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PROTECTION & FILTERS

Mobility

E-bikes

Place for
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Protection & Filters Solutions for e-bikes

Power supply
SM15T series (1500 W) SMA6J series (600 W)
Charging connector Battery (V_{BUS} ; V_{BATT})
SM6FY series (600 W) SMA6J series (600 W)
Back EMF protection
SMCJ series (1500 W) SMC30J series (3 kW) SMC50J series (5 kW)
Gate protection
ESDA14V2L (ESD) SMAJ series (400 W)

BLDC motor position feedback EMI & ESD	
Filter & ESD	EMIF03-22K10M8Y*
ESD	ESDZL5-1F4 USBLC6-4SC6
Battery management system	
V+	SMA6J series (600 W) SM6FY series (600 W)
ISO comm	USBLC6-2SC6 USBLC6-4SC6 ESDAVLC6-2BLY

Buttons/switches
ESDZL5-1F4 ESDZV5-1BF4 EMIF01-1K03AF4*
RF antennas (BLE)
ESDZX168B-1BF4

CAN	RS-485/RS-232
ESDCANx-2BLY ESDCANx-2BWY	ESDA14V2BP6
	I2C/SPI
	USBLC6-2SC6
USB Type-C	
Vbus and CC lines (integrated solution)	TCPP01-M12
CC lines	ESDA5-1F4 ESDA8P30-1T2
USB Vbus and D+/D-	
Vbus	ESDA5-1F4 ESDA8P30-1T2 ESDA7P120-1U1M
Data D+/D-	USBLC6-2SC6 ECMF2-40A100N6 ECMF2-40A100M6Y





Antennas Bluetooth

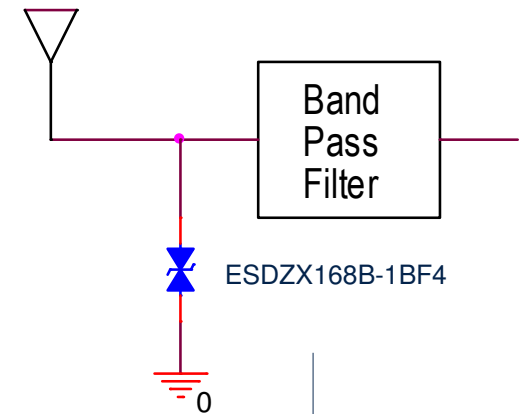
**Antennas are ESD protected according to IEC 61000-4-2 level 4
Very low harmonics generation ensures no disturbance in application**

Needs for Bluetooth antenna	Product key parameters	ST solutions
RF power = 20 dBm ($V_{PEAK} = 3.2\text{ V}$ with $50\ \Omega$ load)	$V_{RM} = 16\text{ V}$	<u>ESDZX168B-1BF4</u>
Alternative signal	Bidirectional device	
$f = 2.4\text{ GHz}$	Extra low capacitance: 0.12 pF - Bandwidth $>40\text{ GHz}$	
Very low harmonic $<41\text{ dBm}$ @ 20 dBm	$H3 = -70\text{ dBm}$ @ 20 dBm , $f = 2.4\text{ GHz}$	

Socket specifics

ST product parameter impact

ST recommended product



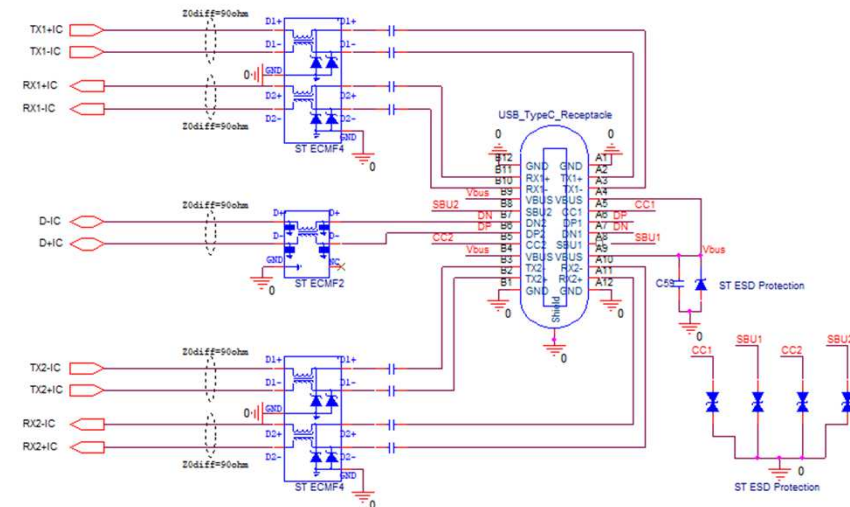


USB Type C Data lines

Complete solution portfolio for USB granting flexibility in design
All sockets are ESD protected according to IEC 61000-4-2 level 4

USB2.0 (D+/ D-) needs*	Product key parameters	ST solutions
Voltage ≤ 3.6 V	$V_{RM} = 5.25$ V	USBLC6-2SC6 (dual lines)
Positive signal	Unidirectional	
Data rate: 480 Mbps Maximum equivalent frequency 240 MHz	Bandwidth 3.0 GHz	
Avoid Bluetooth/Wi-Fi antenna desense (2.4/5 GHz)	CMF rejection ≥ -15 dB (2.4 to 6.5 GHz)	ECMF2-40A100N6
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: ≥ 8 kV Air discharge: ≥ 15 kV	

* Usually D+/D- pins are used. For USB 3.x and greater revisions, extra low capacitance ESD protections for Rx/Tx pins are available. Please contact your STMicroelectronics contact

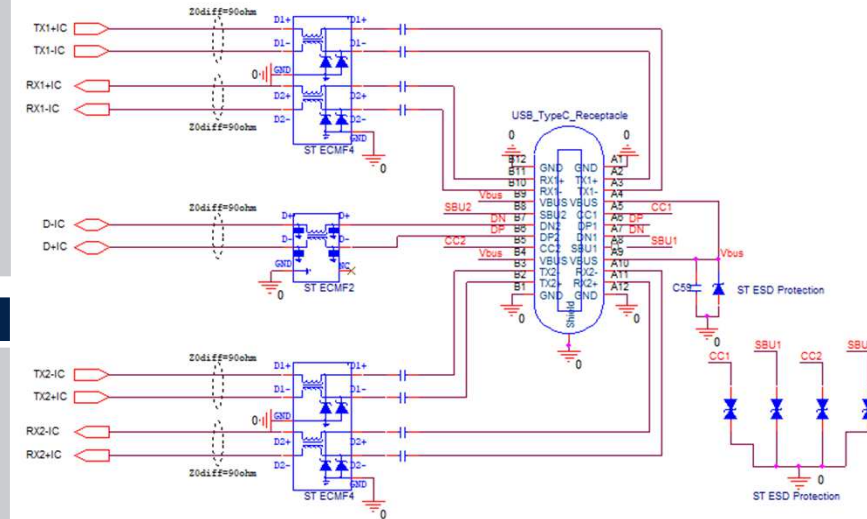




USB Type C CC lines

Complete solution portfolio for USB granting flexibility in design
All sockets are ESD, and surge protected according to IEC 61000-4-5

Needs for CC lines	Product key parameters	ST solutions
Voltage ≤ 5.5 V	$V_{RM} \geq 5.5$ V	ESDA5-1F4 ESDA8P30-1T2
Positive signal	Unidirectional (but bidirectional also suitable)	
Need to withstand 8 / 20 μ s surge as defined in IEC 61000-4-5	Up to Ipp 30 A	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: >30 kV Air discharge: >30 kV	
Needs for CC lines with Power delivery (PD)	Product key parameters	ST solutions
Voltage ≤ 20 V	$V_{RM} \geq 20$ V	ESDALC20-1BF4 ESDA25P35-1U1M
Positive signal	Unidirectional (but bidirectional also suitable)	
Need to withstand 8 / 20 μ s surge as defined in IEC 61000-4-5	Up to Ipp 35 A	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: up to 20 kV Air discharge: up to 30 kV	





USB Power Delivery Power management

**Compatible and reliable up to 100 W (TCPP0 series)
Compliant with USB PD 3.2/PPS; USB-IF certification available.**

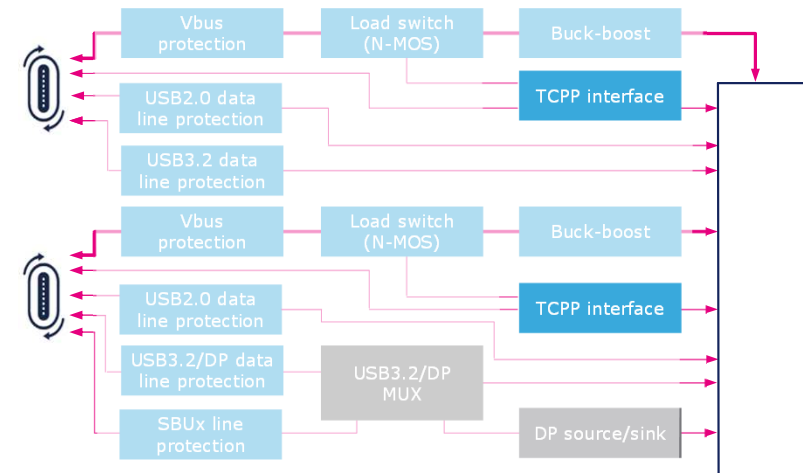
Needs for USB PD management ⁰	Product key parameters	ST solutions
Compliance with USB PD 3.2 specification	USB-IF certification available TCPP01 for Sink → USB-IF-TID: 5205 TCPP02 for source → USB-IF-TID: 7884 TCPP03 for DRP → USB-IF-TID: 6408	<p><u>TCPP01-M12</u></p> <p><u>TCPP02-M18</u></p> <p><u>TCPP03-M20</u></p> <p><u>TCPP series</u></p>
Fast charging	Compliant with USB PD 3.1 including PPS up to 20 V, -5 A	
Compatible with all chargers from the market	V _{cc} = 24 V for TCPP0x	
Able to survive current or voltage surges and short-circuit with V _{bus}	Overcurrent and overvoltage protection on V _{BUS} , CC lines V _{Threshold} = 6 V on CC lines	
Cost effectiveness	Companion chip of STM32 with UCPD Reuse the STM32 of the application	
Use of low-cost MOSFET	Integrated V _{BUS} load switch gate driver for external N-MOSFET	
IEC 61000-4-2 level 4 (8 kV contact/15 kV air)	Contact discharge: ≥8 kV Air discharge: ≥15 kV	

Expansion boards available

X-NUCLEO-SNK1M1

X-NUCLEO-SRC1M1

X-NUCLEO-DRP1M1

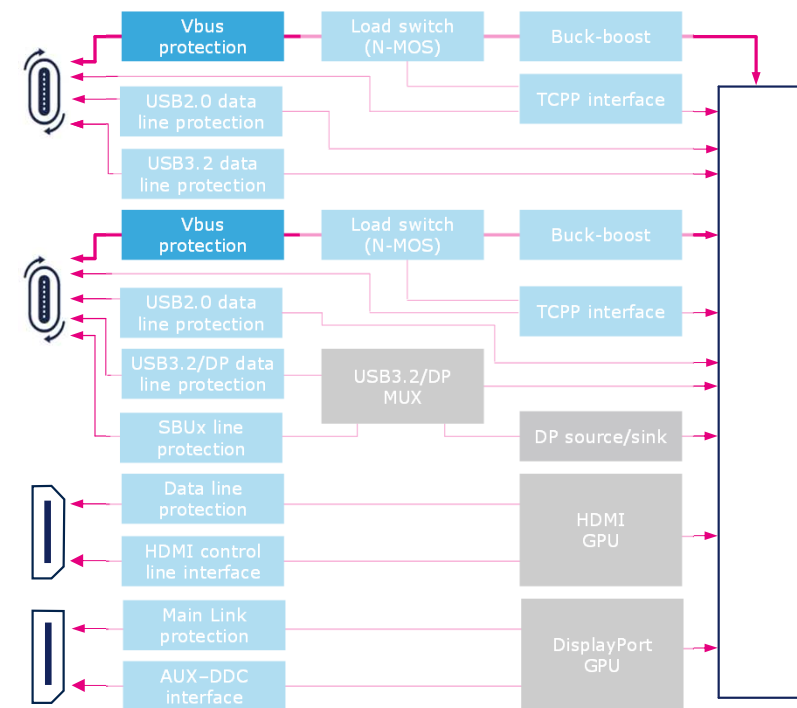




USB Power Delivery Vbus

ESD and EOS protections in CSP, QFN, and SMD packages

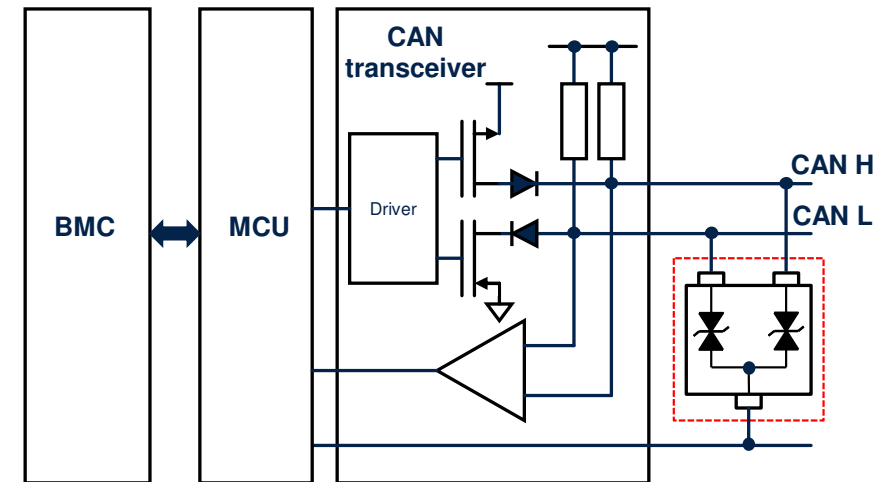
Needs for Vbus input	Product key parameters	ST solutions
V _{max} = 5.5 V	V _{RM} = 5.5 V	<u>ESDA5-1F4</u>
DC signal	Bidirectional is also compatible	
IEC 61000-4-5	Surge capability: 11 A 8/20 μs	
V _{max} = 5.5 V	V _{RM} = 6.3 V	<u>ESDA8P30-1T2</u>
DC signal	Unidirectional	
IEC 61000-4-5	Surge capability: 30 A 8/20 μs	
V _{max} = 20 V (Power Delivery)	V _{RM} = 20 V	<u>ESDALC20-1BF4</u>
DC signal	Bidirectional is also compatible	
IEC 61000-4-5	Surge capability: 2.4 A 8/20 μs	
V _{max} = 20 V (Power Delivery)	V _{RM} = 22 V	<u>ESDA25P35-1U1M</u>
DC signal	Unidirectional	
IEC 61000-4-5	Surge capability: 35 A 8/20 μs	
V _{max} = 28, 36, or 48 V +15% (EPR)	V _{RM} = 30, 40, 58 V	<u>SMAJ</u>
DC signal	Unidirectional	
IEC 61000-4-5	8/20 μs surge capability: 36, 27, 19 A	





Wide CAN transceiver protection portfolio brings design flexibility

CAN needs	Product key parameters	ST solutions
Battery voltage in case of short to battery scenario	V_{RM} from 24 to 36 V	ESDCANx-2BLY ESDCANx-2BWY
2 lines communication bus	Dual line protections	
Compliance with reverse connection	Bidirectional	
Data rate <ul style="list-style-type: none"> ▪ Fault tolerant CAN: 125 kbps ▪ High speed CAN: 1 Mbps ▪ CAN-FD: 5 Mbps ▪ CAN-FD SiC: 8 Mbps ▪ CAN XL: 10 Mbps 	C_{line} down to 3.5 pF, bandwidth: >1 GHz Compliant with all CAN types	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: up to 30 kV Air discharge: ≥30 kV	



[More details on our ESDCAN series](#)

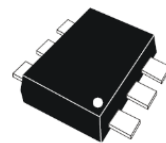
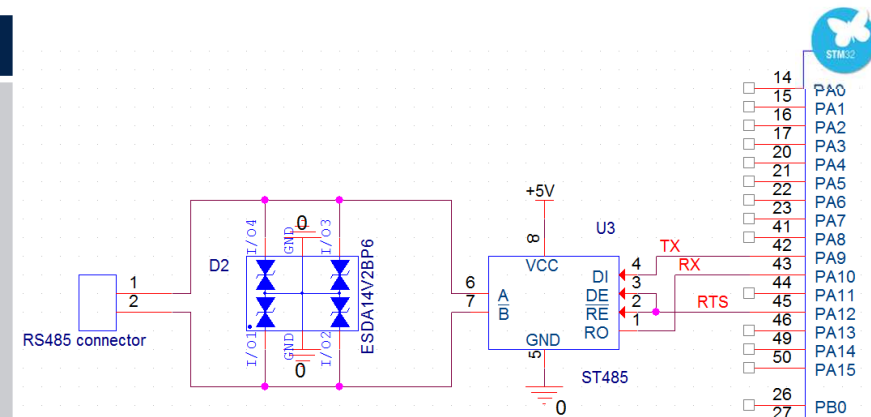




RS-485

Always place the ESD protection close to the ESD source
Here, close to the RS-485 connector

Needs for RS-485	Product key parameters	ST solutions
Voltage range: -7 to +12 V	$V_{RM} \geq 12 V$	ESDA14V2BP6
Positive and negative signal	Bidirectional – 4 lines	
Maximum data rate: 20 Mb/s Maximum equivalent frequency < 10 MHz	Low constraint on capacitance Typical line capacitance 25 pF Bandwidth >> 10 MHz	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: $\geq 8 kV$ Air discharge: $\geq 15 kV$	



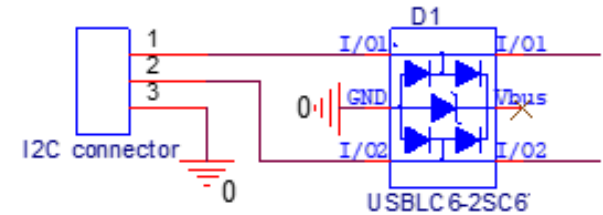
SOT666-6L





I²C socket is ESD protected according to IEC 61000-4-2 with one single device

I ² C needs	Product key parameters	ST solutions
Line voltage range: 0 to 5 V	$V_{RM} \geq 5.25$ V	<u>USBLC6-2SC6</u> (dual lines)
Positive signal	Unidirectional	
Data rate: 3.4 Mbps – Maximum frequency: 20 MHz	Bandwidth: 3 GHz	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: ≥ 15 kV Air discharge: ≥ 25 kV	



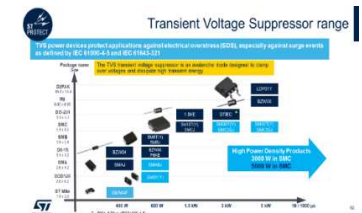
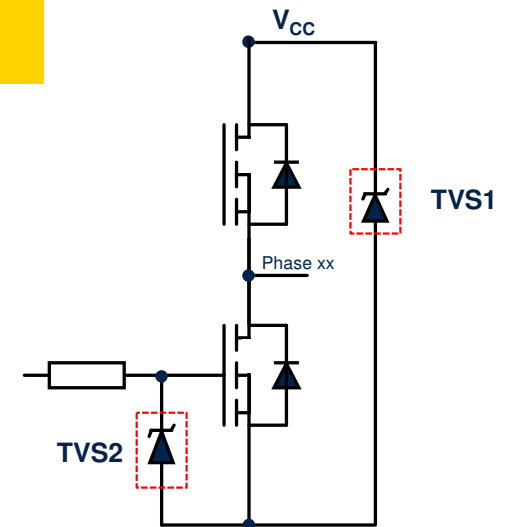


BLDC motor Power stage

Wide range of I_{PP} surge capabilities to protect motor drive from transients induced by a motor or gate driver

Needs for gate protection (TVS2)	Product key parameters	ST solutions
Gate voltage < VGS max	VBR max < VGS max	<u>ESDA14V2L</u> (SOT23-3L) <u>SMAJ series (400 W)</u> (SMA)
Positive or negative signal	Unidirectional/bidirectional respectively	
Low frequency application (Si MOSFET)	No constraints on capacitance	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: ≥ 30 kV Air discharge: ≥ 30 kV	

Needs for back EMF protection (TVS1)	Product key parameters	ST solutions
V_{CC} voltage depends on battery voltage	$V_{RM} \geq V_{CC}$	<u>SMCJ series</u> <u>SMC30J series</u> <u>SMC50J series</u> (SMC)
Positive signal	Unidirectional	
Low frequency application	No constraints on capacitance	
Need to withstand surge (IEC 61000-4-5 & 10/1000 μ s transient)	I_{PP} up to 444 A (8/20 μ s) / 65 A (10/1000 μ s) with V_{RM} 48 V	

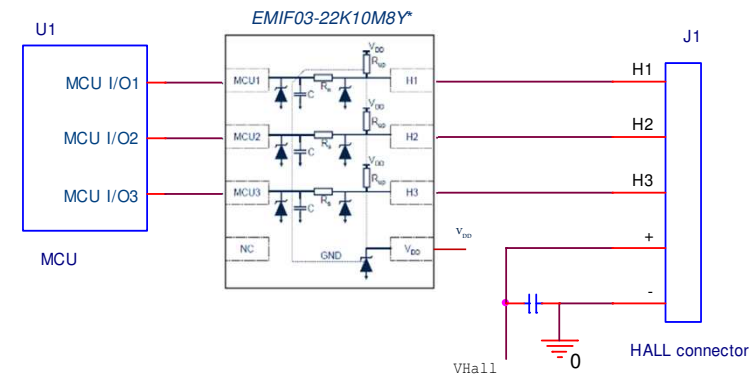




BLDC motor position feedback EMI & ESD protection circuit

Application specific product embedding ESD protection, EMI filters and pull-up resistors in one single package

Sensors signal needs	Product key parameters	ST solutions
MCU power supply, usually 5.0 V or less	$V_{RM} \geq 5 \text{ V}$	<u>EMIF03-22K10M8Y*</u>
Digital positive signal	Unidirectional (bidirectional also suitable)	
Generally, current in each MCU input pins < 5 mA in case of short circuit between sensor pins and V_{BAT}	Serial resistance $R_s = 22 \text{ k}\Omega$ (2.1 mA for 48 V on sensor pins)	
Motor speed up to 100k rpm Hall sensor frequency $1.7 \text{ kHz} \times 4 = 6.8 \text{ kHz}$	Bandwidth $\geq 70 \text{ kHz}$	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: $\geq 25 \text{ kV}$ Air discharge: $\geq 30 \text{ kV}$	<u>ESDZL5-1F4</u> (single line)
Design flexibility	ESD protection only	
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: up to 8 kV Air discharge: up to 15 kV	

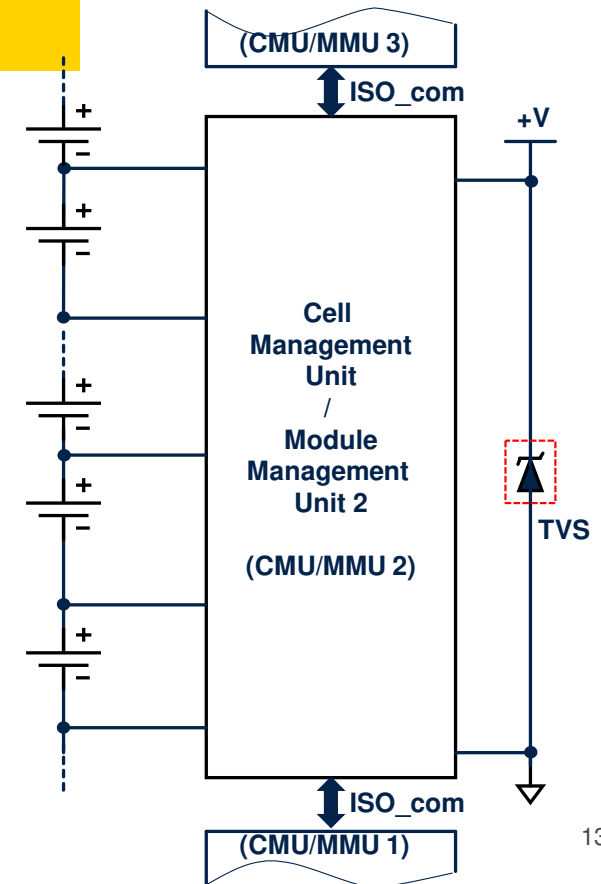




Battery management circuit Cell/module management units

600 W TVS with excellent clamping capability to protect ICs against EOS on the V_{BAT} in SMA or SOD128 flat package

Needs for V_{PWR}	Product key parameters	ST solutions
Voltage according to battery or specification	$V_{RM} \geq V_{bat}$ (generally $V_{bat} = 36$ to 48 V)	<u>SMA6J series</u> (SMA)
Positive signal	Unidirectional	
Need to withstand 8/20 μ s surge (IEC 61000-4-5)	I_{PP} up to 40A with V_{RM} 48 V	<u>SM6FY series</u> (SOD128F)
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: >30 kV Air discharge: >30 kV	

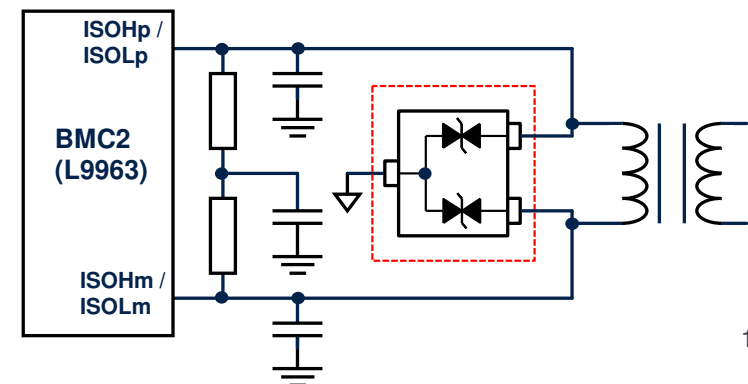
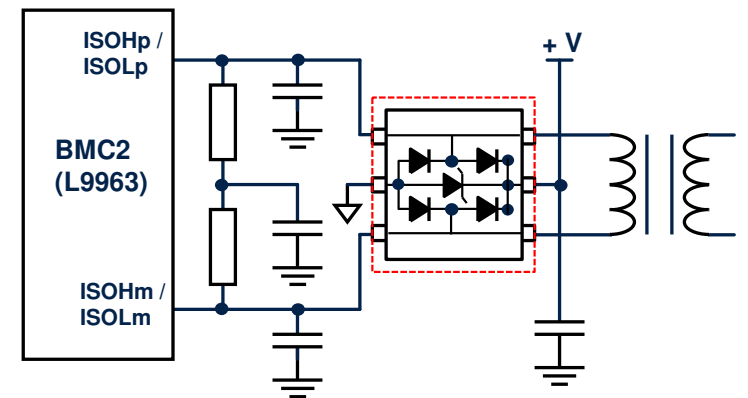




Battery management circuit ISO_COM

Low capacitance ESD protection ensures signal integrity
Bidirectional or unidirectional portfolio brings flexibility

Needs for ISO com bus	Product key parameters	ST solutions
Voltage ≤ 5.0 V	$V_{RM} \geq 5.5$ V	<u>USBLC6-2SC6</u> (unidirectional)
Positive or negative signal depending topologies	Unidirectional Bidirectional	
Data rate: 2.66 Mbps Maximum frequency 15 MHz	Bandwidth 3.0 GHz	<u>USBLC6-4SC6</u> <u>ESDAVLC6-2BLY</u> (bidirectional)
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: > 13 kV	



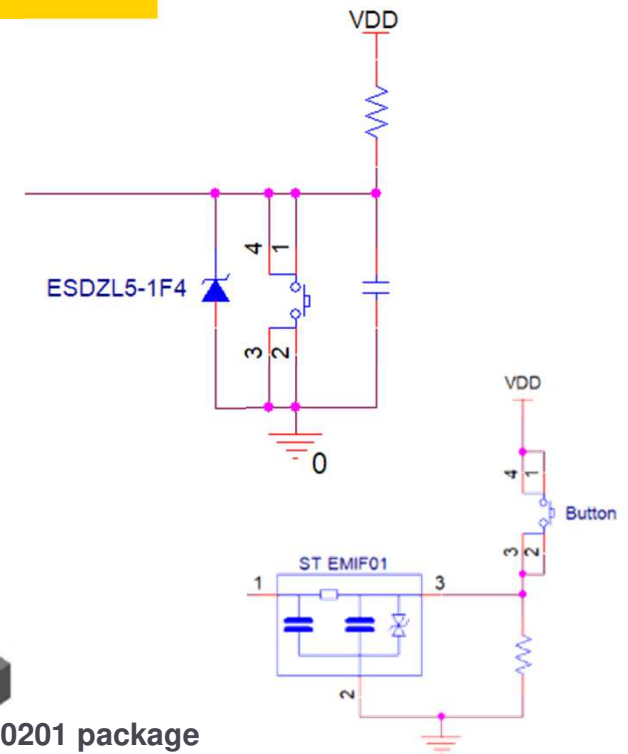


Buttons/switches/GPIOs (sensors)

**All sockets are ESD protected according to IEC 61000-4-2 level 4
Very low clamping thanks to soft snapback type protection**

Needs for switches	Product key parameters	ST solutions
MCU power supply, usually 3.3 V or less	$V_{RM} \geq 5.5$ V	<u>ESDZV5-1BF4</u> (single line)
Digital positive signal	Unidirectional (bidirectional also suitable)	
Low frequency application	No constraints on capacitance Cline < 9.5 pF	<u>ESDZL5-1F4</u> (single line)
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: ≥ 15 kV Air discharge: ≥ 30 kV	
Avoid EMI (antenna desense)	Reject frequency > 700 MHz	<u>EMIF01-1007AF4</u> (*)
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: up to 8 kV Air discharge: up to 15 kV	

(*) Contact our sales office



0201 package



DC Input protection Charging connector & Battery

Wide range of I_{PP} surge capabilities
Flexibility with various voltages and package sizes

Power supply needs	Product key parameters	ST solutions in SMD
DC input voltage (Battery, motor drive, charger converter)	$V_{RM} \geq V_{bat}$ (generally $V_{bat} = 36$ to 48 V)	<u>SMA6J series</u> (SMA)
	Unidirectional	
Need to withstand 8/20 μ s surge (IEC 61000-4-5)	I_{PP} up to 100 A with $V_{RM} 48$ V	<u>SM15T series</u> (SMC)
IEC 61000-4-2 level 4 8 kV contact/15 kV air	Contact discharge: >30 kV Air discharge: >30 kV	

- [AN5958](#), dealing with voltage surges in a 48 V automotive system and transient voltage suppressor (TVS)

Glossary

- **ESD:** electrostatic discharge
- **EOS:** electrical overstress
- **TVS:** transient voltage suppressor diode
- **CMF:** common mode filter
- **MCU:** microcontroller
- **ADC:** Analog-to-digital converter
- **CMU:** cell management unit
- **MMU:** module management unit
- **E-bike:** electric bike; a motorized bicycle with an integrated electric motor used to assist propulsion.
- **Pedelec:** Class 1 e-bikes with electric assistance only when the rider is pedaling.
- **Throttles on demand:** Class 2 e-bikes with a motor powering the bike without pedaling on demand.
- **Speed pedelec:** Class 3 e-bikes with higher speed limit (45 km/h; 28 mph).

Our technology starts with You



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