

# TVS Diodes

Transient Voltage Suppression Diodes

5.0SMDJ Series



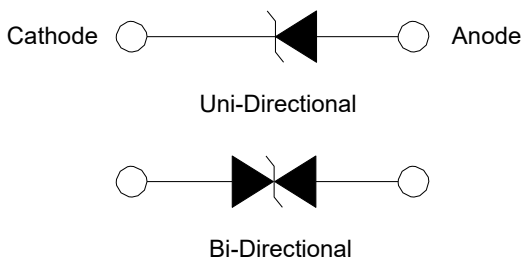
## Description

Transient Voltage Suppressor (TVS) is a circuit protection component that either attenuates (reduces) or filters a transient voltage spike (overvoltage), TVS diodes provide critical protection by going into avalanche breakdown within no more than a few nanoseconds after a strike, clamping the transient voltage, and routing its current to the ground.

## Applications

- Communication Equipment
- Security & Protection
- Industrial Control Equipment
- Power Supply
- Automotive Electronics
- New Energy
- Lightning Protection

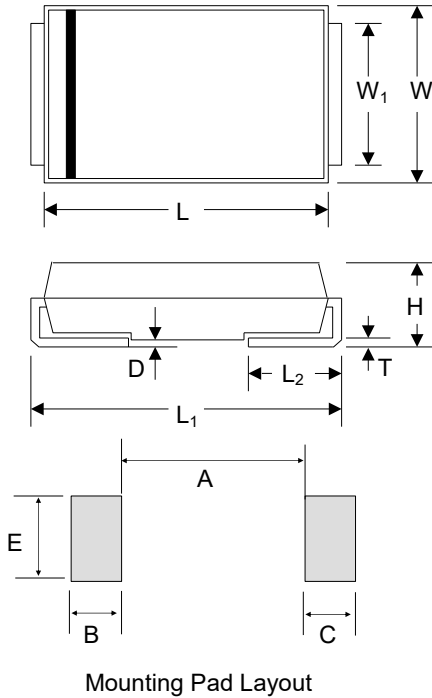
## Functional Diagram



## Features

- Low incremental surge resistance
- Excellent clamping capability
- Low profile package with built-in strain relief
- Typical  $I_R$  less than 5.0  $\mu A$  above 22 V
- 5000 W peak pulse power capability with a 10/1000  $\mu s$  Waveform, repetition rate (duty cycle): 0.01%
- For surface mounted applications to optimize board space
- Typical failure mode is short from over-specified voltage or current
- IEC 61000-4-2 ESD 30 kV (Air), 30 kV (Contact)
- EFT protection of data lines in accordance with IEC 61000-4-4
- Very fast response time
- Glass passivated chip junction
- High temperature to reflow soldering guaranteed: 260  $^{\circ}C/40sec$
- $V_{BR} @ T_J = V_{BR@25^{\circ}C} \times (1 + \alpha T \times (T_J - 25))$   
( $\alpha T$ : Temperature Coefficient, typical value is 0.1%)
- Plastic package is flammability rated V-0 per Underwriters Laboratories
- Meet MSL level1, per J-STD-020
- Matte tin lead-free plated
- Halogen free and RoHS compliant
- Pb-free E3 means 2nd level interconnect is Pb-free and the terminal finish material is tin(Sn) (IPC/JEDEC J-STD-609A.01)

Package Outline Dimensions (DO-214AB)



Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
L	6.60	7.11	0.260	0.280
W	5.59	6.22	0.220	0.245
W <sub>1</sub>	2.90	3.20	0.114	0.126
H	2.06	2.62	0.079	0.103
T	0.152	0.305	0.006	0.012
L <sub>1</sub>	7.75	8.13	0.305	0.320
L <sub>2</sub>	0.76	1.52	0.030	0.060
D	-	0.203	-	0.008
A	-	4.20	-	0.165
B	2.40	-	0.094	-
C	2.40	-	0.094	-
E	3.30	-	0.129	-

Maximum Ratings and Characteristics

(Ratings at 25 °C ambient temperature unless otherwise specified.)

Parameter	Symbol	Value	Unit
Peak Pulse Power Dissipation at T <sub>L</sub> =25 °C by 10/1000 μs waveform <sup>(1)(2)</sup> (Fig.2)	P <sub>PPM</sub>	5000	W
Peak Power Dissipation on Infinite Heat Sink at T <sub>L</sub> =50 °C	P <sub>D</sub>	6.5	W
Peak Forward Surge Current, 8.3 ms single half sine wave superimposed on rated load (JEDEC Method) <sup>(3)</sup>	I <sub>FSM</sub>	300	A
Maximum Instantaneous Forward Voltage at 100 A for Unidirectional Only	V <sub>F</sub>	5.0	V
Operating Temperature Range	T <sub>J</sub>	-65 to 150	°C
Storage Temperature Range	T <sub>STG</sub>	-65 to 175	°C
Typical Thermal Resistance Junction to Lead	R <sub>θJL</sub>	15	°C / W
Typical Thermal Resistance Junction to Ambient	R <sub>θJA</sub>	75	°C / W

Notes

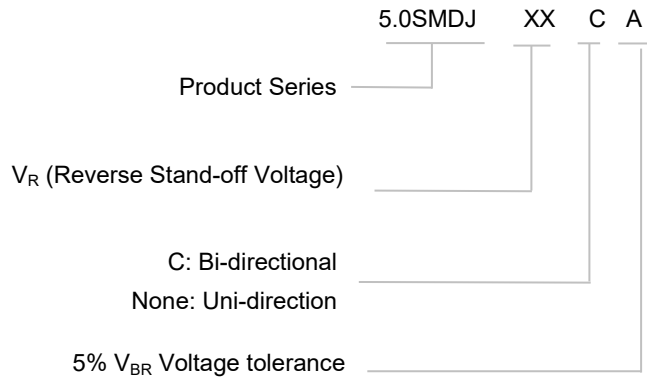
1. Non-repetitive current pulse, per Fig. 4 and derated above T<sub>J</sub>(initial)=25 °C per Fig. 3.
2. Mounted on 8.0 mm<sup>2</sup> land areas.
3. Measured of 8.3 ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum.

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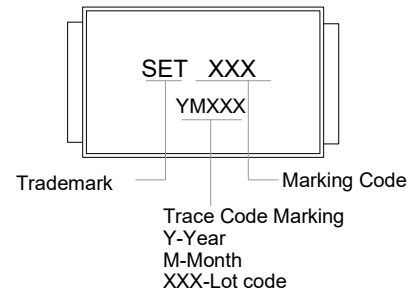
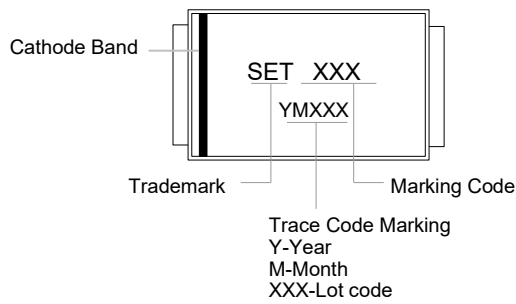
Transient Voltage Suppression Diodes

5.0SMDJ Series

## Part Numbering System



## Marking



# TVS Diodes

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## Electrical Characteristics (T<sub>A</sub>=25 °C unless otherwise noted )

Part Number		Device Marking Code		Breakdown Voltage V <sub>BR@I<sub>T</sub></sub>		Test Current I <sub>T</sub>	Reverse Stand-off Voltage V <sub>R</sub>	Max. Reverse Leakage I <sub>R@V<sub>R</sub></sub>	Max. Peak Pulse Current I <sub>PPM</sub> (10/1000 μs)	Max. Clamping Voltage V <sub>C@I<sub>PPM</sub></sub> (10/1000μs)
				Min	Max					
Uni	Bi	Uni	Bi	(V)		(mA)	(V)	(μA)	(A)	(V)
5.0SMDJ12A	5.0SMDJ12CA	5PEP	5BEP	13.30	14.70	10	12.00	800.00	252.00	19.90
5.0SMDJ13A	5.0SMDJ13CA	5PEQ	5BEQ	14.40	15.90	10	13.00	500.00	233.00	21.50
5.0SMDJ14A	5.0SMDJ14CA	5PER	5BER	15.60	17.20	10	14.00	200.00	216.00	23.20
5.0SMDJ15A	5.0SMDJ15CA	5PES	5BES	16.70	18.50	1	15.00	100.00	205.00	24.40
5.0SMDJ16A	5.0SMDJ16CA	5PET	5BET	17.80	19.70	1	16.00	50.00	193.00	26.00
5.0SMDJ17A	5.0SMDJ17CA	5PEU	5BEU	18.90	20.90	1	17.00	20.00	181.00	27.60
5.0SMDJ18A	5.0SMDJ18CA	5PEV	5BEV	20.00	22.10	1	18.00	10.00	172.00	29.20
5.0SMDJ20A	5.0SMDJ20CA	5PEW	5BEW	22.20	24.50	1	20.00	5.00	155.00	32.40
5.0SMDJ22A	5.0SMDJ22CA	5PEX	5BEX	24.40	26.90	1	22.00	5.00	141.00	35.50
5.0SMDJ24A	5.0SMDJ24CA	5PEZ	5BEZ	26.70	29.50	1	24.00	5.00	129.00	38.90
5.0SMDJ26A	5.0SMDJ26CA	5PFE	5BFE	28.90	31.90	1	26.00	5.00	119.00	42.10
5.0SMDJ28A	5.0SMDJ28CA	5PFG	5BFG	31.10	34.40	1	28.00	5.00	110.00	45.40
5.0SMDJ30A	5.0SMDJ30CA	5PFK	5BFK	33.30	36.80	1	30.00	5.00	103.00	48.40
5.0SMDJ33A	5.0SMDJ33CA	5PFM	5BFM	36.70	40.60	1	33.00	5.00	93.90	53.30
5.0SMDJ36A	5.0SMDJ36CA	5PFP	5BFP	40.00	44.20	1	36.00	5.00	86.10	58.10
5.0SMDJ40A	5.0SMDJ40CA	5PFR	5BFR	44.40	49.10	1	40.00	5.00	77.60	64.50
5.0SMDJ43A	5.0SMDJ43CA	5PFT	5BFT	47.80	52.80	1	43.00	5.00	72.10	69.40
5.0SMDJ45A	5.0SMDJ45CA	5PFV	5BFV	50.00	55.30	1	45.00	5.00	68.80	72.70
5.0SMDJ48A	5.0SMDJ48CA	5PFX	5BFX	53.30	58.90	1	48.00	5.00	64.70	77.40
5.0SMDJ51A	5.0SMDJ51CA	5PFZ	5BFZ	56.70	62.70	1	51.00	5.00	60.70	82.40
5.0SMDJ54A	5.0SMDJ54CA	5PGE	5BGE	60.00	66.30	1	54.00	5.00	57.50	87.10

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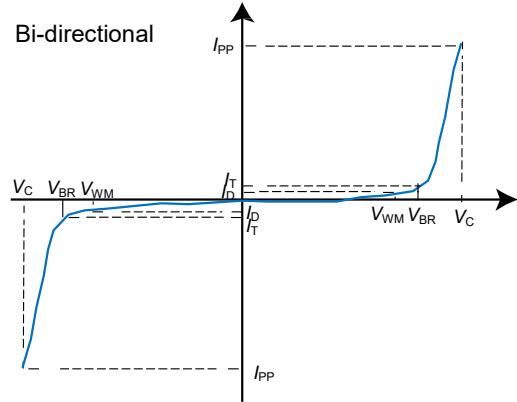
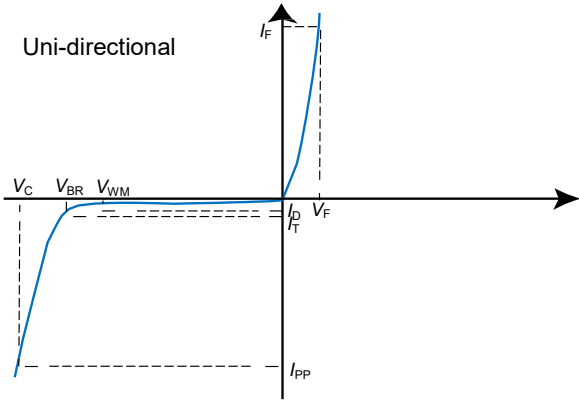
5.0SMDJ Series

Part Number		Device Marking Code		Breakdown Voltage $V_{BR}@I_T$		Test Current $I_T$	Reverse Stand-off Voltage $V_R$	Max. Reverse Leakage $I_R@V_R$	Max. Peak Pulse Current $I_{PPM}$ (10/1000 $\mu$ s)	Max. Clamping Voltage $V_C@I_{PPM}$ (10/1000 $\mu$ s)
				Min	Max					
Uni	Bi	Uni	Bi	(V)		(mA)	(V)	( $\mu$ A)	(A)	(V)
5.0SMDJ58A	5.0SMDJ58CA	5PGG	5BGG	64.40	71.20	1	58.00	5.00	53.50	93.60
5.0SMDJ60A	5.0SMDJ60CA	5PGK	5BGK	66.70	73.70	1	60.00	5.00	51.70	96.80
5.0SMDJ64A	5.0SMDJ64CA	5PGM	5BGM	71.10	78.60	1	64.00	5.00	48.60	103.00
5.0SMDJ70A	5.0SMDJ70CA	5PGP	5BGB	77.80	86.00	1	70.00	5.00	44.30	113.00
5.0SMDJ75A	5.0SMDJ75CA	5PGR	5BGR	83.30	92.10	1	75.00	5.00	41.40	121.00
5.0SMDJ78A	5.0SMDJ78CA	5PGT	5BGT	86.70	95.80	1	78.00	5.00	39.70	126.00
5.0SMDJ85A	5.0SMDJ85CA	5PGV	5BGV	94.40	104.00	1	85.00	5.00	36.50	137.00
5.0SMDJ90A	5.0SMDJ90CA	5PGX	5BGX	100.00	111.00	1	90.00	5.00	34.30	146.00
5.0SMDJ100A	5.0SMDJ100CA	5PGZ	5BGZ	111.00	123.00	1	100.00	5.00	30.90	162.00
5.0SMDJ110A	5.0SMDJ110CA	5PHE	5BHE	122.00	135.00	1	110.00	5.00	28.30	177.00
5.0SMDJ120A	5.0SMDJ120CA	5PHG	5BHG	133.00	147.00	1	120.00	5.00	26.00	193.00
5.0SMDJ130A	5.0SMDJ130CA	5PHK	5BHK	144.00	159.00	1	130.00	5.00	24.00	209.00
5.0SMDJ140A	5.0SMDJ140CA	5PHL	5BHL	156.00	172.00	1	140.00	5.00	22.20	226.00
5.0SMDJ150A	5.0SMDJ150CA	5PHM	5BHM	167.00	185.00	1	150.00	5.00	20.60	243.00
5.0SMDJ160A	5.0SMDJ160CA	5PHP	5BHB	178.00	197.00	1	160.00	5.00	19.30	259.00
5.0SMDJ170A	5.0SMDJ170CA	5PHR	5BHR	189.00	209.00	1	170.00	5.00	18.20	275.00

## Notes:

1. For bidirectional type having  $V_R$  of 20 volts and less, the  $I_R$  should be doubled.
2. For parts without A in the PN , the  $V_{BR}$  tolerance is  $\pm 10\%$  and  $V_C$  is 5% higher than parts with A .The parts without A are currently available, but not recommended for new designs. The parts with A are preferred.

I-V Curve Characteristics



Performance Curve for Reference ( $T_A=25^\circ\text{C}$  unless otherwise noted)

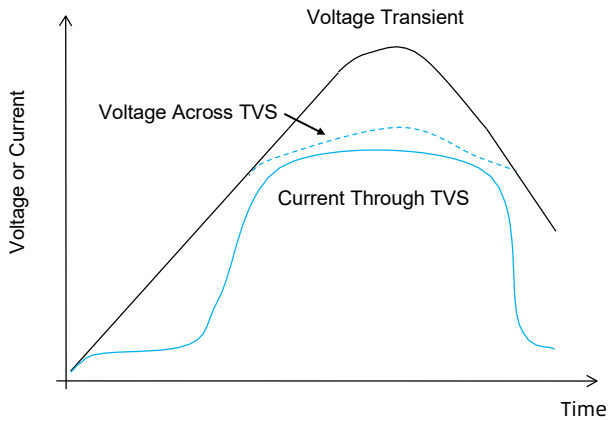


FIGURE 1 TVS Transients Clamping Waveform

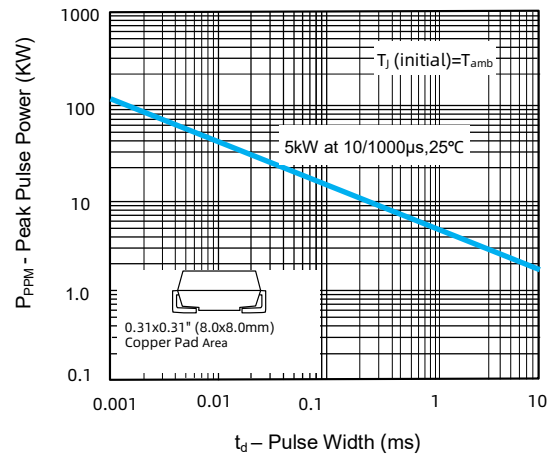


FIGURE 2 Peak Pulse Power Rating Curve

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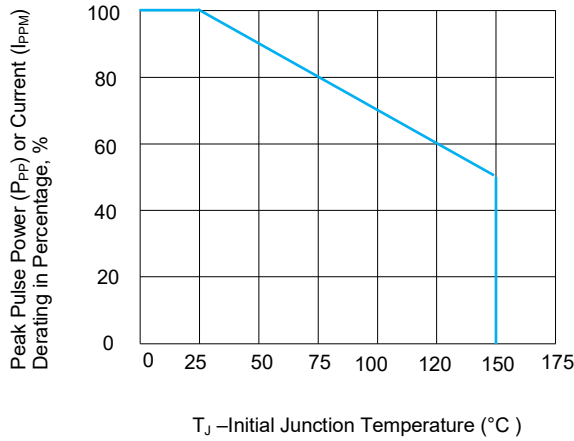


FIGURE 3 Peak Pulse Power Derating Curve

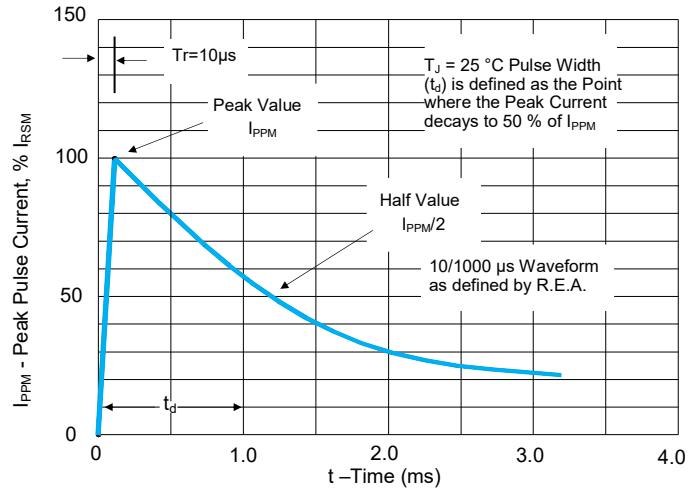


FIGURE 4 Pulse Waveform

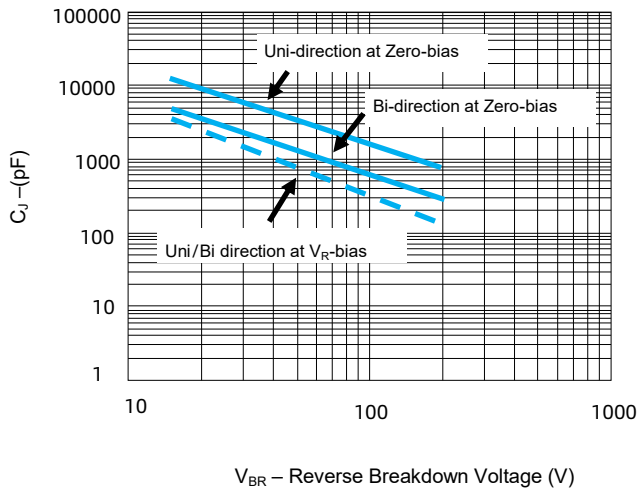


FIGURE 5 Typical Junction Capacitance

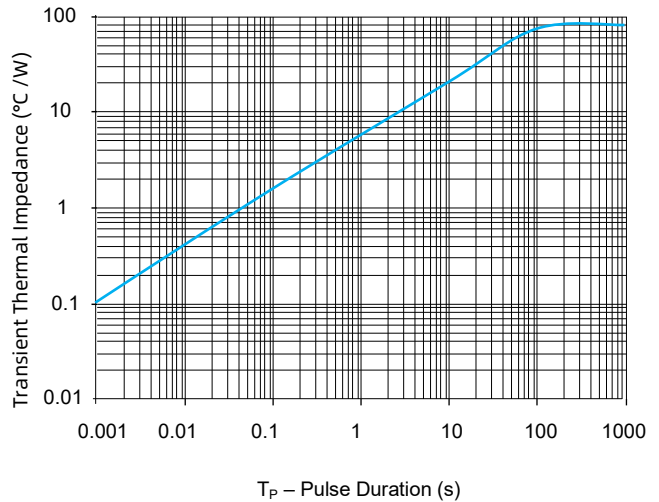


FIGURE 6 Typical Transient Thermal Impedance

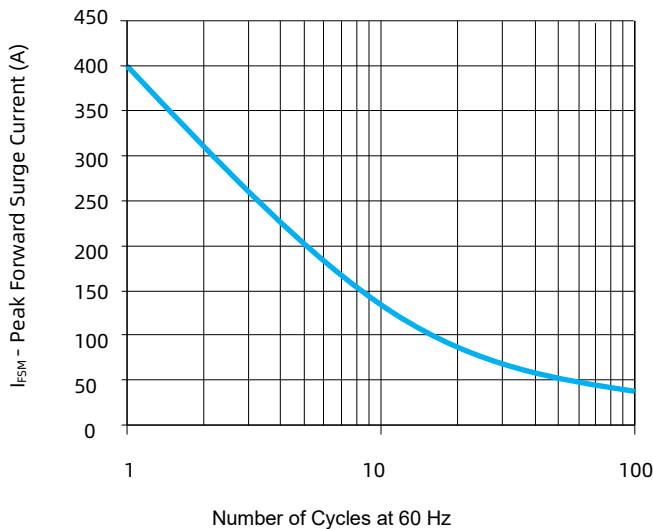


FIGURE 7 Maximum Non-Repetitive Forward Surge Current  
Uni-Directional only

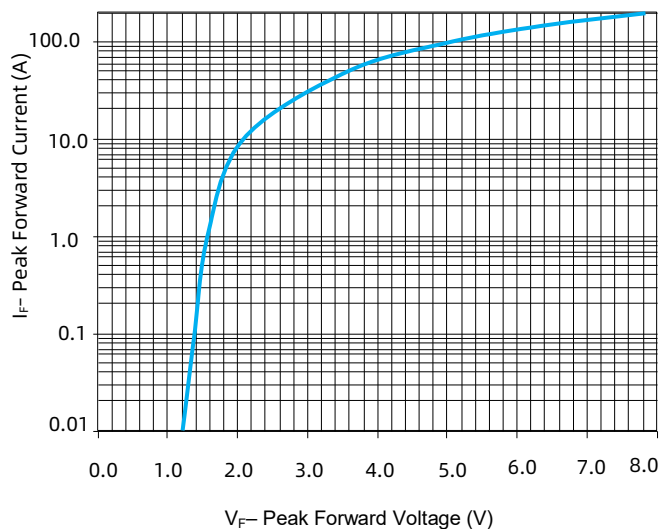


FIGURE 8 Peak Forward Drop vs Peak Forward Current  
(Typical Values)

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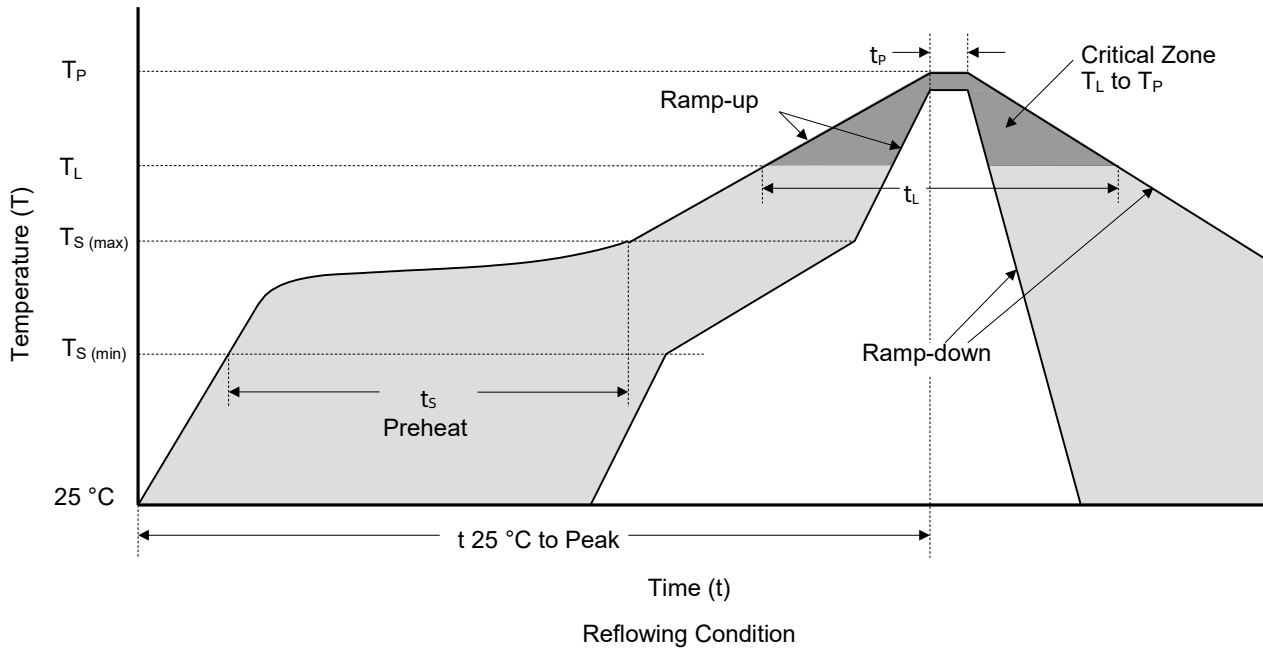
## Environmental Specifications

High Temp. Storage	JESD22-A103
HTRB	JESD22-A108
Temperature Cycling	JESD22-A104
MSL	JESDEC-J-STD-020, Level 1
H3TRB	JESD22-A101
RSH	JESD22-A111

## Physical Specifications

Weight	0.007 ounce, 0.21 grams
Case	JESD22DO214AB. Molded plastic body over glass passivated junction
Polarity	Color band denotes positive end (cathode) except Bidirectional
Terminal	Matte Tin-plated leads, Solderability per JESD22-B102

## Soldering Parameters



Reflow Soldering Parameters		Lead-Free Assembly
Pre-heat	Temperature Min ( $T_{S (min)}$ )	150 °C
	Temperature Max ( $T_{S (max)}$ )	200 °C
	Time (min to max) ( $t_s$ )	60 ~ 120 seconds
Average Ramp Up Rate (Liquidus Temp ( $T_L$ ) to Peak)		3 °C / second max.
$T_{S (max)}$ to $T_L$ Ramp-up Rate		3 °C / second max.
Reflow	Temperature ( $T_L$ ) (Liquidus)	217 °C
	Time (min to max) ( $t_L$ )	60 ~ 150 seconds
Peak Temperature ( $T_P$ )		260 <sup>+0/-5</sup> °C
Time of within 5 °C of Actual Peak Temperature ( $t_p$ )		20 ~ 40 seconds
Ramp-down Rate		6 °C / second max.
Time from 25 °C to Peak Temperature		8 Minutes max.
Do Not Exceed		260 °C



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## Packaging Information

Tape	Symbol	Dimension (mm)
	W	16.00±0.3/-0.1
	P <sub>0</sub>	4.00±0.10
	P <sub>1</sub>	8.00±0.10
	P <sub>2</sub>	2.00±0.10
	D <sub>0</sub>	1.55±0.05
	D <sub>1</sub>	1.55±0.05
	E	1.75±0.10
	F	7.50±0.10
	A <sub>0</sub>	6.15±0.10
	B <sub>0</sub>	8.30±0.10
	K <sub>0</sub>	2.48±0.10
	T	0.30±0.05

Reel Size	13" Reel	
	A	330 mm
	C	13.2 mm
	W <sub>1</sub>	16.4 mm

Part Number	Package	QTY (Reel)	Packaging Option	Packaging Specification
5.0SMDJxxx	DO-214AB	3000 PCS	Tape & Reel – 16 mm tape/13" reel	EIA STD RS-481

Glossary

Item	Description
$V_C$	<b>Clamping Voltage</b> Voltage across TVS in a region of low differential resistance that serves to limit the voltage across the device terminals.
$V_R$	<b>Reverse Stand-off Voltage</b> Maximum voltage that can be applied to the TVS without operation. NOTE : It is also shown as $V_{WM}$ (maximum working voltage (maximum d.c. voltage)) and known as rated stand-off voltage ( $V_{SO}$ ).
$I_R$	<b>Reverse Leakage Current</b> Current measured at $V_R$ . NOTE : Also shown as $I_D$ for stand-by current.
$V_{BR}$	<b>Breakdown Voltage</b> Voltage across TVS at a specified current $I_T$ in the breakdown region.
$I_{PPM}$	<b>Rated Random Recurring Peak Impulse Current</b> Maximum-rated value of random recurring peak impulse current that may be applied to a device.
$P_{M(AV)}$	<b>Rated Average Power Dissipation</b> Maximum-rated value of power dissipation resulting from all sources, including transients and standby current, averaged over a short period of time.
$P_{PPM}$	<b>Rated Random Recurring Peak Impulse Power Dissipation</b> Maximum-rated value of the product of rated random recurring peak impulse current ( $I_{PPM}$ ) multiplies by specified maximum clamping voltage ( $V_C$ ).
$C_J$	<b>Capacitance</b> Capacitance across the TVS measured at a specified frequency and voltage.
$V_{FS}$	<b>Peak Forward Surge Voltage</b> Peak voltage across an TVS for a specified forward surge current ( $I_{FS}$ ) and time duration. NOTE : Also shown as $V_F$ .
$I_{FS}$	<b>Forward Surge Current</b> Pulsed current through TVS in the forward conducting region. NOTE : Also shown as $I_F$ .
$\alpha_{V(BR)}$	<b>Temperature Coefficient of Breakdown Voltage</b> The change of breakdown voltage divided by the change of temperature.
$I_{PP}$	<b>Peak pulse Current</b> Peak pulse current value applied across the TVS to determine the clamping voltage $V_C$ for a specified wave shape.
$I_T$	<b>Pulsed D.C. Test Current</b> Test current for measurement of the breakdown voltage $V_{BR}$ . This is defined by the manufacturer and usually given in milliamperes with a pulse duration of less than 40 ms. NOTE : Also shown as $I_{BR}$ .

—(GB-T 18802.321 / IEC 61643-321 / JESD210A)



# ATTENTION

## Usage

1. TVS must be operated in the specified ambient temp.
2. Do not clean the TVS with strong polar solvent such as ketone, esters, benzene and halogenated hydrocarbon, to avoid damaging the encapsulating layer.
3. Please do not apply severe vibration, shock or pressure to TVS, to avoid element cracking.

## Replacement

1. If TVS is visually damaged, please replace it.
2. TVS is a non-repairable product. For safety sake, please use equivalent TVS for replacement.

## Storage

1. Storage Temp. Range: (-55 to 150) °C.
2. Do not store the TVS at the high temp., high humidity or corrosive gas environment, to avoid influencing the solder- ability of the lead wires. The product shall be used up within 1 year after receiving the goods.

## Environmental Conditions

1. TVS should not be exposed to the open air, nor direct sunshine.
2. TVS should avoid rain, water vapor or other condition of high temp. and high humidity.
3. TVS should avoid sand dust, salt mist, or other harmful gases.

## Max. Typical Capacitance of TVS

The typical capacitance of TVS is listed in the specifications. Designers may refer to it when designing TVS in High frequency circuit.

## Installation Mechanical Stress

1. Do not knock TVS when installing, to avoid mechanical damage.
2. Please do not apply severe vibration, shock or pressure to TVS, to avoid surface resin or element cracking.

**Transient Voltage Suppressor ( Surface Mount ) Features Overview**

Package Type	DO-221AC	DO-214AA	DO-214AB	DO-214AC	SOD-123FL	SMT0-218	SMA6L	SACB	SMBJ	P6SMB	Series
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Product Outline (mm)</b>											
<b><math>V_R / V_{WM}</math> (V)</b> Reverse Stand-off Voltage	5.0 ~ 250	5.0 ~ 85	5.0 ~ 440	5.8 ~ 468	5.0 ~ 250	5.0 ~ 50	5.0 ~ 440	5.8 ~ 512			
<b><math>P_{PPM}</math> (W)</b> (10/1000 $\mu$ s) Rated Peak ImPulse Power Dissipation	200	400	600	500	600						
<b><math>I_{PPM}</math> (kA)</b> (8/20 $\mu$ s) Rated Peak ImPulse Current	<input type="checkbox"/>										
<b>Operating Temperature (°C)</b>	-55 to +150										

**Transient Voltage Suppressor ( Surface Mount ) Features Overview**

Package Type	Series									
	DO-221AC	DO-214AA	DO-214AB	DO-214AC	SOD-123FL	SMT0-218	SPC1	SPC3	SPC6	SPC10
	○	○	○	○	○	○	○	○	○	○
	○	○	○	○	○	○	○	○	○	○
	SMCJ	1.5SMC	3.0SMCJ	SMDJ	5.0SMDJ					
	○	○	○	○	○					
	○	○	○	○	○					
	○	○	○	○	○	SPC1	SPC3	SPC6	SPC10	
<b>Product Outline (mm)</b>										
<b><math>V_R / V_{WM}</math> (V)</b> Reverse Stand-off Voltage	5.0 ~ 440	5.8 ~ 512	5.0 ~ 440	12 ~ 170	380 / 430	66	58 ~ 76	58 ~ 86		
<b><math>P_{PPM}</math> (W)</b> (10/1000 $\mu$ s) Rated Peak ImPulse Power Dissipation	1500	3000	5000							
<b><math>I_{PPM}</math> (kA)(8/20 <math>\mu</math>s)</b> Rated Peak ImPulse Current						1	3	6	10	
<b>Operating Temperature (°C)</b>		-55 to +150					-55 to +125			

**Transient Voltage Suppressor ( Axial Lead ) Features Overview**

Package Type	Series																	
	DO-201	DO-41	DO-15	P600	Radial lead	1.5KE	LCE											
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
	P4KE	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		
	○	SAC	P6KE	○	○	○	○	○	○	○	○	○	○	○	○	○		
	○	○	○	○	○	○	○	5KP	15KPA	20KPA	30KPA	○	○	○	○	○		
	○	○	○	○	○	○	○	○	○	○	○	SPCL1	SPCL3	SPCL6	SPCL10	SPCL15	SPCL20	
Product Outline (mm)																		
$V_R / V_{WM}$ (V) Reverse Stand-off Voltage	5.8 ~ 468	5.0 ~ 50	5.8 ~ 512	5.8 ~ 512	6.5 ~ 90	5.0 ~ 250	17 ~ 280	20 ~ 300	28 ~ 360	76	15 ~ 430	30 ~ 430	15 ~ 530	58 ~ 380	16 ~ 76			
$P_{PPM}$ (W) (10/1000 $\mu$ s) Rated Peak Impulse Power Dissipation	400	500	600	1500	5000	15000	20000	30000					○					
$I_{PPM}$ (kA)(8/20 $\mu$ s) Rated Peak Impulse Current					○					1	3	6	10	15	20			
Operating Temperature (°C)					-55 to +150									-55 to +125				