UM2205
User manual

Getting started with the STM32 Nucleo pack for USB Type-C™ and Power Delivery with the Nucleo-F072RB board and the STUSB1602

Introduction

The USB Type-C™ and Power Delivery Nucleo pack P-NUCLEO-USB002 includes:

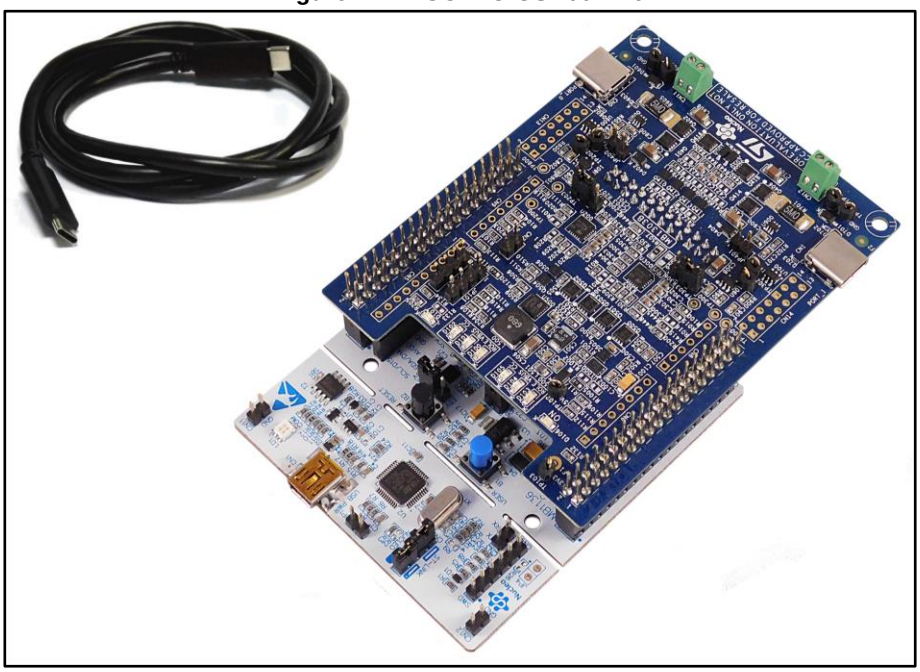
- the NUCLEO-F072RB board
- the P-NUCLEO-USB002 expansion board based on the certified STUSB1602 USB Type-C port controller with PD PHY and BMC driver
- a full-featured Type-C cable

These components, together with the X-CUBE-USB-PD certified STM32F0 USB Type-C PD middleware stack, form a platform for demonstrating USB Type-C and USB Power Delivery (USB PD) capabilities and facilitating solution development.

The new USB PD protocol expands USB functionality by providing up to 100 W power over the same cable used for data communication. Devices supporting the protocol are able to negotiate voltage and current over the USB power pins and define their roles as Provider or Consumer accordingly.

Once the platform is configured, the embedded demonstration firmware can signal cable status (attached or detached) and orientation information, as well as the role of each of the two ports.

Figure 1: P-NUCLEO-USB002 kit



Contents

List of tables

List of figures

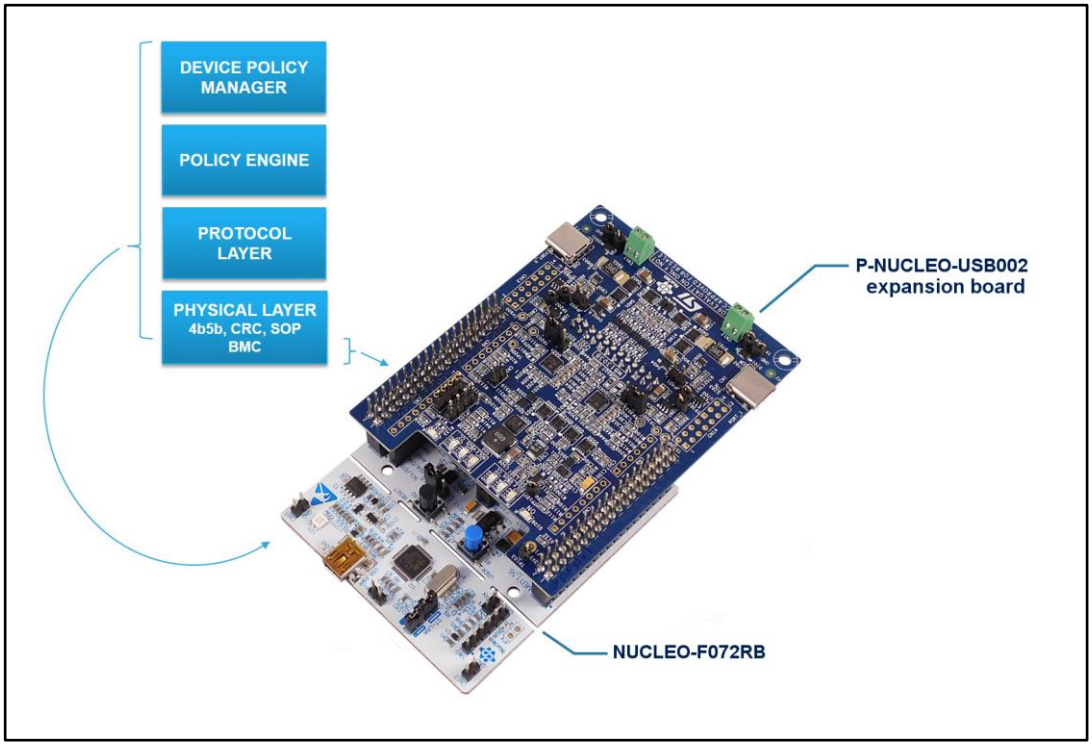
1 Getting started

1.1 System architecture

The P-NUCLEO-USB002 USB Type-C™ and power delivery kit includes:

1. a NUCLEO-F072RB development board acting as the control board running the stack
2. a P-NUCLEO-USB002 expansion board acting as a Type-C and Power Delivery interface, with two STUSB1602 Type-C PD controllers
3. A full-featured and certified USB Type-C cable

Figure 2: The two boards composing the P-NUCLEO-USB002 kit



The P-NUCLEO-USB002 USB Type-C and Power Delivery expansion board is equipped with:

- two DRP USB Type-C™ ports managed by two STUSB1602 Type-C port controllers
- optional V_{BUS} current sensing (and discrete voltage monitoring)
- dedicated power connector to interface with an external power supply (not included) to provide different profiles as well as VCONN (5V), if necessary
- on-board power management able to provide internal supply voltages
- six status-control LEDs for USB-PD port purposes, a user LED and a power LED
- USB 2.0 interface capability available on both Type-C portsthere is only one USB 2.0 controller, which can be mapped to either port or in pass-through configuration.
- RoHS compliant
- PCB type and size:
  - PCB material: FR4
  - four-layer architecture
  - copper thickness: 35 µm

The NUCLEO-F072RB board includes:

- an STM32F072RBT6 32-bit microcontroller based on ARM® Cortex®-M0 with 128-Kbytes of Flash memory, 16-Kbytes of SRAM and a USB 2.0 full speed data interface in a LQFP64 package
- extension resources:
  - Arduino Uno revision 3 connectivity
  - ST morpho extension pin headers for full access to all STM32 I/Os
- on-board ST-LINK/V2-1 debugger/programmer with SWD connector:
  - selection-mode switch to use the kit as a standalone ST-LINK/V2-1
- flexible board power supply:
  - USB VBUS on Type-B connector or external source
  - Power management access point
- LEDs:
  - USB communication (LD1)
  - user LED (LD2)
  - power LED (LD3)
- push buttons:
  - USER
  - RESET
- USB re-enumeration capability; interfaces supported on USB:
  - Virtual Com port
  - Mass storage
  - Debug port
- Supported by various integrated development environments (IDEs):
  - IAR™
  - Keil®
  - GCC-based IDEs

The NUCLEO-F072RB included in the kit has a different solder bridge configuration with respect to the default one (see *Table 1: "Solder bridges and resistors to be modified"*)

1.2 NUCLEO-F072RB STM32 Nucleo board

The STM32 Nucleo board provides an affordable and flexible way for solution and prototype development with any of STM32 microcontroller lines.

The board STM32F072RBT6 32-bit microcontroller is based on the ARM® Cortex®-M0 with 128 Kb Flash memory and 16 Kb SRAM.

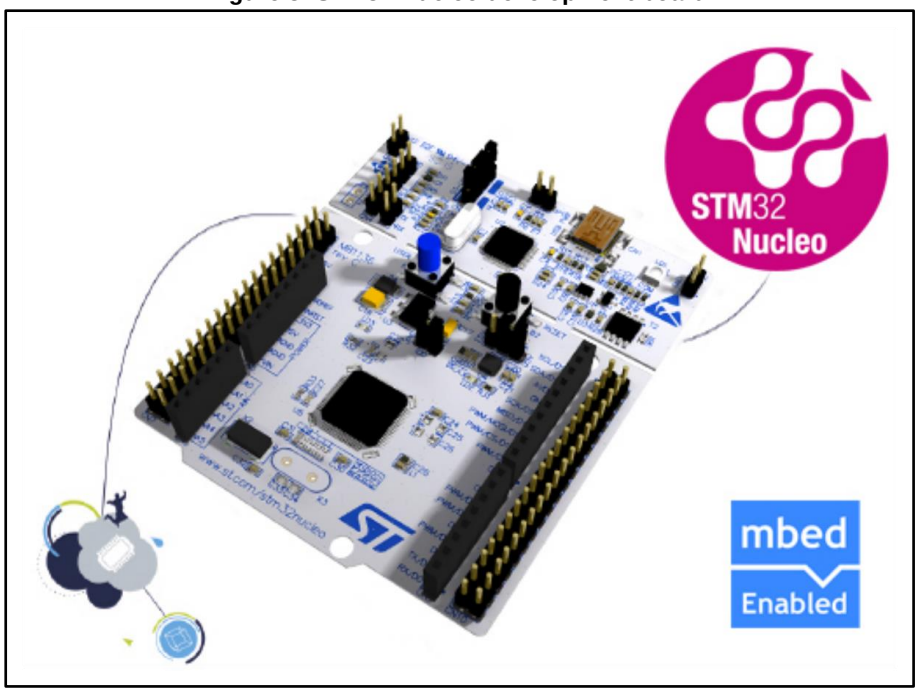
The Arduino™ connectivity support and ST morpho headers make it easy to expand with a wide range of specialized expansion boards.

Separate probes are not required as it integrates the ST-LINK/V2-1 debugger/programmer.

The STM32 Nucleo board comes with the comprehensive STM32 HAL software library together with various packaged software examples.

Visit *http://www.st.com/stm32nucleo* for more information.

Figure 3: STM32 Nucleo development board



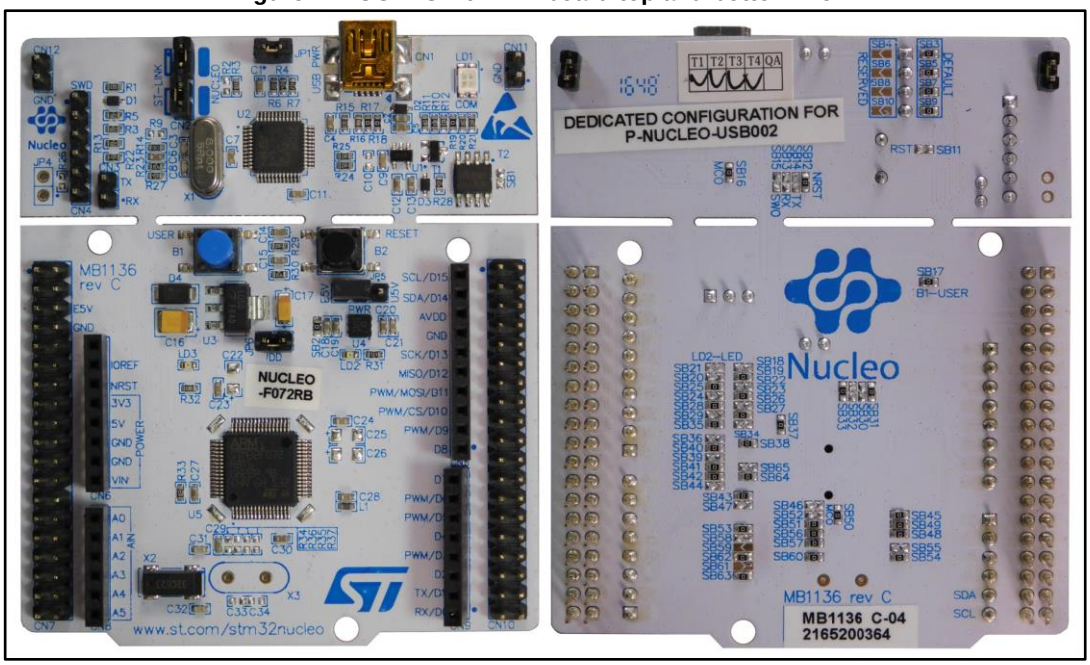
The solder bridge configuration on the NUCLEO-F072RB Nucleo board is customized to support USB PD applications (see *Table 1: "Solder bridges and resistors to be modified"* and *Figure 4: "NUCLEO-F072RB board top and bottom view"*).

For further information, please refer to user manual *UM1724 STM32 Nucleo-64 boards* on www.st.com.

Table 1: Solder bridges and resistors to be modified

Bridge reference	State	Description
SB13	OFF	PA2 and PA3 on STM32F103CBT6 (ST-LINK MCU) are disconnected from PA3 and PA2 of the STM32F072RBT6 MCU.
SB14		
SB15	OFF	The SWO signal is not connected to PB3 on STM32F072RBT6 MCU.
SB21	OFF	Green user LED LD2 is not connected to PA5 on STM32F072RBT6 MCU.
R34	OFF	LSE not used: PC14 and PC15 used as GPIOs instead of low speed clock.
R36		
SB48	ON	
SB49		
SB62	ON	To connect another USART (not the default USART2) to STLINK MCU, using flying wires between ST morpho connector and CN3. SB13 and SB14 should be OFF.
SB63		

Figure 4: NUCLEO-F072RB board top and bottom view



1.3 Connectors, jumpers and LEDs

Table 2: P-NUCLEO-USB002 expansion board connectors, jumpers and LEDs

Reference	Description
CN7	ST morpho connector
CN10	ST morpho connector
CN2	USART connector
CN4	Power Connector (on bottom side)
CN11	V_{BUS} Load PORT_0
CN12	V_{BUS} Load PORT_1
JP000	Port 0 V_{CONN} selector
JP001	Port 1 V_{CONN} selector
JP100	USB DP line selector
JP101	USB DM line selector
JP400	V_{BUS} source for PORT_0(1)
JP401	V_{BUS} source for PORT_1(1)
D100 (Blue LED)	Role indication for PORT_0
D101 (Green LED)	V_{BUS} indication for PORT_0
D102 (Orange LED)	CC line indication for PORT_0
D103 (Blue LED)	Role indication for PORT_1
D104 (Green LED)	V_{BUS} indication for PORT_1
D105 (Orange LED)	CC line indication for PORT_1

Reference	Description
D106 (Blue LED)	3.3V power
D107 (Blue LED)	User LED

Notes:

(1)allows using the 5V from the NUCLEO-F072RB as VBUS when no external power supply is available and only in the provider role – mainly used for demo purposes. If an external power supply is connected, the jumper must be left open

Refer to UM2191 on www.st.com for further details.

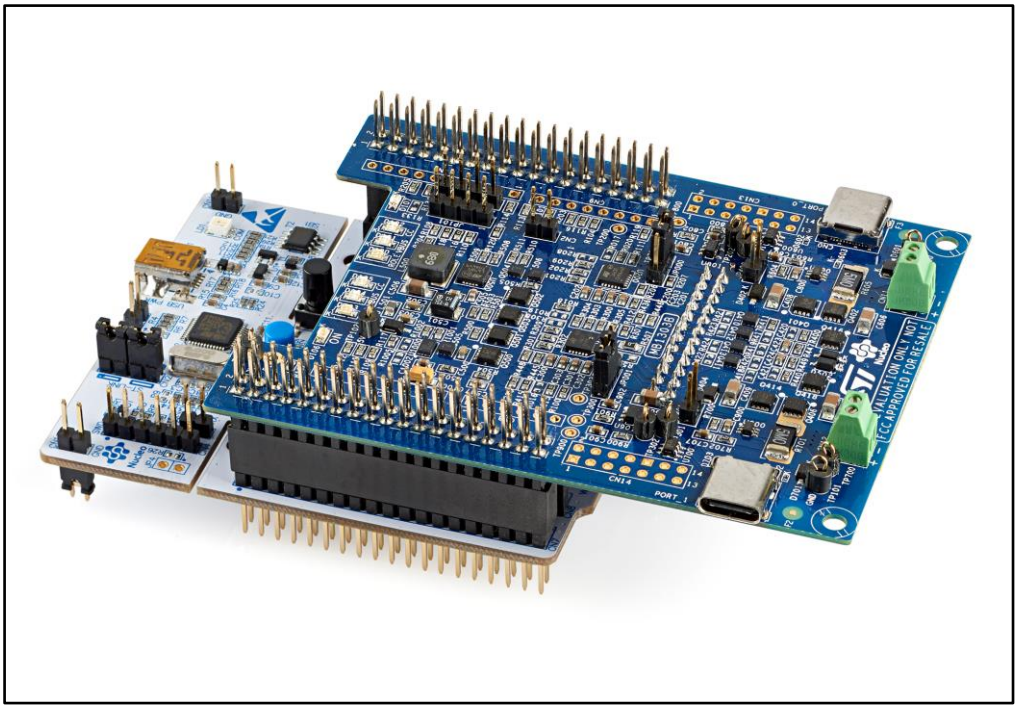
1.4 Basic configuration setup

To run the embedded demonstration example, the hardware must be configured.

1 Plug the P-NUCLEO-USB002 expansion board onto the NUCLEO-F072RB board ST morpho connectors.

The correct orientation is pictured below.

Figure 5: P-NUCLEO-USB002 mounting orientation

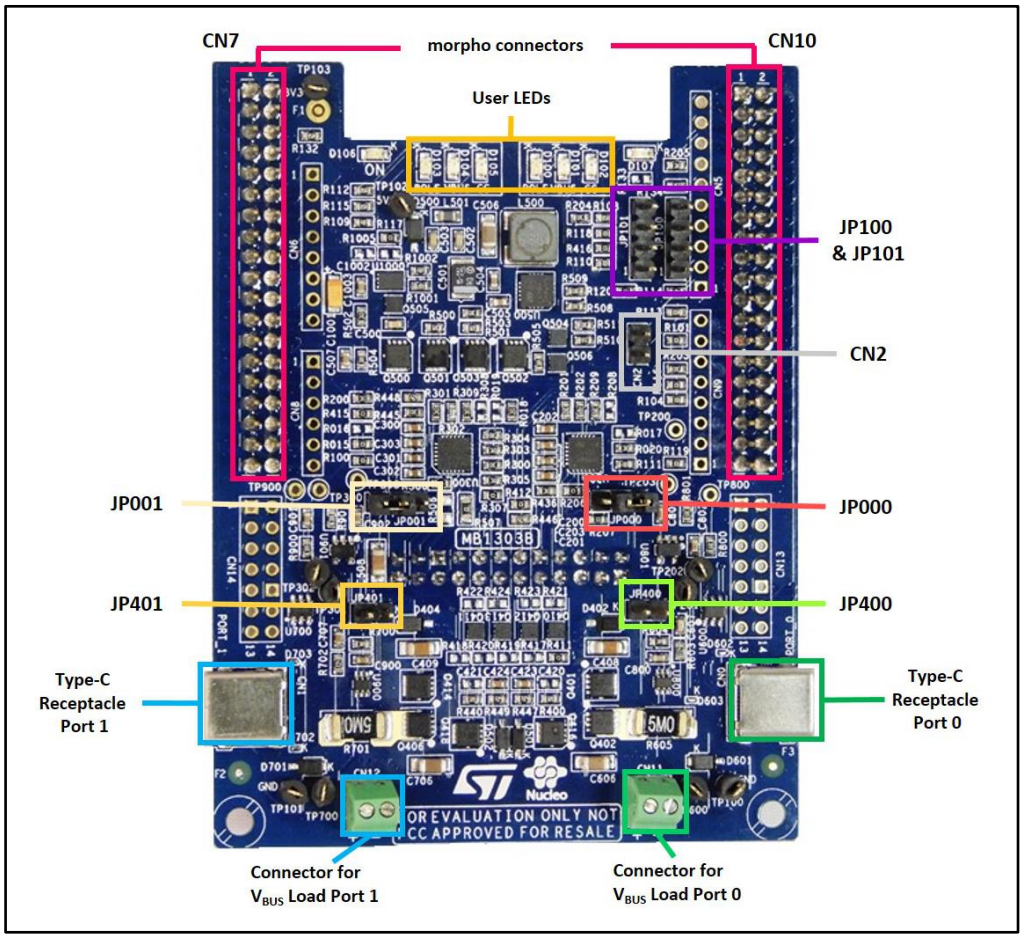


2 Apply the correct NUCLEO-F072RB jumper settings

- JP1 open
- JP5 (PWR) closed on U5V
- JP6 closed (IDD).

3 Apply the correct P-NUCLEO-USB002 expansion board jumper settings
- JP000 and JP001 configured as shown below
- JP100 and JP101 open

Figure 6: P-NUCLEO-USB002 connectors and jumpers



4 Connect the NUCLEO-F072RB to a PC with a USB Type-A to Mini-B cable (not provided).

1.5 Running demos without a PC

This section describes demo operation in standalone mode, without the support of a PC to control the implemented functions

1.5.1 Standalone demo

This procedure lets you change modes and observe P-NUCLEO-USB002 LED feedback signals with the basic setup.

1 Stack the boards, set the jumpers and power the NUCLEO-F072RB board via PC USB connection as per the basic configuration requirements.

Blue LEDs D100 and D103 for PORT_0 and PORT_1 signal their initial configuration:
- three blinks - port is a dual role port (DRP).

2. Connect the two Type-C receptacles on the expansion board using the USB Type-C cables provided

   Blue LEDs D100 and D103 for PORT_0 and PORT_1 signal the current role of the port:

   - one blink - port is a provider
   - two blinks - port is a consumer

3. Change the orientation of the cables.

   Orange LEDs D102 and D105 for PORT_0 and PORT_1 signal the CC line used:

   - one blink - CC1
   - two blinks - CC2

4. Wait until an explicit contract is established.

   Green LEDs D101 and D104 for PORT_0 and PORT_1 signal:

   - LED on - the port has defined an explicit contract with the port partner
   - LED blinking - the port, as provider or consumer, is supplying or is sinking power, respectively
   - LED off - no power is being provided or sunk on the port

1.5.2 Standalone demo with external hardware connected

This procedure lets you change modes and observe P-NUCLEO-USB002 LED feedback signals with an external port partner.

In the Provider and DRP roles, the exposed power profiles are dummies.

1. Stack the boards, set the jumpers and power the NUCLEO-F072RB board via PC USB connection as per the basic configuration requirements.

   Blue LEDs D100 and D103 for PORT_0 and PORT_1 signal their initial configuration:

   - three blinks - port is a dual role port (DRP).

2. Connect P-NUCLEO-USB002 CN2 to NUCLEO-F072RB CN3 with the female wires included in the package.

   Connections:

   - CN2_1 to CN3_TX
   - CN2_2 to CN3_RX

3. Connect the Type-C to Type-C cable to one of the expansion board ports

   The initial role of both ports is DRP.

4 Connect the other plug of the USB Type-C cable to an external port partner.

Blue LEDs D100 and D103 for PORT_0 and PORT_1 signal the current role of the port:

- one blink - port is a provider
- two blinks - port is a consumer

Orange LEDs D102 and D105 for PORT_0 and PORT_1 signal the CC line used:

- one blink - CC1
- two blinks - CC2

Green LEDs D101 and D104 for PORT_0 and PORT_1 signal:

- LED on - the port has defined an explicit contract with the port partner
- LED blinking - the port, as provider or consumer, is supplying or is sinking power, respectively
- LED off - no power is being provided or sunk on the port

5 Use the command line interface to interact with the application.

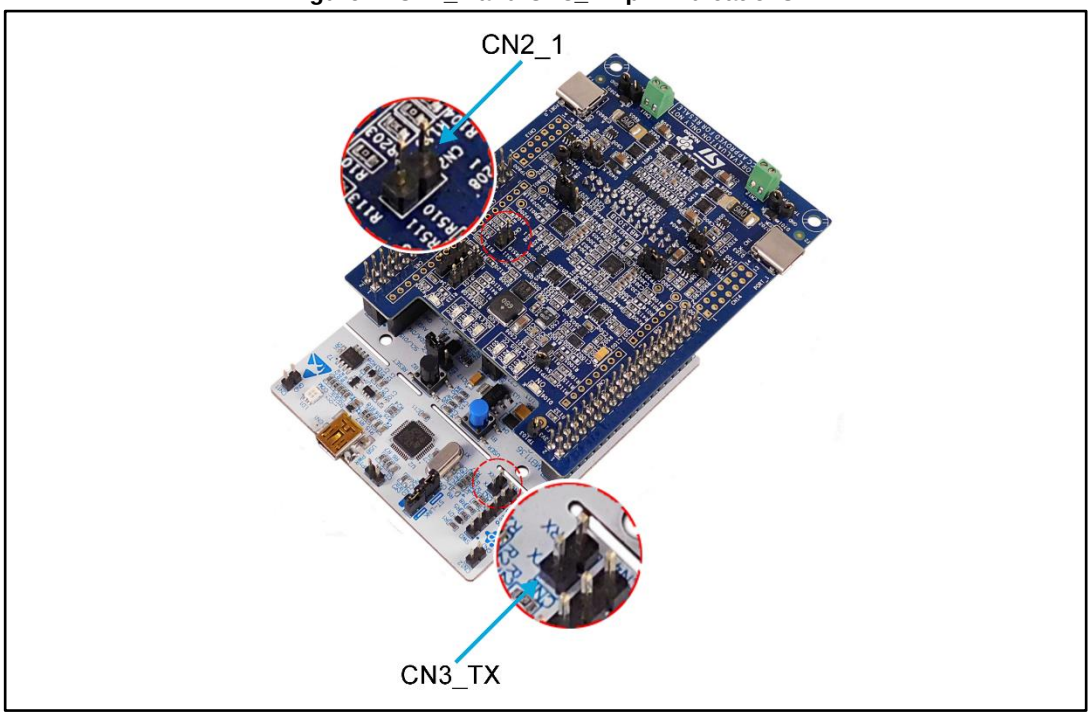
1.6 Running demos with a PC

The following demonstration applications require a PC for serial communication through the "Command Line Interface" (CLI), which lets you access power delivery application data and send commands.

Ensure that P-NUCLEO-USB002 expansion board CN2 is connected to NUCLEO-F072RB CN3 using the female wires included in the package:

- CN2_1 to CN3_TX
- CN2_2 to CN3_RX

Figure 7: CN2_1 and CN3_TX pin indications



1.6.1 Standalone demo with PC

1 Connect the NUCLEO-F072RB board to the PC via the virtual COM port with a standard serial terminal program.

Configuration:

- Baudrate: 115200
- Data bit: 8
- Parity: none
- Stop bit: 1
- Hardware Flow Control: None

2 Use the CLI to access port status and profile information.

When the port is a consumer, you can command it to request a different profile, if available.

A "welcome message" is shown in the terminal on board startup or reset (reset button on NUCLEO-F072RB board).

3 Type "help" (or "?") and hit enter to list the supported commands

Figure 8: CLI - list of available commands

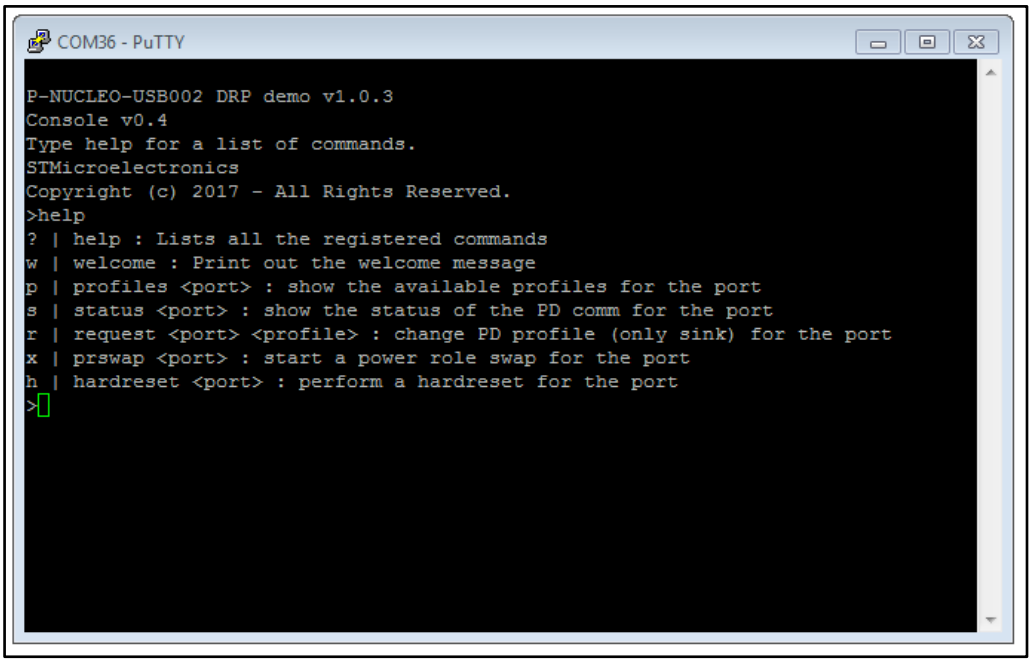


Table 3: CLI commands

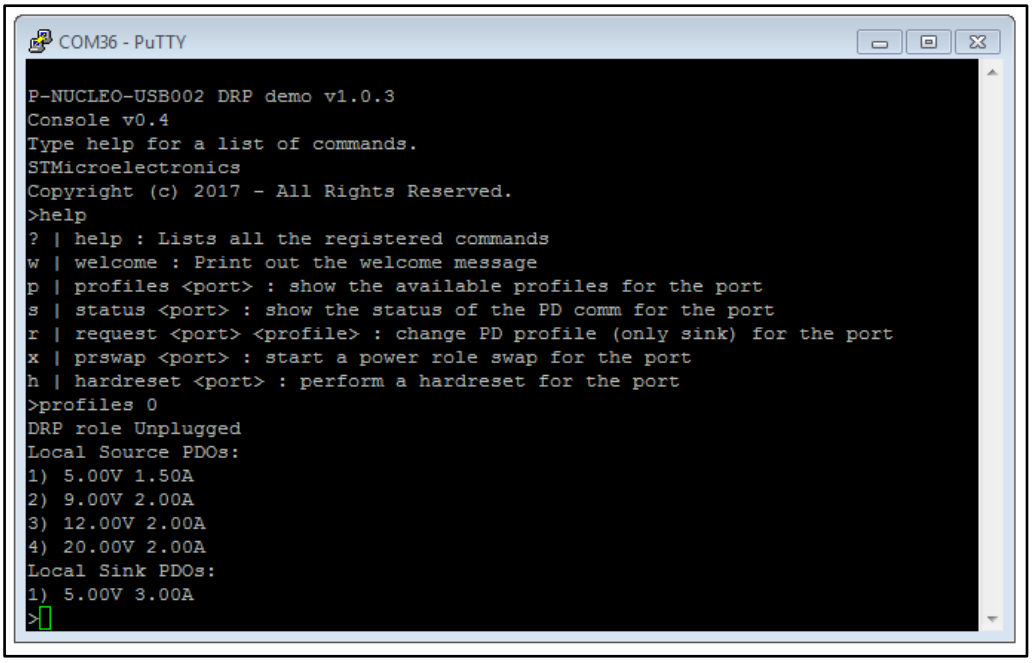
Command (shortcut)	Parameter1	Parameter2	Description
`help` (?)	none	none	List available commands
`welcome` (w)	none	none	Print welcome message and copyright information to screen
`profiles` (p)	`Port Number`	none	Show available power profiles
`status` (s)	`Port Number`	none	Show PD port information and status
`request` (r)	`Port Number`	`Profile number`	Change power profile on PD port (consumer only)
`prswap` (x)	`Port Number`	none	Start a power role swap for the port
`hardreset` (h)	`Port Number`	none	Send a hard reset command to the port

4 Disconnect the USB type-C cable from the port.

5 Type "profiles" (or "p") plus the port number and hit enter

The "profiles" command shows the available power profiles for provider or DRP role (the demo has four dummy power profiles)

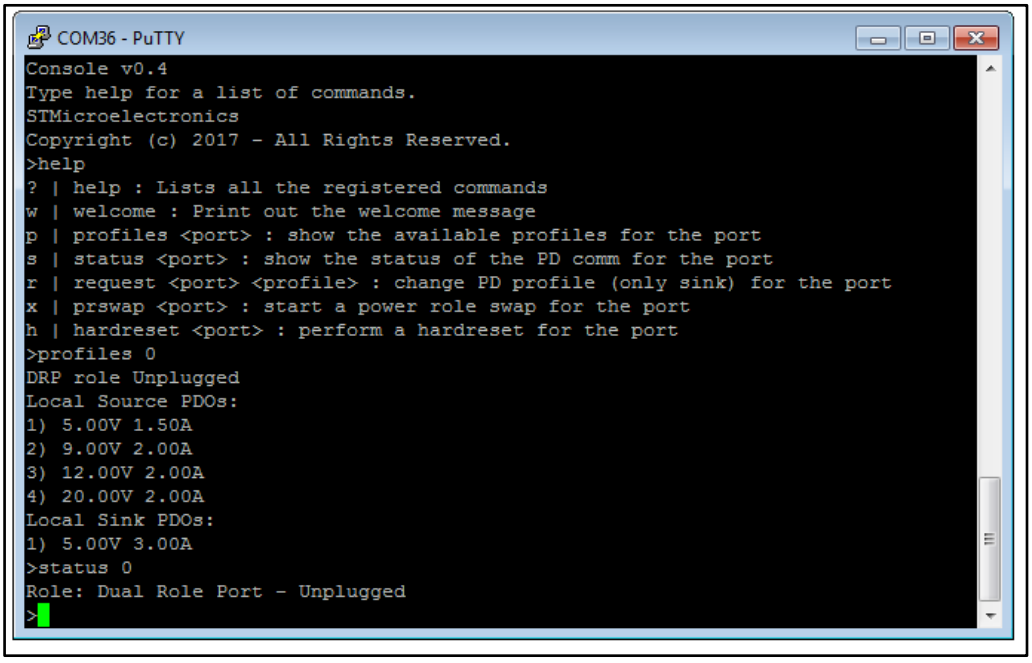
Figure 9: CLI - list of available profiles



6 Type "status" (or "s") plus the port number and hit enter

The "status" command indicates whether the cable is plugged and the current role of the port.

Figure 10: CLI profiles and status commands - ports not connected

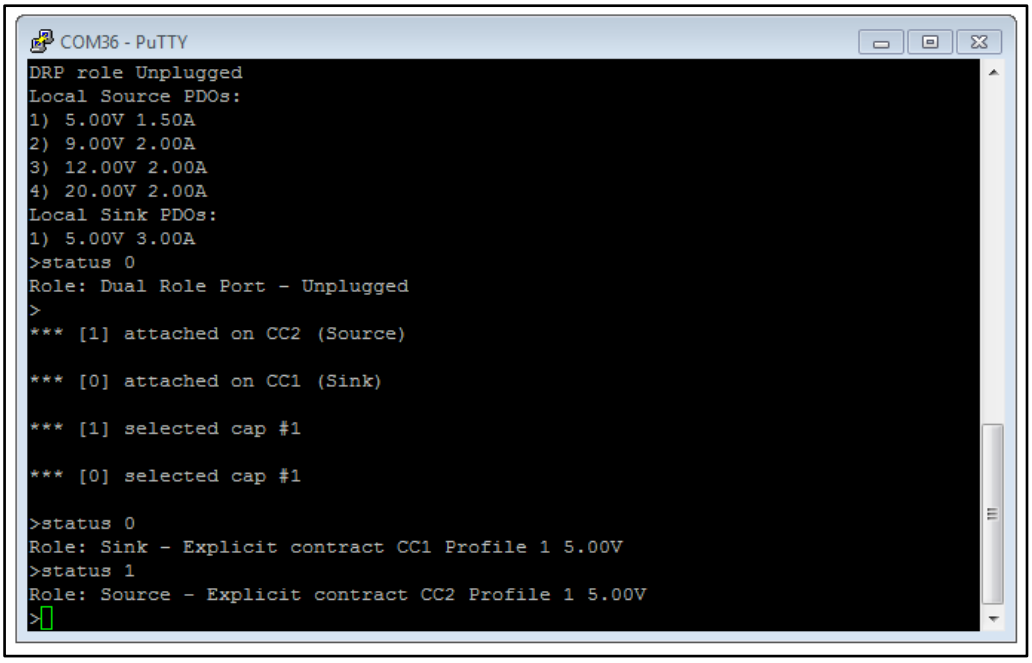


7 Connect PORT_0 to PORT_1

8 Type "status" (or "s") plus the port number and hit enter

The CLI returns information regarding the role, the CC line used and the selected profile for each port.

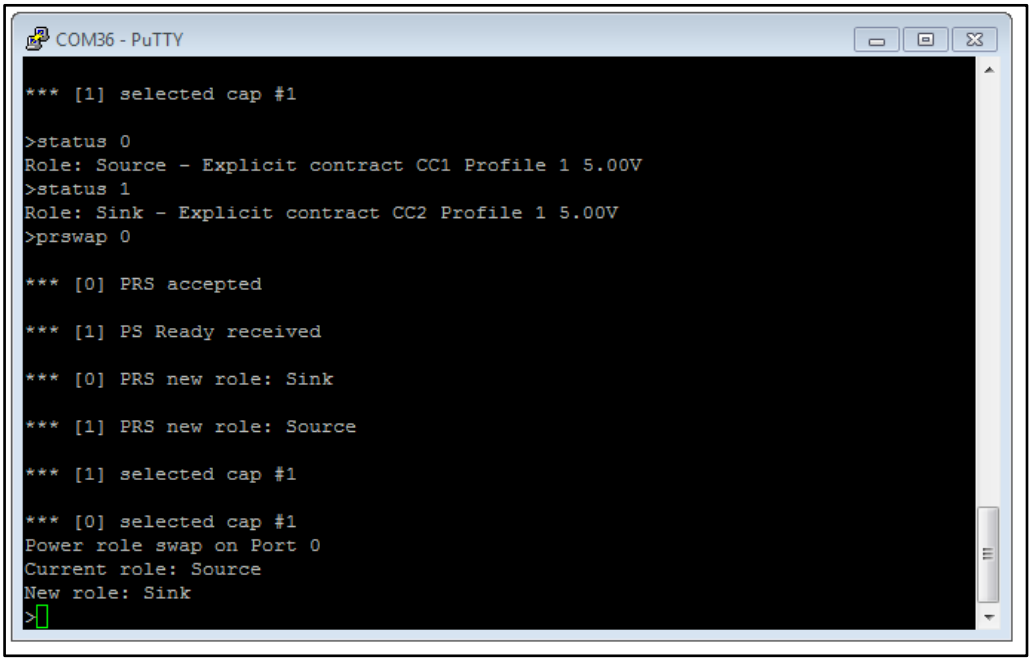
Figure 11: CLI status command – Port_0 connected to Port_1



9 Type "prswap" (or "x") plus the port number and hit enter

The CLI returns information about the newly acquired roles and corresponding capabilities.

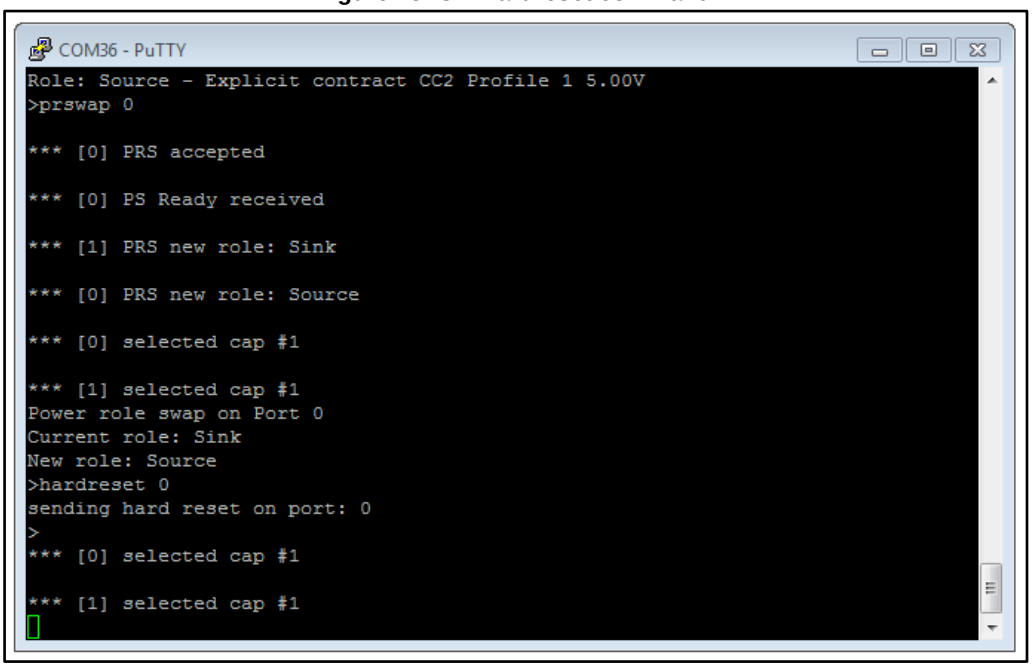
Figure 12: CLI prswap command



10 Type "hardreset" (or "h") plus the port number and hit enter

The CLI returns information regarding the status with the new capabilities.

Figure 13: CLI hardreset command



1.6.2 Demo with PC and externally powered board

1 Connect a PD consumer to one of the ports via external USB Type-C cable

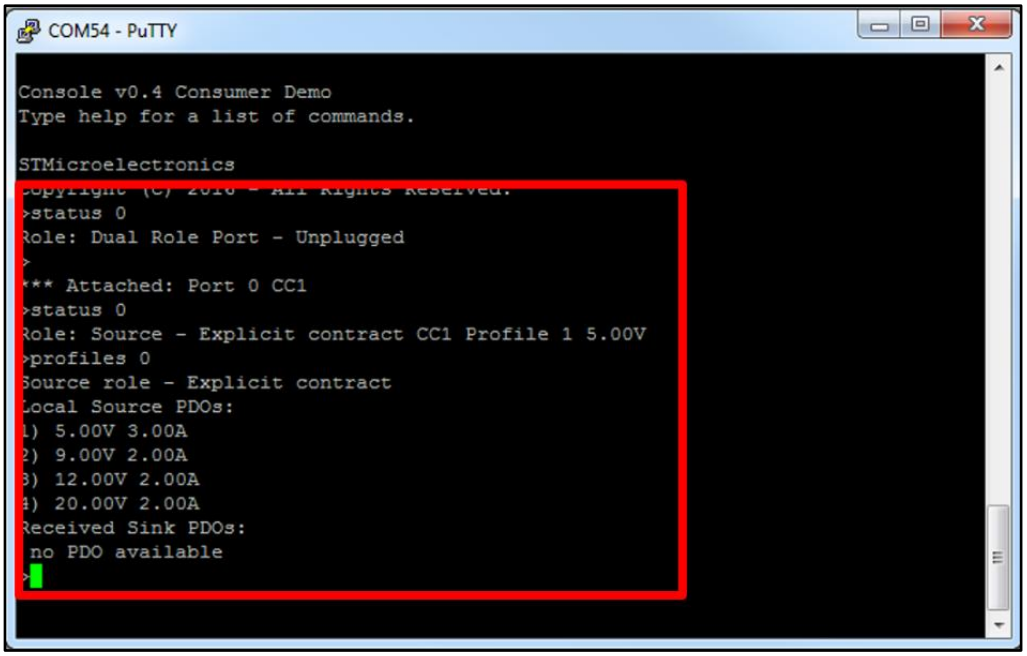
The P-NUCLEO-USB002 becomes a provider and sends the source capabilities of the four "dummy" power profiles:

- 5 V at 3 A
- 9 V at 2 A
- 12 V at 2 A
- 20 V at 2 A

2 Type "status" (or "s") plus port number and hit enter

The CLI returns the dummy power profiles requested by the consumer and the cable orientation.

Figure 14: CLI status command – Port_0 connected to external PD consumer



3 Connect a PD provider to one of the ports via external USB Type-C cable

The P-NUCLEO-USB002 becomes a consumer.

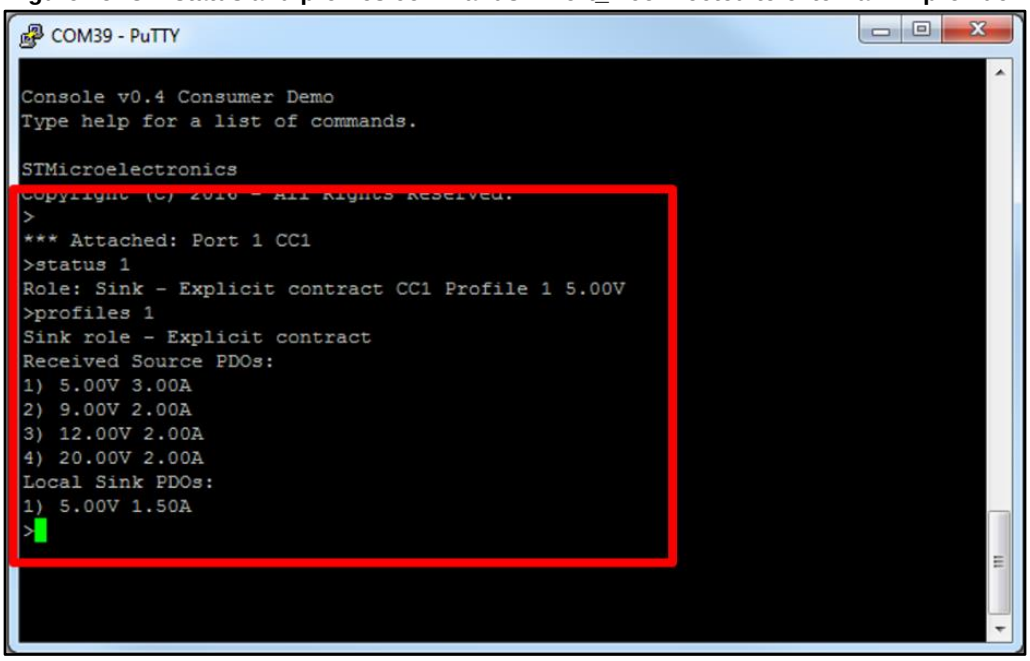
4 Type "profiles" (or "p") plus port number and hit enter

This command shows the list of the power profiles received from the port partner

5 Type "status" (or "s") plus port number and hit enter

This command shows the requested power profile and the cable orientation.

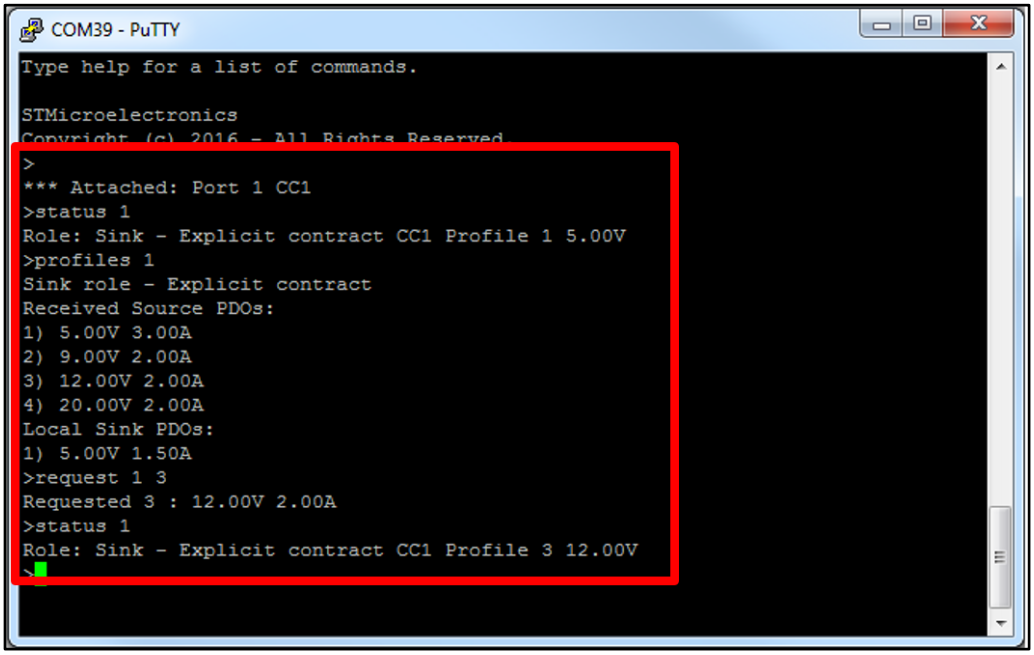
Figure 15: CLI status and profiles commands – Port_1 connected to external PD provider



6 Type "request" (or "r") plus port number and new profile number and hit enter

This command changes the power profile according to the specified parameter and restarts consumer and provider contract negotiation for the selected power.

Figure 16: CLI request command – Port_1 connected to external PD provider



2 Revision history

Table 4: Document revision history

Date	Version	Changes
04-May-2017	1	Initial release.

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