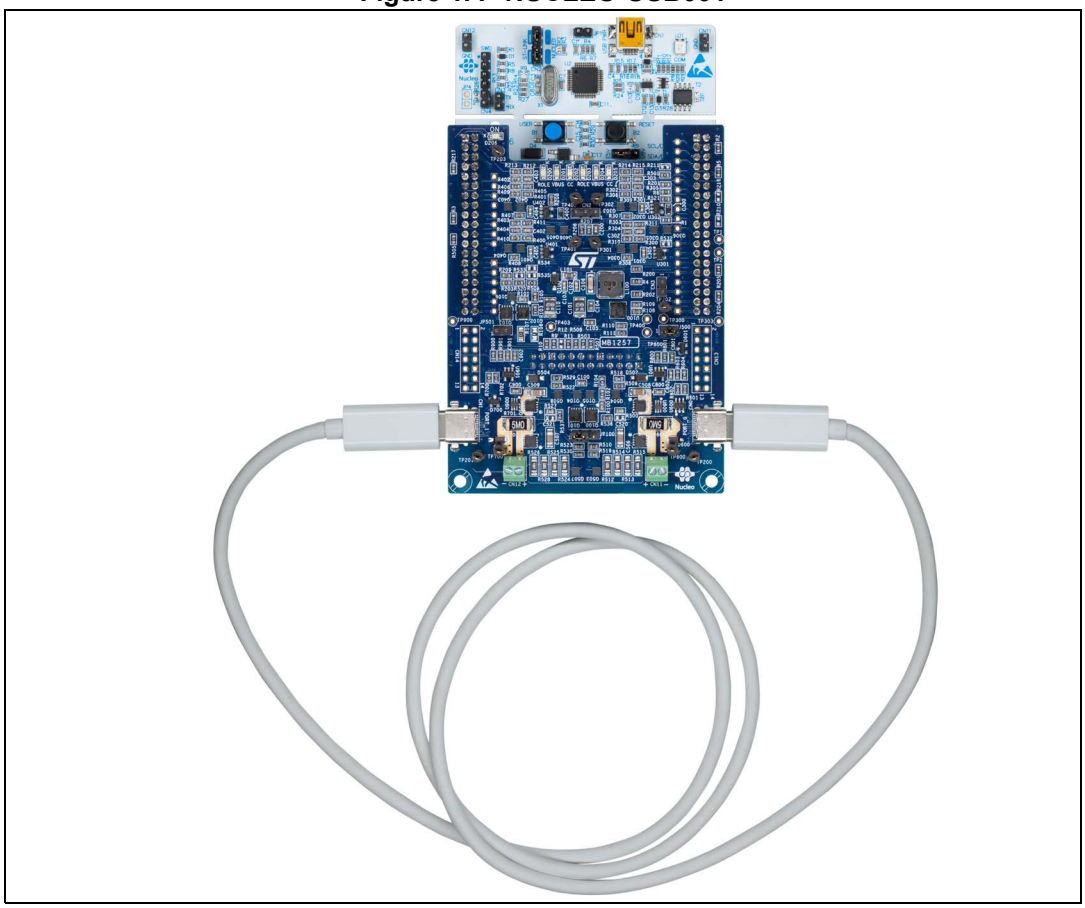
UM2051
User manual

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

Introduction

The STM32 Nucleo pack for USB Type-C™ and Power Delivery (P-NUCLEO-USB001) is a kit based on a NUCLEO-F072RB board and on a USB Type-C™ Power Delivery expansion board (MB1257). The expansion board features two DRP USB Type-C™ ports with a discrete Analog Front-End PHY for USB Type-C™ configuration and management. A complete and certified USB Power Delivery middleware stack, compliant with the USB Type-C™ 1.2 and the Power Delivery 2.0 specifications, running on the STM32F072 MCU, provides the means to control the two USB Type-C™ ports and allows the communication over CC lines using the Power Delivery communication protocol (for all the details refer to the *USB Type-C™ Power Delivery on STM32F0 Series embedded software expansion for STM32Cube* databrief (DB2957) at the *www.st.com* website).This document describes the hardware environment to build the system and to run an application based on the P-NUCLEO-USB001 pack.

Figure 1. P-NUCLEO-USB001



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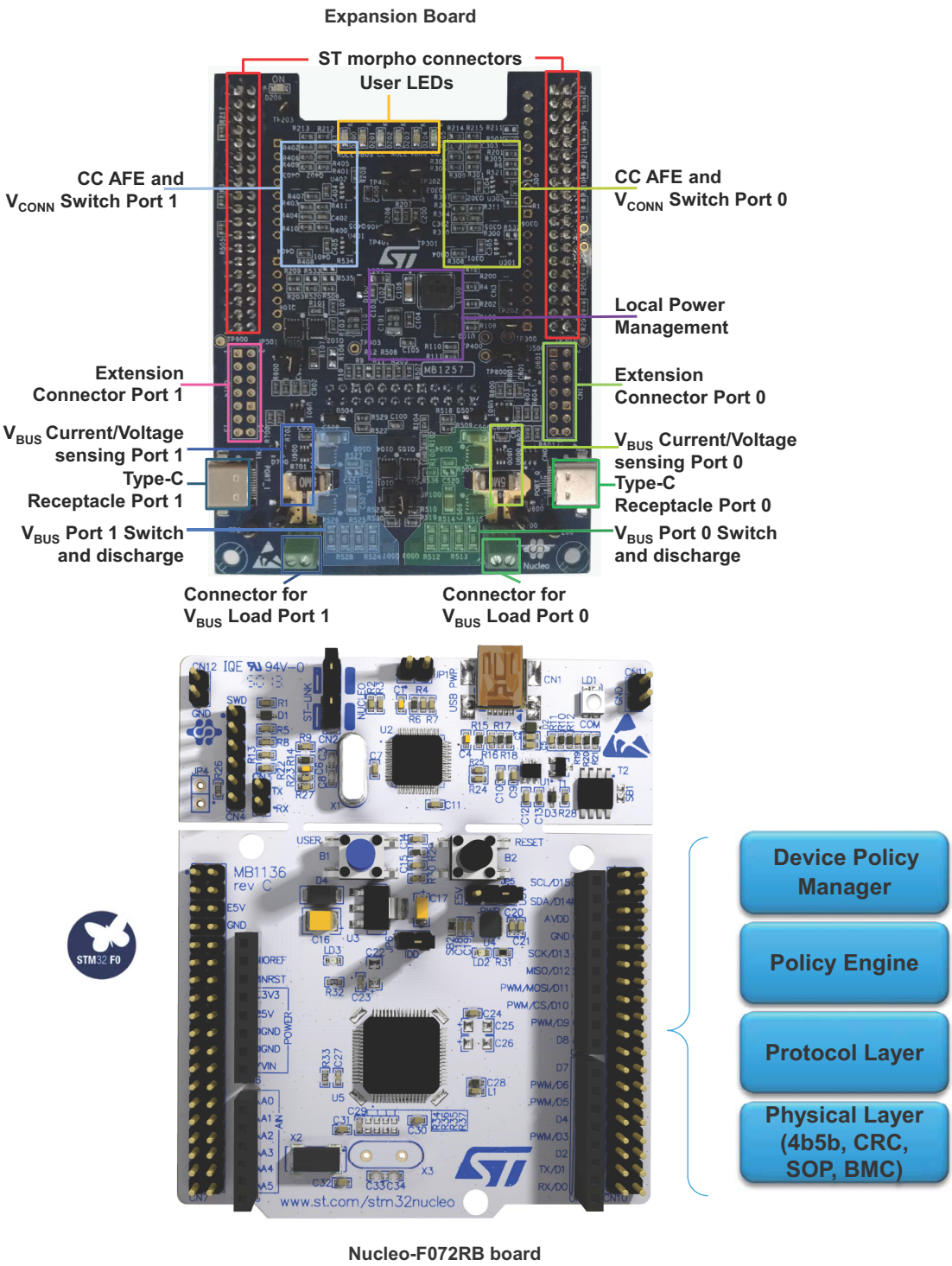
1.1 System architecture

The STM32 Nucleo pack for USB Type-C™ and Power Delivery is composed of two main blocks (see *Figure 2*):

- A **control block:** the NUCLEO-F072RB board where the stack is running
- A **Type-C interface:** the MB1257 expansion board

Note: A certified USB Type-C full-featured cable is provided in the kit.

Figure 2. P-NUCLEO-USB001 system architecture



1.2 The P-NUCLEO-USB001 demonstration

The P-NUCLEO-USB001 is a complete hardware development platform to learn and develop solutions based on USB Type-C™ and USB Power Delivery technologies.

The middleware stack (X-CUBE-USB-PD) offers a set of dedicated API and configuration templates to cover different topologies (Provider, Consumer, DRP,...) and customizations to easily develop USB-C and Power Delivery applications. For more details refer to the *STM32 Nucleo pack for USB Type-C™ and Power Delivery with the Nucleo-F072RB board* User manual *(*UM2050) at the *www.st.com* website.

Thanks to the two Type-C ports available on the USB-C Power Delivery expansion board, the firmware example embedded in the STM32F072RBT6 MCU of the NUCLEO-F072RB board, provides a simple demonstration that the user can run without any additional material, showing the flexibility of Type-C with its reversible plug orientation, cable direction, and the role assumed by each port.

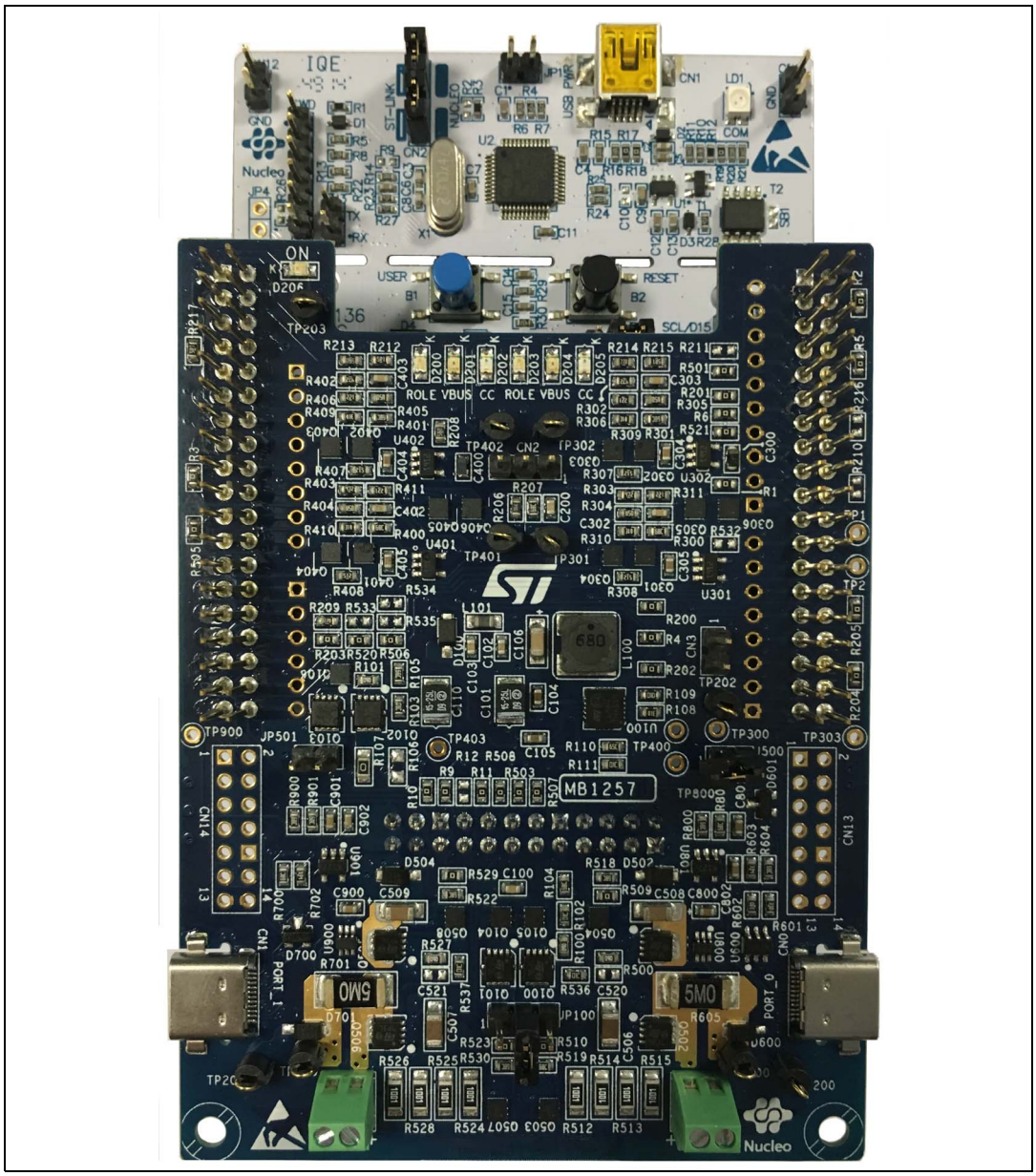
User can build other demonstrations with external tools, using the same firmware embedded in the STM32F072RBT6 MCU of the NUCLEO-F072RB board.

1.3 Configuration setup

To run the embedded demonstration, follow the hardware configuration steps shown below:

1. The MB1257 board must be stacked on a NUCLEO-F072RB board through the ST morpho connector. There is only one position allowed for this connection, the one where the stacked board MB1257 does not cover the two blue and black push-buttons on the NUCLEO-F072RB board (see the blue button B1 and black button B2 in the *Figure 3*).

Figure 3. MB1257 USB-C Power Delivery expansion board and NUCLEO-F072RB assembled



The NUCLEO-F072RB board included in the pack, has a different configuration comparing to the default one. The main differences are listed below:

- Solder bridges SB48, SB49, SB62, SB63 are closed
- Solder bridges SB13, SB14, SB15, SB21 are open
- 0 Ω resistors R34, R36 are removed

2. On NUCLEO-F072RB board, verify jumper settings: JP1 must be open; JP5 (PWR) must be closed on U5V and JP6 must be closed (IDD).
3. On the MB1257 expansion board, verify jumper settings: J500 must be closed, JP501 must be open. Refer to *Figure 4*.
4. Connect the NUCLEO-F072RB board to a PC with a USB Type-A to Mini-B cable (not provided) to power the system and to interact with the demonstration

Figure 4. MB1257 connectors, jumpers and LEDs

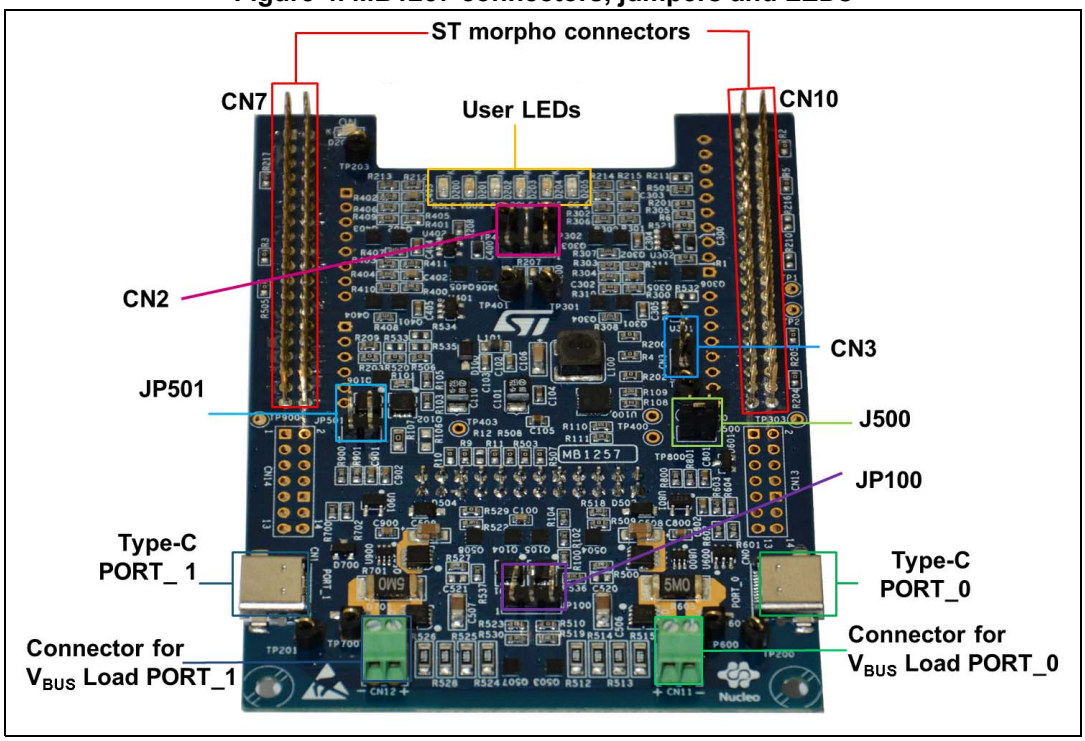


Table 1. Description of connectors, jumpers and LEDs

Part reference	Description
CN7	ST morpho connector
CN10	ST morpho connector
CN2	I^2C connector
CN3	UART connector
CN4	Power connector (on bottom side)
CN11	V_{BUS} Load PORT_0
CN12	V_{BUS} Load PORT_1
JP100	Supply V_{BUS} selection only for consumer role

Table 1. Description of connectors, jumpers and LEDs (continued)

Part reference	Description
J500	V_{BUS} source for PORT_0(1)
JP501	V_{BUS} source for PORT_1(1)
D200 (Blue LED)	Role indication for PORT_1
D201 (Green LED)	V_{BUS} indication for PORT_1
D202 (Orange LED)	CC line indication for PORT_1
D203 (Blue LED)	Role indication for PORT_0
D204 (Green LED)	V_{BUS} indication for PORT_0
D205 (Orange LED)	CC line indication for PORT_0
D206 (Blue LED)	3.3V power

1. It is allowed to use the 5 V from NUCLEO-F072 as V_{BUS}, when no external power supply is available and only for Provider role. It is used mainly for demonstration purpose. **If an external power supply is connected the jumper must be left open.**

Note: The value of the integrated resistor Rp is 4.7 kΩ at 3.3 V to advertise current capability of 3 A at 5 V. User has to change it according to his power supply capabilities.

For more details refer to STM32 Nucleo pack for USB Type-C™ and Power Delivery with the Nucleo-F072RB board User manual *(*UM2050) at the *www.st.com* website.

1.3.1 Standalone demonstration

The PORT_0 is configured as DRP (Provider/Consumer), while PORT_1 offers only Type-C port management and it is configured as Consumer.

PORT_0 will switch from one role to the other each four seconds. The role will be highlighted by the blue LED D203 blinking one or twice for Provider or Consumer role respectively.

Once the two Type-C ports of the expansion board are connected together by the Type-C to Type-C cable, the demonstration shows the cable attachment/detachment operation and orientation mechanism by LEDs blinking.

After the procedure described in *Section 1.3: Configuration setup*, the following actions must be accomplished to run the embedded demonstration:

1. Connect the two Type-C receptacles on the expansion board using the USB Type-C cable (provided).
2. Blue LED (D203) will blink once when the PORT_0 is working as Provider, while it will blink twice when the port is working as Consumer. Blue LED (D200) will blink twice because it is linked to PORT_1 that is configured as Consumer only.
3. The two orange LEDs (D205 and D202) will blink once or twice indicating the CC line used respectively for PORT_0 and PORT_1. Changing the cable insertion, the LEDs will blink according to the cable orientation.
4. Green LEDs (D201 and D204) will blink when the port, working as Provider, is supplying the Port Partner or, working as Consumer, is sinking power.

1.3.2 Other demonstration with external hardware

When connecting the Type-C PORT_0 configured as DRP (Provider/Consumer) to an external Port Partner, the user can see the cable attachment/detachment, the orientation and role configuration. Take care that in case of Provider role the exposed power profiles are dummy roles.

After execution of the procedure described in *Section 1.3: Configuration setup*, the following actions must be accomplished to run demonstration on PORT_0:

1. Connect CN3 of NUCLEO-F072RB with CN3 of MB1257 expansion board through the two female wires included in the package, respecting the numeration (1-1, 2-2).
2. Insert one plug of the included Type-C to Type-C cable on PORT_0 of the expansion board, that is configured as DRP (Provider/Consumer).
3. Connect the other plug of the USB Type-C Cable to an external Port Partner.
4. Blue LED D203 blinks once when the PORT_0 is working as Provider, while it blinks twice when it is working as Consumer.
5. Orange LED D205 blinks once or twice according to the selected CC line on PORT_0.
6. Green LED D204 blinks when the port, working as Provider, is supplying the Port Partner or when the port, working as Consumer, is sinking power. Whichever role has the port, this led turns on whenever an explicit contract has been negotiated.
7. In case of Provider role, after providing the 5 V on V_{BUS}, it starts to advertise source capabilities related to four dummy profiles (5 V, 9 V, 15 V, 20 V).
8. The user can interact with the application by means of a serial communication tool as explained in *Section 1.4*.

1.4 Command Line Interface

The Command Line Interface (CLI) allows the user to get the status of the Power Delivery application running on PORT_0 and to act on it through a serial communication.

When connecting through the two female wires included in the package, CN3 of NUCLEO-F072RB board with CN3 of the MB1257 expansion board, respecting the numeration (1-1, 2-2), user can connect the NUCLEO-F072RB board to the PC using the virtual COM port with a standard serial terminal software. The configuration shall be:

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

Through a set of commands, CLI allows the user to know the profiles available in the system and the status and to request a different profile (only when acting as Consumer).

At the startup of the board a “welcome message” is shown in the terminal. By typing “help” user can get the list of the supported commands (see *Table 2* and *Figure 5*).

Figure 5. Screenshot of the CLI and list of available commands

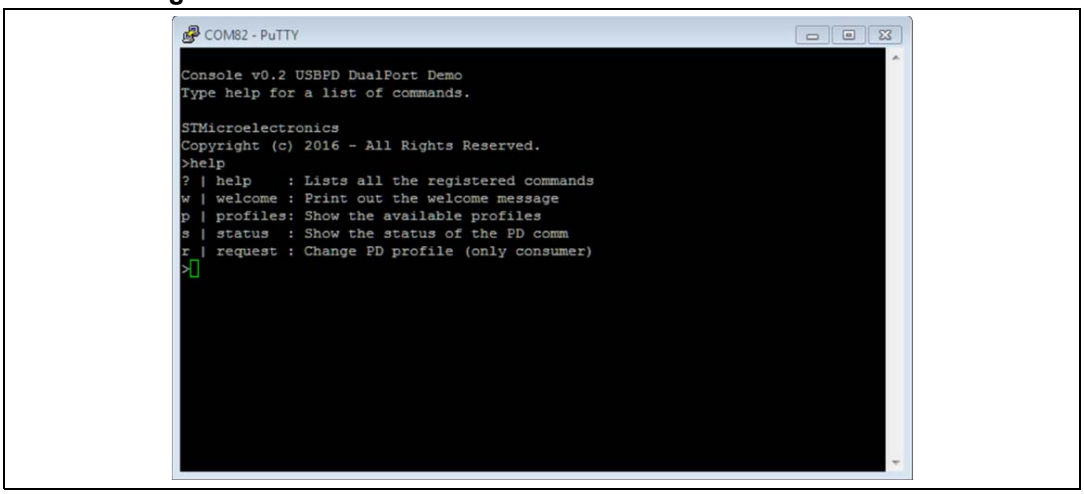
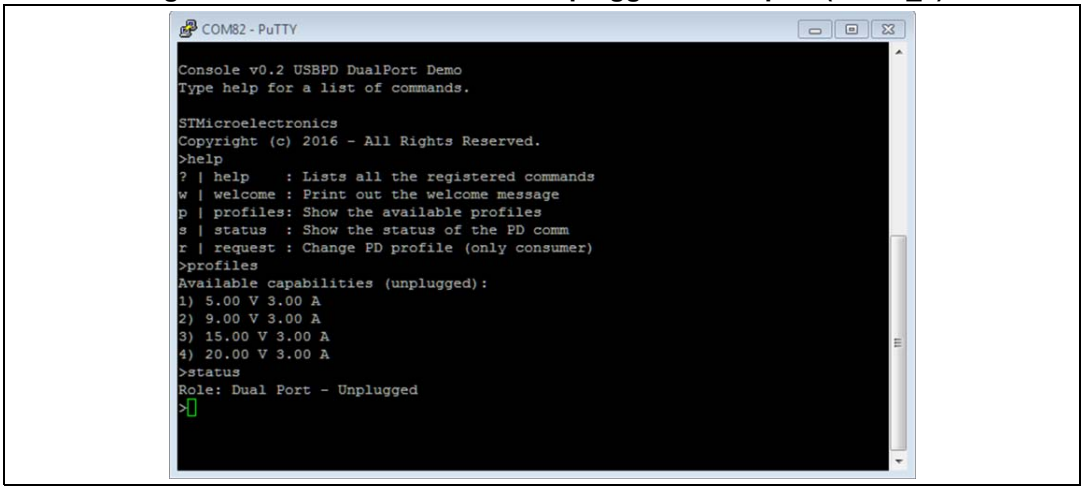


Table 2. Description of the CLI commands

Command	Parameter	Description
help	none	To show the list of the available commands.
welcome	none	To print out the welcome message and copyright information.
profiles	none	To show the available power profiles.
status	none	To retrieve information about the PD port and the status.
request	Profile number	To change the power profile on PD port (in case of Consumer).

When acting as Provider if the cable is unplugged the “profiles” command shows four dummy power profiles and the “status” indicates that it is working in dual-role mode (see *Figure 6*).

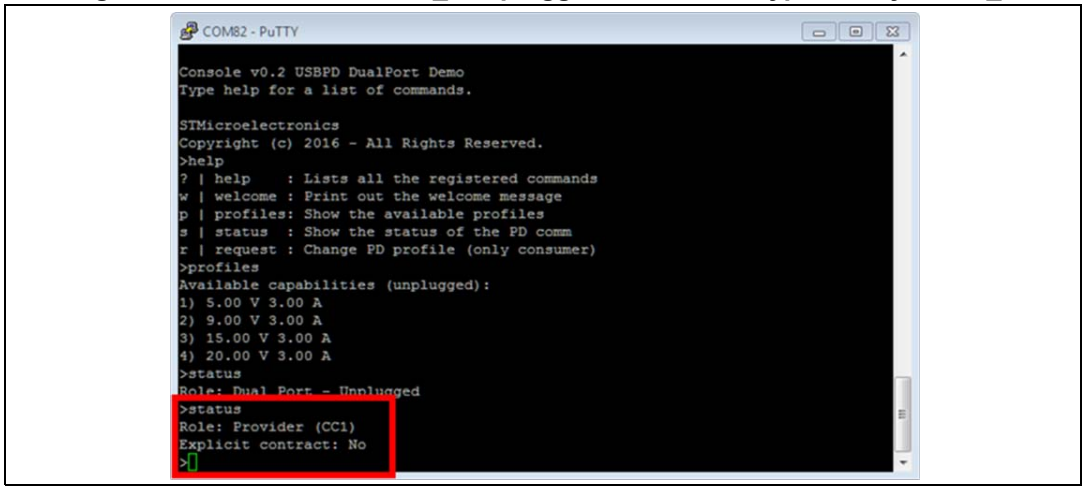
Figure 6. CLI when the cable is unplugged on PD port (PORT_0)



Connecting PD port (PORT_0) to USB-C port (PORT_1) and typing again the status command, the user can get information about cable orientation (CC1 or CC2) and contract

status as shown in *Figure 7* (in this configuration PORT_1 is only Type-C and not Power Delivery).

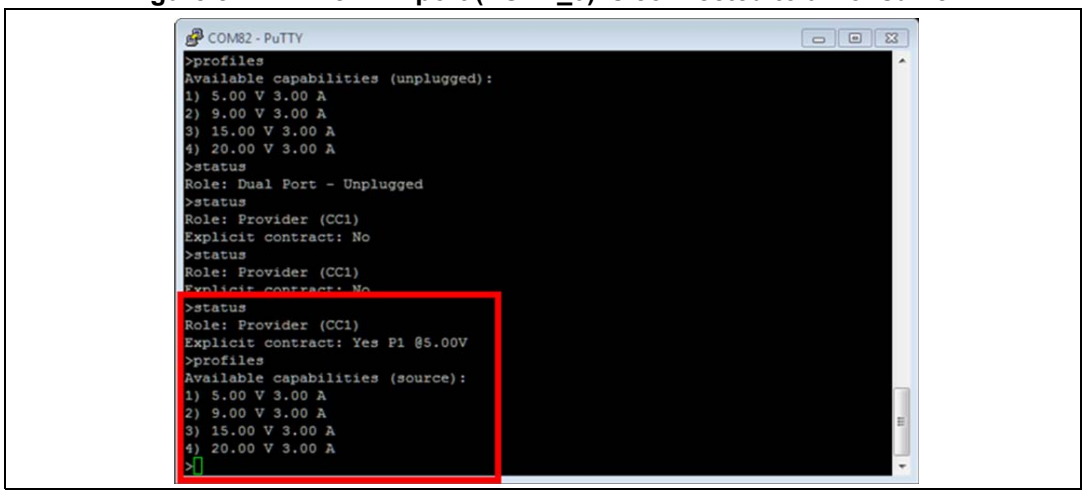
Figure 7. CLI when PD PORT_0 is plugged to the USB Type-C only PORT_1



If a USB Type-C and Power Delivery consumer is plugged in PORT_0, the demonstration acts as Provider and sends the source capabilities according to the four “dummy” power profiles (5 V, 9 V, 15 V, 20 V at 3 A).

The “status” command shows the dummy power profiles requested by the Consumer and the cable orientation, as shown in *Figure 8*.

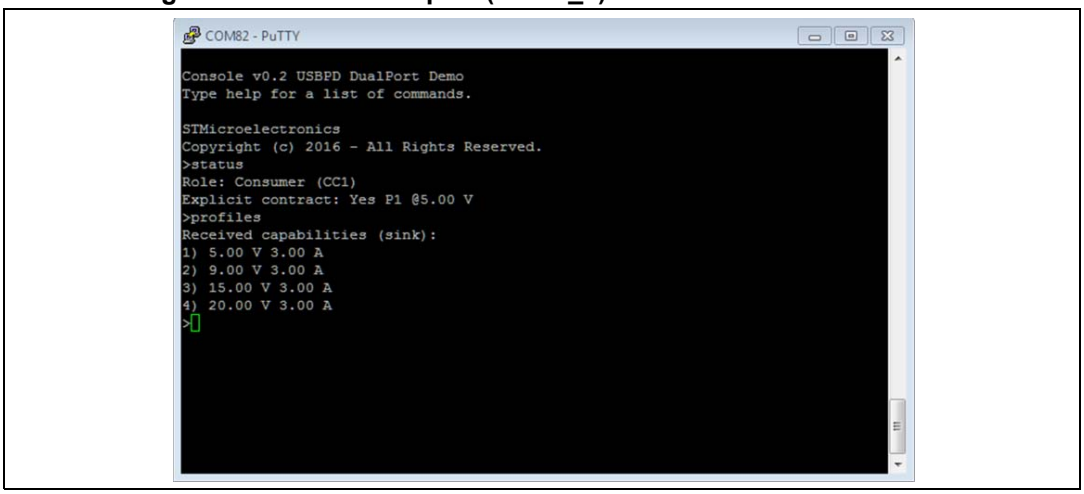
Figure 8. CLI when PD port (PORT_0) is connected to a Consumer



If a USB Type-C and Power Delivery Provider is plugged in PORT_0, the demonstration will act as Consumer.

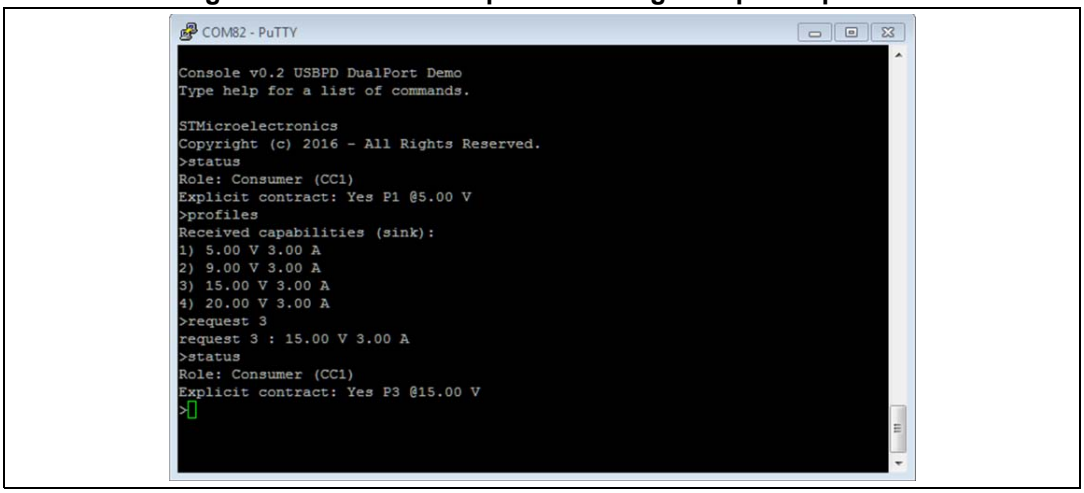
The “profiles” command shows the list of the power profiles received from the Port Partner and the “status” command shows the requested power profile and the cable orientation (see *Figure 9*).

Figure 9. CLI when PD port (PORT_0) is connected to a Provider



The “request” command changes the power profile according to the specified parameter and start again the negotiation between the Consumer and the Provider for the selected power, as shown in *Figure 10*.

Figure 10. CLI after a request to change the power profile



2 Revision history

Table 3. Document revision history

Date	Revision	Changes
02-Jun-2016	1	Initial release.