UMD MICRO

TRANSIENT VOLTAGE SUPPRESSOR (TVS) Diode PRESENTATION

瞬态电压抑制二极管介绍

• High protection on sensitive mobile electronic devices (有效保护高感应可携式设备)

• Follow strictly to the IEC 61000-4-2 ESD test standard (根据及通过IEC国际静电测试标准）

•Using the behavior of diode P/N junction to achieve ESD protection (应用二极管P/N结面的特性来达到静电保护原理)

UMD MICRO

Creating a Diode
二极管的制程

- Silicon and Germanium are used as the main element in semiconductors. （矽和锗是用来生产半导体芯片的主要化学物质。）

- A pure silicon crystal by itself, does not allow any electric current to pass through it. Silicon is considered a semi-conductor. This is because it can carry an electrical charge under special condition.
(纯矽的晶体本质是不导电的, 只有在特殊的情况下才能导电, 因此矽被称为半导体)

- We can change the behavior of a pure silicon crystal by doping it.
（当纯矽的晶体和其它不纯物混杂在一起, 矽的本质会改变。）

- When phosphorus or arsenic is added, N-type silicon is formed.
（把磷或砷和纯矽的晶体混杂在一起, 矽会变成N-type的导体。）

- When boron or gallium is added, P-type silicon is formed.
（把硼或镓和纯矽的晶体混杂在一起, 矽会变成P-type的导体。）

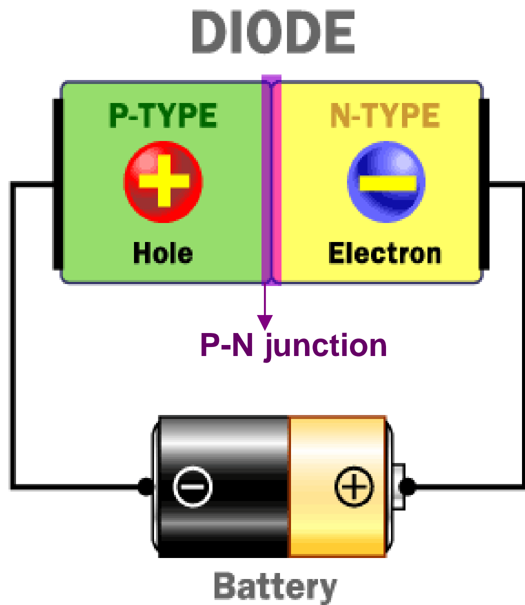
- By putting an N-type silicon and a P-type silicon together, a diode is formed. (把矽的N-type和矽的P-type结面合在一起, 就能制成二极管。)

UMD MICRO

Behavior of a Diode
二极管的特性

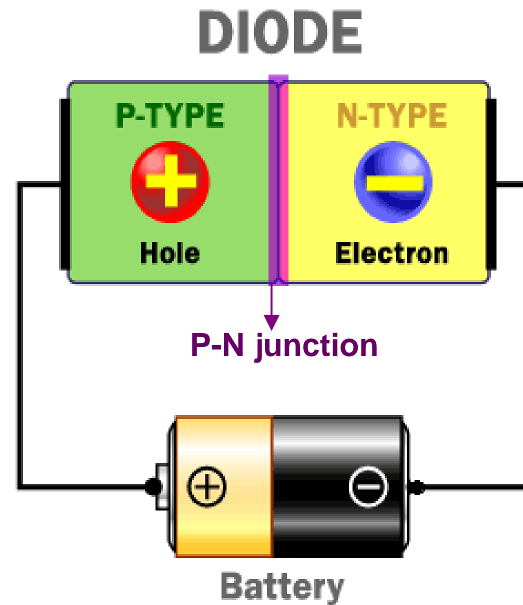
- A diode allows current to flow in one direction but not the other (二极管具有单向导电性的特性)

Reverse-biased (反向电流)



When the P-type of the diode is connected to the –ve terminal of the battery, current does not flow. (二极管的P-type接到负电源, 二极管截止，没有电流。)

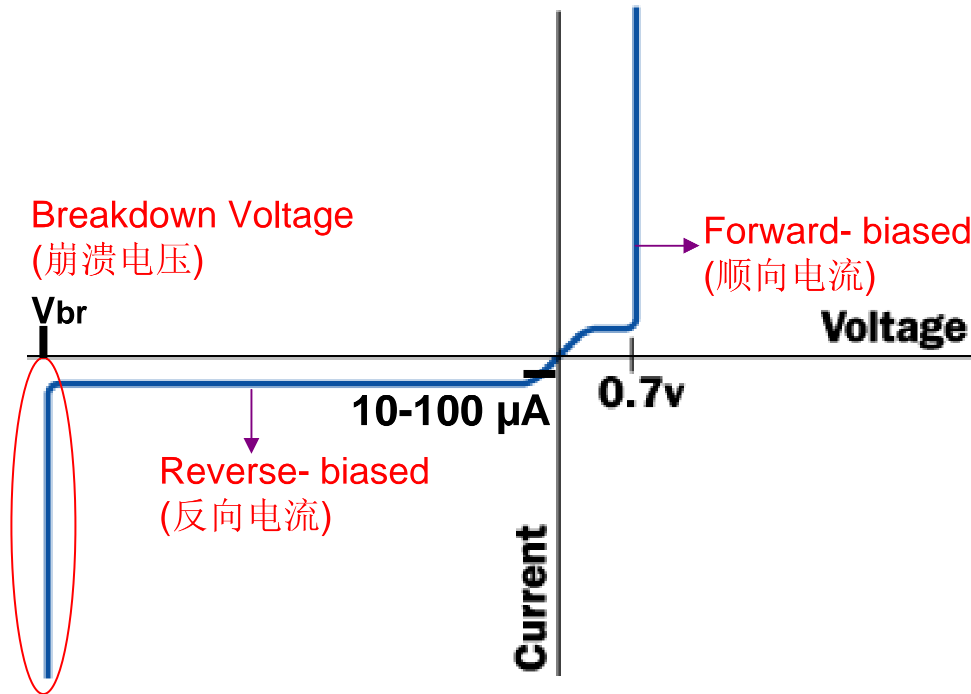
Forward -biased (顺向电流)



When the P-type of the diode is connected to the +ve terminal of the battery, current flows. (二极管的P-type接到正电源, 二极管导通, 有电流。)

UMD MICRO

Graph on Diode's Behavior
二极管的特性图表



We make use of the diode's Reverse Breakdown Voltage to reach our transient voltage protection purpose.
(我们利用二极管反向崩溃电压的特性来达到瞬态电压保护)

- When forward-biased, there is a small amount of voltage, about 0.7 volts, to get the diode going.
（二极管在顺向电流上, 需要0.7v以上的电压才能导通。）

- When reverse-biased, a real diode is not able to block all current. It lets about 10-100μA through. If enough reverse voltage is applied, the P/N junction breaks down and lets current through.
（二极管在反向电流上, P/N结面没有办法截止所有电流, 有10-100μA 的漏电电流。如有足够的反向电压加在P/N结面上, 则产生崩溃, 电流导通。）

UMD MICRO

Avalanche Breakdown Diode
雪崩崩溃二极管

- A conventional solid-state diode will not let current flow if reverse-biased (up to a breakdown voltage). By exceeding the breakdown voltage a conventional diode is destroyed in the breakdown due to excess current and overheating.

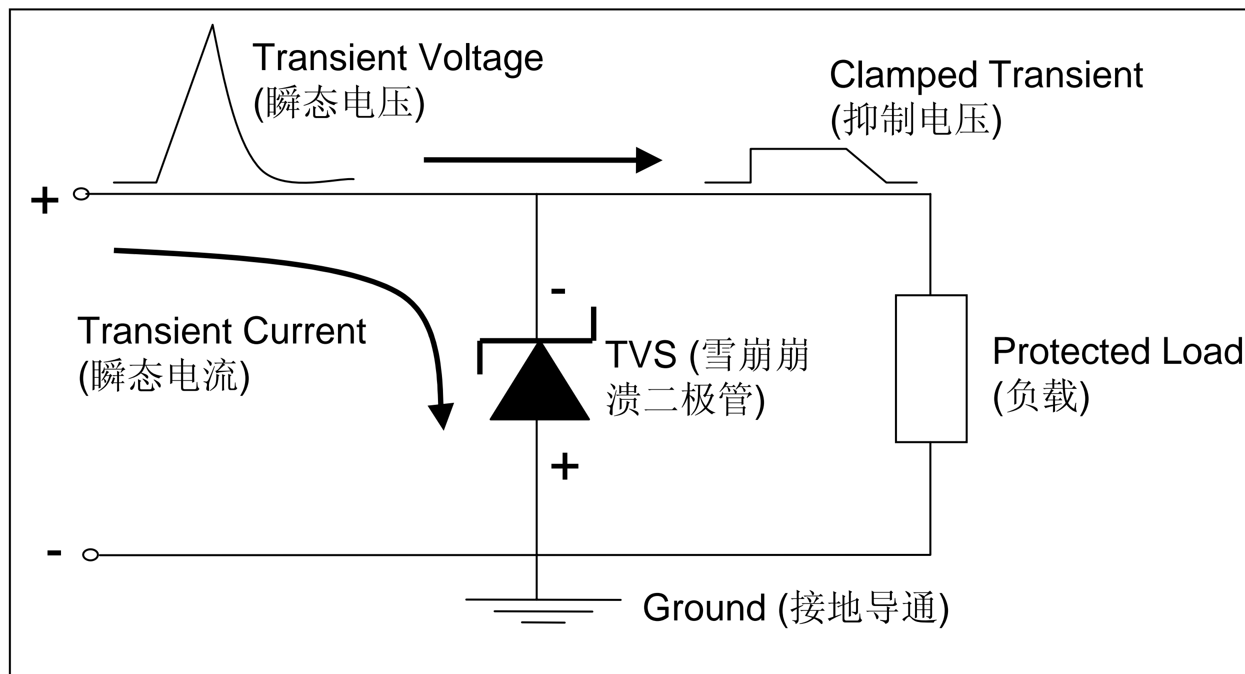
  (传统的二极管在反向电流上,电流没办法导通。如有足够的反向电压(超出崩溃电压后), 二极管会被击穿而损坏。）

- An **Avalanche Breakdown Diode** exhibits almost the same properties, except the device is especially designed so as to have a greatly reduced breakdown voltage. A reverse-biased Avalanche Breakdown Diode will allow a current to flow through at a controlled breakdown and keep the voltage across it at the clamping voltage.

  (雪崩崩溃二极管和传统的二极管有同样的性质。只是雪崩崩溃二极管的崩溃电压已被大大的降低。雪崩崩溃二极管在反向电流上，到达了崩溃电压后，能让电流导通而不被击穿并且能把过电压抑制下来。)

UMD MICRO

Example on Clamping a Transient Voltage 抑制瞬态电压的例图



- The TVS avalanche breakdown diode is connected in a reverse-biased way in the circuit.
  （雪崩崩溃二极管是以反向电流的方式, 连接在线路上。）
- At normal operating voltage, the TVS diode is inactive, like an open circuit. Only when a transient appears, the TVS diode becomes active and clamping it to a certain level.
  （雪崩崩溃二极管平时是不工作的。只有在瞬态电压进入时, 雪崩崩溃二极管产生崩溃才开始工作, 把电压抑制在某个水平。）

UMD MICRO

What are Transient Voltages
什么是瞬态电压

- These are faults which cause the voltage to go outside normal limits for a period of time. Transient voltages are characterized by three things: **<u>Very High Voltage</u>**, **<u>Occur For A Very Short Period of time (in nanoseconds)</u> and <u>High Occurrence</u>**. Many transients cause damage to micro semiconductor chipsets by degrading their performance. This damage is cumulative and eventually reaches a point where sudden and complete failure of the component results. Moreover, some transients are capable of causing immediate equipment failures. Equipment failures caused by transients are hard to detect and are often incorrectly blamed on other 'perceived' causes. Micro semiconductor chipsets damaged by transients often require sophisticated instrument to replace them which make them expensive to repair. The only cure is to clamp transients to a safe level where the protected load can withstand.

(瞬态电压是交流电路上电流与电压的一种瞬时态的畸变。浪涌、谐波为主要的表现形式。瞬态电压最主要的特点有三个: <u>超高压</u>, <u>瞬时态</u>, <u>高频次</u>。超高压是指通常的瞬态电压尖峰，高出正常电路电压幅值的好几倍。瞬时态是指瞬态电压持续的时间非常之短，它可以在数亿分之一秒内完成迸发到消失的过程。高频次是指瞬态电压的活动十分频繁，可以说无时不有、无处不在。瞬态电压是会对微电子半导体芯片造成损坏的。虽然有些微电子半导体芯片受到瞬态电压侵袭后, 它的性能没有明显的下降，但是多次累积的侵袭会给芯片器件造成内伤而形成隐患。瞬态电压对芯片器件造成的损伤难以与其它原因造成的损伤加以区别, 从而不自觉地掩盖了失效的真正原因。由于微电子半导体芯片的精、细、结构, 如要替换或修理需要使用高度精密仪器,是非常费财的。为一的有效方法就是把瞬态电压抑制在被保护元件能承受的安全水平。)

Transient Voltages Caused By Electrostatic Discharge (ESD) 静电释放所形成的瞬态电压

- What is ESD (什么是静电):

  When two different materials are rubbed together, one gives up electrons and becomes positively charged while the other gathers them and becomes negatively charged. Static electricity is a non-moving electrical charge on an object. Given a chance, the object will give up its charge to be neutral again. This charge release is ESD.

  (当两种不同的物质产生摩擦, 有一边释放电子的物质会带正电荷的极性,而另一边收聚电子的物质会带负电荷的极性。当其它物体触碰到这些带着电荷的物质后,这些物质会把它们所带的电荷释放出去因而产生静电。)

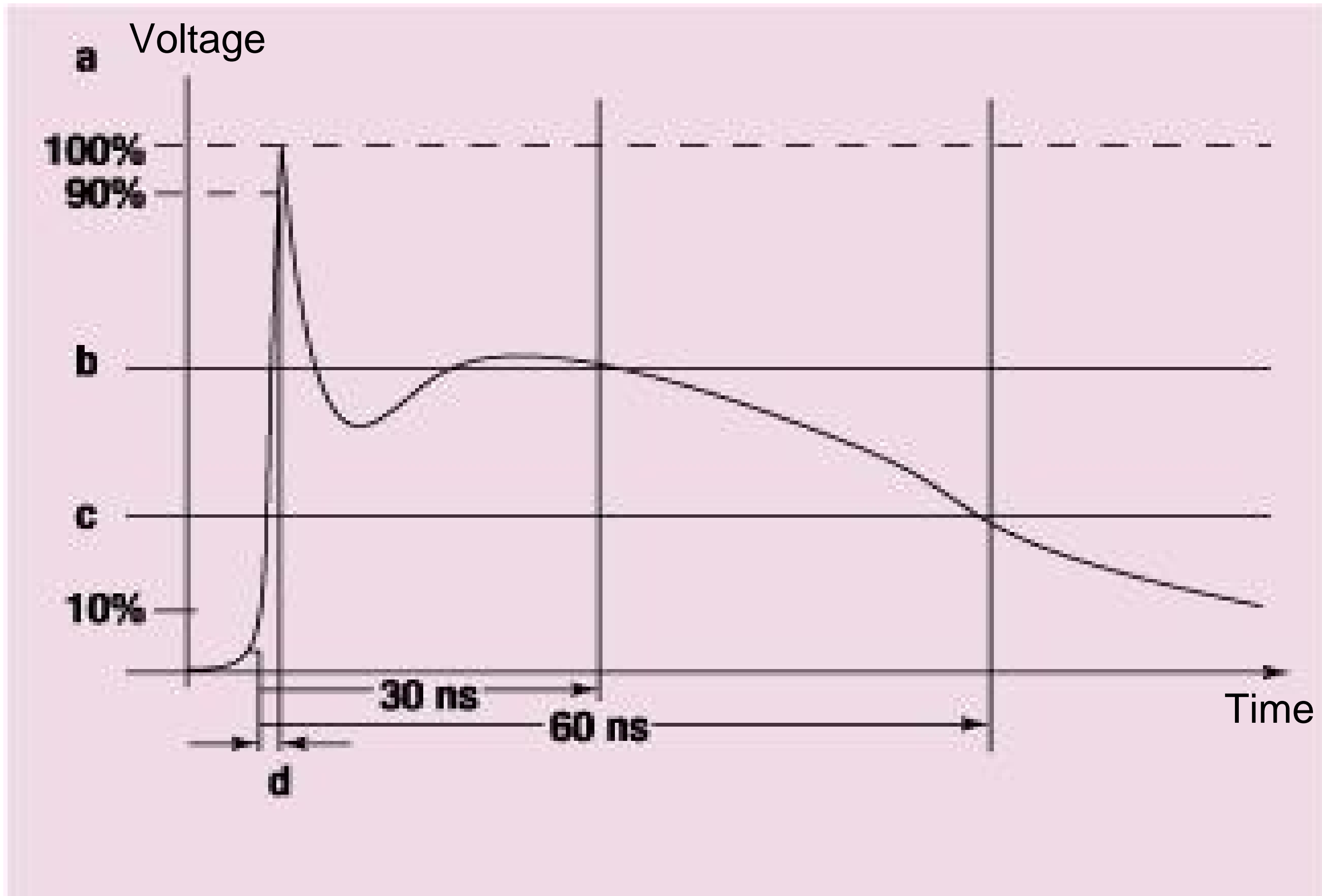
- ESD have steep rise times.

  (静电释放的速度非常快,它可以在数亿分之一秒内完成迸发到消失的过程。)

- Though the total energy released from ESD is minimal, the peak is easily capable of damaging semiconductor chip.

  (虽然静电所放出的能量不大, 可是它的峰值可以对半导体芯片造成损害。)

ESD Current Waveform Standardized By EN-61000-4-2
EN-61000-4-2标准化的静电波形图形



UMD MICRO

The Need to Protect Mobile Devices against Electrostatic Discharge (ESD)
可携式设备需受到保护来抵抗静电的侵袭

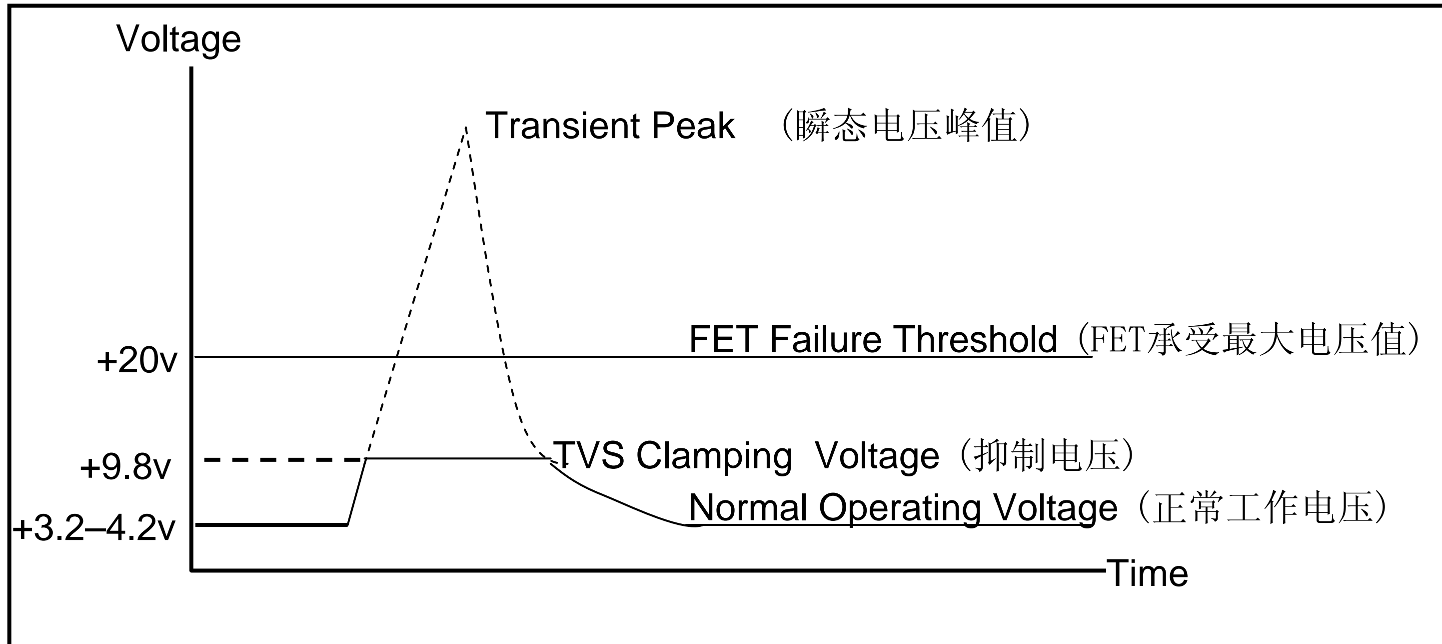
- The nerves in a human hand can feel a static discharge from a range of 2,000 - 3,000 V. However it only requires 30 V of ESD to damage some of the extremely small parts and traces within today's ICs.

  (人的神经所能感受到的静电是阶于2,000v至3,000v。可是只需要30v的静电电压就足以损坏现在所生产的精、细、 IC。)

- It is very common to employ some form of a Field Effect Transistor (FET) in many types of efficient/miniature RF amplifiers in today's mobile devices. FET is very susceptible to ESD damage due to the very thin layer of silicon dioxide (SiO_2) also known as silica, which uses as the gate insulator. The thickness of SiO_2 gate insulator layer within the semiconductor has been reduced because of the required downsizing of semiconductor package.

  (FET是在数字线路中, 主要使用于开关这样的特性, 它可以调节以电压来流动的电流。现在的可携式设备里, 工程师都会很普遍地把FET设计进无线电频率纤小增幅器里。而FET是非常容易受到ESD的损害。原因是在半导体的体积缩小后, 里面一层用来做绝缘保护的氧化矽也跟着变薄了。)

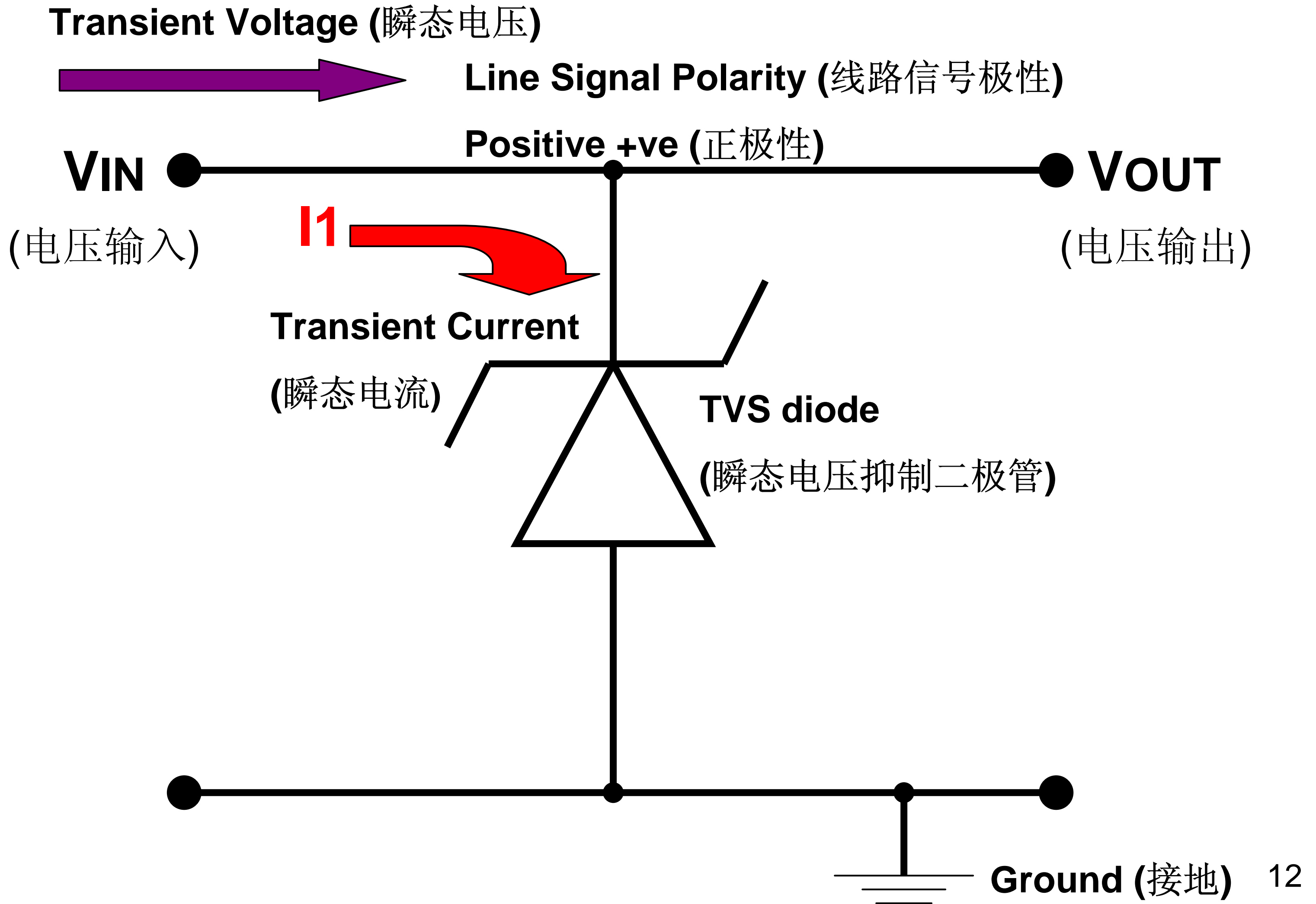
Using TVS diode to Protect a Typical Mobile Phone
应用瞬态电压抑制二极管在移动电话上



- Typical mobile phones use operating voltages between 3.2v and 4.2v. For example, the FET in RF circuit in a mobile phone is able to withstand a maximum of 20v. When a transient appears, the transient peak is much higher than the maximum voltage the FET can withstand. Causing the FET to breakdown.
(大部份手机的工作电压是3.2v至4.2v。如果手机里面的FET所能承受的最大电压是20v,而当瞬态电压侵袭时,电压的最高峰比FET所能承受的电压大出许多,FET被击坏。)

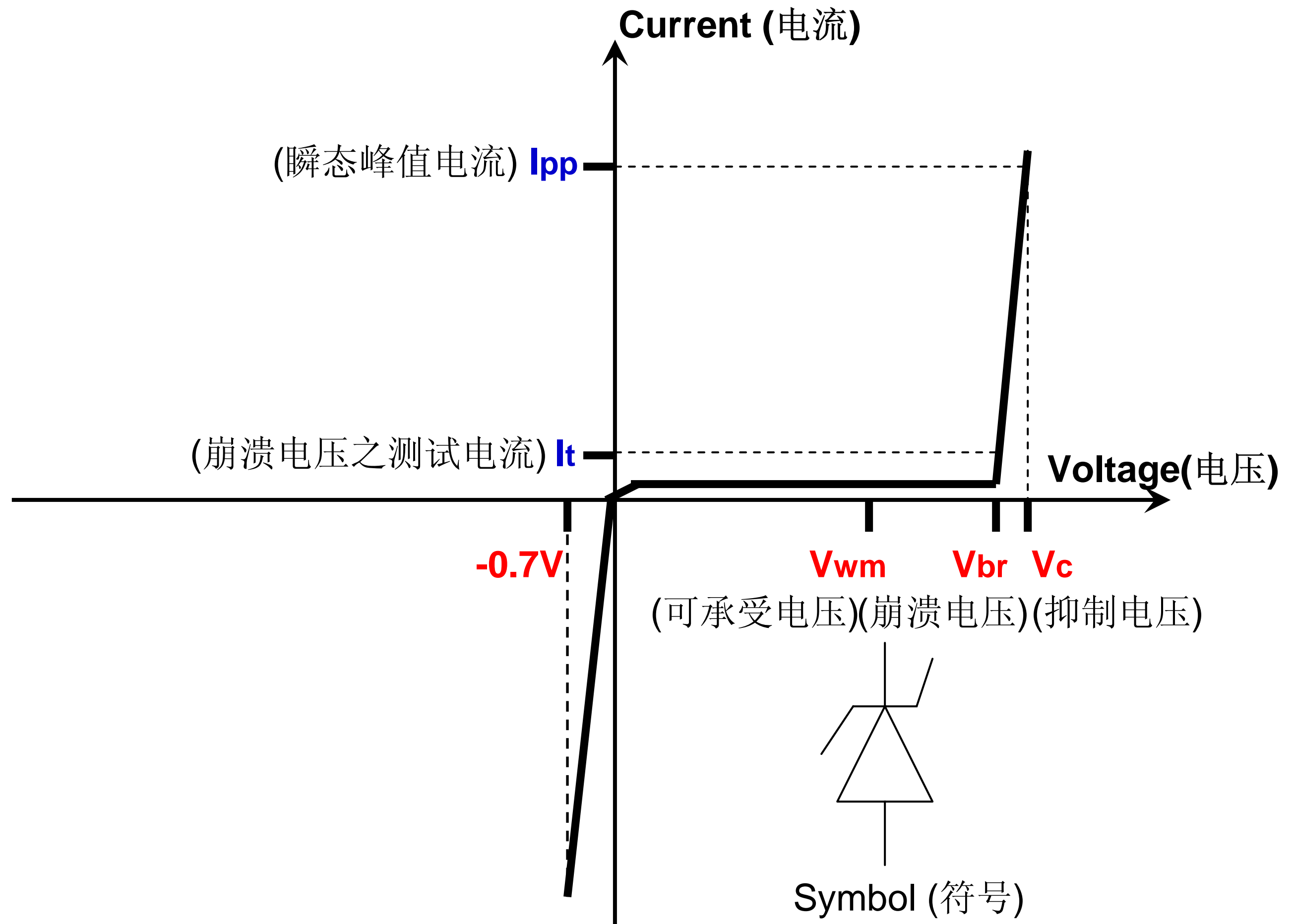
- By selecting one of our UMD TVS diode (U/B02CSP05B), is able to clamp the transient voltage to a safe level, at 9.8v, which the FET is able to withstand.
(利用UMD TVS二极管(U/B02CSP05B),能把瞬态电压抑制在一个FET能承受的安全水平,如图上的9.8v。)

TVS diode Uni-Directional Protection
瞬态电压抑制二极管单向保护



UMD MICRO

Uni-Directional Protection Graph
单向保护图形

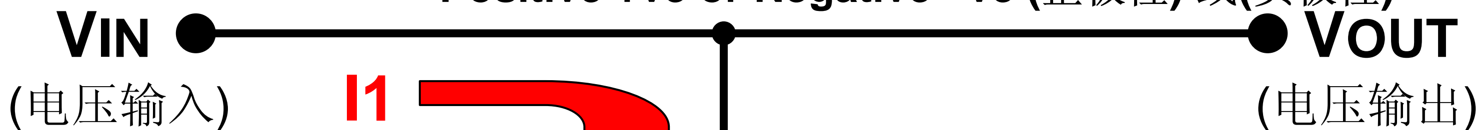


TVS diode Bi-Directional Protection 瞬态电压抑制二极管双向保护

Transient Voltage (瞬态电压)

Line Signal Polarity (线路信号极性)

Positive +ve or Negative –ve (正极性) 或(负极性)



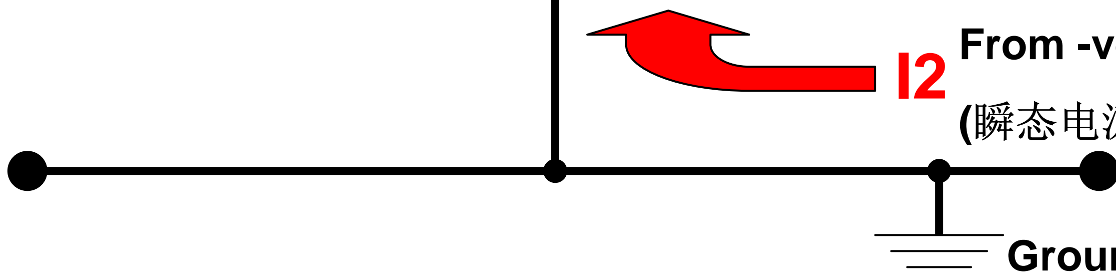
Transient Current

From +ve ESD

(瞬态电流)

TVS diode

(瞬态电压抑制二极管)



Transient Current

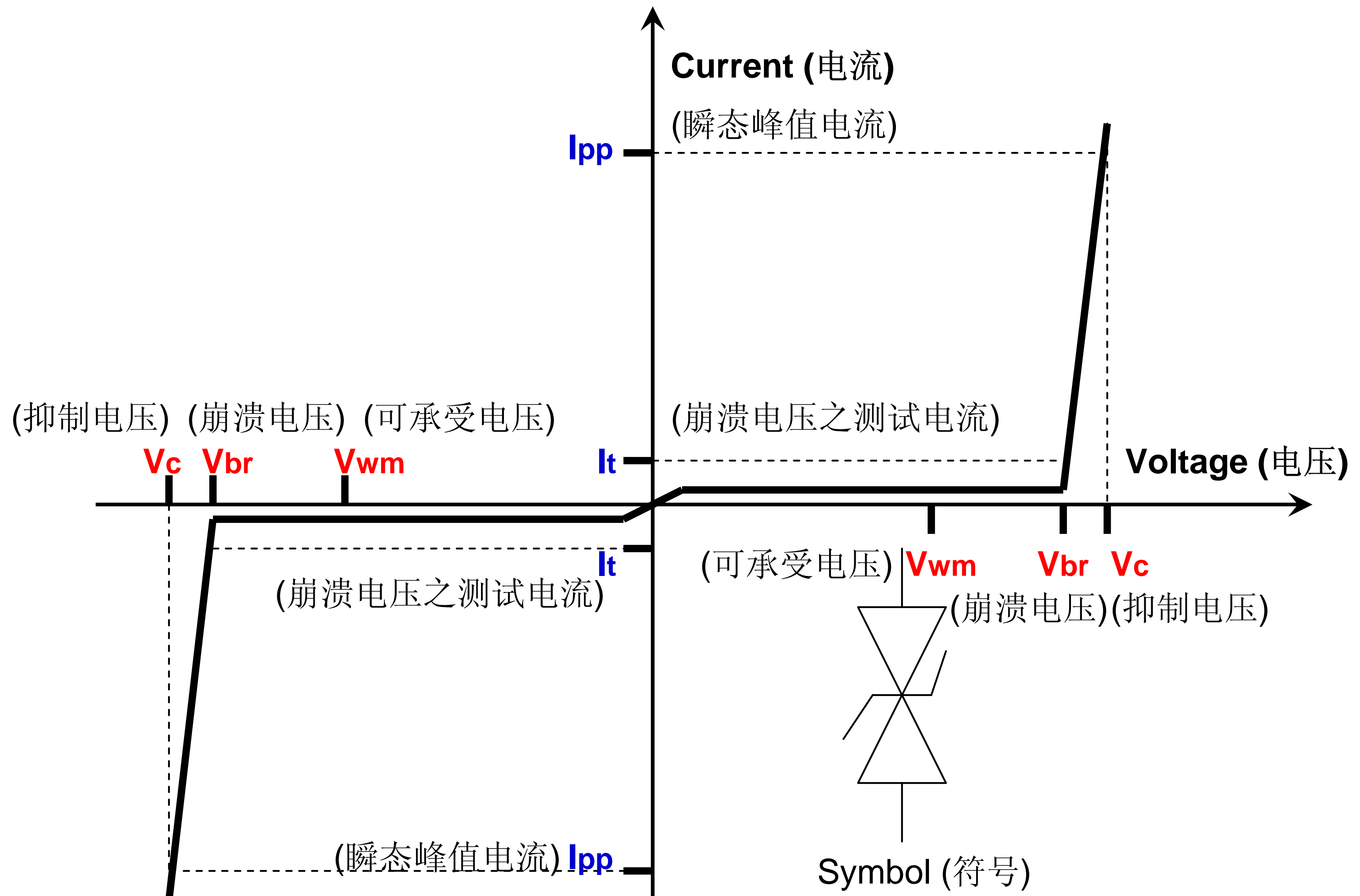
From -ve ESD

(瞬态电流)

Ground (接地)

UMD MICRO

Bi-Directional Protection Graph
双向保护图形



UMD MICRO

TVS diode Electrical Parameters 瞬态电压抑制二极管相关参数

- [V_{rwm}] Reverse Stand-off Voltage（可承受的反向电压）
  This is the maximum voltage that the TVS can withstand, TVS diode in an inactive mode. To ensure maximum protection, the V_{rwm} should be as close to the operating voltage as possible, and it must be higher than the normal operating voltage. If not, the TVS diode will clamp the operating voltage non-stop and interfere the working of the circuit.
  (在此阶段瞬态电压抑制二极管为不导通之状态。V_{rwm}必需大於电路的正常工作电压, 否则瞬态电压抑制二极管会不断截止迴路电压。但V_{rwm}需要尽量與被保护迴路的正常工作电压接近, 这样才不会在瞬态电压抑制二极管工作以前使整个迴路面对过压威胁。)

- [V_{br}] Reverse Breakdown Voltage（反向崩溃电压）
  This is the minimum voltage that will set the TVS diode working, where the transient voltage is clamped to a certain level and the transient current is directed to the ground.
  (当瞬态电压超过V_{br},瞬态电压抑制二极管便产生崩溃把瞬态电压抑制在某个水平, 提供瞬态电流一个超低电阻通路, 让瞬态电流透过瞬态电压抑制二极管被引开, 避开被保护元件。)

- [I_r] Reverse Leakage Current（反向漏电电流）
  TVS diode is connected in a reverse-biased way in the circuit and it lets about 10-100μA leakage current through.
  (瞬态电压抑制二极管是以反向电流的方式连接在线路上,一般都会有10-100μA的反向漏电电流。)

UMD MICRO

- [V_c] TVS diode Clamping Voltage (瞬态电压抑制二极管的抑制电压)
  Clamping voltage is the amount of voltage a suppressor permits to pass through it to the attached load during a transient event. It is also a performance measurement of a suppressor's ability to attenuate a transient. V_c must not be higher than the voltage the protected load can withstand, if not the protected load will be damaged. The lower the better.
  (V_c是在瞬态电压冲击时,例如静电,在截止状态所提供的电压。V_c也是用来测定瞬态电压抑制二极管在抑制瞬态电压时的性能。V_c不能大於被保护迴路的可承受极限电压,否则元件面临被损坏。V_c通常都是越小越好。)

- [C_j] TVS diode Junction Capacitance (瞬态电压抑制二极管的电容值)
  During high frequency data and signal transmission, TVS diode's capacitance will tend to affect the overall flow in the circuit. There maybe be noise or loss of signal. For high frequency transmission like USB2.0 and Firewire, TVS diode's capacitance should not be higher than 10pF. For low frequency transmission, TVS diode's capacitance can be 100pF and above.
  (对於数据/讯号频率越高的迴路,瞬态电压抑制二极管的电容值对电路的干扰越大。这会形成噪音或衰减讯号强度。高频迴路或高传输如USB2.0,1394,需要选择低电容值瞬态电压抑制二极管,电容值不大於10pF。而对电容值要求不高的迴路,电容值可高於100pF。)

UMD TVS diode Packages
UMD瞬态电压抑制二极管产品封装

1.) Chip Scale Package (覆晶晶片微型封装)
- UB02CSP05B, B02CSP05B
- UB02CSP08B, B02CSP08B
- UB02CSP12B, B02CSP12B
- UB06CSP05B, B06CSP05B

2.) SOT-23 Package (SOT23 封装)
- UMD05B
- UMD12B
- UMD24B
- UMD05L [Low capacitance, 低电容值]

3.) SO-16 Package (SO-16 封装)
- UMDSO16LC 05B

4.) SC-79 Package (SC-79 封装)
- UMD6.8B

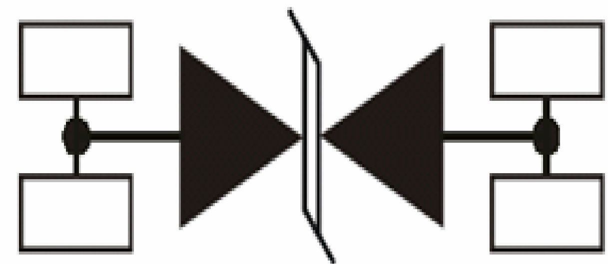
5.) SO-14 Package (SO-14 封装) – NEW
- UMDA05B-8

TVS diode Chip Scale Package

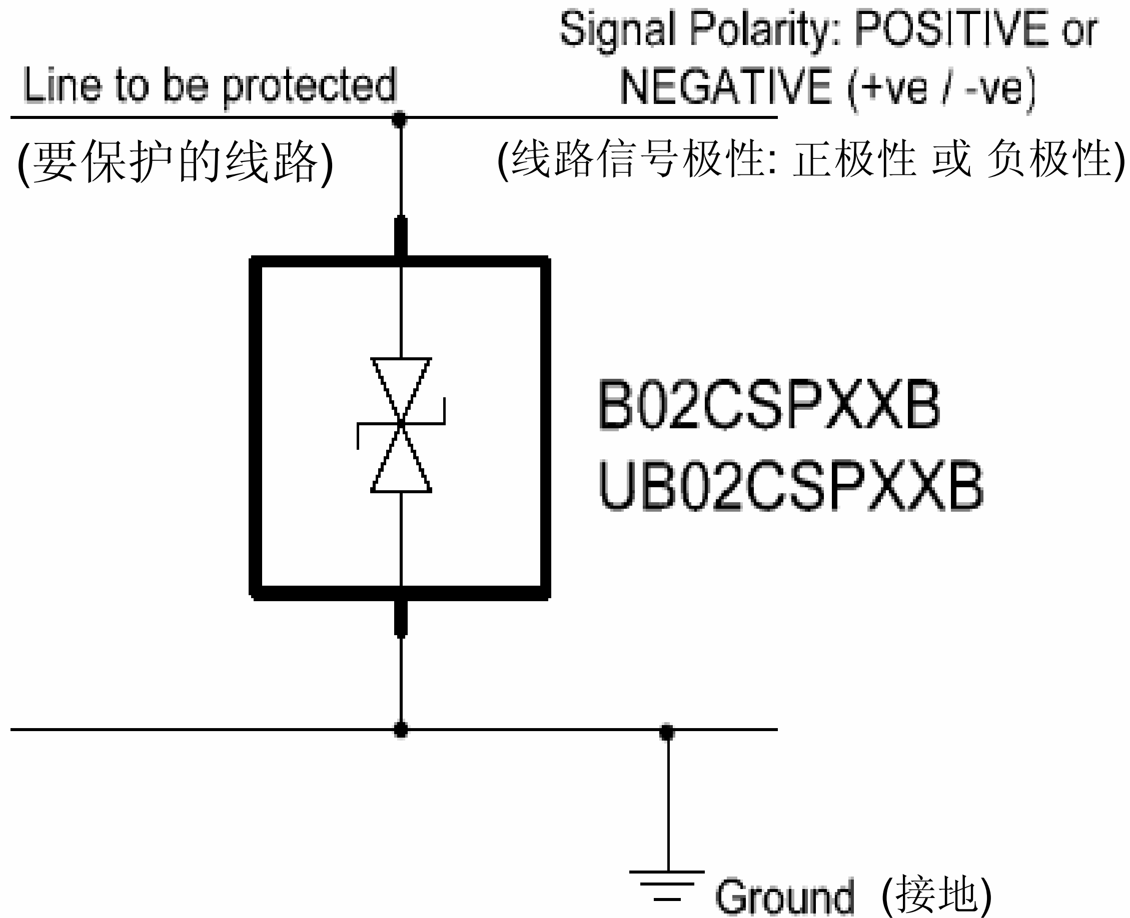
瞬态电压抑制二极管覆晶晶片微型封装

0402 Chip Scale Package

- Size: 0.039 inch * 0.019 inch
  (体积: 0.039英寸*0.019英寸)
- Bi-directional single line protection
  (1条线双向保护)
- ESD protection > 25kv
  (静电保护能达到25kv)
- Working voltage: 5v, 8v,12v
  (现有产品: 5v, 8v,12v)
- Low Clamping voltage
  (低抑制电压)



Single Line, 0402, SMD, Bi-Directional
0402一条线双向保护

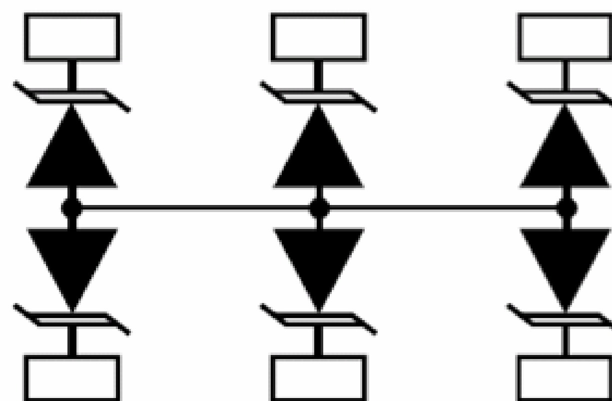


TVS diode Chip Scale Package

瞬态电压抑制二极管覆晶晶片微型封裝

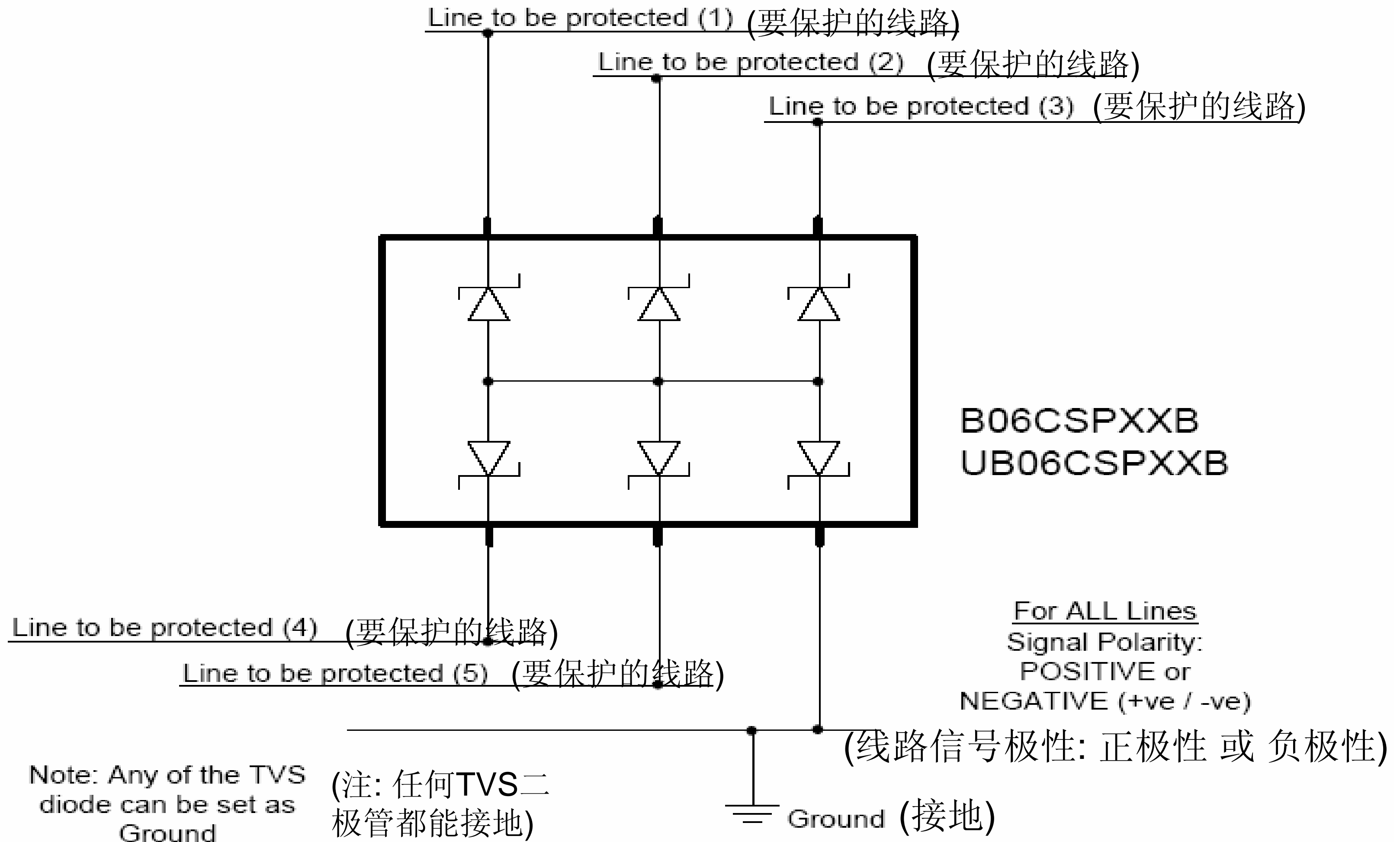
0406 Chip Scale Package

- Size: 0.039 inch * 0.059 inch
  (体积: 0.039英寸*0.059英寸)
- Bi-directional five lines protection
  (5条线双向保护)
- ESD protection > 25kv
  (静电保护能达到25kv)
- Working voltage: 5v
  (现有产品: 5v)
- Low Clamping voltage
  (低抑制电压)

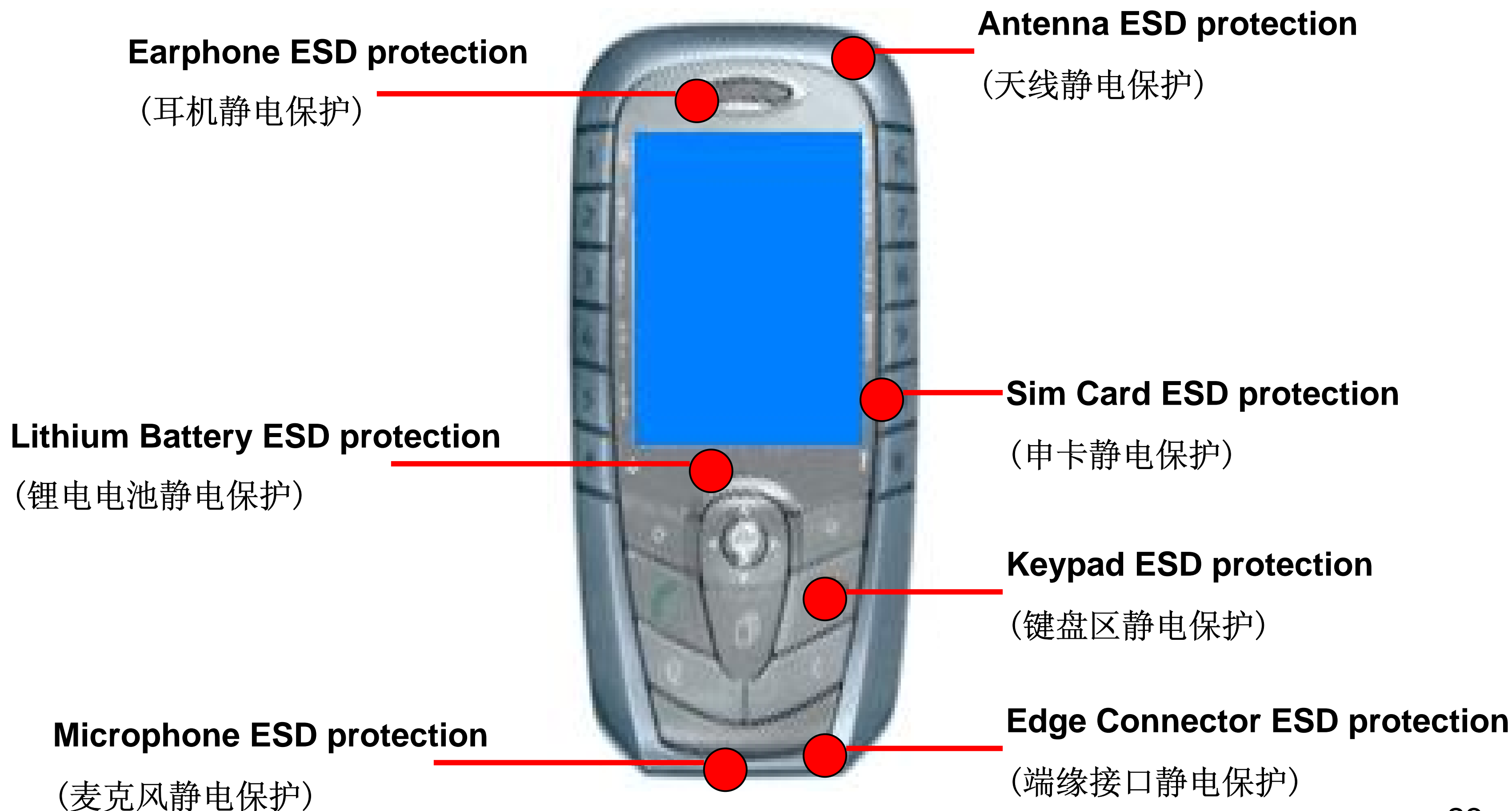


UMD MICRO

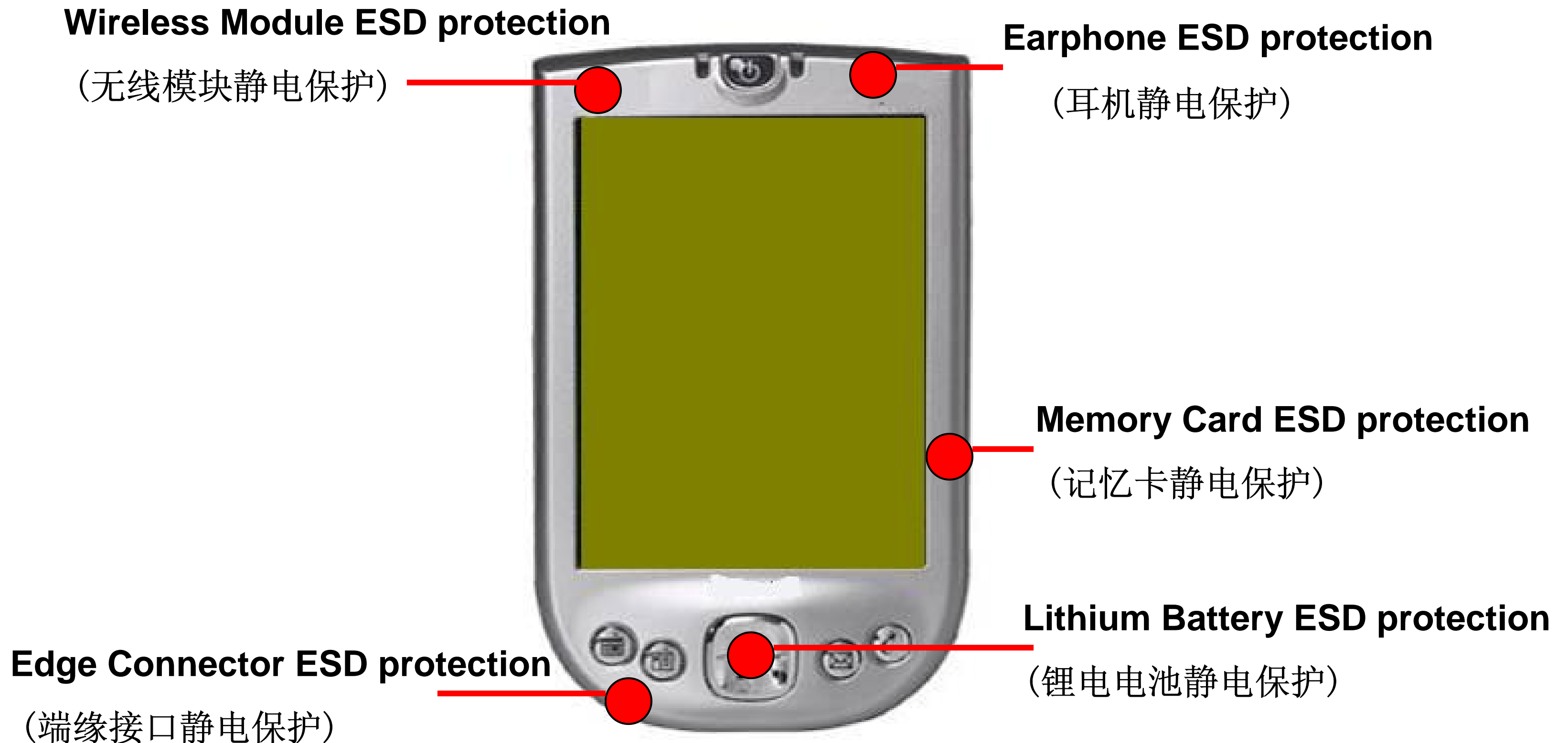
Five Lines, 0406, SMD, Bi-Directional
0406五条线双向保护



Chip Scale Package Applications
覆晶晶片微型封装应用上



Chip Scale Package Applications
覆晶晶片微型封装应用上



UMD MICRO

TVS diode SOT-23 Package
瞬态电压抑制二极管SOT-23封装

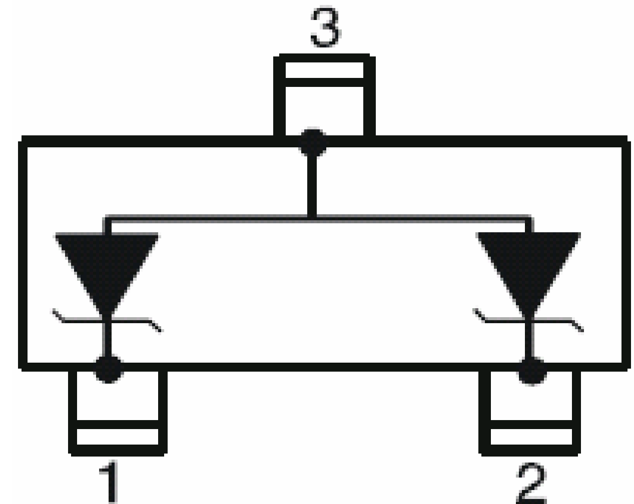
SOT-23 Package

- Size: min 0.1102 inch * 0.0830 inch,
  max 0.1197 inch * 0.0984 inch
  (体积:最小 0.1102英寸*0.0830英寸
  最大 0.1197英寸*0.0984英寸)

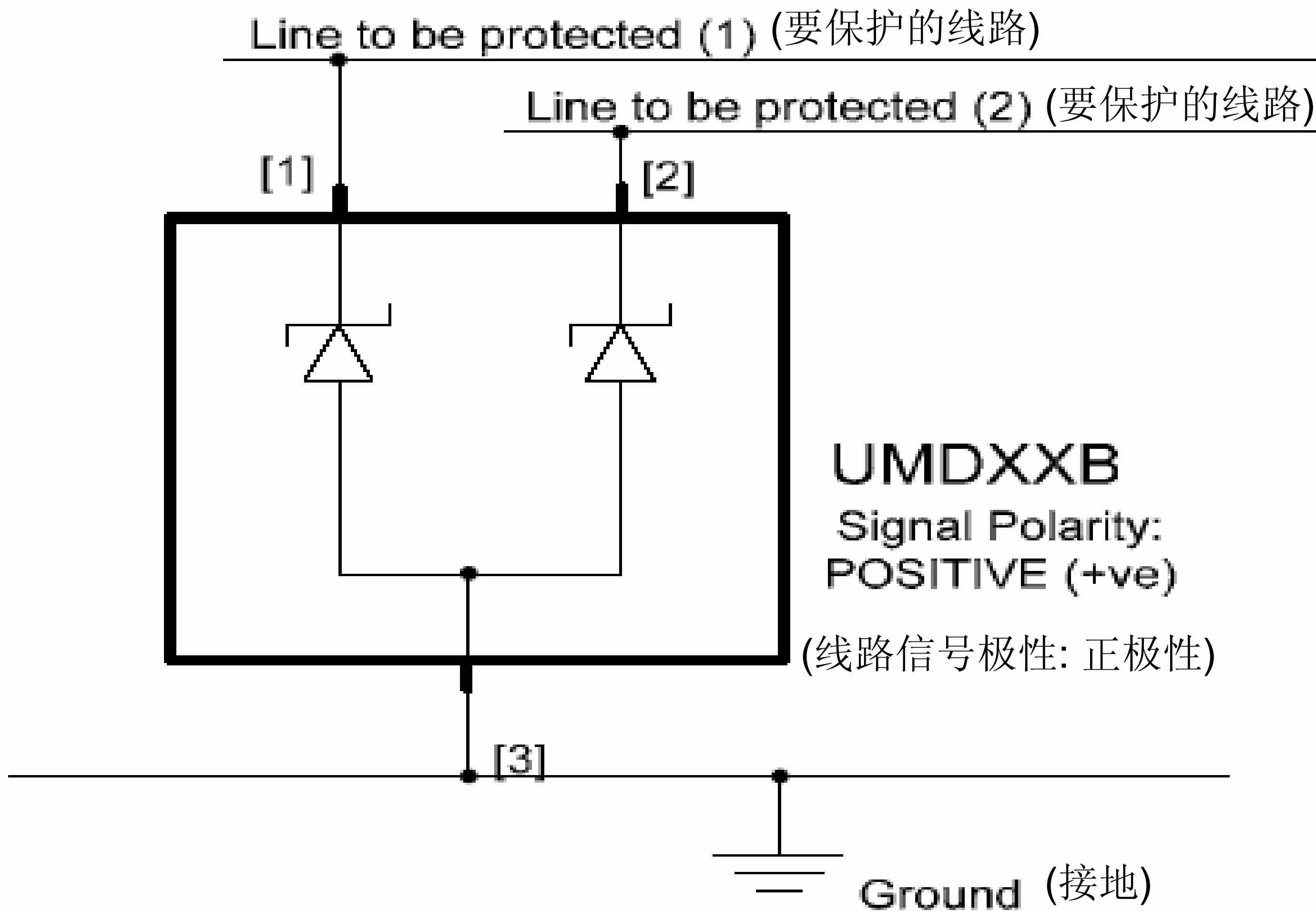
- Bi-directional single line or
  Unidirectional two lines protection
  (1条线双向保护或2条线单向保护)

- ESD protection > 40kv
  (静电保护能达到40kv)

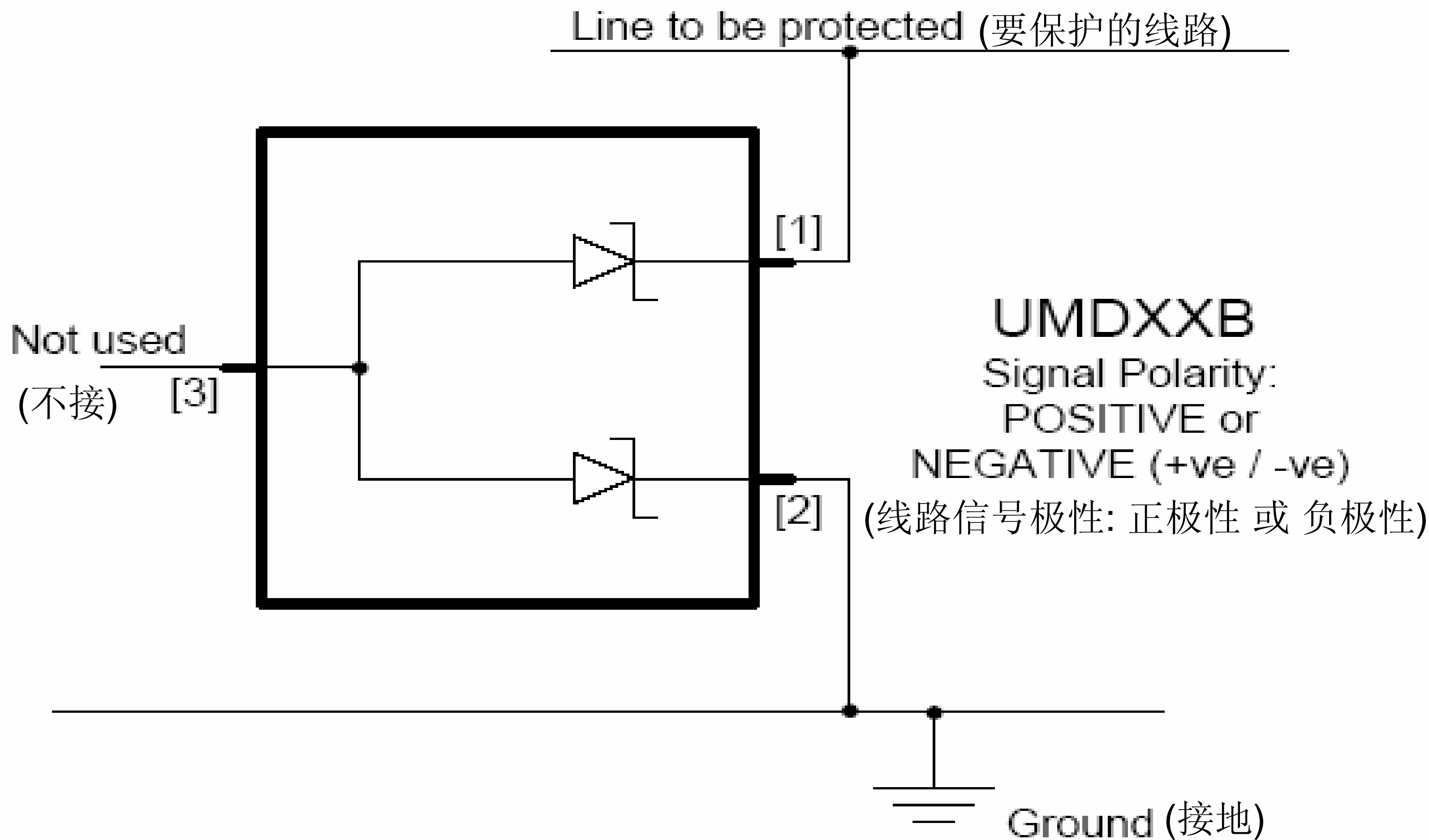
- Working voltage: 5v, 12v,24v
  (现有产品：5v, 12v,24v)



Two Lines, SOT-23, SMD, Unidirectional
SOT-23二条线单向保护



Single Line, SOT-23, SMD, Bi-Directional
SOT-23一条线双向保护



Solution to achieve Low Capacitance TVS 降低瞬态电压抑制二极管低电容值的方法

- In high speed data transmission applications, the extra capacitance introduced by protection devices needs to be kept to a minimum in order to not “load down” the line. The junction capacitance of low voltage TVS devices, however, is relatively large.

  (对於高数据传输的迴路, 瞬态电压抑制二极管的电容值要越低越好, 不然会对迴路造成干扰。问题就是一般低电压的瞬态电压抑制二极管的电容值都过高。)

- Low capacitance TVS devices can be achieved by placing a low-capacitance regular diode (D2) in series but opposite in polarity with a TVS diode (D1)

  (要降低瞬态电压抑制二极管电容值的方法就是把它和一个二极管串连在一起。如下图。)

Low Capacitance TVS diagram
瞬态电压抑制二极管低电容値的串连图

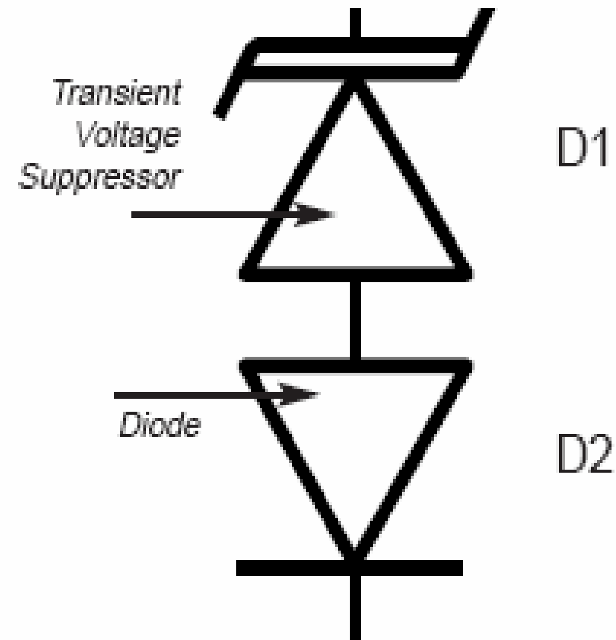
- The total capacitance of two capacitances in series will be as per the following equation: (串连后的电容值如下)

$$C(total) = \frac{C1 * C2}{(C1 + C2)}$$

- Example (例): TVS (C1)= 100PF
  Diode (C2)= 5PF

$$C(total) = \frac{100*5}{100+5}$$

= **<u>4.76PF</u>**

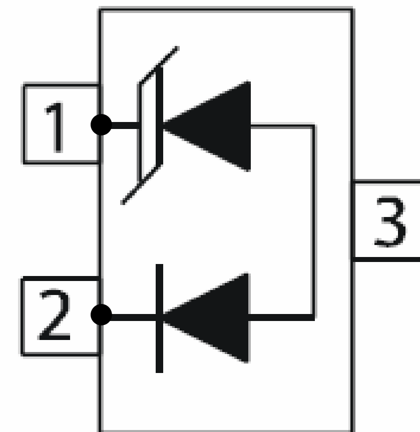


UMD MICRO

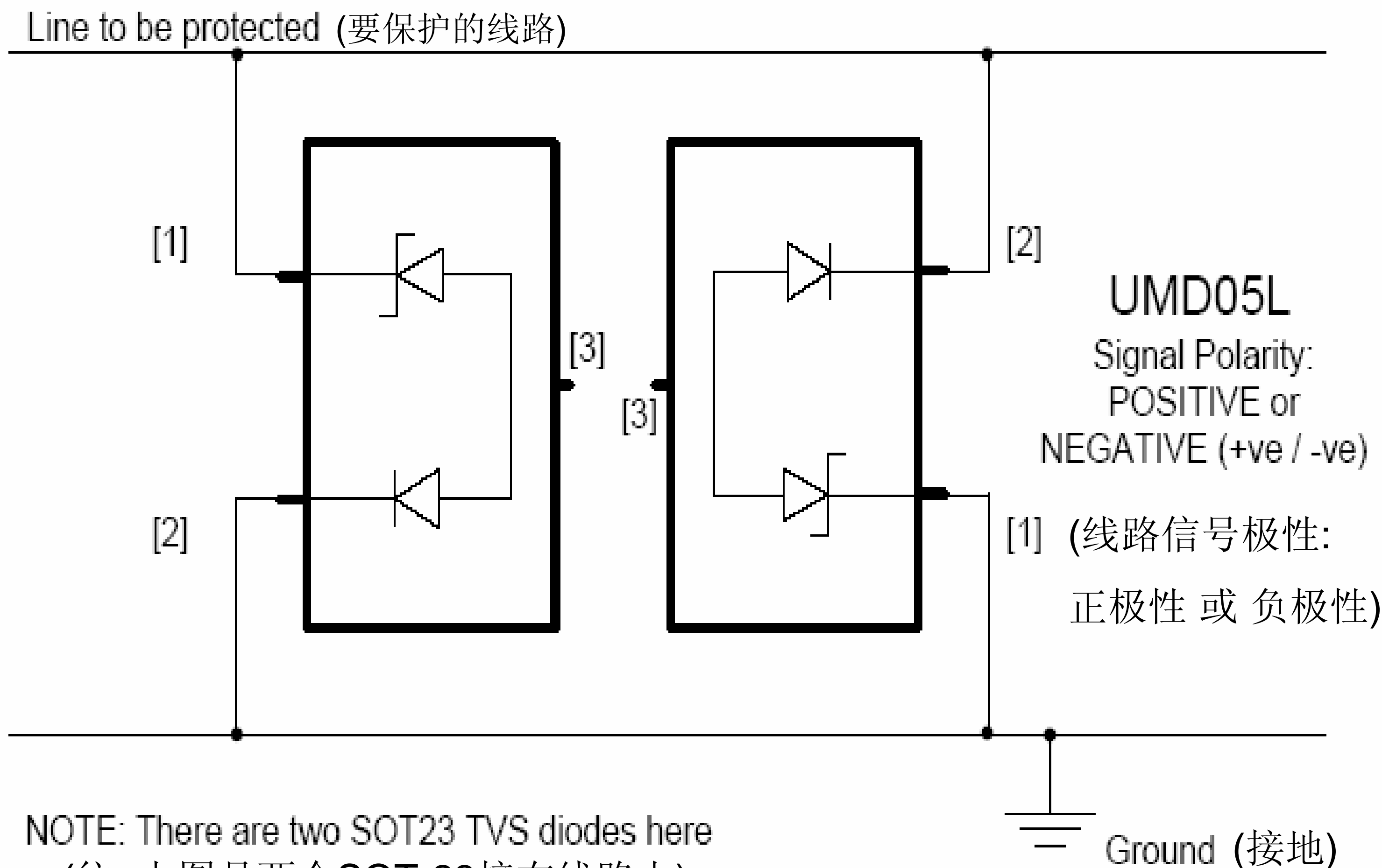
TVS diode SOT-23 Low Capacitance Package
瞬态电压抑制二极管SOT-23低电容值封装

SOT-23 Low Capacitance Package

- Size: min 0.1102 inch * 0.0830 inch,
  max 0.1197 inch * 0.0984 inch
  (体积:最小 0.1102英寸*0.0830英寸
  最大 0.1197英寸*0.0984英寸)
- Bi-directional two lines protection
  (2条线双向保护)
- Low capacitance for high speed interfaces
  (低电容值,適於数据/讯号高的迴路)
- Working voltage: 5v
  (现有产品: 5v)



Two Lines, SOT-23 Low Capacitance, SMD, Bi-directional
SOT-23低电容值二条线双向保护



TVS diode SO-16 Package
瞬态电压抑制二极管SO-16封装

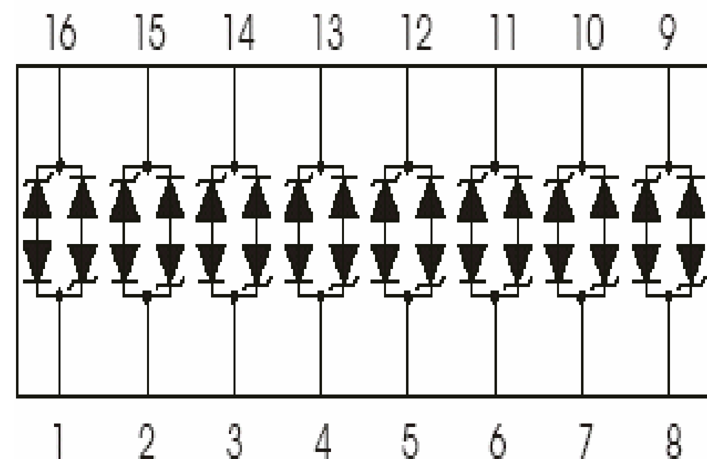
SO-16 Package

- Size: min 0.386 inch * 0.230 inch,
  max 0.394 inch * 0.244 inch
  (体积：最小 0.386英寸*0.230英寸
  最大 0.394英寸*0.244英寸)

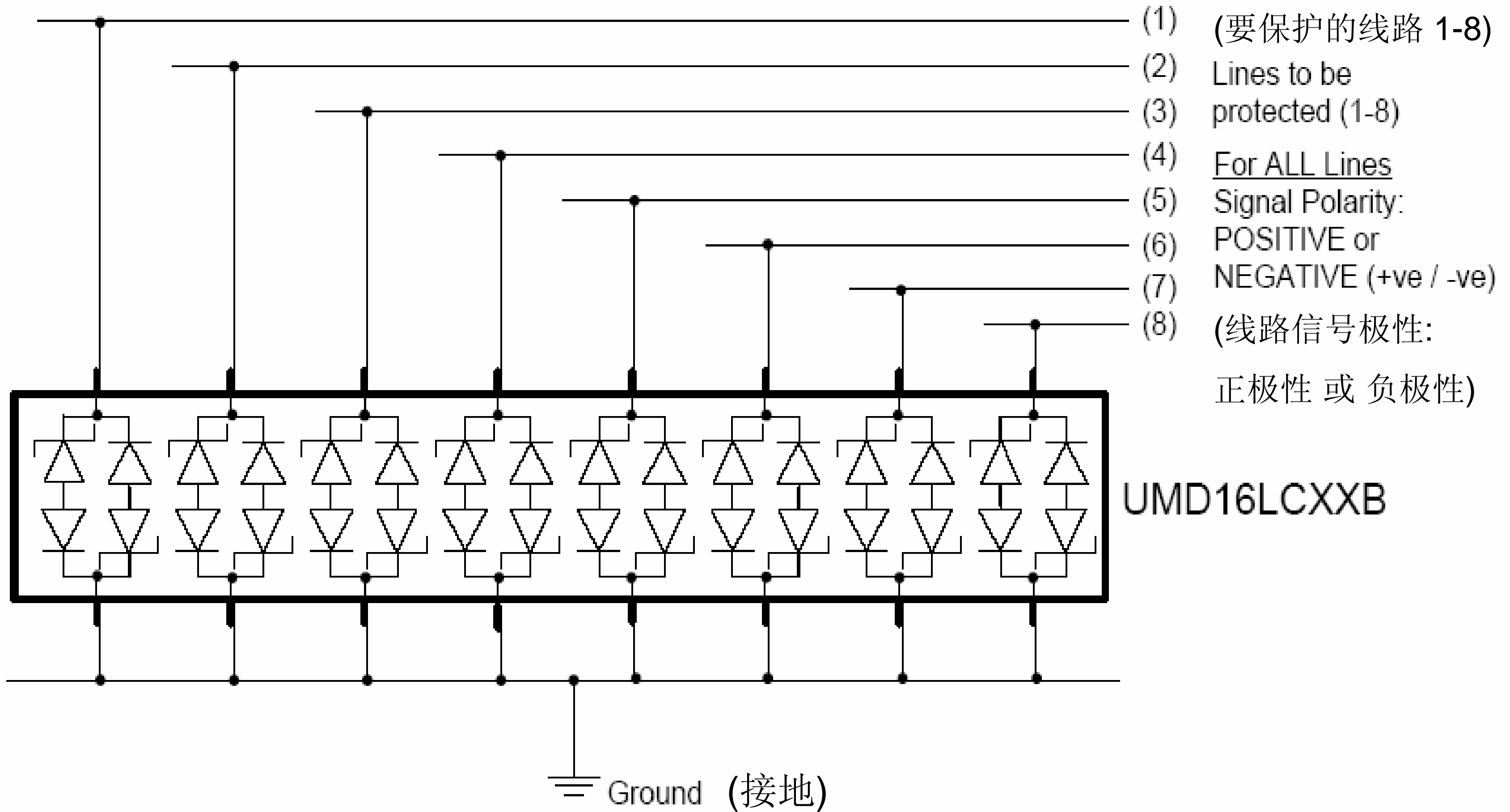
- Bi-directional eight lines protection
  (8条线双向保护)

- Low capacitance for high speed interfaces
  (低电容值,適於数据/讯号高的迴路)

- Working voltage: 5v
  (现有产品：5v)



Eight Lines, SO-16, SMD, Bi-Directional
SO-16八条线双向保护



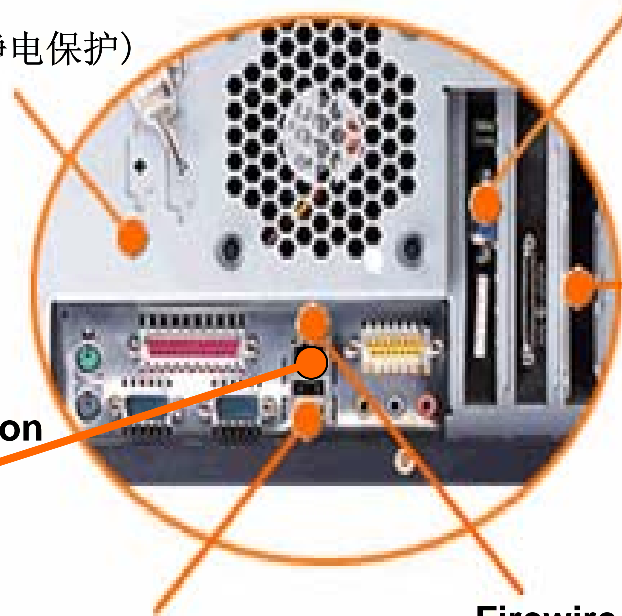
SOT23&SO-16 Package Applications
SOT23和SO-16 封装应用上

Video port ESD protection

（显示卡端口静电保护）

Cache ESD protection

（高速缓冲存储器静电保护）



RS232 port ESD protection

（**RS232**端口静电保护）

Ethernet port ESD protection

（以太网端口静电保护）

USB2.0 port ESD protection

（**USB2.0**端口静电保护）

Firewire port ESD protection

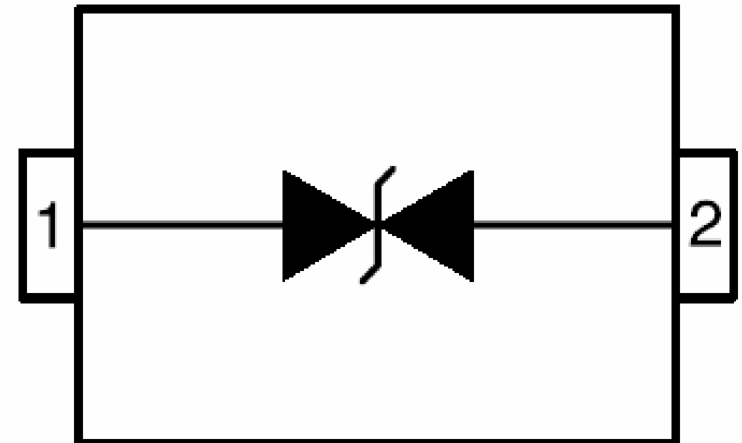
（1394端口静电保护）

UMD MICRO

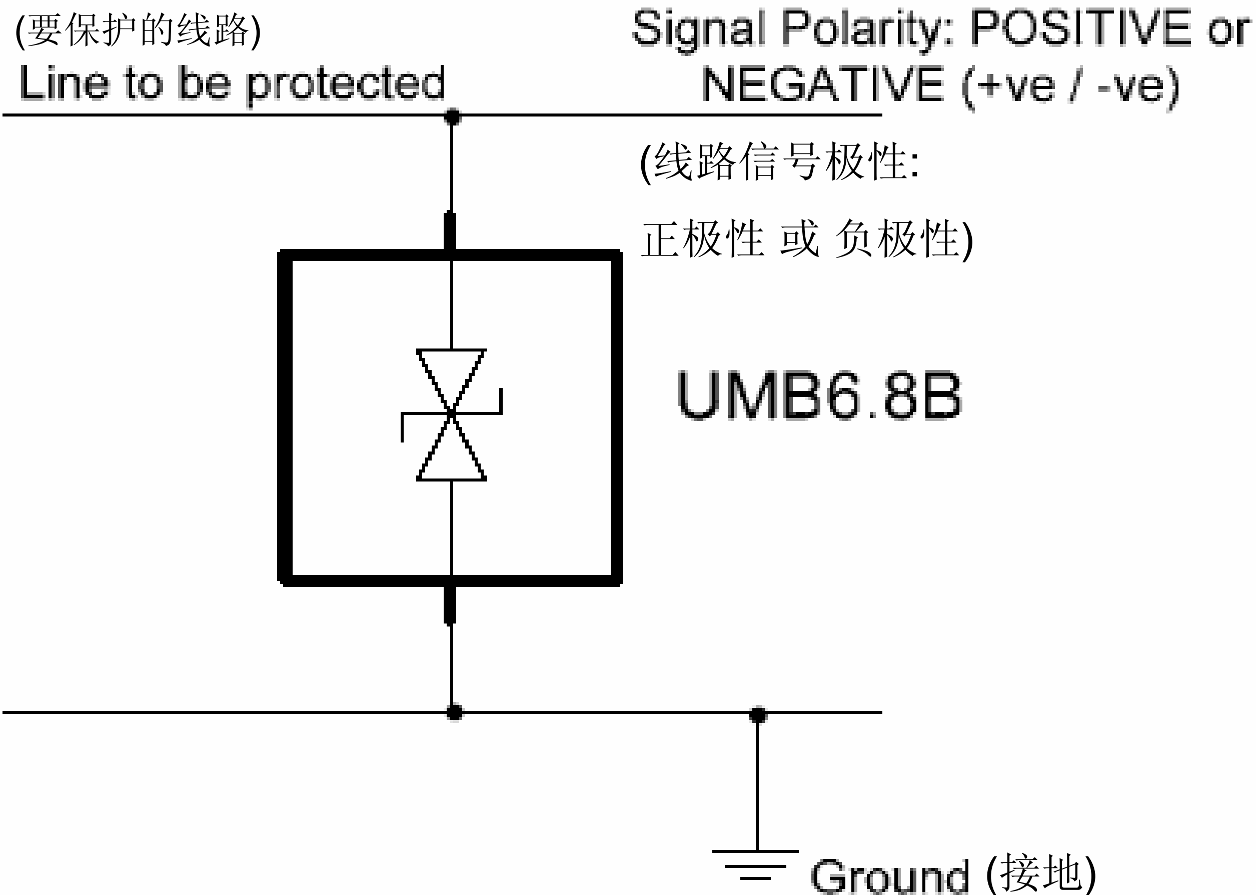
TVS diode SC-79 Package
瞬态电压抑制二极管SC-79封装

SC-79 Package

- Low Clamping voltage
  (低抑制电压)
- Bi-directional single line protection
  (1条线双向保护)
- ESD protection > 40kv
  (静电保护能达到40kv)
- Working voltage: 6.8v
  (现有产品: 6.8v)



Single Line, SC-79, SMD, Bi-Directional
SC-79一条线双向保护

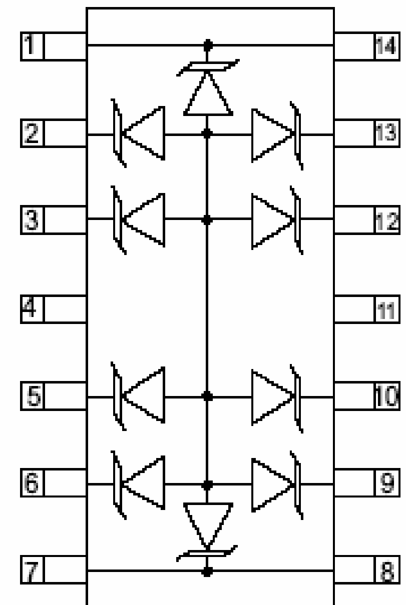


UMD MICRO

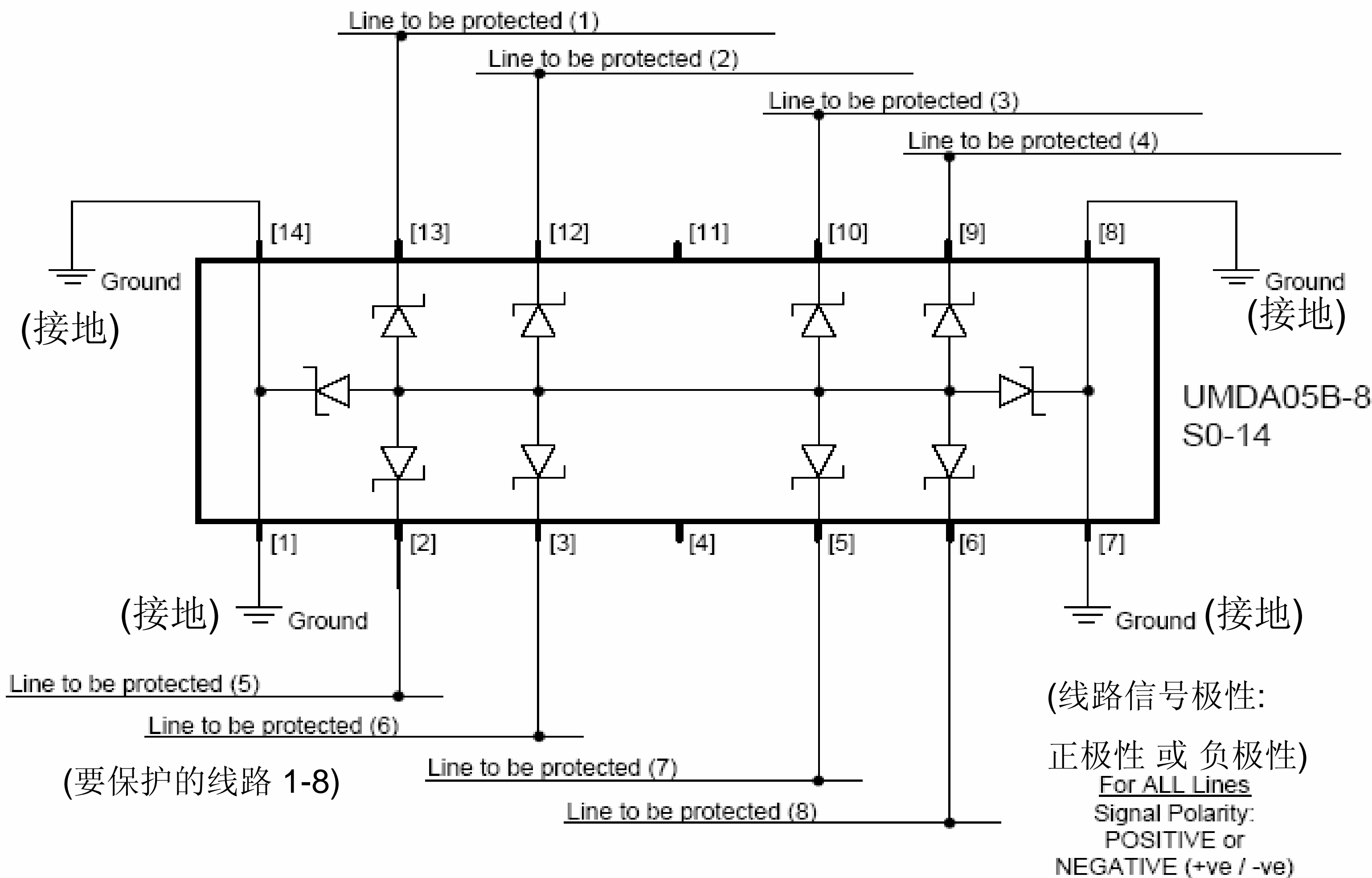
TVS diode SO-14 Package
瞬态电压抑制二极管SO-14封装

SO-14 Package

- Size: min 0.337 inch * 0.228 inch,
  max 0.344 inch * 0.244 inch
  (体积：最小 0.337英寸*0.228英寸
  最大 0.344英寸*0.244英寸)
- Bi-directional eight lines protection
  (8条线双向保护)
- Low clamping voltage and low leakage current
  (低抑制电压和低反向漏电电流)
- Working voltage: 5v
  (现有产品：5v)



Eight Lines, SO-14, SMD, Bi-Directional
SO-14八条线双向保护



Other Transient Voltage Protection Devices
其它瞬态电压保护装置

- Zener Diode (齐纳二极管**)**
- Multilayer Metal oxide Varistor（多层金属氧化物突波吸收器）
- Ceramic Capacitor（陶瓷电容器）
- Gas Discharge Tubes, GDTs（离子气体放电管）
- Thyristors（半导体闸流管）
- PulseGuard（聚合物抑制器）

UMD MICRO

TVS diode's Advantages
瞬态电压抑制二极管的优势

- TVS Diode vs. Zener Diode
  (瞬态电压抑制二极管与齐纳二极管)

  Compared with the traditional Zener diode, TVS diode has a larger P/N cross section. TVS diode component is constructed and designed to absorb larger amounts of energy, joules, with a faster response time than Zener diode. Zener diode has a higher clamping voltage and heat dissipation is slower.

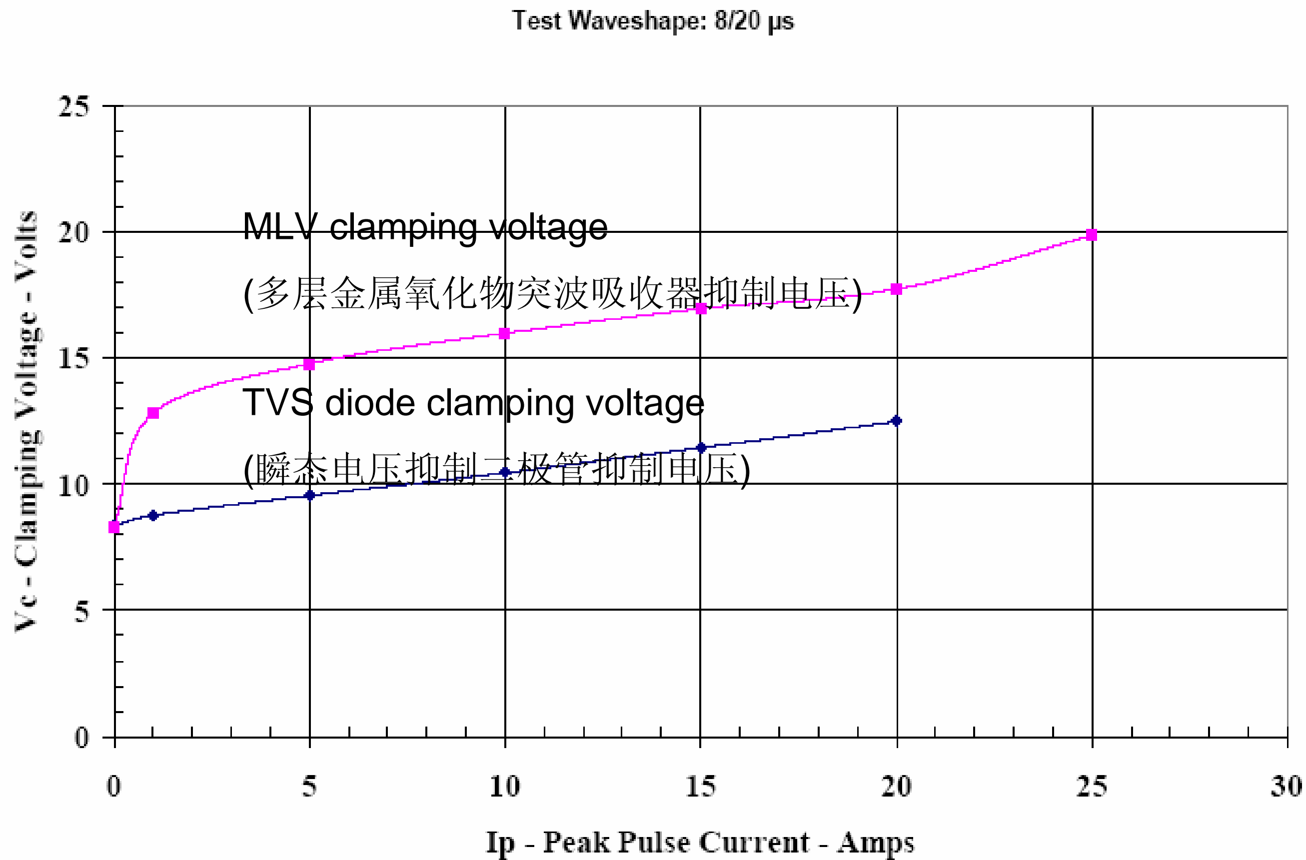
  (与传统的齐纳二极管相较,瞬态电压抑制二极管的P/N结面积更大。这一结构上的改进使瞬态电压抑制二极管具更强的高压承受力和更快的效率。相较之下齐纳二极管也有较高的抑制电压和较慢的散热速度。)

TVS diode's Advantages
瞬态电压抑制二极管的优势

- TVS Diode vs. Multilayer Metal oxide Varistor, MLV
  (瞬态电压抑制二极管与多层金属氧化物突波吸收器)

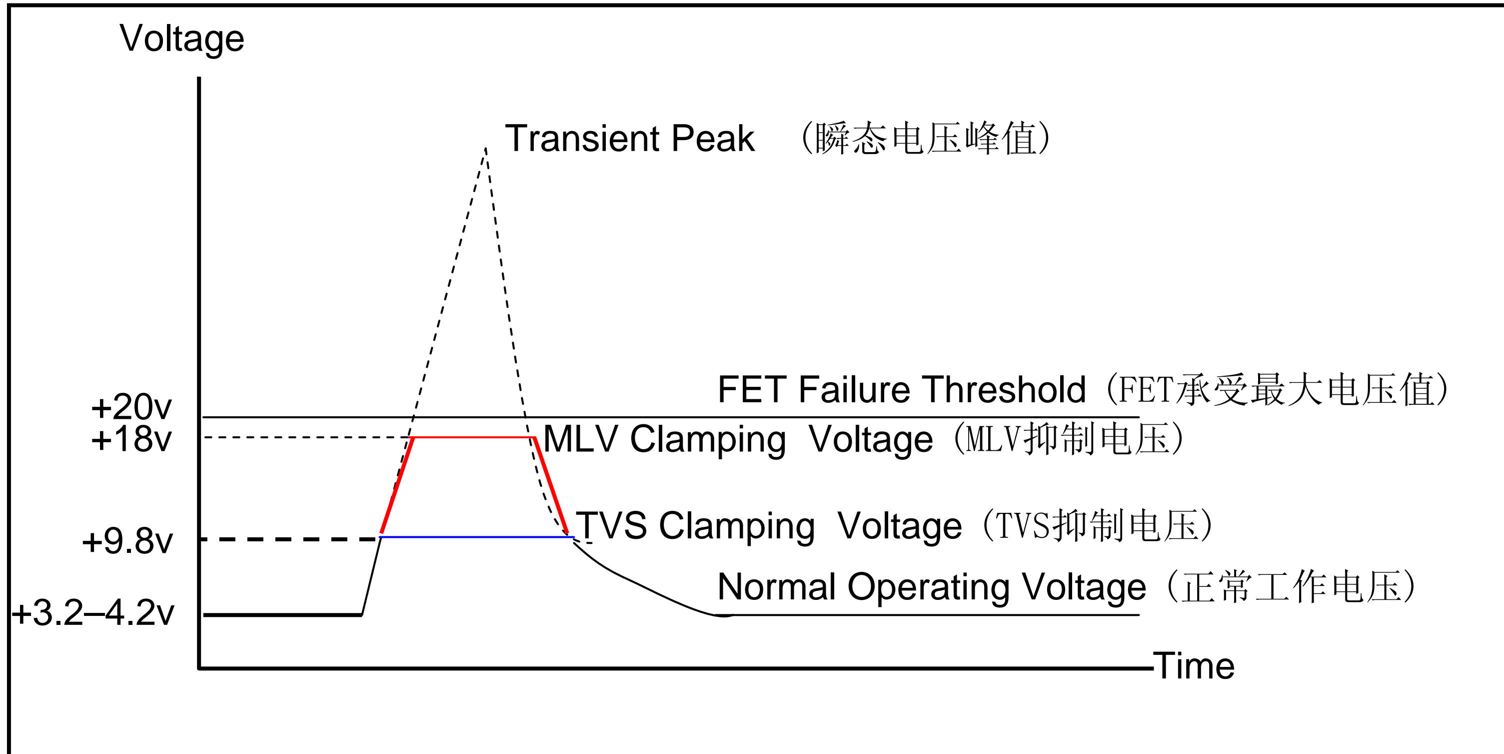
  A major difference between TVS diode and MLV is, as MLV absorbs transient energy, its electrical parameters such as Leakage current and Breakdown voltage tend to drift away from their original specifications which exhibits an inherent wear out mechanism within the structure. Because of its high impedance, its clamping ratio can reach as high as 3. Therefore MLV is more suitable to be applied on less sensitive lines where its high clamping voltage can be tolerated. (瞬态电压抑制二极管与多层金属氧化物突波吸收器最大的不同是多层金属氧化物突波吸收器的功能会在瞬态电压的冲击下衰退。当瞬态电压侵袭时, 多层金属氧化物突波吸收器的相关参数如漏电电流值和中止电压值都会偏离原来的参数而变得不准确。还有多层金属氧化物突波吸收器有较高的阻抗所以它的抑制电压可达最初中止电压的3倍, 这种特性只适合用于对电压不太感应的线路和元件的保护。)

Clamping Voltage comparison for TVS diode and MLV (瞬态电压抑制二极管与多层金属氧化物突波吸收器抑制电压比照图形)



UMD MICRO

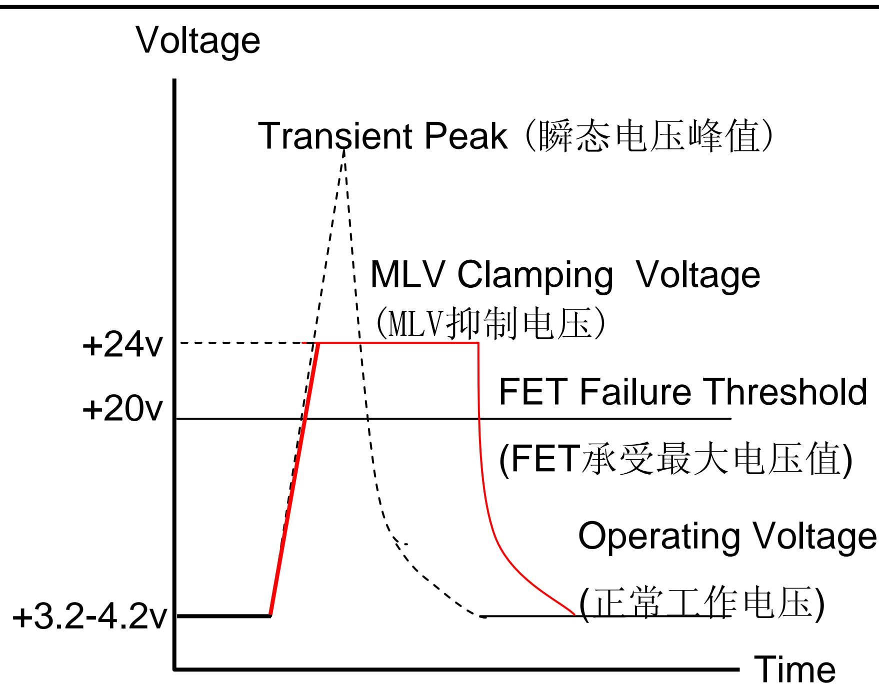
Clamping Voltage comparison for TVS diode and MLV (瞬态电压抑制二极管与多层金属氧化物突波吸收器抑制电压比照图形)



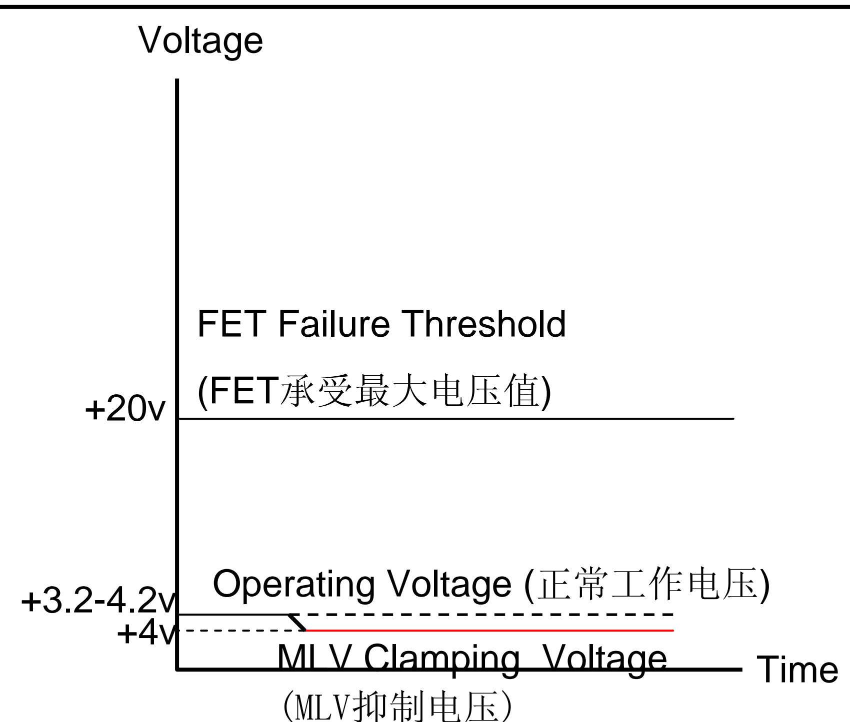
- Using our TVS (U/B02CSP05B) to compare with a typical MLV. Having the same breakdown voltage at 6v, our TVS with a clamping factor of 1.63 will clamp at 9.8v while a typical MLV with a clamping factor of 3 will clamp at 18v. Varistor's much higher clamping voltage explains why it cannot pass some of the ESD test. (在一样6v的崩溃电压, UMD TVS, U/B02CSP05B能把瞬态电压抑制在9.8v而MLV只能把瞬态抑制在18v。这解释了为什么MLV没办法通过一些ESD测试。

The Electrical Parameters of MLV Tend to Drift

多层金属氧化突波吸收器的参数会偏离



If a typical MLV's breakdown voltage drift from 6v to 8v, it will now clamp at 24v instead of 18v. FET will be damaged. (当MLV的崩溃电压参数偏离原来的6v到8v时,它的抑制电压也跟着提高,从18v到24v。这会导致FET被击坏。)



If a typical MLV's breakdown voltage drift from 6v to 4v, it will now clamp the voltage below the operating voltage. FET's normal operating voltage will be affected . (当MLV的崩溃电压参数偏离原来的6v到4v时,它会不断截止迴路电压而影响FET的正常工作。)

UMD MICRO

TVS diode's Advantages
瞬态电压抑制二极管的优势

- TVS Diode vs. Ceramic Capacitor
  (瞬态电压抑制二极管与陶瓷电容器)

Ceramic capacitor is not able to withstand a high transient voltage. A 10kV transient voltage will destroy about 60% of the component of the ceramic capacitor while TVS diode is able to withstand up to 15kV transient voltage. Ceramic capacitor is also not able to dissipate heat efficiently like what TVS diode does when transient occurs.
(陶瓷电容器这类元件对高压的承受力比较弱。如有10kV的瞬态电压冲击时,会对陶瓷电容器造成约60%的损坏,而瞬态电压抑制二极管能承受到15kV的瞬态电压。在瞬态电压侵袭时所产生的热量,陶瓷电容器也没有办法象瞬态电压抑制二极管那样很有效的把它散去。)

TVS diode's Advantages
瞬态电压抑制二极管的优势

- TVS Diode vs. Gas Discharge Tubes, GDTs

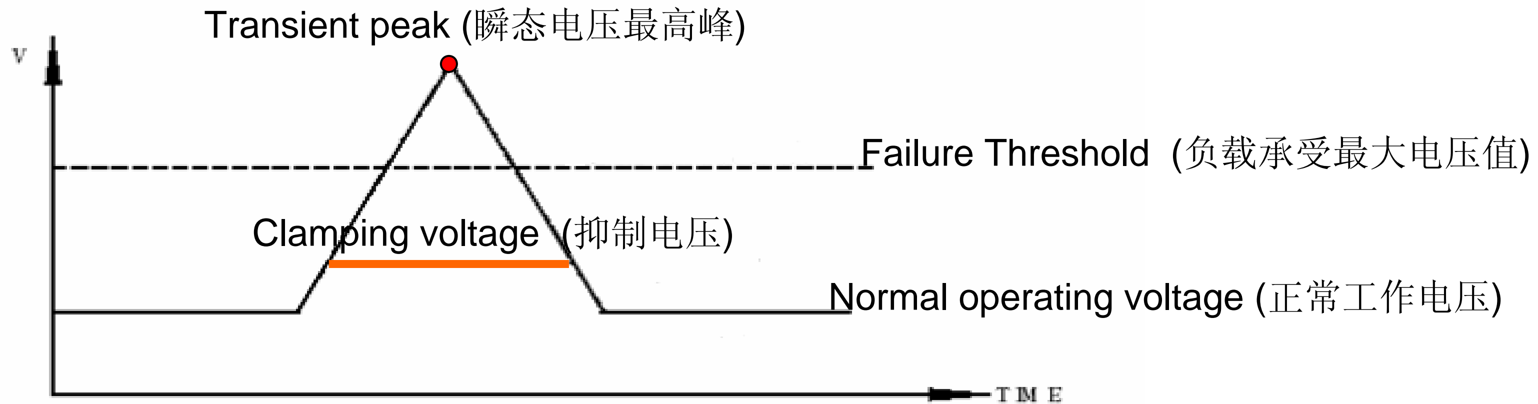
  (瞬态电压抑制二极管与离子气体放电管)

TVS diode limits voltage spike to acceptable level by <u>clamping</u> while GDT limits voltage spike by <u>crowbar action</u>. GDT conducts when its threshold voltage is exceeded and then trigger to an on-state voltage of only a few volts. A drawback of GDT protection is that the trigger on state voltage is below the operating voltage of the protected load. The protected load will be shut down temporarily.

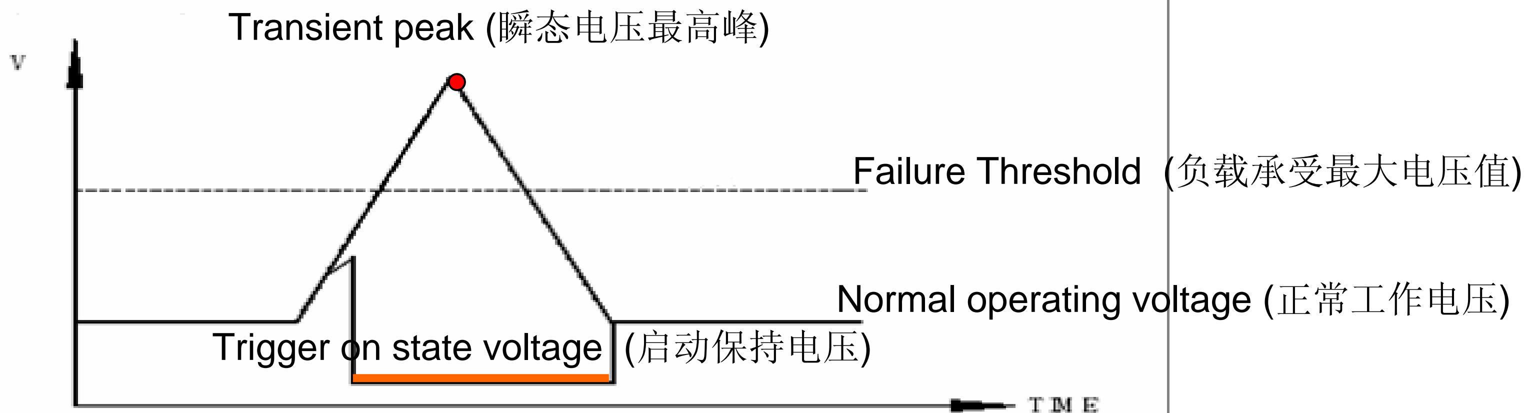
(瞬态电压抑制二极管是以抑制电压的方式来达到瞬态电压保护, 而离子气体放电管是以铁橇动作的方式来达到瞬态电压保护。离子气体放电管的缺点是在启动后保持在非常低的电压状态, 电压低于负载的正常工作电压。在这种情形下, 负载没有办法绩续工作, 会暂时的关闭。)

Voltage Clamping Device vs. Crowbar Action Device
抑制电压方式与铁橇动作方式

Voltage clamping device (抑制电压方式)



Crowbar action device (铁橇动作方式)



TVS diode's Advantages
瞬态电压抑制二极管的优势

- TVS diode vs. Thyristors
  (瞬态电压抑制二极管与半导体闸流管)

  Like GDT, Thyristor also limits voltage spike by crowbar action. The operating voltage of thyristor ranges from 20v up through 250v, therefore it is not able to protect sensitive equipments which use low operating voltages such as mobile handsets and pocket pcs.
  (半导体闸流管也是以铁橇动作的方式来达到瞬态电压保护。半导体闸流管的工作电压是从20v到250v, 所以它不適合用于低电源感应设备装置如手机和掌上型电脑)

TVS diode's Advantages
瞬态电压抑制二极管的优势

- TVS diode vs. PulseGuard
  (瞬态电压抑制二极管与聚合物抑制器)

  Unlike TVS diode, PulseGuard's clamping voltage is as high as 150v which is not suitable for sensitive low operating voltage equipments such as mobile handsets and pocket pcs.
  (聚合物抑制器的抑制电压高达150V, 所以它不適合用于低电源感应设备装置如手机和掌上型电脑)

UMD MICRO

THE END