ESD protection –
Automotive

For In-Vehicle Networks and multimedia buses:
CAN, LIN, FlexRay, BroadR-Reach, HDMI, LVDS, USB Type-C

nexperia

Contents

This document offers a line-up of commonly found interfaces along with suggested methods for protecting against ESD and/or surges.

For each interface we show example circuits and present a line-up of recommended solutions from Nexperia. In all cases, the shown line-up is a subset of the total number of possible solutions we can offer.

Please direct any questions to your local Nexperia representative for further details and information.

What do you get with Nexperia ESD protection?

› Greater system-level immunity (IEC61000-4-2)

› Low clamping voltages, to safeguard the latest SoCs

› Minimized impact on bus and interface signal integrity

› Arrays that combine multi-line protection in single devices

› Packages that simplify PCB design for optimized layouts

› AEC-Q101 qualification grade / PPAP capability
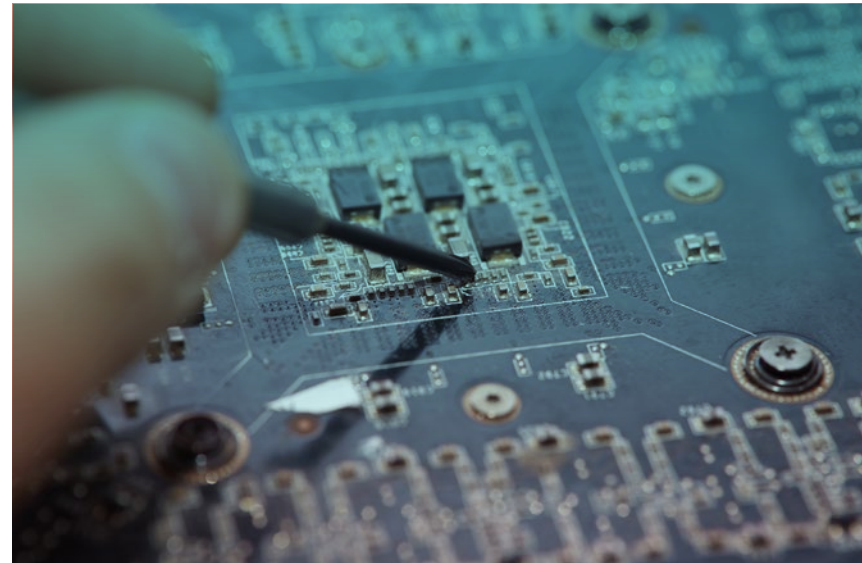
A growing and challenging market for ESD protection

According to a report by the ESD Association in 2015, 25% of all electronics damaged for unknown reasons can be attributed to ESD. Given the unique conditions and potential for spikes that exist in the car, automotive ESD protection has always been a challenging issue. As the number of ECUs (Electronic Control Units) even in standard models grows and we see ever more complex networking solutions to handle the connected car's increased data requirements, then this challenge is only likely grow.

To exchange all the data flowing between powertrain and body ECUs, a number of highly reliable In-Vehicle Networks (CAN, LIN, FlexRay, Ethernet) are needed. To ensure safe operation, solutions are required to pass emission and immunity tests, and guarantee signal integrity. Multimedia bus systems and infotainment networks generally use USB, Automotive Pixel Link (APIX), HDMI or Ethernet, and will adopt USB Type-C – but these also need to meet more stringent specifications than those commonly found in consumer markets.
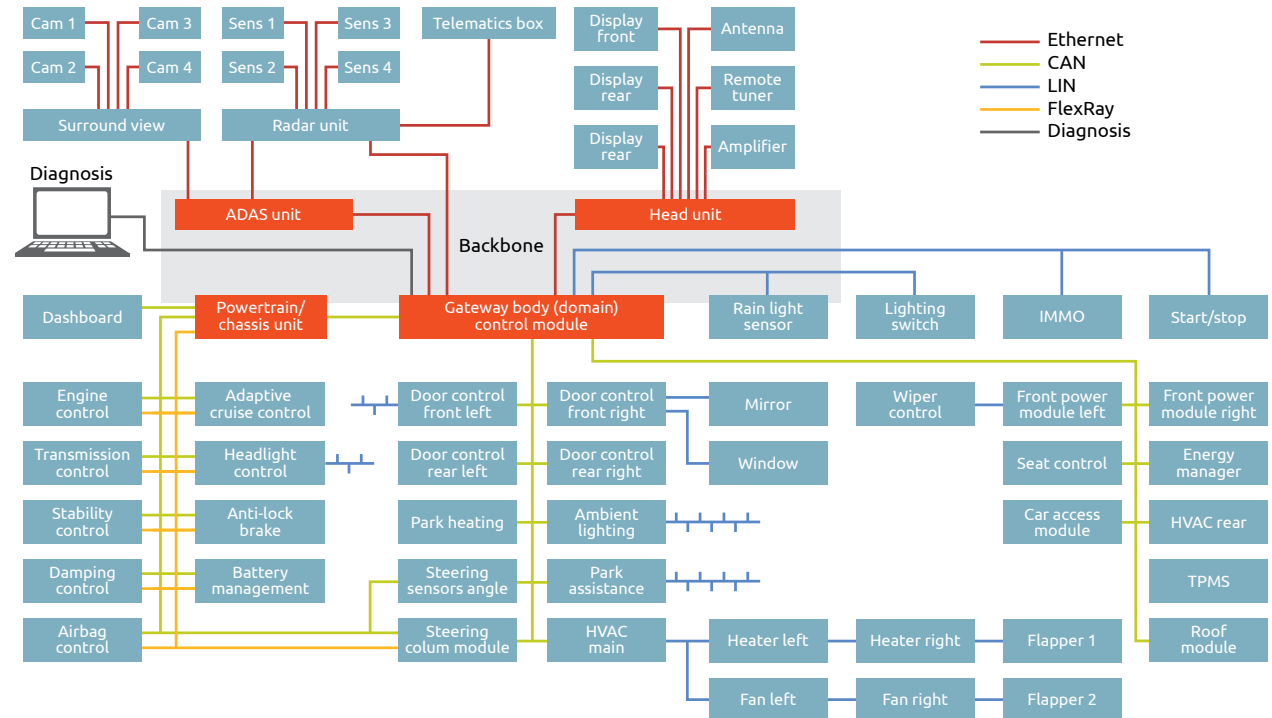
Common networks, standards and protocols

In-Vehicle Networks

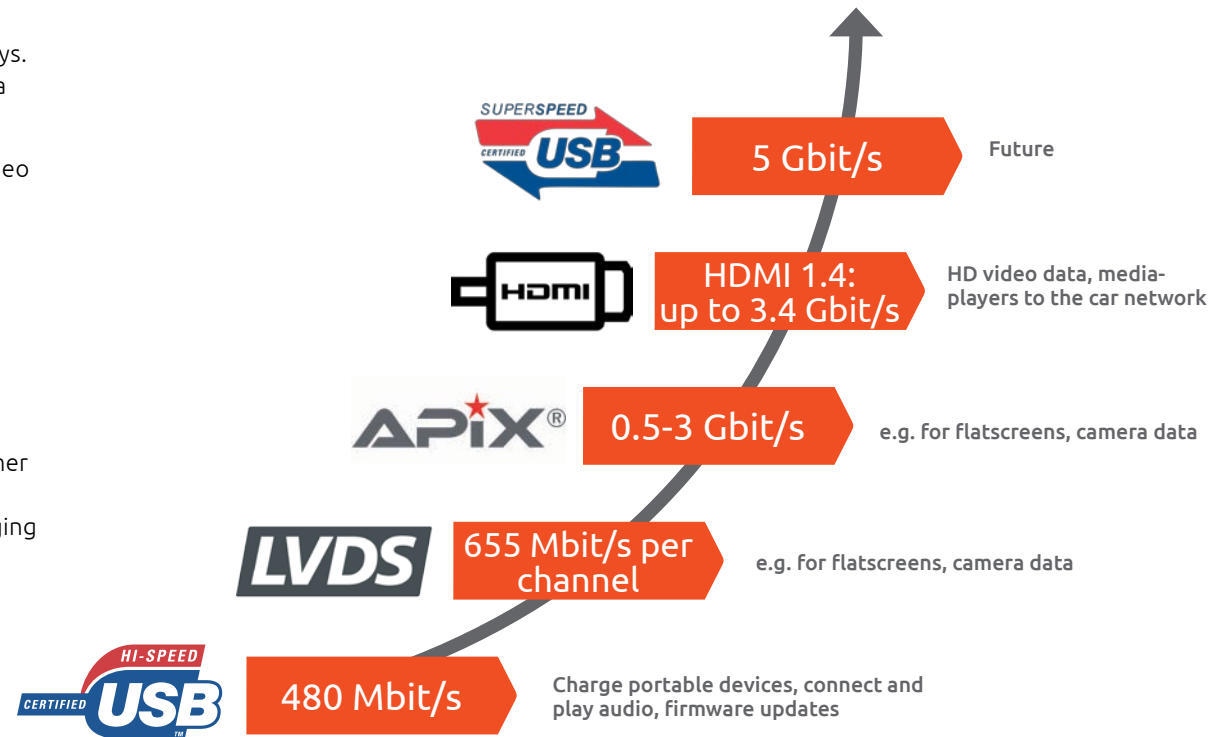› LIN controls systems such as driver assistance, like automatic door locking or windows-lifters, or is used for communication with miscellaneous smart sensors, for instance to detect rain.

› CAN bus systems are also used for driver assistance, along with body control modules like antilock breaking system (ABS), engine management system or power control.

› FlexRay can be applied in electronic systems where safety is paramount, for instance Drive-by-Wire.

› Ethernet is seen as a universal, flexible and low cost alternative to the above. BroadR-Reach is an Ethernet physical layer standard, with 100 Mbit/s full-duplex operations on a single-pair cable.

› For next generations, automotive-suitable gigabit Ethernet is being investigated.

Ethernet

1 Gbit/s — e.g. for Network, Backbone, ADAS

Ethernet

100 Mbit/s — e.g. for ADAS, camera systems

FlexRay™

10 Mbit/s — e.g. in safety related modules like Drive-by-wire, or Body Control

CAN

1 Mbit/s — e.g. for Body Control, Safety, Chassis or Powertrain; like ABS, engine management or power control

lin
LOCAL INTERCONNECT NETWORK

20 kbit/s — e.g. for Driver Assistance, like Climate, Door / Seat modules, or rain sensors

# Common networks, standards and protocols

Multimedia buses

› USB 2.0 is a common interface in head units and car radios, with a maximum transfer rate of 480 Mbit/s. It is used to charge portable devices, connect media players and for firmware updates.

› Low Voltage Differential Signalling (LVDS) uses inexpensive twisted pair cables to transfer video and camera data to displays. It supports a maximum resolution of 2,048 x 1,536 pixels with a transfer rate of 655 Mbit/s per channel.

› Automotive Pixel Link (APIX) is a high-speed bus system for video and camera data. Various versions exist (APIX, APIX2) enabling transfer rates of up to 3 Gbit/s.

› HDMI 1.4 offers a robust automotive connection system, specifically designed to deliver true HD video to a seatback or dashboard display from a connected personal media player. It supports transfer rates of 3.4 Gbit/s (TDMS), while the newer HDMI 2.0 standard supports rates of up to 6 Gbit/s.

› USB Type-C is the latest connection standard to hit the consumer market and is beginning to appear in cars. Features include a simple connector, with high-speed data transfer and fast charging capabilities.

5 Gbit/s — Future

HDMI 1.4: up to 3.4 Gbit/s — HD video data, media-players to the car network

0.5-3 Gbit/s — e.g. for flatscreens, camera data

655 Mbit/s per channel — e.g. for flatscreens, camera data

480 Mbit/s — Charge portable devices, connect and play audio, firmware updates

In-Vehicle Networks (IVN)

LIN (Local Interconnected Network)

Need robust protection for single or dual automotive LIN bus lines? Then our highly reliable ESD devices offer the ideal solution. Their design features an asymmetrical internal diode configuration, ensuring optimized electromagnetic immunity for the protected LIN ECU.
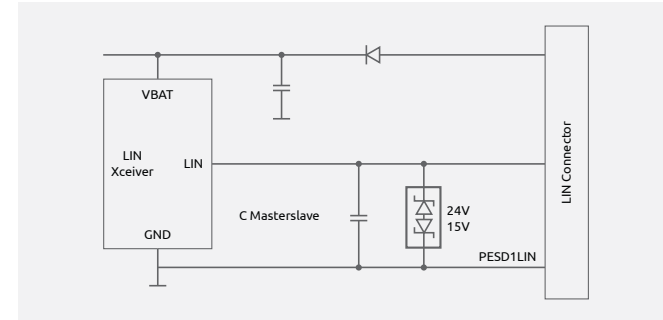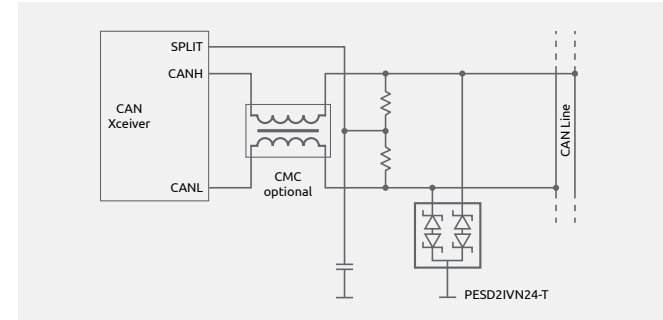

LIN system architecture with a single device to protect the LIN node

Part	Comment	Package	No. of channels	ESD robustness (IEC61000-4-2)	C_D max	I_{PPM} at tp = 8/20µs	V_{RWM}	AEC-Q101 PPAP capable
PESD1LIN	Asymmetrical breakdown voltages / internal diode configuration	SOD323	1 x bi	23 kV	17 pF	3 A	15/24 V	Yes / Yes
PESD1IVN27-A	New generation IVN ESD protection single line	SOD323	1 x bi	30 kV	17 pF	3.0 A	26.5 V	Yes / Yes
PESD2IVN27-U	New generation IVN ESD protection dual line	SOT323	2 x bi	30 kV	17 pF	3.5 A	26.5 V	Yes / Yes
MMBZ27VAL	High surge robustness / Common anode configuration	SOT23	1 x bi 2 x uni	30 kV	60 pF	1 A (10/1000µs)	22 V	Yes / Yes
MMBZ15VAL	High surge robustness / Common anode configuration	SOT23	1 x bi 2 x uni	30 kV	105 pF	1.9 A (10/1000µs)	12 V	Yes / Yes

In-Vehicle Networks (IVN)

CAN (Controller Area Network)

CAN has been the mainstay of automotive networks for over 20 years. Choose the perfect fit for your application from our range of dedicated ESD solutions. The devices protect two automotive CAN bus lines, and they can be used with high-speed and fault-tolerant CAN buses.
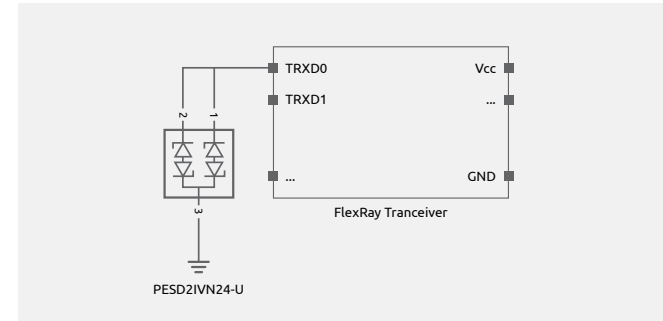

CAN system architecture with a single device to protect the CAN node

Part	Comment	Package	No. of channels	ESD robustness (IEC61000-4-2)	C_D max	I_{PPM} at tp = 8/20µs	V_{RWM}	AEC-Q101 PPAP capable
PESD2IVN24-T	New generation IVN ESD protection dual line	SOT23	2 x bi	30 kV	17 pF	3.5 A	24 V	Yes / Yes
PESD2IVN24-U	New generation IVN ESD protection dual line	SOT323	2 x bi	30 kV	17 pF	3.5 A	24 V	Yes / Yes
PESD2IVN27-U	New generation IVN ESD protection dual line / Higher V_{RWM}	SOT323	2 x bi	30 kV	17 pF	3 A	26.5 V	Yes / Yes
PESD2CAN	High surge robustness dual line	SOT23	2 x bi	30 kV	30 pF	5 A	24 V	Yes / Yes
MMBZ27VAL	High surge robustness / Common anode configuration	SOT23	1 x bi 2 x uni	30 kV	60 pF	1 A (10/1000µs)	22 V	Yes / Yes
MMBZ27VCL	High surge robustness / Common cathode configuration	SOT23	1 x bi 2 x uni	30 kV	60 pF	1 A (10/1000µs)	22V	Yes / Yes

In-Vehicle Networks (IVN)

FlexRay

Protecting FlexRay networks is crucial since they are used for critical systems. Designed specifically for FlexRay data lines, our devices support the FlexRay data rate of 10 Mbit/s. In addition they provide a surge capability of up to 200 W per line for an 8/20 μs pulse.


FlexRay transceiver with a single, bi-directional device to protect the data interface

Part	Comment	Package	No. of channels	ESD robustness (IEC61000-4-2)	C_D max	I_{PPM} at tp = 8/20μs	V_{RWM}	AEC-Q101 PPAP capable
PESD1IVN24-T	New generation IVN ESD protection dual line	SOT23	2 x bi	30 kV	17 pF	3.5 A	24 V	Yes / Yes
PESD2IVN24-U	New generation IVN ESD protection dual line	SOT323	2 x bi	30 kV	17 pF	3.5 A	24 V	Yes / Yes
PESD2IVN27-U	New generation IVN ESD protection dual line / Higher V_{RWM}	SOT323	2 x bi	30 kV	17 pF	3 A	26.5 V	Yes / Yes
PESD1FLEX		SOT23	2 x bi	30 kV	30 pF	3A	24 V	Yes / Yes

In-Vehicle Networks (IVN)

Ethernet (BroadR-Reach, 100Base-TX)

If you are designing an Ethernet IVN, using interfaces like a 100 Mbit BroadR-Reach, our range of dedicated ESD protection devices are indispensable. You can choose from single channel – as illustrated – and multi-channel protection devices.
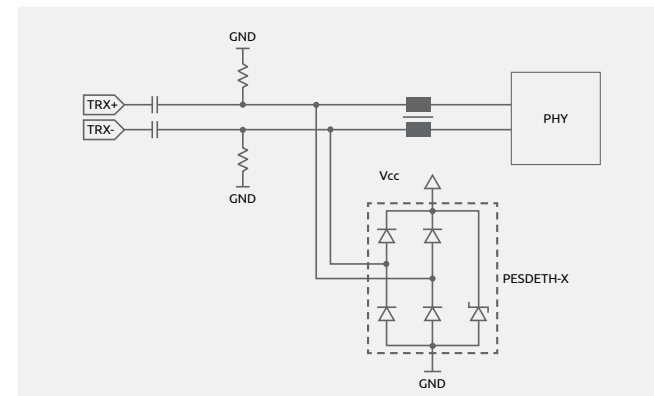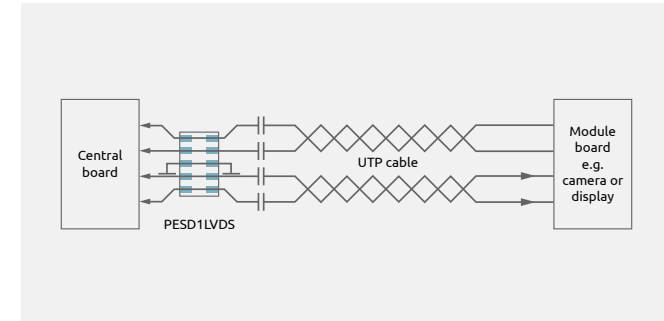

BroadR-reach protection, single channel

Part	Recommendation, comment	Package	No. of channels	ESD robustness (IEC61000-4-2)	C_D	V_{RWM}	AEC-Q101 PPAP capable
PESD2ETH-X	Lower capacitance	SOT143B	1	8 kV	1.5 pF max	5.5 V	Yes / Yes
PESD2ETH-AX	Higher ESD robustness	SOT143B	1	12 kV	2.2 pF max	5.5 V	Yes / Yes
PESD2ETH-D	Lower capacitance	SOT457	1	8 kV	1.8 pF max	5.5 V	Yes / Yes
PESD2ETH-AD	Higher ESD robustness	SOT457	1	12 kV	2.2 pF max	5.5 V	Yes / Yes
PESD1LVDS	Dual channel protection	DFN2510-10 (SOT1165)	2	8 kV	0.6 pF typ	5.5 V	Yes / Yes
PRTR5V0U4D	Dual channel protection	SOT457	2	8 kV	1.0 pF typ	5.5 V	Yes / Yes

Multimedia / infotainment buses

APIX, LVDS, HDMI, USB2.0

While typically for consumer networks, these buses still have to survive the harsh automotive environment and as data rates go up so capacitance must come down. So only the best ESD protection is good enough to ensure reliable operation. Our devices are easily equal to the task, with a range covering all popular bus types.


In LVDS systems, the PESD1LVDS provides ultra high-speed ESD protection that is fully AEC-Q101 compliant

Part	Recommendation, comment	Package	No. of channels	ESD robustness (IEC61000-4-2)	C_D	V_{RWM}	AEC-Q101 PPAP capable
PESD1LVDS	Dual channel protection	DFN2510-10 (SOT1165)	2	8 kV	0.6 pF typ	5.5 V	Yes / Yes
PESD18VF1BL	18 V if supply voltage for display or camera via channel is used	DFN1006-2 (SOD882)	1	10 kV	0.5 pF max	18 V	Yes / Yes
PESD5V0F1BL(D)	Ultra low capacitance	DFN1006(D)-2 (SOD882(D))	1	10 kV	0.55 pF max	5.5 V	Yes / Yes
PESD2ETH-X	Lower capacitance	SOT143B	1	8 kV	1.5 pF max	5.5 V	Yes / Yes
PESD2ETH-AX	Higher ESD robustness	SOT143B	1	12 kV	1.8 pF typ	5.5 V	Yes / Yes
PESD2ETH-D	Lower capacitance	SOT457	1	8 kV	1.8 pF max	5.5 V	Yes / Yes
PESD2ETH-AD	Higher ESD robustness	SOT457	1	12 kV	2.3 pF max	5.5 V	Yes / Yes
PRTR5V0U4D	Dual channel protection	SOT457	2	8 kV	1.0 pF typ	5.5 V	Yes / Yes

Multimedia / infotainment buses

USB Type-C

While USB Type-C is a relatively new interface for consumer devices, we can still provide you with proven ESD protection solutions. They can be used for USB D+, D- and the communication channels (CC1, CC2), and 400 W V_{bus} surge protection.
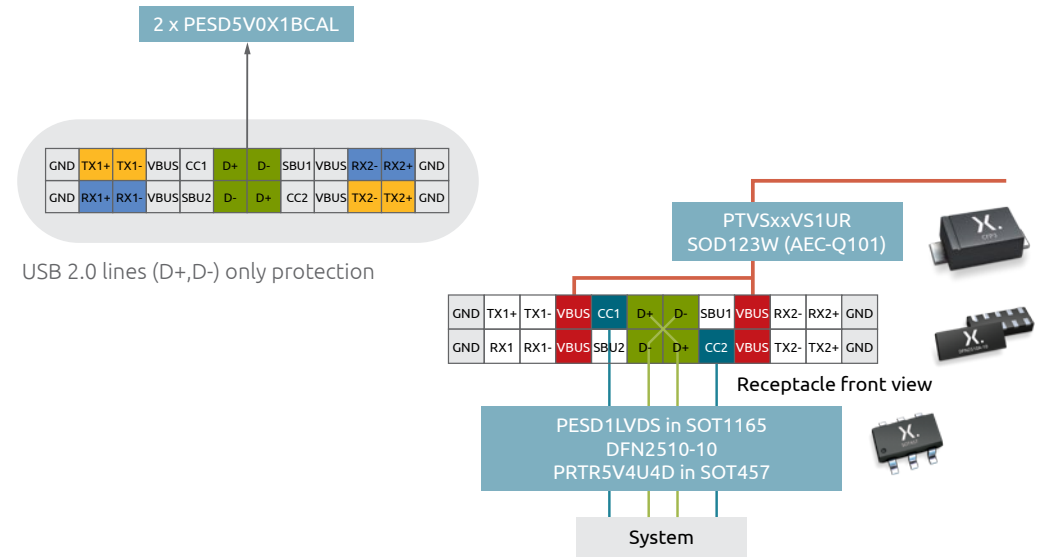
USB 2.0 lines (D+,D-) only protection

Receptacle front view

Part	Recommendation, comment	Package	No. of channels	ESD robustness (IEC61000-4-2)	C_D	V_{RWM}	AEC-Q101 PPAP capable
PESD1LVDS	USB lines plus CC1, CC2	DFN2510-10 (SOT1165)	2	8 kV	0.6 pF	5.5 V	Yes / Yes
PRTR5V0U4D		SOT457	2	8 kV	1.0 pF	5.5 V	Yes / Yes
PESD5V0X1BCAL	USB2.0 lines only	DFN1006D-2 (SOD882)	1	15 kV	0.85 pF	5.5 V	Yes / Yes
PESD5V0X1UALD	USB2.0 lines only, solderable side-pads for AOI	DFN1006D-2 (SOD882D)	1	15 kV	1.55 pF	5.5V	Yes / Yes
PRTR5V0U2AX		SOT143B	1	12 kV	1.8 pF	5.5 V	Yes / Yes
PRTR5V0U2X		SOT143B	1	8 kV	1 pF	5.5 V	Yes / Yes
PVTSxxVS1UR	V_{bus} protection, uni-directional	CFP3 (SOD123W)	1	30 kV		3.3 -64 V	Yes / Yes