STM32 USB Type-C™ Port Manager

Certified Software Pack eases Migration to USB-PD 3.0 Power Delivery
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Why to use USB-C and Power Delivery Technology?

**USB Type-C connector enhances user experience**
- It’s a 24-pin miniature and reversible connector. USB-C cable has same plug as both ends
- Some pins can be repurposed to support proprietary protocols (Alternate Modes)
- 15W of power can transit natively without USB PD protocol

**To exchange more data faster with various protocols**
- 2 separates USB data paths are available simultaneously: USB 2.0 + USB 3.1 (up to 10Gbit/s)
- Display Port, HDMI, MHL, Thunderbolt are supported to carry video/audio signals
- Conventional I²C/SPI/UART/Ethernet interfaces can be “bridge” to USB-C

**To get more power with a comprehensive and robust protocol**
- **USB Power Delivery** protocol enables power negotiation (up to 100W)
- It allows to discover power capabilities and needs between two USB-C connected devices
- It enables advanced voltage and current negotiation to support fast charging
- USB PD is used to activate Alternate Modes or to carry Authentication messages

**To protect your application and extend its functionalities**
- Identification of genuine chargers or accessories using USB PD authentication messages
- USB PD Alternate Modes and Vendor Defined Messages enable product differentiation.
- Secure firmware upgrade capability
Purpose of CC1/CC2 wires (Configuration & Communication channels)

- Attach/detach and role management (SNK,SRC,DRP) between two USB-C devices
- Discover and configure $V_{bus}$
- Discover and configure $V_{conn}$
- Resolve cable orientation and twist connections to establish USB data bus routing
- Discover and configure optional Alternate and Accessory modes (USB PD)
USB Power Delivery is a Protocol!

To enhance user experience safety thru innovation

To get more power in a robust and safe way!

- Enables advanced and higher voltage and current negotiation (up to 100W)
- Source and Sink establish power contracts that match with their power capabilities and needs (ex : technology of battery used, power budget allocation, number of ports etc)
- Supply voltage ($V_{bus}$) is fixed (5V,9V,15V,20V) or configurable (Programming Power Supply)
- Dual Role Power devices can swapped power direction (ex : tablet charging a Notebook !)

To extend devices functionalities and create an unique differentiation!

- Use of USB PD Structured Vendor Defined Messages (VDMs) to extend the functionality a device exposes

<table>
<thead>
<tr>
<th>Mode of operation</th>
<th>Nominal voltage</th>
<th>Maximum current</th>
<th>Maximum power</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB PD</td>
<td>Configurable</td>
<td>5 A</td>
<td>100 W</td>
</tr>
<tr>
<td>USB Type-C Current @ 3.0 A</td>
<td>5 V</td>
<td>3.0 A</td>
<td>15 W</td>
</tr>
<tr>
<td>USB Type-C Current @ 1.5 A</td>
<td>5 V</td>
<td>1.5 A</td>
<td>7.5 W</td>
</tr>
<tr>
<td>USB BC 1.2</td>
<td>5 V</td>
<td>Up to 1.5 A</td>
<td>7.5 W</td>
</tr>
<tr>
<td>Default USB Power</td>
<td>USB 3.2</td>
<td>5 V</td>
<td>4.5 W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,500 mA (x2)</td>
<td>7.5 W</td>
</tr>
<tr>
<td></td>
<td>USB 2.0</td>
<td>5 V</td>
<td>2.5 W</td>
</tr>
</tbody>
</table>

5 V 900 mA (x1)
**Typical Use-cases**

**Terminology**

**Power roles**
- Source/Provider: Provide power
- Sink/Consumer: Consume power
- DRP: Dual Role Power (can be either Sink or Source)

**Data roles**
- DFP: Downstream Facing Port (usually a Host / HUB ports)
- UFP: Upstream Facing Port (usually a device)
- DRD: Dual-Role Data - typical of “on-the-go” ports

**Power role and Data role can swap!**
Roles can be dynamically swapped using USB PD

**Alternate Mode capabilities enabled via USB PD**
Value Proposition

Adding USB-C to your design has never been so easy!

- Add-on USB IF certified software pack X-CUBE-USB-PD for implementing a Type-C Port Manager (TCPM) on any Arm® Cortex®-based STM32 Microcontroller
- Optimized hardware/software partitioning involving standard Type-C port Controller (TCPC) or STUSB1602
- Lowest design and validation effort
X-CUBE-USB-PD Software Pack

Enables any STM32 to handle USB-C and Power Delivery

- X-CUBE-USB-PD complies with:
  - USB-C 1.3 and **USB PD 3.0** specifications
  - Type-C Port Controller Interface specification (TCPCi)

- Hardware architecture supported:
  - Any STM32 as **TCPM** with standardized **TCPC** from 3rd parties (Our stack has been tested with ON Semiconductor® FUSB307B, a USB-PD 3.0 v1.1-certified TCPC)
  - Or STM32F0 with STUSB1602 Type-C interface

- Single-or multi-port supported (Sink, Source, Dual Role Power)

- Optional features such as Programming Power Supply (PPS), Authentication messages and Fast Role Swap (FRS) are supported

TCPM stands for Type-C Port Manager
TCPC stands for Type-C Port Controller
Benefits of TCPM / TCPC Split

Optimized HW/SW partitioning for single- or multi-port

- The STM32 provides a high customization and flexibility to manage power policy, application layers, and to support evolution of the standard faster.

- TCPCI interface provides a low pin count interconnect using Fast-Mode Plus i²C (1 MHz) bus, plus one alert line, and a comprehensive set of TCPC registers making stack porting across STM32 platform easier.

- TCPC provides the “Power Path” and integrate components with fast latency requirements as well as USB-C/PD PHY, $V_{\text{conn}}$, dead battery and protection.
Docking Station

Typical Block Diagram

Example: gaming console or Smartphone

USB-C port n°2: DRP + Alt Mode

USB-C port n°1: Sink

- Port 1 negotiates power contracts with external USB-C power adapter.
- Port 2 supplies plugged accessory and handle HDMI signals request when TV detected, or USB devices inserted into legacy USB connectors.
Power Bank

Typical Block Diagram
• X-CUBE-USB-PD Expansion Software package includes:
  • USB PD “core” library for Cortex™-M0/M4 based devices (STM32F0/F4/L4/F3)
  • Open-source drivers to support TCPC devices and STUSB1602
  • Firmware examples (Provider, Consumer, Dual Role Power) for MDK-ARM, IAR-EWARM and SW4STM32 IDEs

• Key features:
  • Device Policy Manager, Policy Engine and Protocol Layer
  • Cable detection and orientation
  • Supports Vendor-Defined Messages (Alternate Modes)
  • Billboard driver
  • SOP’ and SOP” for communication with cables

<table>
<thead>
<tr>
<th>Typical TCPM Memory Footprint (no VDM, no Vconn)</th>
<th>Source or Sink only</th>
<th>Dual Role Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 port (w/o RTOS)</td>
<td>32 Kbytes in Flash</td>
<td>40 Kbytes in Flash</td>
</tr>
<tr>
<td></td>
<td>3.6 Kbytes in RAM</td>
<td>3.6 Kbytes in RAM</td>
</tr>
<tr>
<td>2 port (w/RTOS)</td>
<td>32 Kbytes in Flash</td>
<td>43 Kbytes in Flash</td>
</tr>
<tr>
<td></td>
<td>7.8 Kbytes in RAM</td>
<td>8.1 Kbytes in RAM</td>
</tr>
</tbody>
</table>
ON-FUSB3-STM32

TCPM/TCPC evaluation board

Main features

- 1 USB Type-C port
- SINK, SOURCE, DRP capability
- STM32F072CBT6, 32-bit Arm® Cortex®-M0 MCU as TCPM
- ON Semiconductor® FUSB307B Type-C port controller
- On board power management and dedicated power connector to interface with an external power supply
- Link to order one kit (149$ range)
Learn more

www.st.com/x-cube-usb-pd