USB Type-C™ datalines and ‘Alternate Mode’
Advanced protection solutions
Is this presentation suited for you?

Where do you stand with USB Type-C™ datalines?

**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]

**Fundamentals**

**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**
Before, there were 7 connectors for 7 protocols.
Now with USB Type-C™: 1 single connector for 7 protocols.
Alternate Mode through USB Type-C™ connector

Plug

- Alternate Mode dedicates physical wires in the USB Type-C cable for direct device-to-host transmission of alternate data protocols:
  - Four high-speed lanes (RX/TX)
  - Two sideband pins (SBU)
  - Two USB 2.0 pins for dock, detachable device and permanent cable applications only (D+/D-)
  - One configuration pin can be used for Alternate Mode transmission (CC1 or CC)

Receptacle

- Alternate Mode dedicates physical wires in the USB Type-C cable for direct device-to-host transmission of alternate data protocols:
  - Four high-speed lanes (RX/TX)
  - Two sideband pins (SBU)
  - Two USB 2.0 pins for dock, detachable device and permanent cable applications only (D+/D-)
  - One configuration pin can be used for Alternate Mode transmission (CC1 or CC)
Alternate Mode

• Alternate Mode partner specifications

The USB-IF is working with its Alternate Mode partners to make sure that ports are properly labeled:

• DisplayPort Alternate Mode on USB Type-C Connector Standard published in September 2014, supporting DisplayPort 1.3

• MHL Alternate Mode (“Alt Mode”) announced November 2014 supporting MHL 3.0

• Thunderbolt Alternate Mode supporting Thunderbolt 3

• Other serial protocols such as PCI Express and Base-T Ethernet are possible.
## Data on USB 2.0 and 3.1 Gen 1 & Gen 2

<table>
<thead>
<tr>
<th>Parameters</th>
<th>USB 2.0</th>
<th></th>
<th>SuperSpeed link USB 3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low speed</td>
<td>Full speed</td>
<td>High speed</td>
</tr>
<tr>
<td>Datarate</td>
<td>Up to 1.5 Mbit/s</td>
<td>Up to 12 Mbit/s</td>
<td>Up to 480 Mbit/s</td>
</tr>
<tr>
<td>Termination</td>
<td>Not terminated</td>
<td></td>
<td>90 Ω differential 45 Ω to ground</td>
</tr>
<tr>
<td>Signaling output low level</td>
<td>$V_{OL} = 0 \text{ to } +0.3 \text{ V}$</td>
<td>$V_{OL} = -10 \text{ to } +10 \text{ mV}$</td>
<td></td>
</tr>
<tr>
<td>Signaling output high level</td>
<td>$V_{OH} = 2.8 \text{ to } 3.6 \text{ V}$</td>
<td>$V_{OH} = +360 \text{ to } +440 \text{ mV}$</td>
<td></td>
</tr>
<tr>
<td>Signaling Differential voltage swing</td>
<td>6.6 $V_{P\text{-}P}$ typ.</td>
<td>800 $mV_{P\text{-}P}$ typ.</td>
<td>1 $V_{P\text{-}P}$ typ. 0.4$mV_{P\text{-}P}$ min, 1.2$mV_{P\text{-}P}$ max</td>
</tr>
<tr>
<td>$V_{BUS}$ voltage</td>
<td></td>
<td></td>
<td>5 V typ. 4.4 V min, 5.5 V max for standard A downstream port</td>
</tr>
<tr>
<td>$V_{BUS}$ max. current</td>
<td></td>
<td></td>
<td>900 mA for standard A downstream port</td>
</tr>
</tbody>
</table>
2 challenges to overcome

USB 3.1

Signal transmission: @ 5 Gbit/s Gen 1 @ 10 Gbit/s Gen 2

Generation of parasitic harmonics @ 2.4 GHz

Wi-Fi and Bluetooth antenna desense* (Wi-Fi and Bluetooth frequency carrier = 2.4 GHz)

Increase Bit Error Rate and/or increase the power consumption of the RF chain

Common Mode filter needed

Best solution ECMF™

Need for common-mode filtering solution

External connector

Vulnerable to ESD

Connector controller internal ESD HBM protection are not enough

External ESD protection solution needed (IEC 61000-4-2)

Need for ESD protection solution

*More on antenna desense and ECMF™ here
Embedded ESD protection

ESD protection

CMF
(Common-mode filter)

Low-dispersion semiconductor process
Advanced technology for optimized performances
Very small size
High and deep rejection
Low-clamping voltage

ECMF™
ECMF™ for USB Type C Alternate Mode
Compatible with USB-PD*

<table>
<thead>
<tr>
<th>Pin</th>
<th>P/N</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSTx / SSRx</td>
<td>ECMF04-4HSWM10</td>
<td>2</td>
</tr>
<tr>
<td>V_{BUS}</td>
<td>ESDA13P70-1U1M</td>
<td>1</td>
</tr>
<tr>
<td>CC1</td>
<td>ESDALC5-1BF4</td>
<td>4</td>
</tr>
<tr>
<td>CC2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBU1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBU2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dp/Dn</td>
<td>ECMF02-2HSMX6</td>
<td>1</td>
</tr>
<tr>
<td>Audio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to USB3.1 Gen 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USB-PD*</td>
<td>Yes, 12V</td>
<td></td>
</tr>
<tr>
<td>Display Port</td>
<td>Up to DP.1.3</td>
<td></td>
</tr>
<tr>
<td>Thunderbolt</td>
<td>Up to TBT Gen 1</td>
<td></td>
</tr>
</tbody>
</table>

Best integrated solution to avoid antenna desense

*USB-PD: USB Power Delivery. More here

Click to know more about ECMF™
No impact on the signal integrity of USB 3.1, Display Port and more

Improve antenna sensibility

Protect transceivers against overvoltages

HDMI 2.0 4K/2K Eye Diagram

Eye diagram PASSED

S21dd Measurement

Wide rejection from 1 to 6 GHz

S21cc Measurement

Attenuation:
-28 dB @ 2.4 GHz
-16 dB @ 5 GHz
-15 dB from 1 to 6 GHz

ESD measurement +8 kV contact

Surge voltage $V_i$ at 30 ns

+8 kV 13.1 V

Low-clamping voltage
EMI filtering & ESD protection for USB datalines

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

+ Common-mode filter (ECMF)

USB 2.0

Data rate (bit/s)

10G

USB 3.1
Gen 2

ECMF04-4HSWM10
4 x ESD + 2 x CMF
QFN (2.60 x 1.35 x 0.5 mm)

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

ESDARF02-1BU2CK
1-line ESD
ST0201
(0.6 x 0.3 x 0.3 mm)

ECMF02-2AMX6
3 x ESD + 2 x CMF
QFN (1.70 x 1.50 x 0.5 mm)

USBULC6-2P6
2-line ESD + VBUS 6 V
SOT-666 (1.6 x 1.6 x 0.53 mm)

ECMF02-2HSMX6
2 x ESD + 2 x CMF
QFN (1.70 x 1.50 x 0.5 mm)

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

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

ECMF02-20A42N10
4 x ESD + 2 x CMF
QFN (2.20 x 1.35 x 0.45 mm)

ECMF04-4CMX8
3 x ESD + CMF + VBUS TVS 16 V
QFN (2.60 x 1.35 x 0.5 mm)

ESDARF02-1BU2CK
1-line ESD

Click here to know more about ECMF™
Let’s go further

### Overview information
- USB type-C™ advanced protection quick start guide
- USB 2.0 protection and IPAD™ solutions presentation

### Fundamentals
- USB type-C™ power delivery advanced protection presentation
- IEC 61000-4-5 standard overview  
  Application note #AN4275

### In-depth information
- ESD - IEC 61000-4-2 standard testing  
  Application note #AN3353
- TVS short pulse dynamic resistance measurement ...  
  Application note #AN4022

### Selection & sampling
- Protection devices & integrated EMI filtering selection guide
- USB port protection web product selector
- USB IPAD™ (including ECMF™) web product selector
Thank you