



ESD
SUPPRESSION
PRODUCTS
BROCHURE



ESD

**Electrostatic Discharge
Suppression Products**

ESD Suppression Technologies

LITTELFUSE ESD SUPPRESSION TECHNOLOGY COMPARISON

Protection Technology	Data Rate Span	Peak/Clamp (8kV)	ESD Surge Level	Discrete Options	Array Options	Applications and Circuits	Key Advantages
Multilayer Varistor (MLVs)	< 125Mbps	Good	Good	0402 0603 0805 1206	1206	Keypad/switch, audio, analog video, USB1.1, RS232	Lowest cost; broad discrete offering
SPA™ Silicon Protection Arrays	0 -> 5Gbps	Excellent	Excellent	SOD723	SOT23 SC70 SOT553 SOT563 SOT953 MSOP 8 MSOP 10 μDFN	Keypad/switch, USB1.1, USB2.0, audio, analog video, FireWire 1394, HDMI, Ethernet, MMC interface, LCD module.	Lowest peak and clamp voltages
PulseGuard® ESD Suppressors	100Mbps -> 5Gbps	Good	Good	0402 0603	SOT23	USB2.0, FireWire 1394, HDMI, RF antenna	Lowest capacitance

When to Choose PulseGuard® ESD Suppressors

- The application tolerates very little added capacitance (high speed data lines or RF circuits)
- ESD is the only transient threat
- Protection is required on data, signal, and control lines (not power supply lines)

When to Choose SPA™ Silicon Protection Arrays

- The device being protected requires the lowest possible clamp voltage, low capacitance (0.65pF – 30pF) and low leakage (0.02μA – 10μA)
- Board space is at a premium and space-savings multi-line protection is needed
- Transients other than ESD, such as EFT or lightning, must also be considered

When to Choose Multilayer Varistors (MLVs)

- Surge currents or energy beyond ESD is expected in the application (EFT, lightning)
- Looking to replace high wattage TVS Zener diodes (300W – 1500W)
- Added capacitance is desirable for EMI filtering (3pF – 6000pF)
- Power supply line or low/medium speed data and signal lines are to be protected
- The operating voltage is above silicon or PulseGuard® ESD suppressor ratings

ESD SUPPRESSION REQUIREMENTS

Electrostatic Discharge (ESD) is an electrical transient that poses a serious threat to electronic circuits. The most common cause is friction between two dissimilar materials, causing a buildup of electric charges on their surfaces. Typically, one of the surfaces is the human body, and it is not uncommon for this static charge to reach a potential as high as 15,000 volts. At 6,000 static volts, an ESD event will be painful to a person. Lower voltage discharges may go unnoticed, but can still cause catastrophic damage to electronic components and circuits.

The likelihood of electronic circuit damage is increasing as integrated circuit (IC) dimensions are shrinking to nanometer sizes. Most ICs operate at low voltages and have structures and conductive paths that cannot survive the high currents and voltages associated with ESD transients.

Another significant trend is the migration to higher frequency communication devices to transmit more information in less time. This means that ESD solutions must not compromise stringent signal integrity requirements at the higher data rates. Therefore, ESD suppressors must have low internal capacitance so that data communication signals are not distorted.

IC designers add a limited amount of ESD suppression to their chips to help avoid damage during manufacturing and assembly processes. However, the level of protection that is added may not be sufficient to protect ICs and other semiconductor devices from ESD during actual usage. Many electronic products, especially portable ones, are used in uncontrolled environments. Portable devices can experience a charge buildup as they are carried by users on their person or in a purse. This energy can then be discharged to another device as the two are connected, usually when a user touches I/O pins on a cable connector. Therefore, end product designers should consider adding ESD suppressors to their circuits.

ABOUT THIS GUIDE

Choosing the most appropriate suppressor technology requires a balance between equipment protection needs and operating requirements, taking into account the anticipated threat level. In addition to the electrical characteristics of suppression devices, the form factor/package style must also be considered.

This guide is designed to summarize some of the comprehensive ESD solutions that Littelfuse offers, and help designers narrow to technologies appropriate to their end application:

- The table opposite this page summarizes general qualitative factors of each Littelfuse technology
- Page 2 describes common ESD threats and circuit design considerations
- Pages 3-5 present common end applications and the particular Littelfuse ESD suppression products designed for those applications
- Pages 6-9 present additional and more detailed product selection and specification criteria

Additional articles on ESD suppression and current data sheets about the products presented in this brochure can be found at www.littelfuse.com/ESD

To discuss your design situation and requirements in detail, please contact your local Littelfuse products representative www.littelfuse.com/contact-us.html

ESD DAMAGE

ESD is characterized by fast rise times and high peak voltages and currents up to 30 amps (per IEC 61000-4-2, level 4), which can melt silicon and conductor traces. However, ESD effects can be more subtle. The three types of damage are:

Soft Failures

Electrical currents due to ESD can change the state of internal logic, causing a system to latch up or behave unpredictably, or cause corruption of a data stream. While this is temporary, it may slow down communications, or require a system reboot in the case of lockup.

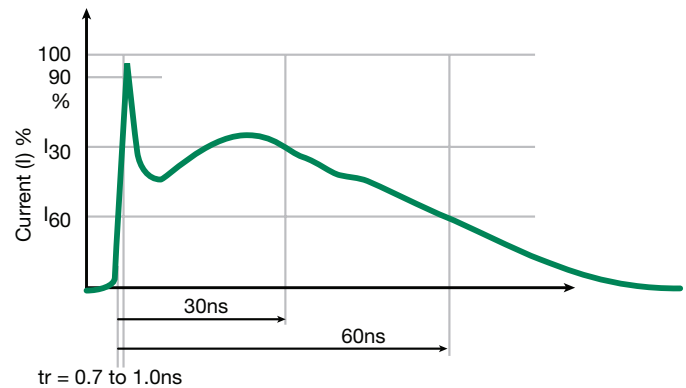
Latent Defects

A component or circuit may be damaged by ESD and its function degraded though the system will continue to work. However, this type of defect often progresses to a premature failure.

Catastrophic Failure

Of course, ESD can damage a component to the point where it does not function as intended, or doesn't work at all.

ESD test waveform



ESD SUPPRESSION AND CIRCUIT DESIGN CONSIDERATIONS

Proper use of ESD circuit protection helps prevent these failures. Still, selection of a suppression device must recognize that ESD has very short rise and fall times—less than one nanosecond (1ns) in most cases. The International Electrotechnical Commission (IEC) has developed a specification (IEC 61000-4-2) for ESD testing that helps determine if products are susceptible to ESD events.

Littelfuse device engineers use specifications like these to design ESD suppressors with the speed, clamping voltage, and residual current levels that will protect today's sensitive semiconductors and electronic circuitry. Many of these designs have the low internal capacitance needed for high bandwidth communications.

When selecting ESD suppressors, circuit designers need to consider potential coupling paths that would allow ESD to enter their equipment and circuits. These weak points identify areas that should be considered for ESD suppressor installation. Ultimately, designers need to select ESD suppressors with characteristics appropriate for their type of equipment, the component sensitivity, and the environment where it will be used.

DATA PROTOCOL, APPLICATION AND PRODUCT SELECTION

The chart below shows the relationship between Data Rates (Protocol), Applications, and Littelfuse ESD suppression products.

The top of the chart shows the standard data protocols, associated data rates, and example end applications that may use the protocols, while the body of the chart shows the applicable Littelfuse ESD suppressors for the various data rates, protocols and applications.

The characteristic of concern here is capacitance. High capacitance suppression devices will tend to add signal distortion as signal frequencies increase; low capacitance devices will maintain signal integrity at high data rates.

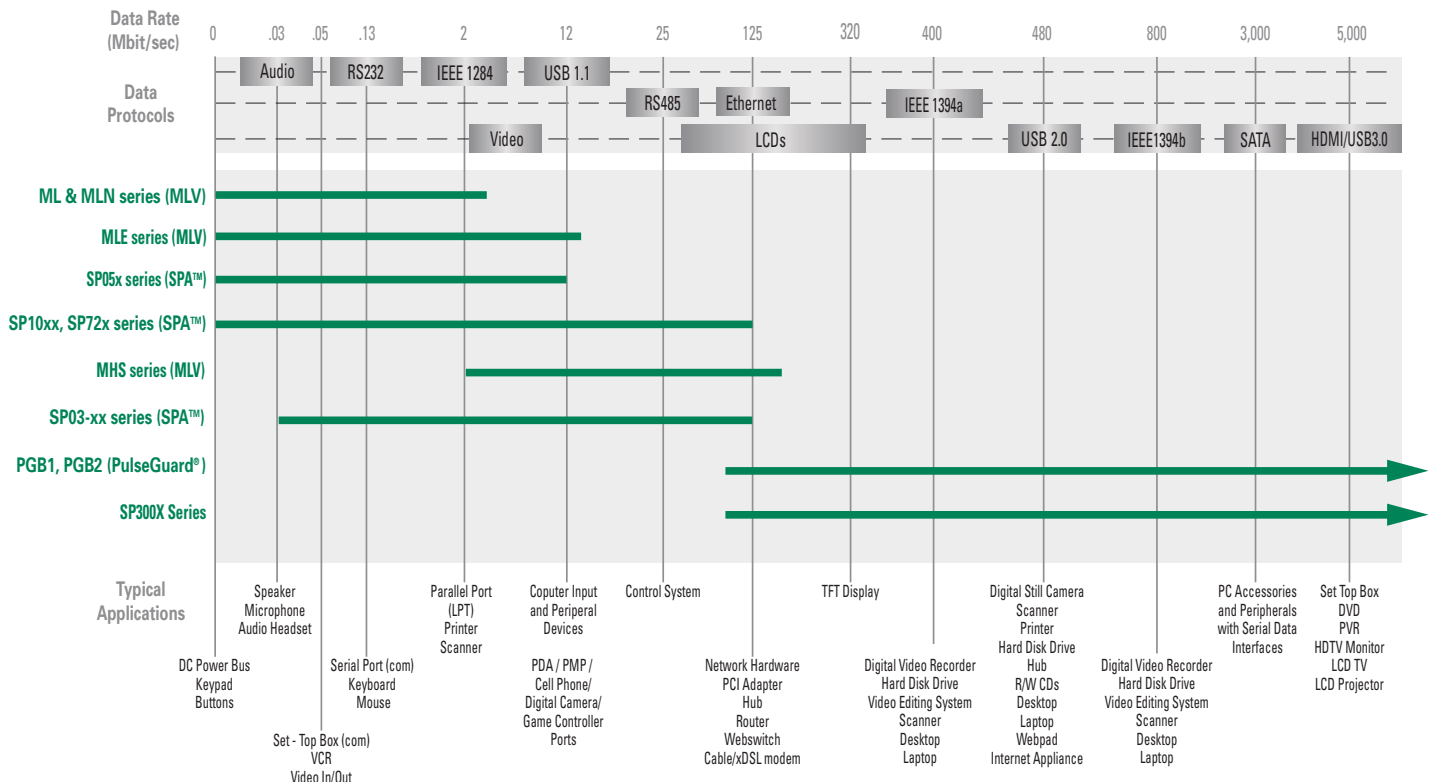
Note that an application may use several different data protocols and could use as many different ESD suppressor

products. For example, a laptop computer could have RS232, USB 2.0, video, and PS2 mouse ports, as well as others.

The RS232 and mouse ports use relatively slow data rates and could use any Littelfuse suppressor (although higher capacitance multi-layer or silicon parts are preferred for EMI filtering capabilities). The appropriate protector for the video port would depend on the data rate, and since the USB 2.0 port requires an extremely low capacitance suppression device, PulseGuard® ESD Suppressor or SPA™ Silicon Protection Array devices should be considered.

If you require further assistance in selecting the appropriate Littelfuse ESD suppressor for your specific circuit, please contact your local Littelfuse products representative.

DATA RATE, PROTOCOL, AND ESD SUPPRESSOR CORRELATION



The information above is intended to help circuit designers determine which Littelfuse ESD suppressors are applicable for given data protocols and data rates. Other key characteristics such as clamping voltage, leakage current, number of lines of protection and ESD capabilities need to be considered, especially where there are overlaps in the recommended Littelfuse ESD suppressor line (ex. IEEE 1284 and Ethernet). This information is detailed on the following pages.

At the upper data rate bounds of the products included above, the capacitances of the suppression device and the circuit board need to be taken into account in order to maintain the signal integrity of the overall system.

COMMON ESD SUPPRESSION SOLUTIONS

The following are examples of the implementation of ESD suppression.

Contact Littelfuse for additional application assistance and design examples.

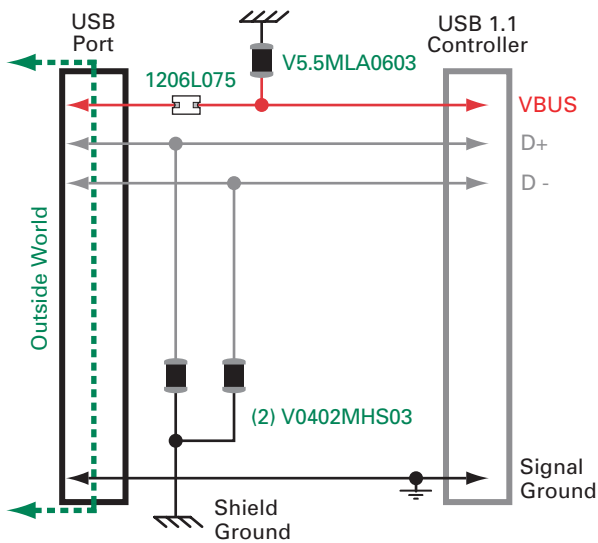
Pb indicates that the provided solution is lead-free.

RoHS indicates that the solution meets the requirements of RoHS.

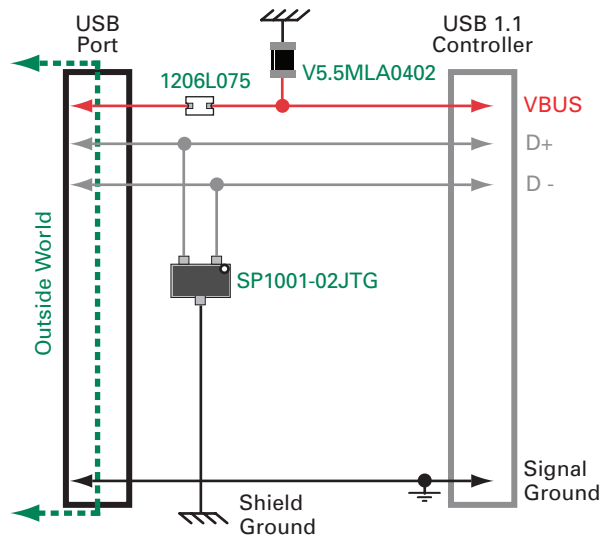
Protection of USB 1.1 (full-speed) port

Data speeds up to 12 Mbps

D+/D-: V0402MHS03 multilayer varistor (3 pF) **RoHS**



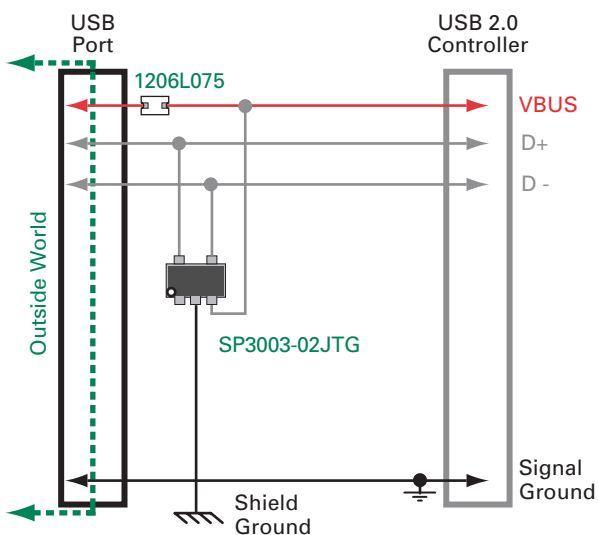
D+/D-: SP1001-02 silicon protection array **RoHS** **Pb**



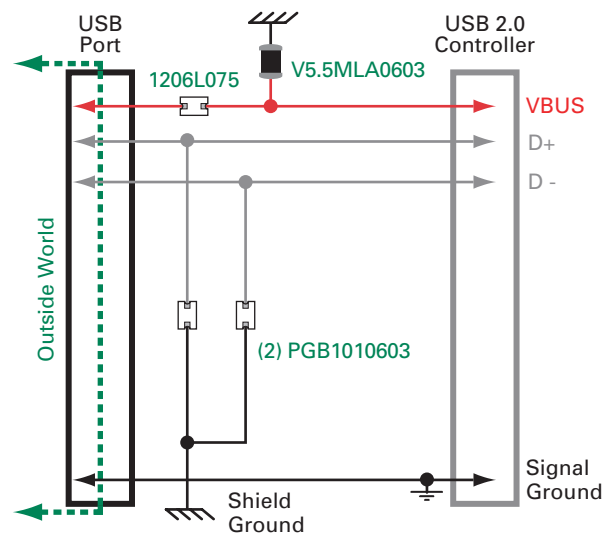
Protection of USB 2.0 (high-speed) port

Data speeds up to 480 Mbps

D+/D-: SP3003-02 silicon protection array **RoHS** **Pb**



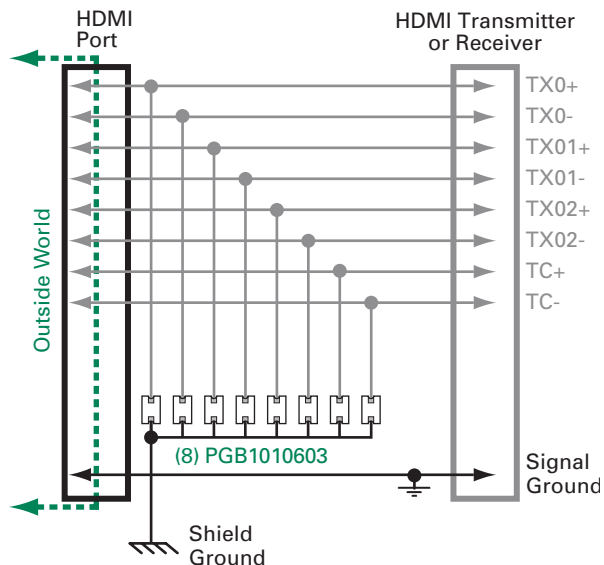
D+/D-: PGB1010603 polymeric suppressor (0.05 pF) **RoHS** **Pb**



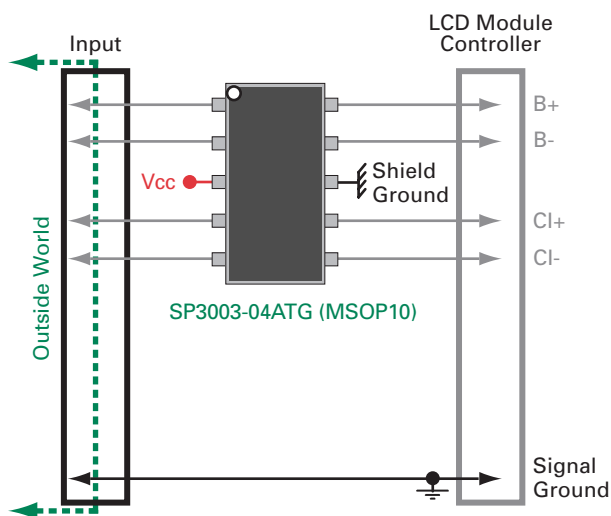
Protection of High Definition Multimedia Interface (HDMI) port

Data speeds up to 1.25 Gbps

TX+/-, TC+/-: PGB1010603 (0.05 pF)  



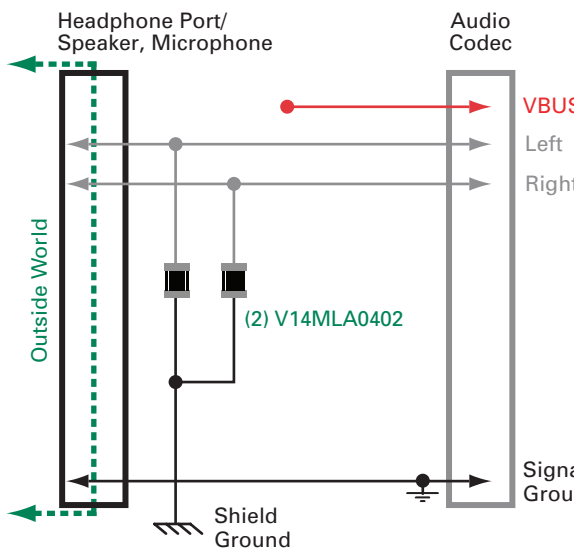
HDMI: SP3003-04AT silicon protection array  



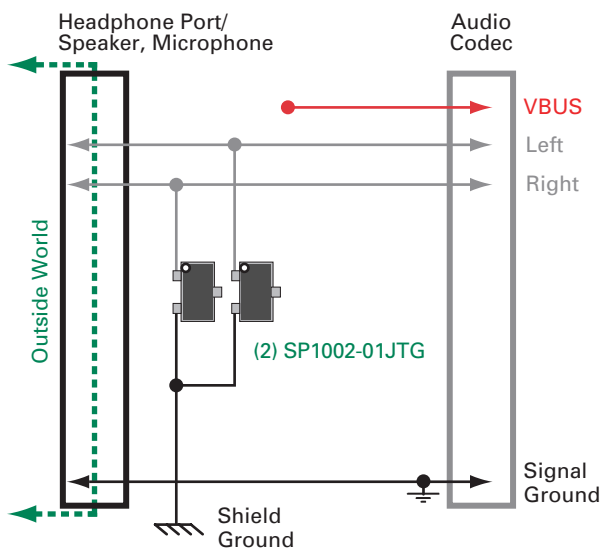
Protection of Audio port

Left/Right channels less than 30,000 Hz

L/R: V14MLA0402 multilayer varistor 



L/R: SP1002-01JTG silicon protection array  



ESD Suppressor Product Selection Guide

Please refer to this table and the next few pages in selecting the ESD suppressors that may best serve the circuit requirements.

Detailed data sheets can be downloaded from our web site www.littelfuse.com

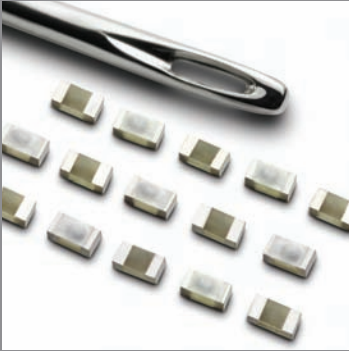
Terms:

EFT: Electrical Fast Transient

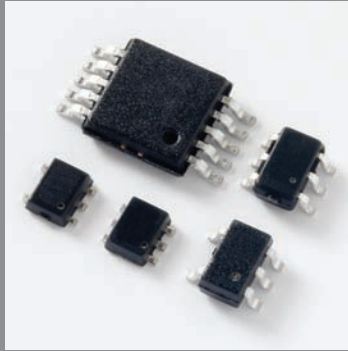
TVS: Transient Voltage Suppressor

	PulseGuard® ESD Suppressors
Mounting Options	Surface Mount
Series Name	PGB1, PGB2
Technology Type	Voltage Variable Material
Working Voltage	0-24VDC
Array Package (No. of Lines)	SOT23 (2)
Single Line Package	0603, 0402
Typical Device Capacitance	0.04-0.12pF
Leakage Current	<1nA typ
Rated Immunity to IEC 61000-4-2 level 4	Yes
Also Rated for EFT or Lightning	No
Bidirectional (transients of either polarity)	Yes
Performs Low Pass Filtering	—
Lead-Free	Yes
RoHS Compliant	Yes

PulseGuard® ESD Suppressors



SPA™ Silicon Protection Arrays



Multilayer Varistors (MLVs)



SPA™ Silicon Protection Arrays				
Surface Mount & Thru-Hole	Surface Mount	Surface Mount	Surface Mount	Surface Mount
SP72x	SP03-xx	SP05x	SP10xx	SP30xx
Silicon Controlled Rectifier / Diode	Low Capacitance Diode Arrays	Uni-directional TVS Arrays	Uni- and Bi-directional TVS Arrays	Low Capacitance Diode Arrays
0–30VDC	0–8VDC	0–5.5VDC	0–6VDC	0–6VDC
PDIP, SOIC (6, 14) SOT23 (4)	SOIC (2)	SOT23 (2, 4, 5), SOT143 (3), MSOP-8 (6), SC70 (2, 4, 5)	SC70 (1, 2, 4, 5), SOT5x3 (2, 4, 5), SOT953 (4), µDFN (4)	SC70 (2, 4), SOT5x3 (2, 4), SOT23 (4), MSOP10 (4), µDFN (4)
NA	NA	NA	SOD723	NA
3–5pF	16pF	30pF	6–30pF	0.8–2.4pF
<0.02µA max	<25µA max	<10µA max	<0.5µA max	<0.5µA max
Yes	Yes	Yes	Yes	Yes
Yes	Yes	No	Yes	Yes
Yes	Yes	Yes	Yes	Yes
—	—	—	No	No
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes

Multilayer Varistors (MLVs)			
Surface Mount	Surface Mount	Surface Mount	Surface Mount
ML	MLE	MHS	MLN
MLV ZnO	MLV ZnO	MLV ZnO	MLV ZnO
0–120VDC range by type	0–18VDC	0–42VDC	0–18VDC
NA	NA	NA	1206 (4)
0402–1210	0402–1206	0402, 0603	NA
40–6000pF	40–1700pF	3–22pF	45–430pF
<25µA typ	<25µA max	<25µA typ	<25µA max
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
No	No	No	No
Yes	Yes	Yes	Yes

SPA™ Silicon Protection Arrays offer a high level of protection (up to 30kV per IEC 61000-4-2) with very low capacitance, leakage current and clamp voltage. For more robust applications, SP03-xx and SP30xx devices are available for EFT and Lightning transient threats per IEC 61000-4-4/5.

Part Number	Capacitance @ 0V (pF)	Clamp Voltage (typ)	Operating Voltage (VDC)	Leakage Current (Max μ A)	Package	Lines	Input Polarity	ESD Protection Level ⁽¹⁾
SP03-3.3BTG	16	10V @ 100A	3.3	1.0	SOIC-8	2	Bi-polar	30kV
SP03-6BTG	16	17V @ 100A	6	25.0	SOIC-8	2	Bi-polar	30kV
SP03-8BTG	16	18V @ 100A	8	25.0	SOIC-8	2	Bi-polar	30kV
SP0502BAHTG	30	6.8V @ 10mA	5.5	0.1	SOT23	2	Bi-polar	20kV
SP0502BAJTG	30	6.8V @ 10mA	5.5	0.1	SC70-3	2	Bi-polar	20kV
SP0503BAHTG	30	6.8V @ 10mA	5.5	0.1	SOT143	3	Bi-polar	20kV
SP0504BAHTG	30	6.8V @ 10mA	5.5	0.1	SOT23-5	4	Bi-polar	20kV
SP0504BAJTG	30	6.8V @ 10mA	5.5	0.1	SC70-5	4	Bi-polar	20kV
SP0505BAHTG	30	6.8V @ 10mA	5.5	0.1	SOT23-6	5	Bi-polar	20kV
SP0505BAJTG	30	6.8V @ 10mA	5.5	0.1	SC70-6	5	Bi-polar	20kV
SP0506BAATG	30	6.8V @ 10mA	5.5	0.1	MSOP-8	6	Bi-polar	20kV
SP1001-02JTG	12	9.7V @ 2A	5.5	0.5	SC70-3	2	Bi-polar	8kV
SP1001-02XTG	12	9.7V @ 2A	5.5	0.5	SOT553	2	Bi-polar	8kV
SP1001-04JTG	12	9.7V @ 2A	5.5	0.5	SC70-5	4	Bi-polar	8kV
SP1001-04XTG	12	9.7V @ 2A	5.5	0.5	SOT553	4	Bi-polar	8kV
SP1001-05JTG	12	9.7V @ 2A	5.5	0.5	SC70-6	5	Bi-polar	8kV
SP1001-05XTG	12	9.7V @ 2A	5.5	0.5	SOT563	5	Bi-polar	8kV
SP1002-01JTG	6	11.2V @ 2A	6	0.5	SC70-3	1	Bi-polar	8kV
SP1002-02JTG	6	11.2V @ 2A	6	0.5	SC70-5	2	Bi-polar	8kV
SP1003-01DTG	30	12.5V @ 7A	5	1.0	SOD723	1	Bi-polar	25kV
SP1004-04VTG ⁽²⁾	6	8.5V @ 1mA	6	0.1	SOT953	4	Bi-polar	8kV
SP1010-04UTG ⁽²⁾	6	7.5V @ 1mA	6	1.0	uDFN-6	4	Bi-polar	8kV
SP3001-04JTG	0.8	10.6V @ 2A	6	0.5	SC70-6	4	Bi-polar	8kV
SP3002-04HTG	1.1	10.6V @ 2A	6	0.5	SOT23-6	4	Bi-polar	12kV
SP3002-04JTG	1.1	10.6V @ 2A	6	0.5	SC70-6	4	Bi-polar	12kV
SP3002-04UTG	1.1	10.6V @ 2A	6	0.5	uDFN-6	4	Bi-polar	12kV
SP3003-02JTG	0.8	11.8V @ 2A	6	0.5	SC70-5	2	Bi-polar	8kV
SP3003-02XTG	0.8	11.8V @ 2A	6	0.5	SOT553	2	Bi-polar	8kV
SP3003-04ATG	0.8	11.8V @ 2A	6	0.5	MSOP-10	4	Bi-polar	8kV
SP3003-04JTG	0.8	11.8V @ 2A	6	0.5	SC70-6	4	Bi-polar	8kV
SP3003-04XTG	0.8	11.8V @ 2A	6	0.5	SOT563	4	Bi-polar	8kV
SP3004-04XTG	1.1	11.8V @ 2A	6	0.5	SOT563	4	Bi-polar	12kV
SP3050-04HTG	2.4	13.2V @ 8A	6	0.5	SOT23-6	4	Bi-polar	20kV
SP720ABG	3	V _{SUPPLY} +2V @ 1A	30	0.02	SOIC-16	14	Bi-polar	4kV
SP720APP	3	V _{SUPPLY} +2V @ 1A	30	0.02	PDIP-16	14	Bi-polar	4kV
SP721ABG	3	V _{SUPPLY} +2V @ 1A	30	0.02	SOIC-8	6	Bi-polar	4kV
SP721APP	3	V _{SUPPLY} +2V @ 1A	30	0.02	PDIP-8	6	Bi-polar	4kV
SP723ABG	5	V _{SUPPLY} +2V @ 2A	30	0.02	SOIC-8	6	Bi-polar	8kV
SP723APP	5	V _{SUPPLY} +2V @ 2A	30	0.02	PDIP-8	6	Bi-polar	8kV
SP724AHTG	3	V _{SUPPLY} +2V @ 1A	20	0.01	SOT23-6	4	Bi-polar	8kV
SP725ABG	5	V _{SUPPLY} +2V @ 2A	30	0.02	SOIC-8	4	Bi-polar	8kV

1. Minimum ESD withstand voltage, tested according to IEC 61000-4-2, level 4 (Contact Discharge).

2. New items to be introduced Q3 2009. Please contact Littelfuse for availability.

PulseGuard® ESD Suppressors

offer extremely low capacitance for use in high-speed data circuits (IEEE 1394, USB 2.0, HDMI, DVI, etc.). Available in single-line and multi-line packages, they provide ESD protection while ensuring that signal integrity is maintained.

Part Number	Capacitance (pF)	Clamp Voltage (V)	Operating Voltage (VDC)	Leakage Current (Max nA)	Package	Lines	Input Polarity	ESD Protection Level ⁽¹⁾
PGB1010402	0.04	250	0–12	1	0402	1	Bi-polar	8kV
PGB2010402	0.07	40	0–12	1	0402	1	Bi-polar	8kV
PGB1010603	0.06	150	0–24	1	0603	1	Bi-polar	8kV
PGB102ST23	0.12	150	0–24	1	SOT23	2	Bi-polar	8kV

Multilayer Varistors (MLVs)

MLVs provide board level protection against ESD, EFT, and other transients that occur on power supply, data and control lines. Single line devices are available in popular industry standard formats, and for more efficient board space usage, four-line devices are also available. Some MLVs also offer low band-pass filtering characteristics that filter high frequency noise from the circuit.

	Part Number	Capacitance (pF)	Clamp Voltage (V) ²	Operating Voltage (VDC) ³	Leakage Current (Max µA)	Package	Lines	Input Polarity	ESD Protection Level ⁽¹⁾
ML	V5.5MLA0402	220	19 at 1A	0–5.5	<5	0402	1	Bi-polar	8kV
	V5.5MLA0603	660	19 at 2A	0–5.5	<25	0603	1	Bi-polar	8kV
	V5.5MLA0402L	70	30 at 1A	0–5.5	<5	0402	1	Bi-polar	8kV
	V9MLA0402	120	26 at 1A	0–9	<5	0402	1	Bi-polar	8kV
	V9MLA0402L	33	30 at 1A	0–9	<5	0402	1	Bi-polar	8kV
	V9MLA0603	420	28 at 2A	0–9	<25	0603	1	Bi-polar	8kV
	V9MLA0805L	450	20 at 2A	0–9	<25	0805	1	Bi-polar	8kV
	V12MLA0805L	350	25 at 2A	0–12	<25	0805	1	Bi-polar	8kV
	V14MLA0402	70	35 at 1A	0–14	<5	0402	1	Bi-polar	8kV
	V14MLA0603	150	40 at 2A	0–14	<25	0603	1	Bi-polar	8kV
	V14MLA0805	480	30 at 5A	0–14	<25	0805	1	Bi-polar	8kV
	V14MLA0805L	270	30 at 2A	0–14	<25	0805	1	Bi-polar	8kV
	V18MLA0402	40	46 at 1A	0–18	<5	0402	1	Bi-polar	8kV
	V18MLA0603	100	46 at 2A	0–18	<25	0603	1	Bi-polar	8kV
	V18MLA0805	450	40 at 5A	0–18	<25	0805	1	Bi-polar	8kV
	V18MLA0805L	250	40 at 2A	0–18	<25	0805	1	Bi-polar	8kV
MLE	V18MLE0402	40	50 at 1A	0–18	<5	0402	1	Bi-polar	8kV
	V18MLE0603	100	50 at 2A	0–18	<25	0603	1	Bi-polar	8kV
	V18MLE0603L	60	50 at 1A	0–18	<25	0603	1	Bi-polar	8kV
	V18MLE0805	500	50 at 5A	0–18	<25	0805	1	Bi-polar	8kV
	V18MLE0805L	100	50 at 2A	0–18	<25	0805	1	Bi-polar	8kV
MLN	V5.5MLN41206	430	19 at 2A	0–5.5	<5	1206	4	Bi-polar	8kV
	V9MLN41206	250	28 at 2A	0–9	<5	1206	4	Bi-polar	8kV
	V14MLN41206	140	40 at 2A	0–14	<5	1206	4	Bi-polar	8kV
	V18MLN41206	100	50 at 2A	0–18	<5	1206	4	Bi-polar	8kV
	V18MLN41206L	45	50 at 1A	0–18	<5	1206	4	Bi-polar	8kV
MHS	V0402MHS03	3	160 at 1A	0–42	<0.5 at 15V	0402	1	Bi-polar	8kV
	V0402MHS12	12	70 at 1A	0–18	<5 at 15V	0402	1	Bi-polar	8kV
	V0402MHS22	22	40 at 1A	0–9	<1 at 5.5V	0402	1	Bi-polar	8kV
	V0603MHS03	3	160 at 1A	0–42	<0.5 at 15V	0603	1	Bi-polar	8kV
	V0603MHS12	12	70 at 1A	0–18	<5 at 15V	0603	1	Bi-polar	8kV
	V0603MHS22	22	40 at 1A	0–9	<1 at 5.5V	0603	1	Bi-polar	8kV

1. Minimum ESD withstand voltage, tested according to IEC 61000-4-2, level 4 (Contact Discharge).

2. Clamp Voltage using 8/20µS waveform.

3. Leakage Current at Max Operating Voltage unless otherwise stated.

As the world's #1 brand in circuit protection Littelfuse offers the broadest and deepest portfolio of circuit protection products and a global network of technical support, backed by more than 80 years of application design expertise. Visit our design support center to access:

- > **Reference Designs**
- > **Application Notes**
- > **Application Testing**
- > **SPICE Models**
- > **Local Technical Support**
- > **Product Samples**
- > **Technical Articles**
- > **Certification Documents**
- > **Data Sheets**



WWW.LITTELFUSE.COM/DESIGNSUPPORT

Littelfuse offers technologies that protect sensitive electronics and their users against electrostatic discharge (ESD), load switching, lightning strikes, overloads, short circuits, power cross, ground faults and other threats.

Overcurrent protection products:

Fuses Littelfuse offers the world's broadest range of fuse types and ratings, including cartridge, leaded, surface mount and thin film designs

PTCs Positive Temperature Coefficient thermistor technology provides resettable current-limiting protection

Overvoltage protection products:

Varistors Littelfuse offers surface mount Multi-layer Varistors (MLVs) and industrial Metal Oxide Varistors (MOVs) to protect against transients

GDTs Gas Discharge Tubes (GDTs) to dissipate voltage through a contained plasma gas

Thyristors Littelfuse's solid state switches control the flow of current in a wide range of appliances, tools and equipment

SIDACTor® Devices Overvoltage protection specifically designed for telecom and datacom requirements

TVS Diodes Silicon transient voltage suppression (TVS) devices

SPA™ Silicon Protection Arrays designed for analog and digital signal line protection

PulseGuard® ESD Suppressors Small, fast-acting Electrostatic Discharge (ESD) suppressors



To request catalogs for the Littelfuse portfolio of circuit protection technologies, please contact your authorized Littelfuse product representative or visit our website at www.littelfuse.com/catalogs