







Lighting Circuit Transient Voltage Protection



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The importance of circuit protection

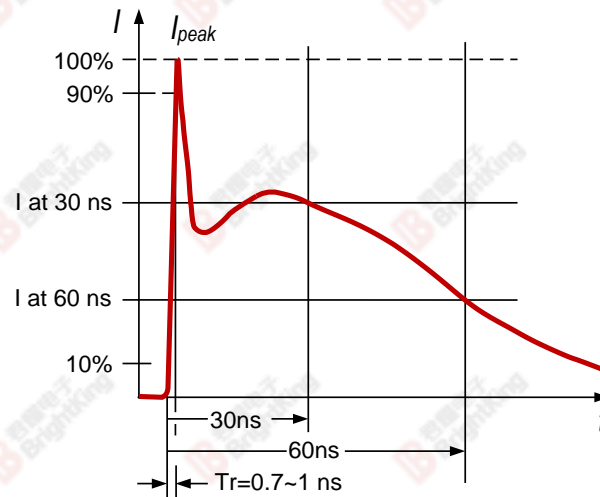
- ✓ People are gaining more and more attention on products' safety, a variety of laws and regulations also clearly require the product lightning protection level, such as IEC61000-4-2, IEC61000-4-5 and so on. Some export products must meet the corresponding safety certification in order to get market access.
- ✓ With the increasing degree of integration of the circuit, the miniaturization of various chips also led to the IC anti-interference ability gradually weakened, and the EMC problem becoming more prominent.
- ✓ To add a low cost protection components in the circuit to protect the high cost IC or other device from the damage of transient interference voltage is an effective way to reduce the product development costs.
- ✓ Design protection devices in the circuit can effectively improve product reliability, reduce product failure rate, reduce maintenance and repair costs.
- ✓ Damage caused by lightning to electronic products is often fatal, adding lightning protection device in the product AC power input can reduce the product damage rate caused by lightning, and at the same time to protect personal safety.
- ✓ From the customer's point of view, high-quality products can enhance the product competitiveness in the market.



Related testing standards

Standard category	Standard Types	Standard Number	Standard Title
GB	ESD	GB/T 17626.2	Electromagnetic compatibility—Testing and measurement techniques—Electrostatic discharge immunity test
IEC		IEC6000-4-2	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
GB	EFT	GB/T 17626.4	Electromagnetic compatibility—Testing and measurement techniques—Electrical fast transient/burst immunity test
IEC		IEC61000-4-4	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test
GB	Surge	GB/T 17626.5	Electromagnetic compatibility-Testing and measurement techniques-Surge immunity test
IEC		IEC61000-4-5	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test

Test waveform



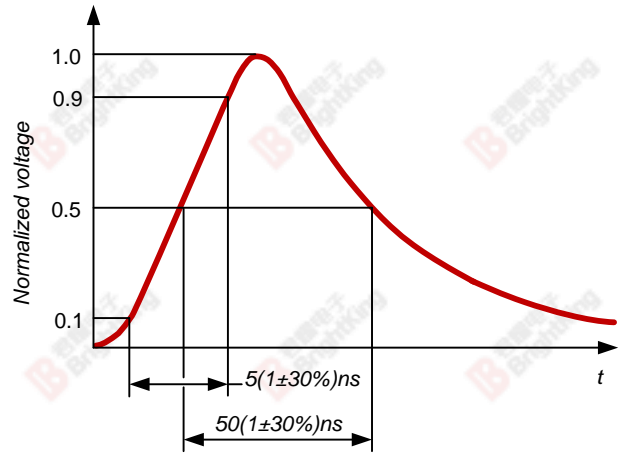
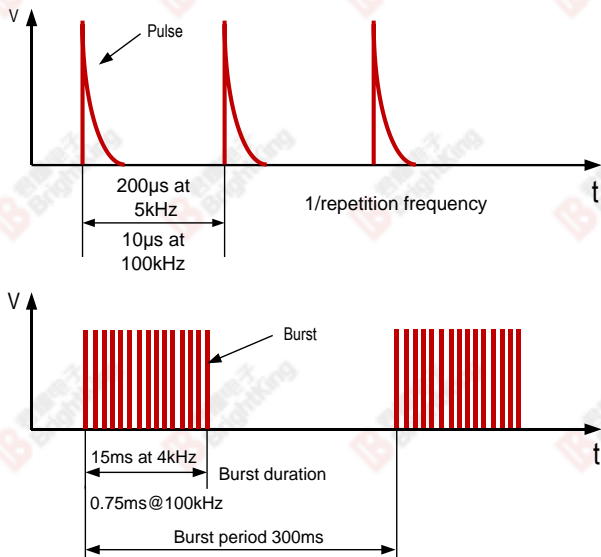
Electrostatic discharge waveform parameters					
Level	Indicated voltage	First peak current of discharge ($\pm 15\%$)	Rise time T_r ($\pm 25\%$)	Current at 30 ns ($\pm 30\%$)	Current at 60 ns ($\pm 30\%$)
	kV	A	ns	A	A
1	2	7.5	0.8	4	2
2	4	15	0.8	8	4
3	6	22.5	0.8	12	6
4	8	30	0.8	16	8

The reference point for measuring the time for the current at 30 ns and 60 ns is the instant when the current first reaches 10 % of the 1st peak of the discharge current.
NOTE The rise time, T_r , is the time interval between 10 % and 90 % value of 1st peak current.

Test level				
Test level	Level 1	Level 2	Level 3	level 4
Contact	2	4	6	8
Air	2	4	8	15

GB/T 17626.4/IEC61000-4-4

Test waveform



Test level

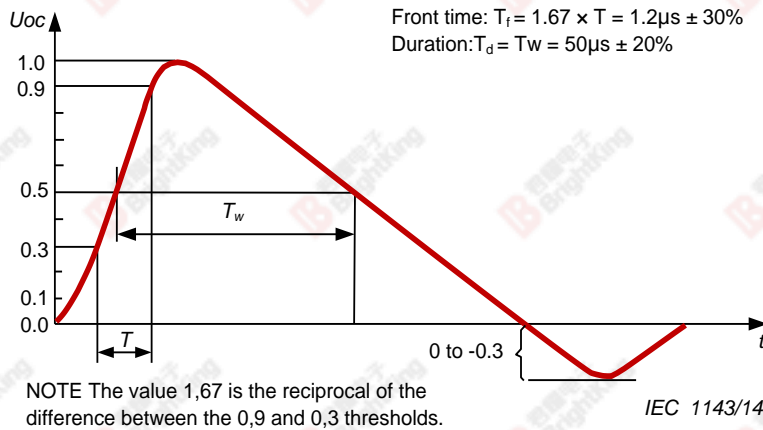
Open circuit output test voltage and repetition rate of the impulses				
Level	On power supply port, PE		On I/O (Input/Output) signal data and control ports	
	Voltage peak (kV)	Repetition rate (kHz)	Voltage peak (kV)	Repetition rate (kHz)
1	0.5	5 or 100, Note 2	0.25	5 or 100, Note 2
2	1	5 or 100, Note 2	0.5	5 or 100, Note 2
3	2	5 or 100, Note 2	1	5 or 100, Note 2
4	4	5 or 100, Note 2	2	5 or 100, Note 2
x ^a	Special	Special	special	Special

Note1 Use of 5kHz repetition rates is traditional; however, 100kHz is closer to reality. Product committees should determine which frequencies are relevant for specific products or product types.

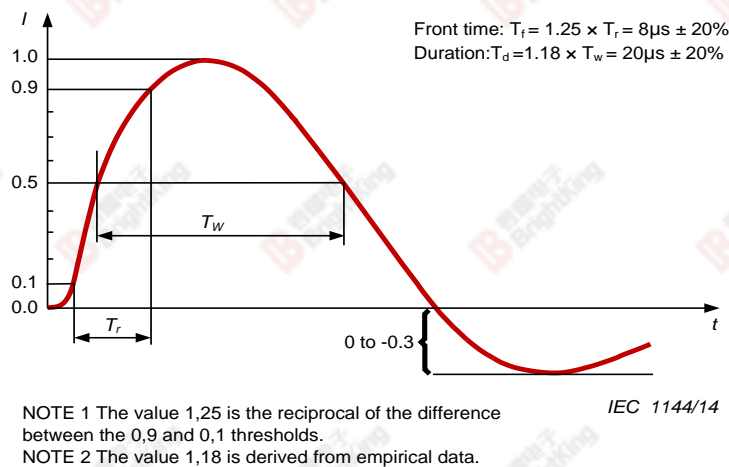
NOTE2 With some product, there may be no clear distinction between power ports and I/O ports, in which case it is up to product committees to make this determination for test purposes.

^a "X" is an open level. The level has to be specified in the dedicated equipment specification.

1.2/50μs & 8/20μs combination wave



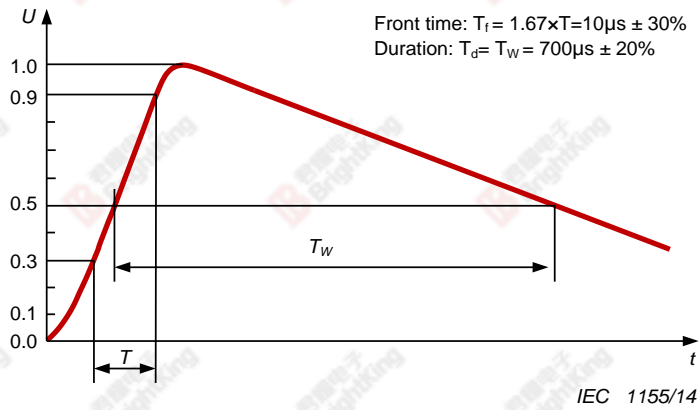
Waveform of open-circuit voltage (1.2/50μs)



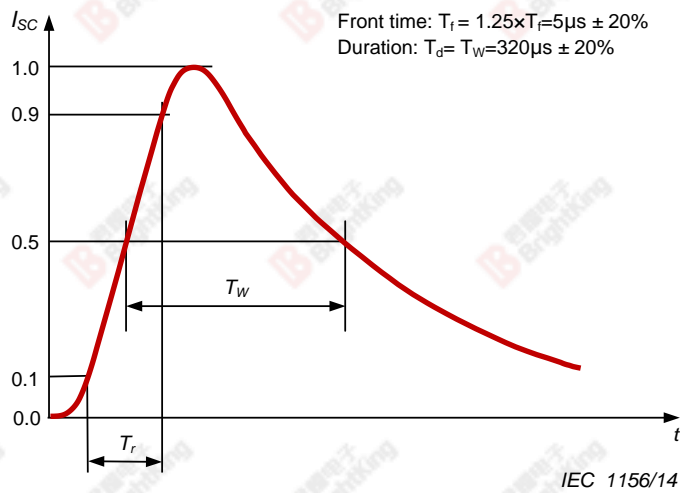
Waveform of short-circuit current (8/20μs)

Relationship between peak open-circuit voltage and peak short-circuit current		
Open-circuit peak voltage ± 10 % at generator output	Short-circuit peak current ± 10 % (18μF)	Short-circuit peak current ± 10 % (9μF+10Ω)
0.5kV	0.25kA	41.7A
1.0kV	0.5kA	83.3A
2.0kV	1.0kA	166.7A
4.0kV	2.0kA	333.3A

10/700μs&5/320μs combination wave



Waveform of open-circuit voltage (10/700μs)



Waveform of the 5/320μs short-circuit current waveform

Relationship between peak open-circuit voltage and peak short-circuit current	
Open-circuit peak voltage $\pm 10\%$ at generator output	Short-circuit peak current $\pm 10\%$ at generator output
0.5kV	12.5A
1.0kV	25A
2.0kV	50A
4.0kV	100A

Test level

Power ports: selection of the test levels (depending on the installation class)								
Installation class	Test levels (kV)							
	AC power supply and a.c. I/O External ports ^a		AC power supply and a.c. I/O Internal ports ^{a,d}		DC power supply and d.c. I/O External ports ^a		DC power supply and d.c. I/O Internal ports ^{a,d}	
	Coupling mode		Coupling mode		Coupling mode		Coupling mode	
	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground	Line to line	Line to ground
0	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	0.5	NA	NA	NA	NA	NA	NA
2	0.5	1.0	NA	NA	NA	NA	NA	NA
3	1.0	2.0	1.0	2.0	NA	NA	NA	NA
4	2.0 ^b	4.0 ^b	2.0 ^b	4.0 ^b	2.0 ^b	4.0 ^b	2.0 ^b	4.0 ^b
5	c . b	c . b	2.0 ^b	4.0 ^b	2.0 ^b	4.0 ^b	2.0 ^b	4.0 ^b

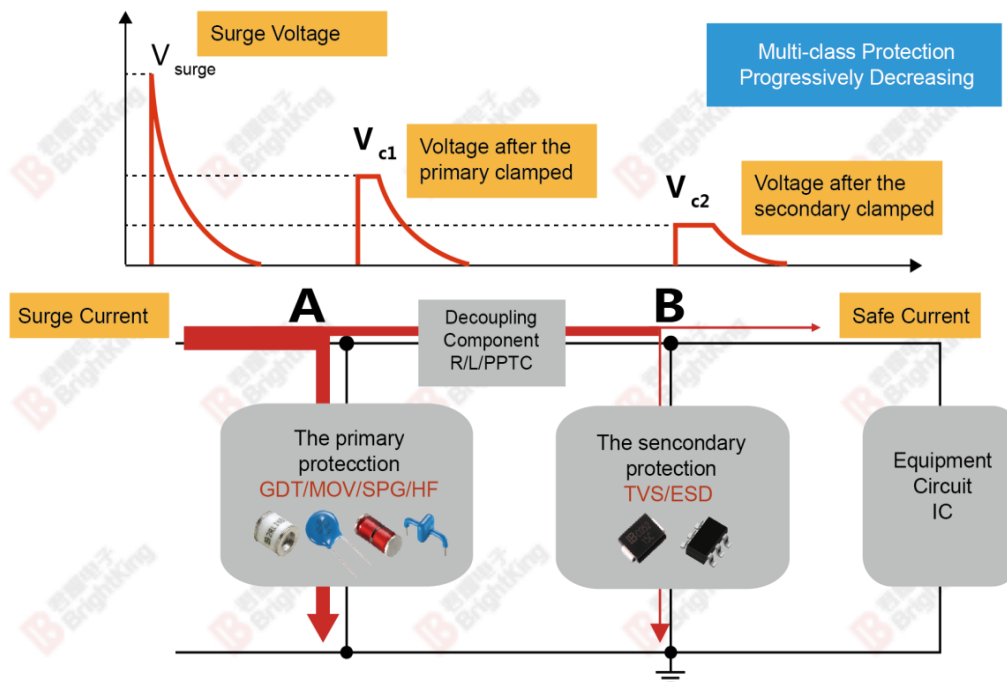
a. No test is advised if the cable length is shorter than or equal to 10 m.
 b. Where the port is always intended to be used with specified primary protection, testing is performed with the primary protection in place to ensure coordination with the protection elements. If primary protection is required to protect the interface but not provided, testing is also performed at the maximum let through level of the specified primary protection and with a typical primary protector.
 c. Depends on the class of the local power supply system.
 d. The testing of intra-system ports is generally not required.

Circuits/lines: selection of the test levels (depending on the installation class)												
Installation class	Test levels (kV)											
	Unsymmetrical operated circuits/lines ^{a,c,e}				Symmetrical operated circuits/lines ^{a,c,e}				Shielded circuits/lines ^{a,d,e}			
	External port		Internal port		External port		Internal port		External port		Internal port	
	Line to line	Line to GND.	Line to line	Line to GND.	Line to line	Line to GND.	Line to line	Line to GND.	Line to line	Shield to GND.	Line to line	Shield to GND.
0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	0.5	NA	NA	NA	0.5	NA	NA	NA	NA
2	NA	NA	0.5	1.0	NA	NA	NA	1.0	NA	NA	NA	0.5
3	NA	NA	1.0	2.0	NA	NA	NA	2.0	NA	NA	NA	2.0
4	2.0 ^b	4.0 ^b	2.0 ^b	4.0 ^b	NA	4.0 ^b	NA	4.0 ^b	NA	4.0 ^b	NA	4.0 ^b
5	2.0 ^b	4.0 ^b	2.0 ^b	4.0 ^b	NA	4.0 ^b	NA	4.0 ^b	NA	4.0 ^b	NA	4.0 ^b

a. No test is advised for data connections intended for cables shorter than 10 m.
 b. Where the port is always intended to be used with specified primary protection, testing is performed with the primary protection in place to ensure coordination with the protection elements. If primary protection is required to protect the interface but not provided, testing is also performed at the maximum let through level of the specified primary protection and with a typical primary protector.
 c. Line-to-line surges (transverse) may occur in networks where SPDs (surge protective devices) with connection to ground are used for protection. Such surges are outside the scope of this standard. This phenomenon can however be simulated by applying common mode surges through the defined primary protection elements.
 d. The testing of ports connecting to antennas is outside the scope of this standard.
 e. The testing of intra-system ports is generally not required.

How to protect a circuit?

It generally use multi-class protections for system-level surge protection. This scheme can gain high protection level and low clamping voltage at the same time.



The Primary Protection

Primary protection devices are generally used for building access and outdoor lines, such as building inlet, AC power input port, etc, these lines or ports are easy introducing lightning. Large withstanding surge current devices are used for primary protection, like MOV, SPG, GDT and hyper-fix.

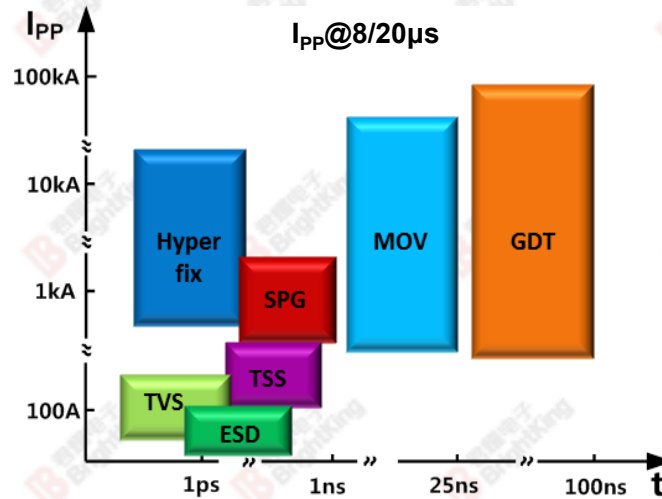
The Secondary Protection

Low clamping voltage and fast response time protection devices should be chosen as the secondary protection devices, such as TVS, ESD, etc.

Decoupling Components

There are differences between the primary protection devices and secondary protection devices, like DC breakdown voltage, response time. Decoupling devices are needed to make sure the primary and secondary protection devices work together at the same time when there is a lightning or surge in the circuit. The point is that the decoupling components must have appropriate impedance.

Performance comparison of different protection devices



Properties Devices	Clamping type over voltage protection devices				Switching type over voltage protection devices		
	MOV	Hyper-fix	TVS	ESD	GDT	SPG	TSS
Peak impulse current @ 8/20 μ s	Very large	Very large	Medium	Small	Very large	Large	Medium
Response time	Fast	Very fast	Very fast	Very fast	Fast	Fast	Very fast
Capacitance	Large	Large	Large	Small	Very small	Very small	Small
DC spark over voltage tolerance	$\pm 10\%$	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$	$\pm 20/30\%$	$\pm 20/30\%$	$\pm 5\%$
Impulse spark over voltage tolerance	Low	Low	Low	Low	High	High	Low

MOV, GDT and SPG have large withstanding surge current. SPG can reach up to 3kA, MOV can reach up to 80kA, and GDT can reach up to 100kA. MOV and GDT and SPG are generally used for primary circuit protection.

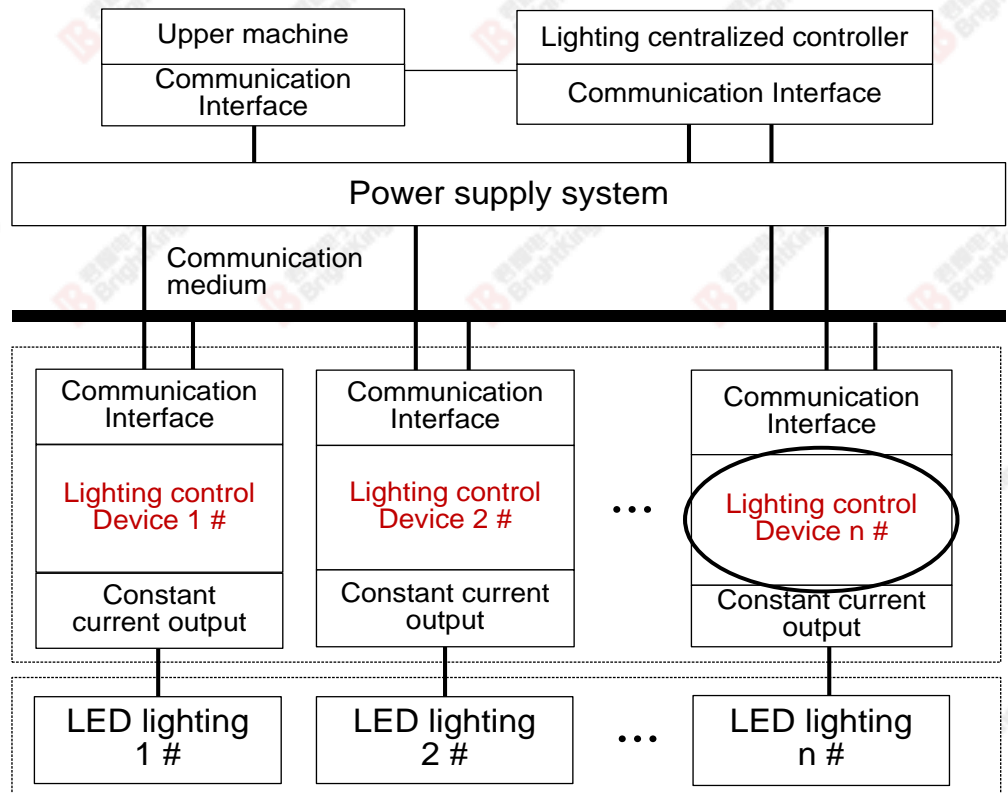
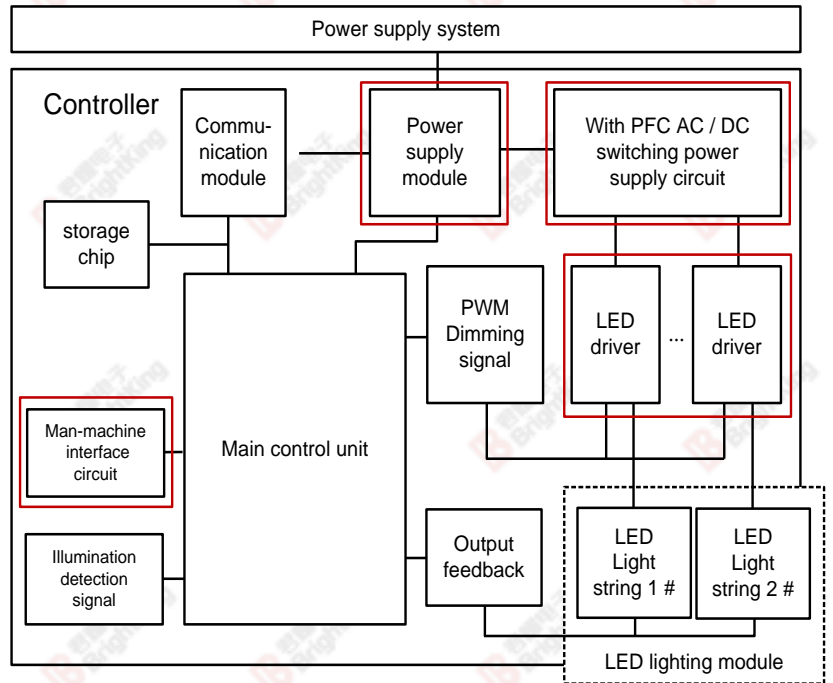
TSS, TVS and ESD are silicon-based material devices which are made by semiconductor technology. They have many advantage, such as accurate breakdown voltage, fast response time, etc. TSS, TVS and ESD are generally used for secondary circuit protection.

Hyper-fix is ultra-high power TVS with the advantages of MOV and TVS. Hyper-fix have accurate breakdown voltage, fast response time, large withstanding surge current, etc. Hyper-fix can be used for replacing MOV in AC power input circuit protection.

Applications of lighting circuit protection

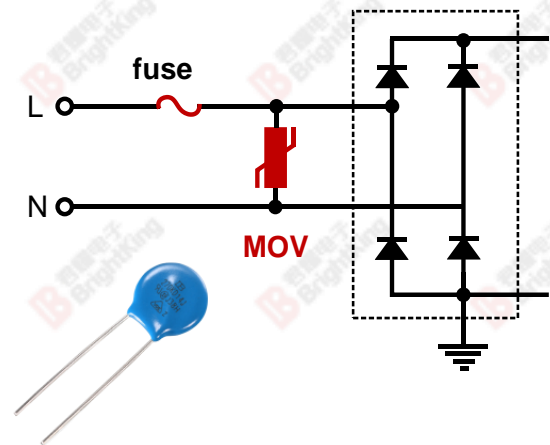
Various types of interfaces protection:

- [AC input port](#)
- [DC power port](#)
- [RS485 port](#)
- [USB2.0 port](#)
- [USB3.0 port](#)
- [USB type C](#)
- [RJ45 port](#)
- [I/O interface](#)
- [Keypad interface](#)
- [Antenna\(RF\) port](#)



AC power line protection solution 1

This solution is suitable for small power supply. MOV is used for differential protection between L and N line.



Differential mode protection with MOV

Varistor voltage (V_{1mA})

Varistor Voltage (V_{1mA}/V_N): Power supply voltage fluctuations, varistor voltage accuracy and varistor aging coefficient should be taken in considerations to choose a MOV's V_{1mA} , the following formula can be taken for reference:

$$V_{1mA} \geq \frac{(1+a)}{(1-b)(1-c)} \cdot V_P$$

a : Voltage fluctuation coefficient (0.1~0.5)

b : Varistor voltage tolerance (0.1~0.2)

c : Varistor aging factor , generally take 0.1

V_P : Power input peak voltage

Protection device selection reference

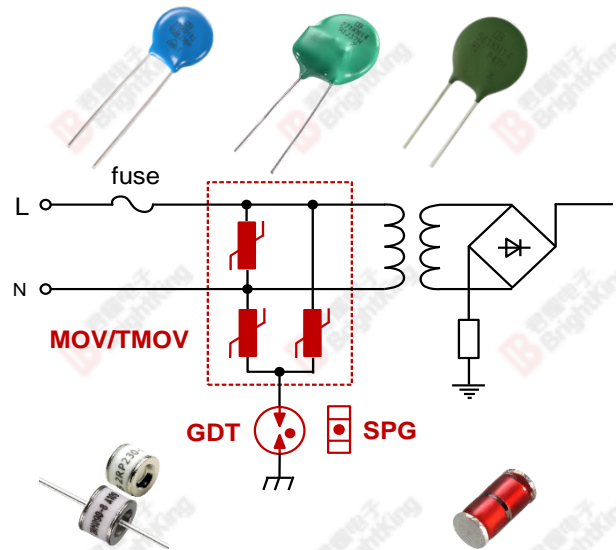
Power input voltage	MOV voltage selection	Surge protection level ¹
110VAC	271KD07 , 271KH07 271KD10 , 271KH10 271KD14 , 271KH14	1000V 2000V 4000V
220VAC	561KD07 , 561KH07 561KD10 , 561KH10 561KD14 , 561KH14	1000V 2000V 4000V

Note1: IEC61000-4-5, 1.2/50μs&8/20μs, 2Ω, ±5 times.

AC power line protection solution 2

Device selection

MOV or TMOV can be chosen for differential mode and common mode protection, and there are 85°C MOV and 140°C MOV. The high temperature MOV have higher reliability than the 85 °C MOV. For hi-pot test, high breakdown voltage GDT or SPG must be chosen.



With no hi-pot test protection device selection			
MOV	TMOV	GDT	Test standards
271^a/561^bKD14 , 271^a/561^bKH14	271^a/561^bKN/E/M14	2RM600M(L)-8	4000V ^c
271^a/561^bKD20 , 271^a/561^bKH20	271^a/561^bKN/E/M20		6000V ^c
271^a/561^bKD25	271^a/561^bKN/E/M25		8000V ^c
Note: a. adapt to AC110V input voltage b. adapt to AC220V input voltage c. IEC61000-4-5, 1.2/50µs&8/20µs, 2Ω, ±5 times			

With hi-pot test protection device selection			
MOV	TMOV	SPG/GDT	Test standards
271^a/561^bKD14J 271^a/561^bKH14J	271^a/561^bKN14 271^a/561^bKE14 271^a/561^bKM14	BK12012002-H 2RH2500L-8	Hi-pot: AC1200V, 60s, I _R < 10mA Surge ^c : 5kV
		BK12015002-H 2RK3000L-8	Hi-pot: AC1500V, 60s, I _R < 10mA Surge ^c : 5kV
		BK12018002-H 2RK3600L-8	Hi-pot: AC1800V, 3s, I _R < 10mA Surge ^c : 6kV
Note: a. adapt to AC110V input voltage b. adapt to AC220V input voltage c. IEC61000-4-5, 1.2/50µs&8/20µs, 2Ω, ±5 times			

MOV products

85 °C MOV product are traditional MOV which is made with epoxy encapsulation.



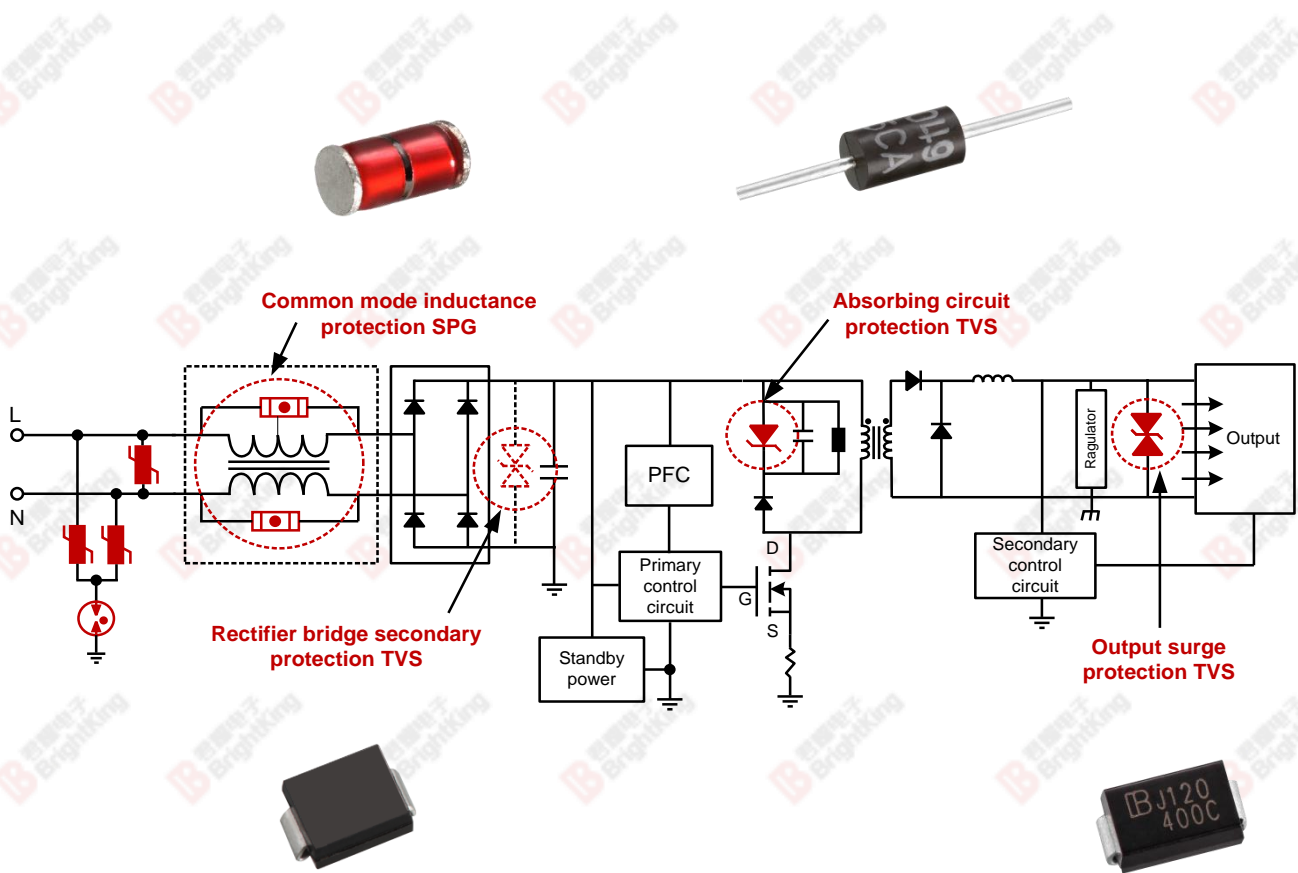
125 °C MOV product are high temperature MOV which is made with silicone encapsulation. with a high ambient temperature, 145 °C MOV has a higher reliability relative to ordinary MOV.

TMOV is thermal protection MOV which is made by welding thermal fuse and MOV silver together, and then made of epoxy resin encapsulation. TMOV have open circuit failure mode which can avoid MOV failure combustion.



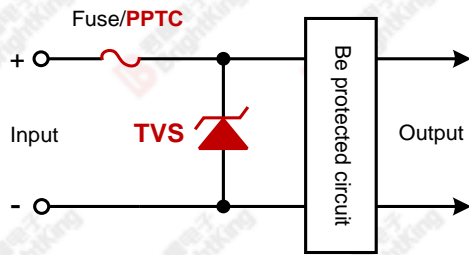
Product series	85°C MOV	125°C MOV	TMOV
Internal material	Zinc oxide + silver paste	Zinc oxide + silver paste	Zinc oxide + silver paste+ thermal fuse
Encapsulation material	Epoxy resin	Silicone	Epoxy resin
Size (mm)	5,7,10,14,20,25,34,40,53	5,7,10,14,20	14,20,25
Withstanding surge capability	stable	stable	stable
Operating temperature	85°C	125°C	85°C

AC power system other parts protection

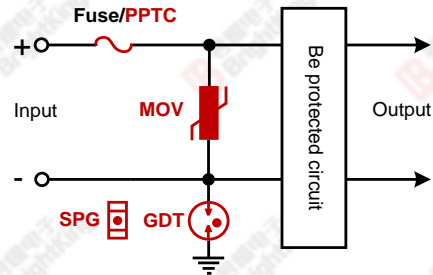


Device selection	
Common mode inductive protection	BK13001502/BK1301502-M BK23001502/BK23001502-M BK33001502/BK33001502-M
Rectifier bridge secondary protection	P6KE440CA SMBJ400CA
Absorption circuit protection	P6KE200A P6KE200LA
Output surge protection	DC3.3V: SMAJ5.0A / SMBJ5.0A / SMCJ5.0A DC5V: SMAJ6.5A / SMBJ6.5A / SMCJ6.5A DC12V: SMAJ18A / SMBJ18A / SMCJ18A DC24V: SMAJ28A / SMBJ28A / SMCJ28A

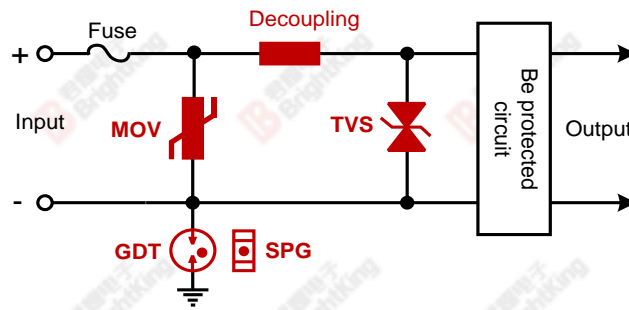
DC power line protection



Solution 1



Solution 2



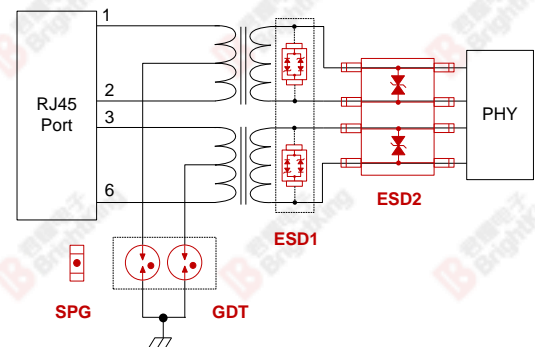
Solution 3

Device selection

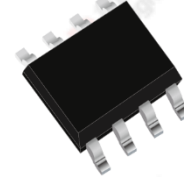
Voltage	Solution 1	Solution 2	Solution 3
DC5V	TVS: SMBJ6.0A (600W) 1.0SMB6.8A (1000W) SMCJ6.0A (1500W)	Not applicable	MOV: 820KD14 GDT: 4532-091-LF SPG: SMAJ6.0CA
DC12V	TVS: SMBJ18A (600W) 1.0SMB18A (1000W) SMCJ18A (1500W)	MOV: 180KD10 GDT: B32-150-LF SPG: BK33000702	MOV: 820KD14 GDT: 4532-091-LF SPG: BK13000702 TVS: SMAJ18CA
DC24V	TVS: SMBJ28A (600W) 1.0SMB33A (1000W) SMCJ28A (1500W)	MOV: 330KD10 GDT: B32-150-LF SPG: BK33000702	MOV: 820KD14 GDT: 4532-091-LF SPG: BK13000702 TVS: SMAJ28CA
DC48V	TVS: SMBJ58A (600W) 1.0SMB68A (1000W) SMCJ58A (1500W)	MOV: 680KD10 GDT: B32-150-LF SPG: BK33000702	MOV: 820KD14 GDT: 4532-091-LF SPG: BK13000702 TVS: SMAJ58CA

100M RJ45 port protection

GDT or SPG are used for the primary common mode surge protection. Single line ESD devices or multi-line ESD device are used for the secondary differential mode protection.



ESD1: [UCD32C05L01](#)
Package: SOD-323
Working voltage: 5V



ESD2: [UCS8C05L02](#)
Package: SOIC-8
Working voltage: 5V



GDT: [2RK075M-4](#)
Size: 4.2*4.0(mm)
Working voltage: 75V
Nominal withstanding surge current: 3kA(8/20μs)



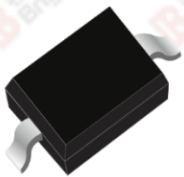
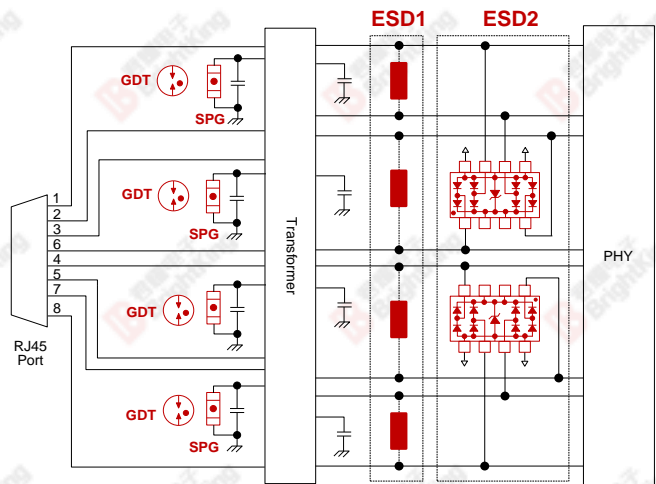
SPG: [BK13000702-M](#)
Size: 6.0*3.3(mm)
Working voltage: 140V
Nominal withstanding surge current: 3kA(8/20μs)

Test standards:

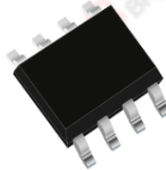
IEC61000-4-2, level 4, 8kV(contact), 15kV(air)
IEC61000-4-5, 10/700μs, 40Ω, 6kV, ±5 times

1000M RJ45 port protection

GDT or SPG are used for the primary common mode surge protection. Single line ESD devices or multi-line ESD device are used for the secondary differential mode protection.



ESD1:
[UCD32C05L01](#)
Package: SOD-323
Working voltage: 5V



ESD2:
[UES08A03L05](#)
Package: SOIC-8
Working voltage: 3.3V



GDT:
[2RK075M-4](#)
Size: 4.2*4.0(mm)
Working voltage: 75V
Nominal withstanding surge current: 3kA(8/20μs)



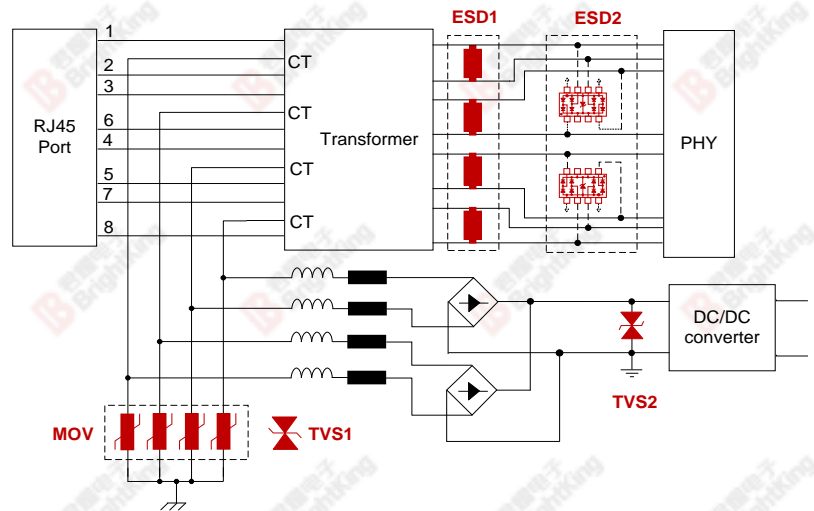
SPG:
[BK13000702-M](#)
Size: 6.0*3.3(mm)
Working voltage: 140V
Nominal withstanding surge current: 3kA(8/20μs)

Test standards:

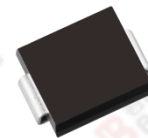
IEC61000-4-2, level 4, 8kV(contact), 15kV(air)
IEC61000-4-5, 10/700μs, 40Ω, 6kV, ±5 times

1000M PoE port protection

MOV or TVS are used for the primary common mode surge protection. Single line ESD devices are used for differential mode protection. Also the multi-line ESD devices can be chosen for the secondary differential mode and common mode protection at the same time.



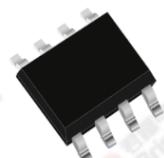
MOV: [101KD14](#)
Size: 14mm
Working voltage: 100V



TVS1: [5.0SMDJ58CA](#)
TVS2: [SMCJ58CA](#)
Package: SMC
Working voltage: 58V



ESD1: [UCD32C05L01](#)
Package: SOD-323
Working voltage: 5V



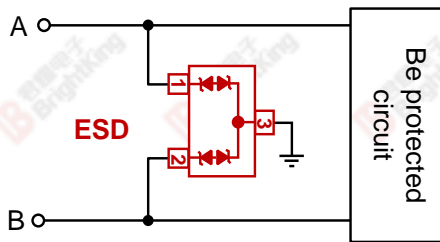
ESD2 : [UES08A03L05](#)
Package: SOIC-8
Working voltage: 3.3V

Test standards:

IEC61000-4-2, level 4, 8kV(contact), 15kV(air)
IEC61000-4-5, 10/700μs, 40Ω, 6kV, ±5 times

RS485 port protection

RS485 port ESD protection



Dedicated RS485 ESD protection device is used for common mode and differential mode protection. This device has an asymmetric 7V and 12V operating voltage.

ESD: [SDT23C712L02](#)

Test standard: IEC61000-4-2, level 4

RS485 port surge protection 1

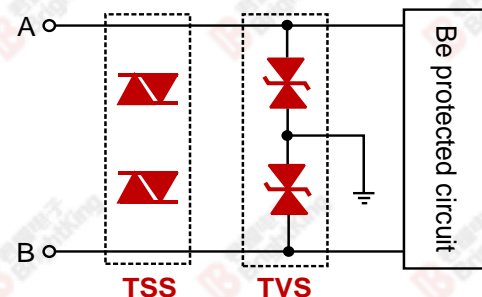
TVS or TSS are used for RS485 surge protection, this can gain high protection level.

TVS: [SMBJ6.5CA](#), SMB package

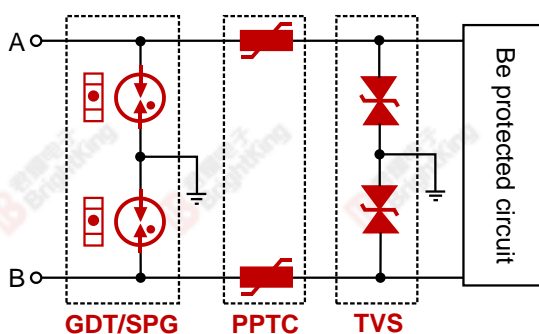
TSS: [P0080SB](#), SMB package

Test standard: IEC61000-4-2, level 4

IEC61000-4-5, 10/700 μ s, 40 Ω , 4kV, \pm 5 times



RS485 port surge protection 2



The primary protection device is GDT. The secondary protection device is TVS. This two grade protection solution can gain high protection level and low clamping voltage.

GDT: [2RM090M-5](#)

SPG: [BK13000702/BK13000702-M](#)

PPTC: [SMD1812B010TF](#)

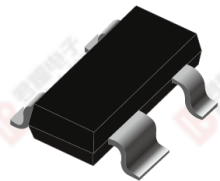
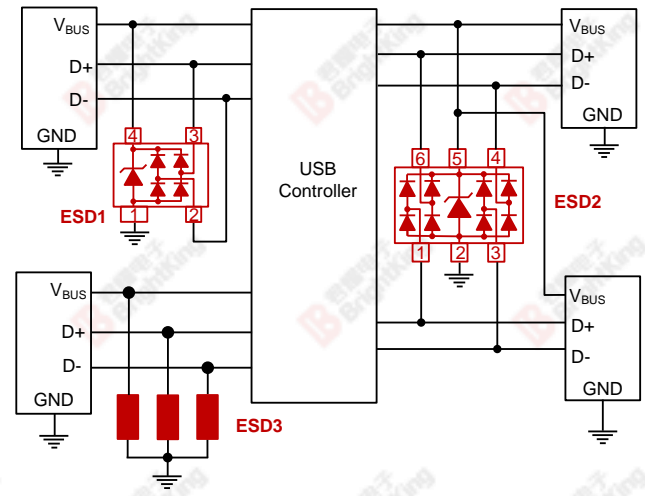
TVS: [SMAJ5.0CA](#)

Test standard: IEC61000-4-2, level 4

IEC61000-4-5, 10/700 μ s, 40 Ω , 4kV, \pm 5 times

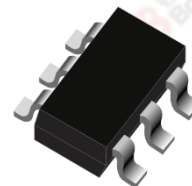
USB2.0 port ESD protection

SOT-143 packaged device can be used for one USB2.0 port data line and power line ESD protection. SOT23-6L packaged device can simultaneously protect two USB2.0 port data line and power line. Discrete ESD protection device also can be chosen for one or two USB2.0 ports protection.

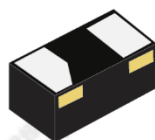


ESD1:
[UET14A05L03-BK](#)
 Package: SOT-143
 Working voltage: 5V

ESD2:
[UDT26A05L05UL](#)
 Package: SOT23-6L
 Working voltage: 5V



SOD-323

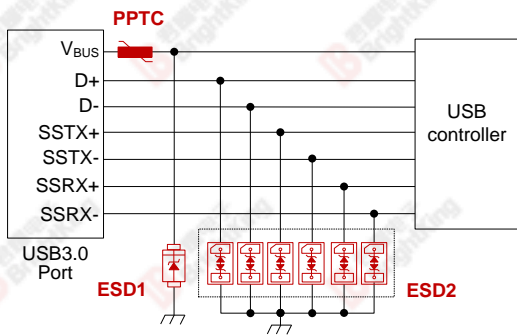


SOD-882

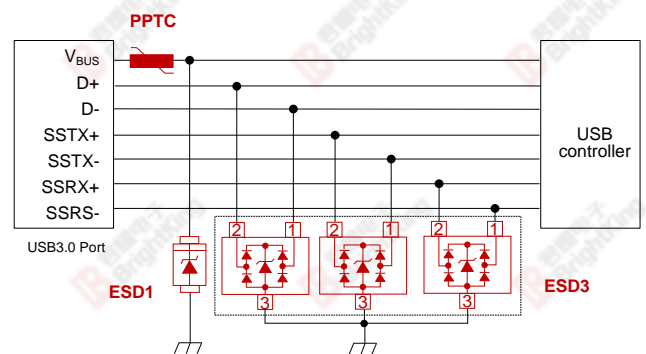
ESD3
[UCD32C05L01](#), SOD-323 package
[UAD8C05L01](#), SOD-882 package
 Working voltage: 5V

Test standard:
 IEC61000-4-2, level 4, 8kV(contact), 15kV(air)

USB3.0 port ESD protection(1)



Single line ESD protection device

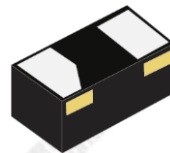


Two lines ESD protection device



ESD1

[SDD32A05L01](#), SOD-323, 5V
[SFD52A05L01](#), SOD-523, 5V
[SFD52A07L01](#), SOD-523, 7V



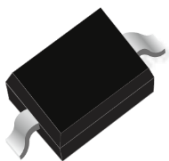
ESD2

[UAD8C05L01](#)
[UBD8C05L01](#)
 Package: SOD-882
 Working voltage: 5V



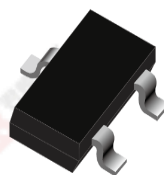
ESD2

[UAD03C05L01](#)
 Package: DFN01608
 Working voltage: 5V



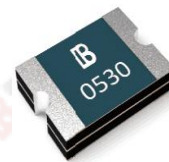
ESD2

[UBD32C05L01](#)
 Package: SOD-323
 Working voltage: 5V



ESD3

[UAT52A05L02](#), SOT-523
[UBT23A05L02](#), SOT-23
 Working voltage: 5V



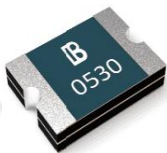
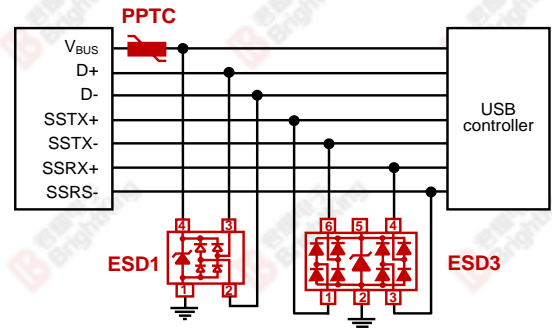
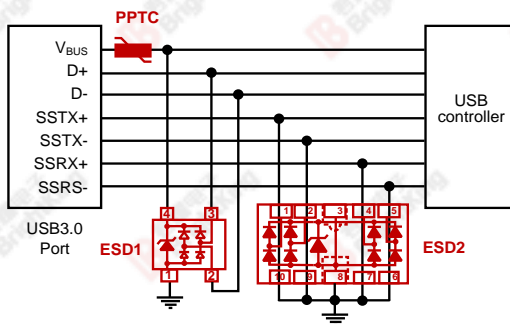
PPTC

[SMD1812B110TF](#)
 Package: SOD-882
 Working voltage: 5V

Test standard:

IEC61000-4-2, level 4, 8kV(contact), 15kV(air)

USB3.0 port ESD protection(2)



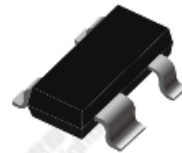
PPTC

[SMD1812B110TF](#)

[SMD1812B150TF/8](#)

Package: 1812

Working voltage: 5V



ESD1

[UET14A05L03-BK](#)

Package: SOT-143

Working voltage: 5V

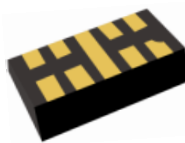


ESD2

[UBQ10A05L04HI](#)

Package: DFN-10

Working voltage: 5V

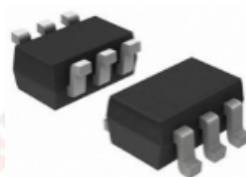


ESD2

[UAD20A05L04](#)

Package: DFN-2010

Working voltage: 5V



ESD3

[UAT36A03L05](#), SOT-363

[UAT56A03L05](#), SOT-563

Working voltage: 3V

Test standard:

IEC61000-4-2, level 4, 8kV(contact), 15kV(air)

USB type C port ESD protection

USB3.1 interface transmission rate increased to 10Gbps, the signal rising edge range is 0.02ns to 0.03ns, ESD protection device junction capacitance is recommended less than 0.3pF. The following figure shows the most popular USB3.1 type C protection solutions circuit connection.



PPTC

[SMD1812B150TF/8](#)

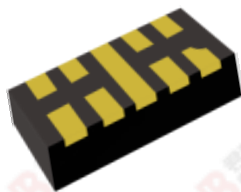
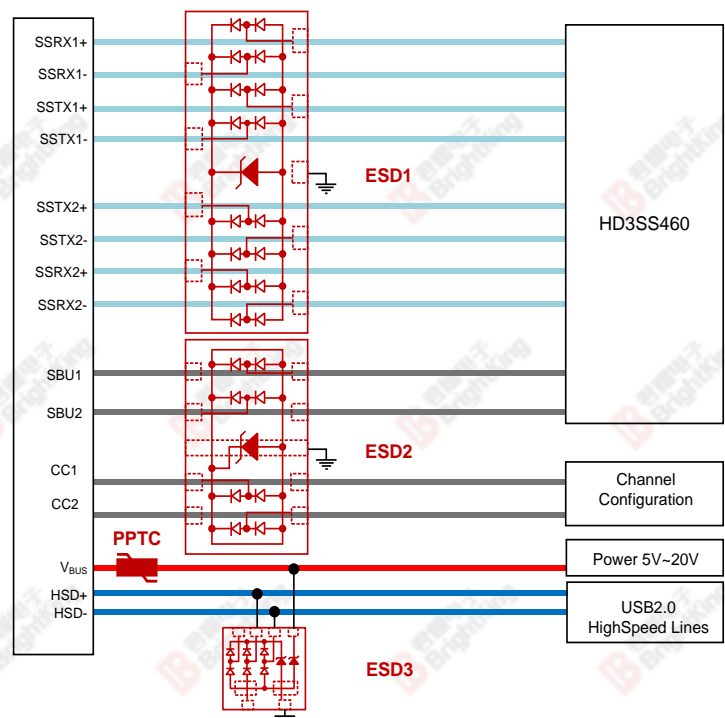
1.5A,8V,0.040Ω~0.120Ω,
1812 package



ESD1

[UAD38A05L08](#)

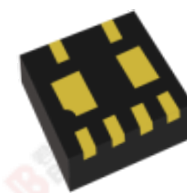
5V, unidirectional, 0.6pF, 5A(8/20μs),
DFN-3810 package



ESD2

[UAD20A05L04](#)

5V, unidirectional, 0.6pF, 5A(8/20μs),
DFN-2010 package



ESD3

[UTDF28A125L04](#)

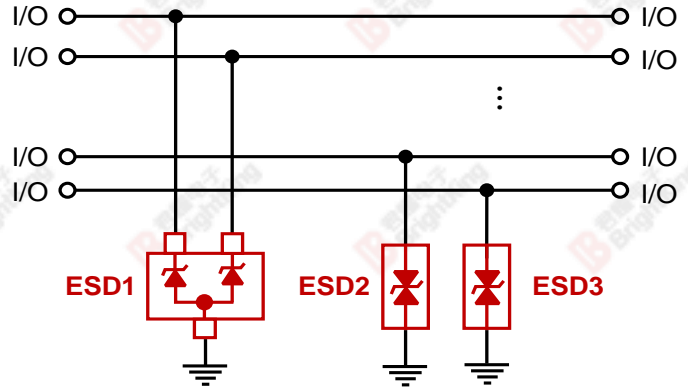
12V(Pin1), 5V(pin 2,3,4), unidirectional,
50A(8/20μs, Pin1), 3A(pin 2,3,4, 8/20μs),
550pF(Pin1), 1pF(Pin2,3,4),
DFN-2018 package

Test standard:

IEC61000-4-2, level 4, 8kV(contact), 15kV(air)

I/O interface ESD protection

SET23AXXL02 series have 3.3V, 5V, 12V, 15V and 24V working voltage. SOT-23 package can protect two I/O lines at the same time. Single line protection device can be chosen to protect the I/O lines.



ESD1:

[SET23AXXL02](#)

Package: SOT-23

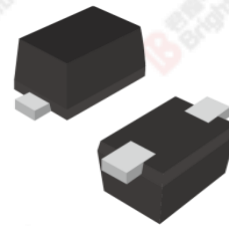
Working voltage: 3.3V, 5V, 12V, 15V, 24V

ESD2:

[SBD52C05L01](#)

Package: SOD-523

Working voltage: 5V



ESD3:

[SJD12CXXL01](#)

Package: SOD-123S

Working voltage: 5V~170V

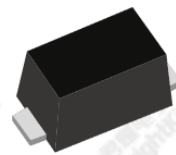
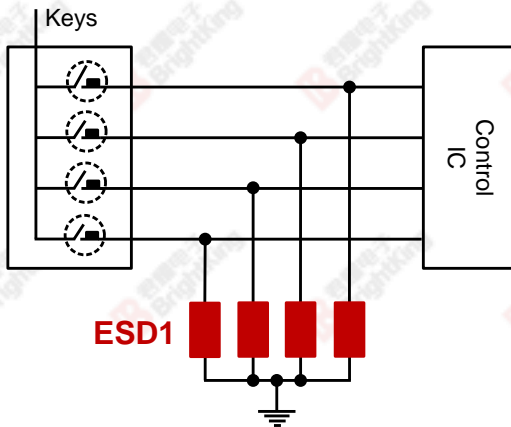


Test standard:

IEC61000-4-2, level 4, 8kV(contact), 15kV(air)

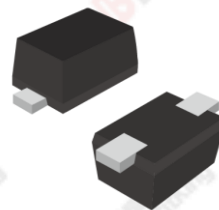
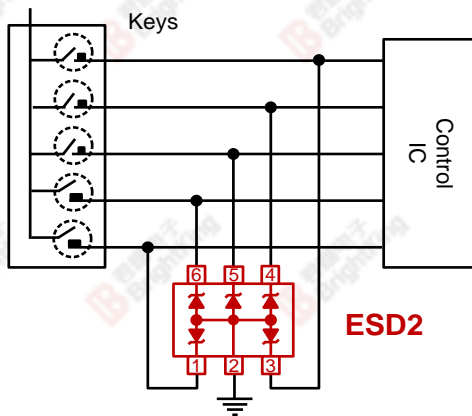
Key pads interface ESD protection

Engineer can choose different package types according to the key interface, single-button interface can choose a single protection device, multi-channel interface can choose multi-line ESD protection devices.

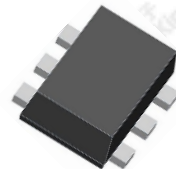


ESD1:
[SJD12A\(C\)XXL01](#)
Package: SOD-123S
Working voltage:
5V~170V

Discrete ESD device protection



ESD1:
[SBD52C05L01](#)
Package: SOD-523
Working voltage: 5V



ESD2:
[SAT36A05L05](#)
Package: SOT-363
Working voltage: 5V

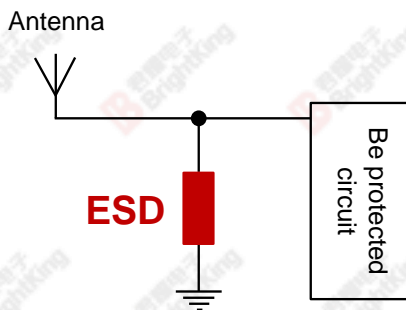
Integrated ESD device protection

Test standard:
IEC61000-4-2, level 4, 8kV(contact), 15kV(air)

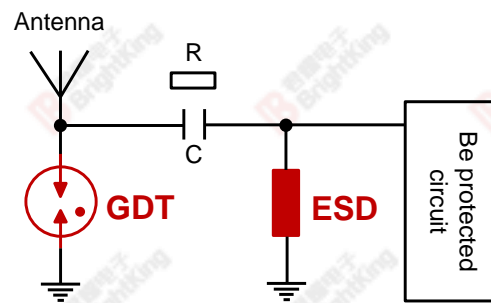
Antenna (RF) port protection

As figure 1 shows, use ultra-low capacitance ESD for antenna ESD protection.

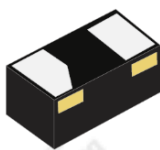
As figure 2 shows, use two stage protection solution for antenna surge protection. Using GDT or SPG for primary protection. The secondary protection using ultra-low capacitance ESD component for precise voltage clamping. Capacitance or resistance can be chosen as decoupling devices.



Antenna port ESD protection



Antenna port surge protection



ESD:
[UAD8C05L01](#)
Package: SOD-882
Working voltage: 5V



GDT: [2RK075M-4](#)
Size: 4.2*4.0(mm)
Working voltage: 75V
Nominal discharge current: 3kA(8/20 μ s)

Test standards:

IEC61000-4-2, level 4, 8kV(contact), 15kV(air)

IEC61000-4-5, 10/700 μ s, 40 Ω , 6kV, ± 5 times

Shanghai

A:
Floor 23, No 465, East Beijing Road,
Huangpu District, Shanghai, PRC
T: +86-21-6322 1578
F: +86-21-3304 0081
E: may@brightking.com

Shenzhen

A: 2F, Tianan Management Center
Building, Tianan cyber park,
Futian District, Shenzhen, China
T: +86-755-8379 5119
F: +86-755-8379 1530
E: kenny@brightking.com

Beijing

A: Room 310, Fanya Building, No
128, Zhichun Road, Haidian District,
Beijing, PRC
T: +86-10-6255 0216
F: +86-10-6252 3764
E: judyxu@brightking.com

Dongguan (Headquarters)

A: #3 Building, Modern enterprise
accelerator park, Song Shan Lake
High-tech Industrial development
zone, Dongguan City, Guangdong
Province, P.R.C
T: +86-769-26626898
F: +86-769-26626198
E: sales@brightking.com

Taiwan

A: 3F., No.105, Zhongcheng Rd.,
Tucheng Dist., New Taipei City 236,
Taiwan (R.O.C.)
T: +886-2-2268-5502
F: +886-2-2268-5512
E: sam@brightking.com

U.S.

A: 3032 Scott Blvd, Santa Clara, CA
95054-3301
T: 408 844 8830 (US)
F: 408 844 8832 (US)
E: RBitney@brightking.com