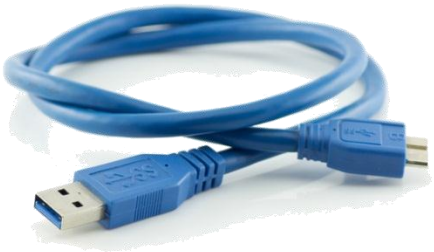
USB 2.0 advanced protection solutions



Is this presentation suited for you?

Where do you stand with USB protection?

Beginner?

I am not familiar with this subject. I am in the discovery phase and would like an overview and a basic understanding of the technology.

Click here to continue to next slide

Overview

Intermediate?

I have a basic understanding of this subject. I would like to go deeper in details and tackle more aspects of this subject.

Click here to continue to next slide

Basic

Advanced?

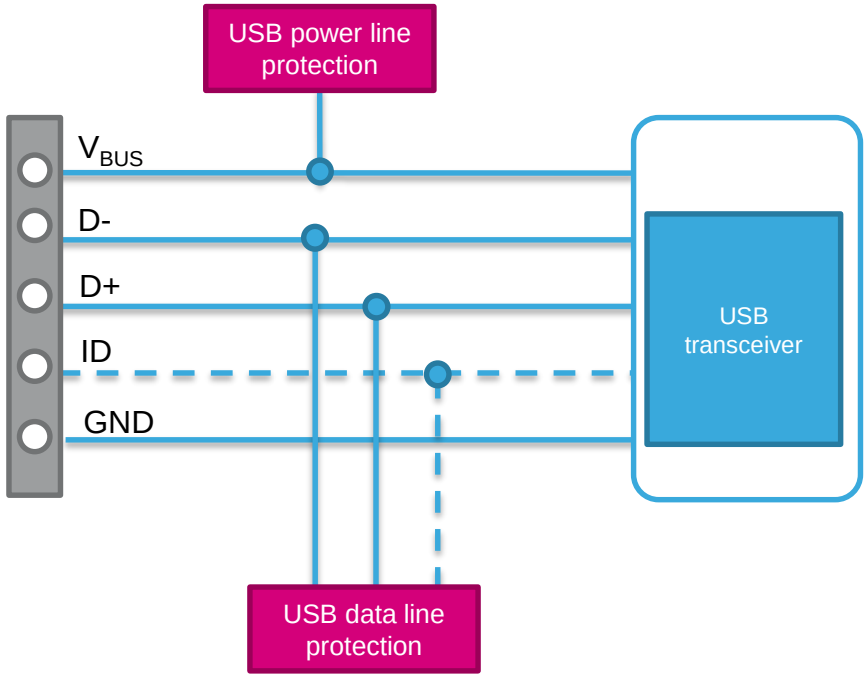
I am very familiar with this subject. I would like to deepen my knowledge and become an expert.

Click here to continue to next slide

In depth

Basics on USB 2.0 (1)

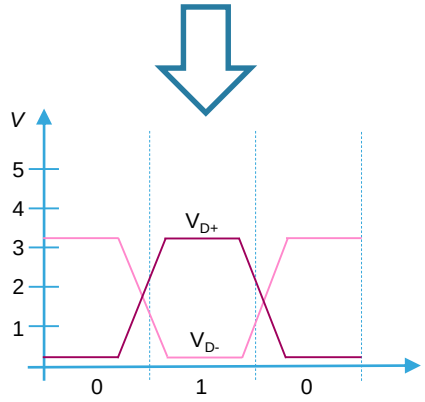
- USB stands for Universal Serial Bus
- It is very popular and present on most electronic devices
- It is a serial bi-directional bus that is hot-pluggable and supports Plug and Play.
- 3 data lines:
  - D+
  - D-
  - ID (for USB On-The-Go only)
- 1 power line: V_{BUS}
- 3 standards:
  - Low speed (1.5 Mbit/s)
  - Full speed (12 Mbit/s)
  - High speed (480 Mbit/s)

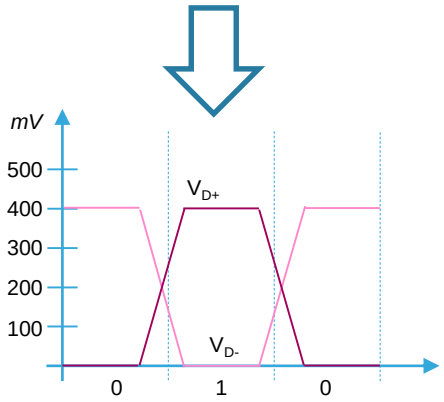


Not mandatory.
Only for USB On-The-Go

USB 2.0 basics (2)

Parameters	Low speed	Full speed	High speed
Data rate	Up to 1.5 Mbit/s	Up to 12 Mbit/s	Up to 480 Mbit/s
Termination	Not terminated	Not terminated	90 Ω differential 45 Ω to ground
Signaling – Logical low level	V_{D+} = 0 to + 0.3 V V_{D-} = 2.8 to 3.6 V	V_{D+} = 0 to + 0.3 V V_{D-} = 2.8 to 3.6 V	V_{D+} = −10 to + 10 mV V_{D-} = +360 to +440 mV
Signaling – Logical high level	V_{D+} = 2.8 to 3.6 V V_{D-} = 0 to + 0.3 V	V_{D+} = 2.8 to 3.6 V V_{D-} = 0 to + 0.3 V	V_{D+} = +360 to +440 mV V_{D-} = −10 to + 10 mV
V_{BUS} voltage *(standard downstream port)*	From 4.4 V to 5.5 V	From 4.4 V to 5.5 V	From 4.4 V to 5.5 V
V_{BUS} max current *(standard downstream port)*	500 mA	500 mA	500 mA





Focus on power: charging ports

- Purpose: Charging batteries through the V_{BUS} pin.
- Need for a current rate higher than 500 mA for the standard downstream port.
- The USB Battery Charging Specification (first release in 2007) defined a new type of port called *charging port*.
- Even if the maximum current is 5.0 A for safety, most USB cables are rated up to 1.5 A, thus creating a limitation.

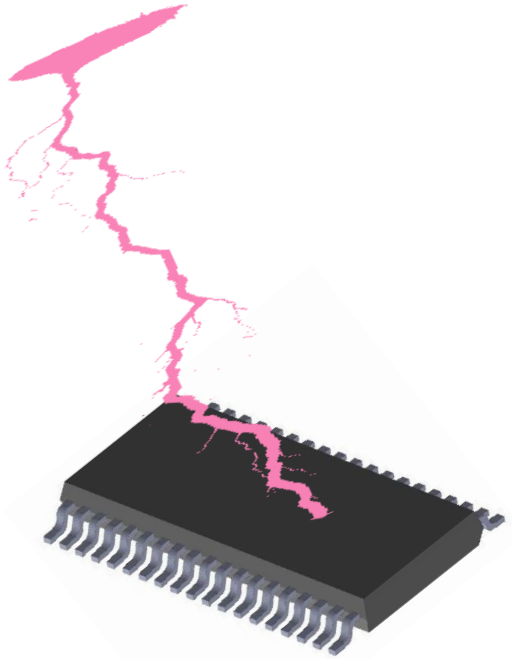
	Standard downstream port (SDP)	Charging downstream port (CDP)	Dedicated charging port (DCP)
Standard	USB Battery Charging Specification Revision 1.2 (released in 2010)		
Data transfer enabled	Yes	Yes (max. current 900 mA on V_{BUS} during high speed transfer)	No (D+ and D- shorted)
Maximum current on V_{BUS}	500 mA @ 5V	1.5 A @ 5V (USB cables rated at 1.5A only)	5A with voltage > 2V (USB cables rated at 1.5A only)

Focus on power: USB Power Delivery

- To further develop the “power” aspect of USB ports, the USB Power Delivery (PD) specification was released in July 2012.
- 6 power profiles are defined extending the supply voltages *(Profile 0 is reserved)*
- This requires new cables withstanding voltages higher than 5 V and currents higher than 1.5 A.
- Profile 4 is the limit for micro-B/AB connectors.

Profile	5 V	12 V	20 V
1	2.0 A, 10 W		
2		1.5 A, 18 W	
3		3.0 A, 36 W	
4			3.0 A, 60 W
5		5.0 A, 60 W	5.0 A, 100 W

The need for ESD protection devices



USB transceivers and controllers …

Advanced technology with very **thin lithography** and gate oxides are highly vulnerable to ESD

Integrated electronics systems with **high-component-density PCBs** facilitate ESD **coupling** and **propagation**

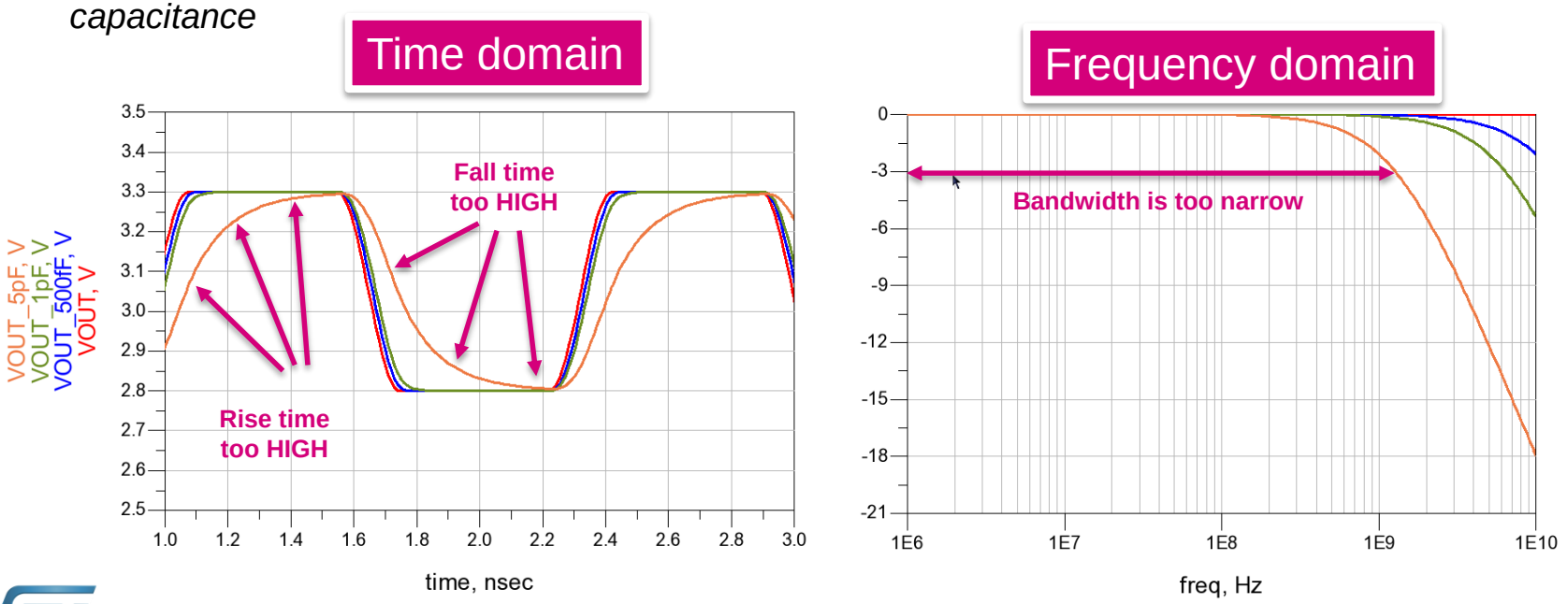
IC manufacturers are reluctant to make robust embedded ESD protection diodes that would take up a **significant active area of their advanced and expensive technology.**

Why ultra-low capacitance ?

- The parasitic capacitance of ESD protection devices must be low enough to allow USB 2.0 high-speed signals (maximum data rate: 480 Mbit/s) to be transmitted without degradation.

- A high parasitic capacitance of the ESD protection devices would increase too much the signal rise/fall time and prevent communications.

Example of the impact of parasitic capacitance on high-speed signal simulated with discrete capacitance

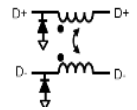


EMI filtering & ESD protection for USB datalines

Data rate (Gbit/s)

System-level ESD protection (IEC 61000-4-2 Level 4)

+ Common-mode filter (ECMF)



10

ESDAXLC6-1BU2
1-line ESD
ST0201
0.6 x 0.3 x 0.3 mm

HSP051-4N10
4-line ESD
QFN 1.85 x 0.95 x 0.32 mm

ECMF02-2HSMX6
2xESD + 2xCMF
QFN 1.70 x 1.50 x 0.5 mm

ECMF04-4HSWM10
4xESD + 2xCMF
QFN 2.60 x 1.35 x 0.5mm

5

USBULC6-2N4
2-line ESD
QFN 1.0 x 0.8 x 0.5 mm

HSP051-4M10
4-line ESD
QFN 2.50 x 1.00 x 0.47 mm

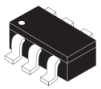
ECMF02-3HSM6
3xESD + 2xCMF
QFN 1.60 x 1.35 x 0.5 mm

ECMF04-4HSM10
4xESD + 2xCMF
QFN 2.60 x 1.35 x 0.5mm

0.48

USBLC6-2P6
2-line ESD + VBUS 6V
SOT-666 1.6 x 1.6 x 0.53 mm

USBLC6-4SC6
4-line ESD + VBUS 6V
SOT23 2.92 x 1.62 x 1.17 mm

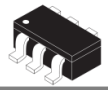


ECMF02-2AMX6
3xESD + 2xCMF
QFN 1.70 x 1.50 x 0.5 mm

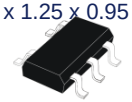
ECMF02-4CMX8
3xESD + CMF + V_{BUS} TVS 16V
QFN 2.60 x 1.35 x 0.5mm

0.012

USBLC6-2SC6
2-line ESD + VBUS 6V
SOT23 2.92 x 1.62 x 1.17 mm



USBDF01W5 / USBUF01W6
4xESD + Serial / Pull-up Resistor
SOT323 2.00 x 1.25 x 0.95 mm



EMIF02-USB03F2
7xESD + Serial and Pull-up Resistor
CSP 1.44 x 1.94 x 0.65 mm

1 or 2 lines | 4 lines | 2 lines | 4 lines

ECMF = Common-mode filter with integrated ESD protection

Click to know more about ECMF™

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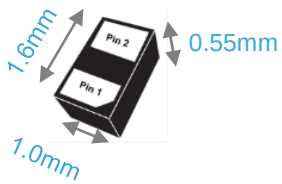
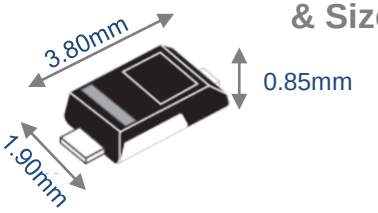
Power Delivery - ESD & EOS protection

VBUS (Typ.)

	SMALLEST	INTEGRATION *With USB 2.0 datalines*	STRONGEST
20 V			**SMM4F24A** Ipp = 60A, Ppp = 2300W
12 V		**ECMF02-4CMX8** 2-lane CMF + ID + V_{BUS} 16V 2.50 x 1.20 x 0.50 mm	**SMM4F13A** Ipp = 85A, Ppp = 2300W
9 V	NEW **ESDA13P70-1U1M** Ipp = 70A, Ppp = 1300W	NEW **ECMF2-0730V12M12** 2-lane CMF + ID + V_{BUS} 13V 2.60 x 1.35 x 0.5 mm	**SMM4F12AVCL** Ipp = 100A, Ppp = 2200W
5 V	NEW **ESDA7P60-1U1M** Ipp = 60A, Ppp = 700W	**HSP061-2M6** 2-line ESD + V_{BUS} 1.45 x 1.00 x 0.55 mm	**SMM4F6.0A** Ipp = 170A, Ppp = 2300W
Package & Size	1610	QFN	SMA Flat





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Let's go further

Basic information

ECMF™ series portfolio overview: common-mode filters embedding ESD protection - Product presentation

HSP series portfolio overview: High-speed port ESD protection - Product presentation

In-depth information

TVS short-pulse dynamic resistance measurements...
Application note AN4022

IEC 61000-4-2 standard testing - Application note AN3353

Pspice models: *ESD protection* and *ECMF™*

Selection & sampling

Our *Protection devices &Integrated EMI filtering* selection guide

Our USB port protection product selector

Our USB IPAD™ (including ECMF™) product selector