ST PROTECT

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CAN bus protection - ST ESDCAN series

Agenda

1. CAN bus overview and standards
2. Why protection is needed
3. ESDCAN series versus standards
4. ESDCAN series versus quality of protection
5. Package miniaturization
6. 5 questions to select the right ESDCAN
7. More on ESDCAN series

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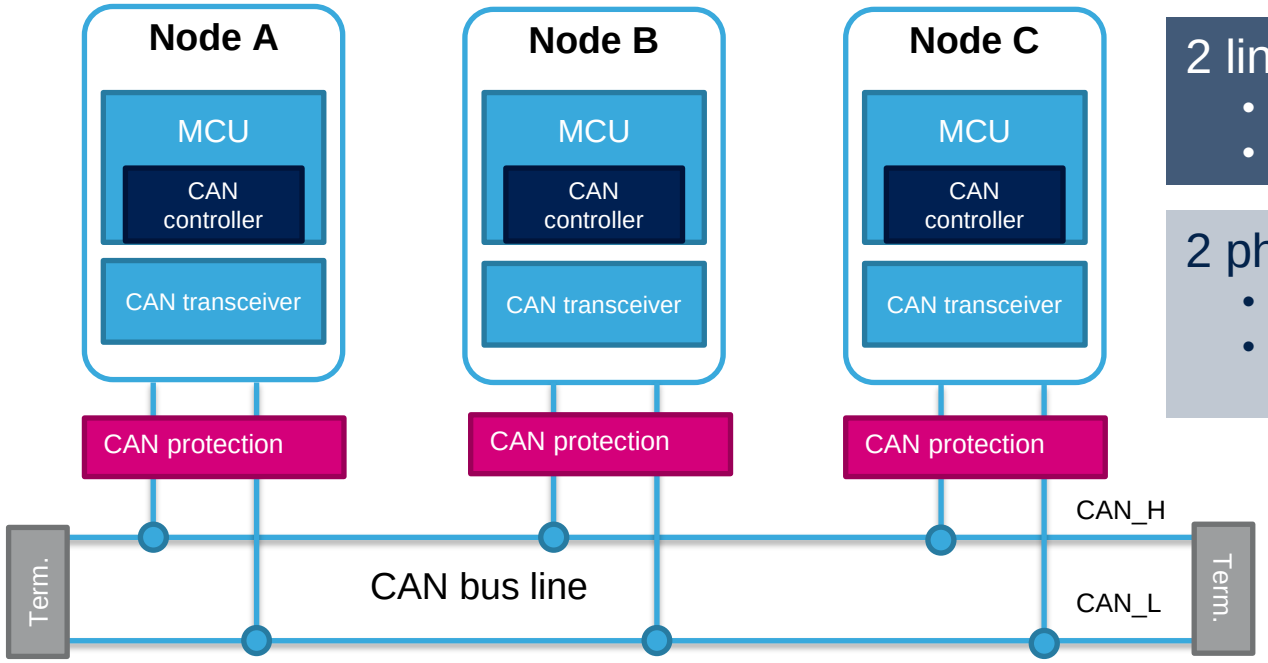
Controller area network bus overview

Cost-effective, light-weight, safe and reliable transmission, and information available for all nodes



CAN serial bidirectional half-duplex multimaster communication bus

2 lines:
- CAN_H (CAN high)
- CAN_L (CAN Low)

2 physical layers and 2 standards
- Low-speed, fault-tolerant CAN (ISO 11898-3)
- High-speed CAN (ISO 11898-2)
  CAN-FD is based on high-speed CAN physical layer

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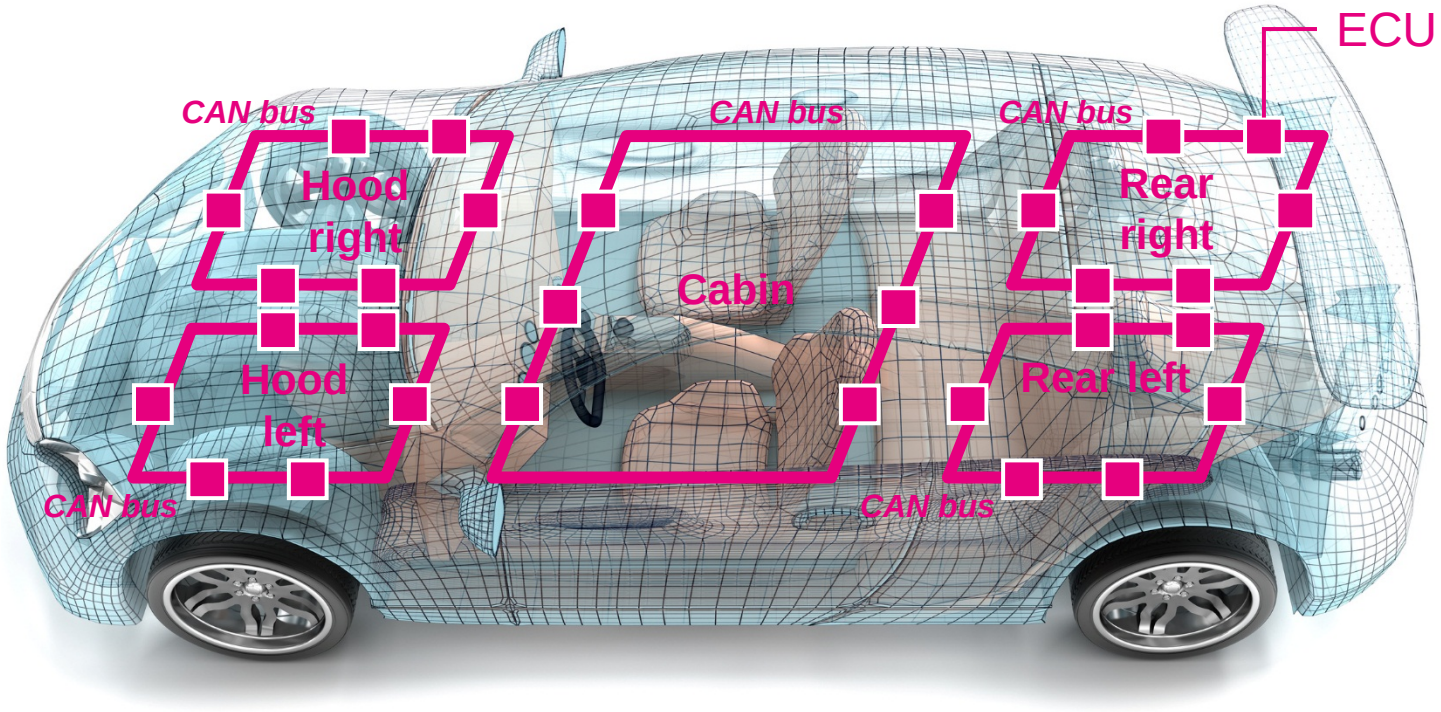
Where CAN is used

The CAN bus is reliable and is used to connect most ECUs in a car domain or car zone, including safety and critical functions



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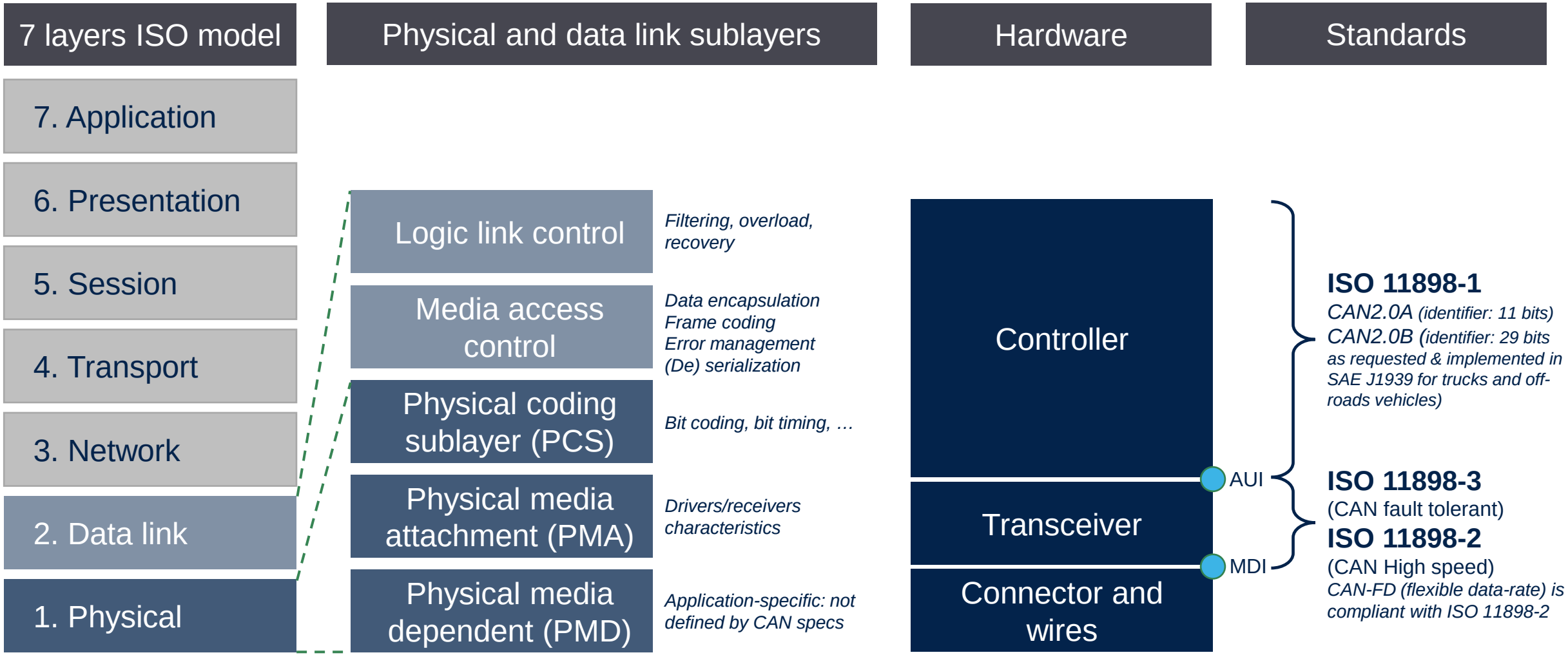
CAN standards ecosystem



NB: SAE-J2962 (communication transceivers qualification requirements) is based on ISO 11898-1 and ISO 11898-2

**AUI: Attachment unit interface* **MDI: Media-dependent interface*

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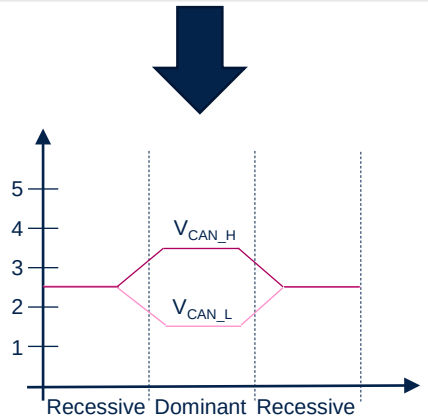
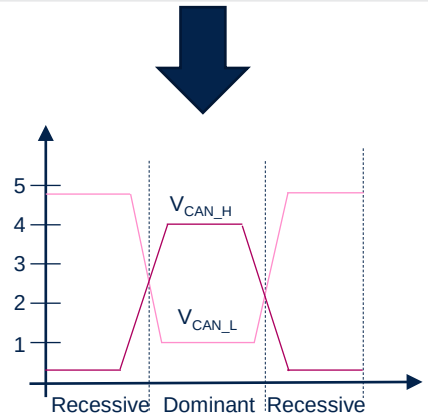
CAN bus characteristics

Parameters	High-speed CAN	Low-speed CAN
Physical layer standards	ISO 11898-2	ISO 11898-3
Data rate	Up to 1 Mbps (5 Mbps for CAN-FD)	Up to 125 kbps
Maximum length	30 m	500 m
Termination	120 Ω shunt	2.2 kΩ serial on each line
Recessive voltage level	$V_{CAN\_H} = V_{CAN\_L} = 2.5$ V	$V_{CAN\_H} \sim 0$ V $V_{CAN\_L} \sim 5$ V
Dominant voltage level	$V_{CAN\_H} = 3.6$ V $V_{CAN\_L} = 1.4$ V	$V_{CAN\_H} = 4$ V $V_{CAN\_L} = 1$ V





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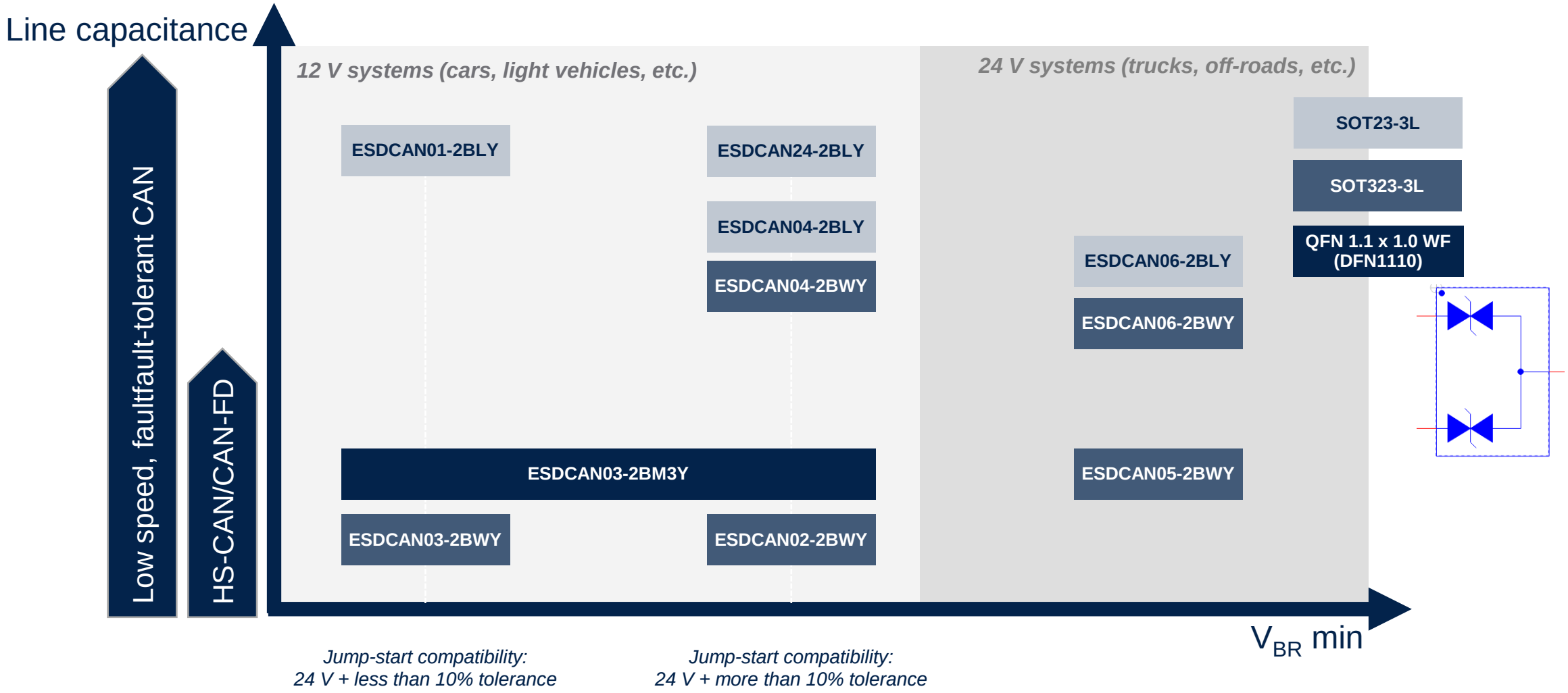
Why protection needed

- Automotive systems require a high level of **robustness** and must be extremely reliable, especially when they control safety devices.
- The **automotive industry** has defined **standards** to guarantee the robustness of car embedded electronics.
- The **SAE-J2962** (communication transceivers qualification requirements) standard **recommends using protection devices** for CAN transceivers to prevent dramatic failures.

Relevant standards for CAN link compliance

Standards	Hazards	Type	CAN protection specifics
ISO 10605	ESD protection	Voltage spikes due to electro-static discharges.	ESD robustness up to 30 kV (R=330Ω, C= 330 pF) and low ESD clamping voltage
ISO 7637-3 pulse 3a/3b	Surge protection	Voltage spikes due to switching processes (influenced by capacitance and inductances of the wiring harness)	Must pass the surge and efficiently clamp the generated overvoltages
ISO 16750	Jump start	Application of 24 V on all inputs to simulate a jump start with a 24 V battery	Reverse breakdown voltage V_{BR} > 24 V
ISO 16750	Reverse battery	Application of -14 V for 12 V battery nominal voltage (passenger cars, etc.) and -28V for 24 V battery nominal voltage (trucks, off-roads, etc.) over 60 s to simulate reversed battery connection when using an auxiliary starting device	Forward breakdown voltage V_{BR} < -14 V for 12 V battery Forward breakdown voltage V_{BR} < -28 V for 24 V battery

ESDCAN series mapping



Low line capacitance ESDCAN are recommended for High-speed CAN and CAN-FD

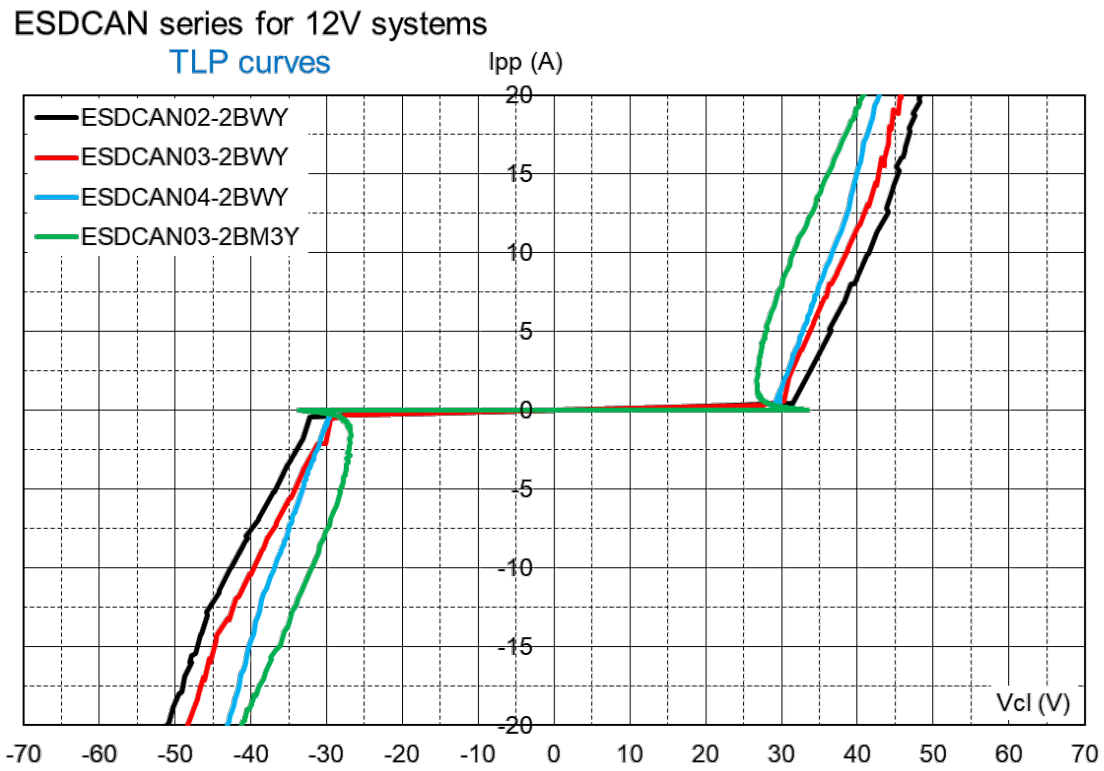
ESDCAN series versus standards

Hazards	Standards	ESDCAN24-2BLY	ESDCAN01-2BLY	ESDCAN04-2BLY	ESDCAN06-2BLY	ESDCAN02-2BWY	ESDCAN03-2BWY	ESDCAN04-2BWY	ESDCAN05-2BWY	ESDCAN06-2BWY	ESDCAN03-2BM3Y
ESD protection	*ISO 10605* (C = 150 pF, R = 330 Ω)	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±30 kV contact	✓ ±15 kV contact
Surge protection	*ISO 7637-3 pulse 3a/3b*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jump-start	*ISO 16750*	✓ V_{BR} min (reverse) = 27 V	✓ V_{BR} min (reverse) = 25 V	✓ V_{BR} min (reverse) = 27.5 V	✓ V_{BR} min (reverse) = 38 V	✓ V_{BR} min (reverse) = 28.5 V	✓ V_{BR} min (reverse) = 26.5 V	✓ V_{BR} min (reverse) = 27.5 V	✓ V_{BR} min (reverse) = 39 V	✓ V_{BR} min (reverse) = 38 V	✓ V_{TRIG} min (reverse) = 28 V
Reverse battery	*ISO 16750*	✓ V_{BR} min (forward) = 27 V	✓ V_{BR} min (forward) = 25 V	✓ V_{BR} min (forward) = 27.5 V	✓ V_{BR} min (forward) = 38 V	✓ V_{BR} min (forward) = 28.5 V	✓ V_{BR} min (forward) = 26.5 V	✓ V_{BR} min (forward) = 27.5 V	✓ V_{BR} min (forward) = 39 V	✓ V_{BR} min (forward) = 38 V	✓ V_{TRIG} min (reverse) = 28 V

ESDCAN series quality of protection

- Not only must protection features comply with standards, but they must efficiently protect against surges, **even at high temperature**.
- The **quality of protection** is measured by its ability to **clamp overvoltages** and overcurrent, thus **protect the CAN transceiver and all the PHY components** against EOS/ESD.
- The lower the clamping voltage, the greater ESD immunity.
- This clamping voltage is usually measured using **TLP** (transmission line pulse) method. Read more in AN5241

ESDCAN series
High EMC immunity against surges

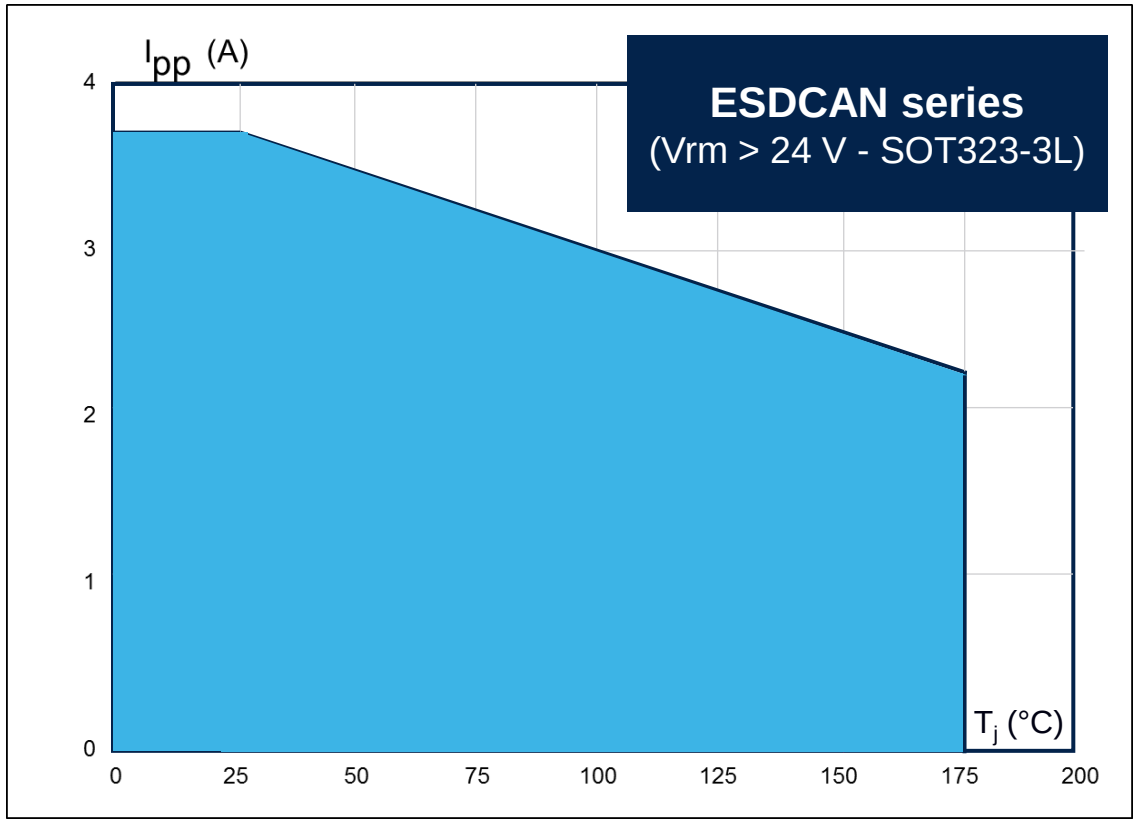


High ESD robustness:
Up to 30kV–ISO 10605

High EOS robustness:
Up to 5.5A–8/20µs surge

High protection quality:
Low clamping voltage

ESDCAN series
High temperature operation

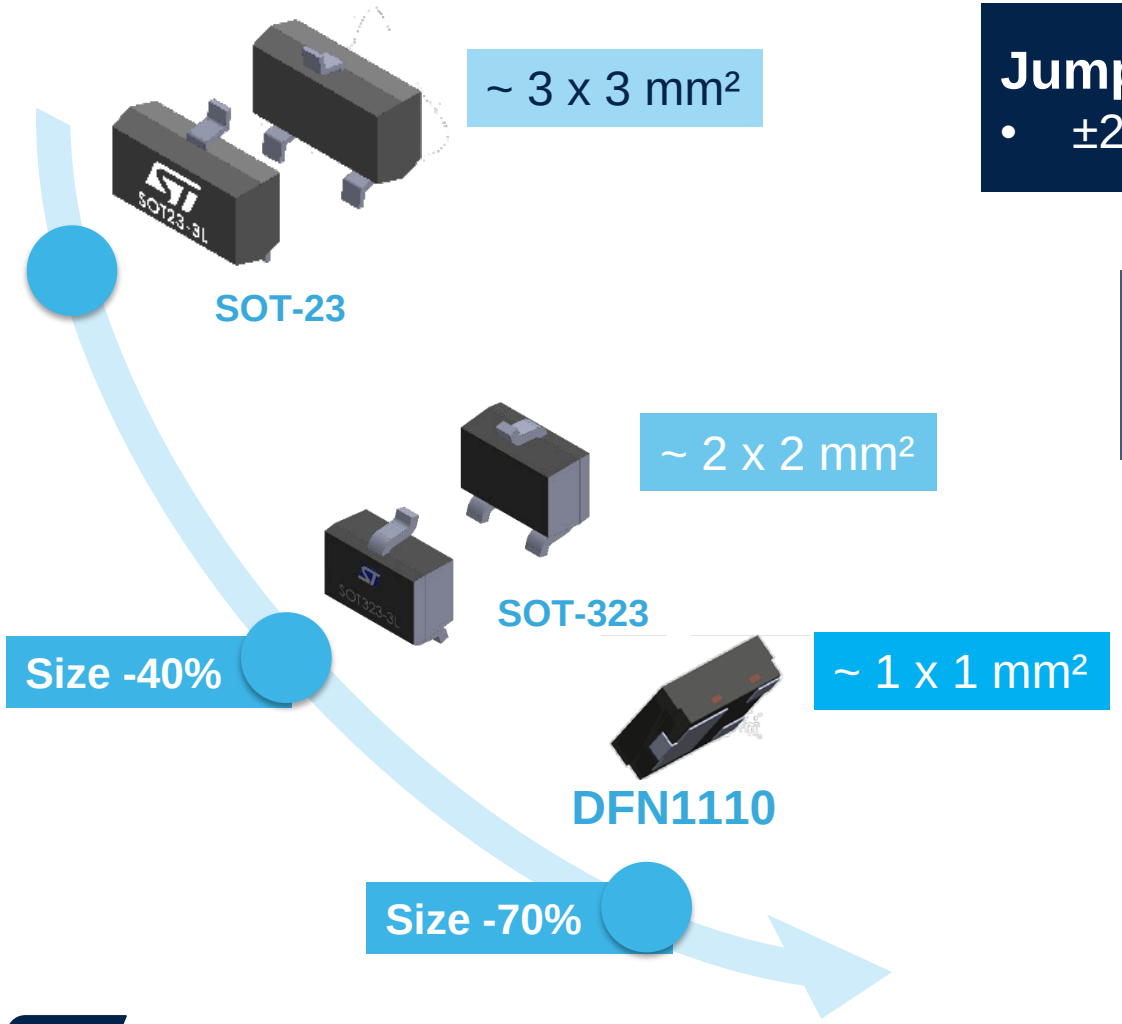


Low derating with temperature

STMicroelectronics **ESDCAN series** still offers protection at high temperature

ESDCAN series maximum junction temperature: **T_J max = 175°C**

Package miniaturization with ESDCAN03-2BM3Y



Jump-start and reverse plugging compatibility
- ±24V operating voltage

Compatible with CAN, CAN-FD and FlexRay
- Low line capacitance: 3.3 pF

Ultra low clamping voltage
- 32V @3A 8/20µs

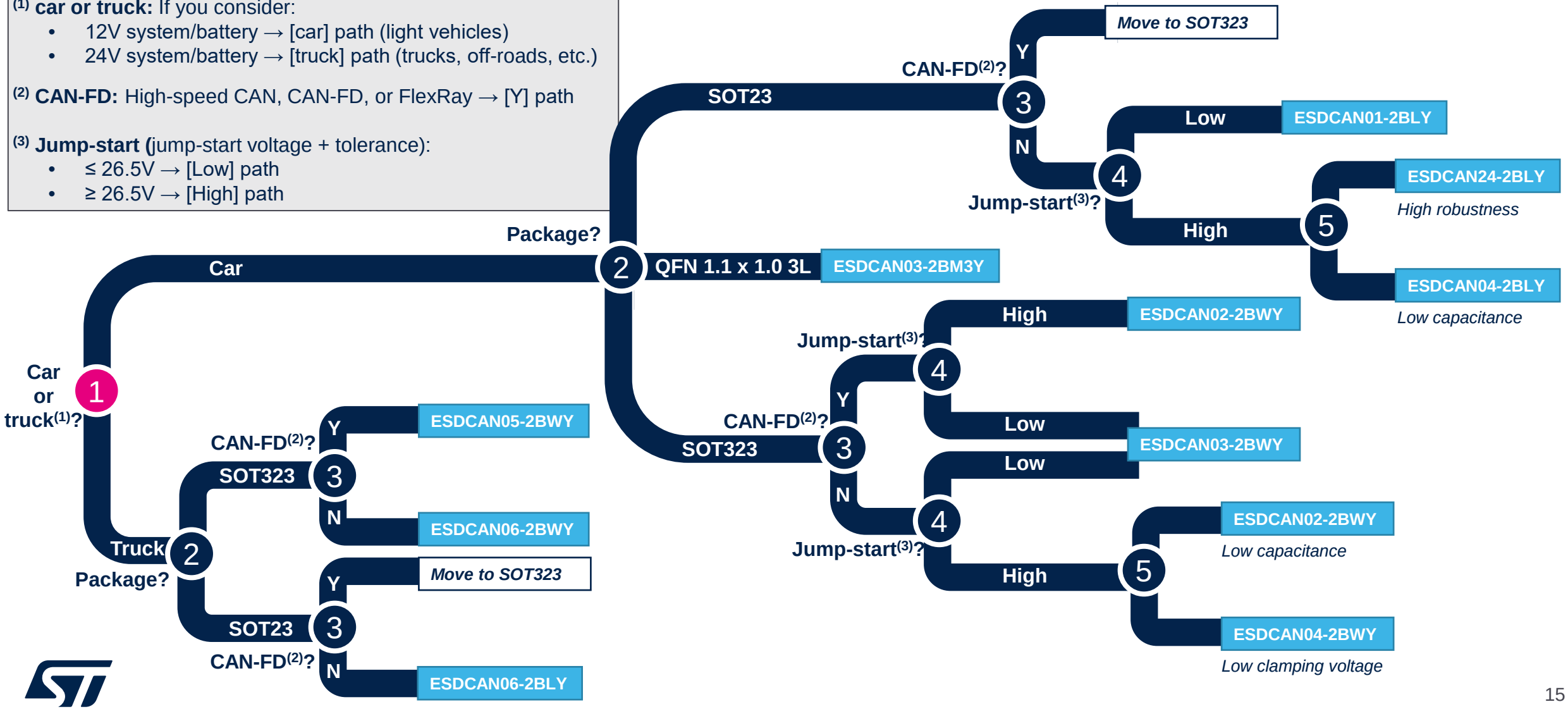
DFN1110 package
- Size: 1.10 mm x 1.0 mm x 0.55 mm

5 steps to select the right ESDCAN

(1) **car or truck:** If you consider:
- 12V system/battery → [car] path (light vehicles)
- 24V system/battery → [truck] path (trucks, off-roads, etc.)

(2) **CAN-FD:** High-speed CAN, CAN-FD, or FlexRay → [Y] path

(3) **Jump-start (**jump-start voltage + tolerance):
- ≤ 26.5V → [Low] path
- ≥ 26.5V → [High] path



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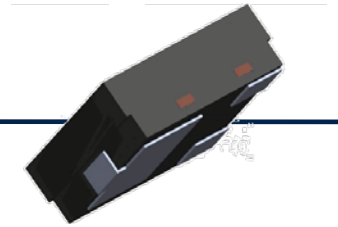
More on ESDCAN series

- ESDCAN web pages
- Blog article
- Application note AN2689
- Evaluation board
- Pspice ESDCAN03-2BM3Y
  Pspice all other ESDCAN

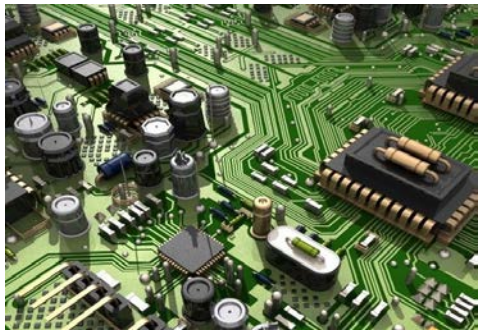
- 3D models, symbols, and footprints
- 10 Years longevity program
- Protection finder
- ESD basics presentation
- ESD video

Create a Digital Twin with ST CAD resources

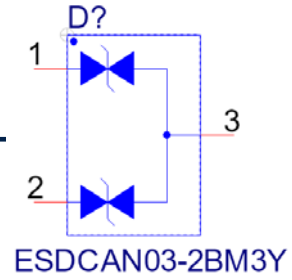
3D models



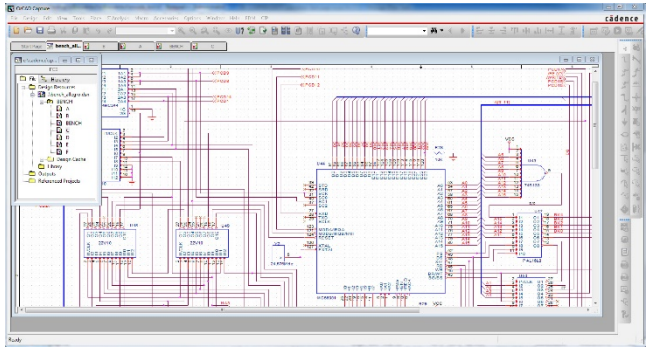
Mechanical modeling



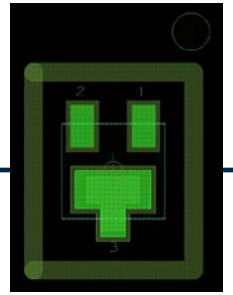
Symbols



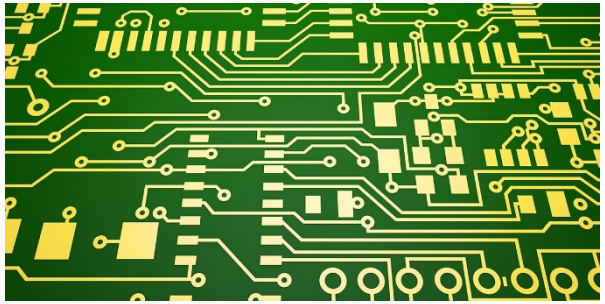
Electronic design



Footprints



Board layout



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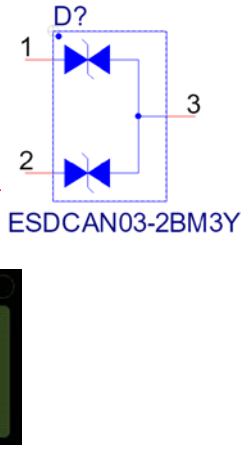
Go digital in four steps

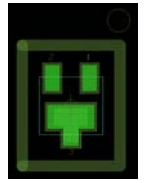
1. Access www.ST.com

2. Select one device

3. Select CAD resources

4. Download files you need





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