

Getting started with the X-NUCLEO-OUT02A1 industrial digital output expansion board for STM32 Nucleo

Introduction

The **X-NUCLEO-OUT02A1** 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 **ISO8200AQ** octal high-side smart power solid state-relay, with embedded galvanic isolation and 20 MHz SPI control interface, in a digital output module connected to 0.7 A industrial loads.

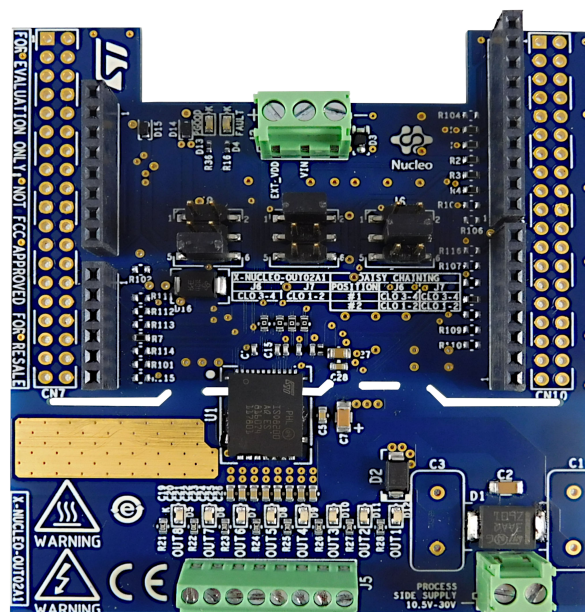
The **X-NUCLEO-OUT02A1** directly interfaces with the microcontroller on the STM32 Nucleo driven by GPIO pins and Arduino® R3 connectors.

The galvanic isolation between the microcontroller and the process stage is guaranteed by the **ISO8200AQ**.

The expansion board can be connected to either a **NUCLEO-F401RE** or a **NUCLEO-G431RB** development board.

It is also possible to evaluate a 16-channel digital output system enabling the daisy chaining feature on two **X-NUCLEO-OUT02A1** stacked expansion boards.

Figure 1. X-NUCLEO-OUT02A1 expansion board



1 Getting started

1.1 Overview

The **X-NUCLEO-OUT02A1** expansion board features:

- Based on the **ISO8200AQ** whose main characteristics are:
 - Embedded 4 kV galvanic isolation
 - Radio frequency communication between the logic and process sides for maximum noise immunity
 - Very low power dissipation ($R_{ON(MAX)} = 220\text{ m}\Omega$)
 - Fast decay for inductive loads
 - 20 MHz SPI I/F on logic side
 - V_{CC} power good diagnostics
 - Overload and overheating protections with thermal shutdown and diagnostics
 - QFN-32L (9x11x1 mm) package
- 10.5 to 33 V operating voltage range
- Green LED (x8) for output on/off status
- Red LED for process supply power good fault
- Red LED for overload and overheating
- Supply reverse polarity protection
- EMC compliance according to IEC61000-4-2, IEC61000-4-3, IEC61000-4-5
- Compatible with **STM32 Nucleo** boards
- Equipped with Arduino® UNO R3 connectors
- CE certified
- RoHS and China RoHS compliant

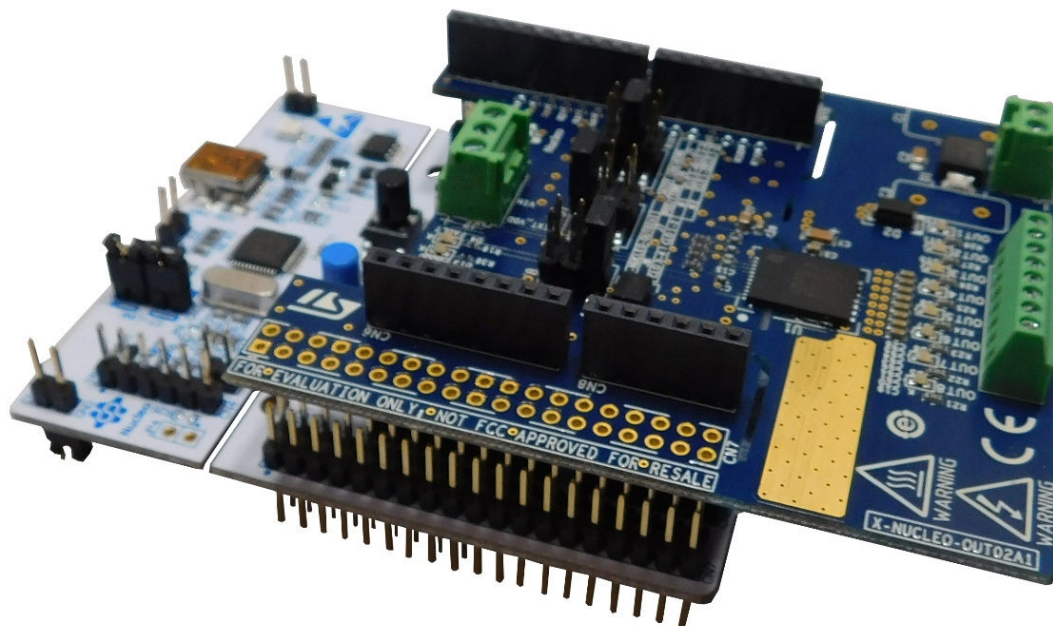
The SPI interface and the embedded power good detection allow a deeper diagnostics, daisy chaining and less MCU GPIO resources on the logic stage.

*Note: The **X-NUCLEO-OUT02A1** offers a digital output solution: each output stage is managed at microcontroller level. As the board has no input stage, no sensors can be connected to it.*

1.2 Hardware requirements

To use **STM32 Nucleo** development boards with the **X-NUCLEO-OUT02A1** expansion board, match the boards via the Arduino® UNO R3 connector pins on the **STM32 Nucleo** development board.

Figure 2. X-NUCLEO-OUT02A1 expansion board connected to an STM32 Nucleo development board



The X-NUCLEO-OUT02A1 has been tested on

- NUCLEO-F401RE
- NUCLEO-G431RB

1.3 System requirements

To use the STM32 Nucleo boards with the X-NUCLEO-OUT02A1 expansion board you need:

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

1.4 Board setup

- Step 1.** Connect the mini-USB or micro-USB cable to your PC to use the X-NUCLEO-OUT02A1 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-OUT02A1** can be used to control the **ISO8200AQ** device in three different operating modes available for the user in three different example projects: *Regular_8_Channels* (one board configured in SPI 8 channels mode), *Regular_16_Channels* (two stacked independent boards both configured in SPI 8 channels mode) and *DaisyChain* (two stacked boards properly configured in Daisy chain mode). 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 1. Nucleo development boards binary files

Nucleo board	Binary path
NUCLEO-F401RE	Projects\NUCLEO-F401RE\Examples\OUT02A1\DaisyChain\Binary\DaisyChain.bin
	Projects\NUCLEO-F401RE\Examples\OUT02A1\Regular_8_Channels\Binary\Regular_8_Channels.bin
	Projects\NUCLEO-F401RE\Examples\OUT02A1\Regular_16_Channels\Binary\Regular_16_Channels.bin
NUCLEO-G431RB	Projects\NUCLEO-G431RB\Examples\OUT02A1\DaisyChain\Binary\DaisyChain.bin
	Projects\NUCLEO-G431RB\Examples\OUT02A1\Regular_8_Channels\Binary\Regular_8_Channels.bin
	Projects\NUCLEO-G431RB\Examples\OUT02A1\Regular_16_Channels\Binary\Regular_16_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 2. Additional information on board configuration

Board configuration	Readme file
<i>DaisyChain</i>	Examples\OUT02A1\DaisyChain\readme.html
<i>Regular_8_Channels</i>	Examples\OUT02A1\Regular_8_Channels\readme.html
<i>Regular_16_Channels</i>	Examples\OUT02A1\Regular_16_Channels\readme.html

Step 3. Connect the **ISO8200AQ** device supply voltage via CN1 (see [Section 2.2: Power section](#)).

Step 4. Provide the digital supply voltage (see [Section 2.1: Digital section](#)).

Step 5. Connect the load on the output connector (see [Section 2.2: Power section](#)).

Step 6. Reset the example sequence by pushing the black button on the **STM32 Nucleo** board.

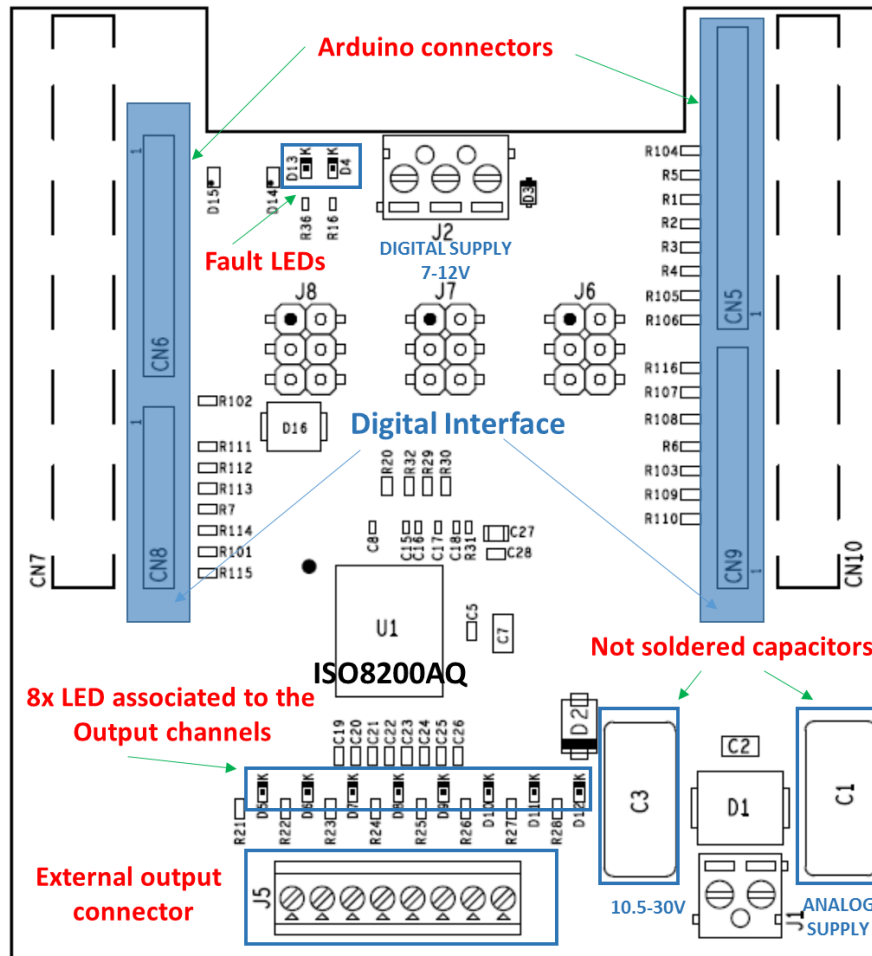
Step 7. Push the blue button on the **STM32 Nucleo** board to choose among the examples provided in the default firmware package.

2 Hardware description and configuration

2.1 Digital section

The digital section is associated with the STM32 interface and digital supply voltage to and from the X-NUCLEO-OUT02A1 expansion board.

Figure 3. X-NUCLEO-OUT02A1 expansion board: digital interface components



The four Arduino® UNO R3 connectors:

- allow the ISO8200AQ communication with the STM32 Nucleo board microcontroller and access to the STM32 peripheral and GPIO resources;
- provide digital supply voltage to/from the STM32 Nucleo development board and the X-NUCLEO-OUT02A1 expansion board.

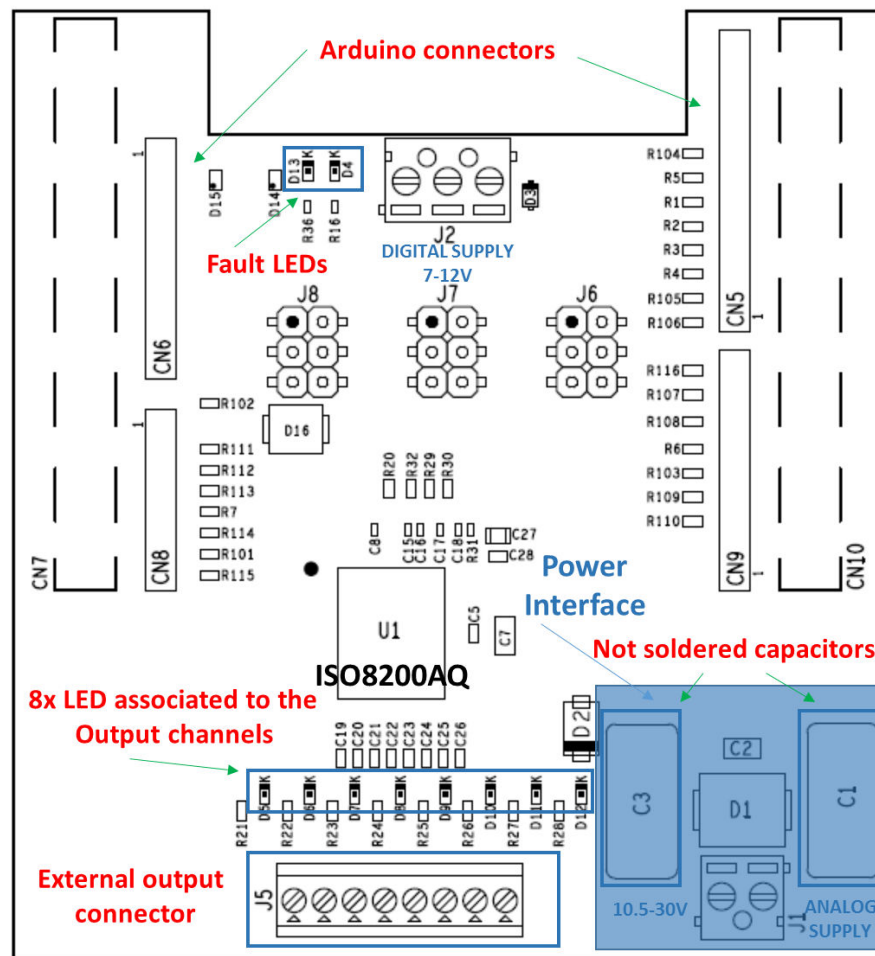
To provide an external digital supply:

- close jumper JP5 between pins 2 and 3 on the STM32 Nucleo development board;
- connect a 7 to 12 V supply at screw connector J2 on the X-NUCLEO-OUT02A1 expansion board.

2.2 Power section

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

Figure 4. X-NUCLEO-OUT02A1 expansion board: power section components



For EMC:

- a Transil™ diode [SMC30J30CA](#) is placed on V_{CC} track to protect the [ISO8200AQ](#) against surge discharge;
- for common mode surge testing, two single-layer capacitors (C1 and C3, not mounted) must be soldered;
- 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.

The EMC performance of the [X-NUCLEO-OUT02A1](#)

- 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

3 Bill of materials

Table 3. X-NUCLEO-OUT02A1 bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	U1	ISO8200AQ TFQFPN32	Galvanic isolated octal high-side smart power solid state-relay	ST	ISO8200AQ
2	8	C19, C20, C21, C22, C23, C24, C25, 26	22 nF 50 V $\pm 10\%$ 0603 X7R	Capacitors	TDK	C1608X7R1H223K080AA
3	8	D5, D6, D7, D8 D9, D10, D11, D12	0603 AlGaInP	Green LEDs	OSRAM	LG L29K-G2J1-24
4	8	R21, R22, R23, R24 R25, R26, R27, R28	10 k Ω 0.1 W $\pm 1\%$ 0603	Resistors	Bourns	CR0603-FX-1002ELF
5	1	J5	8 ways, 1 row, screw connector TH 2.54 mm	Jumper	Phoenix Contact	1725711
6	1	C2, C7	2.2 μ F 50 V $\pm 10\%$ 1206 X7R	Capacitors	Murata	GRM31C71H225KA88K
7	1	C5	100 nF 50 V $\pm 10\%$ 0603 X7R	Capacitor	TDK	CGA3E2X7R1H104K080AA
8	1	C28	100 nF 16 V $\pm 5\%$ 0603 X7R	Capacitor	AVX	0603YC104JAT2A
9	1	C27	2.2 μ F 16 V $\pm 10\%$ 0805 X7R	Capacitor	Murata	GCM21BR71C225KA64L
10	1	R31	47 k Ω 63 mW $\pm 5\%$ 0402	Resistor	Vishay	CRCW040247k0JNED
11	1	C18	10 pF 50 V $\pm 5\%$ 0402 COG	Capacitor	YAGEO	CC0402JRNP09BN100
12	4	R20, R29, R30, R32	0 Ω 100 mW $\pm 1\%$ 0603	Resistors	TE Connectivity	CRG0603ZR
14	4	C8, C15, C16, C17	33 pF 50 V $\pm 5\%$ 0402	Capacitors	Phycomp	2.23887E+11
15	2	R16, R36	910 Ω 63 mW $\pm 1\%$ 0402	Resistors	Vishay	CRCW0402910RFKED
16	2	D13, D4	AlGaInP 0603	Red LEDs	OSRAM	LS L29K-G1 J2-1
17	3	J6, J7, J8	6 ways, 2 rows connector SMD 2.54mm	Jumpers	Harwin	M20-8760342
18	7	R1, R2, R3, R4 R5, R6, R7	100 Ω 0.1 W $\pm 0.5\%$ 0603	Resistors	Panasonic	ERJ3BD1000V
19	0	R101, R102, R103, R104, R105, R106, R107, R108, R109, R110, R111, R112, R113, R114, R115, R116	DNM 0603	Resistors (not mounted)	Any	
20	1	CN5	10 ways, 1 row TH 2.54 mm	Capacitor	SAMTEC	SSQ-110-04-F-S
21	2	CN6, CN9	8 ways, 1row TH 2.54 mm	Capacitors	SAMTEC	SSQ-108-04-F-S
22	0	CN7, CN10	TH 2.54 mm	Capacitors (not mounted)	SAMTEC	SSQ-119-04-L-D
23	1	CN8	6 ways, 1 row TH 2.54 mm	Capacitor	SAMTEC	SSQ-106-04-F-S

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
24	1	J1	2 ways, 1 row (ISO8200AQ HV supply) TH 3.5 mm	Jumper	RS	790-1149
25	1	J2	3 ways, 1 row (STM32, ISO8200AQ LV supply) TH 3.5 mm	Jumper	RS	790-1143
26	0	C1, C3	4.7 nF 3.15 kV TH	Capacitors (not mounted)	Murata	DEBE33F472ZC3B
27	1	D1	SMC	3000 W TVS in SMC package	ST	SMC30J36A
28	1	D2	1 A, 100 V SMA	Power Schottky rectifier	ST	STPS1H100A
29	1	D3	0.35 A, 40 V SOD-323	Small signal Schottky diodes	ST	BAT48JFILM
30	1	D14	700 W $V_{BR} = 6.8$ V; $V_{CL} = 10.2$ V 1610	High-power transient voltage suppressor (TVS)	ST	ESDA7P60-1U1M
31	1	D15	1200 W $V_{BR} = 6.8$ V; $V_{CL} = 10.2$ V 1610	High-power transient voltage suppressor (TVS)	ST	ESDA15P60-1U1M
32	1	D16	600 W $V_{BR} = 14.3$ V; $V_{CL} = 20.8$ V SMB	600 W TVS in SMB	ST	SMBJ5.0A-TR

4 Schematic diagrams

Figure 5. X-NUCLEO-OUT02A1 circuit schematic (1 of 2)

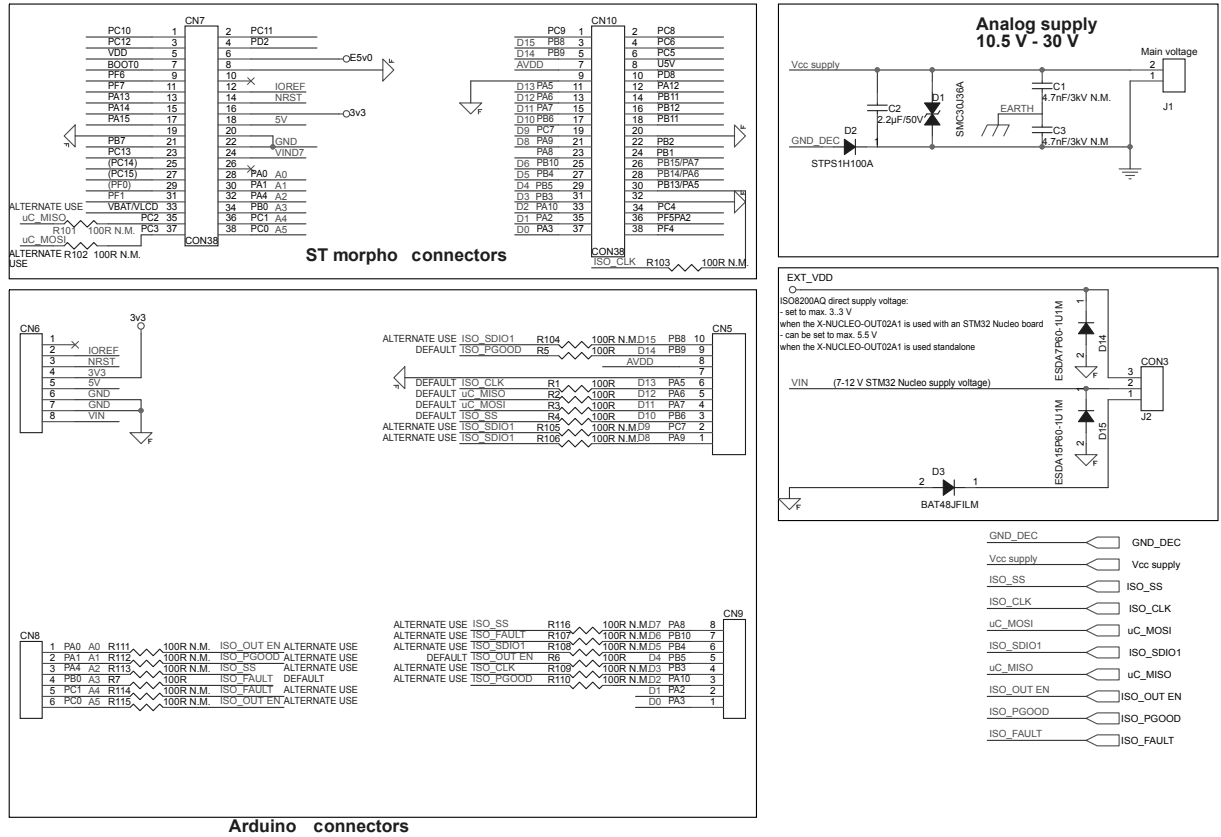
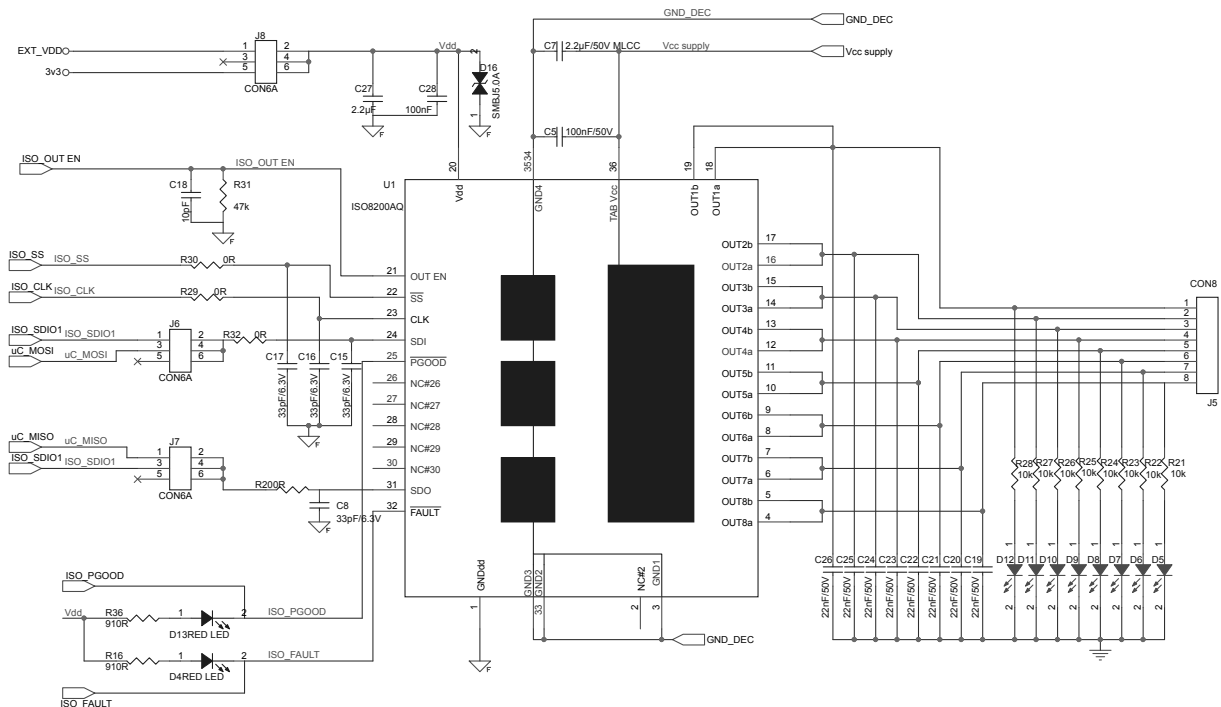


Figure 6. X-NUCLEO-OUT02A1 circuit schematic (2 of 2)



5 Board versions

Table 4. X-NUCLEO-OUT02A1 versions

Finished good	Schematic diagrams	Bill of materials
X\$NUCLEO-OUT02A1 ⁽¹⁾	X\$NUCLEO-OUT02A1 schematic diagrams	X\$NUCLEO-OUT02A1 bill of materials

1. This code identifies the X-NUCLEO-OUT02A1 evaluation board first version.

6 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.

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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).

Appendix A References

Freely available on www.st.com:

- [ISO8200AQ](#) datasheet
- [X-CUBE-IPS](#) user manual
- [NUCLEO-F401RE](#) documentation
- [NUCLEO-G431RB](#) documentation

Revision history

Table 5. Document revision history

Date	Revision	Changes
08-Nov-2018	1	Initial release.
04-Dec-2024	2	Added ref to X-CUBE-IPS.

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