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USB type-C port protections

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Product Marketing Manager

Power Discretes

ST PROTECT

USB-C market

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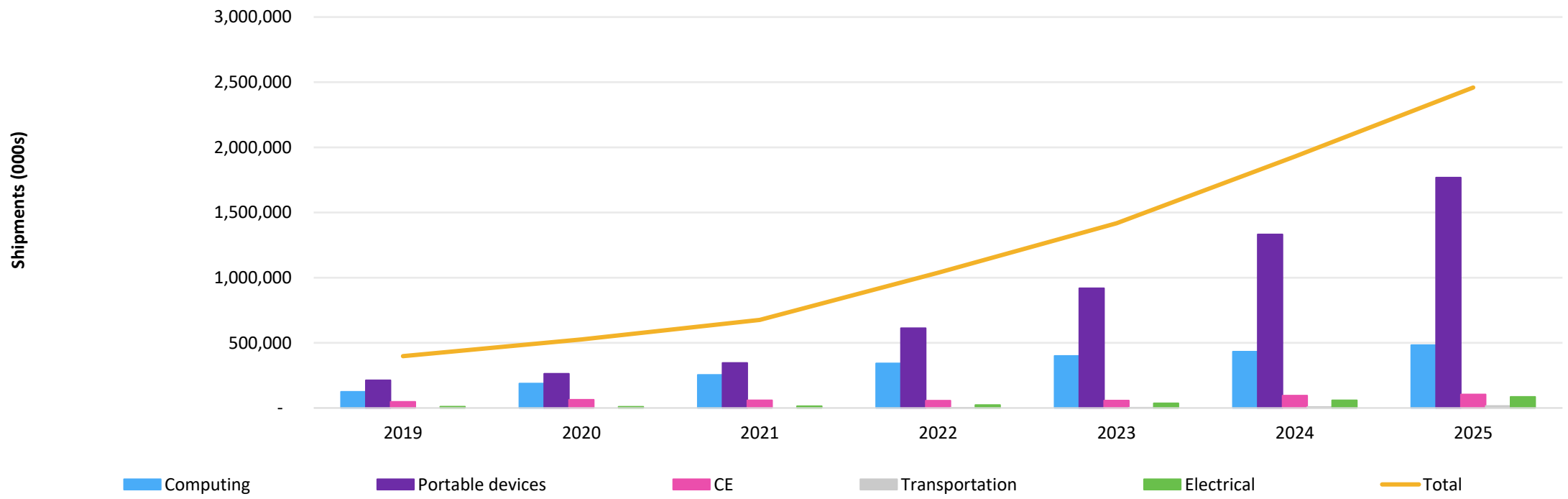
USB-C Power Delivery market

USB-C PD pervasion to Mass Market driven by high volume applications : 1Bu in 2022

Power Delivery shipments by segment



Source: Omdia

- Universal connector offers a simple solution
- USB type C allows to move from 7.5W (USB type A connector) to 100W with Standard Power Range

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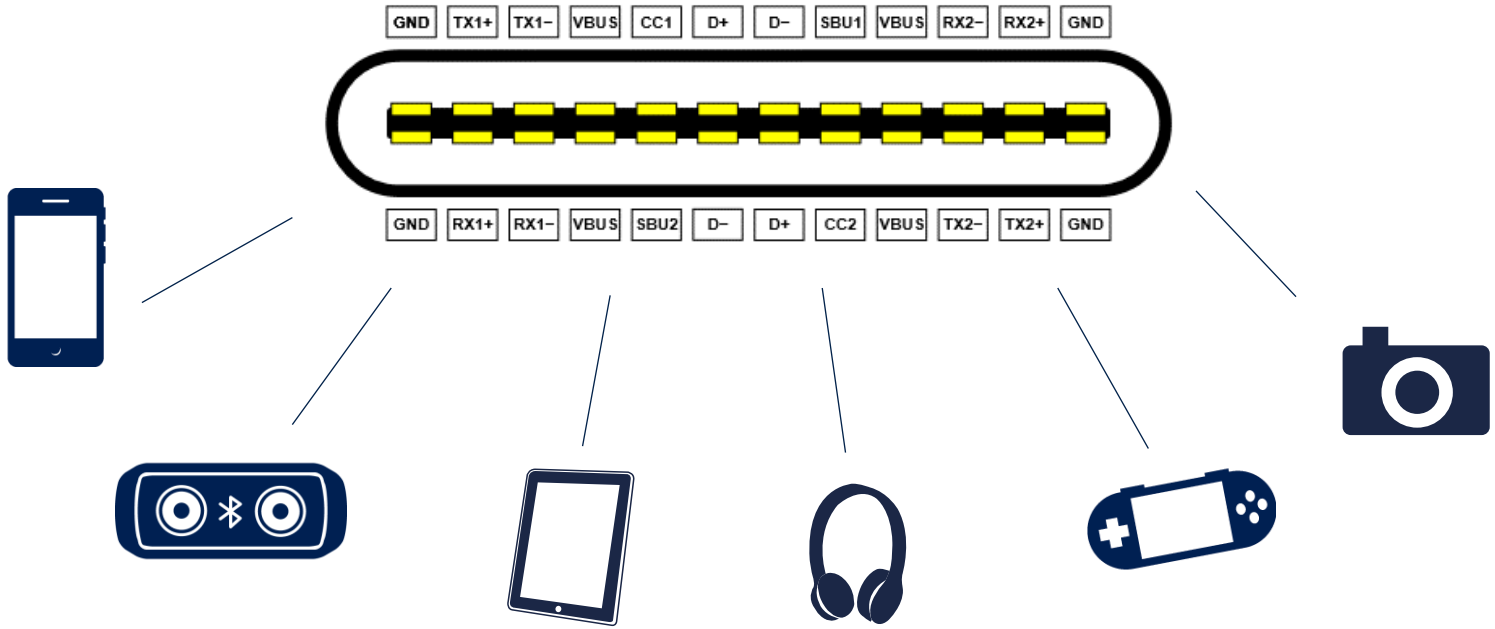
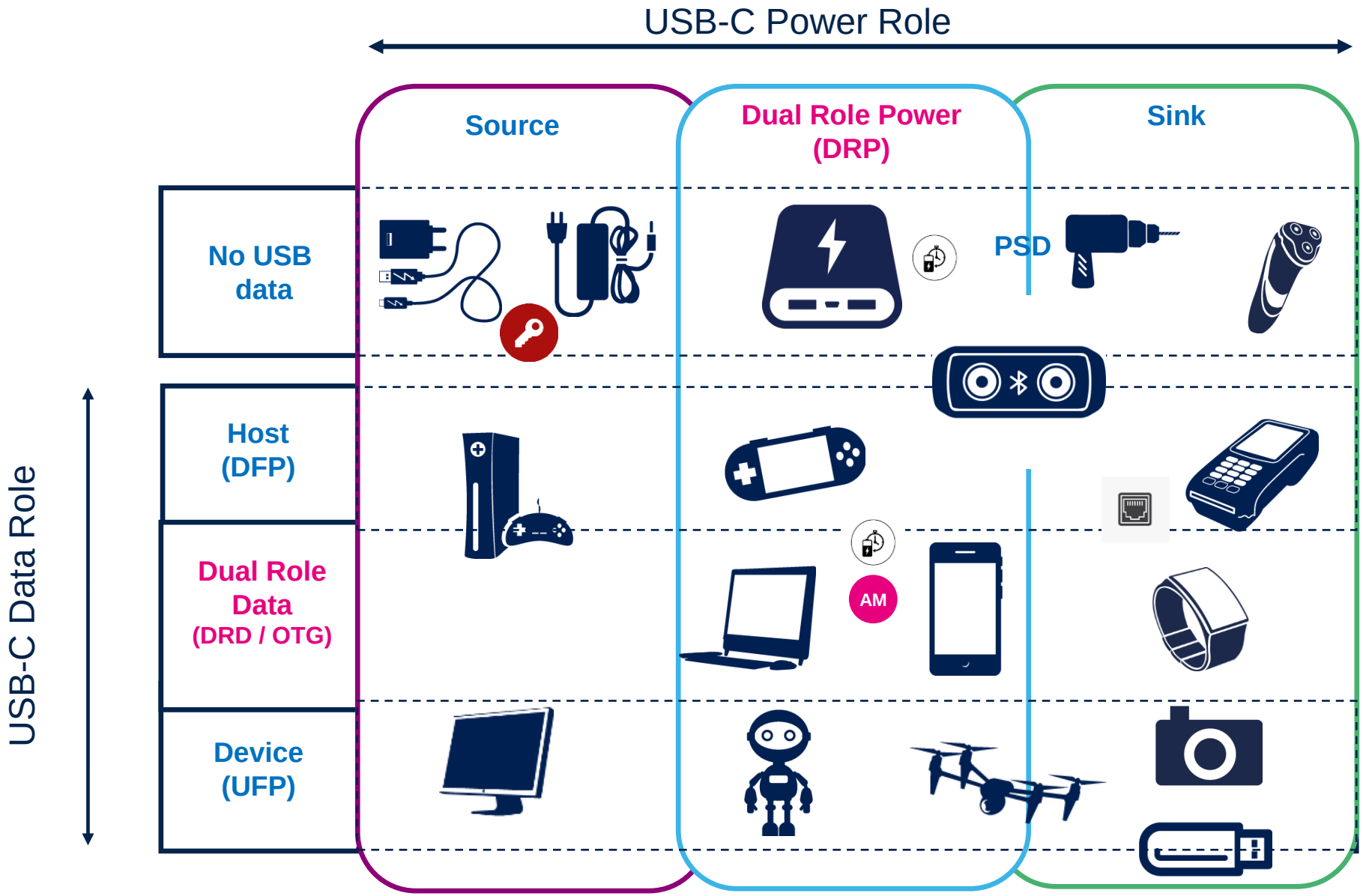
One port to charge them all

Universal charging solution for phones and small electronic devices

- UE commission announced the merge of charging solution making USB-C port the standard port for phones and small electronics devices



Target application & new use case



PSD: Power Sinking Device
DFP: Downstream Facing Port
UFP: Upstream Facing Port
DRD: Dual-Role Data
DRP: Dual Role Power
OTG: On-The-Go
AM: Alternate Mode

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Protections
What the standard says

Port Robustness Philosophy

SOURCES

Protect themselves

Shall not rely on SINKs for protection

- Output over current protection
- Over temperature protection (TCPP)
- V_{BUS} discharge at detach

Note: Sources protection mechanisms are not expected to protect sinks

SINKS

Protect themselves

Shall not rely on SOURCEs for protection

- Input over voltage protection
- Over temperature protection (TCPP)

Note: Sinks protection mechanisms are not expected to protect sources

What protections are mandatory?

ESD

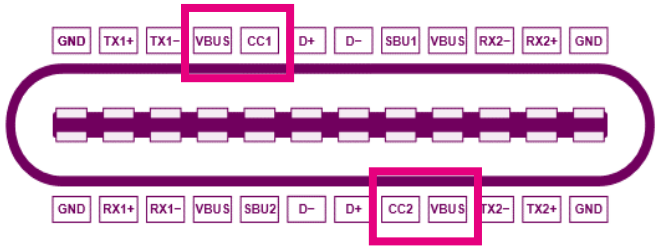
ESD or EOS event can destroy internal circuitry

DEFECTIVE SOURCE

Defective adapter can provide a voltage higher than expected

Defective load can sink higher current than expected

CC pin Short-to-V_{BUS}

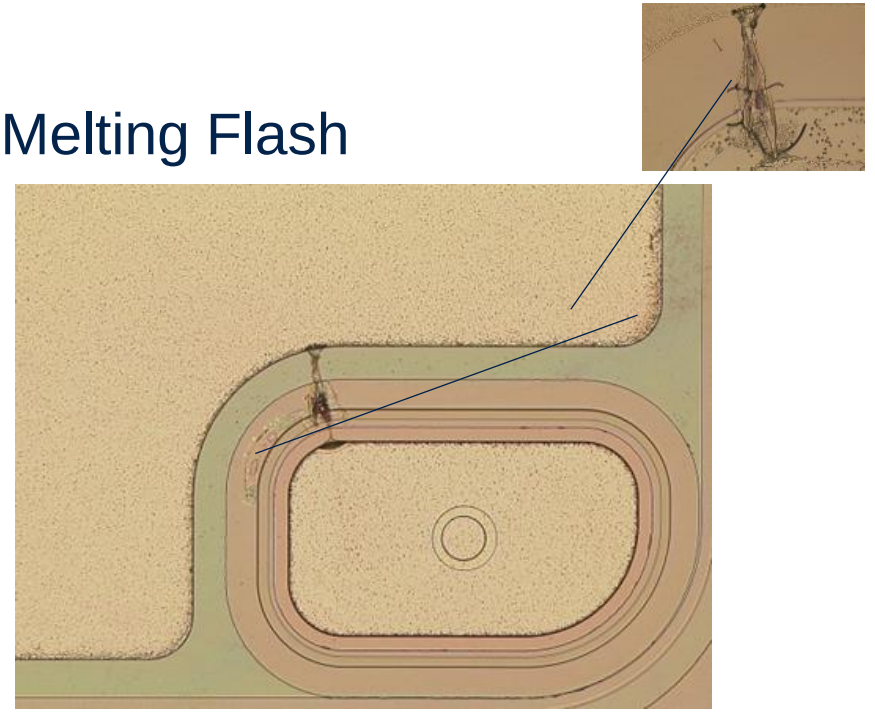


VBUS pin is adjacent to CC pin. **Short between VBUS and CC** can damage the USB-C controller

1: ESD discharge

System-level ESD protections are required as per IEC 61000-4-2 Level 4 (± 8 kV contact)

Melting Flash



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#2: protection against defective source

An Over Voltage Protection (OVP) is required on V_{BUS} for any SINK application, with AMR < 20V

V_{BUS} = 20V

AMR (Absolute Max Rating) = 7V

Defective SOURCE applies 20V DC on V_{BUS}

SINK
Requests 5 V

Example of defective source that can damage the sink device
This story is from July 2020 and outlines a group of hackers who changed the firmware on several USB-PD chargers from various manufacturers.

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'BadPower' Attack Can Rig a Fast Charger to Melt Your Devices

On some fast chargers, an attacker can exploit the read and write ability over the USB port to send malicious code to alter the charger's firmware, according to researchers in China.

By Michael Kan July 20, 2020

(Credit: Tencent)

A fast charger is supposed to replenish a phone's battery in minutes. Just don't let a hacker mess the firmware, or the charger might cause your devices to catch on fire.

Security researchers in China were recently able to infect a variety of fast chargers with malicious code to deliver more voltage than the connected device could handle. The overload caused the components inside the affected electronics to spark, sizzle, and melt.

The findings come from Tencent's Xuanwu Lab, which noticed a potential problem with the technology. To deliver energy, fast chargers use a USB port, which can hook up to your smartphone via a cable. However, in some cases the same USB port will also operate as a data connection, enabling you to read and write information to the charger's firmware.

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#2: protection against defective sink

An Over Current Protection (OCP) is required for any SOURCE application

As an example, a short circuit on a power sinking device will generate an over current on V_{BUS}

Universal Serial Bus Type-C Cable and Connector Specification

4.6.2.1 USB Type-C Current

A Source (port supplying VBUS) shall protect itself from a Sink that draws current in excess of the port's USB Type-C Current advertisement.

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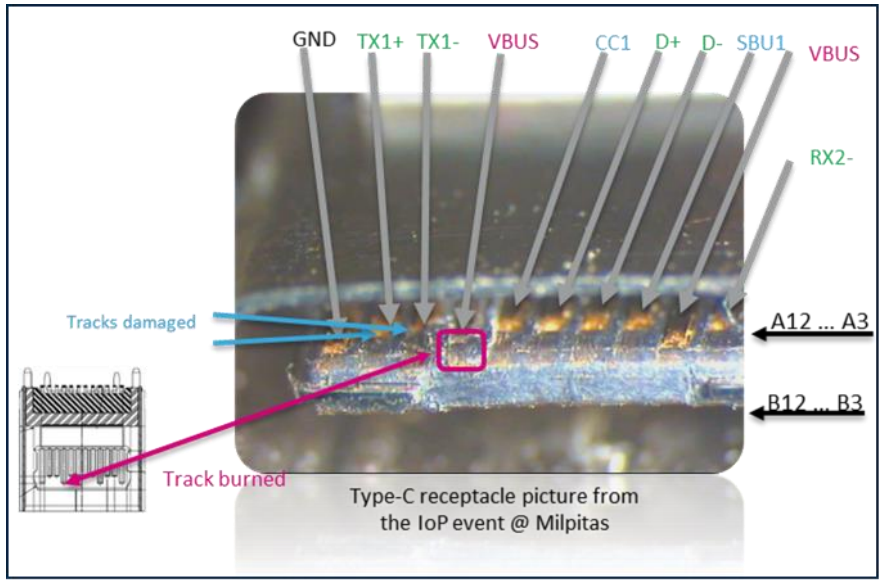
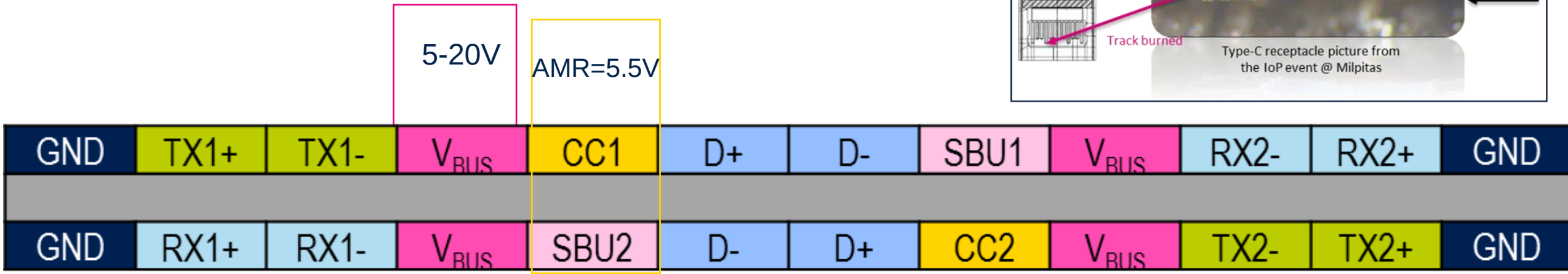
#3: CC lines short to V_{BUS}

An over voltage protection (OVP) is required on CC lines

V_{BUS} contact with CC lines when twisting cable into connector





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Type C Port Protection (TCPP) Products

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TCPP Positioning

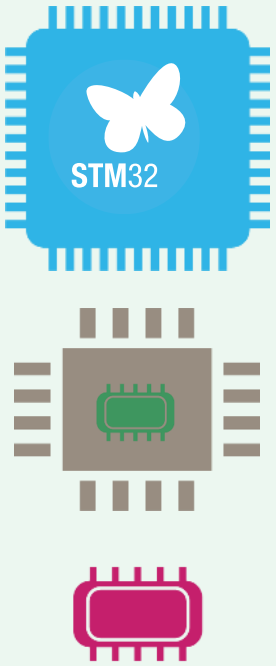
STM32 + TCPP enables cost-effective USB-C solutions

Legacy → **STM32 + TCPP**

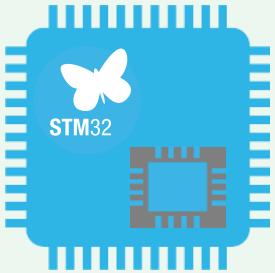
Microcontroller

USB-C controller
+
High-voltage controls
(load switch control, discharge path)

Protections

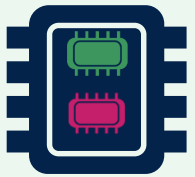


Microcontroller
+
USB-C controller



Type-**C** **P**ort **P**rotection

High-voltage controls
(load switch control, discharge path)
+
Protections



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Wide Range of STM32 UCPD

UCPD proliferation in STM32G0, STM32G4, STM32L5, STM32U5 series and more to come…

2007*/2009	2010	2011	2012	2013	2014	2015	2016	2017/2018	2019	2020	2021
World 1st Cortex-M MCU			1st Mixed Signal **DSP + Analog** STM32F3 Cortex-M4			Leadership **Ultra-low-power** Cortex-M4 **#1 ULP** 447 ULPBench™	**#1 Performance** 3224 CoreMark	Introduction of **M33** Excellence in ULP **with more security**	**Mixed-signal** Cortex-M4 MCUs		
STM32**F1***			STM32**F3**			STM32**H7**	STM32**L5**	STM32**G4**			
World 1st Cortex-M **Ultra-low-power**	**1st High Perf.** 120 MHz, 90nm	**1st High Perf.** Cortex-M4 168 MHz	**Entry Cost** STM32F0 Cortex-M0	Entry Cost **Ultra-low-power**	World 1st **Cortex-M7**		**Ultra-low-power** Excellence	**Dual-core**, multiprotocol and **open radio**	**Dual-core Microprocessor** among the STM32	**The world's first LoRa®-enabled System-on-Chip**	**The flagship ultra-low-power MCUs**
STM32**L1**	STM32**F2**	STM32**F4**	STM32**F0**	STM32**L0**	STM32**F7**	STM32**L4**	STM32**L4+**	STM32**WB**	STM32**MP1**	STM32**WL**	STM32**U5**

Mainstream Cortex-M0+ MCUs Efficiency at its best!

STM32**G0**

World's Most Powerful MCU

STM32**H7**

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TCPP series benefits

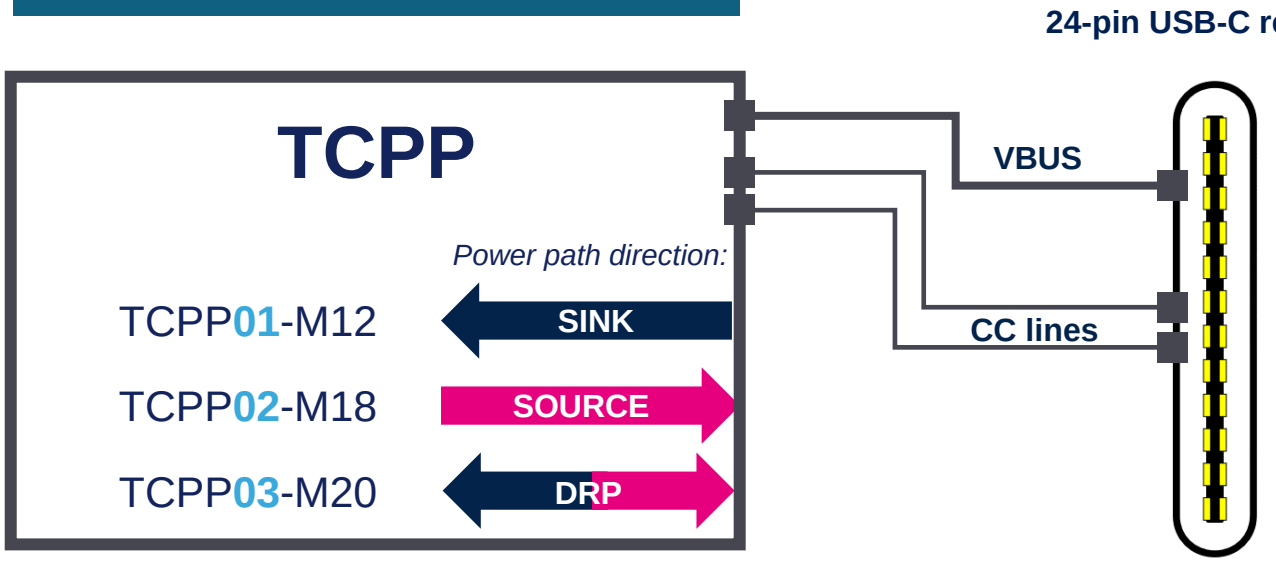
MCU incl. USB-PD CONTROLLER

STM32 G0

STM32 L5

STM32 G4

USB-PD PROTECTION



Cost effective partitioning

Compliant with USB-C PD 3.1

PCB space saving

High system robustness against defective source/sink

Lower design effort

Lower power consumption

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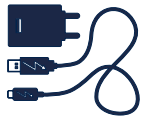
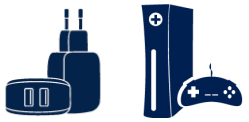
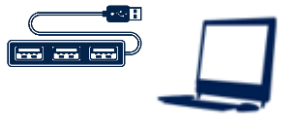
Key products & typical configurations

MCU series	USB PD3.0 MCU	USB2.0 data Interface
STM32G0	2 UCPD	USB2.0 FS dual role (dev/host)
STM32G4	1 UCPD	USB2.0 FS device
STM32L5	1 UCPD	USB2.0 FS device
STM32U5	1 UCPD	USB2.0 FS dual role (dev/host)

1 port SINK/DEVICE	1 port SOURCE	1 port DRP	2 ports SOURCE	2 ports 1 SINK + 1 DRP	2 ports 2 DRP
USB-C device	USB-C Power Adapter	Notebook / Battery pack	USB-C Power Adapter / wall plug	Docking	PC / USB Hub
STM32G0B1KBT6N + **TCPP01**	STM32G071G8U6N + **TCPP02**	STM32G071G8U6N + **TCPP03**	STM32G071G8U6N + **2 TCPP02**	STM32G071CBT6 + **TCPP01** + **TCPP03**	STM32G071CBT6 + **2 TCPP03**





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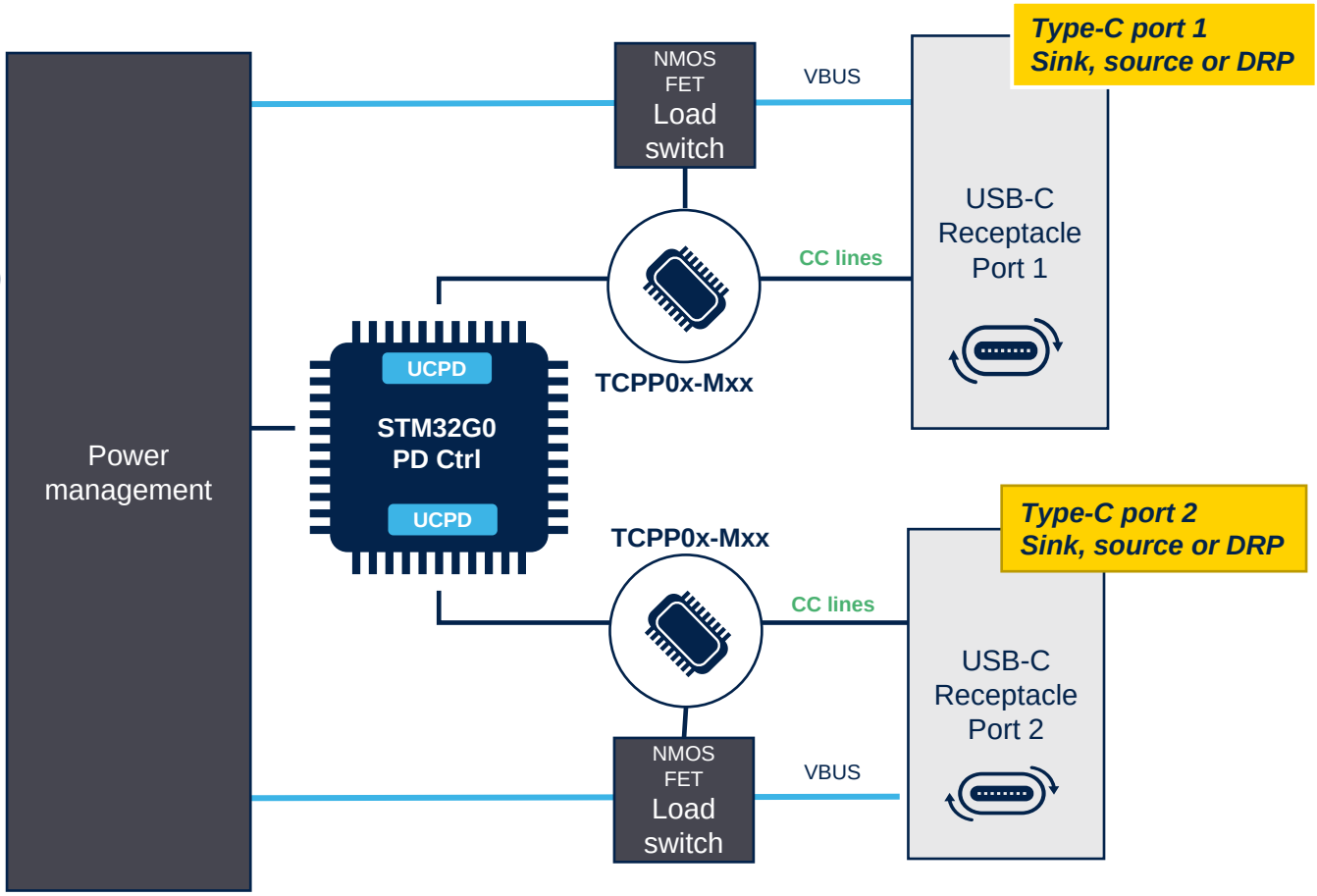
Solution for dual port USB-C : key benefits for customers

Example:
STEVAL-2STPD01
Dual-USB-C PD port up to 120W (60W each port)



- Dual port charger
- Power bank
- Docking station
- USB hub
- Game console

Only one MCU needed to cover 2 USB-C PD ports
Power Sharing feature can be easily implemented by software

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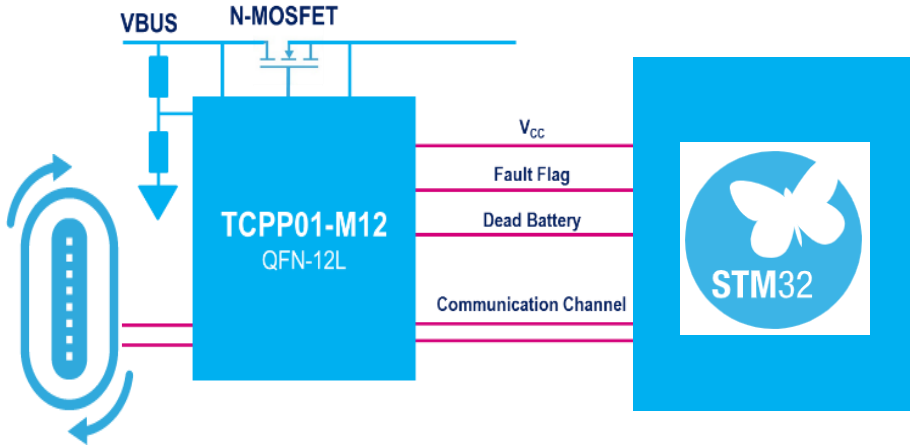
TCPP01-M12 key features

Over Voltage Protection
- On VBUS, with external N-MOSFET
- On CC lines with integrated FET

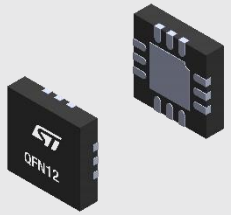
Integrated VBUS gate driver
for external low cost (*), low RDSON (*) N-MOSFET

Supports all USB-C up to 100 W (Legacy and PD profiles)
including Programmable Power Supply
(PPS in PD3.1 specification)

Companion chip of STM32 with UCPD



QFN-12L
3 mm x 3 mm
500 µm pitch



ESD protection on CC pins and VBUS
(IEC61000-4-2 Level 4: +8 kV Contact, +15 kV air)

Integrated "Dead Battery" management logic
No power consumption when no cable attached

Over temperature protection
Open-drain fault reporting

X-NUCLEO-SNK1M1
based on TCPP01-M12

TCPP01-M12 is compliant with PD3.1 for all standard power range (SPR) profiles in sink configuration
USB-IF certification: TID 5205

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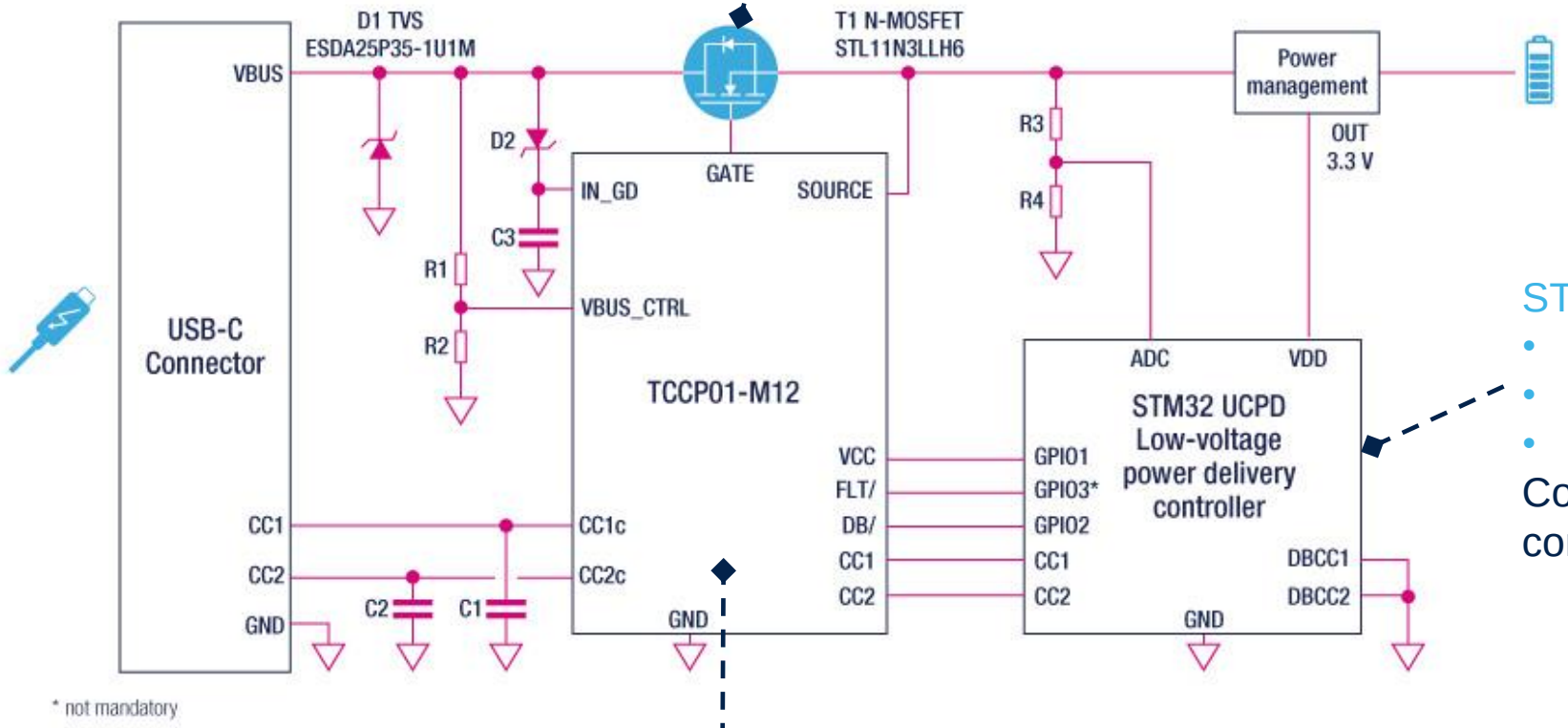
SINK
TCPP01-M12

- VBUS OVP with integrated gate driver:

protection against defective source
Integration & PCB space saving



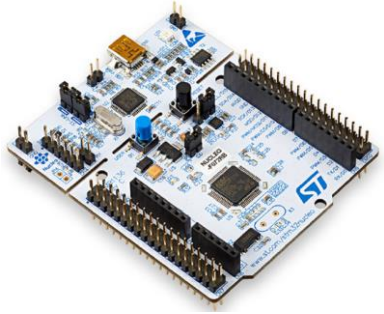
STM32
- USB-C attachment
- USB PD stack
- Application tasks

Cost saving: no need for PD controller

- CC lines OVP against short-to-VBUS
- 24V ESD protection on CC lines

Higher system robustness
Compliant with USB-C PD 3.1 SPR

Quick evaluation up to 100W (20V / 5A) with STM32 Nucleo USB Type-C™ expansion boards



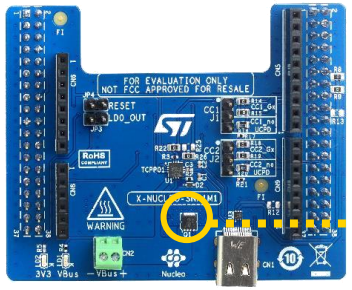
+

X-CUBE-TCPP

Ready to run
firmware examples projects
for STM32 Nucleo 64pin

Application Notes

AN5418



For SINK/Device

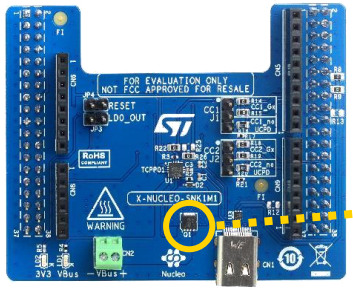
X-NUCLEO-SNK1M1

based on TCPP01-M12

For DRP/DRD

X-NUCLEO-DRP1M1

based on TCPP03-M20

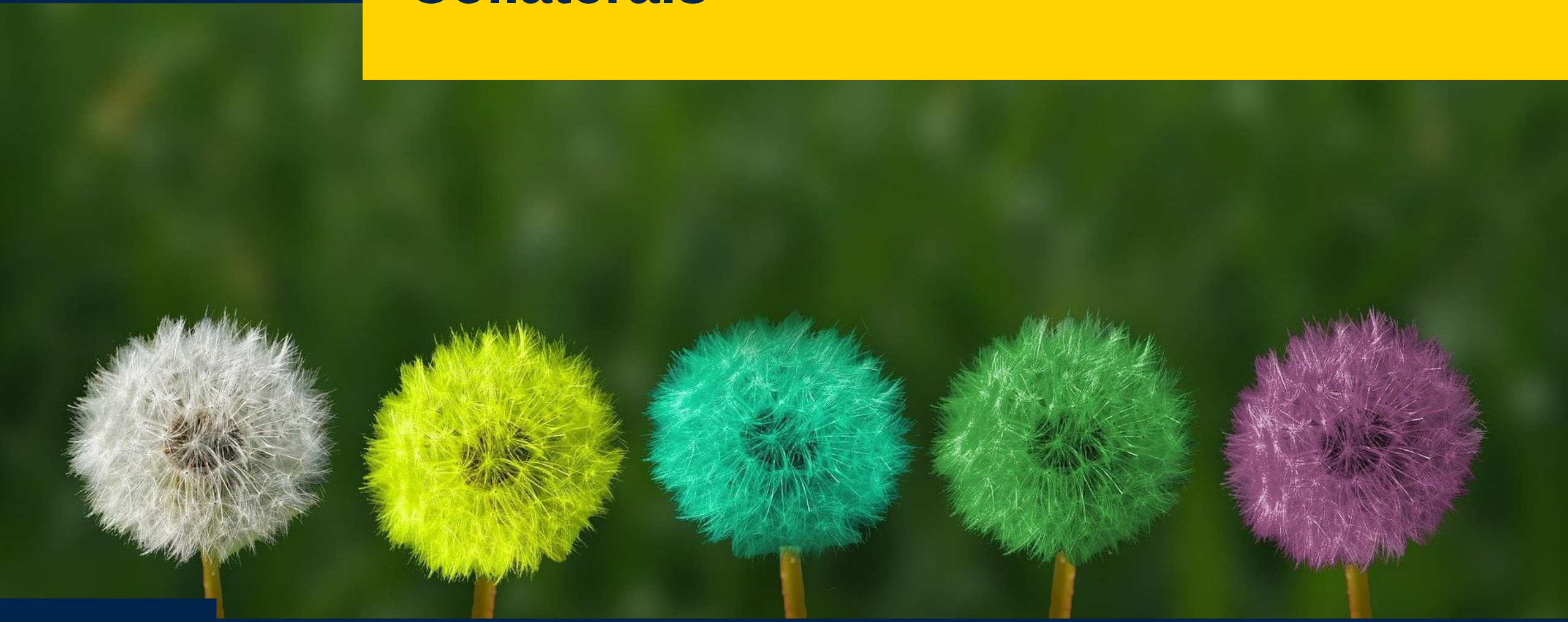


For SOURCE/Host

X-NUCLEO-SRC1M1

based on TCPP02-M18

Collaterals



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For every step in your development
ST has the right tool

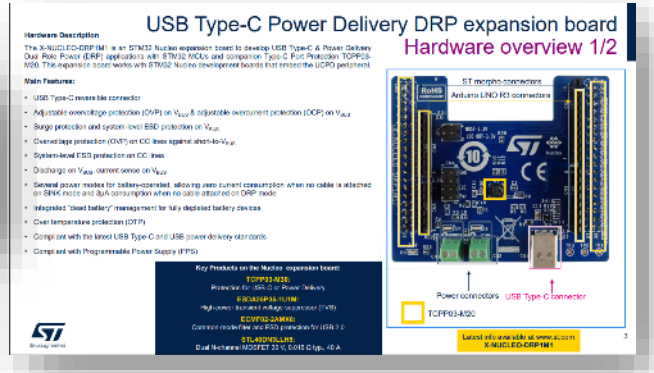
1. Datasheets

Sink | Source | Dual role

2. X-NUCLEO

Sink | Source | Dual role

3. Quick start guide



4. SW files
X-CUBE-TCPP

5. Evaluation board

Discovery-B-U585I-IOT02A

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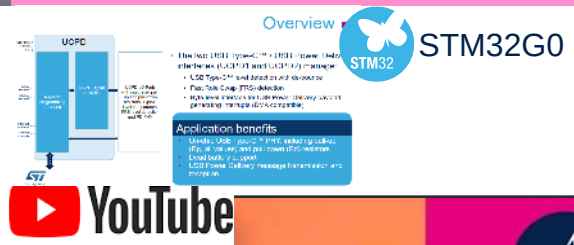
STM32U575I-EV
Evaluation board

6. Training video



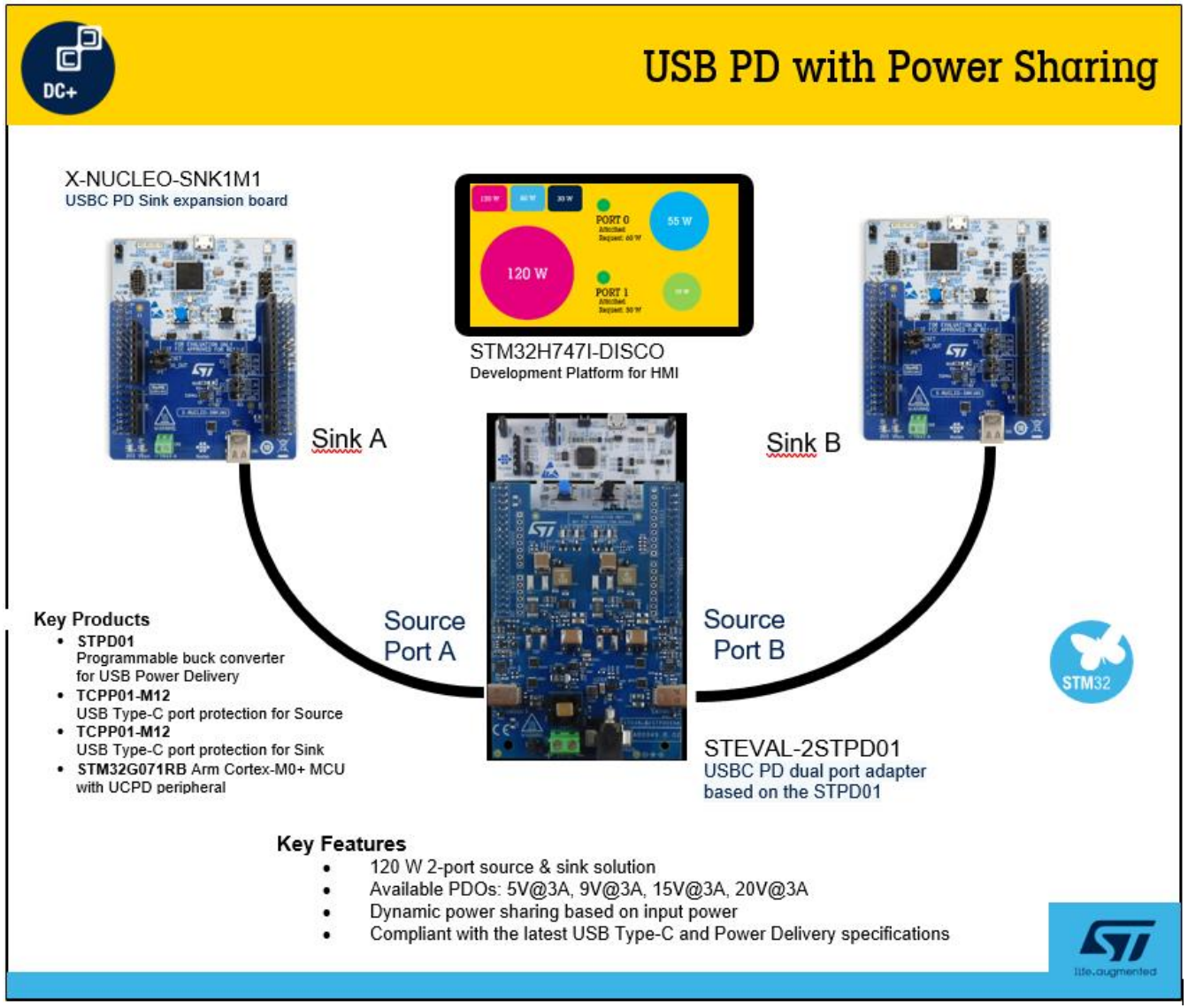
7. ST community

GitHub

Wiki by ST
STM32 MCU
Wiki

8. APPLICATION NOTES
AN5418 and AN5225

Developer's Conference 2022 Demo



Conclusion – Key takeaways

TCPP + STM32 delivers cost effective solution for USB-C Sink, Source or DRP applications

Taking advantage of STM32 MCU series in low-voltage technologies and Type-C Port Protection in BCD technology (IEEE's award winning) offers

- Cost-efficient system with optimized power consumption
- Wide offer of STM32 MCUs, expanding with more UCPD-featured STM32 in the future
- Safe and easy way to add innovative USB-C and Power delivery features thanks to TCPP Nucleo expansion boards within STM32 development ecosystem.
- 10 Years longevity

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Our technology starts with You

Find out more at www.st.com

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