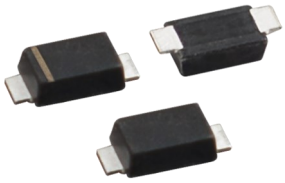
瞬态抑制二极管 TVS Diodes

Transient Voltage Suppression Diodes

P4SMF Series



概述 Description

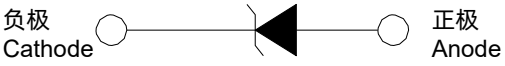
P4SMF产品是专为保护敏感电子设备免受雷电和其他瞬变电压事件引起的电压瞬变。在行业中与SMA封装相比，P4SMF封装减少了50%的占用面积并且是一种低高度的产品（1.2 mm）。

The P4SMF series is designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events. P4SMF package is 50% smaller in footprint when compare to SMA package and delivering one of the low height profiles (1.2 mm) in the industry.

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

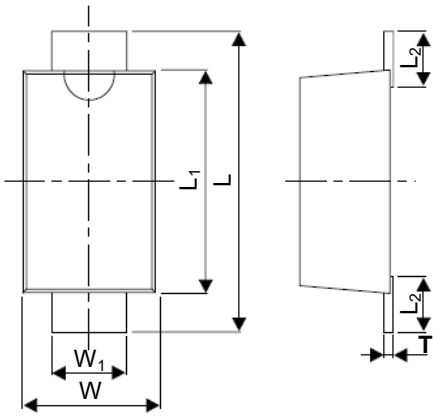
特性 Features

- 重复率0.01% 的10/1000 μS 波形对应峰值脉冲功率400 W
- 兼容行业中标准的SOD-123FL 封装
- 小型包装:最大高度1.2 mm
- 低电感，优异的箝位性能
- 表贴应用，节约空间
- 回流焊高温保证:260 °C / 30 s
- 典型的故障模式为电压或电流超过额定而导致的短路
- 锡须测试依据JEDEC JESD201A表4a和4c进行
- IEC 61000-4-2 ESD 30 kV (空气)，30 kV(接触)
- 数据线ESD保护符合IEC 61000-4-2
- 数据线EFT保护符合IEC 61000-4-4
- 快速响应时间：从0 V到击穿电压的时间小于1.0 ns
- 玻璃钝化保护或平面芯片(< 10 V)
- 消除内部应力
- 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)

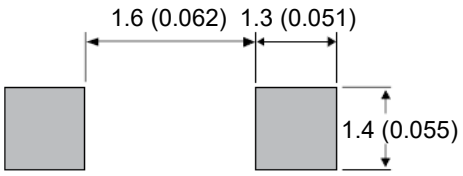
- 400 W peak pulse capability at 10/1000 μS waveform, repetition rate (duty cycles):0.01%
- Compatible with industrial standard package SOD-123FL
- Low profile: maximum height of 1.2 mm
- Low inductance, excellent clamping capability
- For surface mounted applications to optimize board space
- High temperature to reflow soldering guaranteed: 260 °C / 30 sec
- Typical failure mode is short from over-specified voltage or current
- Whisker test is conducted based on JEDEC JESD201A per its table 4a and 4c
- IEC-61000-4-2 ESD 30 kV (Air), 30 kV (Contact)
- ESD protection of data lines in accordance with IEC 61000-4-2
- EFT protection of data lines in accordance with IEC 61000-4-4
- Fast response time: typically less than 1.0 ns from 0 Volts to V_{BR} min
- Glass passivated chip junction or Planar chip (< 10 V)
- Built-in strain relief
- Plastic package is flammability rated V-0 per UL 94
- 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)

TVS

封装尺寸 Package Outline Dimensions (SOD-123FL)



安装布局
Mounting Pad Layout



SOD-123FL

符号 Symbol	公制(毫米) Millimeters		英制(英寸) Inches	
	Min.	Max.	Min.	Max.
L_1	2.70	2.90	0.1060	0.1140
L	3.40	3.90	0.1339	0.1535
W_1	0.70	1.20	0.0275	0.0472
W	1.50	2.00	0.0591	0.0787
L2	0.35	0.90	0.0138	0.0354
T	0.05	0.26	0.0020	0.0102
H	1.20	1.40	0.0470	0.0550

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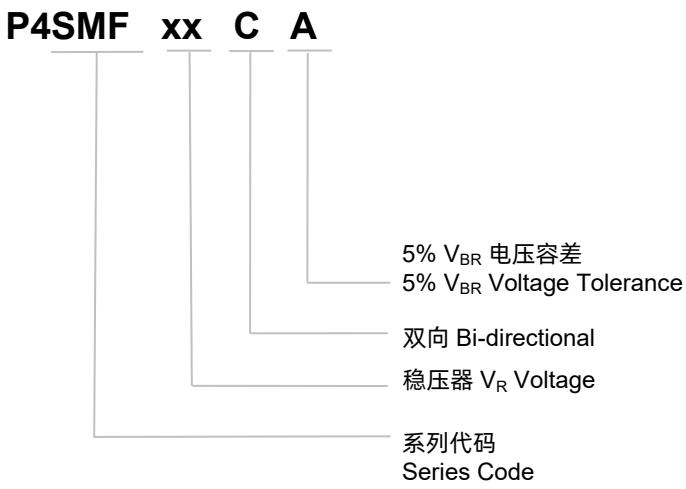
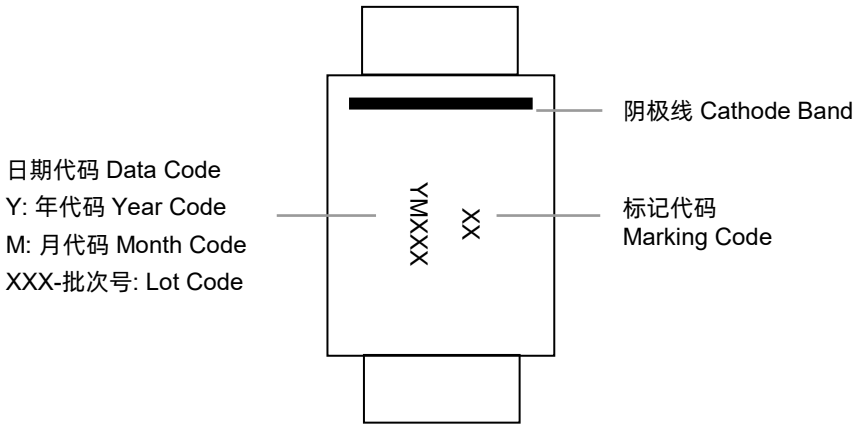
型号规则 Part Numbering System



标记 Marking



额定参数与特性 Maximum Ratings and Characteristics

(除另有注释，默认T_A=25 ℃ Ratings at 25 °C ambient temperature unless otherwise specified.)

参数 Parameter		符号 Symbol	值 Value	单位 Unit
T_A=25 °C (1)条件下峰值脉冲功耗 Peak Pulse Power Dissipation at T_A=25 °C (1)	8/20 μS	P_{PPM}	1000	W
	10/1000 Ms(2)		200	
峰值功耗 ,无限散热，T_L=50 °C Power Dissipation On Infinite Heat Sink at TL=50 °C		P_D	1	W
热阻(结至环境) Thermal Resistance Junction- to- Ambient		$R_{\Theta JA}$	220	°C/W
热阻(结至引线) Thermal Resistance Junction- to- Lead		$R_{\Theta JL}$	100	°C/W
工作温度范围 Operating Temperature Range		T_J	-65 to 150	°C
存储温度范围 Storage Temperature Range		T_{STG}	-65 to 175	°C

注释 Notes

1. 参照图4非重复性脉冲电流波形，初始结温25 °C 以图3所示曲线降额（环境温度TA=25 °C ）。
Non-repetitive current pulse, per Fig. 4 and derated above T_J (initial)=25 °C per Fig. 3.

TVS

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 frequencyx and voltage.

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

TVS

项目 Item	描述 Description
V_{FS}	**正向浪涌峰值电压 Peak Forward Surge Voltage** 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.
I_{FS}	**正向浪涌电流 Forward Surge Current** 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.
$\alpha_{V(BR)}$	**击穿电压温度系数 Temperature Coefficient of Breakdown Voltage** 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.
I_{PP}	**峰值脉冲电流 Peak pulse Current** 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.
I_T	**脉冲直流测试电流 Pulsed D.C. Test Current** 测量击穿电压V_{BR}的试测试电流。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}.

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

TVS

电气特性 (除另有注释，默认T_A = 25 °C)
Electrical Characteristics (T_A = 25 °C unless otherwise noted) Table 1

型号 Model		标记代码 Device Marking Code		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	Uni	Bi	(V)		(mA)	(V)	(μA)	(A)	(V)
P4SMF5.0A	-	KE	-	6.40	7.00	10	5.0	400	43.5	9.2
P4SMF6.0A	-	KG	-	6.67	7.37	10	6.0	400	38.8	10.3
P4SMF6.5A	-	KK	-	7.22	7.98	10	6.5	250	35.7	11.2
P4SMF7.0A	-	KM	-	7.78	8.60	10	7.0	100	33.3	12.0
P4SMF7.5A	-	KP	-	8.33	9.21	1	7.5	50	31.0	12.9
P4SMF8.0A	-	KR	-	8.89	9.83	1	8.0	25	29.4	13.6
P4SMF8.5A	-	KT	-	9.44	10.40	1	8.5	10	27.8	14.4
P4SMF9.0A	P4SMF9.0CA	KV	AV	10.00	11.10	1	9.0	2.5	26.0	15.4
P4SMF10A	P4SMF10CA	KX	AX	11.10	12.30	1	10	2.5	23.5	17.0
P4SMF11A	P4SMF11CA	KZ	AZ	12.20	13.50	1	11	2.5	22.0	18.2
P4SMF12A	P4SMF12CA	LE	BE	13.30	14.70	1	12	2.5	20.1	19.9
P4SMF13A	P4SMF13CA	LG	BG	14.40	15.90	1	13	1.0	18.6	21.5
P4SMF14A	P4SMF14CA	LK	BK	15.60	17.20	1	14	1.0	17.2	23.2
P4SMF15A	P4SMF15CA	LM	BM	16.70	18.50	1	15	1.0	16.4	24.4
P4SMF16A	P4SMF16CA	LP	BP	17.80	19.70	1	16	1.0	15.4	26.0
P4SMF17A	P4SMF17CA	LR	BR	18.90	20.90	1	17	1.0	14.5	27.6
P4SMF18A	P4SMF18CA	LT	BT	20.00	22.10	1	18	1.0	13.7	29.2
P4SMF20A	P4SMF20CA	LV	BV	22.20	24.50	1	20	1.0	12.3	32.4
P4SMF22A	P4SMF22CA	LX	BX	24.40	26.90	1	22	1.0	11.3	35.5
P4SMF24A	P4SMF24CA	LZ	BZ	26.70	29.50	1	24	1.0	10.3	38.9
P4SMF26A	P4SMF26CA	ME	CE	28.90	31.90	1	26	1.0	9.5	42.1
P4SMF28A	P4SMF28CA	MG	CG	31.10	34.40	1	28	1.0	8.8	45.4
P4SMF30A	P4SMF30CA	MK	CK	33.30	36.80	1	30	1.0	8.3	48.4
P4SMF33A	P4SMF33CA	MM	CM	36.70	40.60	1	33	1.0	7.5	53.3
P4SMF36A	P4SMF36CA	MP	CP	40.00	44.20	1	36	1.0	6.9	58.1

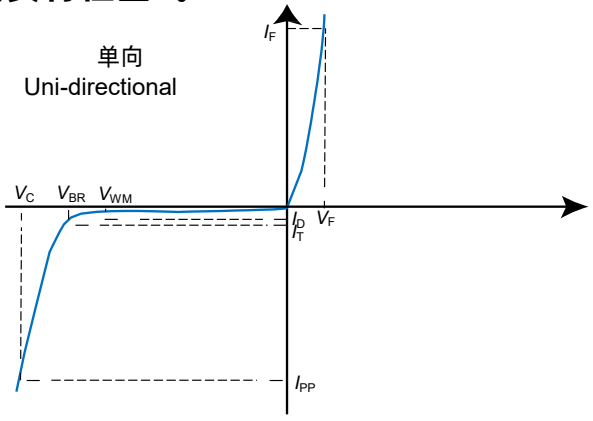
TVS

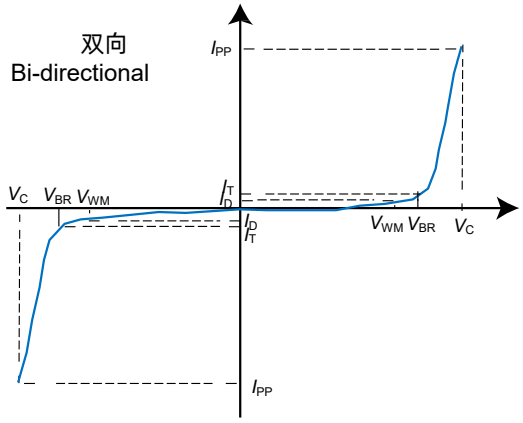
型号 Model		标记代码 Device Marking Code		击穿电压 Breakdown Voltage $V_{BR}@I_T$		测试电流 Test Current I_T	反向关断电压 Reverse Stand-off Voltage V_R	最大反向漏电流 Max. Reverse Leakage $I_R@V_R$	最大峰值脉冲电流 Max. Peak Pulse Current I_{PPM}	最大箝位电压 Max. Clamping Voltage $V_C@I_{PPM}$
				Min	Max					
Uni	Bi	Uni	Bi	(V)		(mA)	(V)	(μA)	(A)	(V)
P4SMF40A	P4SMF40CA	MR	CR	44.40	49.10	1	40	1.0	6.2	64.5
P4SMF43A	P4SMF43CA	MT	CT	47.80	52.80	1	43	1.0	5.8	69.4
P4SMF45A	P4SMF45CA	MV	CV	50.00	55.30	1	45	1.0	5.5	72.7
P4SMF48A	P4SMF48CA	MX	CX	53.30	58.90	1	48	1.0	5.2	77.4
P4SMF51A	P4SMF51CA	MZ	CZ	56.70	62.70	1	51	1.0	4.9	82.4
P4SMF54A	-	NE	-	60	66.3	1	54	1.0	4.6	87.1
P4SMF58A	-	NG	-	64.4	71.2	1	58	1.0	4.3	93.6
P4SMF60A	-	NK	-	66.7	73.7	1	60	1.0	4.1	96.8
P4SMF64A	-	NM	-	71.1	78.6	1	64	1.0	2.9	103.0
P4SMF70A	-	NP	-	77.8	86	1	70	1.0	3.5	113.0
P4SMF75A	-	NR	-	83.3	92.1	1	75	1.0	3.3	121.0
P4SMF78A	-	NT	-	86.7	95.8	1	78	1.0	3.2	126.0
P4SMF85A	-	NV	-	94.4	104	1	85	1.0	2.9	137.0

注释 Notes:

1. I_T 施加300 μS后测得的V_{BR}，I_T=方波脉冲或等效波形。
   V_{BR} measured after I_T applied for 300 μS, I_T = square wave pulse or equivalent.
2. 每10/1000 μS指数波的浪涌电流波形。
   Surge current waveform per 10/1000 μS exponential wave.
3. 所有术语和符号都符合ANSI/IEEE C62.35。
   All terms and symbols are consistent with ANSI/IEEE C62.35.
4. 对于V_R为10 V及更低的双向产品，I_R值需乘以两倍。
   For bidirectional type having V_R of 10 volts and less, the I_R limit is double.

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 ℃)

Performance Curve for Reference(T_A=25 °C unless otherwise noted)

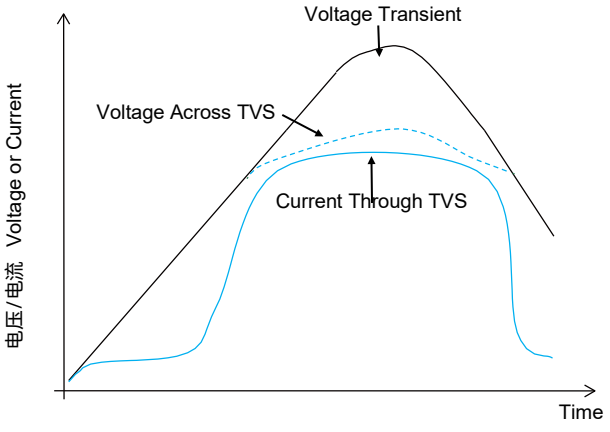


FIGURE 1 TVS瞬态箝位波形
FIGURE 1 TVS Transients Clamping Waveform

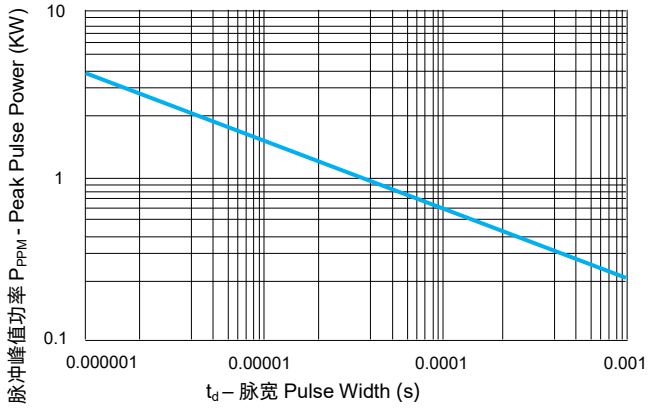


FIGURE 2 峰值脉冲功率额定曲线
FIGURE 2 Peak Pulse Power Rating Curve

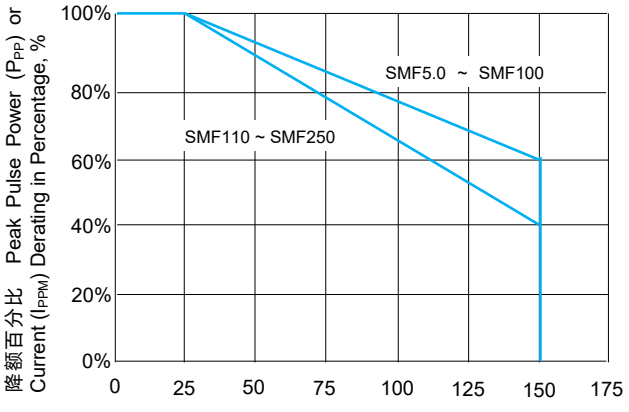


FIGURE 3 峰值脉冲功率降额曲线
Peak Pulse Power Derating Curve

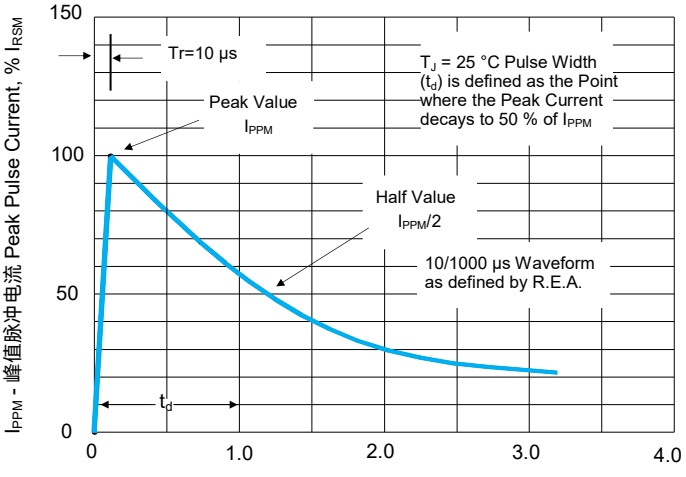


FIGURE 4 脉冲波形 Pulse Waveform - 10/1000 μS

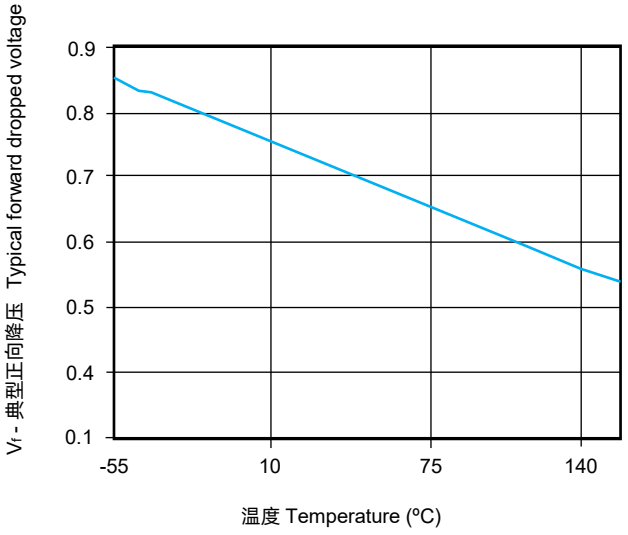
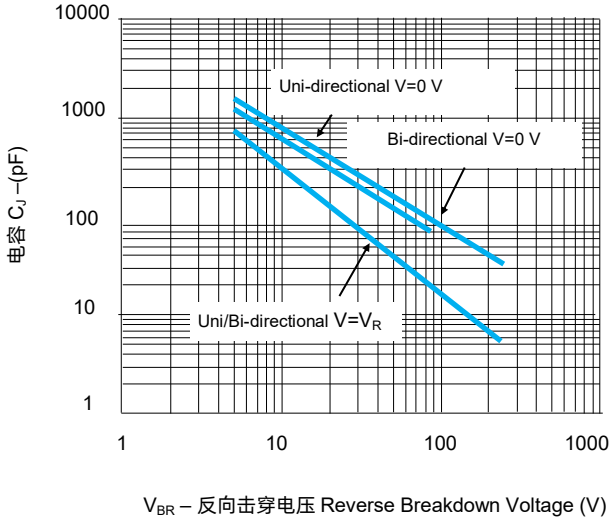


FIGURE 5 正向电压 Forward Voltage



FIHURE 6 典型结电容 Typical Junction Capacitance

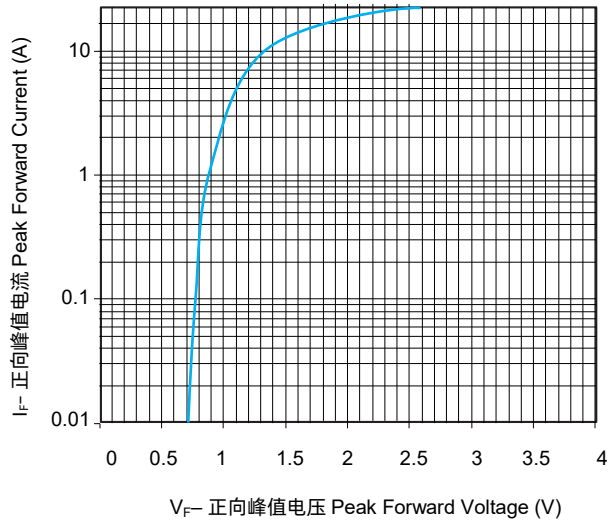


FIGURE 7 峰值正向电压及电流(典型值)
Peak Forward Drop vs Peak Forward Current (Typical Values)

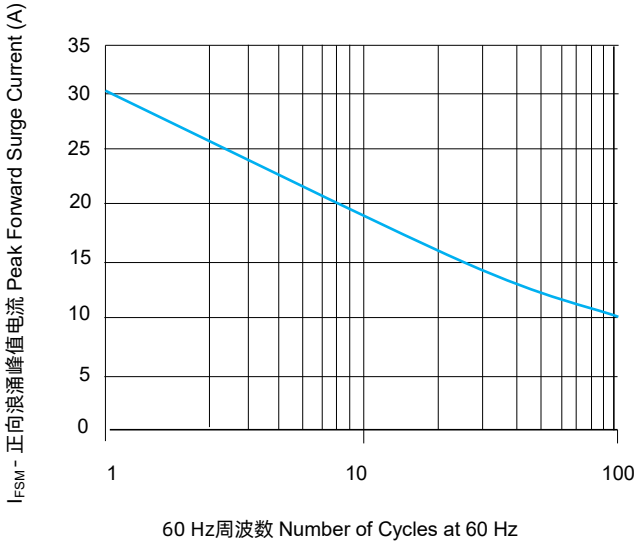


FIGURE 8 最大非重复正向浪涌电流(单向型)
Maximum Non-Repetitive Forward Surge Current
Uni-Directional only

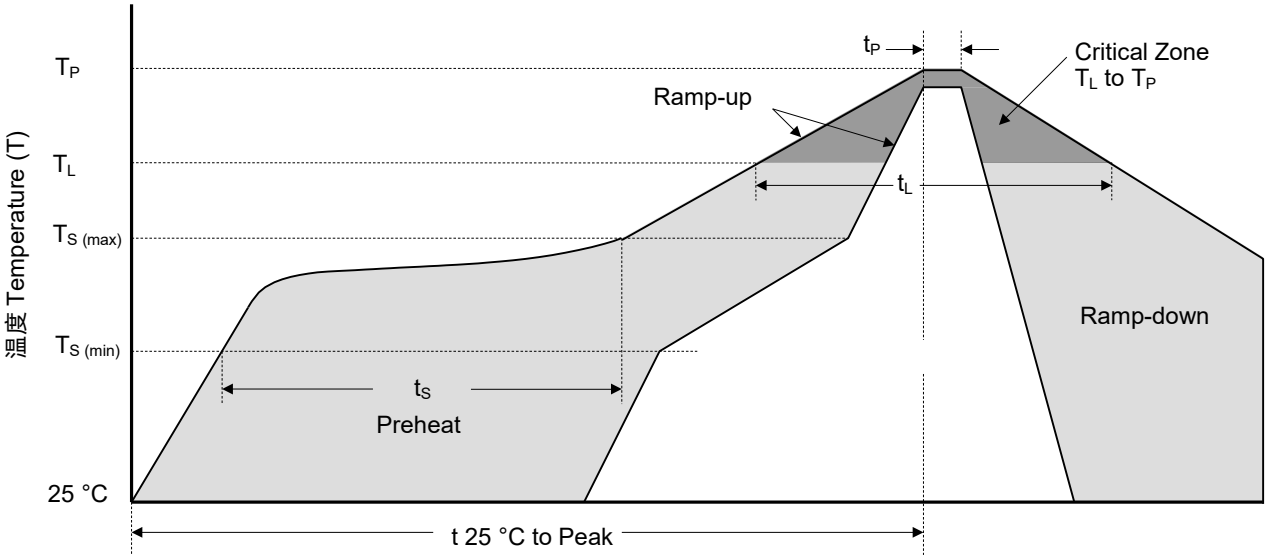
环境特性 Environmental Specifications

高温存储 High Temp. Storage	JESD22-A103
高温反偏 HTRB	JESD22-A108
温度循环 Temperature Cycling	JESD22-A104
湿度敏感性等级 MSL	JEDEC-J-STD-020, Level 1
高温高湿反偏 H3TRB	JESD22-A101
耐焊接热 RSH	JESD22-A111

物理特性 Physical Specifications

封装 Case	SOD-123FL plastic over glass passivated junction
极性 Polarity	Color band denotes cathode except bipolar
端子 Terminal	Matte tin-plated leads, solderable per JESD22-B102

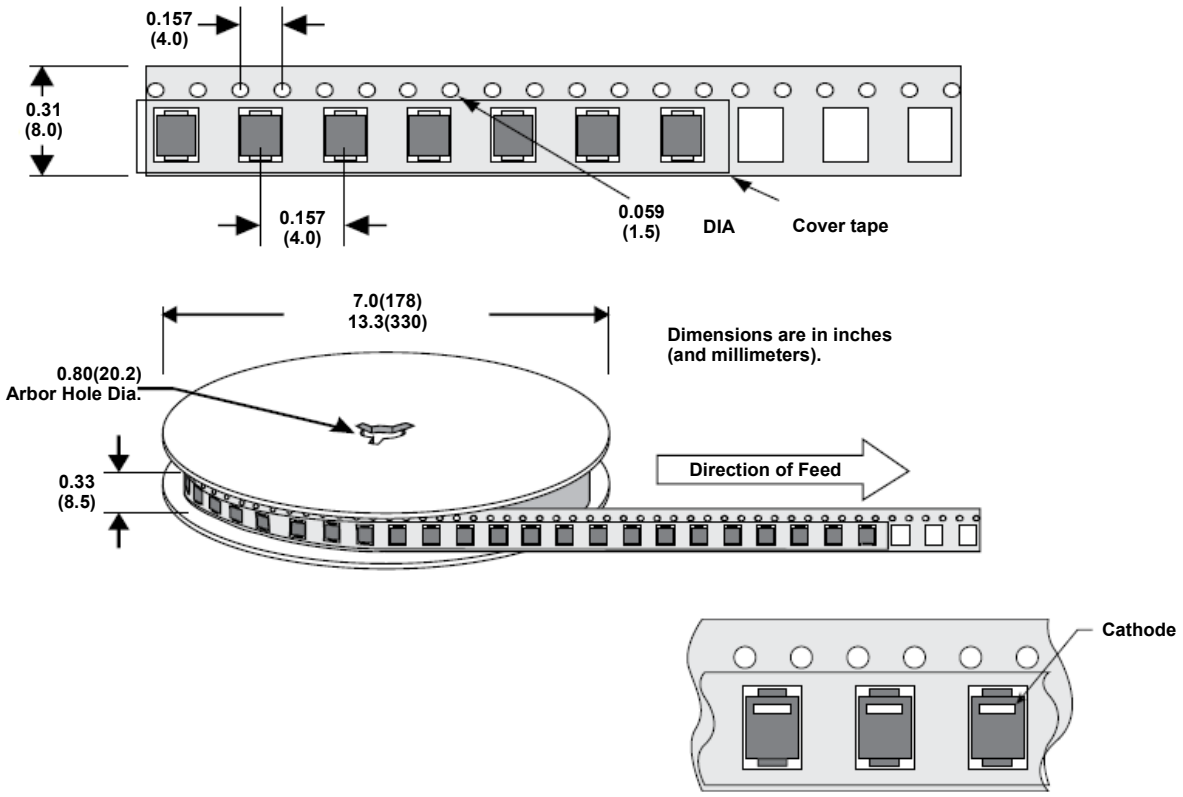
焊接参数 Soldering Parameters



回流焊条件 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

包装信息 Packaging Information



型号 Part Number	封装 Package	卷盘数量 QTY's (Reel)	包装选项 Packaging Option	包装规格 Packaging Specification
P4SMFXXX	SOD-123FL	3000 PCS	Tape & Reel – 8 mm tape/7" reel	EIA RS-481

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.

TVS