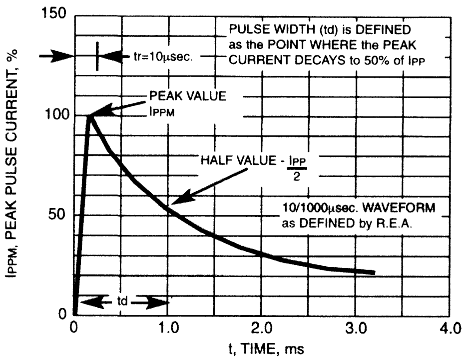


FIG. 4 - TYPICAL JUNCTION CAPACITANCE UNIDIRECTIONAL

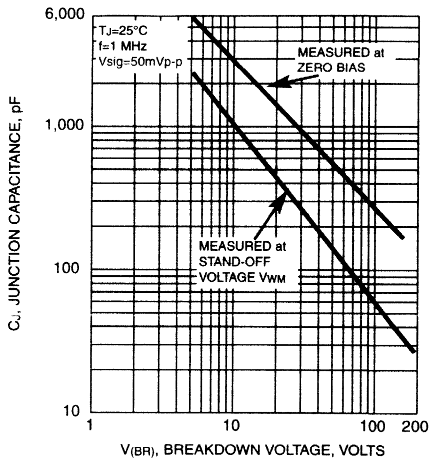


FIG. 5 - STEADY STATE POWER DERATING CURVE

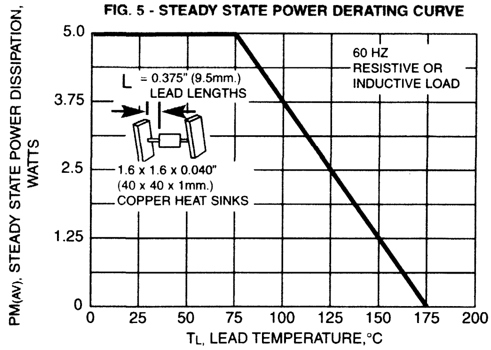


FIG. 6 - MAXIMUM NON-REPETITIVE FORWARD SURGE CURRENT UNI-DIRECTIONAL

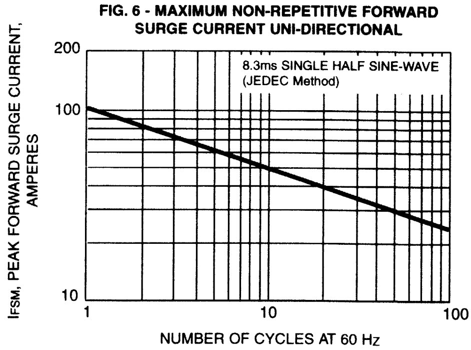
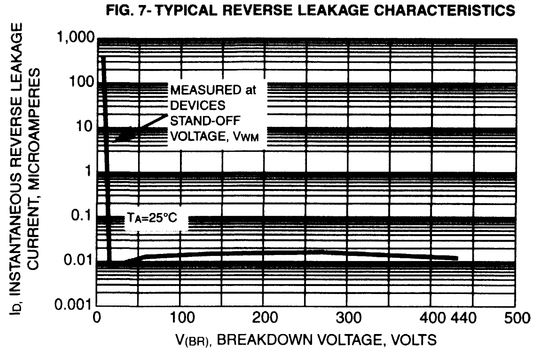


FIG. 7- TYPICAL REVERSE LEAKAGE CHARACTERISTICS



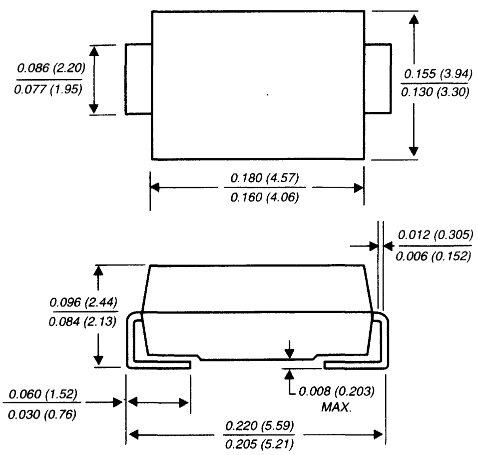
TRANSZORB™ TVS

SM6T SERIES

TRANSZORB™ SURFACE MOUNT TRANSIENT VOLTAGE SUPPRESSOR

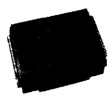
***Breakdown Voltage** - 6.8 to 220 Volts* ***Peak Pulse Power** - 600 Watts*

DO-214AA



Dimensions in inches and (millimeters)

FEATURES



- ♦ For surface mounted applications in order to optimize board space
- ♦ Low profile package
- ♦ Built-in strain relief
- ♦ Glass passivated junction
- ♦ Low inductance
- ♦ Excellent clamping capability
- ♦ Repetition Rate (duty cycle): 0.01%
- ♦ Fast reponse time: typically less than 1ps from 0 volts to V_{BR} min.
- ♦ Typical I_D less than 1μA above 10V
- ♦ High temperature soldering: 250°C/10 seconds at terminals
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-O

MECHANICAL DATA

Case: JEDEC DO-214AA (SMB) molded plastic over passivated junction
Terminals: Solder plated solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types: Color band denotes positive end (cathode)
Standard Packaging: 12mm tape (EIA STD RS-481)
Weight: 0.003 ounces, 0.093 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

	SYMBOLS	*VALUE*	*UNIT*
Peak Pulse Power Dissipation on 10/1000μs waveform (NOTES 1, 2, Fig. 1)	P_{PPM}	Minimum 600	Watts
Peak Pulse Current on 10/1000μs waveform (NOTE 1, Fig. 3)	I_{PPM}	See Table 1	Amps
Power Dissipation on Infinite Heatsink, T_A=50°C	$P_{M(AV)}$	5.0	Watts
Peak Forward Surge Current, 10ms Single Half Sine-wave, Undirectional Only	I_{FSM}	100	Amps
Max. Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{STG}	-65 to +175	°C
Thermal Resistance Junction to Ambient Air (NOTE 2)	$R_{\Theta JA}$	100	°C/W
Thermal Resistance Junction to Leads	$R_{\Theta JL}$	20	°C/W

NOTES
(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A=25°C per Fig. 2
(2) Mounted on 5.0mm² (.013mm thick) land areas.
(3) Measured on 8.3ms single half sine-wave or equivalent squarewave, duty cycle 4 pulses per minute maximum.

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

Type[1]	Device Marking Code		Standoff Voltage V_{RM}	Leakage Current[3] I_{RM} @ V_{RM}	Breakdown Voltage V_{BR} @ I_T[2] (Volts)		Test Current I_T	Clamping Voltage V_C @ I_{PP} 10/1000µs		Clamping Voltage V_C @ I_{PP} 8/20µs		α_T Max 10^{-4}/°C
	Uni	Bi	(Volts)	(µA)	Min	Max	(mA)	(Volts)	(Amps)	(Volts)	(Amps)	
SM6T6V8A	KE7	KE7	5.80	1000	6.45	7.14	10	10.5	57.0	13.4	298	5.7
SM6T7V5A	KK7	AK7	6.40	500	7.13	7.88	10	11.3	53.0	14.5	276	6.1
SM6T10A	KT7	AT7	8.55	10.0	9.50	10.5	1.0	14.5	41.0	18.6	215	7.3
SM6T12A	KX7	AX7	10.2	5.00	11.4	12.6	1.0	16.7	36.0	21.7	184	7.8
SM6T15A	LG7	LG7	12.8	1.00	14.3	15.8	1.0	21.2	28.0	27.2	147	8.4
SM6T18A	LM7	BM7	15.3	1.00	17.1	18.9	1.0	25.2	24	32.5	123	8.8
SM6T22A	LT7	BT7	18.8	1.00	20.9	23.1	1.0	30.6	20.0	39.3	102	9.2
SM6T24A	LV7	LV7	20.5	1.00	22.8	25.2	1.0	33.2	18.0	42.8	93	9.4
SM6T27A	LX7	BX7	23.1	1.00	25.7	28.4	1.0	37.5	16.0	48.3	83	9.6
SM6T30A	ME7	CE7	25.6	1.00	28.5	31.5	1.0	41.5	14.5	53.5	75	9.7
SM6T33A	MG7	MG7	28.2	1.00	31.4	34.7	1.0	45.7	13.1	59.0	68	9.8
SM6T36A	MK7	CK7	30.8	1.00	34.2	37.8	1.0	49.9	12.0	64.3	62	9.9
SM6T39A	MM7	CM7	33.3	1.00	37.1	41.0	1.0	53.9	11.1	69.7	57	10.0
SM6T68A	NG7	NG7	58.1	1.00	64.6	71.4	1.0	92.0	6.50	121	33	10.4
SM6T100A	NV7	NV7	85.5	1.00	95.0	105	1.0	137	4.40	178	22.5	10.6
SM6T150A	PK7	PK7	128	1.00	143	158	1.0	207	2.90	265	15	10.8
SM6T200A	PR7	PR7	171	1.00	190	210	1.0	274	2.20	353	11.3	10.8
SM6T220A	PR8	PR8	188	1.00	209	231	1.0	328	2.00	388	10.3	10.8

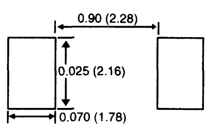
NOTES:
(1) For bi-directional devices add "C" for ±10% and "CA" for ±5% tolerance of V_{BR}
(2) V_{BR} measured after I_T applied for 300µs square wave pulse
(3) For bipolar devices with V_R=10 Volts or under, the I_T limit is doubled

APPLICATION NOTES

A 600W (SMB) 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.

RECOMMENDED PAD SIZES

The pad dimensions should be 0.010" (0.25mm) longer than the contact size, in the lead axis. This allows a solder fillet to form, see figure below. Contact factory for soldering methods.



GENERAL SEMICONDUCTOR®

FIG. 1 - PEAK PULSE POWER RATING CURVE

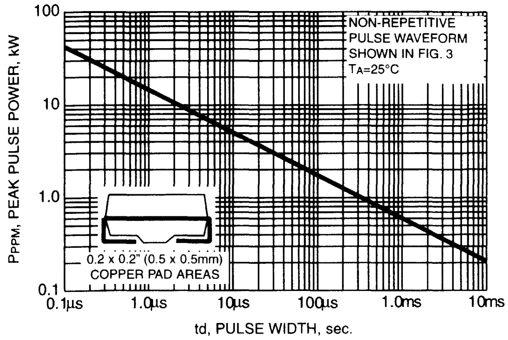


FIG. 2 - PULSE DERATING CURVE

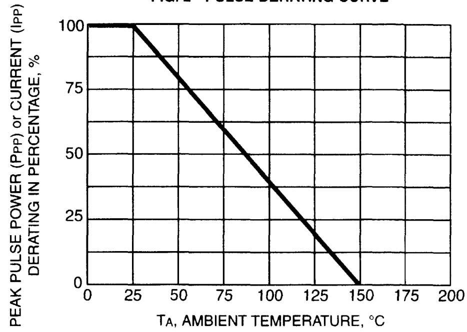


FIG. 3 - PULSE WAVEFORM

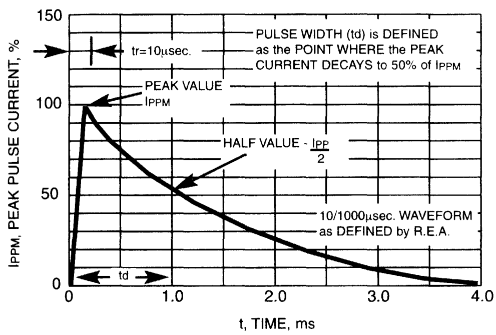


FIG. 4 - TYPICAL JUNCTION CAPACITANCE UNIDIRECTIONAL

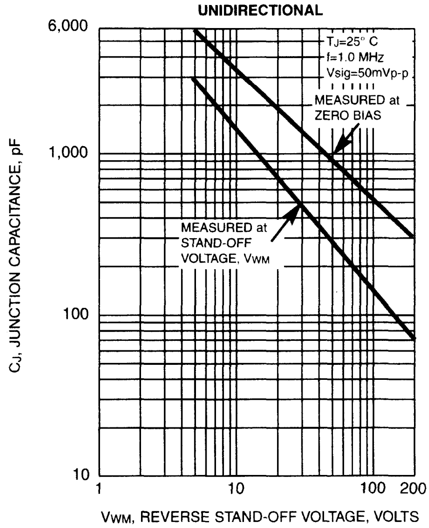


FIG. 5 - TYPICAL JUNCTION CAPACITANCE BIDIRECTIONAL

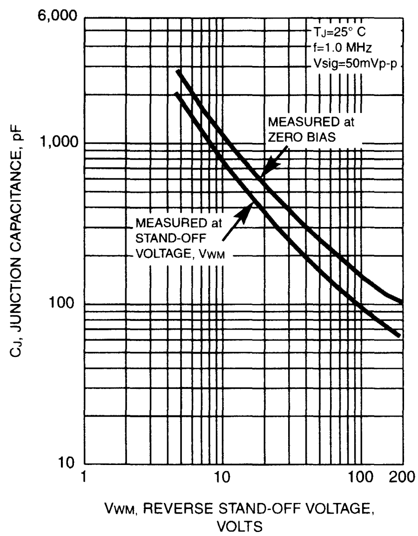
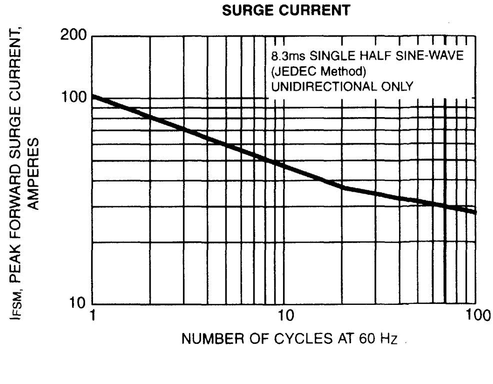


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT

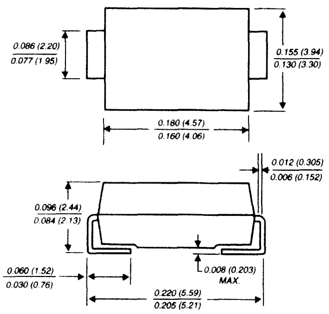


SMBG AND SMBJ5.0 THRU 170CA

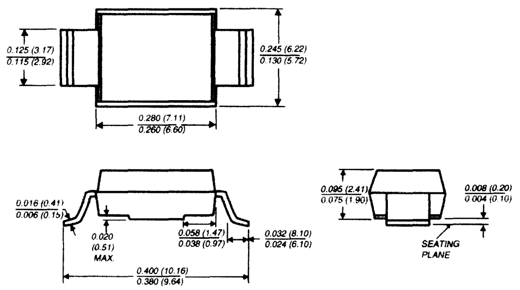
SURFACE MOUNT TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 5.0 to170 Volts*   ***Peak Pulse Power** - 600 Watts*

DO-214AA
MODIFIED J-BEND



DO-215AA
GULL WING



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ For surface mounted applications in order to optimize board space
- ♦ Low profile package
- ♦ Built-in strain relief
- ♦ Glass passivated junction
- ♦ Low incremental surge resistance
- ♦ 600W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Fast response time: typically less than 1.0ps from 0 volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional types
- ♦ For devices with $V_{(BR)} \geq 10V$, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

TRANSZORB™ TVS

MECHANICAL DATA

Case: JEDEC DO214AA / DO215AA molded plastic body over passivated junction
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types the color band denotes the cathode, which is postitive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.003 ounces, 0.093 gram

DEVICES FOR BI-DIRECTIONAL APPLICATIONS

For bi-directional use suffix C or CA for types SMB-5.0 thru SMB-170 (eg. SMBG5.0C, SMBJ170CA).
Electrical characteristics apply in both directions

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTES 1, 2, FIG. 1)	P_{PPM}	Minimum 600	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTES 2, 3) - uni-directional only	I_{FSM}	100.0	Amps
Maximum instantaneous forward voltage at 50A (NOTE 3) uni-directional only	V_F	3.5	Volts
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 5.0mm) copper pads to each terminal
(3) Measured on 8.3ms single half sine-wave. For uni-directional devices only.

1/25/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS (T_A=25°C unless otherwise noted) TABLE 1

Device Type Gull Wing Lead	Device Type Modified "J" Bend Lead	Device Marking Code UNI	BI	Breakdown Voltage $V_{(BR)}$(Volts) (NOTE 1) (MIN /MAX)	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage I_D at V_{WM} (μA) (NOTE 3)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)
SMBG5.0	SMBJ5.0	KD	KD	6.40 / 7.82	10	5.0	800	62.5	9.6
SMBG5.0A	SMBJ5.0A	KE	KE	6.40 / 7.07	10	5.0	800	65.2	9.2
SMBG6.0	SMBJ6.0	KF	KF	6.67 / 8.15	10	6.0	800	52.6	11.4
SMBG6.0A	SMBJ6.0A	KG	KG	6.67 / 7.37	10	6.0	800	58.3	10.3
SMBG6.5	SMBJ6.5	KH	AH	7.22 / 8.82	10	6.5	500	48.8	12.3
SMBG6.5A	SMBJ6.5A	KK	AK	7.22 / 7.98	10	6.5	500	53.6	11.2
SMBG7.0	SMBJ7.0	KL	KL	7.78 / 9.51	10	7.0	200	45.1	13.3
SMBG7.0A	SMBJ7.0A	KM	KM	7.78 / 8.60	10	7.0	200	50.0	12.0
SMBG7.5	SMBJ7.5	KN	AN	8.33 / 10.2	1.0	7.5	100	42.0	14.3
SMBG7.5A	SMBJ7.5A	KP	AP	8.33 / 9.21	1.0	7.5	100	46.5	12.9
SMBG8.0	SMBJ8.0	KQ	AQ	8.89 / 10.9	1.0	8.0	50	40.0	15.0
SMBG8.0A	SMBJ8.0A	KR	AR	8.89 / 9.83	1.0	8.0	50	44.1	13.6
SMBG8.5	SMBJ8.5	KS	AS	9.44 / 11.5	1.0	8.5	20	37.7	15.9
SMBG8.5A	SMBJ8.5A	KT	AT	9.44 / 10.4	1.0	8.5	20	41.7	14.4
SMBG9.0	SMBJ9.0	KU	AU	10.0 / 12.2	1.0	9.0	10	35.5	16.9
SMBG9.0A	SMBJ9.0A	KV	AV	10.0 / 11.1	1.0	9.0	10	39.0	15.4
SMBG10	SMBJ10	KW	AW	11.1 / 13.6	1.0	10	5.0	31.9	18.8
SMBG10A	SMBJ10A	KX	AX	11.1 / 12.3	1.0	10	5.0	35.3	17.0
SMBG11	SMBJ11	KY	KY	12.2 / 14.9	1.0	11	5.0	29.9	20.1
SMBG11A	SMBJ11A	KZ	KZ	12.2 / 13.5	1'0	11	5.0	33.0	18.2
SMBG12	SMBJ12	LD	BD	13.3 / 16.3	1.0	12	5.0	27.3	22.0
SMBG12A	SMBJ12A	LE	BE	13.3 / 14.7	1.0	12	5.0	30.2	19.9
SMBG13	SMBJ13	LF	LF	14.4 / 17,6	1.0	13	5.0	25.2	23.8
SMBG13A	SMBJ13A	LG	LG	14.4 / 15.9	1.0	13	5.0	27.9	21.5
SMBG14	SMBJ14	LH	BH	15,6 / 19.1	1.0	14	5.0	23.3	25.8
SMBG14A	SMBJ14A	LK	BK	15.6 / 17.2	1.0	14	5.0	25.9	23.2
SMBG15	SMBJ15	LL	BL	16.7 / 20.4	1.0	15	5.0	22.3	26.9
SMBG15A	SMBJ15A	LM	BM	16.7 / 18.5	1.0	15	5.0	24.6	24.4
SMBG16	SMBJ16	LN	LN	178 / 21.8	1.0	16	5.0	20.8	28.8
SMBG16A	SMBJ16A	LP	LM	178 / 19.7	1.0	16	5.0	23.1	26.0
SMBG17	SMBJ17	LQ	LQ	18.9 / 23.1	1.0	17	5.0	19.7	30.5
SMBG17A	SMBJ17A	LR	LR	18.9 / 20.9	1.0	17	5.0	21.7	27.6
SMBG18	SMBJ18	LS	BS	20.0 / 24.4	1.0	18	5.0	18.6	32.2
SMBG18A	SMBJ18A	LT	BT	20.0 / 22.1	1.0	18	5.0	20.5	29.2
SMBG20	SMBJ20	LU	LU	22.2 / 27.1	1.0	20	5.0	16.8	35.8
SMBG20A	SMBJ20A	LV	LV	22.2 / 24.5	1.0	20	5.0	18.5	32.4
SMBG22	SMBJ22	LW	BW	24.4 / 29.8	1.0	22	5.0	15.2	39.4
SMBG22A	SMBJ22A	LX	BX	24.4 / 26.9	1.0	22	5.0	16.9	35.5
SMBG24	SMBJ24	LY	BY	26.7 / 32.6	1.0	24	5.0	14.0	43.0
SMBG24A	SMBJ24A	LZ	BZ	26.7 / 29.5	1.0	24	5.0	15.4	38.9
SMBG26	SMBJ26	MD	CD	28.9 / 35.3	1.0	26	5.0	12.9	46.6
SMBG26A	SMBJ26A	ME	CE	28.9 / 31.9	1.0	26	5.0	14.3	42.1
SMBG28	SMBJ28	MF	MF	31.1 / 38.0	1.0	28	5.0	12.0	50.0
SMBG28A	SMBJ28A	MG	MG	31.1 / 34.4	1.0	28	5.0	13.2	45.4
SMBG30	SMBJ30	MH	CH	33.3 / 40.7	1.0	30	5.0	11.2	53.5
SMBG30A	SMBJ30A	MK	CK	33.3 / 36.8	1.0	30	5.0	12.4	48.4
SMBG33	SMBJ33	ML	CL	36.7 / 44.9	1.0	33	5.0	10.2	59.0
SMBG33A	SMBJ33A	MM	CM	36.7 / 40.6	1.0	33	5.0	11.3	53.3
SMBG36	SMBJ36	MN	CN	40.0 / 48.9	1.0	36	5.0	9.3	64.3
SMBG36A	SMBJ36A	MP	CP	40.0 / 44.2	1.0	36	5.0	10.3	58.1
SMBG40	SMBJ40	MQ	CQ	44.4 / 54.3	1.0	40	5.0	8.4	71.4
SMBG40A	SMBJ40A	MR	CR	44.4 / 49.1	1.0	40	5.0	9.3	64.5
SMBG43	SMBJ43	MS	CS	47.8 / 58.4	1.0	43	5.0	7.8	76.7
SMBG43A	SMBJ43A	MT	CT	47.8 / 52.8	1.0	43	5.0	8.6	69.4
SMBG45	SMBJ45	MU	MU	50.0 / 61.1	1.0	45	5.0	7.5	80.3
SMBG45A	SMBJ45A	MV	MV	50.0 / 55.3	1.0	45	5.0	8.3	72.7
SMBG48	SMBJ48	MW	MW	53.3 / 65.1	1.0	48	5.0	7.0	85.5
SMBG48A	SMBJ48A	MX	MX	53.3 / 58.9	1.0	48	5.0	7.8	77.4
SMBG51	SMBJ51	MY	MY	56.7 / 69-3	1.0	51	5.0	6.6	91.1
SMBG51A	SMBJ51A	MZ	MZ	56.7 / 62.7	1.0	51	5.0	7.3	82.4

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type Gull Wing Lead	Device Type Modified "J" Bend Lead	Device Marking Code UNI	Device Marking Code BI	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) (Min /Max)	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage I_D at V_{WM} (μA)(NOTE 3)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)
SMBG54	SMBJ54	ND	ND	60.0 / 73.3	1.0	54	5.0	6.2	96.3
SMBG54A	SMBJ54A	NE	NE	60.0 / 66.3	1.0	54	5.0	6.9	87.1
SMBG58	SMBJ58	NF	NF	64.4 / 78.7	1.0	58	5.0	5.8	103
SMBG58A	SMBJ58A	NG	NG	64.4 / 71.2	1.0	58	5.0	6.4	93.6
SMBG60	SMBJ60	NH	NH	66.7 / 81.5	1.0	60	5.0	5.6	107
SMBG60A	SMBJ60A	NK	NK	66.7 / 73.7	1.0	60	5.0	6.2	96.8
SMBG64	SMBJ64	NL	NL	71.1 / 86.9	1.0	64	5.0	5.3	114
SMBG64A	SMBJ64A	NM	NM	71.1 / 78.6	1.0	64	5.0	5.8	103
SMBG70	SMBJ70	NN	NN	77.8 / 95.1	1.0	70	5.0	4.8	125
SMBG70A	SMBJ70A	NP	NP	77.8 / 86.0	1.0	70	5.0	5.3	113
SMBG75	SMBJ75	NQ	NQ	83.3 / 102	1.0	75	5.0	4.5	134
SMBG75A	SMBJ75A	NR	NR	83.3 / 92.1	1.0	75	5.0	5.0	121
SMBG78	SMBJ78	NS	NS	86.7 / 106	1.0	78	5.0	4.3	139
SMBG78A	SMBJ78A	NT	NT	86.7 / 95.8	1.0	78	5.0	4.8	126
SMBG85	SMBJ85	NU	NU	94.4 / 115	1.0	85	5.0	4.0	151
SMBG85A	SMBJ85A	NV	NV	94.4 / 104	1.0	85	5.0	4.4	137
SMBG90	SMBJ90	NW	NW	100 / 122	1.0	90	5.0	3.8	160
SMBG90A	SMBJ90A	NX	NX	100 / 111	1.0	90	6.0	4.1	146
SMBG100	SMBJ100	NY	NY	111 / 136	1.0	100	5.0	3.4	179
SMBG100A	SMBJ100A	NZ	NZ	111 / 123	1.0	100	5.0	3.7	162
SMBG110	SMBJ110	PD	PD	122 / 149	1.0	110	5.0	3.1	196
SMBG110A	SMBJ110A	PE	PE	122 / 135	1.0	110	5.0	3.4	177
SMBG120	SMBJ120	PF	PF	133 / 163	1.0	120	5.0	2.8	214
SMBG120A	SMBJ120A	PG	PG	133 / 147	1.0	120	5.0	3.1	193
SMBG130	SMBJ130	PH	PH	144 / 176	1.0	130	5.0	2.6	231
SMBG130A	SMBJ130A	PK	PK	144 / 159	1.0	130	5.0	2.9	209
SMBG150	SMBJ150	PL	PL	167 / 204	1.0	150	5.0	2.2	268
SMBG150A	SMBJ150A	PM	PM	167 / 185	1.0	150	5.0	2.5	243
SMBG160	SMBJ160	PN	PN	178 / 218	1.0	160	5.0	2.1	287
SMBG160A	SMBJ160A	PP	PP	178 / 197	1.0	160	5.0	2.3	259
SMBG170	SMBJ170	PQ	PQ	189 / 231	1.0	170	5.0	2.0	304
SMBG170A	SMBJ170A	PR	PR	189 / 209	1.0	170	5.0	2.2	275

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300μs square wave pulse or equivalent
(2) Surge current waveform per Fig. 3 and derate per Fig. 2
(3) For bi-directional types having V_{WM} of 10 Volts and less, the I_D limit is doubled
(4) For the bi-directional SMBG/SMBJ5.0CA, the maximum $V_{(BR)}$ is 7.25 Volts
(5) All terms and symbols are consistent with ANSI/IEEE C62.35

APPLICATION NOTES

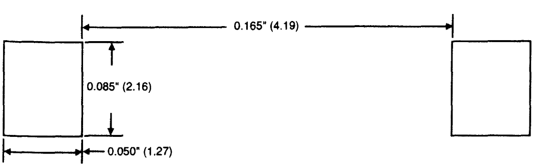
These surface mountable packages are designed specifically for transient voltage suppression. The wide leads assure a large surface contact for good heat dissipation, and a low resistance path for surge current flow to ground. These high speed transient voltage suppressors can be used to effectively protect sensitive components such as integrated circuits and MOS devices.

A 600W (SMB) device is normally selected when the threat of transients is from lightening-induced transients conducted via external leads or 1/0 lines. It is also used to protect against switching transients induced by large coils or industrial motors.
System impedance at component level in a system is usually high enough to limit the current to within the peak pulse current (I_{PP}) rating of this series.

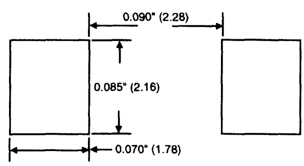
RECOMMENDED PAD SIZES

The pad dimensions should be 0.010" (0.25mm) longer than the contact size, in the lead axis.
This allows a solder fillet to form, see Fig. below. Contact factory for soldering methods.

GULL- WING



MODIFIED J-BEND



GENERAL SEMICONDUCTOR®

FIG. 1 - PEAK PULSE POWER RATING CURVE

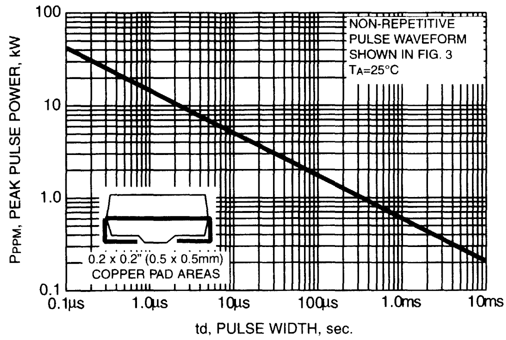


FIG. 2 - PULSE DERATING CURVE

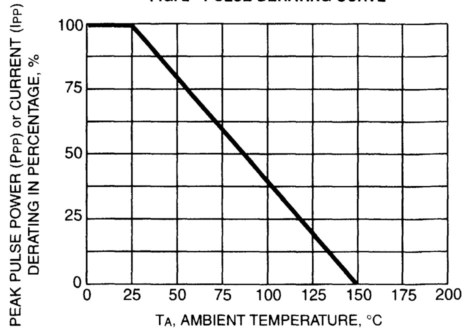


FIG. 3 - PULSE WAVEFORM

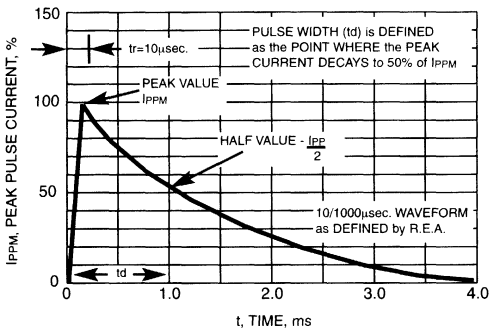


FIG. 4 - TYPICAL JUNCTION CAPACITANCE UNI-DIRECTIONAL

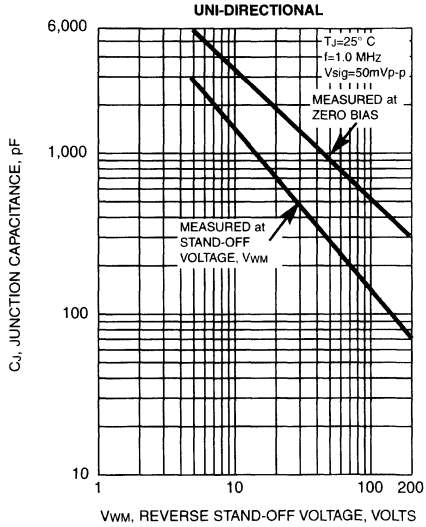


FIG. 5 - TYPICAL JUNCTION CAPACITANCE BI-DIRECTIONAL

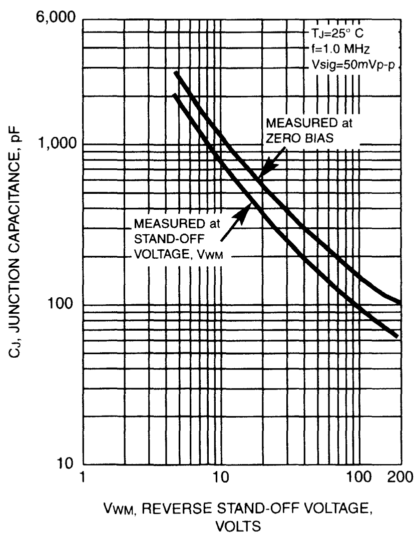
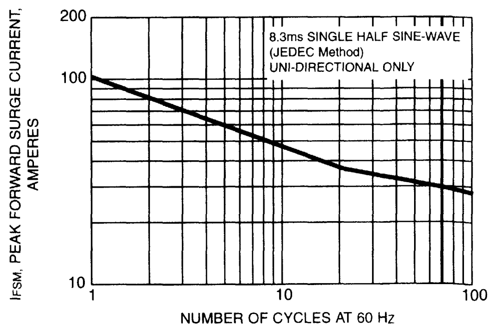


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT

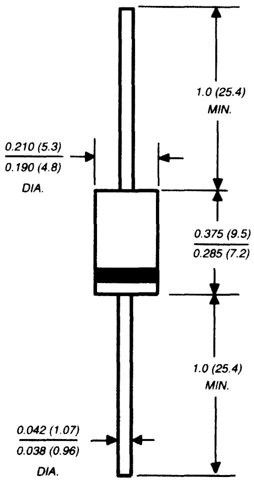


1.5KE6.8 THRU 1.5KE440CA

TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

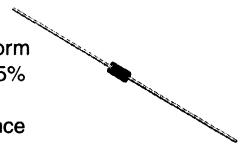
***Breakdown Voltage** - 6.8 to 440 Volts* ***Peak Pulse Power** - 1500 Watts*

Case Style 1.5KE



Dimensions in inches and (millimeters)

FEATURES



- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ 1500W peak pulse power capability on 10/1000μs waveform repetition rate (duty cycle): 0.05%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional types
- ♦ For devices with $V_{(BR)}$ >10V, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension
- ♦ Includes 1N6267 thru 1N6303

MECHANICAL DATA

Case: Molded plastic body over passivated junction
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode) except for bi-directional
Mounting Position: Any
Weight: 0.045 ounce, 1.2 grams

DEVICES FOR BI-DIRECTIONAL APPLICATIONS

For bi-directional use C or CA suffix for types 1.5KE6.8 thru types 1.5KE440A (e.g. 1.5KE6.8C, 1.5KE440CA). Electrical characteristics apply in both directions.

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, Fig. 1)	P_{PPM}	Minimum 1500	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths, 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	6.5	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) uni-directional only (NOTE 3)	I_{FSM}	200	Amps
Maximum instantaneous forward voltage at 100A for uni-directional only (NOTE 4)	V_F	3.5/5.0	Volts
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) Mounted on copper pad area of 1.6 x 1.6" (40 x 40mm) per Fig. 5
(3) Measured on 8.3ms single half sine-wave or equivalent square wave duty cycle=4 pulses per minute maximum
(4) V_F=3.5V for devices of $V_{(BR)}$≤220V and V_F=5.0 Volt max. for devices of $V_{(BR)}$>220V

1/21/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

JEDEC TYPE NUMBER	General Semiconductor PART NUMBER	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) Min	Max	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (NOTE 4) (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) Amps	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
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	5.0	68.2	22.0	0.084
1N6275A	+1.5KE15A	14.3	15.8	1.0	12.8	5.0	70.8	21.2	0.084
1N6276	+1.5KE16	14.4	17.6	1.0	12.9	5.0	63.8	23.5	0.086
1N6276A	+1.5KE16A	15.2	16.8	1.0	13.6	5.0	66.7	22.5	0.086
1N6277	+1.5KE18	16.2	19.8	1.0	14.5	5.0	56.6	26.5	0.088
1N6277A	+1.5KE18A	17.1	18.9	1.0	15.3	5.0	59.5	25.2	0.089
1N6278	+1.5KE20	18.0	22.0	1.0	16.2	5.0	51.5	29.1	0.090
1N6278A	+1.5KE20A	19.0	21.0	1.0	17.1	5.0	54.2	27.7	0.090
1N6279	+1.5KE22	19.8	24.2	1.0	17.8	5.0	47.0	31.9	0.092
1N6279A	+1.5KE22A	20.9	23.1	1.0	18.8	5.0	49.0	30.6	0.092
1N6280	+1.5KE24	21.6	26.4	1.0	19.4	5.0	43.2	34.7	0.094
1N6280A	+1.5KE24A	22.8	25.2	1.0	20.5	5.0	45.2	33.2	0.094
1N6281	+1.5KE27	24.3	29.7	1.0	21.8	5.0	38.4	39.1	0.096
1N6281A	+1.5KE27A	25.7	28.4	1.0	23.1	5.0	40.0	37.5	0.096
1N6282	+1.5KE30	27.0	33.0	1.0	24.3	5.0	34.5	43.5	0.097
1N6282A	+1.5KE30A	28.5	31.5	1.0	25.6	5.0	36.2	41.4	0.097
1N6283	+1.5KE33	29.7	36.3	1.0	26.8	5.0	31.4	47.7	0.098
1N6283A	+1.5KE33A	31.4	34.7	1.0	28.2	5.0	32.8	45.7	0.098
1N6284	+1.5KE36	32.4	39.6	1.0	29.1	5.0	28.8	52.0	0.099
1N6284A	+1.5KE36A	34.2	37.8	1.0	30.8	5.0	30.1	49.9	0.099
1N6285	+1.5KE39	35.1	42.9	1.0	31.6	5.0	26.6	56.4	0.100
1N6285A	+1.5KE39A	37.1	41.0	1.0	33.3	5.0	27.8	53.9	0.100
1N6286	+1.5KE43	38.7	47.3	1.0	34.8	5.0	24.2	61.9	0.101
1N6286A	+1.5KE43A	40.9	45.2	1.0	36.8	5.0	25.3	59.3	0.101
1N6287	+1.5KE47	42.3	51.7	1.0	38.1	5.0	22.1	67.8	0.101
1N6287A	+1.5KE47A	44.7	49.4	1.0	40.2	5.0	23.1	64.8	0.101
1N6288	1.5KE51	45.9	56.1	1.0	41.3	5.0	20.4	73.5	0.102
1N6288A	1.5KE51A	48.5	53.6	1.0	43.6	5.0	21.4	70.1	0.102
1N6289	1.5KE56	50.4	61.8	1.0	45.4	5.0	18.6	80.5	0.103
1N6289A	1.5KE56A	53.2	58.8	1.0	47.8	5.0	19.5	77.0	0.103
1N6290	1.5KE62	55.8	68.2	1.0	50.2	5.0	16.9	89.0	0.104
1N6290A	1.5KE62A	58.9	65.1	1.0	53.0	5.0	17.6	85.0	0.104
1N6291	1.5KE68	61.2	74.8	1.0	55.1	5.0	15.3	98.0	0.104

ELECTRICAL CHARACTERISTICS at (T_A=25□C unless otherwise noted) TABLE 1 (Cont'd)

JEDEC TYPE NUMBER	General Semiconductor PART NUMBER	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) Min	Max	Test Current at (mA) I_T	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (NOTE 4) (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) Amps	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
1N6291A	1.5KE68A	64.6	71.4	1.0	58.1	5.0	16.3	92.0	0.104
1N6292	1.5KE75	67.5	82.5	1.0	60.7	5.0	13.9	109	0.105
1N6292A	1.5KE75A	71.3	78.8	1.0	64.1	5.0	14.6	104	0.105
1N6293	1.5KE82	73.8	90.2	1.0	66.4	5.0	12.7	118	0.105
1N6293A	1.5KE82A	77.9	86.1	1.0	70.1	5.0	13.3	113	0.105
1N6294	1.5KE91	81.9	100.0	1.0	73.7	5.0	11.5	131	0.106
1N6294A	1.5KE91A	86.5	95.5	1.0	77.8	5.0	12.0	125	0.106
1N6295	1.5KE100	90.0	110	1.0	81.0	5.0	10.4	144	0.106
1N6295A	1.5KE100A	95.0	105	1.0	85.5	5.0	10.9	137	0.106
1N6296	1.5KE110	99.0	121	1.0	89.2	5.0	9.5	158	0.107
1N6296A	1.5KE 110A	105	116	1.0	94.0	5.0	9.9	152	0.107
1N6297	1.5KE120	108	132	1.0	97.2	5.0	8.7	173	0.107
1N6297A	1.5KE120A	114	126	1.0	102	5.0	9.1	165	0.107
1N6298	1.5KE130	117	143	1.0	105	5.0	8.0	187	0.107
1N6298A	1.5KE130A	124	137	1.0	111	5.0	8.4	179	0.107
1N6299	1.5KE150	136	165	1.0	121	5.0	7.0	215	0.108
1N6299A	1.5KE150A	143	158	1.0	128	5.0	7.2	207	0.106
1N6300	1.5KE160	144	176	1.0	130	5.0	6.5	230	0.106
1N6300A	1.5KE160A	152	168	1.0	136	5.0	6.8	219	0.108
1N6301	1.5KE170	153	187	1.0	138	5.0	6.1	244	0.108
1N6301A	1.5KE170A	162	179	1.0	145	5.0	6.4	234	0.108
1N6302	1.5KE180	162	198	1.0	146	5.0	5.8	258	0.108
1N6302A	1.5KE180A	171	189	1.0	154	5.0	6.1	246	0.108
1N6303	1.5KE200	180	220	1.0	162	5.0	5.2	287	0.108
1N6303A	1.5KE200A*	190	210	1.0	171	5.0	5.5	274	0.108
	1.5KE220	198	242	1.0	175	5.0	4.4	344	0.108
	1.5KE220A*	209	231	1.0	185	5.0	4.6	328	0.108
	1.5KE250	225	275	1.0	202	5.0	4.2	360	0.110
	1.5KE250A	237	263	1.0	214	5.0	4.4	344	0.110
	1.5KE300	270	330	1.0	243	5.0	3.5	430	0.110
	1.5KE300A	285	315	1.0	256	5.0	3.6	414	0.110
	1.5KE350	315	385	1.0	284	5.0	3.0	504	0.110
	1.5KE350A	333	368	1.0	300	5.0	3.1	482	0.110
	1.5KE400	360	440	1.0	324	5.0	2.6	574	0.110
	1.5KE400A	380	420	1.0	342	5.0	2.7	548	0.110
	1.5KE440	396	484	1.0	356	5.0	2.4	631	0.110
	1.5KE440A	418	462	1.0	376	5.0	2.5	602	0.110

NOTES:

(1) $V_{(BR)}$ measured after I_T applied for 300μs, 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 CA62.35
(4) For bi-directional types with V_R 10 volts 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)
+ UL listed for Telecom applications protection, 497B, file number E136766 for both uni-directional and bi-directional devices

APPLICATION

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 watts for one millisecond. The response time of TVS diode clamping action is effectively instantaneous (1 x 10^{-9} seconds 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.

FIG. 1 - PEAK PULSE POWER RATING CURVE

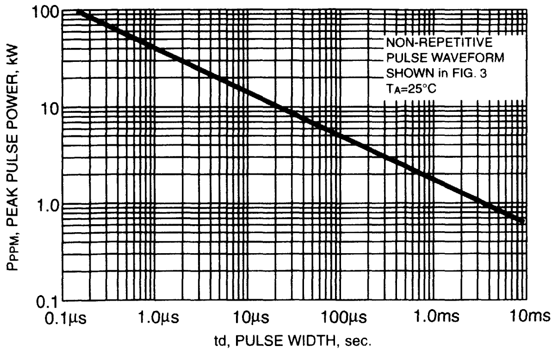


FIG. 2 - PULSE DERATING CURVE

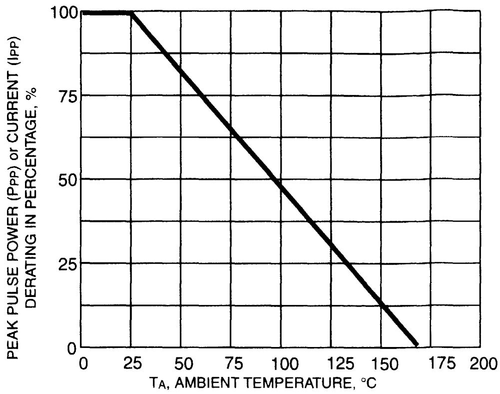


FIG. 3 - PULSE WAVEFORM

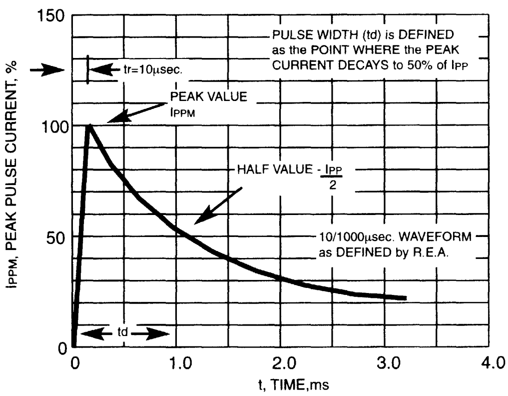


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

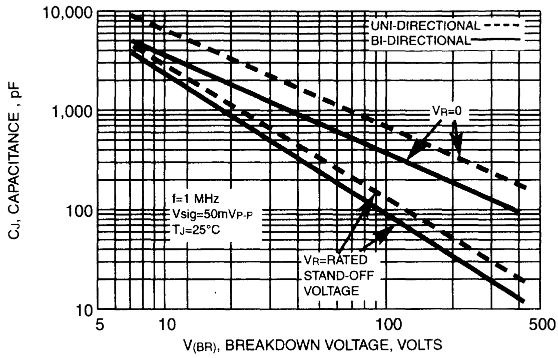


FIG. 5 - STEADY STATE POWER DERATING CURVE

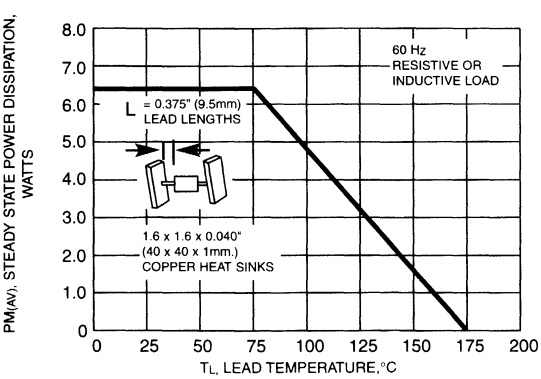
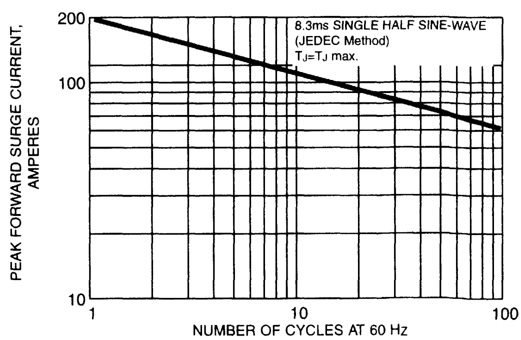


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT UNI-DIRECTIONAL ONLY



RATINGS AND CHARACTERISTIC CURVES 1.5KE6.8 THRU 1.5KE440CA

FIG. 7 - INCREMENTAL CLAMPING VOLTAGE CURVE
UNI-DIRECTIONAL

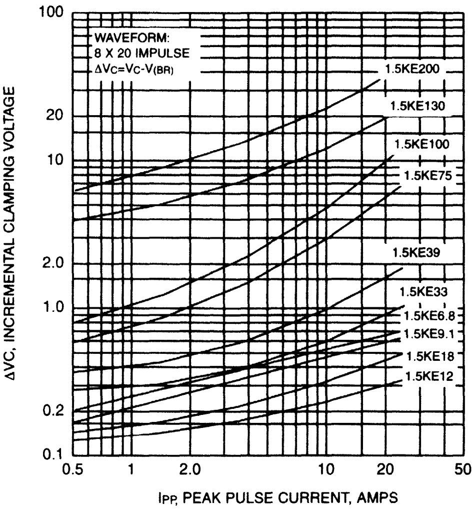


FIG. 8 - INCREMENTAL CLAMPING VOLTAGE CURVE
UNI-DIRECTIONAL

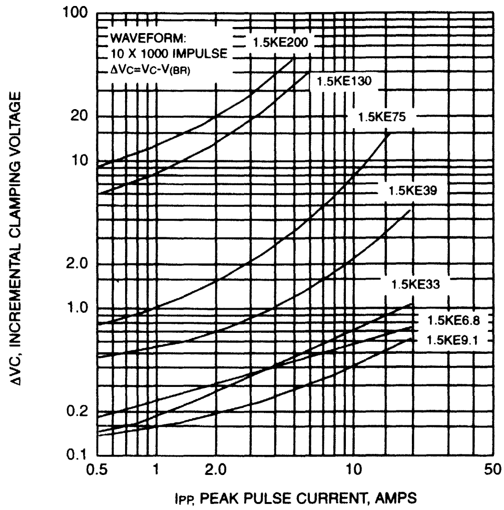


FIG. 9 - INCREMENTAL CLAMPING VOLTAGE CURVE
BI-DIRECTIONAL

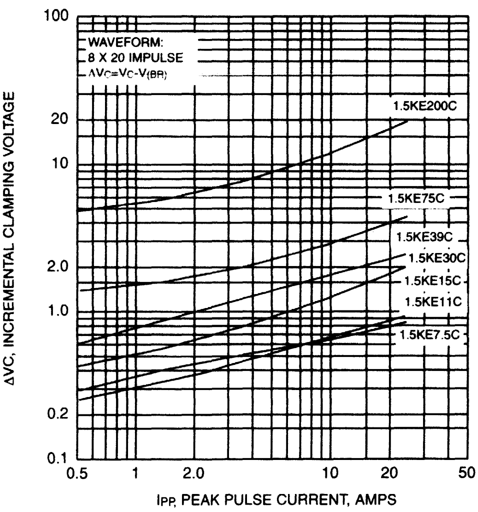


FIG. 10 - INCREMENTAL CLAMPING VOLTAGE CURVE
BI-DIRECTIONAL

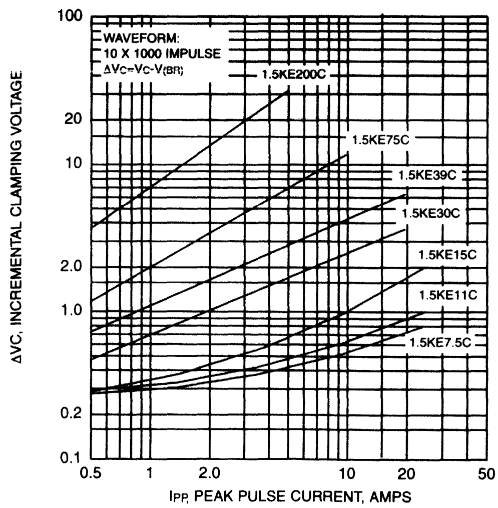


FIG. 11 - INSTANTANEOUS FORWARD VOLTAGE CHARACTERISTICS CURVE

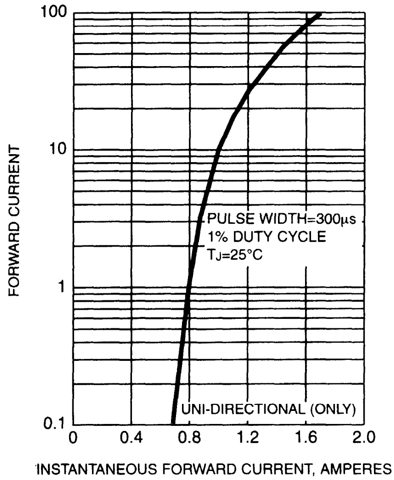
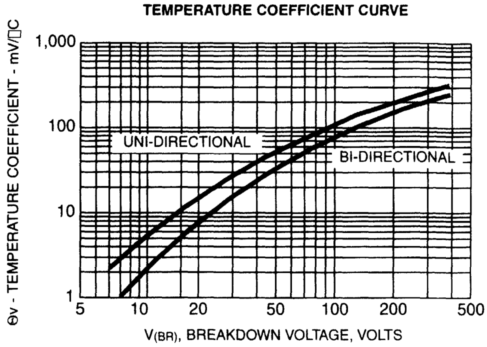


FIG. 12 - BREAKDOWN VOLTAGE TEMPERATURE COEFFICIENT CURVE

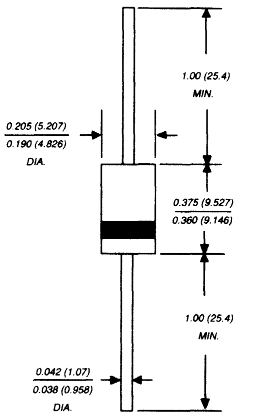


ICTE5.0 THRU ICTE15C SERIES

TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

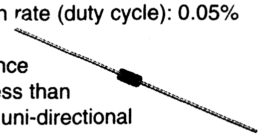
Stand-off Voltage *- 5.0 to 15 Volts* ***Peak Pulse Power*** *- 1500 Watts*

Case Style 1.5KE



Dimensions in inches and (millimeters)

FEATURES



- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ 1500W Peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.05%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional
- ♦ Ideal for data and bus line applications
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension
- ♦ Includes 1N6373 thru 1N6385

MECHANICAL DATA

Case: Molded plastic over a passivated junction
Terminals: Plated Axial leads, solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types the color band denotes the cathode, which is posititive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.045 ounce, 1.2 grams

TRANSZORB™ TVS

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 1500	Watts
Steady state power dissipation, T_L= 75°C at lead lengths 0.375" (9.5mm)	$P_{M(AV)}$	6.5	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1 & 2	Amps
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load for uni-directional only (JEDEC Method) (NOTE 2)	I_{FSM}	200	Amps
Maximum instantaneous forward voltage at 100A for uni-directional only	V_F	3.5	Volts
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) 8.3ms single half sine-wave, duty cycle=4 pulses per minute maximum

1/21/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS at 25°C (JEDEC REGISTERED DATA) TABLE 1

JEDEC TYPE NUMBER	GENERAL SEMICONDUCTOR PART NUMBER	STAND-OFF VOLTAGE V_{WM} (VOLTS)	MINIMUM[3] BREAKDOWN VOLTAGE at 1.0mA. $V_{(BR)}$ (VOLTS)	MAXIMUM REVERSE LEAKAGE at V_{WM} I_D (μA)	MAXIMUM CLAMPING VOLTAGE at I_{PP} = 1.0A V_C (VOLTS)	MAXIMUM CLAMPING VOLTAGE at I_{PP} = 10A V_C (VOLTS)	MAXIMUM PEAK PULSE CURRENT I_{PP} (Amps)
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

ELECTRICAL CHARACTERISTICS AT 25°C (JEDEC REGISTERED DATA) TABLE 2

JEDEC TYPE NUMBER	GENERAL SEMICONDUCTOR PART NUMBER	STAND-OFF VOLTAGE V_{WM} (VOLTS)	MINIMUM[3] BREAKDOWN VOLTAGE at 1.0mA. $V_{(BR)}$ (VOLTS)	MAXIMUM REVERSE LEAKAGE at V_{WM} I_D (μA)	MAXIMUM CLAMPING VOLTAGE at I_{PP} = 1A V_C (VOLTS)	MAXIMUM CLAMPING VOLTAGE at I_{PP} = 10A V_C (VOLTS)	MAXIMUM PEAK PULSE CURRENT I_{PP} (Amps)
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

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 Volt 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 Io rated power; 1.20 at 50% rated power; Clamping Factor: the ratio of the actual Vc (Clamping Voltage) to the $V_{(BR)}$ (Breakdown Voltage) as measured on a specific device.

FIG. 1 - PEAK PULSE POWER RATING CURVE

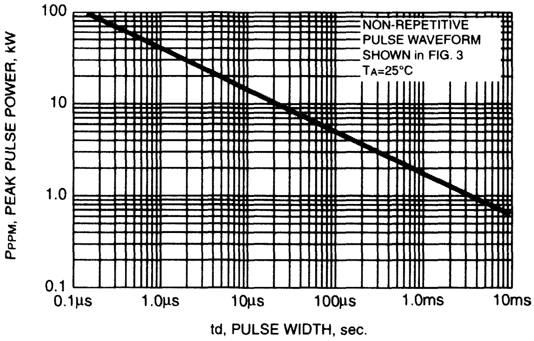


FIG. 2 - PULSE DERATING CURVE

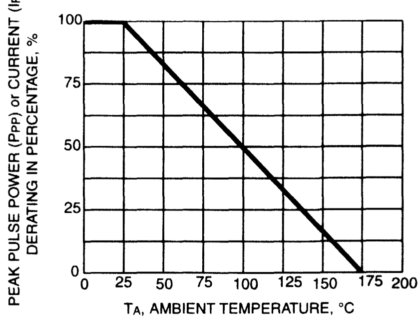


FIG. 3 - PULSE WAVEFORM

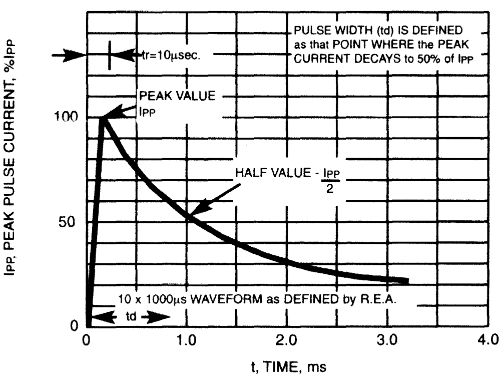


FIG. 4 - TYPICAL JUNCTION CAPACITANCE
UNI-DIRECTIONAL TYPE

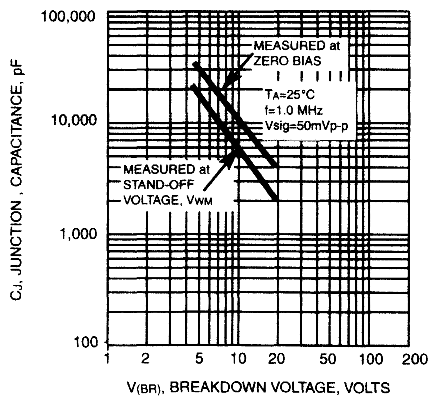


FIG. 5 - TYPICAL JUNCTION CAPACITANCE BI-DIRECTIONAL TYPE

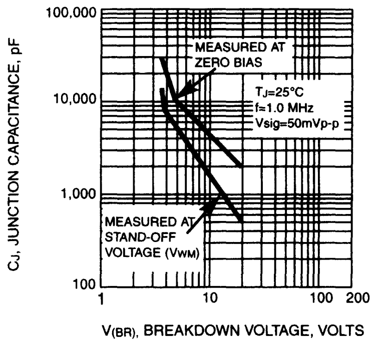


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT

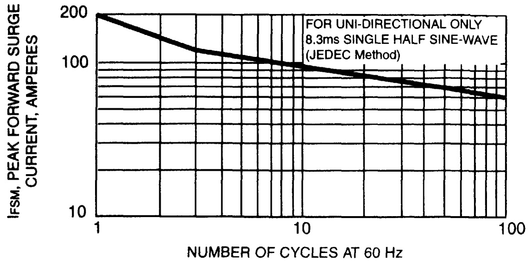
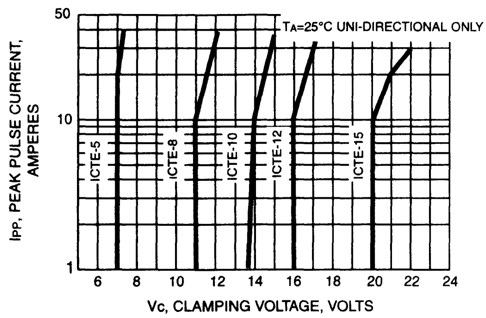


FIG. 7 - TYPICAL CHARACTERISTIC CLAMPING VOLTAGE

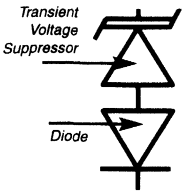


LCE6.5 THRU LCE28A SERIES

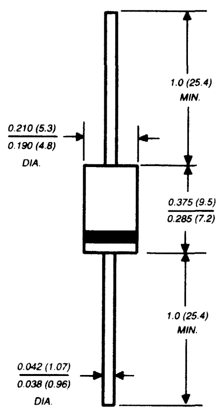
LOW CAPACITANCE TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 6.5 to 28 Volts*   ***Peak Pulse Power** - 1500 Watts*

Schematic



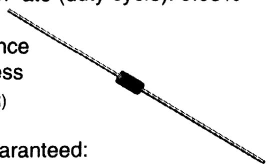
Case Style 1.5KE



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ 1500W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.05%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 5.0ns from 0 volts to $V_{(BR)}$
- ♦ Ideal for data line applications
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: Molded plastic body over a passivated junction
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.045 ounce, 1.2 grams

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 1500	Watts
Steady state power dissipation, T_L=75°C with at lead lengths 0.375" (9.5mm)	$P_{M(AV)}$	6.5	Watts
Peak power pulse surge current with a 10/1000μs waveform (FIG. 3, NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Operating junction and storage temperature range	T_J, T_{STG}	-65 to +175	°C

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

ELECTRICAL CHARACTERISTICS at (T_A=25°C UNLESS OTHERWISE NOTED) TABLE 1

PART NUMBER	STAND-OFF VOLTAGE V_{WM} (VOLTS)	BREAKDOWN VOLTAGE $V_{(BR)}$ (VOLTS) MIN / MAX	TEST CURRENT at I_T mA	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA)	MAXIMUM CLAMPING VOLTAGE AT I_{PP} V_C (VOLTS)	MAXIMUM PEAK PULSE CURRENT FIG.2 I_{PPM} (AMPS)	MAXIMUM JUNCTION CAPACITANCE AT 0 VOLTS (pF)	WORKING INVERSE BLOCKING VOLTAGE V_{WIB} (VOLTS)	MAXIMUM INVERSE BLOCKING LEAKAGE CURRENT AT V_{WIB} I_D (mA)	MINIMUM PEAK INVERSE BLOCKING VOLTAGE V_{PIB} (VOLTS)
·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

ELECTRICAL CHARACTERISTICS at (T_A=25°C UNLESS OTHERWISE NOTED) TABLE 1 (Cont'd)

PART NUMBER	STAND-OFF VOLTAGE V_{WM} (VOLTS)	BREAKDOWN VOLTAGE $V_{(BR)}$ (VOLTS) MIN/MAX	TEST CURRENT at I_T (mA)	MAXIMUM REVERSE LEAKAGE AT V_{WM} I_D (μA)	MAXIMUM CLAMPING VOLTAGE AT I_{PP} V_C (VOLTS)	MAXIMUM PEAK PULSE CURRENT FIG.2 I_{PPM} (AMPS)	MAXIMUM JUNCTION CAPACITANCE AT 0 VOLTS (pF)	WORKING INVERSE BLOCKING VOLTAGE V_{WIB} (VOLTS)	MAXIMUM INVERSE BLOCKING LEAKAGE CURRENT AT V_{WIB} I_D (mA)	MINIMUM PEAK INVERSE BLOCKING VOLTAGE V_{PIB} (VOLTS)
+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	1 6.7-20.4	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

+ UL listed for Telecom application protection 497B, file number E136766

RATINGS AND CHARACTERISTIC CURVES LCE6.5 THRU LCE28A SERIES

FIG. 1 - PEAK PULSE POWER RATING CURVE

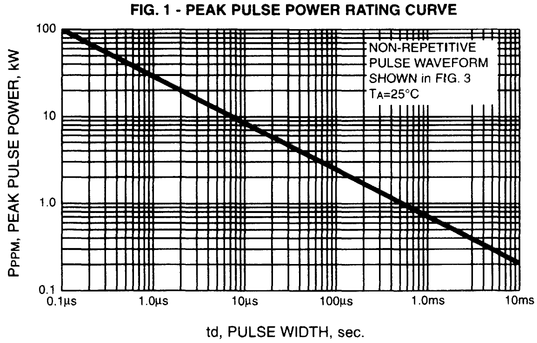


FIG. 2 - POWER DERATING CURVE

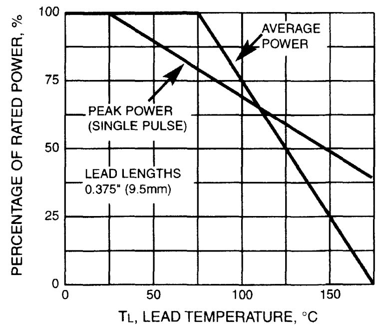


FIG. 3 - PULSE WAVEFORM

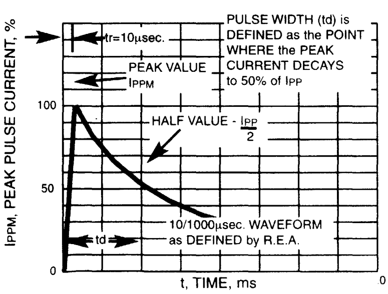
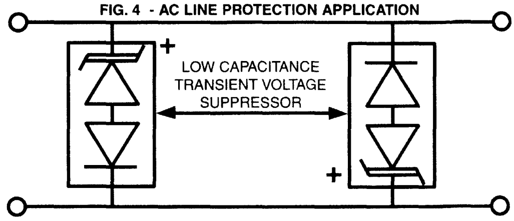


FIG. 4 - AC LINE PROTECTION APPLICATION



APPLICATION NOTE: Device must be used with two units in parallel, opposite in polarity as shown in circuit for AC signal Line protection

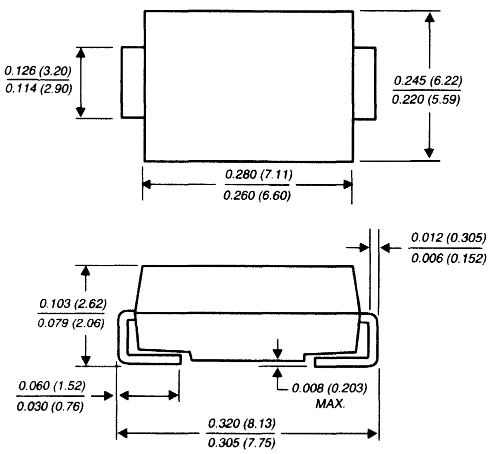
GENERAL SEMICONDUCTOR®

SM15T SERIES

TransZorb™ SURFACE MOUNT TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 220 Volts* ***Peak Pulse Power** - 1500 Watts*

DO-214AB



Dimensions in inches and (millimeters)

FEATURES

- ♦ For surface mounted applications in order to optimize board space
- ♦ Low profile package
- ♦ Built-in strain relief
- ♦ Glass passivated junction
- ♦ Low inductance
- ♦ Excellent clamping capability
- ♦ Repetition Rate (duty cycle): 0.05%
- ♦ Fast reponse time: typically less than 1ps from 0 volts to V_{BR} min.
- ♦ Typical I_D less than 1μA above 10V
- ♦ High temperature soldering: 250°C/10 seconds at terminals
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0

MECHANICAL DATA

Case: JEDEC DO-214AB (SMC) molded plastic over passivated junction
Terminals: Solder plated solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types: Color band denotes positive end (cathode)
Standard Packaging: 12mm tape (EIA STD RS-481)
Weight: 0.003 ounces, 0.093 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

	SYMBOLS	VALUE	UNIT
Peak Pulse Power Dissipation on 10/1000μs waveform (NOTES 1, 2, Fig. 1)	P_{PPM}	Minimum 1500	Watts
Peak Pulse Current on 10/1000μs waveform (NOTE 1, Fig. 3)	I_{PPM}	See Table 1	Amps
Power Dissipation on Infinite Heatsink, T_A=50°C	$P_{M(AV)}$	6.5	Watts
Peak Forward Surge Current, 10ms Single Half Sine-wave, Undirectional Only	I_{FSM}	200	Amps
Max. Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{STG}	-65 to +175	°C
Thermal Resistance Junction to Ambient Air (NOTE 2)	$R_{\Theta JA}$	75	°C/W
Thermal Resistance Junction to Leads	$R_{\Theta JL}$	15	°C/W

NOTES:
(1) Non-repetitive current pulse, per Fig. 3 and derated above T_A=25°C per Fig. 2
(2) Mounted on 5.0mm^2 (.013mm thick) land areas.
(3) Measured on 8.3ms single half sine-wave or equivalent squarewave, duty cycle 4 pulses per minute maximum.

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

Type[(1)]	Device Marking Code		Standoff Voltage V_{RM}	Leakage Current[(3)] I_{RM} @ V_{RM}	Breakdown Voltage V_{BR} @ I_T[(2)] (Volts)		Test Current I_T	Clamping Voltage V_C @ I_{PP} 10/1000μs		Clamping Voltage V_C @ I_{PP} 8/20μs		α_T Max 10^{-4}/°C
	Uni	Bi	(Volts)	(μA)	Min	Max	(mA)	(Volts)	(Amps)	(Volts)	(Amps)	
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	5.00	11.4	12.6	1.0	16.7	90.0	21.7	461	7.8
SM15T15A	GEG7	GEG7	12.8	5.00	14.3	15.8	1.0	21.2	71.0	27.2	368	8.4
SM15T18A	GEM7	BEM7	15.3	5.00	17.1	18.9	1.0	25.2	59.5	32.5	308	8.8
SM15T22A	GET7	BET7	18.8	5.00	20.9	23.1	1.0	30.6	49.0	39.3	254	9.2
SM15T24A	GEV7	GEV7	20.5	5.00	22.8	25.2	1.0	33.2	45.0	42.8	234	9.4
SM15T27A	GEX7	BEX7	23.1	5.00	25.7	28.4	1.0	37.5	40.0	48.3	207	9.6
SM15T30A	GFE7	BFE7	25.6	5.00	28.5	31.5	1.0	41.5	36.0	53.5	187	9.7
SM15T33A	GFG7	GFG7	28.2	5.00	31.4	34.7	1.0	45.7	33.0	59.0	169	9.8
SM15T36A	GFK7	BFK7	30.8	5.00	34.2	37.8	1.0	49.9	30.0	64.3	156	9.9
SM15T39A	GFM7	BFM7	33.3	5.00	37.1	41.0	1.0	53.9	28.0	69.7	143	10.0
SM15T68A	GGG7	GGG7	58.1	5.00	64.6	71.4	1.0	92.0	16.3	121	83	10.4
SM15T100A	GGV7	GGV7	85.5	5.00	95.0	105	1.0	137	11.0	178	56	10.6
SM15T150A	GHK7	GHK7	128	5.00	143	158	1.0	207	7.20	265	38	10.8
SM15T200A	GHR7	GHR7	171	5.00	190	210	1.0	274	5.50	353	28	10.8
SM15T220A	GHR8	GHR8	188	5.00	209	231	1.0	328	4.60	388	26	10.8

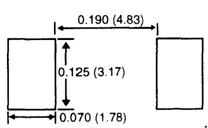
NOTES:
(1) For bi-directional devices add "C" for ±10% and "CA" for ±5% tolerance of V_{BR}
(2) V_{BR} measured after I_T applied for 300μs square wave pulse
(3) For bipolar devices with V_R=10 Volts or under, the I_T limit is doubled

APPLICATION NOTES

A 1500W (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.

RECOMMENDED PAD SIZES

The pad dimensions should be 0.010" (0.25mm) longer than the contact size, in the lead axis. This allows a solder fillet to form, see figure below. Contact factory for soldering methods



RATINGS AND CHARACTERISTIC CURVES SM15T SERIES

FIG. 1 - PEAK PULSE POWER RATING CURVE

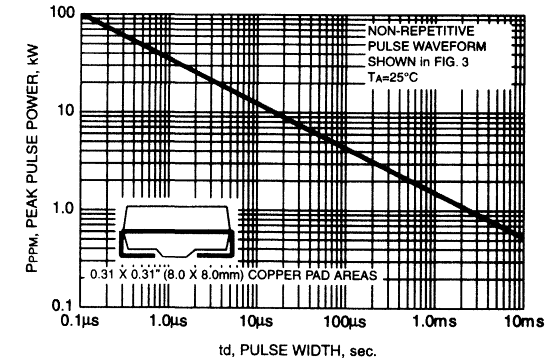


FIG. 2 - PULSE DERATING CURVE

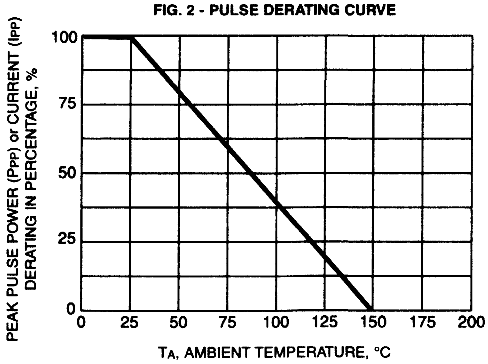


FIG. 3 - PULSE WAVEFORM

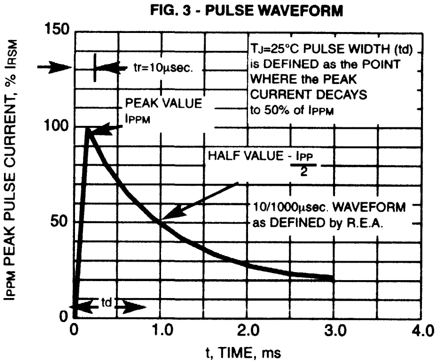


FIG. 4 - TYPICAL JUNCTION CAPACITANCE
UNI-DIRECTIONAL

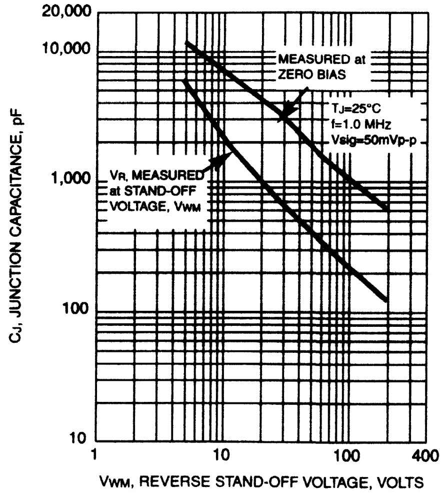


FIG. 5 - TYPICAL JUNCTION CAPACITANCE
BI-DIRECTIONAL

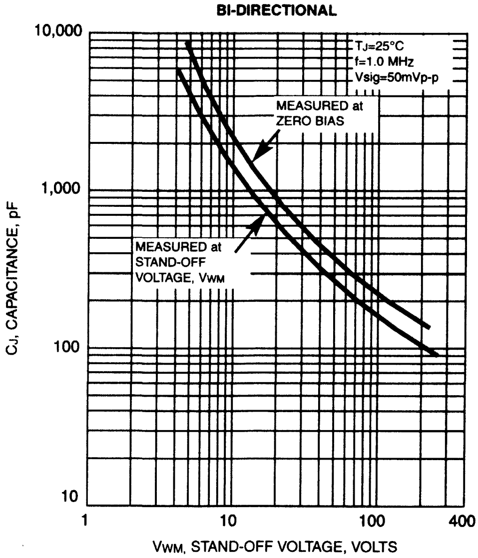
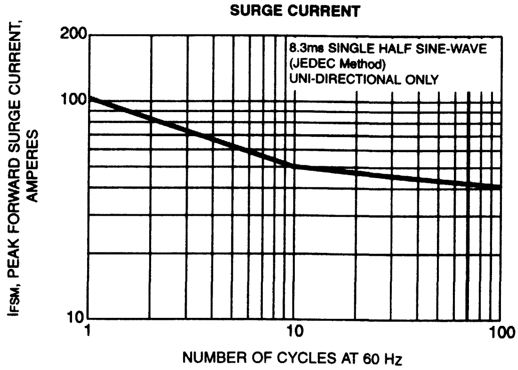


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD
SURGE CURRENT



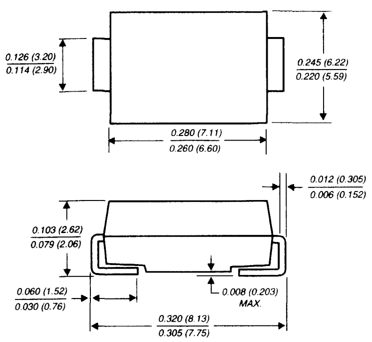
TRANSZORB™ TVS

SMCG AND SMCJ5.0 THRU 170CA

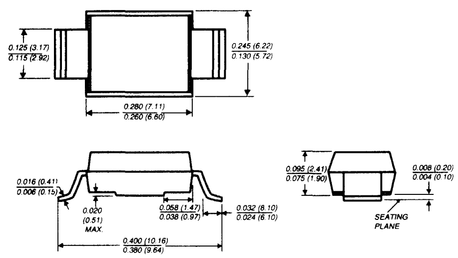
SURFACE MOUNT TransZorb™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 5.0 - 170 Volts* ***Peak Pulse Power** - 1500 Watts*

DO-214AB
MODIFIED J-BEND



DO-215AB
GULL WING



Dimensions in inches and (millimeters)

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ For surface mounted applications in order to optimize board space
- ♦ Low profile package
- ♦ Built-in strain relief
- ♦ Glass passivated junction
- ♦ Low inductance
- ♦ 1500W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ for uni-directional and 5.0ns for bi-directional types
- ♦ For devices with $V_{(BR)} \geq 10V$, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO214AB / DO215AB molded plastic over passivated junction
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: For uni-directional types the color band denotes the cathode, which is postitive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.007 ounces, 0.21 gram

DEVICES FOR BI-DIRECTIONAL APPLICATIONS

For bi-directional use add suffix C or CA for types SMC-5.0 thru SMC-170 (e.g. SMCG5.0C, SMCJ170CA).
Electrical characteristics apply in both directions.

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs waveform (NOTES 1, 2, FIG. 1)	P_{PPM}	Minimum 1500	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTES 2, 3) - uni-directional only	I_{FSM}	200.0	Amps
Maximum instantaneous forward voltage at 100A (NOTE 3) uni-directional only	V_F	3.5	Volts
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 8.0mm) copper pads to each terminal
(3) Measured on 8.3ms single half sine-wave. For uni-directional devices only.

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type Gull Wing Lead	Device Type Modified "J" Bend Lead	Device Marking Code UNI	BI	Breakdown Voltage $V_{(BR)}$(Volts) (NOTE 1) (MIN / MAX)	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} (NOTE 3) I_D (μA)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)
SMCG5.0	SMCJ5.0	GDD	GDD	6.40 / 7.82	10.0	5.0	1000	156.3	9.6
SMCG5.0A	SMCJ5.0	GDE	GDE	6.40 / 7.07	10.0	5.0	1000	163.0	9.2
SMCG6.0	SMCJ6.0	GDF	GDF	6.67 / 8.15	10.0	6.0	1000	131.6	11.4
SMCG6.0A	SMCJ6.0A	GDG	GDG	6.67 / 7.37	10.0	6.0	1000	145.6	10.3
SMCG6.5	SMCJ6.5	GDH	BDH	7.22 / 8.82	10.0	6.5	500	122.0	12.3
SMCG6.0A	SMCJ6.5A	GDK	BDK	7.22 / 7.98	10.0	6.5	500	133.9	11.2
SMCG7.0	SMCJ7.0	GDL	GDL	7.78 / 9.51	10.0	7.0	200	112.8	13.3
SMCG7.0A	SMCJ7.0A	GDM	GDM	7.78 / 8.60	10.0	7.0	200	125.0	12.0
SMCG7.5	SMCJ7.5	GDN	BDN	8.33 / 10.2	1.0	7.5	100	104.9	14.3
SMCG7.5A	SMCJ7.5A	GDP	BDP	8.33 / 9.21	1.0	7.5	100	116.3	12.9
SMCG8.0	SMCJ8.0	GDQ	BDG	8.89 / 10.9	1.0	8.0	50	100.0	15.0
SMCG8.0A	SMCJ8.0A	GDR	BDR	8.89 / 9.83	1.0	8.0	50	110.3	13.6
SMCG8.5	SMCJ8.5	GDS	BDS	9.44 / 11.5	1.0	8.5	20	94.3	15.9
SMCG8.5A	SMCJ8.5A	GDT	BDT	9.44 / 10.4	1.0	8.5	20	104.2	14.4
SMCG9.0	SMCJ9.0	GDU	BDU	10.0 / 12.2	1.0	9.0	10	88.8	16.9
SMCG9.0A	SMCJ9.0A	GDV	BDV	10.0 / 11.1	1.0	9.0	10	97.4	15.4
SMCG10	SMCJ10	GDW	BDW	11.1 / 13.6	1.0	10.0	5.0	79.8	18.8
SMCG10A	SMCJ10A	GDX	BDX	11.1 / 12.3	1.0	10.0	5.0	88.2	17.0
SMCG11	SMCJ11	GDY	GDY	12.2 / 14.9	1.0	11.0	5.0	74.6	20.1
SMCG11A	SMCJ11A	GDZ	GDZ	12.2 / 13.5	1.0	11.0	5.0	82.4	18.2
SMCG12	SMCJ12	GED	BED	13.3 / 16.3	1.0	12.0	5.0	68.2	22.0
SMCG12A	SMCJ12A	GEE	BEE	13.3 / 14.7	1.0	12.0	5.0	75.4	19.9
SMCG13	SMCJ13	GEF	GEF	14.4 / 17.6	1.0	13.0	5.0	63.0	23.8
SMCG13A	SMCJ13A	GEG	GEG	14.4 / 15.9	1.0	13.0	5.0	69.8	21.5
SMCG14	SMCJ14	GEH	BEH	15.6 / 19.1	1.0	14.0	5.0	58.1	25.8
SMCG14A	SMCJ14A	GEK	BEK	15.6 / 17.2	1.0	14.0	5.0	64.7	23.2
SMCG15	SMCJ15	GEL	BEL	16.7 / 20.4	1.0	15.0	5.0	55.8	26.9
SMCG15A	SMCJ15A	GEM	BEM	16.7 / 18.5	1.0	15.0	5.0	61.5	24.4
SMCG16	SMCJ16	GEN	GEN	17.8 / 21.8	1.0	16.0	5.0	52.1	28.8
SMCG16A	SMCJ16A	GEP	GEP	17.8 / 19.7	1.0	16.0	5.0	57.7	26.0
SMCG17	SMCJ17	GEQ	GEQ	18.9 / 23.1	1.0	17.0	5.0	49.2	30.5
SMCG17A	SMCJ17A	GER	GER	18.9 / 20.9	1.0	17.0	5.0	54.3	27.6
SMCG18	SMCJ18	GES	BES	20.0 / 24.4	1.0	18.0	5.0	46.6	32.2
SMCG18A	SMCJ18A	GET	BET	20.0 / 22.1	1.0	18.0	5.0	51.4	29.2
SMCG20	SMCJ20	GEU	BEU	22.2 / 27.1	1.0	20.0	5.0	41.9	35.8
SMCG20A	SMCJ20A	GEV	BEV	22.2 / 24.5	1.0	20.0	5.0	46.3	32.4
SMCG22	SMCJ22	GEW	BEW	24.4 / 29.8	1.0	22.0	5.0	38.1	39.4
SMCG22A	SMCJ22A	GEX	BEX	24,4 / 26.9	1.0	22.0	5.0	42.3	35.5
SMCG24	SMCJ24	GEY	BEY	26.7 / 32.6	1.0	24.0	5.0	34.9	43.0
SMCG24A	SMCJ24A	GEZ	BEZ	26.7 / 29.5	1.0	24.0	5.0	38.6	38.9
SMCG26	SMCJ26	GFD	BFD	28.9 / 35.3	1.0	26.0	5.0	32.2	46.6
SMCG26A	SMCJ26A	GFE	BFE	28.9 / 31.9	1.0	26.0	5.0	35.6	42.1
SMCG28	SMCJ28	GFF	BFF	31.1 / 38.0	1.0	28.0	5.0	30.0	50.0
SMCG28A	SMCJ28A	GFG	BFG	31.1 / 34.4	1.0	28.0	5.0	33.0	45.4
SMCG30	SMCJ30	GFH	BFH	33.3 / 40.7	1.0	30.0	5.0	28.0	53.5
SMCG30A	SMCJ30A	GFK	BFK	33.3 / 36.8	1.0	30.0	5.0	31.0	48.4
SMCG33	SMCJ33	GFL	BFL	36.7 / 44.9	1.0	33.0	5.0	25.4	59.0
SMCG33A	SMCJ33A	GFM	BFM	36.7 / 40.6	1.0	33.0	5.0	28.1	53.3
SMCG36	SMCJ36	GFN	BFN	40.0 / 48.9	1.0	36.0	5.0	23.3	64.3
SMCG36A	SMCJ36A	GFP	BFP	40.0 / 44.2	1.0	36.0	5.0	25.8	58.1
SMCG40	SMCJ40	GFQ	BFQ	44.4 / 54.3	1.0	40.0	5.0	21.0	71.4
SMCG40A	SMCJ40A	GFR	BFR	44.4 / 49.1	1.0	40.0	5.0	23.3	64.5
SMCG43	SMCJ43	GFS	BFS	47.8 / 58.4	1.0	43.0	5.0	19.6	76.7
SMCG43A	SMCJ43A	GFT	BFT	47.8 / 52.8	1.0	43.0	5.0	21.6	69.4
SMCG45	SMCJ45	GFU	GFU	50.0 / 61.1	1.0	45.0	5.0	18.7	80.3
SMCG45A	SMCJ45A	GFV	GFV	50.0 / 55.3	1.0	45.0	5.0	20.6	72.7
SMCG48	SMCJ48	GFW	GFW	53.3 / 65.1	1.0	48.0	5.0	17.5	85.5
SMCG48A	SMCJ48A	GFX	GFX	53.3 / 58.9	1.0	48.0	5.0	19.4	77.4
SMCG51	SMCJ51	GFY	GFY	56.7 / 69.3	1.0	51.0	5.0	16.5	91.1
SMCG51A	SMCJ51A	GFZ	GFZ	56.7 / 62.7	1.0	51.0	5.0	18.2	82.4

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type Gull Wing Lead	Device Type Modified "J" Bend Lead	Device Marking Code UNI	BI	Breakdown Voltage $V_{(BR)}$(Volts) (NOTE 1) (MIN / MAX)	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} (NOTE 3) I_D (μA)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)
SMCG54	SMCJ54	GGD	GGD	60.0 / 73.3	1.0	54.0	5.0	15.6	96.3
SMCG54A	SMCJ54A	GGE	GGE	60.0 / 66.3	1.0	54.0	5.0	17.2	87.1
SMCG58	SMCJ58	GGF	GGF	64.4 / 78.7	1.0	58	5.0	14.6	103
SMCG58A	SMCJ58A	GGG	GGG	6.4.4 / 71.2	1.0	58	5.0	16.0	93
SMCG60	SMCJ60	GGH	GGH	66.7 / 81.5	1.0	60	5.0	14.0	107
SMCG60A	SMCJ60A	GGK	GGK	66.7 / 73.7	1.0	60	5.0	15.5	96
SMCG64	SMCJ64	GGL	GGL	71.1 / 86.9	1.0	64	5.0	13.2	114
SMCG64A	SMCJ64A	GGM	GGM	71.1 / 78.6	1.0	64	5.0	14.6	103
SMCG70	SMCJ70	GGN	GGN	77.8 / 95.1	1.0	70	5.0	12.0	125
SMCG70A	SMCJ70A	GGP	GGP	77.8 / 86.0	1.0	70	5.0	13.3	113
SMCG75	SMCJ75	GGQ	GGQ	83.3 / 102	1.0	75	5.0	11.2	134
SMCG75A	SMCJ75A	GGR	GGR	83.3 / 92.1	1.0	75	5.0	12.4	121
SMCG78	SMCJ78	GGS	GGS	86.7 / 106	1.0	78	5.0	10.8	139
SMCG78A	SMCJ78A	GGT	GGT	86.7 / 95.8	1.0	78	5.0	11.9	126
SMCG85	SMCJ85	GGU	GGU	94.4 / 115	1.0	85	5.0	9.9	151
SMCG85A	SMCJ85A	GGV	GGV	94.4 / 104	1.0	85	5.0	10.9	137
SMCG90	SMCJ90	GGW	GGW	100 / 122	1.0	90	5.0	9.4	160
SMCG90A	SMCJ90A	GGX	GGX	100 / 111	1.0	90	5.0	10.3	146
SMCG100	SMCJ100	GGY	GGY	111 / 136	1.0	100	5.0	8.4	179
SMCG100A	SMCJ100A	GGZ	GGZ	111 / 123	1.0	100	5.0	9.3	162
SMCG110	SMCJ110	GHD	GHD	122 / 149	1.0	110	5.0	7.7	196
SMCG110A	SMCJ110A	GHE	GHE	122 / 135	1.0	110	5.0	8.5	177
SMCG120	SMCJ120	GHF	GHF	133 / 163	1.0	120	5.0	7.0	214
SMCG120A	SMCJ120A	GHG	GHG	133 / 147	1.0	120	5.0	7.8	193
SMCG130	SMCJ130	GHH	GHH	144 / 176	1.0	130	5.0	6.5	231
SMCG130A	SMCJ130A	GHK	GHK	144 / 159	1.0	130	5.0	7.2	209
SMCG150	SMCJ150	GHL	GHL	16.7 / 204	1.0	150	5.0	5.6	268
SMCG150A	SMCJ150A	GHM	GHM	167 / 185	1.0	150	5.0	6.2	243
SMCG160	SMCJ160	GHN	GHN	178 / 218	1.0	160	5.0	5.2	287
SMCG160A	SMCJ160A	GHP	GHP	178 / 197	1.0	160	5.0	5.8	259
SMCG170	SMCJ170	GHQ	GHQ	189 / 231	1.0	170	5.0	4.9	304
SMCG170A	SMCJ170A	GHR	GHR	189 / 209	1.0	170	5.0	5.5	275

NOTES:

(1) $V_{(BR)}$ measured after I_T applied for 300μs square wave pulse or equivalent
(2) Surge current waveform per Fig. 3 and derate per Fig. 2
(3) For bi-directional types having V_{WM} of 10 Volts and less, the I_D limit is doubled
(4) For the bi-directional SMCG/SMCJ5.0CA, the maximum $V_{(BR)}$ is 7.25 Volts
(5) All terms and symbols are consistent with ANSI/IEEE C62.35

APPLICATION NOTES

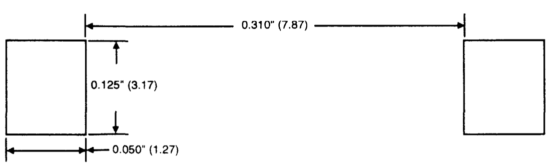
These surface mountable packages are designed specifically for transient voltage suppression. The wide leads assure a large surface contact for good heat dissipation, and a low resistance path for surge current flow to ground. These high speed transient voltage suppressors can be used to effectively protect sensitive components such as integrated circuits and MOS devices.

A 1500W (SMC) device is normally selected when the threat of transients is from lightning-induced transients conducted via external leads or I/0 lines. It is also used to protect against switching transients induced by large coils or industrial motors.
System impedance at component level in a system is usually high enough to limit the current to within the peak pulse current (I_{PP}) rating of this series.

RECOMMENDED PAD SIZES

The pad dimensions should be 0.010" (0.25mm) longer than the contact size, in the lead axis.
This allows a solder fillet to form, see figure below. Contact factory for soldering methods.

GULL- WING



MODIFIED J-BEND

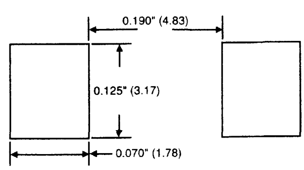


FIG. 1 - PEAK PULSE POWER RATING CURVE

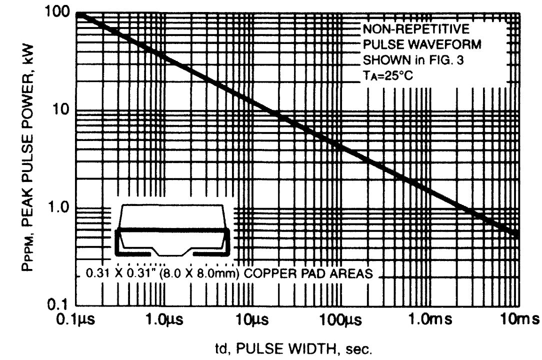


FIG. 2 - PULSE DERATING CURVE

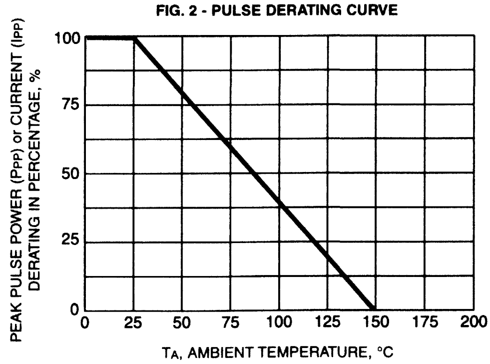


FIG. 3 - PULSE WAVEFORM

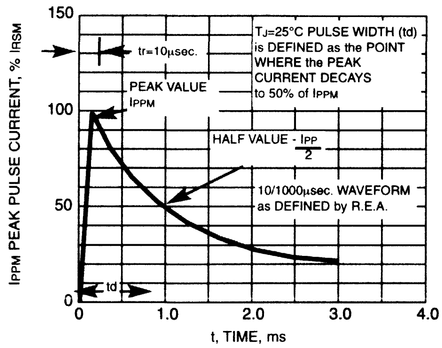


FIG. 4 - TYPICAL JUNCTION CAPACITANCE UNI-DIRECTIONAL

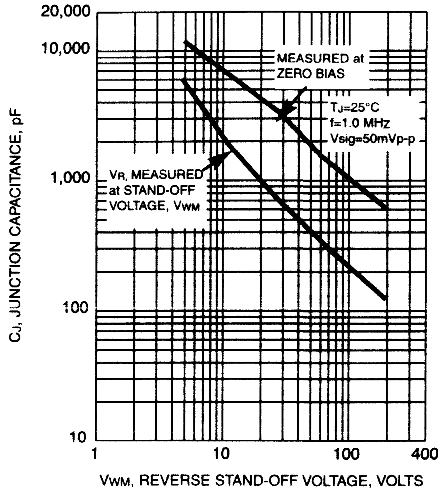


FIG. 5 - TYPICAL JUNCTION CAPACITANCE BI-DIRECTIONAL

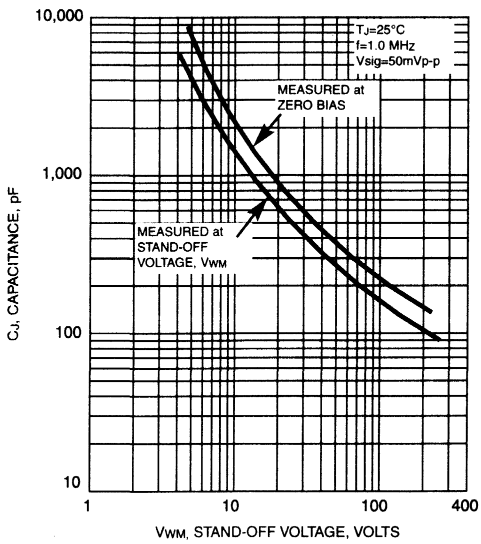
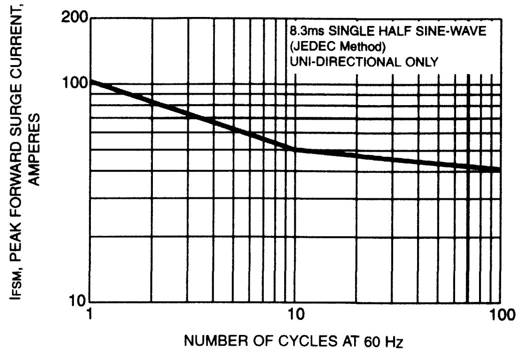


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT

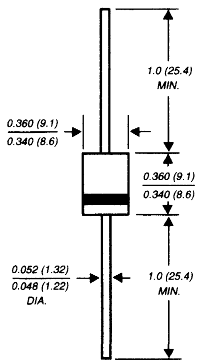


5KP5.0 THRU 5KP110A

TRANSZORB™ TRANSIENT VOLTAGE SUPPRESSOR

***Stand-off Voltage** - 5.0 to 110 Volts* ***Peak Pulse Power** - 5000 Watts*

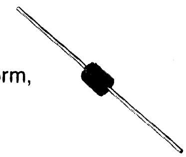
Case Style P600



Dimensions in inches and (millimeters)

Available in uni-directional only

FEATURES



- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Glass passivated junction
- ♦ 5000W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.05%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$
- ♦ Devices with $V_{(BR)}$>10V I_D are typically I_D less than 1.0μA
- ♦ High temperature soldering guaranteed: 265°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension

MECHANICAL DATA

Case: Molded plastic body over glass passivated junction
Terminals: Solder plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: The color band denotes the cathode, which is postitive with respect to the anode under normal TVS operation
Mounting Position: Any
Weight: 0.07 ounce, 2.1 grams

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 5000	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	8.0	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	400	Amps
Instantaneous forward voltage at 100A, (NOTE 3)	V_F	3.5	Volts
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) Mounted on copper pad area of 0.8 x 0.8" (20 x 20mm) per Fig. 5
(3) Measured on 8.3ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum

1/21/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1)		Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	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	50.0	314	15.9	0.078
5KP8.5A	9.44	10.4	5.0	8.5	50.0	347	14.4	0.078
5KP9.0	10.0	12.2	5.0	9.0	20.0	296	16.9	0.081
5KP9.0A	10.0	11.1	5.0	9.0	20.0	325	15.4	0.081
5KP10	11.1	13.6	5.0	10.0	15.0	266	18.8	0.084
5KP10A	11.1	12.3	5.0	10.0	15.0	294	17.0	0.084
5KP11	12.2	14.9	5.0	11.0	10.0	249	20.1	0.086
5KP11A	12.2	13.5	5.0	11.0	10.0	275	18.2	0.086
5KP12	13.3	16.3	5.0	12.0	10.0	227	22.0	0.088
5KP12A	13.3	14.7	5.0	12.0	10.0	251	19.9	0.088
5KP13	14.4	17.6	5.0	13.0	10.0	210	23.8	0.090
5KP13A	14.4	15.9	5.0	13.0	10.0	233	21.5	0.090
5KP14	15.6	19.1	5.0	14.0	10.0	194	25.8	0.092
5KP14A	15.6	17.2	5.0	14.0	10.0	216	23.2	0.092
5KP15	16.7	20.4	5.0	15.0	10.0	186	26.9	0.094
5KP15A	16.7	18.5	5.0	15.0	10.0	205	24.4	0.094
5KP16	17.8	21.8	5.0	16.0	10.0	174	28.8	0.096
5KP16A	17.8	19.7	5.0	16.0	10.0	192	26.0	0.096
5KP17	18.9	23.1	5.0	17.0	10.0	164	30.5	0.097
5KP17A	18.9	20.9	5.0	17.0	10.0	181	27.6	0.097
5KP18	20.0	24.4	5.0	18.0	10.0	155	32.2	0.098
5KP18A	20.0	22.1	5.0	18.0	10.0	171	29.2	0.098
5KP20	22.2	27.1	5.0	20.0	10.0	140	35.8	0.099
5KP20A	22.2	24.5	5.0	20.0	10.0	154	32.4	0.099
5KP22	24.4	29.8	5.0	22.0	10.0	127	39.4	0.100
5KP22A	24.4	26.9	5.0	22.0	10.0	141	35.5	0.100
5KP24	26.7	32.6	5.0	24.0	10.0	116	43.0	0.101
5KP24A	26.7	29.5	5.0	24.0	10.0	129	38.9	0.101
5KP26	28.9	35.3	5.0	26.0	10.0	107	46.6	0.101
5KP26A	28.9	31.9	5.0	26.0	10.0	119	42.1	0.101
5KP28	31.1	38.0	5.0	28.0	10.0	100	50.1	0.102
5KP28A	31.1	34.4	5.0	28.0	10.0	110	45.4	0.102
5KP30	33.3	40.7	5.0	30.0	10.0	93.5	53.5	0.103
5KP30A	33.3	36.8	5.0	30.0	10.0	103	48.4	0.103

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) MIN	MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
5KP33	36.7	44.9	5.0	33.0	10.0	84.7	59.0	0.104
5KP33A	36.7	40.6	5.0	33.0	10.0	93.8	53.3	0.104
5KP36	40.0	48.9	5.0	36.0	10.0	77.8	64.3	0.104
5KP36A	40.0	44.2	5.0	36.0	10.0	86.1	58.1	0.104
5KP40	44.4	54.3	5.0	40.0	10.0	70.0	71.4	0.105
5KP40A	44.4	49.1	5.0	40.0	10.0	77.5	64.5	0.105
5KP43	47.8	58.4	5.0	43.0	10.0	65.2	76.7	0.105
5KP43A	47.8	52.8	5.0	43.0	10.0	72.0	69.4	0.105
5KP45	50.0	61.1	5.0	45.0	10.0	62.3	80.3	0.106
5KP45A	50.0	55.3	5.0	45.0	10.0	68.8	72.7	0.106
5KP48	53.3	65.2	5.0	48.0	10.0	58.5	85.5	0.106
5KP48A	53.3	58.9	5.0	48.0	10.0	64.6	77.4	0.106
5KP51	56.1	69.3	5.0	51.0	10.0	54.9	91.1	0.107
5KP51A	56.7	62.7	5.0	51.0	10.0	60.7	82.4	0.107
5KP54	60.0	73.3	5.0	54.0	10.0	51.9	96.3	0.107
5KP54A	60.0	66.3	5.0	54.0	10.0	57.4	87.1	0.107
5KP58	64.4	78.7	5.0	58.0	10.0	48.5	103	0.107
5KP58A	64.4	71.2	5.0	58.0	10.0	53.4	94	0.107
5KP60	66.7	81.5	5.0	60.0	10.0	46.7	107	0.108
5KP60A	66.7	73.7	5.0	60.0	10.0	51.7	97	0.108
5KP64	71.1	96.9	5.0	64.0	10.0	43.9	114	0.108
5KP64A	71.1	78.6	5.0	64.0	10.0	48.5	103	0.108
5KP70	77.6	95.1	5.0	70.0	10.0	40.0	125	0.108
5KP70A	77.8	86.0	5.0	70.0	10.0	44.2	113	0.108
5KP75	83.3	102	5.0	75.0	10.0	37.3	134	0.108
5KP75A	83.3	92.1	5.0	75.0	10.0	41.3	121	0.108
5KP78	86.7	106.0	5.0	78.0	10.0	36.0	139	0.108
5KP78A	86.7	95.8	5.0	78.0	10.0	39.7	126	0.108
5KP85	94.4	115	5.0	85.0	10.0	33.1	151	0.108
5KP85A	94.4	104	5.0	85.0	10.0	36.5	137	0.110
5KP90	100	122	5.0	90.0	10.0	31.3	160	0.110
5KP90A	100	111	5.0	90.0	10.0	34.2	146	0.110
5KP100	111	136	5.0	100	10.0	27.9	179	0.110
5KP100A	111	123	5.0	100	10.0	30.9	162	0.110
5KP110	122	149	5.0	110	10.0	25.5	196	0.112
5KP110A	122	135	5.0	110	10.0	28.2	177	0.112

NOTES:

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

APPLICATION

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 percent 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.

Transient Voltage Suppressors are Silicon PN Junction devices designed for absorption of high voltage transients associated with power disturbances, switching and induced lighting effects. This series is available from 5.0 volts thru 110 volts.

FIG. 1 - PEAK PULSE POWER RATING CURVE

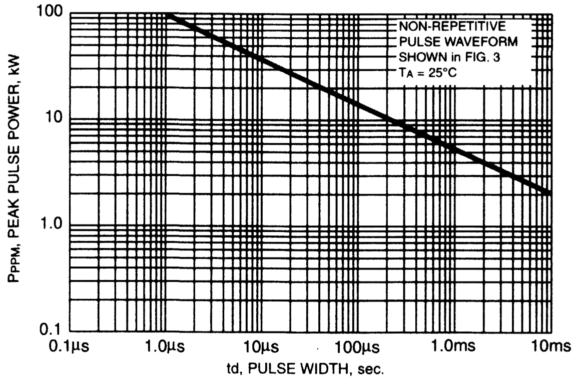


FIG. 2 - PULSE DERATING CURVE

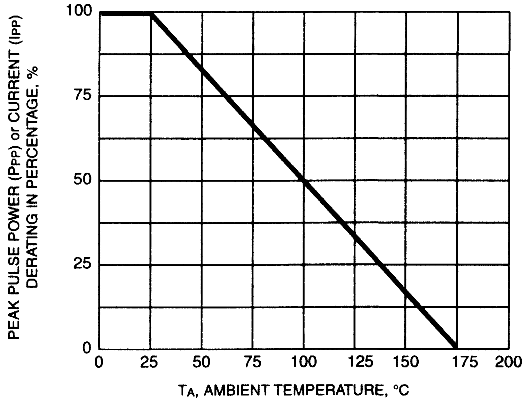


FIG. 3 - PULSE WAVEFORM

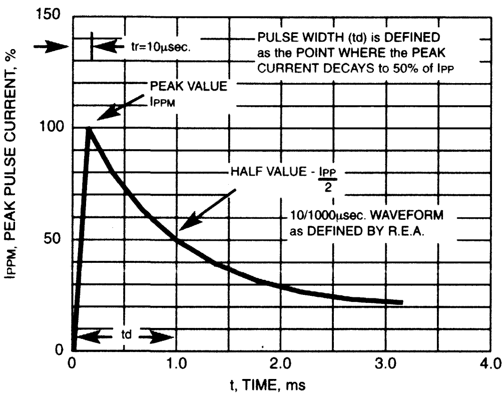


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

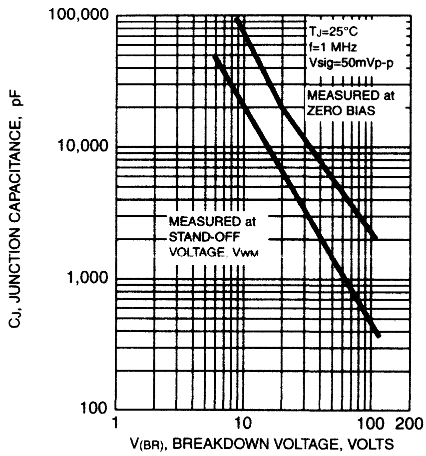


FIG. 5 - STEADY STATE POWER DERATING CURVE

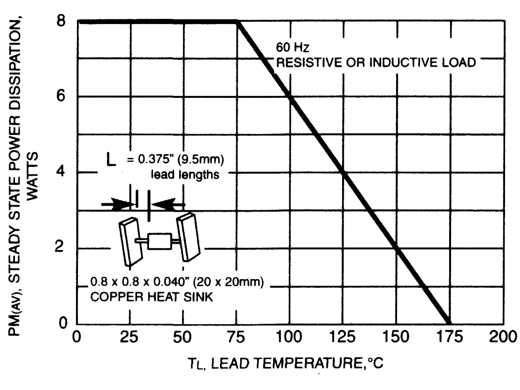
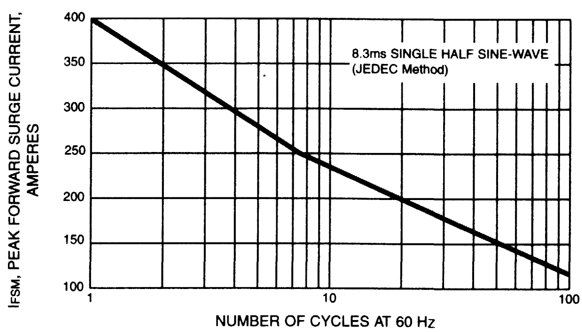


FIG. 6 - MAXIMUM NON-REPETITIVE FORWARD SURGE CURRENT



AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSORS

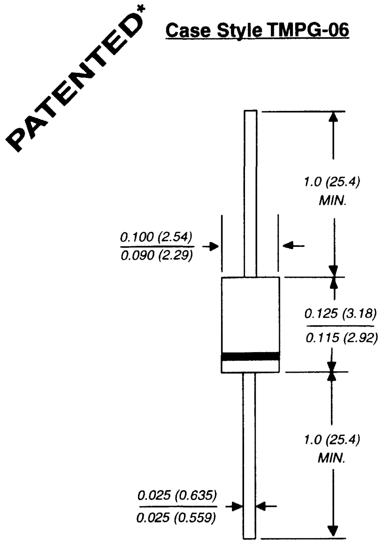
General Semiconductor is a leading supplier of discrete semiconductor components to the automotive electronics industry. With QS-9000 and ISO 9001 certified factories, General Semiconductor has developed a number of products specifically to meet the demands of the severe automotive environment. These products include the SUPERECTIFIER® and PAR™ TVS. General Semiconductor is pleased to introduce the surface mount load dump TVS series (SM5A27 through SM8A27), the avalanche alternator rectifier series (AS30 through AS40) and the POWERBLOCK™ (DO-218AA) package. These products exhibit low forward voltage drop for reduced power loss and cooler operation, excellent reverse stability over temperature, and avalanche capability which safely shunts load dump energy while clamping overvoltage to a safe level. For more information on the AS30 through AS40 families, please consult your local General Semiconductor sales office.

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

TMPG06-6.8 THRU TMPG06-43A

AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 43 Volts* ***Peak Pulse Power** - 400 Watts*



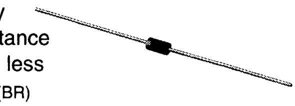
Dimensions in inches and (millimeters)

** Patent #'s 4,980,315
5,166,769
5,278,094*

Available in uni-directional only

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Designed for the hood applications
- ♦ Available in uni-directional only
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ 400W peak pulse power capability on 10/1000μs waveform, repetition rate (duty cycle): 1.0%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$
- ♦ For devices with $V_{(BR)} \geq 10V$, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 300°C/10 seconds 0.375 (9.5mm) lead length, 5lbs (2.3 kg) tension



MECHANICAL DATA

Case: Molded plastic over a passivated junction
Terminals: Axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.0064 ounce, 0.181 gram

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNITS*
Peak power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 400	Watts
Peak pulse power current with a 10/1000μs waveform (NOTE1,2, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths 0.25" (6.33mm) (NOTE 2)	$P_{M(AV)}$	1.0	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	40.0	Amps
Maximum instantaneous forward voltage at 25A (NOTE 3)	V_F	3.5	Volts
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 copper pads area of 1.6 x 1.6" (40 x 40mm)
(3) Measured on 8.3ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MAX	Test Current at I_T (mA)	Stand-off Voltage Vwm (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Maximum Reverse Leakage at V_{WM} T_J=150°C I_D (μA)	Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
TMPG06-6.8	6.12	7.48	10.0	5.50	300	1000	27.8	10.8	0.057
TMPG06-6.8A	6.45	7.14	10.0	5.80	300	1000	28.6	10.5	0.057
TMPG06-7.5	6.75	8.25	10.0	6.05	150	500	25.6	11.7	0.060
TMPG06-7.5A	7.13	7.88	10.0	6.40	150	500	26.5	11.3	0.061
TMPG06-8.2	7.38	9.02	10.0	6.63	50.0	200	24.0	12.5	0.065
TMPG06-8.2A	7.79	8.61	10.0	7.02	50.0	200	24.8	12.1	0.065
TMPG06-9.1	8.19	10.0	1.0	7.37	10.0	50.0	21.7	13.8	0.068
TMPG06-9.1A	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

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Maximum Reverse Leakage at V_{WM} T_J=150°C I_D (μA)	Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
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) $V_{(BR)}$ measured after I_T applied for 300μs, 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

FIG. 1 - PEAK PULSE POWER RATING CURVE

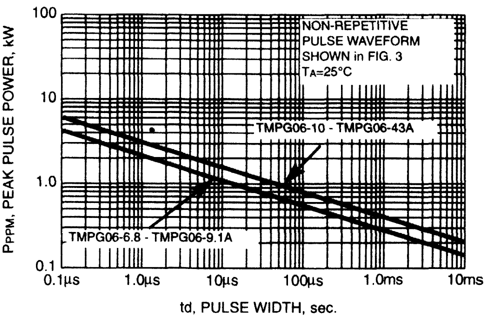


FIG. 2 - PULSE DERATING CURVE

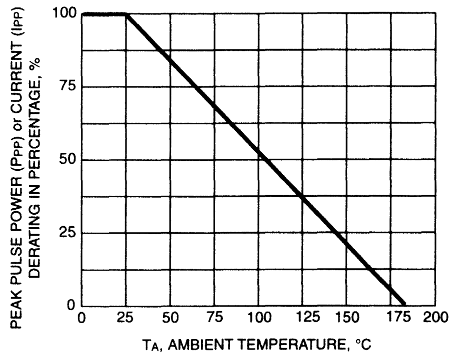


FIG. 3 - PULSE WAVEFORM

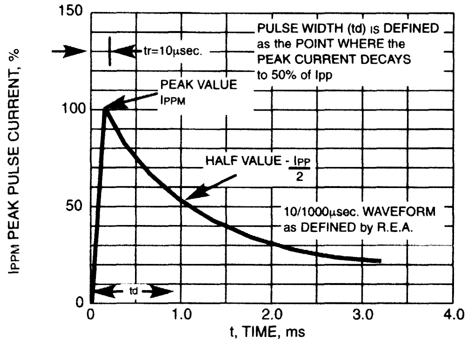


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

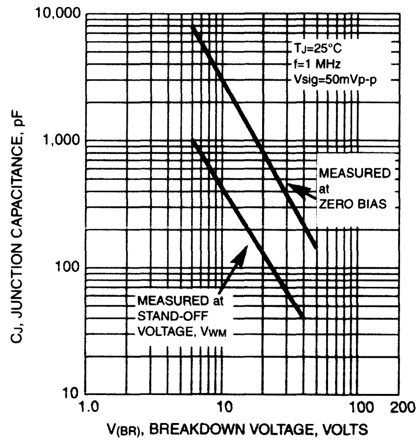


FIG. 5 - STEADY STATE POWER DERATING CURVE

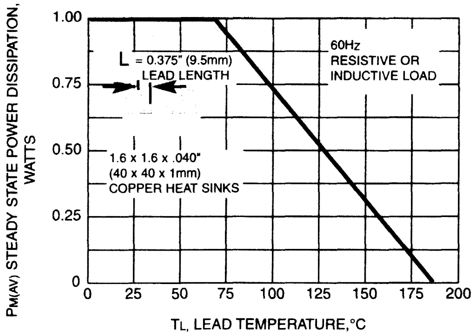
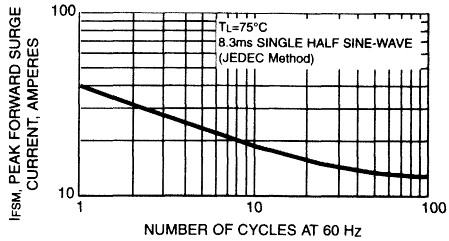


FIG. 6 - MAXIMUM NON-REPETITIVE FORWARD SURGE CURRENT



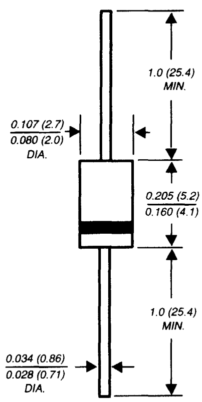
P4KA6.8 THRU P4KA43A

AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 43 Volts* ***Peak Pulse Power** - 400 Watts*

PATENTED*

DO-204AL

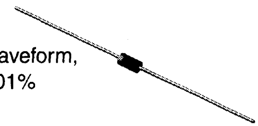


Dimensions in inches and (millimeters)
** Patent #'s 4,980,315*
5,166,769
5,278,094

Available in uni-directional only

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Designed for under the hood applications
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ 400W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$
- ♦ For devices with $V_{(BR)} \geq 10V$, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 300°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: JEDEC DO-204AL molded plastic body over passivated junction
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.012 ounce, 0.3 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 400	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	1.0	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	40.0	Amps
Maximum instantaneous forward voltage at 25A	V_F	3.5	Volts
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 copper pad area of 1.6 x 1.6" (40 x 40mm) per Fig. 5

1/25/99

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1)		Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (µA)	Maximum Reverse Leakage at V_{WM}, T_J=150°C I_D (µA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
	MIN	MAX							
P4KA6.8	6.12	7.48	10.0	5.50	300	1000	37.0	10.8	0.057
P4KA6.8A	6.45	7.14	10.0	5.80	300	1000	38.1	10.5	0.057
P4KA7.5	6.75	8.25	10.0	6.05	150	500	34.2	11.7	0.060
P4KA7.5A	7.13	7.88	10.0	6.40	150	500	35.4	11.3	0.061
P4KA8.2	7.38	9.02	10.0	6.63	50.0	200	32.0	12.5	0.065
P4KA8.2A	7.79	8.61	10.0	7.02	50.0	200	33.1	12.1	0.065
P4KA9.1	8.19	10.0	1.0	7.37	10.0	50.0	29.0	13.8	0.068
P4KA9.1A	8.65	9.55	1.0	7.78	10.0	50.0	29.9	13.4	0.068
P4KA10	9.00	11.0	1.0	8.10	5.0	20.0	26.7	15.0	0.073
P4KA10A	9.50	10.5	1.0	8.55	5.0	20.0	27.6	14.5	0.073
P4KA11	9.90	12.1	1.0	8.92	2.0	10.0	24.7	16.2	0.075
P4KA11A	10.5	11.6	1.0	9.40	2.0	10.0	25.6	15.6	0.075
P4KA12	10.8	13.2	1.0	9.72	1.0	10.0	23.1	17.3	0.076
P4KA12A	11.4	12.6	1.0	10.2	1.0	10.0	24.0	16.7	0.078
P4KA13	11.7	14.3	1.0	10.5	1.0	10.0	21.1	19.0	0.081
P4KA13A	12.4	13.7	1.0	11.1	1.0	10.0	22.0	18.2	0.081
P4KA15	13.5	16.3	1.0	12.1	1.0	10.0	18.2	22.0	0.084
P4KA15A	14.3	15.8	1.0	12.8	1.0	10.0	18.9	21.2	0.084
P4KA16	14.4	17.6	1.0	12.9	1.0	10.0	17.0	23.5	0.086
P4KA16A	15.2	16.8	1.0	13.6	1.0	10.0	17.8	22.5	0.086
P4KA18	16.2	19.8	1.0	14.5	1.0	10.0	15.1	26.5	0.088
P4KA18A	17.1	18.9	1.0	15.3	1.0	10.0	15.9	25.5	0.088
P4KA20	18.0	22.0	1.0	16.2	1.0	10.0	13.7	29.1	0.090
P4KA20A	19.0	21.0	1.0	17.0	1.0	10.0	14.4	27.7	0.0903

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Maximum Reverse Leakage at V_{WM}, T_C=150°C I_D (μA)	Maximum Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
P4KA22	19.8	24.2	1.0	17.8	1.0	10.0	12.5	31.9	0.092
P4KA22A	20.9	23.1	1.0	18.8	1.0	10.0	13.1	30.6	0.092
P4KA24	21.6	26.4	1.0	19.4	1.0	10.0	11.5	34.2	0.094
P4KA24A	22.8	25.2	1.0	20.5	1.0	10.0	12.0	33.2	0.094
P4KA27	24.3	29.7	1.0	21.8	1.0	10.0	10.2	39.1	0.096
P4KA27A	25.7	28.4	1.0	23.1	1.0	10.0	10.7	37.5	0.096
P4KA30	27.0	33.0	1.0	24.3	1.0	10.0	9.2	43.5	0.097
P4KA30A	28.5	31.5	1.0	25.6	1.0	10.0	9.7	41.4	0.097
P4KA33	29.7	36.3	1.0	26.8	1.0	10.0	8.4	47.7	0.098
P4KA33A	31.4	34.7	1.0	28.2	1.0	10.0	8.8	45.7	0.098
P4KA36	32.4	39.6	1.0	29.1	1.0	10.0	7.7	52.0	0.099
P4KA36A	34.2	37.8	1.0	30.8	1.0	10.0	8.0	49.9	0.099
P4KA39	35.1	42.9	1.0	31.6	1.0	10.0	7.1	56.4	0.100
P4KA39A	37.1	41.0	1.0	33.3	1.0	10.0	7.4	53.9	0.100
P4KA43	38.7	47.3	1.0	34.8	1.0	10.0	6.5	61.9	0.101
P4KA43A	40.9	45.2	1.0	36.8	1.0	10.0	6.7	59.3	0.101

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300μs, 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

FIG. 1 - PEAK PULSE POWER RATING CURVE

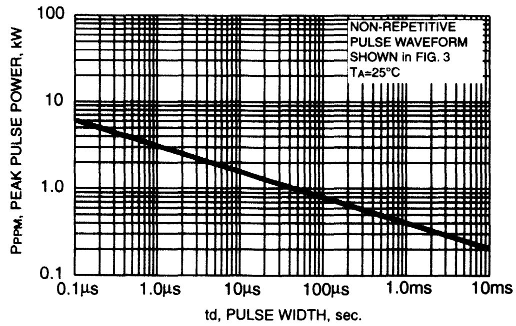


FIG. 2 - PULSE DERATING CURVE

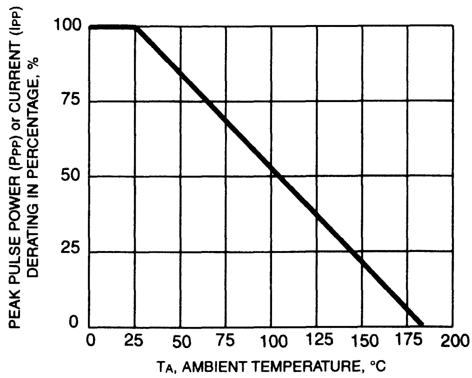


FIG. 3 - PULSE WAVEFORM

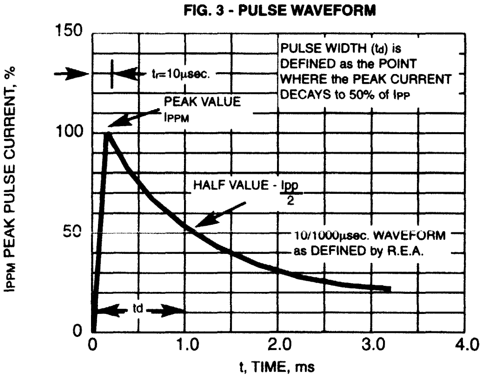


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

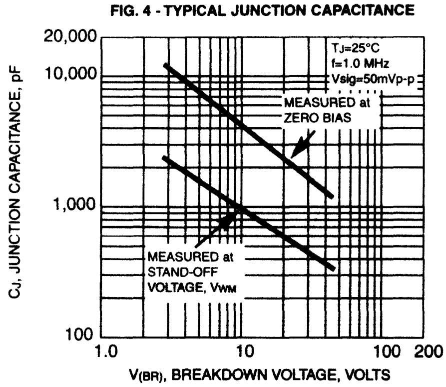


FIG. 5 - STEADY STATE POWER DERATING CURVE

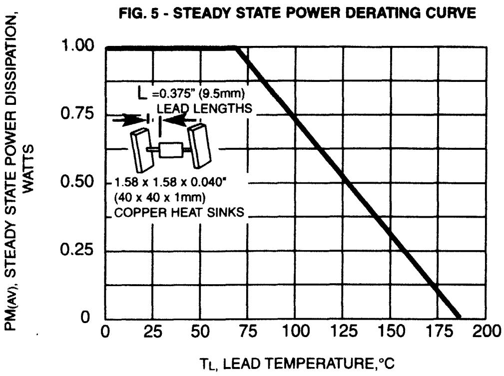
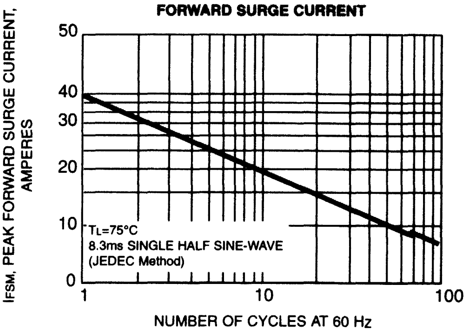


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT

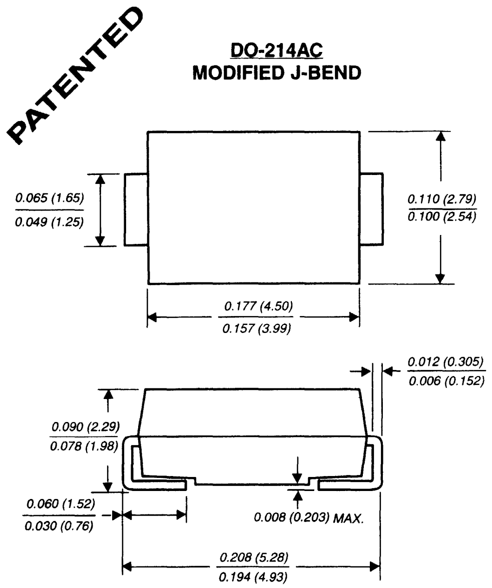


Automotive TVS

TPSMA6.8 THRU TPSMA43A

SURFACE MOUNT AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 43.0 Volts* ***Peak Pulse Power** - 400 Watts*



Dimensions in inches and (millimeters)

Available in uni-directional only

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Ideal for automated placement
- ♦ Low profile package
- ♦ Built-in strain relief
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ 400W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$ min.
- ♦ For devices with $V_{(BR)} \geq 10V$ I_D are typically less than 1.0μA at T_A=150°C
- ♦ Designed for under the hood surface mount applications
- ♦ High temperature soldering: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-214AC molded plastic body over passivated chip
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.002 ounces, 0.064 grams

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

RATINGS	*SYMBOLS*	*VALUE*	*UNITS*
Peak power dissipation with a 10/1000μs waveform, (NOTES 1, 2 FIG. 3)	P_{PPM}	Minimum 400	Watts
Peak power pulse current with a 10/1000μs waveform (NOTE 1, FIG. 1)	I_{PPM}	SEE TABLE 1	Amps
Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	40.0	Amps
Maximum instantaneous forward voltage at 25A (NOTE 3)	V_F	3.5	Volts
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 x 0.5mm) copper pads attached to each terminal
(3) Measured on 8.3ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minutes maximum

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device	Device Marking Code	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN.	MAX.	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_R (μA)	Maximum Reverse Leakage at V_{WM}, T_A=150°C I_D (μA)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PP} V_C (Volts)
TPSMA6.8	ADP	6.12	7.48	10.0	5.50	300	1000	37.0	10.8
TPSMA6.8A	AEP	6.45	7.14	10.0	5.80	300	1000	38.1	10.5
TPSMA7.5	AFP	6.75	8.25	10.0	6.05	150	500	34.2	11.7
TPSMA7.5A	AGP	7.13	7.88	10.0	6.40	150	500	35.4	11.3
TPSMA8.2	AHP	7.38	9.02	10.0	6.63	50.0	200	32.0	12.5
TPSMA8.2A	AKP	7.79	8.61	10.0	7.02	50.0	200	33.1	12.1
TPSMA9.1	ALP	8.19	10.00	1.0	7.37	10.0	50.0	29.0	13.8
TPSMA9.1A	AMP	8.65	9.55	1.0	7.78	10.0	50.0	29.9	13.4
TPSMA10	ANP	9.00	11.00	1.0	8.10	5.0	20.0	26.7	15.0
TPSMA10A	APP	9.50	10.50	1.0	8.65	5.0	20.0	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	22.5
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	47.7
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 300μs, 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

FIG. 1 - PEAK PULSE POWER RATING CURVE

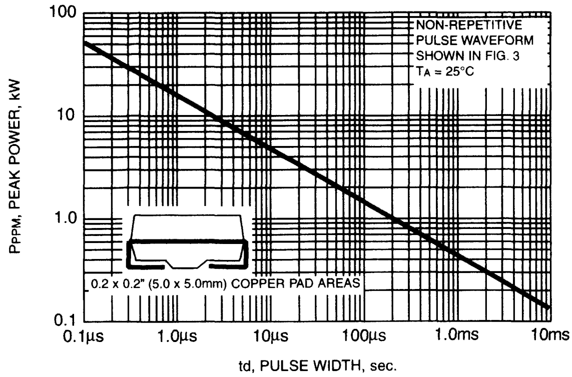


FIG. 2 - PULSE DERATING CURVE

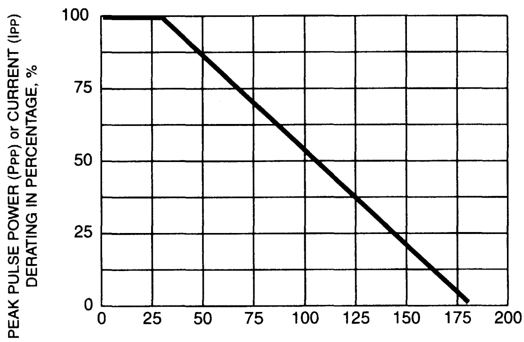


FIG. 3 - PULSE WAVEFORM

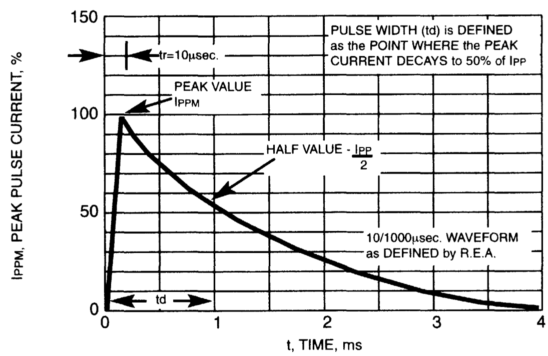


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

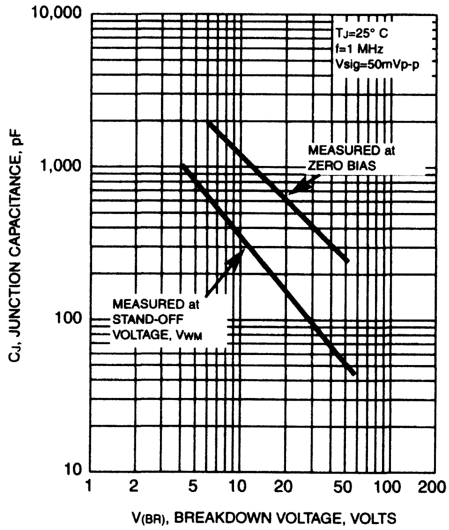
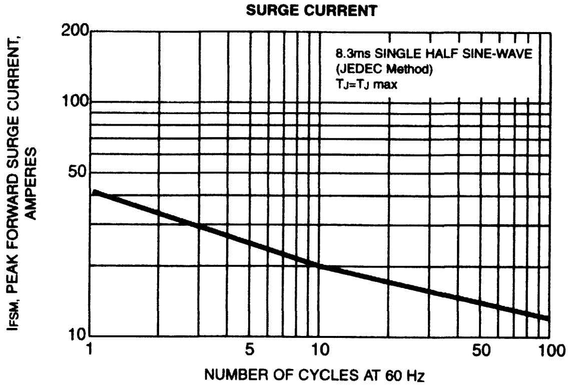


FIG. 5 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT



Automotive TVS

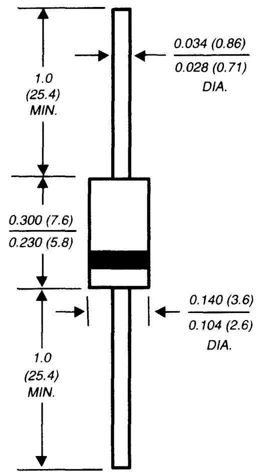
P6KA6.8 THRU P6KA43A

AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 43 Volts* ***Peak Pulse Power** - 600 Watts*

PATENTED*

DO-204AC



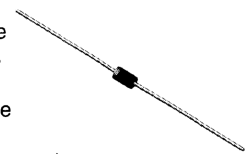
Dimensions in inches and (millimeters)

** Patent #'s 4,980,315*
5,166,769
5,278,094

Available in uni-directional only

FEATURES

- ♦ Designed for under the hood applications
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ 600W peak pulse power surge capability with a 10/1000μs waveform repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$
- ♦ For devices with $V_{(BR)} \geq 10V$, I_D are typically less than 1.0μA
- ♦ High temperature soldering guaranteed: 300°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: JEDEC DO-204AC molded plastic body over passivated junction
Terminals: Solder plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.015 ounce, 0.4 gram

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs (NOTE 1, FIG. 1)	P_{PPM}	Minimum 600	Watts
Pulse pulse current with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	5.0	Watts
Peak forward surge current, 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	70.0	Amps
Maximum instantaneous forward voltage at 50A (NOTE 3)	V_F	3.5	Volts
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 copper pad area of 1.6 x 1.6" (40 x 40mm) per Fig. 5
(3) Measured on 8.3ms single half sine-wave, or equivalent square wave, duty cycle=4 pulses per minutes maximum

1/21/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS RATINGS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) MAX	Test Current at I_T (Amps)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (µA)	Maximum Reverse Leakage at V_{WM} T_J=150°C I_D (µA)	Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
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	25.0	100	43.5	13.8	0.068
P6KA9.1A	8.65	9.55	1.0	7.78	25.0	100	44.8	13.4	0.068
P6KA10	9.00	11.0	1.0	8.10	10.0	50	40.0	15.0	0.073
P6KA10A	9.50	10.5	1.0	8.55	10.0	50	41.4	14.5	0.073
P6KA11	9.90	12.1	1.0	8.92	5.0	20.0	37.0	16.2	0.075
P6KA11A	10.5	11.6	1.0	9.40	5.0	20.0	38.5	15.6	0.076
P6KA12	10.8	13.2	1.0	9.72	2.0	10.0	34.7	17.3	0.076
P6KA12A	11.4	12.6	1.0	10.2	2.0	10.0	35.9	16.7	0.078
P6KA13	11.7	14.3	1.0	10.5	2.0	10.0	31.6	19.0	0.081
P6KA13A	12.4	13.7	1.0	11.1	2.0	10.0	33.0	18.2	0.081
P6KA15	13.5	16.3	1.0	12.1	2.0	10.0	27.3	22.0	0.084
P6KA15A	14.3	15.8	1.0	12.8	2.0	10.0	28.3	21.2	0.084
P6KA16	14.4	17.6	1.0	12.9	2.0	10.0	25.5	23.5	0.086
P6KA16A	15.2	16.8	1.0	13.6	2.0	10.0	26.7	22.5	0.086
P6KA18	16.2	19.8	1.0	14.5	2.0	10.0	22.6	26.5	0.088
P6KA18A	17.1	18.9	1.0	15.3	2.0	10.0	23.8	25.2	0.088

ELECTRICAL CHARACTERISTIC RATINGS ($T_A = 25°C$ unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	MAX	Test Current at I_T (mA)	Stand-off Voltage Vwm (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Tc=150°C Maximum Reverse Leakage at V_{WM} I_D (μA)	Peak Pulse Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
P6KA20	18.0	22.0	1.0	16.2	2.0	10.0	20.6	29.1	0.090
P6KA20A	19.0	21.0	1.0	17.1	2,0	10.0	21.7	27.7	0.090
P6KA22	19.8	24.2	1.0	17.8	2.0	10.0	18.8	31.9	0.092
P6KA22A	20.9	23.1	1.0	18.8	2.0	10.0	19.6	30.6	0.092
P6KA24	21.6	26.4	1.0	19.4	2.0	10.0	17.3	34.7	0.094
P6KA24A	22.8	25.2	1.0	20.5	2.0	10.0	18.1	33.6	0.094
P6KA27	24.3	29.7	1.0	21.8	2.0	10.0	15.3	39.1	0.096
P6KA27A	25.7	28.4	1.0	23.1	2.0	10.0	16.0	37.5	0.096
P6KA30	27.0	33.0	1.0	24.3	2.0	10.0	13.8	43.5	0.097
P6KA30A	28.5	31.5	1.0	25.6	2.0	10.0	14.5	41.4	0.097
P6KA33	29.7	36.3	1.0	26.8	2.0	10.0	12.6	47.7	0.098
P6KA33A	31.4	34.7	1.0	28.2	2.0	10.0	13.1	45.7	0.098
P6KA36	32.4	39.6	1.0	29.1	2.0	10.0	11.5	52.0	0.099
P6KA36A	34.2	37.8	1.0	30.8	2.0	10.0	12.0	49.9	0.099
P6KA39	35.1	42.9	1.0	31.6	2.0	10.0	10.6	56.4	0.100
P6KA39A	37.1	41.0	1.0	33.3	2.0	10.0	11.1	53.9	0.100
P6KA43	38.7	47.3	1.0	34.8	2.0	10.0	9.7	61.9	0.101
P6KA43A	40.9	45.2	1.0	36.8	2.0	10.0	10.1	59.3	0.101

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300μs. 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

FIG. 1 - PEAK PULSE POWER RATING CURVE

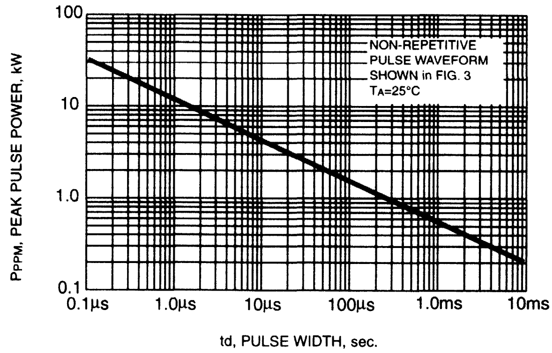


FIG. 2 - PULSE DERATING CURVE

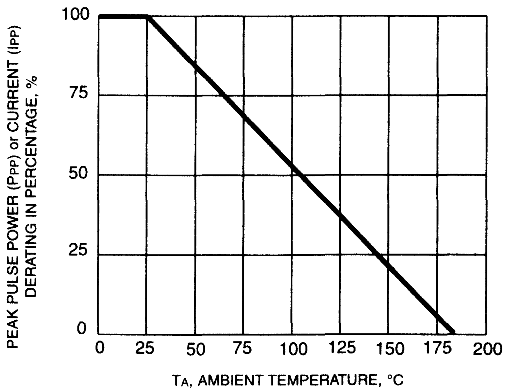


FIG. 3 - PULSE WAVEFORM

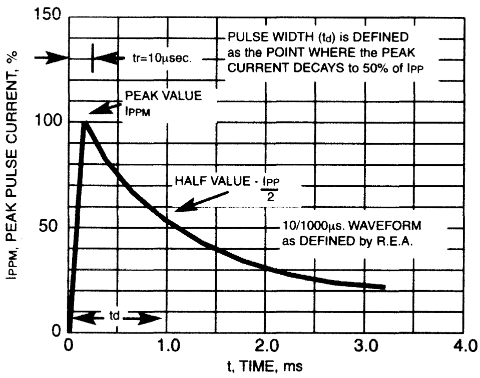


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

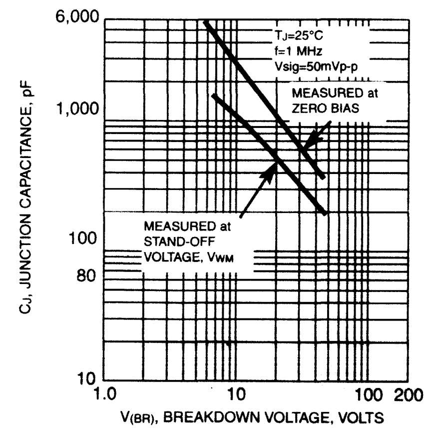


FIG. 5 - STEADY STATE POWER DERATING CURVE

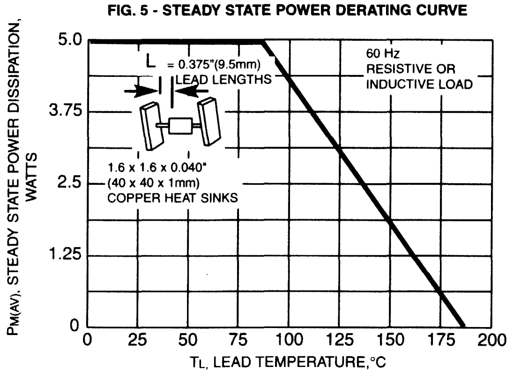
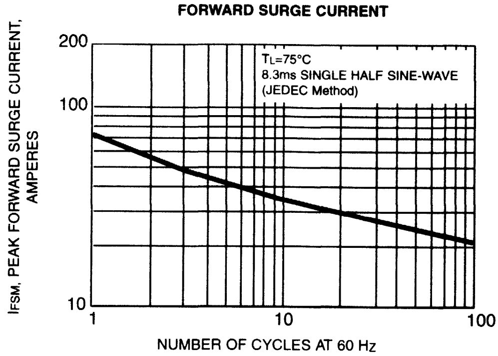


FIG. 6 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT



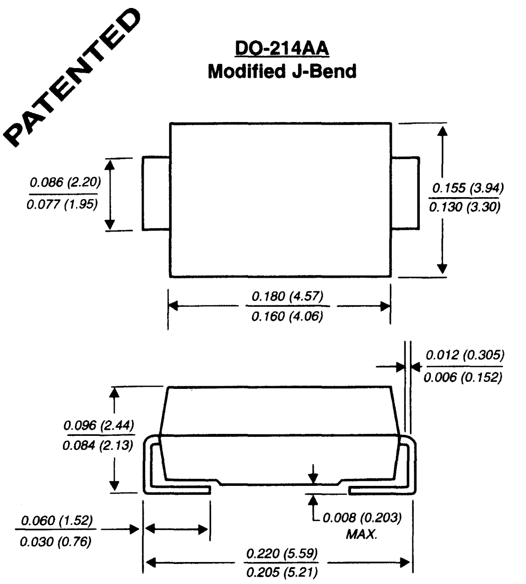
Automotive TVS

TPSMB6.8 THRU TPSMB43A

SURFACE MOUNT AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 - 43 Volts* ***Peak Pulse Power** - 600 Watts*

DO-214AA
Modified J-Bend



Dimensions in inches and (millimeters)

Available in uni-directional only

FEATURES

- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Easy pick and place
- ♦ Low profile package
- ♦ Built-in strain relief ideal for automated placement
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ 600W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$
- ♦ For devices with $V_{(BR)} \geq 10V$ I_D is typically less than 2.0μA at T_A=150°C
- ♦ Designed for under the hood surface mount applications
- ♦ High temperature soldering: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-214AA molded plastic body over passivated junction
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.003 ounces, 0.093 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTES 1,2, FIG. 1)	P_{PPM}	Minimum 600	Watts
Peak pulse current with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTES 2, 3)	I_{FSM}	70.0	Amps
Instantaneous forward voltage at 50A (NOTE 3)	V_F	3.5	Volts
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 x 5.0mm) land areas per figure
(3) Mounted on 8.3ms single half sine-wave duty cycle=4 pulses per minute maximum

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device	Device Marking Code	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) Min.	Max.	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_D (μA)	Maximum Reverse Leakage at V_{WM},T_J =150°C I_D (μA)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PP} V_C (Volts)
TPSMB6.8	KDP	6.12	7.48	10.0	5.50	500	1000	55.6	10.8
TPSMB6.8A	KEP	6.45	7.14	10.0	5.80	500	1000	57.1	10.5
TPSMB7.5	KFP	6.75	8.25	10.0	6.05	250	500	51.3	11.7
TPSMB7.5A	KGP	7.13	7.88	10.0	6.40	250	500	53.1	11.3
TPSMB8.2	KHP	7.38	9.02	10.0	6.63	100	200	48.0	12.5
TPSMB8.2A	KKP	7.79	8.61	10.0	7.02	100	200	49.6	12.1
TPSMB9.1	KLP	8.19	10.0	1.0	7.37	25	50.0	43.5	13.8
TPSMB9.1A	KMP	8.65	9.55	1.0	7.78	25	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	2.0	5.0	27.3	22.0
TPSMB15A	KXP	14.3	15.8	1.0	12.8	2.0	5.0	28.3	21.2
TPSMB16	KYP	14.4	17.6	1.0	12.9	2.0	5.0	25.5	23.5
TPSMB16A	KZP	15.2	16.8	1.0	13.6	2.0	5.0	26.7	22.5
TPSMB18	LDP	16.2	19.8	1.0	14.5	2.0	5.0	22.6	26.5
TPSMB18A	LEP	17.1	18.9	1.0	15.3	2.0	5.0	23.8	25.2
TPSMB20	LFP	18.0	22.0	1.0	16.2	2.0	5.0	20.6	29.1
TPSMB20A	LGP	19.0	21.0	1.0	17.1	2.0	5.0	21.7	27.7
TPSMB22	LHP	19.8	24.2	1.0	17.8	2.0	5.0	18.8	31.9
TPSMB22A	LKP	20.9	23.1	1.0	18.8	2.0	5.0	19.6	30.6
TPSMB24	LLP	21.6	26.4	1.0	19.4	2.0	5.0	17.3	34.7
TPSMB24A	LMP	22.8	25.2	1.0	20.5	2.0	5.0	18.1	33.2
TPSMB27	LNP	24.3	29.7	1.0	21.8	2.0	5.0	15.3	39.1
TPSMB27A	LPP	25.7	28.4	1.0	23.1	2.0	5.0	16.0	37.5
TPSMB30	LQP	27.0	33.0	1.0	24.3	2.0	5.0	13.8	43.5
TPSMB30A	LRP	28.5	31.5	1.0	25.6	2.0	5.0	14.5	41.4
TPSMB33	LSP	29.7	36.3	1.0	26.8	2.0	5.0	12.6	47.7
TPSMB33A	LTP	31.4	34.7	1.0	28.2	2.0	5.0	13.1	45.7
TPSMB36	LUP	32.4	39.6	1.0	29.1	2.0	5.0	11.5	52.0
TPSMB36A	LVP	34.2	37.8	1.0	30.8	2.0	5.0	12.0	49.9
TPSMB39	LWP	35.1	42.9	1.0	31.6	2.0	5.0	10.6	56.4
TPSMB39A	LXP	37.1	41.0	1.0	33.3	2.0	5.0	11.1	53.9
TPSMB43	LYP	38.7	47.3	1.0	34.8	2.0	5.0	9.7	61.9
TPSMB43A	LZP	40.9	45.2	1.0	36.8	2.0	5.0	10.1	59.3

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300μs, 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

FIG. 1 - PEAK PULSE POWER RATING CURVE

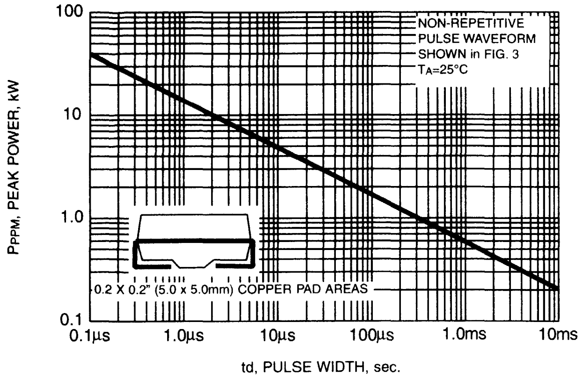


FIG. 2 - PULSE DERATING CURVE

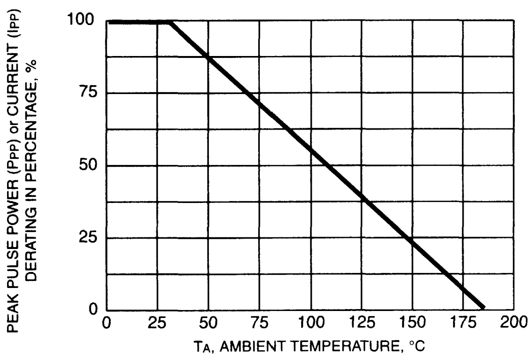


FIG. 3 - PULSE WAVEFORM

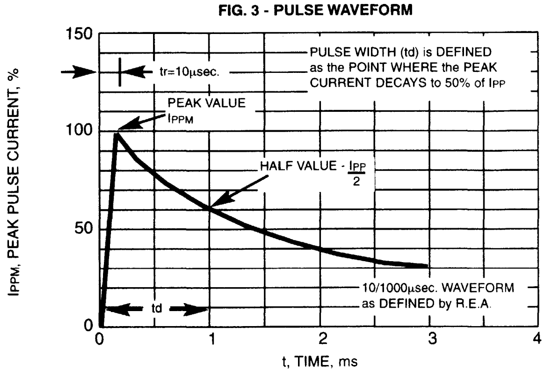


FIG. 4 - TYPICAL JUNCTION CAPACITANCE

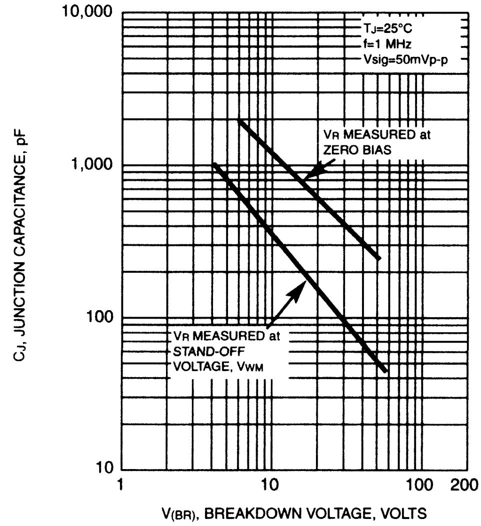
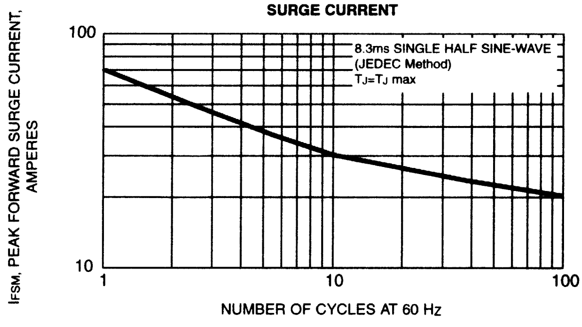


FIG. 5 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT

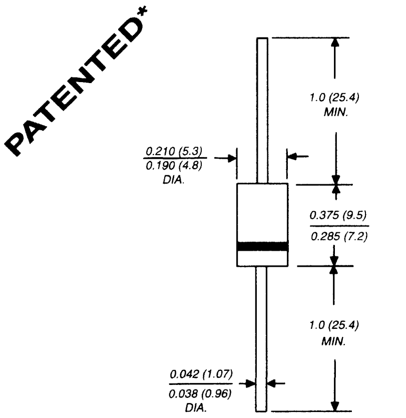


1.5KA6.8 THRU 1.5KA43A

AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 43 Volts* ***Peak Pulse Power** - 1500 Watts*

Case Style 1.5KA



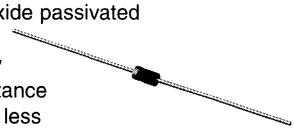
Dimensions in inches and (millimeters)

**Patent #'s 4,980,315*
5,166,769
5,278,094

Available in uni-directional only

FEATURES

- Designed for under the hood applications
- Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- 1500W peak pulse power surge capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- Exclusive patented PAR™ oxide passivated chip construction
- Excellent clamping capability
- Low incremental surge resistance
- Fast response time: typically less than 1.0 ps from 0 Volts to $V_{(BR)}$ for uni-directional
- For devices with $V_{(BR)} \Delta 10V$ I_D are typically less than 1.0μA at T_A=150°C
- High temperature soldering guaranteed: 300°C/10 seconds, 0.375" (9.5mm) lead length, 5lbs. (2.3 kg) tension



MECHANICAL DATA

Case: Molded plastic over passivated junction
Terminals: Solder plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.045 ounce, 1.2 grams

MAXIMUM RATINGS AND CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNITS*
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1, FIG. 1)	P_{PPM}	Minimum 1500	Watts
Peak pulse current at T_A=25°C with a 10/1000μs waveform (NOTE 1, FIG. 3)	I_{PPM}	SEE TABLE 1	Amps
Steady state power dissipation at T_L=75°C lead lengths 0.375" (9.5mm) (NOTE 2)	$P_{M(AV)}$	5.0	Watts
Peak forward surge current, 8.3ms single half Sine-wave superimposed on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	200	Amps
Maximum instantaneous forward voltage at 100A (NOTE 3)	V_F	3.5	Volts
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 copper pad area of 0.8 x 0.8" (20 x 20mm) per Fig. 5
(3) 8.3ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minutes maximum

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1)		Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	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} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
	MIN	MAX							
1.5KA6.8	6.12	7.48	10	5.50	1000	10000	139	10.8	0.057
1.5KA6.8A	6.45	7.14	10	5.80	1000	10000	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	2.0	10	68.2	22.0	0.084
1.5KA15A	14.3	15.8	1.0	12.8	2.0	10	70.8	21.2	0.084
1.5KA16	14.4	17.6	1.0	12.9	2.0	10	63.8	23.5	0.086
1.5KA16A	15.2	16.8	1.0	13.6	2.0	10	66.7	22.5	0.086
1.5KA18	16.2	19.8	1.0	14.5	2.0	10	56.6	26.5	0.088

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1 (Cont'd)

Device Type	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MIN	Breakdown Voltage $V_{(BR)}$ Volts (NOTE 1) MAX	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	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} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PPM} V_C (Volts)	Maximum Temperature Coefficient of $V_{(BR)}$ (% / °C)
1.5KA18A	17.1	18.9	1.0	15.3	2.0	10	59.5	25.2	0.088
1.5KA20	18.0	22.0	1.0	16.2	2.0	10	51.5	29.1	0.090
1.5KA20A	19.0	21.0	1.0	17.1	2.0	10	54.2	27.7	0.090
1.5KA22	19.8	24.2	1.0	17.8	2.0	10	47.0	31.9	0.092
1.5KA22A	20.9	23.1	1.0	18.8	2.0	10	49.0	30.6	0.092
1.5KA24	21.6	26.4	1.0	19.4	2.0	10	43.2	34.7	0.094
1.5KA24A	22.8	25.2	1.0	20.5	2.0	10	45.2	33.2	0.094
1.5KA27	24.3	29.7	1.0	21.8	2.0	10	38.4	39.1	0.096
1.5KA27A	25.7	28.4	1.0	23.1	2.0	10	40.0	37.5	0.096
1.5KA30	27.0	33.0	1.0	24.3	2.0	10	34.5	43.5	0.097
1.5KA30A	28.5	31.5	1.0	25.6	2.0	10	36.2	41.4	0.097
1.5KA33	29.7	36.3	1.0	26.8	2.0	10	31.4	47.7	0.098
1.5KA33A	31.4	34.7	1.0	28.2	2.0	10	32.8	45.7	0.098
1.5KA36	32.4	39.6	1.0	29.1	2.0	10	28.8	52.0	0.099
1.5KA36A	34.2	37.8	1.0	30.8	2.0	10	30.1	49.9	0.099
1.5KA39	35.1	42.9	1.0	31.6	2.0	10	26.6	56.4	0.100
1.5KA39A	37.1	41.0	1.0	33.3	2.0	10	27.8	53.9	0.100
1.5KA43	38.7	47.3	1.0	34.8	2.0	10	24.2	61.9	0.101
1.5KA43A	40.9	45.2	1.0	36.8	2.0	10	25.3	59.3	0.101

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300μs = 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

RATINGS AND CHARACTERISTIC CURVES 1.5KA6.8 THRU 1.5KA43A

FIG. 1 - PEAK PULSE POWER RATING CURVE

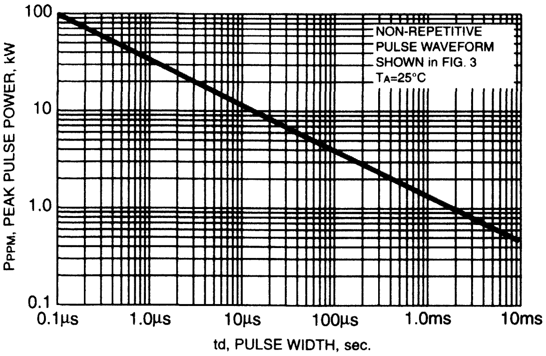


FIG. 2 - PULSE DERATING CURVE

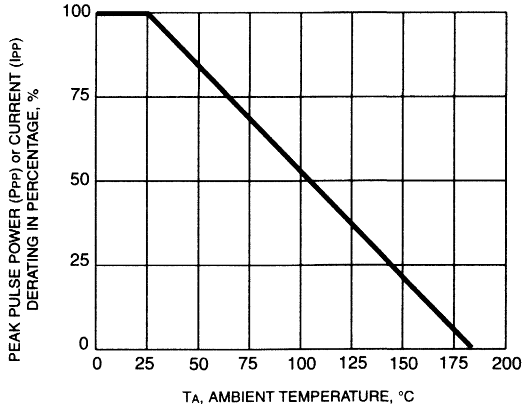


FIG. 3 - PULSE WAVEFORM

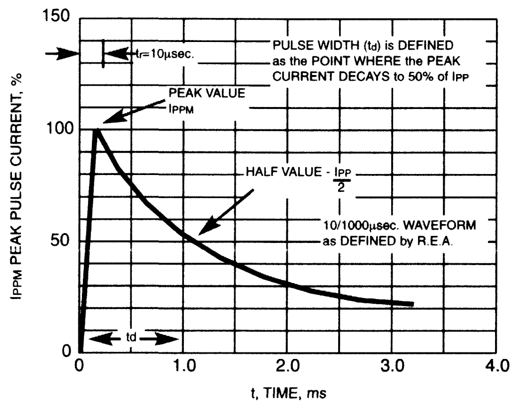


FIG. 4 - TYPICAL JUNCTION CAPACITANCE
UNI-DIRECTIONAL

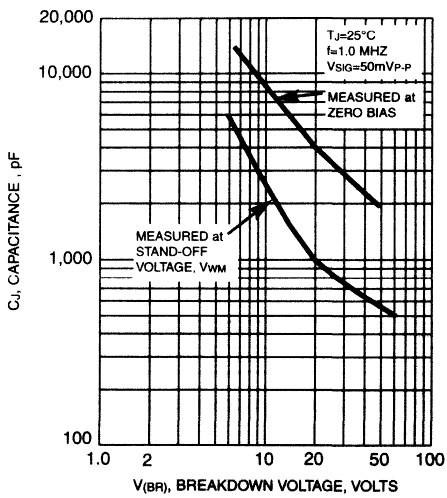


FIG. 5 - STEADY STATE POWER DERATING
CURVE

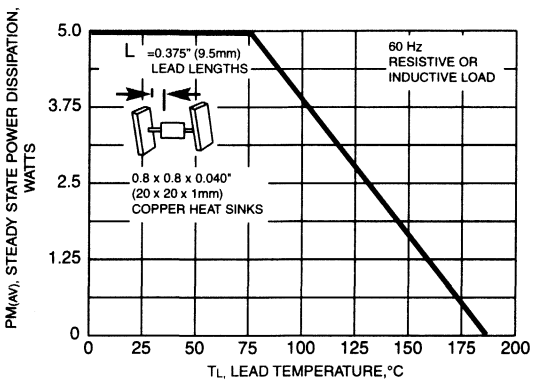
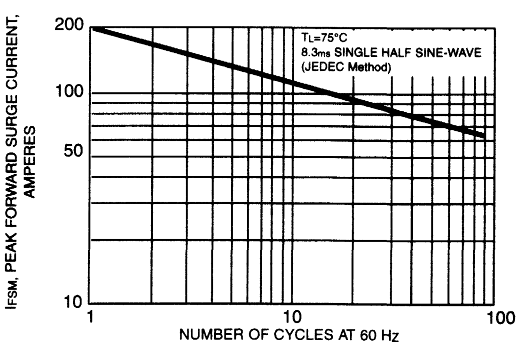


FIG. 6 - MAXIMUM NON-REPETITIVE FORWARD
SURGE CURRENT



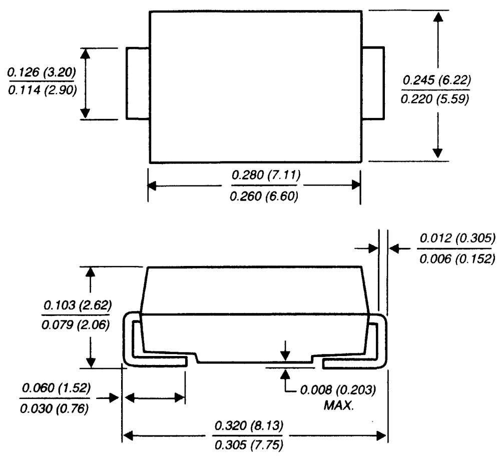
TPSMC6.8 THRU TPSMC43A

AUTOMOTIVE SURFACE MOUNT TRANSIENT VOLTAGE SUPPRESSOR

***Breakdown Voltage** - 6.8 to 43 Volts* ***Peak Pulse Power** - 1500 Watts*

PATENTED

DO-214AB
Modified J-Bend



Dimensions in inches and (millimeters)

Available in uni-directional only

FEATURES

- ♦ Designed for under the hood surface mount applications
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ Easy pick and place
- ♦ Low profile package
- ♦ Built-in strain relief
- ♦ Ideal for automated placement
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ 1500W peak pulse power capability with a 10/1000μs waveform, repetition rate (duty cycle): 0.01%
- ♦ Excellent clamping capability
- ♦ Low incremental surge resistance
- ♦ Fast response time: typically less than 1.0ps from 0 Volts to $V_{(BR)}$
- ♦ For devices with $V_{(BR)} \geq 10V$ I_D are typically less than 1.0μA at T_A=150°C
- ♦ High temperature soldering: 250°C/10 seconds at terminals

MECHANICAL DATA

Case: JEDEC DO-214AB molded plastic body over passivated junction
Terminals: Solder plated, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.007 ounces, 0.2 gram

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTES 1, 2, FIG. 3)	P_{PPM}	Minimum 1500	Watts
Peak power pulse current with a 10/1000μs waveform (NOTE 1, FIG. 1)	I_{PPM}	SEE TABLE 1	Amps
Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) (NOTES 2, 3)	I_{FSM}	200.0	Amps
Maximum instantaneous forward voltage at 100A (NOTE 3)	V_F	3.5	Volts
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 X 8.0mm^2) copper pads to each terminal
(3) Measured on 8.3ms single half sine-wave, or equivalent square wave, duty cycle=4 pulses per minute maximum

1/27/99

GENERAL SEMICONDUCTOR®

ELECTRICAL CHARACTERISTICS at (T_A=25°C unless otherwise noted) TABLE 1

Device	Device Marking Code	Breakdown Voltage $V_{(BR)}$ (Volts) (NOTE 1) Min.	Max.	Test Current at I_T (mA)	Stand-off Voltage V_{WM} (Volts)	Maximum Reverse Leakage at V_{WM} I_R (µA)	Maximum Reverse Leakage at V_{WM}, T_J =150°C I_D (µA)	Maximum Peak Pulse Surge Current I_{PPM} (NOTE 2) (Amps)	Maximum Clamping Voltage at I_{PP} V_C (Volts)
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	2.0	10	68.2	22.0
TPSMC15A	DXP	14.3	15.8	1.0	12.8	2.0	10	70.8	21.2
TPSMC16	DYP	14.4	17.6	1.0	12.9	2.0	10	63.8	23.5
TPSMC16A	DZP	15.2	16.8	1.0	13.6	2.0	10	66.7	22.5
TPSMC18	EDP	16.2	19.8	1.0	14.5	2.0	10	56.6	26.5
TPSMC18A	EEP	17.1	18.9	1.0	15.3	2.0	10	59.5	25.2
TPSMC20	EFP	18.0	22.0	1.0	16.2	2.0	10	51.5	29.1
TPSMC20A	EGP	19.0	21.0	1.0	17.1	2.0	10	54.2	27.7
TPSMC22	EHP	19.8	24.2	1.0	17.8	2.0	10	47.0	31.9
TPSMC22A	EKP	20.9	23.1	1.0	18.8	2.0	10	49.0	30.6
TPSMC24	ELP	21.6	26.4	1.0	19.4	2.0	10	43.2	34.7
TPSMC24A	EMP	22.8	25.2	1.0	20.5	2.0	10	45.2	33.2
TPSMC27	ENP	24.3	29.7	1.0	21.8	2.0	10	38.4	39.1
TPSMC27A	EPP	25.7	28.4	1.0	23.1	2.0	10	40.0	37.5
TPSMC30	EQP	27.0	33.0	1.0	24.3	2.0	10	34.5	43.5
TPSMC30A	ERP	28.5	31.5	1.0	25.6	2.0	10	36.2	41.4
TPSMC33	ESP	29.7	36.3	1.0	26.8	2.0	10	31.4	47.7
TPSMC33A	ETP	31.4	34.7	1.0	28.2	2.0	10	32.8	45.7
TPSMC36	EUP	32.4	39.6	1.0	29.1	2.0	10	28.8	52.0
TPSMC36A	EVP	34.2	37.8	1.0	30.8	2.0	10	30.1	49.9
TPSMC39	EWP	35.1	42.9	1.0	31.6	2.0	10	26.6	56.4
TPMSC39A	EXP	37.1	41.0	1.0	33.3	2.0	10	27.8	53.9
TPSMC43	EYP	38.7	47.3	1.0	34.8	2.0	10	24.2	61.9
TPSMC43A	EZP	40.9	45.2	1.0	36.8	2.0	10	25.3	59.3

NOTES:
(1) $V_{(BR)}$ measured after I_T applied for 300µs, 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

FIG. 1 - PEAK PULSE POWER RATING CURVE

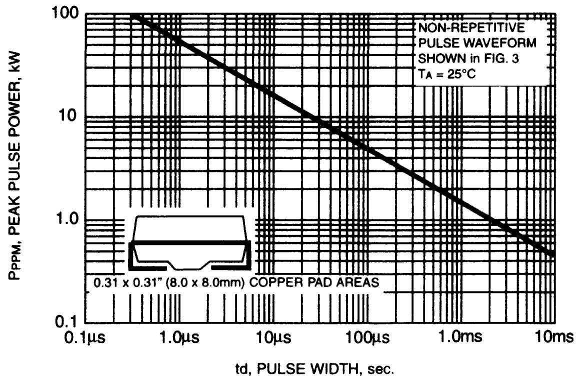


FIG. 2 - PULSE DERATING CURVE

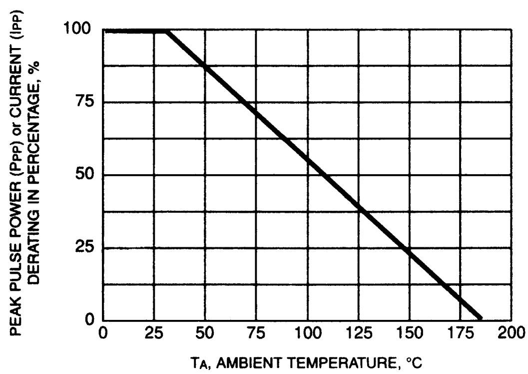


FIG. 3 - PULSE WAVEFORM

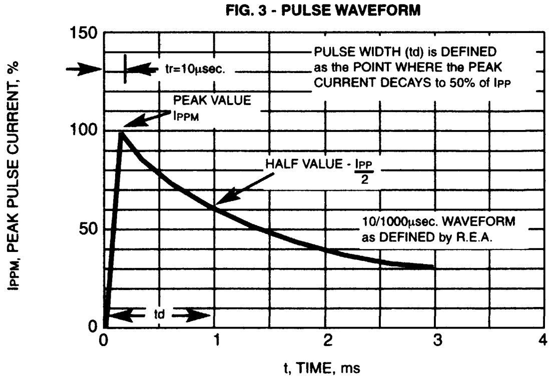


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FIG. 4 - TYPICAL JUNCTION CAPACITANCE

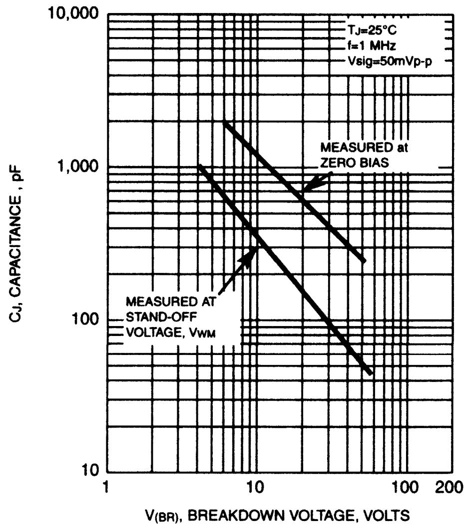
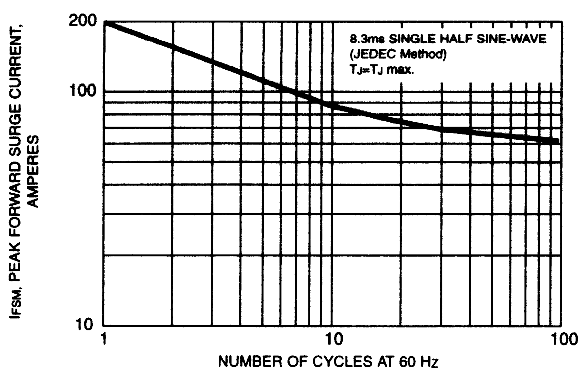


FIG. 5 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT



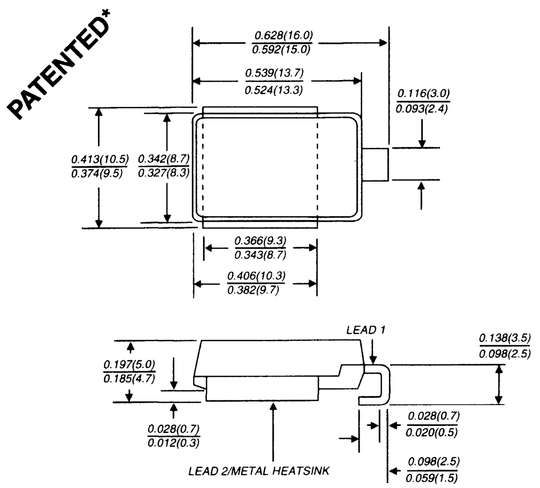
Automotive TVS

SM5A27 TRANSIENT SUPPRESSOR

SURFACE MOUNT AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Zener Voltage** - 27 Volts* ***Peak Pulse Current** - 70 Amps*

DO-218



*Patent #'s, 4,980,315, 5,166,769, 5,278,095

Dimensions in inches and (millimeters)

FEATURES

- ♦ Ideally suited for load dump protection
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ High temperature stability due to unique oxide passivation
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ Integrally molded heatsink provides a very low thermal resistance for maximum heat dissipation
- ♦ Low leakage current at T_J=175°C
- ♦ Low forward voltage drop
- ♦ High temperature soldering guaranteed: 260°C for 10 seconds at terminals

MECHANICAL DATA

Case: Molded plastic body, surface mount with heatsink integrally mounted in the encapsulation
Terminals: Plated, solderable per MIL-STD-750, Method 2026
Polarity: Heatsink is anode
Mounting Position: Any
Weight: 0.091 ounce, 2.58 grams

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	SM5A27	UNITS
Steady state power dissipation	P_D	5.0	Watts
Non-repetitive peak reverse surge current for 10μs/10ms exponentially decaying waveform	I_{RSM}	70	Amps
Maximum working peak stand-off voltage	V_{WM}	22.0	Volts
Minimum reverse zener voltage at 10mA	V_Z	24.0	Volts
Maximum reverse zener voltage at 10mA	V_Z	30.0	Volts
Maximum zener voltage temperature coefficient at I_Z=10mA	V_{ZTC}	36.0	mV/°C
Peak forward surge current, 8.3ms single half sine-wave	I_{FSM}	500	Amps
Maximum clamping voltage for 10μs/10ms exponentially decaying waveform at I_{PP}=55A	V_C	40.0	Volts
Maximum instantaneous forward voltage at 6.0A (NOTE 1)	V_F	1.0	Volts
Maximum reverse leakage current at rated V_{WM} T_J=25°C T_J=175°C	I_R	0.2 10.0	μA
Maximum thermal resistance junction to case	$R_{\Theta JC}$	1.0	°C/W
Operating junction and storage temperature range	T_J, T_{STG}	-55 to +175	°C

NOTE:
(1) Measured on a 300μs square pulse width

NOTICE: Advanced product information is subject to change without notice

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RATINGS AND CHARACTERISTIC CURVES SM5A27

FIG. 1 - POWER DERATING CURVE

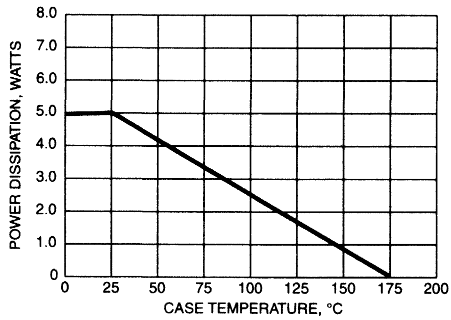


FIG. 2 - TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS

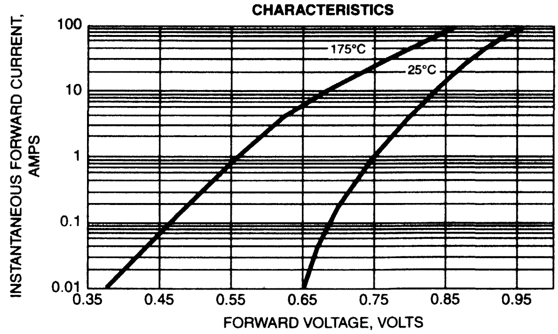


FIG. 3 - PULSE WAVEFORM

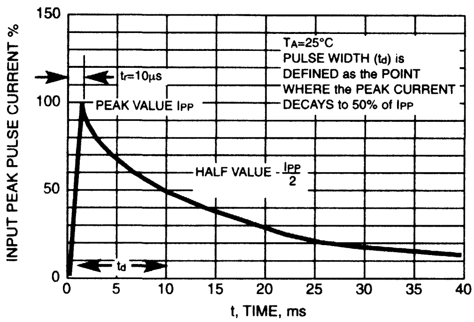


FIG. 4 - REVERSE POWER CAPABILITY

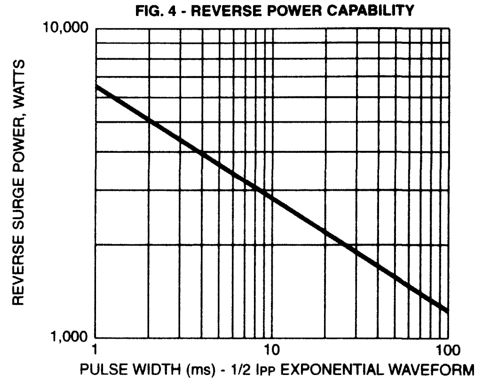


FIG. 5 - LOAD DUMP POWER CHARACTERISTICS (10ms EXPONENTIAL WAVEFORM)

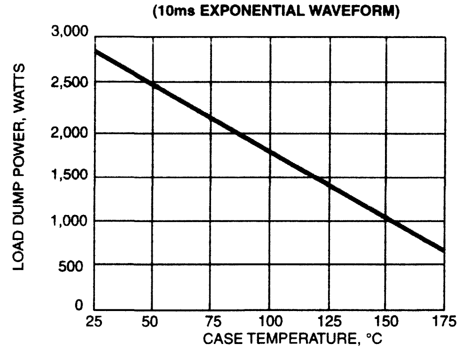


FIG. 6 - TYPICAL REVERSE CHARACTERISTICS

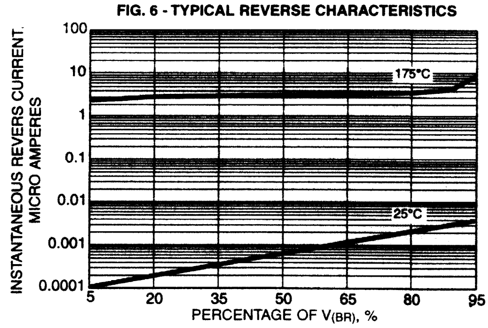
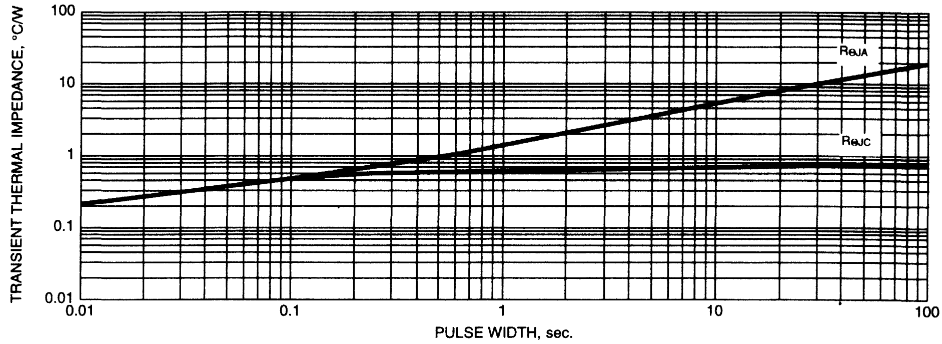


FIG. 7 - TYPICAL TRANSIENT THERMAL IMPEDANCE



Automotive TVS

GENERAL SEMICONDUCTOR®

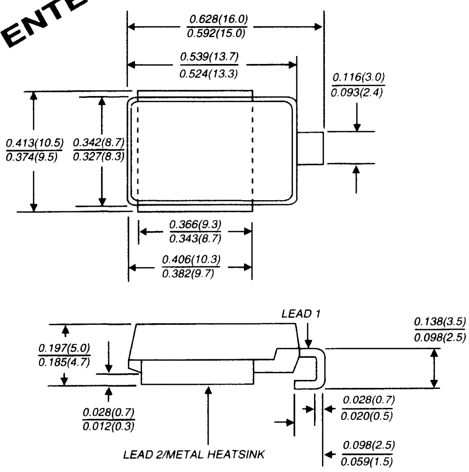
SM6A27 TRANSIENT SUPPRESSOR

SURFACE MOUNT AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Zener Voltage** - 27 Volts* ***Peak Pulse Current** - 90 Amps*

PATENTED*

DO-218



*Patent #'s, 4,980,315, 5,166,769, 5,278,095

Dimensions in inches and (millimeters)

FEATURES

- ♦ Ideally suited for load dump protection
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ High temperature stability due to unique oxide passivation
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ Integrally molded heatsink provides a very low thermal resistance for maximum heat dissipation
- ♦ Low leakage current at T_J=175°C
- ♦ Low forward voltage drop
- ♦ High temperature soldering guaranteed: 260°C for 10 seconds at terminals

MECHANICAL DATA

Case: Molded plastic body, surface mount with heatsink integrally mounted in the encapsulation
Terminals: Plated, solderable per MIL-STD-750, Method 2026
Polarity: Heatsink is anode
Mounting Position: Any
Weight: 0.091 ounce, 2.58 grams

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	*SM6A27*	*UNITS*
Steady state power dissipation	P_D	6.0	Watts
Non-repetitive peak reverse surge current for 10μs/10ms exponentially decaying waveform	I_{RSM}	90	Amps
Maximum working peak stand-off voltage	V_{WM}	22.0	Volts
Minimum reverse zener voltage at 10mA	V_Z	24.0	Volts
Maximum reverse zener voltage at 10mA	V_Z	30.0	Volts
Maximum zener voltage temperature coefficient at I_Z=10mA	V_{ZTC}	36.0	mV/°C
Peak forward surge current, 8.3ms single half sine-wave	I_{FSM}	600	Amps
Maximum clamping voltage for 10μs/10ms exponentially decaying waveform at I_{PP}=65A	V_C	40.0	Volts
Maximum instantaneous forward voltage at 6.0A (NOTE 1)	V_F	0.99	Volts
Maximum reverse leakage current at rated V_{WM} T_J=25°C T_J=175°C	I_R	0.5 20.0	μA
Maximum thermal resistance junction to case	$R_{\Theta JC}$	0.95	°C/W
Operating junction and storage temperature range	T_J, T_{STG}	-55 to +175	°C

NOTE:
(1) Measured on a 300μs square pulse width

NOTICE: Advanced product information is subject to change without notice

RATINGS AND CHARACTERISTIC CURVES SM6A27

FIG. 1 - POWER DERATING CURVE

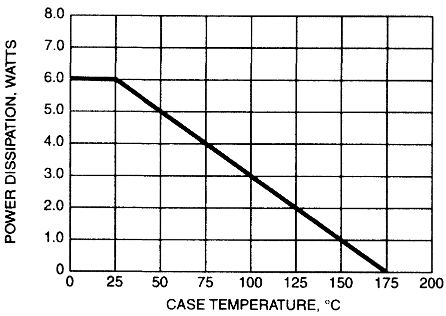


FIG. 2 - TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS

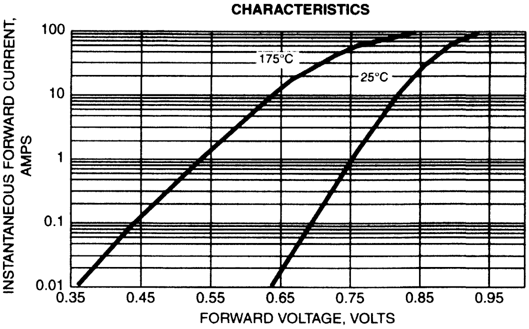


FIG. 3 - PULSE WAVEFORM

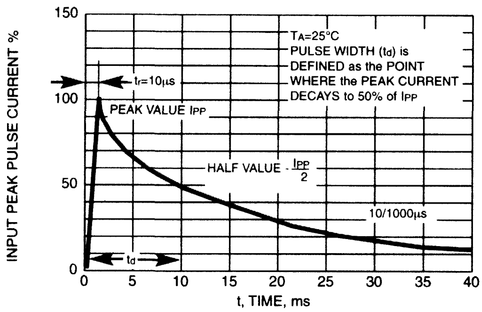


FIG. 4 - REVERSE POWER CAPABILITY

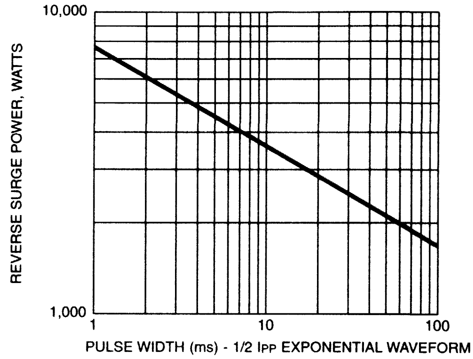


FIG. 5 - LOAD DUMP POWER CHARACTERISTICS (10ms EXPONENTIAL WAVEFORM)

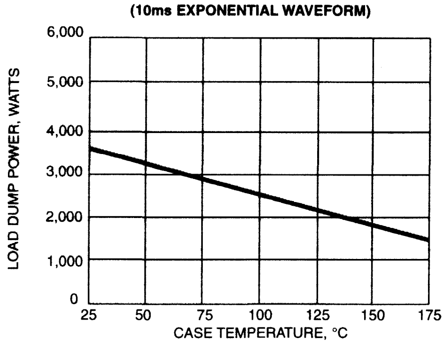


FIG. 6 - TYPICAL REVERSE CHARACTERISTICS

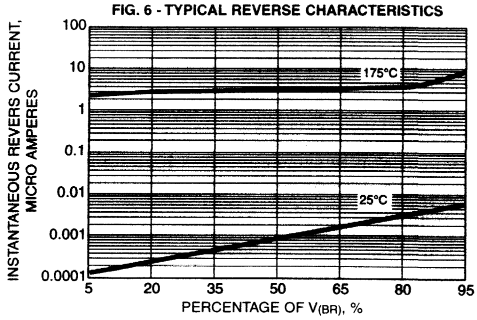
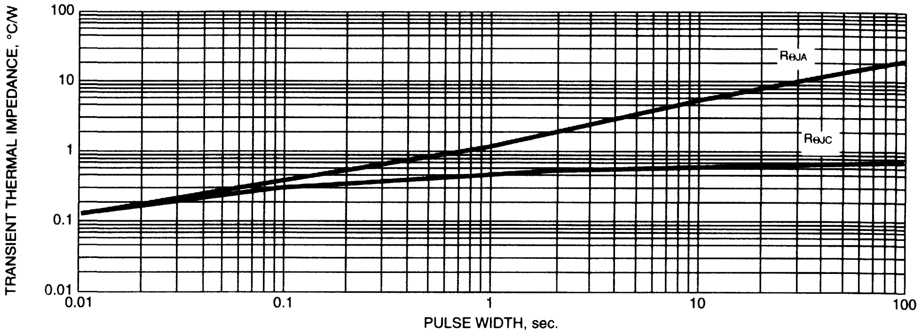


FIG. 7 - TYPICAL TRANSIENT THERMAL IMPEDANCE



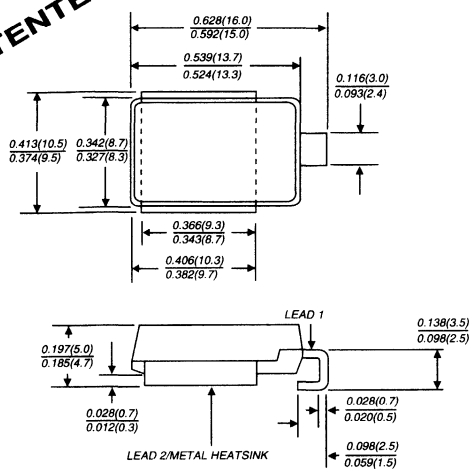
SM8A27 TRANSIENT SUPPRESSOR

SURFACE MOUNT AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

***Zener Voltage** - 27 Volts* ***Peak Pulse Current** - 130 Amps*

PATENTED*

DO-218



Patent #'s, 4,980,315, 5,166,769, 5,278,095

Dimensions in inches and (millimeters)

FEATURES

- ♦ Ideally suited for load dump protection
- ♦ Plastic package has Underwriters Laboratory Flammability Classification 94V-0
- ♦ High temperature stability due to unique oxide passivation
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ Integrally molded heatsink provides a very low thermal resistance for maximum heat dissipation
- ♦ Low leakage current at T_J=175°C
- ♦ Low forward voltage drop
- ♦ High temperature soldering guaranteed: 260°C for 10 seconds at terminals

MECHANICAL DATA

Case: Molded plastic body, surface mount with heatsink integrally mounted in the encapsulation
Terminals: Plated, solderable per MIL-STD-750, Method 2026
Polarity: Heatsink is anode
Mounting Position: Any
Weight: 0.091 ounce, 2.58 grams

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOLS	*SM8A27*	*UNITS*
Steady state power dissipation	P_D	8.0	Watts
Non-repetitive peak reverse surge current for 10µs/10ms exponentially decaying waveform	I_{RSM}	130	Amps
Maximum working peak stand-off voltage	V_{WM}	22.0	Volts
Minimum reverse zener voltage at 10mA	V_Z	24.0	Volts
Maximum reverse zener voltage at 10mA	V_Z	30.0	Volts
Maximum zener voltage temperature coefficient at I_Z=10mA	Vztc	36.0	m V/°C
Peak forward surge current, 8.3ms single half sine-wave	I_{FSM}	700	Amps
Maximum clamping voltage for 10µs/10ms exponentially decaying waveform at I_{PP}=75A	V_C	40.0	Volts
Maximum instantaneous forward voltage at 6.0A (NOTE 1)	V_F	0.98	Volts
Maximum reverse leakage current at rated V_{WM} T_J=25°C T_J=175°C	I_R	1.0 50.0	µA
Maximum thermal resistance junction to case	$R_{\Theta JC}$	0.90	°C/W
Operating junction and storage temperature range	T_J, T_{STG}	-55 to +175	°C

NOTE:
(1) Measured on a 300µs square pulse width

NOTICE: Advanced product information is subject to change without notice

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FIG. 1 - POWER DERATING CURVE

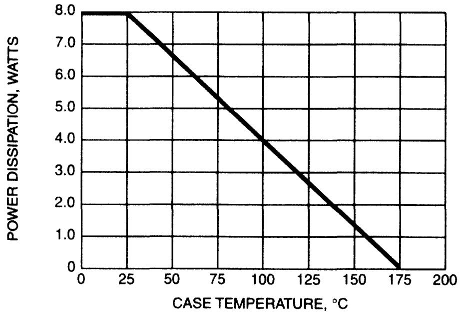


FIG. 2 - TYPICAL INSTANTANEOUS FORWARD CHARACTERISTICS

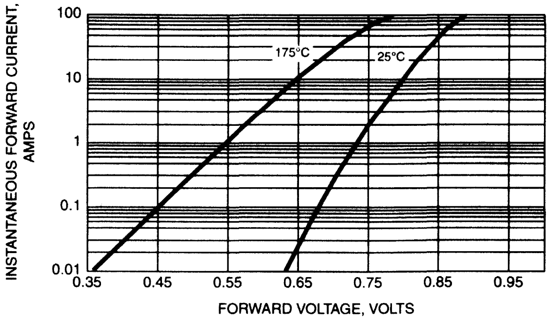


FIG. 3 - PULSE WAVEFORM

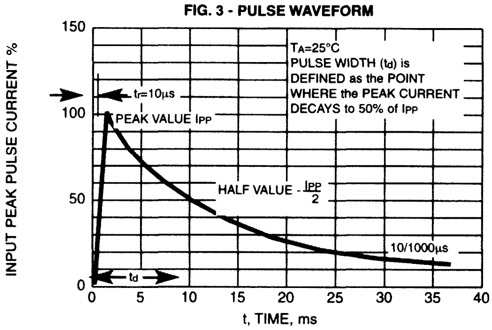


FIG. 4 - REVERSE POWER CAPABILITY

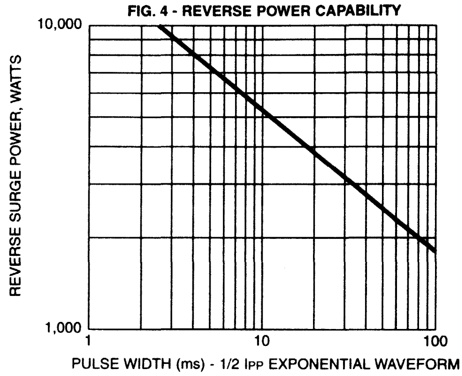


FIG. 5 - LOAD DUMP POWER CHARACTERISTICS (10ms EXPONENTIAL WAVEFORM)

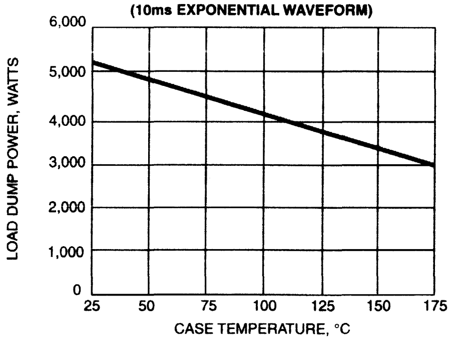


FIG. 6 - TYPICAL REVERSE CHARACTERISTICS

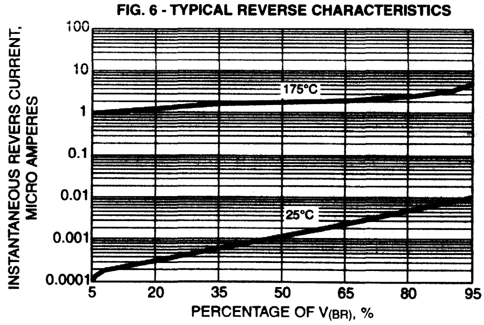
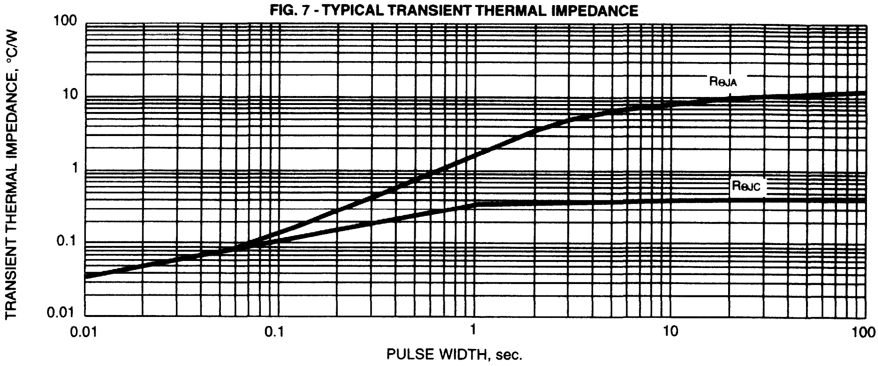


FIG. 7 - TYPICAL TRANSIENT THERMAL IMPEDANCE



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GENERAL SEMICONDUCTOR®

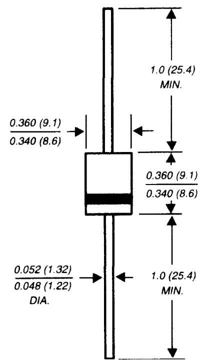
6KA24 TRANSIENT SUPPRESSOR

PREMIUM AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

Stand-off Voltage *- 24 Volts* ***Peak Pulse Power*** *- 6000 Watts*

PATENTED*

Case Style P600

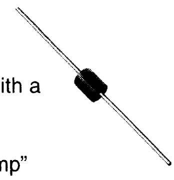


Dimensions in inches and (millimeters)

* *Patent #'s 4,980,315*
5,166,769
5,278,094

FEATURES

- ♦ Designed for under the hood applications
- ♦ Plastic package has Underwriters Laboratories Flammability Classification 94V-0
- ♦ Exclusive patented PAR™ oxide passivated chip construction
- ♦ 6000W peak pulse power capability with a 10/1000μs waveform
- ♦ 2000W peak pulse power capability with a 10μs/50ms waveform
- ♦ Low incremental surge resistance
- ♦ Ideally suited for automotive "load dump" applications
- ♦ High temperature soldering guaranteed: 300°C/10 seconds 0.375" (9.5mm) lead lengths, 5lbs (2.3kg) tension



MECHANICAL DATA

Case: Molded plastic body over nitride passivated die
Terminals: Axial leads solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes positive end (cathode)
Mounting Position: Any
Weight: 0.07 ounce, 2.1 grams

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°ambient temperature unless otherwise specified.

RATINGS	SYMBOL	VALUE	UNITS
Peak pulse power dissipation with a 10/1000μs waveform (NOTE 1)	P_{PPM}	6000	Watts
Peak pulse power dissipation with a 10μs/50ms waveform (NOTE 2)	P_{PPM}	2000	Watts
Steady state power dissipation, (NOTE 6) lead lengths 0.375" (9.5mm), T_L=85°C	$P_{M(AV)}$	5.0	Watts
Peak forward surge current, 8.3ms single half sine-wave on rated load (JEDEC Method) (NOTE 3)	I_{FSM}	400	Amps
Maximum DC reverse leakage current at V_{WM}=24V T_A=25°C T_A=150°C	I_D	1.0 50.0	μA
Reverse Breakdown Voltage at 100mA T_A=25°C minimum T_A=25°C maximum T_A=150°C minimum T_A=150°C maximum	$V_{(BR)}$	26.7 32.6 29.7 36.7	Volts
Maximum clamping voltage at I_{PP}=90A (NOTE 4) T_A=25°C T_A=150°C	V_C	40.0 45.0	Volts
Maximum instantaneous forward voltage at 100A (NOTE 5)	V_F	1.8	Volts
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 10/1000μs waveform
(2) Non-repetitive current pulse, per Fig. 5, with a 10μs/50ms waveform
(3) Measured on 8.3ms half sine-wave, or equivalent square wave, duty cycle=4 pulses maximum
(4) Measured on 80μs square pulse width
(5) Measured on 300μs second square pulse width
(6) Mounted on copper pad area of 0.8 x 8.0" (20 x 20mm) per Fig. 5

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GENERAL SEMICONDUCTOR®

FIG. 1 - PEAK PULSE POWER RATING CURVE

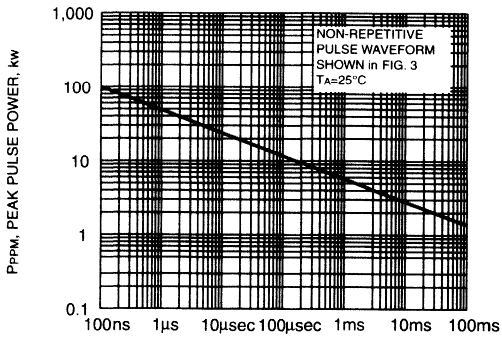


FIG. 2 - 10/1000µs PULSE WAVEFORM

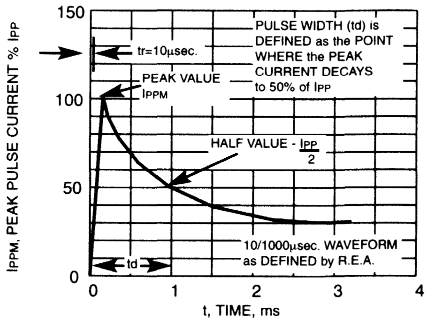


FIG. 3 - PULSE DERATING CURVE

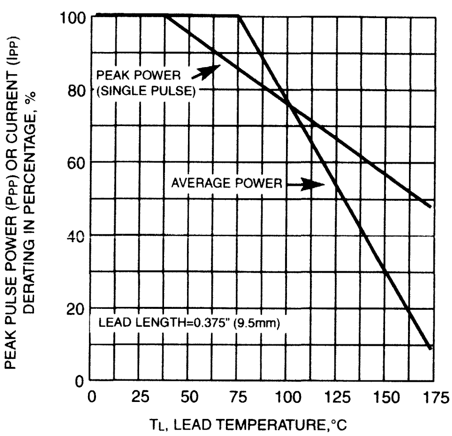


FIG. 4 - MAXIMUM NON-REPETITIVE PEAK FORWARD SURGE CURRENT

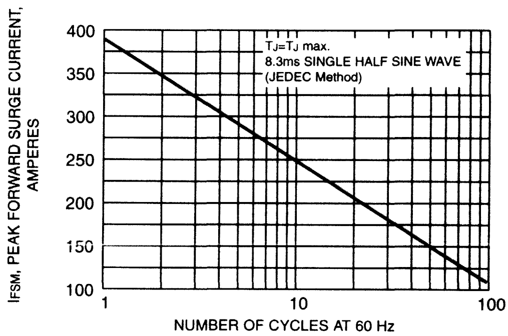
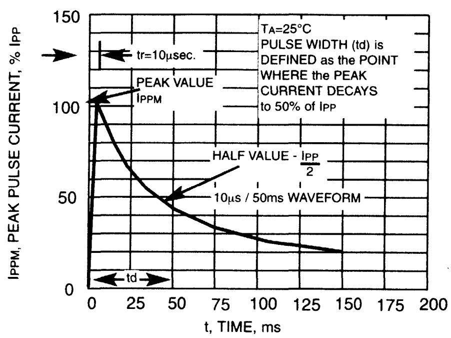


FIG. 5 - 10µs/50ms PULSE WAVEFORM



Automotive TVS

APPLICATION NOTES

Zener diodes are special silicon diodes which have a relatively low, defined breakdown voltage, called the Zener voltage.

At low reverse voltages a Zener diode behaves in a similar manner to an ordinary silicon diode, that is, it passes only a very small leakage current. If, however, the reverse bias is increased until it reaches the breakdown region, then a small reverse voltage increase causes a considerable increase in leakage current; the reverse current is then called the Zener current. The characteristics of a Zener diode operating under reverse breakdown conditions are similar to those of a struck glow discharge tube. Because of this, Zener diodes can be used in a similar way, i. e. as stabilizers, limiters, ripple reduction elements, reference voltage sources, and also as DC coupling elements with a constant voltage drop.

A special kind of Zener diodes is the bi-directional Zener diode with breakdown characteristics in both directions. The main features are:

- Energy absorption in both directions
- Very fast response
- Low Zener voltage variation from standby to peak pulse power load
- After power pulse load the bi-directional Zener diode automatically recovers to ready state

The bi-directional Zener diodes are designed to protect voltage sensitive components, integrated circuits, MOS devices, hybrids and complete electronic systems.

Characteristics

The slope of the reverse breakdown characteristic defines the static differential resistance $r_{zu} = dV_Z/dI_Z$, which, in turn, comprises a dynamic (or inherent differential) resistance r_{zj} and a thermal differential resistance r_{zth}.

Use of the dynamic resistance alone for characterizing the performance of a Zener diode is only satisfactory if the ambient temperature can be assumed to be constant, and the Zener current variations are so rapid that the junction temperature is unable to follow them. A generalized design approach requires that the effect of slow Zener current variations is also taken into consideration, in which case the design must be based on the static differential resistance value r_{zu}, which is the sum of the dynamic and the thermal differential resistance:

$$r_{zu} = r_{zj} + r_{zth}$$
$$\text{At } T_{amb} = const.,$$
$$V_Z = f(I_Z, T)$$

so that
$$\frac{dV_Z}{dI_Z} = \left(\frac{\delta V_Z}{\delta I_Z}\right)_T + \left(\frac{\delta V_Z}{\delta T}\right)_{I_Z} \frac{dT}{dI_Z} \qquad (1)$$

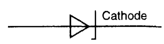
Setting $\frac{dV_Z}{V_Z \cdot dT} = \alpha_{vz}$ (2) and $\frac{dT}{V_Z \cdot dI_Z} = R_{thA}$ (3)

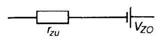
yields $r_{zu} = r_{zj} + V_Z^2 \cdot \alpha_{vz} \cdot R_{thA} = r_{zj} + r_{zth}$ (4)

where α_{vz} is the Zener voltage temperature coefficient, T the junction temperature, and R_{thA} the thermal resistance between the junction and the ambient air.

The dynamic resistance is largely dependent on current, and decreases as the Zener current increases. The temperature coefficient α_{vz} is dependent on temperature, but only at Zener voltages below 7 V.

Circuit symbol for a Zener diode 

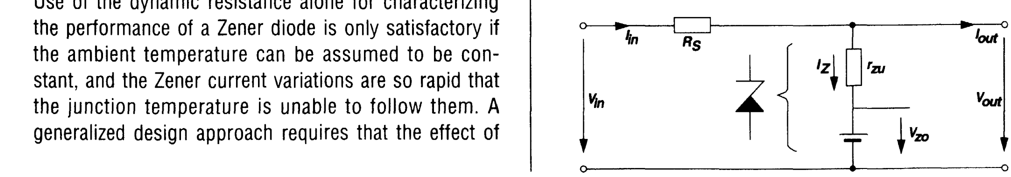
or 

Simplified equivalent circuit diagram 

V_{ZO} is the breakdown voltage, extrapolated for $I_Z = 0$.

Design of Stabilizer Circuits

To simplify the design procedure, a constant differential resistance r_Z is assumed in the following expressions. Since this does not strictly apply (as has been pointed out previously), an r_Z value which lies in the middle of the stabilization range should be used. It is also assumed that T_{amb} is constant.



In the above circuit, the Zener diode is replaced by an equivalent circuit comprising a constant voltage generator giving a DC voltage of V_{ZO} in series with a differential resistance r_{zu}. Other parameters in this circuit diagram are: V_{out} = output voltage, I_{out} = output current, V_{in} = input voltage, I_{in} = input current, I_Z = Zener current, and R_S = series resistance.

The following equations apply

$$V_{in} - V_{out} = (I_{out} + I_Z) \cdot R_S \quad (5)$$

$$V_{out} - V_{ZO} = I_Z \cdot r_{zu} \quad (6)$$

If equation (6) is combined with equation (5) one obtains

$$V_{in} = V_{out} + I^{out} \cdot R_S + (V_{out} - V_{ZO}) \cdot \frac{R_S}{r_{zu}} \quad (7)$$

Differentiation yields the smoothing factor

$$G = \frac{dV_{in}}{dV_{out}} = 1 + \frac{R_S}{r_{zu}} \quad (8)$$

where I_{out} is assumed to be constant.

Because R_S is, as a rule, very much larger than r_{zu}, the smoothing factor G can be taken as being approximately equal to the ratio R_S/r_{zu}. As can be deduced from equation (8), G increases linearly with R_S (provided that V_{in} is also increased), and, if V_{in} and R_S approach infinity, the G will also approach infinity.

More important than the smoothing factor is the stabilization factor S, i. e. the ratio of a relative input voltage change to a relative output voltage change:

$$S = \frac{\frac{dV_{in}}{V_{in}}}{\frac{dV_{out}}{V_{out}}} = \left(1 + \frac{R_S}{r_{zu}}\right) \cdot \frac{V_{out}}{V_{in}} \quad (9)$$

The stabilization factor, unlike the smoothing factor, does not increase linearly with V_{in} and R_S, but approaches a finite limit value when V_{in} and $R_S \to \infty$. In order to determine this limit value, R_S is eliminated from equation (9) by the use of equation (5):

$$R_S = \frac{V_{in} - V_{out}}{I_{in} + I_{out}} = \frac{V_{in} - V_{out}}{I_{in}}$$

with the result that

$$S = \frac{V_{out}}{V_{in}} + \frac{V_{out}}{I_{in} \cdot r_{zu}} \cdot \left(1 - \frac{V_{out}}{V_{in}}\right) \quad (10)$$

If $V_{in} \to \infty$, then this reduces to

$$S_{max} = \frac{V_{out}}{I_{in} \cdot r_{zu}} \quad (11)$$

It can be seen that for a given Zener diode and a given load, the stabilization improves as the input voltage is increased; it should be noted, however, that the power dissipated in the diode series resistor rises at a higher rate than that at which the stabilization factor is increased. As a sensible compromise between the requirements of good stabilization and acceptable power dissipation, it is suggested that the input voltage be made about 2 to 4 times the value of the output voltage.

The output resistance presented by the stabilizer is equal to the diode series resistance R_S in parallel with the differential resistance r_{zu} of the diode. Since R_S is usually very much larger than r_{zu}, the stabilizer output resistance is virtually equal to r_{zu}. It should be noted that in this calculation R_S includes the source resistance of the input supply so that V_{in} is the source EMF.

Other important factors which must be taken into consideration in the design of a shunt stabilizer are, apart from the stabilization factor and the output resistance, the maximum admissible power dissipation and the maximum admissible Zener current. These must not be exceeded under maximum input voltage and minimum load current conditions. The following conditions must be fulfilled:

$$V_{out} \cdot \left(\frac{V_{in\,max} - V_{out}}{R_S} - I_{out,\,min}\right) < P_{tot} \quad (14)$$

$$R_S > \frac{V_{in\,max} - V_{out}}{I_{Z\,max} + I_{out\,min}} \quad (15)$$

Finally, steps must be taken to ensure that the output current I_{out} does not become excessive. If the input voltage is constant, then the Zener current decreases in the same proportion as the output current increases. However, at very small Zener currents the dynamic resistance of the Zener diode rises sharply and the stabilization performance is correspondingly degraded.

Therefore, the following conditions must be fulfilled:

$$\left(\frac{V_{in\,min} - V_{out}}{R_S} - I_{out,\,max} \right) > I_{Z\,min} \qquad (16)$$

$$R_S < \frac{V_{in\,min} - V_{out}}{I_{Z\,min} + I_{out\,max}} \qquad (17)$$

$I_{Z\,min}$ should be 5 to 10% of $I_{Z\,max}$.

Breakdown Voltage (Zener Voltage) Measurements on Zener Diodes

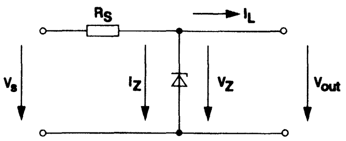
If a Zener diode is connected to a constant current source, then at constant ambient temperature, the Zener voltage changes and approaches asymptotically a final value. This voltage change is due to the power dissipated in the junction which in turn causes a rise in junction temperature. Zener diodes with a negative temperature coefficient exhibit a Zener voltage reduction, whereas those with a positive temperature coefficient show a Zener voltage increase on application of current. The magnitude of this voltage change due to intrinsic heat generation can be derived from the relevant curves.

Because it is not practical to wait during tests until each device has reached its thermal equilibrium, it is common practice to measure the breakdown voltage of Zener diodes by application of a pulsating current of less than 1 sec duration. Under these conditions the junction temperature is the same as the ambient temperature. The magnitude of the test current used varies from type to type and is quoted in the relevant data sheets.

Therefore, designers, but especially customers carrying out acceptance tests, should allow for the fact that the Zener voltage of a device which is at thermal equilibrium will differ from that quoted in the data sheet. To arrive at an estimate of the equilibrium Zener voltage, a voltage equal to the product of Zener current and thermal differential resistance should be added to the voltage associated with the chosen current as derived from the published dynamically measured breakdown curves.

TEMPERATURE-COMPENSATED STABILIZING CIRCUITS

Two Zener diode parameters in particular affect the stabilizer performance – the voltage temperature coefficient α_{vz} and the differential resistance r_{zj}. These parameters are determined by the physical properties of the conventional Zener diodes and their effect on stabilization performance will be better appreciated if the simple stabilizer circuit shown in the figure below, consisting of a resistor in series with a Zener diode, is considered.



In this circuit the output voltage V_{out} (which in this case is the same as the Zener voltage V_Z) is related to the supply voltage V_S, the load current I_L and the ambient temperature T_{amb} by the expression

$$\Delta V_{out} = \frac{r_Z}{R_S} \cdot \Delta V_S + r_Z \cdot \Delta I_L + \alpha_{vz} \cdot V_Z \cdot \Delta T_{amb} \qquad (18)$$

As far as the differential resistance r_Z is concerned a distinction should be made between the inherent differential resistance r_{zj} and the static differential resistance r_{zu}. The following equation applies:

$$r_{zu} = r_{zj} + \alpha_{vz} \cdot V_Z^2 \cdot R_{th} = r_{zj} + r_{zth} \qquad (19)$$

where R_{th} is the thermal resistance and r_{zth} the thermal differential resistance of the diode.

The second term in this expression takes into account the change in dissipation $V_Z \cdot \Delta I_L$ due to the current variation ΔI_L, which, for a thermal resistance R_{th}, produces a crystal temperature change of

$$\Delta T_j = V_Z \cdot R_{th} \cdot \Delta I_L \qquad (20)$$

and consequently an output change of

$$\Delta V_Z = \alpha_{vz} \cdot V_Z \cdot \Delta T_j = \alpha_{vz} \cdot V_Z^2 \cdot R_{th} \cdot \Delta I_L \qquad (21)$$

Let us, by way of an example, calculate the performance of a stabilizer circuit which incorporates a Zener diode type ZPD22 from General Semiconductor and operates from a high supply voltage and with low load current. For this type the following data are published for $I_Z = 5$ mA:

$$V_Z = 22\,V$$

$$r_{zu} = r_{zj} + r_{zth} = 25\Omega + 100\Omega = 125\Omega$$

$$\alpha_{vz} = 9 \cdot 10^{-4}/K$$

For a supply voltage of $V_S = 220$ V, a load current of $I_L = 5$ mA and a diode Zener current of $I_Z = 5$ mA the value of the series resistor works out to

$$R_S = + \frac{220V - 22V}{5mA + 5mA} = 19.8 \approx 20k\Omega$$

Let us also assume that the supply voltage varies by ± 10%, i. e. $\Delta V_S \approx 40$ V, the load current by $\Delta I_L = 2$ mA and the ambient temperature by $\Delta T_{amb} = 20$ K, then, according to equation (18), the output varies by

$$\Delta V_{out} = \frac{125\Omega \cdot 40V}{20k\Omega} + 125\Omega \cdot 2\,mA + 9 \cdot 10^{-4}/K \cdot 22V \cdot 20K = 250\,mV + 250\,mV + 396\,mV$$

This example shows that ambient temperature variations exercise a larger effect on the output than supply voltage or load current variations.

Let us consider once more the example of the simple stabilizer circuit operating under low load current and high supply voltage conditions, discussed at the beginning of this section, but this time under the assumption that a temperature-compensated diode ZTK22 is used in place of the conventional ZPD22 device. Using equation (18) and inserting the same values for supply voltage, load current and ambient temperature variations into the expression, one obtains

$$\Delta V_{out} = + \frac{-8.4\Omega - 40V}{20k\Omega} + 8.4\Omega \cdot 2\,mA + (-10 \cdot 10^{-5}/K \cdot 20\,K \cdot 22V) = -16.8\,mV - 16.8\,mV - 44\,mV$$

The output voltage variation due to the specified change in temperature is only one tenth of that obtained in the previous mentioned example using the conventional Zener diode ZPD22. Moreover it should be noted that the temperature coefficient used in the calculation ($-10 \cdot 10^{-5}$/K) is the one guaranteed in the data, whereas the typical temperature coefficient of a ZTK device is normally $-2 \cdot 10^{-5}$/K. Use of this value would reduce the temperature effect, as expressed in the third term of the equation, even further, namely to –8.8 mV.

The conclusion is that in all applications where a simple stabilizer circuit is considered the use of ZTK temperature-compensated stabilizing circuits can bring a considerable improvement.

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.

Fig. 1

Transients of several thousand Volts can be'clamped' to a safe level by the TVS

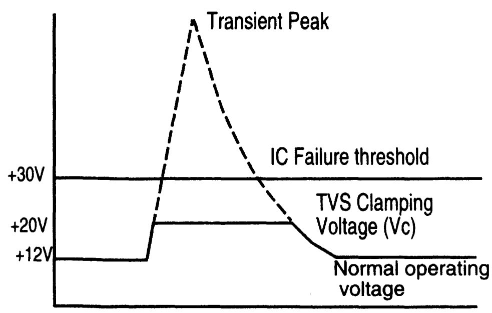
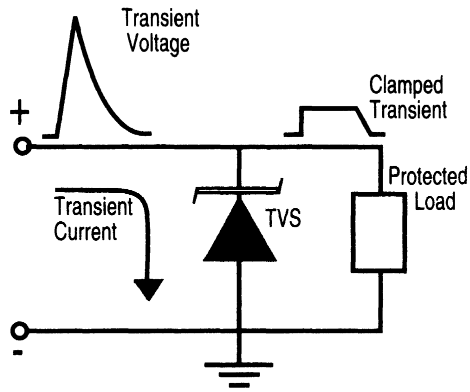


Fig. 2

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.

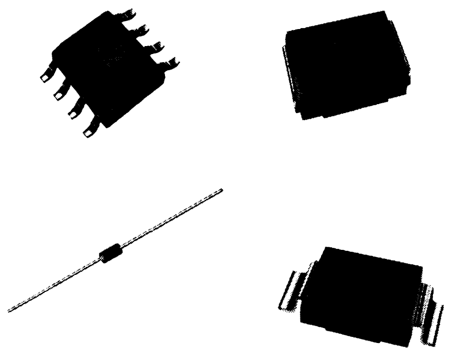
The surge power and surge current capability of the TVS are proportional to its junction area. Surge ratings for silicon TVS families are normally specified in kilowatts of peak pulse power (P_{PP}) during a given waveform. Early devices were specified with a 10/1000μs waveform (10μs rise to peak and 1000μs exponential decay to one half peak), while more recent product introductions are rated for an 8/20μs test waveform. Power ratings range from 5KW for 10/1000μs, down to 400W for 8/20μs. This power is derived from the product of the peak voltage across the TVS and the peak current conducted through the device.

(continued)

WHAT IS A SILICON TRANSIENT VOLTAGE SUPPRESSOR AND HOW DOES IT WORK? (continued)

Packaging covers a broad spectrum according the need. Discrete axial leaded components are available in peak pulse power ratings of 400W, 500W, 600W, 1.5KW and 5KW. The higher power devices are most frequently used across power buses.

Fig. 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 5V up through 376V 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.

General Semiconductor has become the world's leading supplier of silicon TVS protection.

SELECTING THE OPTIMUM TRANSIENT VOLTAGE SUPPRESSOR

Although the published data for several transient suppressors may appear similar enough to make the devices seem interchangeable, careful analysis can rule out nearly identical parts whose use could prove disastrous.

Jon R. Schleisner,
Senior Marketing Engineer

Transient Voltage Suppressors (TVS) are specialized zener diodes intended to clamp the voltage appearing across a line, thereby preventing transient spikes from damaging sensitive components. They accomplish this conducting when the voltage across the line exceeds the Zener-avalanche rating. Because transient voltages can be quite high, suppressors must be able to handle large avalanche currents. This means that care must be taken in the construction of the package and assembly process to ensure that the suppressor can tolerate high energy levels for short periods.

Typical Transient Voltage Suppressors carry peak ratings of 400, 600, 1500 or 5000 Watts. These wattages translate to 0.55, 0.80, 2.10 or 7.00 joules of energy during a 1-millisecond period. Avalanche ratings generally range from a few volts to several hundred Volts. Key operating parameters include:

♦ ***Breakdown voltage ($V_{(BR)}$),*** the voltage at which a given device breaks down in its avalanche mode. This voltage is usually characterized at a test current (I_t) of 1 milliamp and is often specified as a range with minimum ($V_{(BR)}$ min.) and maximum ($V_{(BR)}$ max.) voltages listed.

♦ ***Working stand-off reverse voltage (V_{WM}),*** the voltage at which the device's leakage current is measured. This voltage is always at least 10 percent lower than the minimum breakdown voltage. Suppressors with a breakdown-voltage rating of less than 10 volts can exhibit leakage currents as high as 1 milliamp, but suppressors with higher breakdown ratings typically exhibit leakage currents of 5 microamps or less.

♦ ***Maximum peak pulse surge current (I_{PPM}),*** the maximum current that the suppressor is guaranteed to withstand without incurring damage. This parameter is usually characterized with a 1 millisecond exponential waveform.

Maximum clamping voltage (V_C), the maximum voltage that can appear across the suppressor when the maximum rated surge current is flowing through it.

Maximum breakdown-voltage temperature coefficient ($\%V_{(BR)}/°C$), the maximum allowable change in the breakdown voltage as a function of the temperature.

Design Criteria

The best way to demonstrate the selection process is through a hypothetical example. In this example, the device to be protected is an integrated circuit, IC_X, which is designed to operate on a nominal rail voltage of 15 Volts, and which has an absolute maximum voltage rating of 22 Volts. The first step in the selection process is to determine the energy (joules) or power (Watts) contained in the surge against which the device is to be protected, and the duration of that surge.

Transients are by definition nonrepetitive, with energy levels that are difficult to ascertain. Moreover, they generally result from an unexpected failure elsewhere in the system or from natural phenomenon such as lightning. Because of this, determining energy content and duration of the surge is the most difficult step in the transient-suppressor selection process.

Some surges, however, are predictable. The surge produced by solenoid driver is a good example. If the inductance of the coil is known and the load on the solenoid is defined, it is possible to calculate or measure the duration and magnitude of the surge. Whenever possible, a "hands on" measurement of the worst-case transient condition should be made. For the

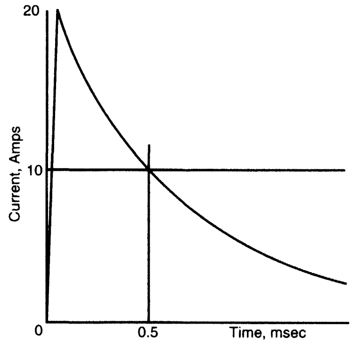


Figure 1

Waveform of an exponential-decay transient pulse with a peak current and a 0.5-millisecond pulse width at the half-peak-current point

sake of discussion, assume that the transient being presented to IC_X has a peak current of 20 Amps with a classic exponential decay, as shown in Figure 1, and a duration of 0.5 milliseconds, measured at 50 percent of the peak current.

With this data in hand, the next step is to examine manufacturer's data sheets to find a transient suppressor able to handle the anticipated surge. The breakdown voltage and maximum reverse surge current ratings published in the data sheets are key selection criteria. Since IC_X has a nominal 15-Volt operating voltage, the minimum breakdown voltage must be greater than 15 Volts. However, since it carries a 22-Volt absolute maximum voltage rating, the suppressor's maximum breakdown voltage must be less than 22 Volts. The foregoing assumes a relative-

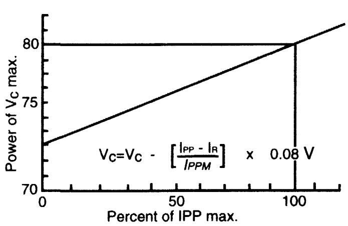
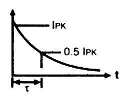
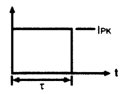
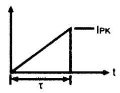
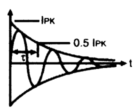
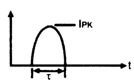


Figure 2

The clamping characteristic of a typical transient suppressor

ly stable ambient temperature, such as that usually experienced in an office environment. If the product in which IC_X is used is expected to see wider temperature fluctuations, the minimum breakdown voltage would have to be based on the lowest expected temperature. The resulting voltage would be determined by multiplying the difference between the expected temperature and room temperature by the temperature coefficient.

WAVESHAPE	EQUATION	K-FACTOR
	$I_{PK}\, e^{-t/1.44\tau}$	1.4
	I_{PK}	1.0
	$I_{PK}(t/\tau)$	0.5
	$I_{PK} \sin(\pi\, t)\, e^{-t/\tau}$	0.86
	$I_{PK} \sin([\pi /] t)$	0.637

$$\text{Energy} = \int_0^{\tau} V_C(t)\, I(t)\, \Delta t = K\, V_C\, I\, \tau$$

Figure 3

The energy contained in a transient pulse depends on its wave shape

With the minimum and maximum permissible breakdown voltages in hand, examine the clamping-voltage ratings published in the manufacturer's data sheets to identify suppressors falling within the required range. It is possible that there is no device that falls well within the upper and lower limits. If the device with the closest voltage rating falls about the upper voltage limit, a very close examination of its parameters must be made. Most reputable semiconductor manufacturers apply a one-percent guardband around voltage ratings as a safety margin. In this example, the guardband raises the absolute maximum rail voltage from 22 Volts to 22.22 Volts. This small increase may not seem like much, but can make the difference in selecting a transient suppressor.

Selecting the Best Transient Suppressor

Consider a situation in which the only suppressor that comes close to meeting the protection need of IC carries a maximum clamping voltage rating of 22.5 Volts. The actual voltage at which the suppressor will clamp depends on the actual current flowing through it, as shown in Figure 2, and can be predicted using the following equation:

$$V_C\,[\,(I_{PPM} - I_P) / (I_{PPM})\,]\ x\ (0.08)V_C = V$$

For the sake of discussion, consider the General Semiconductor type P6KE16A transient suppressor, which carries a 22.5-Volt maximum clamping-voltage rating.

$$22.5 - [(27 - 20)/27]\ x\ 0.08\ (22.5) = 22.03\ Volts$$

Although the resulting clamping voltage is still greater than the 22-Volt absolute maximum voltage rating carried by ICx, it is well within the 22.22-Volt rating provided by the one-percent guardband. Thus, although carrying a maximum clamping-voltage rating 0.5 Volt higher than the maximum voltage rating carried by ICx, this suppressor can be safely used in this application.

The same, however, cannot be said of all 22.5-Volt suppressors. Another device in the same family, the P4KE16A, has slightly different current ratings and yields considerably different results:

$$22.5 - [(19 - 20)/19]\ x\ 0.08\ (22.5) = 22.59\ Volts$$

Clearly, with a 22.59-Volt clamping voltage, this device cannot be used because it exceeds the maximum clamping-voltage rating plus guardband of ICx. The next step in the selection process is to verify the transient suppressor's power rating. There are two approaches that can be taken:

1. Since the waveform of the transient is a classic exponential decay with a 0.5-millisecond duration at the half-peak current point, a graphic plot of peak power versus time can be used. This graph is often published in manufacturer's data sheets and if it is available for the device under consideration, one need only compare the anticipated current against the current shown in the graph. Using the peak-power versus time graph published for the P6KE series suppressors, it can be seen that with a 0.5-millisecond time-constant decay, a P6KE device can handle a peak power of 792 Watts. Using Ohm's law and a 22-Volt clamping voltage, this translates to:

$$I = P/V = 792/22 = 36\ Amps$$

Since the anticipated peak reverse current with a 0.5-millisecond time constant is 20 Amps, it is clear that a P6KE device can easily withstand the anticipated peak power of the surge.

2. Calculate the energy in joules contained in the transient and compare it to the maximum energy rating of the transient suppressor. The energy in the transient, of course, depends on its wave shape, as shown in Figure 3. The amount of energy a given transient suppressor can handle, on the other hand, depends on its energy rating and the duration of the pulse, as shown in Figure 4. In this example, the waveform has an exponential shape with a 20-Amp peak current and a 0.5 millisecond half-peak-power point. Using these data, the energy calculations are as follows:

$$E = \int_0^{\tau} V_C(t)\ x\ I(t)\ \Delta t = KV_C\ x\ I\ x\ \tau$$

where, in this example,

$$V_C = 22V$$
$$I = 20A$$
$$\tau = 0.5\ msec$$
$$K = 1.4\ (from\ \textbf{Figure 3})$$
$$Thus\ E = 1.4\ x\ 22\ x\ 20\ x\ (0.5\ x\ 10^{-3}) = 0.308J$$

The maximum single-pulse energy rating for a P6KE series is 0.83 joules for a pulse of 1 millisecond duration. Referring to Equation 4, the energy rating for a 0.5 millisecond pulse becomes 0.7 x 0.83 J, or 0.581 joules. Clearly, then, a P6KE device can easily handle the 0.308-joule energy contained in the anticipated transient pulse.

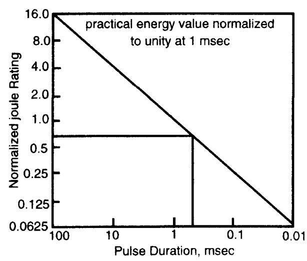


Figure 4

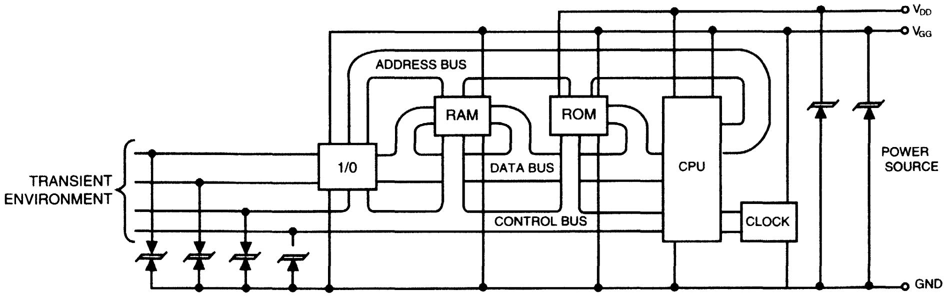
Energy-handling capacity of a transient voltage suppressor as a function of the transient's duration

Conclusion

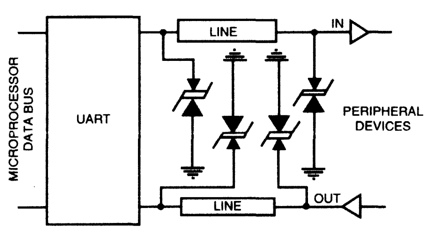
The above example assumes a nonrepetitive transient, or, if repetitive, each pulse is separated from the others by an interval of at least 20 seconds. Under these conditions, however, the procedures outlined provide a straightforward and reliable method of selecting the best Transient Voltage Suppressor for a given application.

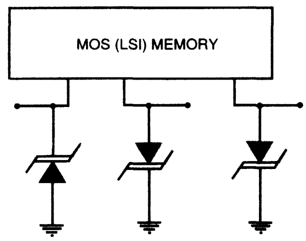
APPLICATION NOTES

Transient Voltage Suppressors are characterized by the reverse stand-off voltage (V_{MW}). They are synonymous with the integrated or micro circuit power supply voltage. The breakdown voltage [$V_{(BR)}$] is that point at which the Transient Voltage Suppressor is in avalanche breakdown. This is temperature coefficient. Allowance has been made in establishing the minimum breakdown voltage at 25°C to provide a safe operation over the full temperature range of -65°C to +150°C.



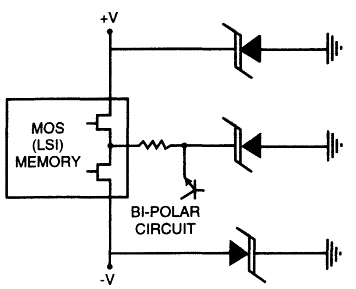
The Transient Voltage Suppressor on the signal and input poser lines prevent microprocessor system failures caused by transients (electrostatic charges), AC power surges, or during switching of the power supply to ON or OFF. A static discharge can exceed 10,000V for 10 microseconds with a 60 Amp current potential. 10V applied to a typical T²L circuit for 30 nanoseconds will cause destruction. Placing Transient Voltage Suppressors across the signal lines to ground will keep unwanted transients out of the Data and Control Buses. Transient Voltage Suppressors which are shunted across the power lines maintain a continuous operating voltage during AC line surges and switching transients.





Transients generated on the line can vary from a few microseconds to several milliseconds duration and up to 10,000 Volts. This threat of potential energy has given rise to high noise immunity integrated circuits. High immunity and super high immunity circuits are prone to damage by noise transients as a result of the power being dissipated by the substrate input diode. Excess current passing through the input diode can cause an open circuit condition or slow degradation of the circuit performance. Transient Voltage Suppressors located on the signal line can absorb this excess energy. For some circuit applications a low capacitance unit may be required, which is available upon request.

The Transient Voltage Suppressors protect the internal MOSFET from transients introduced on the power supply line. When interfaced with bipolar TTL circuits, the same power supply is often used. A common practice is to place a series protection diode from source to gate, but this does not offer protection from source to ground and is usually limited on peak power dissipation. A Transient Voltage Suppressor is required on each voltage supply line to the integrated circuit.

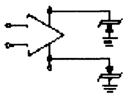


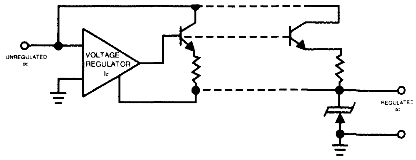
Totem pole output circuits often generate current spikes requiring decoupling capacitors. While maintaining circuit continuity, the Transient Voltage Suppressor is capable of absorbing the energy pulse as well as eliminating noise spikes due to such things as cross-talk, etc. A clamp diode in the IC substrate is limited in conduction current, <100mA, providing a minimum protection.

APPLICATION NOTES

DC LINE APPLICATIONS

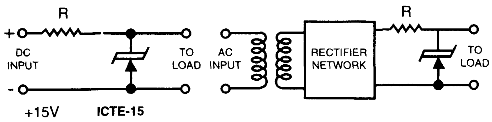
The Transient Voltage Suppressor on the power line prevents IC failures caused by transients (electrostatic discharge), power supply reversals or during switching of the power supply to on or off.



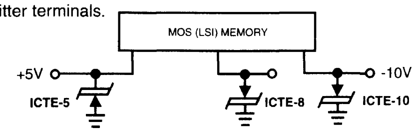


The Transient Voltage Suppressor placed in the output of a voltage regulator can often replace many components associated with a protection circuit such as a crowbar circuit. It may also be required to protect the bypass transistor from voltage spikes across the collector to emitter terminals.

Typical power sources employing the Transient Voltage Suppressor for transient protection.

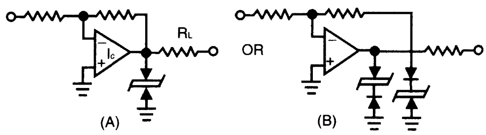


The Transient Voltage Suppressor is chosen in which the reverse stand-off voltage is equal to or greater than the DC output voltage. For certain applications it may be more desirable to replace the series resistor (R) with an inductor. In most applications, a fuse in the line is desirable. Elimination of a transformer will require an LC filter on the line for most industrial applications, when the Transient Voltage Suppressor is placed on the input to the power supply and with an input voltage greater than 40 Volts.

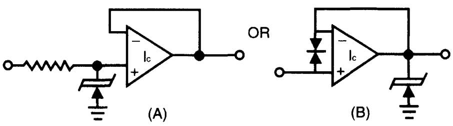


The Transient Voltage Suppressors protect the internal MOSFET from transients introduced on the power supply line. When interfaced with bipolar TTL circuits, the same power supply is often used. A common practice is to place a series protection diode from source to gate, but this does not offer protection from source to ground and is usually limited on peak power dissipation. A Transient Voltage Suppressor is required on each voltage supply line to the integrated circuit.

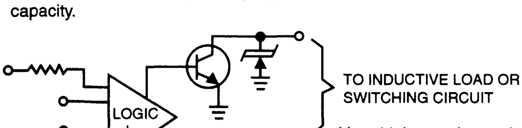
SINGLE LINE APPLICATIONS



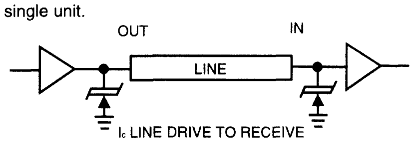
A Transient Voltage Suppressor on the output of an Op-amp will prevent a voltage transient, due to a short circuit or an inductive load, from being transmitted into the output stage. Fig. A is for linear circuits whereas Fig. B may be required for reducing effective capacity at the output. The Transient Voltage Suppressor and a blocking diode is available as a single unit.



Input states are vulnerable to low energy, high voltage static discharges or crosstalk transmitted on the signal wires. Limited protection is provided by the clamp diode or an input network within the IC substrate. The diodes, however, must have a breakdown voltage greater than the supply voltage (VCC) and are limited in current capacity.



Very high transient voltages are generated when an inductive load is disconnected, such as motors, relay coils and solenoids. The Transient Voltage Suppressor provides protections for the output transistor as well as the IC, eliminating a resistor/capacitor network. The ICTE series Transient Voltage Suppressor is capable of dissipating the full load current for short duration pulses (<8.3 msec). For longer pulses, the Transient Voltage Suppressor is available in stud or press fit package.



Transients generated on the line can vary from a few microseconds to several milliseconds duration and up to 10,000 volts. This threat of potential energy has given rise to high noise immunity integrated circuits. An independent study* has found that high immunity and super high immunity circuits are prone to damage by noise transients as a result of the power being dissipated by the substrate input diode. Excess current passing through the input diode can cause an open circuit condition or a slow degradation of the circuit performance. Transient Voltage Suppressors located on the signal line can absorb this excess energy.

*The Radio & Electronic Engineer, Vol. 43, No. 4, April 1973.

Transient Voltage Suppressors can be used in series or parallel to increase their power handling capability. No precautions are required when using Transient Voltage Suppressors in a series string since power dissipation for two or more devices of the same type is equally shared. When using Transient Voltage Suppressors in parallel it is necessary for the units to be closely matched (approx. 0.1 Volt of each other) in order for equal sharing to take place. Matched sets can be ordered from the factory for an additional charge.

TYPICAL TVS APPLICATIONS

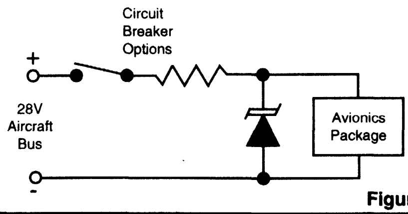


Figure 1

28V D.C. Supply Protection

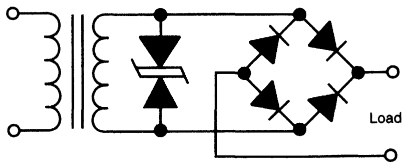


Figure 2

A.C. Supply Protection

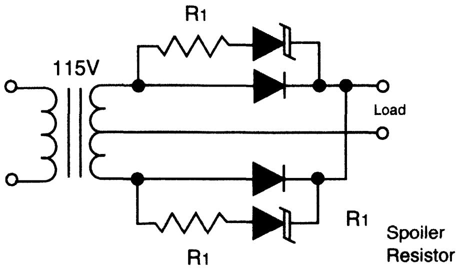


Figure 3

Breakdown Voltage Rectifier Protection

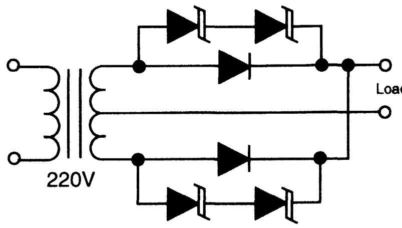


Figure 4

Breakdown Voltage Rectifier Protection

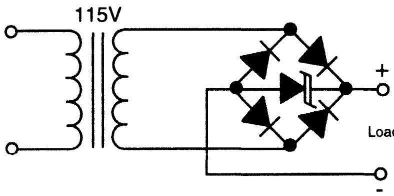


Figure 5

115V A.C. Supply Protection

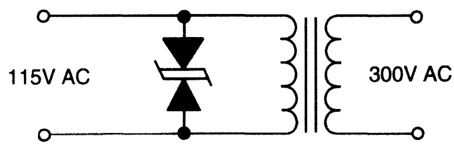


Figure 6

Circuit Protection from Overvoltage Supply Power

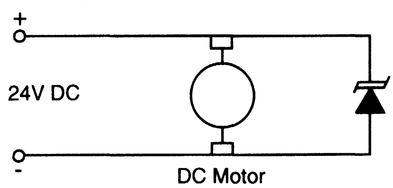


Figure 7

EMI Limiting

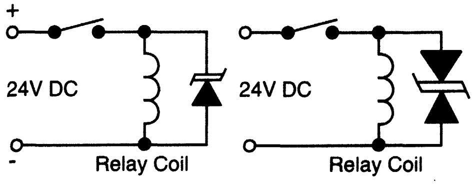


Figure 8

Relay and Contactor Transient Limiting

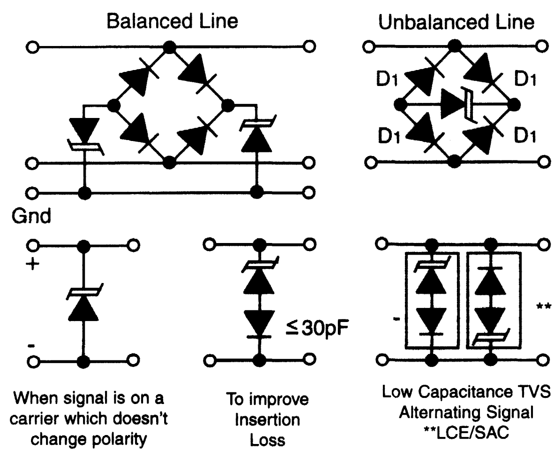


Figure 9

R.F. Coupling

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 ohm at a dc voltage of 0.1 volts (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.

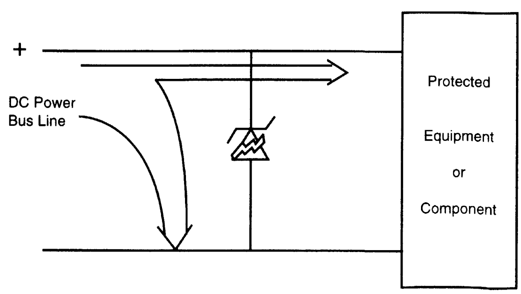


Figure 1

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.

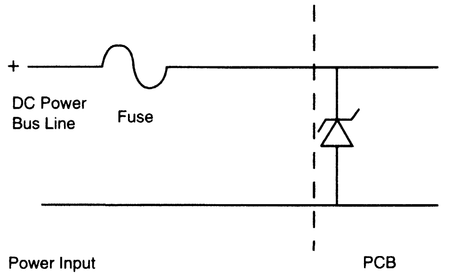


Figure 2

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

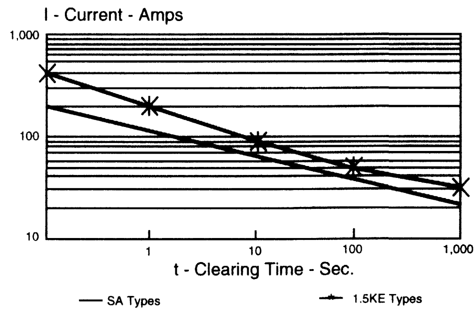


Figure 3

Clearing Time for Transient Voltage Suppressor Device - Fail Opened Condition

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.

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

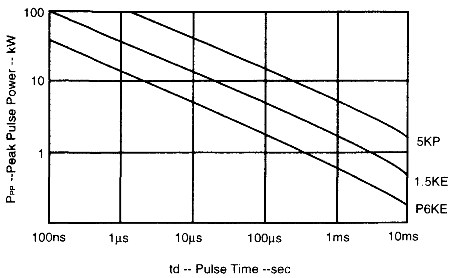


Figure 4

Peak Pulse Power vs. Pulse Time

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.

Product selection begins by equating the circuit operating voltage to the stand-off voltage of the TVS device, Table I.

Table I
Avalanche Junction Selection Process

DEVICE PARAMETERS		CONDITIONS
1) Stand-Off Voltage	>	Operating Voltage
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. Inline 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.

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.

TABLE1
Minimum Failure Thresholds of CMOS and TTL

Device Type	Pulse Width					
	20µsec	2µsec	1µsec	.02µsec	.01µsec	.025µsec
55107	22V	16V		22V		
55109	36V	38V		60V		
5404			30V		50V	120V
54L30			20V		50V	90V

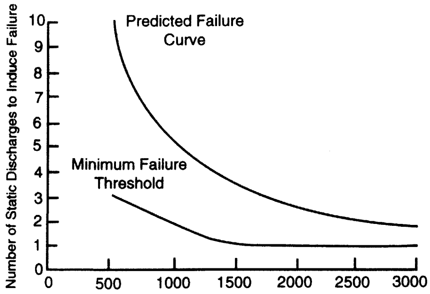


Figure 1

Pulse Voltage (Volts) Stress Failure of CD4011F

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.

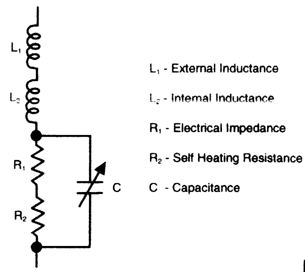


Figure 2

Equivalent Circuit of Protector

The inductance within an axial leaded part, as represented by L_2, is of the order of 10^{-8} henrys 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 5kV/nsec. 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 Figures 3 and 4.

Application Notes

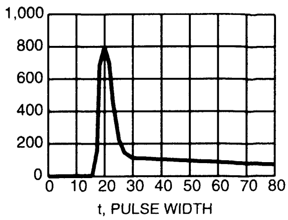


Figure 3

7.5 cm Lead Wires

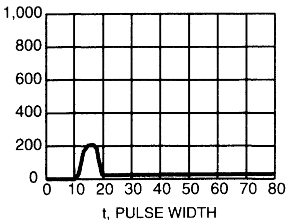


Figure 4

Zero Length Lead Wires

In Figure 3, a 30V Transient Voltage Suppressor in the DO-13 package was pulsed with a 100A 4kV/nsec 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 800V. The energy under this curve is calculated to be 70μjoules, 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 200V. The energy under this curve is less than 1μjoule, below the destruct threshold of MOS and TTL devices.

B. **Lightning and Inductive Switching:** From measurements made on 120V ac power systems, Martzloff[3] has proposed a waveform with a frequency of 100kH. The lightning stroke, which is usually reported with current rise-times ranging from 1 to 3μsec has been more recently measured by Llewellyn[4] to be as low as 500nsec. Transients on shipboard ac power systems have been defined by MIL-STD-1339 as having transient rise-times of 1.5μsec.

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 IμH/m for a straight wire, most lead wires have inductance values in the nanohenry 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.

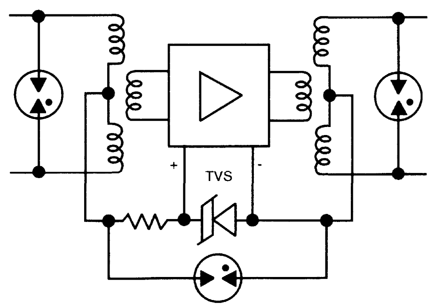


Figure 5

Telecom Repeater With Protection

The microcircuitry used in this equipment has some well defined failure levels; 20V in the positive direction and 6.5V 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 100A with an 8.4 msec, 1/2 sine wave pulse. To determine higher current capability, pulse tests were made with a 1.2 x 50μsec 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 100A to 500A with lead lengths from the body of the device of zero, 1.0 cm and 2.0 cm. Tests were made on a molded 1.5kW 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 4V at 100A and 13.5V at 500A. By contrast, the cell only has a peak clamping voltage of 1.3V at 100A and 3V at 500A. Voltage probe placement for taking measurements is shown in Figure 7.

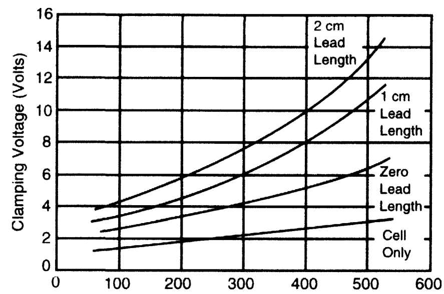


Figure 6

Clamping Voltage vs Pulse Current

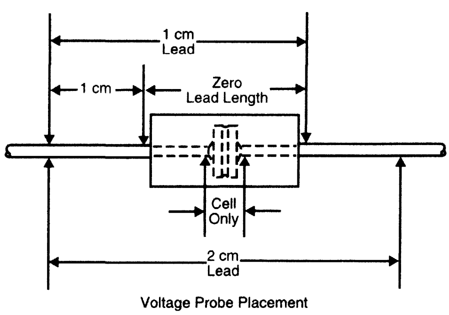


Figure 7

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 .040 in dia. copper wire at pulse current levels from 100A to 500A. Rise-time is 1.2μsec. This data is shown in Table II.

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 II
Pulse Current Level and Voltage Drop

Pulse Current (Amps)	Measured Voltage Drop (Volts)	Calculated Resistive Voltage Drop (Volts)	Calculated Inductive Voltage Drop (Volts)
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 in., 48 in., and 72 in. Pulse currents were 100A, 200A, 300A and 400A with a wave form of 1.2 x 50μsec. Lead length vs additive peak clamping voltage plotted here, is that value above the normal clamping voltage with zero lead length.

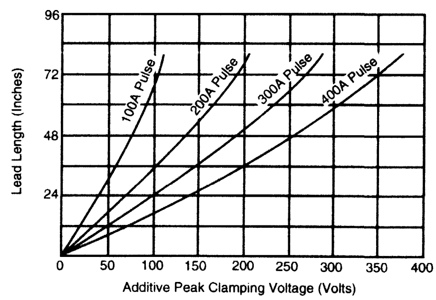


Figure 8

Lead Length vs Clamping Voltage

Note that the additive clamping voltage can be down in the range of 35V at 100A for 24 in. leads extending up to 350V at 400A for 72 in. leads. An oscillograph depicting optimum protection at 100A and 400A is shown in Figure 9. The 100A pulse is being clamped at about 215V and 400A pulse at 265V. The peak clamping voltage is substantially increased by the inductive effects of 72 in. leads as shown in Figure 10. In this oscillograph, the 100A pulse produced a peak of about 320V and 400A pulse produced a peak of about 615V. The inductive overshoot illustrated in Figure 10 is quite profound by comparison with Figure 9.

Application Notes

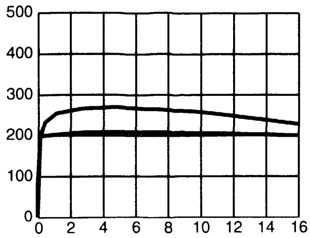


FIGURE 9

AC Protector, Optimum Protection

Vert: 100V/div.
Horiz: 2μsec/div.

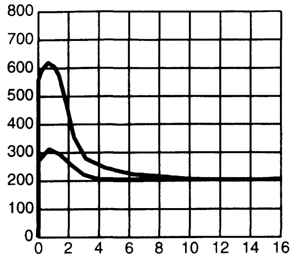


FIGURE 10

AC Protector, 72 in Leads

Vert: 100V/div.
Horiz: 2μsec/div.

Clamping Voltage of Microcircuit Protector

An ICT-5 type Transient Voltage Suppressor, designed for protecting low voltage logic circuits, was pulsed at levels of 100A, 200A, 300A, 400A and 500A with a 1.2 x 50μsec 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 dia. 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.

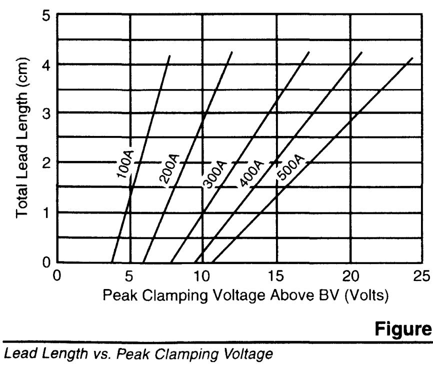


Figure 11

Lead Length vs. Peak Clamping Voltage

These curves are plotted as additive above the breakdown voltage (BV) at lmA, which was 6.3V 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 3.6V above BV to 24V above BV depending on peak current and insertion method.

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 5V logic protection was tested with a 300A pulse having a 1.2 x 50μsec 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 24V. Placing a 12μH choke ahead of the suppressor to reduce the rise-time, reduced the peak to 19V and using 24μH reduced the peak to 17V. These curves are also shown in Figure 12.

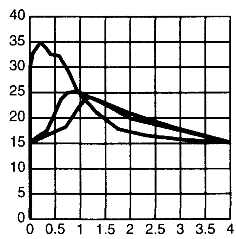


FIGURE 12

AC Protector, 72 in. Leads

Vert: 100V/div.
Horiz: 2μsec/div.

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.

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HARDENING POWER SUPPLIES TO LINE VOLTAGE TRANSIENTS

Originally presented at the Power Electronics Design Conference, October, 1985, Anaheim, California
Also published in Power Conversion & Intelligent Motion, June, 1986

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 if 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, 8μs rise time, 20μs decay to half of peak) having a peak amplitude of 3000A.

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 3000A, 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 60Hz surge current rating exceeding 300A would most probably handle the 3000A, 8/20μs 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 $V_B^{2.5}$. 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.

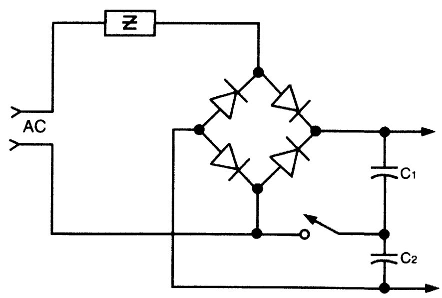

Figure 1

Basic line rectifier & filter for SMPS operating from 120/240V lines

It is not unusual to allow for a 20% tolerance on a 120/240V ac power line which puts the voltage crest at about 400 Volts. Added to the dc level is the overshoot caused by the 3000A impulse. The usual switching power supply which operates from 120/240V inputs has two capacitors as part of the voltage double arrangement. The capacitors are connected in series when used on 240V. Thus, the total dc bus voltage spikes up to twice the individual capacitor transients when used on 240V.

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 Equation 1.

$$V_C = \frac{I}{C}\int i\,dt + iR_S + L_S\frac{di}{dt} \qquad (1)$$

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

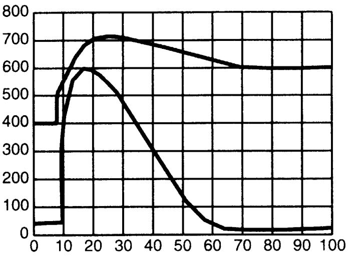

Figure 2

Capacitor waveform showing spike caused by current, and charge placed on capacitor
($C_1 = C_2 = 60\mu F$; Upper: 10V/div; Lower: 100A/div; Time: 10µs/div)

Measured voltage transients for some different capacitors when pulsed with 500A in the circuit of Figure 1 are shown in Table 1. With a 3000A pulse, overshoots of 6 times the values shown would occur. In all cases of 240V input, the transient voltage exceeds the typical 250V surge rating of a 200 volt capacitor. Even worse, the DC bus – possibly at about 400 volts because of high line, low load condition – is now up to at least 560 volts! No wonder power switch failures occur in seemingly well designed systems.

C_1, C_2	Type	Input	Peak Transient Voltage	Charge Voltage
540µF	Mepco/Electra 319DA541T250AMA1	120V	39V	30V
		240V	75V	58V
650µF	Mepco/Electra 3120EA651T200BHA1	120V	33V	23V
		240V	65V	46V
2100µF	General Electric 44A417052M21	120V	12V	7V
		240V	27V	16V

TABLE 1 – Transient performance of the circuit of Figure 1
(Peak Pulse Current = 500A)

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 3000A 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.

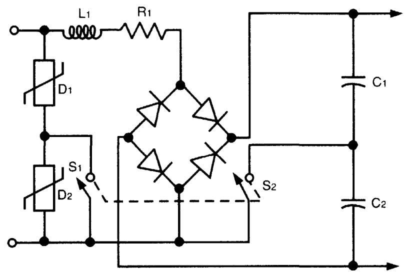

Figure 3

Basic circuit with MOV protection

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 240V position when both switches are open. However, unless the MOV voltage is adjusted to fit the lower line voltage when used on 120V ac, (i.e., S_1 is closed), a very large capacitor current flows. For example, with only .5 ohm impedance the 77 volt spike appears across only one capacitor; with 3000A of input current the spike would increase to 115V which could exceed the surge voltage rating of the capacitor. The 106 volt transient increases to about 150 volts when 3000A is applied, bringing the bus voltage to 550 Volts.

R_1 - L_1	Input	S_1	Peak Transient Voltage	Charge Voltage	Peak Capacitor Current
0.5Ω - 0µH	120V	Open	77V	54V	1080A
		Closed	24V	21V	440A
	240V	Open	106V	78V	780A
0.5Ω - 100µH	120V	Closed	18V	10V	190A
	240V	Open	74V	47V	440A
1.0Ω - 100µH	120V	Closed	12V	7V	130A
	240V	Open	53V	34V	300A

TABLE 2 – Transient performance of the circuit of Figure 3
(R_1 = .05Ω, $C_1 = C_2$ = 540µF, Peak Pulse Current = 2000A)

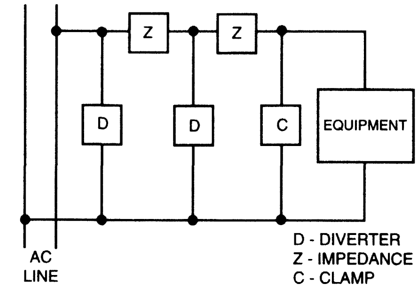

Figure 4

General topology for a protection network

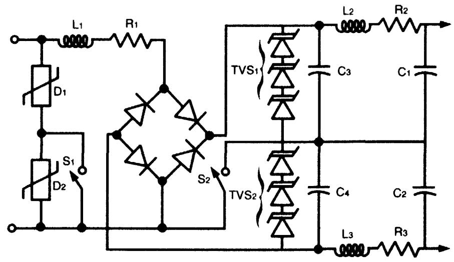

Figure 5

Circuit providing a high level of protection

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 2100µF capacitor allowed only 27V of overshoot with a 500A pulse. This capacitor would be satisfactory if used in Figure 3 with the 0.5 ohm-100µH input 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 (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 2500A. The resulting 25V peak transient appearing at the output is low enough to allow the use of 450V rated transistors in the power switching section.

Input	Peak Transient Voltage	Charge Voltage	Peak Capacitor Current
120V	9V	5V	103A
240V	25V	16V	163A

TABLE 3 – *Transient performance of the circuit of Figure 5 (Pulse Current ≈ 2500A, $L_1 = L_2 = L_3 = 100\mu H$, $R_1 = R_2 = R_3 = 0.5\Omega$ TVS Stack; 5KP60)*

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.

Reference

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AUTOMOTIVE TRANSIENT VOLTAGE SUPPRESSOR

Premium Automotive Overvoltage Protection

Jon Schleisner, Senior Applications Engineer

General Semiconductor has developed a TVS style transient voltage suppressor specifically for automotive applications. As we approach the twenty-first century, automotive electrical systems are becoming:

-More complex
-Increasingly vital to vehicle operation
-A larger percentage of manufacturing and replacement cost

To protect this principle automotive system, General Semiconductor has developed the 6KA24 "load dump" rectifier.

The 6KA component offers superior performance compared to the standard 5KP series and the leaded button rectifier several manufactures supply for this application. The features include:

- Enhanced power handling capability. With a 10x1000µs power rating of 6500 watts and 2000 watt rating on a 50ms. to 1/2 Ipp surge the 6KA24 is among the most rugged automotive TVS devices.

- Superior clamping performance. Fig.1 displays the very low impedance and resultant tight clamping characteristics. This implies more protection for the dollar invested.

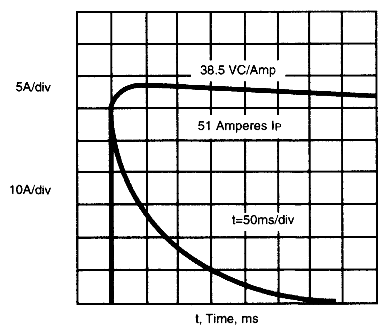


Figure 1

- Excellent high temperature reverse leakage characteristics (see Fig. 2). This TVS component has a 180°C upper temperature limit.

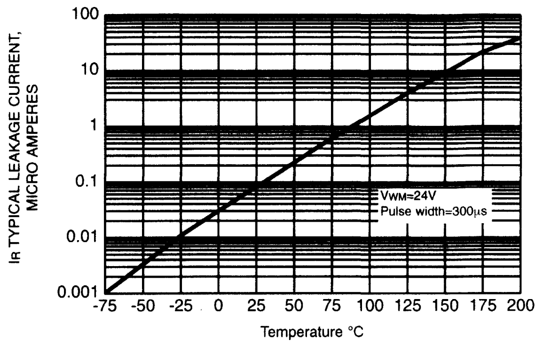


Figure 2

- Specified to withstand "double battery" and "load dump" conditions.

- Exclusive PAR chip design for Superior Reliability performance.

The PAR (Passivated Anisotropric etched Rectifier) has two physical characteristics that help realize superior " under the hood" performance.

1. The junction allows for very uniform current density across the surface area of the die. This results in minimum "hot spots" across the chip. Uniform surface area temperature results in efficient use of the available die area.

2. The passivation is a grown oxide. This oxide has thermal properties similar to silicon. The benefit here is excellent thermal cycling characteristics. Figure 3 is a composite reliability summary of the 6KA24.

Figure 3

LIFE AND ENVIRONMENT TEST SUMMARY

6KA24 TVS	QUALIFICATION DATA
LIFE TESTS	**FR**
(1000 HRS) **STORAGE: 200°C**	0/45
(1000 HRS) **HTRB: 175°C Tj/RATED BIAS**	0/45
(1000 HRS) **HUMIDITY: 85°CC/85% R.H.**	0/45
121°C, 15 PSI **AUTOCLAVE: 24 HOURS**	0/45
SOLDER DIP: 260°C/10 SEC.	0/45
(JEDEC SPEC) **FORWARD SURGE: 400 AMPS**	0/45
TEMP CYCLE: 1000 CYCLES -55°C to +200°C/30 MIN.	0/45

FR=Failure Rate/Total Tested

The 6KA TVS is an ideal product to protect automotive electrical systems from automotive "load dump" transients and other unexpected surges within the electrical system. A typical applications circuit including a GP30 for reverse battery protection is shown in Figure 4.

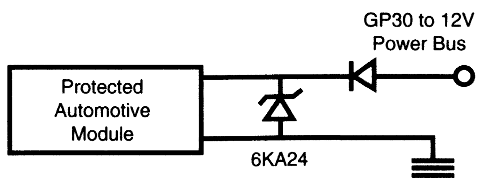


Figure 4

Typical application circuit

TRANSIENT SUPPRESSORS, A COMPETITIVE LOOK

Jon Schleisner, Senior Applications Engineer

Several different technologies share the transient suppressor marketplace. The energy capacity of these devices ranges from 0.1 joules 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. I_R (Leakage) and BV_R (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.

<u>Figure 1</u>

Clamping Ratio @ 20 Amps

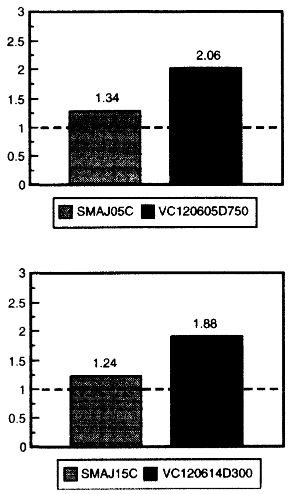
$$\textbf{Clamping Ratio} = \frac{V_C \text{ at } 20A}{BV_R \text{ at } 1mA}$$

$$\textbf{Perfect Device} = \frac{V_C}{BV_R} = 1.0$$

A Clamping Ratio of 1 implies zero impedance.

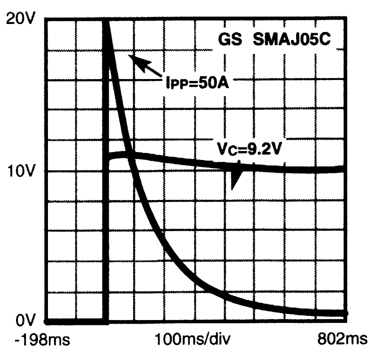
In Figure 2 the clamping ratio for five and fifteen volt protection components can be seen. The difference in clamping performance is obvious. The silicon based SMAJ05C and SMAJ15C exhibit clamping ratios in the range of 1.25 to 1.33. The ZnO technology shows clamping ratios approaching 2.0. From the 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

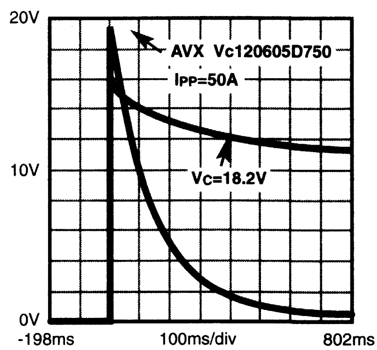
ZnO Suppressor:

- ← **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 quality protection**
- ← **Faster turn-on response: 1 - 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.

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 t_p (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

$$T_j = T_{amb} + P_I \cdot r_{thA},$$

or, if additional power P_D is continuously dissipated, by use of the formula

$$T_j = T_{amb} + P_D \cdot R_{thA} + P_I \cdot r_{thA},$$

If the diode is fitted to a heat sink, then the equation becomes

$$T_j = T_{amb} + P_{tot} \cdot R_{thS} + P_I \cdot r_{thC},$$

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

$$T_j = T_{amb} + P_{tot} \cdot R_{thS} + P_D \cdot R_{thC} + P_I \cdot r_{thC},$$

where P_{tot} is the mean value of the total dissipated power.

Figure 1.

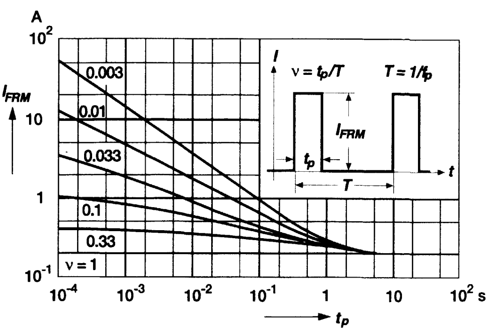
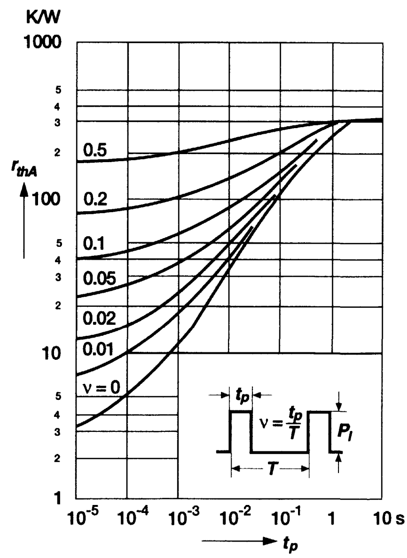


Figure 2.



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

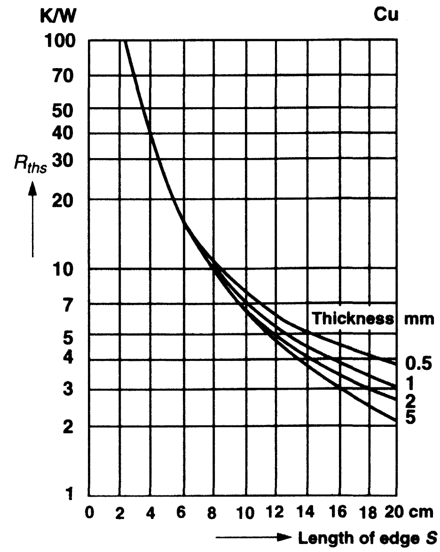
$$R_{thS} < \frac{T_j - T_{amb}}{P} = R_{thC}$$

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.

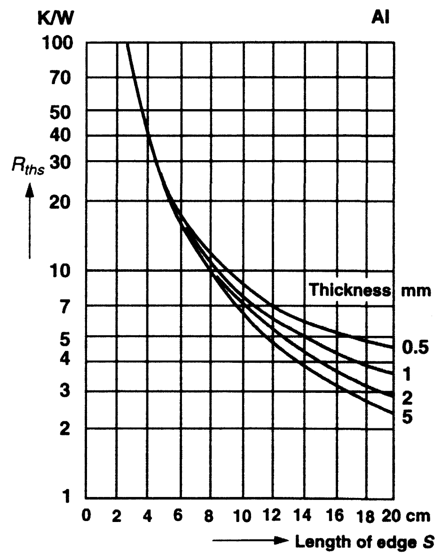
The calculations are based on the following assumptions: Use of a squareshaped heat sink without any finish, mounted in a vertical position; semiconductor device located in the centre of the sink; heat sink operated in still air and not subjected to any additional heat radiation. The calculated area 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.

Copper Cooling Fin

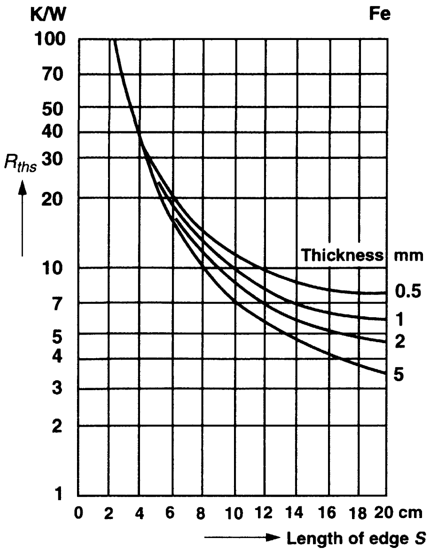


Aluminum Cooling Fin



Application Notes

Steel Cooling Fin



DETERMINING CLAMPING VOLTAGE LEVELS FOR A BROAD RANGE OF PULSE CURRENTS

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*

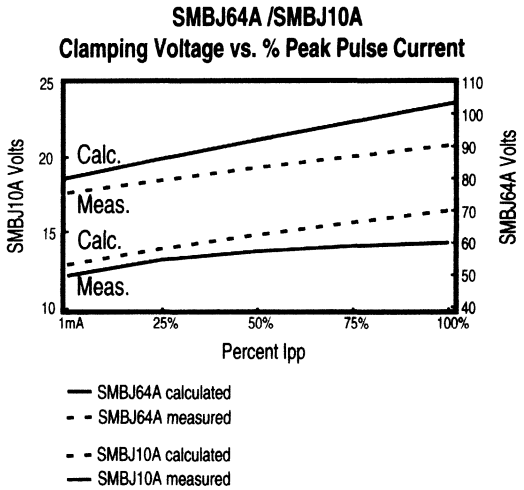
This calculation assumes a linear increase in V_C between $V_{(BR)}$ and V_C max, which is realistic. Figure 1 illustrates the ΔV_C vs ΔI_P relationship for two voltage levels, 10V and 64V, in the SMB 600W series between $V_{(BR)}$ and V_C as determined by this formula. Results are linear as expected. $V_{(BR)}$ 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 Fig. 1. Surge tests were performed for a 30 piece sample at 25°C ambient with a 10/1000µs 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.

Fig 1.
V_C vs I_{PP} for SMBJ10A and SMBJ64A Calculated and Measured



USING THE POWER VS TIME CURVE

Bruce Hartwig, Senior Automotive Applications Engineer

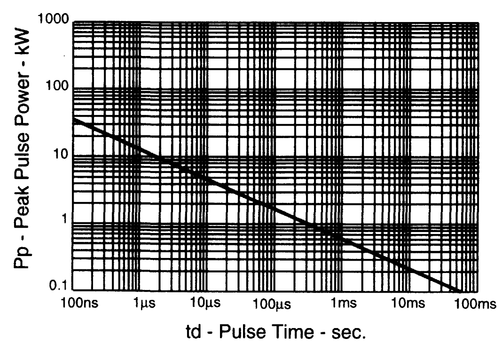
How can the maximum transient power and current capability for silicon Transient Voltage Suppressors (TVS) be derived for conditions other than the 10/1000μs pulse specified on data sheets?

Most Transient Voltage Suppressors are rated for 10/1000μs non-repetitive pulse waveforms (10μs being the front time and 1000μs 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 1.2/50μs.

The graph in Fig. 1 relates peak pulse power with time for 600W suppressors; similar curves exist for TVS's rated at other power levels. At 1000μs

Fig 1.

Peak Pulse Power vs Pulse Time



the maximum pulse power (P_P) is 600W, the rating condition of the device. The graph illustrates that at 50μs, the rating is 2100W and at 10,000μs (10ms), P_P rating is down to approximately 200W. This applies to all devices in the 600W series regardless of their operating voltage.

Under shorter pulse widths a TVS will sustain higher pulse currents (I_P). For a width of 50μs, for example, a TVS will sustain 3.5 times its rated I_P at 1000μs, 600W. Thus the peak I_P of an SMBJ12A would increase from 30.2A at 10/1000μs to 105.7A at 1.2/50μs. The current rating of an SMBJ64A would increase from 5.8A to 20.3A.

Increasing the pulse width to 10,000μs will reduce the I_P rating by a factor of 0.33 since the P_P is reduced to 200W. An SMBJ12A with an I_P of 30.2A at 1000μs would be reduced to an I_P of 9.9A for a 10,000μs duration.

This method can be applied to derive the P_P and the I_P of a TVS from any other series (such as 400W, 500W, 1.5KW, 5KW,) using its published power vs pulse time curve.

Most Transient Voltage Suppressors, including the examples shown here, are rated for 10/1000μs 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%.

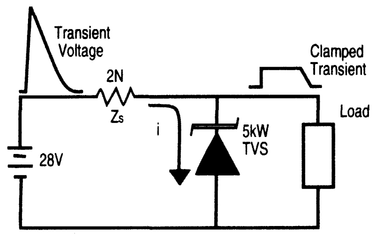
PROTECTING LOW CURRENT LOADS IN HARSH ELECTRICAL ENVIRONMENTS

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 Fig. 1.

Fig. 1
A 5kW TVS is required to handle the high surge current



Consider as an example, a pressure transducer which operates at 28V, placed in an environment in which it encounters a transient voltage of 140V peak, having a source impedance of 2 ohms and a duration of 10/1000µs. The failure threshold of the transducer is 40V, therefore the TVS must clamp at 40V or less. The current delivered by this transient is:

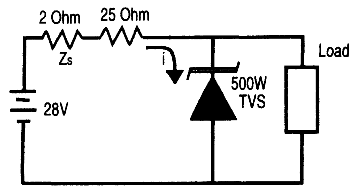
$$I = (140V- 40V)/2\Omega = 50A$$

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 100V. 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 5KW- 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 fig 2 Since the current drawn by the transducer under normal operation is small (<20mA typical), performance is not adversely affected by reduction in supply current.

Fig. 2
Series resistor reduces transient current allowing a much smaller TVS to be used



For a small load current, 10mA, the voltage drop across the added resistance is minimal, about 0.25V for a 0.25 Ohm resistor. Adding this resistor reduces the surge current to:

$$I = (140V- 40V)/(2\Omega + 25\Omega) = 3.7A$$

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 500W suppressor, such as the SA28A TVS, replaces the 5KW device, saving board space and cost.

An SA28A was chosen in this example since its current rating for a 10/1000µs pulse is 11A, easily withstanding the 3.7A surge calculated above. Although the maximum clamping voltage for the SA28A is given on the data sheet as 45.4V, the reduced surge current is 33% of the suppressor's peak capability, hence the clamping voltage would be approximately 38V, 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 0.25W requiring a 0.5W 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

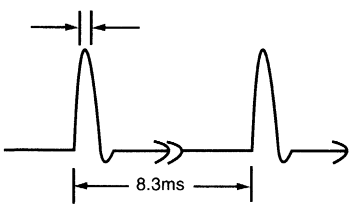
Bruce Hartwig, Senior Automotive Applications Engineer

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 4µs duration and a 25A peak current at a frequency of 120 Hz.

Fig. 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 volts. But will this suppressor survive the continuous (120 times per second) application of this transient?

Pulse interval, the inverse of the frequency, is:

$$1/120 \text{ pulse/sec.} = 0.0083 \text{ sec.}$$

Peak pulse power is the clamping voltage multiplied by the pulse current:

$$P_{PP} = 11.2V \times 25A = 280W$$

Average power can be closely estimated by multiplying the peak power times the ratio of the pulse width to its interval:

$$P\ avg. = 280W \times (0.000004 / 0.0083 \text{ sec.}) = 0.134W$$

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.

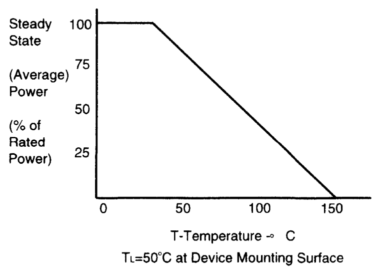


Fig. 2

Temperature derating for steady-state power dissipation

The average power calculation shown here is generally valid for pulses up to 10µs in duration, occurring at intervals in the range of 100 to 1000µs. Longer pulse durations approaching 1ms 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

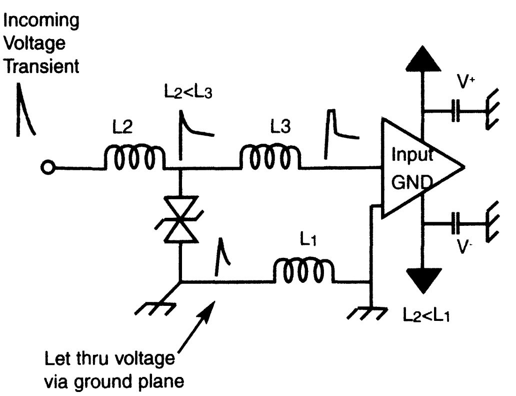
Jon Schleisner, Senior Applications Engineer

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 fig. 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.

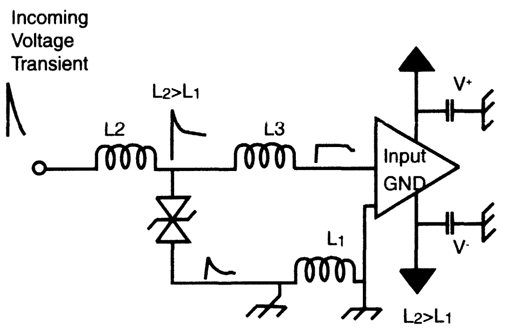
Fig. 1



ESD can have rise times as steep as 64KV/µs or 30KA/µs. 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 Fig. 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.

Fig. 2



For both Fig. 1 and Fig. 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

A. Karl, 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 440V 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 170V (working voltage). Applications requiring a working voltage that is higher than 170V 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 VCL, where I_{PP}*VCL 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.

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 5.2A. The 5KP series is only available up to V_R-110V. Some transients, however, have higher pulse currents.

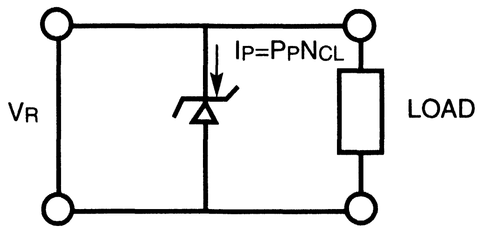
To keep the advantages of AJTVS, several TVS diodes can be put in series.

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.

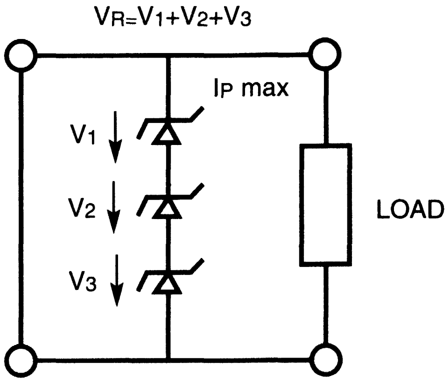
In this case, the total power capability of the TVS diodes put in series is equal to the sum of each TVS diode.

continued

SERIES STACKING OF TVS FOR HIGHER VOLTAGES AND POWER (cont'd)



Where:	PP =	power rating of used TVS
	VR =	reverse working voltage
	IP =	peak pulse current
	VR 1/2/3 =	reverse working voltages for single TVS
	IP max =	lowest IP of the TVS diodes put in series



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 General Semiconductor's range(400, 500, 600, 1500, 5000W), it might be worth it to contact your 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

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 Volts, and in power ratings from 300 through 6000 Watts.

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 10µs rise time, and an exponential decay to 1/2 its peak at 1000 microseconds. 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, Fig. 1 shows an example in which a 300V transient of 150A total current is divided among three TVSs (p/n 1.5KE15) in parallel. 150A 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 50A to ground. This value is within its rated capability, and the transient is safely clamped to 20V, protecting the load from damage.

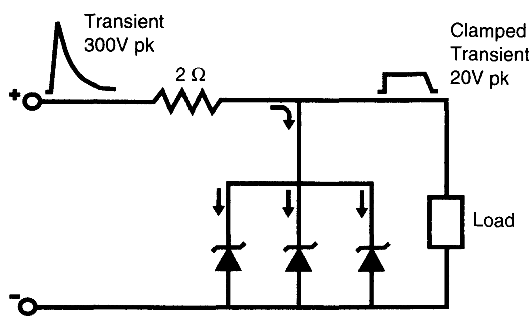
Matching

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 1A, 1ms 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.

Fig. 1



GENERAL SEMICONDUCTOR IS QS-9000 APPROVED!!!

B. Hibel and F.B. Hartwig

GENERAL SEMICONDUCTOR QS-9000 APPROVED!!! General Semiconductor is proud to announce approval of its Ireland and Taiwan manufacturing facilities to the quality system requirements of QS-9000. This certification recognizes General Semiconductor's commitment to total customer satisfaction, through implementation of state-of-the-art quality systems. Following are some common questions associated with QS-9000.

Question: What is QS-9000?

Answer: "QS-9000 Quality System Requirements" is the standard which defines the fundamental quality system expectations of Chrysler Corp., Ford Motor Co., and General Motors Corp., for suppliers of parts and materials. The Big Three formed the Automotive Industries Action Group (AIAG) in an effort to redefine their quality systems with the common objective of improving efficiency and reducing cost through standardizing supplier requirements. QS-9000 is a harmonization of Chrysler's "Supplier Quality Assurance Manual", Ford's "Q-101 Quality System Standard", and General Motors' "Targets for Excellence".

Question: Why was QS-9000 developed?

Answer: QS-9000 was developed by the Chrysler/Ford/General Motors Supplier Quality Requirements Task Force, whose goal was to develop fundamental quality systems providing for continuous improvement, emphasis on defect prevention and the reduction of variation and waste in the supply chain.

Question: QS-9000 sounds like ISO 9000. Is it the same?

Answer: QS-9000 is based in large part on ISO 9000, an internationally recognized standard for quality systems. In addition to the ISO 9000 fundamentals (detailed in Section I of QS-9000), each of the Big Three has included some of their special requirements, making it the new benchmark for quality. The document supersedes ISO 9000 and all editions of Chrysler's, Ford's and General Motors' quality system documentation.

Question: What is the AEC?

Answer: The electronics divisions of Chrysler, Ford, and GM (Delco) formed the Automotive Electronics Council (AEC), in order to provide additional assistance to suppliers of components and materials for vehicle electronics, in quality system implementation. Further, for semiconductor suppliers, they prepared the "QS-9000 Semiconductor Supplement", which includes QS-9000 in its entirety, then goes further to focus on the special concerns of semiconductor manufacturing.

Question: How does a supplier become QS-9000 certified?

Answer: In order to gain certification, a supplier must pass the AIAG "Quality System Assessment" (QSA). QSA is a standardized auditing format involving 23 elements and containing 177 questions, covering every aspect of quality system implementation. For the first time, the Big Three have agreed to allow an accredited third party auditor monitor their suppliers' quality systems.

Question: What is the AEC-A100?

Answer: AEC-A100 is the "QS-9000 Quality System Assessment, Semiconductor Edition". This is an expanded auditing format, incorporating QSA and the additional requirements of the "QS-9000 Semiconductor Supplement". Only AEC auditors may perform an A100 assessment, conferring a second party QS-9000 approval upon passing.

Question: What does QS-9000 approval mean to General Semiconductor and our customers?

Answer: General Semiconductor is both a direct and secondary supplier to the Big Three, that is, product is supplied directly to these organizations, and also to other first tier suppliers of automotive electronics. QS-9000 presented an opportunity to upgrade our existing ISO 9001 status at our manufacturing sites, as part of our commitment to continuous improvement and total customer satisfaction. While ensuring the quality levels required by our automotive customers, it also benefits our customers in other end markets as well, by assuring the highest quality products and services.

General Semiconductor's certification under QS-9000 and the Semiconductor Supplement is an achievement we are proud of. It underscores our commitment, as the world's leading supplier of power semiconductors, to continuous improvement and total customer satisfaction.

PACKAGING

Packaging

PACKAGING CODES

STANDARD PACKAGE CODE	ANTI-STATIC PACKAGE CODES	PACKAGING DESCRIPTION
1	51	Bulk
2	52	DO-214/215AA (SMB), 12mm Tape, 7" Diameter Plastic Reel
2B	2C	DO-214/215AA (SMB), 12mm Tape, 7" Diameter Paper Reel
2D		DO-218AA (SM5-8A), 16mm Tape, 13" Diameter Paper Reel, Anode Towards Sprocket Hole
2E		DO-218AA (SM5-8A), 16mm Tape, 13" Diameter Paper Reel, Cathode Towards Sprocket Hole
2F	2G	DO-214/215AC (SMA), 12mm Tape, 7" Diameter Paper Reel
2M		Tube Packing for 5KP/6KA Type Lead Formed Components
3	53	26mm Horizontal Taping and Ammo Box Packing
4	54	52.4mm Horizontal Tape, 13" Diameter Paper Reel Class I
5	55	DO-214/215AA (SMB), 12mm Tape, 13" Diameter Paper Reel
	5A	DO-214AC (SMA), 12mm Tape, 13" Diameter Plastic Reel, Electro-static Packing
	5B	DO-214/215AA (SMB), 12mm Tape, 13" Diameter Plastic Reel, Electro-static Packing
6	56	Avisert, Cathode Up, Cathode First Off Reel
7	57	DO-214/215AB (SMC), 16mm Tape, 7" Diameter Plastic Reel
8	58	Avisert, Cathode Up, Cathode First Out of Ammo Pack
9	59	DO-214/215AB (SMC), 16mm Tape, 13" Diameter Paper Reel
	9A	DO-214/215AB (SMC), 16mm Tape, 13" Diameter Plastic Reel, Electro-static Packing
9B	9C	DO-214/215AB (SMC), 16mm Tape, 7" Diameter Paper Reel
10	60	Avisert, Cathode Down, Anode First Off Reel
11	61	DO-214AC (SMA), 12mm Tape, 7" Diameter Plastic Reel
12	62	Avisert, Cathode Down, Anode First Out of Ammo Pack
13	63	DO-214AC (SMA), 12mm Tape, 13" Diameter Paper Reel
14	64	Panasert, Cathode Up, Cathode First Off Reel
15	65	Panasert, Cathode Up, Anode Out of First, Ammo Pack
16	66	Panasert, Cathode Up, Cathode First Out of Ammo Pack
18	68	Panasert, Cathode Down, Anode First Off Reel
20	70	Panasert, Cathode Down, Anode First Out of Ammo Pack
22	72	Bulk Pack for Special Axial-Leaded Formed Devices
23	73	52.4mm Horizontal Tape and Ammo Box Packing, Class I
25	75	DO-213AB (GL41), 12mm Tape, 7" Diameter Paper Reel
26	76	DO-213AB (GL41), 12mm Tape, 13" Diameter Paper Reel
44	94	52.4mm Horizontal Tape, 13" Diameter Paper Reel, 5mm Component Spacing for 1.5KA devices only.
46	96	DO-213AB (GL41), 12mm Tape, 7" Diameter Plastic Reels
50	100	MPG06 Pseudo Radial Tape, Cathode First Out of Ammo Pack

Also available for all packaging Electro-Static-Protection by adding the number "50" to the existing codes unless otherwise noted. For example, "51" would be Bulk, Electro-Static Packaging. "54" would be T/R, Electro-Static Packaging.

PACKAGING CODES

GENERAL SEMICONDUCTOR TAIWAN BULK PACKAGING

CASE TYPES:	PACKAGING CODES	PACKAGING	BOX SIZE		QUANTITY	GROSS WEIGHT	
			INCHES	CM	EA.	LBS.	KG
DO-213AB (GL41) SURFACE MOUNT	1	PAPER BOX	8.0 x 3.5 x 1.0	20.3 x 8.8 x 2.54	4000	1.03	0.47
DO-214AC (SMA) SURFACE MOUNT	1	PAPER BOX	8.0 x 3.3 x .87	20.3 x 8.4 x 2.2	2000	0.77	1.69
DO-214AA (SMB) SURFACE MOUNT	1	PAPER BOX	8.0 x 3.3 x .87	20.3 x 8.4 x 2.2	2000	0.77	1.69
DO-214AB (SMC) SURFACE MOUNT	1	PAPER BOX	8.0 x 3.3 x .87	20.3 x 8.4 x 2.2	1000	0.87	1.92
DO-204AC	1	PAPER BOX	11.75 x 5.125 x 2.5	29.8 x 13.0 x 6.3	4000	3.85	1.75
DO-204AL/MPG06	1	PAPER BOX	11.75 x 5.125 x 2.5	29.8 x 13.0 x 6.3	5000	2.38/2.20	1.08/1.0
1.5KA	1	PAPER BOX	11.75 x 5.125 x 2.5	29.8 x 13.0 x 6.3	1500	3.75	1.7
P600 (5KP)	1	PAPER BOX	11.75 x 5.125 x 2.5	29.8 x 13.0 x 6.3	750	3.72	1.69

GENERAL SEMICONDUCTOR IRELAND BULK PACKAGING

CASE TYPES:	PACKAGING CODES	PACKAGING	BOX SIZE		QUANTITY	GROSS WEIGHT	
		INCHES	CM	EA.	LBS.	KG	
1.5KE	1	PAPER BOX	9.8 x 4.7 x 3.1	25.0 x 12.0 x 8.0	1000	2.17	.98
DO-204AL	1	PAPER BOX	8.8 x 3.1 x 1.8	22.5 x 8.0 x 4.5	1000	1.16	.53
DO-204AC	1	PAPER BOX	8.8 x 3.1 x 1.8	22.5 x 8.0 x 4.5	1000	.91	.41
DO-214AA/DO-215AA	1	PAPER BOX	10 x 3.25 x 4.75	25.4 x 10.6 x 12.1	2000	.55	.250
DO-214AB/DO-215AB	1	PAPER BOX	10 x 3.25 x 4.75	25.4 x 10.6 x 12.1	1000	.63	.286

TAIWAN AMMO PACK PACKAGING

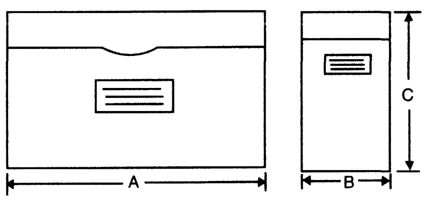


TABLE 1

Packaging	Available Product Outlines	Packaging Codes	Dimension "A"	Dimension "B"	Dimension "C"	Quantity Box
26mm Horizontal Tape, Ammo Pack	DO-204AL (DO-41),MPG06	3	9.7" (247mm)	1.7 (44mm)	"3.7" (95mm)	3.0K
	DO-204AC	3				2.5K
	DO-204AH (DO-35)	F6	10" (255MM)	2.0" (51MM)	2.5" (100MM)	6.0K
52mm Horizontal Tape, Ammo Pack	DO-204AL, MPG06	23				3.0K
	DO-204AC, G4	23	10.0"	3.15"	4.53"	2.0K
	1.5KA	23	(255mm)	(80mm)	(115mm)	1.0K
	P600 (5KP)	23				0.3K
	DO-204AH (DO-35)	D8, F2	10"	2.7"	5.3"	10.0K
	DO-204AL (DO-41)	E1/E2	(255mm)	(70mm)	(135mm)	5.0K/4.0K
*Radial (Avisert, Panasert Vertical Tape	DO-204AL (DO-41)	8, 12 15,16, 20	13.4" (340mm)	1.8" (47mm)	7.9" (200mm)	2.5K
*Pseudo /Radial Tape, Ammo Pack	MPG06	50	13.4" (340mm)	1.8" (47mm)	7.9" (200mm)	2.5K

*Only available on Taiwan manufactured components

Packaging

GENERAL SEMICONDUCTOR®

GENERAL SEMICONDUCTOR TAPE / REEL PACKAGING

TABLE 2

COMPONENT CASE TYPE	PACKAGING CODE	UNITS PER REEL EA.	COMPONENT SPACING "A" FIG. 1 in.	mm	TAPE SPACING "B" FIG. 1 in	mm	REEL DIMENSION "D" FIG.2 in.	mm	MAX. OFF ALIGNMENT "E"FIG. 1 in.	mm	TYP. GROSS WEIGHT PER REEL lbs.	kg.
1.5KA (PAR)	4	2,000	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	7.1	3.2
DO-204AC	4	4,000	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	4.66	2.11
DO-204AL	4	5,500	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	5.2	2.3
DO-213AB (GL41)	25/26	1,500 / 5,000	0.157	4.0	-	-	7.0 / 13.0	178 / 330	See Fig. 11		0.62/1.96	0.281/0.89
P4KE / P4KA Radial	See Fig.6&7	2,500	0.500	12.7	-	-	13.0	330	0.079	2.0	3.0	1.34
1.5KE	4	1,400	0.395	10.0	2.06	52.4	13.0	330	0.047	1.2	4.9/3.8	2.22/1.76
MPG06	4	5,500	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	3.8	1.71
MPG06 Radial	50	2,000	0.500	12.7	-	-	-	-	0.080	2.0	2.4	1.07
(P600)5KP	4	800	0.395	10.0	2.06	52.4	13.0	330	0.047	1.2	5.3	2.39
DO-214AC (SMA)	2F/13	1,800 / 7,500	0.157	4.0	-	-	7.0 / 13.0	178 / 330	See Fig. 11		0.24/0.99	0.11/0.45
DO-214AA (SMB)	2B/5	750 / 3,200	0.314	8.0	-	-	7.0 / 13.0	178 / 330	See Fig. 11		0.24/0.99	0.11/0.45
DO-214AB (SMC)	9B/9	850 / 3,500	0.472	12.0	-	-	7.0 / 13.0	178 / 330	See Fig. 11		0.44/1.39	0.20/0.63
DO-218AA	2D/2E	750	0.630	16.0	-	-	13.0	330	See Fig. 11		4.85	2.2

GENERAL SEMICONDUCTOR SMALL SIGNAL TAPE / REEL PACKAGING

COMPONENT CASE TYPE	PACKAGING CODE	UNITS PER REEL EA.	COMPONENT SPACING "A" FIG. 1 in.	mm	TAPE SPACING "B" FIG. 1 in	mm	REEL DIMENSION "D" FIG.2 in.	mm	MAX. OFF ALIGNMENT "E"FIG. 1 in.	mm	TYP. GROSS WEIGHT PER REEL lbs.	kg.
DO-204AH (DO-35)	D7	10,000	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	4.19	1.9
DO-204AL (Glass DO-41)	D9	5,000	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	4.36	1.98
DO-204AL (Plastic D0-41)	E3	5,000	0.200	5.0	2.06	52.4	13.0	330	0.047	1.2	4.72	2.14
DO-213AB (Glass MELF)	E4/E5	5,000 / 1,250	0.157	4.0	-	-	13.0/7.0	330/178	See Fig. 11		2.14/0.48	0.97/0.22
SOD-80C (mini-MELF)	D1/D2	10,000 / 2,500	0.157	4.0	-	-	13.0/7.0	330/178	See Fig. 11		1.32/0.33	0.60/0.15
SOD-123	D3/D4	10,000 / 3,000	0.157	4.0	-	-	13.0/7.0	330/178	See Fig. 11		0.88/0.24	0.40/0.11
SOD-323	D5/D6	10,000 / 3,000	0.157	4.0	-	-	13.0/7.0	330/178	See Fig. 11		0.77/0.22	0.35/0.10
TO-236AB (SOT-23)	E8/E9	10,000 / 3,000	0.157	4.0	-	-	13.0/7.0	330/178	See Fig. 11		0.88/0.22	0.40/0.10

COMPONENT AND INSIDE HORIZONTAL TAPE SPACING

TABLE 3

Component Body Diameter	Components Spacing "A"(Lead to Lead)	Inside Tape Spacing "B"	Cumulative Pitch Tolerance
0mm to 5mm (0.0" to 0.197")	5.0mm ± 0.5mm (0.197" ± 0.020")	26mm+1.5mm/-0.0mm (1.024" + 0.059"/-0.0")	
0mm to 5mm (0.0" to 0.197")	5.0mm + 0.5mm (0.197" ± 0.020")	52.4mm+1.5mm/-0.4mm (2.062" + 0.059"/-0.016")	Not to Exceed 1.5mm (0.059") over 6 Consecutive Components
5.01mm to 10mm (0.197" to 0.394")	10mm ± 0.5mm (0.394" ± 0.020")	52.4mm + 1.5mm/-0.4mm (2.062" + 0.059"/-0.016")	

All Axial leaded devices are packed in accordance with EIA Standard RS-296-E and the diagrams given below which refer to these specifications.

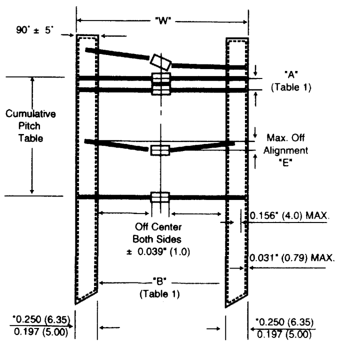


FIG. 1

*These are mounted values and have a ± 0.0157" (0.40) tolerance range at each value

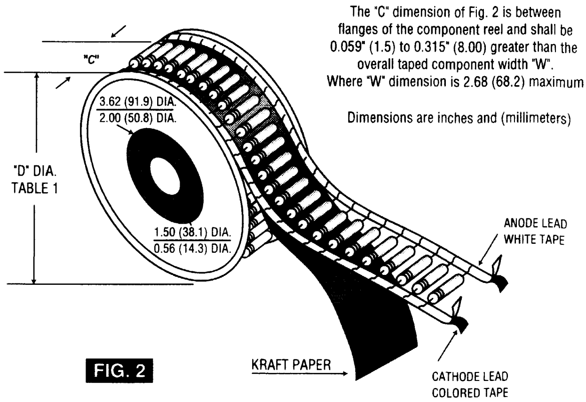
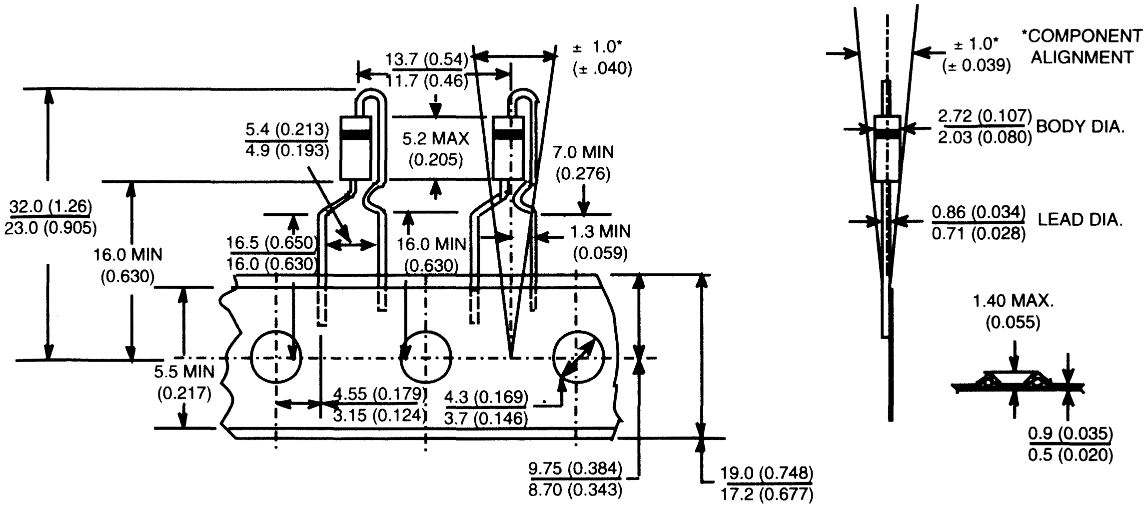


FIG. 2

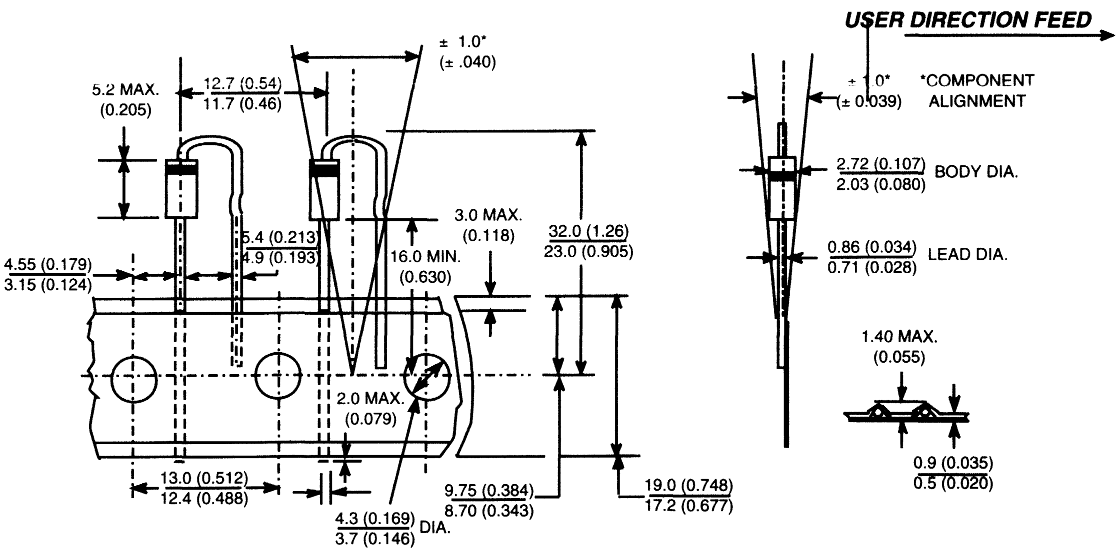
GENERAL SEMICONDUCTOR®

FIG. 3 - PANASERT



All dimensions are in millimeters and (inches)

FIG. 4 - AVISERT

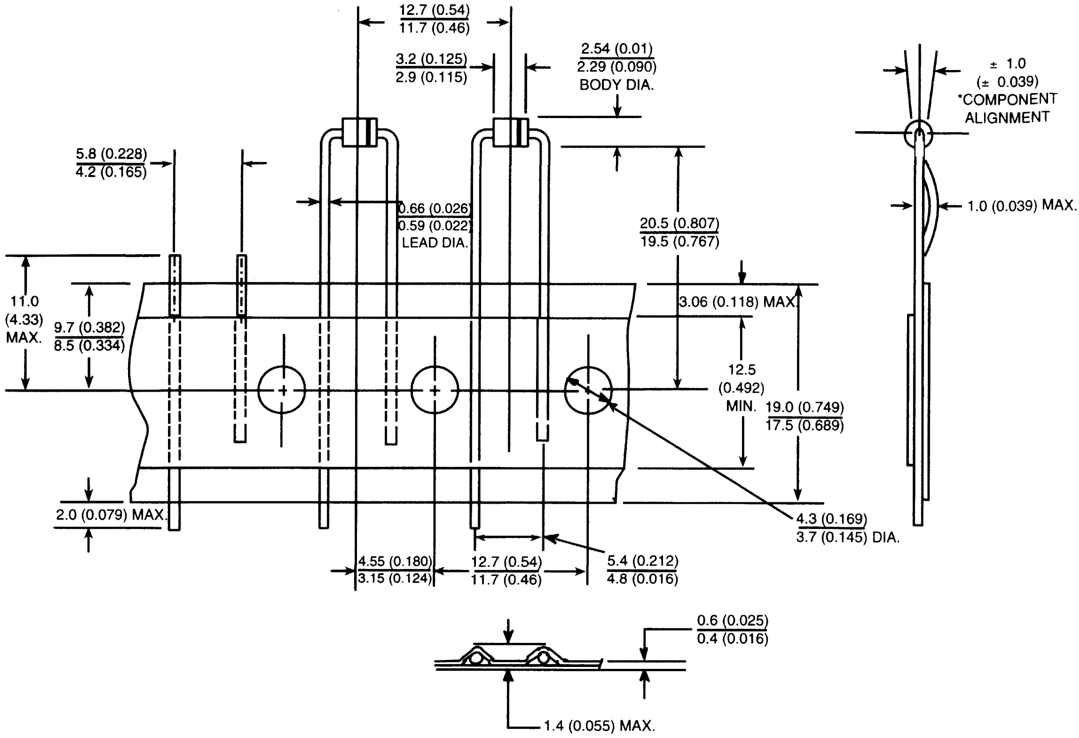


Available only for DO-204AL style products utilizing 0.65mm (0.025") or 0.76mm (0.030") diameter leads for Panasert and Avisert tape and reeling. Lead coating is not available on DO-204AL products.

Standard polarity cathode oriented away from sprocket holes (Optional polarity cathode oriented toward sprocket holes)

All dimensions are in millimeters and (inches)

FIG. 5 - PSEUDO RADIAL



Available only for MPG06 product in Ammo Pack in accordance with EIA Standard RS-468-A utilizing 0.61mm (0.024") diameter leads.
Maximum cumulative pitch tolerance: 1.0mm (0.039") /20 pitch.

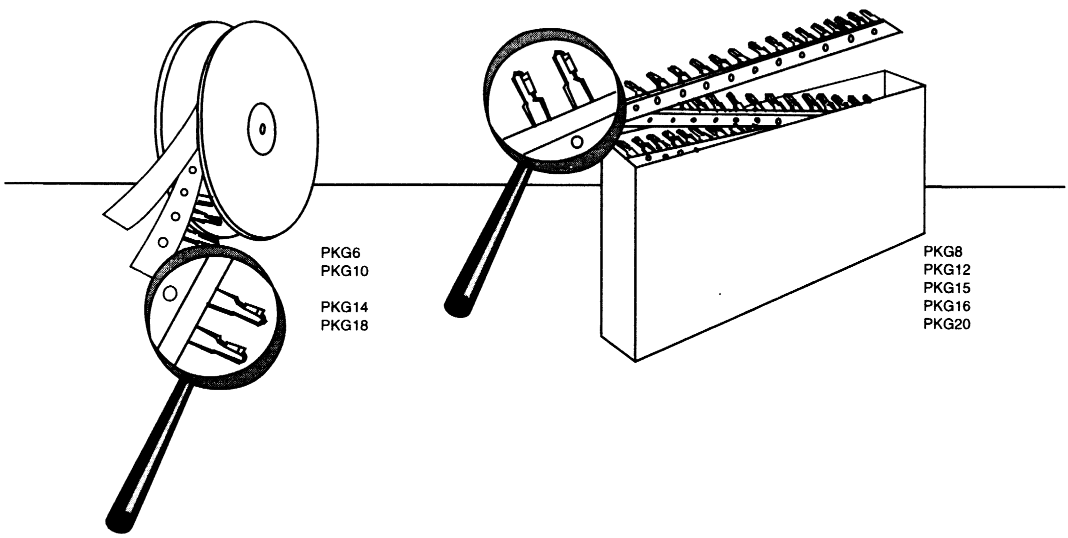


FIG. 6 & 7 - REEL AND AMMO BOX PACKAGING

AVISERT	PANASERT
PKG6	PKG14
PKG8	PKG15
PKG10	PKG16
PKG12	PKG18
	PKG20

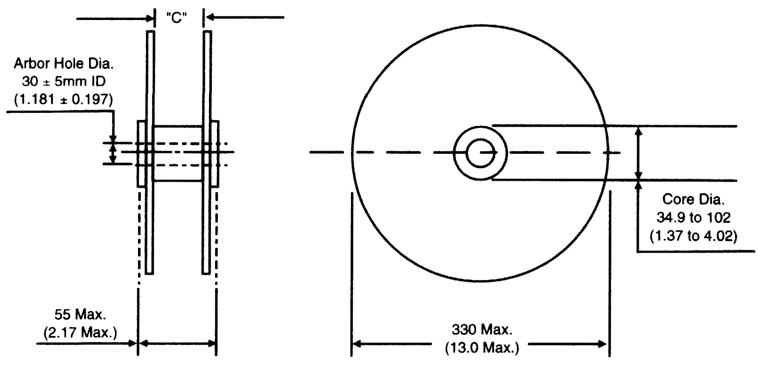


FIG. 8 - REEL DIMENSIONS

"C" Dimension between the reel flanges shall be governed by the overall width of the taped components and shall be 1.5mm (0.057) to 8.0mm (0.315") greater than the overall width

All leaded devices are packaged in accordance with EIA Standard RS-468-A specification and are available on reel, or in fan fold box (ammo pack.)
All dimensions are in millimeters and (inches)
The above packaging is only available from Taiwan.

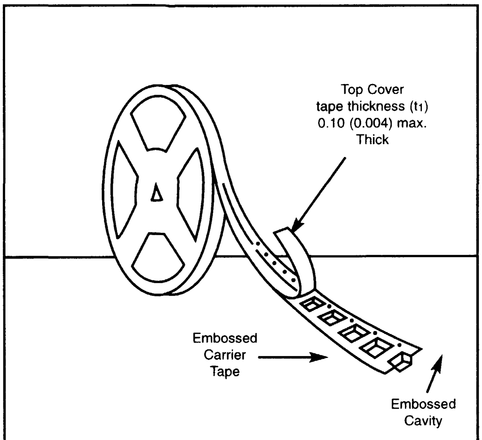


FIG. 9

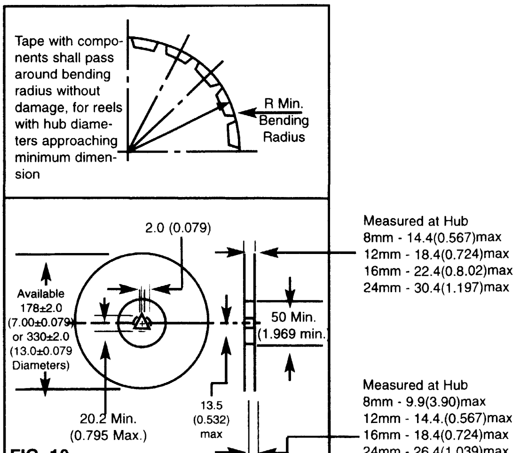


FIG. 10

8,12,16, and 24 mm Embossed Tape

All Dimensions in Millimeters and (Inches)

	Tape Size	D	E	P_o	Tmax	Ao, Bo, Ko	P_2	Constant Dimensions
	8, 12, 16, 24mm	1.5±0.1 (0.059±0.004)	1.75 ± 0.1 (0.069 ± 0.004)	4.0 ± 0.1 (0.157 ±0.004)	0.600 (0.024)	See Note 1	2.0±0.05 (0.79±0.002)	

Case Type	Tape Size	Max. B_1	Min. D_1	F	Max. T_2	Min. R	W	P	
SOD-80C (Mini-MELF) SOD-123 SOD-323 TO-236AB (SOT-23)	8mm (0.315)	4.2 (0.165)	1.0 (0.39)	3.5 ± 0.051 (0.138 ± 0.002)	2.4 (0.094)	25 (0.984)	8.0±0.30 (0.315 ±0.012)		
DO-213AB (GL41 & Glass MELF)					4.5 (0.177)			4.0 ± 0.10 (0.57± 0.004)	
DO-214AC(SMA)	12mm (0.472)	8.2 (0.323)		5.5 ± 0.051 (0.217± 0.12)	3.15 ± 0.10 (1.00 ± 0.004)		12.0 ± 0.30 (0.472 ± 0.012)		Variable Dimensions
			1.5 (0.059)		2.54 ± 0.10 (1.24 ± 0.004)	30 (1.181)			
DO214/215 (SMB)					2.67 ± 0.10 (1.05 ± 0.004)			8.0 ± 0.10 (0.315± 0.004)	
DO-214/215AB (SMC)	16mm (0.630)	12.1 (0.476)		7.5 ± 0.051 (0.295 ±0.002)	2.5 ± 0.10 (0.100 ± 0.004)		16.0 ± 0.2 (0.630 ± 0.008)	12.0 ± 0.10 (0.472 ± 0.004)	
DO-218AA	24mm (0.945)	20.1 (0.791)		11.5 ± 0.1 (0.453 ± 0.004)	3.8 ± 0.07 (0.150 ±0.003)		24.0 ± 0.2 (0.945 ± 0.008)	16.0 ± 0.10 (0.630 ± 0.004)	

NOTE: 1. Ao, Bo, and Ko 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 8mm tape and 12mm tape, 0.15mm (0.066") min. to 0.90mm (0.035") max. for 16mm tape and 0.15mm(0.006) min. to 1.0mm (0.59") max for 24mm tape.
2. All surface mount components are packed in accordance with EIA standard 481-1 and 481-2

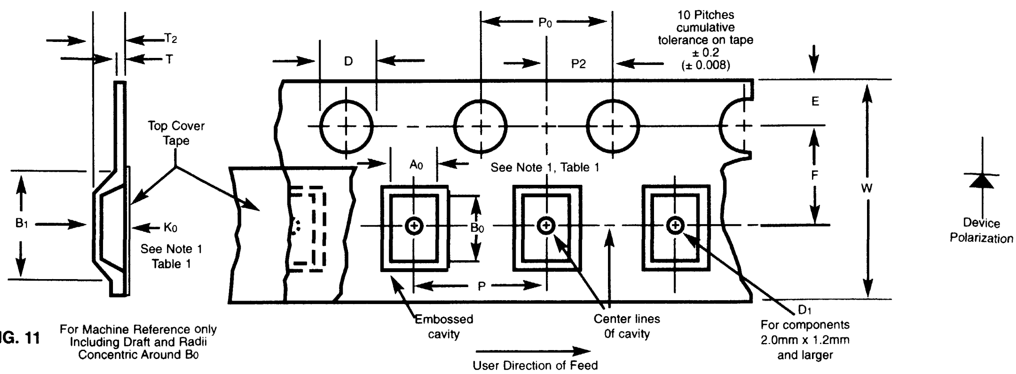


FIG. 11 For Machine Reference only Including Draft and Radii Concentric Around Bo

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