

概述 Description

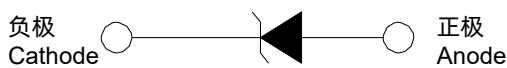
瞬态抑制二极管 (TVS) 是一种电路保护元件，它可以削弱或过滤瞬态电压峰值(过压)，在浪涌到来瞬间几纳秒时间内发生雪崩击穿，将浪涌电流引至接地端，并将电压箝位在安全范围内，从而实现了高效能的电压保护。

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.

应用 Applications

- 通信设备 Communication Equipment
- 安防 Security & Protection
- 工控设备 Industrial Control Equipment
- 电源 Power Supply
- 汽车电子 Automotive Electronics
- 新能源设备 New Energy
- 防雷保护 Lightning Protection

功能图 Functional Diagram



单向 Uni-Directional

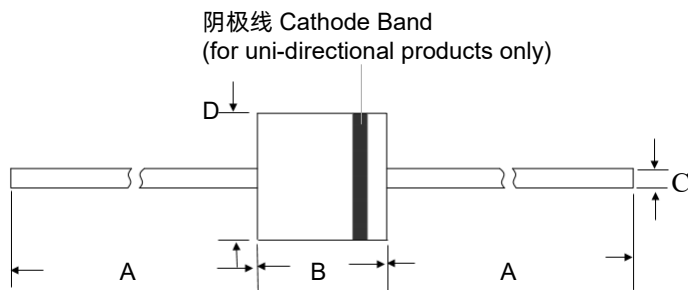


双向 Bi-Directional

特性 Features

- 优异的箝位性能
- 小型化紧凑封装
- P600 封装内置玻璃钝化保护
- 36 V以上电压规格对应漏电流典型值低于2.0 μ A
- 重复率0.01% 的10/1000 μ S 波形对应峰值脉冲功率15 kW
- 典型的故障模式为电压或电流超过额定而导致的短路
- IEC 61000-4-2 防静电: 30 kV (接触/空气放电)
- 符合IEC 61000-4-4标准的数据线路的EFT保护
- 急速响应时间
- 回流焊高温保证:260 $^{\circ}$ C / 40 s
- 温度系数典型值0.1%
- 密封材料阻燃等级V-0
- 湿度敏感等级符合MSL 等级1
- 引脚镀雾锡
- 无卤素, 符合RoHS要求
- 无铅E3: 二级互连引线无铅, 端子镀锡(Sn) (IPC/JEDEC J-STD-609A.01)
- Excellent clamping capability
- Low profile package
- Glass passivated chip junction in P600 package
- Typical I_R less than 2.0 μ A above 36 V
- 15 kW peak pulse power capability with a 10/1000 μ S Waveform, repetition rate (duty cycle): 0.01%
- 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
- High temperature to reflow soldering guaranteed: 260 $^{\circ}$ C/40 sec / 0.375", (9.5 mm) lead length, 5 lbs., (2.3 kg) tension
- $V_{BR} @ T_J = V_{BR}@25^{\circ}C \times (1 + \alpha T \times (T_J - 25))$
(αT : Temperature Coefficient, typical value is 0.1%)
- Plastic package is flammability rated V-0 per Underwriters Laboratories
- Meet MSL level1, per J-STD-020, LF maximum peak of 260 $^{\circ}$ C
- 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)

封装尺寸 Package Outline Dimensions (P600)



阴极线 Cathode Band
(for uni-directional products only)

P600

符号 Symbol	公制(毫米) Millimeters		英制(英寸) Inches	
	Min.	Max.	Min.	Max.
A	25.40	-	1.000	-
B	8.60	9.10	0.340	0.360
C	1.22	1.36	0.048	0.054
D	8.60	9.10	0.340	0.360

额定参数与特性 Maximum Ratings and Characteristics

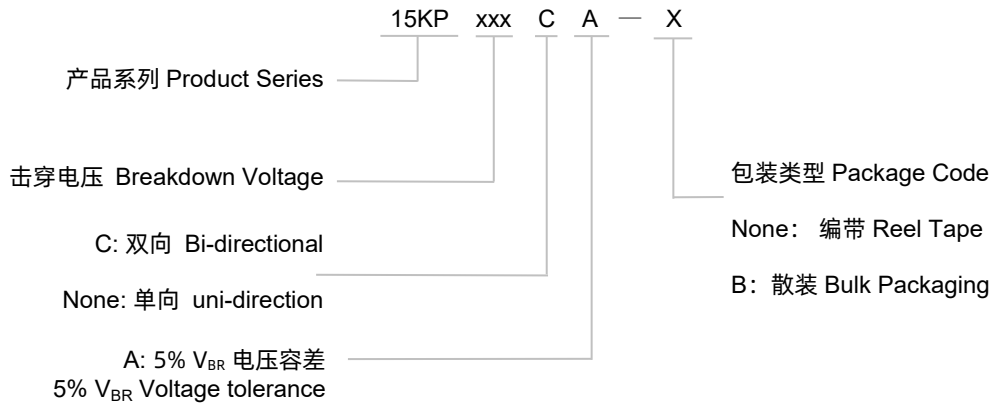
(除另有注释, 默认 $T_A=25\text{ }^\circ\text{C}$ Ratings at $25\text{ }^\circ\text{C}$ ambient temperature unless otherwise specified.)

参数 Parameter	符号 Symbol	值 Value	单位 Unit
10/1000 μS 脉冲波形 ⁽¹⁾ 下, 峰值脉冲功率 图(2) Peak Power Dissipation(Fig.2)- with a 10/1000 μS waveform ⁽¹⁾	P_{PPM}	15	kW
峰值功耗,无限散热, $T_L=75\text{ }^\circ\text{C}$ Peak Power Dissipation on Infinite Heat Sink at $T_L=75\text{ }^\circ\text{C}$	P_D	8.0	W
正向脉冲电流峰值 ⁽²⁾ ,额定负载叠加8.3 ms 单半正弦波测得(JEDEC方法) Peak Forward Surge Current,8.3 ms single half sinewave unidirectional only ⁽²⁾	I_{FSM}	400	A
工作及存储温度范围 Operating Temperature Range	T_J	-55 to 175	$^\circ\text{C}$
存储温度范围 Storage Temperature Range	T_{STG}	-55 to 175	$^\circ\text{C}$
典型热阻(结至引线) Typical Thermal Resistance Junction to Lead	$R_{\theta JL}$	8.0	$^\circ\text{C/W}$
典型热阻(结至环境) Typical Thermal Resistance Junction to Ambient	$R_{\theta JA}$	40	$^\circ\text{C/W}$

注释 Notes

- 参照图4非重复性脉冲电流波形, 初始结温 $25\text{ }^\circ\text{C}$ 以图3所示曲线降额(环境温度 $T_A=25\text{ }^\circ\text{C}$)。
Non-repetitive current pulse, per Fig. 4 and derated above $T_J(\text{initial})=25\text{ }^\circ\text{C}$ per Fig. 3.
- 叠加波形为8.3 ms单个半周期正弦波或等幅方波, 最长周期4次/min。
Measured of 8.3 ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum.

型号规则 Part Numbering System



标记 Marking



术语 Glossary

项目 Item	描述 Description
V_C	箝位电压 Clamping Voltage TVS在低差阻区域内的电压，用于限制设备两端的电压。 Voltage across TVS in a region of low differential resistance that serves to limit the voltage across the device terminals.
V_R	反向关断电压 Reverse Stand-off Voltage TVS 在没有导通状态下最高电压。 Maximum voltage that can be applied to the TVS without operation. 注：也用 V_{WM} （最高直流工作电压）表示，也称为截止电压(V_{so})。 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	反向漏电流 Reverse Leakage Current 量测 V_R 的电流。 Current measured at V_R . 注：也用 I_D 待机电流表示。 NOTE : Also shown as I_D for stand-by current.
V_{BR}	击穿电压 Breakdown Voltage 在击穿区以指定电流 I_T (测试电流)通过TVS的电压。 Voltage across TVS at a specified current I_T (test current) in the breakdown region.
I_{PPM}	额定随机重复峰值脉冲电流 Rated Random Recurring Peak Impulse Current 施加在设备上的随机重复峰值脉冲电流的最大额定值。 Maximum-rated value of random recurring peak impulse current that may be applied to a device.
$P_{M(AV)}$	额定平均功率 Rated Average Power Dissipation 所有电源(包括瞬态电流和待机电流)在短时间内平均产生的最大额定功耗。 Maximum-rated value of power dissipation resulting from all sources, including transients and standby current, averaged over a short period of time.
P_{PPM}	额定随机重复峰值脉冲功率 Rated Random Recurring Peak Impulse Power Dissipation 额定随机重复峰值脉冲电流(I_{PPM})和规定的最大箝位电压(V_C)乘积的最大额定值。 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	电容 Capacitance 在规定的频率和电压下所测量的TVS电容。 Capacitance across the TVS measured at a specified frequency and voltage.

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

项目 Item	描述 Description
V_{FS}	<p>正向浪涌峰值电压 Peak Forward Surge Voltage</p> <p>在指定的正向浪涌电流(I_{FS})和持续时间下, 通过TVS的峰值电压。 Peak voltage across TVS for a specified forward surge current (I_{FS}) and time duration. 注: 也用V_F表示。 NOTE : Also shown as V_F.</p>
I_{FS}	<p>正向浪涌电流 Forward Surge Current</p> <p>在正向导通区域通过TVS的脉冲电流。 Pulsed current through TVS in the forward conducting region. 注: 也用I_F表示。 NOTE : Also shown as I_F.</p>
$\alpha_{V(BR)}$	<p>击穿电压温度系数 Temperature Coefficient of Breakdown Voltage</p> <p>击穿电压的变化与温度变化的比值。 The change of breakdown voltage divided by the change of temperature.</p>
I_{PP}	<p>峰值脉冲电流 Peak pulse Current</p> <p>施加在TVS上的峰值脉冲电流, 以确定箝位电压V_C的特定波形。 Peak pulse current value applied across the TVS to determine the clamping voltage V_C for a specified wave shape.</p>
I_T	<p>脉冲直流测试电流 Pulsed D.C. Test Current</p> <p>测量击穿电压V_{BR}的测试电流。该电流值由制造商确定, 通常以脉冲持续时间小于40 ms的毫安级电流给出。 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. 注: 也用I_{BR}表示。 NOTE : Also shown as I_{BR}.</p>

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

电气特性 (除另有注释, 默认 $T_A=25\text{ }^\circ\text{C}$)Electrical Characteristics ($T_A=25\text{ }^\circ\text{C}$ unless otherwise noted) Table 1

型号 Part Number		击穿电压 Breakdown Voltage $V_{BR@I_T}$		测试电 流 Test Current I_T	反向关 断电压 Reverse Stand-off Voltage V_R	最大反向 漏电流 Max. Reverse Leakage $I_R@V_R$	最大峰值 脉冲电流 Max. Peak Pulse Current I_{PPM}	最大箝位 电压 Max. Clamping Voltage $V_C@I_{PPM}$
		Min	Max					
Uni	Bi	(V)		(mA)	(V)	(μA)	(A)	(V)
15KPA17A	15KPA17CA	18.99	20.79	50	17	5000	515.4	29.3
15KPA18A	15KPA18CA	20.11	22.01	50	18	5000	488.7	30.9
15KPA20A	15KPA20CA	22.34	24.46	20	20	1500	440.2	34.3
15KPA22A	15KPA22CA	24.57	26.91	10	22	500	407	37.1
15KPA24A	15KPA24CA	26.81	29.35	5	24	150	371	40.7
15KPA26A	15KPA26CA	29.04	31.8	5	26	50	343.2	44
15KPA28A	15KPA28CA	31.28	34.24	5	28	25	317.9	47.5
15KPA30A	15KPA30CA	33.51	36.7	5	30	15	297.8	50.7
15KPA33A	15KPA33CA	36.9	40.4	5	33	2	276.1	54.7
15KPA36A	15KPA36CA	40.2	44	5	36	2	252.5	59.8
15KPA40A	15KPA40CA	44.7	48.9	5	40	2	229.5	65.8
15KPA43A	15KPA43CA	48	52.6	5	43	2	216.3	69.8
15KPA45A	15KPA45CA	50.3	55	5	45	2	207.4	72.8
15KPA48A	15KPA48CA	53.6	58.7	5	48	2	194.3	77.7
15KPA51A	15KPA51CA	57	62.4	5	51	2	182.1	82.9
15KPA54A	15KPA54CA	60.3	66	5	54	2	172.2	87.7
15KPA58A	15KPA58CA	64.8	70.9	5	58	2	161	93.8
15KPA60A	15KPA60CA	67	73.4	5	60	2	155	97.4
15KPA64A	15KPA64CA	71.5	78.3	5	64	2	144.9	104.2
15KPA70A	15KPA70CA	78.2	85.6	5	70	2	132.9	113.6
15KPA75A	15KPA75CA	83.8	91.7	5	75	2	123.8	122
15KPA78A	15KPA78CA	87.1	95.4	5	78	2	119.7	126.1
15KPA85A	15KPA85CA	94.9	104	5	85	2	109.7	137.6

瞬态抑制二极管 TVS Diodes

Transient Voltage Suppression Diodes

15KPA Series

型号 Part Number		击穿电压 Breakdown Voltage $V_{BR@I_T}$		测试电 流 Test Current I_T	反向关断 电压 Reverse Stand-off Voltage V_R	最大反向 漏电流 Max. Reverse Leakage $I_R@V_R$	最大峰值 脉冲电流 Max. Peak Pulse Current I_{PPM}	最大箝位 电压 Max. Clamping Voltage $V_C@I_{PPM}$
		Min	Max					
Uni	Bi	(V)		(mA)	(V)	(μ A)	(A)	(V)
15KPA90A	15KPA90CA	100.5	110.1	5	90	2	103.7	145.6
15KPA100A	15KPA100CA	111.7	122.3	5	100	2	93.6	161.3
15KPA110A	15KPA110CA	122.9	134.5	5	110	2	84.5	178.6
15KPA120A	15KPA120CA	134	146.8	5	120	2	78.5	192.3
15KPA130A	15KPA130CA	145.2	159	5	130	2	72.5	208.3
15KPA150A	15KPA150CA	167.6	183.5	5	150	2	62.4	241.9
15KPA160A	15KPA160CA	178.7	195.7	5	160	2	58.4	258.6
15KPA170A	15KPA170CA	189.9	207.9	5	170	2	55.4	272.7
15KPA180A	15KPA180CA	201.1	220.1	5	180	2	52.3	288.5
15KPA200A	15KPA200CA	223.4	244.6	5	200	2	47.3	319.1
15KPA220A	15KPA220CA	245.7	269.1	5	220	2	42.4	356
15KPA240A	15KPA240CA	268.1	293.5	5	240	2	39.3	384.6
15KPA260A	15KPA260CA	290.4	318	5	260	2	36.2	416.7
15KPA280A	15KPA280CA	312.8	342.4	5	280	2	33.2	454.5

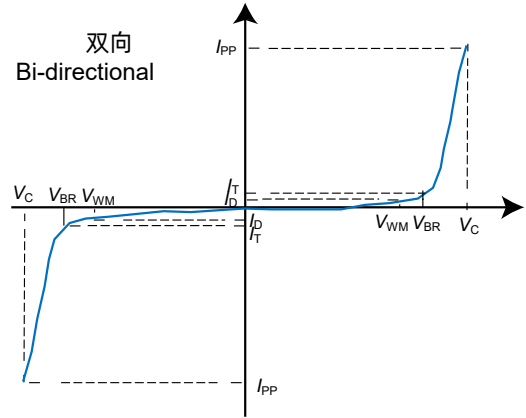
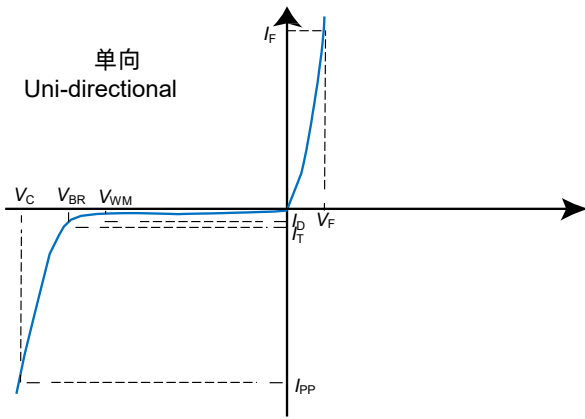
注释 Notes:

1. 叠加波形为8.3 ms单个半周期正弦波或等幅方波，最长周期4次/min。

Measured of 8.3 ms single half sine-wave or equivalent square wave, duty cycle=4 pulses per minute maximum.

2. $V_F < 3.5$ V为单芯片产品， $V_F < 5.0$ V为双芯片产品。 $V_F < 3.5$ V for single die parts and $V_F < 5.0$ V for stacked-die parts.3. 对于 V_R 为30 V及更低的双向产品， I_R 值需乘以两倍。For bidirectional type having V_R of 30 volts and less, the I_R should be doubled.

伏安特性曲线 I-V Curve Characteristics



参考性能曲线 (除有另外注释, 默认 $T_A=25^\circ\text{C}$)

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

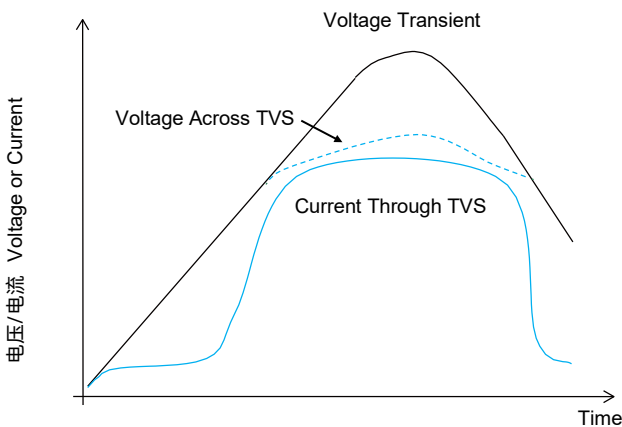


FIGURE 1 TVS瞬态箝位波形
TVS Transients Clamping Waveform

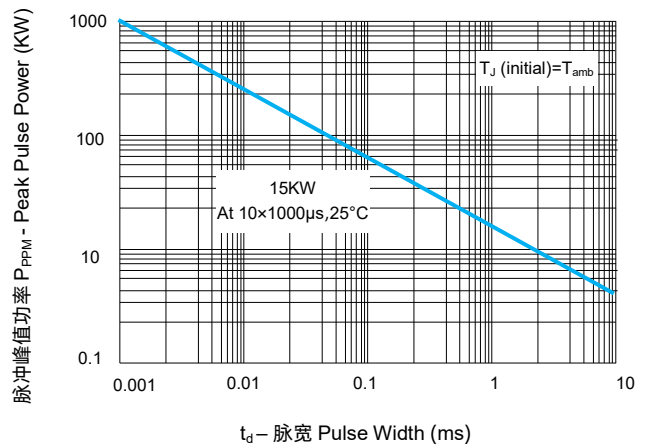


FIGURE 2 峰值脉冲功率额定曲线
Peak Pulse Power Rating Curve

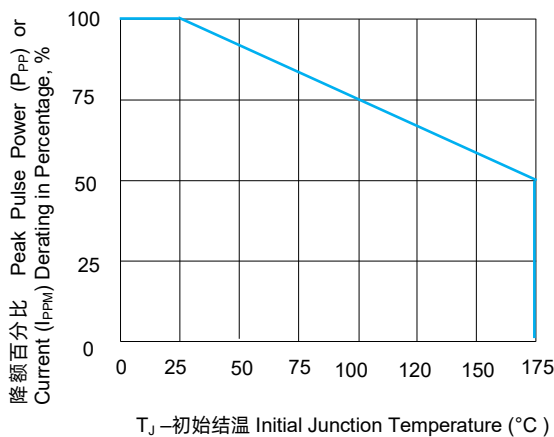


FIGURE 3 峰值脉冲功率降额曲线
Peak Pulse Power Derating Curve

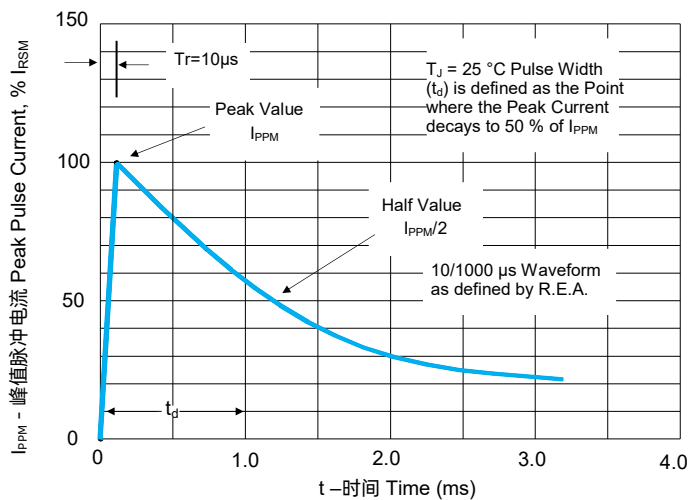


FIGURE 4 脉冲波形
Pulse Waveform

TVS

TVS

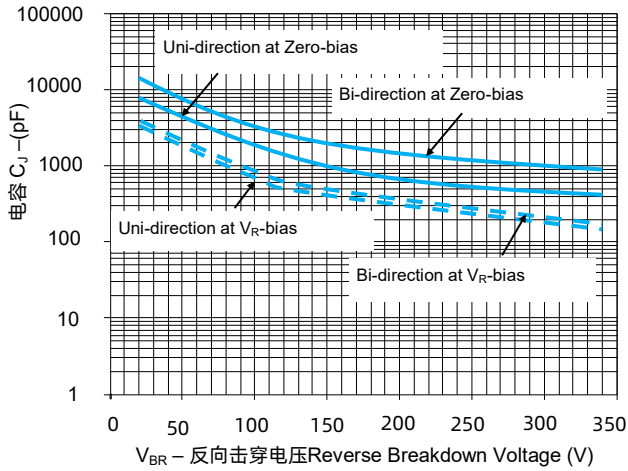


FIGURE 5 典型结电容 Typical Junction Capacitance

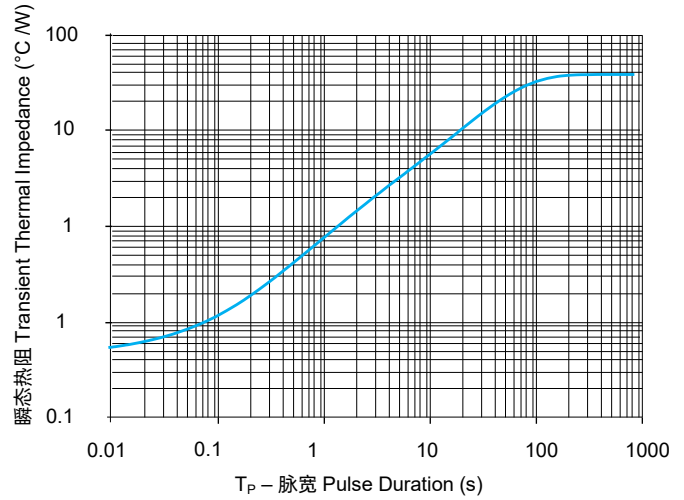


FIGURE 6 典型瞬态热阻 Typical Transient Thermal Impedance

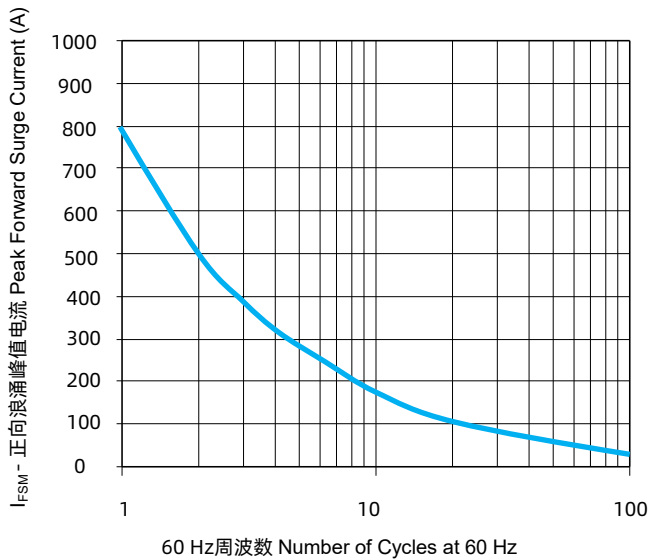


FIGURE 7 最大非重复正向浪涌电流(单向型)
Maximum Non-Repetitive Forward Surge Current
Uni-Directional only

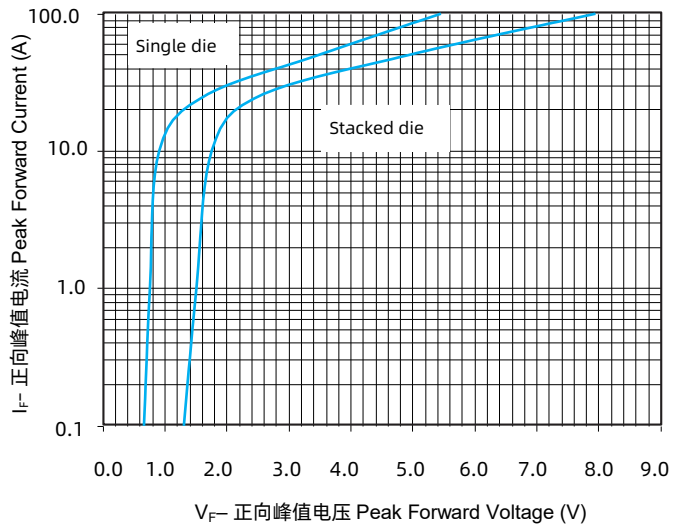


FIGURE 8 峰值正向电压及电流(典型值)
Peak Forward Drop vs Peak Forward Current (Typical Values)

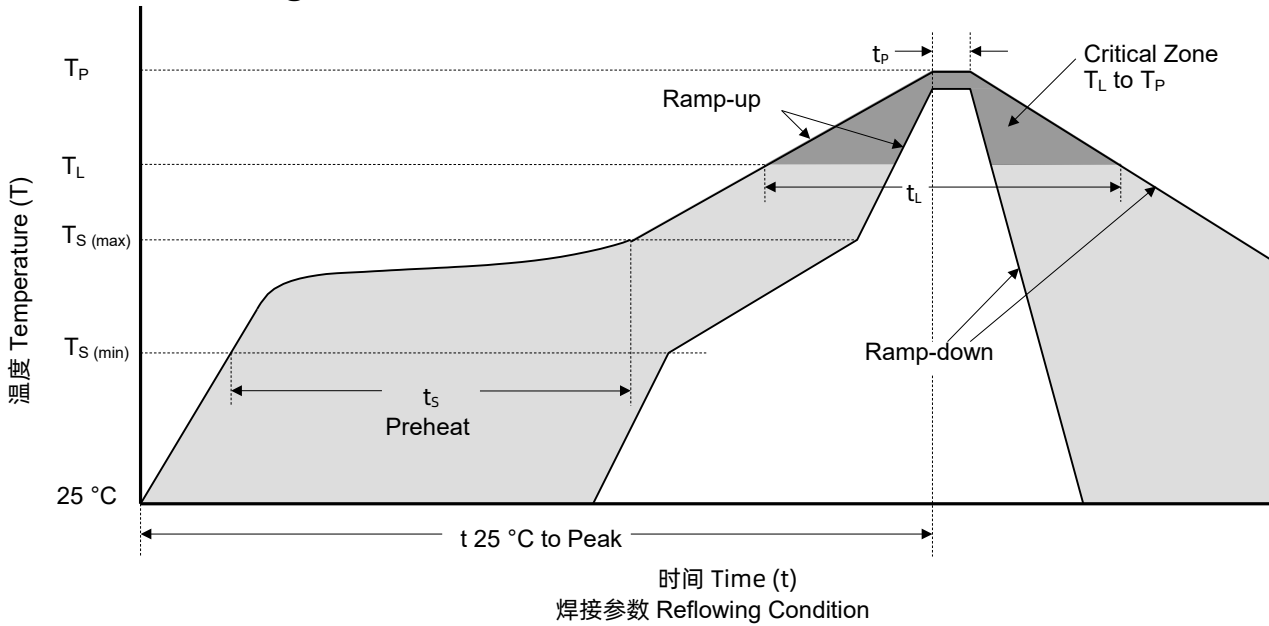
环境特性 Environmental Specifications

物理特性 Physical Specifications

高温存储 High Temp. Storage	JESD22-A103
高温反偏 HTRB	JESD22-A108
温度循环 Temperature Cycling	JESD22-A104
高温高湿反偏 H3TRB	JESD22-A101
耐焊接热 RSH	JESD22-B106

重量 Weight	0.007 ounce, 2.5 grams
封装 Case	JEDEC P600 Molded plastic body over glass passivated junction
极性 Polarity	Color band denotes positive end (cathode) except Bidirectional
端子 Terminal	Matte Tin-plated leads, Solderability per JESD22-B102

焊接参数 Soldering Parameters



时间 Time (t)
焊接参数 Reflowing Condition

回流焊接参数 Reflow Soldering Parameters		无铅组装 Lead-Free Assembly
预热 Pre-heat	最低温($T_{S(min)}$) Temperature Min ($T_{S(min)}$)	150 °C
	最高温($T_{S(max)}$) Temperature Max ($T_{S(max)}$)	200 °C
	升温时长(t_s) Time (min to max) (t_s)	60 ~ 120 seconds
平均升温速率(液相温度(T_L)至峰值温度(T_P)) Average Ramp-up Rate (Liquidus Temp (T_L) to Peak Temp (T_P))		3 °C / second max.
$T_{S(max)}$ 到 T_L 升温速率 $T_{S(max)}$ to T_L Ramp-up Rate		3 °C / second max.
回流 Reflow	温度 Temperature (T_L) (Liquidus)	217 °C
	时长 Time (min to max) (t_L)	60 ~ 150 seconds
峰值温度 Peak Temperature (T_P)		260 ^{+0/-5} °C
实际峰值温度 (t_p) 5 °C 以内的时间 Time of within 5 °C of Actual Peak Temperature (t_p)		20 ~ 40 seconds
降温速率 Ramp-down Rate		6 °C / second max.
25 °C 至峰值温度时长 Time from 25 °C to Peak Temperature		8 Minutes max.
极限温度 Do Not Exceed		260 °C

波峰焊(浸焊) Flow/Wave Soldering (Solder Dipping)

项目 Item	条件 Conditions
峰值温度 Peak Temperature	260 °C+0 /- 5 °C
浸焊时间 Dipping Time	10 second
焊接次数 Soldering	1 time

包装信息 Packaging Information

型号 Part Number	封装 Component Package	数量 QTY' s (Reel)	包装选项 Package Option
15KPAxxxXX	P600	800 PCS	Tape & Reel
15KPAxxxXX-TB	P600	300 PCS	TB
15KPAxxxXX-B	P600	100 PCS	Bulk

编带 Tape	符号 Symbol	公制(毫米) Millimeters	英制(英寸) Inches
	A	10±0.5	0.394+/-0.020
	B	53.0+2.0/-1.0	2.063+0.079/-0.039
	E	1.2	0.047
	W	65.0	2.56
	T	6.0	0.236
	ΔL	0.7Max.	0.028Max.
编带&卷盘 Tape & Reel (T/R)	符号 Symbol	公制(毫米) Millimeters	英制(英寸) Inches
	D	330	13.0
	D ₁	76.2	3.0
	W ₁	69.85	2.75

TVS

TVS



注意

ATTENTION

使用方法 Usage

1. 请在规定的温度范围内使用TVS。
TVS must be operated in the specified ambient temp.
2. 请勿使用强极性溶剂清洗TVS以免破坏封装层。
Do not clean the TVS with strong polar solvent such as ketone, esters, benzene and halogenated hydrocarbon, to avoid damaging the encapsulating layer.
3. 请勿对TVS施加剧烈的振动，冲击或压力，以避免元件开裂。
Please do not apply severe vibration, shock or pressure to TVS, to avoid element cracking.

更换 Replacement

1. 若TVS出现可视化损伤，请将其更换。
If TVS is visually damaged, please replace it.
2. TVS为非修理型产品，安全起见，请更换同等规格的TVS。
TVS is a non-repairable product. For safety sake, please use equivalent TVS for replacement.

存储 Storage

1. 存储温度范围。
Storage Temp. Range: (-55 to 150) °C.
2. 请勿将TVS存放于高温高湿或腐蚀性气体环境中，已避免影响引脚的焊接性能，请于收货后一年内进行使用。
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.

环境条件 Environmental Conditions

1. 请勿暴露于室外阳光直射环境。
TVS should not be exposed to the open air, nor direct sunshine.
2. 请避免雨水，水汽等高温高湿环境。
TVS should avoid rain, water vapor or other condition of high temp. and high humidity.
3. 请避免沙尘，盐雾等有害环境。
TVS should avoid sand dust, salt mist, or other harmful gases.

TVS最大典型结电容 Max. Typical Capacitance of TVS

高频线路应用中请参照规格书中所给出的典型电容曲线。

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

安装机械应力 Installation Mechanical Stress

1. 安装TVS时请避免敲击，防止物理损伤。
Do not knock TVS when installing, to avoid mechanical damage.
2. 请不要对 TVS 施加剧烈的振动、冲击或压力，以免表面树脂或元件破裂。
Please do not apply severe vibration, shock or pressure to TVS, to avoid surface resin or element cracking.