

## Getting started with the X-NUCLEO-OUT17A1 industrial digital output expansion board for STM32 Nucleo

### Introduction

The **X-NUCLEO-OUT17A1** is an industrial digital output expansion board for **STM32 Nucleo**. It provides a powerful and flexible environment for the evaluation of the driving and diagnostic capabilities of the **IPS8200HQ-1** octal high-side, smart power, solid-state relay in a digital output module connected to 1.0 A industrial loads.

The **X-NUCLEO-OUT17A1** interfaces with the microcontroller on the **STM32 Nucleo** via **STISO620** and **STISO621** and Arduino® UNO R3 connectors.

The user can select which driving mode controls the **IPS8200HQ-1**: parallel (SEL2 = L by JP21 = open) or SPI (SEL2 = H by JP21 = closed).

In the case of SPI selection, the user can select the communication protocol between 8 bits (SEL1 = L by JP22 = open) or 16 bits (SEL1 = H by JP22 = closed).

The V<sub>CC</sub> supply pin of the **IPS8200HQ-1** is provided by the connector CN1, while the loads (driven by the eight output channels of the **IPS8200HQ-1**) can be connected between the connectors CN2, CN3, CN4, CN12, and the pin 2 of the connector CN1.

The on-board digital isolators (**STISO620** and **STISO621**) feature the 2.8k V<sub>RMS</sub> (4k V<sub>PK</sub>) galvanic isolation between the two application sides: logic and process sides.

The logic side is the application side of the MCU and it is supplied by the VISO\_L rail (3.3 or 5.0 V). VISO\_L can be supplied by an external power supply connected to CN13 or, alternatively by the pin 4 (SW1 = close 1-2) or pin 5 (SW1 = close 2-3) of CN6.

The process side is the application side of the industrial loads and it is supplied by the VCC and VISO\_P rails. The VISO\_P (3.3 or 5.0 V) is usually supplied by the VREG rail (JP31 = closed) that can be generated by the step-down embedded in the **IPS8200HQ-1** (SW17 = close 1-2, JP20 = closed, JP15 = closed and JP28 = close 2-4 (VREG = 3.3 V) or JP28 = 1-3 (VREG = 5.0 V)).

Alternatively, VREG can be provided by an external power supply connected to CN14 (SW17 = close 2-3, JP20 = open, JP15 = open).

In parallel driving mode (active with the default jumper and switch settings) the application board can work even without any Nucleo board: in this case, the user must provide the process side voltage (usually 24 V) by the CN1 and the VISO\_L (usually 3.3 V) by the CN13. The IN<sub>x</sub> signals, available on CN5[1, 2, 3], CN8[4] and CN9[3, 5, 7, 8], drives on/off the correspondent OUT<sub>x</sub> connected to the loads on the process side.

The IN<sub>x</sub> pins can be driven low/high swinging between 0V and VISO\_L. The activation of each OUT<sub>x</sub> (OUT1... OUT8) can be monitored by the green LEDs DOX (DO1... DO8).

The activation of the three diagnostic pins (TWARN, PGOOD, FAULT) can be visualized on the correspondent red LEDs (D11, D12, D13, respectively) or monitored by an oscilloscope on TP6, TP7, and TP5.

Note: Although the pins CN8[5], CN5[9], CN5[10] are connected to the nets FAULT\_L, PGOOD\_L and TWARN\_L, these pins cannot correctly report the status of the corresponding signals on the process side (FAULT, PGOOD, and TWARN) due to routing mistake on the same side.

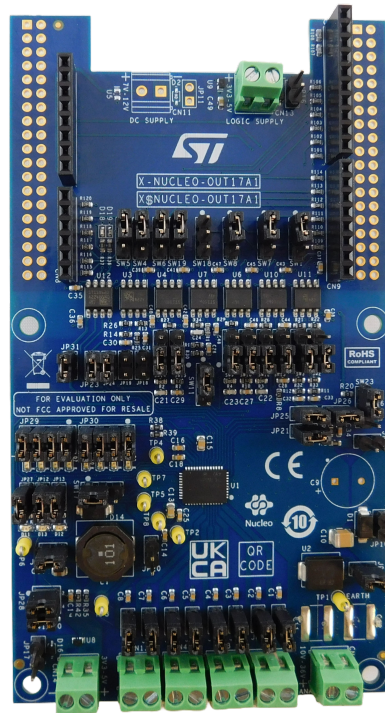
The SPI driving mode can be set by changing the default configuration (JP21 = close; SW4, SW5, SW6, SW7, SW9, SW10, SW11, SW12, SW13, SW14, SW15, and SW20 = close 2-3, SW18 = close 1-2). The SPI-8bits is the default mode (JP22 = open), while the SPI-16bits mode can be activated by JP22 = close.

In SPI driving mode it is also possible to activate the MCU freeze detection feature by setting SW3 = close 2-3.

The expansion board can be connected to either a **NUCLEO-F401RE** or a **NUCLEO-G431RB** development board. In this case the companion firmware **X-CUBE-IPS** detects the selected configuration (GPIO, SPI-8bits, SPI-16bits) by reading the signals SEL2\_L and SEL1 from CN8[1] and CN8[6]. The activation of the MCU freeze feature is detected by WDEN(in) on CN9[4].

It is also possible to evaluate a system composed of a **X-NUCLEO-OUT17A1** stacked on other expansion boards. In fact, SPI driving mode allows the daisy-chaining communication with another **X-NUCLEO-OUT17A1** stacked through the Arduino connectors: the two stacked boards must be configured with SW6, SW18 = close 2-3 on one board, and SW6, SW18 = close 1-2 on the other board.

Figure 1. X-NUCLEO-OUT17A1 expansion board



# 1 Getting started

## 1.1 Overview

The **X-NUCLEO-OUT17A1** embeds the **IPS8200HQ-1** intelligent power switch (IPS), which features serial/parallel selectable interface on-chip, 8-bit and 16-bit SPI interface for IC command and control diagnostic, Power Good diagnostic, IC warning temperature detection, overcurrent and overtemperature protection for safe output loads control.

The board is designed to meet the application requirements for the galvanic isolation between the user and power interfaces.

An optical isolation satisfies this requirement. The isolation is implemented through three dual channel digital isolators with 2 – 0 channel directionality (U3, U11, U12) for the input signals forward to the device, and four dual channel digital isolators with 1 – 1 channel directionality (U4, U6, U7, U10) for the diagnostic feedback signals of the device and the daisy chaining service lines.

The expansion board features:

- Based on the **IPS8200HQ-1** octal high-side switch, which features:
  - Operating range 10.5 to 36 V
  - Operating output current  $\leq 1.0$  A
  - Low power dissipation ( $R_{ON}(MAX) = 200$  m $\Omega$ )
  - Undervoltage lock-out
  - Selectable driving modes parallel or 5 MHz SPI (8 or 16 bits)
  - Embedded step-down converter
  - 4x2 LED matrix for efficient status indication
  - MCU freeze detection
  - Fast decay for inductive loads
  - Overload and overtemperature protections
  - Loss of ground protection
  - Junction Overtemperature and parity check diagnostic pin (FAULT)
  - Case overtemperature diagnostic pin (TWARN)
  - Supply voltage Level diagnostic pin (PGOOD)
  - QFN48L 8x6 mm package
- Application board voltage operating range: 12 to 33 V
- Extended voltage operating range (J9 open) up to 36 V
- Operating current: up to 1.0 A per channel
- Blue LED showing SPI mode selection
- Yellow LED showing SPI mode 16-bits selection
- Red LED for FAULT diagnostic pin (JP12 closed)
- Red LED for PGOOD diagnostic pin (JP13 closed)
- Red LED for TWARN diagnostic pin (JP27 closed)
- 4 kV<sub>PK</sub> galvanic isolation guaranteed by **STISO620** and **STISO621**
- Supply rail reverse polarity protection
- Compatible with **STM32 Nucleo** development boards
- Equipped with Arduino® UNO R3 connectors
- RoHS and China RoHS compliant
- CE certified

## 1.2 Board configuration

A set of jumpers and switches is available to configure the board. Table 1 shows the configurations to be used respectively for Parallel 8 Channels Mode, SPI 8 Channels Mode and Daisy Chain Mode.

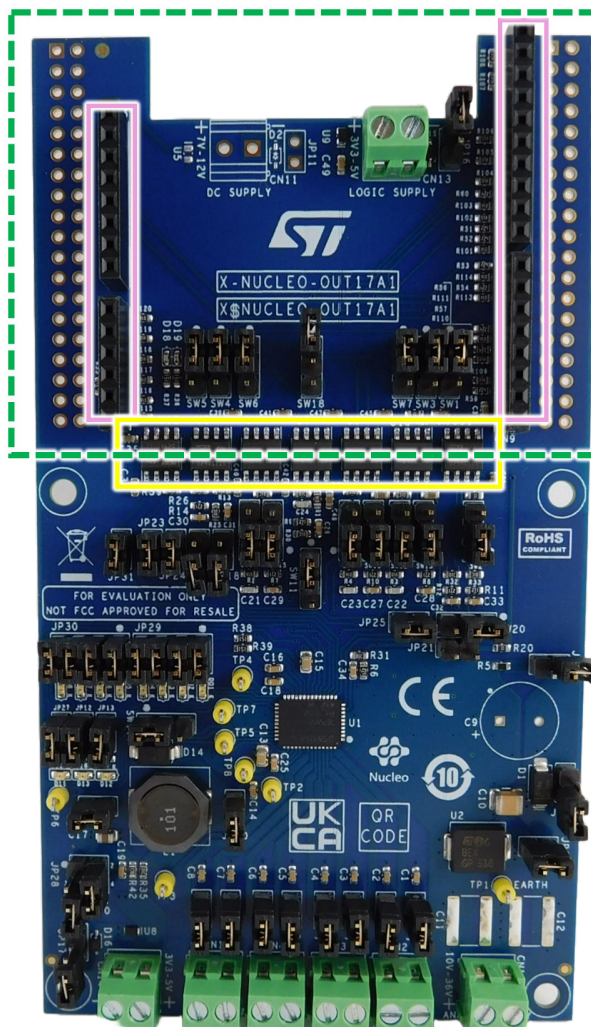
**Table 1. X-NUCLEO-OUT17A1**

| Jumpers/Switches                                                                                  | Parallel 8 Ch             | SPI 8 Ch                                                 | Daisy Chain                                              |
|---------------------------------------------------------------------------------------------------|---------------------------|----------------------------------------------------------|----------------------------------------------------------|
| SW1, SW3, SW17                                                                                    | Closed 1-2                | Closed 1-2                                               | Closed 1-2                                               |
| JP1, JP2, JP3, JP4, JP5, JP6, JP7, JP8, JP9, JP12, JP13, JP15, JP20, JP23, JP24, JP25, JP27, JP31 | Closed                    | Closed                                                   | Closed                                                   |
| JP10, JP14, JP16, JP17, JP18, JP19                                                                | Open                      | Open                                                     | Open                                                     |
| JP11                                                                                              | Not mounted               | Not mounted                                              | Not mounted                                              |
| JP28                                                                                              | Closed 2-4                | Closed 2-4                                               | Closed 2-4                                               |
| JP29, JP30                                                                                        | Closed 1-2, 3-4, 5-6, 7-8 | Closed 1-2, 3-4, 5-6, 7-8                                | Closed 1-2, 3-4, 5-6, 7-8                                |
| SW4, SW5, SW7, SW9, SW10, SW11, SW12, SW13, SW14, SW15                                            | Closed 1-2                | Closed 2-3                                               | Closed 2-3                                               |
| SW6                                                                                               | Closed 1-2                | Closed 2-3                                               | Board 0: Closed 2-3<br>Board 1: Closed 1-2               |
| SW18                                                                                              | Open                      | Closed 1-2                                               | Board 0: Closed 2-3<br>Board 1: Closed 1-2               |
| SW20                                                                                              | Closed 1-2                | Closed 2-3                                               | Closed 2-3                                               |
| JP21                                                                                              | Open                      | Closed                                                   | Closed                                                   |
| JP22                                                                                              | Open                      | Open (SEL1 L, SPI 8bits)<br>Closed (SEL1 H, SPI 16 bits) | Open (SEL1 L, SPI 8bits)<br>Closed (SEL1 H, SPI 16 bits) |

### 1.3 Digital section

The digital section is associated with the STM32 interface and the digital supply voltage to and from the X-NUCLEO-OUT17A1 expansion board.

**Figure 2. X-NUCLEO-OUT17A1 expansion board: digital interface section**



The dotted green line indicates the whole digital interface section. The pink rectangles identify the Arduino® UNO R3 connectors and the yellow ones identify STISO620 and STISO621 digital isolators.

The four Arduino® UNO R3 connectors:

- allow the expansion board to communicate with the STM32 Nucleo development microcontroller board accessing the STM32 peripheral and GPIO resources;
- provide the digital supply voltage between the STM32 Nucleo development board and the X-NUCLEO-OUT17A1 expansion board, in either direction.

The five digital isolators (STISO620 and STISO621) provide 4 kV<sub>PK</sub> galvanic isolation between logic and process sides of the expansion board.

Usually, the STM32 Nucleo development board supplies the expansion board by a 3.3 V or 5.0 V generated by the USB.

Alternatively, it is possible to supply the STM32 Nucleo development board from the expansion board. In this case, an external supply voltage (7-12 V) should be connected to the CN11 connector (not mounted by default) on the expansion board and the ground loop should be closed by mounting D2 (enabling the reverse polarity protection) or by closing JP11 (without reverse polarity).

To supply the VIN voltage rail, it is necessary to:

- close the JP5 jumper between pins 2 and 3 and open the JP1 jumper on the [NUCLEO-F401RE](#);
- open the JP5 jumper between pins 1 and 2 and close the JP5 jumper between pins 3 and 4 on the [NUCLEO-G431RB](#).

Logic side is then supplied by the VISO\_L rail (3.3 V or 5.0 V). VISO\_L can be supplied by an external power supply connected to CN13 (SW1 open) or, alternatively by the pin 4 (SW1 = close 1-2) or pin 5 (SW1 = close 2-3) of CN6.

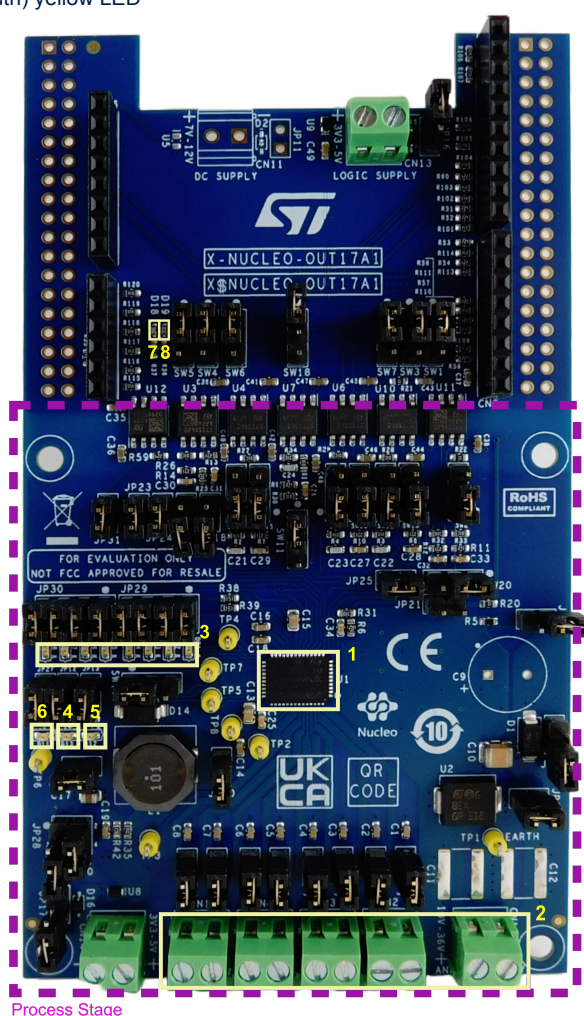
The user can select which driving mode controls the [IPS8200HQ-1](#): parallel (SEL2 = L by JP21 = open) or SPI (SEL2 = H by JP21 = closed). In the case of SPI selection, the user can select the communication protocol between 8 bits (SEL1 = L by JP22 = open) or 16 bits (SEL1 = H by JP22 = closed).

## 1.4 Power section

The power section involves the power supply voltage (CN1, pin 1 for  $V_{CC}$ , pin 2 for GND), the load connection (eight loads can be connected between each pin of CN2, CN3, CN4, and CN12 and pin 2 of CN1), EMC protections (U2), and supply reverse polarity protection (D1).

**Figure 3. X-NUCLEO-OUT17A1 expansion board: power section**

1. IPS8200HQ-1
2. Output and power supply connector
3. Output channels - green LEDs
4. FAULT (diagnostic pin) red LED
5. PGOOD (diagnostic pin) red LED
6. TWARN (diagnostic pin) red LED
7. SEL2 H (SPI) blue LED
8. SEL1 H (16 bits SPI data width) yellow LED



The process side is supplied by the VCC and VISO\_P rails. The VISO\_P (3.3 or 5.0 V) is usually supplied by the VREG rail (JP31 = closed) that can be generated by the step-down embedded in the IPS8200HQ-1 (SW17 = close 1-2, JP20 = closed, JP15 = closed and JP28 = close 2-4 (VREG = 3.3 V) or JP28 = 1-3 (VREG = 5.0 V)). Alternatively, VREG can be provided by an external power supply connected to CN14 (SW17 = close 2-3, JP20 = open, JP15 = open).

For EMC:

- the SMC30J30CA transient voltage suppressor (U2), enabled by closing J9, is placed between  $V_{CC}$  and GND tracks to protect the IPS8200HQ-1 against surge discharge on the supply rail path up to  $\pm 1 \text{ kV}/2 \Omega$  coupling;

- in the common mode surge testing, two single-layer capacitors (C11 and C12 - not included) must be soldered at the predisposed locations;
- the [IPS8200HQ-1](#) output stages do not require additional EMC protections with respect to the IEC61000-4-2, IEC61000-4-3, IEC61000-4-4, IEC61000-4-5, IEC61000-4-8 standards.

The EMC performance of the [X-NUCLEO-OUT17A1](#) is detailed below:

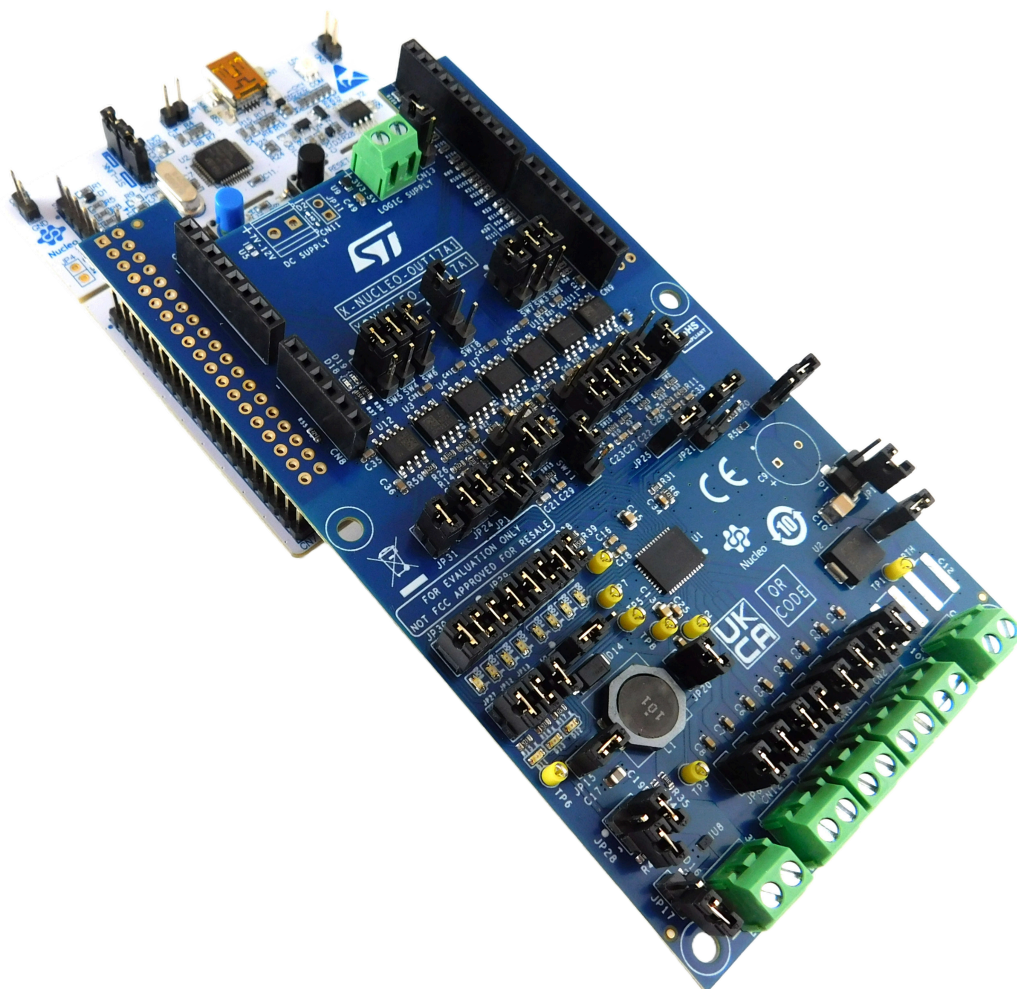
- for emission (when the DC input port of the board is powered by an AC-DC, DC-DC or battery with a cable that does not exceed a three-meter length), compliance with standards:
  - EN IEC 61000-6-3:2021
  - EN 55032:2015 +A1:2020
- for immunity, compliance with standards:
  - EN IEC 61000-6-1:2019
  - EN 55035:2017 +A11:2020

## 1.5 Hardware requirements

The X-NUCLEO-OUT17A1 expansion board is designed to be used with the NUCLEO-F401RE or NUCLEO-G431RB STM32 Nucleo development boards.

To function correctly, the X-NUCLEO-OUT17A1 must be plugged onto the matching Arduino® UNO R3 connector pins on the STM32 Nucleo board as shown below.

**Figure 4. X-NUCLEO-OUT17A1 and STM32 Nucleo stack**



## 1.6 System requirements

To use the STM32 Nucleo development boards with the X-NUCLEO-OUT17A1 expansion board, you need:

- a Windows PC/laptop (Windows 7 or above)
- a type A to mini-B USB cable to connect the STM32 Nucleo board to the PC when using a NUCLEO-F401RE development board
- a type A to micro-B USB cable to connect the STM32 Nucleo board to the PC when using a NUCLEO-G431RB development board
- the X-CUBE-IPS firmware and software package installed on your PC/laptop

## 1.7 Board setup

- Step 1.** Connect the mini-USB or micro-USB cable to your PC to use the **X-NUCLEO-OUT17A1** with **NUCLEO-F401RE** or **NUCLEO-G431RB** development board
- Step 2.** Download the proper firmware (.bin) onto the **STM32 Nucleo** development board microcontroller through **STM32 ST-LINK** utility, **STM32CubeProgrammer**, and according with the information detailed in the table below. The **X-NUCLEO-OUT17A1** can be used to control the **IPS8200HQ** device in three different operating modes available for the user in three different example projects: **Parallel\_8\_Channels** (one board configured in parallel 8 channels mode, direct pin input interface), **SPI\_8\_Channels** (one board configured in SPI 8 channels mode, SPI input interface) and **DaisyChain** (two stacked boards properly configured in Daisy chain mode, SPI input interface with daisy chaining). The binary files provided with the **X-CUBE-IPS** software package enable the user to choose the preferred control mode by selecting the binary file contained in the proper example project **Binary** folder, as reported in the following table

**Table 2. Nucleo development boards binary files**

| Nucleo board         | Binary path                                                                                     |
|----------------------|-------------------------------------------------------------------------------------------------|
| <b>NUCLEO-F401RE</b> | Projects\STM32F401RE-Nucleo\Examples\OUT17A1\DaisyChain\Binary\DaisyChain.bin                   |
|                      | Projects\STM32F401RE-Nucleo\Examples\OUT17A1\Parallel_8_Channels\Binary\Parallel_8_Channels.bin |
|                      | Projects\STM32F401RE-Nucleo\Examples\OUT17A1\SPI_8_Channels\Binary\SPI_8_Channels.bin           |
| <b>NUCLEO-G431RB</b> | Projects\STM32G431RB-Nucleo\Examples\OUT17A1\DaisyChain\Binary\DaisyChain.bin                   |
|                      | Projects\STM32G431RB-Nucleo\Examples\OUT17A1\Parallel_8_Channels\Binary\Parallel_8_Channels.bin |
|                      | Projects\STM32G431RB-Nucleo\Examples\OUT17A1\SPI_8_Channels\Binary\SPI_8_Channels.bin           |

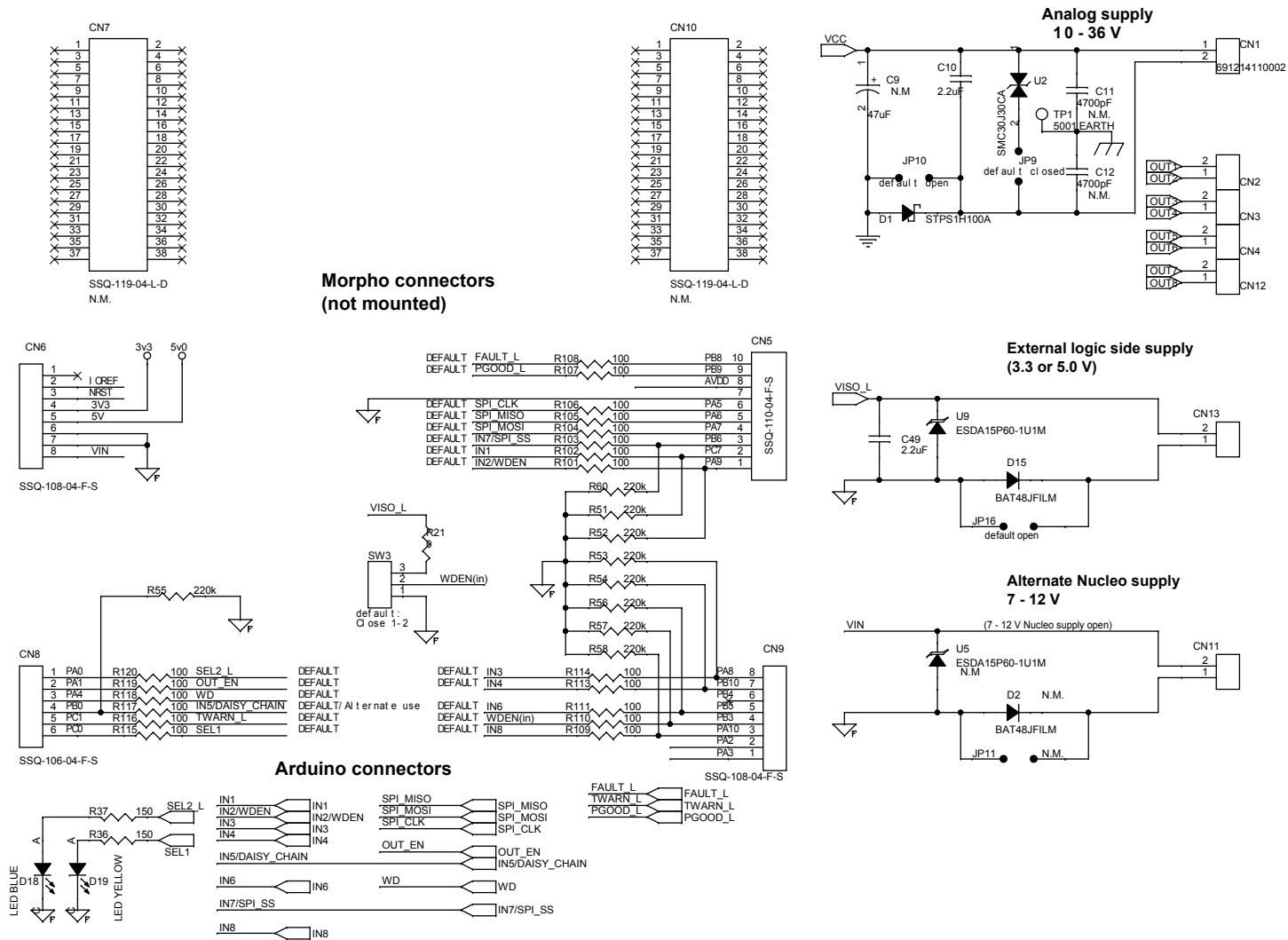
**Note:** Additional details on each operating mode configuration are available inside the **X-CUBE-IPS** software package as reported in the below table:

**Table 3. Additional information on board configuration**

| Board configuration        | Readme file                                      |
|----------------------------|--------------------------------------------------|
| <b>DaisyChain</b>          | Examples\OUT17A1\DaisyChain\readme.html          |
| <b>Parallel_8_Channels</b> | Examples\OUT17A1\Parallel_8_Channels\readme.html |
| <b>SPI_8_Channels</b>      | Examples\OUT17A1\SPI_8_Channels\readme.html      |

- Step 3.** Connect the **IPS8200HQ-1** device supply voltage via CN1 (see [Section 1.4: Power section](#)).
- Step 4.** Provide the digital supply voltage (see [Section 1.3: Digital section](#)).
- Step 5.** Connect the load on the output connector (see [Section 1.4: Power section](#)).
- Step 6.** Reset the example sequence by pushing the black button on the **STM32 Nucleo** board.
- Step 7.** Push the blue button on the **STM32 Nucleo** board to choose among the examples provided in the default firmware package.

Figure 5. X-NUCLEO-OUT17A1 circuit schematic (1 of 3)



## UM3247

### Schematic diagrams

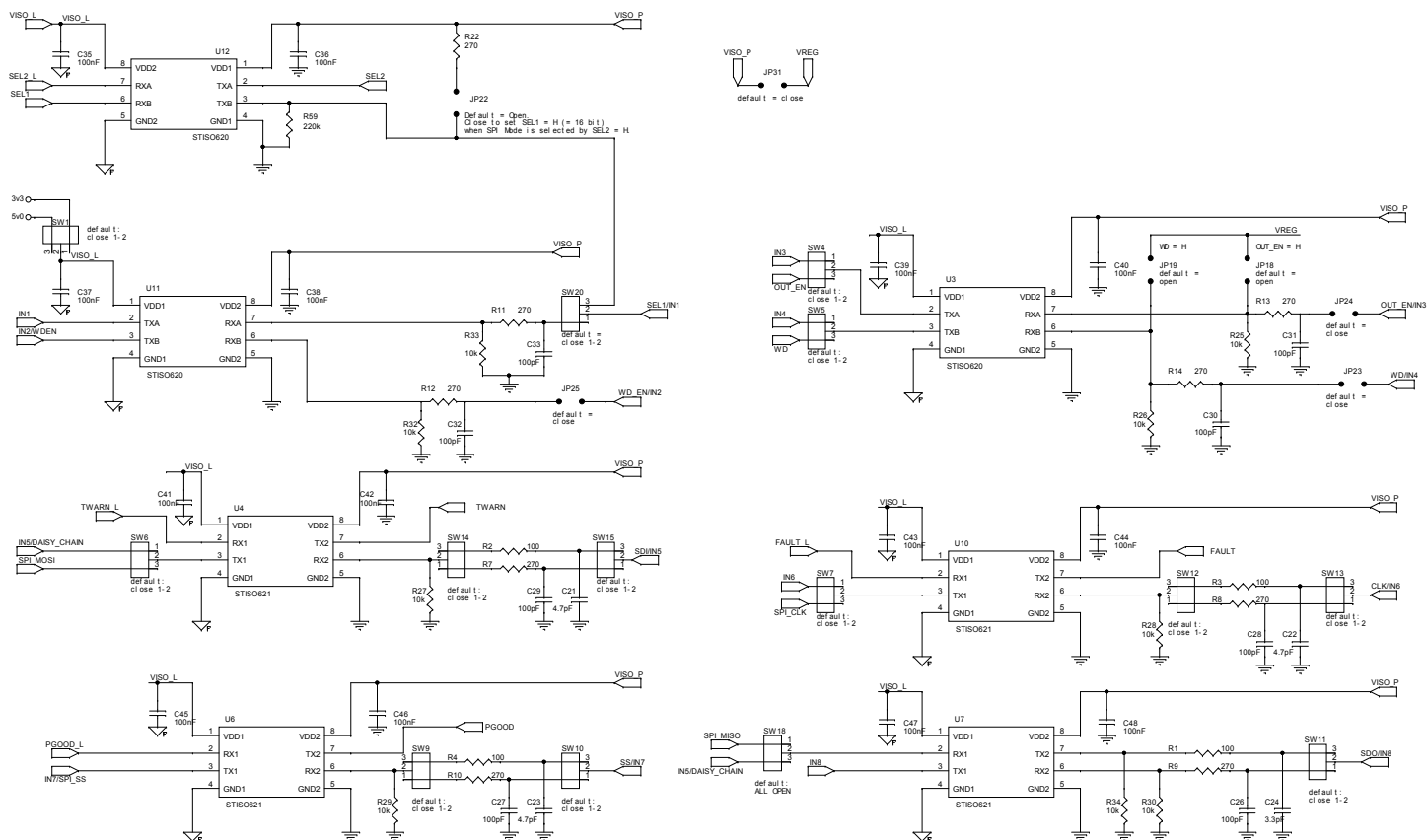
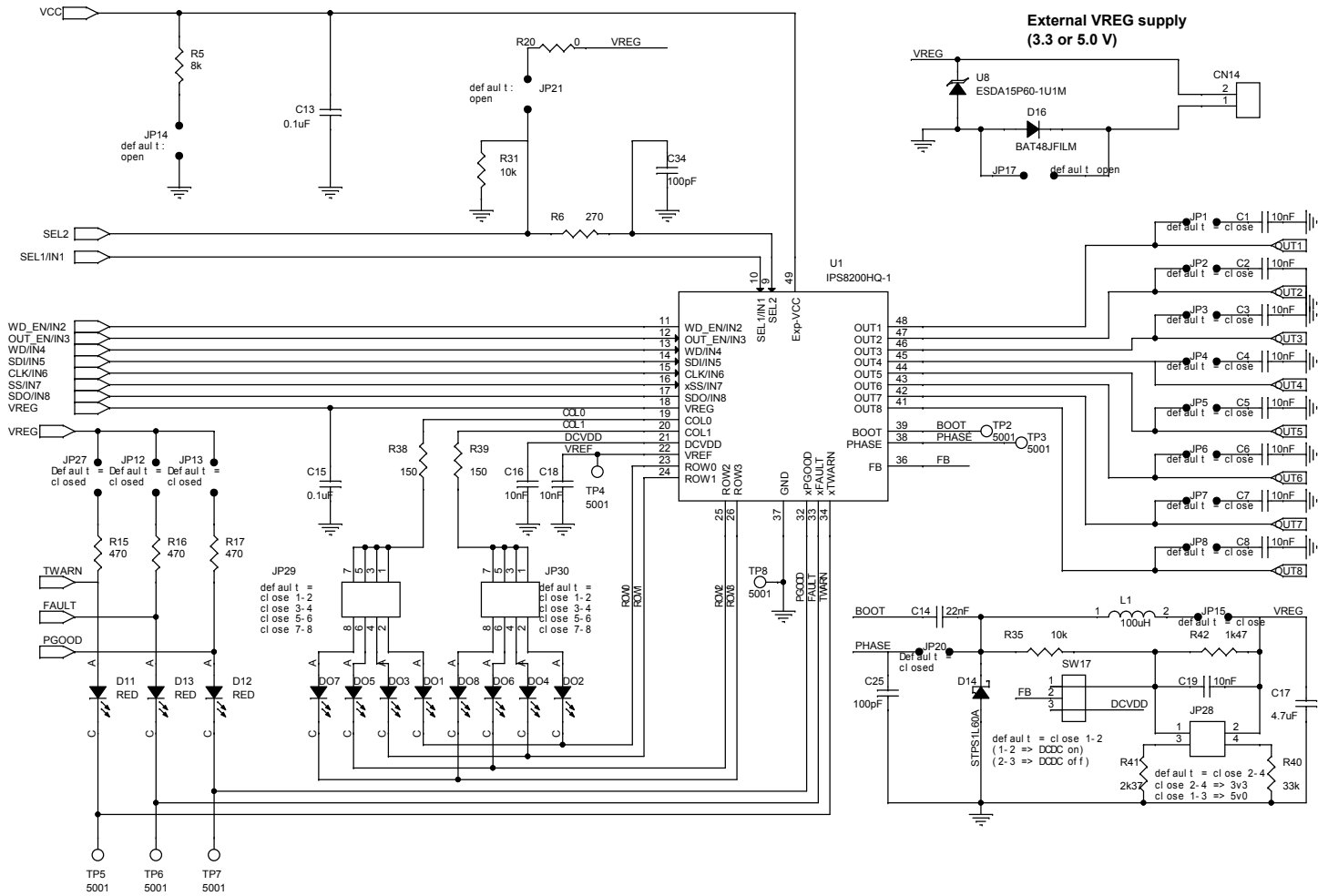


Figure 7. X-NUCLEO-OUT17A1 circuit schematic (3 of 3)



### 3 Bill of materials

**Table 4. X-NUCLEO-OUT17A1 bill of materials**

| Item | Q.ty | Ref.                                                                | Part/value                                         | Description                                                  | Manufacturer              | Order code           |
|------|------|---------------------------------------------------------------------|----------------------------------------------------|--------------------------------------------------------------|---------------------------|----------------------|
| 1    | 11   | C1 C2 C3 C4<br>C5 C6 C7 C8<br>C16 C18 C19                           | 10nF 0603<br>(1608 Metric)<br>50V 10%              | CAP CER<br>10000PF 50V<br>X7R 0603                           | Würth<br>Electronics Inc. | 885382206002         |
| 2    | 2    | C13 C15                                                             | 0.1uF 0805<br>(2012 Metric)<br>100V 10%            | CAP CER<br>0.1UF 100V<br>X7R 0805                            | Würth<br>Electronics Inc. | 885012207128         |
| 3    | 1    | C14                                                                 | 22nF 0603 50V<br>10%                               |                                                              | Würth<br>Electronics Inc. | 885382206003         |
| 4    | 0    | C11 C12                                                             | 4700pF 1825<br>(4564 Metric)<br>3000V (3kV)<br>10% | CAP CER<br>4700PF 3KV<br>X7R 1825 (not<br>assembled)         | Vishay Vitramon           | HV1825Y472KXHATHV    |
| 5    | 1    | C17                                                                 | 4.7uF 0805 10V<br>10%                              | CAP CER<br>4.7UF 10V X7R<br>0805                             | Würth<br>Electronics Inc. | 885012207025         |
| 6    | 1    | C10                                                                 | 2.2uF 1210<br>(3225 Metric)<br>100V 10%            | CAP CER<br>2.2UF 100V<br>X7R 1210                            | Würth<br>Electronics Inc. | 885382209002         |
| 7    | 0    | C9                                                                  | 47uF (N.M.)<br>Radial, Can<br>100V 20%             | CAP 47 UF<br>20% 100 V (not<br>assembled)                    | Würth<br>Electronics Inc. | 860040875002         |
| 8    | 3    | C21 C22 C23                                                         | 4.7pF 0603 10V<br>10%                              | CAP CER<br>4.7PF 10V COG<br>0603                             | Würth<br>Electronics Inc. | 885012006001         |
| 9    | 1    | C24                                                                 | 3.3pF 0603 50V<br>10%                              | CAP CER<br>3.3PF 50V COG<br>0603                             | Würth<br>Electronics Inc. | 885012006048         |
| 10   | 10   | C25 C26 C27<br>C28 C29 C30<br>C31 C32 C33<br>C34                    | 100pF 0603<br>25V 10%                              | CAP CER<br>100PF 25V X7R<br>0603                             | Würth<br>Electronics Inc. | 885012206028         |
| 11   | 14   | C35 C36 C37<br>C38 C39 C40<br>C41 C42 C43<br>C44 C45 C46<br>C47 C48 | 100nF 0603<br>10V 10%                              | CAP CER<br>0.1UF 10V X7R<br>0603                             | Würth<br>Electronics Inc. | 885012206020         |
| 12   | 1    | C49                                                                 | 2.2uF 0603 10V<br>10%                              | CAP CER<br>2.2UF 10V X7R<br>0603                             | Würth<br>Electronics Inc. | 885012206027         |
| 13   | 7    | CN1 CN2 CN3<br>CN4 CN11<br>CN12 CN13<br>CN14                        | 691214110002<br>7.4X7 pitch 3.5                    | TERM BLK<br>2POS SIDE<br>ENT 3.5MM<br>PCB                    | Würth<br>Electronics Inc. | 691214110002         |
| 14   | 0    | CN11                                                                | 691214110002<br>7.4X7 pitch 3.5                    | TERM BLK<br>2POS SIDE<br>ENT 3.5MM<br>PCB (not<br>assembled) | Würth<br>Electronics Inc. | 691214110002         |
| 15   | 1    | CN5                                                                 | 10 ways, 1 row                                     | CONN RCPT<br>10POS 0.1<br>GOLD PCB                           | SAMTEC<br>4UCON           | ESQ-110-14-T-S 17896 |

| Item | Q.ty | Ref.                                                                                                                                                      | Part/value                                                        | Description                                                   | Manufacturer              | Order code                 |
|------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------|---------------------------|----------------------------|
| 16   | 2    | CN6 CN9                                                                                                                                                   | 8 ways, 1 row                                                     | CONN RCPT<br>8POS 0.1<br>GOLD PCB                             | SAMTEC<br>4UCON           | ESQ-108-14-T-S 15782       |
| 17   | 0    | CN7 CN10                                                                                                                                                  |                                                                   | CONN RCPT<br>38POS 0.1<br>GOLD PCB (not<br>assembled)         | Samtec Inc.               | SSQ-119-04-L-D             |
| 18   | 1    | CN8                                                                                                                                                       | 6 ways, 1 row                                                     | CONN RCPT<br>6POS 0.1<br>GOLD PCB                             | SAMTEC<br>4UCON           | ESQ-106-04-T-S 15781       |
| 19   | 8    | DO1 DO2 DO3<br>DO4 DO5 DO6<br>DO7 DO8                                                                                                                     | 150060VS7500<br>0 0603 (1608<br>Metric) 20mA                      | LED GREEN<br>CLEAR 0603<br>SMD                                | Wurth<br>Electronics Inc. | 150060VS75000              |
| 20   | 1    | D1                                                                                                                                                        | STPS1H100A<br>DO-214AC,<br>SMA SMA Flat<br>Notch 1A               | DIODE<br>SCHOTTKY<br>100V 1A SMA                              | ST                        | <a href="#">STPS1H100A</a> |
| 21   | 3    | D11 D12 D13                                                                                                                                               | RED 0603<br>(1608 Metric)<br>20mA                                 | LED RED<br>CLEAR 0603<br>SMD                                  | Wurth<br>Electronics Inc. | 150060RS75000              |
| 22   | 1    | D14                                                                                                                                                       | STPS1L60A<br>DO-214AC,<br>SMA 1A                                  | STMicroelectron<br>ics                                        | ST                        | <a href="#">STPS1L60A</a>  |
| 23   | 2    | D15 D16                                                                                                                                                   | BAT48JFILM<br>SC-76,<br>SOD-323<br>750mV @<br>200mA 350mA<br>(DC) | DIODE<br>SCHOTTKY<br>40V 350MA<br>SOD323                      | ST                        | <a href="#">BAT48JFILM</a> |
| 24   | 0    | D2                                                                                                                                                        | BAT48JFILM<br>SC-76,<br>SOD-323<br>750mV @<br>200mA 350mA<br>(DC) | DIODE<br>SCHOTTKY<br>40V 350MA<br>SOD323 (not<br>assembled)   | ST                        | <a href="#">BAT48JFILM</a> |
| 25   | 1    | D18                                                                                                                                                       | BLUE 0402<br>20mA                                                 | LED LIGHT<br>BLUE 0402<br>SMD                                 | Wurth<br>Electronics Inc. | 150040BS73220              |
| 26   | 1    | D19                                                                                                                                                       | YELLOW 0402<br>20mA                                               | LED LIGHT<br>YELLOW 0402<br>SMD                               | Wurth<br>Electronics Inc. | 150040YS73220              |
| 27   | 26   | JP1 JP2 JP3<br>JP4 JP5 JP6<br>JP7 JP8 JP9<br>JP10 JP12<br>JP13 JP14<br>JP15 JP16<br>JP17 JP18<br>JP19 JP20<br>JP21 JP22<br>JP23 JP24<br>JP25 JP27<br>JP31 | JUMPER-con2-<br>strip-male                                        | JUMPER-<br>CONN<br>HEADER .100<br>STR 2POS                    | Wurth<br>Electronics Inc. | 61300211121                |
| 28   | 0    | JP11                                                                                                                                                      | JUMPER-con2-<br>strip-male                                        | JUMPER-<br>CONN<br>HEADER .100<br>STR 2POS (not<br>assembled) | Wurth<br>Electronics Inc. | 61300211121                |

| Item | Q.ty | Ref.                                                                                       | Part/value                                            | Description                             | Manufacturer              | Order code                  |
|------|------|--------------------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------------------------|---------------------------|-----------------------------|
| 29   | 1    | JP28                                                                                       | con4-2x2-strip-male                                   | CONN<br>HEADER .100<br>DUAL STR<br>4POS | Wurth<br>Electronics Inc. | 61300421121                 |
| 30   | 2    | JP29 JP30                                                                                  | con8-2x4-strip-male                                   | CONN<br>HEADER .100<br>DUAL STR<br>8POS | Wurth<br>Electronics Inc. | 61300821121                 |
| 31   | 1    | L1                                                                                         | 100uH<br>indm1030x1030<br>x300l180x460                | INDUCTOR<br>100UH 1A<br>470MOHM         | Wurth<br>Electronics Inc. | 744065101                   |
| 32   | 24   | R1 to R4 R101<br>to R111, R113<br>to R120                                                  | 100Ω 0603<br>(1608 Metric)<br>0.1W, 1/10W<br>1%       | RES SMD 100<br>OHM 1% 1/10W<br>0603     | Yageo                     | RC0603FR-07100RP            |
| 33   | 1    | R5                                                                                         | 8kΩ 0603 0.1W,<br>1/10W                               | RES SMD 8k<br>OHM 1% 1/10W<br>0603      | Vishay                    | PLTU0603U8001LST5           |
| 34   | 10   | R6 to R14, R22                                                                             | 270 Ω 0603<br>0.1W, 1/10W                             | RES SMD 270<br>OHM 1% 1/10W<br>0603     | Vishay                    | CRCW0603270RJNECC           |
| 35   | 3    | R15 R16 R17                                                                                | 470 Ω 0603<br>0.1W, 1/10W                             | RES SMD 470<br>OHM 1% 1/10W<br>0603     | Vishay                    | CRCW0603470RJNEBC           |
| 36   | 2    | R20 R21                                                                                    | 0 Ω 0603 0.1W,<br>1/10W                               | RES SMD 0<br>OHM 1% 1/10W<br>0603       | Yageo                     | RC0603JR-070RL              |
| 37   | 11   | R25 to R35                                                                                 | 10kΩ 0603<br>0.1W, 1/10W                              | RES SMD 10k<br>OHM 1% 1/10W<br>0603     | Bourns                    | CR0603-JW-103ELF            |
| 38   | 4    | R36 R37 R38<br>R39                                                                         | 150 Ω 0603<br>0.1W, 1/10W                             | RES SMD 150<br>OHM 1% 1/10W<br>0603     | Bourns                    | CR0603-FX-1500ELF           |
| 39   | 1    | R40                                                                                        | 33kΩ 0603<br>0.1W, 1/10W                              | RES SMD 33k<br>OHM 1% 1/10W<br>0603     | Bourns                    | CR0603-JW-333ELF            |
| 40   | 1    | R41                                                                                        | 2.37kΩ 0603<br>0.1W, 1/10W                            | RES SMD 2.37k<br>OHM 1% 1/10W<br>0603   | Bourns                    | CR0603-FX-2371ELF           |
| 41   | 1    | R42                                                                                        | 1.47kΩ 0603<br>0.1W, 1/10W                            | RES SMD 1.47k<br>OHM 1% 1/10W<br>0603   | Bourns                    | CR0603-FX-1471ELF           |
| 42   | 16   | SW1 SW3 SW4<br>SW5 SW6 SW7<br>SW9 SW10<br>SW11 SW12<br>SW13 SW14<br>SW15 SW17<br>SW18 SW20 | con3-strip-male                                       | CONN<br>HEADER .100<br>STR 3POS         | Wurth<br>Electronics Inc. | 61300311121                 |
| 43   | 8    | TP1 TP2 TP3<br>TP4 TP5 TP6<br>TP7 TP8                                                      | 5001 0.100" Dia<br>x 0.180" L<br>(2.54mm x<br>4.57mm) | TEST POINT<br>PC MINI .040"D<br>BLACK   | Keystone<br>Electronics   | 5001                        |
| 44   | 1    | U1                                                                                         | IPS8200HQ-1<br>QFN48L 8x6<br>mm (opt A)               | 8 channel/1.0A<br>high side driver      | ST                        | <a href="#">IPS8200HQ-1</a> |

| Item | Q.ty | Ref.                                             | Part/value                                       | Description                                         | Manufacturer              | Order code     |
|------|------|--------------------------------------------------|--------------------------------------------------|-----------------------------------------------------|---------------------------|----------------|
| 45   | 3    | U3 U11 U12                                       | STISO620<br>SOIC8P127_49<br>0X600X175L83<br>X42N | Digital Isolator<br>2ch<br>unidirectional           | ST                        | STISO620       |
| 46   | 4    | U4 U6 U7 U10                                     | STISO621<br>SOIC8P127_49<br>0X600X175L83<br>X42N | Digital Isolator<br>2ch bidirectional               | ST                        | STISO621       |
| 47   | 2    | U8 U9                                            | ESDA15P60-1U<br>1M 2-UDFN                        | TVS DIODE<br>13.2V 22.7V<br>1610                    | ST                        | ESDA15P60-1U1M |
| 48   | 0    | U5                                               | ESDA15P60-1U<br>1M 2-UDFN                        | TVS DIODE<br>13.2V 22.7V<br>1610 (not<br>assembled) | ST                        | ESDA15P60-1U1M |
| 49   | 1    | U2                                               | SMC30J30CA,<br>DO-214AB,<br>SMC                  | TVS DIODE<br>33.3V 48.7V<br>SMC, 3 kW               | ST                        | SMC30J30CA     |
| 50   | 55   | No Reference                                     | jumper close<br>2.54mm jumper<br>close 2.54mm    | jumper close<br>2.54mm                              | Wurth<br>Electronics Inc. | 60900213421    |
| 51   | 10   | R51 R52 R53<br>R54 R55 R56<br>R57 R58 R59<br>R60 | 220kΩ 0603<br>0.1W, 1/10W                        | RES SMD 220k<br>OHM 1% 1/10W<br>0603                | ANY                       | ANY            |

## 4 Board versions

**Table 5. X-NUCLEO-OUT17A1 versions**

| PCB version                      | Schematic diagrams                   | Bill of materials                   |
|----------------------------------|--------------------------------------|-------------------------------------|
| X\$NUCLEO-OUT17A1 <sup>(1)</sup> | X\$NUCLEO-OUT17A1 schematic diagrams | X\$NUCLEO-OUT17A1 bill of materials |

1. This code identifies the X-NUCLEO-OUT17A1 evaluation board first version. It is printed on the board PCB.

## 5 Regulatory compliance information

### Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

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.

### Notice for Innovation, Science and Economic Development Canada (ISED)

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).

### Notice for the European Union

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

### Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

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## 6 References

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Freely available on [www.st.com](http://www.st.com):

- [IPS8200HQ-1 datasheet](#)
- [UM3035: "Getting started with X-CUBE-IPS industrial digital output software for STM32 Nucleo"](#)
- [NUCLEO-F401RE documentation](#)
- [NUCLEO-G431RB documentation](#)

## Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes                                                                     |
|-------------|----------|-----------------------------------------------------------------------------|
| 14-Nov-2023 | 1        | Initial release.                                                            |
| 24-Apr-2024 | 2        | Updated Introduction and <a href="#">Section 1.2: Board configuration</a> . |

## Contents

|          |                                          |           |
|----------|------------------------------------------|-----------|
| <b>1</b> | <b>Getting started</b>                   | <b>3</b>  |
| 1.1      | Overview                                 | 3         |
| 1.2      | Board configuration                      | 4         |
| 1.3      | Digital section                          | 5         |
| 1.4      | Power section                            | 7         |
| 1.5      | Hardware requirements                    | 9         |
| 1.6      | System requirements                      | 9         |
| 1.7      | Board setup                              | 10        |
| <b>2</b> | <b>Schematic diagrams</b>                | <b>11</b> |
| <b>3</b> | <b>Bill of materials</b>                 | <b>14</b> |
| <b>4</b> | <b>Board versions</b>                    | <b>18</b> |
| <b>5</b> | <b>Regulatory compliance information</b> | <b>19</b> |
| <b>6</b> | <b>References</b>                        | <b>20</b> |
|          | <b>Revision history</b>                  | <b>21</b> |
|          | <b>List of tables</b>                    | <b>23</b> |
|          | <b>List of figures</b>                   | <b>24</b> |

## List of tables

|                 |                                                     |    |
|-----------------|-----------------------------------------------------|----|
| <b>Table 1.</b> | X-NUCLEO-OUT17A1 .....                              | 4  |
| <b>Table 2.</b> | Nucleo development boards binary files .....        | 10 |
| <b>Table 3.</b> | Additional information on board configuration ..... | 10 |
| <b>Table 4.</b> | X-NUCLEO-OUT17A1 bill of materials .....            | 14 |
| <b>Table 5.</b> | X-NUCLEO-OUT17A1 versions .....                     | 18 |
| <b>Table 6.</b> | Document revision history .....                     | 21 |

## List of figures

|                  |                                                                       |    |
|------------------|-----------------------------------------------------------------------|----|
| <b>Figure 1.</b> | X-NUCLEO-OUT17A1 expansion board. . . . .                             | 2  |
| <b>Figure 2.</b> | X-NUCLEO-OUT17A1 expansion board: digital interface section . . . . . | 5  |
| <b>Figure 3.</b> | X-NUCLEO-OUT17A1 expansion board: power section . . . . .             | 7  |
| <b>Figure 4.</b> | X-NUCLEO-OUT17A1 and STM32 Nucleo stack. . . . .                      | 9  |
| <b>Figure 5.</b> | X-NUCLEO-OUT17A1 circuit schematic (1 of 3) . . . . .                 | 11 |
| <b>Figure 6.</b> | X-NUCLEO-OUT17A1 circuit schematic (2 of 3) . . . . .                 | 12 |
| <b>Figure 7.</b> | X-NUCLEO-OUT17A1 circuit schematic (3 of 3) . . . . .                 | 13 |

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