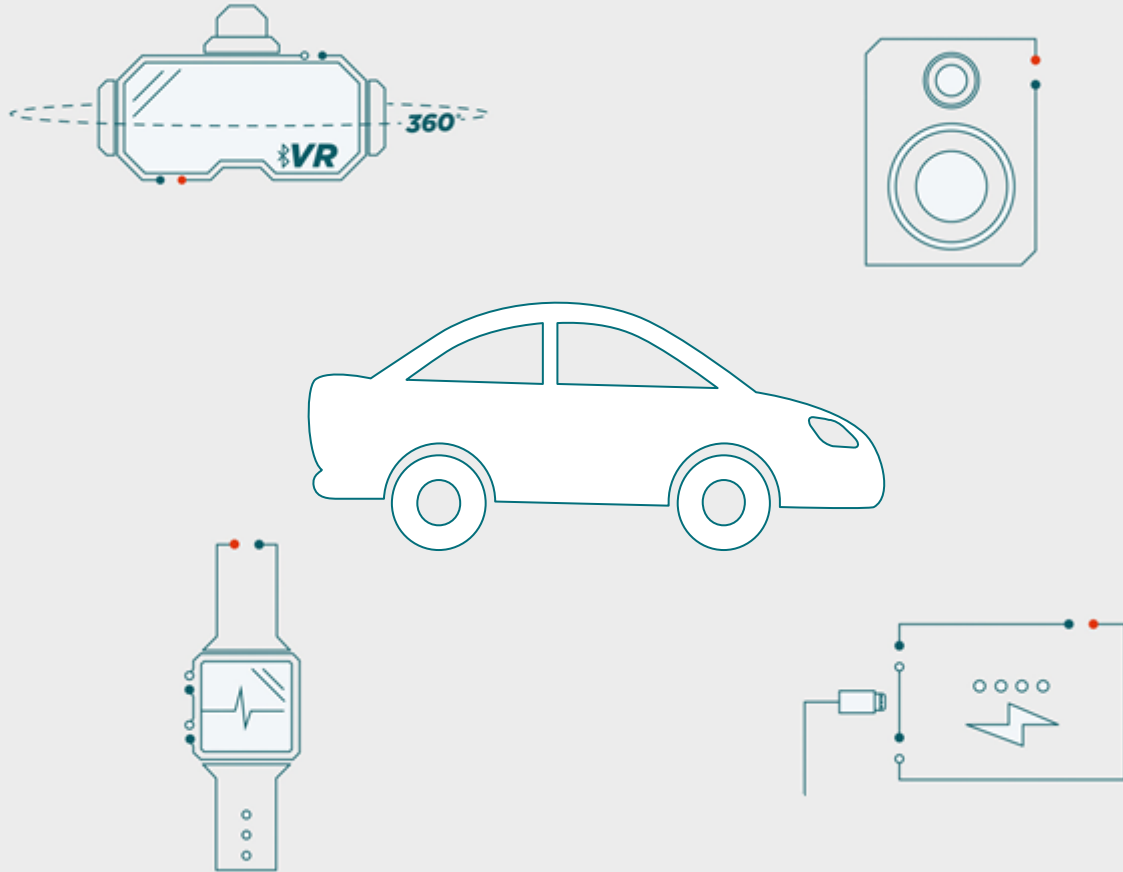


# **Nexperia ESD Protection**

## Automotive



# Nexperia | the #1 Protection supplier



- **Worldwide #1 ESD supplier** by volume & value according to IHS and WSTS
- Setting **performance benchmarks** in high-speed ESD
- **Supplying all major electronic OEMs** across all segments and regions
- Protection Portfolio with **>100 leading performance devices**





# Overview

- **Datasheet Parameters for ESD Protection Devices**
- **ESD protection**
  - LIN/CAN, CAN-FD
  - Automotive Ethernet (Open Alliance)
  - Infotainment/SerDes
- **Miniaturization**
- **Simulation, Service & Support**



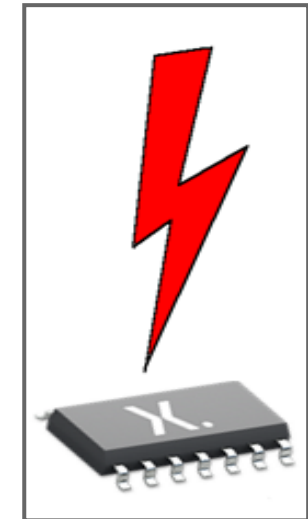
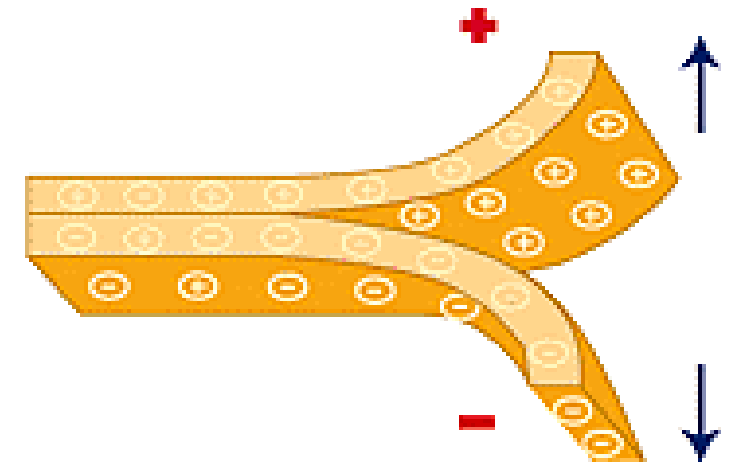
# ESD Basic



# ElectroStatic Discharge (ESD)

## Sources of Electrostatic Charges

- A sudden discharge between persons, devices or components, eg: friction
- While no harmful effects are known to humans, ESD can damage electronics.
- In the early days of electronics, most damages happened in production environment (moving parts), which lead to strict control of assembly lines and good ground contacts to avoid charge being built up. This is simulated by a **Machine Model (MM)**
- The main focus today is on people being charged and touching electronics in the field. This kind of discharge is simulated by **Human Body Model (HBM)** testing.
- In **Charge device model (CDM)** a component itself becomes charged (e.g. electrostatic field is induced by high voltages) and is rapidly discharged (by an ESD event) as it closely approaches a conductive object.
- ESD exists EVERYWHERE



# ESD Defect Mechanisms

Differentiation between high voltage and high energy - ESD devices need to protect from both

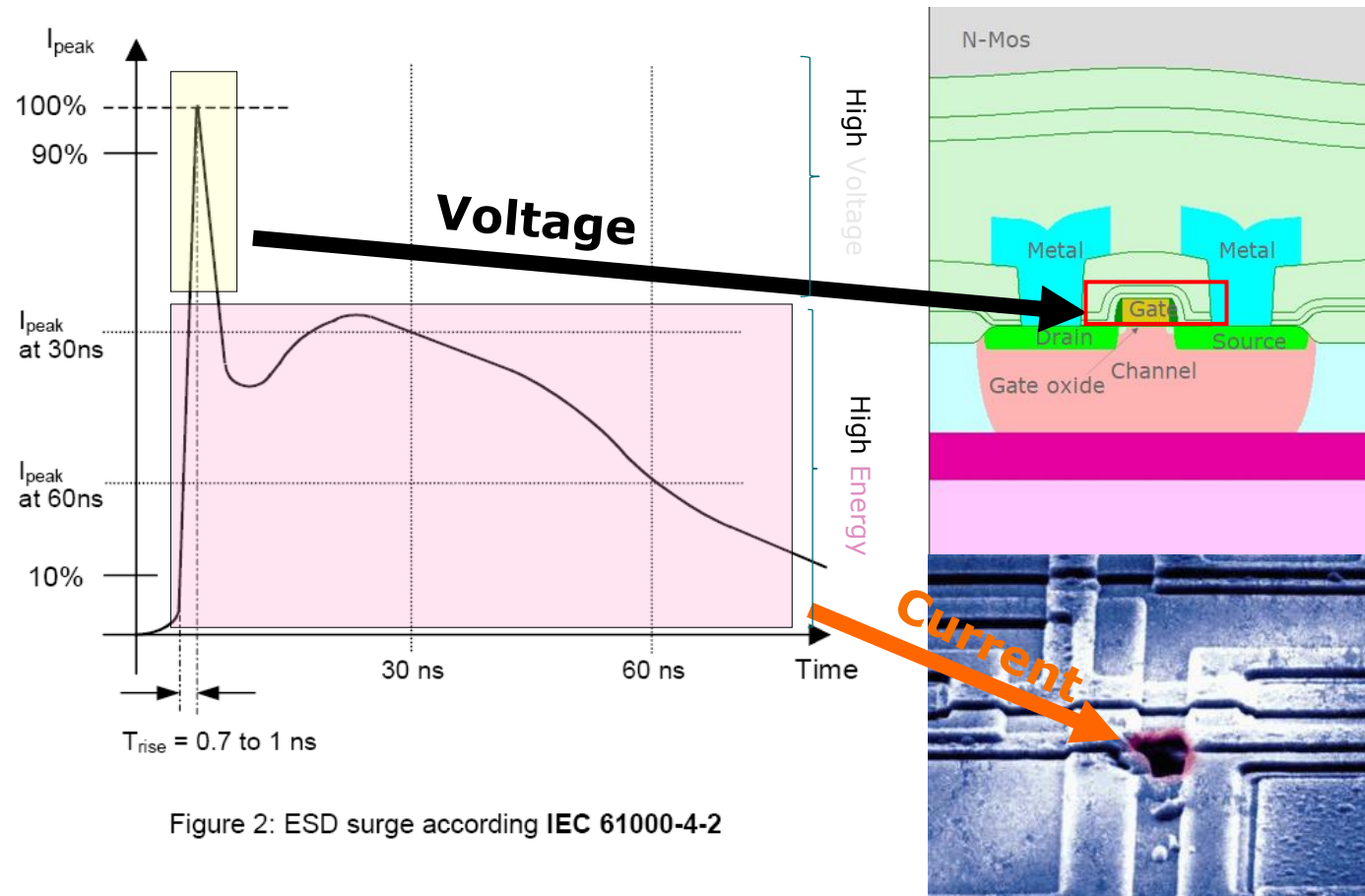


Figure 2: ESD surge according IEC 61000-4-2

## Damage by Field Strength

- Steep rise time and high peak voltage of the first peak can damage gate oxide
- ESD protection with fast turn on time required to safeguard sensitive SoCs

## Damage by Thermal Load

- Through the longer duration of the second pulse high amount of energy can accumulate to damage the system over thermal load
- For low frequency applications this can be addressed by a larger device areas

# ESD – Electro Static Discharge

## Device level

- ICs can be destroyed (ESD) during placement.
- ESD "on-chip protection" protects against defects during production.
- Qualification by standards (JEDEC)
  - Human Body Model (HBM)
  - Machine Model (MM)
  - Charged Device Model (CDM)
- ESD pulses are given to all IC pins.



## System level

- ESD threatens also boards and (complete) devices.
- Special diodes are added on the board to avoid destruction by ESD.
- "System Level" ESD standards
  - IEC 61000-4-2  
Electrostatic discharge immunity test
  - ISO 10605
- ESD pulses are given to certain accessible interfaces.  
Individual components are not tested!





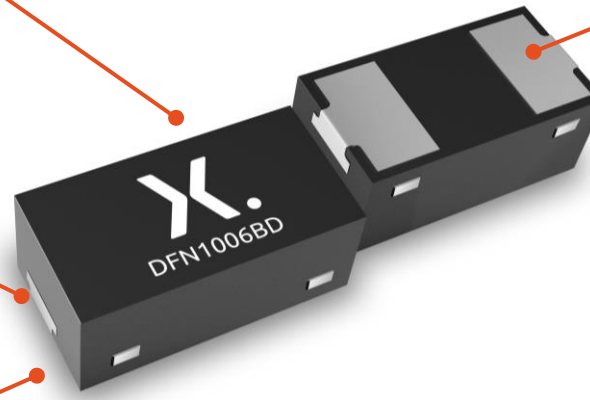
# Selection Criterion

Package (shape/size/footprint)

Electrical performance

Side-wettable flanks for AOI

Number of signal lines



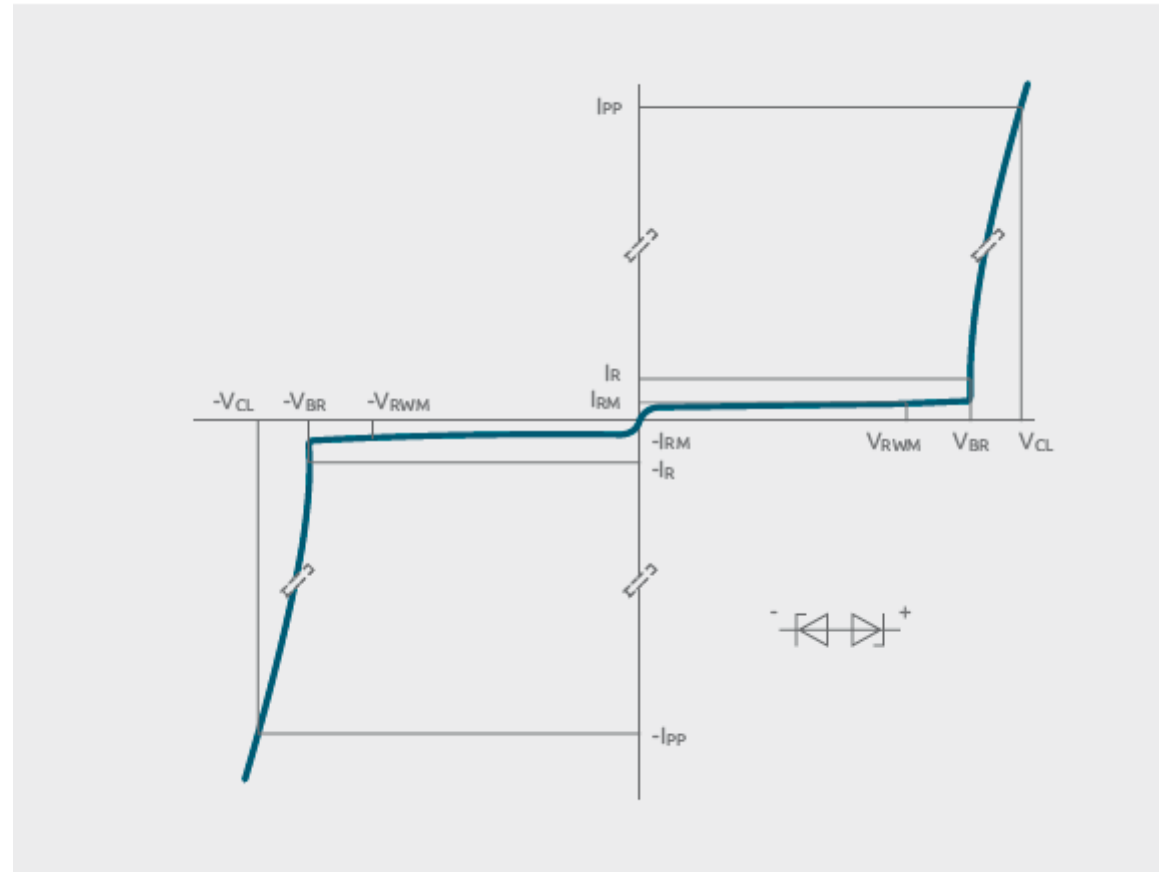
- Reverse stand-off voltage  $V_{RWM}$
- ESD robustness level  $V_{ESD}$
- Clamping voltage  $V_{clamp}$
- Dynamic resistance  $R_{dyn}$
- Topology: uni- / bi-directional, rail to rail, ...
- Device capacitance  $C_{diode}$  and other parasitics





# Characteristics of ESD Protections

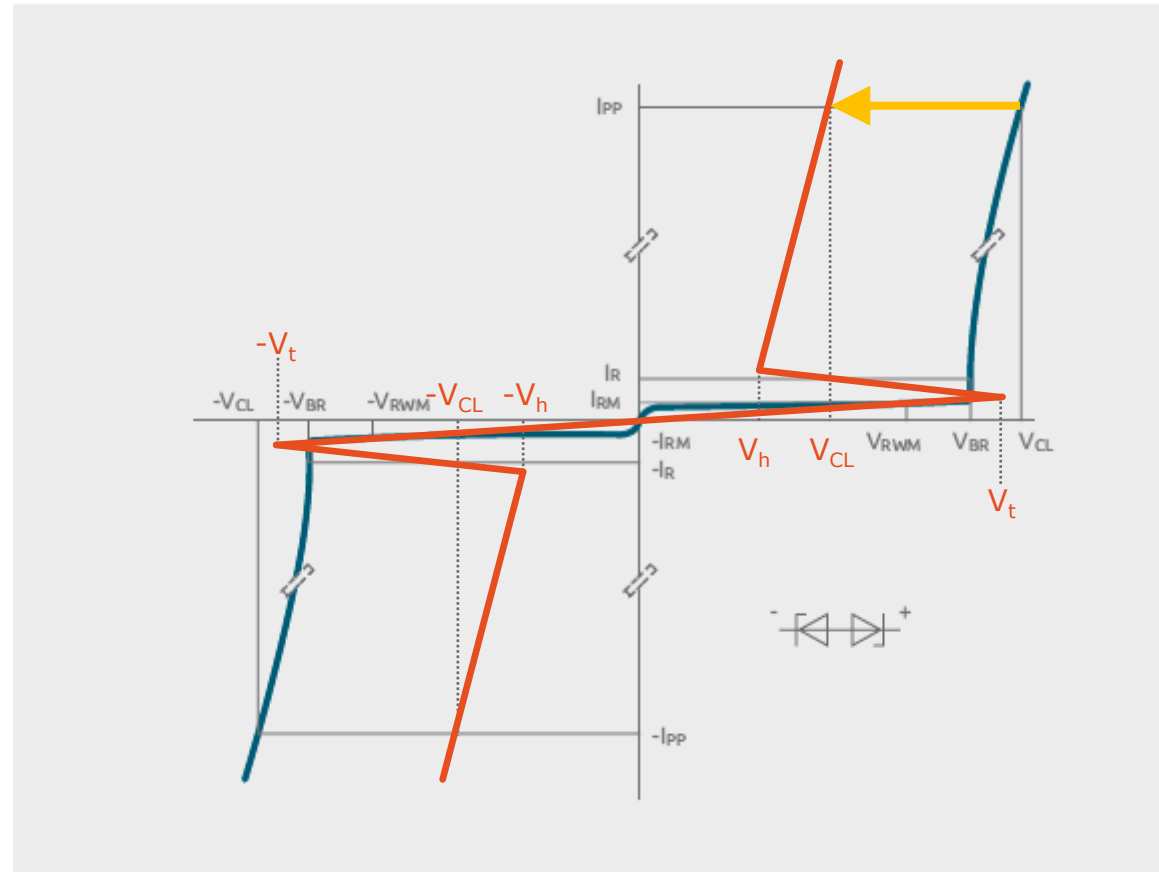
## Classical Zener Characteristic



$V_{RWM}$ : Reverse standoff voltage  
 $V_{BR}$ : Breakdown voltage  
 $V_{CL}$ : Clamping voltage  
 $I_{RM}$ : Maximum reverse current  
 $I_{PP}$ : Maximum surge current

# Characteristics of new ESD Protections

Snap Back



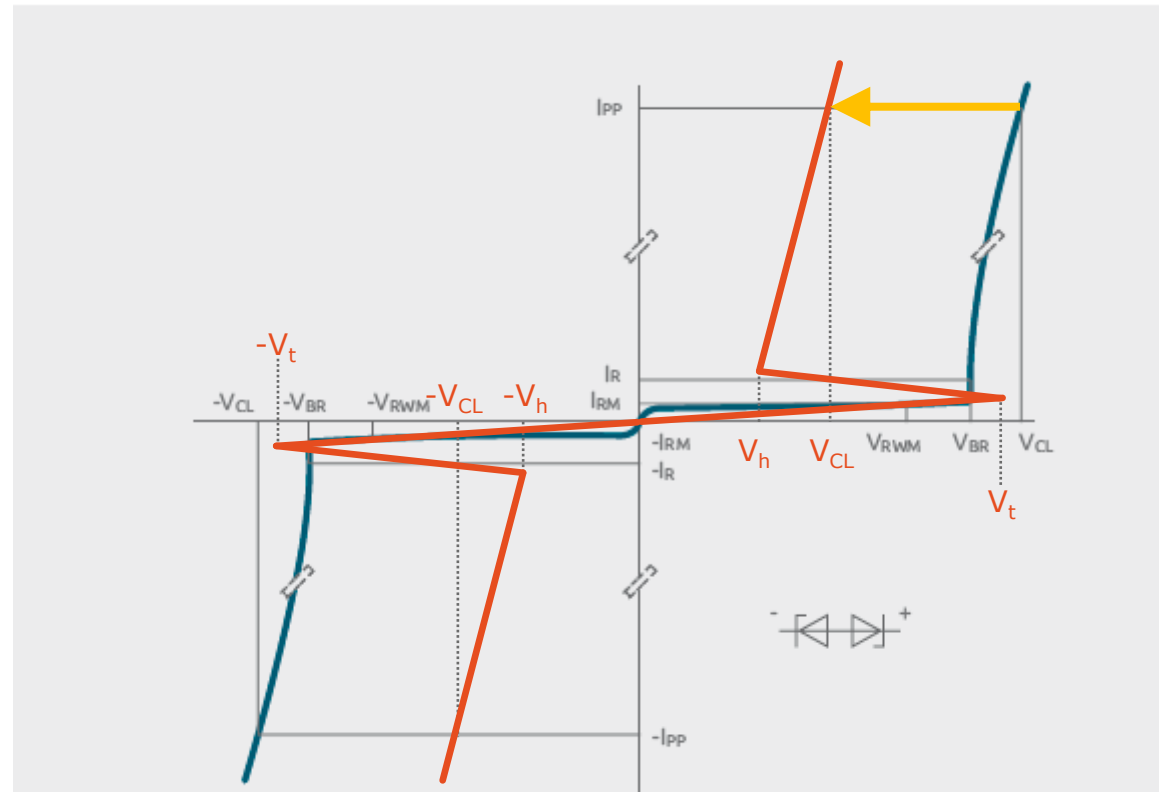
$V_{RWM}$ : Reverse standoff voltage  
 $V_{BR}$ : Breakdown voltage  
 $V_{CL}$ : Clamping voltage  
 $I_{RM}$ : Maximum reverse current  
 $I_{PP}$ : Maximum surge current

$V_t$ : Trigger voltage  
 $V_h$ : Holding voltage



# Characteristics of new ESD Protections

Snap Back



$V_{RWM}$ : Reverse standoff voltage  
 $V_{BR}$ : Breakdown voltage  
 $V_{CL}$ : Clamping voltage  
 $I_{RM}$ : Maximum reverse current  
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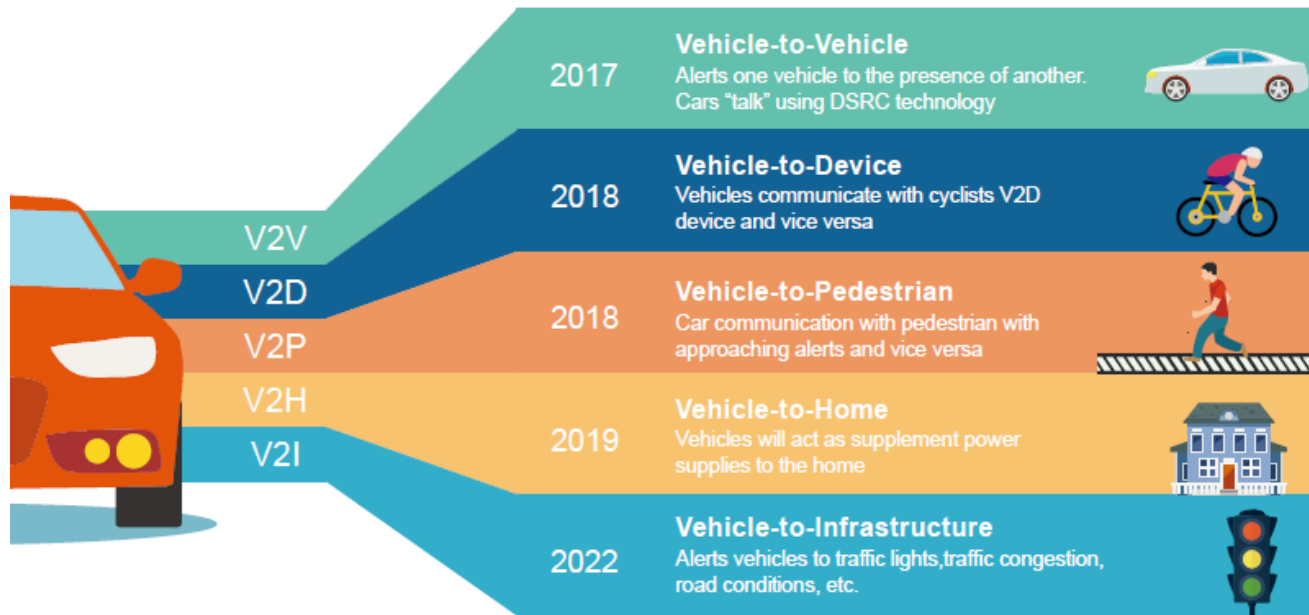
$V_t$ : Trigger voltage  
 $V_h$ : Holding voltage

Reducing  $V_{CL}$  -> Improving Robustness



# Connectivity

Undisruptive communication towards pedestrians (V2P) and infrastructure (V2I) is critical to assure safety



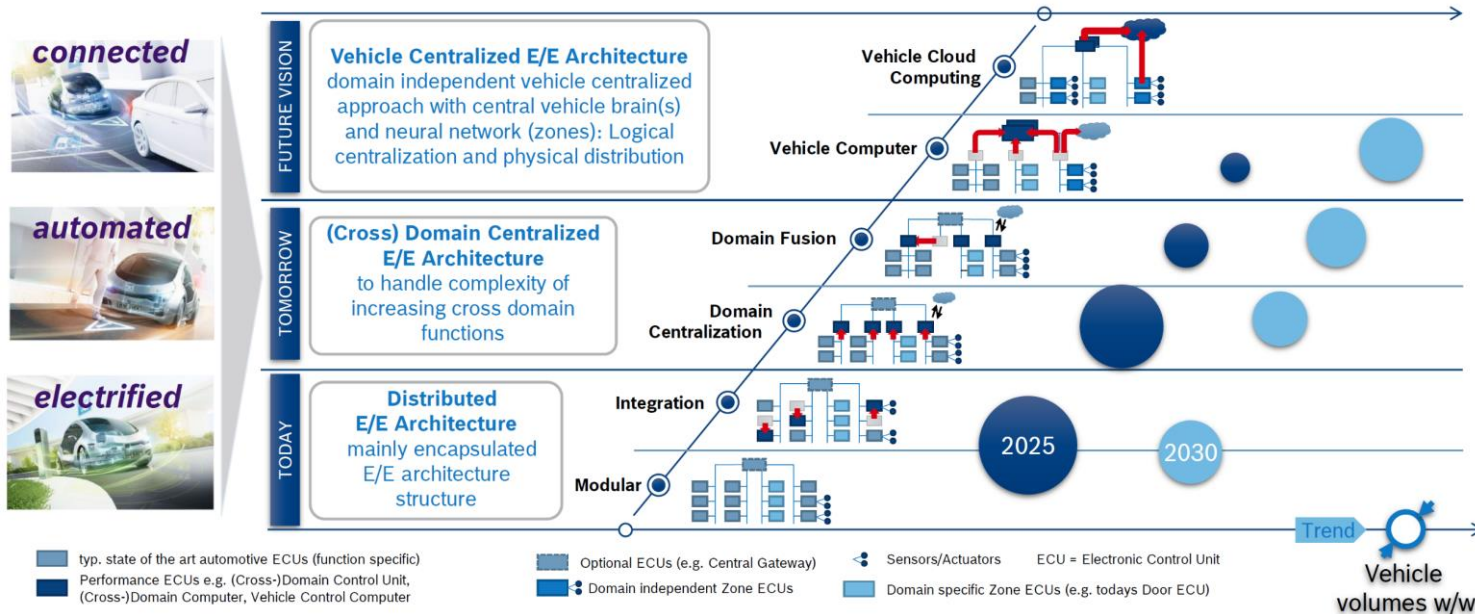
- Cars will communicate with each other and the infrastructure around
- The dashboard converts to a large display that includes connectivity to traffic data or personal data
- The car works as a hub in the connected world – 'dirty' electronic environment require automotive grade EMI filter and ESD protection
- **Reliable connectivity is one component to achieve "Vision ZERO" - no fatalities or serious injuries by road traffic**
- **Reliable connectivity requires automotive grade components!**

# **Automotive ESD Device Portfolio**



# Evolution of automotive E/E architecture

## Automotive In-Vehicle Network (IVN) Protection



Source: Dr. Andreas Lock, Robert Bosch GmbH, 2020

- Automotive networks develop from a distributed to a cross domain/ vehicle centralized architecture
- The number of IVN nodes is steadily increasing
  - Steady growth for LIN/CAN
  - Automotive Ethernet is the next normal
- Most network technologies suggest additional ESD Protection
  - about 50% of the LIN/CAN nodes are additionally protected against ESD

Nexperia provides the protection solution for a reliable In-Vehicle Network

# Automotive ESD Protection



## Miniaturization

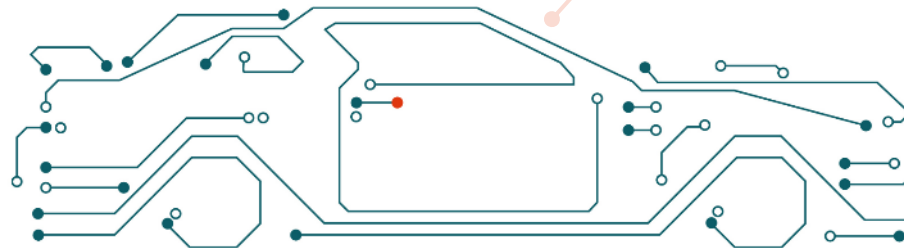
Driving space saving with new automotive grade DFN packages incl. side wettable flanks

- DFN1006BD-2
- DFN1x1xD-3



New solutions for Ethernet ESD Protection + package investigation study

- PESD2ETH100-T
- PESD2ETH1G-T



New portfolio based on IVN ESD Protection family in SOT23, SOT323, DFN1010BD-3, DFN1412D-3 for 12 V and 24 V board net



New portfolio for SerDes applications and protocols such as GMSL, FPD link in leadless packages

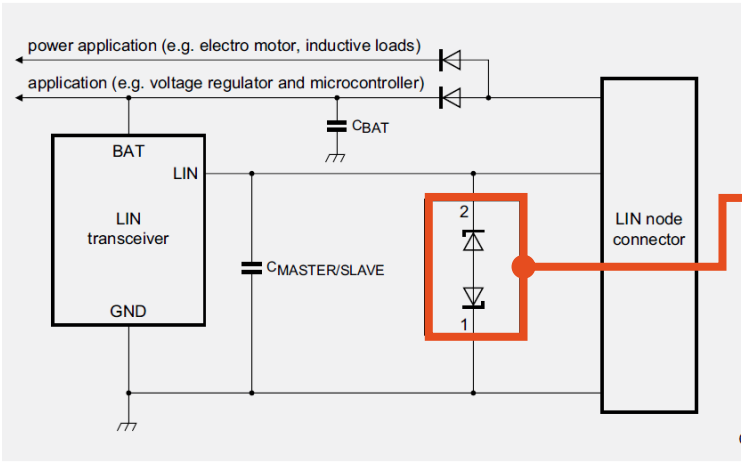


New portfolio based on Nexperia TrEOS protection technology for automotive infotainment in SOT23, SOT1176 and SOD882BD

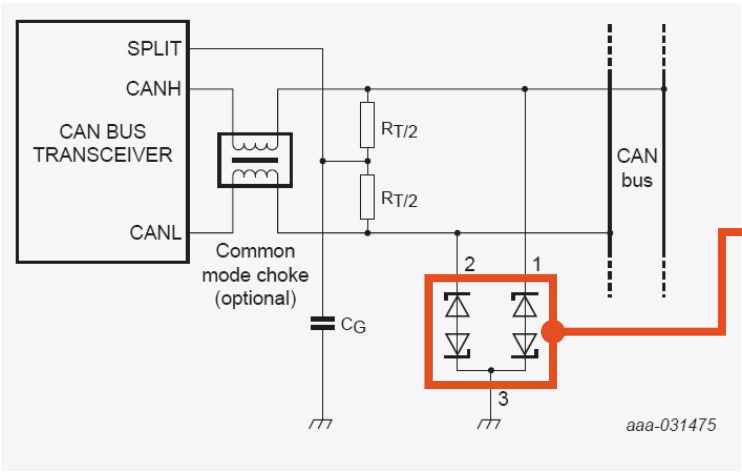




# LIN | CAN (FD) | FlexRay



Device	Package	V <sub>RWM</sub>	C <sub>D</sub>	V <sub>ESD</sub>	Board net
PESD1IVN2x-A	SOD323	24/27 V	<17pF	30 kV	12 V
PESD1IVN2x-LS	DFN1006BD-2	24/27 V	<17pF	30 kV	12 V



Device	Package	V <sub>RWM</sub>	C <sub>D</sub>	V <sub>ESD</sub>	Board net
PESD2IVN2x-T PESD2IVN2x-U	SOT23 SOT323	24/27 V	<17pF	30 kV	12V
PESD2CANFD2x-T PESD2CANFD2x-U	SOT23 SOT323	24/27 V	<10pF	30 kV	12V
PESD2CANFD2x-QB PESD2CANFD2x-QC	DFN1110D-3 DFN1412D-3	24/27 V	<10pF	30 kV	12V
PESD2CANFD36x-T PESD2CANFD36x-U	SOT23 SOT323	36 V	<10pF	30 kV	24V

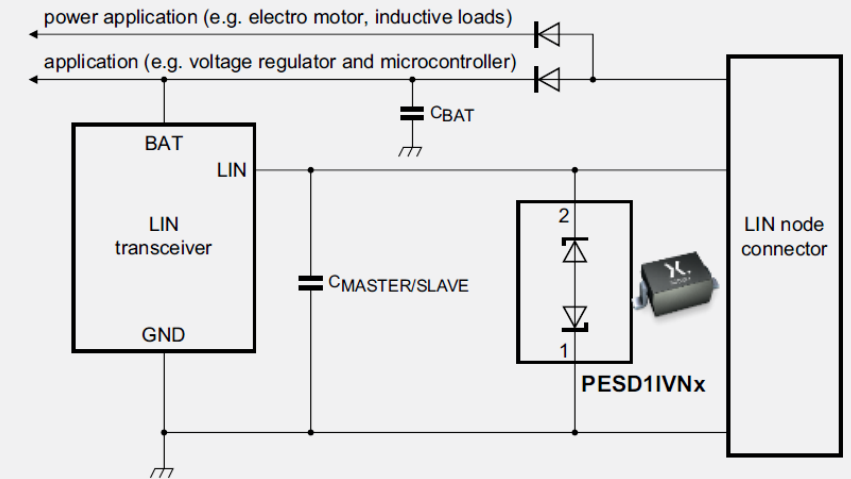
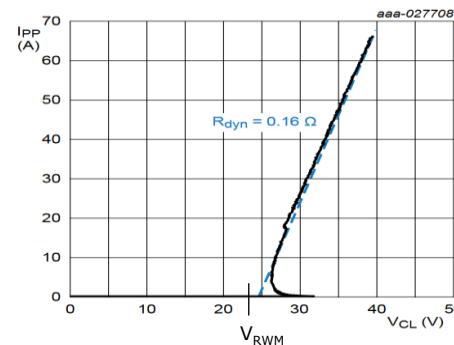
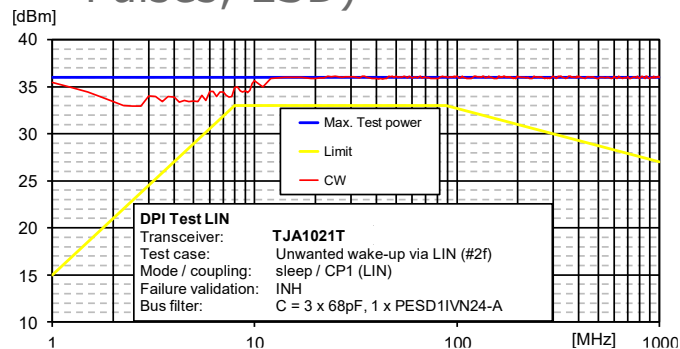


# LIN

## Local Interconnect Network



- Requirement for ESD protection depend on OEM (approval list)
- Common requirements:
  - Parasitic capacitance of 30-100pF max
  - Short-to-battery and jumpstart robust
    - ISO16750-2 (26 V) or internal norms (28 V)
  - Compliance with ISO17987 in combination with a transceiver (Emission, Immunity: DPI(Direct Power Injection), Pulses, ESD)



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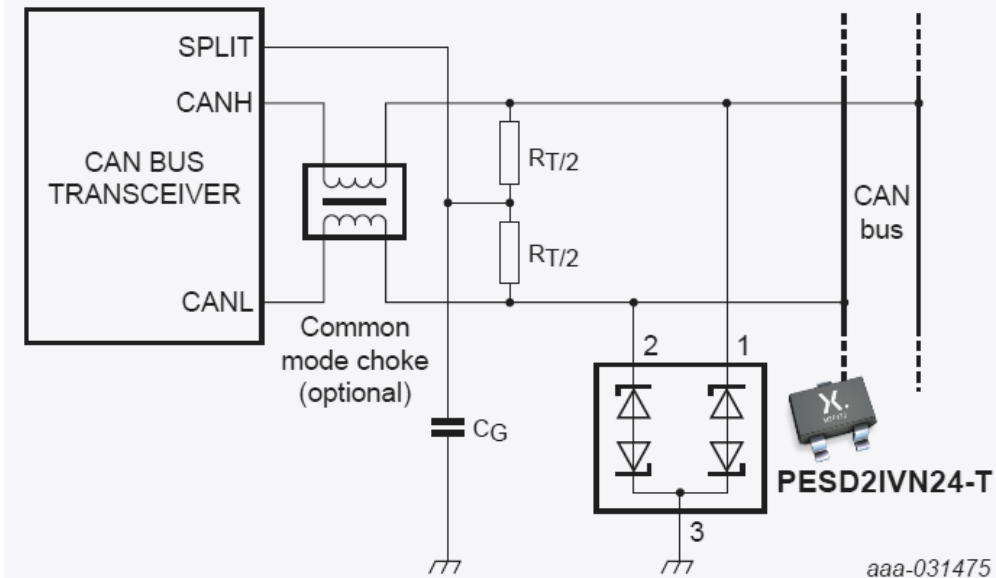
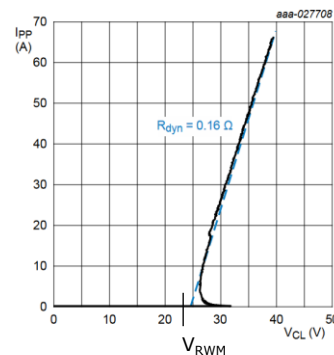
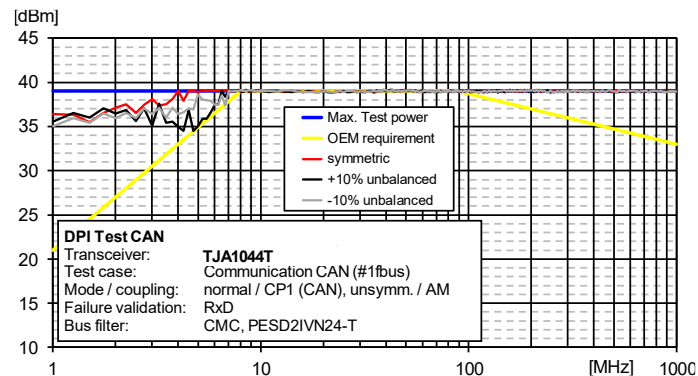


# CAN

## Controller Area Network



- Requirement for ESD protection depend on OEM (approval list)
- Common requirements:
  - Parasitic capacitance of 17-30pF max (for CAN FD 6-10)
    - Because of rather high  $C_p$ , matching is required
  - Short-to-battery and jumpstart robust
    - ISO16750-2 (26 V) or internal norms (28 V)
  - Compliance with IEC62228-3 in combination with a CAN transceiver (Emission, Immunity: DPI, Pulses, ESD)



# PESDxIVN series









## Key Features

- AEC-Q101 qualified / Automotive grade
- ESD protection up to 30kV / Surge up to 3.5A (8/20μs)
- Low capacitance (max. 17pF) with matching:  $\Delta C/C_d < 0.1\%$
- Ultra low leakage current
- Clamping performance on a new level
- Future proof package options
- All devices released

PESD1LIN  
Drop-in  
alternative

PESD1CAN  
Drop-in  
alternative

## Portfolio

Type	V <sub>RWM</sub>	# lines	Package
PESD1IVN24-A	24		1 SOD323 
<b>PESD1IVN27-A</b>	27		1 SOD323
PESD1IVN27-U	27		1 SOT323
<b>PESD2IVN24-T</b>	24	<b>CAN</b>	2 SOT23 
PESD2IVN27-T	27	<b>CAN</b>	2 SOT23
PESD2IVN24-U	24	<b>CAN</b>	2 SOT323 
PESD2IVN27-U	27	<b>CAN</b>	2 SOT323

**OEM Approval**

## Key Applications

- Automotive bus protection
- Data and audio interfaces e.g. car multimedia line protection
- Overvoltage protection e.g. airbag controllers, ABS, ESC
- Car drivers interface protection e.g. dashboard panel

**LIN | CAN | FlexRay  
SENT**

# Nexperia ESD Protection for CAN-FD | 24/27 V

**NEXPERIA**

**CAN<sup>FD</sup>**

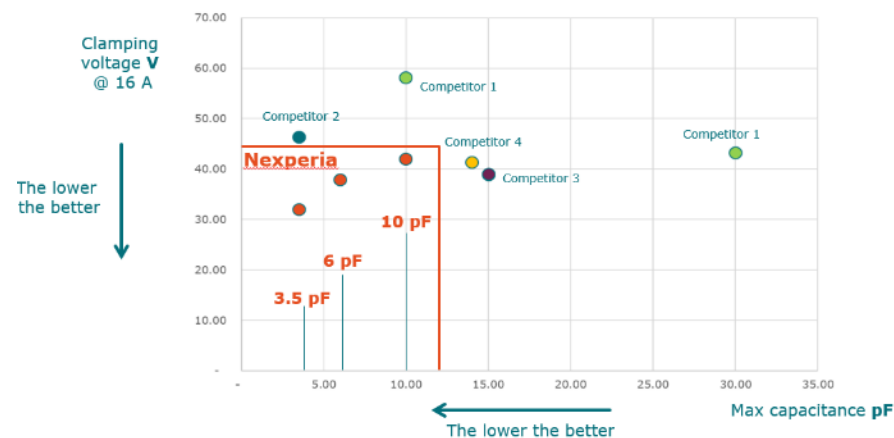
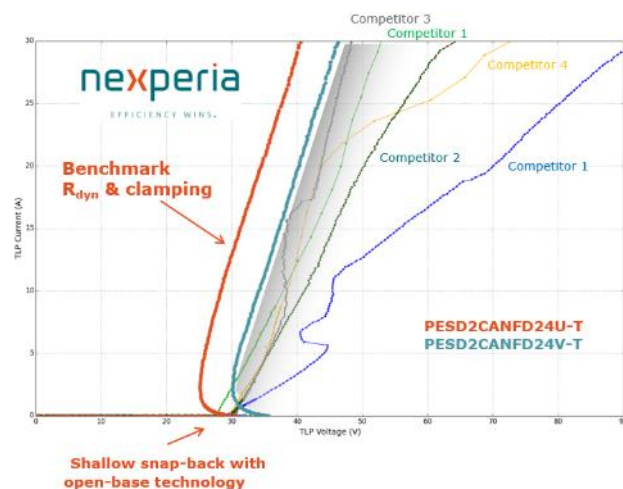
**Nexperia CAN-FD ESD Protection**

**Super efficient design**

- SOT23, SOT323 & DFN1x1x
- $V_{RWM}$  24 V & 27 V
- $C_D$  3.5 pF, 6 pF & 10 pF
- $V_{ESD}$  14 kV, 23 kV & 30 kV

**nexperia**  
EFFICIENCY WINS.

Portfolio	Positioning	Status
<b>PESD2CANFDxL-xy</b>	10 pF in SOT23, SOT323 for LS CAN-FD	<b>Released</b>
<b>PESD2CANFDxV-xy</b>	6 pF in SOT23, SOT323 meeting VW spec	
<b>PESD2CANFDxU-xy</b>	3.5 pF in SOT23, SOT323 for HS CAN-FD and custom designs	
<b>PESD2CANFDxx-QB</b>	DFN1110D-3 leadless CAN-FD ESD protection with SWF feature	
<b>PESD2CANFDxx-QC</b>	DFN1412D-3 leadless CAN-FD ESD protection with SWF feature	



# Nexperia ESD Protection for CAN-FD | 32/36 V

**NEXPERIA**

**CAN<sup>FD</sup>**

**Nexperia CAN-FD ESD Protection**

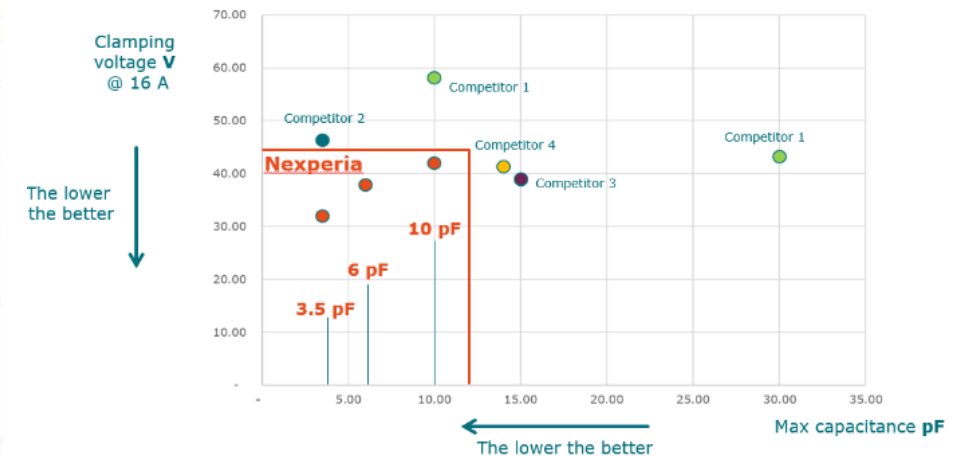
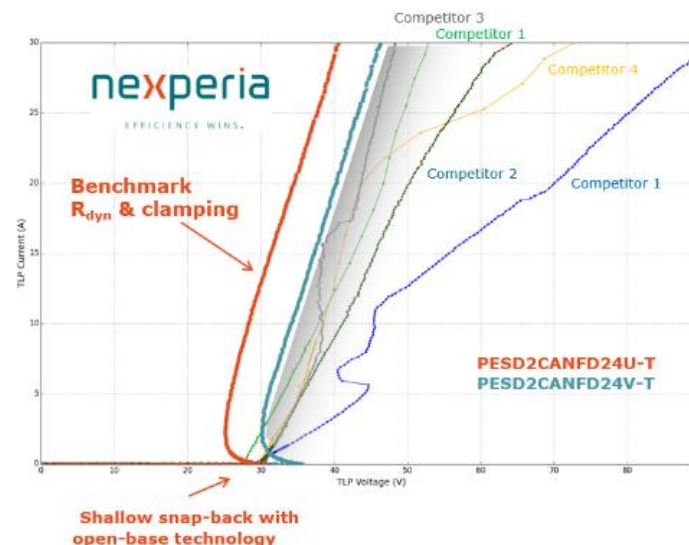
**Super efficient design**

- SOT23, SOT323 & DFN1x1x
- $V_{RWM}$  32 V & 36 V
- $C_D$  3.5 pF, 6 pF & 10 pF
- $V_{ESD}$  14 kV, 23 kV & 30 kV

**nexperia**  
EFFICIENCY WINS.

Portfolio	Positioning	CQS	RFS
PESD2CANFDxL-xy	10 pF in SOT23, SOT323 for LS CAN-FD	August 2021	October 2021
PESD2CANFDxV-xy	6 pF in SOT23, SOT323 meeting VW spec		
PESD2CANFDxU-xy	3.5 pF in SOT23, SOT323 for HS CAN-FD and custom designs		
DFN packages will follow in Q1 2022			

For 24 V board net



# Portfolio | Legacy Replacement

LIN | CAN (FD) | FlexRay | SENT

Legacy	Package	New device	Package	New	DFN Package with SWF
<b>PESD1CAN-U</b>	SOT323	<b>PESD2CANFD24L-U</b>	SOT323	<b>PESD2CANFD24V-QB PESD2CANFD24V-QC</b>	DFN1110D-3 DFN1412D-3
<b>PESD1IVN-U</b>	SOT323	<b>PESD2CANFD27L-U</b>	SOT323	<b>PESD2CANFD27V-QB PESD2CANFD27V-QC</b>	DFN1110D-3 DFN1412D-3
<b>PESD1IVN27-U</b>	SOT323	<b>PESD2CANFD27L-U</b>	SOT323	<b>PESD2CANFD27V-QB PESD2CANFD27V-QC</b>	DFN1110D-3 DFN1412D-3
<b>PESD1LIN</b>	SOD323	<b>PESD1IVN24-A PESD1IVN27-A</b>	SOD323	<b>PESD1IVN24-LS PESD1IVN27-LS</b>	DFN1006BD-2
<b>PESD2IVN-U</b>	SOT323	<b>PESD2CANFD27L-U</b>	SOT323	<b>PESD2CANFD27V-QB PESD2CANFD27V-QC</b>	DFN1110D-3 DFN1412D-3
<b>PESD2CAN</b>	SOT23	<b>PESD2CANFD24L-T</b>	SOT23	<b>PESD2CANFD27V-QB PESD2CANFD27V-QC</b>	DFN1110D-3 DFN1412D-3
<b>PESD1FLEX</b>	SOT23	<b>PESD2IVN24-T</b>	SOT23	<b>PESD2CANFD24V-QB PESD2CANFD24V-QC</b>	DFN1110D-3 DFN1412D-3
<b>PESD1CAN</b>	SOT23	<b>PESD2IVN24-T</b>	SOT23	<b>PESD2CANFD24V-QB PESD2CANFD24V-QC</b>	DFN1110D-3 DFN1412D-3



# Automotive ESD Protection

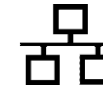
## For OPEN ALLIANCE



### Miniaturization

Driving space saving with new automotive grade DFN packages incl. side wettable flanks

- DFN1006BD-2
- DFN1x1xD-3



New solutions for Ethernet ESD Protection + package investigation study

- PESD2ETH100-T
- PESD2ETH1G-T
- PESD2ETH1GX-T
- PESD1ETH1G-LS



New portfolio based on IVN ESD Protection family in SOT23, SOT323, DFN1010BD-3, DFN1412D-3 for 12 V and 24 V board net

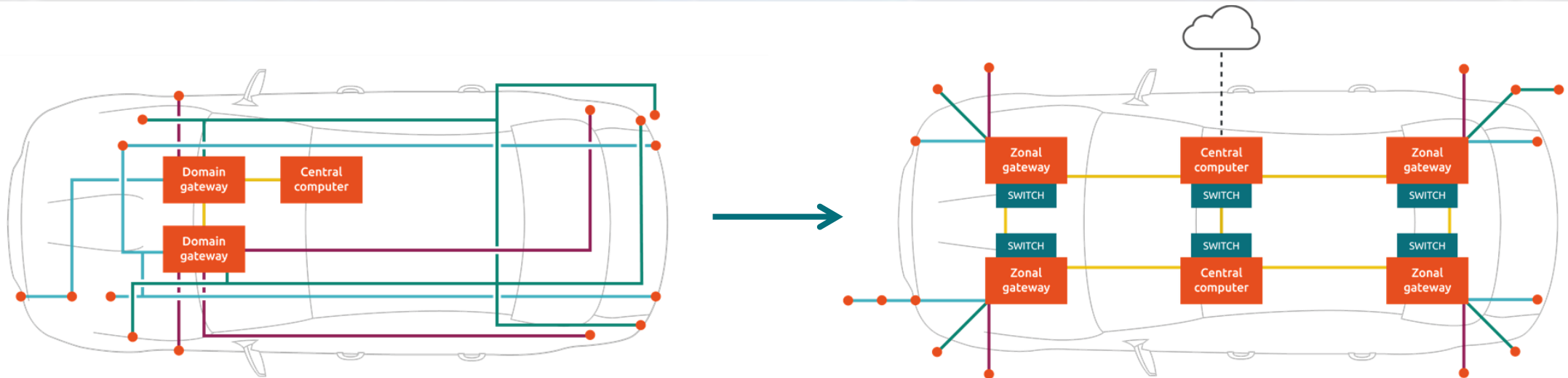


New portfolio for SerDes applications and protocols such as GSML, FPD link in leadless packages



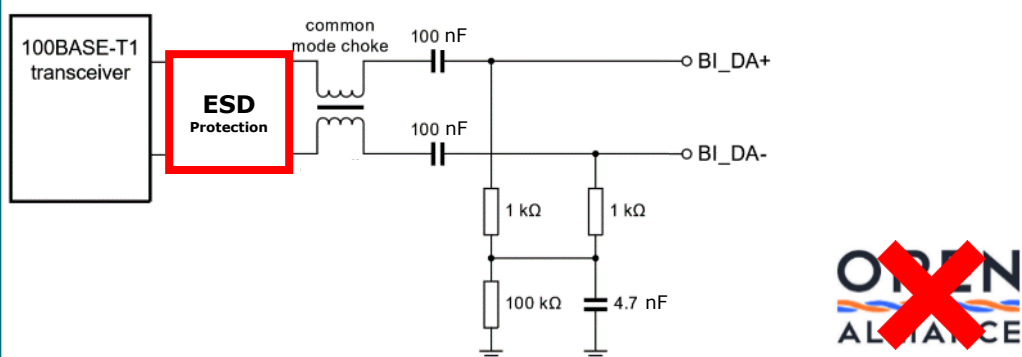
New portfolio based on Nexperia TrEOS protection technology for automotive infotainment in SOT23, SOT1176 and SOD882BD

# Evolution of In-Vehicle Networking



# Classic Ethernet vs. OPEN Alliance

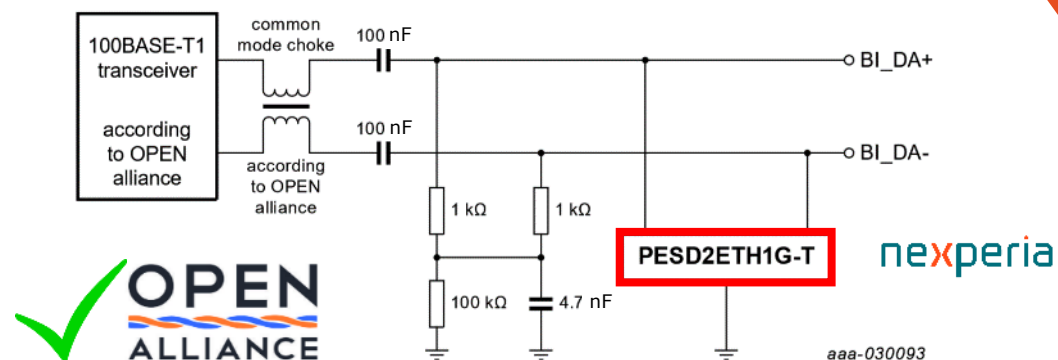
## Classic Ethernet



ESD Protection behind DC block, CMC and in front of PHY

- **Dual sourcing of ESD protection critical**, because TLP curves and turn on behaviour need to match
- Internal protection of the PHY and external ESD protection cannot always be matched

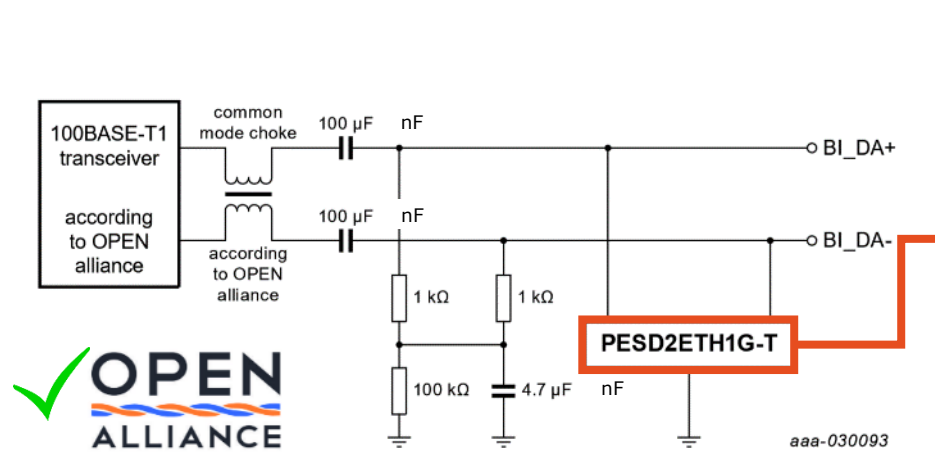
## OPEN Alliance Ethernet



ESD Protection in front of DC Block, CMC and PHY

- **Dual sourcing of ESD protection uncritical**, because ESD protection in front of DC block and CMC protect whole system
- External ESD protection is decoupled from internal protection of the PHY. **PESD2ETH1G-T matches with every PHY**
- **RE-Use of the schematic in a wide range**

# Ethernet OPEN Alliance - IEC62228-5



Portfolio	Package	V <sub>RWM</sub>	V <sub>trigger</sub>	C <sub>D</sub>	V <sub>ESD</sub>
PESD2ETH100-T	SOT23	24 V	> 100 V	3 pF	30 kV
PESD2ETH1G-T	SOT23	24 V	> 100 V	2 pF	30 kV
PESD2ETH1GX-T	SOT23	24 V	> 100 V	1 pF	30 kV
PESD1ETH1GLS-Q	DFN1006BD-2	24 V	> 100 V	2 pF	30 kV
PESD1ETH1GXLS-Q	DFN1006BD-2	24 V	> 100 V	1 pF	30 kV

According to car manufacture specifications for supply voltages  $\geq 56V$  voltage range for 48V electrical systems, typically 100V min. electric strength recommended for ceramic caps. For 12V systems typ. 50V electrical strength is sufficient

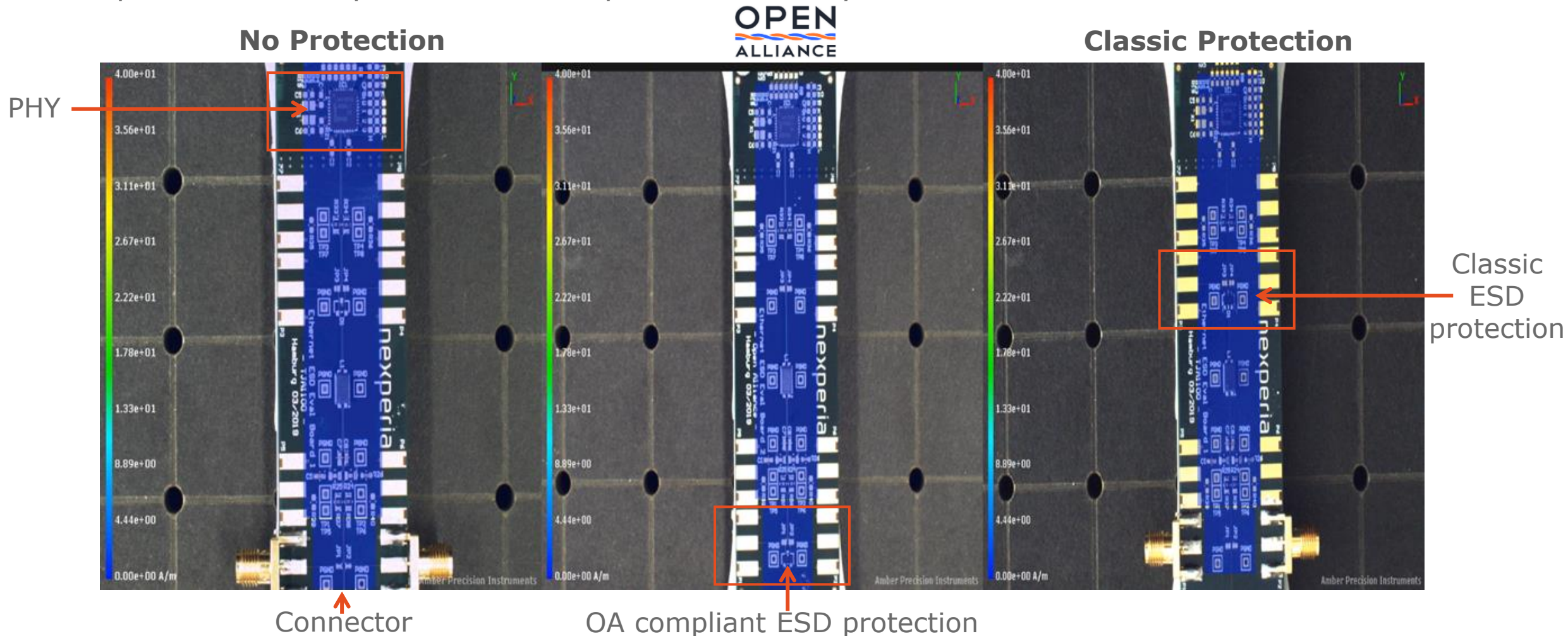
## Benefits of the placement directly at the connector:

- Best clamping performance
- Dual source possible
- Re-Use ready



# 100BASE-T1 concept comparison

Comparison of ESD protection concepts evaluated by EMI scanner





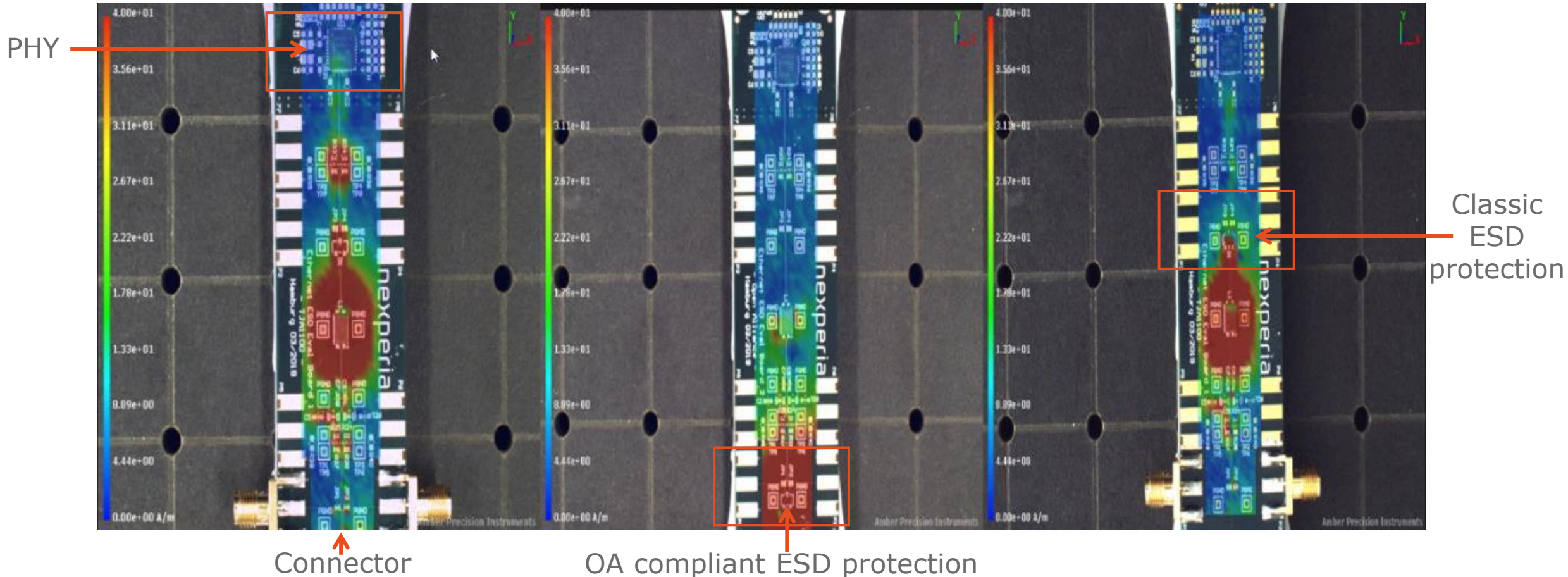
# 100BASE-T1 concept comparison

Comparison of ESD protection concepts evaluated by EMI scanner

OPEN  
ALLIANCE

No Protection

Classic Protection



# 100/1000BASE-T1 Ethernet Protection

Nexperia – Your Partner for ESD Protection

FTZ e.V. an der Westsächsischen Hochschule  
Zwickau, University of Applied Science  
Department of Electrical Engineering  
EMC Investigations

EMC Test report  
Nr. 02-05-19  
Page 1 of 32

**Test report**

**1 Device information**  
**1.1 General**

DUT: ESD protection device for 100BASE-T1 application  
**Nexperia PESD2ETH1G-T**

Customer: Nexperia Germany GmbH

Standard to be used: OPEN Alliance: IEEE 100BASE-T1 EMC Test Specification  
for ESD suppression devices  
Version 1.0 rev. draft, December 30, 2018

Execution of measurements: FTZ Zwickau e.V.

Tester: Dr.-Ing. B. Körber  
Dipl.-Ing. (FH) T. Wunderlich  
T. Pöcker

The test report includes 32 pages.

Zwickau, 5/10/2019

Prof. Dr.-Ing. M. Richter

**OPEN ALLIANCE**

**nexperia**  
EFFICIENCY WINS.

New Portfolio for Automotive Ethernet Protection

Nexperia develops **first true compliant OPEN Alliance** IEEE 100BASE-T1 Ethernet silicon based **ESD Protection**

Portfolio	Positioning	Samples	RFS
<b>PESD2ETH100-T</b>	<b><math>C_D &lt; 3\text{pF}</math></b> , <b><math>V_{\text{ESD}} &gt; 30\text{ kV}</math></b> (1000 shots) in <b>SOT23</b> OPEN Alliance 100BASE-T1	<b>Released</b>	
<b>PESD2ETH1G-T</b>	<b><math>C_D &lt; 2\text{pF}</math></b> , <b><math>V_{\text{ESD}} &gt; 15\text{ kV}</math></b> (1000 shots) in <b>SOT23</b> OPEN Alliance 100/1000BASE-T1		
<b>PESD2ETH1GX-T</b>	<b><math>C_D &lt; 1\text{pF}</math></b> , <b><math>V_{\text{ESD}} &gt; 15\text{ kV}</math></b> (1000 shots) in <b>SOT23</b> OPEN Alliance 100/1000BASE-T1	<b>Available</b>	July 2021
<b>PESD1ETH1G-L</b>	<b><math>C_D &lt; 2\text{pF}</math></b> , <b><math>V_{\text{ESD}} &gt; 15\text{ kV}</math></b> (1000 shots) in <b>SOD882</b> OPEN Alliance 100/1000BASE-T1		July 2021
<b>PESD1ETH1G-LS</b>	<b><math>C_D &lt; 2\text{pF}</math></b> , <b><math>V_{\text{ESD}} &gt; 15\text{ kV}</math></b> (1000 shots) in <b>SOD882BD</b> OPEN Alliance 100/1000BASE-T1		July 2021
<b>PESD1ETH1GX-LS</b>	<b><math>C_D &lt; 1\text{pF}</math></b> , <b><math>V_{\text{ESD}} &gt; 15\text{ kV}</math></b> (1000 shots) in <b>SOD882BD</b> OPEN Alliance 100/1000BASE-T1		July 2021

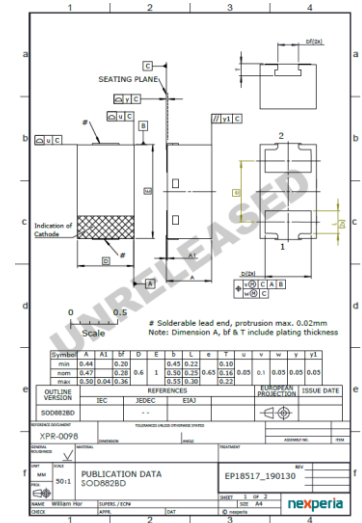
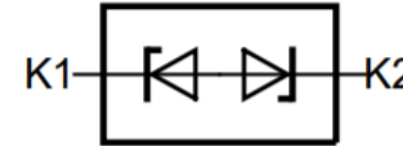
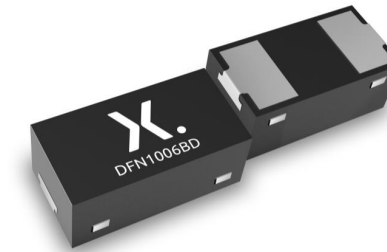




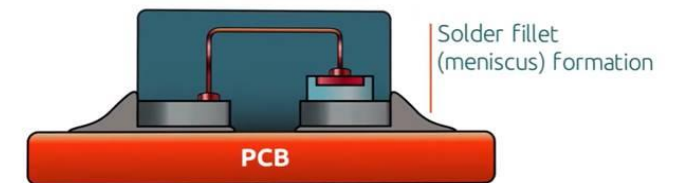
# PESD1ETH1G-LS in SOD882BD

Small footprint | High design flexibility | High reliability

- **Application:** 100/1000BASE-T1 Ethernet
- **Package:** DFN1006BD-2 (SOD882BD) → sourced by BOSCH
- **Parameters:**
  - $\geq 15$  kV ESD ISO10605; IEC6100-4-2; 1000 shots OPEN Alliance
  - Junction / Storage Temperature range  $T = -40\text{ }^{\circ}\text{C} \dots 150\text{ }^{\circ}\text{C}$
  - $V_{\text{trigger}} > 100\text{ V}$
  - $C_D < 2\text{ pF}$
  - Snap-back technology allowing extremely good clamping performance
  - DFN1006BD-2 2 pin leadless DFN package with side-wettable flank → 100% BOSCH AOI Guideline compliant
  - Footprint compatibility allows high design flexibility
  - Tight matching requirements on capacitance are not necessary to meet mode conversion requirements



**AOI capable and reliable**



- ✓ Side-wettable flanks for easy automated optical inspection (AOI)
- ✓ Robust solder joints, high reliability
- ✓ Pitch of 0.6 mm (min)



# PESD1ETH1G-LS in SOD882BD

Small footprint | High design flexibility | High reliability

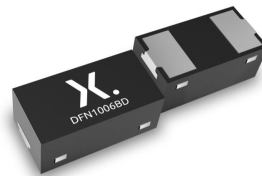
SOT23



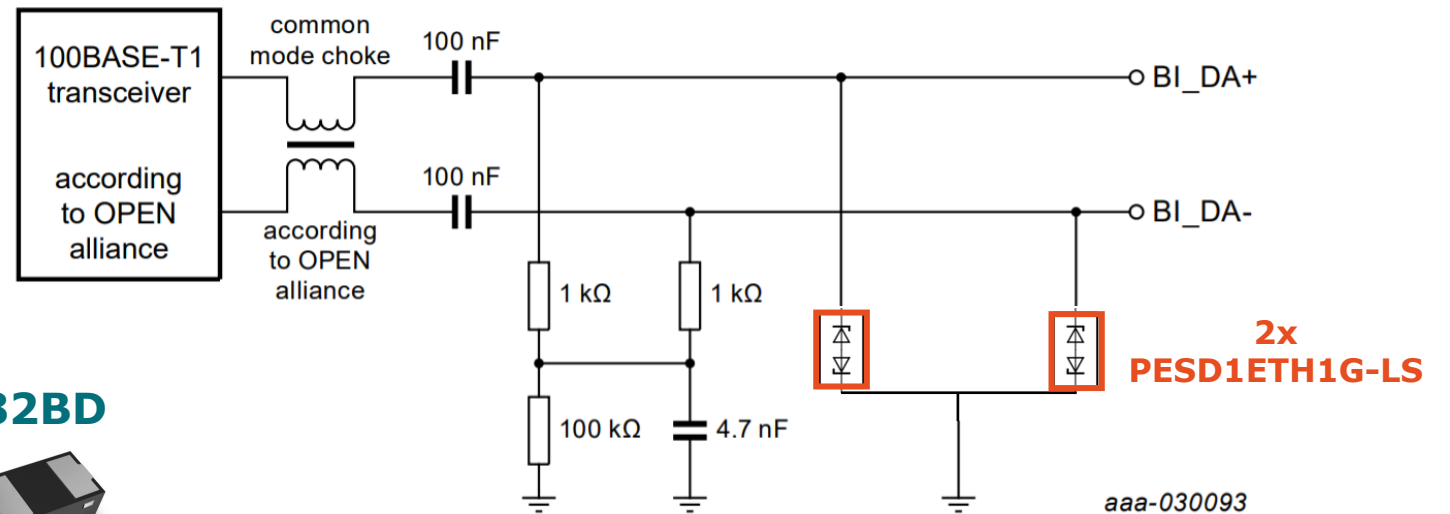
3.77 mm<sup>2</sup>

68%  
space saving\*

SOD882BD



0.6 mm<sup>2</sup>



\*2 x DFN1006BD-2 footprint considered in order to achieve 2 line comparable performance

# Automotive ESD Protection



## Miniaturization

Driving space saving with new automotive grade DFN packages incl. side wettable flanks

- DFN1006BD-2
- DFN1x1xD-3



New solutions for Ethernet ESD Protection + package investigation study

- PESD2ETH100-T
- PESD2ETH1G-T
- PESD2ETH1GX-T
- PESD1ETH1G-LS



New portfolio based on IVN ESD Protection family in SOT23, SOT323, DFN1010BD-3, DFN1412D-3 for 12 V and 24 V board net



New portfolio for SerDes applications and protocols such as GSML, FPD link in leadless packages

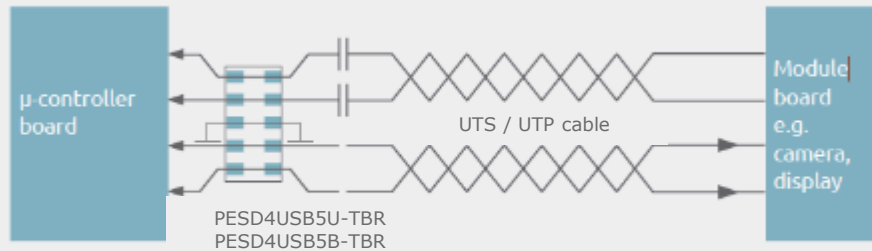


New portfolio based on Nexperia TrEOS protection technology for automotive infotainment in SOT23, SOT1176 and SOD882BD



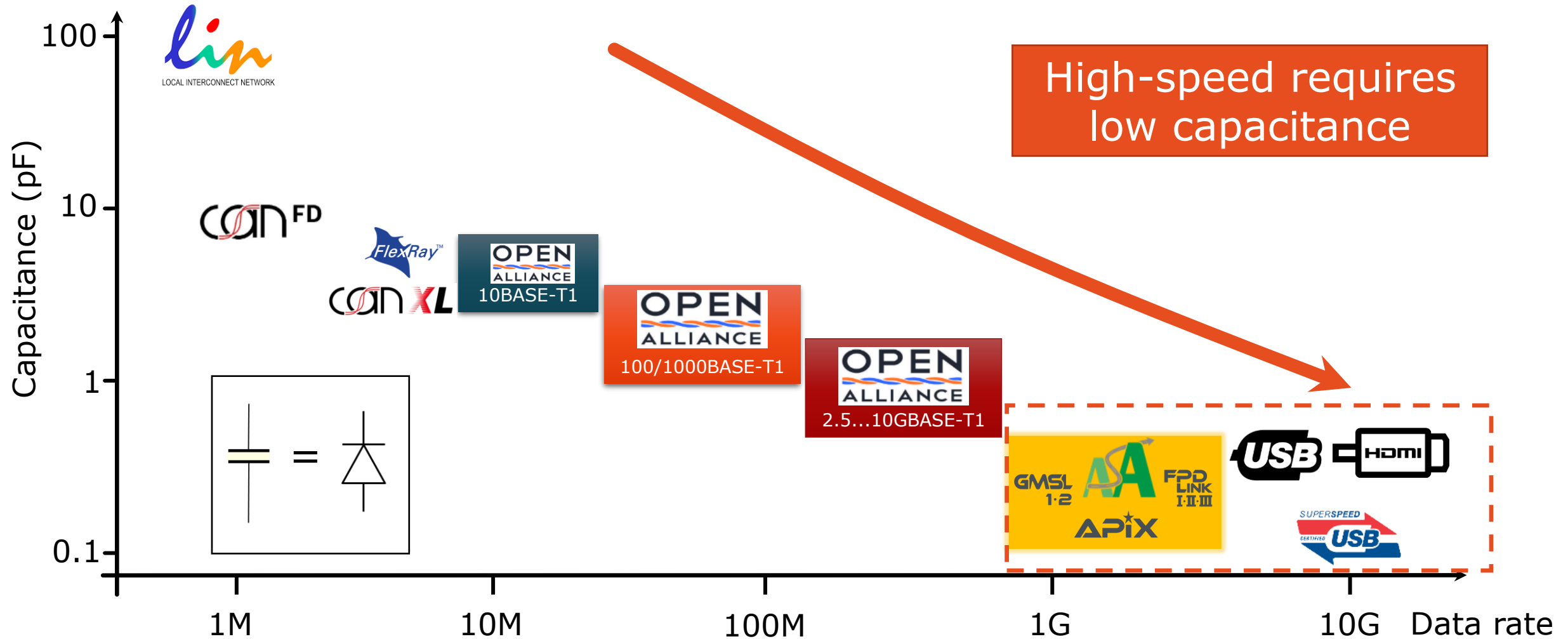
# SerDes

LVDS physical layer



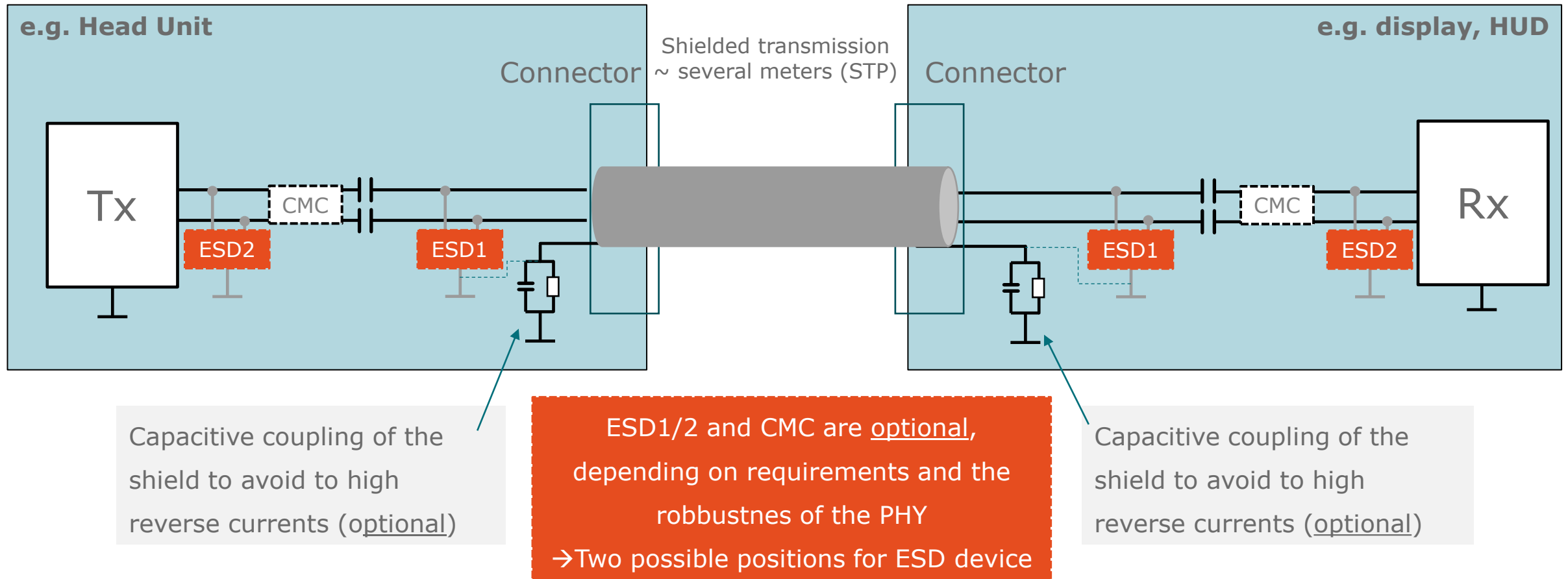
- Applications Camera, Display, Infotainment
- Status Quo: Proprietary systems (GMSL, Apix, FPD link).
- ASA Alliance upcoming creating a common SerDes Standard
- Differential and Single ended data transmission
  - 2 line or 1 line protection ESD protection devices
- Data rates up to 12Gbps (today) up to 16Gbps in future
  - High focus on SI ( $C_p \ll 1\text{pF}$ , S-Parameter, Eye diagram)
  - Leadless packages help to reduce parasitics
- The lower the clamping voltage, the better is the protection.
- The protection should be as close as possible at the connector

# In-Vehicle Networks and Parasitic Capacitance



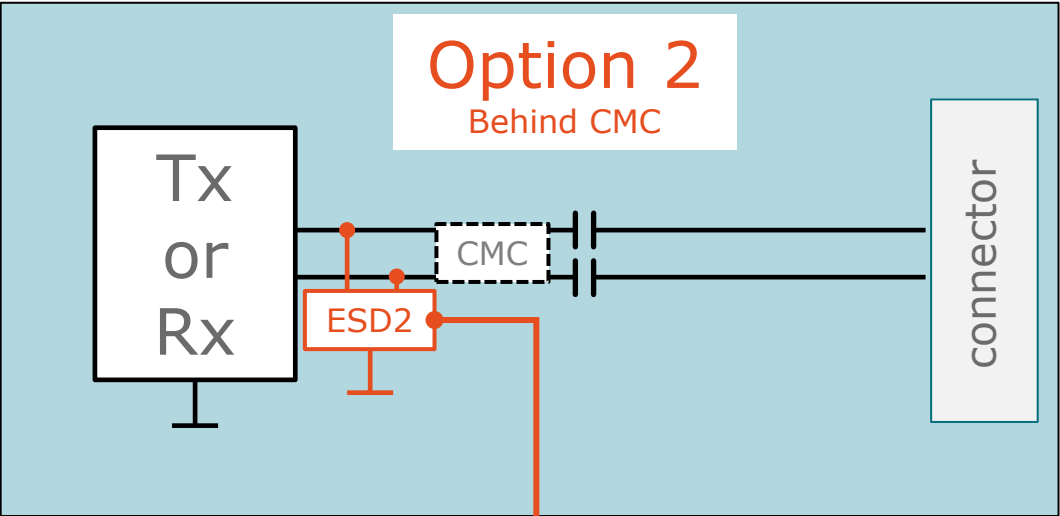
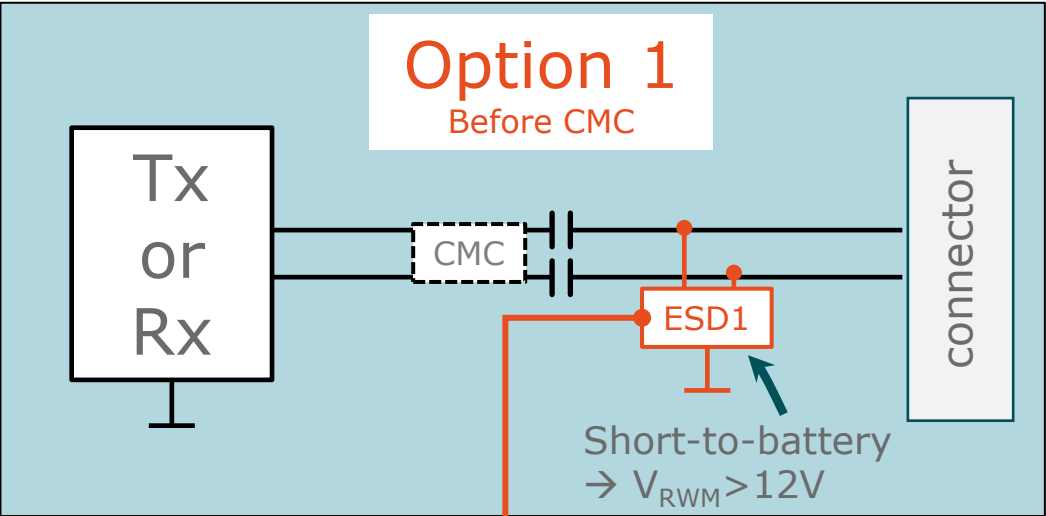
# ESD Protection for High-Speed Video Links

VideoLinks: APIX, GMSL, FPDlink



# ESD Protection for High-Speed Video Links

VideoLinks: APIX, GMSL, FPDlink



## Devices for ESD1

Device	Package	$V_{RWM}$	$C_D$	$V_{ESD}$
PESD18VF1BL	DFN1006-2	18 V	0.35 pF	10 kV
PESD24VF1BL	DFN1006-2	24 V	0.30 pF	10 kV
PESD30VF1BL	DFN1006-2	30 V	0.4 pF	12 kV

✓ Short to battery robust with  $V_{RWM} > 12 V$ !

## Devices for ESD2

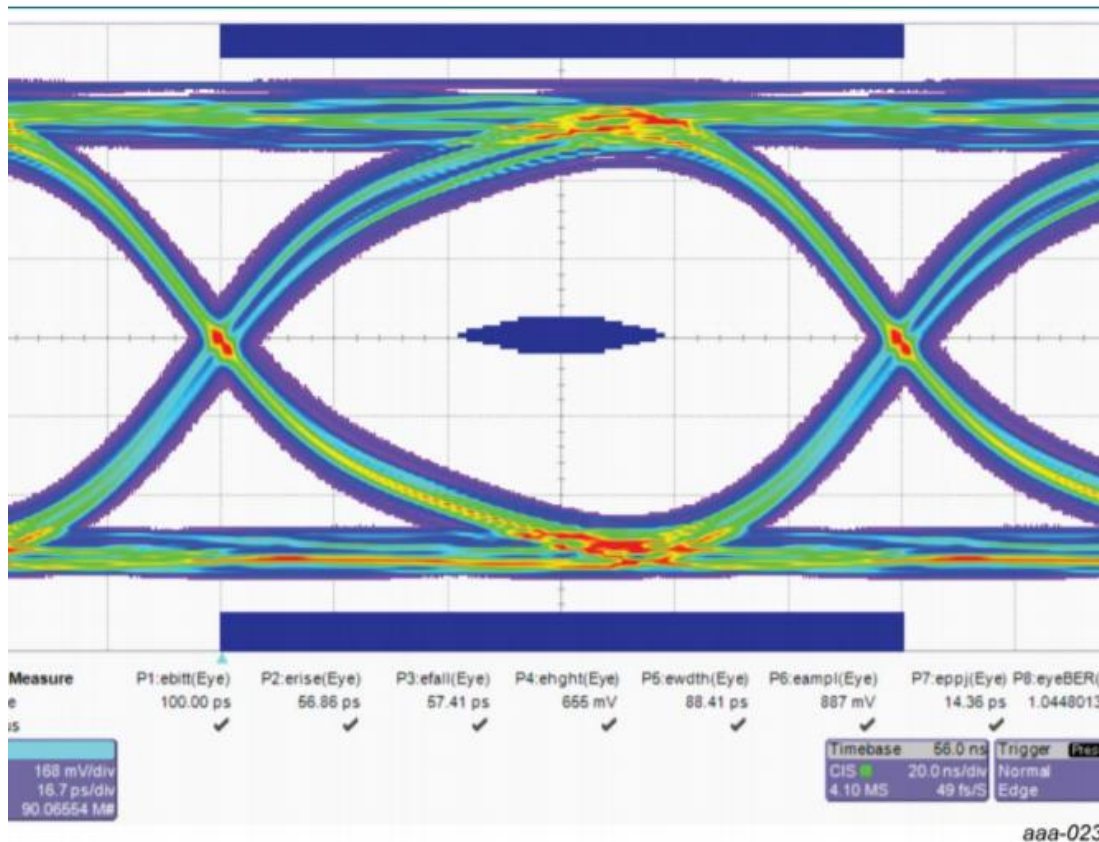
Device	Package	$V_{RWM}$	$C_D$	$V_{ESD}$
PESD5V0F1BL	DFN1006-2	5 V	0.4 pF	10 kV
PESD5V0F1BLD	DFN1006D-2	5 V	0.4 pF	10 kV
<b>PESD4USBx-TBR</b>	DFN2510A-10	5 V	0.3 pF	15 kV
<b>PESD4USBx-TxS</b>	DFN2510D-10	5 V	0.3 pF	15 kV
<b>PESD2USBx-T</b>	SOT23	5 V	0.9 pF	20 kV



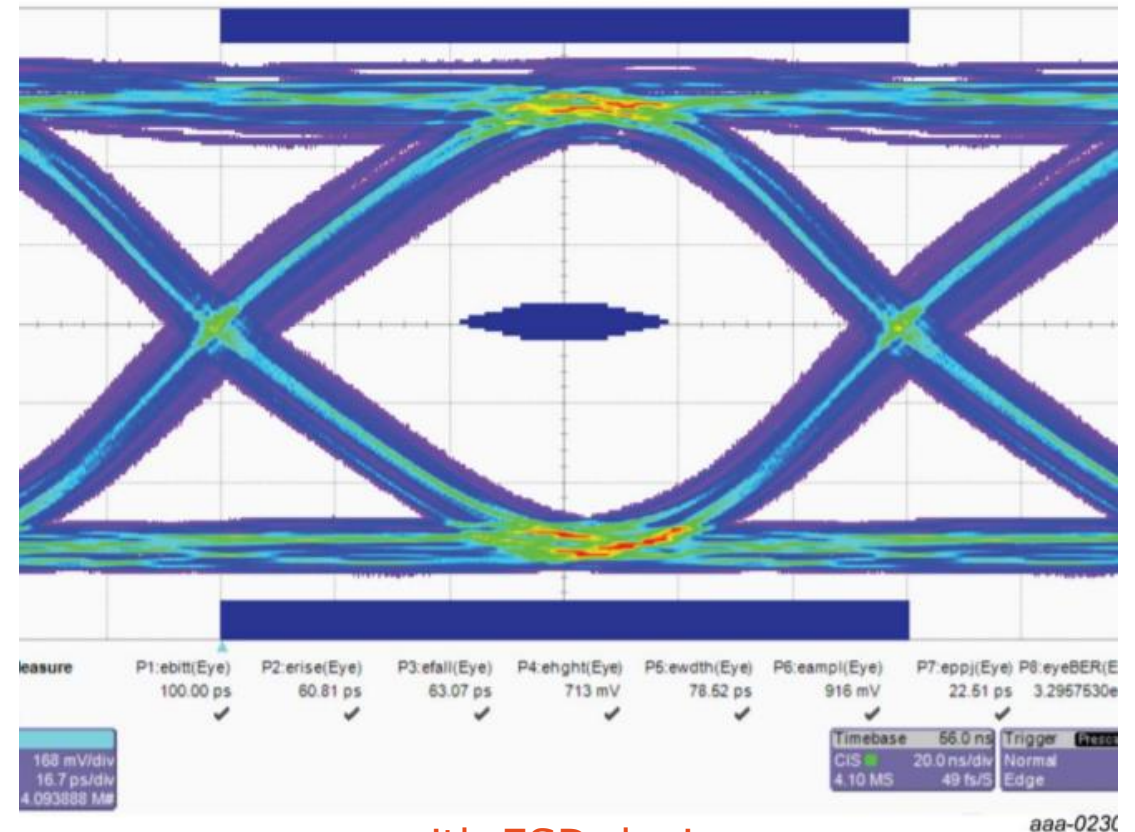


# Signal Integrity

Eye Diagramm 10Gbps ( $C_d=0.17\text{pF}$ )



w/o ESD device



with ESD device

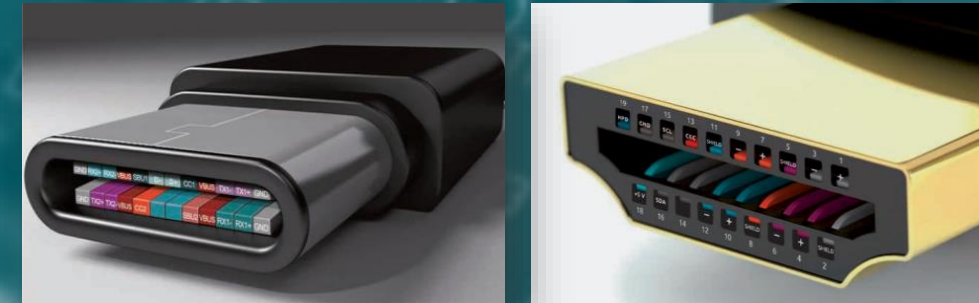
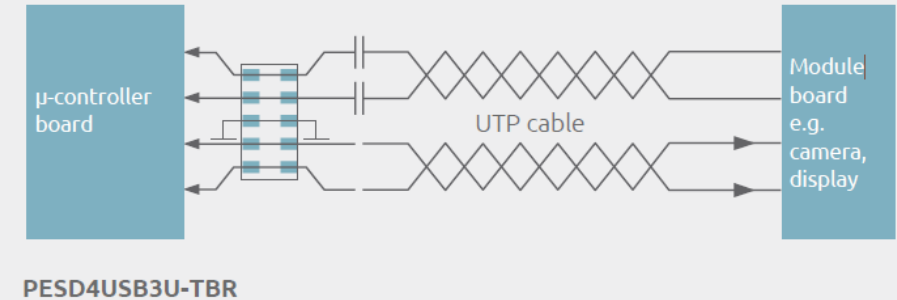
# Infotainment

Common infotainment busses

**USB - Universal Serial Bus**

**HDMI - High Definition Multimedia Interface**

- Very low capacitance mandatory  $\ll 1\text{pF}$
- RF compliance via
  - S-parameters
  - Eye diagrams
  - TDR
- Very low clamping required to protect sensitive ICs
- Fast turn-on required to prevent dynamic overshoot


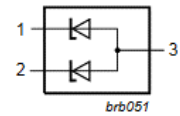


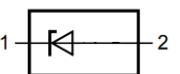
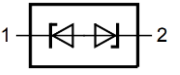


# Automotive Interior



# TrEOS Automotive Portfolio

For USB2.0, HDMI and other infotainment/mulimedia/SerDes applications

Part	Package	Configuration	Graphic Symbol	V <sub>RWM</sub> (V)	C <sub>D max</sub> (pF)	ESD <sub>max</sub> (kV)	Samples	Release
PESD2USB3UV-T	<b>SOT23</b> 	<b>2 lines unidirectional</b>		<b>3.3 V</b>	<b>0.9</b>	<b>20 kV</b>	<b>Available</b>	<b>Released</b>
PESD2USB3UX-T					<b>0.58</b>	<b>8 kV</b>		
PESD2USB5UV-T				<b>5 V</b>	<b>0.78</b>	<b>20 kV</b>		
PESD2USB5UX-T					<b>0.53</b>	<b>8 kV</b>		
PESD5V0C2U-M	<b>SOT883</b> 				<b>0.5 pF</b>	<b>15 kV</b>	<b>April 2021</b>	<b>Dezember 2021</b>
<b>PESD5V0C1UL</b> <b>PESD5V0C1ULS</b> *	<b>SOD882</b> <b>SOD882BD</b> 	<b>1 line unidirectional</b>			<b>0.5 pF</b>	<b>15 kV</b>		
<b>PESD5V0C1BL</b> <b>PESD5V0C1BLS</b> *		<b>1 line bidirectional</b>			<b>0.5 pF</b>	<b>15 kV</b>		


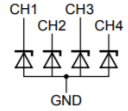
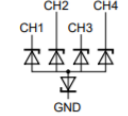

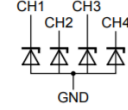
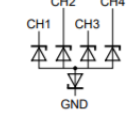

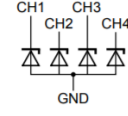
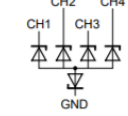
\*with side-wettable flanks (SWF) for automatical optical inspection (AOI)





# TrEOS Automotive Portfolio

For USB2.0, HDMI and other infotainment/mulimedia/SerDes applications

Part	Package	Configuration	Graphic Symbol	V <sub>RWM</sub> (V)	C <sub>D</sub> max (pF)	ESD max (kV)	Samples	Release
PESD4USB3U-TBR	 SOT1176	4 lines Unidirectional		3.3 V	0.34	15 kV	Available	Released
PESD4USB5U-TBR				5 V				
PESD4USB3B-TBR		4 lines Bidirectional		3.3 V	0.25			
PESD4USB5B-TBR				5 V				
PESD4USB3U-TBS	 SOT1176D with SWF	4 lines Unidirectional		3.3 V	0.34	15 kV		
PESD4USB5U-TBS				5 V				
PESD4USB3B-TBS		4 lines Bidirectional		3.3 V	0.25			
PESD4USB5B-TBS				5 V				
PESD4USB3U-TTS	 SOT1165D with SWF	4 lines Unidirectional		3.3 V	0.34	15 kV		
PESD4USB5U-TTS				5 V				
PESD4USB3B-TTS		4 lines Bidirectional		3.3 V	0.25			
PESD4USB5B-TTS				5 V				

4: \*SOT1176D/SOT1165D with SWF for AOI



# Miniaturization



# Automotive ESD Protection



## Miniaturization

Driving space saving with new automotive grade DFN packages incl. side wettable flanks

- DFN1006BD-2
- DFN1x1xD-3

OPEN  
ALLIANCE



New solutions for Ethernet ESD Protection + package investigation study

- PESD2ETH100-T
- PESD2ETH1G-T
- PESD2ETH1GX-T
- PESD1ETH1G-LS



New portfolio based on IVN ESD Protection family in SOT23, SOT323, DFN1010BD-3, DFN1412D-3 for 12 V and 24 V board net



New portfolio for SerDes applications and protocols such as GSML, FPD link in leadless packages



New portfolio based on Nexperia TrEOS protection technology for automotive infotainment in SOT23, SOT1176 and SOD882BD



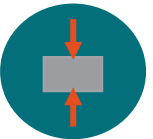
# Automotive DFN Highlights

## Value Proposition



### IMPROVED POWER DISSIPATION

- Up to 30% higher  $P_{tot}$  compared to SOT23 solution
- Lower operating temperature extending the total system lifetime



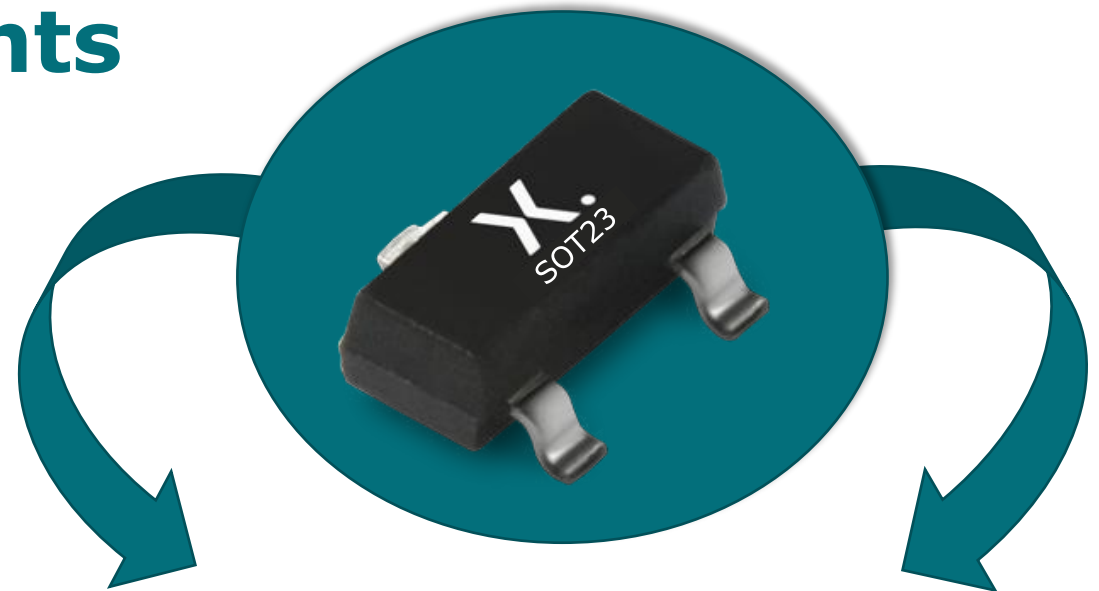
### SUPPORTS SPACE EFFICIENT DESIGNS

- Save up to 90% of footprint compared to SOT23 solution
- Only 50% of SOT23 height



### DESIGNED WITH HIGHEST QUALITY REQUIREMENTS

- Side wettable flanks for optimized Automated Optical Inspection
- AEC-Q101 qualified
- $T_j=175^{\circ}\text{C}$  capability



### 3-Pin solutions



**DFN1412D-3**

1.4 x 1.2 x 0.5 mm



**DFN1110D-3**

1.1 x 1.0 x 0.5 mm

### 2-Pin solution

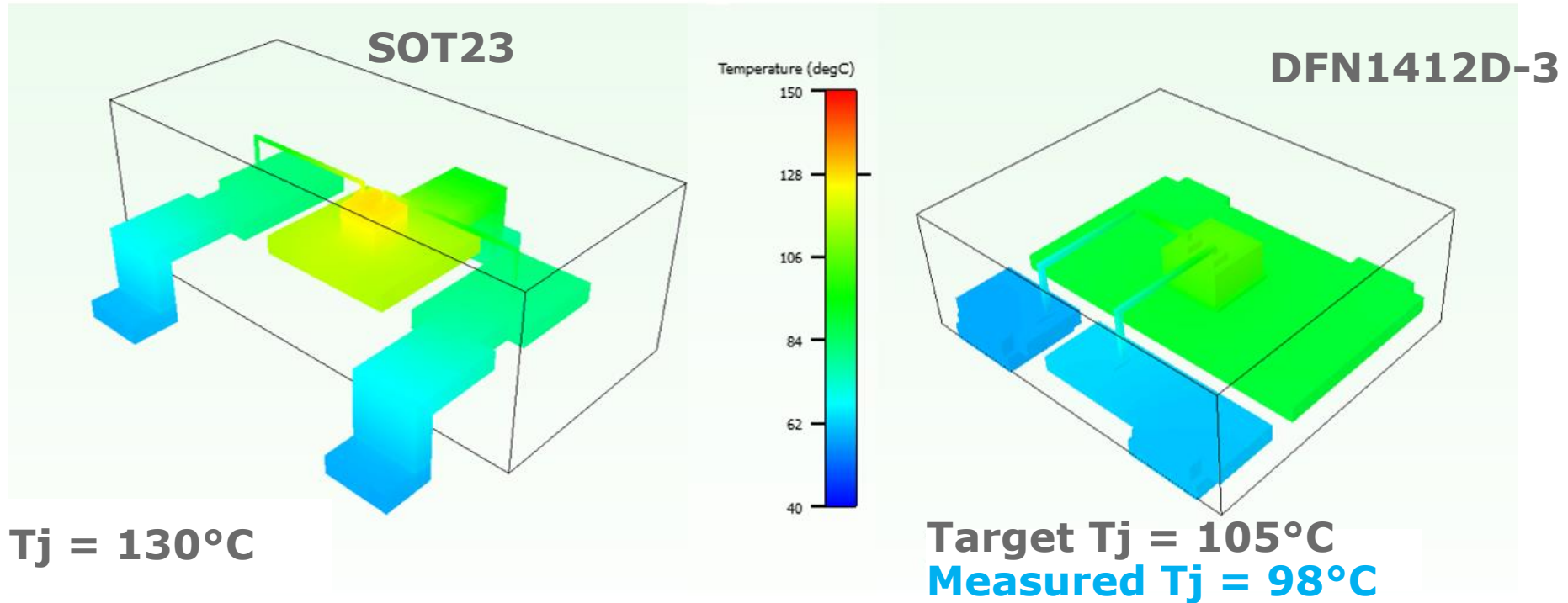


**DFN1006BD-2**

1.0 x 0.6 x 0.5 mm

# DFN1412D-3 Thermal Performance

$P=250\text{mW}$ ;  $290 \times 290 \mu\text{m}^2$ ;  $35 \mu\text{m}$  thick Cu lanes; standard footprint; FR4 ;  $T_a=25^\circ\text{C}$



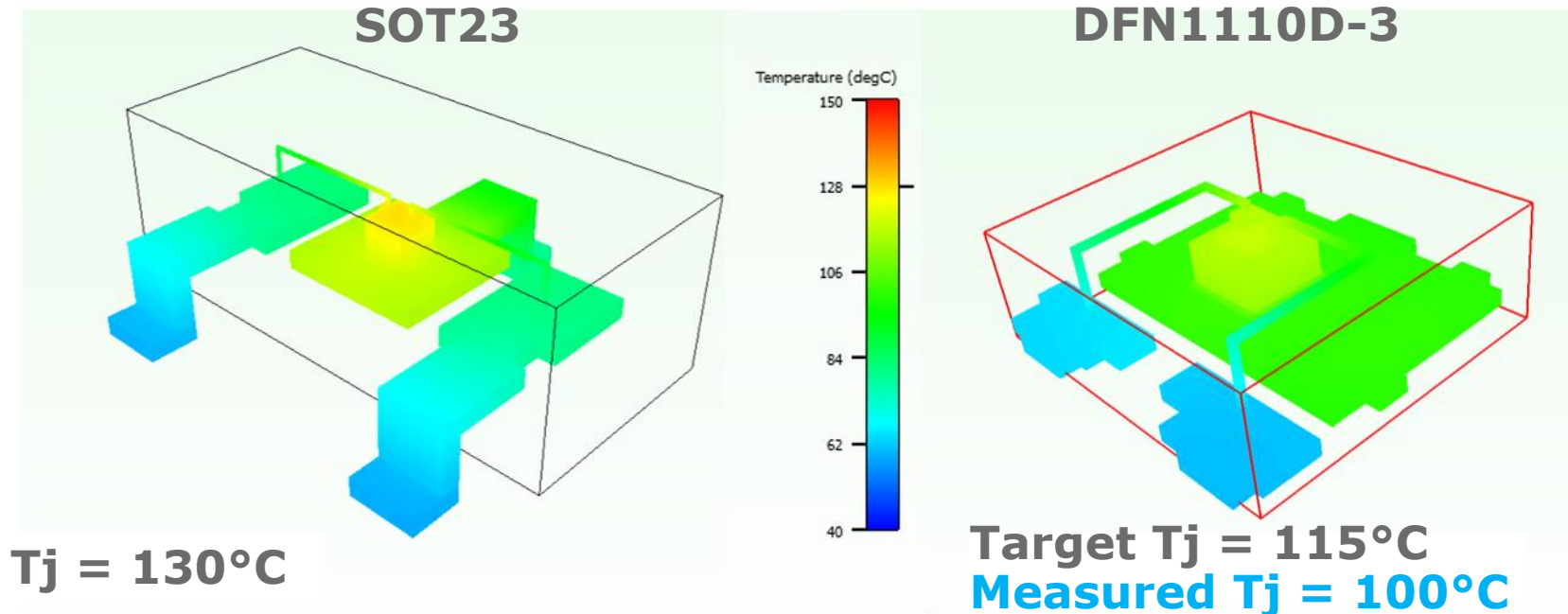
Target spec on standard footprint @ $T_a 25^\circ\text{C}$ :  $P_{\text{tot}} \geq 325\text{mW}$   
(SOT23:  $250\text{mW}$ )

**BC84xBQC types typical measured:  $410\text{mW}$  (spec.:  $350\text{mW}$ )**

$P_{\text{tot}}$  40% up  
Area 75% down

# DFN1110D-3 Thermal Performance

$P=250\text{mW}$ ;  $290 \times 290 \mu\text{m}^2$ ;  $35 \mu\text{m}$  thick Cu lanes; standard footprint; FR4;  $T_a=25^\circ\text{C}$



Target spec on standard footprint @ $T_a 25^\circ\text{C}$ :  
 $P_{\text{tot}} \geq 280\text{mW}$  (SOT23:  $250\text{mW}$ )

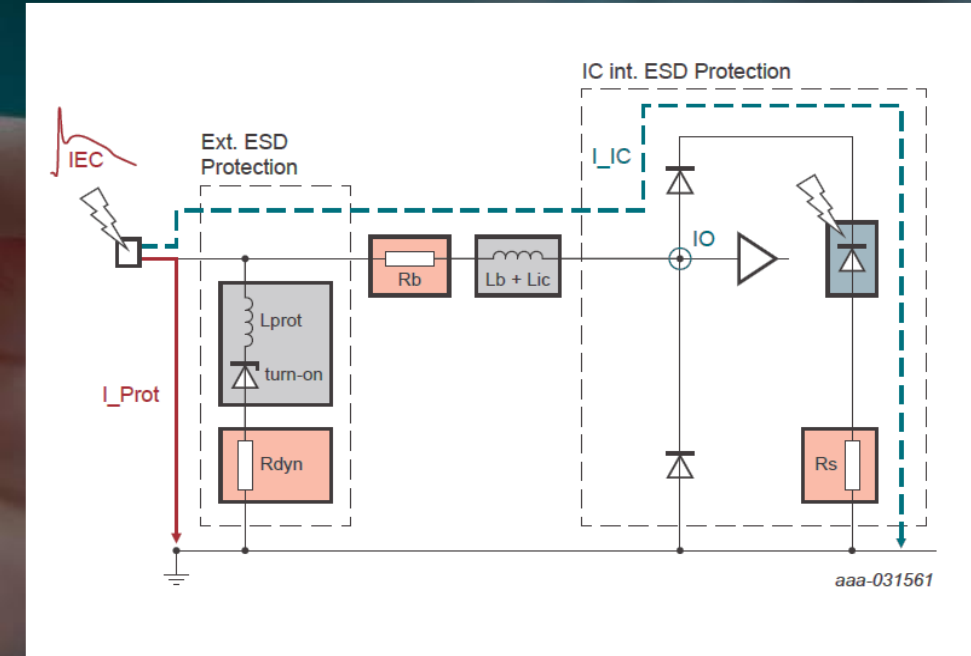
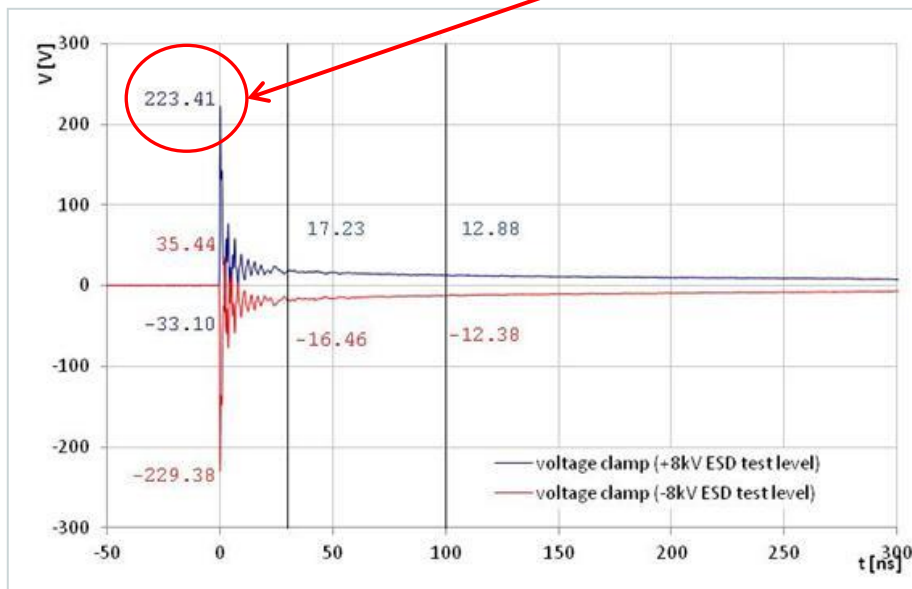
➔  $P_{\text{tot}}$  36% up  
Area 84% down

**BC84xBQB types typical measured:  $390\text{mW}$  (spec.:  $340\text{mW}$ )**

# Package aspects – Clamping behavior

For high-speed busses

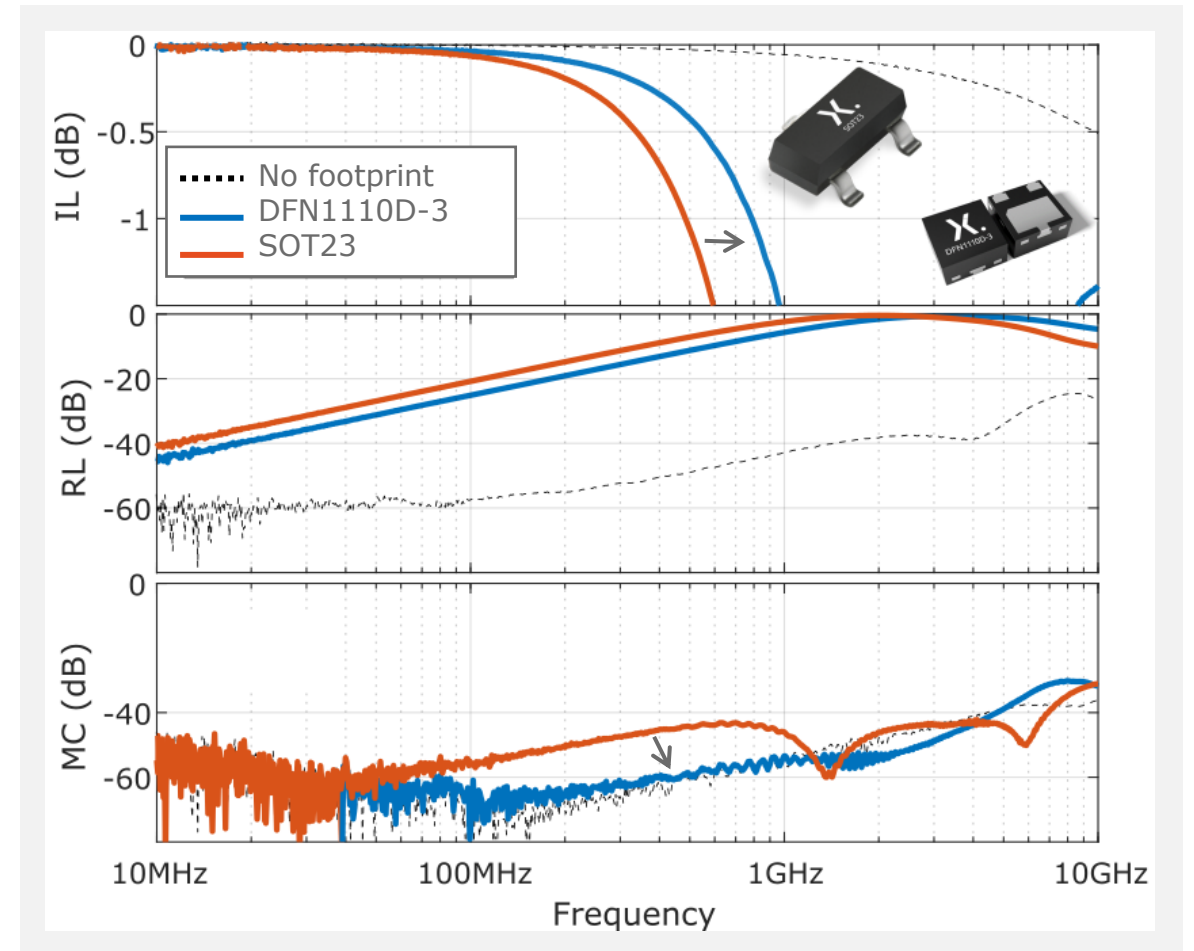
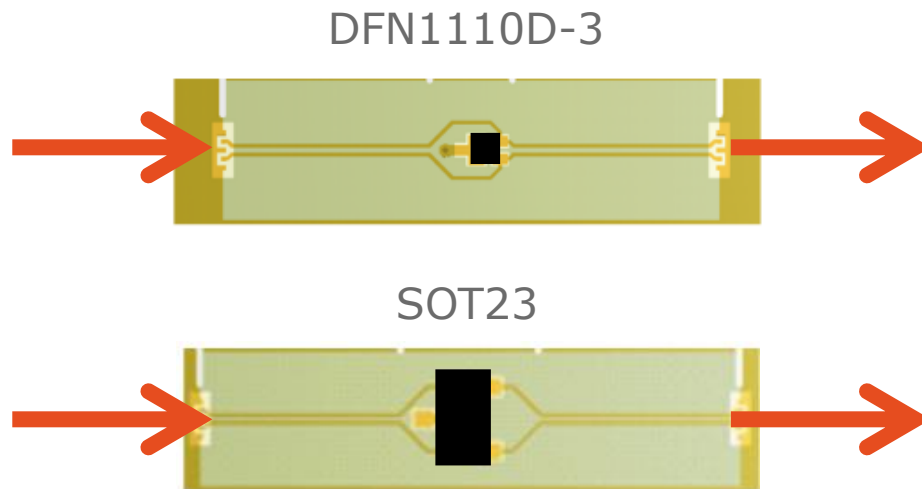
- $R_{dyn}$  governs the clamping voltage in a quasi-static condition
- The dynamic behavior is determined by inductances and turn-on behavior



# Package aspects – RF behavior

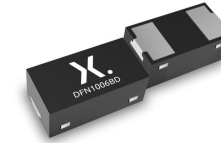
Comparison of SOT23 and DFN1110D-3 with PESD2CANFD24Vx ( $C_p = 5.2$  pF)

- Ca. 2 cm traces on FR4
- Dashed line: no footprint
- **Clear advantage of leadless package**



# ESD Protection in DFN1006BD-2

DFN Portfolio roll-out 2020 and 2021



## xT/V1B series

- PESD12VV1BLS
- PESD3V3T1BLS
- PESD5V0V1BLS

## IVN series

- PESD1IVN24-LS\*
- PESD1IVN27-LS\*

## OPEN Alliance

- PESD1ETH1G-LS\*

## xS1U series

- PESD3V3S1ULS
- PESD5V0S1ULS
- PESD8V0S1ULS
- PESD12VS1ULS
- PESD15VS1ULS
- PESD24VS1ULS
- PESD36VS1ULS

## New MMBZ

- MMB16VZ-IS\*
- MMBZ7V5Z-LS\*
- MMBZ27VZ-LS\*
- MMBZ33VZ-LS\*
- MMBZ43VZ-LS\*

## Portfolio planned for 2021

- NFC/Antenna protection PESDxVF1B series
- OPEN Alliance PESDx1GX < 1 pF
- Further portfolio expansion for automotive applications and generic ESD protection
- >150 °C capability extension

\*samples only in 2020

2020

2021

# Service & Support



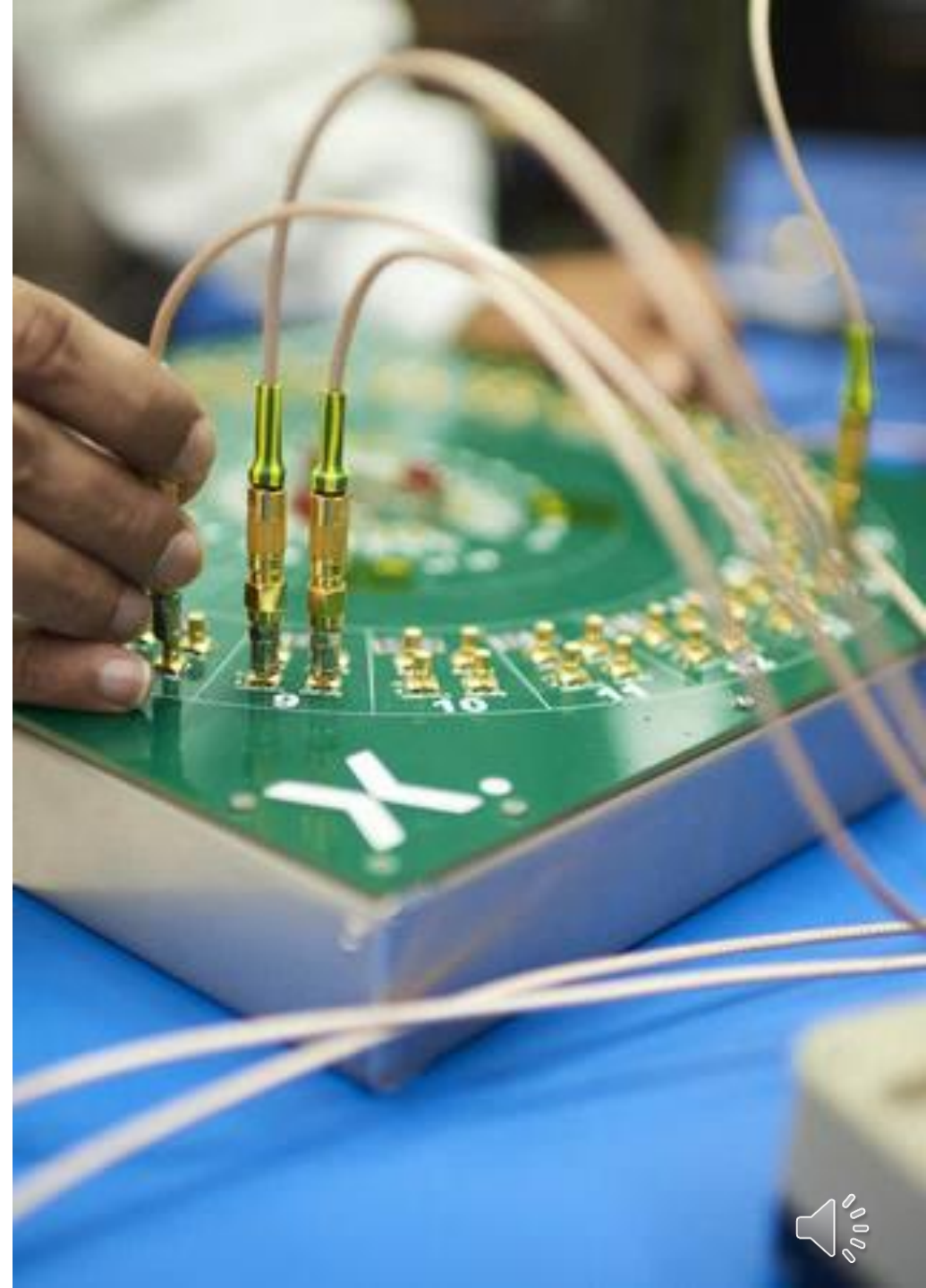


# Nexperia Lab

Only on customer request

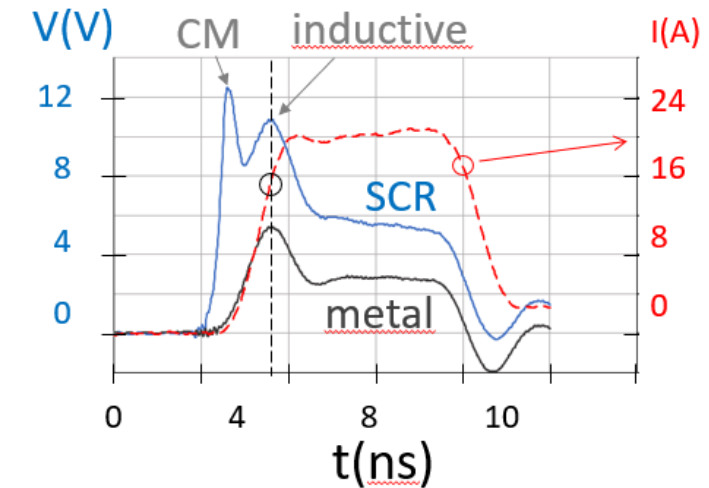
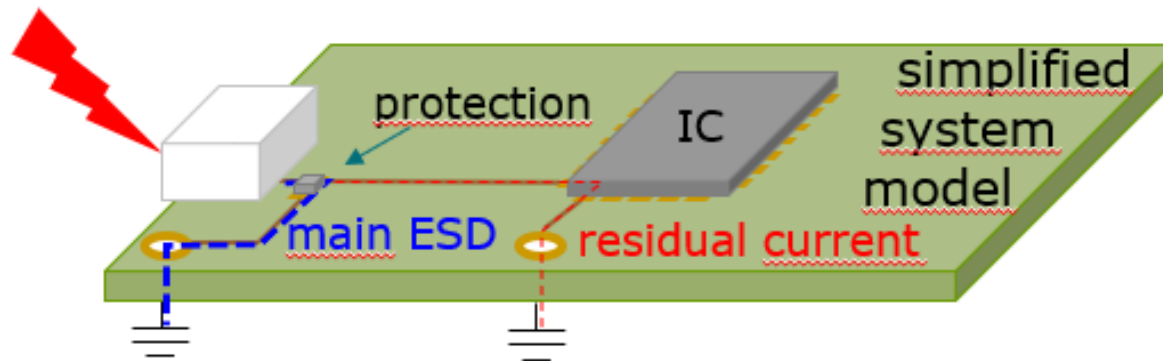
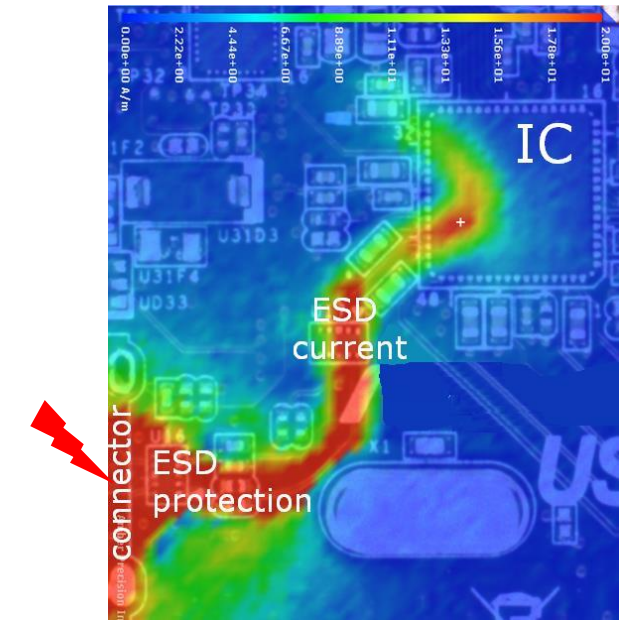
With our dedicated team we offer a broad variety of design support. This includes:

- Design review and error tracking from application to device level
- Analysis tools
- Device characterization with TLP measurements
- PCB screening with EMI scanner
- SEED modelation and simulation
- S-Parameters, (RF)-SPICE models and others



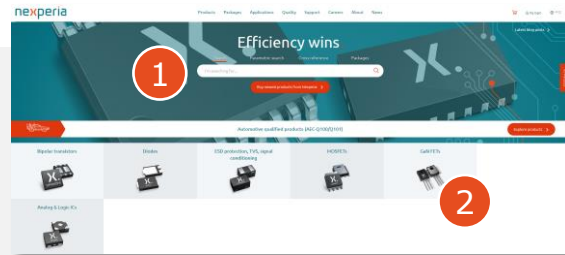
# System Efficient ESD Design (SEED)

- SEED simulates residual current into IC for each protection
- Allows to pick best protection during system design
- Dynamic clamp effects cause double overshoot (CM/Inductive) during switching
- Dynamic model predicts both peaks and trigger delay
- Dynamic SEED model used to improve system robustness

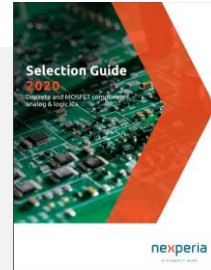


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**Documentation Center**  
[Link Selection Guide](#)



**Application Handbook**  
[Link ESD](#)



**Lab support**

- 1**
  - Search Function
  - Cross Reference
  - Parametric Search
  - Package Search
- 2**
  - Product Overview  
[Path to Datasheets, Product Brochures, Application Examples, ... ]

- Overview on all our Discrete, Logic and MOSFET devices
  - Diodes & Transistors
  - **Protection & Filtering**
  - MOSFETs
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  - Packages

- Automotive interfaces and applications
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- English & Chinese version
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- Dedicated engineering team to support customer requests
- Solution investigation with various analysis tools especially
- TLP, EMI scan, SEED
- Contact us for details





EFFICIENCY WINS.