Getting started with the dual channel IO-Link device expansion board for STM32 Nucleo

Introduction

The X-NUCLEO-IOD02A1 expansion board for STM32 Nucleo is based on the L6364 dual channel SIO and IO-Link PHY device transceiver embedding 50 mA 3.3 V and 5.0 V voltage regulators, DC-DC converter and M-sequence management.

The expansion board provides an affordable and easy-to-use solution for the development of SIO and IO-Link industrial sensor applications, letting you easily evaluate the L6364 communication features and robustness.

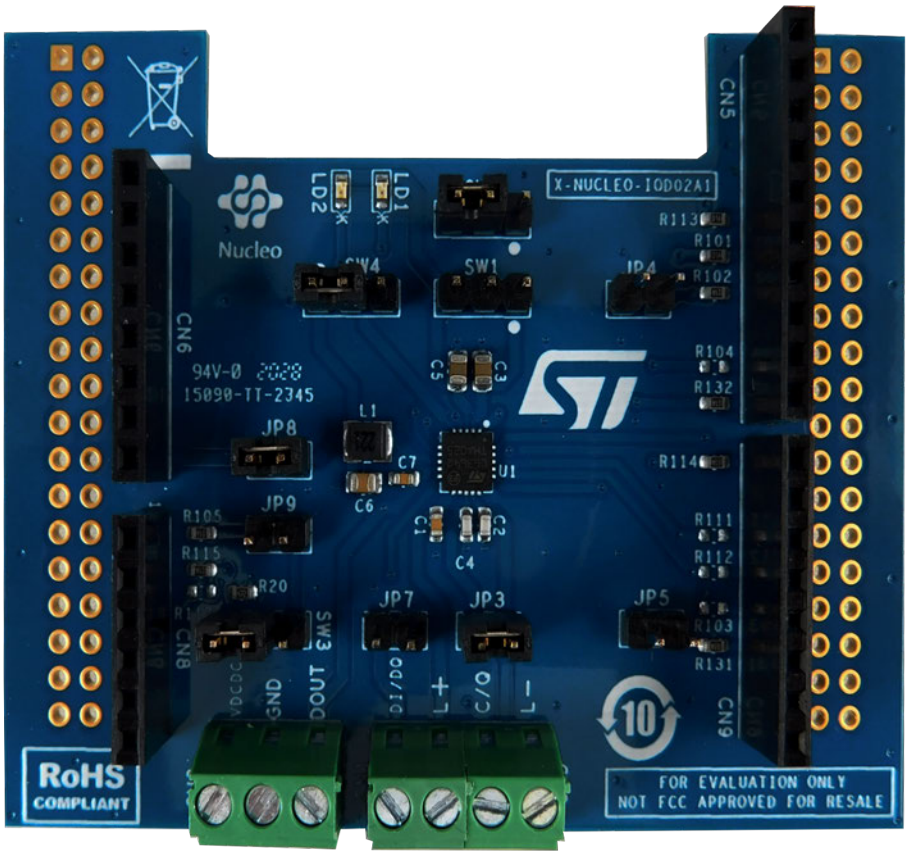
The X-NUCLEO-IOD02A1 communicates with the STM32 controller via SPI and GPIO pins and it is compatible with the Arduino UNO R3 (default configuration) and ST morpho (optional, not mounted) connectors (when connected to a NUCLEO-L073RZ or NUCLEO-G071RB development board).

Communication via IO-Link can be performed in either Multi-byte and Single-byte modes with SPI control of IC configuration and bidirectional sensor data transmission, or in Transparent mode with SPI control of IC configuration and UART interfacing for bidirectional sensor data transmission.

The switches on the X-NUCLEO-IOD02A1 conveniently allow you to configure L6364 and expansion board settings such as transmission mode and DC-DC converter enable/disable according to application requirements.

You can also perform evaluation of comprehensive industrial sensor modules by connecting the X-NUCLEO-IOD02A1 to the X-NUCLEO-IKS02A1 sensor shield.

Figure 1. X-NUCLEO-IOD02A1 expansion board



1 Getting started

1.1 Overview

The X-NUCLEO-IOD02A1 SIO and IO-Link device board, embedding the L6364 intelligent dual channel IO-Link transceiver, is designed to meet the electrical and communication protocol requirements with the IO-Link master.

The expansion board main features are:

- Based on the L6364 IO-Link device dual transceiver in QFN package with the following main characteristics:
  - 2-channel (CQ and DIO) IO-Link PHY layer
  - IO-Link DLL (M-sequence handler and checksum)
  - Wake-up detection
  - Interrupt diagnostic pin
  - SPI and UART interfaces
  - 50 mA 3.3 V and 5.0 V linear regulators
  - 50 mA adjustable (5.0 ÷ 10.8 V) buck converter
  - Overload protection with adjustable intervention threshold
  - Overheating protection with adjustable shutdown threshold
  - Full reverse polarity on process side
  - Ground and V_{CC} wire break protections
  - QFN-20L (4 x 4 x 0.9 mm) package
- 5 to 35 V operating voltage range
- Red LED and green LED for status diagnostics
- Radiated Emissions (EM Fields 30 MHz-1 GHz) < 40dB µV/m
- Immunity to conducted disturbance (150 kHz-80 MHz) ≤ 10 V
- Immunity to RF EM Fields (80 MHz-1 GHz) ≤ 10 V/m
- Immunity to RF EM Fields (1 GHz-2.7 GHz) ≤ 3 V/m
- Immunity to SURGE pulse (500 Ohm coupling) ≤ ± 1.2 kV
- Immunity to ESD contact/air ≤ ±3 kV
- Immunity to BURST noise ≤ ±1 kV
- Compatible with STM32 Nucleo development boards
- Equipped with Arduino UNO R3 connectors
- RoHS and WEEE compliant

Important:
The L6364 is designed for full compliance with EMC immunity levels required by IEC 61131-9 (and IEC 60947-5-2 for surge pulse). The X-NUCLEO-IOD02A1 expansion board, however, is intended for development purposes and the long net paths along the Arduino connectors may impact ESD and Burst immunity levels.

1.1.1 Digital section

The digital section consists of the STM32 interface and the digital supply voltages to and from the STM32 Nucleo development board and the X-NUCLEO-IOD02A1 expansion board via four Arduino UNO R3 connectors.

The on-board L1 inductor and C6 capacitor enable the step-down converter (active by default through SW4 by closing 1-2) embedded in the L6364. The converter also supplies the two L6364 internal LDOs to reduce power dissipation, whose output voltage can supply the STM32 Nucleo development board via the V_{in} net through JP8 (closed) and CN6.

To supply your development board through an L6364 LDO:

- set JP5 to E5V for the NUCLEO-L073RZ development board
- close JP2 between pins 2-3 instead of 1-2 for the NUCLEO-G071RB development board

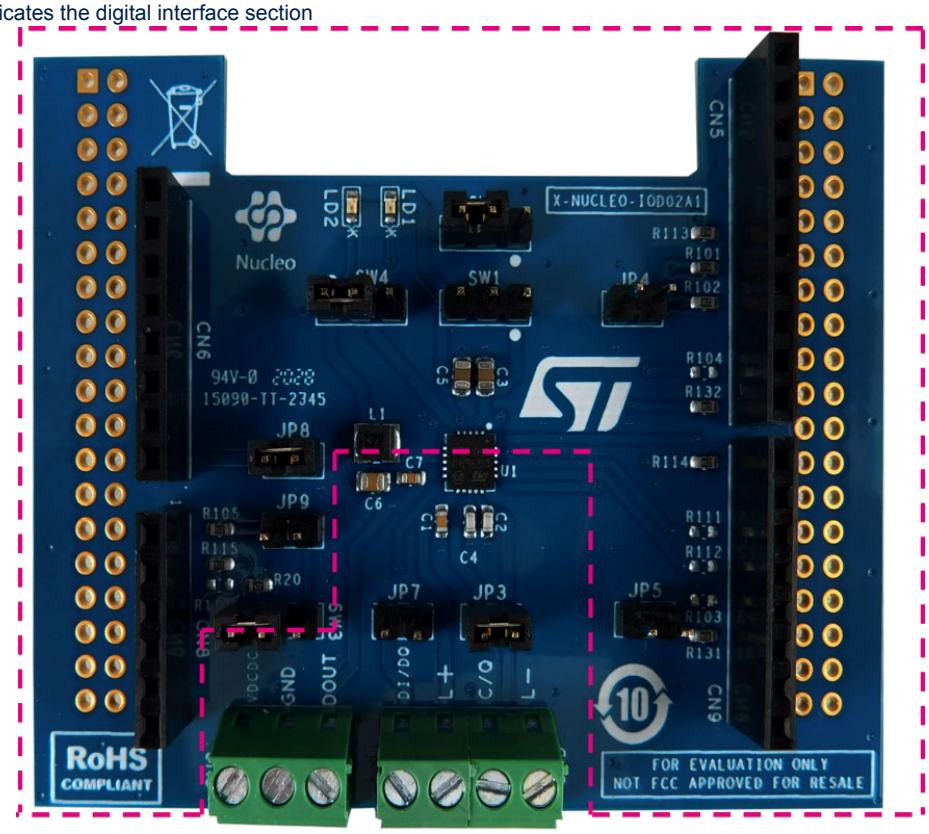
The digital signal levels are set by the MCU on the STM32 Nucleo development board, so the L6364 VDIG pin is connected by SW2 to the proper voltage rail (3.3 V or 5.0 V from CN6).

To alternatively supply the STM32 Nucleo development boards independently via USB:

- close JP5 to U5V on NUCLEO-L073RZ development board
- close JP2 pins 1-2 on NUCLEO-G071RB and ensure J8 is left open

Figure 2. X-NUCLEO-IOD02A1 expansion board

dotted line indicates the digital interface section



The four Arduino UNO R3 connectors also allow the expansion board to communicate with the STM32 Nucleo development board via the following STM32 peripheral and GPIO resources:

- SPI (CN5, CN8): control interface allowing communication between the MCU (SPI master) and the L6364 (SPI slave) to configure the internal L6364 register or read the status registers. In Single-Byte and Multi-Byte Communication Modes, the SPI is also used for the data transfer to and from the sensor.
- INT (CN9): interrupt line driven by the L6364 to alert the MCU of a new event. The MCU reads the status register of the L6364 via the SPI interface to determine which event occurred.
- UART TX (CN5), UART RX (CN9): interface for sensor data transfer via CQ line used by the MCU in Transparent Communication Mode. When this mode is selected, JP4 and JP5 jumpers must be closed.
- CTLD (CN8): the L6364 provides the DIO as a secondary digital input/output pin. In DIO Mode, this pin can be controlled by SPI (similar to CQ) or in direct mode by CTLD pin (J9 must be closed).

1.1.2 Power section

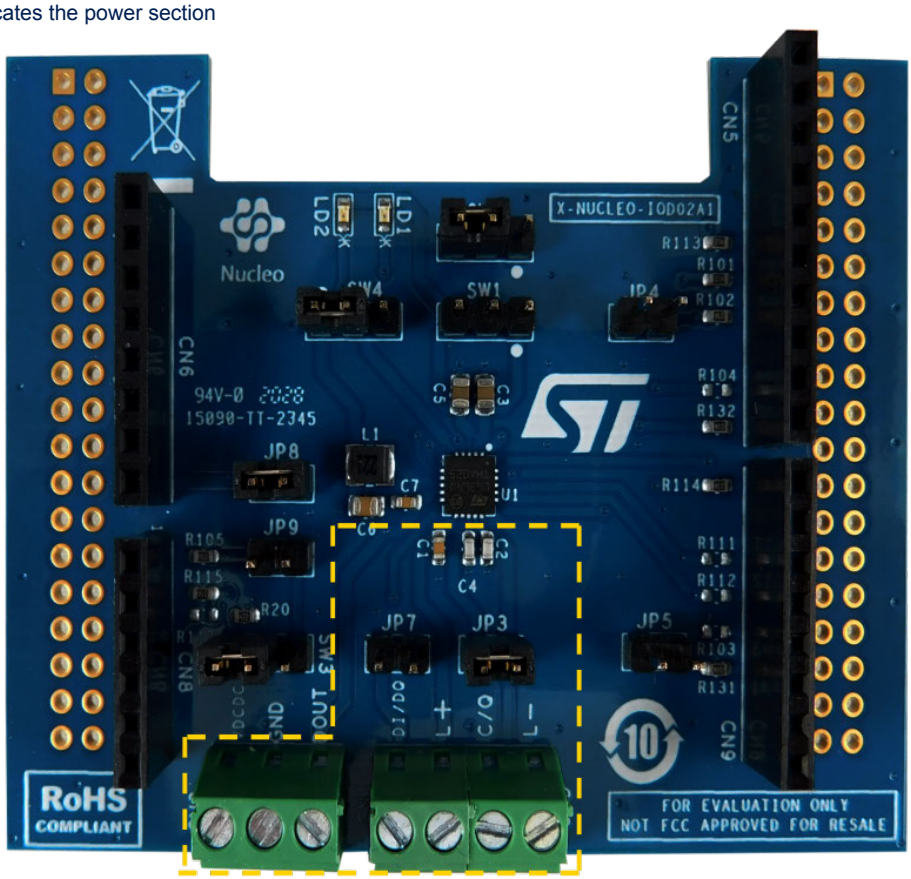
The power section (CN1, CN2, CN3) includes the power supply voltage (L+, L-), the transmission lines (CQ, DIO), the output voltage of the step-down converter (VDCDC) and the additional supply rail (DOUT), which is protected against reverse polarity by the diode embedded in the L6364.

CN1 and CN2 are usually connected to the corresponding pins of an IO-Link Master (e.g. P-NUCLEO-IOM01M1) that controls communication and supplies the X-NUCLEO-IOD02A1 via the L+ rail. The CQ line is used to exchanged data between IO-Link Master and IO-Link Device. The DIO line is the additional digital channel typically used in the port class A (type A). L- is the electrical ground reference between the two systems.

CN3 is an additional connector allowing further connections, such as for actuators.

Figure 3. **X-NUCLEO-IOD02A1 expansion board**

Dotted line indicates the power section

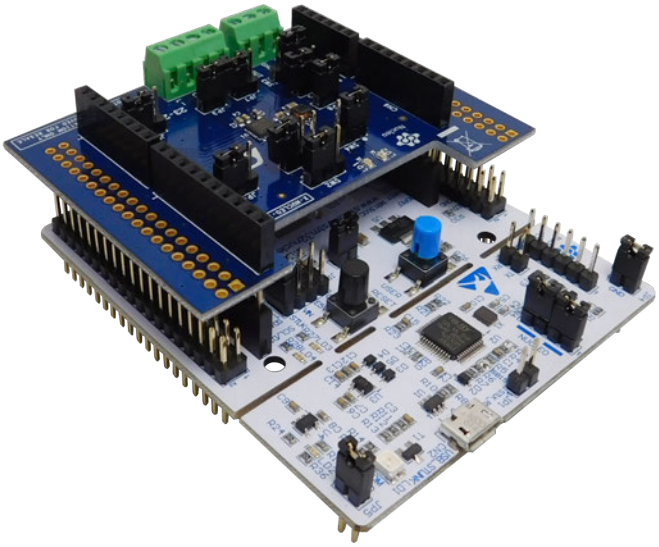


1.2 Hardware requirements

The X-NUCLEO-IOD02A1 expansion board is designed to be used with the NUCLEO-L073RZ or NUCLEO-G071RB STM32 Nucleo development boards.

To function correctly, the X-NUCLEO-IOD02A1 must be plugged onto the matching Arduino UNO R3 connector pins on the STM32 Nucleo board as shown below.

Figure 4. **X-NUCLEO-IOD02A1 and STM32 Nucleo stack**



1.3 System requirements

To use the STM32 Nucleo development boards with the X-NUCLEO-IOD02A1 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-L073RZ development board
- a type A to micro-B USB cable to connect the STM32 Nucleo board to the PC when using a NUCLEO-G071RB development board
- the X-CUBE-IOD02 firmware and software package installed on your PC/laptop
- an IO-Link Master (e.g. P-NUCLEO-IOM01M1) with the related control tool (e.g. IO-Link Control Tool when using the P-NUCLEO-IOM01M1)

1.4 Board setup

Step 1. Check the configuration of JP5 (on NUCLEO-L073RZ) and set it to “U5V”, or check the configuration of JP2 (on NUCLEO-G071RB) and close between pins 1-2.

Step 2. Connect the mini-USB (for NUCLEO-L073RZ) or micro-USB (for NUCLEO-G071RB) to your PC and the STM32 Nucleo development board.

Step 3. Download the selected firmware onto the microcontroller.

You can use the tools available in your IDE, STM32 LINK Utility or STM32CubeProgrammer and you can select among different firmware packages (.bin or .hex) according to the MCU (STM32L0x or STM32G0x), the communication speed (COM2 or COM3) and communication mode (Single-Byte, Multi-Byte and Transparent). In Single-Byte and Multi-Byte communication modes, JP4 and JP5 remain open. In Transparent communication mode, JP4 and JP5 must be closed.

Step 4. Disconnect the USB cable from the STM32 Nucleo development board and close JP5 to “E5V” (on NUCLEO-L073RZ), or set JP2 from 1-2 to 3-4 (on NUCLEO-G071RB).

In this setup, the STM32 Nucleo development board is supplied by the X-NUCLEO-IOD02A1 and the step-down converter is active (for SW4 close pins 1-2) to supply Vin (JP8 closed). VDIG must be referred to 3.3 V rail supplied by the STM32 Nucleo development board (SW1 open, for SW2 close pins 1-2).

Step 5. Connect the X-NUCLEO-IOD02A1 to the STM32 Nucleo development board through the Arduino connectors.

Step 6. Connect the X-NUCLEO-IOD02A1 power section (CN1, CN2) to the IO-Link master according to the schematic and serigraphy (see Section 1.1.2 Power section).

Step 7. Open the control tool of your IO-Link master and upload the IODD XML file (included in the X-CUBE-IOD02 software package).

You can select between the two IODD files according to the communication speed (COM2 or COM3) of the firmware downloaded on the STM32 Nucleo development board.

Step 8. Activate your IO-Link Master (usually requires a connection to a 24 V supply rail).

The IO-Link master control tool lets you supply the X-NUCLEO-IOD02A1 L+ line and launch a wake-up request to initiate communication.

Step 9. Set to the IO-Link port of the Master as digital input and then press the STM32 Nucleo development board blue button to drive the CQ line status to 24 V/0 V.

2 Schematic diagrams

Figure 5. X-NUCLEO-IOD02A1 circuit schematic (1 of 2)

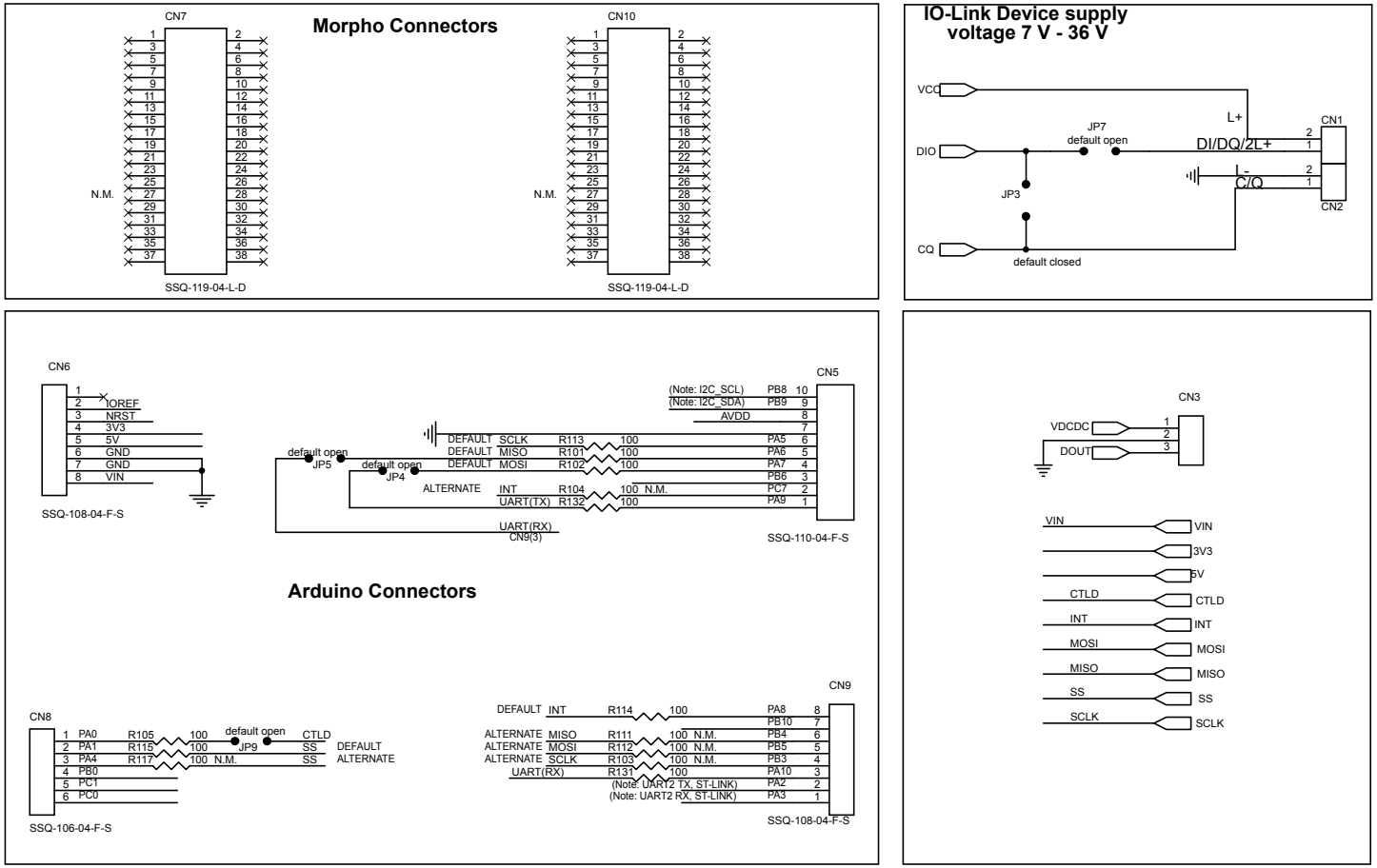
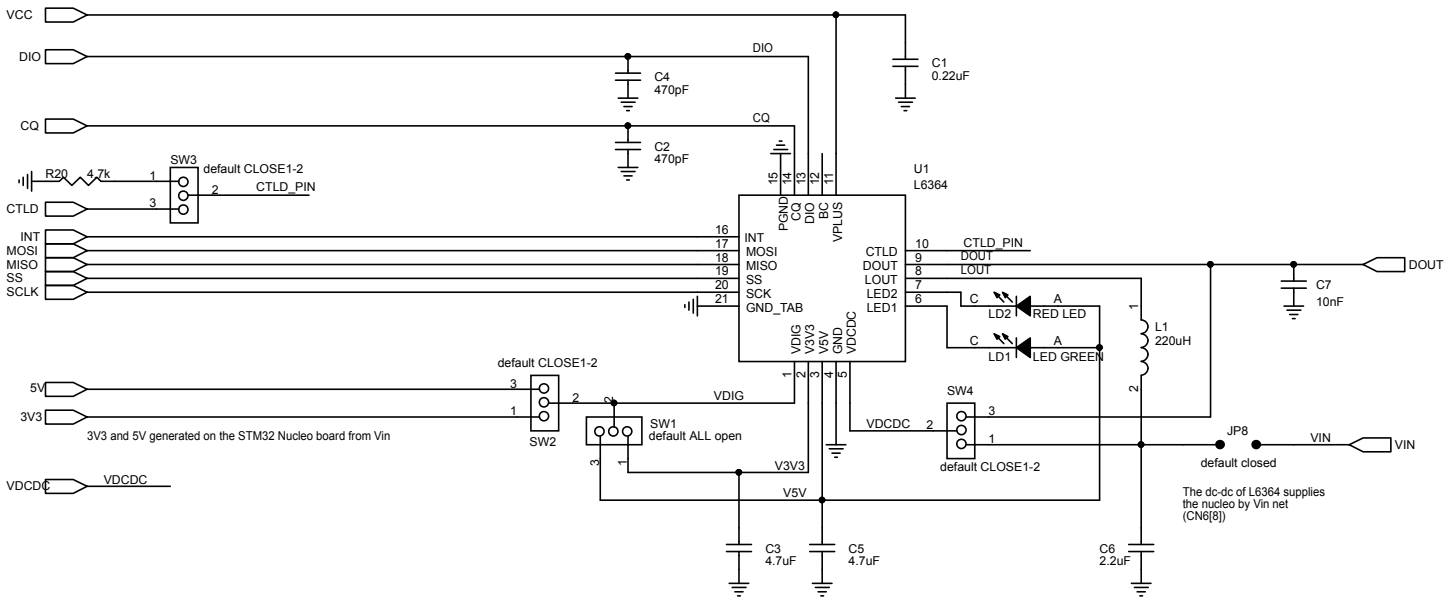


Figure 6. X-NUCLEO-IOD02A1 circuit schematic (2 of 2)



3 Bill of materials

Table 1. **X-NUCLEO-IOD02A1 bill of materials**

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	C1	0.22 µF 50 V ±10% X7R 0603	Ceramic capacitor	TDK Corporation	CGA3E3X7R1H224K080AD
2	2	C2 C4	470 pF 50 V ±5% C0G/NP0 0603	Ceramic capacitor	Wurth Electronics Inc.	885012006061
3	2	C3 C5	4.7 µF 10 V ±20% X7R SMD 0805	Ceramic capacitor	Any	
4	1	C6	2.2 µF 25 V ±10% X7R 0805	Ceramic capacitor	Würth Elektronik	885012207079
5	1	C7	10 nF 50 V ±10% X7R 0603	Ceramic capacitor	Murata Electronics North America	GRM188R71H103KA01D
6	2	CN1 CN2	CON2 7.4X7 pitch 3.5 mm 2 pos.	Terminal block	Wurth Electronics Inc.	691214110002
7	1	CN3	CON3 10.5X7.4 pitch 3.5mm 3 pos.	Terminal block	Wurth Electronics Inc.	691214110003
8	1	CN5	SSQ-110-04-F-S 10 pos. 0.1 gold PCB	Connector	Samtec Inc.	SSQ-110-04-F-S
9	2	CN6 CN9	SSQ-108-04-F-S 8 pos. 0.1 gold PCB	Connector	Samtec Inc.	SSQ-108-04-F-S
10	0	CN7 CN10	SSQ-119-04-L-D 38 pos. 01. gold PCB	Connector (not mounted)	Samtec Inc.	SSQ-119-04-L-D
11	1	CN8	SSQ-106-04-F-S 6 pos. 0.1 gold PCB	Connector	Samtec Inc.	SSQ-106-04-F-S
12	10	J1 J2 J3 J4 J5 J6 J7 J8 J9 J10	Jumper_Female 100" gold	Jumper	Sullins Connector Solutions	QPC02SXGN-RC
13	2	JP3 JP8	JUMPER-con2-strip-male 2 pos.	Jumper	Any	
14	4	JP4 JP5 JP7 JP9	JUMPER-con2-strip-male 2 pos.	Jumper	Any	
15	1	L1	220 µH 75 mA 11.8 Ohm ±10%	Fixed inductor	Würth Elektronik	744032221
16	1	LD1	20 mA 0603 SMD	Green LED	Wurth Electronics Inc.	150060VS75000
17	1	LD2	20 mA 0603 SMD	Red LED	Wurth Electronics Inc.	150060RS75000
18	1	R20	4.7 k Ohm ±1% 1/10W 0603	Resistor	Yageo	RC0603FR-074K7L
19	8	R101 R102 R105 R113 R114 R115 R131 R132	100 Ohm ±1% 1/10W 0603	Resistors	Yageo	RC0603FR-07100RP
20	0	R103 R104 R111 R112 R117	100 Ohm ±1% 1/10W 0603	Resistors (not mounted)	Yageo	RC0603FR-07100RP
21	1	SW1	con3-strip-male 3 pos.	Connector header	Any	

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
22	3	SW2 SW3 SW4	con3-strip-male 3 pos.	Connector header	Any	
23	1	U1	20-QFN	IO-Link dual communication transceiver device IC	ST	L6364Q

Revision history

Table 2. **Document revision history**

Date	Revision	Changes
01-Sep-2020	1	Initial release.
05-Oct-2020	2	Updated Section 1.1.1 Digital section, Section 1.2 Hardware requirements, Section 1.3 System requirements and Section 1.4 Board setup.

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