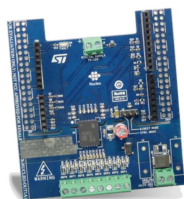


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STMicroelectronics UM3082 X-NUCLEO-OUT14A1 Industrial Digital Output Expansion Board User Manual

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Contents [hide](#)

[1 STMicroelectronics UM3082 X-NUCLEO-OUT14A1 Industrial Digital Output Expansion Board](#)

[2 Introduction](#)

[3 Getting started](#)

[3.1 Overview](#)

[3.2 Digital section](#)

[3.3 Hardware requirements](#)

[3.4 Board setup](#)

[4 Schematic diagrams](#)

[5 Bill of materials](#)

[6 Board versions](#)

[7 Regulatory compliance information](#)

[7.1 Notice for US Federal Communication Commission \(FCC\)](#)

[8 References](#)

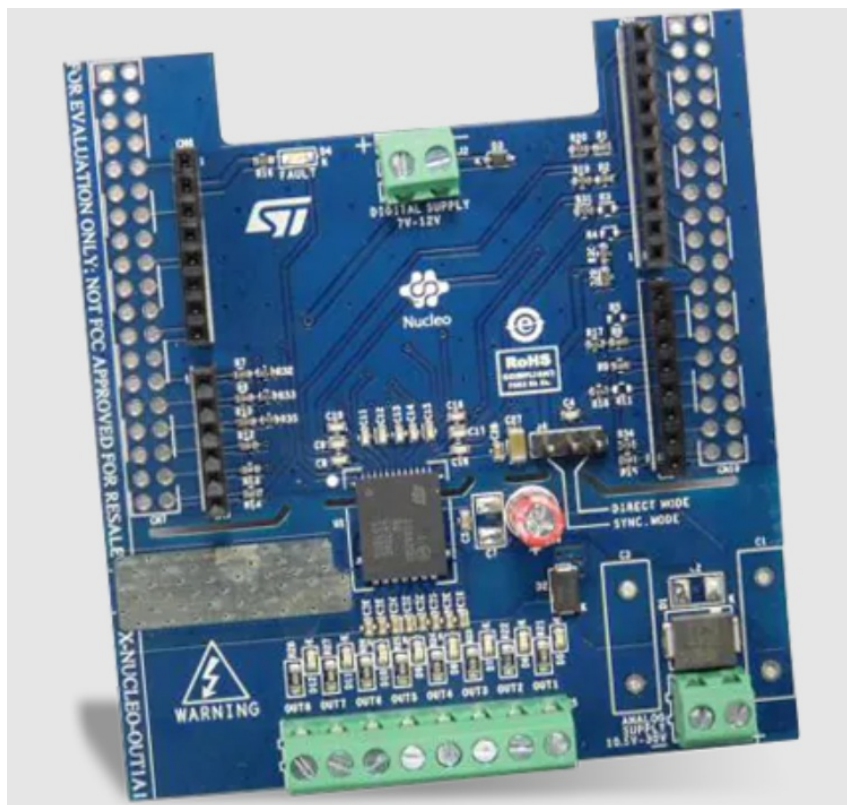
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[9.1 References](#)

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STMicroelectronics UM3082 X-NUCLEO-OUT14A1 Industrial Digital Output Expansion Board



Introduction

The X-NUCLEO-OUT14A1 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 ISO808A-1 octal high-side smart power solid state relay, with embedded galvanic isolation and 20MHz SPI control interface, in a digital output module connected to 1.0 A industrial loads.

The X-NUCLEO-OUT14A1 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 ISO808A-1. 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-OUT14A1 stacked expansion boards.

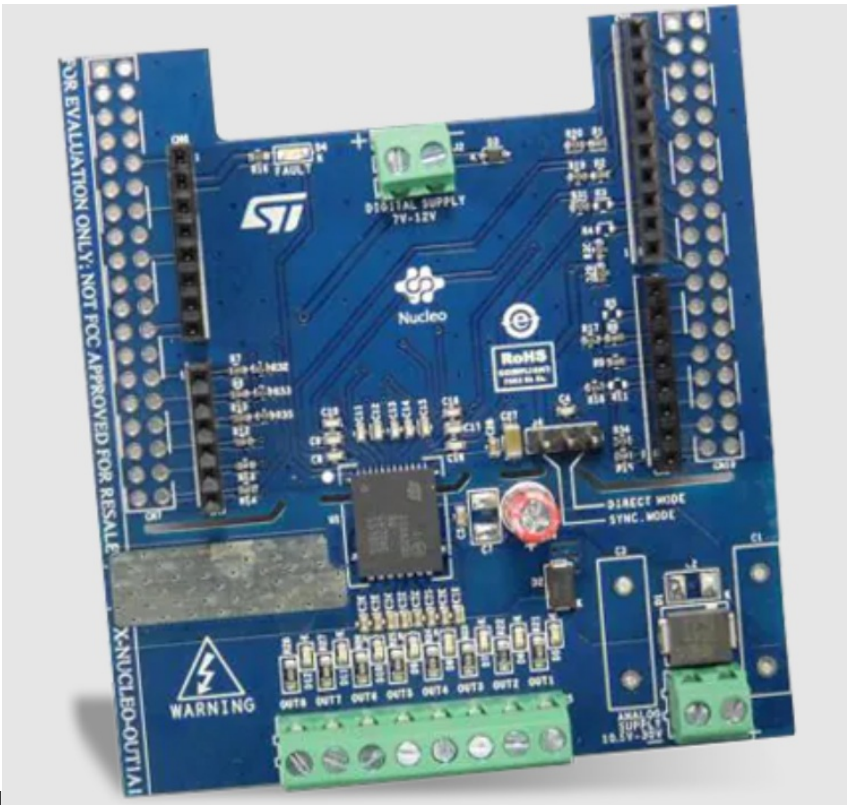


Figure 1. X-NUCLEO-OUT14A1 expansion board

Getting started

Overview

The X-NUCLEO-OUT14A1 embeds the ISO808A-1 intelligent power switch (IPS), which features galvanic isolation, 20 MHz SPI and Power Good diagnostic, 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. The galvanic isolation embedded by the ISO808A-1 satisfies this requirement, avoiding the necessity of external optocouplers, with a consequent cost saving and a reduced application size.

The expansion board features:

- Based on the ISO808A-1 octal high-side switch, which features:
 - Operating range 9.2 to 36 V
 - Low power dissipation ($R_{ON}(MAX) = 260\text{ m}\Omega$)
 - Process side operating current: up to 1.0 A per channel
 - Embedded 2k VRMS galvanic isolation
 - PGOOD (VCC voltage level alarm signalization)
 - 20 MHz SPI with daisy chaining
 - Fast decay for inductive loads
 - Undervoltage lock-out
 - Overload and overtemperature protections
 - Loss of ground protection
 - PowerSO36 package
- Application board process side operating range: 10 (J10 open) to 33 V (J9 closed)
- Extended operating range of process side from 9.2 (J10 closed) up to 36 V (J9 open)
- Application board logic side operating voltage 3.3 to 5 V
- Green LEDs for outputs on/off status (J6 and J7 close 1-2, 3-4, 5-6, 7-8)
- Red LED for common overheating and communication error diagnostic (J3 close 1-2)
- Red LED for PGOOD signalization (J3 close 3-4)
- Yellow LED for output enable status signalization (J3 close 5-6)
- Process and logic supply rails reverse polarity protections
- Compatible with STM32 Nucleo development boards
- Equipped with Arduino® UNO R3 connectors
- RoHS and China RoHS compliant
- CE certified
- Radiated emission: class B according to the standard EN 55032

Digital section

The digital section is associated with the STM32 interface and the digital supply voltage to and from the X-NUCLEO-OUT14A1 expansion board.

Figure 2. X-NUCLEO-OUT14A1 expansion board: digital interface section



The dotted green line indicates the whole digital interface section. The pink rectangles identify the Arduino® UNO R3 connectors.

The four Arduino® UNO R3 connectors:

- allow the expansion board to communicate with the STM32 Nucleo development board microcontroller accessing the STM32 peripheral and GPIO resources;
- provide the digital supply voltage between the STM32 Nucleo development board and the X-NUCLEO-OUT14A1 expansion board, in either direction.

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 by 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 J5 (without reverse polarity). In this scenario, the logic side of the ISO808A-1 can be supplied by the 3.3 V supply rail generated by the expansion board: in this case, on the X-NUCLEO-OUT14A1, J4 must be closed between pins 5 and 6.

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.

The pin 3 of the connector CN11 can be used to supply the logic side of the ISO808A-1 independently by the expansion board. In this case, on the X-NUCLEO-OUT14A1, the pins 1 and 2 of J4 must be closed (pins 5-6 open).

Power section

The power section involves the power supply voltage (CN1, pin 1 for VCC, 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-OUT14A1 expansion board: power section components

1. ISO808A-1
2. Output and power supply connector
3. Output channels – green LEDs
4. Status (overtemperature) red LED
5. Output Enable yellow LED
6. Power Good – red LED



- The SM15T39CA transient voltage suppressor (U2), enabled by closing J9, is placed between VCC and GND tracks to protect the ISO808A-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 ISO808A-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-OUT14A1 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

Hardware requirements

The X-NUCLEO-OUT14A1 expansion board is designed to be used with the NUCLEO-F401RE or NUCLEO-G431RB STM32 Nucleo development boards. To function correctly, the X-NUCLEO-OUT14A1 must be plugged onto the matching Arduino® UNO R3 connector pins on the STM32 Nucleo board as shown below.



Figure 4. X-NUCLEO-OUT14A1 and STM32 Nucleo stack

System requirements

To use the STM32 Nucleo development boards with the X-NUCLEO-OUT14A1 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

Board setup

Step 1. Connect the mini-USB or micro-USB cable to your PC to use the X-NUCLEO-OUT14A1 with NUCLEO-F401RE or NUCLEO-G431RB development board

Step 2. Download the firmware (.bin) onto the STM32 Nucleo development board microcontroller through STM32 ST-LINK utility, STM32CubeProgrammer, and according to your IDE environment as detailed in the table below.

Table 1. NUCLEO-F401RE development board supported IDEs – bin files

NUCLEO-F401RE

IAR	Keil	STM32CubeIDE
EWARM-OUT12_14-	MDK-ARM-OUT12_14-	STM32CubeIDE-OUT12_14-
STM32F4xx_Nucleo.bin	STM32F4xx_Nucleo.bin	STM32F4xx_Nucleo.bin

Table 2. NUCLEO-G431RB development board supported IDEs – bin files

NUCLEO-G431RB

IAR	Keil	STM32CubeIDE
EWARM-OUT12_14-	MDK-ARM-OUT12_14-	STM32CubeIDE-OUT12_14-
STM32G4xx_Nucleo.bin	STM32G4xx_Nucleo.bin	STM32G4xx_Nucleo.bin

Note:

By default, the X-NUCLEO-OUT14A1 is configured to work stand-alone. However, it is possible to stack two X-NUCLEO-OUT14A1 and enable the related control by enabling the daisy chaining communication:

- Close J12 [1-2] and J13 [3-4] in board #1
- Close J12 [3-4] and J13 [1-2] in board #2
- Rework board #1: remove R105 and mount R102
- Rework board #2: remove R119, R108, R107, R104 and mount R102, R113, R111, R109

In terms of software, it is necessary to generate the new binary file after having defined the preprocessor directive USE_DAISSY_CHAIN and removed the directive USE_PAR_IND (or changed in noUSE_PAR_IND). The modification to control mode becomes effective on the binary files after rebuilding.

Step 3. Connect the ISO808A-1 device supply voltage via CN1 (see Section 1.3 Power section).

Step 4. Provide the digital supply voltage (see Section 1.2 Digital section).

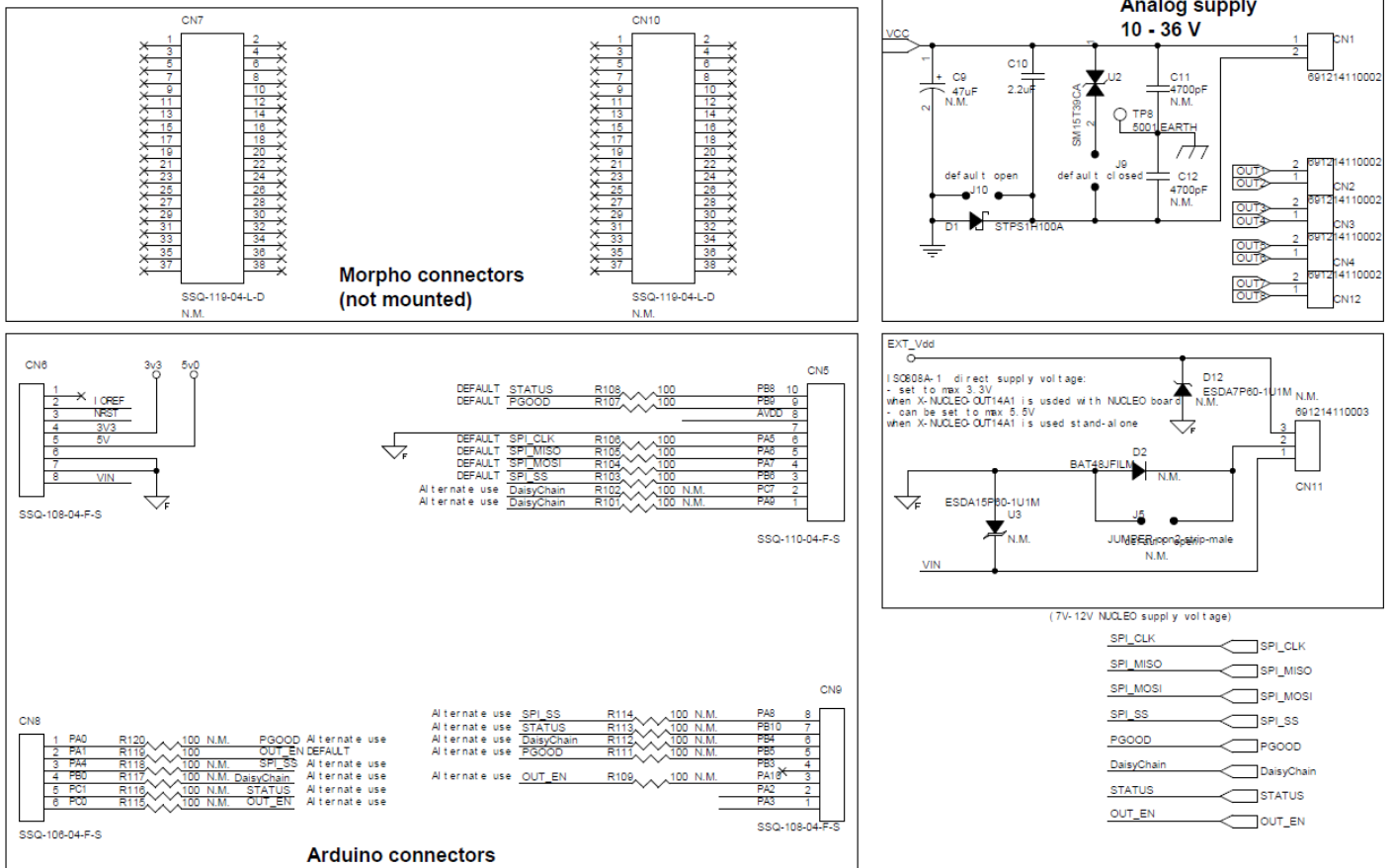
Step 5. Connect the load on the output connector (see Section 1.3 Power section).

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.

Schematic diagrams

Figure 5. X-NUCLEO-OUT14A1 circuit schematic (1 of 2)



1	8	C1 C2 C3 C4 C5 C6 C7 C8	10nF 0603 (1608 Metric) 50V 10%	CAP CER 10000PF 50V X7R 0603	Wurth Electronics Inc.	885382206002
2	0	C9	47uF Radial, Can 100V 20%	CAP 47 UF 20% 100 V (not mounted)	Wurth Electronics Inc.	860040875002
3	1	C10	2.2uF 1206 (3216 Metric) 100V 10%	CAP CER 2.2UF 100V X7R 1206	AVX Corporation	12061C225KAT2A
4	0	C11 C12	4700pF 1825 (4564 Metric) 3000V (3kV) 10%	CAP CER 4700PF 3KV X7R 1825 (not mounted)	Vishay Vitramon	HV1825Y472KXHATHV
5	2	C13 C26	0.1uF 0805 (2012 Metric) 100V 10%	CAP CER 0.1UF 100V X7R 0805	Wurth Electronics Inc.	885012207128
6	5	C14 C21 C22 C23 C24	33pF 0402 (1005 Metric) 10V 5%	CAPACITOR CERAMIC SMD 0402	Wurth Electronics Inc.	885012005010
7	1	C25	2.2uF 0402 (1005 Metric) 10V 20%	CAP CER 2.2UF 10V X5R 0402	Wurth Electronics Inc.	885012105013
8	5	CN1 CN2 CN3 CN4 CN12	691214110002 7.4X7 pitch 3.5	TERM BLK 2POS SIDE ENT 3.5MM PCB	Wurth Electronics Inc.	691214110002
9	1	CN5	10 ways, 1 row	CONN RCPT 10POS 0.1 GOLD PCB	SAMTEC 4UCON	ESQ-110-14-T-S 17896
10	2	CN6 CN9	8 ways, 1row	CONN RCPT 8POS 0.1 GOLD PCB	SAMTEC 4UCON	ESQ-108-14-T-S 15782
11	0	CN7 CN10		CONN RCPT 38POS 0.1 GOLD PCB (not mounted)	Samtec Inc.	SSQ-119-04-L-D
12	1	CN8	6 ways, 1 row	CONN RCPT 6POS 0.1 GOLD PCB	SAMTEC 4UCON	ESQ-106-04-T-S 15781
13	0	CN11	691214110003 10.5X7.4 pitch 3.5mm	TERM BLK 3POS SIDE ENT 3.5MM PCB (not mounted)	Wurth Electronics Inc.	691214110003
14	1	D1	STPS1H100A DO-214AC, SMA 1A	DIODE SCHOTTKY 100V 1A SMA	ST	STPS1H100A

15	0	D2	BAT48JFILM SC-76, SOD-323 750mV @ 200mA 350mA (DC)	DIODE SCHOTTKY 40V 350MA SOD323 (not ST mounted)	BAT48JFILM
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Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
16	8	D3 D4 D5 D6 D7 D8 D9 D10	LED GREEN 0603 (1608 Metric) 20mA	LED GREEN CLEAR 0603 SMD	Wurth Electronics Inc.	150060VS75000
17	2	D11 D16	RED LED 0603 (1608 Metric) 20mA	LED RED CLEAR 0603 SMD	Wurth Electronics Inc.	150060RS75000
18	0	D12	ESDA7P60- 1U1 M 2- UDFN	TVS DIODE 5VWM 11.6VCL 1610 (not mounted)	ST	ESDA7P60-1U1M
19	1	D13	SMBJ5.0A- TR DO- 214AA, SMB 600W	TVS DIODE 5V 13.4V SMB	ST	SMBJ5.0A-TR
20	1	D15	LED YELLOW 0603 (1608 Metric) 20mA	LED YELLOW CLEAR 0603 SMD	Wurth Electronics Inc.	150060YS75000
21	1	J3	con6-2x3- strip- male	CONN HEADER .100 DUAL STR 6POS	Wurth Electronics Inc.	61300621121
22	1	J4	con6-2x3- strip- male	CONN HEADER .100 DUAL STR 6POS	Wurth Electronics Inc.	61300621121
23	0	J5	JUMPER- CONN JUMPER- con2- strip-male	JUMPER- CONN HEADER .100 STR 2POS (not mounted)	Wurth Electronics Inc.	61300211121
24	2	J6 J7	con8-2x4- strip- male	CONN HEADER VERT 8POS 2.54MM	Wurth Electronics Inc.	61300821121
25	2	J9 J10	JUMPER- CONN JUMPER- con2- strip-male	JUMPER- CONN HEADER .100 STR 2POS	Wurth Electronics Inc.	61300211121
26	2	J12 J13	con4-2x2- strip- male	CONN HEADER .100 DUAL STR 4POS	Wurth Electronics Inc.	61300421121

27	5	R1 R8 R9 R10 R11	390 0402 (1005 Metric) 0.1W, 1/10W 5%	CHIP RESISTOR SMD 5% 1/10W 0402	Panasonic	ERJH2GJ391X
28	2	R2 R3	0 0402 (1005 Metric) 0.1W, 1/10W 0%	CHIP RESISTOR SMD 0% 1/10W 0402	Panasonic	ERJH2G0R00X
29	2	R14 R20	22k 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 22K OHM 1% 1/10W 0603	Yageo	RC0603FR- 0722KL
30	1	R17	390 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 390 OHM 1% 1/10W 0603	Yageo	RC0603FR- 07390RL
31	2	R15 R121	1k 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 1K OHM 1% 1/10W 0603	Yageo	RC0603FR-071KL

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
32	8		15k 0603	RES SMD		
		R18 R19	(1608	15K OHM		
		R25 R26		1% 1/10W		
		R27 R28	Metric) 0.1W,		Yageo	RC0603FR-
		R29 R30	1/10W 1%	0603		0715KL
33	0					
		R101 R102		RES SMD		
		R109 R111	100 0603	100		
		R112 R113	(1608			
		R114 R115		OHM 1%		
34	7					
		R103 R104	100 0603	100		
		R105 R106	(1608			
		R107 R108	Metric) 0.1W,	1/10W	Yageo	RC0603FR-
		R119	1/10W 1%	0603		07100RP
35	1					
			5001 0.100"			
			Dia			
			x 0.180" L	TEST POINT PC	Keystone Electronics	5001
			(2.54mm x 4.57mm)	MINI .040"D BLACK		
36	1					
				Galvanic isolated octal high side smart power solid state relay with SPI interface	ST	ISO808ATR-1
			ISO808ATR-1			
			PowerSO-36			
37	1					
			SM15T39CA	TVS DIODE		
			DO-214AB,			
			SMC 1500W	33.3V 69.7V SMC	ST	SM15T39CA
			(1.5kW)			
38	16					
			2.54mm	Close Jumper	Würth Electronics Inc.	60900213421
				TVS DIODE		
39	0					
			ESDA15P60-	13.2V 22.7V		
			1U 1M 2-		ST	ESDA15P60-
			UDFN	1610		1U1M

Board versions

Table 4. X-NUCLEO-OUT14A1 versions

PCB version	Schematic diagrams	Bill of materials
X\$NUCLEO-OUT14A1 (1)	X\$NUCLEO-OUT14A1 schematic diagrams	X\$NUCLEO-OUT14A1 bill of materials

This code identifies the X-NUCLEO-OUT14A1 evaluation board first version. It is printed on the board PCB.

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
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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).

References

Freely available on www.st.com:

- ISO808A-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 5. Document revision history

Date	Revision	Changes
12-Dec-2022	1	Initial release.

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References

- [STMicroelectronics: Our technology starts with you](#)
- [ISO808A-1 - Galvanic isolated octal high-side power solid state relay with SPI interface for high inductive loads - STMicroelectronics](#)
- [STMicroelectronics Trademark List - STMicroelectronics](#)
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- [NUCLEO-G431RB - STM32 Nucleo-64 development board with STM32G431RB MCU, supports Arduino and ST morpho connectivity - STMicroelectronics](#)
- [BAT48 - 40 V, 350 mA Axial General purpose Signal Schottky Diode - STMicroelectronics](#)
- [ESDA15P60-1U1M - High-power transient voltage suppressor \(TVS\) - STMicroelectronics](#)
- [ESDA7P60-1U1M - High-power transient voltage suppressor \(TVS\) - STMicroelectronics](#)
- [ISO808A-1 - Galvanic isolated octal high-side power solid state relay with SPI interface for high inductive loads - STMicroelectronics](#)
- [NUCLEO-F401RE - STM32 Nucleo-64 development board with STM32F401RE MCU, supports Arduino and ST morpho connectivity - STMicroelectronics](#)
- [NUCLEO-G431RB - STM32 Nucleo-64 development board with STM32G431RB MCU, supports Arduino and ST morpho connectivity - STMicroelectronics](#)
- [SM15T39CA - 1500 W, 33.3 V TVS in SMC - STMicroelectronics](#)
- [SMBJ5.0A - 600 W, 5 V TVS in SMB - STMicroelectronics](#)
- [STPS1H100 - 100 V, 1 A Power Schottky Rectifier - STMicroelectronics](#)
- [STSW-LINK004 - STM32 ST-LINK utility \(replaced by STM32CubeProgrammer\) - STMicroelectronics](#)
- [X-CUBE-IPS - Software expansion for STM32Cube driving industrial digital output based on IPS - STMicroelectronics](#)
- [X-NUCLEO-OUT14A1 - Industrial digital output expansion board based on ISO808A-1 for STM32 Nucleo - STMicroelectronics](#)
- [STM32CubeProg - STM32CubeProgrammer software for all STM32 - STMicroelectronics](#)
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