Solutions for USB-C™ & Power Delivery

life.augmented
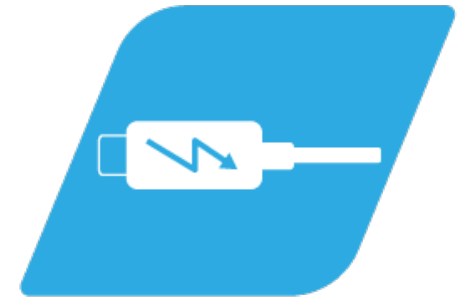
USB-C Technology – Behind the " C "

USB Power Delivery (USB PD) protocol (optional feature)
- Optimized voltages rails 5, 9, 15, 20V
- Power goes bi-directionally
- Up to 100W (20V@5A)
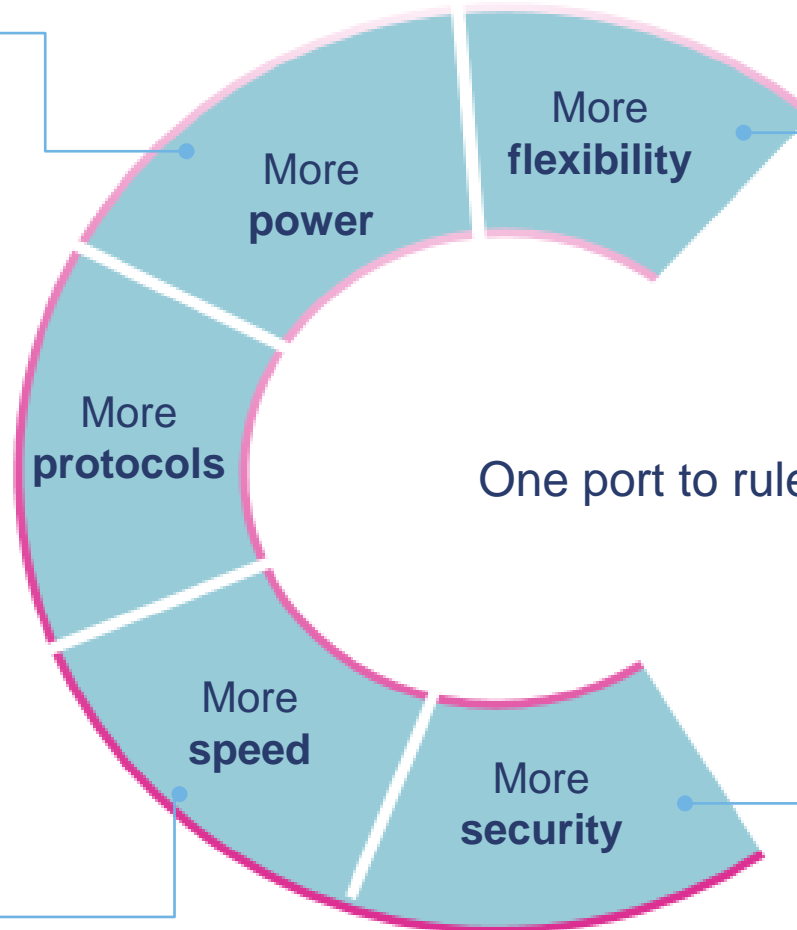- Programmable Power Supply (PPS) to support proprietary charging algorithm

Proprietary protocols
(Alternate Mode capabilities enabled via USB PD)
- Video: DisplayPort, HDMI, VGA, Thunderbolt, and MHL
- Ethernet
- Analog / Digital Audio

USB data communication
- USB 3.1 SuperSpeed (SS)
- USB 2.0 (LS/FS/HS)
- Up to 10 Gbit/s

More **power**

More **flexibility**

More **protocols**
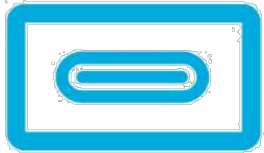
More **speed**
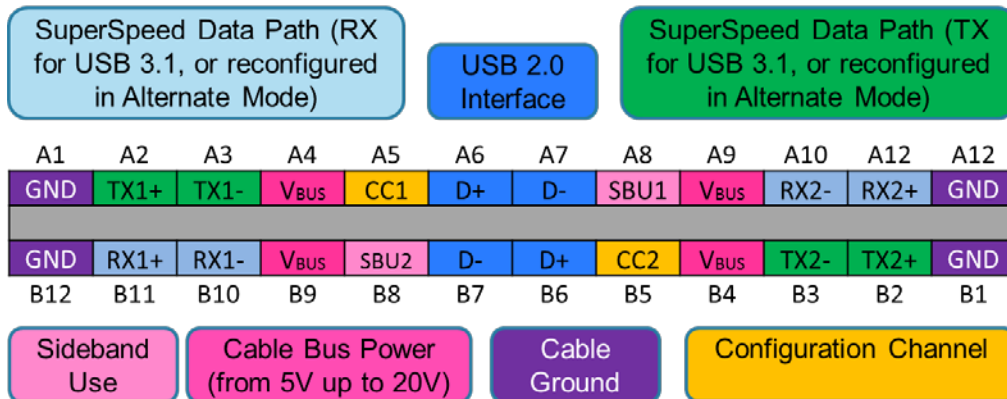
More **security**

One port to rule them all !

180° Rotation

- New reversible connector
- 15W natively (5V@3A)
- Same plug at both ends of the cable

- Authentication over USB PD
- Secure FW install

life.augmented

Type-C pinout functions

Receptacle

Plug

Receptacle

| SuperSpeed Data Path (RX for USB 3.1, or reconfigured in Alternate Mode) | | | | | USB 2.0 Interface | | SuperSpeed Data Path (TX for USB 3.1, or reconfigured in Alternate Mode) | | | | |

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A12	A12
GND	TX1+	TX1-	V_{BUS}	CC1	D+	D-	SBU1	V_{BUS}	RX2-	RX2+	GND

GND	RX1+	RX1-	V_{BUS}	SBU2	D-	D+	CC2	V_{BUS}	TX2-	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

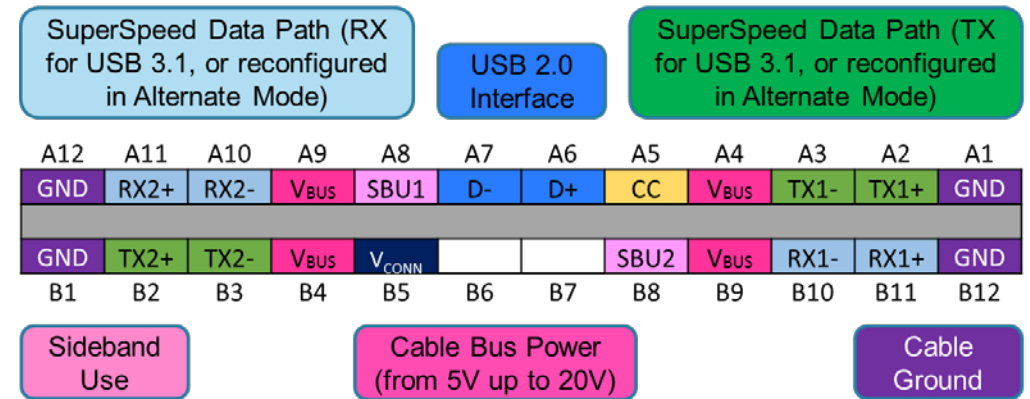| Sideband Use	Cable Bus Power (from 5V up to 20V)	Cable Ground	Configuration Channel

Two pins on the USB Type-C receptacle, CC1 and CC2 are used in the discovery, configuration and management of connections across USB type-C cable.

Plug

| SuperSpeed Data Path (RX for USB 3.1, or reconfigured in Alternate Mode) | | | | | USB 2.0 Interface | | SuperSpeed Data Path (TX for USB 3.1, or reconfigured in Alternate Mode) | | | | |

A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	RX2+	RX2-	V_{BUS}	SBU1	D-	D+	CC	V_{BUS}	TX1-	TX1+	GND

GND	TX2+	TX2-	V_{BUS}	V_{CONN}			SBU2	V_{BUS}	RX1-	RX1+	GND
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12

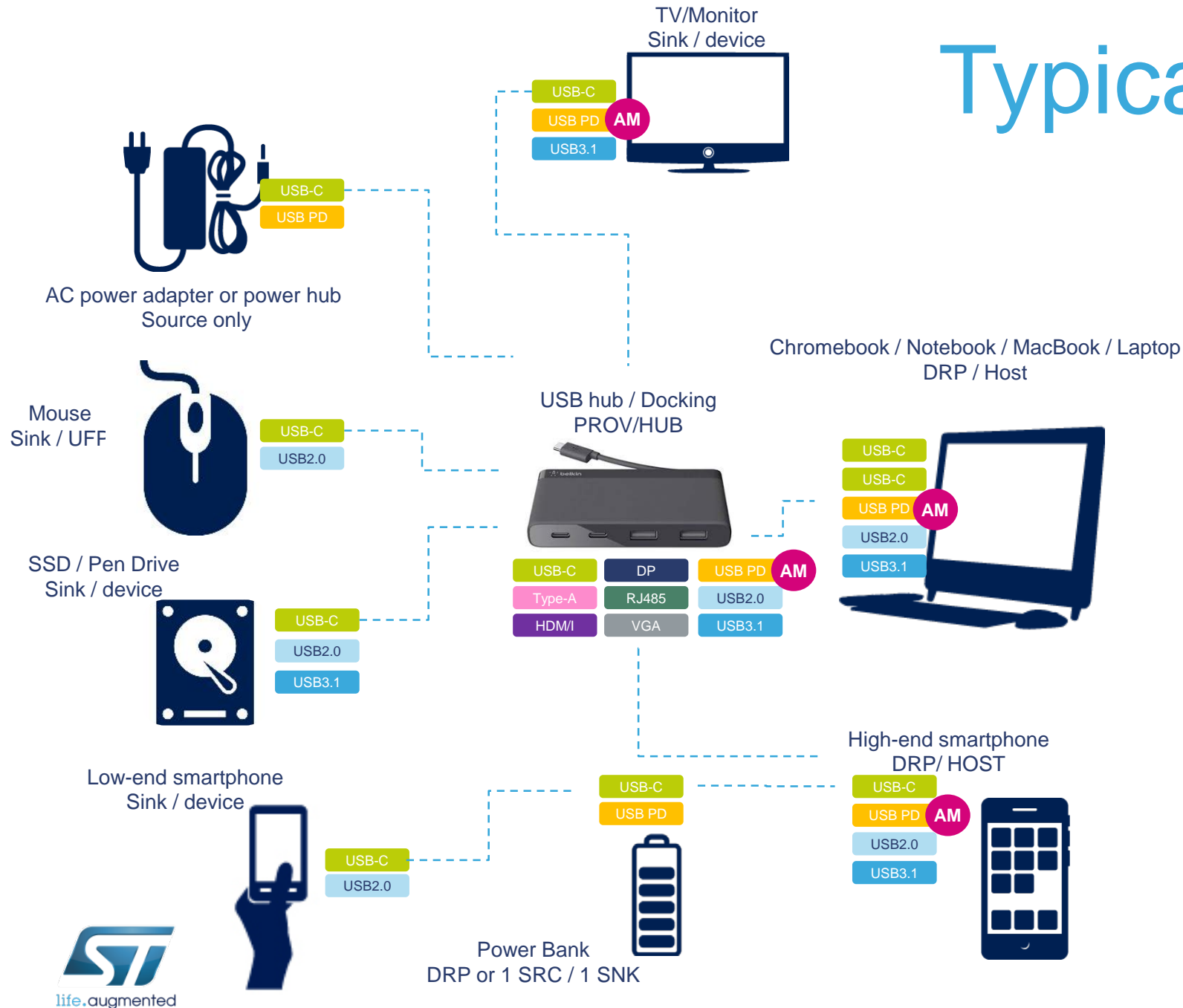| Sideband Use	Cable Bus Power (from 5V up to 20V)	Cable Ground

Within a standard USB Type-C cable, only a single CC wire within each plug is connected through the cable to establish signal orientation and the other CC pin is repurposed as V_{CONN} for powering electronics in the USB Type-C plug.
Also, only one set of USB 2.0 D+/D- wires are implemented in a USB Type-C cable.

life.augmented

Typical applications

TV/Monitor
Sink / device

- USB-C
- USB PD **AM**
- USB3.1

AC power adapter or power hub
Source only

- USB-C
- USB PD

Mouse
Sink / UFF

- USB-C
- USB2.0

SSD / Pen Drive
Sink / device

- USB-C
- USB2.0
- USB3.1

Chromebook / Notebook / MacBook / Laptop
DRP / Host

- USB-C
- USB-C
- USB PD **AM**
- USB2.0
- USB3.1

USB hub / Docking
PROV/HUB

USB-C	DP	USB PD **AM**
Type-A	RJ485	USB2.0
HDM/I	VGA	USB3.1

Low-end smartphone
Sink / device

- USB-C
- USB2.0

Power Bank
DRP or 1 SRC / 1 SNK

- USB-C
- USB PD

High-end smartphone
DRP/ HOST

- USB-C
- USB PD **AM**
- USB2.0
- USB3.1

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)
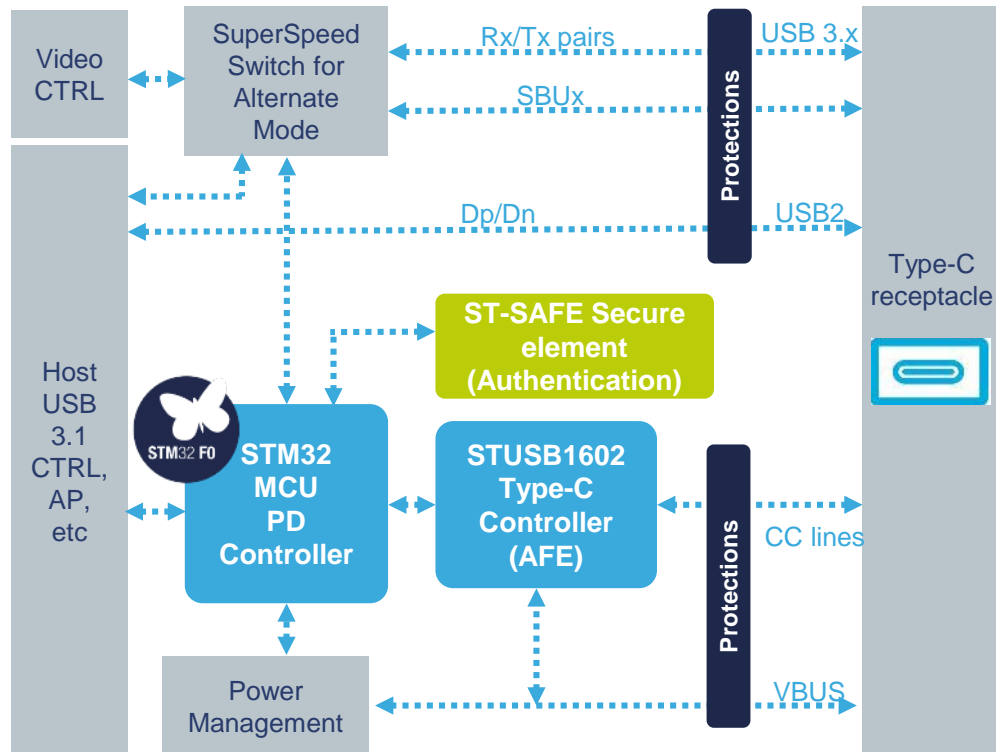- Dual-Role Data –typical of "on-the-go" ports

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

AM Alternate Mode capabilities enabled via USB PD

life.augmented

ST chipset & system architecture

A complete offer to "lean in" USB Type-C PD ecosystem

- Scalable offer for USB-PD controller and Type-C interface based on STM32 general-purpose MCU and high-voltage STUSB1602 Type-C analog front-end interface

- Large product portfolio for protection and filtering covering all application needs

- Highly secure solution using STSAFE secure element family for strong authentication needs

USB-C solution - Value proposition

X-CUBE-USB-PD

STM32 as System / Device policy manager running USB Power Delivery Stack and application specific layers

I2C / SPI / I/O…

- **STUSB1602** Type-C Controller
  - USB-C
- **STUSB1602** Type-C Controller
  - USB-C

- Our solution partitioning includes ARM Cortex-based **STM32 MCU and STUSB1602** USB-C controller.

- It offers the best trade-off between flexibility, time-to-market and cost to develop multi-port applications (Consumer/Provider/DRP roles).

- STM32 and its FW package (USB PD stack and drivers) provide the means supporting the specific application use-cases and new features (authentication, Programmable Power Supply (PPS) and FW upgrade) while to support latest USB IF standard revision faster.

- STUSB1602 offers BOM cost optimization with the integration of main analog functions such as 600mA V_{conn} switches, V_{BUS} gate drivers and discharge, 28V short-to-V_{BUS} protections, voltage monitoring, and dead battery management, features that rule out integration in many SoC processes not suitable for high power and high voltage constraints.
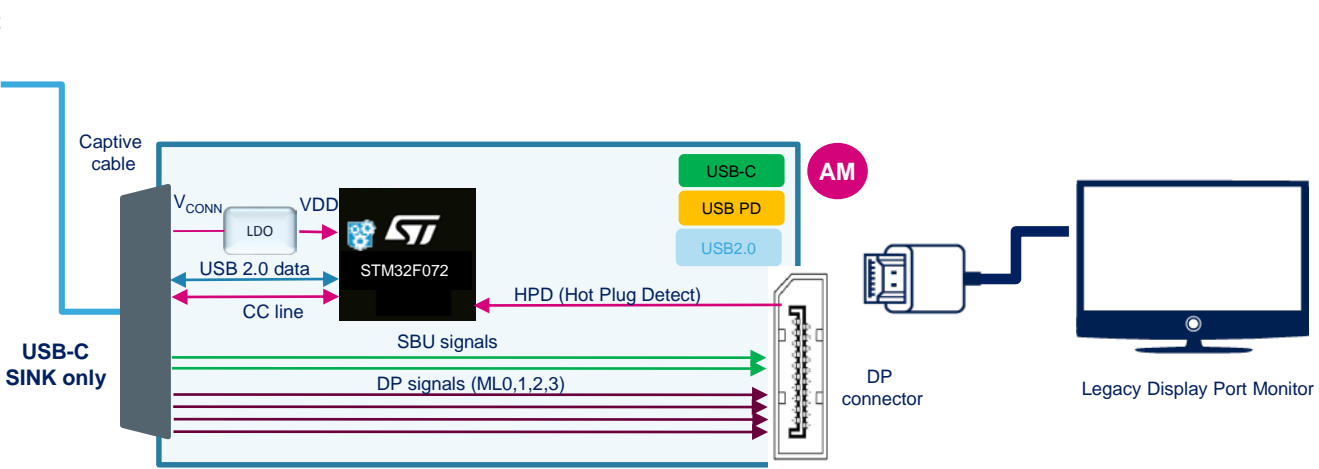
life.augmented

Typical use-cases
Computers, power adapters and multi-function accessories

Dual-port DRP *with STM32 and two STUSB1602*
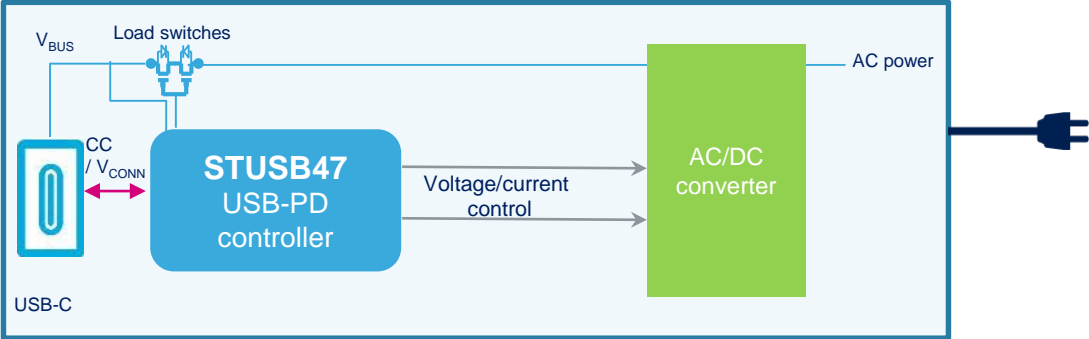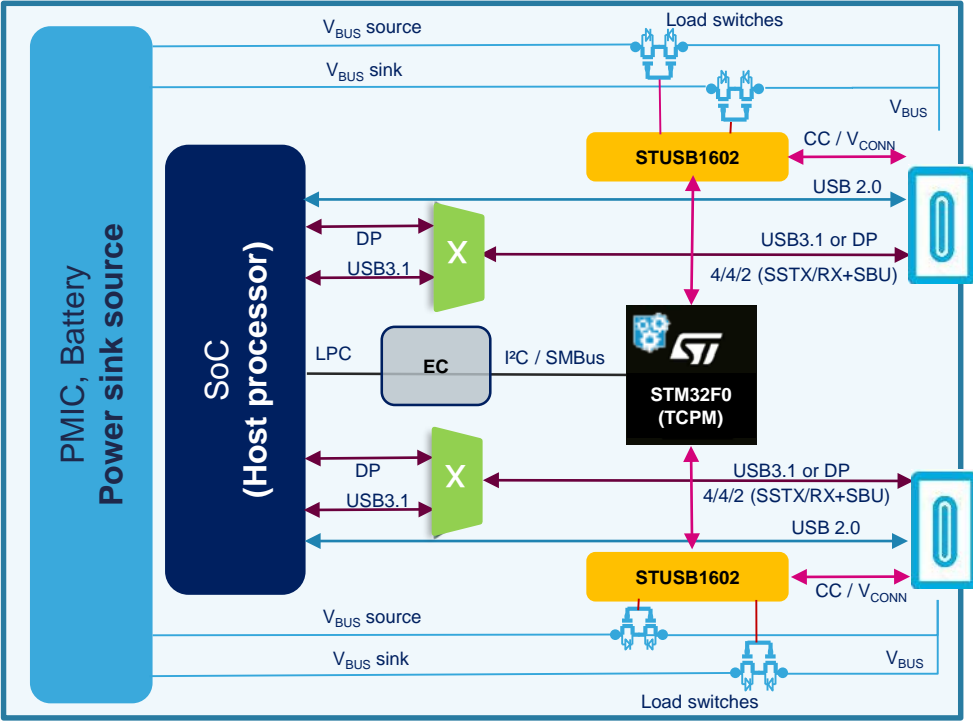
45W USB PD AC/DC Adapter certified as a Power Brick (TID #1030024)

Type-C to DP accessory *with STM32F072* **Billboard** *Class Device and X_CUBE_USB_PD stack*

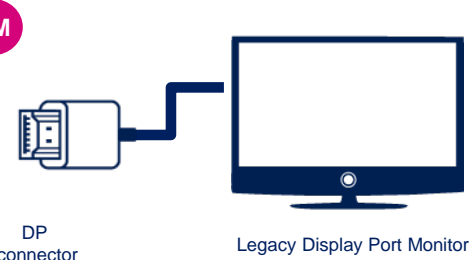**Example: Gaming console or smartphone**
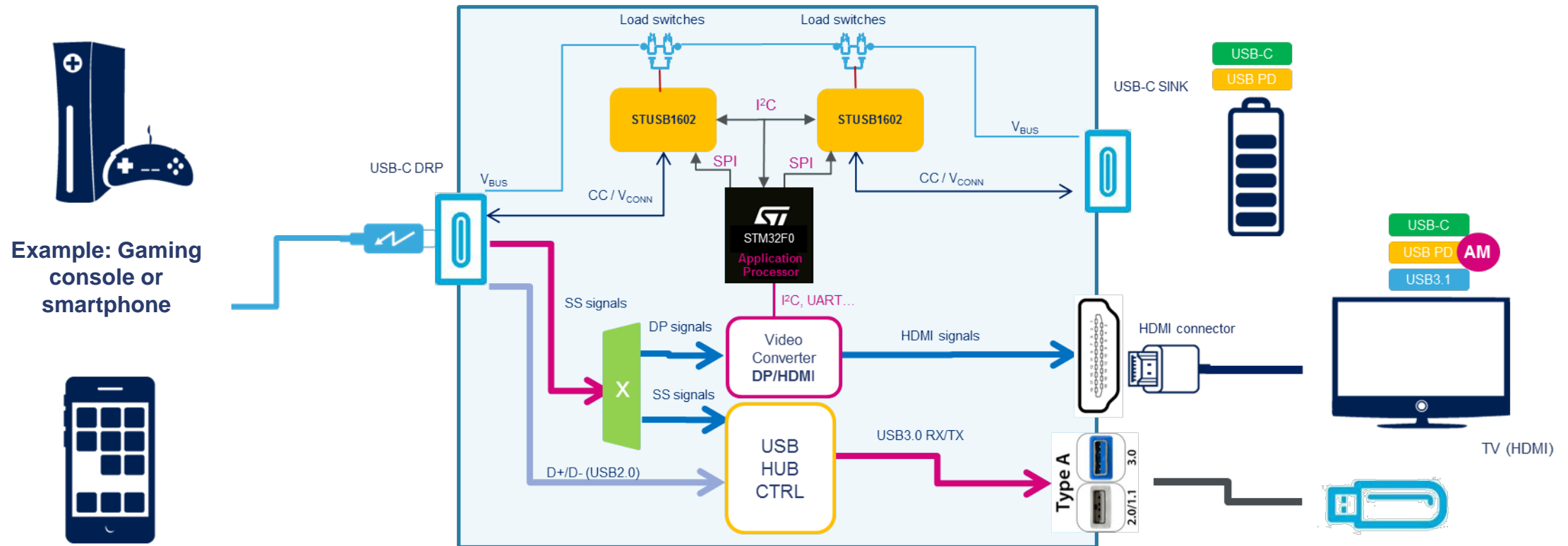
Dual USB-C power bank
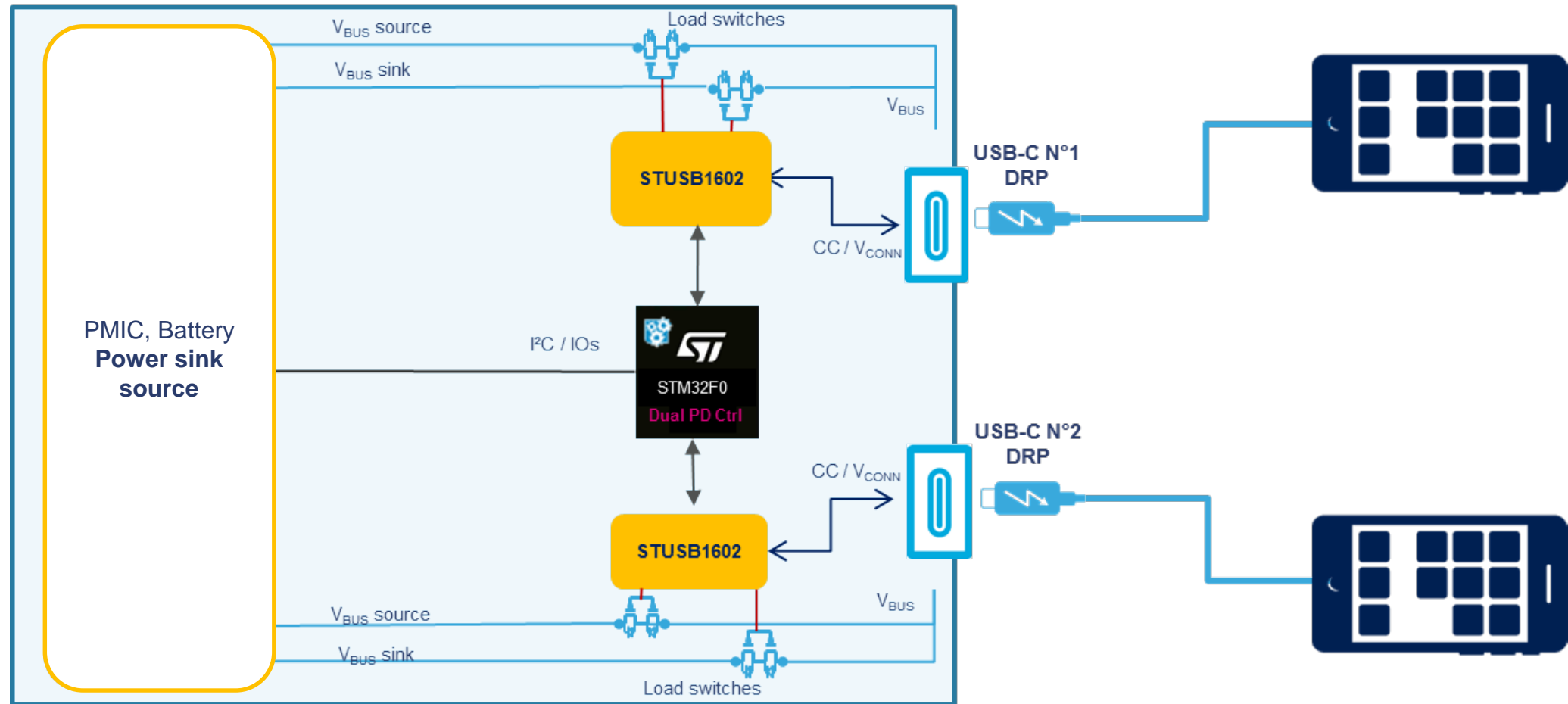
Offer to designers the flexibility to enable the needed optimization of stack partitioning and BOM

Highest **flexibility** and **adaptability** with GP STM32 MCU for **multi-port** management

+

Embedded Software (X-CUBE-USB-PD) & low-level drivers for STUSB1602

+

Highest **integration** with high-voltage USB-C and PD controllers (STUSBXX)

Digital functions

Analog functions

| System Policy Manager |
| Device Policy Manager |
| Policy Engine |
| Protocol layer |
| 4b5b, CRC, SoP |
| BMC encoder |
| USB PD RX/TX analog PHY |
| Type-C™ Interface |
| High Voltage Protection |

STM32
X-CUBE-USB-PD

STM32 F0

STM32 F

Type-C™ Controller
STUSB1602
(SNK/SRC/DRP)

STUSB1600
SNK/SRC/DRP

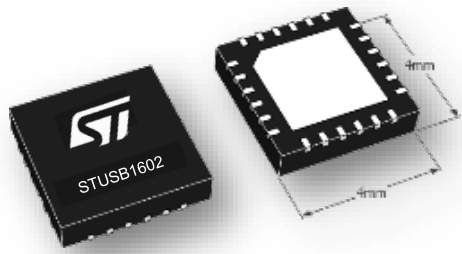Full Hardware USB PD Controller Optimized for AC Adapters (Provider Only)
STUSB47

① ② ③

1. Standalone Type-C interface STUSB1600 up to 15W

2. Multi-Ports PD r2.0 with Certified STUSB1602 Type-C Controller including PD PHY, V_{CONN} switches, gate drivers, protections, sensing

3. Full HW solution with Certified STUSB47 PD controller optimized for AC adapters (1 Port Provider)

life.augmented

Certified Products - Rank N°3

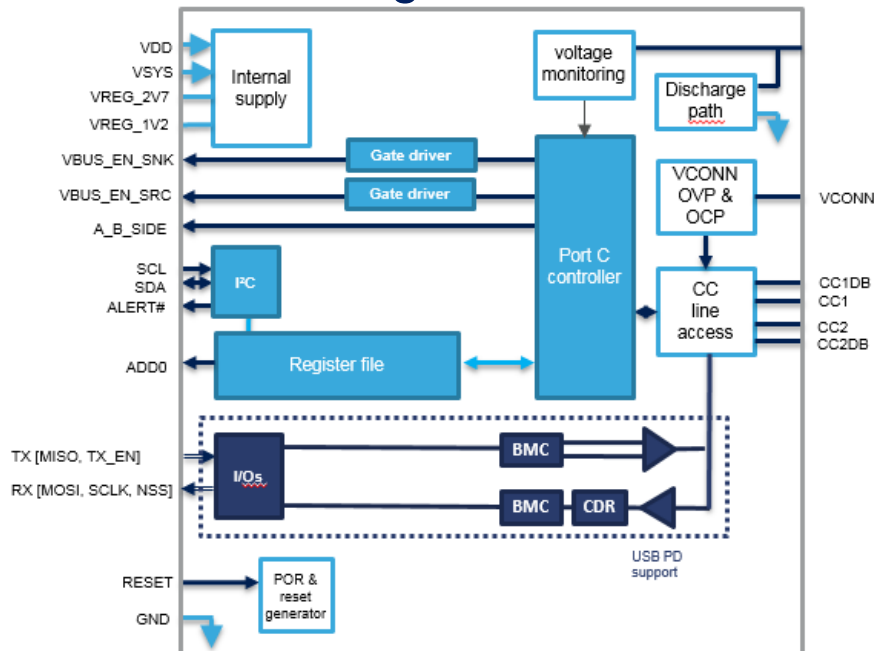|	"PD only Silicon" Category	TID	
1	P-NUCLEO-USB001 with STM32F072RBT6 (SRC)	TID 1099010	5/13/2016
2	P-NUCLEO-USB001 with STM32F072RBT6 (SNK)	TID 1000016	11/2/2016
3	STUSB1602 SNK	TID 1010032	11/23/2016
4	P-NUCLEO-USB001 with STM32F072RBT6 (DRP)	TID 1010046	11/23/2016
5	P-NUCLEO-USB002 with STUSB1602 (SRC)	TID 1030022	24/05/2017
6	STUSB4700 SRC only	TID 1030023	24/05/2017
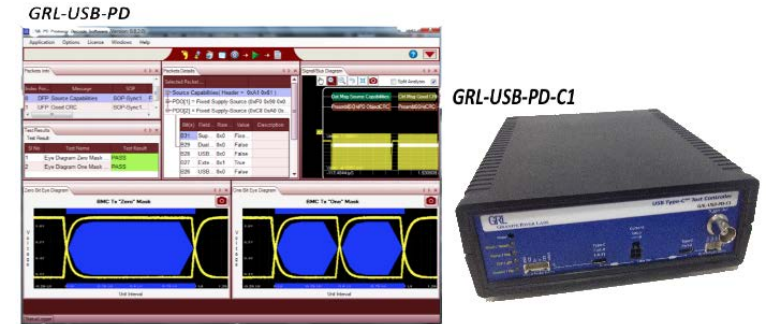
USB Type-C and PD Analog front-end

Block diagram

Features	Benefits
✓ **Certified silicon**	• Proven interoperability • Guaranteed Eye Diagram
✓ **Wide Supply Voltage range** 3 to 22 V - AMR 28V	• Supplied by V_{BUS} (No external LDO required) • 3.0V lower voltage limit is in line PPS
✓ **Short-to-V_{BUS} protection:** Up to 22V on CC pins Up to 28V on power-path pins	• User and Device safety
✓ **High integration with** - Discharge path - V_{BUS} switch gate drivers - V_{BUS} monitoring - Dead battery switch - V_{CONN} switches and OCP protection	• Low BOM cost • Small footprint

- High-voltage mixed-signal technology
- Certified USB PD r2.0 and compatible with USB PDr3.0 "core"
- High Integration with built-in V_{BUS} monitoring, V_{BUS} discharge, CC termination & HV protection, Dead battery switch, SNK and SRC gate drivers, V_{CONN} switches & OCP
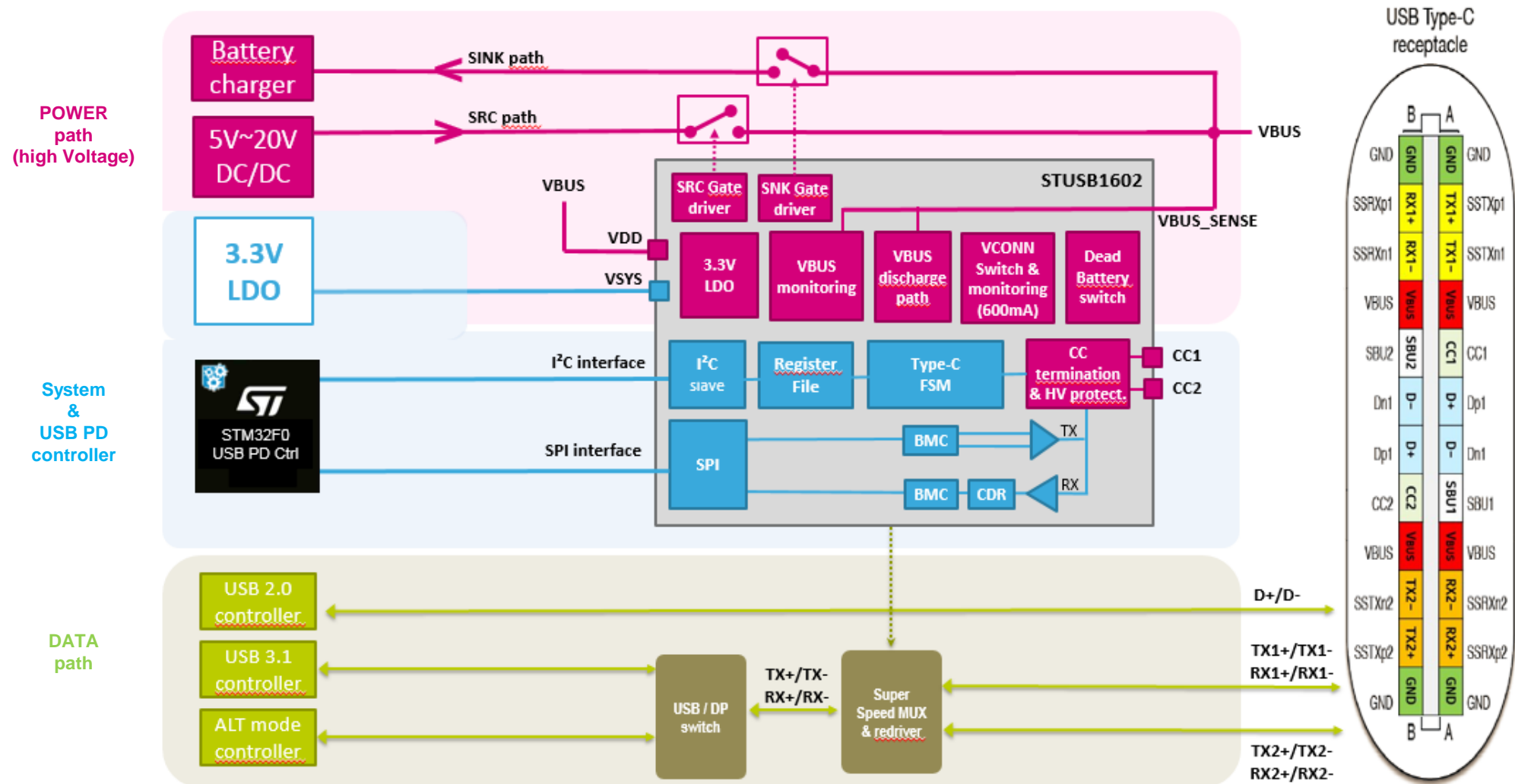
Typical schematic - Consumer single port

System Policy Manager

Device Policy Manager

Policy Engine

Protocol layer

4b5b, CRC, SoP

BMC encoder

USB PD RX/TX analog PHY

Type-C™ Interface

High Voltage Protection

STM32 F0

STM32
X-CUBE-USB-PD

Type-C™ Controller
STUSB1602
(SNK/SRC/DRP)
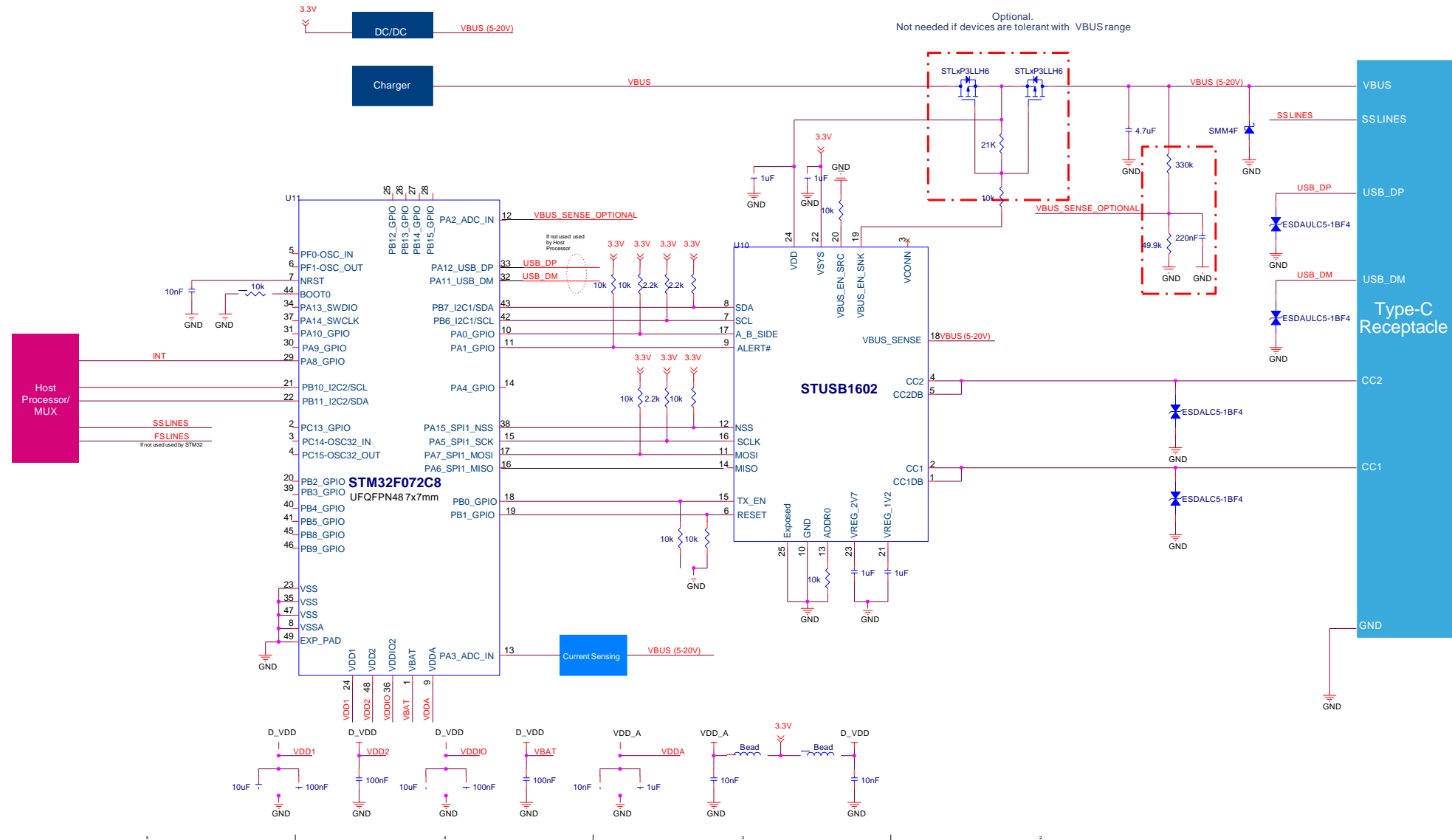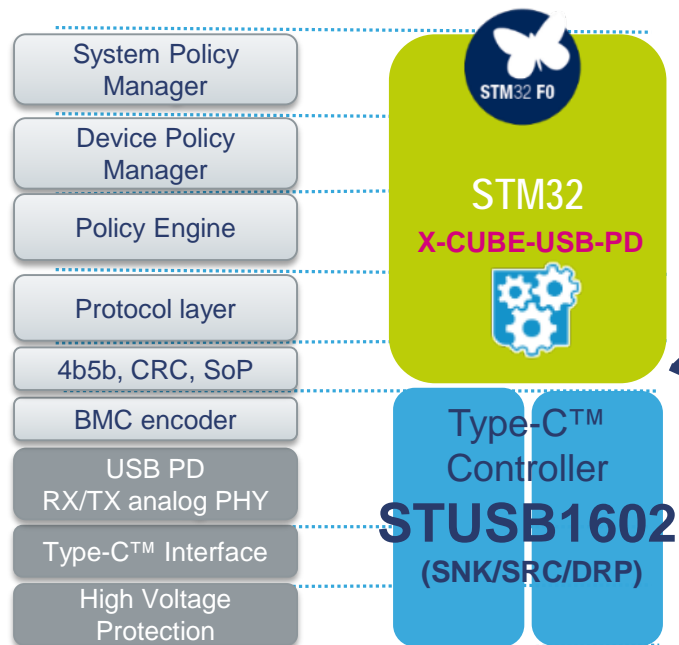
USB PD features

- Packet **signal conditioning** for both RX / TX
- Packet **encoding /decoding** (BMC)

Type-C features

- **Manage** USB Type-C port connections
- **Handle**   Dead Battery connection & system start-up
- **Manage** cable orientation
- **Supply** V_{CONN} (programmable limit)

System/application features

- **Enable** the power path   ➔ V_{BUS} gate drivers (PMOS)
- **Manage** voltage transitions   ➔ V_{BUS} discharge path
- **Monitor** the power path   ➔ V_{BUS} monitoring
- **Protects** from high voltage   ➔ Short-to-V_{BUS} protections (up to 28V)
- **Protects** V_{CONN} ➔ OVP, OCP and OTP

life.augmented

STUSB1602 versus competition

	Equivalent discrete components	STUSB1602	COMPETITION
V_{BUS} monitoring	MCU (ADC) + comparator	automatic	Comparator only. Need SW support
V_{BUS} discharge	1 x MOS	automatic	NO
CC termination & HV protection	2 x MOS	22V AMR	NO
Dead battery switch	2 x MOS	integrated	integrated
SNK gate driver	1 x MOS	integrated	NO
SRC gate driver	1 x MOS	integrated	NO
V_{CONN} switch & OCP protection	2 x MOS + 1 x protection switch	integrated	NO
ESD 4 kV HBM	2x ESD protections	integrated	integrated

EXTRA DISCRETE COST with COMPETITOR

about $0.40

Certified STM32 USB-PD Libraries

Compliant with USB Type-C™ 1.2 and USB PD 2.0 specifications

Firmware package includes :
- USB PD "core" library for STM32F0 Cortex™-M0 based devices (binaries for 1 or 2 ports)
- Porting to STM32 Cortex™-M4 series on-going (STM32F3 / STM32F4)
- Open-source, device-level libraries, HAL and drivers to support STUSB1602
- Firmware examples for Provider, Consumer and DRP using P-NUCLEO-USB002.
- Software PC utility (Command Line Interface)

Key features including Device Policy Manager, Policy Engine and Protocol Layer
- Cable detection and orientation
- USB-PD messages coding/decoding
- Supports vendor-defined messages (Alternate Modes)
- Billboard driver
- SOP' and SOP"

STM32 USB-PD libraries are PD 3.0 ready, enabling new optional features such as PPS, Authentication and FW upgrade.
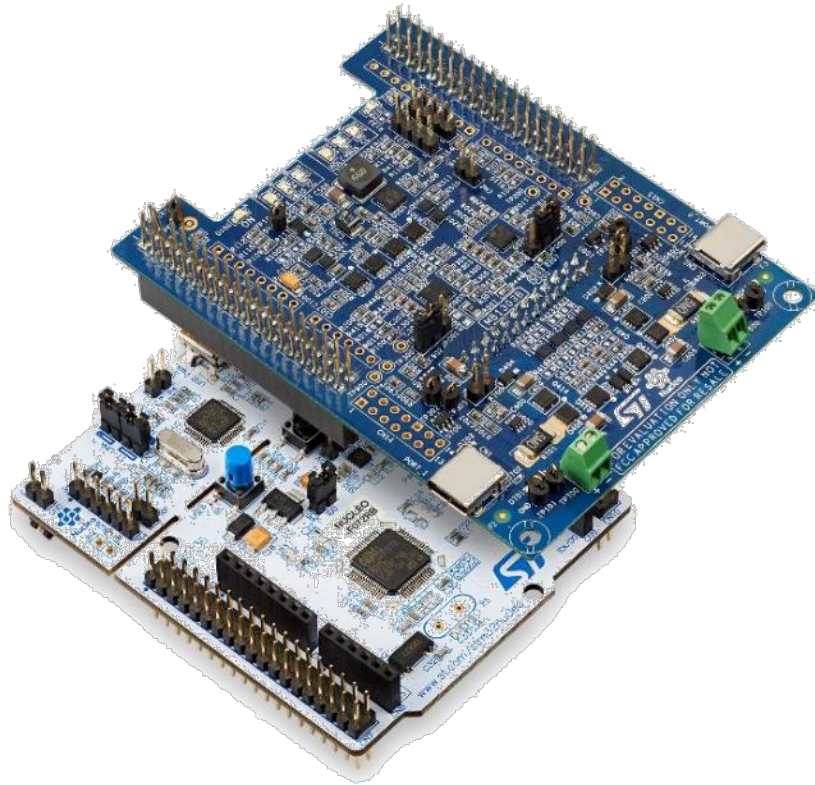
life.augmented

HW resources	FW Resources (Flash/RAM in Kbytes)	
Min Use case : STM32 min peripheral set to control STUSB1602	**Min** Use case : SRC only + PD 2.0	**Max** Note : DRP + VDM + Billboard +VCONN swap + PD3
1 port • 1 I²C , 1 SPI, 4 I/Os (reset, Alert, Side, TX_EN, A_B_Side)	• 30.5K / 5.7K	• 47K / 7.8K
2 port • 1 I²C , 2 SPI, 8 I/Os (reset, Alert, Side, TX_EN, A_B_Side)	• 31.2K / 6.7K	• 53K / 8.8K

- Select the best STM32 MCU using our "MCU finder" to meet application and USB PD stack requirements.

STM32   STM8

MCU Finder

MCU Selector

STM32F030RC

Mainstream ARM Cortex-M0 Value line MCU with 256 Kbytes Flash, 48 MHz CPU

ACTIVE Product is in mass production   Unit Price for 10kU from US$1.21   LQFP64 (10x10mm)

Features | Block Diagram | Datasheet | Docs & Ressources | Buy | STM32CubeMX

Peripherals	ND	Max
ADC 12-bit	1	16
ADC 16-bit	0	0
AES		
CAN	0	1
COMP	0	2
DAC 12-bit	0	2
DCMI		
DES/TDES		
DFSDM		
DSIHOST		
Ethernet		
FMC		
FMPI2C		
FSMC		
HDMI CEC		
HMAC		
HRTIM		
I2C	1	2
I2S	0	2
IRTIM		
LPTIM	0	0
LPUART		
MD5		
OPAMP	0	0
QUADSPI		
RTC		
SAI	0	0
SDIO		
SDMMC		
SHA		
SPDIFRX		
SPI	1	2
SWPMI		
Segment LCD		
TFT LCD		
TRNG		
Timer 16-bit	0	8
Timer 32-bit	0	1
Touch Sensing		
UART	0	0
USART	0	8
USB Device		
USB OTG_FS		
USB OTG_HS		

MCUs List: 65 Items

...	Reference	Package	Flash	RAM	IO	I2C	SPI	USB Device
S...	STM32F030C8Tx	LQFP48 (7x7mm)	64 KBytes	8 kBytes	39	2	2	0
S...	STM32F030R8Tx	LQFP64 (10x10mm)	64 KBytes	8 kBytes	55	2	2	0
S...	STM32F051C8Tx	LQFP48 (7x7mm)	64 KBytes	8 kBytes	39	2	2	0
S...	STM32F051C8Ux	UFQFPN48 (7x7mm)	64 KBytes	8 kBytes	39	2	2	0
S...	STM32F051K8Tx	LQFP32 (7x7mm)	64 KBytes	8 kBytes	25	1	1	0
S...	STM32F051K8Ux	UFQFPN32 (5x5mm)	64 KBytes	8 kBytes	27	1	1	0
S...	STM32F051R8Hx	UFBGA64 (5x5mm)	64 KBytes	8 kBytes	55	2	2	0
S...	STM32F051R8Tx	LQFP64 (10x10mm)	64 KBytes	8 kBytes	55	2	2	0
S...	STM32F051T8Yx	WLCSP36	64 KBytes	8 kBytes	29	1	1	0
S...	STM32F058C8Ux	UFQFPN48 (7x7mm)	64 KBytes	8 kBytes	38	2	2	0
S...	STM32F058R8Hx	UFBGA64 (5x5mm)	64 KBytes	8 kBytes	54	2	2	0
S...	STM32F058R8Tx	LQFP64 (10x10mm)	64 KBytes	8 kBytes	54	2	2	0
S...	STM32F058T8Yx	WLCSP36	64 KBytes	8 kBytes	28	1	1	0
S...	STM32F071C8Tx	LQFP48 (7x7mm)	64 KBytes	16 kBytes	37	2	2	0
S...	STM32F071C8Ux	UFQFPN48 (7x7mm)	64 KBytes	16 kBytes	37	2	2	0
S...	STM32F071V8Hx	UFBGA100 (7x7mm)	64 KBytes	16 kBytes	87	2	2	0
S...	STM32F071V8Tx	LQFP100 (14x14mm)	64 KBytes	16 kBytes	87	2	2	0
S...	STM32F072C8Tx	LQFP48 (7x7mm)	64 KBytes	16 kBytes	37	2	2	1
S...	STM32F072C8Ux	UFQFPN48 (7x7mm)	64 KBytes	16 kBytes	37	2	2	1
S...	STM32F072R8Tx	LQFP64 (10x10mm)	64 KBytes	16 kBytes	51	2	2	1
S...	STM32F072V8Hx	UFBGA100 (7x7mm)	64 KBytes	16 kBytes	87	2	2	1
S...	STM32F072V8Tx	LQFP100 (14x14mm)	64 KBytes	16 kBytes	87	2	2	1
S...	STM32F070CBTx	LQFP48 (7x7mm)	128 KBytes	16 kBytes	37	2	2	1
S...	STM32F070RBTx	LQFP64 (10x10mm)	128 KBytes	16 kBytes	51	2	2	1
S...	STM32F071CBTx	LQFP48 (7x7mm)	128 KBytes	16 kBytes	37	2	2	0

life.augmented

STM32 Nucleo development pack

ORDERING CODE:
P-NUCLEO-USB002 ($49.90)

Main features

- 2 x full-featured USB Type-C™ ports
  - Provider, Consumer and Dual Role
  - 600mA V_{CONN} & discharge path
  - Dead battery support
- On-board power management
- Dedicated power connector to interface with an external power supply (not included in the kit)

- NUCLEO-F072RB
- Dual-port certified USB Type-C Nucleo shield with two STUSB1602 AFE
- Full-feature 3A certified cable

| USB-C and PD Solution	Benefits

• Compliant with USB-C 1.2 and PD 2.0 :
  ✓ Provider/Consumer/DRP
  ✓ Cable detection and orientation
  ✓ Attach/detach, role of port partners
  ✓ Current capability detection
  ✓ PD communication + VDM
 	
• Highly integrated USB-C analog front-end controller (STUSB1602) with :
  ✓ V_{BUS} monitoring
  ✓ V_{BUS} discharge switch
  ✓ CC termination & HV protection
  ✓ Dead battery switch, SNK and SRC gate drivers, V_{CONN} switches and over-current protection
• Entry level STM32F0 Cortex-M0 MCU companion IC with:
  ✓ USB PD r2.0 stack and drivers.
  ✓ Versatile set of peripherals (ADC, DAC, SMBUS, I2C, USB 2.0)
• Device Firmware Upgrade
• Authentication over USB PD protocol capability
• Battery charging detection (v1.2)
	High Flexibility to support various topologies, specific application use-cases and fast **Adaptability** vs USB standard evolution (PD r3 ready).
	
	Safe solution
	
	Low BOM

Software distribution

Type	Binary library distribution, with examples and drivers in source code Runs on STM32 microcontrollers only
License	Binary under MCD-ST Ultimate Liberty V2 Source code under open-source BSD or MCD-ST Ultimate Liberty V2
Certification	Fully certified solution
Location	Available for download on www.st.com/x-cube, once users are logged in

Note: Library sources can be obtained under NDA upon request to nearest ST sales office:
- Library sources will be provided under MCD-ST Liberty License V2 that prevents source redistribution
- Users can modify library sources, but changes will require a re-certification
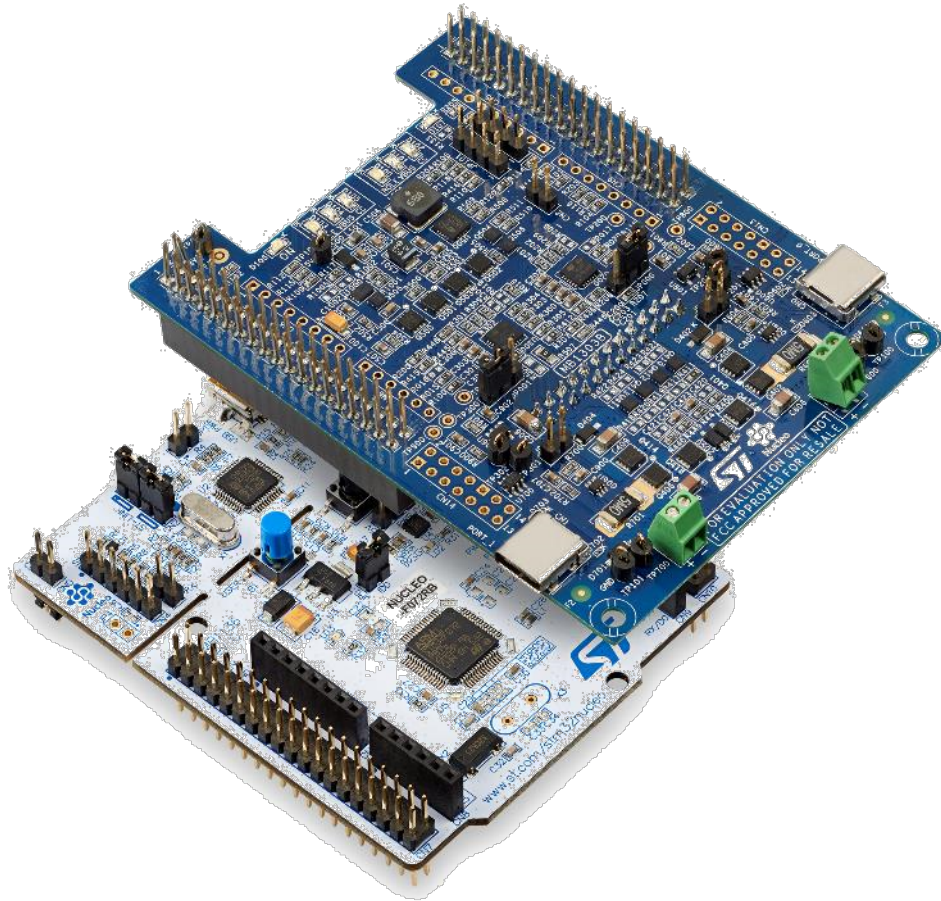
www.st.com/x-nucleo
www.st.com/x-cube

/STMicroelectronics

@ST_World

community.st.com

life.augmented