

概述 Description

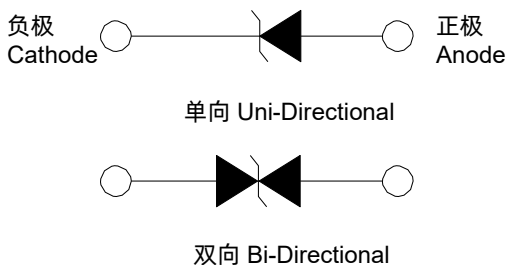
P4KE 系列是专为保护敏感电子设备免受雷电和其他瞬变电压事件引起的电压瞬变。

The P4KE Series is designed specifically to protect sensitive electronic equipment from voltage transients induced by lightning and other transient voltage events.

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

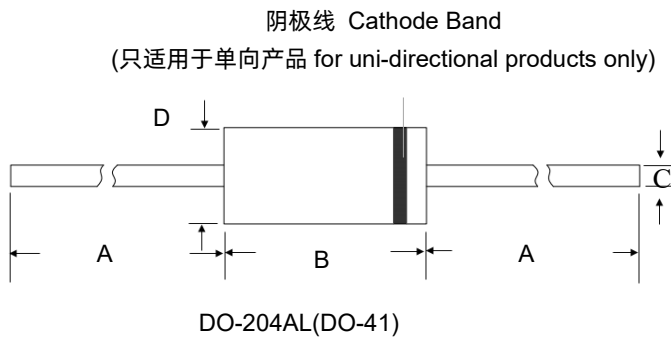
功能图 Functional Diagram



特性 Features

- 重复率0.01% 的10/1000 μ S 波形对应峰值脉冲功率 400 W
- DO-41封装内置玻璃钝化保护或平面芯片(< 10 V)
- 急速响应时间, 通常小于 1.0 PS 从 0 V 到 V_{BR} min
- 优异的箝位性能
- 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 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
- 低浪涌电阻
- V_{BR} min > 12.6 V 时的典型 $I_R \leq 1 \mu A$
- 回流焊高温保证:260 °C/30 s
- 温度系数典型值0.1%
- UL认证的塑封料符合可燃性等级V-0
- 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 μ S waveform, repetition rate (duty cycles):0.01%
- Glass passivated chip junction or Planar chip (< 10 V) in DO-41 Package
- Fast response time: typically less than 1.0 PS from 0 Volts to V_{BR} min
- Excellent clamping capability
- Typical failure mode is a short circuit
- Whisker test is conducted per Table 4a/4c of JEDEC JESD201A
- IEC 61000-4-2 ESD 30 kV (Air), 30 kV (Contact)
- EFT protection of data lines in accordance with IEC 61000-4-4
- Low incremental surge resistance
- Typical $I_R \leq 1 \mu A$ for V_{BR} min > 12.6 V
- High temperature reflow soldering guaranteed: 260 °C/30 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%)
- UL Recognized compound meeting flammability rating V-0
- 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 (DO-204AL/DO-41)



符号 Symbol	公制(毫米) Millimeters		英制(英寸) Inches	
	Min.	Max.	Min.	Max.
A	25.40	-	1.000	-
B	4.10	5.20	0.160	0.205
C	0.71	0.86	0.028	0.034
D	2.00	2.70	0.080	0.107

额定参数与特性 Maximum Ratings and Characteristics

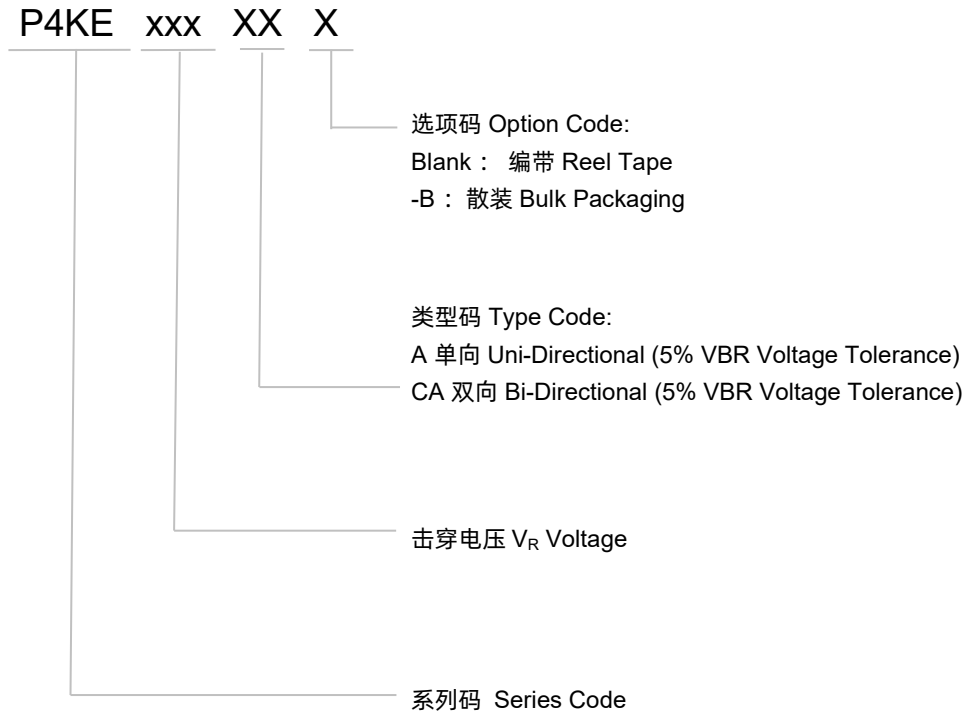
(除另有注释, 默认 $T_A=25^\circ\text{C}$ Ratings at 25°C ambient temperature unless otherwise specified.)

参数 Parameter	符号 Symbol	值 Value	单位 Unit
10/1000 uS脉冲波形下(图4), 峰值脉冲功率 ⁽¹⁾ (图2)-单芯片 Peak Pulse Power Dissipation(Fig.2) by 10/1000 uS Test Waveform(Fig.4) (Note 1)- Single Die Parts	P_{PPM}	400	W
10/1000 uS 脉冲波形下(图4), 峰值脉冲功率 ⁽¹⁾ (图2)-叠层芯片 ⁽⁴⁾ Peak Pulse Power Dissipation(Fig.2) by 10/1000 uS Test Waveform(Fig.4) (Note 1)- Stacked Die Parts (Note 4)	P_{PPM}	600	W
峰值功耗, 无限散热, $T_L=75^\circ\text{C}$ Steady State Power Dissipation on Infinite Heat Sink at $T_L=75^\circ\text{C}$	P_D	1.5	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 Sine Wave Unidirectional Only (Note 2)	I_{FSM}	60	A
正向瞬态电压峰值 ⁽³⁾ , 单向25 A Maximum Instantaneous Forward Voltage at 25 A for Unidirectional Only (Note 3)	V_F	3.5/5.0	V
工作和存储温度范围 Operating Junction and Storage Temperature Range	T_J, T_{STG}	-55 to 175	$^\circ\text{C}$
典型热阻(结至引线) Typical Thermal Resistance Junction to Lead	$R_{\theta JL}$	60	$^\circ\text{C/W}$
典型热阻(结至环境) Typical Thermal Resistance Junction to Ambient	$R_{\theta JA}$	100	$^\circ\text{C/W}$

注释 Notes

- 参照图4非重复性脉冲电流波形, 初始结温 25°C 以图3所示曲线降额(环境温度 $T_A=25^\circ\text{C}$)。
Non-repetitive current pulse, per Fig. 4 and derated above $T_J(\text{initial})=25^\circ\text{C}$ 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.
- 单芯片 $V_F < 3.5\text{ V}$, 叠层芯片 $V_F < 5.0\text{ V}$ 。
 $V_F < 3.5\text{ V}$ for single die parts and $V_F < 5.0\text{ V}$ for stacked-die parts.
- 叠层芯片元件的详细信息, 请参阅电气特性中标有*的规格编号。
For stacked die component details, please refer to models marked with * in electrical characteristics table.

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 $T_A=25^\circ\text{C}$)Electrical Characteristics ($T_A = 25^\circ\text{C}$ 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)
P4KE6.8A	P4KE6.8CA	6.45	7.14	10	5.80	1000	39.00	10.5
P4KE7.5A	P4KE7.5CA	7.13	7.88	10	6.40	500	36.30	11.3
P4KE8.2A	P4KE8.2CA	7.79	8.61	10	7.02	200	33.90	12.1
P4KE9.1A	P4KE9.1CA	8.65	9.55	1	7.78	50	30.60	13.4
P4KE10A	P4KE10CA	9.50	10.50	1	8.55	10	28.30	14.5
P4KE11A	P4KE11CA	10.50	11.60	1	9.40	5	26.30	15.6
P4KE12A	P4KE12CA	11.40	12.60	1	10.20	5	24.60	16.7
P4KE13A	P4KE13CA	12.40	13.70	1	11.10	1	22.50	18.2
P4KE15A	P4KE15CA	14.30	15.80	1	12.80	1	19.30	21.2
P4KE16A	P4KE16CA	15.20	16.80	1	13.60	1	18.20	22.5
P4KE18A	P4KE18CA	17.10	18.90	1	15.30	1	16.10	25.5
P4KE20A	P4KE20CA	19.00	21.00	1	17.10	1	14.80	27.7
P4KE22A	P4KE22CA	20.90	23.10	1	18.80	1	13.40	30.6
P4KE24A	P4KE24CA	22.80	25.20	1	20.50	1	12.30	33.2
P4KE27A	P4KE27CA	25.70	28.40	1	23.10	1	10.90	37.5
P4KE30A	P4KE30CA	28.50	31.50	1	25.60	1	9.90	41.4
P4KE33A	P4KE33CA	31.40	34.70	1	28.20	1	9.00	45.7
P4KE36A	P4KE36CA	34.20	37.80	1	30.80	1	8.20	49.9
P4KE39A	P4KE39CA	37.10	41.00	1	33.30	1	7.60	53.9
P4KE43A	P4KE43CA	40.90	45.20	1	36.80	1	6.90	59.3
P4KE47A	P4KE47CA	44.70	49.40	1	40.20	1	6.30	64.8
P4KE51A	P4KE51CA	48.50	53.60	1	43.60	1	5.80	70.1
P4KE56A	P4KE56CA	53.20	58.80	1	47.80	1	5.30	77.0
P4KE62A	P4KE62CA	58.90	65.10	1	53.00	1	4.80	85.0
P4KE68A	P4KE68CA	64.60	71.40	1	58.10	1	4.50	92.0

瞬态抑制二极管 TVS Diodes

Transient Voltage Suppression Diodes

P4KE 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 $V_C@I_{PPM}$
Uni	Bi	Min	Max					
		(V)		(mA)	(V)	(μ A)	(A)	(V)
P4KE75A	P4KE75CA	71.30	78.80	1	64.10	1	4.00	103.0
P4KE82A	P4KE82CA	77.90	86.10	1	70.10	1	3.60	113.0
P4KE91A	P4KE91CA	86.50	95.50	1	77.80	1	3.30	125.0
P4KE100A	P4KE100CA	95.00	105.00	1	85.50	1	3.00	137.0
P4KE110A	-	105.00	116.00	1	94.00	1	2.70	152.0
-	P4KE110CA*	105.00	116.00	1	94.00	1	4.00	152.0
P4KE120A	-	114.00	126.00	1	102.00	1	2.50	165.0
-	P4KE120CA*	114.00	126.00	1	102.00	1	3.70	165.0
P4KE130A	-	124.00	137.00	1	111.00	1	2.30	179.0
-	P4KE130CA*	124.00	137.00	1	111.00	1	3.40	179.0
P4KE150A	-	143.00	158.00	1	128.00	1	2.00	207.0
-	P4KE150CA*	143.00	158.00	1	128.00	1	2.90	207.0
P4KE160A	-	152.00	168.00	1	136.00	1	1.90	219.0
-	P4KE160CA*	152.00	168.00	1	136.00	1	2.80	219.0
P4KE170A	-	162.00	179.00	1	145.00	1	1.80	234.0
-	P4KE170CA*	162.00	179.00	1	145.00	1	2.60	234.0
P4KE180A	-	171.00	189.00	1	154.00	1	1.70	246.0
-	P4KE180CA*	171.00	189.00	1	154.00	1	2.50	246.0
P4KE200A	-	190.00	210.00	1	171.00	1	1.50	274.0
-	P4KE200CA*	190.00	210.00	1	171.00	1	2.20	274.0
P4KE220A	-	209.00	231.00	1	185.00	1	1.30	328.0
-	P4KE220CA*	209.00	231.00	1	185.00	1	1.90	328.0
P4KE250A	-	237.00	263.00	1	214.00	1	1.20	344.0
-	P4KE250CA*	237.00	263.00	1	214.00	1	1.80	344.0
P4KE300A	-	285.00	315.00	1	256.00	1	1.00	414.0
-	P4KE300CA*	285.00	315.00	1	256.00	1	1.50	414.0
P4KE350A*	P4KE350CA*	332.00	368.00	1	300.00	1	1.30	482.0
P4KE400A*	P4KE400CA*	380.00	420.00	1	342.00	1	1.10	548.0
P4KE440A*	P4KE440CA*	418.00	462.00	1	376.00	1	1.00	602.0
P4KE480A*	P4KE480CA*	456.00	504.00	1	408.00	1	0.92	658.0
P4KE510A*	P4KE510CA*	485.00	535.00	1	434.00	1	0.86	698.0

瞬态抑制二极管 TVS Diodes

Transient Voltage Suppression Diodes

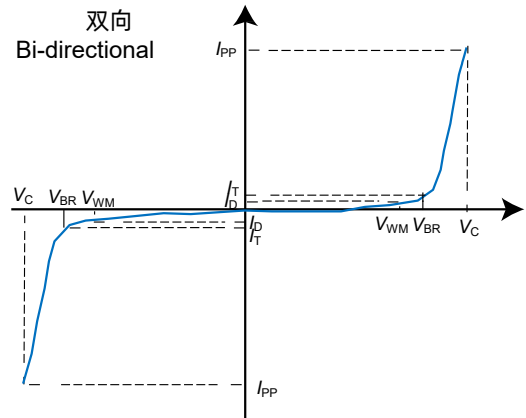
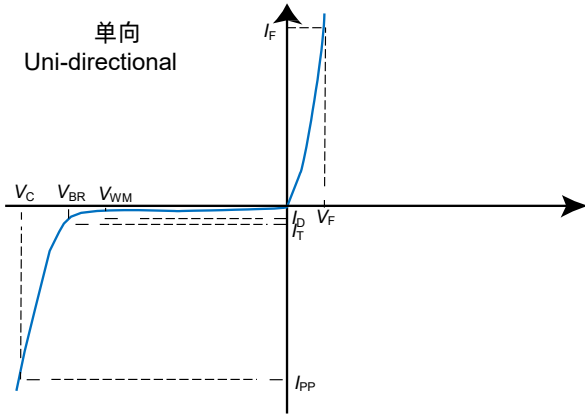
P4KE Series

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		Min	Max					
Uni	Bi	(V)		(mA)	(V)	(μ A)	(A)	(V)
P4KE530A*	P4KE530CA*	503.50	556.50	1	451.00	1	0.83	725.0
P4KE540A*	P4KE540CA*	513.00	567.00	1	460.00	1	0.82	740.0
P4KE550A*	P4KE550CA*	522.50	577.50	1	468.00	1	0.79	760.0

注释 Notes:

- 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.
- $V_F < 3.5$ 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.
- 双芯片产品的详细信息，请参阅电气特性中以*标示的部件编号。
For stacked die component details, please refer to models marked with * in electrical characteristics table.
- 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 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)

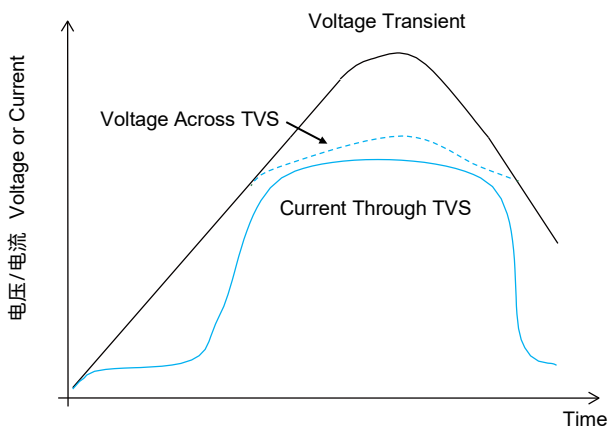


FIGURE 1 TVS瞬态箝位波形
TVS Transients Clamping Waveform

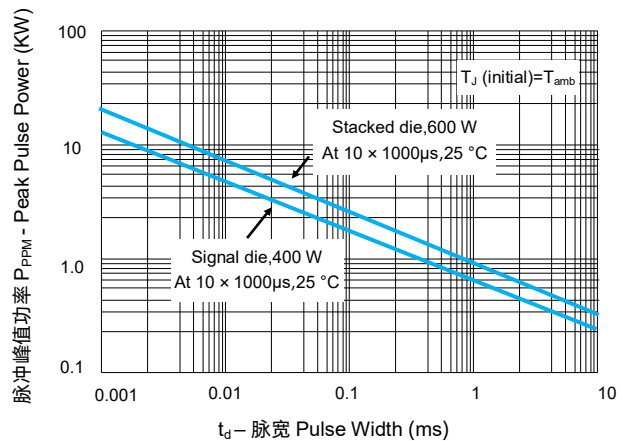


FIGURE 2 峰值脉冲功率额定曲线
Peak Pulse Power Rating Curve

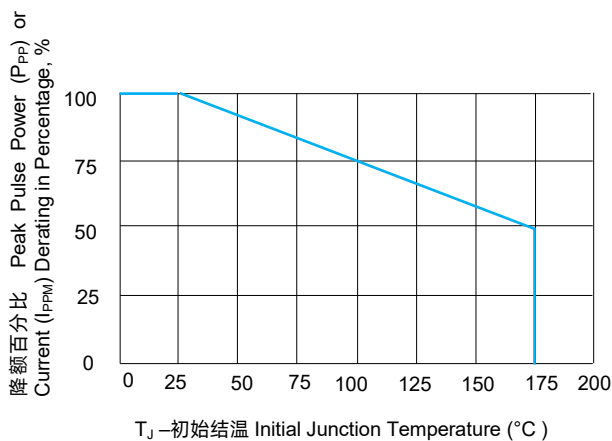


FIGURE 3 峰值脉冲功率降额曲线
Peak Pulse Power Derating Curve

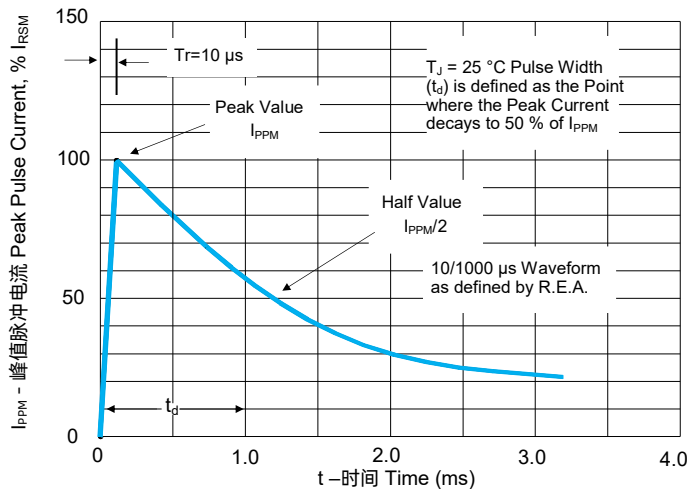


FIGURE 4 脉冲波形
Pulse Waveform

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Transient Voltage Suppression Diodes

TVS

TVS

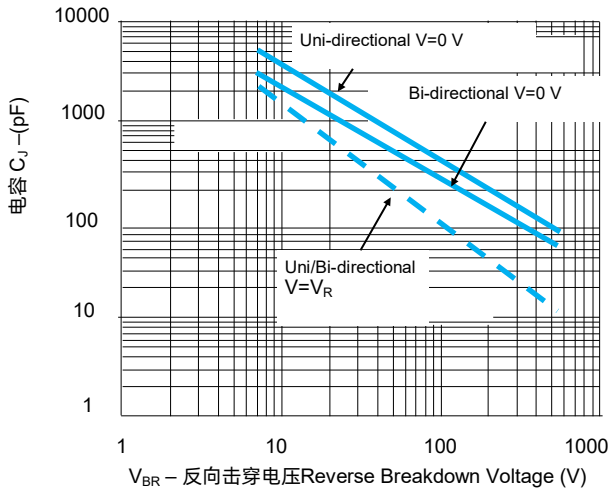


FIGURE 5 典型结电容 Typical Junction Capacitance

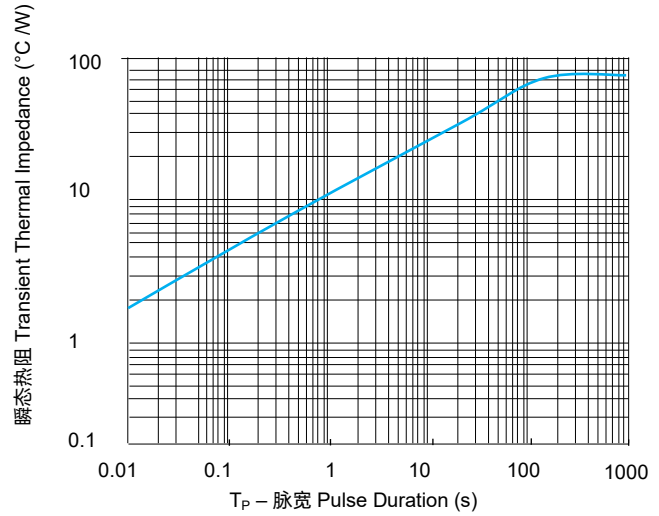


FIGURE 6 典型瞬态热阻 Typical Transient Thermal Impedance

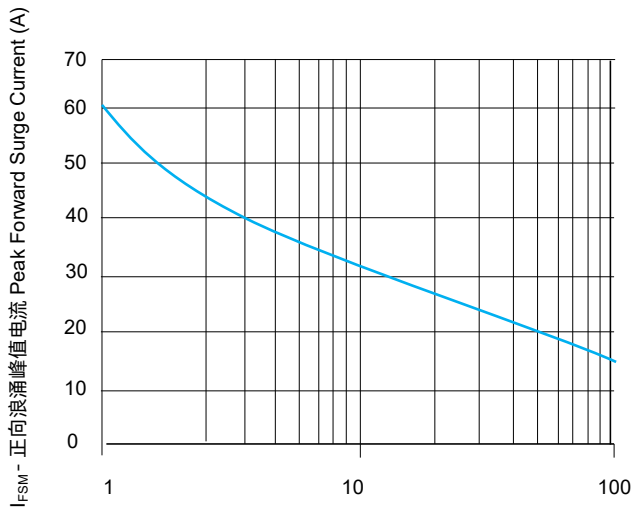


FIGURE 7 最大非重复正向浪涌电流(单向型)
Maximum Non-Repetitive Forward Surge Current
Uni-Directional only

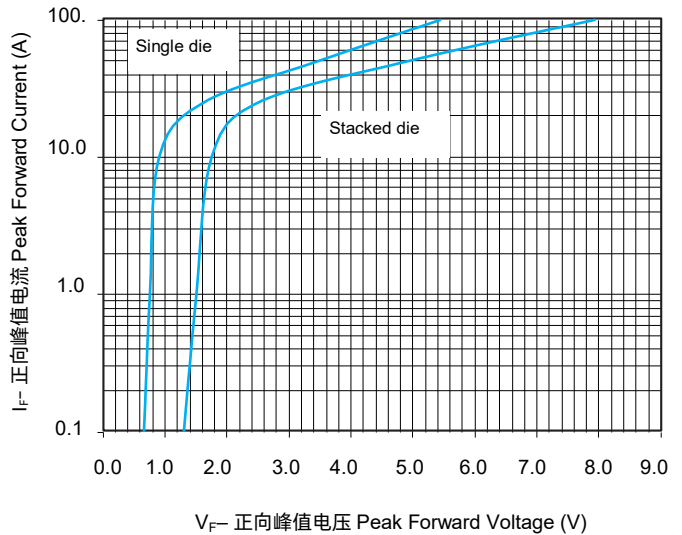


FIGURE 8 峰值正向电压及电流(典型值)
Peak Forward Drop vs Peak Forward Current (Typical Values)

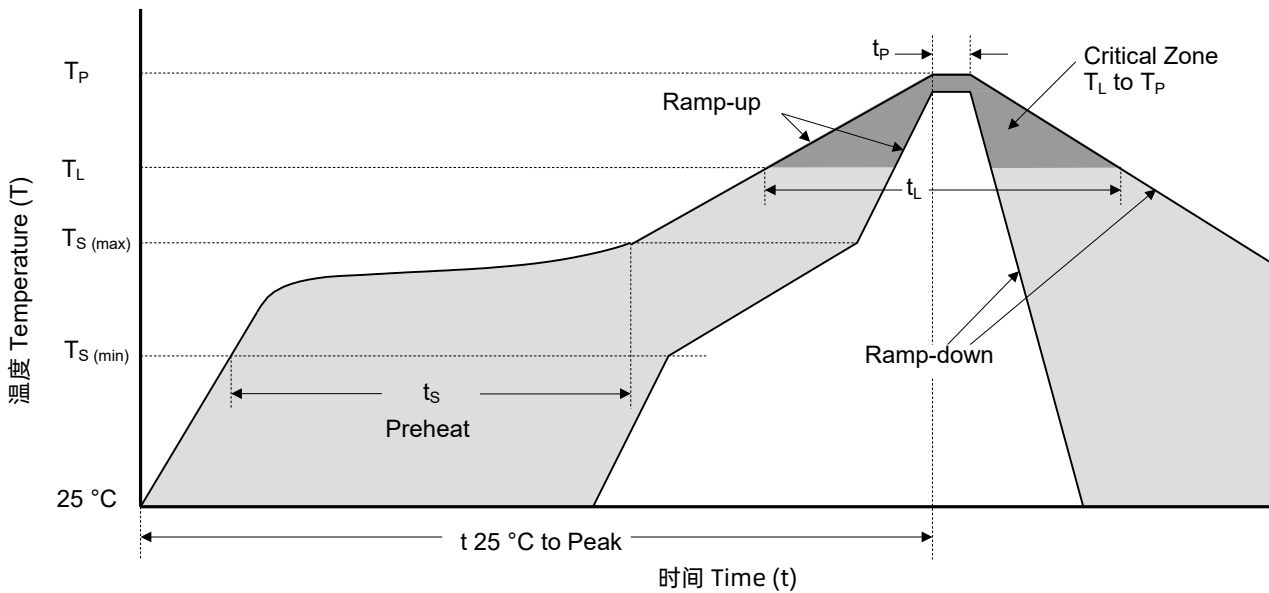
环境特性 Environmental Specifications

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

物理特性 Physical Specifications

重量 Weight	0.012 oz., 0.3 g
封装 Case	JEDEC DO-204AL (DO-41) molded plastic body over passivated junction.
极性 Polarity	Colored band indicates unidirectional component's cathode end
端子 Terminal	Matte Tin-plated leads, solderability per JESD22-B102

焊接参数 Soldering Parameters



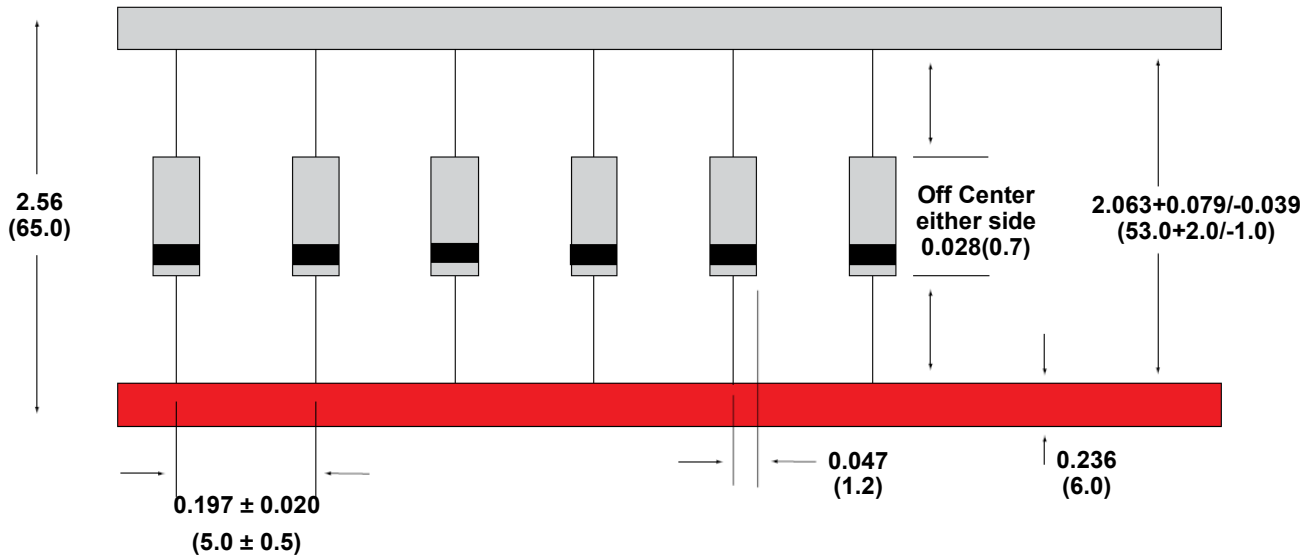
回流焊条件 Reflowing Condition

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

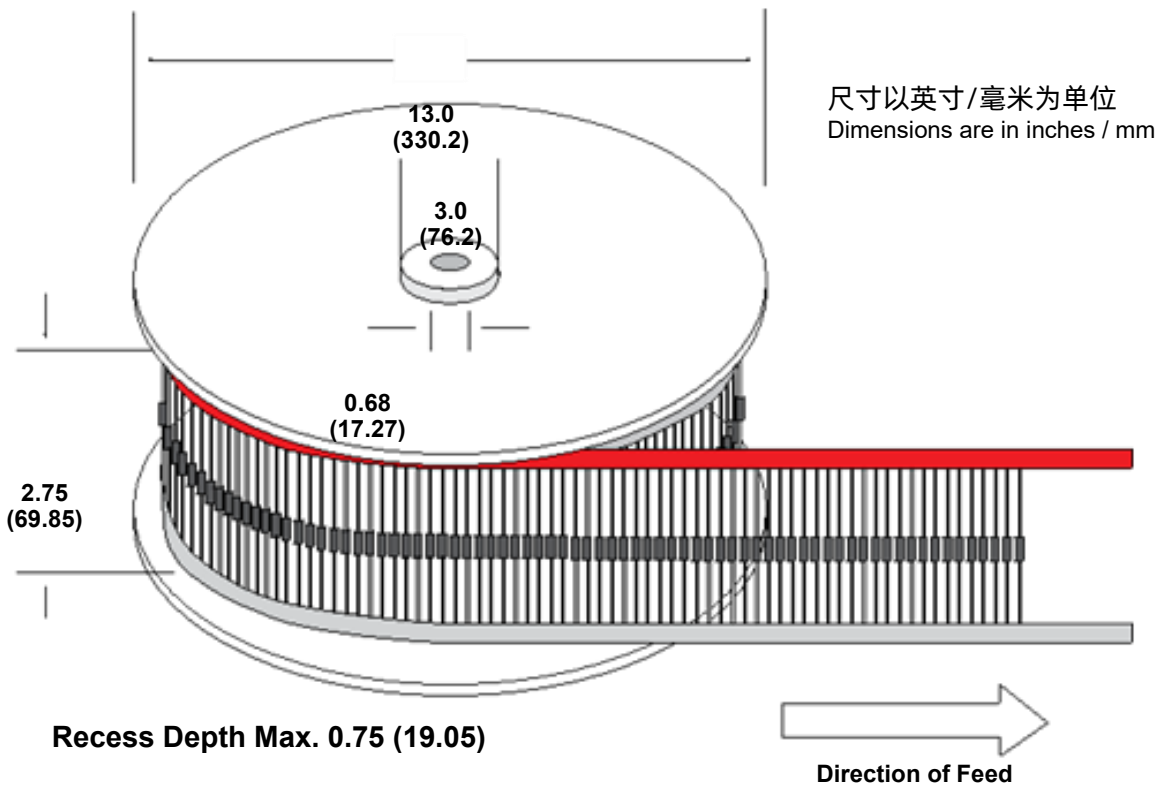
波峰焊(浸焊) Flow/Wave Soldering (Solder Dipping)

峰值温度 Peak Temperature	260 °C+0 /- 5 °C
浸焊时间 Dipping Time	5 seconds
焊接次数 Soldering Number	1 time

包装信息 Packaging Information



包装信息 Packaging Information



型号 Part Number	封装 Package	数量 QTY' s (Reel)	包装选项 Packaging Option	包装规格 Packaging Specification
P4KExxxXX	DO-204AL	5000 PCS	Tape & Reel	EIA STD RS-296
P4KExxxXX-TB	DO-204AL	5000 PCS	TB	/
P4KExxxXX-B	DO-204AL	500 PCS	BOX	SETsafe SETfuse Spec



注意

ATTENTION

使用方法 Usage

1. 请在规定的温度范围内使用TVS。
TVS must operate 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.