Greetings from Olaf Vogt

Director and Head of Application Marketing

Olaf Vogt
Director and Head of Application Marketing

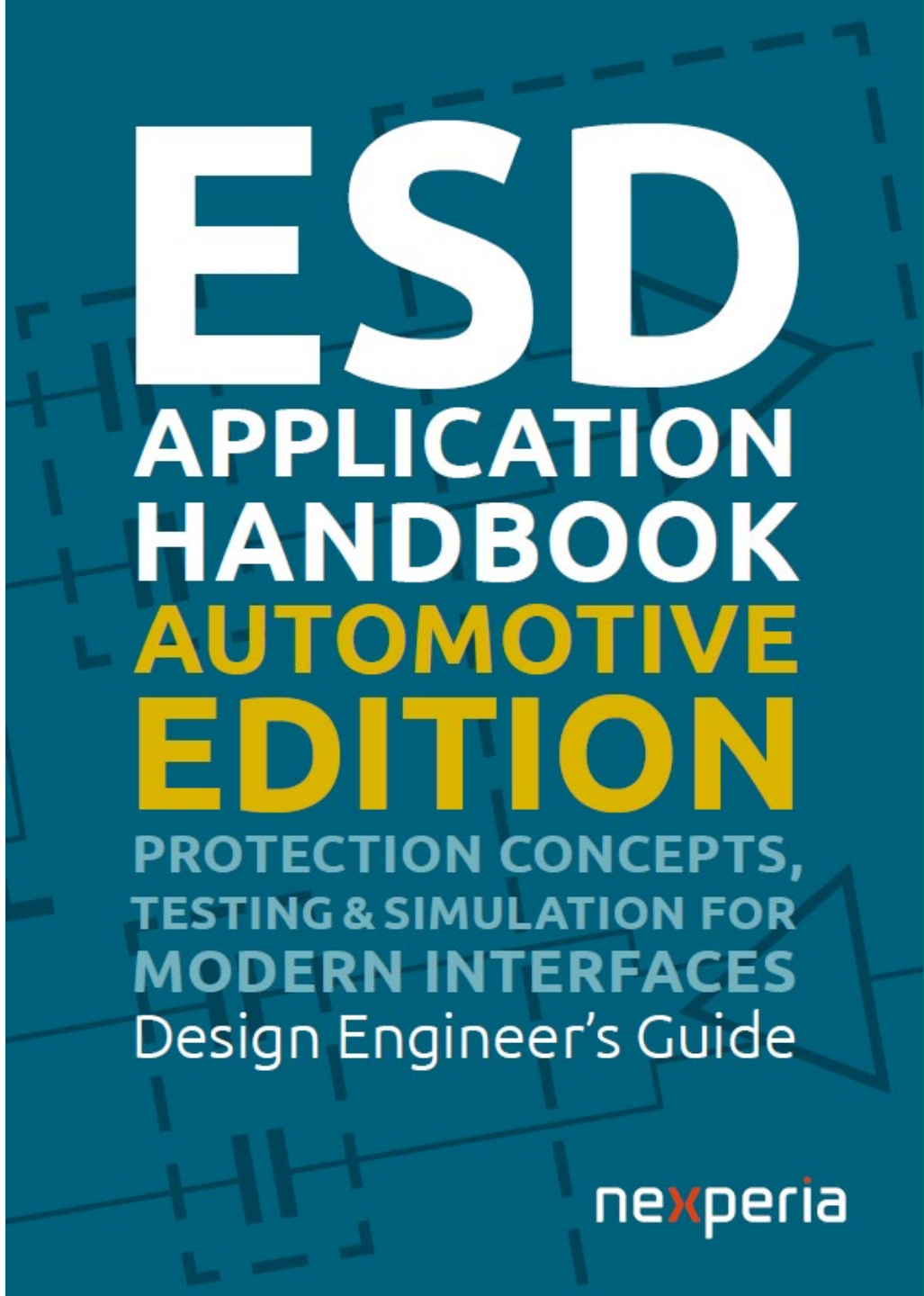
"I would like to thank all participants for joining this first-of-its-kind Nexperia virtual ESD seminar.

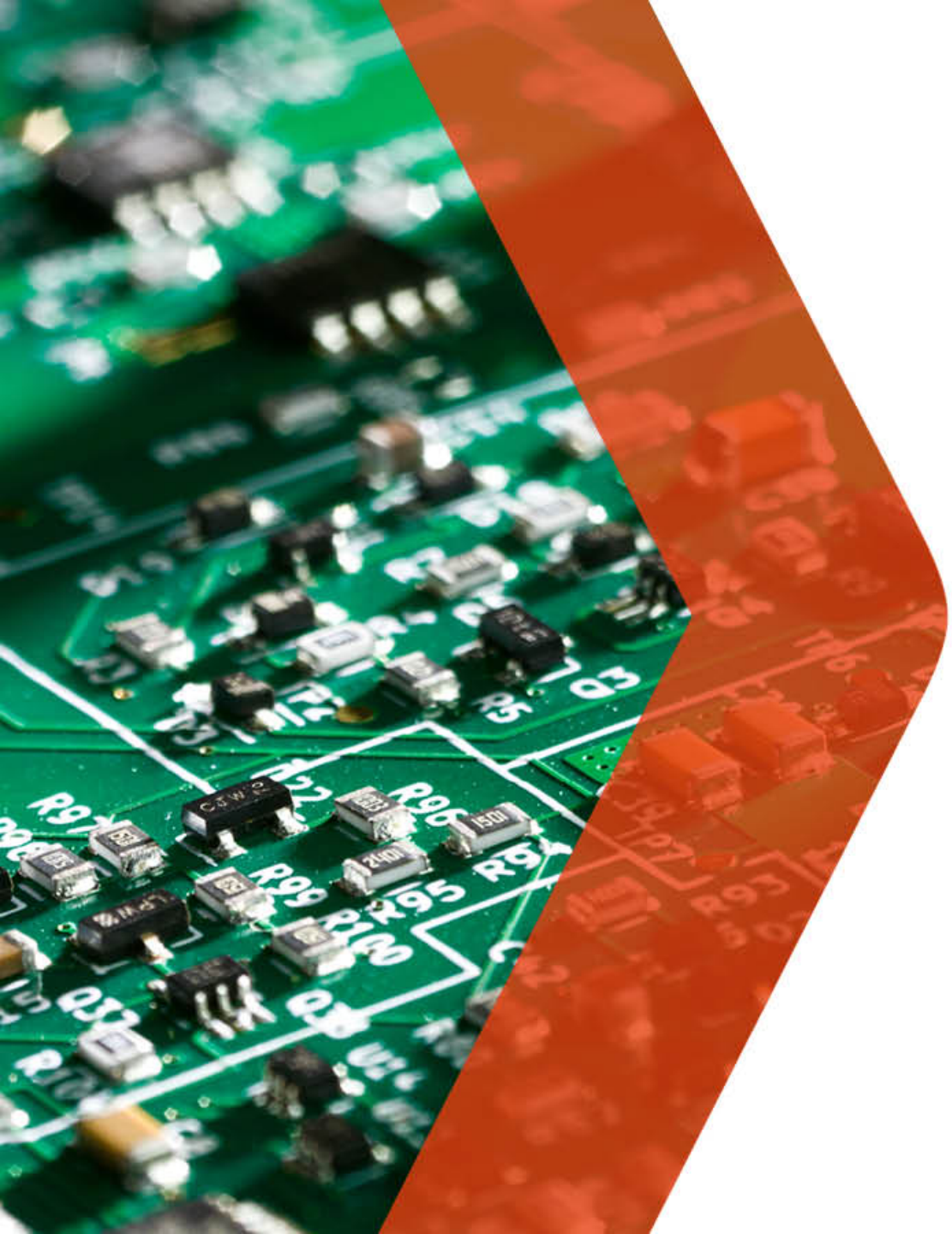
*The **automotive industry** is driven by the major trends of **electrification, autonomous driving and shared 'connected' mobility**.*

*We also see that ever-increasing data rates, greater calculation power of System-on-Chips and IC miniaturization are making **systems even more sensitive to ESD**.*

*With our Nexperia ESD Seminar, we want to **support the design community** in protecting applications and products against ESD issues and make systems more reliable.*

*Additionally, we published an **automotive ESD application handbook to share our expertise and best practices with you.**"*





Nexperia ESD Seminar Session 2

ESD Protection for Automotive Interfaces

Dr. Andreas Hardock

Application Marketing Manager for ESD and EMC

andreas.hardock@nexperia.com

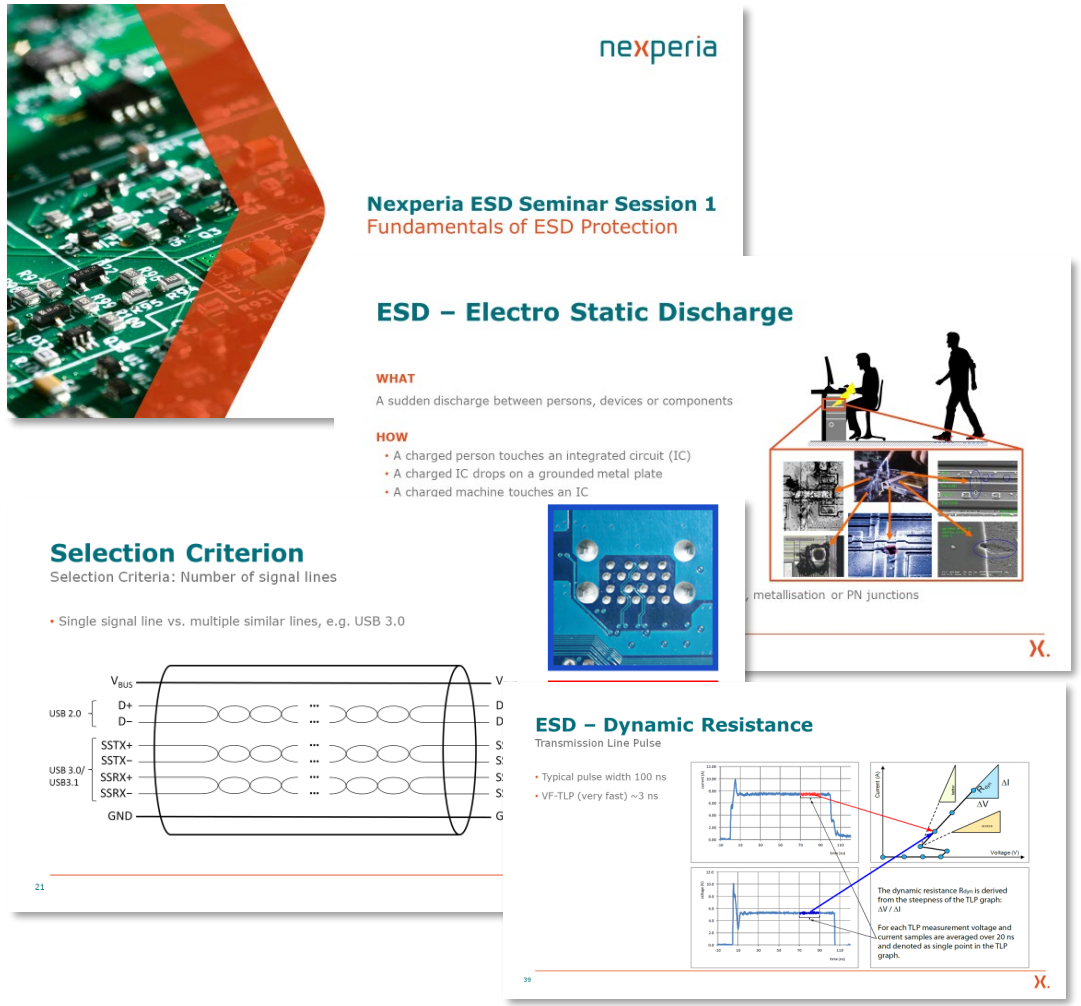
Lukas Droemer

Product Manager Automotive ESD Protection & Filtering

lukas.droemer@nexperia.com

Sept 2020

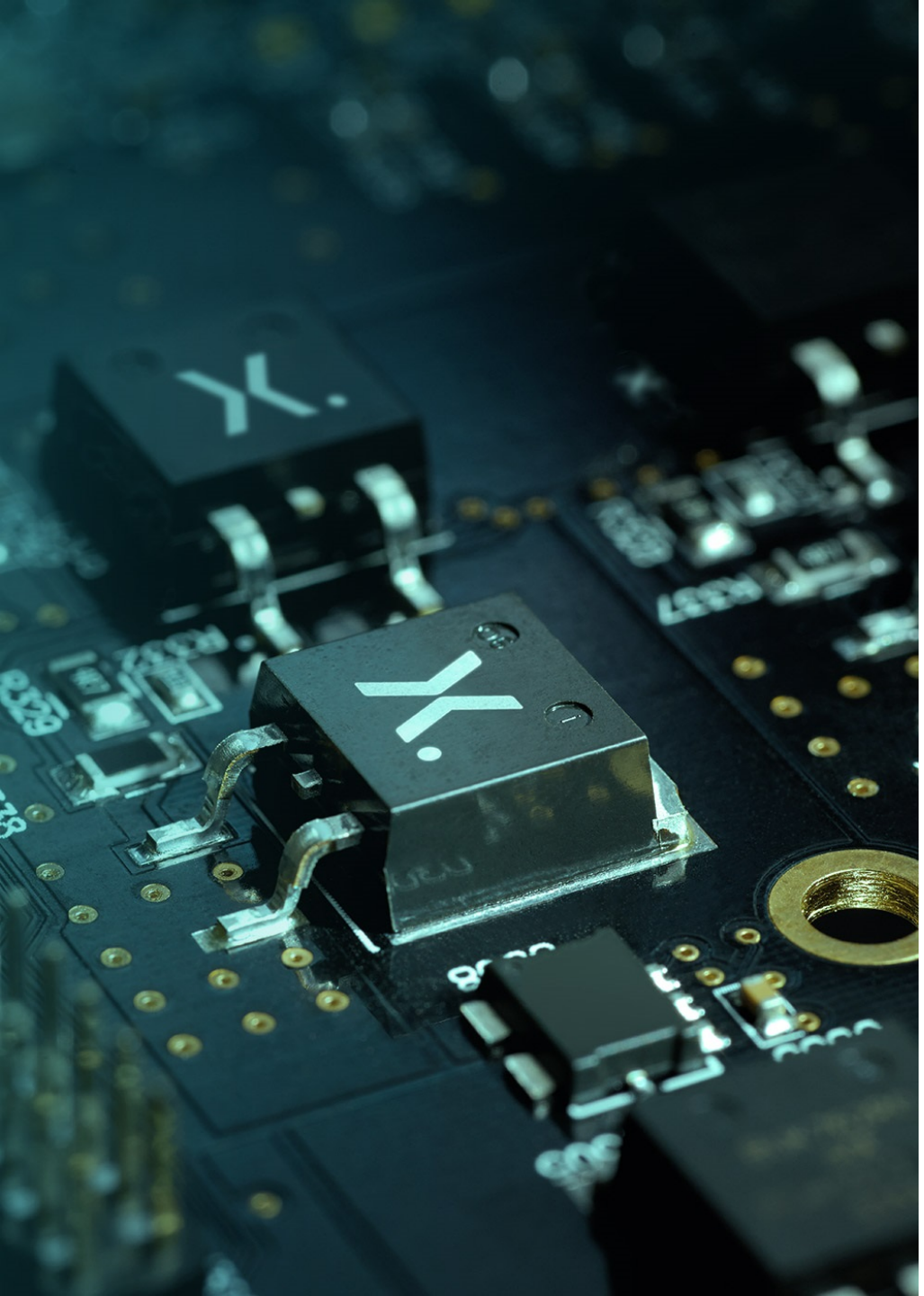
Recap | Nexperia ESD Seminar Session 1



In session 1, we talked about:

- **Fundamentals of ESD Protection**
  - ESD protection background
  - Device vs. system level perspective
  - Impact and trends
- **Measurement and Characterization**
  - Selection Criterion
  - ESD Tolerance Test
  - Clamping Voltage
  - Dynamic Resistance using TLP
  - Zener and Snapback

In session 2, we will learn how to apply the concept of ESD protection with common automotive interfaces.



ESD Seminar Session 2

Agenda

- Classic in-vehicle networks
- OPEN Alliance Ethernet
- SerDes
- Infotainment/Multimedia
- Extra: Package aspects
- Q&A

Evolution of In-Vehicle Networking

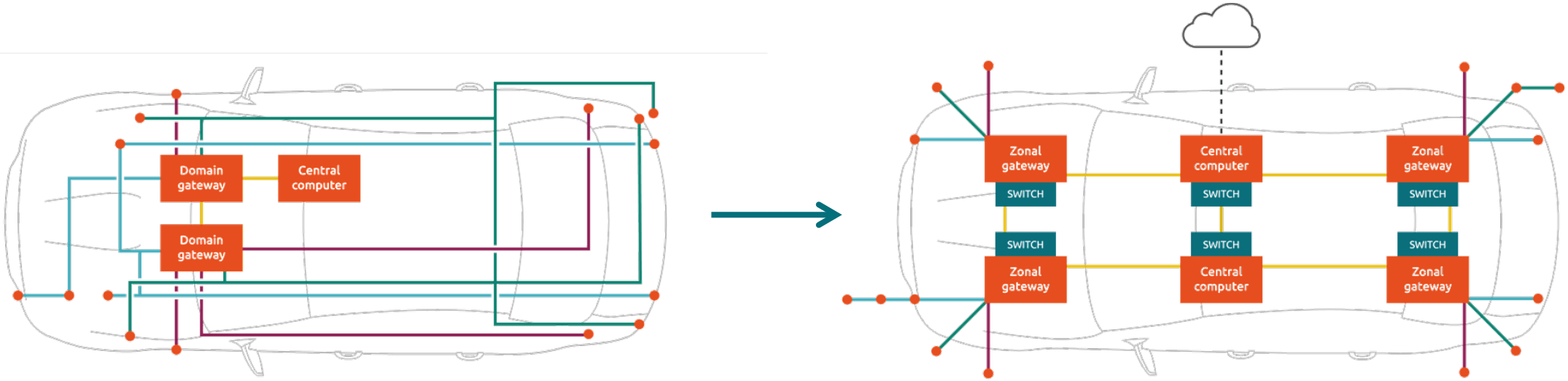
1980s — 1990s — 2000s — 2010s — 2020s

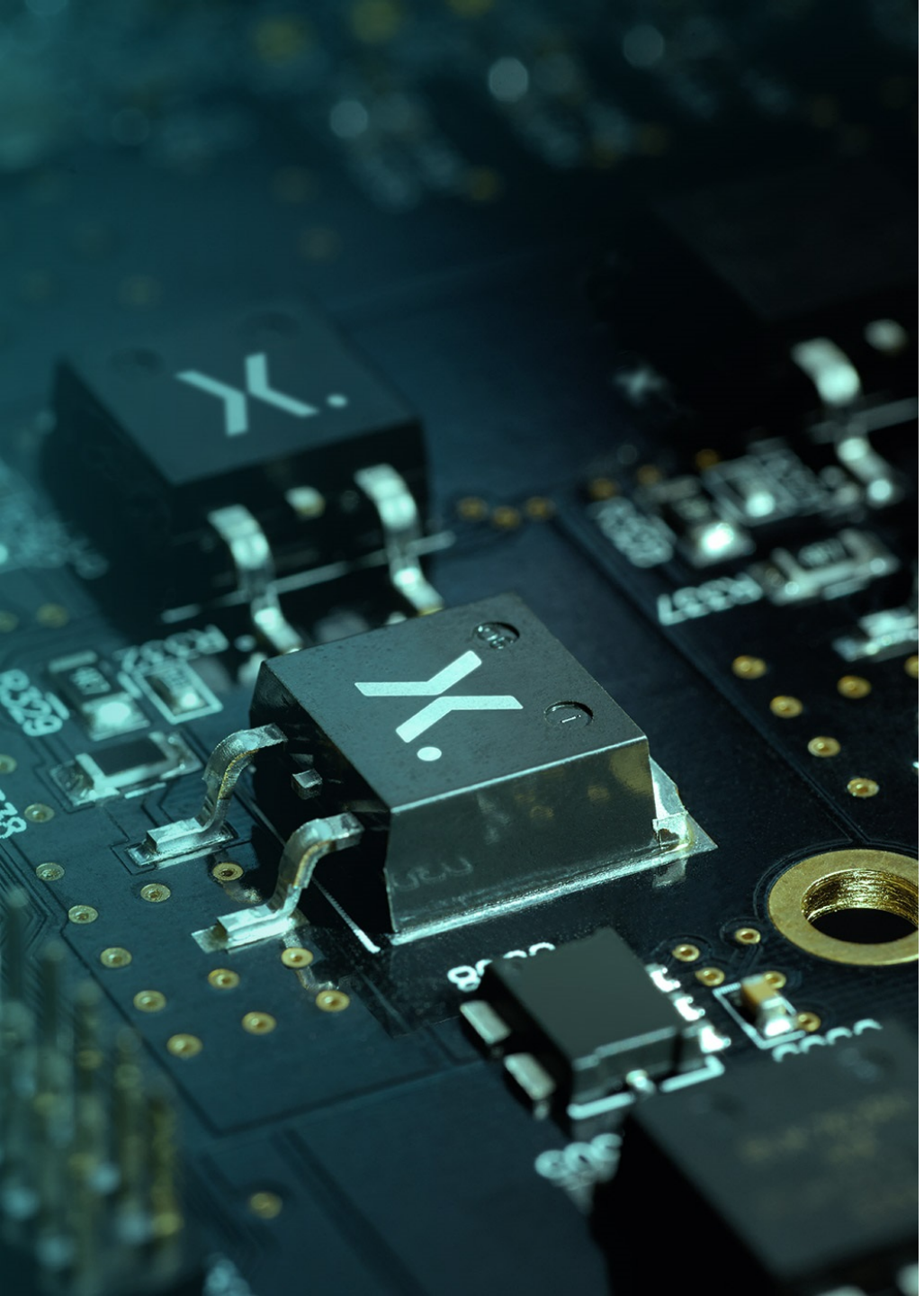
CAN

lin
LOCAL INTERCONNECT NETWORK

CAN FD

OPEN ALLIANCE





ESD Seminar Session 2

Agenda

- **Classic in-vehicle networks**
- OPEN Alliance Ethernet
- SerDes
- Infotainment/Multimedia
- Extra: Package aspects
- Q&A

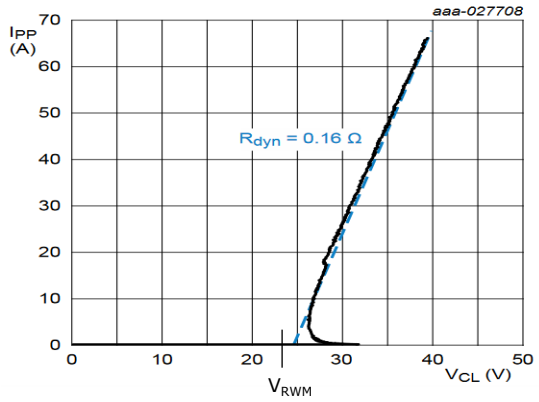
LIN

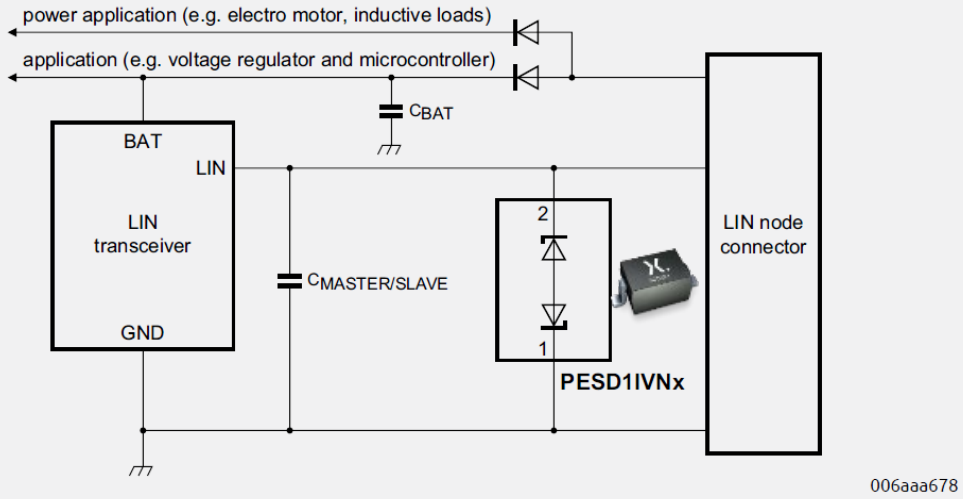
Local Interconnect Network

- Requirement for ESD protection depend on OEM

  Sometimes only specific devices are approved, most of the time, just general requirements to the interface exist

- Common requirements:
  - Parasitic capacitance of 30-100pF max
  - Short-to-battery and jumpstart robust
    - ISO16750-2 (26 V) or internal norms (28 V)



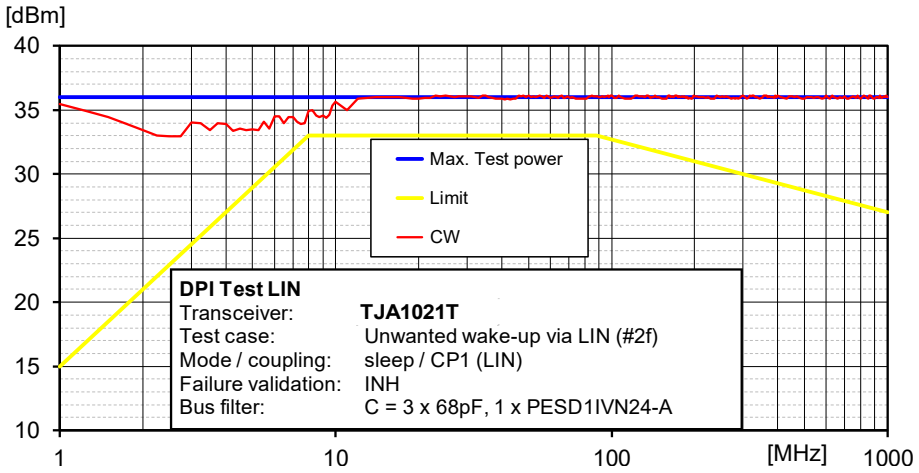


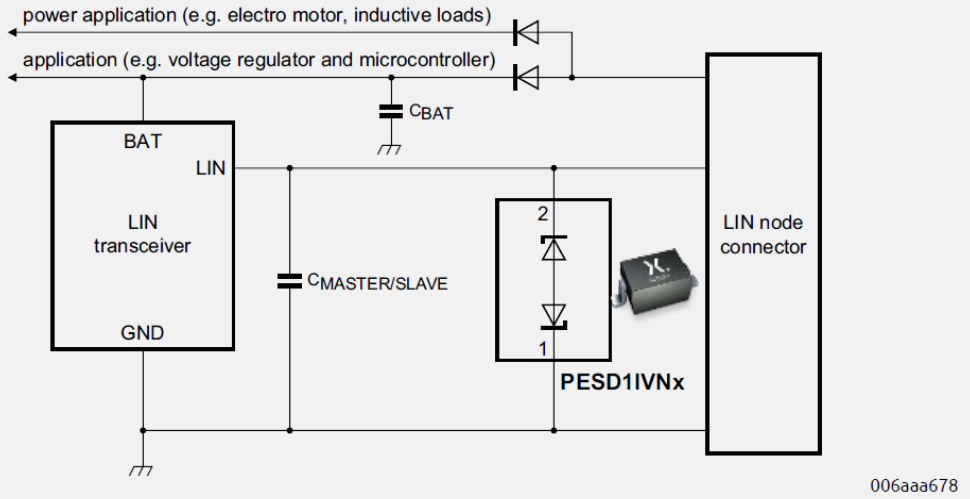
LIN

Local Interconnect Network

Compliance with ISO17987 in combination with a transceiver

- ESD
- RF emission
- immunity to transients -> ISO7637-2 (3a/b)
- RF immunity -> DPI





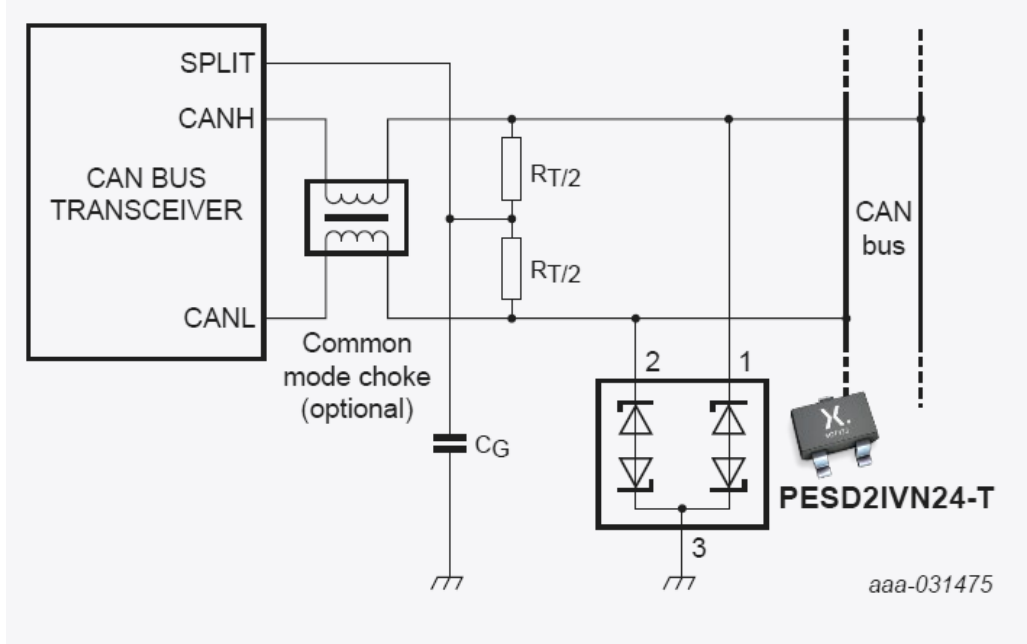
CAN

Controller **A**rea **N**etwork

- Requirement for ESD protection depend on OEM

  Sometimes only specific devices are approved, most of the time, just general requirements to the interface exist

- Common requirements:
  - Parasitic capacitance of 17-30pF max
    - (for CAN FD 6-10)
    - Because of rather high Cp, matching is required
  - Short-to-battery and jumpstart robust
    - ISO16750-2 (26 V) or internal norms (28 V)

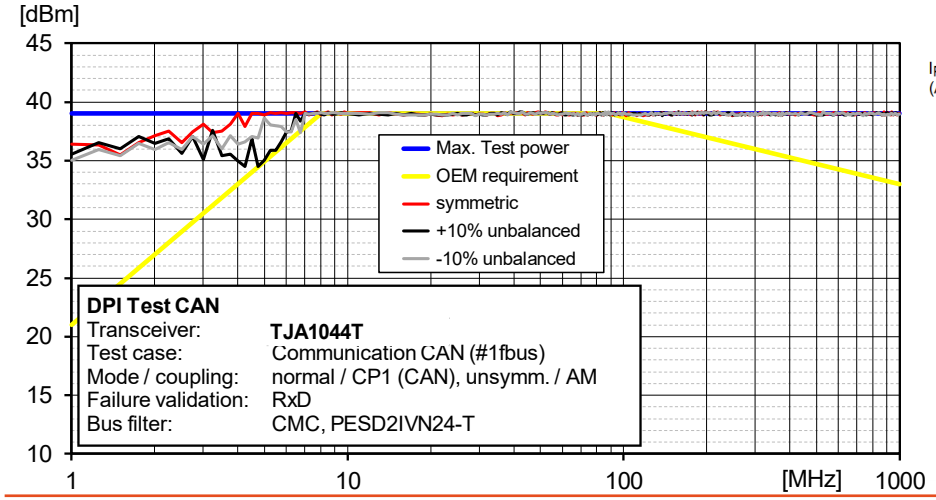


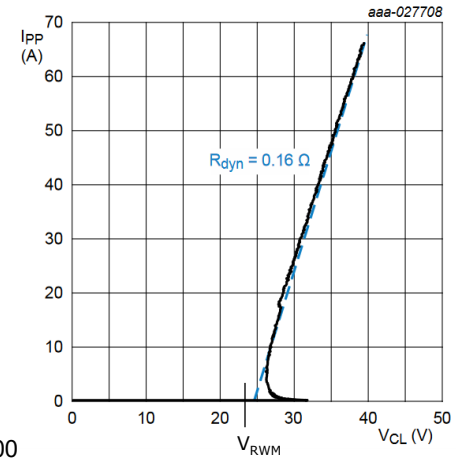
CAN

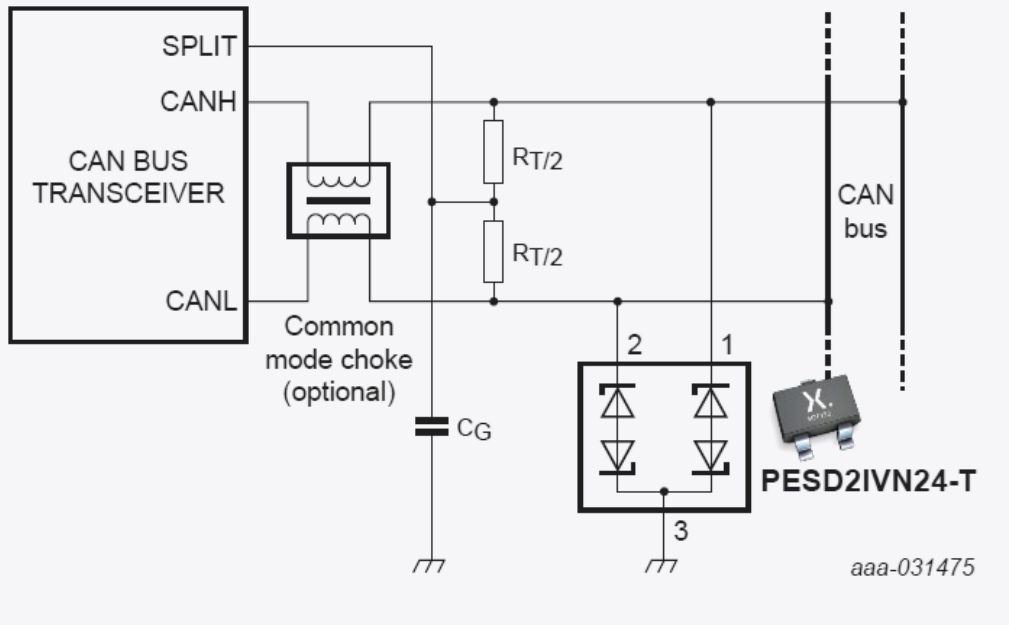
Controller **A**rea **N**etwork

Compliance with IEC62228-3 in combination with a transceiver

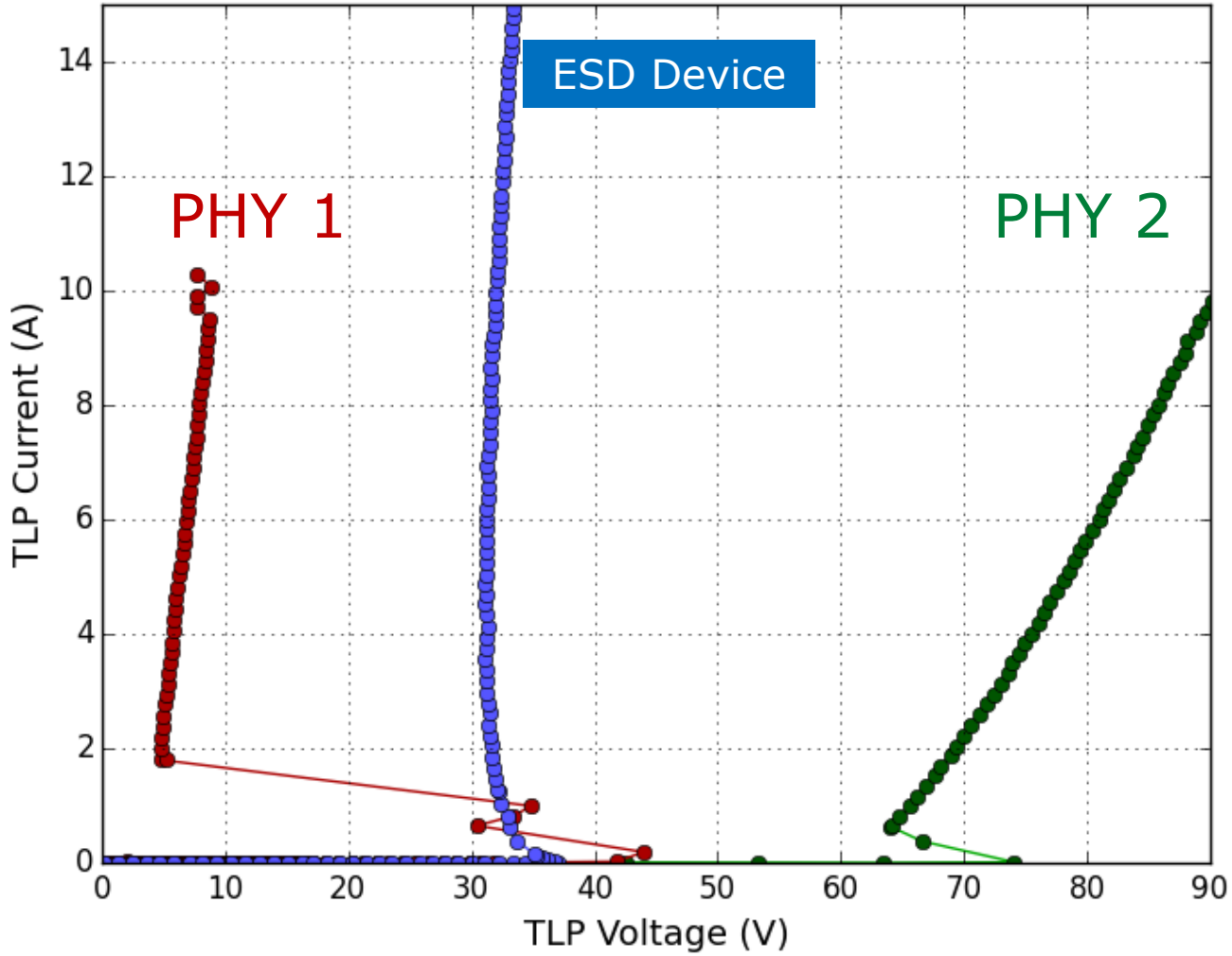
- ESD
- RF emission
- immunity to transients -> ISO7637-2 (3a/b)
- RF immunity -> DPI







Example CAN Device vs. System Robustness



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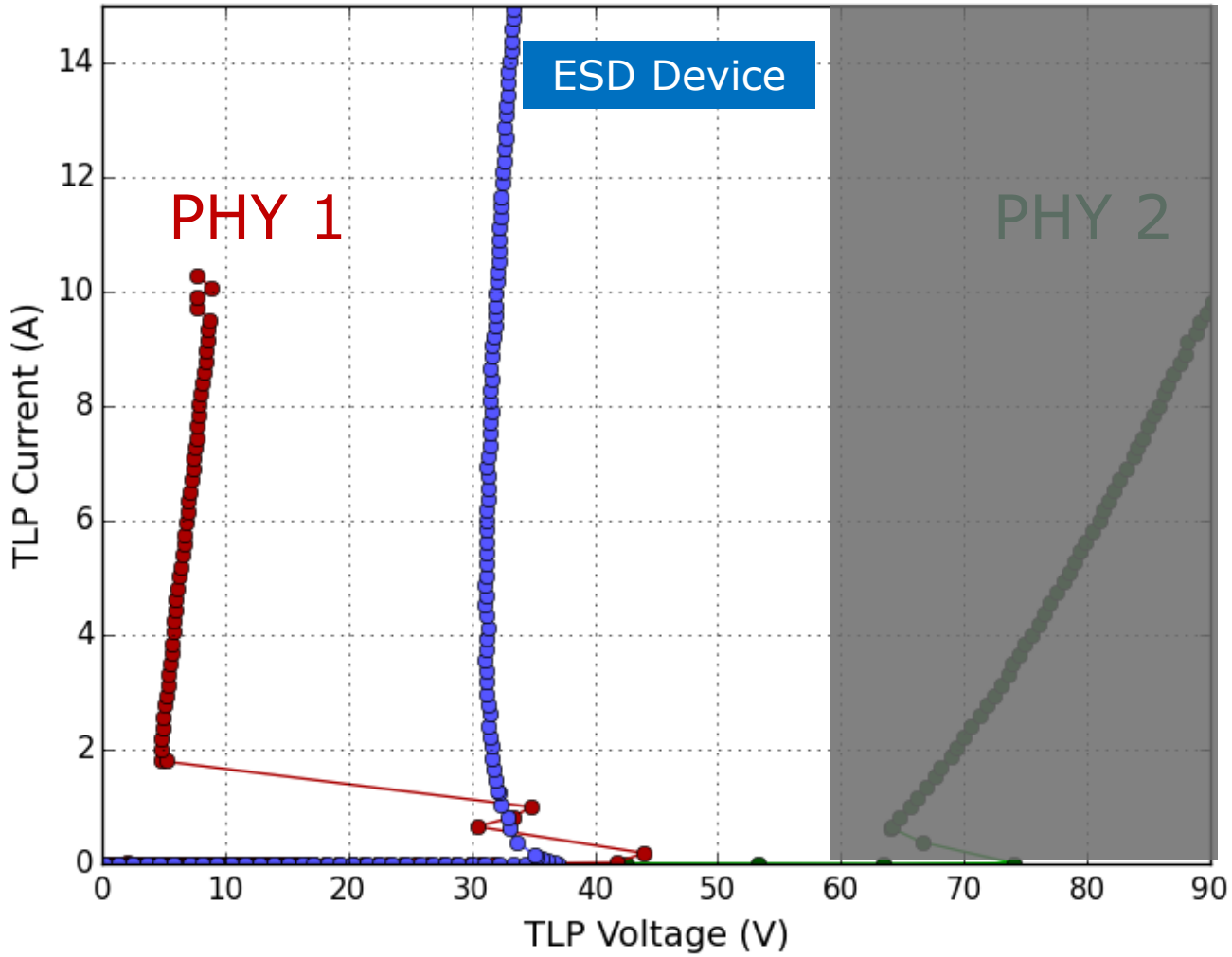
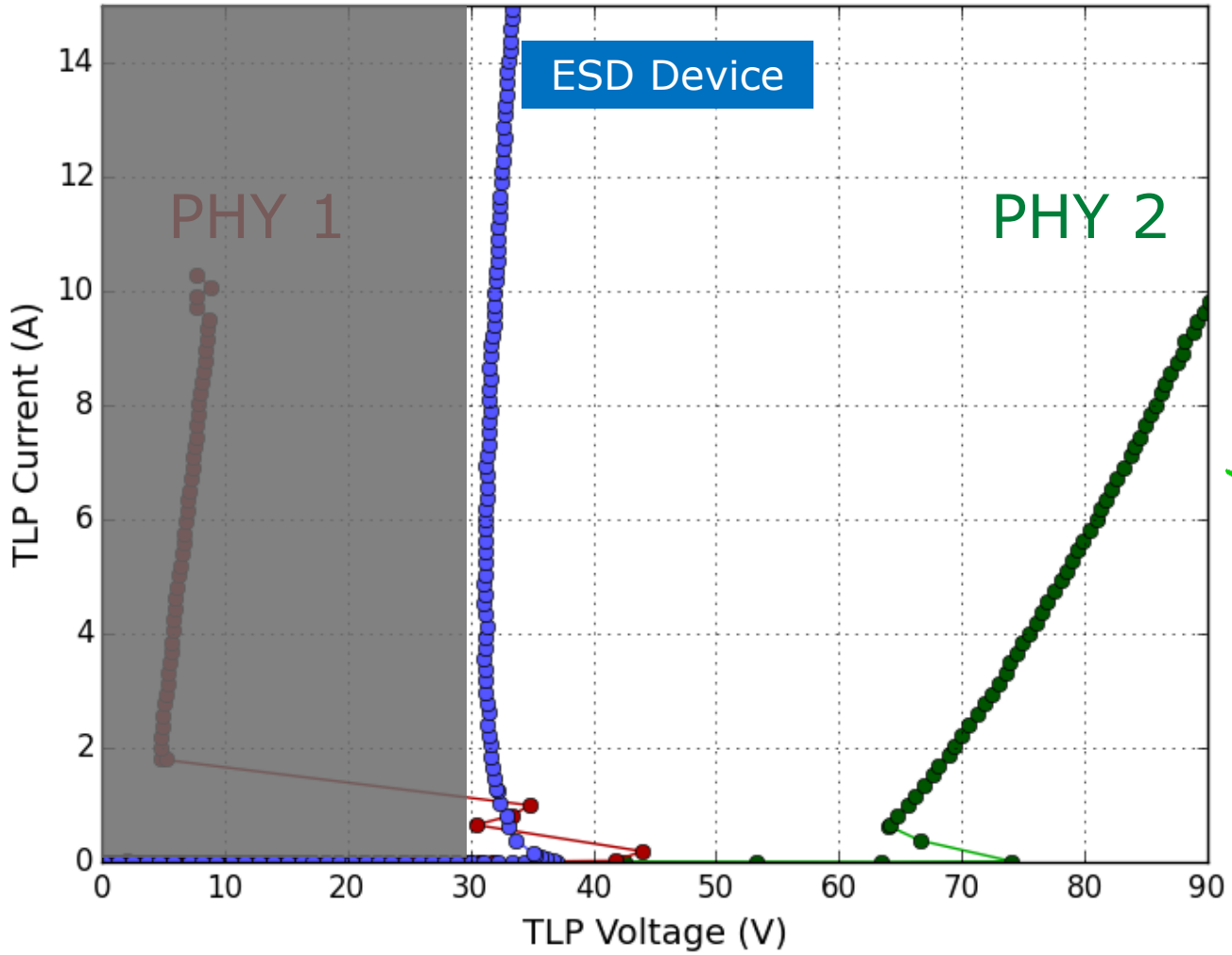
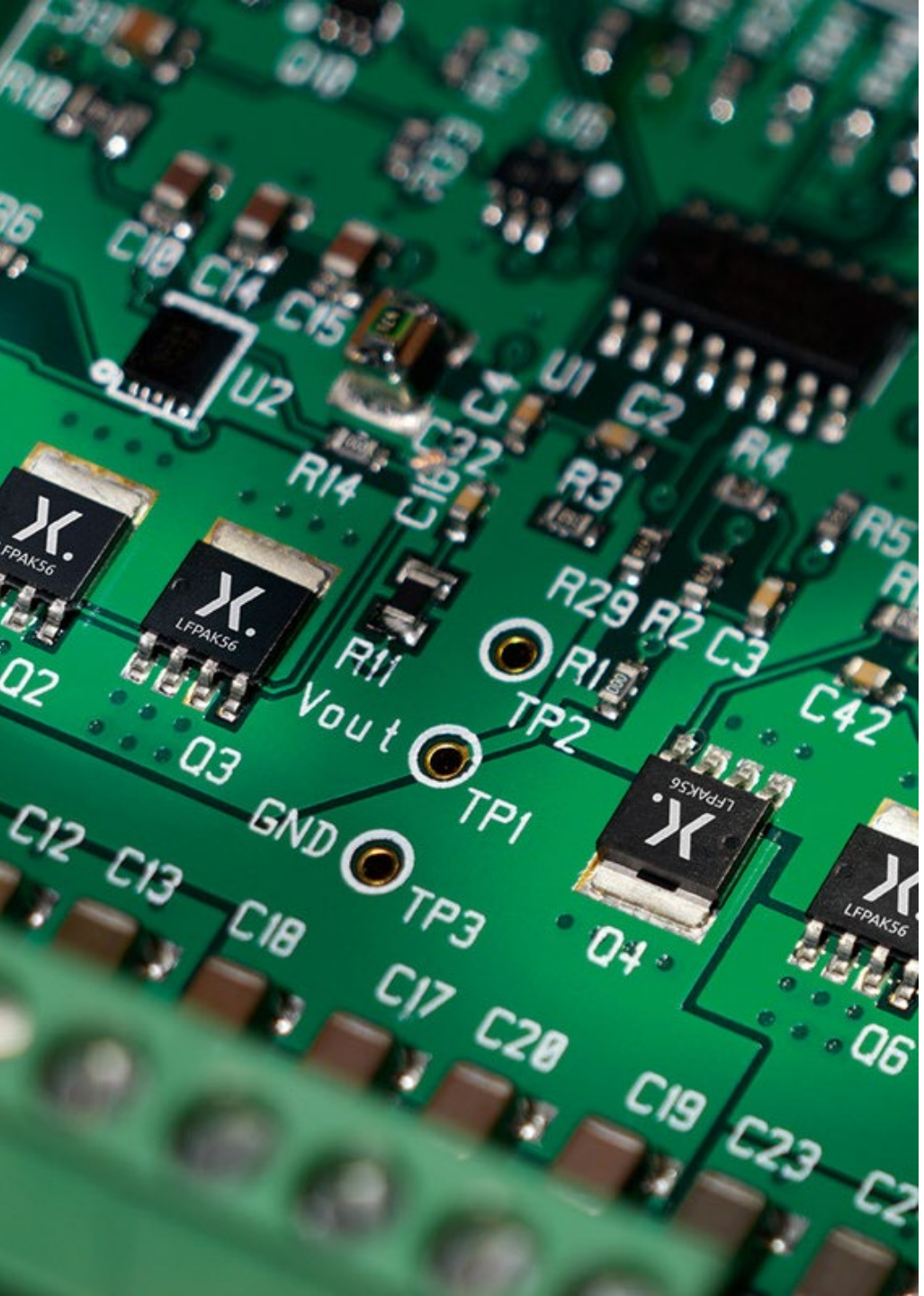


✗ PHY and ESD device not matched

Example CAN Device vs. System Robustness



✓ PHY and ESD device matched

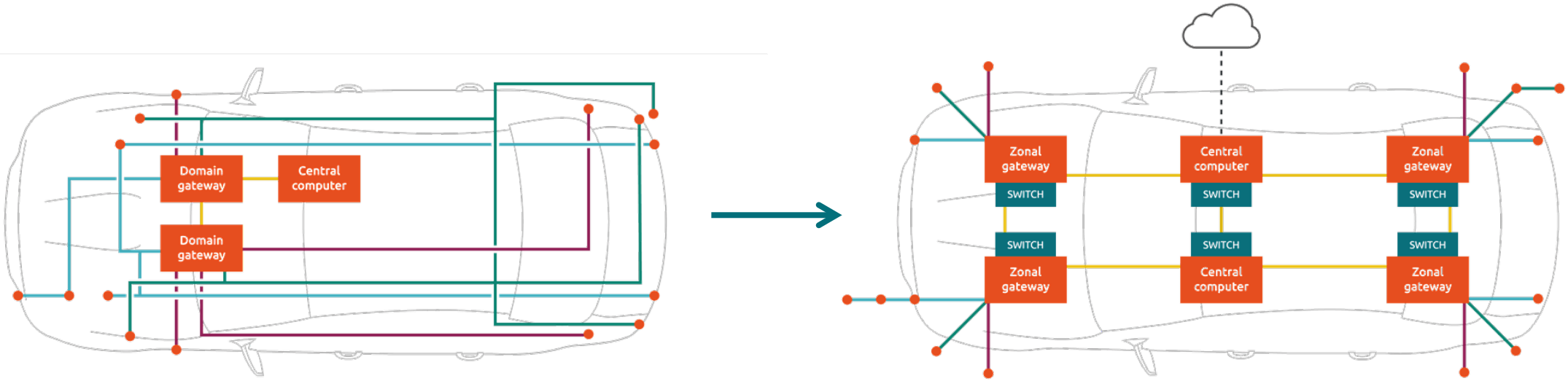


ESD Seminar Session 2

Agenda

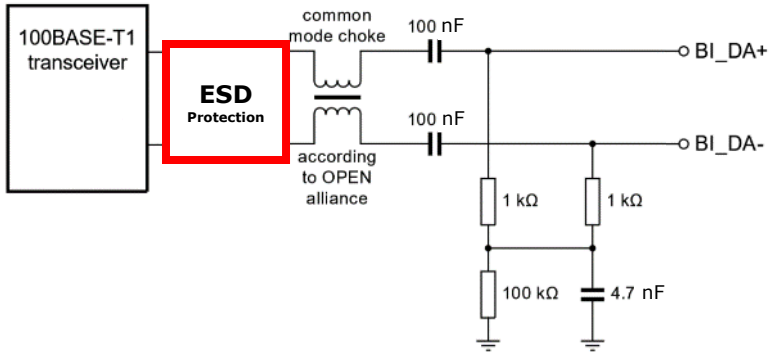
- Classic in-vehicle networks
- **OPEN Alliance Ethernet**
- SerDes
- Infotainment/Multimedia
- Extra: Package aspects
- Q&A

Automotive Ethernet requires the transition from traditional to domain and zonal architectures to support our shared vision of automotive future.



Classic Ethernet vs. OPEN Alliance

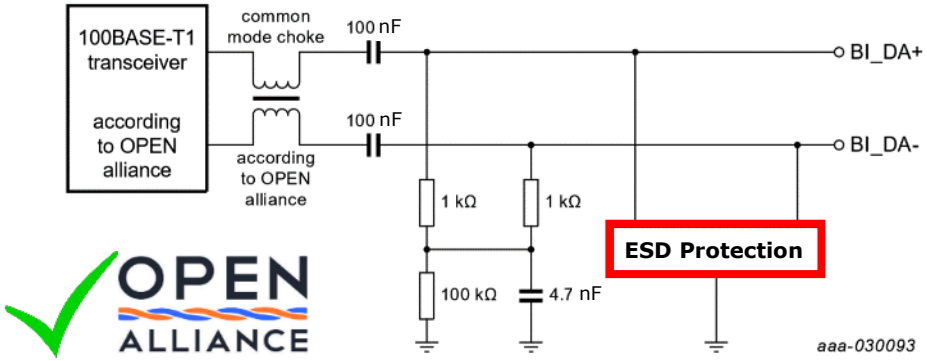
Classic Ethernet



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



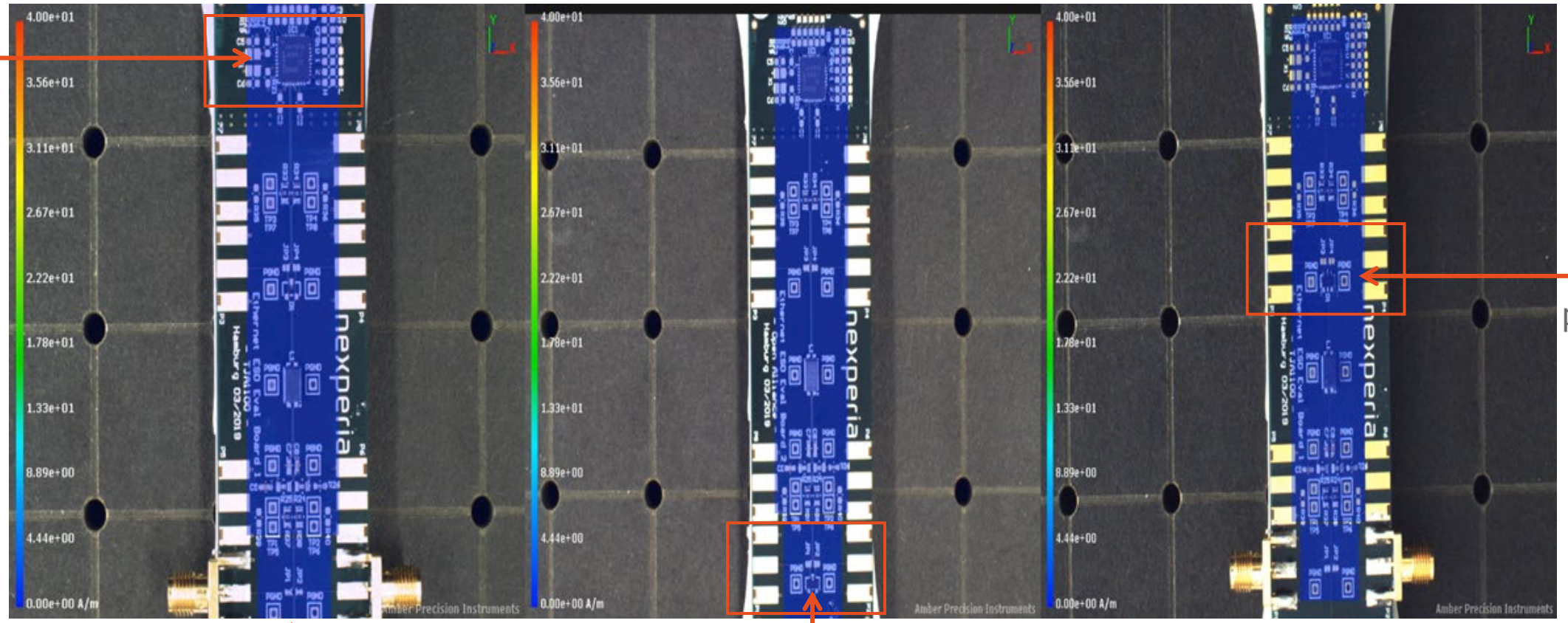
ESD Protection in front of DC Block, CMC and PHY

- **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**

100BASE-T1 concept comparison

Comparison of ESD protection concepts evaluated by EMI scanner

No Protection | **OPEN ALLIANCE** | **Classic Protection**



100BASE-T1 concept comparison

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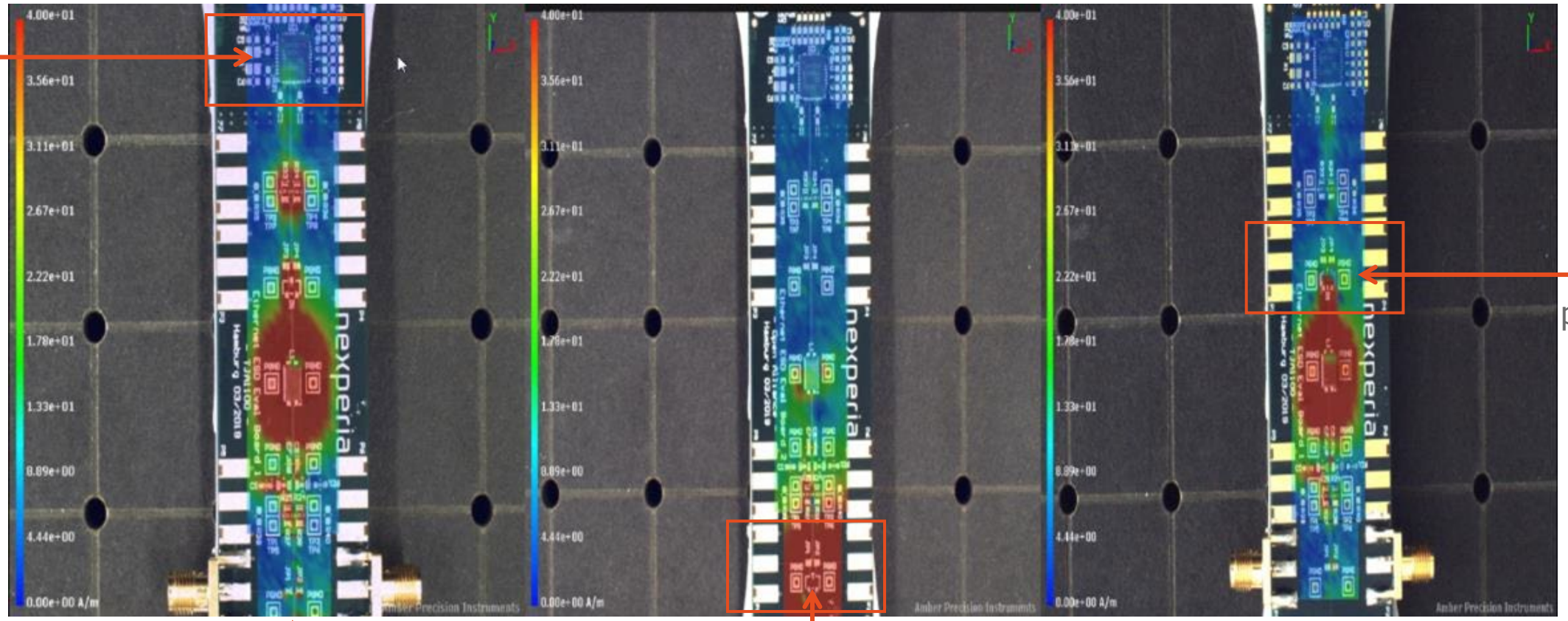
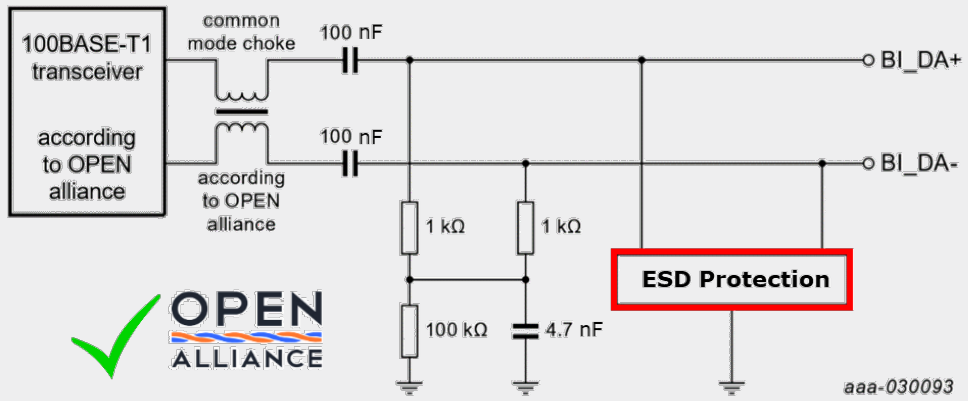
No Protection

Classic Protection



OPEN Alliance Spec. for ESD protection devices

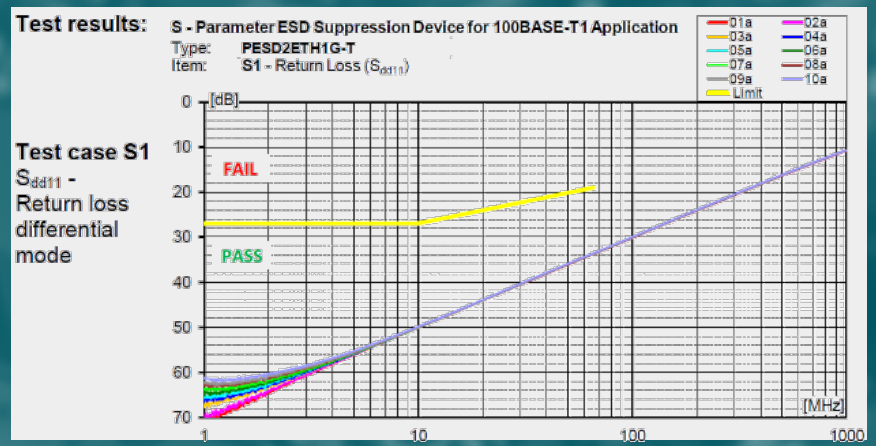
General requirements

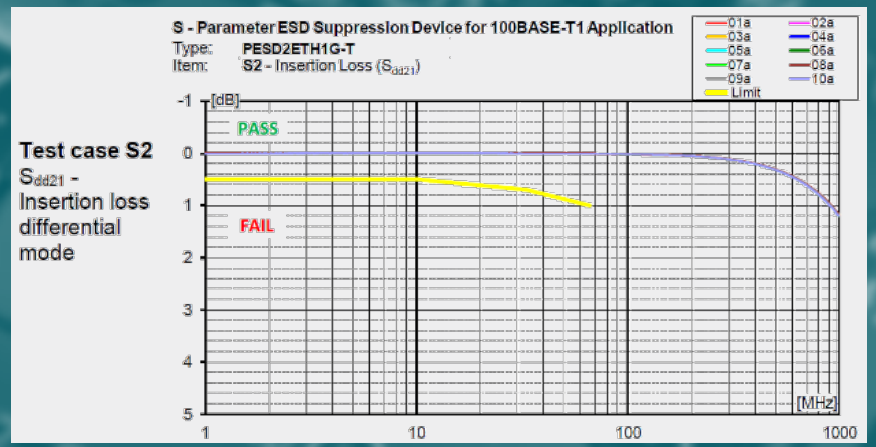


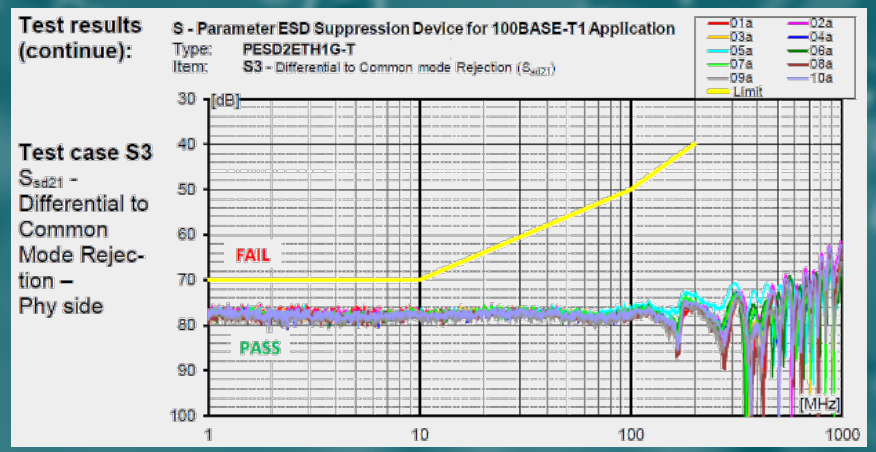
- **General requirements**
  - **Trigger voltage > 100V, $V_{DC,max}$ > 24V**
  - **Bi-direction device, 15kV IEC, 1000 discharges**
- Additional tests
  - Mixed mode S-parameter measurements
    - To evaluate transmission, symmetry, and mode conversion, replaces requirements on C_p and matching
  - Damage from ESD
    - To verify degradation, first measure S-parameters, apply ESD (8kV) discharges, and check S-parameters again
  - ESD discharge current measurement
    - Quantification of the current that would flow into the PHY
  - Unwanted clamping
    - Evaluate impact of ESD device onto RF immunity testing

OPEN Alliance Spec. for ESD protection devices

Mixed mode S-parameter measurements







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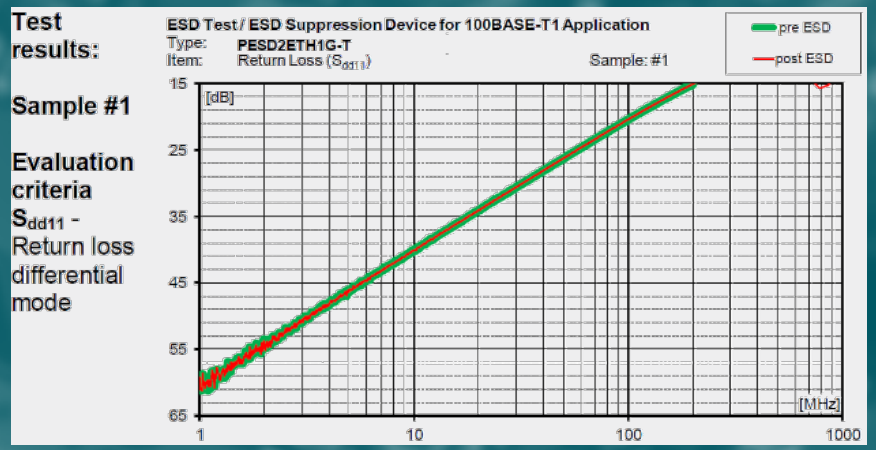
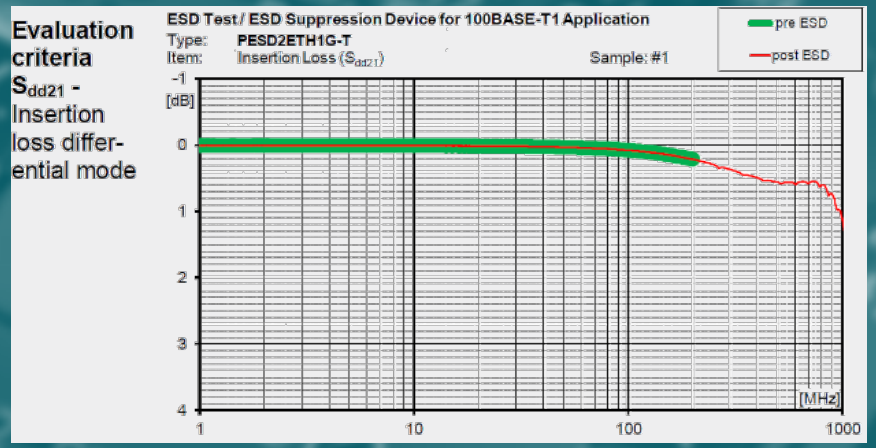
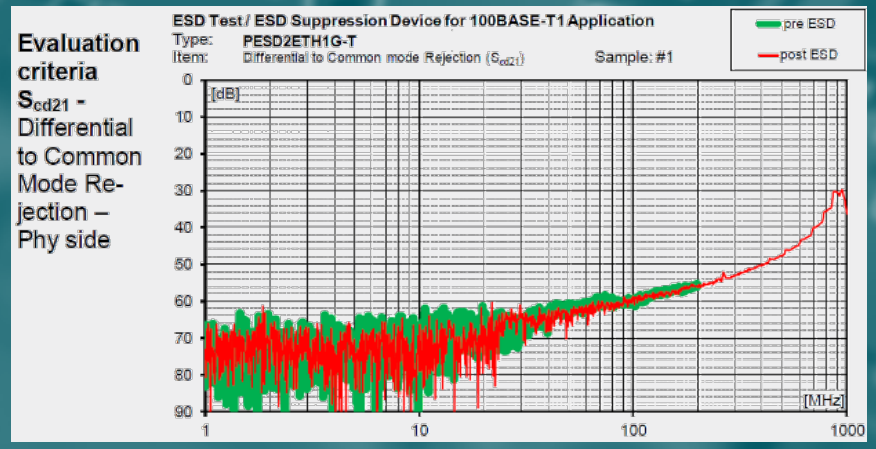
OPEN Alliance Spec. for ESD protection devices

Damage from ESD







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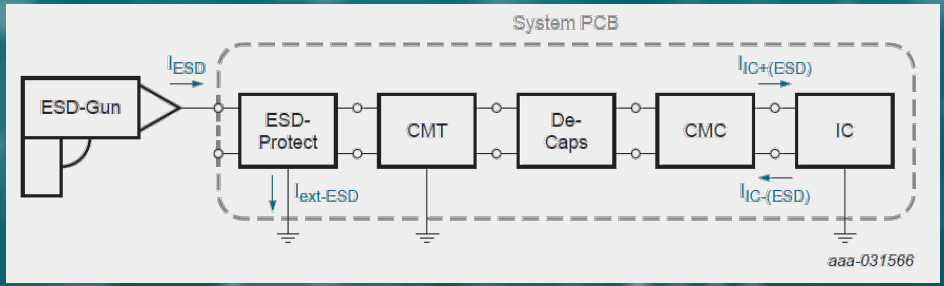
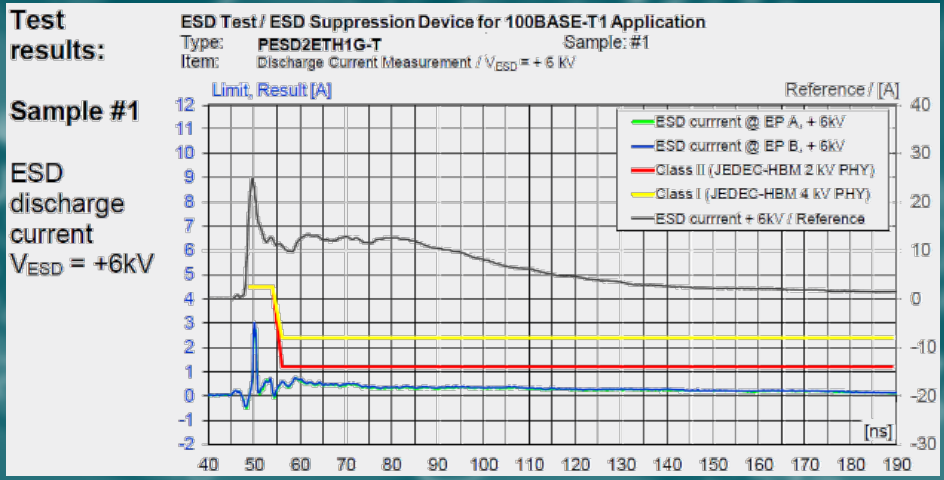
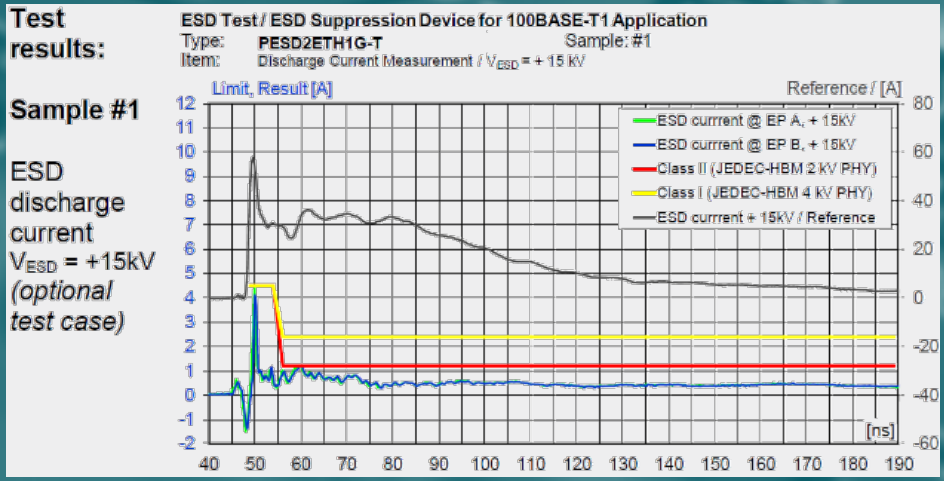
OPEN Alliance Spec. for ESD protection devices

ESD discharge current measurement







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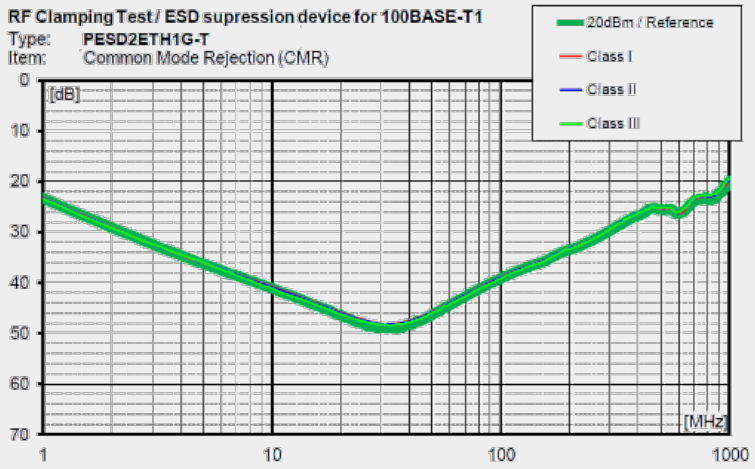
  - **ESD discharge current measurement**
    - **Quantification of the current that would flow into the PHY**
  - Unwanted clamping
    - Evaluate impact of ESD device onto RF immunity testing

OPEN Alliance Spec. for ESD protection devices

Unwanted clamping

Test results:

Evaluation criteria CMC value - Common mode rejection MDI test network



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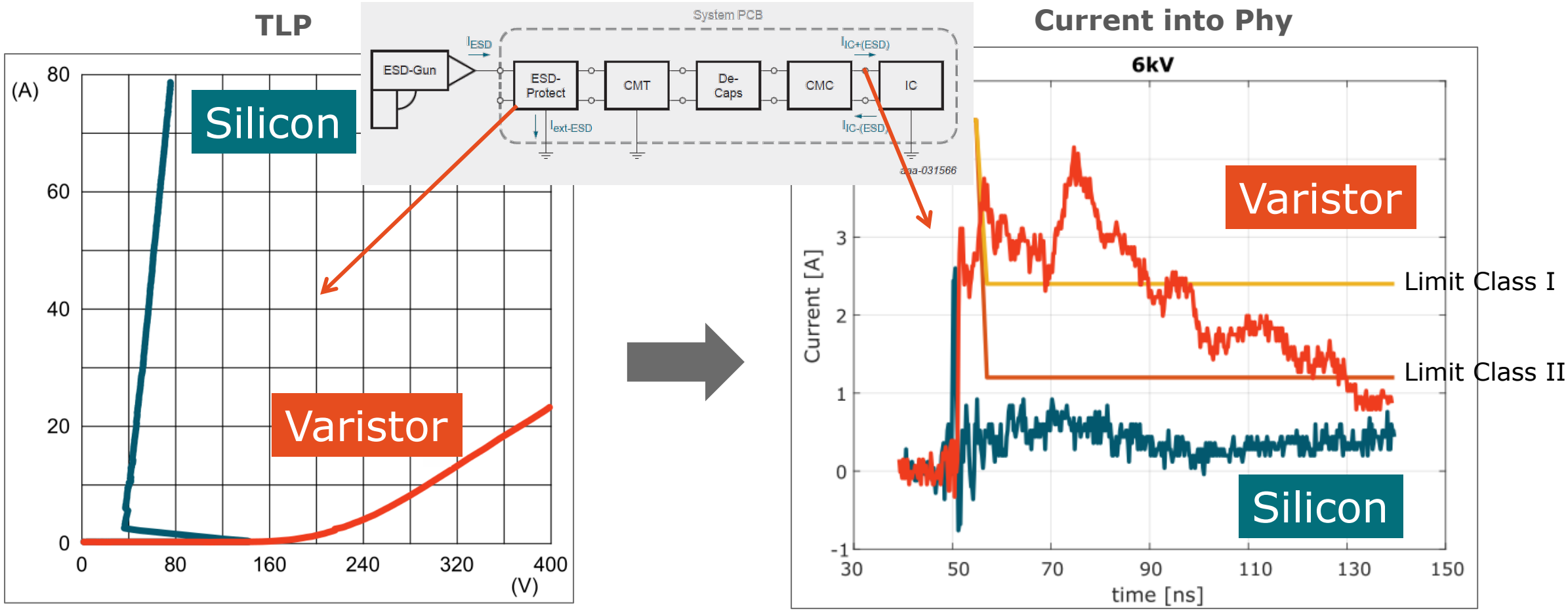
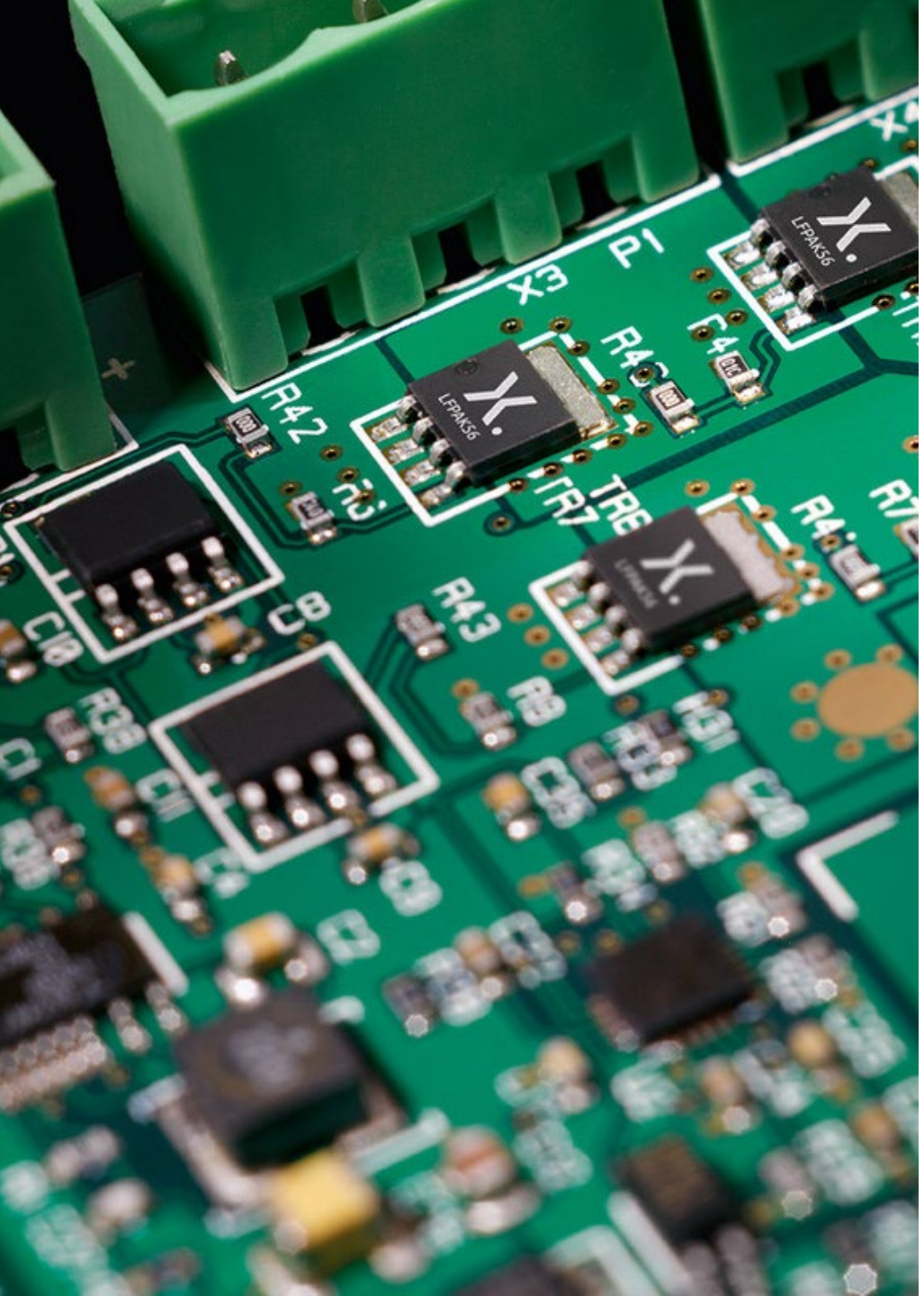
  - ESD discharge current measurement
    - Quantification of the current that would flow into the PHY
  - **Unwanted clamping**
    - **Evaluate impact of ESD device onto RF immunity testing**

ESD Discharge Current Measurement

Clamping performance and system robustness





ESD Seminar Session 2

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- Classic in-vehicle networks
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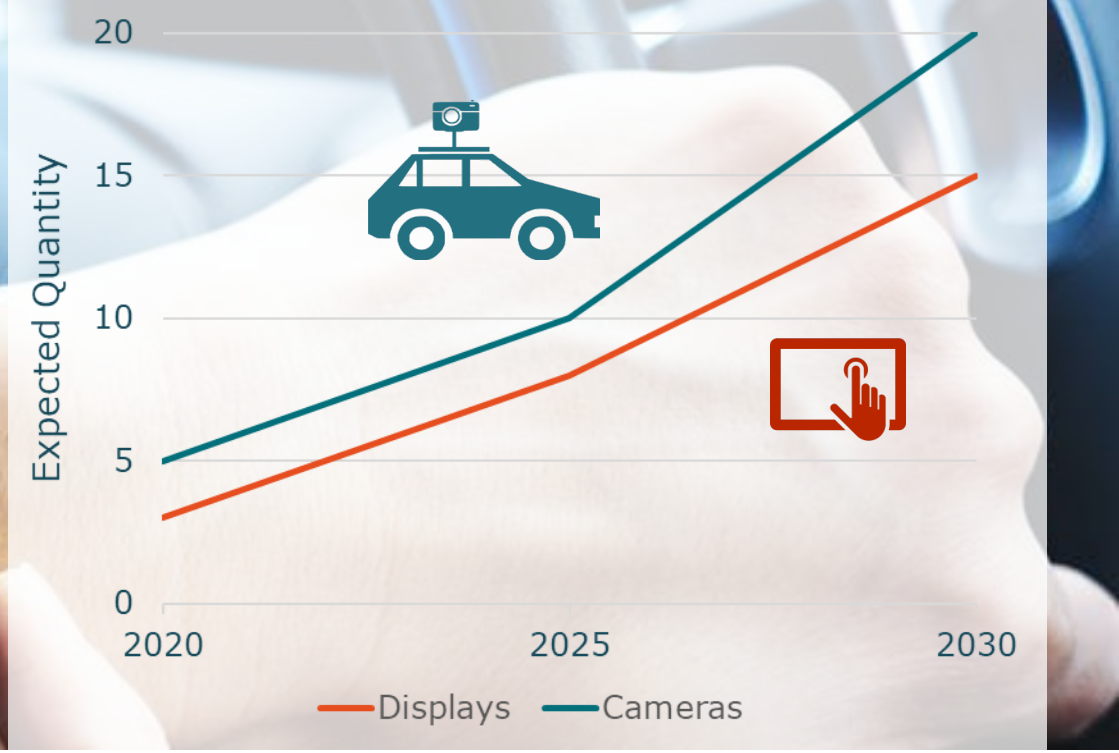
SerDes

Image credit: lucabravo | Unsplash



In 2019, **82% of vehicles** sold featured a touch screen, compared to 53% five years ago.

ALTEN Group

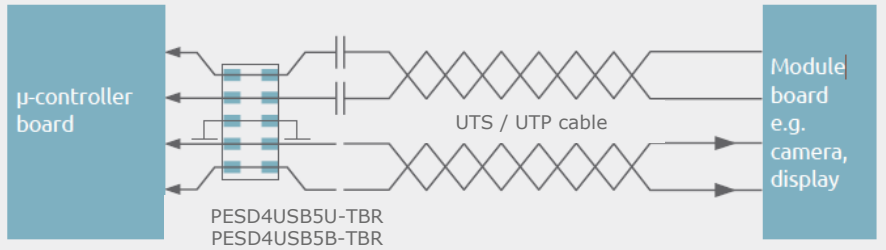
By 2030, the average car will have **~20 cameras** and **~15 displays per vehicle.**

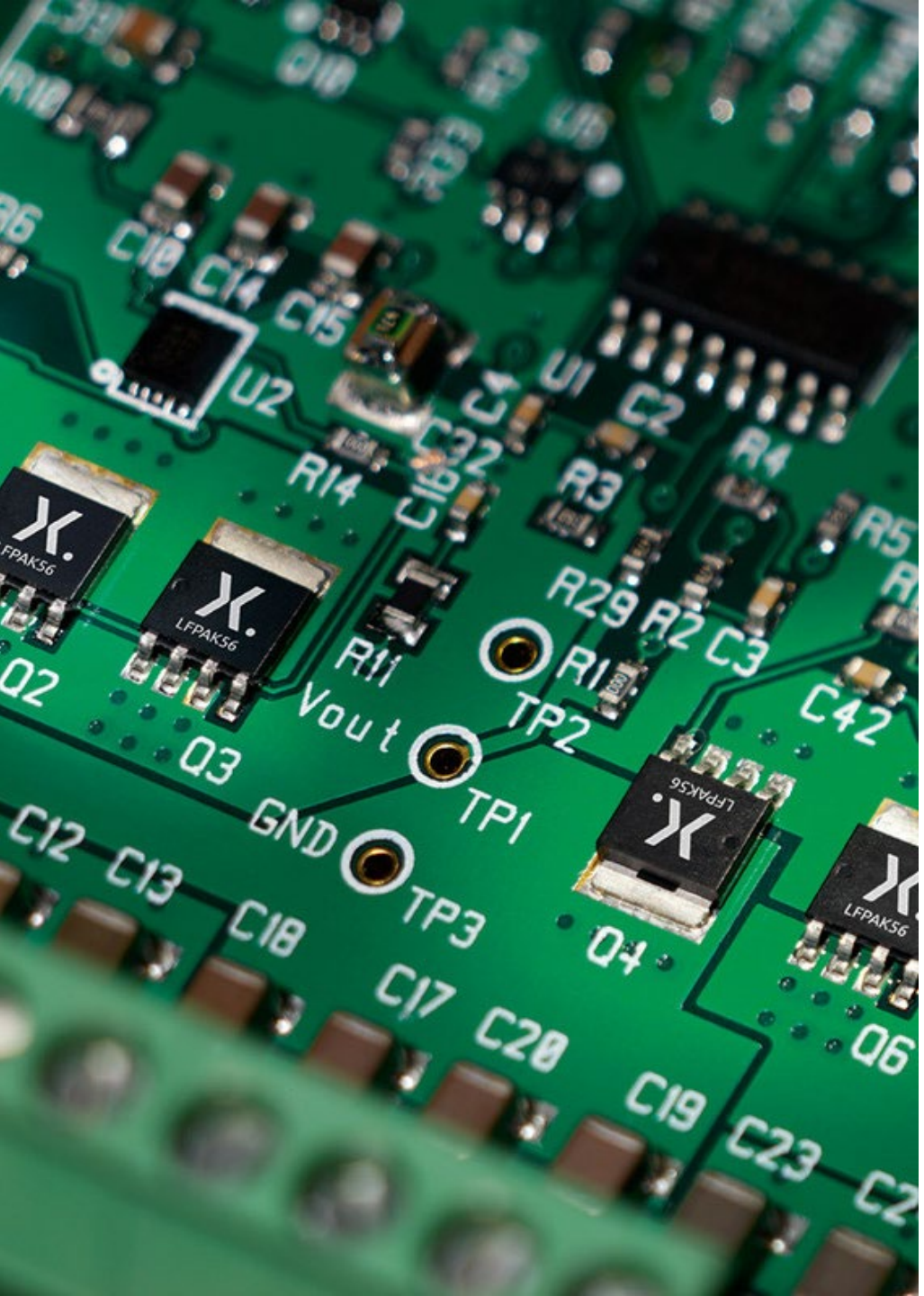
Brunner & Gauthier | ASA

SerDes

LVDS physical layer

- Many propriatary systems. No open standards and different handling by OEMs and IC vendors.
- Max parasitic capacitance depends on datarate
  - Usually, should be very low Cp < 1pF
  - Matching of lines usually not required, as Cp is very small
- Short-to-battery and jumpstart are not considered
- The lower the clamping voltage, the better is the protection.
- The protection should be as close as possible at the connector
- Leadless packages help to reduce parasitics





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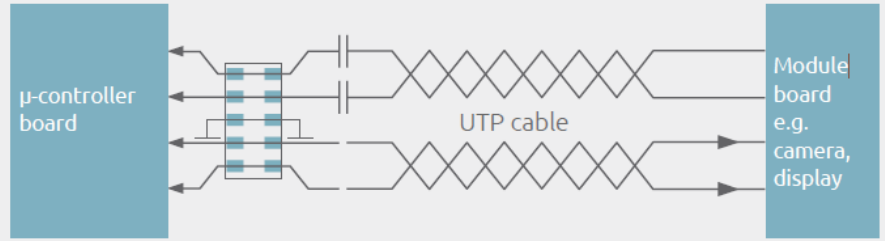
Infotainment

Common infotainment busses

USB - Universal Serial Bus

HDMI - High Definition Multimedia Interface

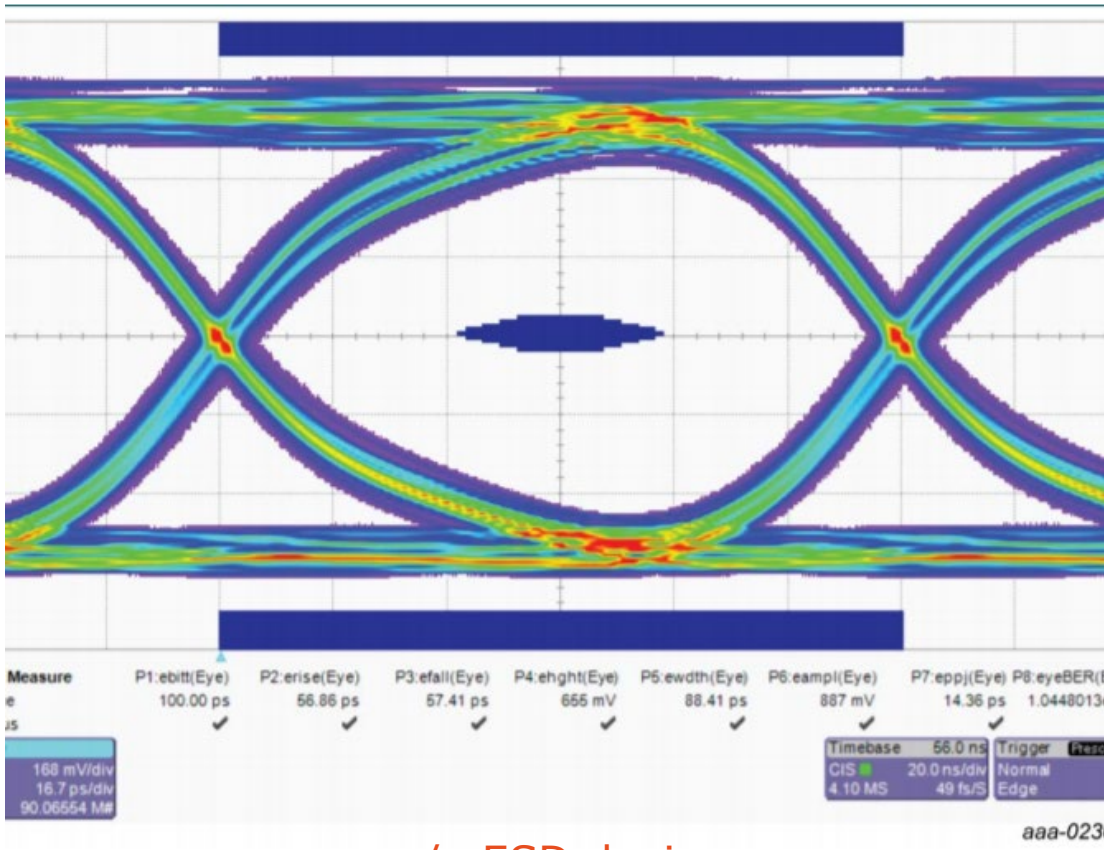
- Very low capacitance mandatory <<1pF
- RF compliance via
  - S-parameters
  - Eye diagrams
  - TDR
- Very low clamping required to protect sensitive ICs
- Fast turn-on required to prevent dynamic overshoot



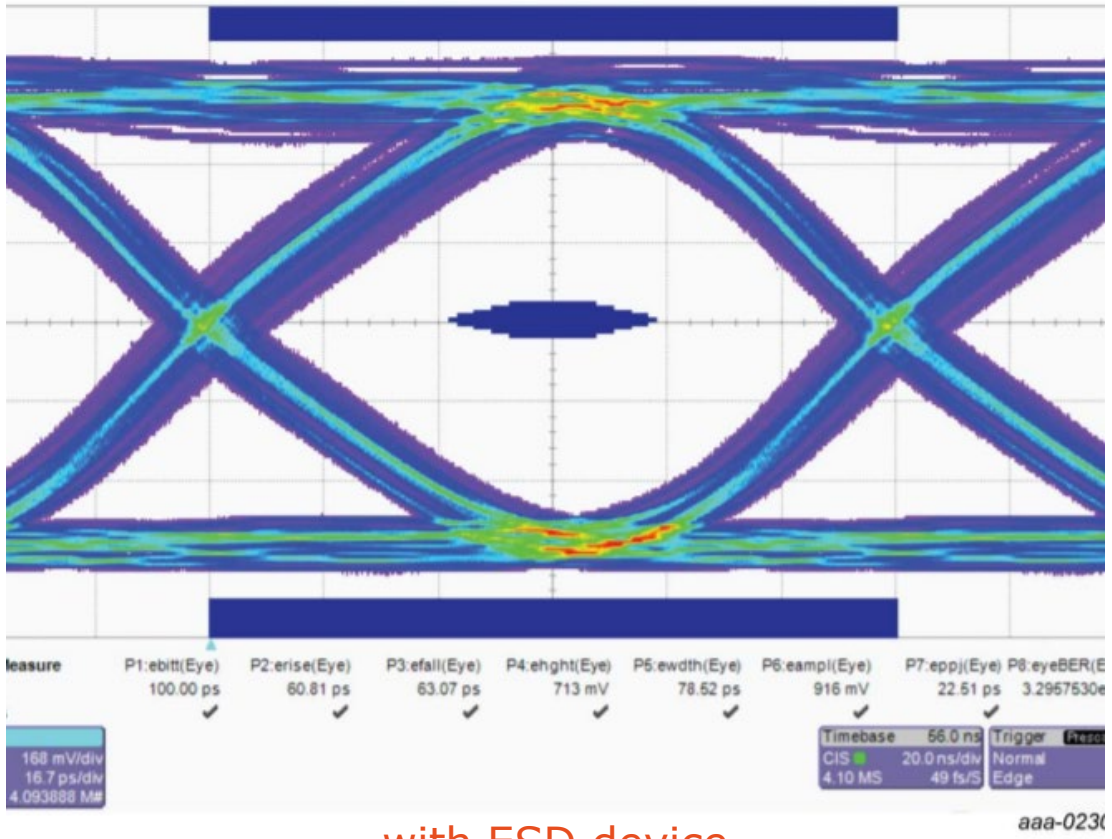
PESD4USB3U-TBR

Signal integrity importance

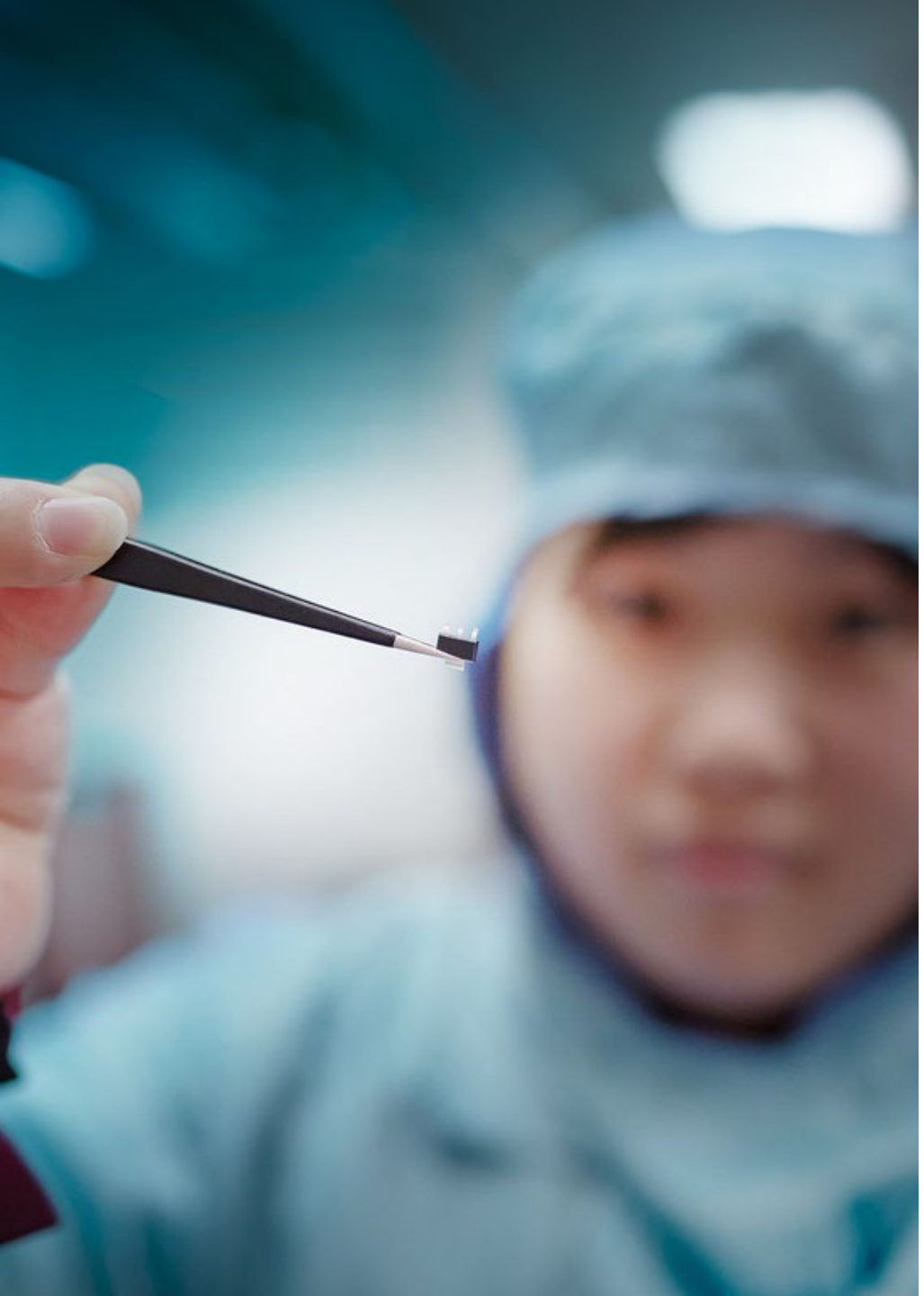
Eye diagramm



w/o ESD device



with ESD device



ESD Seminar Session 2

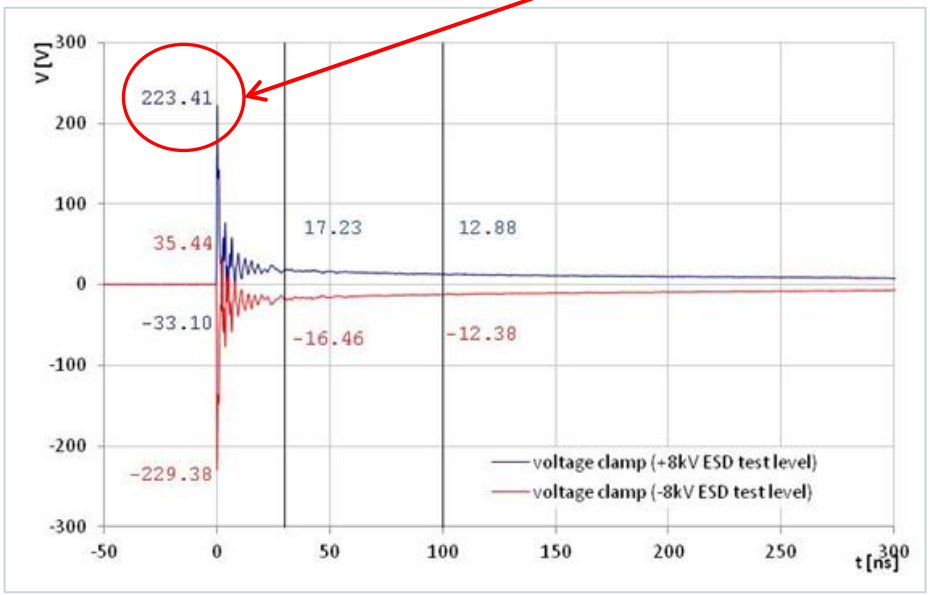
Agenda

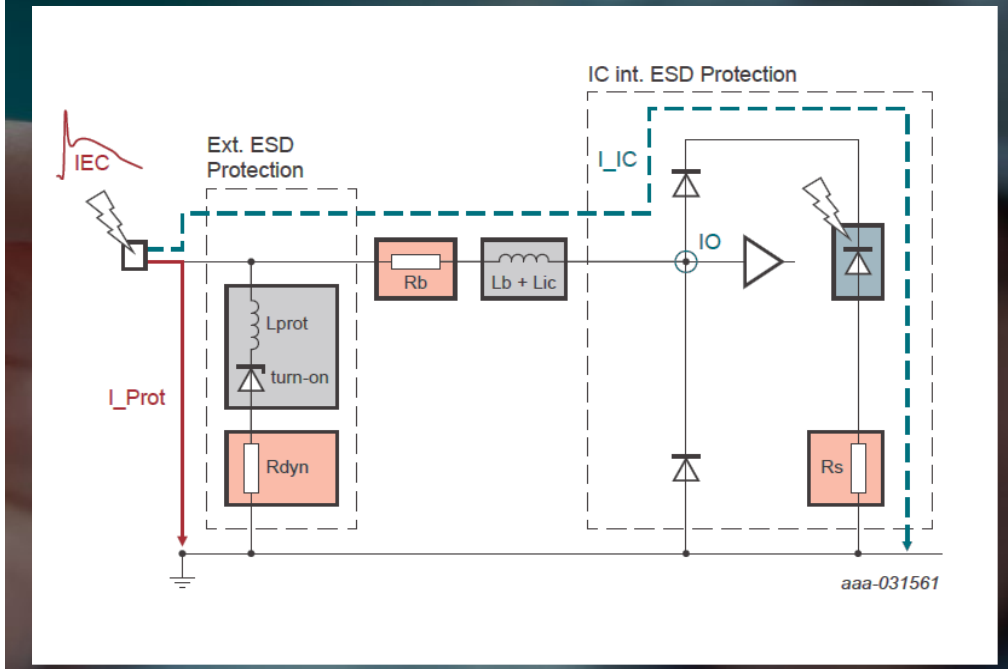
- Classic in-vehicle networks
- OPEN Alliance Ethernet
- SerDes
- Infotainment/Multimedia
- **Extra: Package aspects**
- Q&A

Package aspects – Clamping behavior

For high-speed busses

- Rdyn governs the clamping voltage in a quasi-static condition
- The dynamic behavior is determined by inductances and turn-on behavior



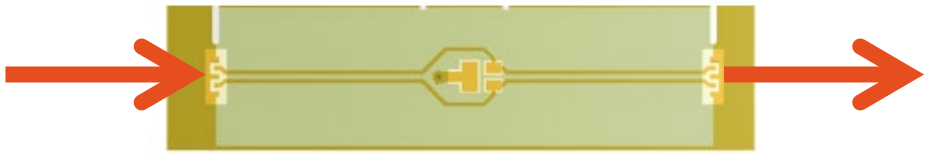


Package aspects – RF behavior

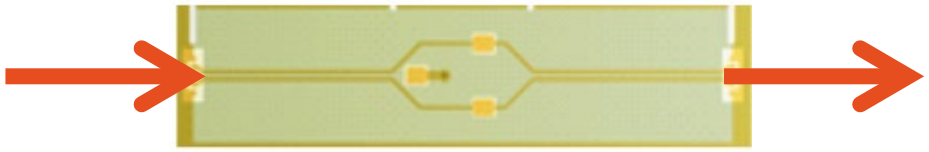
Comparison of SOT23 and DFN1110D-3 only footprint

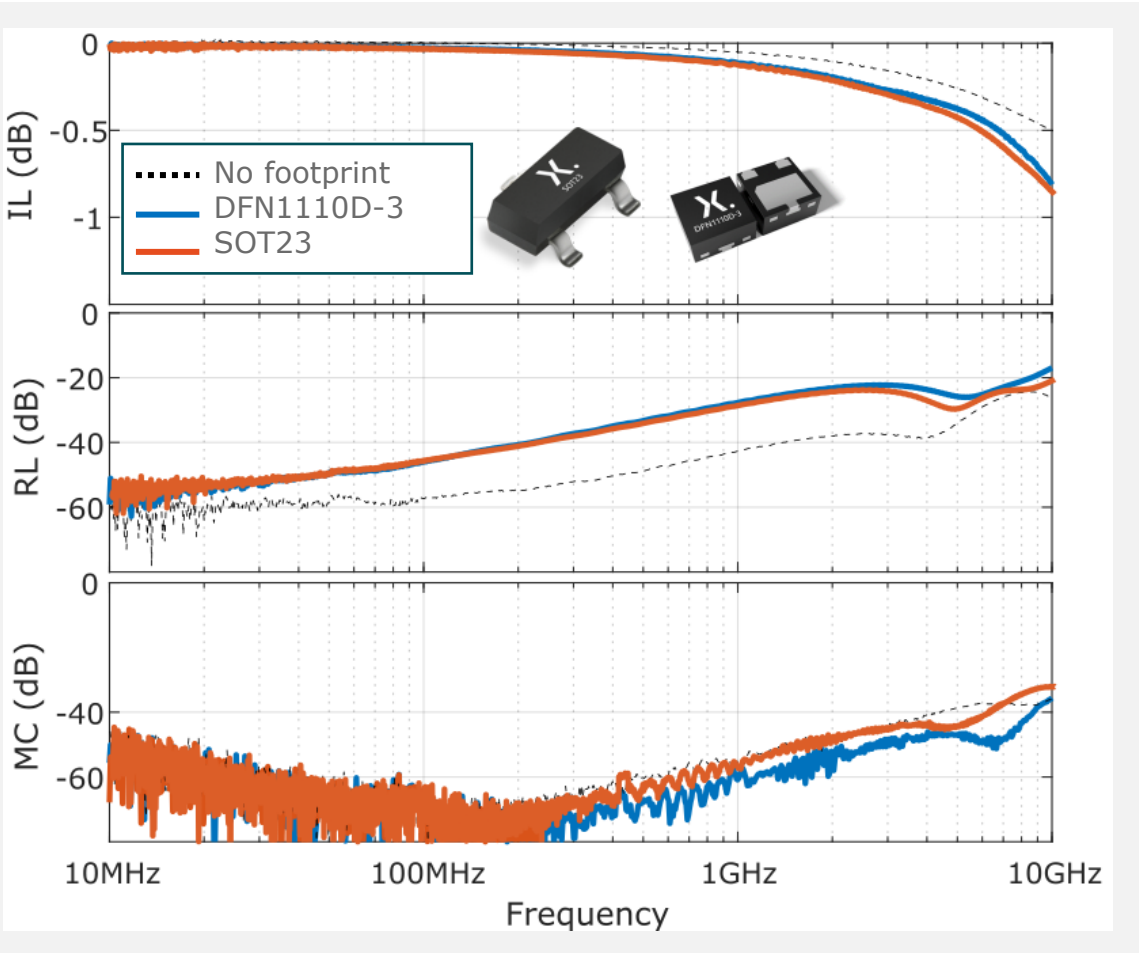
- Ca. 2 cm traces on FR4
- Dashed line: no footprint
- **No big difference between footprints**

DFN1110D-3



SOT23



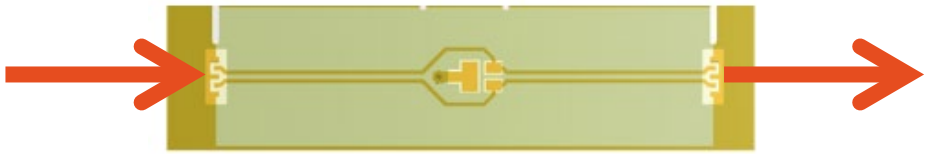


Package aspects – RF behavior

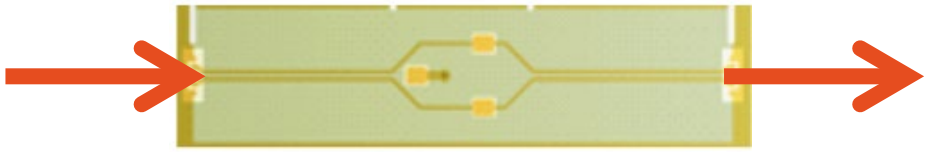
Comparison of SOT23 and DFN1110D-3 with PESD2CANFD24V (C_p = 5.2 pF)

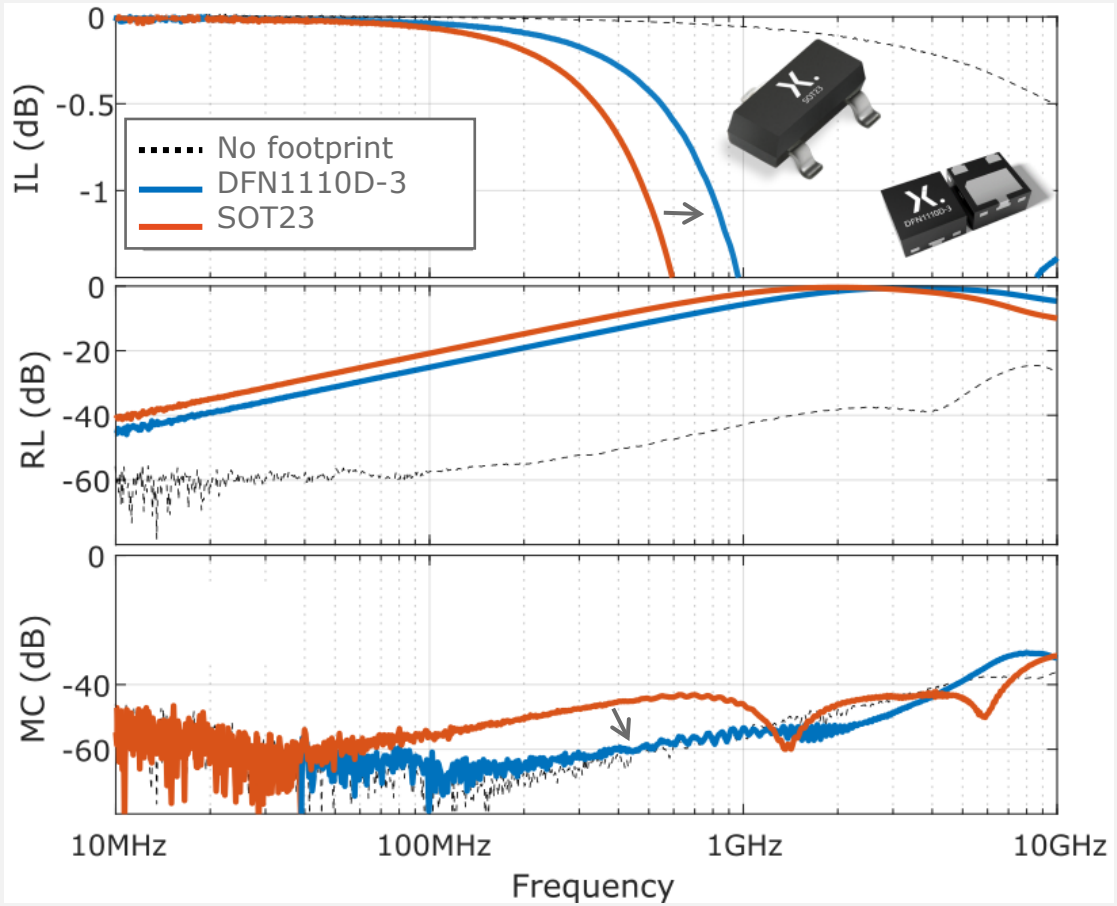
- Ca. 2 cm traces on FR4
- Dashed line: no footprint
- **Clear advantage of leadless package**

DFN1110D-3



SOT23





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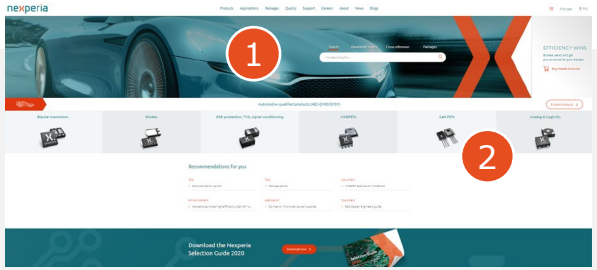

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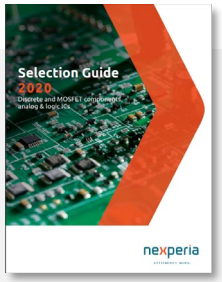
1
- Search Function
- Cross Reference
- Parametric Search
- Package Search

2
- Product Overview

  [Path to Datasheets, Product Brochures, Application Examples, …]



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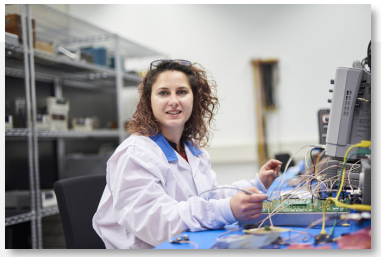

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- TLP, EMI scan, SEED
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Q&A

ESD for Electronic Design Engineers Seminar

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