STM32G0
The world’s first USB-C™ & Power Delivery 3.0 MCU
Why use USB-C™ and Power Delivery technology?

**USB Type-C™ connectors enhance the user experience**
- It's a 24-pin miniature and reversible connector. USB-C plug is the same on both sides.
- Some pins can be repurposed to support proprietary protocols (Alternate Modes).
- Able to transmit 15W of power natively without USB PD protocol.

**To exchange more data faster with various protocols**
- 2 separate USB data paths are available simultaneously: USB 2.0 + USB 3.1 (up to 10 Gbit/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 100 W).
- Able to discover power capabilities and needs between two USB-C™ connected devices.
- 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**
- Identify genuine chargers or accessories using USB PD authentication messages.
- USB PD Alternate Modes and Vendor Defined Messages enable product differentiation.
- Secure firmware upgrade capability.
USB Power Delivery is a protocol!

To safely enhance user experience through innovation

To get more power in a robust and safe way!
- Enables advanced and higher voltage and current negotiation (up to 100 W)
- Source and Sink establish power contracts that match 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, or 20V) or configurable (Programming Power Supply)
- Dual Role Power devices can swap power direction (ex: using a tablet to charge a notebook!)

To extend devices functionalities and create an unique differentiation!
- Use of USB PD Structured Vendor Defined Messages (VDMs) to extend functionalities (video output, authentication, etc.)

<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>900 mA (x1) 1,500 mA (x2)</td>
<td>4.5 W 7.5 W</td>
</tr>
<tr>
<td></td>
<td>USB 2.0</td>
<td>500 mA</td>
<td>2.5 W</td>
</tr>
</tbody>
</table>
Many combinations

**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

**Terminology**
- **Alternate Mode capabilities enabled via USB PD**
- **Authentication**
- **Fast charging using PPS**
The world’s First conventional MCU with built-in USB-C and PD interfaces

- Harness to the innovative features of USB-C™ technology with a standard microcontroller.
- Get more “power” and support new use-cases with USB Power Delivery
- Create differentiation features (authentication, fast charge, FW upgrade)

* UCPD stands for USB Type-C and Power Delivery Interface
Smart integration

- **UCPD** is a new interface that supports:
  - USB Type-C connector management
  - USB Power Delivery r3.0 communication protocol

- First implementation in STM32G0 series
High flexibility

Sink, Source and Dual Role Power roles supported

Dual Port - Certified* Solution

- Cortex®-M0+ STM32 platform
- Up to 2 built-in USB-C & PD3.0 interfaces
- 128 Kbytes of Flash – 36 Kbytes of SRAM
- Versatile analog and digital peripherals
- 28,32,48,64-pin packages available

(*): USB-IF TID 227
STM32G0 UCPD manages the Configuration & Communication channels (CC lines) allowing:

1. Type-C Control
2. USB PD communication

STM32G0

24-pin USB-C receptacle

Make connectivity easier

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Make connectivity easier
Optimized partitioning

Source (charger)
- Device Policy Manager
- Source Port
- Policy Engine
- Protocol
- USB-C Control
- Physical Layer
- Power Source(s)
- BMC
- USB Port
- CC
- $V_{bus}$

Sink (device)
- Device Policy Manager
- Sink Port
- Policy Engine
- Protocol
- Physical Layer
- USB-C Control
- Power Source(s)
- BMC
- USB Port
- CC
- $V_{bus}$
Built-in features

**USB-C™ control**
- Built-in Rp/Rd resistors
- CC logic control (CC PHY)
- CC lines voltage monitoring
- Dead battery resistors
- Fast Role Swap signaling

- **enabling**
  - Attach/detach and role management (SNK, SRC, DRP)
  - Resolve cable orientation and twist connections to establish USB 2.0 /USB 3.x data bus routing
  - Discover and configure VBUS or VCONN

Integration value represents $0.15

**USB PD**
- PD transceiver PHY
- Digital BMC
- CRC encoding/decoding

- **enabling**
  - Power contract negotiation (up to 100W)
  - Power or USB data Role swap
  - Alternate mode through Vendor Define Messages
  - PPS, Firmware upgrade, Authentication messages

15W max (5V/3A)  
100W max
Typical block diagram
Example: multi-port docking station

- 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.
STM32G0 MCU is PD3.0 compliant device and it supports all PD3.0 features:
- Collision avoidance
- Fast role swap (FRS)
- Programming Power Supply (PPS)
- FW upgrade via CC lines
- Authentication via USB PD
More security

Integrated security features, ready for tomorrow’s needs

Firmware IP protection
Mutual distrustful
Secret key storage
Secure firmware upgrade

Authentication

STM32G0

User flash

Securable Memory Area
Execute-only Protection
Read-out Protection
Write Protection
Memory Protection Unit (MPU)
AES-256 / SHA-256 Encryption
True Random Number Generator
Unique ID

STM32

Standard user flash by default
Can be secured once exiting
No more access nor debug

Configurable size

Good fit to store critical data
- Critical routines
- Keys
USB-C authentication ready

Verify that the device is genuine & embeds the expected profile

- Security messages carry via USB PD3.0
- Compliant solution with timing constraints
- Flexible authentication library.
- Initiator and Responder mode supported
- Secret keys storage in securable memory area or external secure-micro (ST-SAFE)
Smart ecosystem for short time-to-market

Discover and learn
STM32G071B-DISCO

Develop
STM32G081B-EVAL
NUCLEO-G071RB

Configure and Debug
- STM32CubeMX
- STM32CubeMonitor-UCPD
Master platform

STM32G071B-DISCO
USB-C Discovery Kit

STM32G081B-EVAL
Evaluation board with USB-C daughter board
- USB-C N°1: DRP / 45W,
- USB-C N°2: USB-C adapter to type-A and Display Port
STM32G071B-DISCO

Discovering USB-C

- Discover and display USB-C™ power and feature capabilities of any host.
- Analyze and sniff USB PD data packets and display $V_{BUS}$ voltage, $I_{BUS}$ current
- Debug, configure and inject USB PD3.0 packet using STM32CubeMonitor-UCPD.
Easy configuration

Device selection and peripherals configuration (port 1 or 2 and role of each port: SNK, SRC, DRP)

USB-PD middleware parameters settings

Visit STM32Cube Ecosystem webpage

Code generation
Easy debug with stm32cubemonucpd

PC Software GUI to display and configure parameters of USB PD Middleware

https://www.st.com/STM32CubeMonUCPD
USB IF-certified solution

Note: Our STM32G0/UCPD solution has successfully passed the USB-IF Test Procedure for PD 3.0 Controller Silicon || PD 3.0 Power Brick || PD 3.0 Power Bank, and it’s posted on the USB-IF Integrator’s List. During the certification workshop our STM32G0 evaluation board (Port 1 / DRP role) has been used.
Easy configuration

Device selection and peripherals configuration (port 1 or 2 and role of each port: SNK, SRC, DRP)

USB-PD middleware parameters settings

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FREE TOOL!

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Certified software pack eases migration to USB-PD 3.0 Power Delivery
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, and Dual Role Power)

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

Compliant with USB Type-C™ 1.3 and USB PD 3.0 specifications

- 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
STM32F072 type-c port manager evaluation board

TCPM/TCPC evaluation board

Main features
- 1 USB Type-C port
- Sink, Source, and 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)
• Getting started video with USB type-C and STM32G0 ecosystem: [YouTube]
• STM32G0 Entry-level Arm® Cortex®-M0+ MCUs webpage: link
• STM32G0 Discovery kit for USB Type-C™ and Power Delivery (STM32G071B-DISCO) Databrief: [PDF]
• STM32CubeMonUCPD Monitoring and configuration software tool for STM32 USB-C and Power Delivery 3.0 applications webpage: link
• STM32G0 Online Training: link and a specific training on STM32G0 UCPD interface here
• Application note AN5225: USB Type-C™ Power Delivery using STM32xx Series MCUs and STM32xxx Series MPUs: [PDF]
• USB Power Delivery on STM32 expansion software for STM32Cube (X-CUBE-USB-PD) webpage: link
• Single-chip USB type-C port protection IC (TCPP01-M12) webpage: link
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community.st.com

www.st.com/STM32G0-discovery

STM32G0-online-training
Thank you