USB Power Delivery
Advanced protection solutions

Fundamentals
Is this presentation suited for you?

Where do you stand with USB Power Delivery?

**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.

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

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

**Overview**

**Fundamentals**

**In depth**
Power over USB

• The success of the USB Battery Charging standard for mobile devices demonstrated the need for a standardized connector to power small devices.

• To power up bigger devices like SSD/HDD, laptops or even screens, it is necessary to reach power up to 100 W.
A new specification

- The USB Power Delivery specification V1.1 was released on May 7, 2015 to address these needs.

- This specification is an extension to the existing USB 2.0, USB 3.1, USB Type-C and Battery Charging specifications covering only the elements required to implement USB Power Delivery.
- 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 the micro-B/AB connector.

<table>
<thead>
<tr>
<th>Profile</th>
<th>5 V</th>
<th>12 V</th>
<th>20 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.0 A, 10 W</td>
<td>1.5 A, 18 W</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2.0 A, 10 W</td>
<td>1.5 A, 18 W</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>3.0 A, 36 W</td>
<td>3.0 A, 60 W</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>5.0 A, 60 W</td>
<td>5.0 A, 100 W</td>
</tr>
</tbody>
</table>
Sources with 100 W operation capability must meet various worldwide safety standards. As such, the continuous output power cannot exceed 100 W and the continuous output current cannot exceed 5 A.

Interpretation of the safety requirements imposed by IEC/UL 60950
More power means more protection

• With USB power capability increasing, the risks of surges and transients must be properly mitigated.

• Portable devices often implement miniature ICs using the thinnest - and more vulnerable - technologies.

• The power sources are not controlled by the portable device manufacturers, so the need to protect power ports is obvious.

Two types of hazards:
• ESD hazards
• Lightning and industrial surges
ESD protection needed ... 

Advanced technology with very thin lithography and gate oxide highly vulnerable to ESD

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

IC manufacturers reluctant to use robust embedded ESD protection diodes that would require a significant active area of their advanced and expensive technology.

USB transceivers, controllers ...
Experiments and measurements have demonstrated that the current waveform of a lightning strike or switching noise has a rise time close of 8 µs to reach the peak.

==> The IEC/UL 61000-4-5 has provided a standardized current waveform called 8/20 µs waveform modeling lightning stresses or switching noise.

The key performance factor for a \( V_{\text{BUS}} \) protection is the clamping voltage versus 8/20 µs surges (IEC/UL 61000-4-5 standard)
### ESD PROTECTION
- IEC/UL 61000-4-2 Level 4 (+8 kV contact)

### ESD & EOS PROTECTION
- EN 55024 / CISPR 24 (I_{pp} 8/20μs > 59 A)
- IEC/UL 61000-4-5

#### SMALLEST
- **ESDALC20-1BF4**
  - $V_{CL} @ 30\,\text{ns} = 37\,\text{V}$
  - $I_{pp} = 2.4\,\text{A}$, $P_{pp} = 90\,\text{W}$
- **ESDALC14-1BF4**
  - $V_{CL} @ 30\,\text{ns} = 18\,\text{V}$
  - $I_{pp} = 5\,\text{A}$, $P_{pp} = 100\,\text{W}$
- **ESDA5-1BF4**
  - $V_{CL} @ 30\,\text{ns} = 11\,\text{V}$
  - $I_{pp} = 10\,\text{A}$, $P_{pp} = 110\,\text{W}$

#### HIGH POWER DENSITY
- **ESDA13P70-1U1M**
  - $V_{CL} 8/20\,\mu\text{s} = 20\,\text{V}$
  - $I_{pp} = 70\,\text{A}$, $P_{pp} = 1300\,\text{W}$
- **ESDA13P60-1U1M**
  - $V_{CL} 8/20\,\mu\text{s} = 12\,\text{V}$
  - $I_{pp} = 60\,\text{A}$, $P_{pp} = 700\,\text{W}$

#### STRONGEST
- **SMM4F24A**
  - $V_{CL} 8/20\,\mu\text{s} = 58\,\text{V}$
  - $I_{pp} = 60\,\text{A}$, $P_{pp} = 2300\,\text{W}$
- **SMM4F13A**
  - $V_{CL} 8/20\,\mu\text{s} = 24\,\text{V}$
  - $I_{pp} = 85\,\text{A}$, $P_{pp} = 2300\,\text{W}$
- **SMM4F12AVCL**
  - $V_{CL} 8/20\,\mu\text{s} = 20\,\text{V}$
  - $I_{pp} = 100\,\text{A}$, $P_{pp} = 2200\,\text{W}$
- **SMM4F6.0A**
  - $V_{CL} 8/20\,\mu\text{s} = 10\,\text{V}$
  - $I_{pp} = 170\,\text{A}$, $P_{pp} = 2300\,\text{W}$

#### Package & Size
- **0201**
  - 0.9 mm x 0.3 mm
- **1610**
  - 1.6 mm x 0.55 mm
- **STmiteFLAT**
  - 3.80 mm x 0.85 mm
**Small but robust**
- Can withstand 30 kV contact discharge ESD strikes
- A high transient current ($I_{PP}$ 60 A for 8/20 μs) in a small 1.6 mm² package.

**USB transceiver is safe!**
- This product is able to keep the overvoltage at 11.6 V while shunting 60 A to the GND.

**Strong even at high temperature**
- Peak pulse power guaranteed up to 150 °C.

**Electrical parameters**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{BR}$</td>
<td>$I_R = 1$ mA</td>
<td>6.4</td>
<td>6.8</td>
<td>7.2</td>
<td>V</td>
</tr>
<tr>
<td>$I_{RM}$</td>
<td>$V_{RM} = 5$ V</td>
<td></td>
<td></td>
<td>200</td>
<td>nA</td>
</tr>
</tbody>
</table>

Constant $P_{PP}$ guaranteed over $T^\circ$
Let’s go further

**Overview information**
- USB type-C™ advanced protection quick start guide
- USB2.0 protection and IPAD™ solutions presentation

**Fundamentals**
- USB type-C™ dataline 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