USB Type-C™ and Power Delivery

Overview:
Flexible, robust solution for power and interconnect

Type-C & USB-PD Architecture Features

ST products for Type-C & USB-PD

Type-C & USB-PD Solution
USB Type-C Overview

USB Power Delivery specification introduces USB Type-C receptacle, plug and cable; they provide a smaller, thinner and more robust alternative to existing USB interconnect. Main features are:

- Enable new and exciting host and device form-factors where size, industrial design and style are important parameters
- Work seamlessly with existing USB host and device silicon solutions
- Enhance ease of use for connecting USB devices with a focus on minimizing user confusion for plug and cable orientation
USB Type-C with Power Delivery

New USB Type-C receptacle, plug and cable; a smaller, thinner and more robust alternative to existing USB interconnect

Enables new and exciting host and device form-factors where size, industrial design and style are important parameters

Work seamlessly with existing USB host and device silicon solutions

Enhances ease of use for connecting USB devices
Focus on minimizing user confusion for plug and cable orientation
The Re-Evolution of USB

USB has evolved from a data interface capable of supplying limited power to a primary provider of *power* with a data interface.

- **Power Delivery**: More *Power* with USB Power Delivery (100W)
- **Type-C**: More *Flexibility* with a new reversible USB-C connector
- **Alternate Mode**: More *Protocols* (Display Port, HDMI, Thunderbolt …)
- **USB IF**: More Speed with USB 3.2 (20 Gbit/s)
## USB Type-C: More Power Options

<table>
<thead>
<tr>
<th>Mode of Operation</th>
<th>Nominal Voltage</th>
<th>Maximum Current</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB 2.0</td>
<td>5 V</td>
<td>500 mA</td>
<td>Default current, based on definitions in the base specifications</td>
</tr>
<tr>
<td>USB 3.1</td>
<td>5 V</td>
<td>900 mA</td>
<td></td>
</tr>
<tr>
<td>USB BC 1.2</td>
<td>5 V</td>
<td>Up to 1.5 A</td>
<td>Legacy charging</td>
</tr>
<tr>
<td>USB Type-C @ 1.5 A</td>
<td>5 V</td>
<td>1.5 A</td>
<td>Supports high power devices</td>
</tr>
<tr>
<td>USB Type-C @ 3.0 A</td>
<td>5 V</td>
<td>3 A</td>
<td>Supports higher power devices</td>
</tr>
<tr>
<td>USB PD</td>
<td>Configurable up to 20 V</td>
<td>Configurable up to 5 A</td>
<td>Directional control and power level management</td>
</tr>
</tbody>
</table>
USB Type-C Power Rules

Example #1
- 18W

Example #2
- 50W

Current (A) vs. Source Power Rating (W)
- 5V: 7.5W
- 9V: 15W
- 15V: 27W
- 5 + 9V: 45W
- 5 + 9 + 15V: 45W

Graph showing the power and current relationships for USB Type-C.
USB Type-C™ Pin Outs Functions

### Receptacle

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>A7</th>
<th>A8</th>
<th>A9</th>
<th>A10</th>
<th>A11</th>
<th>A12</th>
</tr>
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<tbody>
<tr>
<td>GND</td>
<td>TX1+</td>
<td>TX1-</td>
<td>VBUS</td>
<td>CC1</td>
<td>D-</td>
<td>D+</td>
<td>SB1</td>
<td>VBUS</td>
<td>RX2-</td>
<td>RX2+</td>
<td>GND</td>
<td></td>
</tr>
<tr>
<td>B12</td>
<td>B11</td>
<td>B10</td>
<td>B9</td>
<td>B8</td>
<td>B7</td>
<td>B6</td>
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<td>B4</td>
<td>B3</td>
<td>B2</td>
<td>B1</td>
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</tr>
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</table>

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

### Plug

<table>
<thead>
<tr>
<th></th>
<th>A12</th>
<th>A11</th>
<th>A10</th>
<th>A9</th>
<th>A8</th>
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<th>A3</th>
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</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>RX2+</td>
<td>RX2-</td>
<td>VBUS</td>
<td>SBU1</td>
<td>D-</td>
<td>D+</td>
<td>CC</td>
<td>VBUS</td>
<td>TX1-</td>
<td>TX1+</td>
<td>GND</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>B2</td>
<td>B3</td>
<td>B4</td>
<td>B5</td>
<td>B6</td>
<td>B7</td>
<td>B8</td>
<td>B9</td>
<td>B10</td>
<td>B11</td>
<td>B12</td>
<td></td>
</tr>
</tbody>
</table>

On a standard USB Type-C cable, only a single CC wire within each plug is connected through the cable to establish signal orientation. The other CC pin is repurposed as VCONN for powering electronics. Also, only one set of USB 2.0 D+/D- wires are implemented.
Architecture and key words

Communication across the channel uses Biphasa Mark Coding (BMC) over CC in Type C connector.
USB Type-C CC Connections

• Detect attach/detach of USB ports, e.g. a DFP to a UFP
• **Resolve cable orientation and twist connections** to establish USB data bus routing
• Establish DFP and UFP roles between two attached ports
• Discover and configure VBUS
• USB Power Delivery Communication
System Policy Manager (system wide) is optional. It monitors and controls System Policy between various Providers and Consumers connected via USB.

Device Policy Manager (one per Provider or Consumer) provides mechanisms to monitor and control the USB-PD within a particular Provider or Consumer. It enables local policies to be enforced across the system by communication with the System Policy Manager.

Policy Engine (one per Source or Sink Port) interacts directly with the Device Policy Manager in order to determine the present local policy to be enforced.

The Protocol Layer forms the messages used to communicate information between a pair of ports. It receives inputs from the Policy Engine indicating which messages to send and indicates the responses back to the Policy Engine.

It is responsible for sending and receiving messages across either the VBUS or CC wire. It consists of a transceiver that superimposes a signal (BFSK on VBUS or BMC on CC) on the wire.

It is responsible for managing data on the wire and for collision avoidance and detects errors in the messages using a CRC.
ST Products for USB Type-C & PD

ST Chipset: A flexible offer in the USB Type-C PD ecosystem

- Scalable offer for USB-PD controller and USB Type-C interface: from STM32 general purpose MCU to hard-coded solution to fit different use cases and power ratings
- Large product portfolio for protection and filtering covering all the application needs
- Highly secure solution using STSAFE secure element family for strong authentication needs

Diagram details:
- SuperSpeed Switch
- Host USB 3.x CTRL, AP, etc.
- USB PD Controller (MCU or ASSP)
- USB Type-C Interface (PHY)
- Power Management
- Authentication
- Protectors
- USB 3.x
- USB 2.0
- D+/D-
- Rx/Tx pairs
- SBUx
- VBUS
- CC lines
- USB-C receptacle
- USB Type-C
USB Type-C™ and USB PD Controller

STUSB Family: from USB Type-C Interface to 100% HW Power Delivery Controllers

<table>
<thead>
<tr>
<th>Standalone ICs</th>
<th>Analog Front-end</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUSB1600</td>
<td>STUSB1602</td>
</tr>
<tr>
<td>USB Type-C controller with Vconn SWITCH</td>
<td>USB Type-C controller with PD PHY and BMC driver</td>
</tr>
<tr>
<td>Power Delivery controller Provider only</td>
<td></td>
</tr>
</tbody>
</table>

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- **USB Type-C**: Up to 15W
- **Power Delivery**: 15W to 100W
- **Alternate Mode**: 5W to 100W

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- **Standalone ICs**
  - **STUSB1600**: USB Type-C controller with Vconn SWITCH
  - **STUSB4700**: Power Delivery controller Provider only
  - **STUSB1602**: USB Type-C controller with PD PHY and BMC driver

- **Analog Front-end**

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*Image credits to STMicroelectronics*
A complete offer to “lean in” USB PD Ecosystem

- Host, USB 3.1 Controller
- Access Point (optional)
- SuperSpeed Switch
- USB Power Delivery Controller
- USB Power Delivery Stack Middleware
- PHY-Type-C Interface
- Type-C Connector
- Power Management
Profile 1-2-3

Power source building blocks

- Flyback Controller: STCH02
- Power MOSFET
- Rectifier
- CC/CV SEA01
- Feedback Network Selection
- USB PD Interface IC
- DC/DC Post regulation
- Multi Port case: Post regulation for each port

- It covers profile 1-2-3 from 5W to 45W
- High Efficiency
- Low EMI design: intelligent Jitter for EMI suppression
STCH02

Primary side controller: Adapters up to 45W

- Proprietary Constant current output regulation (CC) with no opto-coupler
- 700V embedded HV start-up circuit
- Quasi-resonant (QR) Zero Voltage Switching (ZVS) operation
- Valley skipping at medium-light load and advanced burst mode operation at no-load for under 10mW consumption
- Accurate adjustable output OVP

Features
- Low part count. BOM reduction thanks to an extensive features integration
- Exceeding 5 stars: No-Load power < 10mW
  - HV start-up zero power consumption
  - Advanced burst-mode operation
- Flexibility: suitable for adapters from 5W to 40W
- High Efficiency
- Low EMI design: intelligent jitter for EMI suppression
Profile 4, 5
Power source building blocks

High Voltage
- PFC L6563H
- Power MOSFET
- LLC L6699
- PFC-LLC Integrated New solution STCMB1

Low Voltage
- Main transformer
- Synchronous Rectification SRK2001
- Power MOSFET
- CC/CV SEA01

Post Regulation
- DC/DC Post regulation
- USB PD Interface IC
- 1 per port
L6563H Transition mode PFC controller

Features
- 700V High Voltage Start-up circuit
- Fast bidirectional input voltage feed-forward
- Adjustable OVP
- AC Brownout Detection
- Tracking boost function
- Inductor saturation protection
- Proprietary THD optimizer circuit
- Interface for cascaded converters
- -600mA/+800mA gate driver

Low steady state ripple and current distortion with limited under- or overshoot of the pre-regulator’s output thanks to new input voltage feed-forward implementation
- Reduced THD of the current
- High reliability thanks to a full set of protections
- HV start-up significantly reduces consumption compared to standard discrete circuit solutions
- Facilitated cooperation with cascaded DC-DC converter thanks to several power management & housekeeping functions

Datasheet: available on www.st.com
High power adapters 90W to 250W

Series-resonant half-bridge topology

Datasheet: available on www.st.com

Features

- Self adjusting adaptive dead time
- Anti-capacitive mode protection
- Two-level OCP: Frequency shift and Immediate shutdown
- Safe-start procedure
- Burst-mode operation at light load
- Brown-out protection
- Interface with PFC controller

High efficiency:
- Reduced internal consumption (Iq=1mA)
- Adaptive dead time allows design optimization to achieve ZVS with lower magnetizing current
- Improved reliability and lifetime thanks to anti-capacitive protection and smooth start-up circuit
- Reduced audible noise when entering burst-mode operation thanks to smooth restart feature
USB-PD

Power MOSFET product families

800V-1500V
K5
Flyback

600V-650V
M2
M6
Flyback/PFC/LLC
Price/Performance
Premium efficiency

40-120V
F7
Synch Rec
VHV Power MOSFETs

Features
- Unmatched $R_{DS(on)}$ at very high BVDSS - 800-950V-1050V
- Ultra-Low $Q_G$ and high switching speed
- Extremely low thermal resistance
- High quality & reliability

Benefits
- Lower on-state conduction losses
- Best switching losses
- High efficiency with lower design complexity
- Ultra small Form factor

Product range example

<table>
<thead>
<tr>
<th>Part Number</th>
<th>$B_{VDss}$</th>
<th>$R_{DS(on)}$</th>
<th>$I_D$</th>
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<tbody>
<tr>
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<td>800V</td>
<td>0.45Ω</td>
<td>12A</td>
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<tr>
<td>STD8N80K5</td>
<td>800V</td>
<td>0.95Ω</td>
<td>6A</td>
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<tr>
<td>STD9N80K5</td>
<td>800V</td>
<td>0.90Ω</td>
<td>7A</td>
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</table>
**Power MOSFET**

**PFC & LLC architecture**

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**Product range example**

<table>
<thead>
<tr>
<th>PFC</th>
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<tbody>
<tr>
<td>STF24N60M2</td>
</tr>
<tr>
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<tr>
<td>R&lt;sub&gt;DS(on)&lt;/sub&gt;</td>
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<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>R&lt;sub&gt;DS(on)&lt;/sub&gt;</td>
</tr>
<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
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<td>V&lt;sub&gt;DSS&lt;/sub&gt;</td>
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<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
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<table>
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<tr>
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<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
</tr>
<tr>
<td>STF15N60M2-EP</td>
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<tr>
<td>V&lt;sub&gt;DSS&lt;/sub&gt;</td>
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<tr>
<td>R&lt;sub&gt;DS(on)&lt;/sub&gt;</td>
</tr>
<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
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<tr>
<td>STF11N60M2-EP (e.s.available)</td>
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<tr>
<td>V&lt;sub&gt;DSS&lt;/sub&gt;</td>
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<tr>
<td>R&lt;sub&gt;DS(on)&lt;/sub&gt;</td>
</tr>
<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
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</tbody>
</table>

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**Features**
- Up to 30% lower Q<sub>G</sub> vs main competition (equivalent die size)
- 400 – 700V BV<sub>DSS</sub> rated
- Back-to-Back G-S Zener protected

**Benefits**
- Reduced switching losses
- Enhanced immunity vs ESD & Vgs spikes
- Technologies dedicated to specific topology

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**Product range example**

**PFC Performance**

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<tbody>
<tr>
<td>STL24N60</td>
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**LLC Performance**

<table>
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<td>R&lt;sub&gt;DS(on)&lt;/sub&gt;</td>
</tr>
<tr>
<td>I&lt;sub&gt;D&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

**LLC Premium**

**STL24N60M2**

600V, 210mΩ, 28nC

PowerFLAT8x8

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**life.augmented**
Power MOSFETs
Synchronous rectification

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Voltage</th>
<th>Ron</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>STL260N4LF7</td>
<td>40V</td>
<td>&lt;1.1mΩ</td>
<td>5.5A</td>
</tr>
<tr>
<td>STL200N45LF7</td>
<td>40V</td>
<td>&lt;1.8mΩ</td>
<td>11A</td>
</tr>
</tbody>
</table>

Features
- Very low $R_{\text{DS(on)}}$
- Proper $C_{\text{OSS}}$
- Low $V_{\text{SD}}$ and $Q_{\text{RR}}$ with soft recovery body-drain diode
- LL $V_{\text{th}}$

Benefits
- Efficiency improvement due low conduction losses and to static and dynamic diode ones, minimized switching noise and $V_{\text{ds}}$ spike at turn OFF
- Easy driving features
Protections

A complete offer to “lean in” USB PD Ecosystem

Host, USB 3.1 Controller, Access Point (optional)

SuperSpeed Switch

USB Power Delivery Controller

USB PD Stack Middleware

Power Management

PHY-Type-C interface

Protection

Type-C connector
Protections
ESD/CMF/ECMF

High flexibility for the Designers needs to find best compatibilities

ESD Protection

- Robustness: Surge capability up to 25kV and low clamping
- Flexibility & Integration: Single or multi lines products
- Transparency: High bandwidth for high speed signals

ESD + CMF

- High quality of protection
- Unique filtering shape capabilities
- Serial Interface: USB2.0/3.0, MIPI, DP, HDMI
- Filters radiated noise and limits antenna de-sense.

ECMF = ESD + CMF integrated

- High quality of protection
- High integration: 1mm2 / 2 differential lines
- Serial Interface: USB2.0/3.0, MIPI, DP, HDMI
- Filters radiated noise and limits antenna de-sense
Type-C and USB PD Controller

A complete offer to “lean in” USB PD Ecosystem

Host, USB 3.1 Controller Access Point (optional)

SuperSpeed Switch

USB Power Delivery Controller

PHY- Type-C interface

Power Management

Type-C connector

Protections
Controller & Interface

Offering flexible and scalable solutions for designers

USB PD Controller
- MCU Based
- STM32
- FW USB PD Stack
- Adaptability versus USB PD specification new release
- PHY-Type-C interface companion chip
- Market proven solution

PHY-Type-C Interface
- STUSB16
- Dual Role Type-C Interface with BMC
- Dual role capability
- Configurable start-up profiles
- Interface with external MCU through I²C
- Accessory support

USB PD Hard Coded Controller
- STUSB47
- HW USB PD Stack
- Flexible HW-SW partitioning
- Autorun or Micro based
- Easy Dead Battery Support
- P2P with PHY-Type-C interface
Key Message #4AC/DC 45W USB-C PD adapter with SR (STEVAL-USBPD45C)

Key Features

- Modular design composed of Power Supply Board (PSB) STEVAL-USBPD45P and Digital Control Board (DCB) STEVAL-USBPD45I.
- Adaptive Synchronous Rectification with direct driving managed by STM32 for better efficiency.
- USB Type-C and Power Delivery based on certified STM32F0 and STUSB1602A.
- Supported PDOs: 5V@3A, 9V@3A, 15V@3A, 20V@2.25A
- VDM support for customized messages and features
- PD 3.0 core features support

Key Products

- Primary Side Controller: STCH02 (or STCH03)
  High efficient and fully integrated AC-DC controller with primary CC regulation enabling, low stand-by power, high efficiency and low EMI design of AC-DC adapters

- Primary MOSFET: STF7N80K5
  MDmesh™ K5 HV Power MOSFET with reduced switching losses and ultra-low gate charge for applications requiring superior power density and high efficiency

- SR MOSFET: STL40N75LF3
  STRipFET™ III N-Channel Power MOSFET specifically designed to minimize on-resistance and gate charge to provide superior switching performance

- USB PD and SR Controller: STM32F051K8U7
  32-bit ARM Cortex™-M0 48 MHz, managing USB Power Delivery Stack (X-CUBE-USB-PD) and Synchronous Rectification

- USB Type-C Interface: STUSB1602A
  Type-C™ Interface with PD PHY BMC driver, featuring high voltage protections on VBUS and CC lines, VBUS monitoring and discharge path

ORDERING CODE:
STEVAL-USBPD45C: STEVAL-USBPD45P + STEVAL-USBPD45I (STM32F051+STUSB1602A)
Digital Control Board: STEVAL-USBPD45I features

Advantages on using the STM32F051 + STUSB1602A solution (STEVAL-USBPD45I)

- Even if 48MHz clock could limit the execution time, the integrated functionalities of STUSB1602A help on Type-C and PD management.
- For Type-C and PD only I2C and SPI peripherals needed
- No Comparator with integrated blanking window
- Two Comparators available allowing Adaptive SR
- Lower cost solution
STEVAL-USBC2DP: USB Type-C to DisplayPort adapter

Key Features:
- The USB Type-C to DisplayPort Adapter expands a USB Type-C laptop screen onto a monitor or projector equipped with DisplayPort.
- Based on the Alternate Mode Functional Extension of the USB Type-C & Power Delivery to enables the DisplayPort interface.

Key Products
- **STM32F072**: the high-performance ARM® Cortex®-M0 32-bit RISC core operating at up to 48 MHz frequency, high-speed embedded memories and with USB 2.0 data interface.
- **LDK220**: 200 mA low quiescent current and low noise LDO.
- **STG3684A**: Low Voltage 0.5 Ohm Max Dual SPDT Switch with Break-Before-Make.
- **ESDALC5-1BF4**: Low clamping and low capacitance bidirectional single line ESD protection.
- **STPS0520Z**: Power Schottky rectifier.
- **X-CUBE-USB-PD**: STM32 USB-PD package consisting of libraries and application examples for STM32F0 devices acting as USB-PD controllers.

Competitive Advantages:
- Type-C Alternate Mode demo in a compact PCB design (5.5 x 2.3 mm).
- Full ST BOM for a cost-effective solution based on Discrete AFE approach.
- Including the DFU feature.
USB-PD Provider Solution

• AC/DC Multi-output 45W Converter
  • Based on STCH02 QR controller
  • Multiple Output voltages (5V, 9V, 12V)

• STUSB4700 hard coded controller
  • to interface with USB-C connector
  • to handle the USB Power Delivery protocol
  • No software, better reliability
ST 45W Adapter for ST USB-PD

Board Layout: dimensions: L=3.47in, W=1.42in, H=0.95in

Top view

- FERD20H100S
- STF10LN80K5
- HF XFRM*
- Control Board with STUSB4700 and TS391
- Connection for Captive Cable: Vbus, GND, CC line

Bottom view

- AC Input
- Opto
- STCH02
- Stripline Conn for Control Board
- DSCH Switch
- Load Switch

*RM10 Core Replaced EFD20
USB PD 2.0 Vs. USB PD 3.0

USB 3.0 ensures full compatibility with respect to USB 2.0 and requires some additional optional and mandatory features.

<table>
<thead>
<tr>
<th>New mandatory features in USB PD 3.0</th>
<th>Enables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery status data message (Required for systems with batteries)</td>
<td>Reporting of the battery state of charge</td>
</tr>
<tr>
<td>Battery capabilities extended message (Required for systems with batteries)</td>
<td>Reporting of the battery design capacity and last full charge capacity</td>
</tr>
<tr>
<td>Tighter control on communication to the cable (Required)</td>
<td>Only the $V_{CONN}$ source to communicate to the cable plug e-marker</td>
</tr>
<tr>
<td>Source-coordinated collision avoidance (Required)</td>
<td>A more robust mechanism to avoid collisions caused when both source and sink want to send messages beyond the typical power negotiation. USB PD 2.0 has a collision-avoidance mechanism, but with the many new optional messages that may be sent in USB PD 3.0 a more robust method was needed</td>
</tr>
<tr>
<td>Not supported control message (Required)</td>
<td>A way to inform a port partner that a particular message is not supported. This is meant to help in the future as USB PD 3.0 expands to include more options and features.</td>
</tr>
</tbody>
</table>

- The voltages required by the new “Power Rules” are 5V, 9V, 15V, and 20V.
- USB PD 3.0 new features are not necessary in all application
- A simple Source device may not need USB PD 3.0 new features

For others optional features visit [http://www.usb.org/developers/powerdelivery/](http://www.usb.org/developers/powerdelivery/)
Efficiency: 120VAC Input Voltage

- Power measured at output capacitor
- Tested at 5V and 15V; Load current swept from 0.1A to 3A
- ST Nucleo USB-PD board connected as a host
- Input Power Measured with Yokogawa WT200
- Output current and Voltage measured with Fluke True RMS Digital Multimeters
- Efficiency measured at room temperature after 20 min operation at full power
- No cable drop compensation

![Efficiency 5V, 120Vac](image1)

![Efficiency at 15V, 120Vac](image2)
Efficiency: 230VAC Input Voltage

- Power measured at output capacitor
- Tested at 5V and 15V; Load current swept from 0.1A to 3A
- ST Nucleo USB-PD board connected as a host
- Input Power Measured with Yokogawa WT200
- Output current and Voltage measured with Fluke True RMS Digital Multimeters
- Efficiency measured at room temperature after 20 min operation at full power
USB-PD Dual Role Solution
MCU + Analog Front-End overview

• STM32 Embedded Software Solution + STUSB1602 AFE
  • Provide Flexibility
  • Possibility to customize the software

• Hardware: Entry level Cortex-M0 based STM32F0 microcontroller series with simple discrete Analog Front End PHY
• Embedded Software: USB-C & PD Middleware

Best device for 2 ports management: STM32F051 in 48 pin package
Best device for 1 port management: STM32F051/31 in 20/32 pin package
MCU Overview

STM32F0 HW resources

- Transmission uses: **TIM14, SPI1, DMA, GPIO**
- Reception uses: **TIM3, DMA, 1 comparator**
- **TIM2** is used to time-schedule tasks
- Embedded **ADC** to detect device on the CC bus and perform power measurements
- **CRC** to evaluate message's CRC
- Standard GP I/Os to control Vconn, Load switch, Vbus discharge switch, Vout selection (primary feedback...)

<table>
<thead>
<tr>
<th>Project</th>
<th>Flash Memory</th>
<th>RAM Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provider only</td>
<td>25.5 kB</td>
<td>4.4 kB</td>
</tr>
<tr>
<td>Provider only (RTOS)</td>
<td>29.0 kB</td>
<td>7.3 kB</td>
</tr>
<tr>
<td>Provider/Consumer DRP (RTOS)</td>
<td>30.2 kB</td>
<td>7.3 kB</td>
</tr>
</tbody>
</table>
USB-PD Interface
STUSB16xx

Features

- Dual Role Type-C Interface with BMC
- Dual role capability
- Configurable start-up profiles
- 600mA VCONN
- 120uA Idle current measured
- Interface with external MCU through I²C+Interrupt
- Integrated Voltage monitoring
- Integrated VBUS discharge path
- Accessory support
- Dual Power supply:
  - \( V_{SYS} = 3.3V \),
  - \( V_{DD} [4.6V; 22V] \) (from VBUS)

Benefits

- Low Pin count
- Integrated BMC transceiver
- Simple, Robust
- Configurable, Flexible
- Optimized for Portable applications
- P2P with STUSB4x
X-NUCLEO-USBPDM1

- USB-C Power Delivery expansion board with two USB Type-C connectors for two port management

- Main features:
  - Two Dual Role Port
  - Dedicated Power Connector to interface with external Power Supply board providing different profiles (up to 20V and 5A) and \( V_{\text{CONN}} \)
  - On-board Power management able to provide internal needed voltages from \( V_{\text{BUS}} \)
  - Six debug LEDs
  - USB 2.0 interface capability available on one port
  - Compatible with STM32 Nucleo boards
  - Equipped with ST morpho connectors
**X-NUCLEO-USBPDM1**

Board details

**Power Connector for external Power Source**

**User LEDs**

**Morpho connectors**

**Local Power Management**

**Type-C Receptacle Port 1**

**Power Role Configuration Port 1**

**CC AFE and V_{CONN} Switch Port 1**

**VBUS Port 1 Switch and discharge**

**VBUS Port 1 Switch and discharge**

**Connector for V_{BUS} Load Port 1**

**Connector for V_{BUS} Load Port 0**

**VBUS Current/Voltage sensing Port 1**

**VBUS Current/Voltage sensing Port 0**

**Type-C Receptacle Port 0 (USB2.0 Capability)**

**Power Role Configuration Port 0**

**CC AFE and V_{CONN} Switch Port 0**

**VBUS Port 0 Switch and discharge**

**VBUS Current/Voltage sensing Port 0**

**Type-C Receptacle Port 0 (USB2.0 Capability)**