# Getting Started with X-NUCLEO-OUT01A1 industrial digital output expansion board for STM32 Nucleo

## Introduction

The X-NUCLEO-OUT01A1 industrial digital output expansion board for STM32 Nucleo is based on the ISO8200BQ galvanic isolated octal high-side smart power solid state-relay.
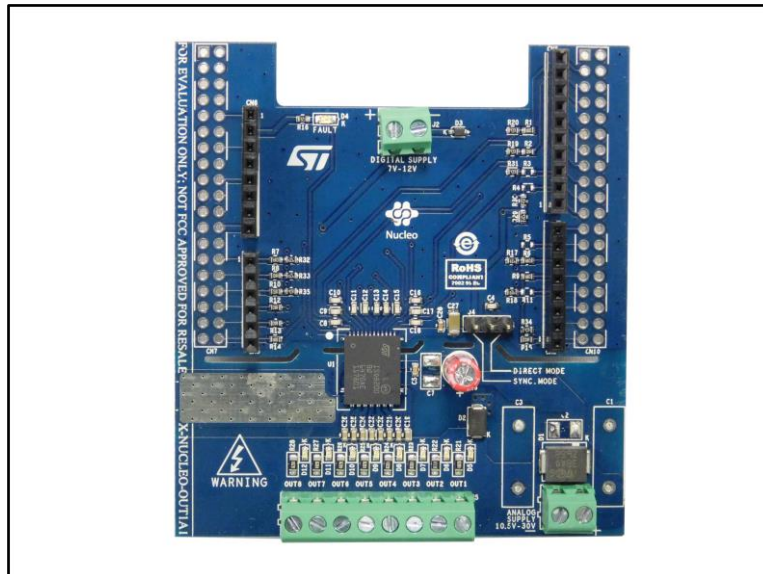
It provides an affordable and easy-to-use development platform for implementing galvanic insulation in industrial power switch driver applications.

The board can be plugged onto an STM32 Nucleo development board (NUCLEO-F103RB, NUCLEO-F302R8 or NUCLEO-F401RE) via its Arduino® UNO R3 connectors.

Other boards can also be stacked to further expand functionality: industrial PLC functionality with 8 inputs and 16 outputs can be added with the X-NUCLEO-PLC01A1 expansion board, and the X-NUCLEO-IDW01M1 expansion board adds wireless communication functionality for remote PLC management, which is enhanced by the ST-PLC Android™ or iOS™ app.

This board is designed to comply with applicable industrial EMC standards.

**Figure 1: X-NUCLEO-OUT01A1 expansion board**

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# 1 Getting started

## 1.1 Hardware requirements

The X-NUCLEO-OUT01A1 is designed to be used with the following STM32 Nucleo boards (visit www.st.com for further information):

- NUCLEO-F103RB
- NUCLEO-F302R8
- NUCLEO-F401RE

**Figure 2: X-NUCLEO-OUT01A1 plugged on an STM32 Nucleo board**



The X-NUCLEO-OUT01A1 is plugged onto the matching Arduino® UNO R3 connector pins on the STM32 Nucleo board.
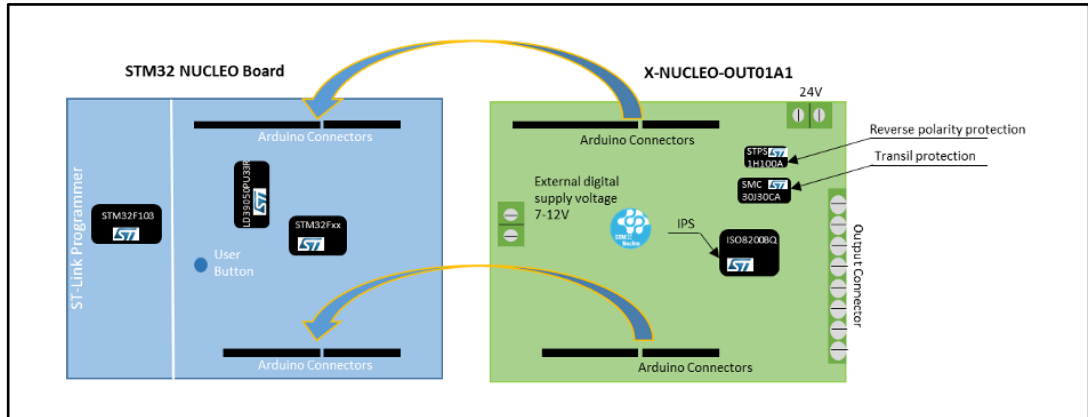
## 1.2 System requirements

To complete the system, you need:

- a Windows® (version 7 or above) PC
- a USB type A to mini-B USB cable to connect the STM32 Nucleo to the PC
- the X-CUBE-OUT1 board firmware and software package installed on the user PC

# 2    X-NUCLEO-OUT01A1 expansion board overview

The X-NUCLEO-OUT01A1 is equipped with the ISO8200BQ intelligent power switch (IPS), featuring galvanic insulation for safe digital microcontroller interface and overcurrent and over temperature protection for safe output load control.

**Figure 3: STM32 Nucleo development board plus X-NUCLEO-OUT01A1 expansion board layout and connection**



The X-NUCLEO-OUT01A1 expansion board features:

- Industrial programmable logic controller (PLC ) functionality for STM32 Nucleo
- ISO8200BQ galvanic isolated octal high-side smart power solid state-relay:
    - voltage range: 10.5 V to 30 V
    - max. output current per channel $I_{OUT}$ = 0.7 A
- status LEDs: Fault, thermal protection
- Arduino® UNO R3 connector compatibility
- compliance with EMC standards:
    - IEC61000-4-2: 8kV Contact Discharge and 15kV Air discharge
    - IEC61000-4-3: 4kV Discharge on output and supply line
    - IEC61000-4-5: 2kV Discharge on output and supply line
- specifically designed for STM32 Nucleo development boards
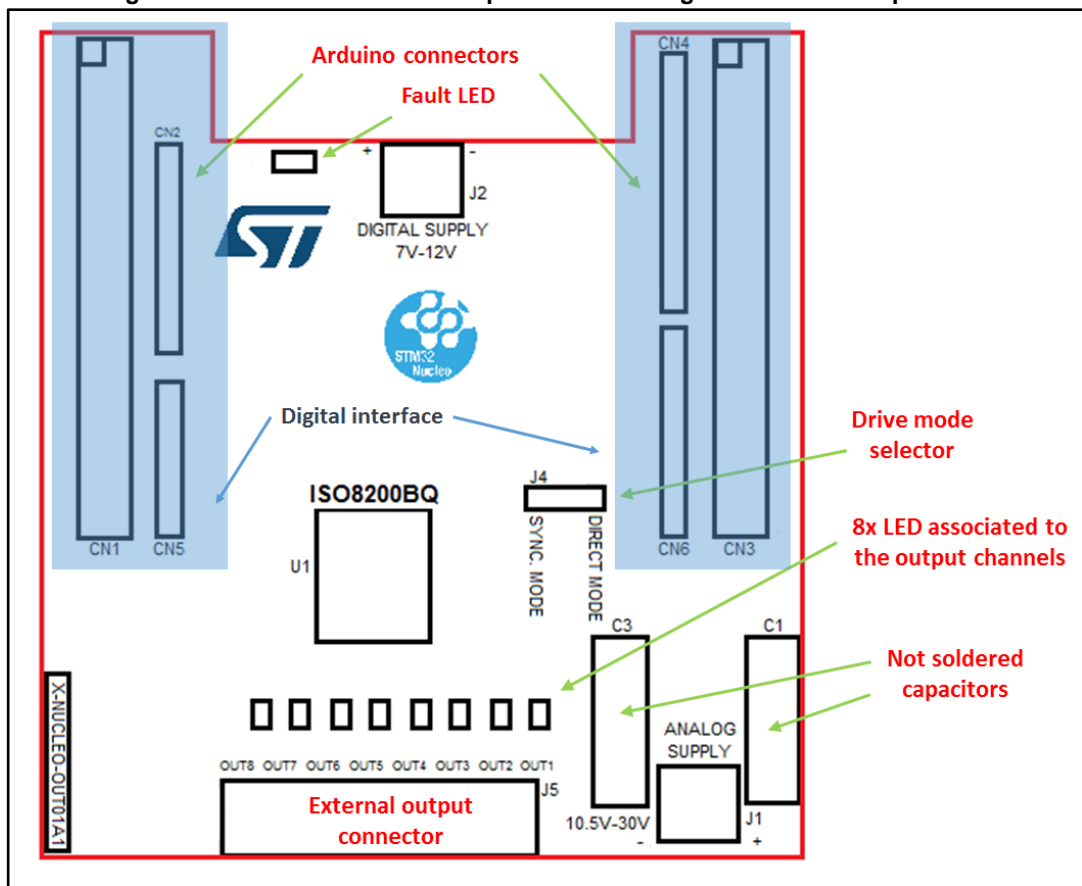- RoHS compliance

> As this is a digital output solution, each output state is managed at the microcontroller level; indeed, the X-NUCLEO-OUT01A1 has no input stage and no sensors can be connected to the expansion board.

## 2.1    Digital section

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

**Figure 4: X-NUCLEO-OUT01A1 expansion board digital interface components**



The four Arduino® UNO R3 connectors:

- allow expansion board ISO8200QB communication with the STM32 Nucleo board microcontroller and access to STM32 peripheral and GPIO resources.
- provide digital supply voltage between the STM32 Nucleo development board and the X-NUCLEO-OUT01A1 expansion board, in either direction.
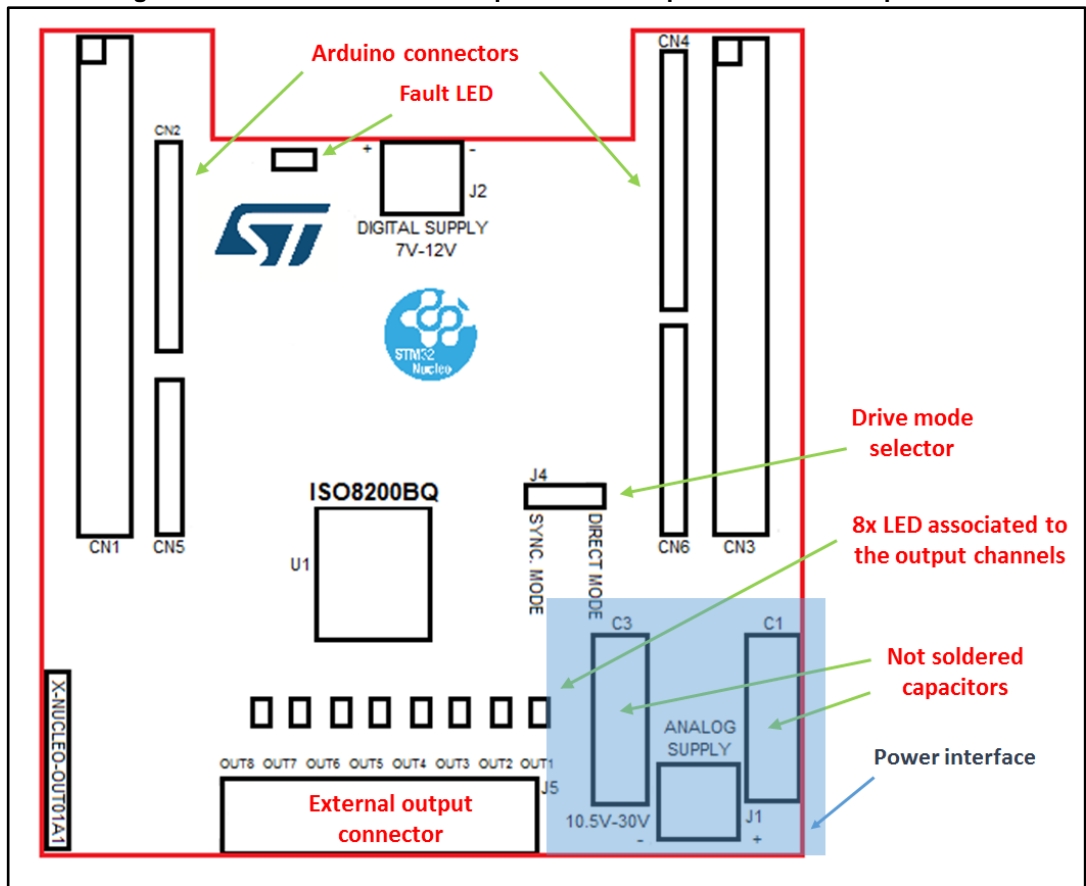
To provide an external digital supply:

- close jumper JP5 between pins 2 and 3 on the STM32 Nucleo development board
- connect a 7 V to 12 V supply at screw connector J2 on the X-NUCLEO-OUT01A1 expansion board

## 2.2 Power section

The power section involves the power supply voltage, load connection and Electromagnetic compatibility (EMC) protections.

**Figure 5: X-NUCLEO-OUT01A1 expansion board power section components**



For EMC:

- a Transil™ diode SMC30J30CA is placed on VCC track to protect the ISO8200BQ against surge discharge
- for common mode surge testing, solder two single-layer capacitors C1 and C3 (not included) at the predisposed locations
- 22 nF capacitors are included on the output lines for burst disturbance filtering

To supply the load, connect the supply voltage to the J1 2-way screw connector.

The load is connected to the 8-way output.

## 2.3 Direct access and synchronised access

Supplementary direct access and synchronized access routines are provided to allow further evaluation of ISO8200BQ IC functionality.

**Table 1: ISO8200BQ access modes**

| Access mode | Configuration |
|---|---|
| Direct access | connect the center pin of J4 to GND |
| Synchronous access | connect the center pin of jumper J4 to 3.3 V |

Once the selection is configured, push the blue user button on the STM32 Nucleo development board to begin evaluation.

## 2.4 Powering and initializing the board

To start working with the X-NUCLEO-OUT01A1 board:

1. connect the micro-USB cable to your PC
2. download the firmware version onto the microcontroller
3. set the following jumper configurations on the STM32 Nucleo board:
   - Close jumpers SB62 and SB63
   - Open jumpers SB13 and SB14
4. connect the ISO8200BQ device supply voltage via J1 on the X-NUCLEO-OUT01A1
5. provide the digital supply voltage:
   - **when connected to a PC**: keep the micro-USB cable connected and close jumper JP5 on the STM32 Nucleo board between pins 1 and 2.
   - **in standalone mode**: supply an external 7 V to 12 V via J2 on the X-NUCLEO-OUT01A1 and close jumper JP5 on the STM32 Nucleo board between pins 2 and 3.
6. connect the load on the output connector
7. run the STM32 and push the blue button on STM32 Nucleo board to select the example provided in the firmware package

# 3        Schematic diagrams
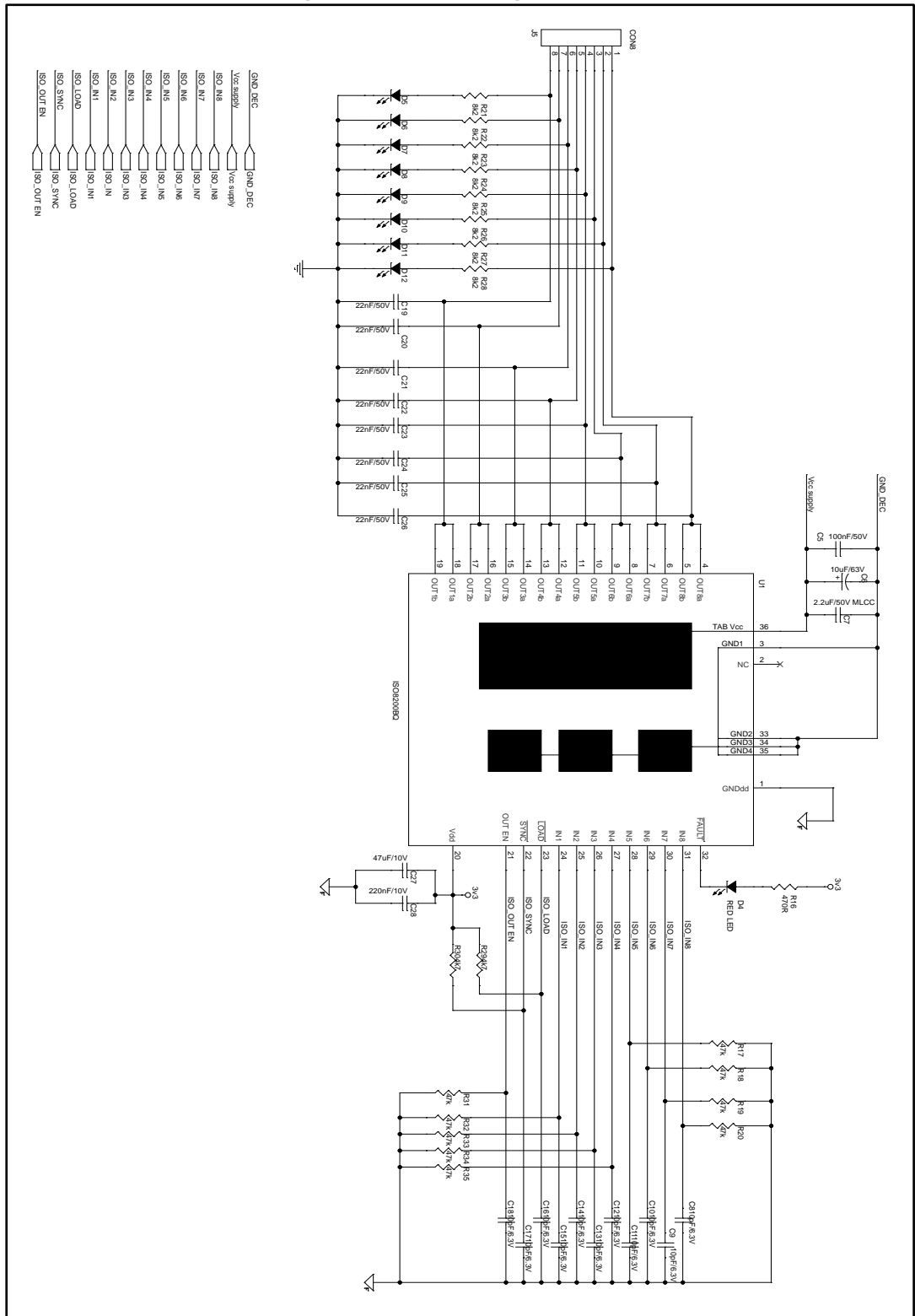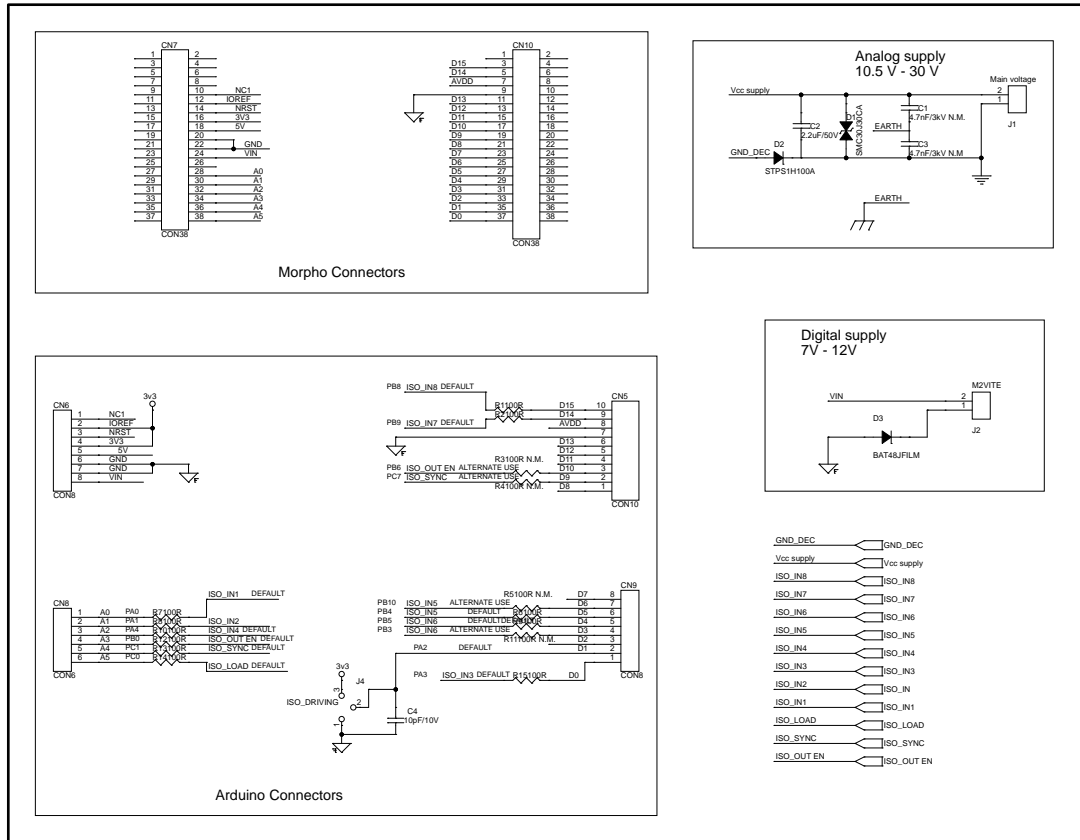
**Figure 6: Schematic diagram (1 of 2)**

**Figure 7: Schematic diagram (2 of 2)**

# 4        Bill of materials

**Table 2: Bill of materials**

| Item | Quantity | Reference | Part/Value | Description | Manufacturer | Order code |
|------|----------|-----------|------------|-------------|--------------|------------|
| 1 | 8 | C19,C20,C21,C22,C23, C24,C25,C26 | 22nF, 50V, +/- 10% | Ceramic MLCC | Kemet | C0603C223 K1RACTU |
| 2 | 12 | C4,C8,C9,C10,C11,C1 2,C13,C14,C15,C16,C1 7,C18 | 10pF, 50V, +/-5% | Ceramic capacitor | MULTICOMP | MCMT15N1 00F100CT |
| 3 | 1 | C6 | 10uF, 63V , +/- 10% | Low ESR | Rubycon | 63YXF10M5 X11 |
| 4 | 1 | C27 | 47uF, 10V, +/- 10% | MLCC Low ESR | Murata | GRM31CR6 1A476KE15 L |
| 5 | 1 | C28 | 220nF, 10V, +/- 10% | | Kemet | C0603C224 K8RACTU |
| 6 | 1 | C5 | 100nF, 50V, +/- 10% | | Murata | GCM188R71 H104KA43D |
| 7 | 2 | C1,C3 | 4.7nF, 3kV , | | Vishay / BC Components | VY1472M63 Y5UQ63V0 |
| 8 | 2 | C2,C7 | 2.2uF, 100V, +/- 10% | MLCC Low ESR | TDK | C3225X7R2 A225K230A B |
| 9 | 1 | D1 | | Transil series diode | ST | SMC30J30C A |
| 10 | 1 | D2 | | High Voltage Power Schottky Rectifier | ST | STPS1H100 A |
| 11 | 1 | D4 | | CHIPLED | OSRAM Opto Semiconducto rs | LR Q396 |
| 12 | 8 | D5,D6,D7,D8,D9,D10, D11,D12 | | CHIPLED | OSRAM Opto Semiconducto rs | LT Q39G- Q1S2-25-1 |
| 13 | 1 | D3 | | Small signal Schottky diodes | ST | BAT48JFILM |
| 14 | 1 | CN5 | | | Samtec | SSQ-110- 03-L-S |
| 15 | 2 | CN6,CN9 | | | Samtec | SSQ-108- 03-L-S |
| 16 | 1 | CN8 | | | Samtec | SSQ-106- 03-L-S |
| 17 | 1 | J5 | | | RS | |

| Item | Quantity | Reference | Part/Value | Description | Manufacturer | Order code |
|------|----------|-----------|------------|-------------|--------------|------------|
| 18 | 2 | J1,J2 | | | RS | |
| 19 | 1 | J4 | | | TE Connectivity | 87224-3 |
| 20 | 2 | CN7,CN10 | | | Samtec | SSQ-119-04-L-D |
| 21 | 1 | R16 | 470R, +/-5% | | Bourns | CR0603-JW-471GLF |
| 22 | 2 | R29,R30 | 4k7, +/-5% | | Bourns | CR0603-JW-472GLF |
| 23 | 8 | R21,R22,R23,R24,R25, R26,R27,R28 | 8.2K, +/-1% | | TE Connectivity | CRG0805F8K2 |
| 24 | 11 | R1,R2,R6,R7,R8,R9,R10,R12,R13,R14,R15 | 100R, +/-5% | | Bornus | CR0603-JW-101GLF |
| 25 | 4 | R3,R4,R5,R11 | 100R, +/-5% | | Bornus | CR0603-JW-101GLF |
| 26 | 9 | R17,R18,R19,R20,R31, R32,R33,R34,R35 | 47k, +/-5% | | Bourns | CR0603-JW-473GLF |
| 27 | 1 | U1 | | Galvanic isolated octal high-side smart power solid state-relay | ST | ISO8200BQ |

# 5 References

The following resources are all readily available on *www.st.com*

1. ISO8200BQ datasheet
2. X-CUBE-OUT1 user manual
3. X-NUCLEO-PLC01A1 user manual
4. X-NUCLEO-IDW01M1 user manual
5. ST-PLC databrief
6. STM32 Nucleo-64 board user manual

# 6 Revision history

**Table 3: Document revision history**

| Date | Version | Changes |
|------|---------|---------|
| 09-Jun-2017 | 1 | Initial release. |

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**