



Protection and Filters application book for : In-Vehicle Infotainment

Protection & Filter business Unit, DFD division



Glossary

- **IVI:** In-vehicle infotainment
- **ADAS:** Advanced driver assistance systems
- **V2X:** Vehicle-to-everything
- **NFC:** Near field communication
- **GNSS:** Global navigation system
- **SIM:** Subscriber identity module
- **SD:** Secure digital
- **ECU:** Electronics control unit
- **LVDS:** Low voltage differential signaling
- **SERDES:** Serializer deserializer
- **ESD:** electrostatic discharge
- **EOS:** electrical overstress
- **TVS:** transient voltage suppressor diode
- **ECMF:** Common-mode filter with ESD protection

In-vehicle infotainment (IVI) overview

Better connectivity, higher safety, and enhanced in-vehicle user-experience through the central in-vehicle infotainment system

In-vehicle infotainment systems

- Now connect all new smart automotive technologies:
- Offer interactive experiences:



ADAS systems, sensors, telematics devices, V2X connectivity solutions, smartphones

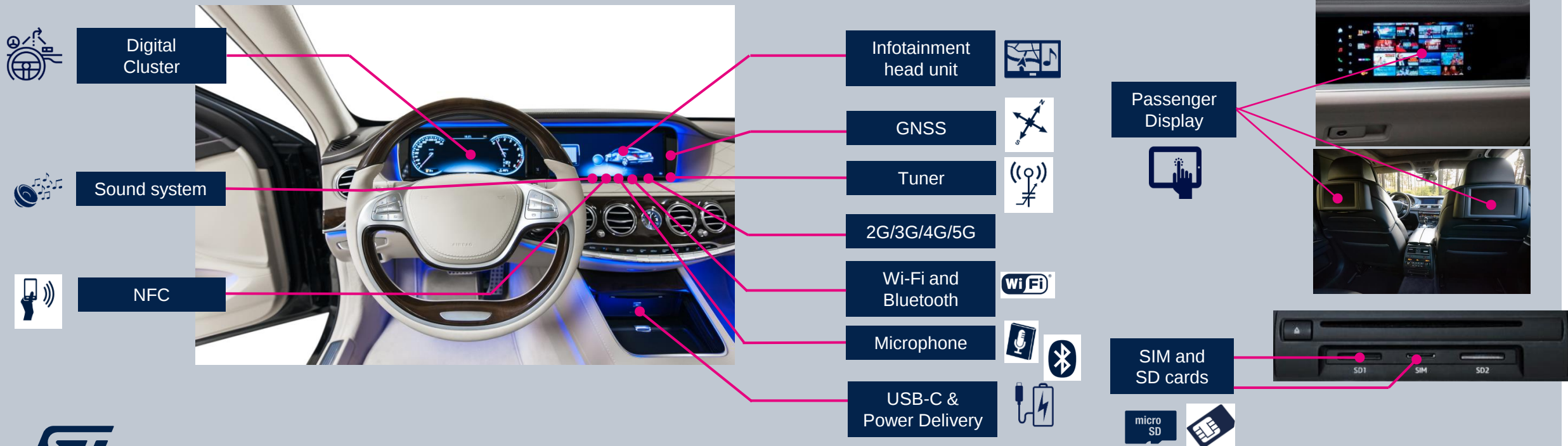
Videos & audio systems, real-time traffic updates, still calling or texting in safety conditions

What is in-vehicle infotainment?

Delivering entertainment and information to occupants through audio/video, touch screens, button panel, voice commands, and more

In-vehicle infotainment works in integration with many other in-vehicle and external systems to deliver entertainment and information to the driver and passengers

Main components of an in-vehicle infotainment system

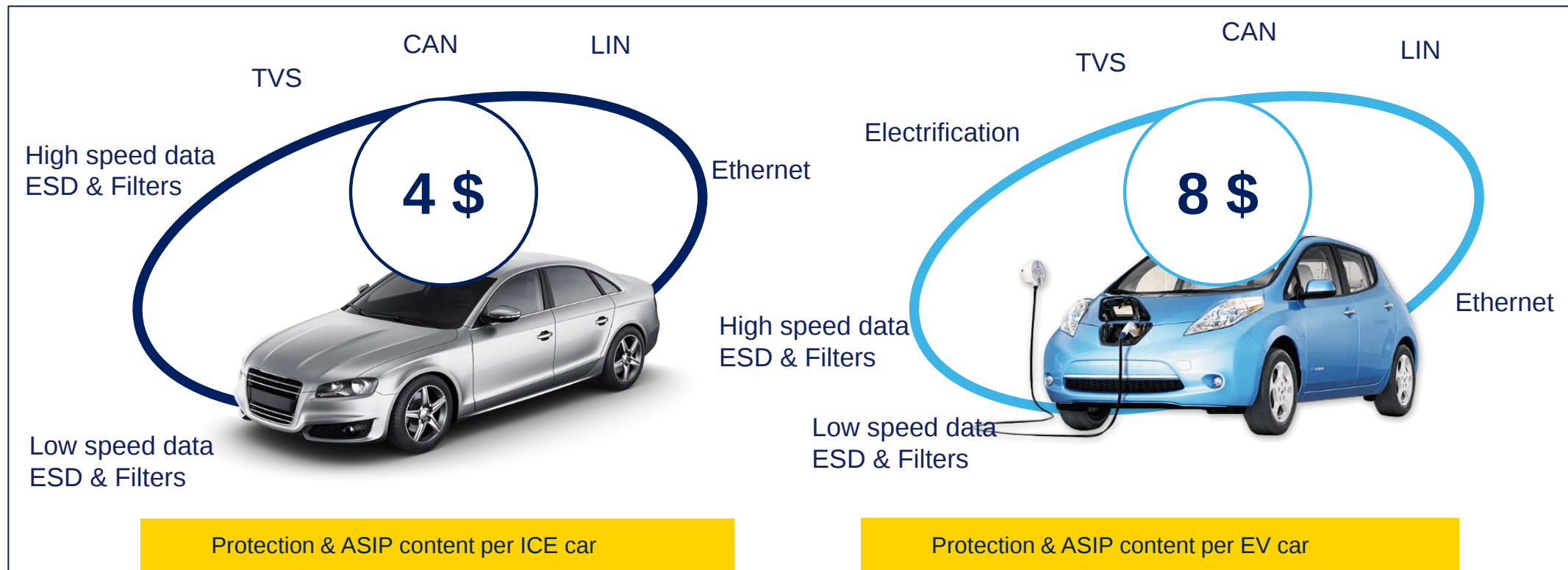


Market overview



Protection & Filters SAM = 520 M\$ in 2025

IVI content: \$2, IVI CAGR: 9%



Socket descriptions/suitable devices



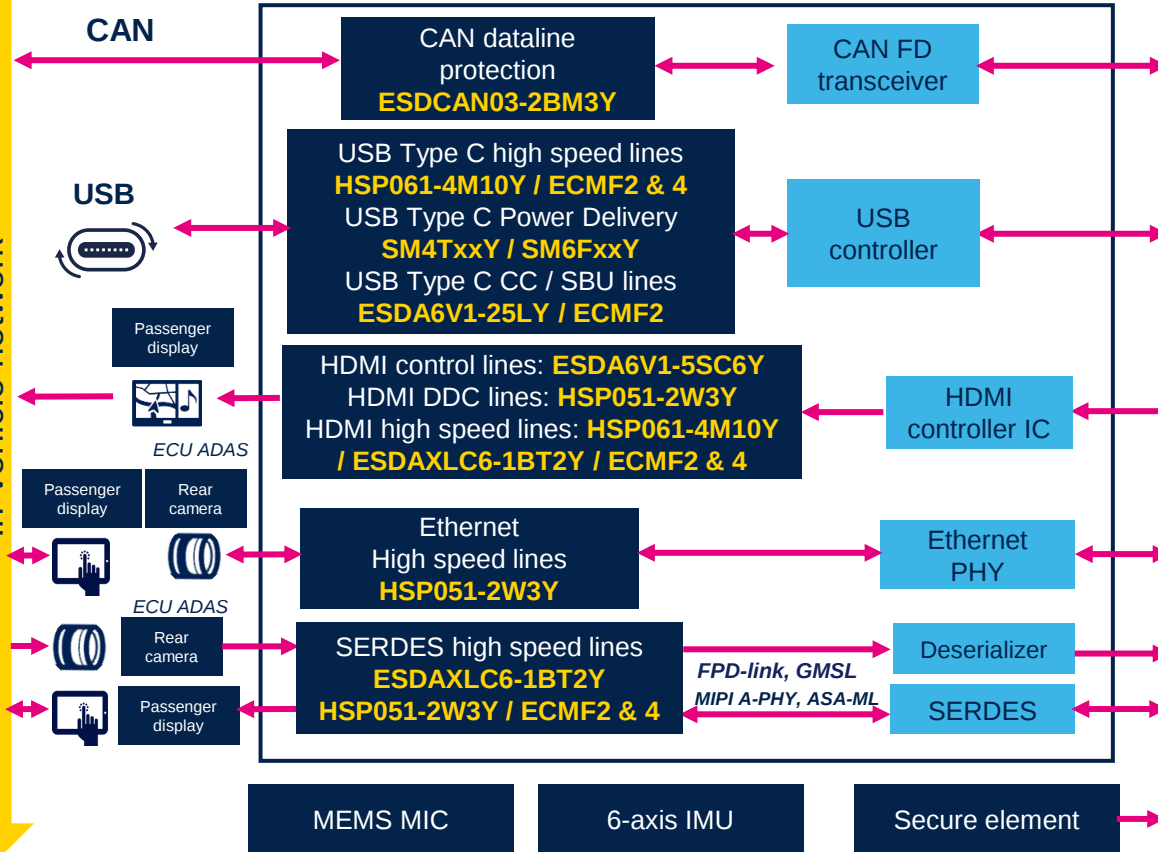
Agenda

Infotainment head unit

Power management



Wired connectivity



Serial EEPROM

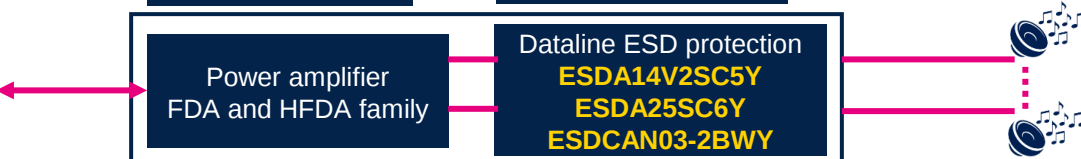
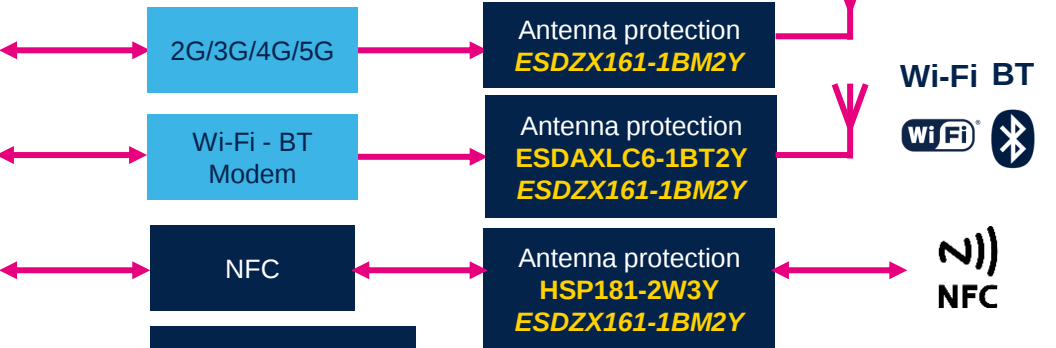
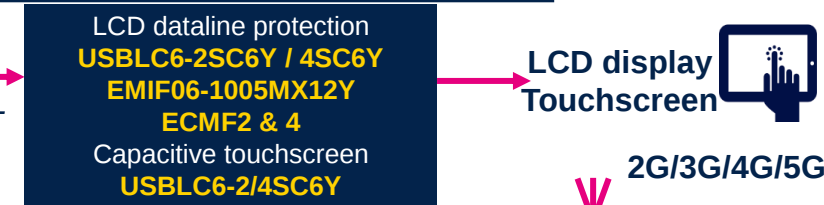
Infotainment processor

Broadcast receiver



FPD-link, GMSL

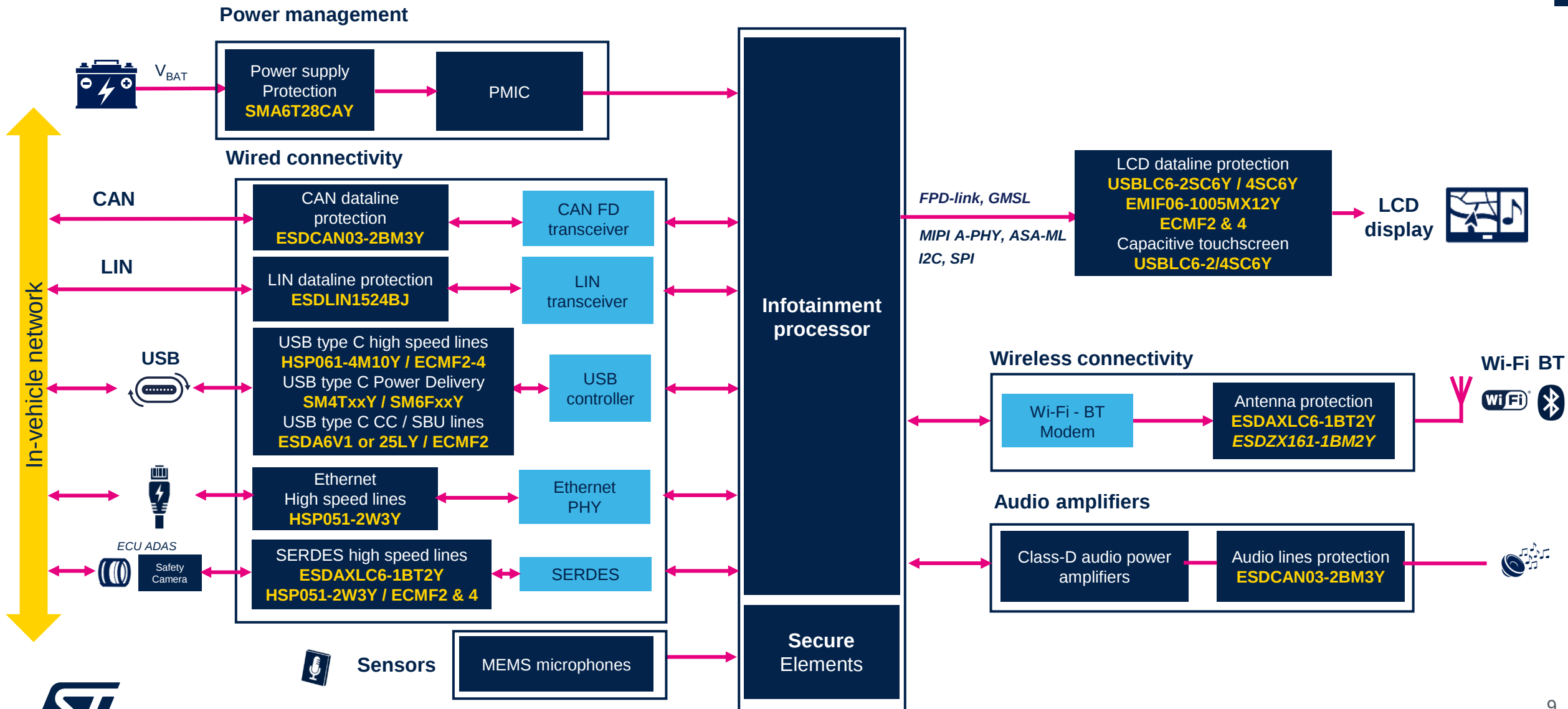
MIPI A-PHY, ASA-ML
I2C, SPI



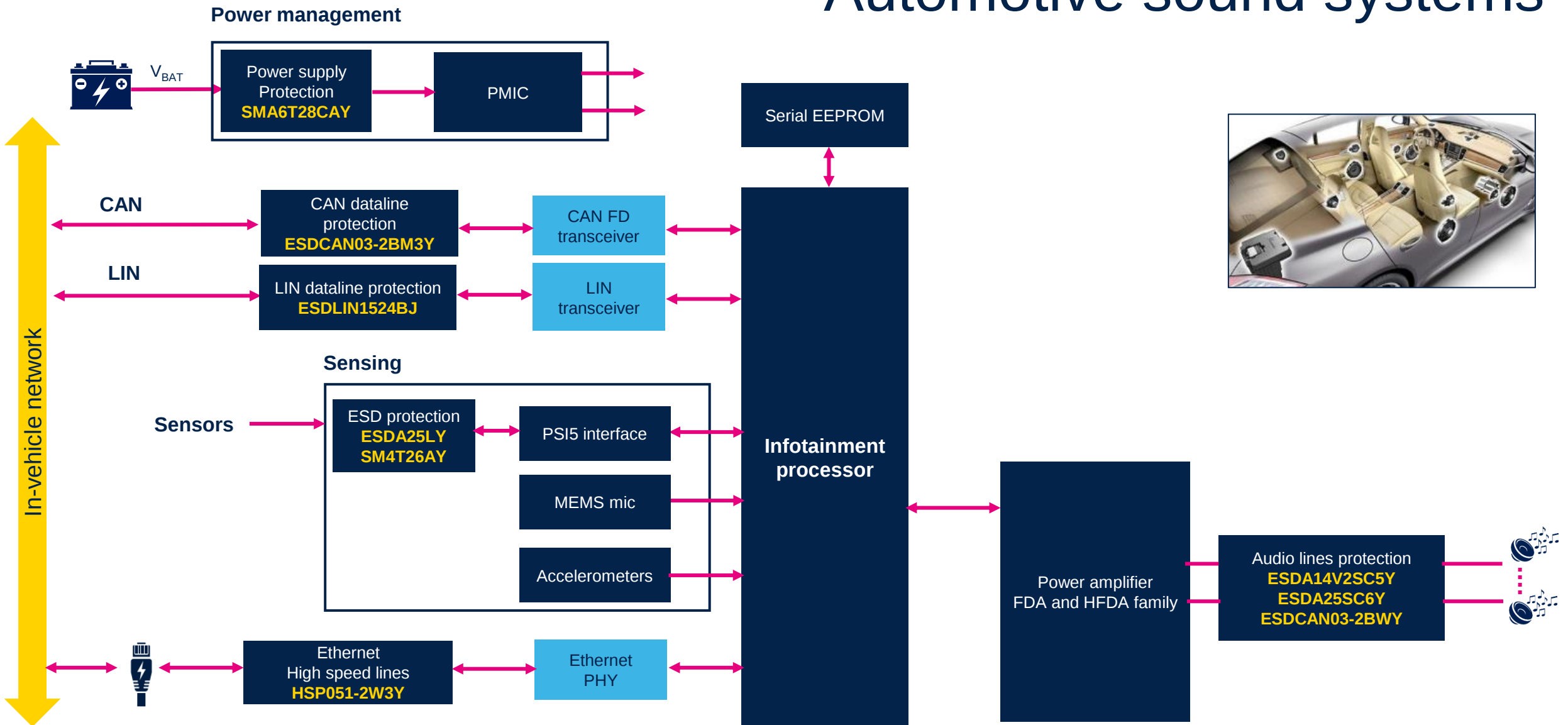
Audio amplifiers



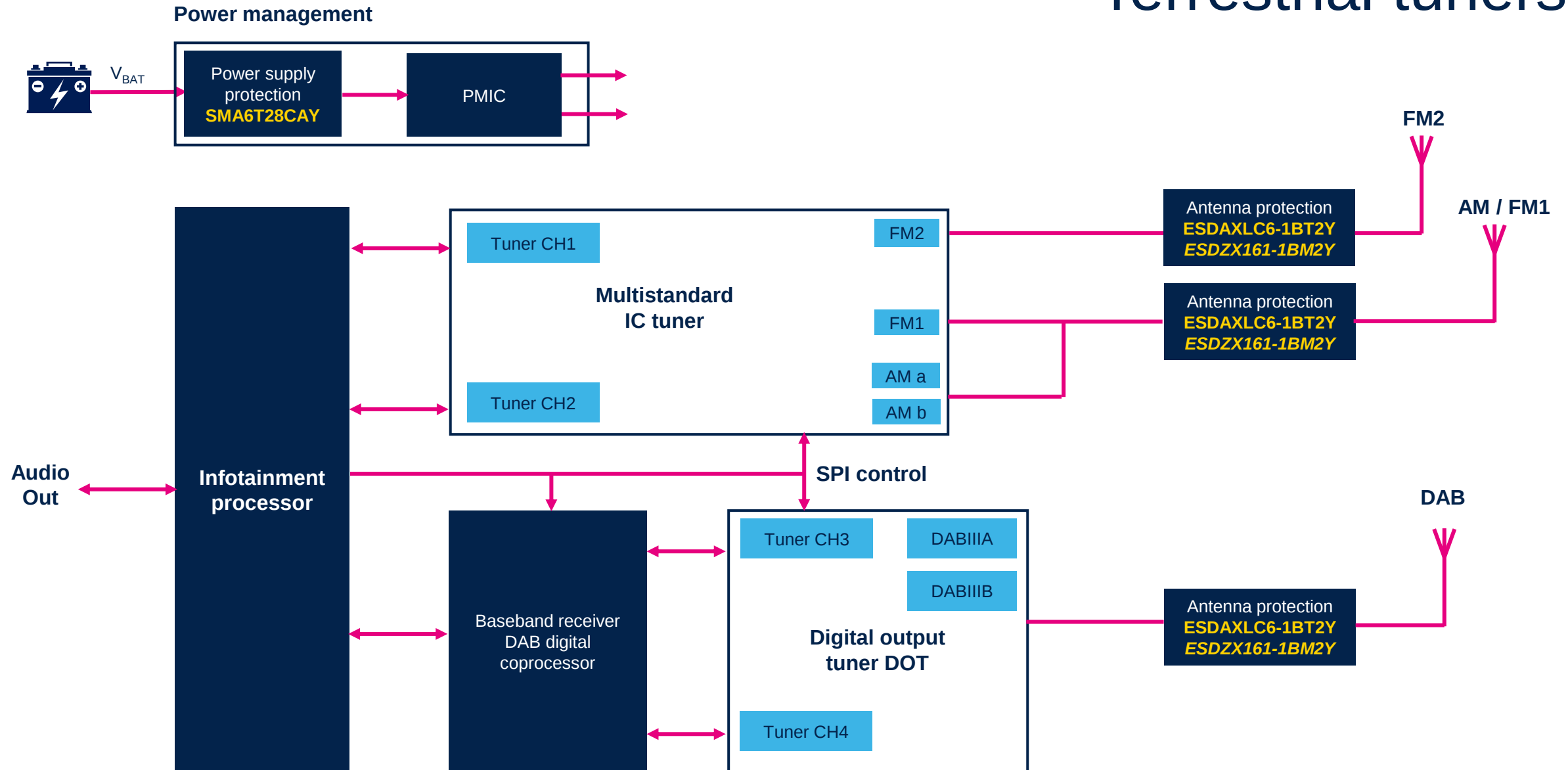
Digital cluster



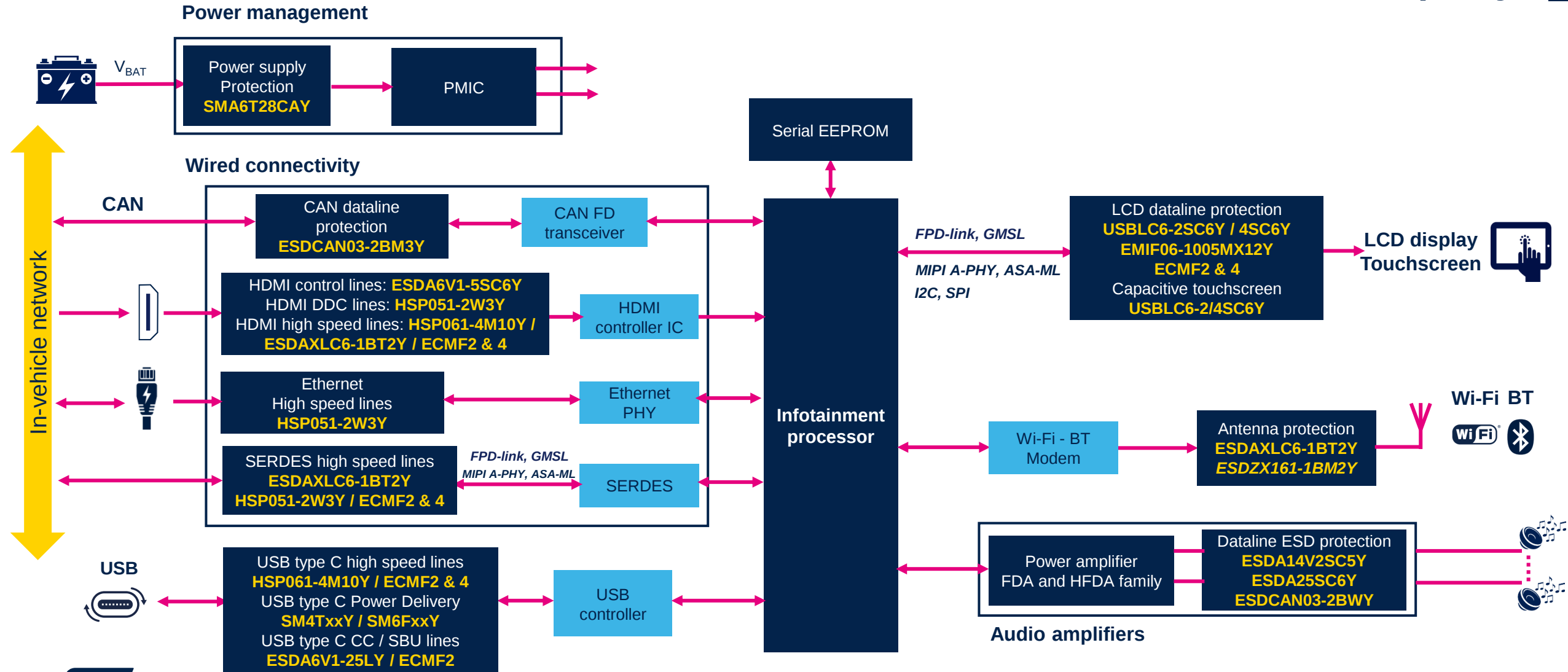
Automotive sound systems



Terrestrial tuners

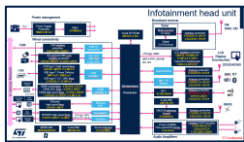


Passenger display Codriver & rear seat display



Application overview/product solution



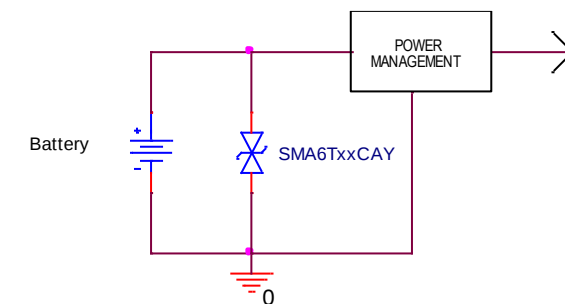


[Complete BOM](#)

VBAT input

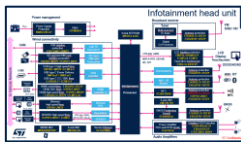
600 W TVS in small SMA compliant with all ISO standards

V _{BAT} output needs	Product key parameters	ST solutions
ISO 16750-2: ▪ overvoltage test required ▪ 18 V ± 0.2 V applied for 60 min ▪ reversed voltage test required ▪ -14 V ± 0.2 V applied for 60 s ▪ jump-start test required ▪ 24 V ± 0.2 V applied for 60 s	Bidirectional devices needed 12 V systems ▪ V_{BR} ≥ 26.7 V	<u>SMA6T28CAY</u>
ISO 16750-2: ▪ Centralized load dump suppression ▪ U_{S*} = 35 V ± 0.2 V for 12 V systems ▪ U_{S*} specified by OEM (typical value 58 V ± 0.2 V)	12 V systems ▪ V_{BR} ≥ 34.2 V	<u>SMA6T36CAY</u>
Low speed signal	No capacitance constraints	
ISO7637-2 ▪ Pulse1: VS = -150 V ▪ Pulse 2a: VS = +112 V ▪ Pulse 3a: VS = -220 V ▪ Pulse 3b: VS = +150 V	PASS	
ISO 10605 (C = 330 pF, R = 330 Ω) ≥ 15 kV	Contact discharge: ≥ 30 kV Air discharge: ≥ 30 kV	





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USB Type-C Power Delivery Vbus

**EOS and ESD protection according to ISO 10605
(C = 150 pF, R = 330 Ω) and (C = 330 pF, R = 330 Ω)**

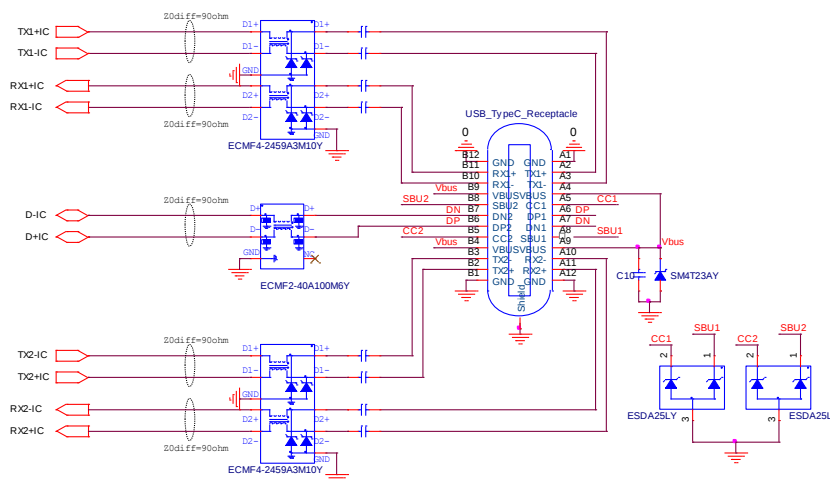
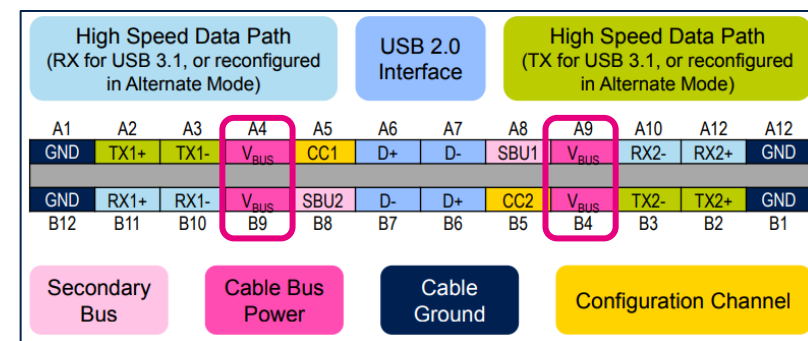
Nominal USB charging voltage	Needs for Vbus input	Product key parameters	ST solutions
For all TVS products	IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 30 kV contact / 30 kV air ISO 10605 (C = 330 pF, R = 330 Ω) 30 kV contact / 30 kV air	IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 30 kV contact / 30 kV air ISO 10605 (C = 330 pF, R = 330 Ω) 30 kV contact / 30 kV air	
	DC signal	Unidirectional	
5 V	Vmax = 5.0 V	V _{RM} = 6.5 V & 6.0 V I _{PP} max 8/20 μ s = 174 A & 290 A	<u>SM4T7V6AY</u> <u>SM6F6.0AY</u>
9 V	Vmax = 9 V	V _{RM} = 10 V I _{PP} max 8/20 μ s = 124 A & 184 A	<u>SM4T12AY</u> <u>SM6F10AY</u>

With a risk of connection to the battery consideration: ISO 16750-2 compliant min V_{RM} = 13.5 V

15 V	Vmax = 15 V	V _{RM} = 15 V I _{PP} max 8/20 μ s = 71 A and 123 A	<u>SM4T18AY</u> <u>SM6F15AY</u>
20 V	Vmax = 20 V	V _{RM} = 22 V & 20 V I _{PP} max 8/20 μ s = 54 A and 93 A	<u>SM4T23AY</u> <u>SM6F20AY</u>

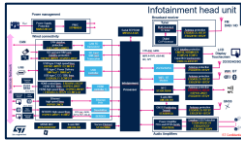
To comply with ISO 16750-2 to simulate electro overstress in case of unexpected connection to the battery:

- V_{RM} must be high to battery voltage = 13.5 V





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Complete BOM

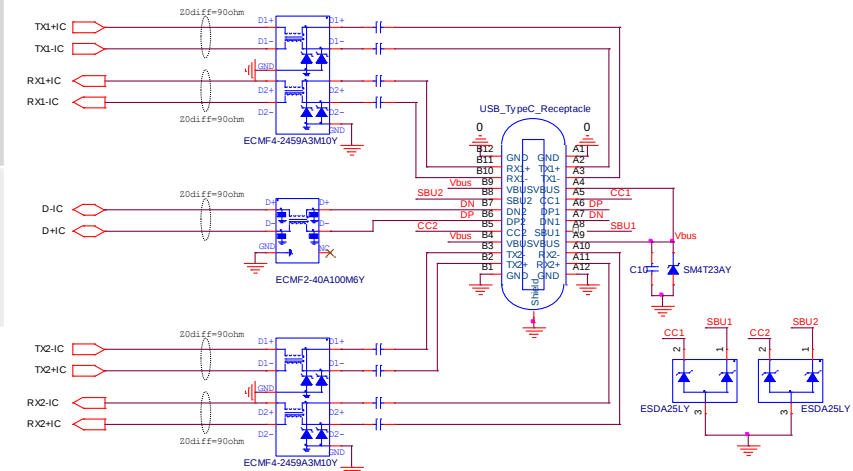
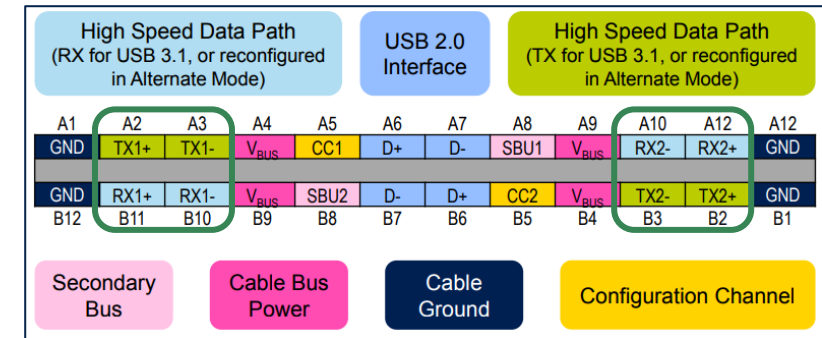
USB Type-C SSRx & SSTx lines

Standalone ESD protection or integrated solution with ESD protection and common-mode noise filter in the same package

Needs for USB 3.2 SSRx and SSTx lines	Product key parameters	ST solutions
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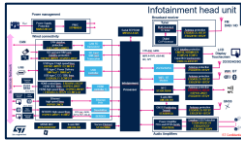
Compliant with Short to battery consideration (ISO 16750-2)
when ESD protection placed after AC coupling capacitance

IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	8 kV contact discharge and 15 kV air discharge	ESD protection HSP061-4M10Y
Voltage < 2.5 V	$V_{RM} = 3.0$ V	
Positive signal	Unidirectional	
Data rate: 10 Gbps	Compliant with USB 3.2 Gen 2 eye diagram	
Avoid disturbing Wi-Fi, BT	8 kV contact / 15 kV air, unidirectional and compliant with USB 3.2 Gen 2 eye diagrams - $V_{RM} = 5$ V Rejection @ 2.4 GHz $\rightarrow$ min -15 dB, 5 GHz $\rightarrow$ min -20 dB & rejection @ 6 GHz: min -15 dB	ESD protection + common-mode filter ECMF2-40A100M6Y ECMF4-2459A6M10Y





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USB Type-C CC & SBU lines

Standalone ESD protection or integrated solution with ESD protection and common-mode noise filter in the same package

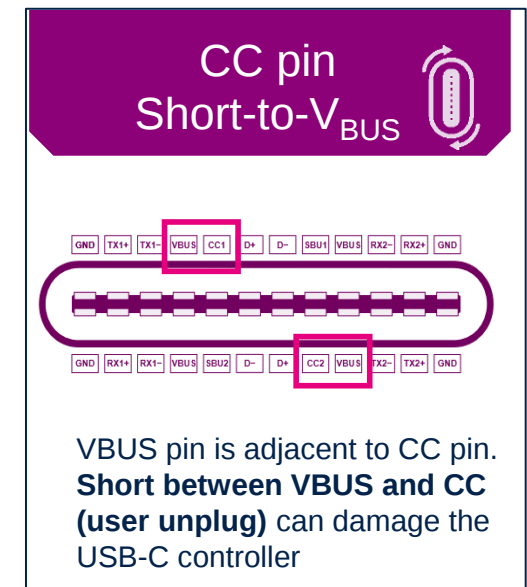
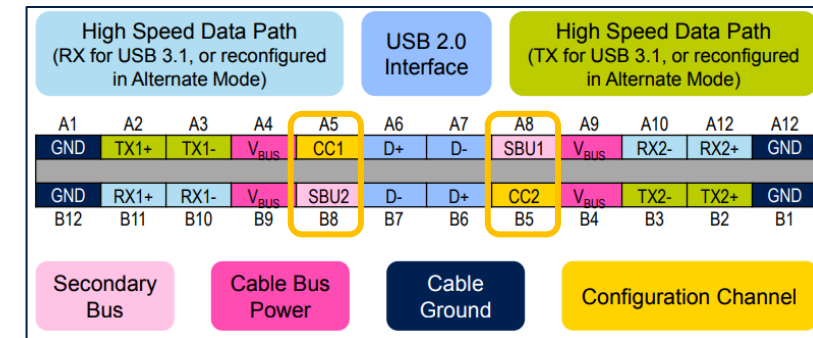
Nominal USB charging voltage	Needs for CC and SBU lines	Product key parameters	ST solutions
For all products	IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air Bandwidth on CC lines: 10 MHz	1 μ F max capacitance to comply with 10 MHz bandwidth	

Without unexpected connection to the battery consideration

5 V	Compatible with 5 V Vbus short circuit: 5 V min V_{RM}	25 kV min contact / 30 kV air 6V1LY : I_{PP} max 8/20 μ s = 18 A V_{RM} = 6.25 V & Cline = 140 pF 5WY : I_{PP} max 8/20 μ s = 12 A V_{RM} = 5.5 V & Cline = 4 pF	ESD protection <u>ESDA6V1LY</u> <u>ESDA5WY</u>
	For SBU lines, avoid disturbing Wi-Fi, BT	8 kV contact / 15 kV air V_{RM} = 5 V & Cline < 1 pF Rejection @ 2.4 GHz $\rightarrow$ min -15 dB, 5 GHz $\rightarrow$ min -20 dB & rejection @ 6 GHz: min -15 dB	ESD protection + common-mode filter <u>ECMF2-40A100M6Y</u>
9 V	Compatible up to 9 V Vbus short circuit: 9 V min V_{RM}	30 kV contact / 30 kV air V_{RM} = 12 V & Cline = 90 pF and 125 pF I_{PP} max 8/20 μ s = 14 A and 13 A	ESD protection <u>ESDA14V2LY</u> <u>ESDA14WY</u>

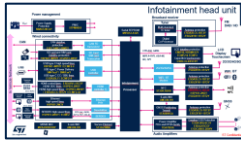
With a risk of connection to the battery consideration: ISO 16750-2 compliant min V_{RM} = 13.5 V

15 V & 20 V	Compatible with up to 20 V Vbus short circuit: 20 V min V_{RM}	30 kV contact / 30 kV air V_{RM} = 42 V & Cline = 50 pF I_{PP} max 8/20 μ s = 7 A	ESD protection <u>ESDA25LY</u>
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Complete BOM

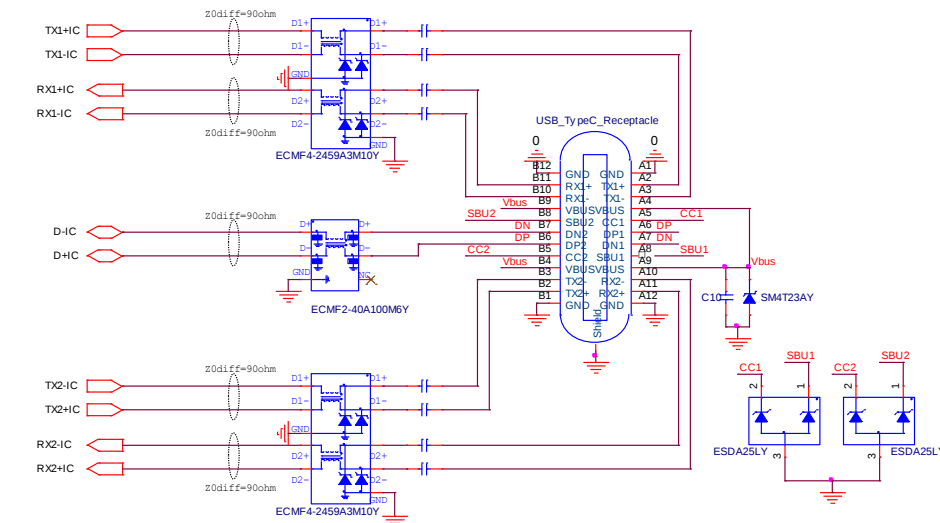
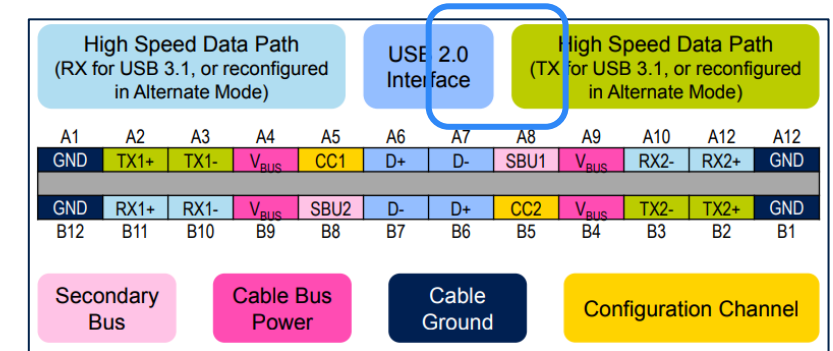
USB Type-C D+ and D- lines

Standalone ESD protection or integrated solution with ESD protection and common-mode noise filter in the same package

Needs for UEB 2.0 D+ and D- lines	Product key parameters	ST solutions
Without unexpected connection to the battery consideration		
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	15 kV contact discharge and 25 kV air discharge	ESD protection <u>USBLC6-2SC6Y</u>
0 V < voltage < 3.6 V	$V_{RM} = 5.25$ V	
Positive signal	Unidirectional	
Data rate: 480 Mbps	Compliant with USB 2.0 eye diagram	ESD protection + common-mode filter <u>ECMF2-40A100M6Y</u> <u>ECMF4-2459A6M10Y</u>
Avoid disturbing Wi-Fi, BT	8 kV contact / 15 kV air, unidirectional and compliant with USB 2.0 eye diagrams - $V_{RM} = 5$ V Rejection @ 2.4 GHz $\rightarrow$ min -15 dB, 5 GHz $\rightarrow$ min -20 dB & rejection @ 6 GHz: min -15 dB	
Avoid disturbing GPS, Wi-Fi and BT	8 kV contact / 15 kV air, unidirectional and compliant with USB2.0 eye diagrams Rejection @ 1.5 GHz: -24 dB, 2.4 GHz: -30 dB Rejection @ 5 GHz & 6 GHz: -16 dB	

With a risk of connection to the battery consideration: ISO 16750-2 compliant min $V_{RM} = 13.5$ V

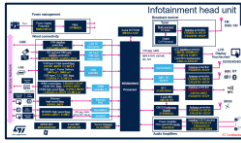
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	12 kV contact discharge and 30 kV air discharge	ESD protection <u>HSP181-2W3Y</u>
Min $V_{RM} = 13.5$ V	$V_{RM} = 18$ V	
Positive signal	Unidirectional	
Data rate: 480 Mbps	Compliant with USB 2.0 eye diagram	





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HDMI



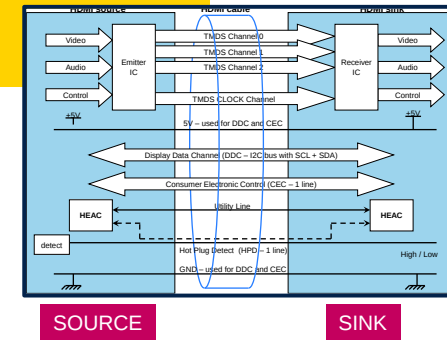
Complete BOM

HDMI high-speed lines TMDS or FRL lanes

Standalone ESD protection or integrated solution with ESD protection and common-mode noise filter in the same package

TMDS / FRL needs	Product key parameters	ST solutions
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	min 16 kV contact / min 30 kV air	ESD protection for HDMI 2.1: <u>ESDAXLC6-1BT2Y</u> Single line 0402 package
Voltage ≤ 3.3 V	$V_{RM} \geq 3.6$ V	ESD protection for HDMI 2.0: <u>HSP061-4M10Y</u> 4 lines μ QFN-10L 500 μ m pitch
Positive signal	Unidirectional	
HDMI 2.1: Data rate: 12 Gbps HDMI 2.0: Data rate: 6 Gbps Eye diagram compliancy	Bandwidth: > 10 GHz Compliant with HDMI 2.1 eye diagram Bandwidth: > 5 GHz Compliant with HDMI 2.0 eye diagram	
Avoid disturbing Wi-Fi, BT	min 8 kV contact / min 15 kV air $V_{RM} = 5$ V Compliant with HDMI 2.1 eye diagram Rejection @ 2.4 GHz $\rightarrow$ min -15 dB, 5 GHz $\rightarrow$ min -20 dB & rejection @ 6 GHz: min -15 dB	ESD protection + CMF for HDMI 2.0 and 2.1 <u>ECMF2-40A100M6Y</u> 2 lines μ QFN-10L 500 μ m pitch <u>ECMF4-2459A6M10Y</u> 4 lines μ QFN-10L 500 μ m pitch
Avoid disturbing GPS, Wi-Fi and BT	min 8 kV contact / min 15 kV air V_{BR} min = 6 V Compliant with HDMI 2.0 eye diagram Rejection @ 1.5 GHz: -24 dB, 2.4 GHz: -30 dB Rejection @ 5 GHz & 6 GHz: -16 dB	ESD protection + CMF for HDMI2.0 <u>ECMF04-4HSWM10Y</u> 4 lines μ QFN-10L 500 μ m pitch

HDMI 1.4 (up to 10.2 Gbps)
HDMI 2.0 (up to 18 Gbps)



- 3 TMDS lanes & 1 CLK lane :
- HDMI 1.4 : up to 3.3 Gbps
 - HDMI 2.0 : up to 6 Gbps

HDMI data lines

TMDS / FRL 1

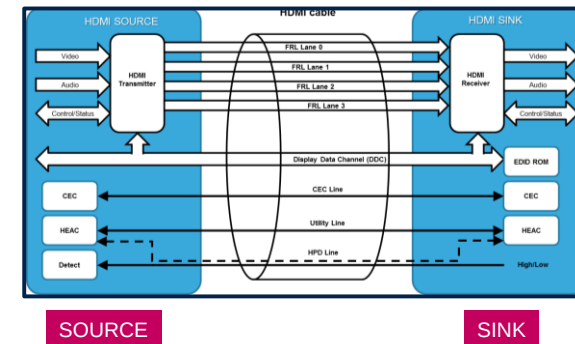
TMDS / FRL 2

TMDS / FRL 3

CLK / FRL 4

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A

HDMI 2.1 (up to 48 Gbps)



With 4 FRL lanes :

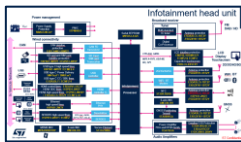
- Bit rate up to 12 Gbps
- Clock can be included in FRL lanes





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HDMI™



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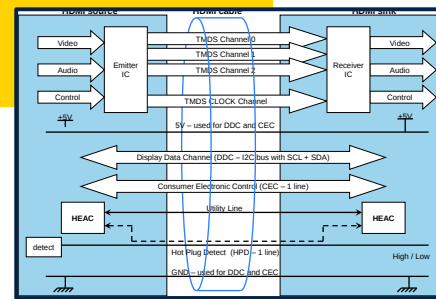
Small ESD protection in various packages protected according to ISO 10605 (C = 150 pF, R = 330 Ω)

Control lines – DDC SCL & SDA lines	Product key parameters	ST solutions
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	min 12 kV contact / min 15 kV air	HSP051-2W3Y (two lines – SOT323-6L) USBLC6-2SC6Y (two lines – SOT23-6L)
Voltage ≤ 5.0 V	V _{RM} = 5 V	
Positive signal	Unidirectional	
Data rate: 3.4 Mbps	Bandwidth > 400 MHz	

Control lines – CEC, utility, 5 V & HPD	Product key parameters	ST solutions
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	Min 25 kV contact / 30 kV air	ESDALC5-1BT2Y (single line - 0402) ESDA5WY (Dual line – SOT323-3L) ESDA6V1LY (Dual line – SOT23-3L) ESDA6V1SC6Y (Four lines – SOT23-6L)
Voltage ≤ 5.0 V	V _{RM} ≥ 5 V	
Positive signal	Unidirectional	

HDMI control lines

HDMI 1.4 (up to 10.2 Gbps)
HDMI 2.0 (up to 18 Gbps)



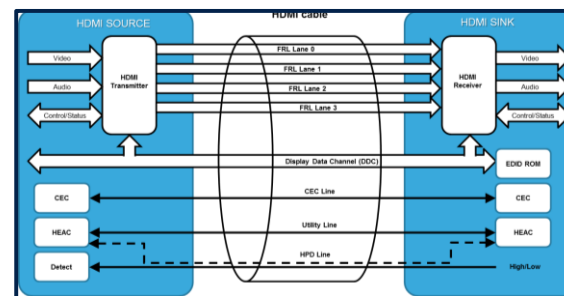
SOURCE

SINK

3 TMD5 lanes & 1 CLK lane :

- HDMI 1.4 : up to 3.3 Gbps
- HDMI 2.0 : up to 6 Gbps

HDMI 2.1 (up to 48 Gbps)



SOURCE

SINK

With 4 FRL lanes :

- Bit rate up to 12 Gbps
- Clock can be included in FRL lanes

HDMI control lines

SCL for DDC

SDA for DDC

CEC

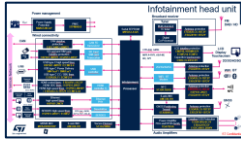
Utility/HEAC+

5V SUPPLY

HPD/HEAC-

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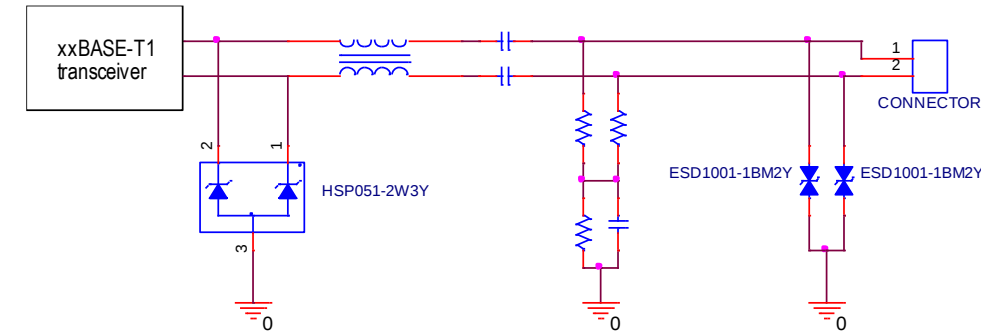


Ethernet xxBASE-T1

Low capacitance ESD protection in line with IEEE 1000BASE-T1

Connector side Ethernet needs	Product key parameters	ST solutions
IEEE 1000BASE-T1 requirements: ▪ Bidirectional ▪ Operation voltage ≥ 24 V ▪ Trigger voltage ≥ 100 V ▪ ESD: ISO 10605 ($C = 150$ pF, $R = 330$ Ω) min = 15 kV contact ▪ S parameters requirements	PASS	ESD1001-1BM2Y (under development)

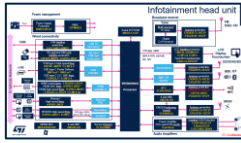
PHY side Ethernet needs	Product key parameters	ST solutions
Voltage ≤ 3 V	$V_{RM} = 5$ V (HSP051-2W3Y)	HSP051-2W3Y (two lines – SOT323-6L)
Positive signal	Unidirectional	
Datarate: up to 1 Gbps (125 MBaud, PAM 3)	Bandwidth up to 3 GHz	
IEC 61000-4-2 level 4 ISO 10605 ($C = 150$ pF, $R = 330$ Ω) 8 kV contact / 15 kV air	Contact discharge: ≥ 12 kV Air discharge: ≥ 15 kV	





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Rear camera Passenger display



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Long-reach LVDS (SERDES) FPD-link, GMSL, APIX, MIPI A-PHY, ASA

Standalone ESD protection or integrated solution with ESD protection and common-mode noise filter in the same package

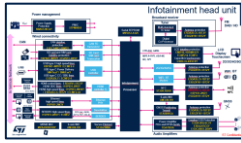
Long-reach LVDS needs	Product key parameters	ST solutions
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	Contact discharge: ≥ 8 kV Air discharge: ≥ 15 kV	
Design flexibility	Multiline or single line // unidirectional or bidirectional	
Higher data rate: 8 GBaud / lane: MIPI A-PHY G3 P1 NRZ, FPD-link IV & ASA-ML	Bandwidth up to 12 GHz: ESDAXLC6-1BT2Y & ECMF2-40A100M6Y	
Voltage ≤ 2.5 V	$V_{RM} = 3$ V: HSP061-4M10Y ESDXLC6-1BT2Y $V_{RM} = 5$ V: HSP051-2W3Y (uni) ESDAVLC6-2BLY (bidir)	ESD protection for 8GBaud / lane ESDAXLC6-1BT2Y High-speed ESD protection for other standards ESDAXLC6-1BT2Y / HSP061-4M10Y HSP051-2W3Y / ESDAVLC6-2BLY
Avoid disturbing Wi-Fi, BT	$V_{RM} = 5$ V ECMF2-40A100M6Y compliant with MIPI A-PHY eye diagram, 12.5 GHz bandwidth Rejection @ 2.4 GHz $\rightarrow$ min -15 dB, 5 GHz $\rightarrow$ min -20 dB & rejection @ 6 GHz: min -15 dB	ESD protection + CMF ECMF2-40A100M6Y 2 lines μ QFN-6L ECMF4-2459A6M10Y 4 lines μ QFN-10L
Avoid disturbing GPS, Wi-Fi and BT	$V_{RM} = 3$ V Rejection @ 1.5 GHz: -24 dB, 2.4 GHz: -30 dB Rejection @ 5 GHz & 6 GHz: -16 dB	ESD protection + CMF ECMF04-4HSWM10Y 4 lines μ QFN-10L

Link	Max data rate per lane (Gbps)	Max symbol rate per lane (Gbaud)
APIX 1	1	1
APIX 2	3	3
APIX 3	6	6
FPD-link III	4	4
FPD-link IV	8	8
GMSL1	3.125	3.125
GMSL2	6	6
GMSL3 PAM4	12	6
A-PHY G1 PAM4	2	1
A-PHY G1 NRZ	2	2
A-PHY G2 PAM4	4	2
A-PHY G2 NRZ	4	4
A-PHY G3 PAM4	8	4
A-PHY G3 NRZ	8	8
A-PHY G4 PAM8	12	4
A-PHY G4 PAM4	12	8
A-PHY G5 PAM16	16	4
A-PHY G5 PAM4	16	8
A-PHY G6 PAM8	24	8
A-PHY G7 PAM8	32	8
ASA-ML Grade1 PAM2	2	2
ASA-ML Grade2 PAM2	4	4
ASA-ML Grade3 PAM2	8	8
ASA-ML Grade4 PAM4	12	6
ASA-ML Grade5 PAM4	16	8





Agenda



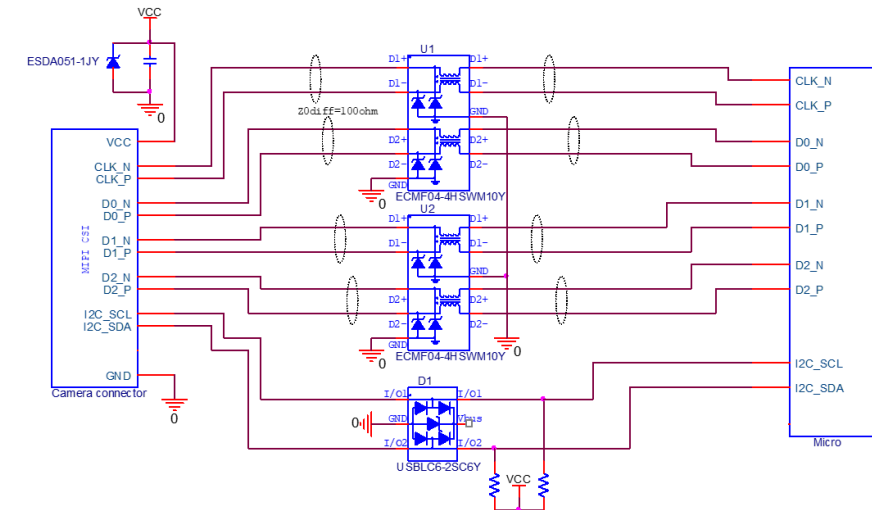
Complete BOM

Short-reach LVDS MIPI CSI

Standalone ESD protection or integrated solution with ESD protection and common-mode noise filter in the same package

Short-reach LVDS needs	Product key parameters	ST solutions
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	Contact discharge: ≥ 8 kV Air discharge: ≥ 15 kV	
Design flexibility	Multiline or single line // unidirectional or bidirectional	
Higher data rate: 9 Gbps (CSI-2 over D-PHY 3.0)	Bandwidth up to 9 GHz: ESD protection: ESDAXLC6-1BT2Y , HSP061-4M10Y + CMF: ECMF2-40A100M6Y & ECMF4-2459A6M10Y	
Voltage ≤ 2.5 V	$V_{RM} \geq 3$ V: HSP061-4M10Y ESDAXLC6-1BT2Y $V_{RM} \geq 5$ V: HSP051-2W3Y	ESD protection for 9 Gbps ESDAXLC6-1BT2Y ESD protection for other standards HSP061-4M10Y & HSP051-2W3Y
Avoid disturbing Wi-Fi, BT	$V_{RM} = 5$ V Rejection @ 2.4 GHz $\rightarrow$ min -15 dB, 5 GHz $\rightarrow$ min -20 dB & rejection @ 6 GHz: min -15 dB	ESD protection + CMF 2 lines ECMF2-40A100M6Y 4 lines ECMF4-2459A6M10Y
Avoid disturbing GPS, Wi-Fi and BT	$V_{RM} = 3$ V Rejection @ 1.5 GHz: -24 dB, 2.4 GHz: -30 dB Rejection @ 5 GHz & 6 GHz: -16 dB	ESD protection + CMF 4 lines: ECMF04-4HSWM10Y

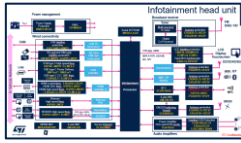
Control lines – DDC SCL & SDA lines	Product key parameters	ST solutions
IEC 61000-4-2 level 4, ISO 10605 (C = 150 pF, R = 330 Ω): 8 kV contact / 15 kV air	min 12 kV contact / min 15 kV air	USBLC6-2SC6Y (two lines – SOT23-6L)
Voltage ≤ 5.0 V	$V_{RM} = 5$ V	
Positive signal	Unidirectional	HSP051-2W3Y (two lines – SOT323-3L)
Data rate: 3.4 Mbps	Bandwidth > 400 MHz	





Agenda

LCD
Display

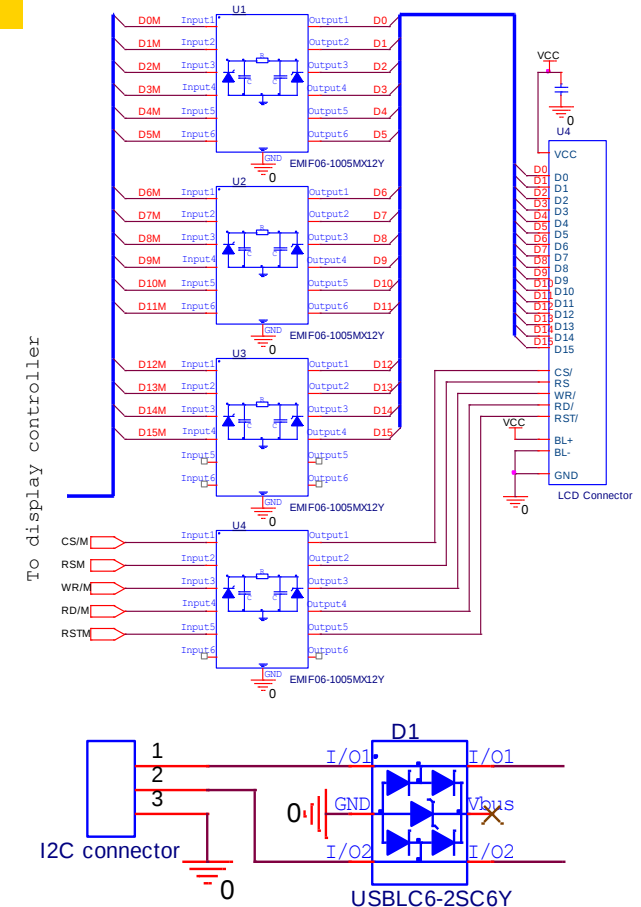


[Complete BOM](#)

Parallel video lines and I2C

Standalone ESD protection or integrated solution with ESD protection and EMI filter in the same package

Parallel video line needs	Product key parameters	ST solutions
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	Contact discharge: ≥ 15 kV Air discharge: ≥ 15 kV	
Positive signal	Unidirectional	
Design flexibility	Dual lines, four lines and six lines // unidirectional	
Voltage 1.8 V or 3.3 V	$V_{RM} \geq 3$ V (EMIF06-1005MX12Y) $V_{RM} \geq 5.25$ V (USBLC6-xSC6Y)	<u>USBLC6-4SC6Y</u> <u>USBLC6-2SC6Y</u> <u>EMIF06-1005MX12Y</u> <u>ECMF04-4HSWM10Y</u> <u>ECMF2-40A100M6Y</u>
Pixel clock frequency up to 200 MHz	Bandwidth: 120 MHz: EMIF06-1005MX12Y - Up to 3 GHz: USBLC6-xSC6Y & ECMF04-4HSWM10Y - Up to 12 GHz: ECMF2-40A100M6Y	
Noise filtering Avoid to disturb antennas	Attenuation ≥ -15 dB (250 MHz to 6 GHz) $S_{cc21} \geq -15$ dB (900 MHz to 6 GHz) $S_{cc21} \geq -15$ dB (2.4 GHz to 6 GHz)	<u>EMIF06-1005MX12Y</u> <u>ECMF04-4HSWM10Y</u> <u>ECMF2-40A100M6Y</u>
I2C needs	Product key parameters	ST solutions
IEC 61000-4-2 level 4 ISO 10605 (C = 150 pF, R = 330 Ω) 8 kV contact / 15 kV air	min 12 kV contact / min 15 kV air	<u>HSP051-2W3Y</u> (two lines – SOT323-3L) <u>USBLC6-2SC6Y</u> (two lines – SOT23-6L)
Voltage ≤ 5.0 V	$V_{RM} = 5$ V	
Positive signal	Unidirectional	
Data rate: 3.4 Mbps	Bandwidth > 400 MHz	

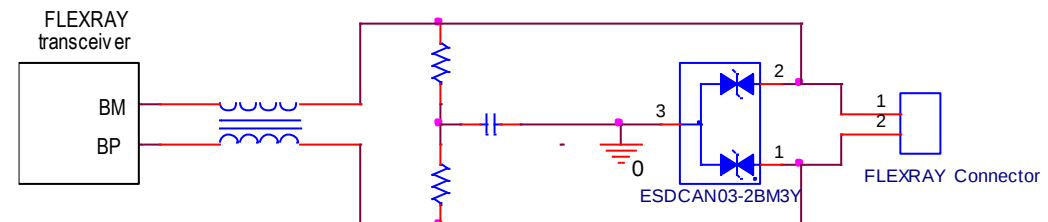


Wide CAN transceiver protection portfolio covering 12 and 24 V battery systems

CAN needs		Product key parameters	ST solutions
ISO 16750-2: - overvoltage test required 18 V $\pm$0.2 V applied for 60 min for 12 V systems 36 V $\pm$0.2 V applied for 60 min for 24 V systems - reversed voltage test required -14 V $\pm$0.2 V applied for 60 s for 12 V systems -28 V $\pm$0.2 V applied for 60 s for 24 V systems - jump-start- test required 24 V $\pm$0.2 V applied for 60 s for 12 V systems		Bidirectional devices needed 12 V systems $V_{BR} \geq 26.7$ V 24 V systems (incl. overvoltage test) $V_{BR} \geq 37.1$ V	
Data rate - Fault tolerant CAN: - High speed CAN: - CAN-FD: - CAN-FD SIC: - CAN XL:	125 kbps 1 Mbps 5 Mbps 8 Mbps 10 Mbps	Cline ≤ 3 pF for High-speed CAN, CAN-FD, CAN-FD-SIC	
Design flexibility		Dual-line in SOT23-3L	
Design flexibility		Dual-line in DFN1110 (12 V systems only)	
IEC 61000-4-2 level 4 8 kV contact/15 kV air		Contact discharge: up to 30 kV Air discharge: ≥ 30 kV	

Wide FlexRay transceiver protection portfolio covering 12 and 24 V battery systems

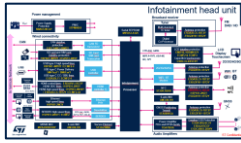
FlexRay needs	Product key parameters	ST solutions
ISO 16750-2: - overvoltage test required 18 V ± 0.2 V applied for 60 min for 12 V systems 36 V ± 0.2 V applied for 60 min for 24 V systems - reversed voltage test required -14 V ± 0.2 V applied for 60 s for 12 V systems -28 V ± 0.2 V applied for 60 s for 24 V systems - jump-start test required 24 V ± 0.2 V applied for 60 s for 12 V systems	Bidirectional devices needed 12 V systems $V_{BR} \geq 26.7$ V 24 V systems (incl. overvoltage test) $V_{BR} \geq 37.1$ V	<u>ESDCAN02-2BWY</u> (for 12 V systems) <u>ESDCAN03-2BWY</u> (for 12 V systems) <u>ESDCAN05-2BWY</u> (for 24 V systems) <u>ESDCAN03-2BM3Y</u> (for 12 V systems)
Data rate up to 10 Mbps	Cline ≤ 3 pF/Bandwidth: 1.1 GHz	
Design flexibility	Dual-line in DFN1110WF (12 V systems only)	<u>ESDCAN03-2BM3Y</u> (for 12 V systems)
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: up to 30 kV Air discharge: ≥ 30 kV	





Agenda

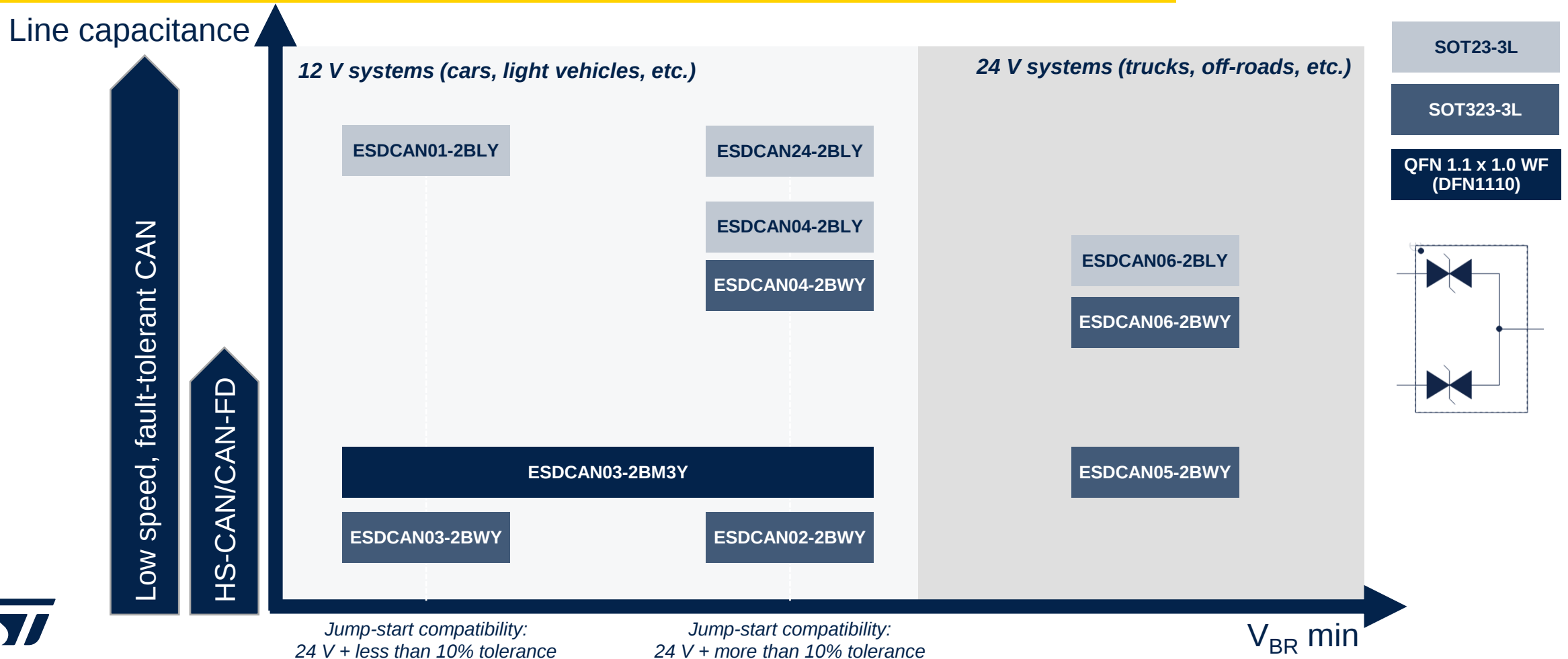
CAN



[Complete BOM](#)

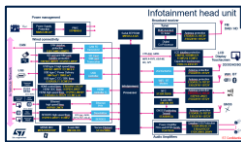
ESDCAN series portfolio

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





Agenda



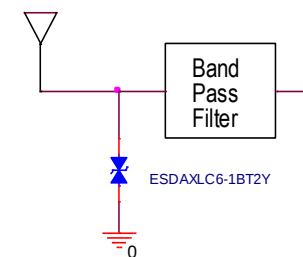
Complete BOM

Antennas Wi-Fi and Bluetooth

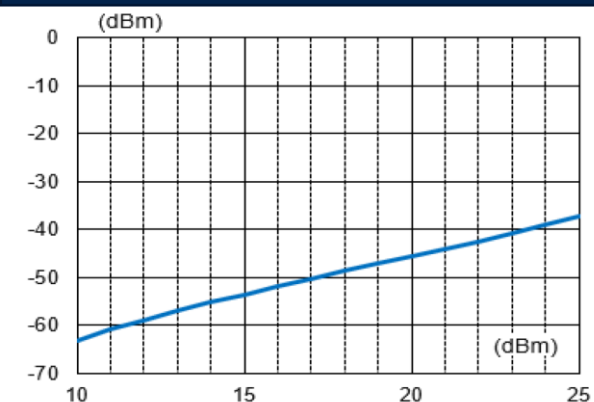
ESD protection according to ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$)
Very low harmonics ensure no disturbance – low insertion losses

Wi-Fi antenna needs	Key product parameters	ST solutions
RF power = 23 dBm ($V_{\text{PEAK}} = 4.5 \text{ V}$ with 50Ω load)	$V_{\text{BR}} \geq 6 \text{ V}$	ESDAXLC6-1BT2Y Single line 0402 package ESDZX161-1BM2Y * <i>under development</i>
Alternative signal	Bidirectional device	
$f = 2.4 \text{ GHz}$ $f = 5.0 \text{ GHz}$	Extralow capacitance ($\leq 0.5 \text{ pF}$) Bandwidth = 12 GHz Typical IL @ 2.4 GHz = 0.2 dB	
Very low harmonic generation $\leq -41 \text{ dBm}$ @ 23 dBm	H3 = -41 dBm at 23 dBm power; $f = 2.4 \text{ GHz}$	
IEC 61000-4-2 level 4 ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$) 8 kV contact / 15 kV air	Contact discharge: 16 kV Air discharge: 30 kV	

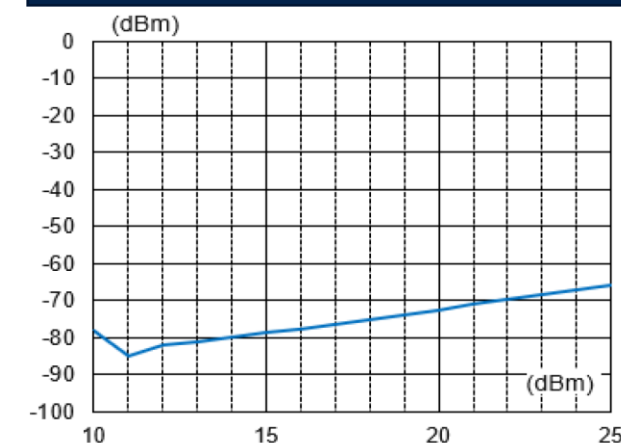
Bluetooth antenna needs	Key product parameters	ST solutions
RF power = 20 dBm ($V_{\text{PEAK}} = 3.2 \text{ V}$ with 50Ω load)	$V_{\text{BR}} \geq 6 \text{ V}$	ESDAXLC6-1BT2Y Single line 0402 package ESDZX161-1BM2Y * <i>under development</i>
Alternative signal	Bidirectional device	
$f = 2.4 \text{ GHz}$	Extralow capacitance ($\leq 0.5 \text{ pF}$) Bandwidth = 12 GHz Typical IL @ 2.4 GHz = 0.2 dB	
Very low harmonic generation $\leq -41 \text{ dBm}$ @ 23 dBm	H3 = -45 dBm at 20 dBm power; $f = 2.4 \text{ GHz}$	
IEC 61000-4-2 level 4 ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$) 8 kV contact / 15 kV air	Contact discharge: 16 kV Air discharge: 30 kV	



H3 harmonic versus input power at 2400 MHz



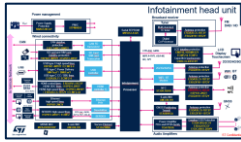
H2 harmonic versus input power at 2400 MHz



*With a risk of connection to the battery consideration: ISO 16750-2 compliant min VRM = 13.5 V



Agenda

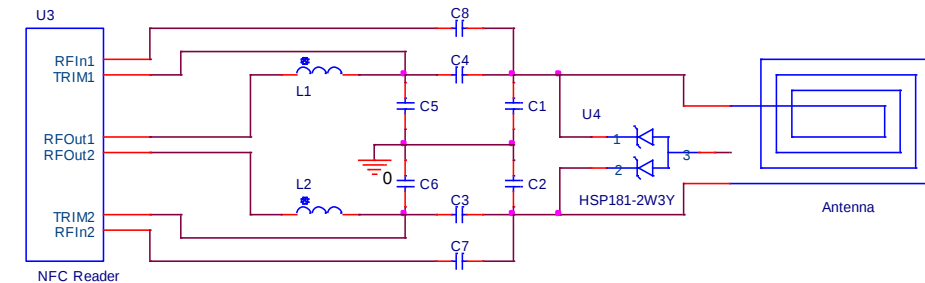


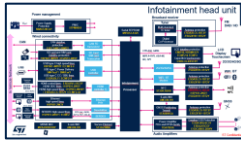
[Complete BOM](#)

Antennas NFC

ESD protection according to ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$)
Low capacitance – 18 V min VRM

Needs for NFC reader	Product key parameters	ST solutions
Max voltage = 18 V	$V_{\text{TRIG}} \geq 21.5 \text{ V}$	HSP181-2W3Y (two lines – SOT323-6L) ESDZX161-1BM2Y <i>under development</i>
Alternative signal	Bidirectional connection (between pin 1 & 2)	
$f = 13.56 \text{ MHz}$, Line capacitance must be well below the value of matching capacitance	Very low capacitance ($= 1.05 \text{ pF}$)	
To comply with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$)	Compliant with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$) Contact discharge: 12 kV Air discharge: 30 kV	



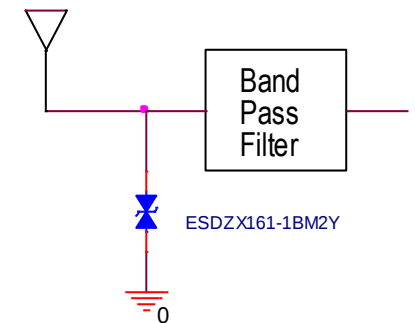


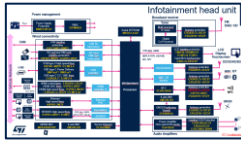
Antennas 2G/3G/4G/5G

ESD protection according to ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \text{ }\Omega$)
Very low harmonics ensure no disturbance – low insertion losses

Needs for WCDMA (3G), LTE (4G) and 5G	Product key parameters	ST solutions
RFpower max = 27 dBm ($V_{\text{PEAK}} = 7 \text{ V}$ on $50 \text{ }\Omega$ load)	$V_{\text{RM}} \geq 7 \text{ V}$	ESDZX161-1BM2Y <i>under development</i>
Alternative signal	Bidirectional device	
3G: $f = 900 \text{ MHz}$ or 2.1 GHz 4G: $f < 2.7 \text{ GHz}$ 5G: $f < 5 \text{ GHz}$	IL @ $5.0 \text{ GHz} = -0.3 \text{ dB}$ Extralow capacitance = 0.3 pF Bandwidth = 13 GHz	
Very low harmonic < -41 dBm at 27 dBm		
IEC 61000-4-2 level 4 ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \text{ }\Omega$) 8 kV contact / 15 kV air	Contact discharge: 12 kV Air discharge: 20 kV	

Needs for GSM, DCS, PCS (2G)	Product key parameters	ST solutions
RF power = 34 dBm ($V_{\text{PEAK}} = 16 \text{ V}$ with $50 \text{ }\Omega$ load)	$V_{\text{RM}} = 16 \text{ V}$	ESDZX161-1BM2Y <i>under development</i>
Alternative signal	Bidirectional device	
$f < 1.9 \text{ GHz}$	IL @ $1.9 \text{ GHz} = -0.2 \text{ dB}$ Extralow capacitance = 0.3 pF Bandwidth = 13 GHz	
IEC 61000-4-2 level 4 ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \text{ }\Omega$) 8 kV contact / 15 kV air	Contact discharge: 12 kV Air discharge: 20 kV	





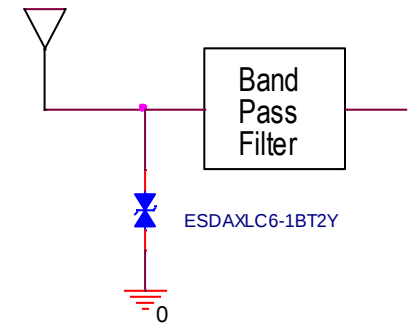
Antennas

FM DAB/HD GNSS

ESD protection according to ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$)

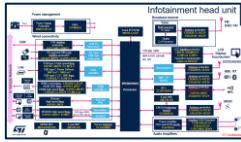
Low insertion losses

Needs for DAB / HD	Product key parameters	ST solutions
Very low voltage @ antenna reception // $V_{RM} < 3 \text{ V}$	$V_{RM} = 3.0 \text{ V}$	<u>ESDAXLC6-1BT2Y</u> Single line 0402 package <i>ESDZX161-1BM2Y *</i> <i>under development</i>
Alternative signal	Bidirectional	
f up to 2.3 GHz	IL @ 2.3 GHz = -0.2 dB // bandwidth = 12 GHz	
To comply with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$)	Compliant with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$) Contact discharge: 12 kV // air discharge: 30 kV	
Needs for AM / FM	Product key parameters	ST solutions
Very low voltage @ antenna reception // $V_{RM} < 3 \text{ V}$	$V_{RM} = 3.0 \text{ V}$	<u>ESDAXLC6-1BT2Y</u> Single line 0402 package
Alternative signal	Bidirectional	
f up to 108 MHz	IL @ 108 MHz = 0 dB // bandwidth = 12 GHz	
To comply with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$)	Compliant with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$) Contact discharge: 12 kV // air discharge: 30 kV	
Needs for GNSS	Product key parameters	ST solutions
Very low voltage @ antenna reception // $V_{RM} < 3 \text{ V}$	$V_{RM} = 3.0 \text{ V}$	<u>ESDAXLC6-1BT2Y</u> Single line 0402 package
Alternative signal	Bidirectional	
f up to 1.575 GHz	IL @ 1.575 GHz = -0.1 dB // bandwidth = 12 GHz	
To comply with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$)	Compliant with ISO 10605 ($C = 150 \text{ pF}$, $R = 330 \Omega$) Contact discharge: 12 kV // air discharge: 30 kV	





Agenda



Complete BOM

Audio interfaces

All sockets are ESD protected according to ISO 10605 (C = 150 pF, R = 330 Ω)

Needs for speaker	Product key parameters	ST solutions
High power output ≤ 11 V 2 x dual internal speakers: front and rear	$V_{RM} = 12$ V	<u>ESDA14V2SC5Y</u> SOT23-5L – dual bidir lines
Audio analog (alternative signal)	Bidirectional	
$f < 20$ kHz	No constraints on capacitance	
IEC 61000-4-2 level 4 & ISO 10605 (C = 150 pF, R = 330 Ω): 8 kV contact / 15 kV air	Contact discharge: 30 kV Air discharge: 30 kV	

With a risk of connection to the battery consideration: ISO 16750-2 compliant min

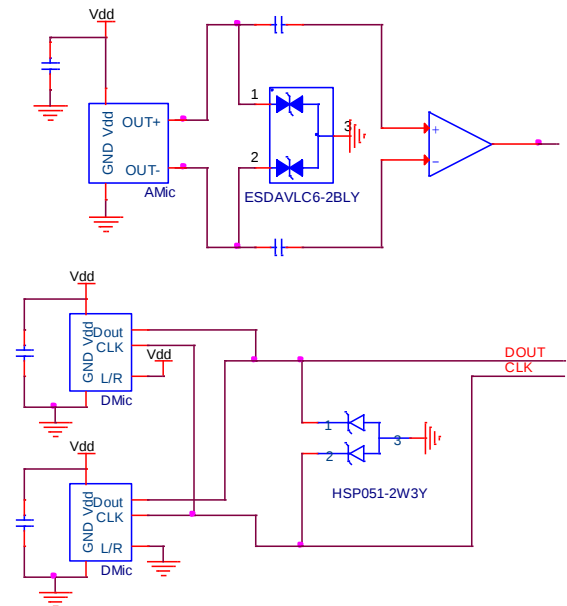
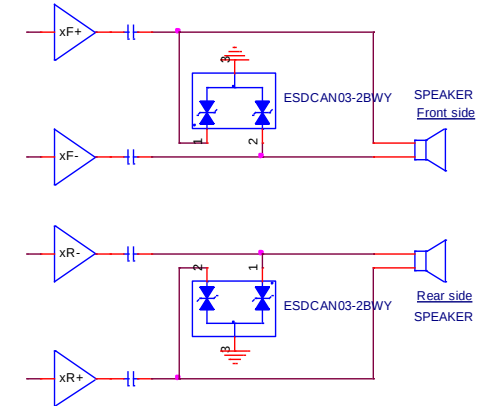
Same as above with min	$V_{RM} = 24$ V Contact discharge: 30 kV // air discharge: 30 kV	<u>ESDA25SC6Y</u> <u>ESDCAN03-2BWY</u>
Needs for analog microphone	Product key parameters	ST solutions
Voltage ≤ 5.0 V	$V_{RM} \geq 5.0$ V	<u>ESDAVLC6-2BLY</u> <u>ESDCAN03-2BWY</u>
Audio analog	Bidirectional	
$f < 20$ kHz	No constraints on capacitance	

With a risk of connection to the battery consideration: ISO 16750-2 compliant min $V_{RM} = 13.5$ V

Needs for digital microphone	Product key parameters	ST solutions
Voltage ≤ 3.3 V	$V_{RM} \geq 3.3$ V	<u>HSP051-2W3Y</u> SOT323-3L – dual unidir lines
Positive signal	Unidirectional (but bidirectional also suitable)	
Small consumption during digital communication	Capacitance = 0.7 pF	
IEC 61000-4-2 level 4 & ISO 10605 (C = 150 pF, R = 330 Ω): 8 kV contact / 15 kV air	Contact discharge: 12 kV Air discharge: 15 kV	

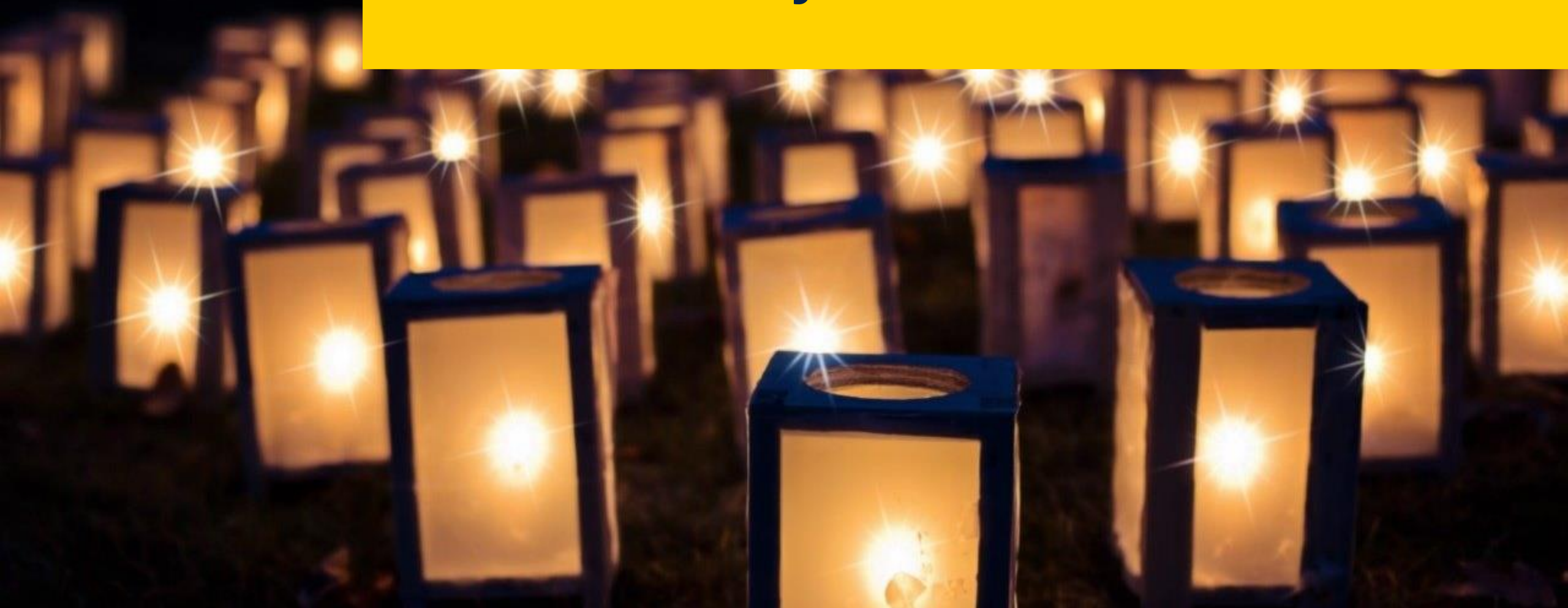
With a risk of connection to the battery consideration: ISO 16750-2 compliant min $V_{RM} = 13.5$ V

Same as above with min $V_{RM} = 13.5$ V	$V_{RM} = 24$ V, capacitance = 3.3 pF Contact discharge: 15 kV // air discharge: 30 kV	<u>ESDCAN03-2BM3Y</u>
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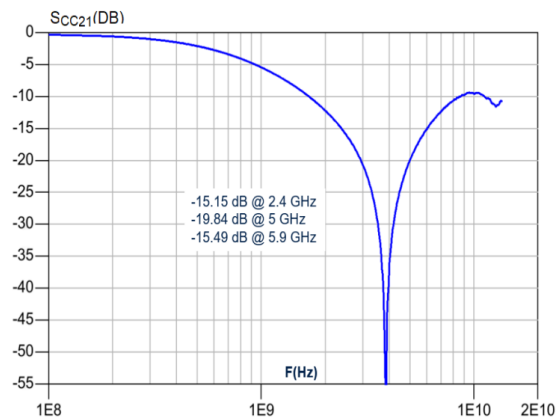


BOM summary

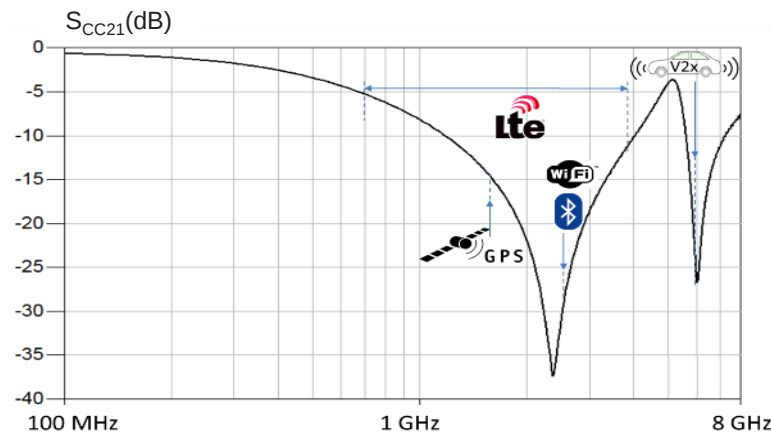


Family		Part numbers	V _{rm}	Uni/Bi	IEC 61000-4-2	Freq @-3 dB	S21 / Scc21 GPS freq	S21 / Scc21 @2.4GHz	S21 / Scc21 @5.0GHz	S21 / Scc21 V2X freq	S21 / Scc21 LTE freq	Package	Comments
Filters	EMI filter	EMIF06-1005MX12Y	3 V	UNI	15 kV	120 MHz	-36 dB	-34 dB	-28 dB	-27 dB	< -30 dB	QFN 12L 3.0 x 1.35 WF	Wettable flank package
	ESD + CMF	ECMF2-40A100M6Y	5 V	UNI	9 kV	12.5 GHz	-5 dB	-15 dB	-20 dB	-15.5 dB	N/A	QFN 6L 1.4 x 1.35 WF	Wettable flank package
		ECMF4-2459A6M10Y	5 V	UNI	8 kV	9 GHz	-13 dB	-34 dB	-4 dB	-20 dB	N/A	QFN 10L 2.6 x 1.35 WF	Wettable flank package
		ECMF04-4HSWM10Y	3 V	UNI	8 kV	3.5 GHz	-23 dB	-30 dB	-16 dB	-16 dB	<-13 dB	QFN 10L 2.6 x 1.35 WF	Wettable flank package
		ECMF04-4HSM10Y	3 V	UNI	8 kV	2.2 GHz	-12 dB	-7 dB	-4 dB	-12 dB	< -7 dB	QFN 10L 2.6x1.35 WF	Wettable flank package

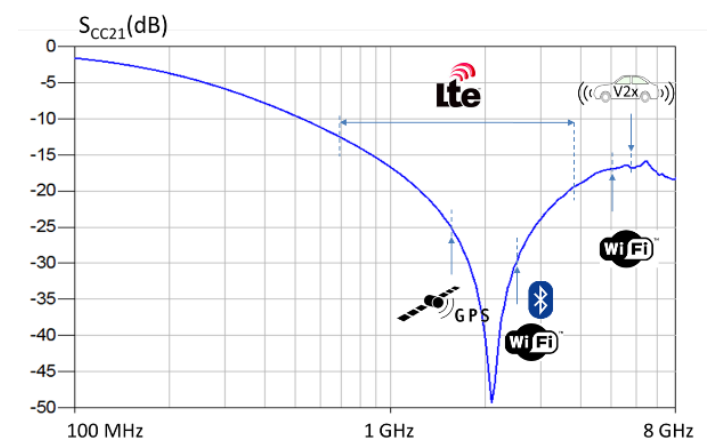
ECMF2-2450A6M6Y



ECMF4-2459A6M10Y



ECMF04-4HSWM10Y





List of protections

Family	Part numbers	V _{rm}	Uni/Bi	Snapback	Cline typ	IEC 61000-4-2	ESD TLP V _{cl} @16A	Package	Comments
Protection	Low capacitance	<u>ESD1001-1BM2Y</u>	-	BI	-	-	-	DFN1006WF	under development (WF = Wettable flank)
		<u>ESDAVLC6-2BLY</u>	3 V	BI	NO	0.95 pF	13 kV	SOT23-3L	
		<u>ESDAXLC6-1BT2Y</u>	3 V	BI	NO	0.4 pF	16 kV	DFN1006	
		<u>ESDZX161-1BM2Y</u>	16 V	BI	-	-	-	DFN1006WF	under development (WF = Wettable flank)
		<u>HSP051-2W3Y</u>	5 V	UNI	NO	0.7 pF	12 kV	SOT323-3L	
		<u>HSP061-4M10Y</u>	3 V	UNI	NO	0.6 pF	8 kV	QFN 10L 2.5x1.0	
		<u>HSP181-2W3Y</u>	18 V	UNI	SOFT	2.1 pF	12 kV	SOT323-3L	
		<u>USBLC6-2SC6Y</u>	5.25 V	UNI	NO	2.5 pF	15 kV	SOT23-6L	
		<u>USBLC6-4SC6Y</u>	5.25 V	UNI	NO	3.0 pF	15 kV	SOT23-6L	
	Power TVS	<u>SM4TxxY</u>	-	UNI / BI	NO	-	30 kV	SMA	400 W TVS
		<u>SM6FxxY</u>	-	UNI	NO	-	30 kV	SOD128F	600 W TVS
		<u>SMA6TxxY</u>	-	UNI / BI	NO	-	30 kV	SMA	600 W TVS
	General purpose	<u>ESDA5WY</u>	5.5 V	UNI	NO	4 pF	25 kV	SOT323-3L	
		<u>ESDA6V1LY</u>	5.25 V	UNI	NO	140 pF	30 kV	SOT23-3L	
		<u>ESDA6V1SC6Y</u>	5.2 V	UNI	NO	190 pF	30 kV	SOT23-6L	
		<u>ESDA14WY</u>	12 V	UNI	NO	125 pF	30 kV	SOT323-3L	
		<u>ESDA14V2LY</u>	12 V	UNI	NO	90 pF	30 kV	SOT23-3L	
		<u>ESDA14V2SC5Y</u>	12 V	UNI	NO	100 pF	30 kV	SOT23-5L	
		<u>ESDA18WY</u>	16 V	UNI	NO	95 pF	30 kV	SOT323-3L	
		<u>ESDA25LY</u>	25 V	UNI	NO	50 pF	30 kV	SOT23-3L	
		<u>ESDA25SC6Y</u>	24 V	UNI	NO	60 pF	30 kV	SOT23-6L	
		<u>ESDALC5-1BT2Y</u>	5 V	BI	NO	26 pF	30 kV	DFN1006	
		<u>ESDAVLC8-1BT2Y</u>	3 V	BI	NO	4.5 pF	17 kV	DFN1006	



List of protections

Family		Part numbers	V _{rm}	Uni/Bi	Snapback	Cline typ	IEC 61000-4-2	ESD TLP V _{cl} @16A	Package	Comments
Protection	CAN protection	ESDCAN01-2BLY	24 V	BI	NO	26 pF	30 kV	34 V	SOT23-3L	12 V battery
		ESDCAN02-2BWY	26.5 V	BI	NO	3 pF	30 kV	46 V	SOT323-3L	12 V battery
		ESDCAN03-2BM3Y	24 V	BI	SOFT	3.3 pF	15 kV	37 V	QFN 3L 1.1x1.0	12 V battery / DFN1110
		ESDCAN03-2BWY	24 V	BI	NO	3 pF	30 kV	43 V	SOT323-3L	12 V battery
		ESDCAN04-2BLY	25.5 V	BI	NO	17 pF	30 kV	40 V	SOT23-3L	12 V battery
		ESDCAN04-2BWY	25.5 V	BI	NO	17 pF	30 kV	40 V	SOT323-3L	12 V battery
		ESDCAN05-2BWY	36 V	BI	NO	3 pF	30 kV	58 V	SOT323-3L	24 V battery
		ESDCAN06-2BLY	35 V	BI	NO	13 pF	30 kV	52 V	SOT23-3L	24 V battery
		ESDCAN06-2BWY	35 V	BI	NO	13 pF	30 kV	53 V	SOT323-3L	24 V battery
		ESDCAN24-2BLY	24 V	BI	NO	25 pF	30 kV	39 V	SOT23-3L	12 V battery

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