

# TI'S ESD PROTECTION DEVICES AND NEW DEDICATED SOLUTIONS FOR CAN & LIN

## New Product Update

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- Applications Engineer

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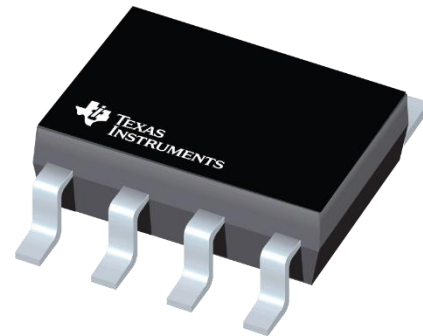
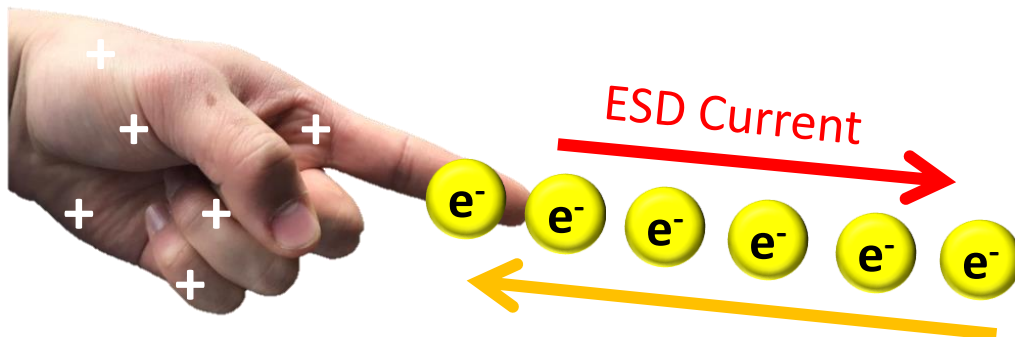
# Agenda

- Introduction to ESD protection
  - What is electrostatic discharge (ESD) and where is ESD protection used?
  - Key parameters of ESD protection devices and their impact on system performance
  - How to choose an ESD device for any application
- Device family overview of ESD protection solutions for controller area network (CAN) & local interconnect network (LIN) in industry standard packages

Please feel free to “chat” Matthew Smith, Systems Engineer, who is available to answer any questions you have throughout this presentation.

# What is ESD?

Electrostatic discharge (ESD) is the release of stored static electricity.



Integrated  
Circuit

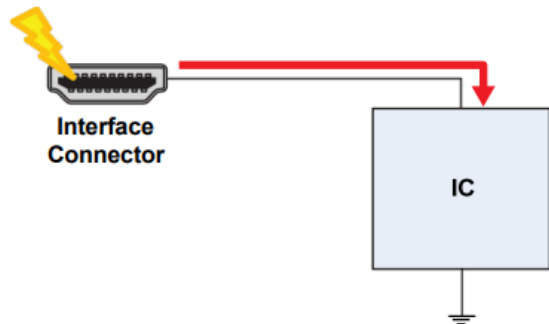
The discharge can produce very high voltages that can damage ICs

Source of ESD Voltage	Typical ESD Voltage at 20% Relative Humidity
Triggering a vacuum solder remover	8 kV
Walking across Vinyl floor	12 kV
Removing plastic tape for a PC board	12 kV
Removing shrink film from PC board	12 kV
Spraying aerosol freezer spray	15 kV
Arising from a foam cushion	18 kV
Sliding plastic box on carpet	18 kV
Opening a plastic bag	20 kV

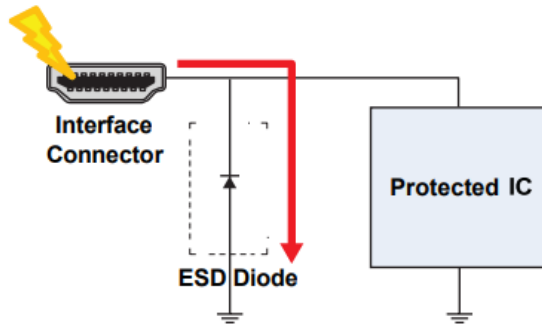
ESD voltage will typically be lower in higher humidity environments

# Where to place ESD protection

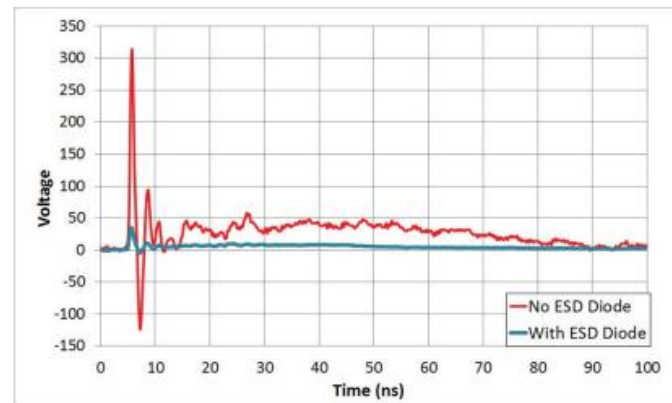
ESD suppressors should be placed in parallel between the source of ESD (typically an exposed interface connector) and the IC that needs protection.



*ESD strike without protection.*



*ESD strike with protection.*



*Voltage waveforms with and without ESD protection.*

# Where is ESD protection used?

## Automotive

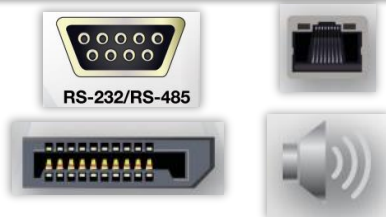


Interfaces: CAN, CAN-FD, CAN-XL, LIN, LVDS, SDIO, FPD-Link/SERDES

### Applications

- ADAS domain controller
- Medium/short range radar
- Body control module (BCM)
- Traction inverter
- Electric power steering
- Battery pack passive balancing
- Head unit

## Industrial/ Comms



Interfaces: Audio, Display, Display Port, Ethernet, RS-485/432/232/422, I2C

### Applications

- Electric meter
- String inverter
- Battery storage system
- HVAC controller
- Vacuum robot
- Cordless power tool
- Rack server
- SSD

## General Purpose

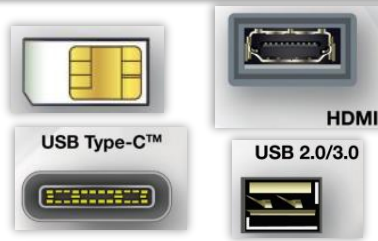


Interfaces: LCD, Keypad, Push Button, USB-PD

### Applications

- Notebook PC
- Gaming controller
- Smart speaker
- Streaming media player
- Router
- WiFi access point
- Digital input module
- STB & DVR

## High Speed



Interfaces: HDMI 1.3/1.4, HDMI2.x, PCIe, Antenna, USB2.0, USB3.2, USB Type C

### Applications

- Desktop PC
- Notebook PC
- Smartphone
- TV
- Data center switch
- Network interface card

# At a glance | recommended protection devices

Category & End Equipment	Recommend device by interface (Left to right: Decreasing Interface Signal Speed)								
	Antenna	HDMI, DisplayPort	PCIe	USB 2.0, 3.x	Ethernet	CAN, LIN, FPD Link	GPIO, I2C, Audio JTAG, Keypad	RS-485, RS-232	Power line, USB-PD, 4-20mA
<b>Advanced driver assistance system (ADAS)</b> Medium/Short Range Radar, ADAS Domain Controller, Camera Module	TPD1E01B04-Q1		TPD4E02B04-Q1	TPD2E2U06-Q1	TPD4E02B04-Q1	ESD2CAN24-Q1	TPD1E05U06-Q1	ESD752-Q1	TPD1E10B06-Q1
<b>Body Electronics &amp; Lighting</b> Body Control Module (BCM), Headlight, Automotive Gateway	TPD1E01B04-Q1		TPD4E02B04-Q1	TPD1E10B06-Q1	TPD4E02B04-Q1	ESD1LIN24-Q1	TPD1E10B06-Q1	ESD762-Q1	ESD1LIN24-Q1
<b>Hybrid, electric &amp; powertrain systems</b> Traction Inverter, Electric Power Steering, Battery Pack Passive Balancing	TPD1E01B04-Q1			TPD4E05U06-Q1	TPD4E02B04-Q1	ESD2CAN36-Q1	TPD1E05U06-Q1	ESD761-Q1	TPD1E10B06-Q1
<b>Infotainment &amp; Cluster</b> Head Unit, USB Charging, Digital Cockpit Processing Unit, Info Display	TPD1E01B04-Q1		TPD4E02B04-Q1	TPD2E2U06-Q1	TPD4E05U06-Q1	ESD761-Q1	TPD1E10B06-Q1	ESD752-Q1	TPD1E10B06-Q1
<b>Grid Infrastructure</b> Electric Meter, Battery Storage System, Data Concentrator, String Inverter	TPD1E01B04			ESD122	ESDS304	ESD2CAN24-Q1	ESD351	ESD752	TVS1800/01
<b>Building Automation</b> IP Network Camera, Video Recorder, HVAC Controller	TPD1E01B04	ESD204	ESDS314	ESD224	TPD4E05U06	ESD2CANFD24-Q1	TPD1E05U06	ESD762	TSM36A
<b>Appliances</b> Vacuum Robot, Cordless Power Tool, AC unit, Battery Charger	TPD1E01B04			ESD401	TPD4E02B04	ESD1LIN24-Q1	TPD1E10B06	ESD751	TVS2700/01
<b>Personal Electronics</b> Notebook PC, Motherboard, Smartphone, TV	TPD1E0B04	TPD4E02B04	TPD4E02B04	ESD321	ESD204		ESD341		TVS2200/01
<b>Wired Networking</b> Data Center Switch, WLAN/Wi-Fi Access Point, Router	TPD1E01B04		TPD4E02B04	TPD2E2U06	ESDS314		TPD4E05U06	ESD752	TVS0701
<b>Datacenter &amp; Enterprise Computing</b> Rack Server, Network Interface Card, SSD		ESD224	TPD4E02B04	TPD4E1U06	ESDS304		ESD401	ESD762	TVS1400/01
<b>Factory Automation</b> Single Board Computer, Digital Input Module	TPD1E0B04	ESD204	TPD4E02B04	TPD1E05U06	ESDS312	ESD762	TPD1E10B06	ESD752	TVS3300/01
<b>Home Theater &amp; Entertainment</b> STB & DVR, Streaming Media Player, Smart Speaker	TPD1E01B04	TPD4E02B04		TPD6E05U06	ESDS314		TPD1E10B09		TVS2700/01

Advanced protection >15kV

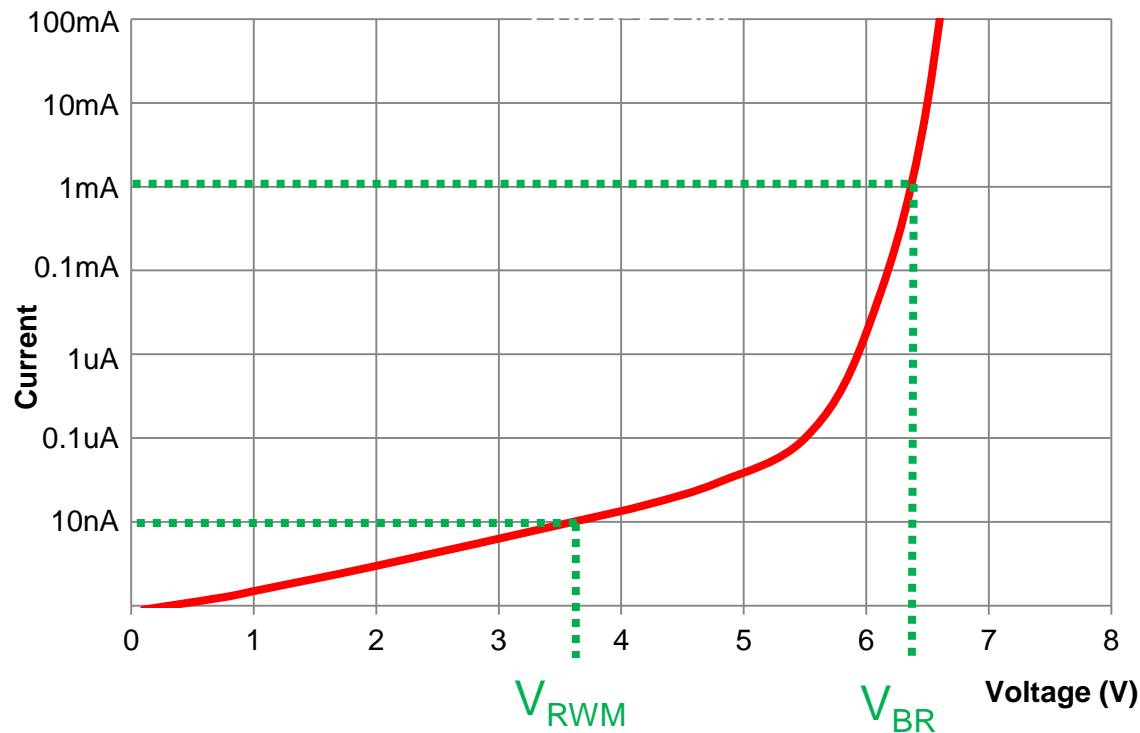
Surge Protection >=6A

Low cap. <=0.5pF

Small size

Multi-Ch

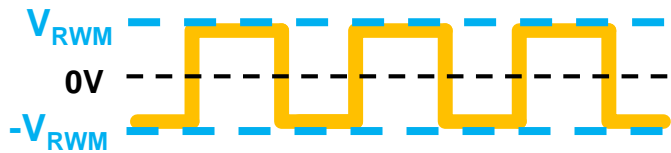
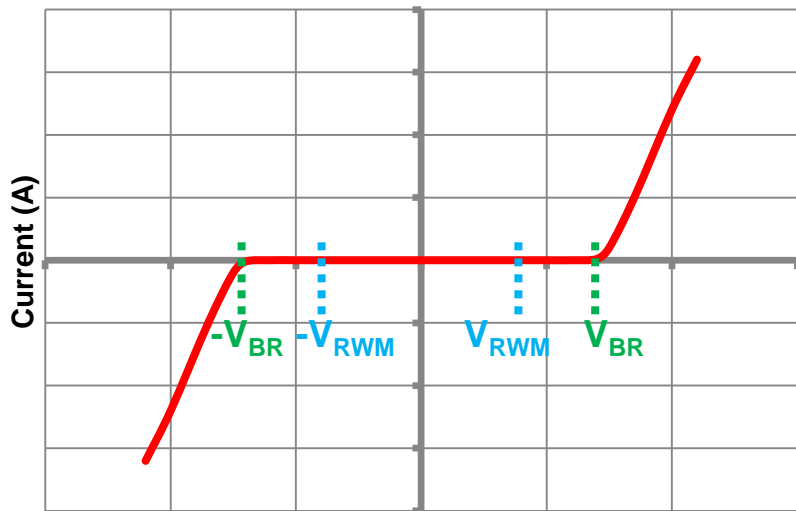
# Key parameters – working voltage ( $V_{RWM}$ )



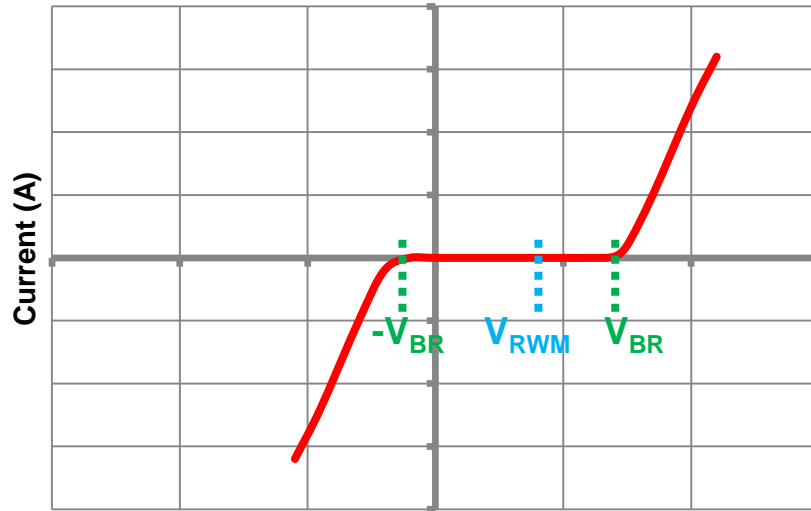
- $V_{RWM}$  is defined as the maximum positive and negative voltage where current flowing through the diode does not exceed a certain amperage, typically low nA range.
  - The  $V_{RWM}$  should encompass the entire interface's voltage range to minimize leakage during operation
- Once the voltage exceeds  $V_{RWM}$ , it approaches the breakdown voltage ( $V_{BR}$ ), which is defined as the voltage where current through the diode exceeds 1mA

# Key parameters - polarity

Bidirectional ESD I-V

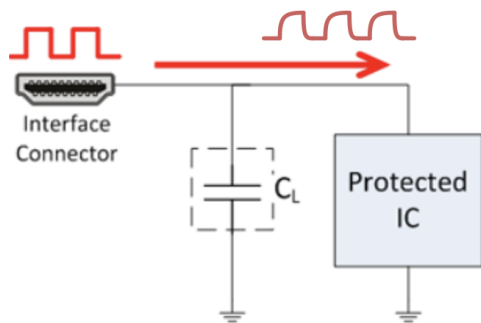


Unidirectional ESD I-V



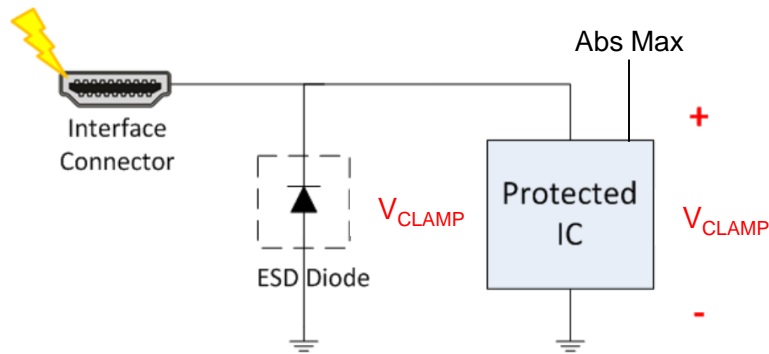


# Key parameters - clamping voltage



During regular operation, the diode is reverse biased and behaves like a capacitor

Ideally, the diode is invisible to the system



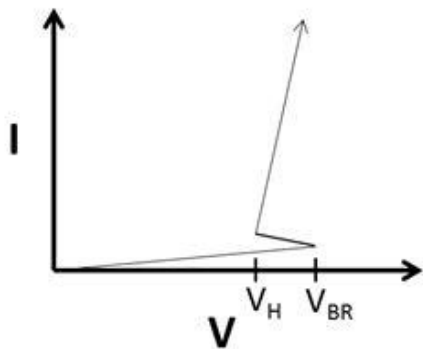
During an ESD strike, the diode breaks down and steers “all” of the ESD current to ground.

The diode should ideally clamp at or below the abs max rating of the protected IC pins.

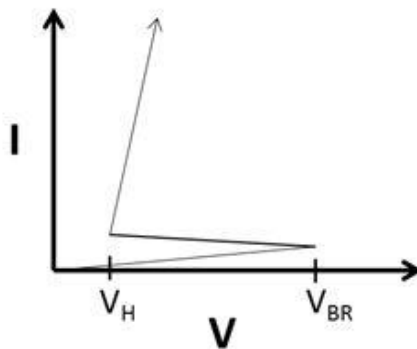
# Key parameters - snapback

Some ESD protection devices can exhibit a temporary negative resistance and “snap back” the voltage to the holding voltage ( $V_H$ ).

The difference between the breakdown voltage and holding voltage can be small (shallow snapback) or very large (deep snapback)



Shallow Snapback



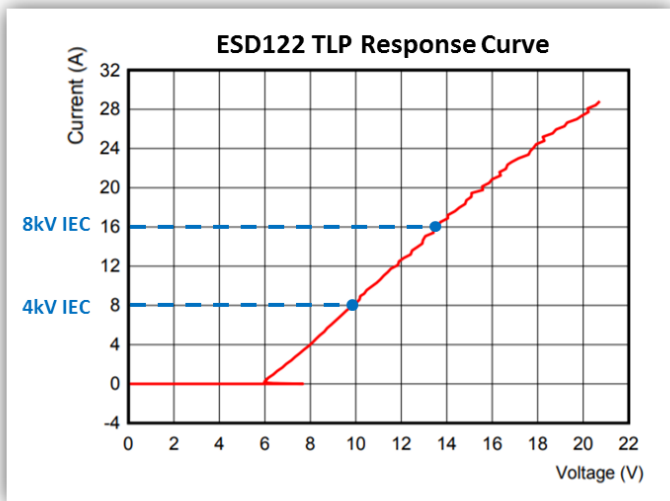
Deep Snapback

Our portfolio currently offers shallow snapback devices across multiple voltage nodes.

# Key parameters – TLP

A transmission line pulse (**TLP**) can be used to characterize the diodes IV curve during an ESD strike. TLP is useful because it has similar characteristics to an IEC 61000-4-2 ESD strike. Thus you can correlate TLP current with IEC ESD.

Below is the TLP I-V curve of one of our shallow snap back devices.



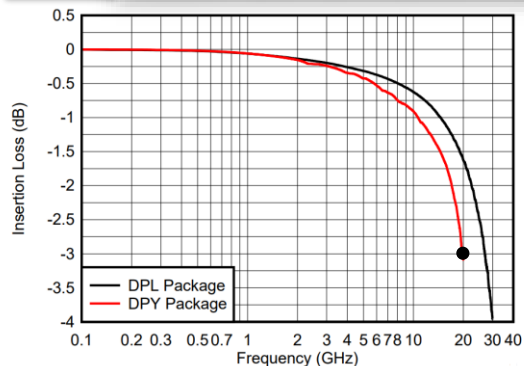
- A 2kV IEC strike = 4A TLP.
- A 4kV IEC strike = 8A TLP.
- A 6kV IEC strike = 12A TLP.
- A 8kV IEC strike = 16A TLP.

# Key parameters – capacitance

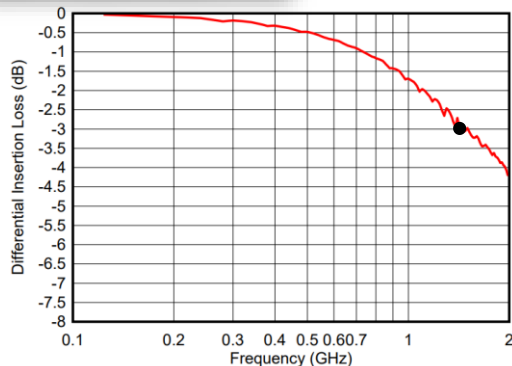
Capacitance of the diode must be low enough to not degrade the signal integrity of the protected line.

Capacitance requirements will vary from system to system, thus capacitance recommendations are broad.

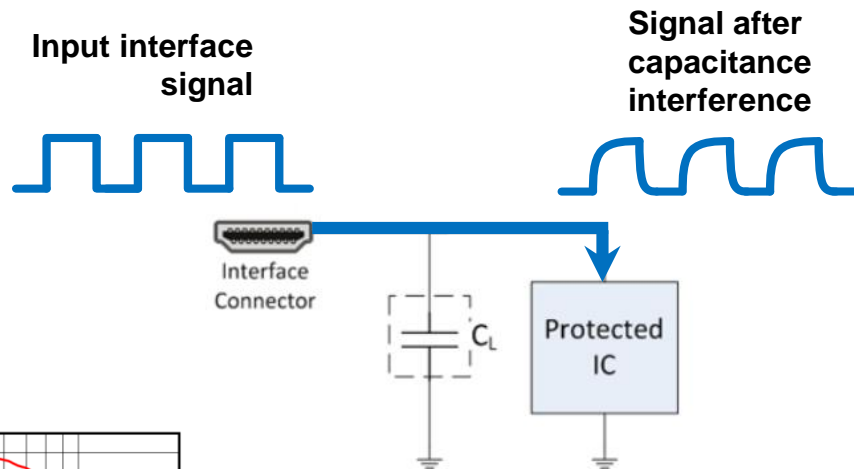
TI's low capacitance diodes will typically have an insertion loss graph in the datasheet, you can reference this to see what signal speeds the diode can support and the insertion loss at those frequencies.



TPD1E01B04 (0.18 pF)

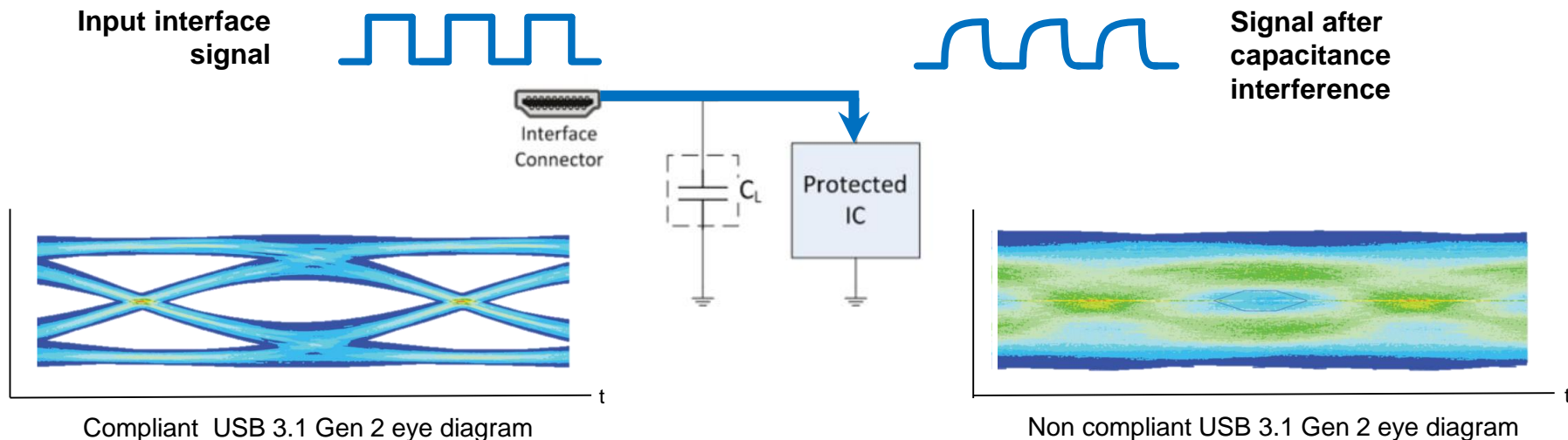


ESDS302 (2.3 pF)



- The general rule of thumb is to protect signals with speeds up to the -3dB point.
- Diodes with a lower capacitance will cause less insertion loss at higher frequencies.

# Key parameters – capacitance

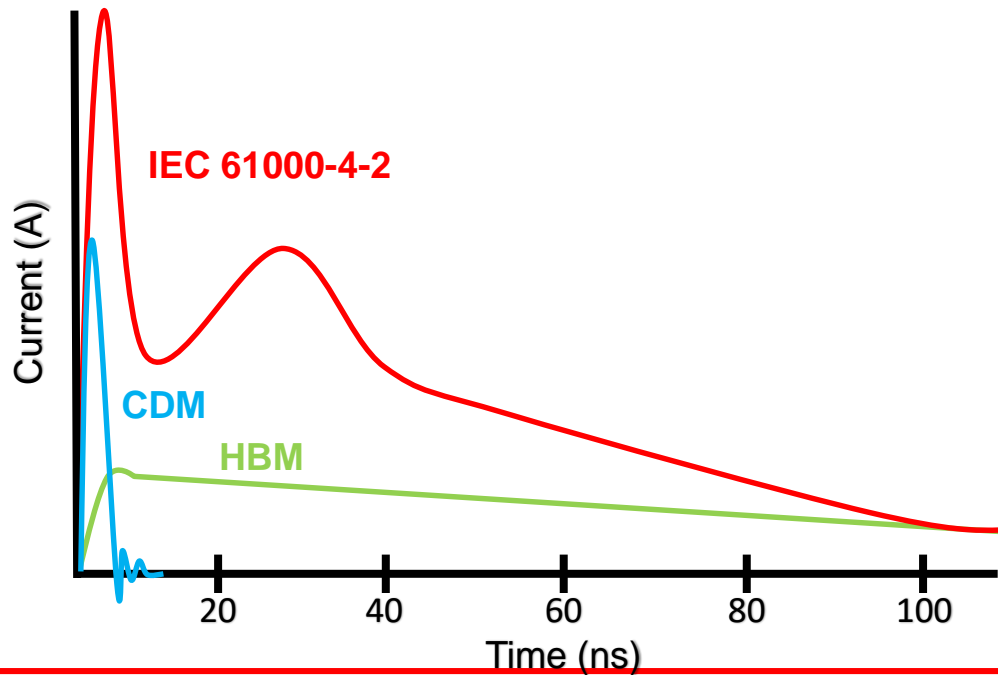


- The eye diagrams above show a compliant USB3.1 eye diagram and a non compliant USB 3.1 eye diagram due to high capacitance on the trace.
- High-speed signals for interfaces such as USB or HDMI will require low capacitance diodes to remain within compliance with interface standards.
- TI's low capacitance diode datasheets offer eye diagrams for common interfaces.

# ESD standards: IEC 61000-4-2

## 6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±500	



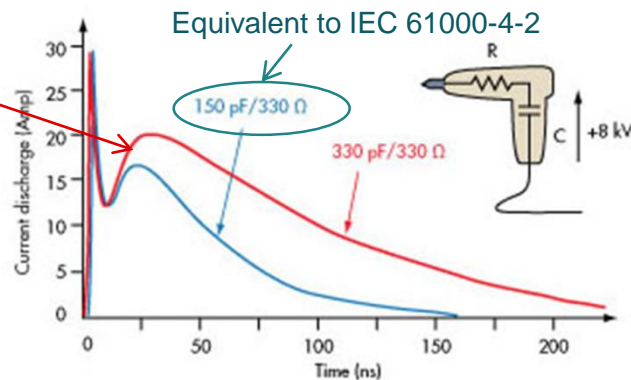
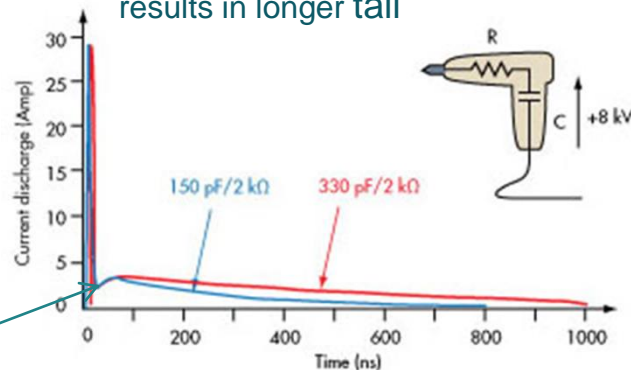
# ESD standards: ISO 10605 vs. IEC 61000-4-2

ISO 10605 is required for automotive qualifications

	IEC 61000-4-2 Contact	ISO 10605 Contact
Resistor & Capacitor Combo	R = 330 $\Omega$ C = 150 pF	R = 330 $\Omega$ OR 2 k $\Omega$ C = 150 pF OR 330 pF

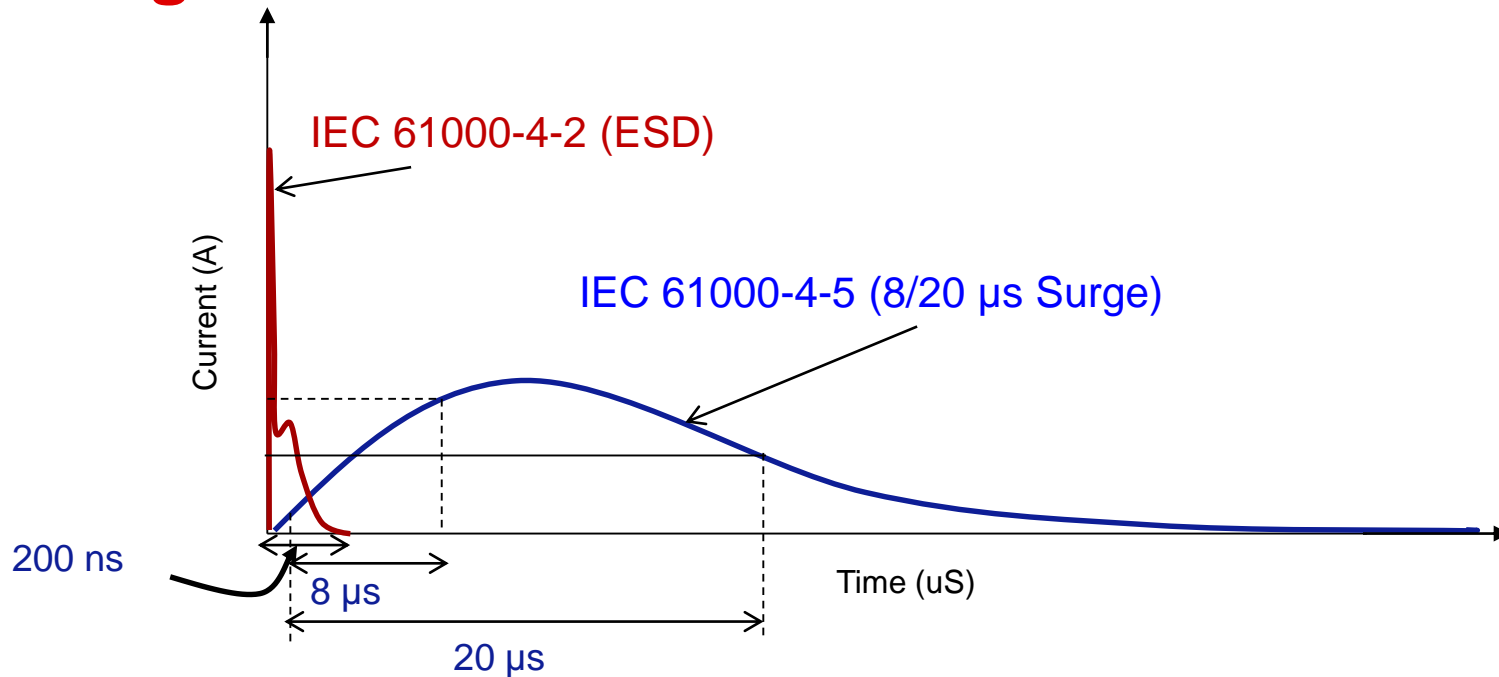
330 pF / 330  $\Omega$  is stricter and widely used 10605 standard

2 k $\Omega$  suppresses the second peak and results in longer tail



330  $\Omega$  network results in higher peak and shorter tail

# Surge vs ESD: current waveforms

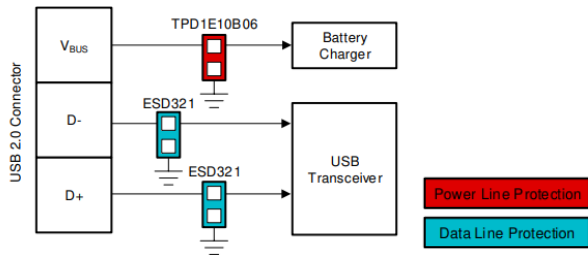


Surge pulses contain significantly more energy than ESD pulses and require more protection



# Choosing an ESD Diode

Interface Requirement	Diode Spec	TPD1E10B06	ESD321
Max voltage of protected signal	<b>Working Voltage (<math>V_{RWM}</math>)</b> Learn More: <a href="#">Video</a>   <a href="#">Article</a>	5.5V	3.6V
Differential signals, AC signals, protect from DC miswiring events = bidirectional	<b>Bi/Uni-directional</b> Learn More: <a href="#">Video</a>   <a href="#">Article</a>	Bi	Uni
Protection of downstream circuitry during ESD strike	<b>Clamping Voltage (V)</b> Learn More: <a href="#">Video</a>   <a href="#">Article</a>	10V	6.3V
Signal speed	<b>Capacitance (Typ.)</b> Learn More: <a href="#">Video</a>   <a href="#">Article</a>	12pF	0.9pF
Environment/Handling (System level ESD immunity)	<b>IEC 61000-4-2 (ESD)</b> Learn More: <a href="#">Video</a>   <a href="#">Article</a>	±30/30kV	±30/30kV
Environment/ Handling (Protection against surge currents)	<b>IEC 61000-4-5 (Surge)</b> (tp - 8/20 $\mu$ s) Learn More: <a href="#">Video</a>   <a href="#">Article</a>	6A	6A



## 6.6 Electrical Characteristics

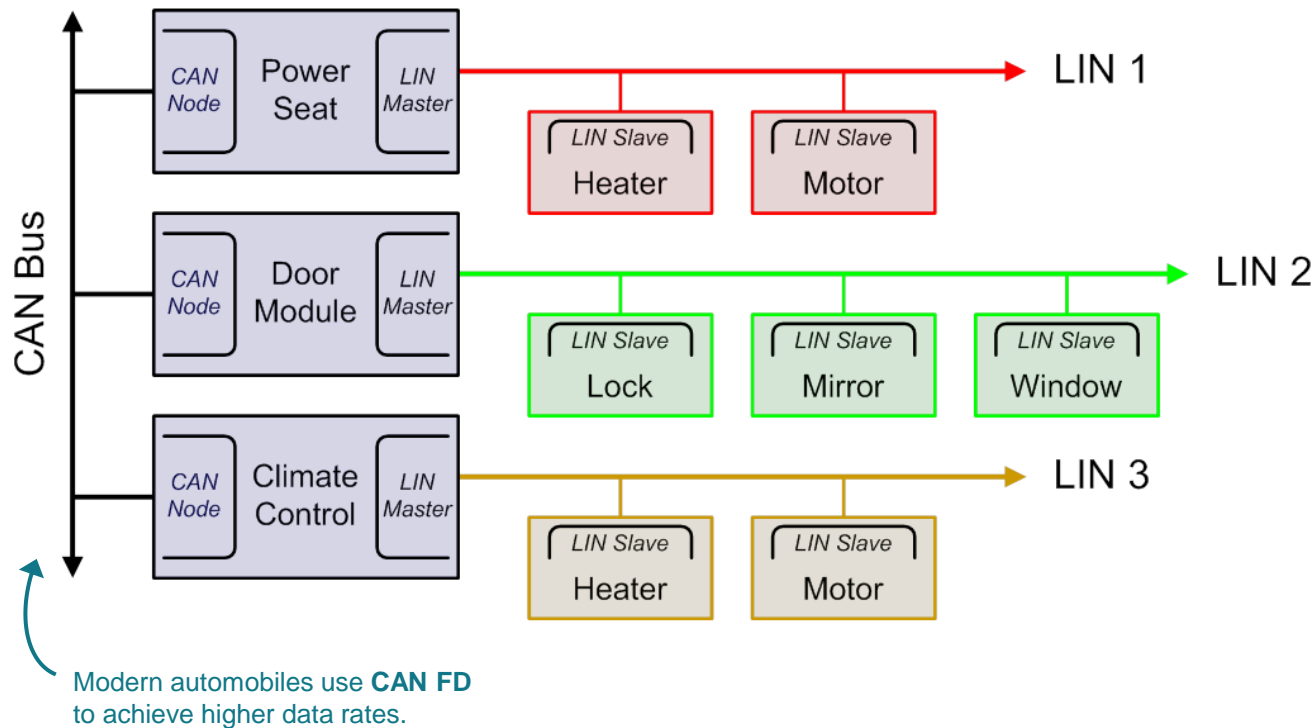
At TA = 25°C unless otherwise noted

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{RWM}$	Reverse stand-off voltage $I_{IO} < 50$ nA, across operating temperature range			3.6	V
$I_{LEAKAGE}$	Leakage current at 3.6 V $V_{IO} = 3.6$ V, I/O to GND		0.1	10	nA
$V_{BRF}$	Breakdown voltage, I/O to GND <sup>(1)</sup>	4.5		7.5	V
$V_{FWD}$	Forward Voltage, GND to I/O <sup>(1)</sup>		0.8		V
$V_{HOLD}$	Holding voltage, I/O to GND <sup>(2)</sup>		5.1		V
$V_{CLAMP}$	Clamping voltage $I_{PP} = 6$ A (8/20 $\mu$ s Surge), I/O to GND		6.3		V
	$I_{PP} = 16$ A (100 ns TLP), I/O to GND		6.8		V
	$I_{PP} = 16$ A (100 ns TLP), GND to I/O		4.7		V
$R_{DYN}$	Dynamic resistance I/O to GND, 100 ns TLP, between 10 to 20 A $I_{PP}$ GND to I/O, 100 ns TLP, between 10 to 20 A $I_{PP}$		0.13		$\Omega$
$C_{LINE}$	Line capacitance, IO to GND $V_{IO} = 0$ V, $V_{P-P} = 30$ mV, $f = 1$ MHz		0.9	1.1	pF

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	±30000	V
	IEC 61000-4-2 Air Discharge, all pins	±30000	

Surge Pulse	IEC 61000-4-5 Surge (tp 8/20 $\mu$ s) Peak Power at 25 °C	40	W
	IEC 61000-4-5 Surge (tp 8/20 $\mu$ s) Peak Current at 25 °C	6	A

# CAN & LIN in automotive applications



## CAN is a main bus

- **Differential**
- **Two-wire**
- **1Mbps (up to 20 Mbps)**

## LIN is a sub-bus

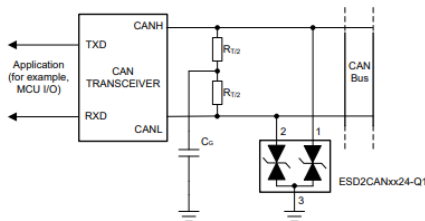
- **Single-ended**
- **One-wire**
- **20kbps**

# CAN/LIN protocols – data rates

## CAN

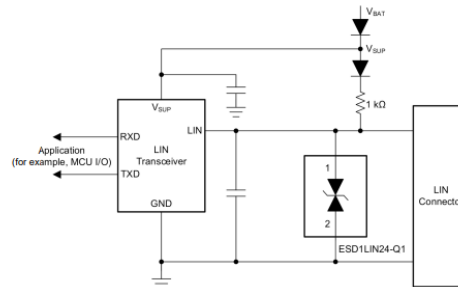
The CAN protocol has evolved over time with new versions enabling higher data rates.

- Low speed (**LS CAN**): Up to 125 Kbps
- High speed (**HS CAN**): Up to 1 Mbps
- Flexible data rate (**CAN FD**): Up to 5 Mbps
- Signal Improved capable CAN (**CAN SIC**): Up to 8 Mbps
- **CAN XL**: Up to 10-20 Mbps



## LIN

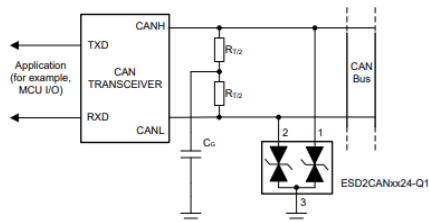
The LIN protocol is limited to <20Kbps



- All of TI's CAN/LIN ESD diodes have low capacitance and can support data rates of ~1 Gbps, thus any of these devices can be used with any CAN/LIN protocol.

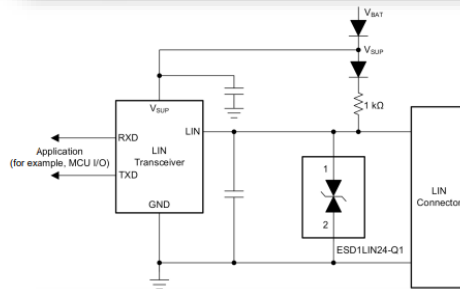
# CAN/LIN protocols – signal voltages

The CAN data lines are low voltage however in vehicles there is a common mode voltage present on the BUS that is dependent on the battery voltage. This will require a diode with a higher working voltage to avoid the diode breaking down during normal operation.



The CANH and CANL pins max voltage ratings will vary depending on the CAN transceiver used. These ratings can range from  $\pm 14$  V all the way up to  $\pm 70$  V for newer TI CAN transceivers.

The LIN data lines can range from 9 – 18 V. There is also a common mode voltage present on the BUS that is dependent on the battery voltage in vehicles. This will require a diode with a higher working voltage to avoid the diode breaking down during normal operation.



The LIN communication pin max voltage ratings will vary depending on the LIN transceiver. These ratings can range from  $\pm 40$  V up to  $\pm 60$  V for TI's newer LIN transceivers.

# CAN/LIN interface requirements

Interface Spec	CAN	CANFD	CAN-XL	Diode Spec	Recommendations
Interface voltage (V)	+3.3-5 V			Working voltage ( $V_{RWM}$ )	24 V for a 12 V battery system to protect from miswiring.
# of wires	2			# channels	2 channel diode to protect CANH and CANL lines
Signal architecture	Differential			Configuration	Bi-directional to protect from line faults and miswiring
CAN transceiver max voltage ratings <small>Abs Max Rating of CANH/CANL Pins</small>	$\pm 14$ -70 V			16A TLP clamping voltage	<70 V
Max data rate	1Mbps	5 Mbps	10-20Mbps	Capacitance	< 20 pF

Interface Spec	LIN			Diode Spec	Recommendations
Interface voltage (V)	+9-18 V			Working voltage ( $V_{RWM}$ )	24 V for a 12 V battery system to protect from miswiring.
# of wires	1			# channels	1 channel diode to protect LIN bus
Signal architecture	Single ended			Configuration	Bi-directional to protect from line faults and miswiring
LIN transceiver max voltage ratings <small>Abs Max Rating of LIN Pins</small>	$\pm 40$ -60V			16A TLP clamping voltage	<60 V
Max data rate	20kbps			Capacitance	< 40 pF

# ESD2CAN24-Q1

Key EEs: Infotainment & cluster | Body electronics & lighting | Hybrid, electric & powertrain | ADAS

## Features

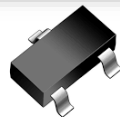
- 24 V working voltage, 2 channel, **SOT23 & SC70 package**
- Outstanding protection
  - Low clamping voltage  $V_{CL} = 35 \text{ V}$  (TLP 16A)
  - IEC 61000-4-2, level 4 (ESD) **30 kV**
  - IEC 61000-4-5 (surge)  $I_{PP} = 5.7 \text{ A}$  @  $t_p = 8/20 \mu\text{s}$  **30 kV**
  - ISO 10605
- Ultra low leakage current  $I_{RM} < 5 \text{ nA}$
- Low line capacitance **3 pF (typ) / 5pF (max)**
- AEC-Q101 qualified

## Applications

- Automotive In-vehicle Networks
  - CAN / CAN-FD / CAN-XL
  - Low and High-speed CAN
  - Fault Tolerant CAN
- Industrial Control Networks
  - DeviceNet™ IEC 62026-3
  - CANopen - CiA 301/302-2 and EN 50325-4

## Benefits

- Maximum ESD/surge robustness per the IEC standard
- Maximum ESD robustness per the ISO10605 standard
- Protects 12 V systems without failing due to jumpstart issue or DC faults
- Small, leaded SOT Surface-Mounted Device (SMD) allows low cost automatic optical inspection (AOI)
- 2-ch device provides complete ESD protection with single component
- Low clamping voltage protects downstream components
- Well-matched capacitance matching provides CAN bus signal integrity
- Pin-to-pin compatible with most competitor solutions



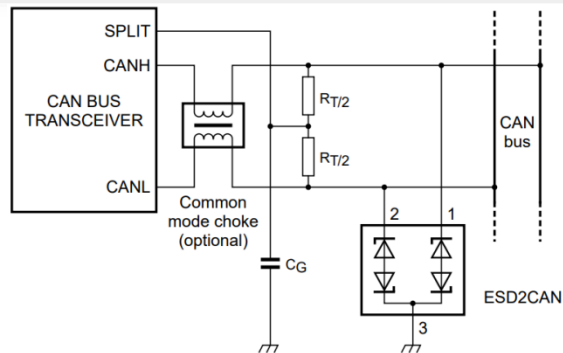
**SOT23-3**

2.92 x 2.37 x 1.05 mm



**SC-70**

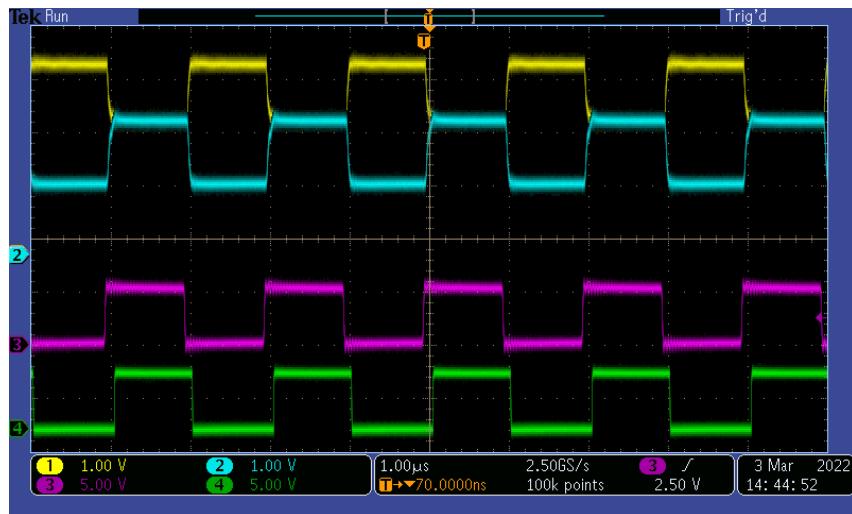
2.1 x 2 x 1 mm



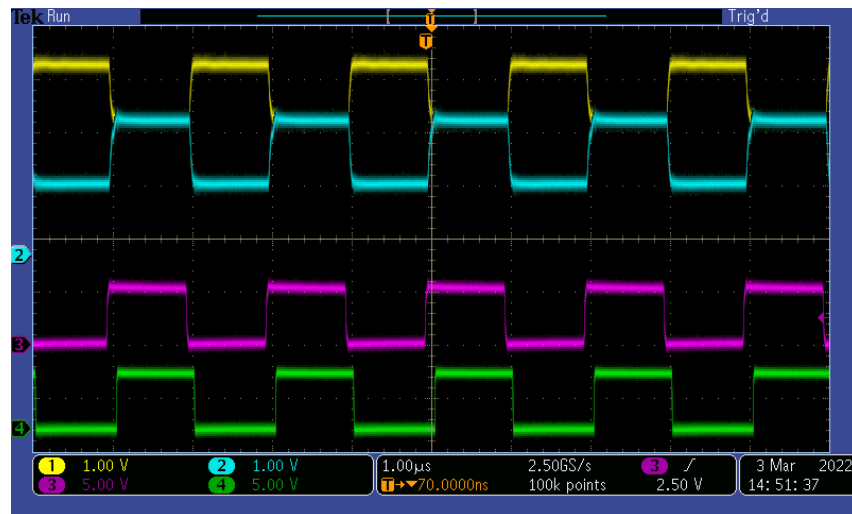
# ESD2CAN24-Q1 + TCAN1042V

## Signal Integrity @ 500 kHz (1 Mbps)

No diode



With ESD2CAN24-Q1



# ESD1LIN24-Q1

Key EEs: Infotainment & cluster | Body electronics & lighting | Hybrid, electric & powertrain | ADAS

## Features

- 24 V working voltage ,1 CH, [SOD323 package](#)
- Bidirectional polarity
- Low clamping voltage  $V_{CL} = 40 \text{ V (TLP 16A)}$
- IEC 61000-4-2 ESD [30kV](#)
- ISO 10605 ESD protection [30kV](#)
- IEC 61000-4-5 (Surge)  $I_{PP} = 4.3 \text{ A at } t_p = 8/20 \mu\text{s}$
- Ultra low leakage current  $I_{RM} < 5 \text{ nA}$
- Low line capacitance [2.3 pF \(typ\) / 5 pF \(max\)](#)

## Applications

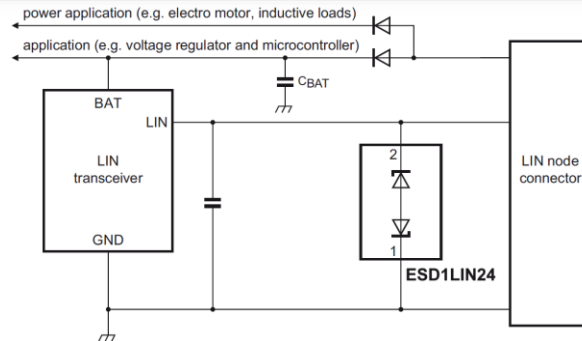
- Automotive In-vehicle Networks
  - LIN-bus protection
  - CAN-bus protection
  - FlexRay
- Industrial Control Networks
  - DeviceNet™ IEC 62026-3
  - Smart Distribution Systems (SDS)

## Spec Justification

- Protects 12 V systems without failing due to jumpstart issue or DC faults
- LIN standard calls for positive & negative working voltages
- Leaded package allows for optical inspection during PCB assembly
- Low clamping voltage protects downstream components
- Maximum ESD Robustness per the IEC standard
- Maximum ESD Robustness per the ISO10605 standard
- Immunity to protect from surge events
- Low leakage current
- Low cap for signal integrity, maintain less than ~250pF total bus capacitance
- AEC-Q101 automotive qualified and PPAP capable



**SOD323**  
2.5 x 1.25 x 0.95 mm





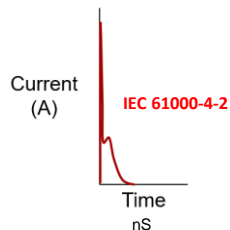
# CAN/LIN ESD families

Devices	ESD2CAN24-Q1	ESD2CANFD24-Q1	ESD2CANXL24-Q1	ESD1LIN24-Q1	ESD751-Q1	ESD761-Q1
Working Voltage (V <sub>RWM</sub> )	±24V			±24V		
# Channels	2			1		
Configuration	Bidirectional					
16A TLP Clamping Voltage <small>Indicates how well solution protects from 8kV ESD strike Learn More: <a href="#">Video</a>   <a href="#">Article</a></small>	35 V	36 V	38 V	40 V	41.5 V	42.5 V
Capacitance <small>Impacts System Bandwidth   Learn More: <a href="#">Video</a>   <a href="#">Article</a></small>	3pF	2.3pF	1.7pF	2.3pF	1.6pF	1.1pF
IEC 61000-4-2 (ESD) <small>System Level ESD Immunity Standard Learn More: <a href="#">Video</a>   <a href="#">Article</a></small>	±30kV	±25kV	±20kV	±30kV	±22kV	±20kV
ISO 10605 (ESD) 330 pF / 330 Ohms <small>Automotive System Level ESD Immunity Standard Learn More: <a href="#">Article</a></small>	±30kV	±25kV	±20 kV	±30kV	±22kV	±20kV
IEC 61000-4-5 (Surge) (tp=8/20us)	5.7 A	3.5 A	2.5 A	4.3 A	2.8 A	1.8 A
Packages	DBZ (SOT-23), DCK (SC-70)	DBZ (SOT-23)	DBZ (SOT-23)	DYF (SOD-323)	DYA (SOD-523)	DPY (0402)

The main spec to compare between these devices is the ESD rating, the lower capacitance variants of the 1 and 2-ch devices have lower ESD ratings and will be offered at a lower cost.

# Where to use protection devices

## ESD protection

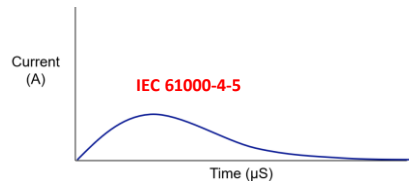


Pair with ANY INTERFACE  
that opens a system to the  
outside world

Look for:

- CAN/LIN
- USB
- Ethernet
- Audio
- Antennas
- SD and SIM Cards
- Even Buttons and Keypads!

## Surge protection



Pair with power/data Lines  
with environmental risk of  
surge exposure

Surge-prone characteristics:

- Systems that live outdoors
- High current/voltage power inputs
- Frequent load changes
- Long cabling
- Cabling running parallel to other systems
- Direct connection to car battery

# At a glance | recommended protection devices

Category & End Equipment	Recommend device by interface (Left to right: Decreasing Interface Signal Speed)								
	Antenna	HDMI, DisplayPort	PCIe	USB 2.0, 3.x	Ethernet	CAN, LIN, FPD Link	GPIO, I2C, Audio JTAG, Keypad	RS-485, RS-232	Power line, USB-PD, 4-20mA
<b>Advanced driver assistance system (ADAS)</b> Medium/Short Range Radar, ADAS Domain Controller, Camera Module	TPD1E01B04-Q1		TPD4E02B04-Q1	TPD2E2U06-Q1	TPD4E02B04-Q1	ESD2CAN24-Q1	TPD1E05U06-Q1	ESD752-Q1	TPD1E10B06-Q1
<b>Body Electronics &amp; Lighting</b> Body Control Module (BCM), Headlight, Automotive Gateway	TPD1E01B04-Q1		TPD4E02B04-Q1	TPD1E10B06-Q1	TPD4E02B04-Q1	ESD1LIN24-Q1	TPD1E10B06-Q1	ESD762-Q1	ESD1LIN24-Q1
<b>Hybrid, electric &amp; powertrain systems</b> Traction Inverter, Electric Power Steering, Battery Pack Passive Balancing	TPD1E01B04-Q1			TPD4E05U06-Q1	TPD4E02B04-Q1	ESD2CAN36-Q1	TPD1E05U06-Q1	ESD761-Q1	TPD1E10B06-Q1
<b>Infotainment &amp; Cluster</b> Head Unit, USB Charging, Digital Cockpit Processing Unit, Info Display	TPD1E01B04-Q1		TPD4E02B04-Q1	TPD2E2U06-Q1	TPD4E05U06-Q1	ESD761-Q1	TPD1E10B06-Q1	ESD752-Q1	TPD1E10B06-Q1
<b>Grid Infrastructure</b> Electric Meter, Battery Storage System, Data Concentrator, String Inverter	TPD1E01B04			ESD122	ESDS304	ESD2CAN24-Q1	ESD351	ESD752	TVS1800/01
<b>Building Automation</b> IP Network Camera, Video Recorder, HVAC Controller	TPD1E01B04	ESD204	ESDS314	ESD224	TPD4E05U06	ESD2CANFD24-Q1	TPD1E05U06	ESD762	TSM36A
<b>Appliances</b> Vacuum Robot, Cordless Power Tool, AC unit, Battery Charger	TPD1E01B04			ESD401	TPD4E02B04	ESD1LIN24-Q1	TPD1E10B06	ESD751	TVS2700/01
<b>Personal Electronics</b> Notebook PC, Motherboard, Smartphone, TV	TPD1E0B04	TPD4E02B04	TPD4E02B04	ESD321	ESD204		ESD341		TVS2200/01
<b>Wired Networking</b> Data Center Switch, WLAN/Wi-Fi Access Point, Router	TPD1E01B04		TPD4E02B04	TPD2E2U06	ESDS314		TPD4E05U06	ESD752	TVS0701
<b>Datacenter &amp; Enterprise Computing</b> Rack Server, Network Interface Card, SSD		ESD224	TPD4E02B04	TPD4E1U06	ESDS304		ESD401	ESD762	TVS1400/01
<b>Factory Automation</b> Single Board Computer, Digital Input Module	TPD1E0B04	ESD204	TPD4E02B04	TPD1E05U06	ESDS312	ESD762	TPD1E10B06	ESD752	TVS3300/01
<b>Home Theater &amp; Entertainment</b> STB & DVR, Streaming Media Player, Smart Speaker	TPD1E01B04	TPD4E02B04		TPD6E05U06	ESDS314		TPD1E10B09		TVS2700/01

Advanced protection >15kV

Surge Protection >=6A

Low cap. <=0.5pF

Small size

Multi-Ch

# Getting started

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
E2E design support forums	Interface	<a href="https://e2e.ti.com/support/interface-group/interface/f/interface-forum/">https://e2e.ti.com/support/interface-group/interface/f/interface-forum/</a>
	ESD fundamentals training	<a href="https://e2e.ti.com/support/interface-group/interface/f/interface-forum/1090733/faq-esd-fundamentals-training">https://e2e.ti.com/support/interface-group/interface/f/interface-forum/1090733/faq-esd-fundamentals-training</a>
Technical content	System level ESD guide CAN bus ESD protection	<a href="https://www.ti.com/lit/sg/sszb130d/sszb130d.pdf">https://www.ti.com/lit/sg/sszb130d/sszb130d.pdf</a> <a href="https://www.ti.com/lit/an/slva4c1/slva4c1.pdf">https://www.ti.com/lit/an/slva4c1/slva4c1.pdf</a>
Product folder	ESD2CAN24-Q1 product folder ESD1LIN24-Q1 product folder	<a href="https://www.ti.com/product/ESD2CAN24-Q1">https://www.ti.com/product/ESD2CAN24-Q1</a> <a href="https://www.ti.com/product/ESD1LIN24-Q1">https://www.ti.com/product/ESD1LIN24-Q1</a>
Development tool or evaluation kit	Generic ESD evaluation module for common single and multi-channel packages in our portfolio.	<a href="https://www.ti.com/tool/ESDEVM">https://www.ti.com/tool/ESDEVM</a>

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