Getting started with the STEVAL-2STPD01 USB Type-C™ Power Delivery dual port adapter based on the STPD01 programmable buck converter

Introduction

The STEVAL-2STPD01 is an evaluation kit composed of an expansion board containing two Type-C ports and integrating two STPD01PUR programmable buck converters for USB Power Delivery, and the NUCLEO-G071RB STM32 Nucleo-64 development board.

The kit exploits the characteristics of the STPD01PUR programmable buck regulator controlled through I²C interface, and the UCPD peripheral embedded in the STM32G071RBT6 microcontroller supported by a dedicated firmware stack to implement a USB Type-C and PD dual port source adapter with power sharing capability.

Once the input power rate is fixed, the kit is able to balance the power on the two ports, supporting the requests sent by the USB PD devices connected to each port.

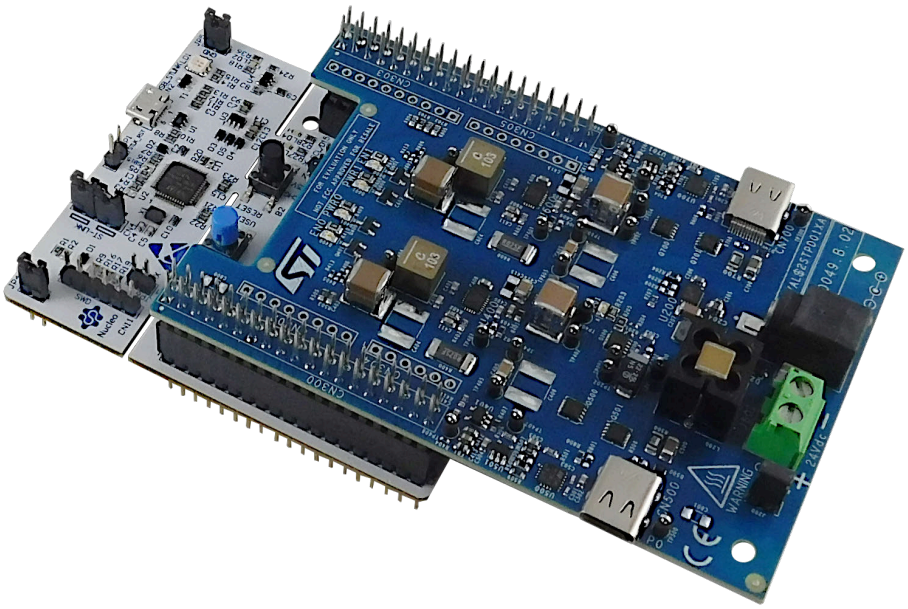
Taking advantage of STPD01PUR characteristics to output several voltage levels, the solution is able to manage up to 120 W (60 W for each port) according to the DC input power.

The expansion board has been specifically developed to be stacked on the NUCLEO-G071RB development board using the capability of its microcontroller to manage two UCPD peripherals at the same time. It also embeds the TCPP02-M18 USB Type-C port protection for Source applications and the L7983PU50R synchronous step-down switching regulator.

To fully demonstrate the USB Type-C and Power Delivery functionalities of the solution, the STSW-2STP01 software package, containing the demo application example, has been designed for the NUCLEO-G071RB STM32 Nucleo development board.

The solution is compliant with USB Type-C 2.1 and PD 3.1 specifications.

Figure 1. STEVAL-2STPD01 evaluation kit



1 Getting started

1.1 Overview

The STEVAL-2STPD01 features:

- Two USB Type-C and Power Delivery Source ports
- Output power up to 120 W-rated (60 W per port), managed through power sharing algorithm
- Up to four output PDOs for each port (5 V@3 A, 9 V@3 A, 15 V@3 A, 20 V@3 A)
- Compliant with USB Type-C 2.1 and PD 3.1 specifications
- Two STPD01PUR DC-DC converters dynamically set by I²C, suitable to implement power sharing in USB PD applications
- Two on-board TCPP02-M18 protections for USB Type-C and PD Source applications
- OVP, UVP, OC, short-circuit and OTP protections
- Surge protection (8/20 µs) and system level ESD protection on V_{BUS}
- System level ESD protection on CC lines as per IEC61000-4-2 level 4 (±8 kV contact discharge)
- RoHS compliant

1.2 System architecture

The STEVAL-2STPD01 evaluation kit architecture can be divided into two sub-systems:

- a **digital stage** represented by a NUCLEO-G071RB STM32 Nucleo-64 development board embedding the STM32G071RBT6;
- a **power stage** represented by an expansion board, that physically manages, redirects and converts the input supply to the kit main functional blocks, contributing also to output the expected voltages.

Figure 2. STEVAL-2STPD01 evaluation kit: NUCLEO-G071RB development board and expansion board

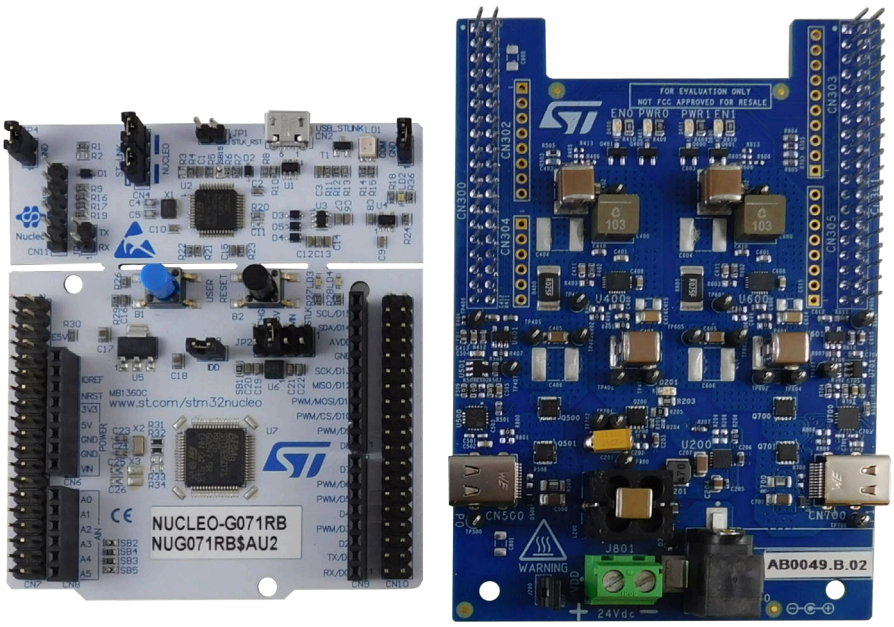
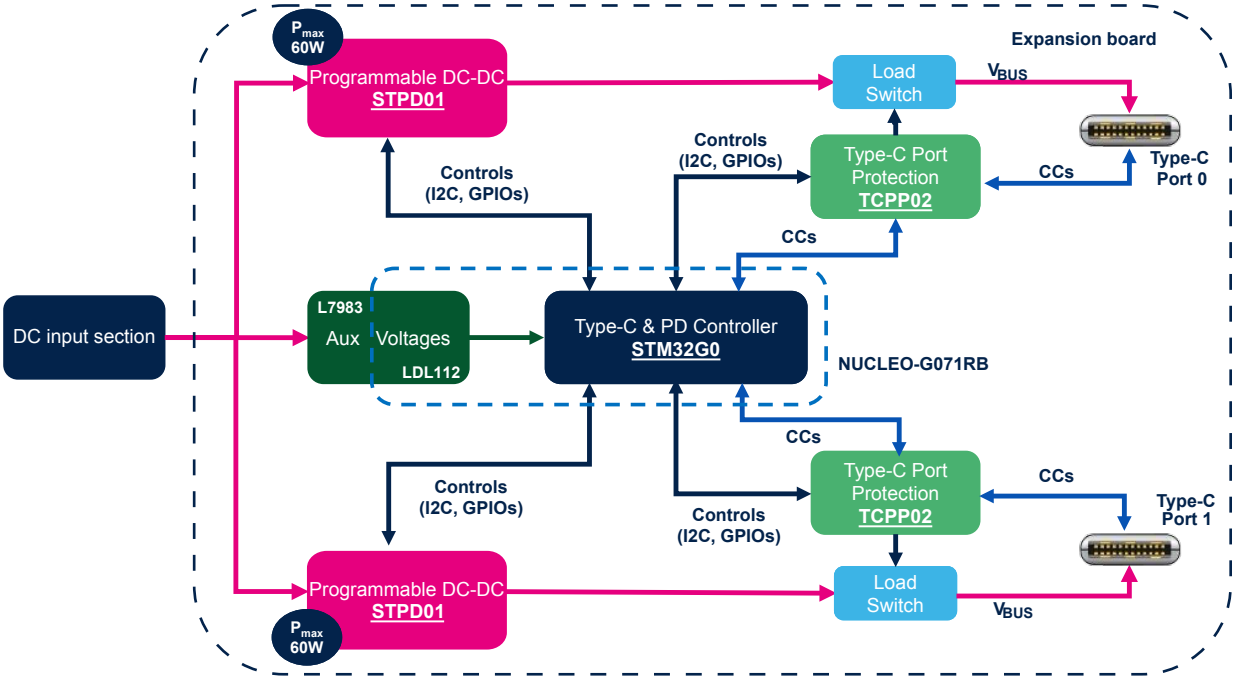


Figure 3. **STEVAL-2STPD01 architecture block diagram**



1.2.1 NUCLEO-G071RB development board

The NUCLEO-G071RB STM32 Nucleo-64 development board is based on the high-performance Arm® Cortex®-M0+ 32-bit RISC core operating at up to 64 MHz frequency, with 128 Kb Flash memory and 16 Kb SRAM.

The ST morpho headers allows expanding the functionality of the STM32 Nucleo open development platform with a wide choice of specific shields.

The STM32 Nucleo-64 boards do not require any separate probe as they integrate the ST-LINK/V2-1 debugger/programmer. They embed comprehensive free STM32 software libraries and examples available with the STM32CubeG0 MCU package.

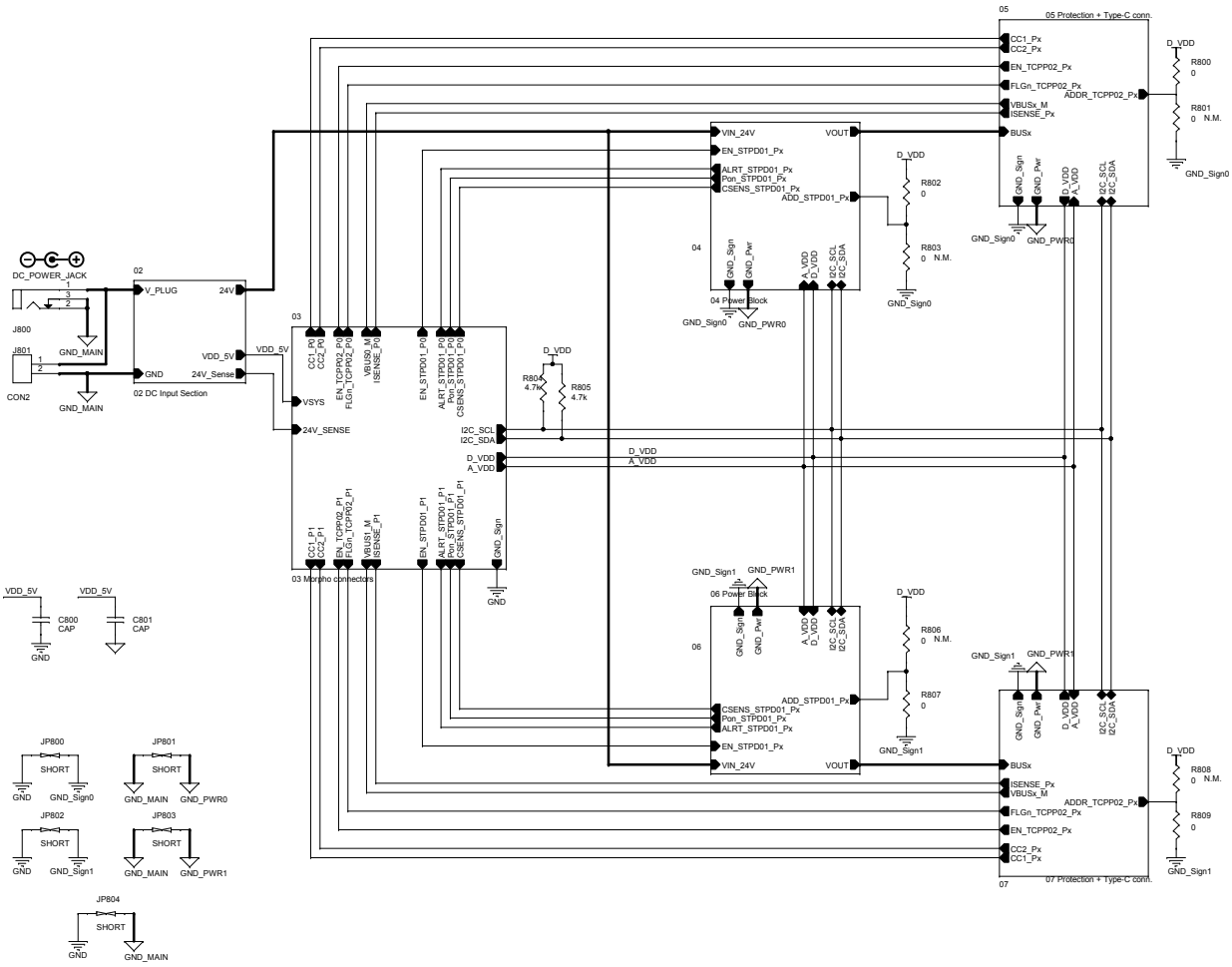
Note: The NUCLEO-G071RB is compliant with the USB Type-C and Power Delivery specification thanks to the UCPD peripheral embedded in its STM32G071RBT6 microcontroller.

RELATED LINKS

Refer to the related ST web page NUCLEO-G071RB bill of materials and schematic diagrams

1.2.2 Expansion board

Figure 4. Expansion board schematic diagram main blocks



As shown in the figure above, the expansion board schematic diagram integrates four main functional blocks, of which two are duplicated to implement the Dual Port functionality:

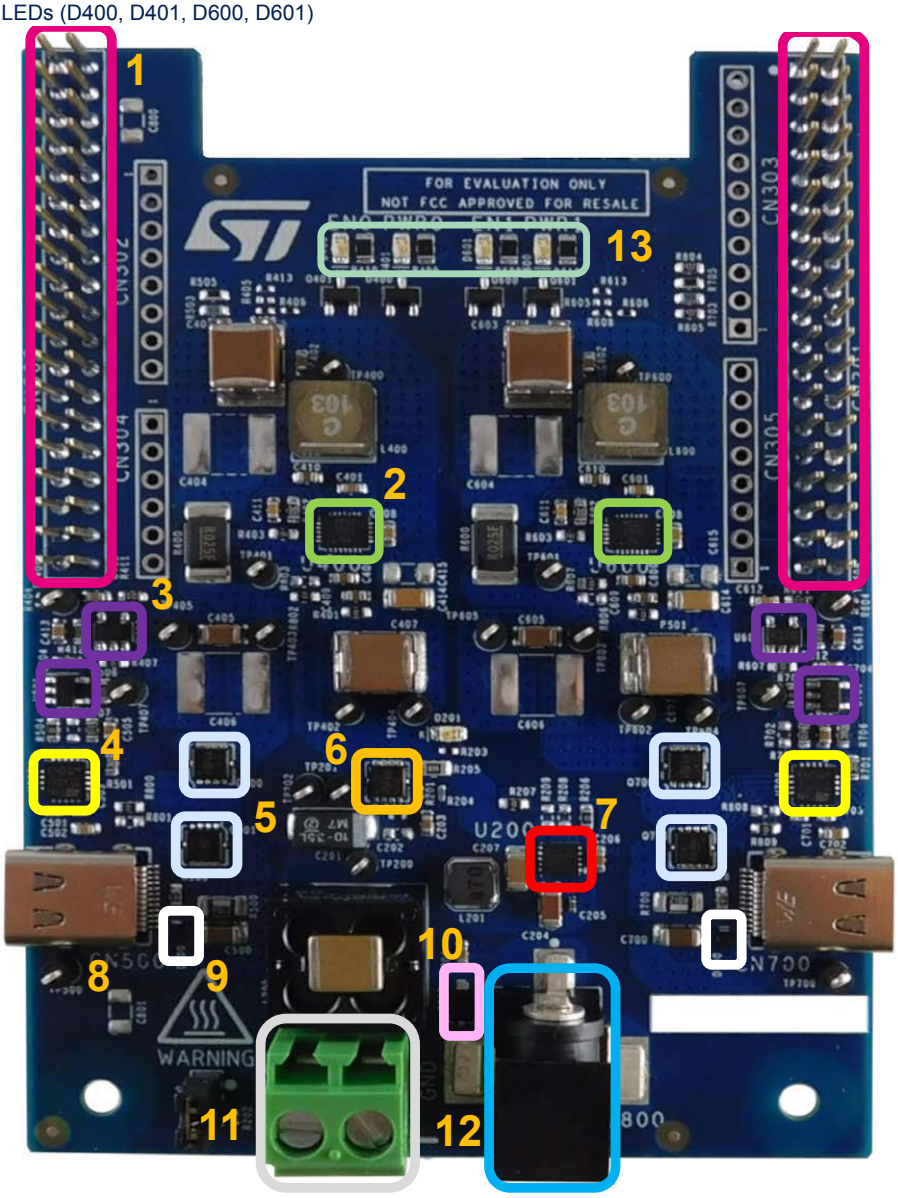
1. the input power section block (02) that manages the input power to supply all other devices. It features a plug and a screwed connector and integrates the L7983PU50R synchronous step-down switching regulator;
2. the morpho connector block (03) that routes the signal path from the stacked NUCLEO-G071RB development board;
3. the USBPD power blocks (04 and 06) which integrate the STPD01PUR programmable buck converters for USB Power Delivery;
4. the protection and Type-C connector blocks (05 and 07) which integrate the TCPP02-M18 USB Type-C port protection devices for Source applications.

The STM32G071RBT6 embedded in the NUCLEO-G071RB development board uses the I²C peripheral to configure and manage both the STPD01PUR converters and the TCPP02-M18 protections, connecting them through the morpho connectors.

Indeed, the power blocks (04 and 06) and the protection and Type-C connector blocks (05 and 07) report the I²C addressing setup of each port, referring to the STPD01PUR and the TCPP02-M18 devices.

Figure 5. Expansion board main functional blocks (top view)

1. ST morpho connectors (CN300, CN301)
2. STPD01PUR programmable buck converter for USB Power Delivery (U400, U600)
3. TSV991AILT rail-to-rail op-amp (U401, U501, U601, U701)
4. TCPP02-M18 Type-C port protection for Source (U500, U700)
5. STL11N3LLH6 N-channel 30 V, 11 A STripFET H6 Power MOSFET (Q500, Q501, Q700, Q701)
6. STL9P3LLH6 P-channel 30 V, 9 A STripFET H6 Power MOSFET (Q200)
7. L7983PU50R 60 V, 300 mA synchronous step-down switching regulator (U200)
8. Type-C connector (CN500, CN700)
9. ESDA25P35-1U1M high-power transient voltage suppressor (D500, D700)
10. SMM4F28A 400 W, 28 V TVS (D200)
11. DC power connector (J801)
12. DC power jack (J800)
13. Indication LEDs (D400, D401, D600, D601)

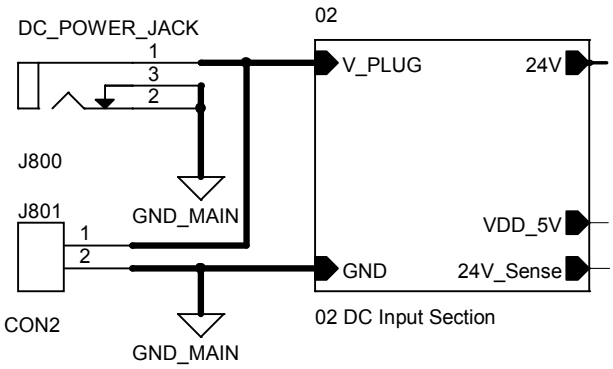


1.2.2.1 *Input power section*

When the two boards are stacked, the kit can be supplied through one of the two DC power connectors (J800 and J801), depending on the capabilities of the power supply.

Note: The J800 power jack connector is able to sustain up to 5 A, while the J801 power connector is able to sustain more than 5 A.

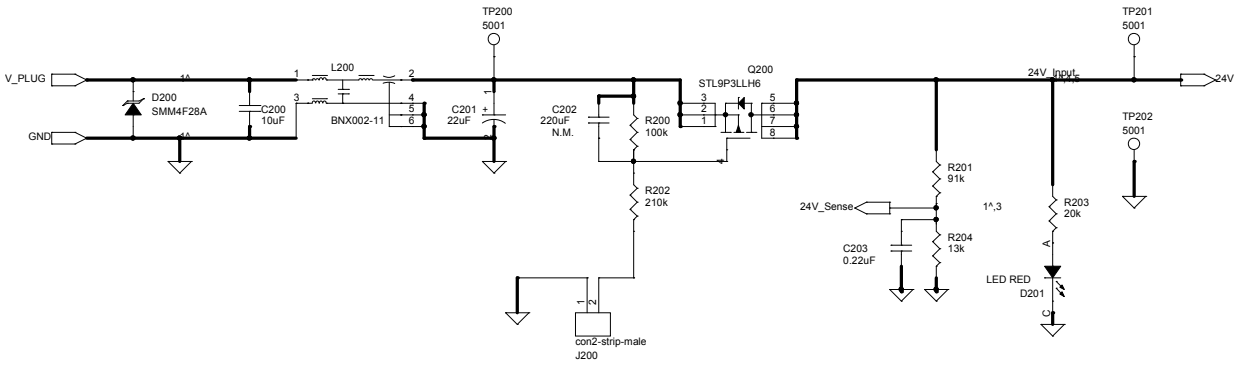
Figure 6. Input power connectors (J800 and J801)



Note: The STEVAL-2STPD01 has been designed to target 120 W output power when the input source is a DC power supply with 24 V and 6 A capability at least. This type of power supply has to be connected to J801 power connector.

As shown in the following figure, the first stage of the input power section manages the input voltage through a filtering stage (composed of C200, L200, C201) and protections (D200 and Q200) to make it available to the whole solution: the input voltage (labelled 24V_Input on the schematics) directly supplies the two STPD01PUR devices for the USBPD V_{BUS} generation on each port (04 and 06 blocks shown in Figure 4), and the L7983PU50R switching regulator that generates the voltage supply for the digital stage.

Figure 7. Input power section



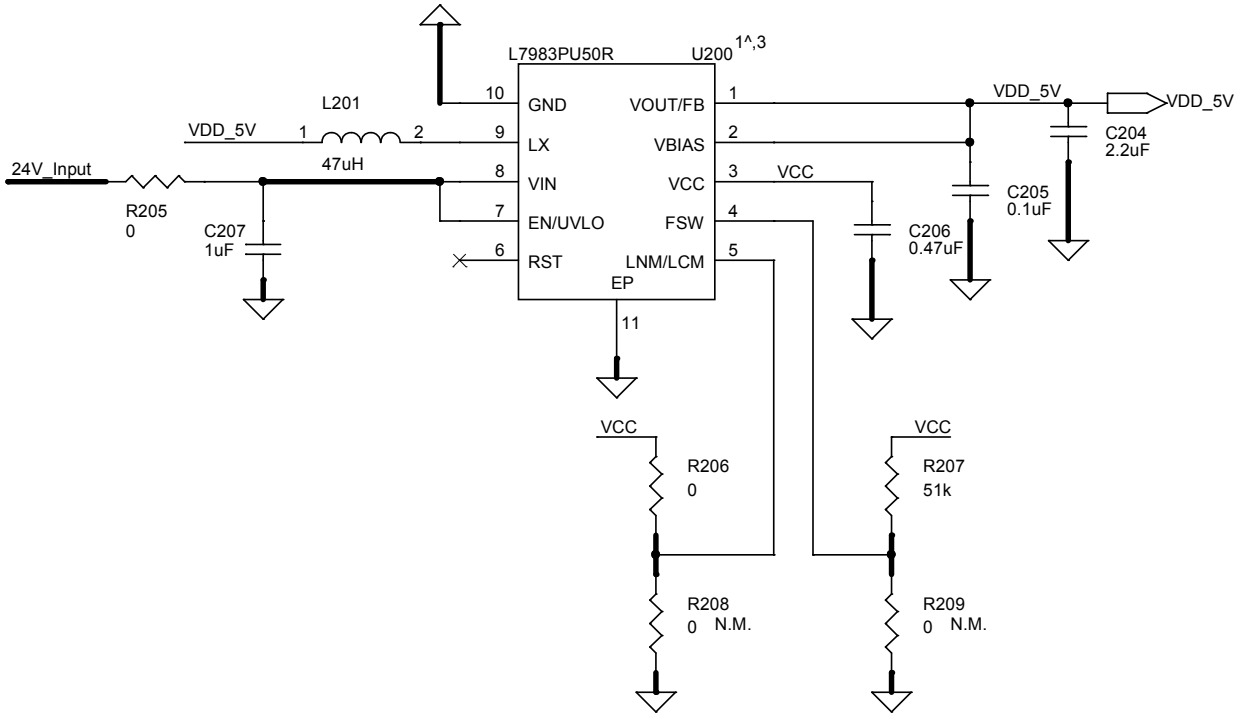
J200 jumper drives the MOS and sets the input voltage path on continuity, thus maintaining the external power plug attached to the input connectors and disabling the supply even if still connected to the kit plug.

Moreover, a sensing stage has been integrated with R201/R204 voltage dividers. One channel of the ADC peripheral in the STM32G071RBT6 microcontroller is used to monitor the input voltage path.

When this section is supplied and a jumper is set on J200 header, D201 red LED turns on signaling the kit is powered.

The L7983PU50R switching regulator has been integrated to convert the DC input voltage and supply the NUCLEO-G071RB development board.

Figure 8. **L7983PU50R stage**



The L7983PU50R can deliver up to 300 mA DC, with a wide input voltage range (from 3.5 V up to 48 V).

The device features dynamic low consumption mode (LCM) to low noise mode (LNM) transitions.

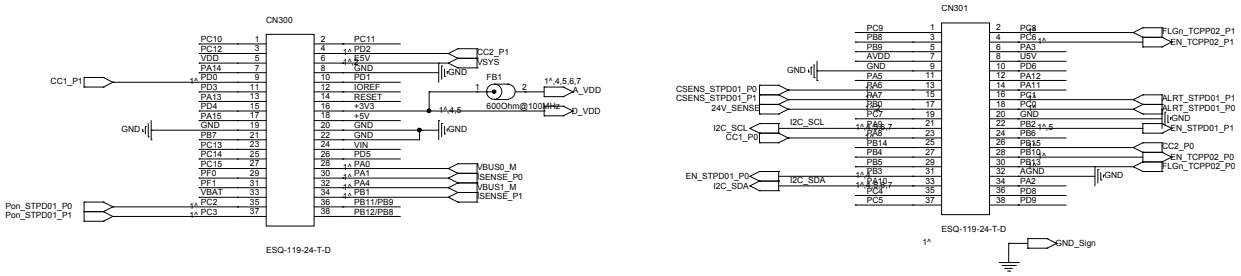
LNM, set by mounting R206 pull-up, makes the switching frequency constant, meeting the low noise application specification, whereas LCM is designed for applications active during idle mode to maximize the efficiency at light load with controlled output voltage ripple.

Note: The NUCLEO-G071RB development board can be powered by the external 5 V coming from the expansion board, when a jumper fits pins 5-6 in JP2 header or, alternatively, by CN2 USB_STLINK connector, fitting a jumper on pins 1-2 of the NUCLEO-G071RB JP2 header. In the second case, by connecting the board to a laptop with the STM32CubeMonUCPD installed, it is also possible to exploit the development board serial communication to monitor the USBPD messages exchanged by the kit with one or two attached Sink platforms.

1.2.2.2 *Morpho connectors*

CN300 and CN301 morpho connectors interconnect the two boards allowing the STM32G071RBT6 microcontroller to control the expansion board functionalities and to be supplied by an external power source.

Figure 9. **CN300 and CN301 morpho connectors**



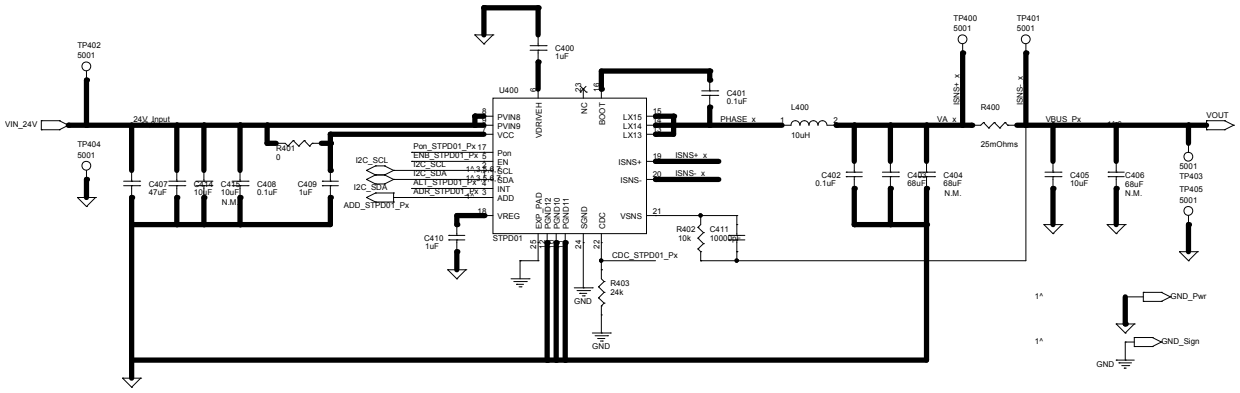
1.2.2.3 *USBPD power block*

The USBPD power blocks are the expansion board key sections as they permit to deliver the correct power to the attached Sink paired ports once the negotiation with the PD controller is completed.

The STPD01PUR programmable buck converters (U400 and U600) constitute the core of these blocks. These devices, controlled by the STM32G071RBT6 microcontroller through I²C communication and GPIOs, set the correct level of voltage and current every time a new power negotiation is accomplished with a Sink platform connected to a port Type-C connector (P0 or P1).

The figure below shows the STPD01PUR setup for port P0 (for analogy, the stage is repeated for port P1).

Figure 10. STPD01 USBPD programmable buck converter (U400, for port P0)



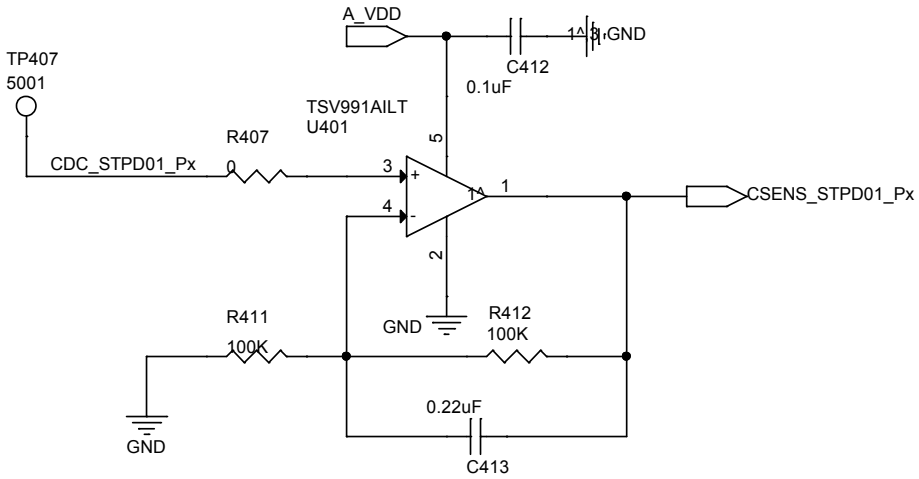
The STPD01PUR ENABLE pin (EN) is driven by the microcontroller to enable the device startup and, consequently, its I²C communication interface. The microcontroller sets the STPD01PUR registers via I²C commands and, at startup, the V_{OUT} level to the default voltage value.

After startup, the Power-on (Pon) pin is high if the value is within ±5% of the regulation point. This event on Pon pin is also monitored by the microcontroller.

The STPD01PUR Interrupt pin (INT) triggers the STM32 microcontroller providing notifications related to the watchdog functionalities (OVP, OTP, SCP,etc.). These notifications shall be read by the microcontroller through I²C communication as well.

The output voltage on the STPD01PUR CDC pin is managed by the conditioning stage (shown in Figure 11), before being acquired by the microcontroller to monitor the output current.

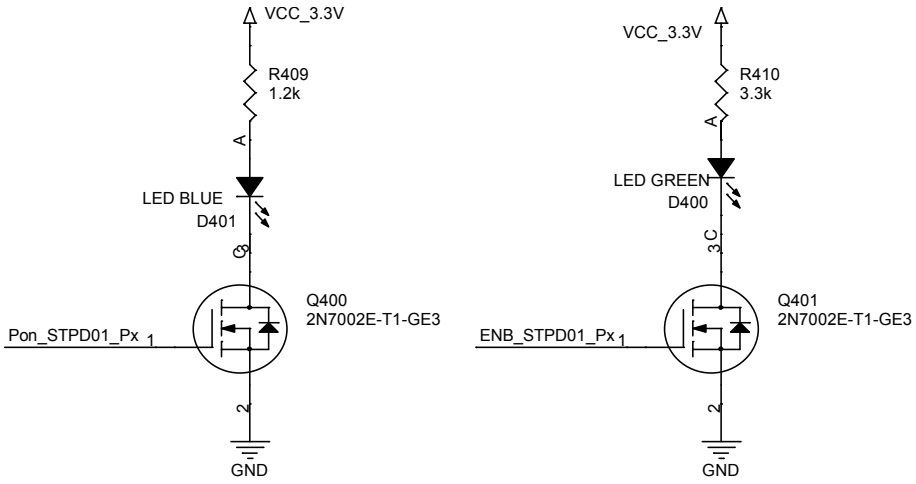
Figure 11. STPD01PUR CDC conditioning stage



For each USBPD power block, two LEDs mounted on the expansion board top side provide clear information on the STPD01PUR status as shown in Figure 12:

- when the microcontroller sets high the STPD01PUR EN pins, the associated device immediately switches on after the startup sequence, turning on D400 (EN0) and D600 (EN1) green LEDs, respectively;
- when the STPD01PUR Pon pin is high, D401 (PWR0) and D601 (PWR1) blue LEDs turn on, indicating the device is providing the right value of output voltage (within ±5% of the regulation point).

Figure 12. **D400 and D401 indicator LEDs (for port P0)**



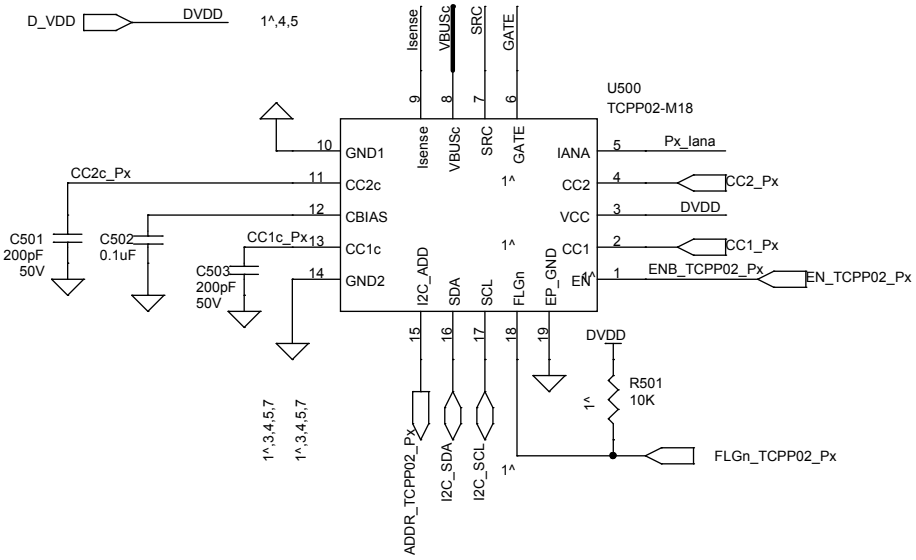
1.2.2.4 *Protection and Type-C connector block*

The last section of the expansion board contains the TCPP02-M18 (U500 and U600) USB Type-C protections and the receptacles (CN500 and CN700) which gather the V_{BUS} path and the CC lines after dispatching from the major functional blocks and morpho connectors.

The TCPP02-M18 is a source protection solution for USB Type-C applications that integrate overvoltage, overcurrent, discharge protections required for V_{BUS} path and CC lines.

The TCPP02-M18 setup on port P0 is shown in the figure below (for analogy, the stage is repeated for port P1).

Figure 13. **TCPP02-M18 protection (U500) on port P0**

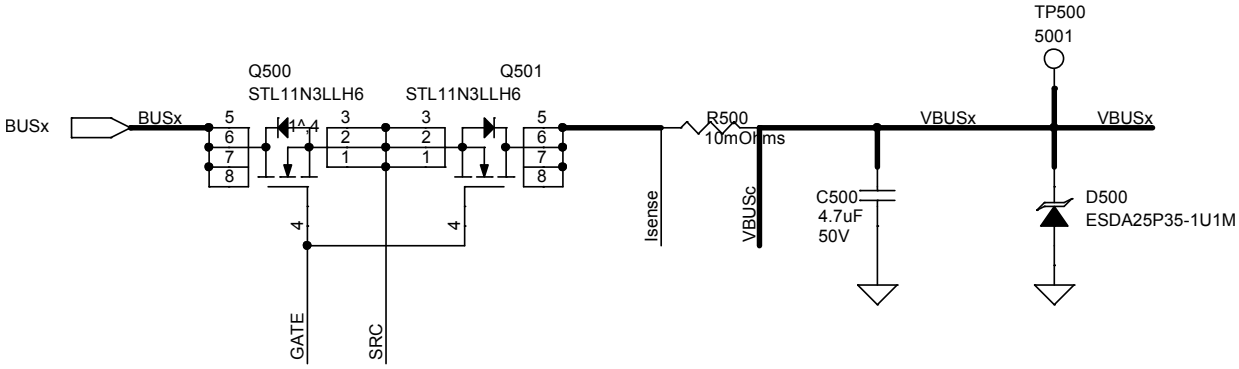


The TCPP02-M18 provides overvoltage protection on CC1 and CC2 pins in case a short-circuit occurs when plugging/removing the USB Type-C cable from its receptacle.

The TCPP02-M18 ENABLE pin is driven by the microcontroller.

When the device is enabled, it controls the two N-channel MOSFET (Q500 and Q501) representing the load switch on port P0 V_{BUS} path as shown below (for analogy, the stage is repeated for port P1 port).

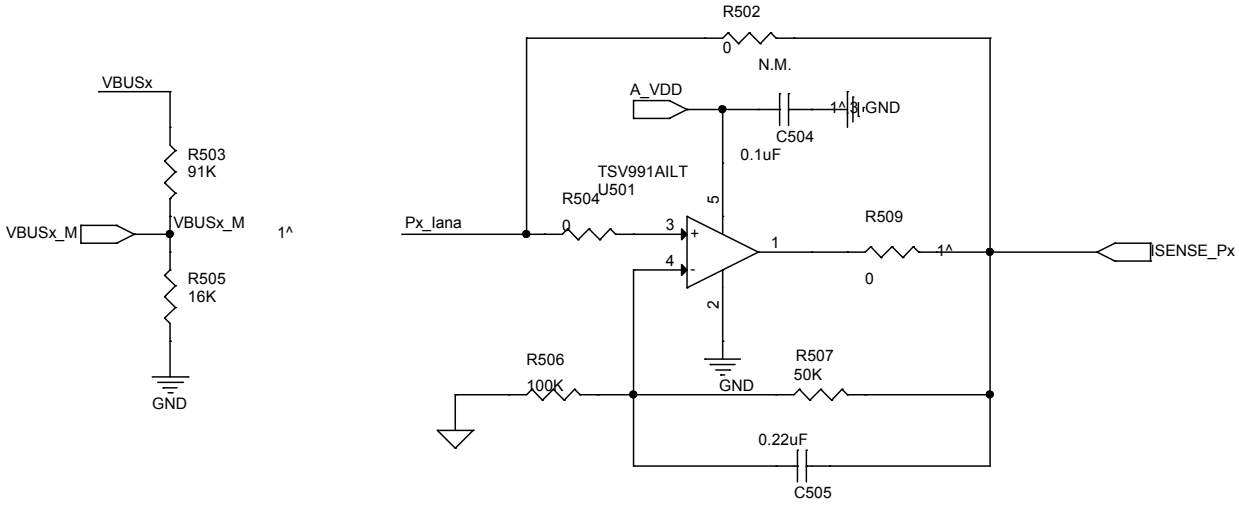
Figure 14. V_{BUS} path load switch based on STL11N3H6 (Q500 and Q501) driven by TCPP02-M18



Moreover, the device measures the current on the V_{BUS} through an external resistor (R500 or R600) and on the path through two pins (I_{sense} and V_{BUSc}) connected to an internal integrated operational amplifier, detecting overcurrent events and acting on the load switch to open the V_{BUS} path.

An additional monitoring of the V_{BUS} path is performed through the current and voltage sense conditioning stage, thanks to the TSV991 operational amplifier (U501). The stage can be also bypassed by mounting the resistances (R502 on port P0, R702 on port P1) and removing the solder bridges (R504 on port P0, R704 on port P1).

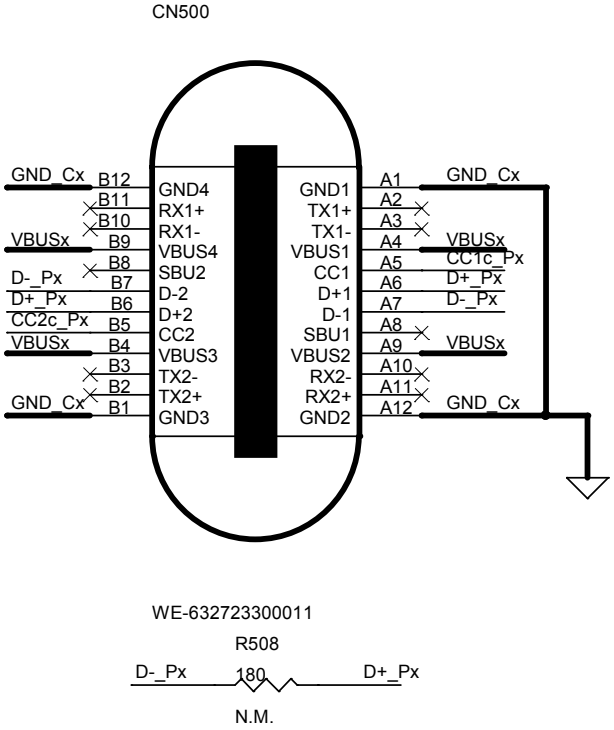
Figure 15. Current and voltage conditioning stage



To assure further protection on the V_{BUS} power line and, consequently, the entire system against EOS and ESD transients, when a Sink is connected through the USB-C cable, an ESDA25P35-1U1M TVS diode has been integrated.

The V_{BUS} power lines are connected to the Type-C connectors: CN500 receptacles for port P0 (as shown below) or CN700 for port P1.

Figure 16. **Type-C receptacle (CN500)**



1.3 Application example setup

The STSW-2STPD01 software package for the STEVAL-2STPD01 evaluation kit contains an application example specific for the STM32G071RBT6 microcontroller embedding the USB Type-C and Power Delivery management with the two ports and a module featuring the power sharing on these two stages.

To set up the demo and run the application with two Sink devices, you need:

- an STEVAL-2STPD01 evaluation kit
- a power supply: the DC power supply capability can start from 18.5 W (with a minimum voltage of 8.1 V), depending on the input power; the solution adapts the output profiles for the required operating conditions
- two Type-C cables
- two Sinks (for example, two USB-C and Power Delivery mobile phones)

Section 1.3.1 describes how to run the application when a 144 W rated power supply (voltage = 24 V, current = 6 A) is plugged to the STEVAL-2STPD01 J801 connector allowing the board to reach the 120 W maximum power (60 W for each port) and making all the PDOs (5 V, 9 V, 15 V and 20 V, up to 3 A) available to both ports.

Section 1.3.2 describes how to configure the board input power in case a low power supply is used as input, enabling the power sharing module to share the available power between the two ports.

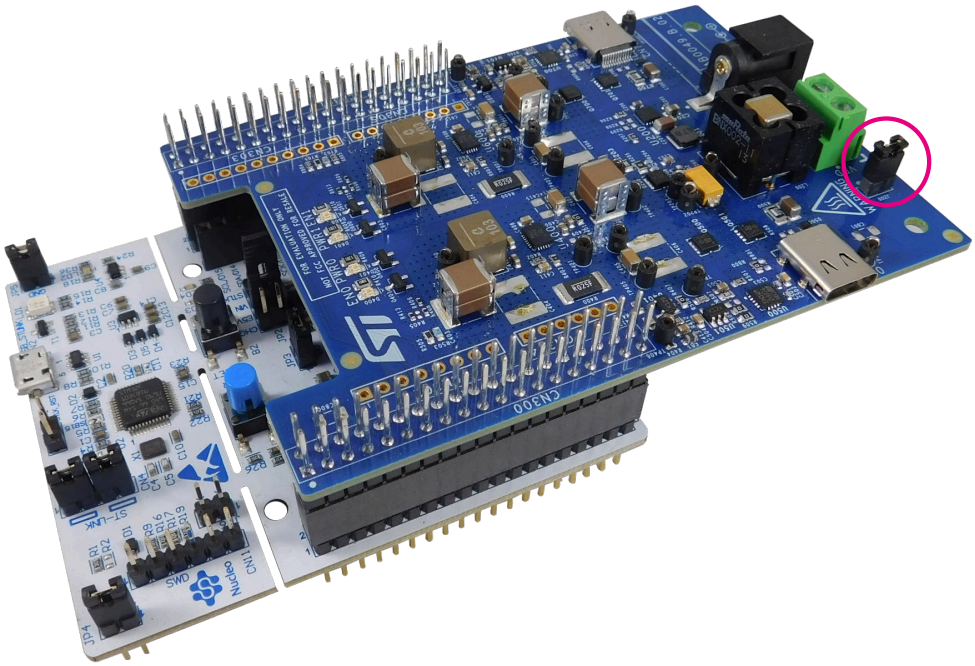
Warning: *Respect the following safety limitations:*

- *Voltage min. = 8.1 V*
- *Voltage max. = 24 V*
- *Power min. = 18.5 W*

1.3.1 How to run the application with the maximum power rate input

Step 1. Verify that a jumper closes the expansion board J200 header, as highlighted in pink in the figure below.

Figure 17. STEVAL-2STPD01 evaluation kit - J200 closed by a jumper



Step 2. Plug the 24 V/6 A DC power supply into the expansion board J801 connector.

D201 red LED turns on.

After few milliseconds, the microcontroller runs the application firmware example, initializes all the essential peripherals, and puts the system in standby, waiting for an "attach" event on the Type-C receptacles: when the system is ready to interact with the Sinks, the LEDs (D400, D401, D600 and D601) on top of the expansion board switch on.

Figure 18. 24 V, 6 A DC power supply connected to J801 connector

Step 3. Connect a Sink to one port through a Type-C cable.

After connecting the 24 V, 6 A DC power supply, the STEVAL-2STPD01 transmits the list of the available PDOs (5 V, 9 V, 15 V and 20 V, up to 3 A) to the attached Sink which requests the suitable one. If the request is accepted, the two systems reach an explicit contract.

Step 4. Repeat step 3 for the other port with the other Sink.

Figure 19. STEVAL-2STPD01 evaluation kit connection example - charging two mobile phones

Note: Using a 24 V, 6 A power supply, each port of the kit can provide the maximum power of 60 W and four PDOs: 5 V, 9 V, 15 V and 20 V, up to 3 A.

Note: If the two ENx (green) and PWRx (blue) LEDs blink, it means a fault event has occurred and the port has gone under protection. A power cycle is required to make it operative again.

RELATED LINKS

For further details on USBPD contract negotiation and specification, refer to AN5225.

1.3.2 How to set up the STEVAL-2STPD01 power input

By default, the STEVAL-2STPD01 is set to be plugged to an input power supply able of 24 V and 6 A. In case a power supply with reduced capabilities is available, it is possible to test the application with a reduced input power after storing the new value of the input voltage and current or power in the STEVAL-2STPD01 Flash memory.

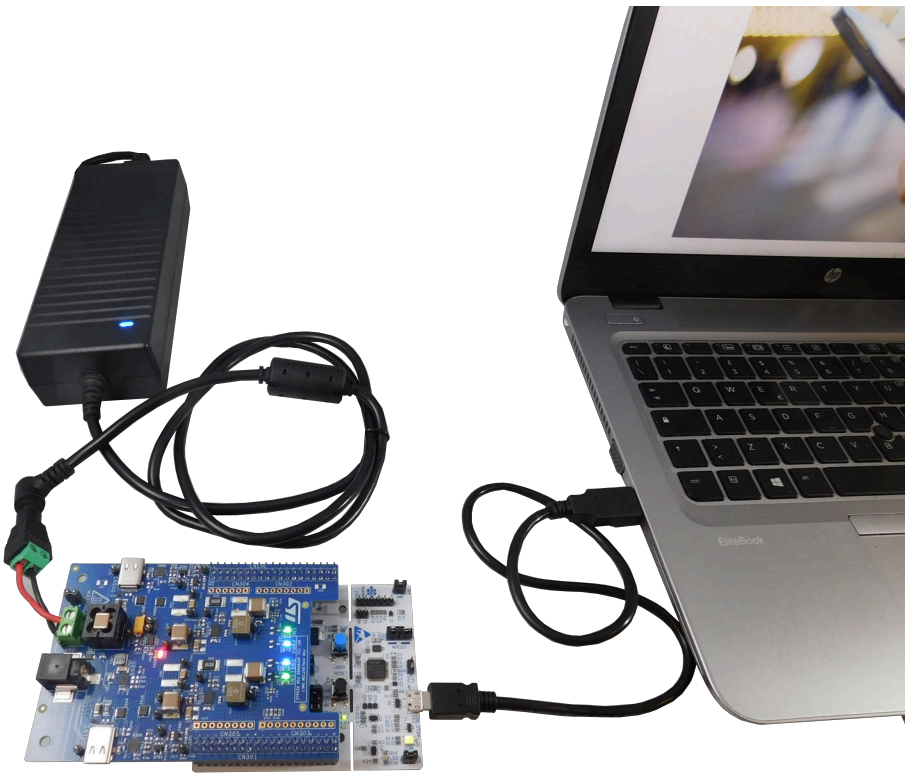
In the following steps, we set up the board to be supplied with a 15 V, 3.5 A DC power supply.

Note: By reducing the input power, the PDOs are limited to the maximum value of the voltage provided.

For example, with a power supply with a minimum power capability of 20 W and 8.5 V, the solution is able to provide only one PDO of 5 V, 3 A in one of the two ports.

Step 1. Download and install the STM32CubeMonUCPD, connect your power supply to one of the two STEVAL-2STPD01 power connectors (J800 or J801) and connect the NUCLEO-G071RB USB_STLINK CN2 connector to the PC through a micro-B USB cable.

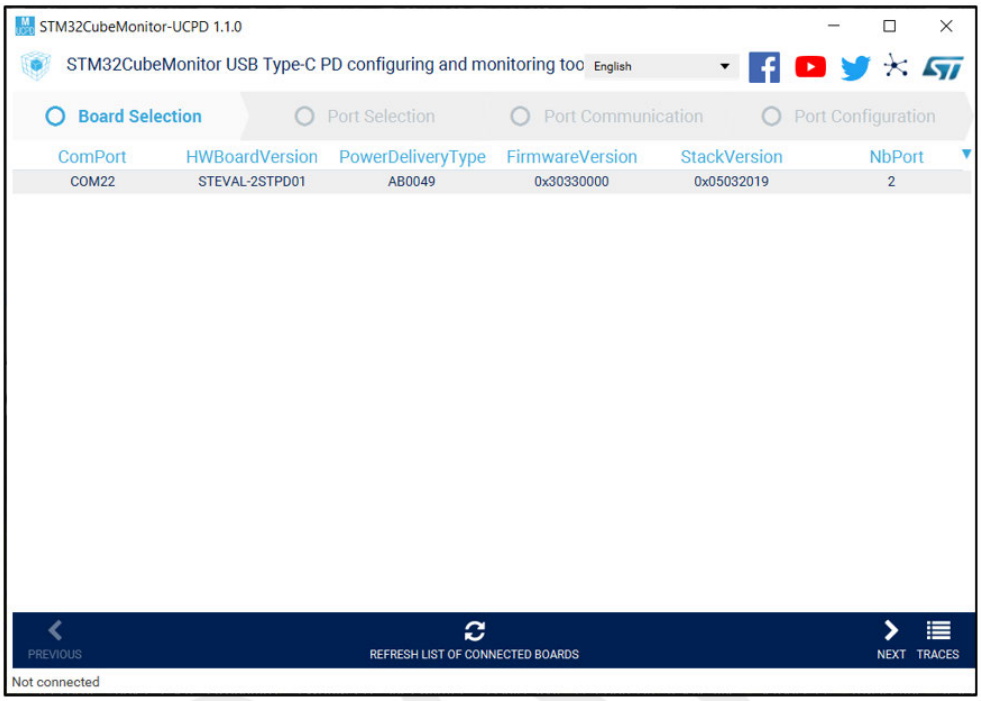
Figure 20. Connections for input power setup



Step 2. Run STM32CubeMonUCPD.

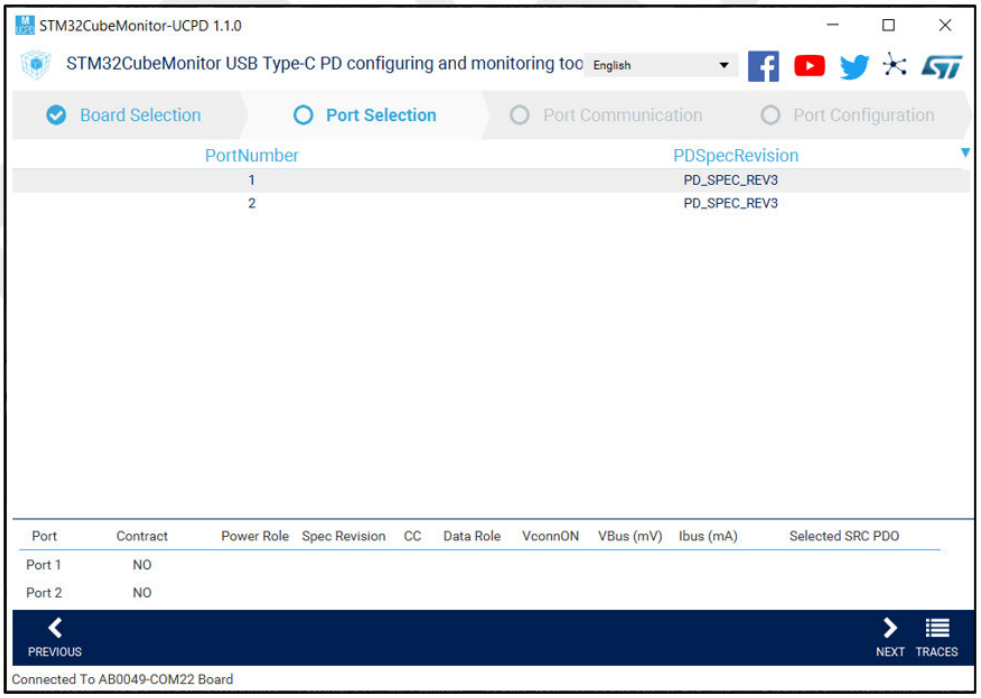
Step 2a. In the first window, double-click the name of board to select it.

Figure 21. STM32CubeMonUCPD (1 of 2)



Step 2b. In the next window, double-click on the port number (1 or 2) to select it.

Figure 22. STM32CubeMonUCPD (2 of 2)



Step 3. In the [**Message Selector**] tab, select [**Send free text**] by scrolling the right side bar or typing "free" in the [**Filtering messages**] text box.

In the Free text box, you can insert the values of the used power supply for nominal voltage, current and power, on the basis of the syntax described in Table 1.

Figure 23. STM32CubeMonUCPD main window

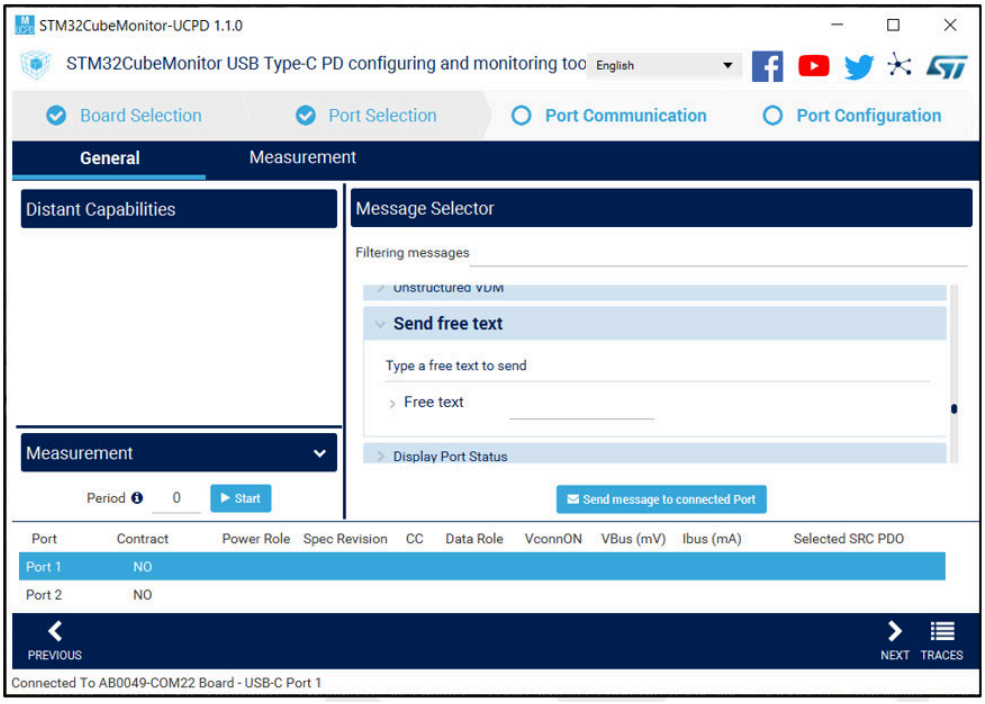


Table 1. Syntax to insert new input power values

Parameters	Syntax
Voltage (Volts)	V=XX[.X]
Current (Amperes)	C=X[.X]
Power (Watts)	P=XXX[.X]
Current values stored (voltage and current)	?

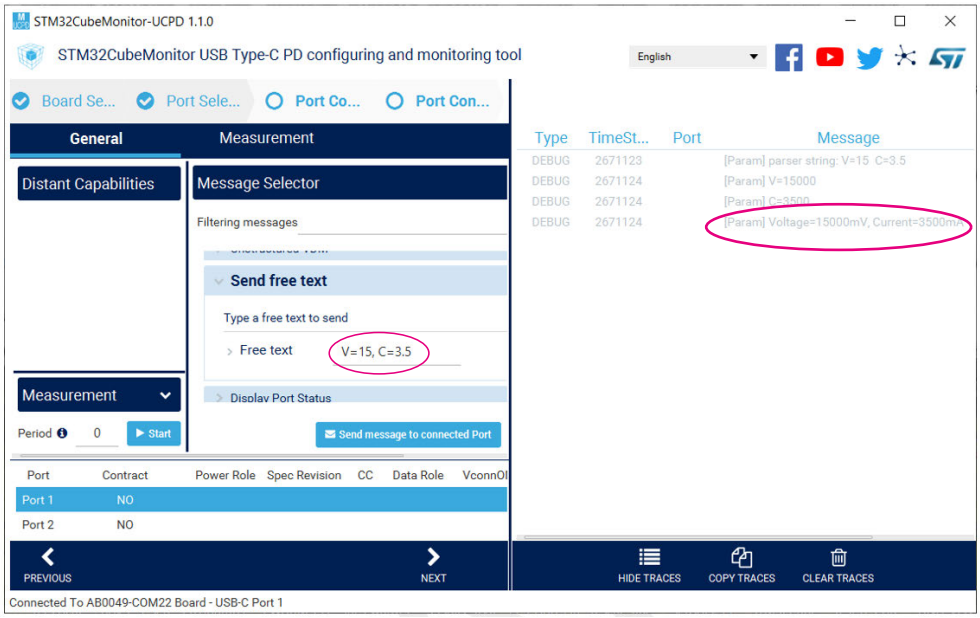
The input power rate can be specified in the text area, as a value list of voltage (V), current (C) or power (P), separated by a comma, semicolon or space.

For example, with a power supply of 15 V, 3.5 A (rated as 52.5 W), valid configuration strings are:

– V=15, C=3.5
– C=3.5→ the system acquires the input voltage through an ADC channel
– P=52.5→ the system acquires the input voltage through an ADC channel and calculates the current
– C=3.5, P=52.5→ the system calculates the voltage

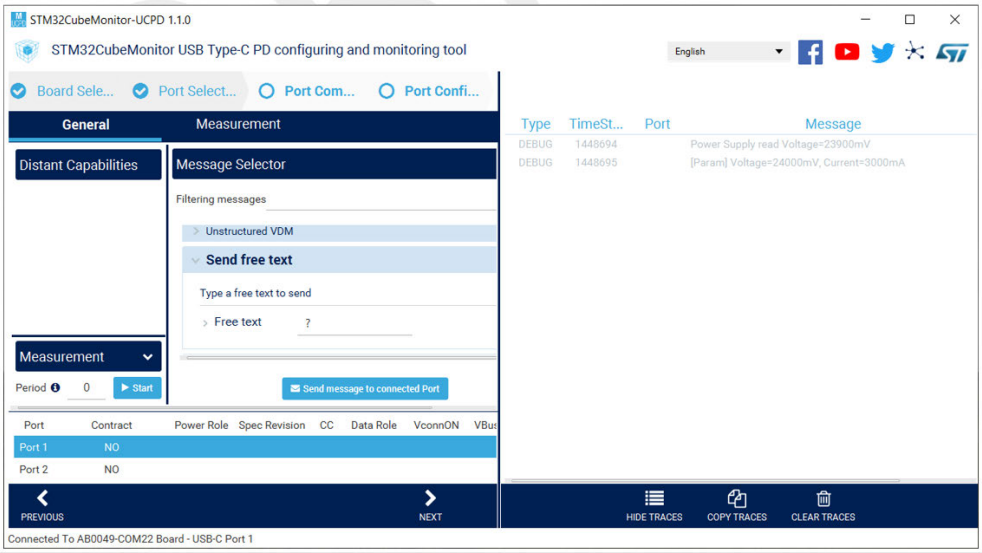
Step 4. To send new values click on the [**Send message to connected Port**] button.
By clicking on the lower right corner ([**Traces**]), the new stored values are visible as shown below (circled in pink).

Figure 24. New stored values



Step 5. Insert '?' in the Free text row to view the current values stored in the Flash memory and the input voltage read by the microcontroller ADC.

Figure 25. Current values



1.3.3 How to reprogram the NUCLEO-G071RB

The following procedure describes how to restore the initial application example (contained in the STSW-2STPD01 software package) in the STM32G071RBT6 microcontroller.

To reprogram the NUCLEO-G071RB you need:

- an STEVAL-2STPD01 evaluation kit
- the STSW-2STPD01 software package
- a PC/laptop with at least a type-A port

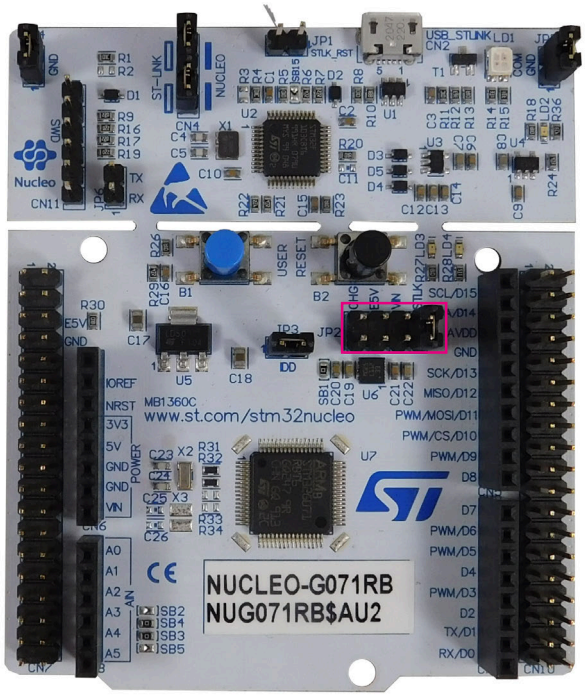
- a USB Micro-B cable

Step 1. Download, unzip and save STSW-2STPD01 software package.

Step 2. Open the firmware\project\STEVAL-2STPD01\bin folder and target the bin file.
You can also open the source code project with your favourite IDE and generate a new binary file or start a debug session.

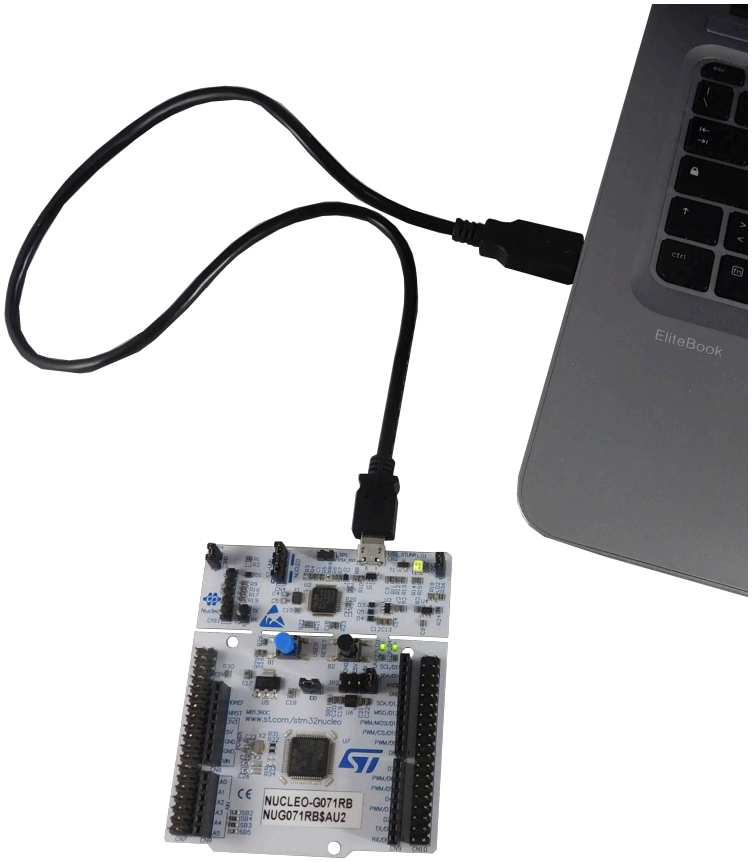
Step 3. Check the jumper on JP2 connector of the NUCLEO-G071RB development board is mounted on position 1-2 (ST-LINK) as shown below.

Figure 26. NUCLEO-G071RB JP2 set on 1-2 before programming



Step 4. Connect the USB Micro-B cable to the NUCLEO-G071RB USB micro-B USB_STLINK connector CN2, and then connect the type-A side to the laptop type-A port as shown below.

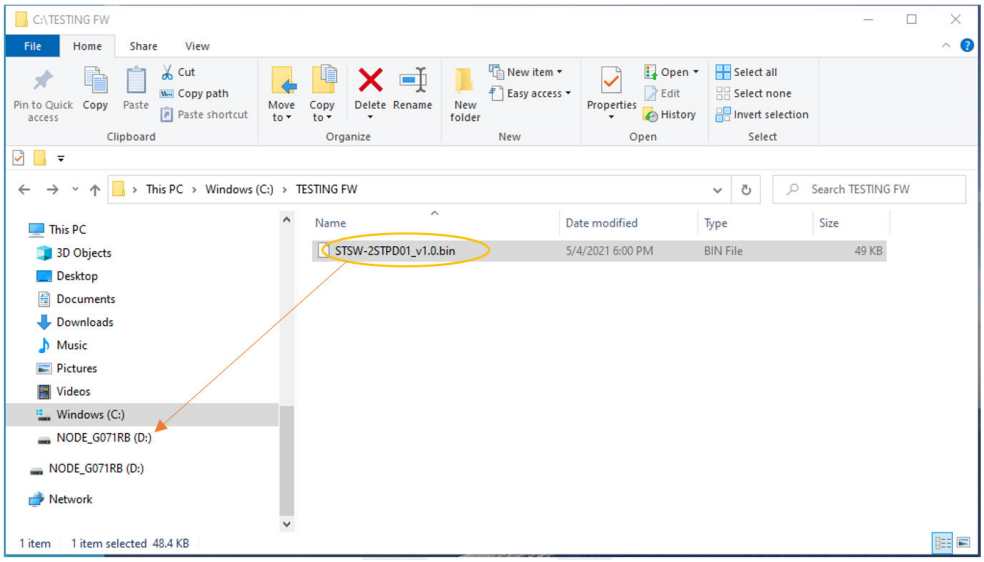
Figure 27. NUCLEO-G071RB connected to the laptop to program the testing firmware



Step 5. Open a new explorer window and ensure the NUCLEO-G071RB board is mapped by the laptop operative system as a virtual mass-storage device.

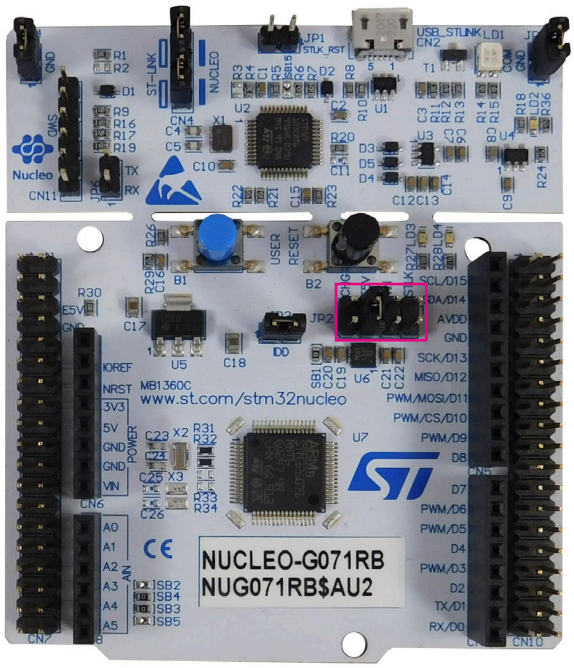
Step 6. Drag and drop the targeted binary file (i.e. STSW-2STPD01_vX.Y.bin) into the new mapped device named NODE_G071RB.

Figure 28. Drag and drop the testing firmware to the new mapped device



Step 7. Disconnect the USB cable from the NUCLEO-G071RB board, move the jumper on JP2 connector from position 1-2 (ST-LINK) to position 5-6 (E5V), as shown below.

Figure 29. Programmed NUCLEO-G071RB with JP2 set, before being stacked under the expansion board



JP2 setup enables the NUCLEO-G071RB board to be supplied by the external power source when the expansion board is stacked on it.

Step 8. Stack the expansion board on the NUCLEO-G071RB board, ensuring that the expansion board morpho connectors (CN300 and CN301) perfectly fit into the NUCLEO-G071RB connectors.

Note: The same procedure can be also followed to program the board with a new application example to test specific characteristics of your own application, adding or removing some software feature.

2 Schematic diagrams

Note: The schematic diagrams below refer to the expansion board included in the STEVAL-2STPD01 evaluation kit. For the schematic diagrams of the NUCLEO-G071RB development board, see the related web page.

Figure 30. STEVAL-2STPD01 circuit schematic (1 of 7)

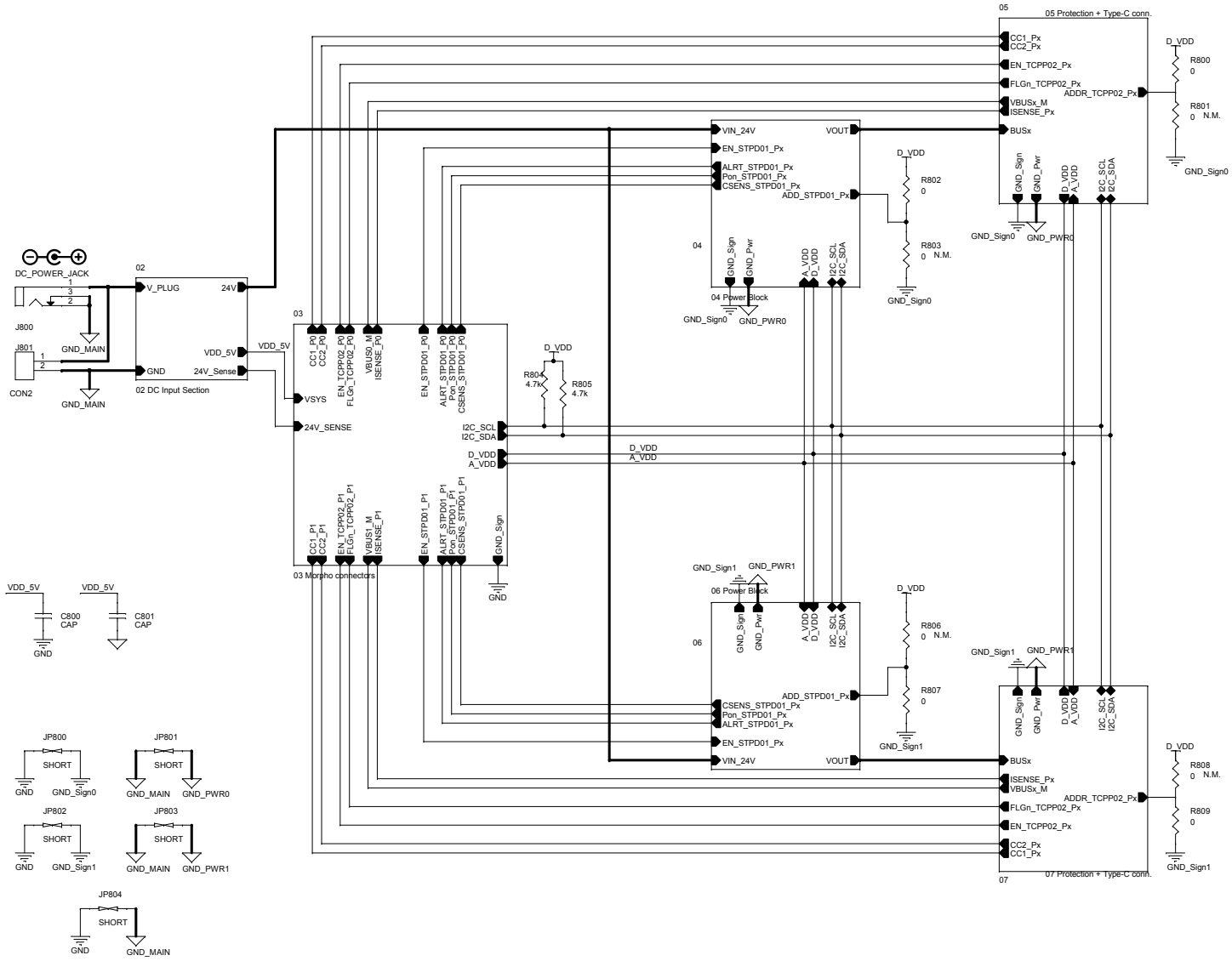


Figure 31. STEVAL-2STPD01 circuit schematic (2 of 7)

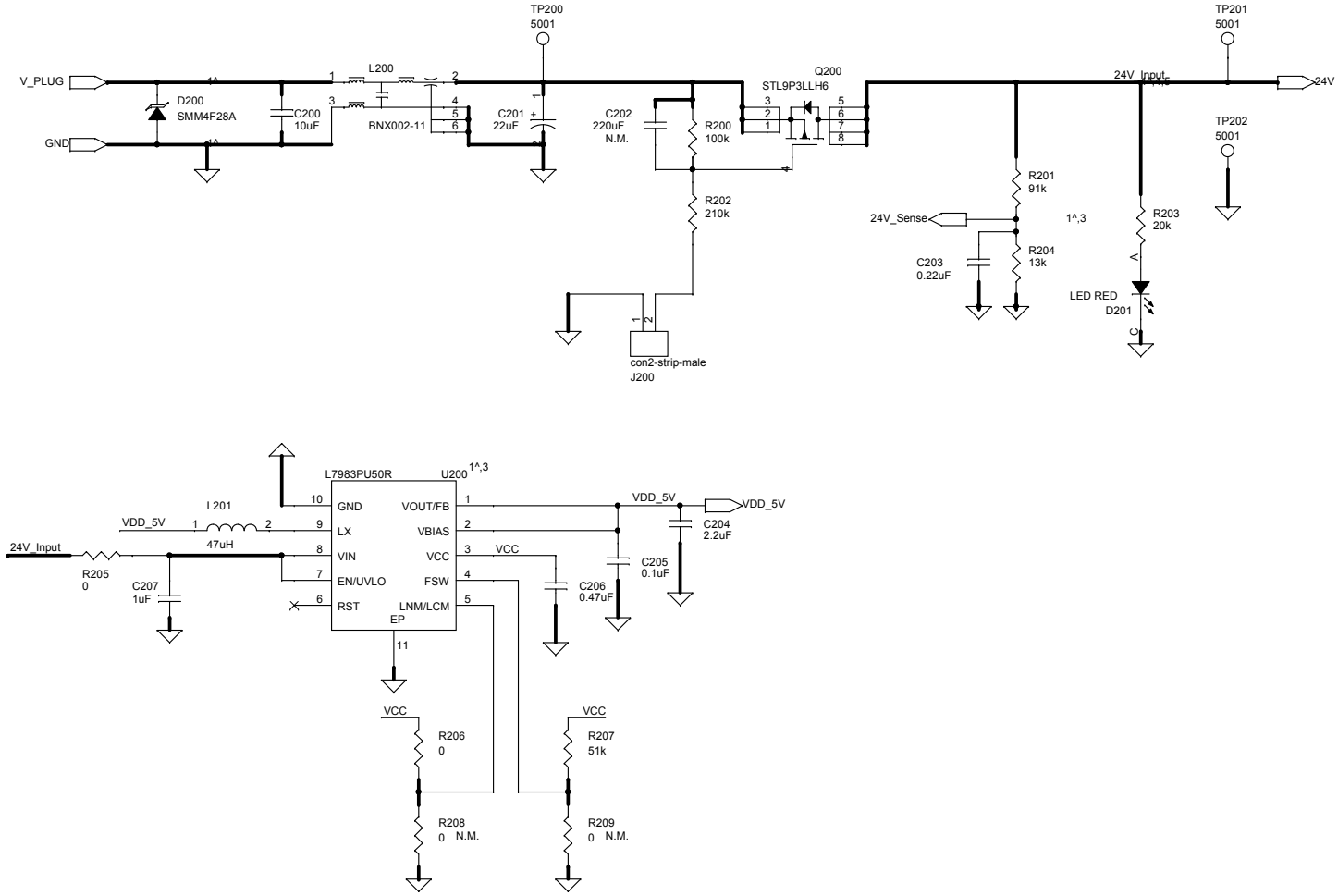


Figure 32. STEVAL-2STPD01 circuit schematic (3 of 7)

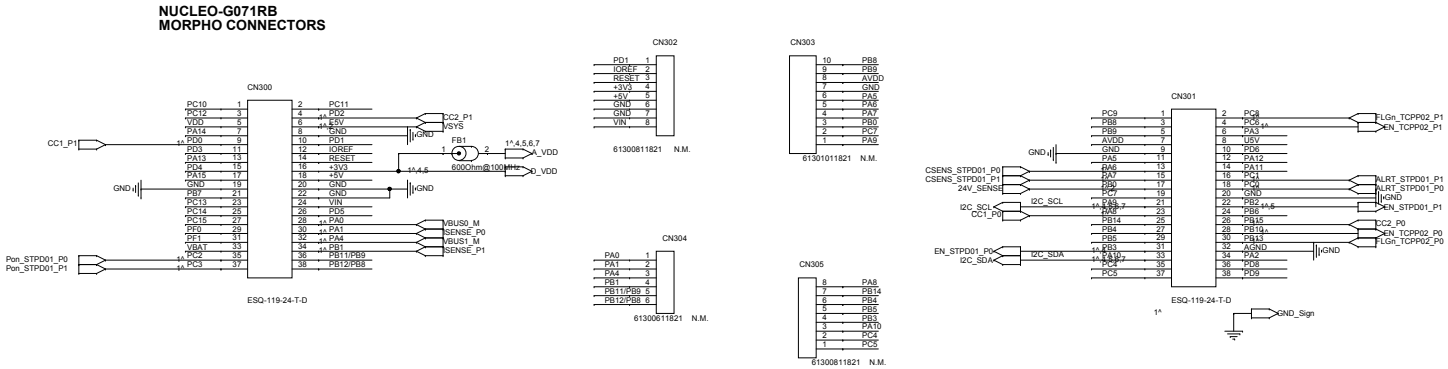


Figure 33. STEVAL-2STPD01 circuit schematic (4 of 7)

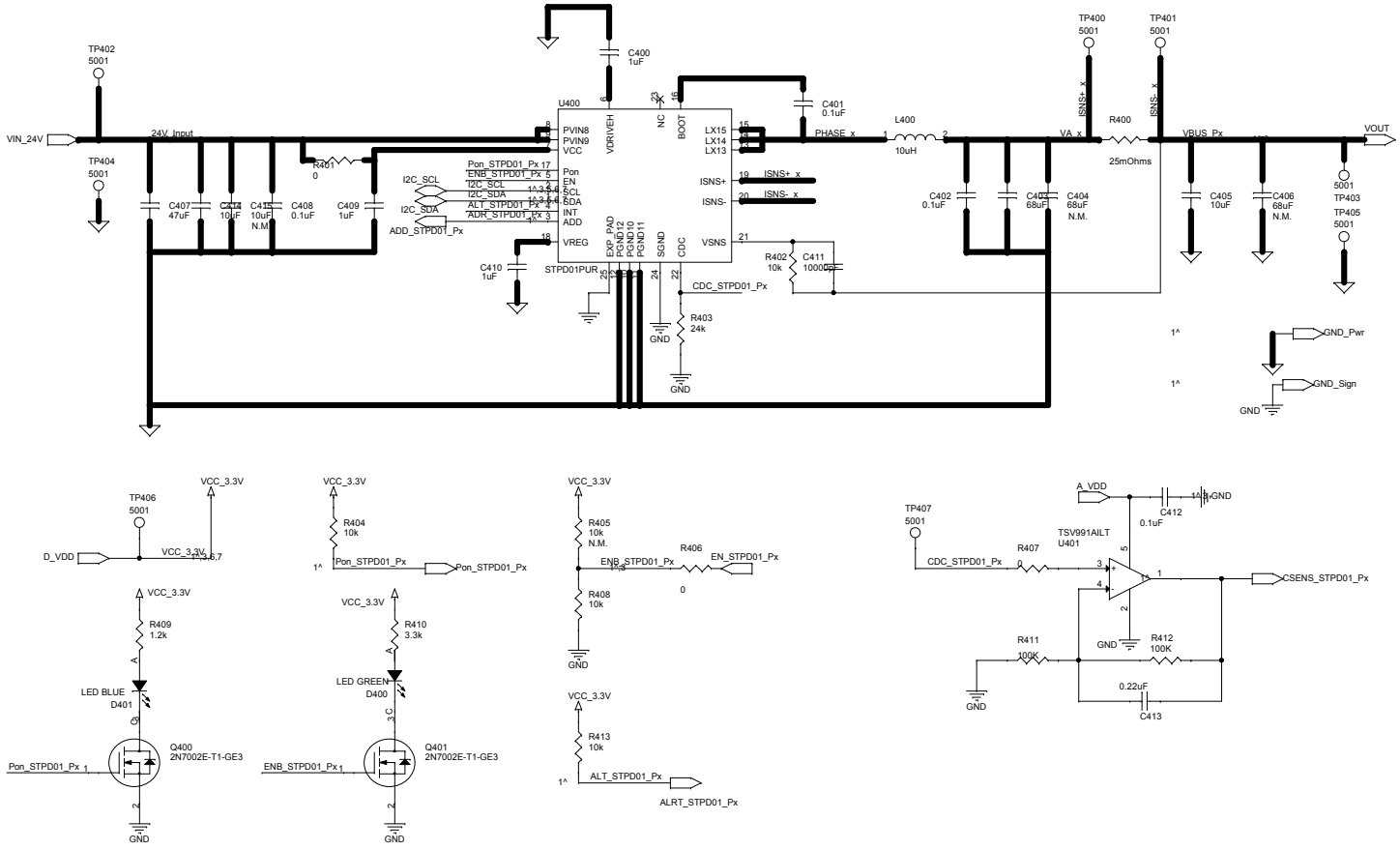


Figure 34. **STEVAL-2STPD01 circuit schematic (5 of 7)**

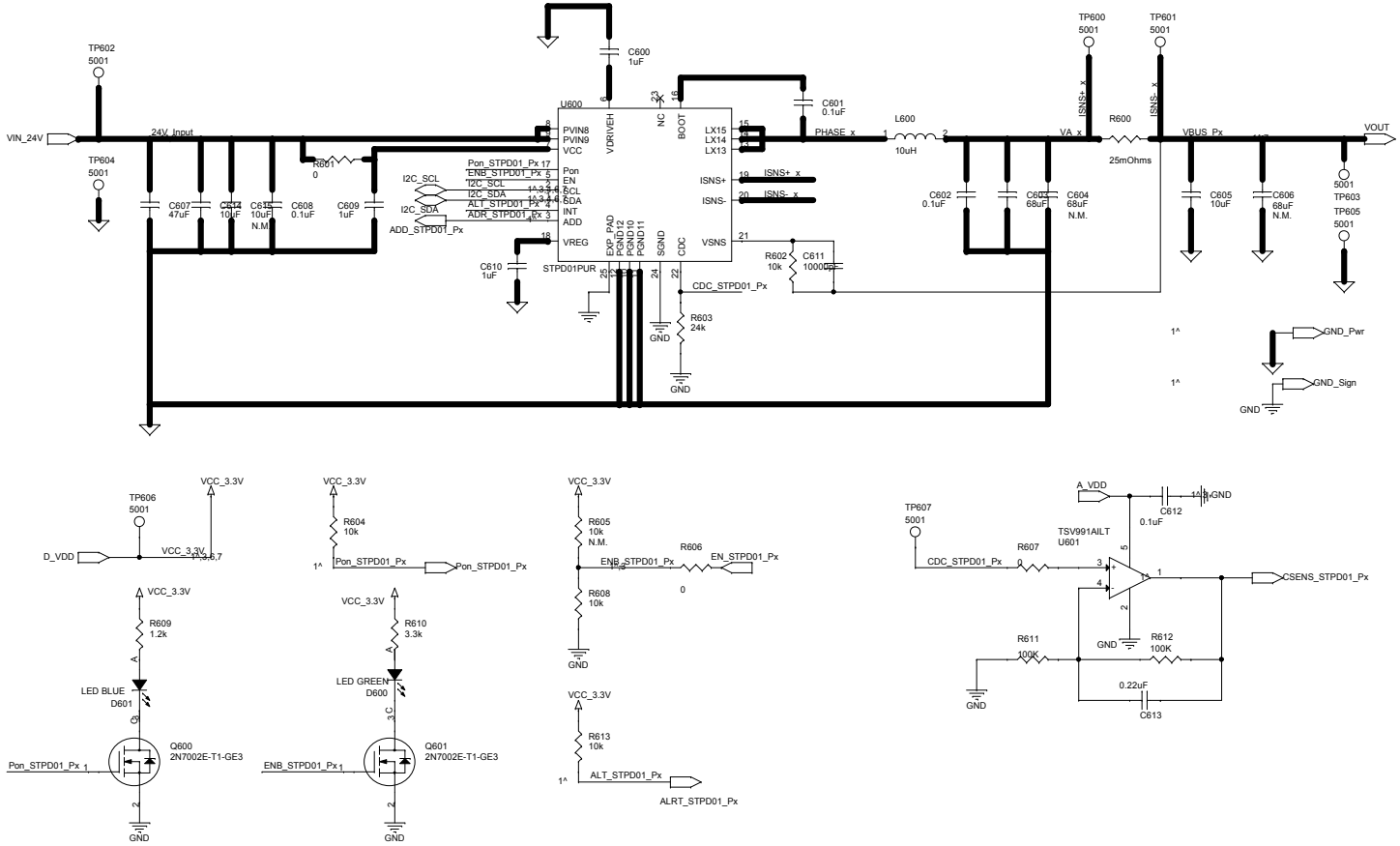
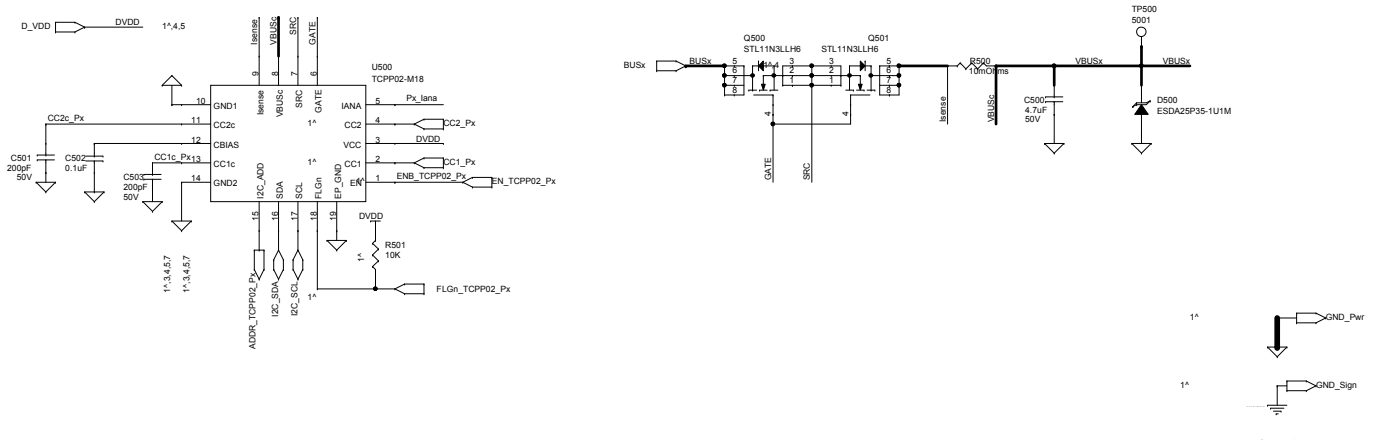
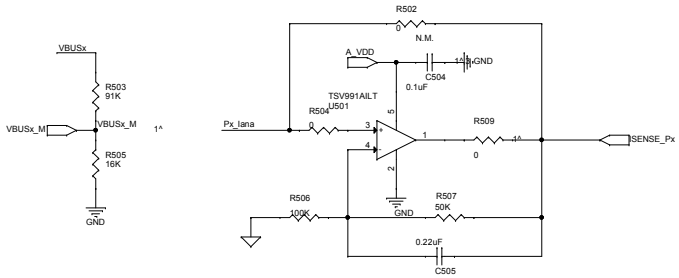


Figure 35. STEVAL-2STPD01 circuit schematic (6 of 7)

Port Protection & BUS Control



Port Current & Voltage Sense conditioning stage



Type-C Receptacle

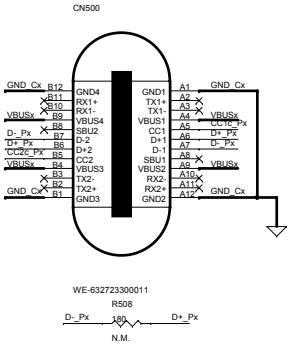
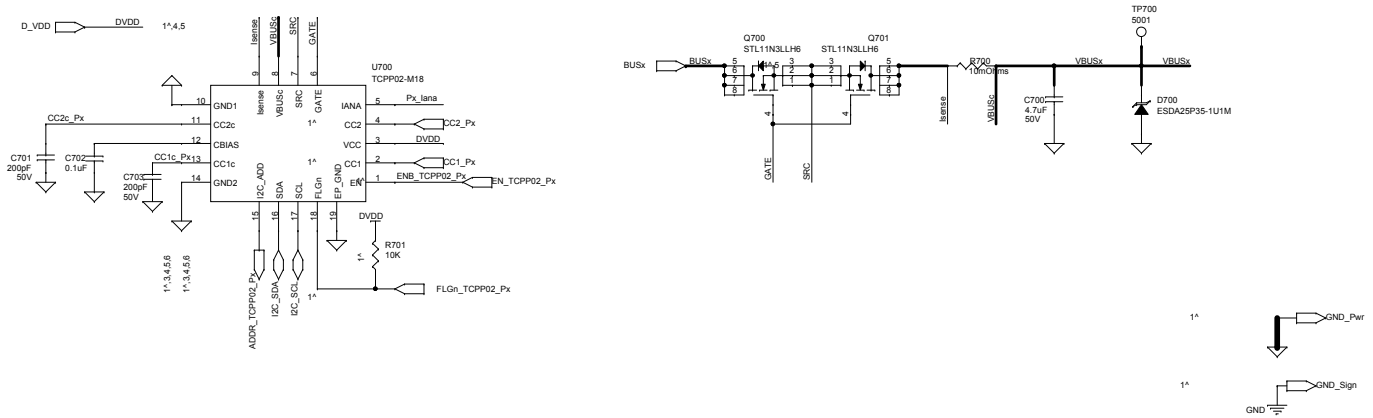
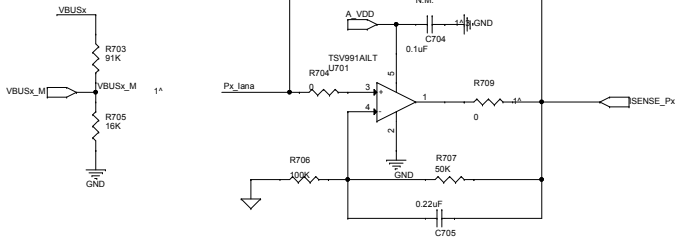


Figure 36. STEVAL-2STPD01 circuit schematic (7 of 7)

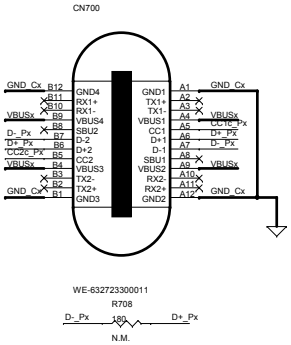
Port Protection & BUS Control



Port Current & Voltage Sense conditioning stage



Type-C Receptacle



3 Bill of materials

Table 2. STEVAL-2STPD01 bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	Table 3. Expansion board bill of materials		Expansion board	ST	
2	1	NUCLEO-G071RB (for the related BOM, see the relevant web page).		Development board	ST	NUCLEO-G071RB

Table 3. Expansion board bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	C200	10 µF, 0603 (1608 Metric), 35 V, ±20 %	CAP CER 10UF 35V X5R 0603	Murata Electronics	GRM188R6YA106MA73D
2	8	C401 C402 C408 C502 C601 C602 C608 C702	0.1 µF, 0603 (1608 Metric), 50 V, ±10 %	CAP CER 0.1UF 50V X7R 0603	Würth Elektronik	885012206095
3	1	C201	22 µF, 2312 (6032 Metric), 25 V, ±10 %	CAP TANT 22UF 10% 25V 2312	Vishay Sprague	TR3C226K025C0425
4	1	C202 N.M.	220 µF, 0603 (1608 Metric), 50 V, ±10 %	CAPACITOR CERAMIC SMD 0603	Any	Any
5	1	C203	0.22 µF, 0603 (1608 Metric), 16 V, ±10 %	CAP CER 0.22UF 16V X7R 0603	Würth Elektronik	885012206048
6	1	C204	2.2 µF, 0805 (2012 Metric), 16 V, ±10 %	CAP CER 2.2UF 16V X7R 0805	TDK Corporation	C2012X7R1C225K125AB
7	1	C205	0.1 µF, 0402 (1005 Metric), 16 V, ±10 %	CAP CER 0.1UF 16V X7R 0402	Würth Elektronik	885012205037
8	1	C206	0.47 µF, 0603 (1608 Metric), 16 V, ±10 %	CAP CER 0.47UF 16V X7R 0603	TDK Corporation	C1608X7R1C474K080AC
9	1	C207	1 µF, 1206 (3216 Metric), 100 V, ±10 %	CAP CER 1UF 100V X7R 1206	TDK Corporation	C3216X7R2A105K160AA
10	6	C400 C409 C410 C600 C609 C610	1 µF, 0603 (1608 Metric), 16 V, ±10 %	CAP CER 1UF 16V X7R 0603	Würth Elektronik	885012206052
11	2	C403 C603	68 µF, SMD, J-Lead, 25 V, ±10 %	CAP CER 68UF 25V X7R SMD	Murata Electronics	KRM55WR71E686MH01K
12	4	C404 C406 C604 C606 N.M.	68 µF, SMD, J-Lead, 25 V, ±20 %	CAP CER 68UF 25V X7R SMD	Murata Electronics	KRM55WR71E686MH01K
13	4	C405 C414 C605 C614	10 µF, 1206 (3216 Metric), 50 V, ±20 %	CAP CER 10UF 50V X5R 1206	Murata Electronics	GRT31CR61H106ME01L

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
14	2	C407 C607	47 µF, Stacked SMD, 2 J-Lead, 35 V, ±10 %	CAP CER 47UF 35V X7R SMD	Murata Electronics	KRM55WR7YA476MH01K
15	2	C411 C611	10000 pF, 0603 (1608 Metric), 25 V, ±10 %	CAP CER 10000PF 25V X7R 0603	Würth Elektronik	885012206065
16	4	C412 C504 C612 C704	0.1 µF, 0603 (1608 Metric), 25 V, ±10 %	CAP CER 0.1UF 25V X7R 0603	Würth Elektronik	885012206071
17	4	C413 C505 C613 C705	0.22 µF, 0603 (1608 Metric), 25 V, ±10 %	CAP CER 0.22UF 25V X7R 0603	Würth Elektronik	885012206073
18	2	C415 C615 N.M.	10 µF, 1206 (3216 Metric), 50 V	CAP CER 10UF 50V X5R 1206	Würth Elektronik	885012108022
19	2	C500 C700	4.7 µF, 1206 (3216 Metric), 50 V, ±10 %	CAP CER 4.7UF 50V X7R 1206	Würth Elektronik	885012208094
20	4	C501 C503 C701 C703	200 pF, 0402 (1005 Metric), 50 V, ±5 %	CAP CER 200PF 50V NP0 0402	Murata Electronics	GCM1555C1H201JA16D
21	2	C800 C801 N.M.	CAP, 1206 (3216 Metric)	CAPACITOR CERAMIC SMD 1206 X7R	Any	Any
22	2	CN300 CN301	ESQ-119-24-T-D	CONN RCPT 38POS 0.1 GOLD PCB	Samtec Inc.	ESQ-119-24-T-D
23	2	CN302 CN305 N.M.	61300811821	CONN RCPT 8POS 0.1 GOLD PCB	Würth Elektronik	61300811821
24	1	CN303 N.M.	61301011821	CONN RCPT 10POS 0.1 GOLD PCB	Würth Elektronik	61301011821
25	1	CN304 N.M.	61300611821	CONN RCPT 6POS 0.1 GOLD PCB	Würth Elektronik	61300611821
26	2	CN500 CN700	WE-632723300011	USB 3.1 TYPE C RECEPTACLE THT/SM	Würth Elektronik	632723300011
27	1	D200	SMM4F28A-TR, STmiteFlat, 400 W	TVS in STmiteFlat	ST	SMM4F28A-TR
28	1	D201	LED RED, 0805 (2012 Metric), 20 mA	LED RED CLEAR 0805 SMD	Würth Elektronik	150080RS75000
29	2	D400 D600	LED GREEN, 0805 (2012 Metric), 20 mA	LED GREEN CLEAR 0805 SMD	Würth Elektronik	150080GS75000

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
30	2	D401 D601	LED BLUE, 0805 (2012 Metric), 20 mA	LED BLUE CLEAR 0805 SMD	Würth Elektronik	150080BS75000
31	2	D500 D700	ESDA25P35-1U1M, QFN-2L, 1400 W (1.4 kW) W	High-power transient voltage suppressor	ST	ESDA25P35-1U1M
32	1	FB1	600 Ohm@100MHz, 0603 (1608 Metric), 200 mA	FERRITE BEAD 600 OHM 0603 1LN	Würth Elektronik	742861160
33	1	J200	con2-strip-male	CONN HEADER VERT 2POS 2.54MM	Würth Elektronik	61300211121
34	1	J800	DC_POWER_JACK	CONN PWR JACK 2.05X5.5MM SOLDER	Würth Elektronik	694106105102
35	1	J801	CON2	5.08 MM TERMINAL BLOCK, HORIZONT	Würth Elektronik	691213510002
36	5	JP800 JP801 JP802 JP803 JP804	SHORT	2 PIN SHORTED TO CONNECT DIFFERENT NETS	Any	Any
37	1	L200	BNX002-11	EMI Filter Circuits 12.5mm 50V 10A 100Mohm EMI Filter	Murata Electronics	BNX002-11
38	1	L201	47 µH, Nonstandard, ±20 %	FIXED IND 47UH 560MA 987 MOHM	Würth Elektronik	74404041470
39	2	L400 L600	10 µH, 7 A, ±20 %	Fixed Inductors 10uH Shld 20% 7A 29.82mOhms AECQ2	Coilcraft	XAL6060-103MEB
40	1	Q200	STL9P3LLH6, PowerFLAT-3.3x3.3-8	P-channel -30 V, 12 mOhm typ., 9 A STripFET H6 power MOSFET	ST	STL9P3LLH6
41	4	Q400 Q401 Q600 Q601	2N7002E-T1-GE3, SOT-23-3	MOSFET 60V 240mA 0.35W 3.0ohm @ 10V	Vishay Semiconductors	2N7002E-T1-GE3

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
42	4	Q500 Q501 Q700 Q701	STL11N3LLH6, PowerFLAT, 3.3 x 3.3	N-channel 30 V, 6 mOhm typ., 11 A STripFET H6 power MOSFET	ST	STL11N3LLH6
43	1	R200	100k, 0402 (1005 Metric), 0.063W, 1/16 W, ±1 %	CHIP RESISTOR SMD 1% 1/16W 0402	Yageo	RC0402FR-07100KL
44	1	R201	91 k, 0402 (1005 Metric), 0.063W, 1/16 W, ±1 %	CHIP RESISTOR SMD 1% 1/16W 0402	KOA	RK73H1ETTP9102F
45	1	R202	210 k, 0402 (1005 Metric), 0.063W, 1/16 W, ±1 %	CHIP RESISTOR SMD 1% 1/16W 0402	KOA	RK73H1ETTP2103F
46	1	R203	20 k, 0805 (2012 Metric), 0.125W, 1/8 W, ±1 %	CHIP RESISTOR SMD 1% 1/8W 0805	Yageo	RC0805FR-0720KL
47	1	R204	13 k, 0402 (1005 Metric), 0.063W, 1/16 W, ±1 %	CHIP RESISTOR SMD 1% 1/16W 0402	KOA	RK73H1ERTTP1302F
48	1	R205	0, 0805 (2012 Metric), 0.125W, 1/8 W, ±1 %	CHIP RESISTOR SMD 1% 1/8W 0805	Yageo	RC0805JR-070RL
49	13	R206 R401 R407 R504 R509 R601 R607 R704 R709 R800 R802 R807 R809	0, 0603 (1608 Metric), 0.1W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	Yageo	RC0603JR-070RL
51	8	R208 R209 R502 R702 R801 R803 R806 R808 N.M.	0, 0603 (1608 Metric), 0.1W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	Any	Any
52	2	R400 R600	25 mOhms, 2512 (6432 Metric), 1 W, ±1 %	RES 0.025 OHM 1% 1W 2512	Vishay Dale	WSL2512R0250FEA
53	4	R402 R501 R602 R701	10 k, 0603 (1608 Metric), 0.1W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	Yageo	RC0603FR-0710KL
54	2	R403 R603	24 k, 0603 (1608 Metric), 0.1 W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	Rohm	KTR03EZPF2402
55	6	R404 R408 R413 R604 R608 R613	10 k, 0402 (1005 Metric), 0.063W, 1/16 W, ±1 %	CHIP RESISTOR SMD 1% 1/16W 0402	Yageo	RC0402FR-0710KL

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
56	2	R405 R605 N.M.	10 k, 0402 (1005 Metric), 0.063 W, 1/16 W, ±1 %	CHIP RESISTOR SMD 1% 1/16W 0402	Any	
57	2	R406 R606	0, 0402 (1005 Metric), 0.063 W, 1/16 W, ±1 %	CHIP RESISTOR SMD 1% 1/16W 0402	Yageo	RC0402FR-070RL
58	2	R409 R609	1.2 k, 0805 (2012 Metric), 0.125 W, 1/8 W, ±1 %	CHIP RESISTOR SMD 1% 1/8W 0805	Yageo	RC0805FR-071K2L
59	2	R410 R610	3.3 k, 0805 (2012 Metric), 0.125 W, 1/8 W, ±1 %	CHIP RESISTOR SMD 1% 1/8W 0805	Panasonic	ERJ-P06F3301V
60	6	R411 R412 R506 R611 R612 R706	100 K, 0603 (1608 Metric), 0.1 W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	Yageo	RC0603FR-07100KL
61	2	R500 R700	10 mOhms, 1206 (3216 Metric), 0.5 W, 1/2 W, ±1 %	RES 0.01 OHM 1% 1/2W 1206	Yageo	PE1206FRM7W0R01L
62	2	R503 R703	91 K, 0603 (1608 Metric), 0.1 W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	KOA	RK73H1JTTD9102F
63	2	R505 R705	16 K, 0603 (1608 Metric), 0.1 W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	PANASONIC	ERJ-3EKF1602V
64	2	R507 R707	50 K, 0603 (1608 Metric), 0.1 W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	YAGEO	RC0603FR-0749R9L
65	2	R508 R708 N.M.	180, 0603 (1608 Metric), 0.1 W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	Any	Any
66	2	R804 R805	4.7 k, 0603 (1608 Metric), 0.1 W, 1/10 W, ±1 %	CHIP RESISTOR SMD 1% 1/10W 0603	YAGEO	RC0603FR-074K7L
67	21	TP200 TP201 TP202 TP400 TP401 TP402 TP403 TP404 TP405 TP406 TP407 TP500 TP600 TP601 TP602 TP603 TP604 TP605	5001, 0.100" Dia x 0.180" L (2.54mm x 4.57mm)	TEST POINT PC MINI .040"D BLACK	Keystone Electronics	5001

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
		TP606 TP607 TP700				
68	1	U200	L7983PU50R, DFN 3X3X0.8 10L pitch 0.5	60 V 300 mA synchronous step-down switching regulator with 10 µA quiescent current	ST	L7983PU50R
69	2	U400 U600	STPD01PUR, QFN-24L, 3X4 mm	Programmable buck converter for USB power delivery	ST	STPD01PUR
70	4	U401 U501 U601 U701	TSV991AILT, SOT23-5L	Wide bandwidth (20 MHz) rail to rail input/ output 5 V CMOS op-amp	ST	TSV991AILT
71	2	U500 U700	TCPP02-M18, QFN-18L	IC USB Type-C port protection	ST	TCPP02-M18
72	1	PCB not reference	FR4 TG140 70x102,4 mm, 70x102,4 mm	FR4 TG140 70x102,4 mm 4 layer Thickness int/ext layer 35micron	Any	Any

4 Kit versions

Table 4. STEVAL-2STPD01 versions

Finished good	Schematic diagrams	Bill of materials
STEVAL$2STPD01XA(1)	STEVAL$2STPD01XA schematic diagrams	STEVAL$2STPD01XA bill of materials
NUG071RB$AU2(2)	NUG071RB$AU2 schematic diagrams	NUG071RB$AU2 bill of materials(3)

1. *This code identifies the expansion board version.*
2. *This code identifies the development board version.*
3. *Refer to MB1360-G071RB-C02_BOM.xlsx included in the zip file.*

5 Regulatory compliance information

Formal Notice Required by the U.S. Federal Communications Commission

FCC NOTICE:

This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

The evaluation kit has been designed to comply with part 15 of the FCC Technical Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This evaluation kit has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Standard applied: FCC CFR 47 Part 15 Subpart B. Test method applied: ANSI C63.4 (2014).

Formal Product Notice Required by Industry Canada Innovation, Science and Economic Development

Canada compliance:

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

This device has been tested with Innovation, Science and Economic Development RSS standards. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Standard applied: ICES-003 Issue 7 (2020), Class A. Test method applied: ANSI C63.4 (2014).

Cet appareil a été testé pour les normes RSS d'Innovation, Science et Développement économique. L'utilisation est soumise aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférences nuisibles, et (2) cet appareil doit accepter de recevoir tous les types d’interférence, y comprises les interférences susceptibles d'entraîner un fonctionnement indésirable.

Norme appliquée: NMB-003, 7e édition (2020), Classe A. Méthode d'essai appliquée: ANSI C63.4 (2014).

Formal product notice required by EU

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

Standards applied (Class A: industrial intended use): IEC 61000-6-1:2016, IEC 61000-6-3:2020, EN 61000-6-1:2019, EN 61000-6-3:2021, CISPR 32:2015 + A1:2019, EN 55032:2015 + A1:2020, CISPR 35:2016, EN 55035:2017 + A11:2020, IEC 61000-3-2:2018 + A1:2020, EN 61000-3-2:2019, IEC 61000-3-3:2013 + A1:2017 + A2:2021, EN 61000-3-3:2013 + A1:2019

Revision history

Table 5. **Document revision history**

Date	Revision	Changes
22-Nov-2021	1	Initial release.

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