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**Fast & effective USB Type-C® PD deployment with certified STM32 solutions.**

**No coding required.**



# Agenda

- 1 Introduction to USB Type-C® technology
- 2 Solutions using STM32 UCPD controller
- 3 Development ecosystem
- 4 USB Type-C® solution for Linux-based STM32 MPUs

# Introduction to USB Type-C® Power Delivery technology



# The industry is moving to USB Type-C® for charging embedded devices

Using a single USB Type-C® charging solution for small and medium devices to reduce charging options and e-waste



Universal USB Type-C® charging brings more convenience and a better experience compared to previous USB generation



E-waste and CO2 emission reduction thanks to single USB Type-C® charging solution deployed in the EU



A wide range of products subject to a common charger as part of the radio equipment directive proposal



# Why choose USB Type-C® for embedded devices



## More versatile

- **Reversible, robust** connector, thinner than previous micro-C connector
- **More interoperability:** sink, source or dual role, while being host or device

## More power

- 15 W at 5 V with Type-C only
- **Up to 100 W with USB Power Delivery** (USB PD) 3.1 protocol
- **Extend power range up to 240 W @ 48 V** with USB PD 3.1
- Universal **fast charging capability** with programming power supply (PPS)

## More protocols and speeds

- **Separate channels** for USB 2.0 (LS/FS/HS) and USB 3.x (SuperSpeed)
- **Proprietary protocols supported** (DP, HDMI, Ethernet, Thunderbolt...)

## More protection

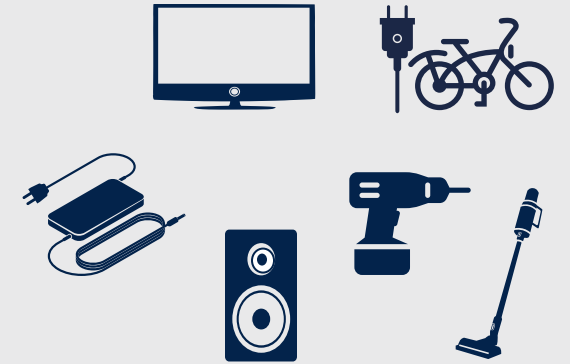
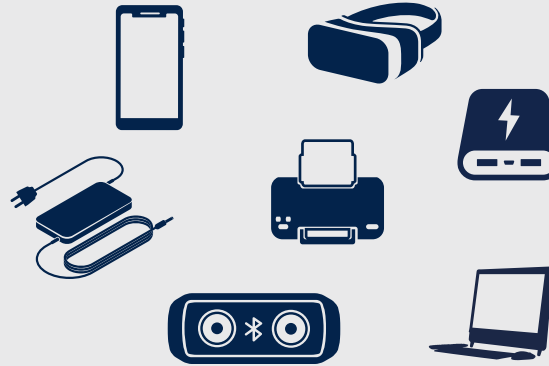
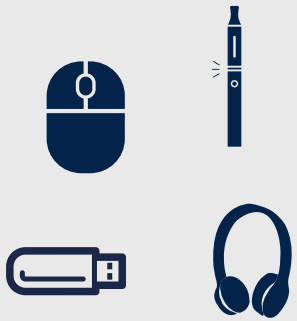
- **Device/source authentication** via USB PD (Vendor define messages)
- Firmware update or **secure firmware install** (SFI)

## Enabling many use cases

- **Power swap** capability (from sink to source or vice versa)
- **USB data swap** capability (from device to host or vice versa as for OTG)

# USB Implementers Forum extends power range up to 240 W

Supply your device with a universal power adapter



## Legacy USB

From 2.5 W  
(5V-0.5A)

## USB Type-C® only

Up to 15 W  
(5V-3A)

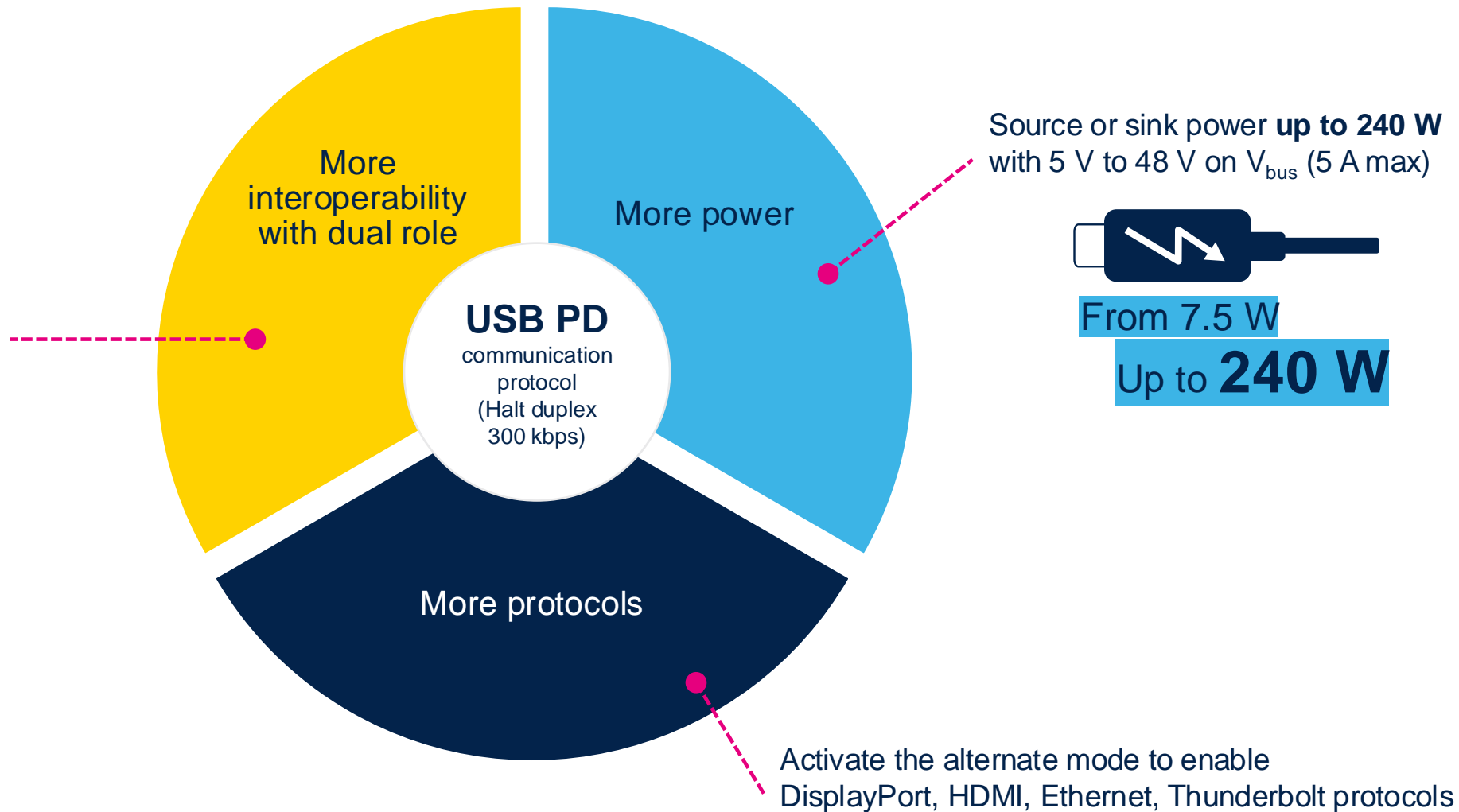
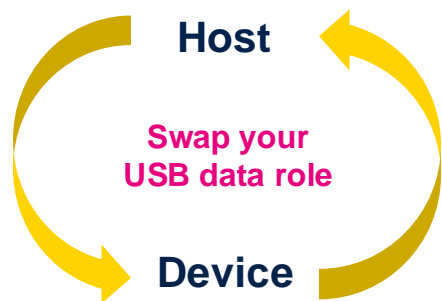
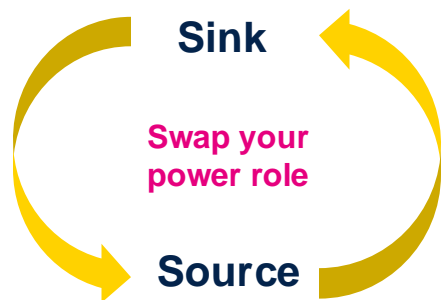
## USB Type-C® & PD3.1 (SPR\*)

Up to 100 W  
9V/15V/20V up to 5A  
(\*standard power range)

## USB Type-C® & PD3.1 (EPR\*\*)

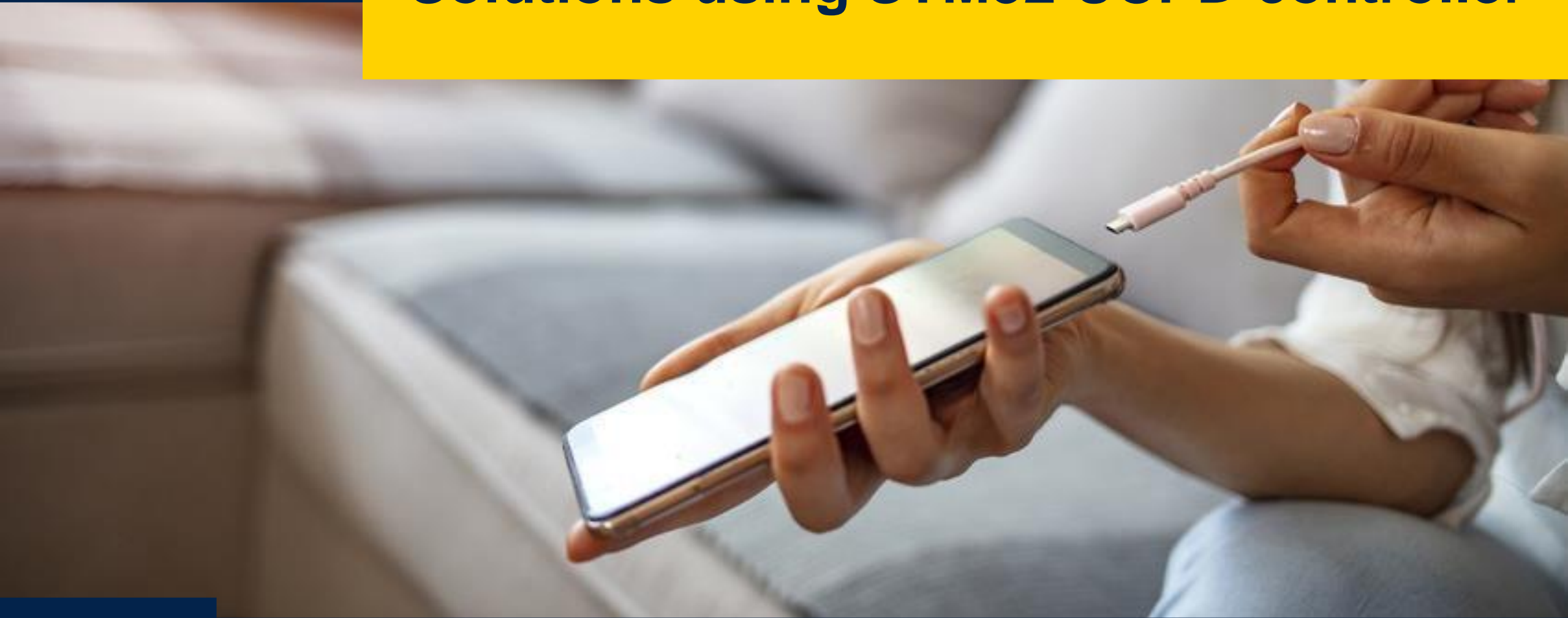
Up to 240 W  
28V/36/48V up to 5A  
(\*\*extended power range)

# More interoperability and use cases





# Solutions using STM32 UCPD controller

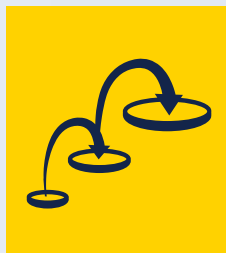






# Saving time, cost, and reducing complexity with STM32

## STM32 with USB Type-C® connector simplifies your design, eliminating the need for an external PD controller



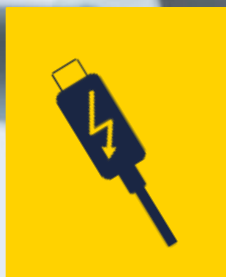
### Fast prototyping without coding

- Ready-to-use hardware and firmware examples
- Code generation for all USB Type-C® roles on STM32
- Easy debug with STM32CubeMonUCPD software tool



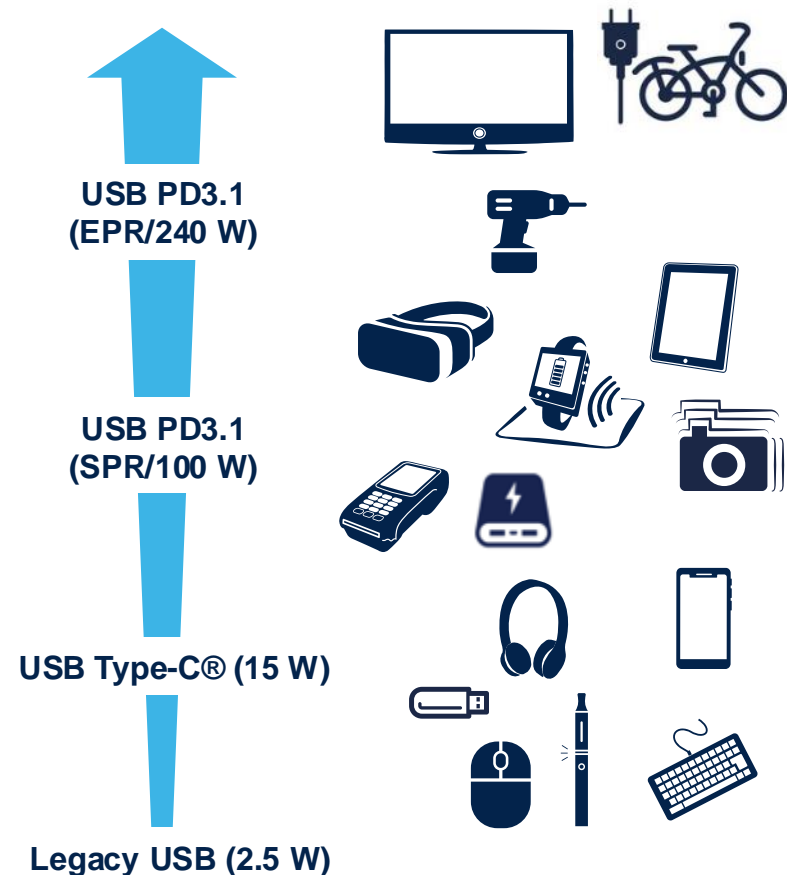
### Optimize bill of material and safety

- CC logic, PD transceiver PHY, USB2 device/host interface
- Companion Type-C Port Protection devices (TCPP0x)



### STM32 supports the latest USB Type-C® and PD3.1 standards

- SPR and EPR(\*) power range up to 240 W, PPS ready. Sink, source, dual-role power and data roles
- UCPD peripheral is USB-IF certified & supports connector management and USB PD r3.1 protocol (SPR, EPR\*, PPS etc.)





# A wide range of STM32 MCUs with UCPD

**More than 730 STM32 MCUs  
feature a certified USB  
Type-C® & PD 3.1 controller**

## **Mainstream microcontrollers**

STM32G0

## **Ultra-low power microcontrollers**

- STM32L5
- STM32U5

## **Mixed-signal microcontrollers**

STM32G4

## **High-performance microcontrollers**

- STM32H5
- STM32H7R/S
- STM32N6 (coming soon)

## **Microprocessors**

- STM32MP2

# UCPD highlights

## Example in STM32G0x1 access line

System	Arm® Cortex®-M0+ CPU	Connectivity
Power supply POR/PDR/PVD/BOR	Up to 64 MHz	3x SPI (I²S)
Xtal oscillator 32 kHz + 4 to 48 MHz	Nested vector interrupt Controller (NVIC)	6x USART (3x with LIN, smartcard, IrDA, modem control)
Internal RC oscillators 32 kHz (±5%) + 16 MHz (±1%)	SW debug	2x LPUART
Internal RC oscillator 48 MHz (auto trimming on ext. synchro)	Memory Protection Unit	3x I²C Fast Mode Plus (2x SMBus, PMBus)
PLL + Prescaler	AHB-Lite bus matrix	2x FDCAN
Clock control	APB bus	USB Power Delivery (UCPD) (incl. BMC + PHY)
RTC/AWU	Up to 512-Kbyte Flash memory	USB2.0 full Speed Dual role (D/H) Crystal less
Systick timer	Up to 144-Kbyte SRAM	
2x watchdogs (independent and window)	Boot ROM	
94 I/Os on 100 pins	12-channel DMA	
Cyclic redundancy check (CRC)		
Encryption	Analog	Control
AES (256-bit)	Temp. sensor	1x 32-bit timer
True RNG	1x 12-bit ADC SAR 16-channels / 2.5 MSPS	1x 16-bit Motor C. timer $f_{max} = 128$ MHz 4 PWM + 3 compl.
	1x 12-bit DAC 2ch	6x 16-bit timers one with $f_{max} = 128$ MHz
	3x comparators	2x Low-power timers

x 2

### UCPD peripheral

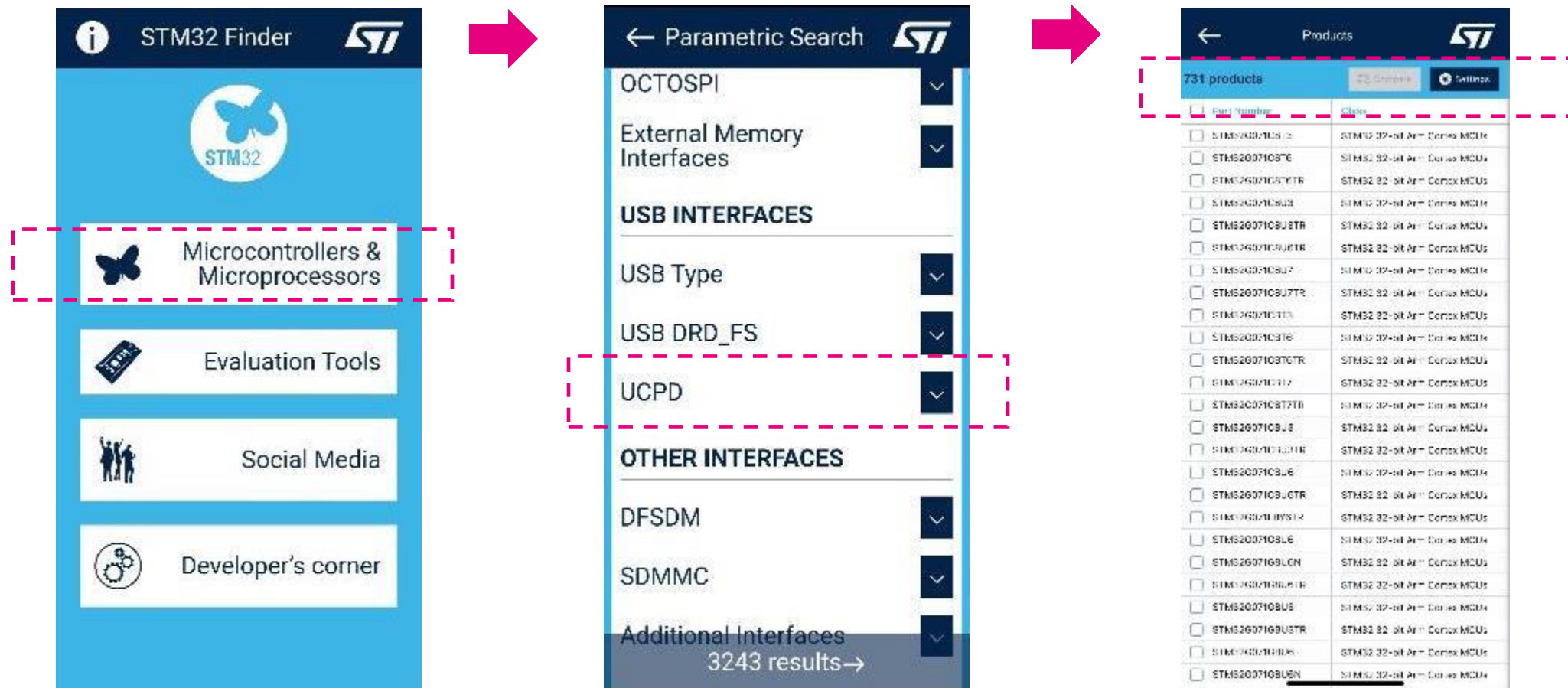
- Dual port USBP3.1 certified solution (TID 227)
- Support sink, source & dual role modes (DRP/DRD)
- CC logic control and voltage monitoring
- Built-in Rp/Rd and dead battery resistors
- USB PD transceiver PHY
- Digital BMC / CRC encoding/decoding
- Support programming power supply (PPS)
- Enable Fast role swap signaling (FRS)

### USB2.0 dual role data interface

- USB2.0 data interface (FS, HS)
- Dual-Role mode supported (Device/Host)
- Crystal-less

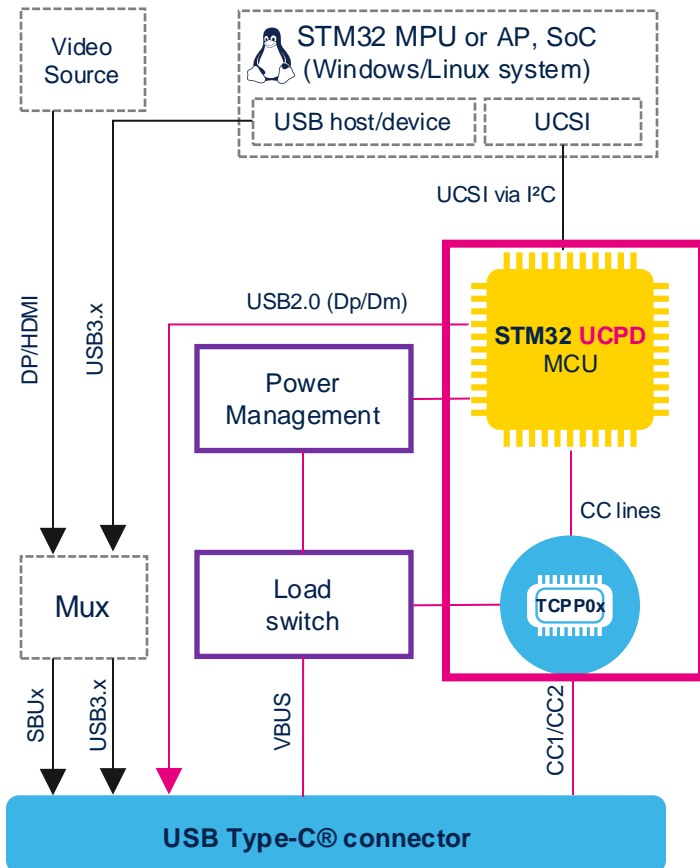
# Use the STM32-FINDER app to quickly find STM32 MCUs with USB interfaces

Our smartphone application **STM32-FINDER** allows you to identify STM32 with a UCPD controller





# Architecture & solutions overview



- Application tasks
- UCSI driver (optional)
- Policy manager
- USB PD stack
- UCPD peripheral

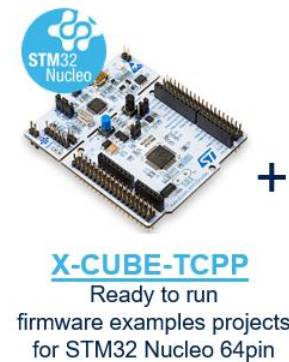
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- ## TCPP0x port protection

- Dead battery
- ESD/OVP protection
- N-gate driver
- OCP\*
- Bus discharge\*

\*when required

## References design



### For SINK/Device

**X-NUCLEO-SNK1M1**  
based on TCPP01-M12



**For DRP/DRD**

**X-NUCLEO-DRP1M1**  
... based on TCPP03-M20

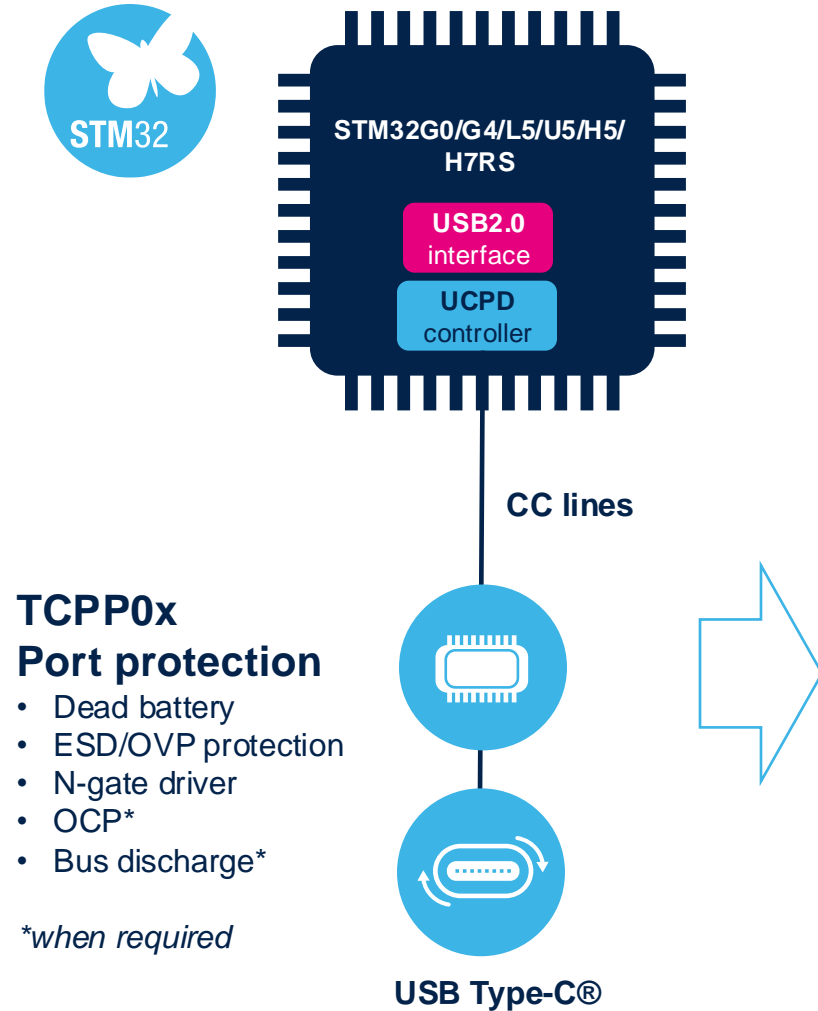


**For SOURCE/Host**

**X-NUCLEO-SRC1M1**  
based on TCPP02-M18

- **UCPD** stands for **USB Type-C®** and **power delivery** controller
- **UCSI** stands **USB Type-C®** connector **system interface**

# Safely connect with high-voltage Port Protection TCPP



		SINK TCPP01-M12	SOURCE TCPP02-M18	DRP TCPP03-M20
CC	ESD $\pm 8$ kV, OVP	✓	✓	✓
	Dead batteries	✓		✓
	V <sub>conn</sub> switch, Over current protection, discharge		✓	✓
V <sub>BUS</sub>	Gate driver	Sink	Source	Sink / Source
	Over Voltage protection	✓		✓
	Over current protection, current sense		✓	Bidirectional
	Discharge		✓	✓

Low pin count package

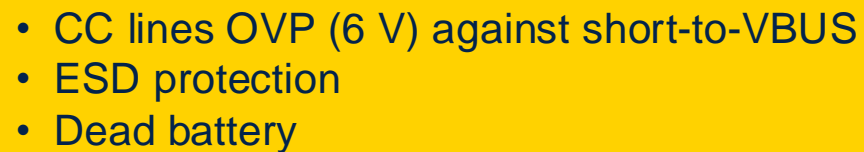
QFN-12L (3x3)

QFN-18L (3.5x3.5)

QFN-20L (4x4)



- VBUS monitoring and protection (OVP)
- Drive VBUS with integrated gate driver

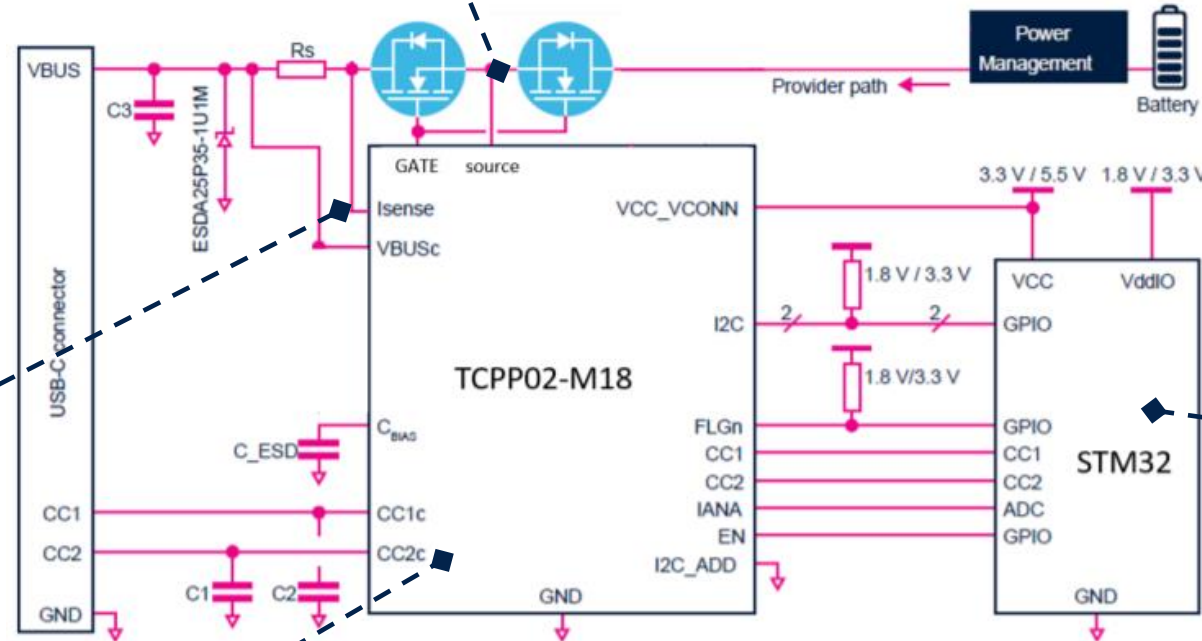




# Typical implementation for source with TCPP02-M18

- VBUS monitoring, OVP/OCP protections
- Integrated gate driver
- Integrated discharge for VBUS and VCONN

- Current sensing

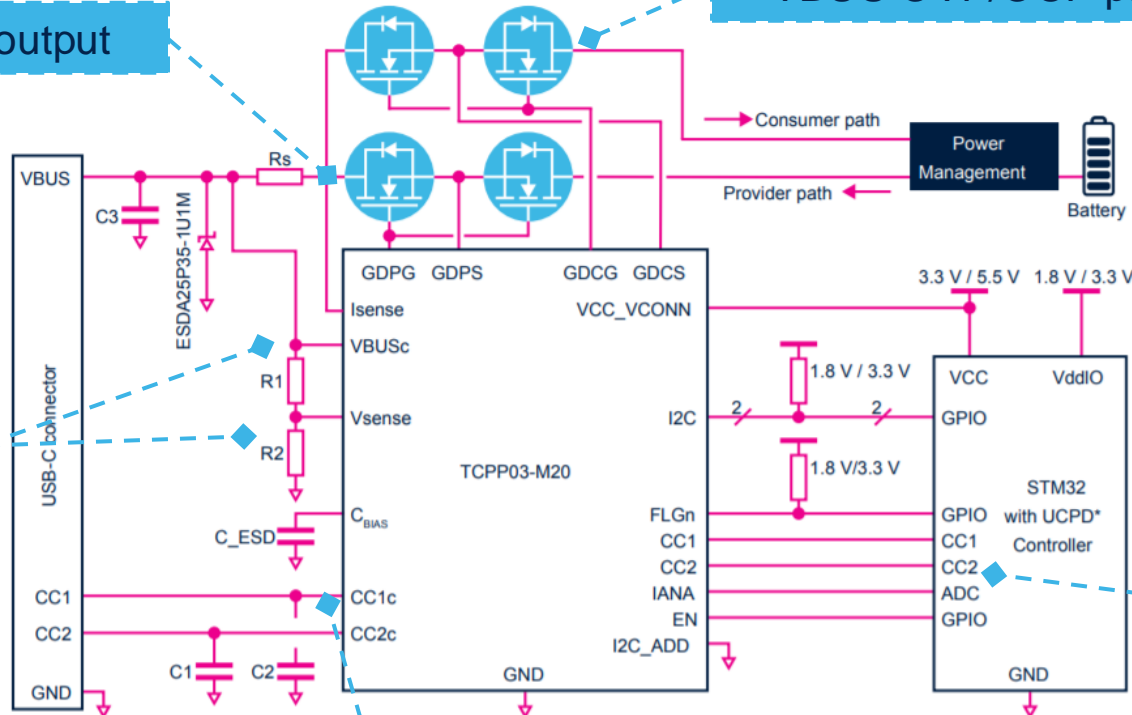


- STM32 UCPD
  - USB Type-C® attachment
  - USB PD stack
  - Application tasks

- CC lines OVP (6 V) against short-to-VBUS
- ESD protection
- Dead battery

- VBUS OVP/OCP protections and gate drivers

- VBUS/VCONN discharge
- VBUS/IBUS monitoring



- ## STM32 UCPD
- USB Type-C® attachment
  - USB PD stack
  - Application tasks

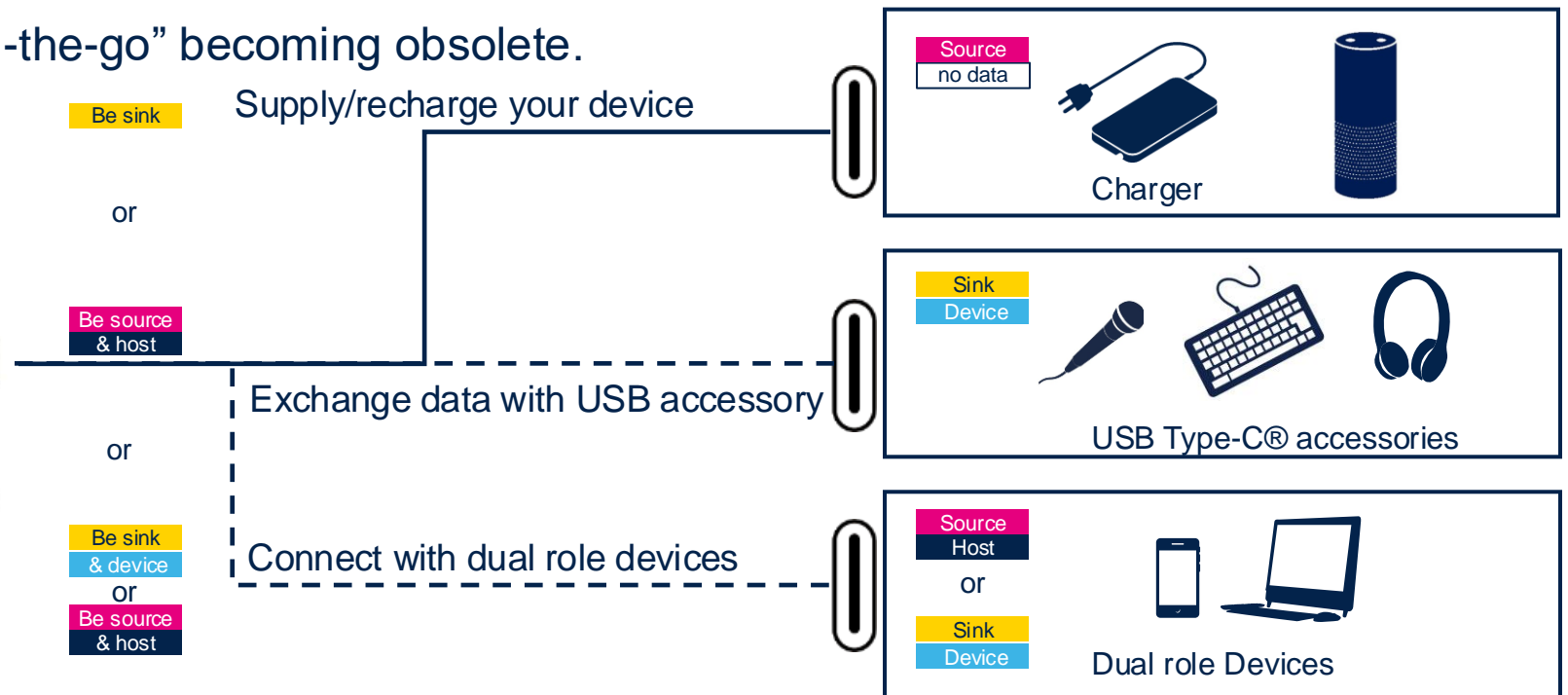
- CC lines OVP (6 V) against short-to-VBUS
- 24 V ESD protection on CC lines
- VCONN OCP (100 mW) and OVP(6 V)
- Dead battery

# Enable dual-role devices

- Dual role devices can act as source or sink (dual role power) while being host or device (dual role data) for USB data communication purposes.
- DRD allows developers to extend interoperability of their device by supporting advanced use-cases.
- Swapping between power and data roles is performed independently by using USB PD swap commands.
- DRD replaces and enhances “on-the-go” becoming obsolete.



STM32H573I-DK discovery kit



# Dual-role device showcase with STM32H7S78-DK



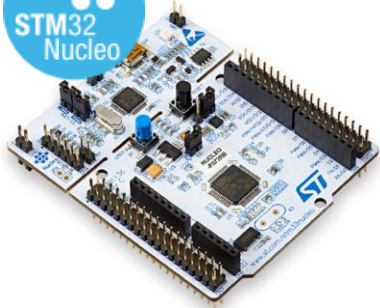
[Watch the demo video](#)

# Development ecosystem





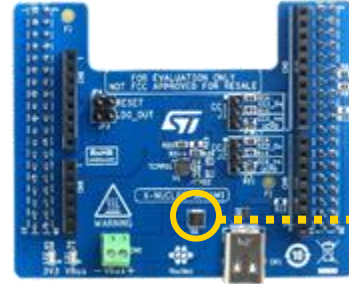
# Quickly evaluate our solutions with STM32 Nucleo USB Type-C<sup>®</sup> expansion boards



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**X-CUBE-TCPP**

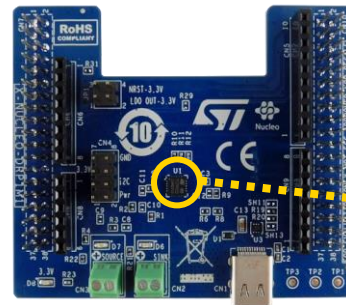
Ready to run  
firmware examples projects  
for STM32G0/G4 Nucleo-64 pin



**For sink/device**

**X-NUCLEO-SNK1M1**

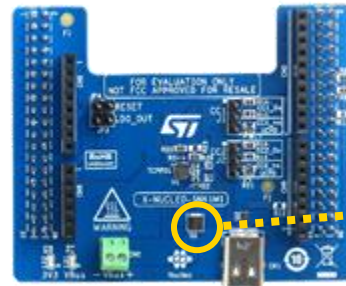
Based on TCPP01-M12



**For DRP/DRD**

**X-NUCLEO-DRP1M1**

Based on TCPP03-M20



**For source/host**

**X-NUCLEO-SRC1M1**

Based on TCPP02-M18



# A no-code solution for your development

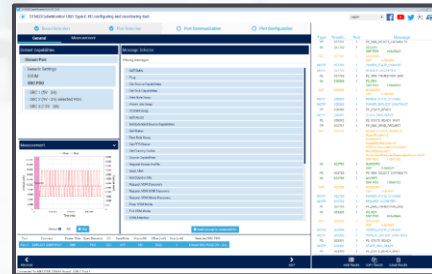
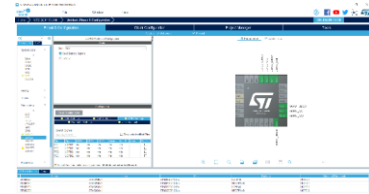


**Video tutorials.** How to use X-CUBE-TCPP software to build:

- [a USB-PD sink application](#)
- [a USB-PD source application](#)
- [a USB-PD dual-role application](#)

## Master USB Type-C®/PD on STM32 without coding

- Selection and configuration of STM32 UCPD peripheral
- Generation of certified USB Type-C® application codes for sink, source, and dual role using STM32CubeMX and [X-CUBE-TCPP software pack](#)



## Debug your application with our monitoring tools.

[STM32CubeMonUCPD](#), a free software monitoring tool for USB Type-C® applications

- Support of USB Type-C® 1.2 and USB PD r3.1
- Port configuration pane for PD setting, VDM, SOP, source, and sink capabilities
- Port communication pane for VBUS and IBUS monitoring, distant port capabilities, message selector, and real-time traces

## [STM32G071B-DISCO](#) is a USB Type-C® and PD sniffer

- Discover, display USB Type-C® power and feature capabilities of any host.
- Sniff USB PD data packets and display Vbus voltage, Ibus current
- Inject USB PD3.1 packet



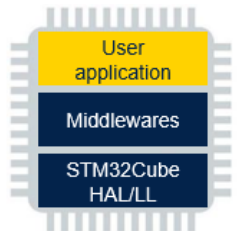


# Reuse our application source codes in your project




## Shorten development time with STM32CubeMCU packages

- USB PD middleware library
- Billboard USB drivers, FreeRTOS™, AzureRTOS ThreadX
- HAL, low-layer APIs CMSIS
- Application examples running on ST boards



## Download links

- [STM32CubeG0](#)
- [STM32CubeG4](#)
- [STM32CubeL5](#)
- [STM32CubeU5](#)
- [STM32CubeH5](#)
- [STM32CubeH7RS](#) 

# Visit our Wiki page on USB Type-C®

Find all the information required for beginners and advanced users



by



[https://wiki.st.com/stm32mcu/wiki/USB\\_Power\\_Delivery\\_overview](https://wiki.st.com/stm32mcu/wiki/USB_Power_Delivery_overview)

# Hardware tools & reference designs

SOLUTIONS	STM32G0	STM32G4	STM32L5	STM32U5	STM32H5	STM32H7RS	STM32MP13
AC/DC USB PD power adapter	<a href="#"><u>STEVAL-USBPD27S</u></a> (27 W / PPS ready) <a href="#"><u>STEVAL-2STPD01</u></a> (2x 60 W)						
USB Type-C® discovery kits	<a href="#"><u>STM32G071B-DISCO</u></a> (USB Type-C® Sniffer/Analyzer)	<a href="#"><u>B-G474E-DPOW1</u></a> 1 port DRP	<a href="#"><u>STM32L562E-DK</u></a> 1 port SNK	<a href="#"><u>B-U585I-IOT02A</u></a> 1 port DRP	<a href="#"><u>STM32H573I-DK</u></a> 1 port DRP/DRD 1 port sink	<a href="#"><u>STM32H7S78-DK</u></a> 1 port DRP 1 port sink	<a href="#"><u>STM32MP135F-DK</u></a> 1 port DRP/DRD UCSI-certified
Evaluation boards	<a href="#"><u>STM32G0C1E-EV</u></a> 1 port 45 W DRP 1 port Sink	<a href="#"><u>STM32G474E-EVAL</u></a> featuring 1 port DRP	<a href="#"><u>STM32L552E-EVAL</u></a> 1 port SNK	<a href="#"><u>STM32U575I-EV</u></a> 1 port DRP			
Nucleo board Nucleo shield	<a href="#"><u>X-NUCLEO-SNK1M1</u></a> <a href="#"><u>X-NUCLEO-DRP1M1</u></a> <a href="#"><u>X-NUCLEO-SRC1M1</u></a>	<a href="#"><u>X-NUCLEO-SNK1M1</u></a> <a href="#"><u>X-NUCLEO-DRP1M1</u></a> <a href="#"><u>X-NUCLEO-SRC1M1</u></a>	<a href="#"><u>NUCLEO-L552ZE-Q</u></a> 1 port SNK	<a href="#"><u>NUCLEO-U575ZI-Q</u></a> 1 port SNK	<a href="#"><u>NUCLEO-H563ZI</u></a> 1 port sink	<a href="#"><u>NUCLEO-H7S3L8</u></a> 1 port DRP	

# 2x60 W PD3.1 dual port power adapter

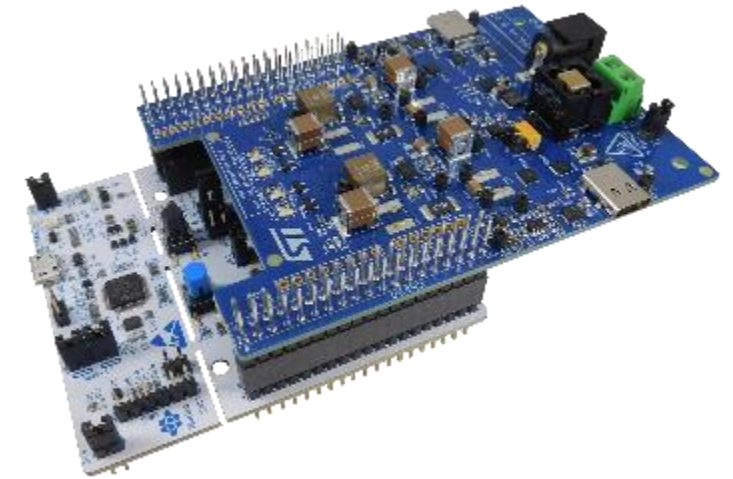
**Based on STM32G0 and STPD01PUR programmable buck converters**

## Key features

- Two USB Power Delivery source ports
- Output power up to 120 W-rated (60 W per port), managed through a power sharing algorithm
- Up to four output PDOs for each port (5 V@3 A, 9 V@3 A, 15 V@3 A, 20 V@3 A)
- Compliant with USB Type-C® 2.1 and PD 3.1 specifications

## Key products

- STM32G071RBT6 MCU embedding two USB PD interfaces.
- Two STPD01PUR DC-DC converters dynamically set by I<sup>2</sup>C, suitable to implement power sharing in USB PD applications
- Two on-board TCPP02-M18 protections for USB Type-C® and PD source applications
- OVP, UVP, OC, short-circuit, and OTP protections

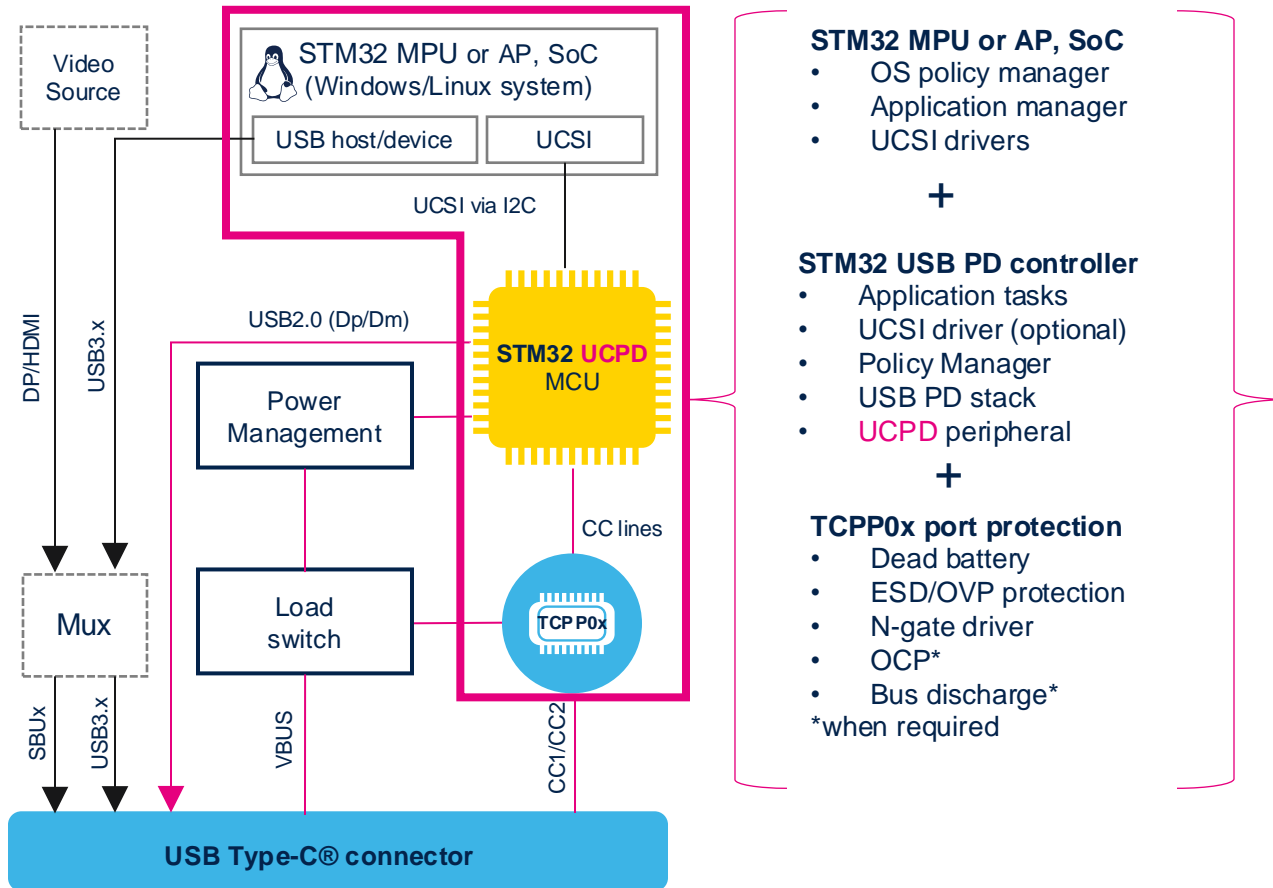


Board: [STEVAL-2STPD01](#)

# USB Type-C® solutions for Linux-based STM32 MPUs



# Architecture & solutions overview



## Reference design

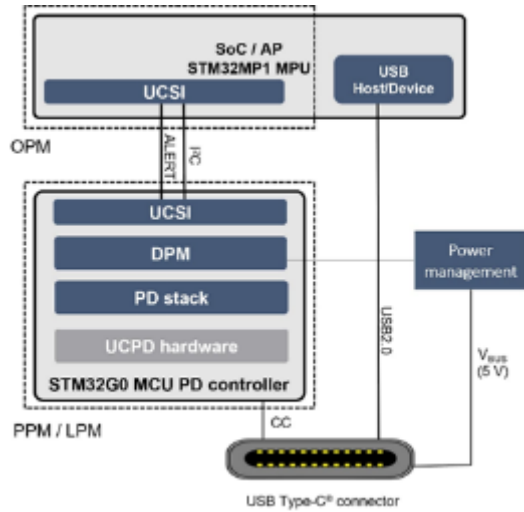


STM32MP135F-DK  
with X-CUBE-UCSI Cube expansion firmware

- UCPD stands for **USB Type-C®** and **power Delivery** controller
- UCSI stands **USB Type-C®** connector **System interface**



# Turnkey UCSI-certified solution



STM32MP135F-DK

## X-CUBE-UCSI

- Allows users to implement USB Type-C® ports in OS-based system
- Compliant with the **USB Type-C®** connector system interface. (UCSI) specification enabling OS (Linux, Windows, Android) to supervise the USB Type-C® ports.

## Reference design

- USB-certified (TID 8088) STM32MP135F-DK discovery board features an STM32MP135 as the main application processor, connected to an STM32G071 MCU as the UCSI PD controller.
- The X-CUBE-UCSI STM32Cube expansion software to build a USB PD dual-role power (DRP) project.



# Releasing your creativity



[/STM32](#)



[@ST\\_World](#)



[USB PD Community](#)



[STM32 solutions for USB Type-C® PD](#)



[wiki.st.com/USBPD](#)



[X-CUBE-TCPP on github.com](#)



[STM32 USB Type-C® & PD solutions](#)



[TCPP product page](#)

# Our technology starts with You



Find out more at [www.st.com/stm32-usb-c](http://www.st.com/stm32-usb-c)

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