Getting started with STEVAL-IOD003V1 IO-Link PHY device evaluation board compatible with STM32 Nucleo

Introduction

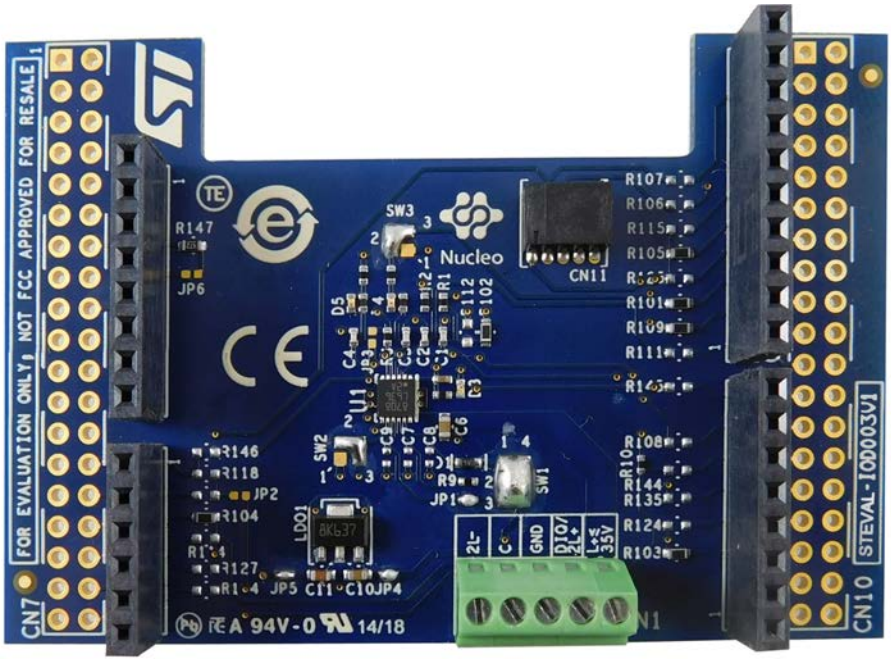
The STEVAL-IOD003V1 evaluation board is based on the L6362A IO-Link PHY device with full integrated EMC protection (according to IO-Link v1.1 specification) and surge protection (according to IEC 60947-5-2). It provides an affordable and easy-to-use solution for the development of IO-Link and SIO applications, letting you easily evaluate the communication features and robustness of the L6362A.

The on-board linear regulators (12 mA-3.3 V from L6362A and 100 mA-12 V from L78L12ABUTR) can be used to supply the micro-controller via the 24 V bus, instead of via USB.

When the L78L12ABUTR is enabled (default configuration), you can also perform evaluation of complete industrial sensor modules by connecting the STEVAL-IOD003V1 to a NUCLEO-L073RZ (or NUCLEO-L053R8) board and an X-NUCLEO-IKS01A2 expansion board.

The STEVAL-IOD003V1 interfaces with the STM32 controller via UART and GPIO pins and is compatible with the Arduino UNO R3 (default configuration) and ST morpho (optional, not mounted) connectors.

Figure 1. STEVAL-IOD003V1 evaluation board



1 Getting started

1.1 STEVAL-IOD003V1 expansion board overview

The STEVAL-IOD003V1 is equipped with the L6362A transceiver, featuring as IO-Link physical device, and the L78L12ABUTR featuring as voltage regulator to supply high current sensor applications (up to 100 mA).

The STEVAL-IOD003V1 expansion board features:

- L6362A IO-Link device transceiver main characteristics:
  - IO-Link PHY layer
  - Dedicated overload diagnostics pin
  - UART interface
  - Selectable 12 mA 3.3 V or 10 mA 5.0 V linear regulator
  - Overload and overheating protections with non-dissipative cut-off function
  - Full reverse polarity on IO-Link interface pins
  - EMC protections (as per IO-Link v1.1)
  - Surge protection (as per IEC 60947-5-2)
  - DFN-12L (3x3x0.9 mm) package
- 6.5 to 35 V operating voltage range
- On-board 100 mA 12 V linear regulator (L78L)
- LEDs for status and diagnostics
- Ground and V_{CC} wire break protections
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connectors
- RoHS and China RoHS compliant

1.2 Hardware requirements

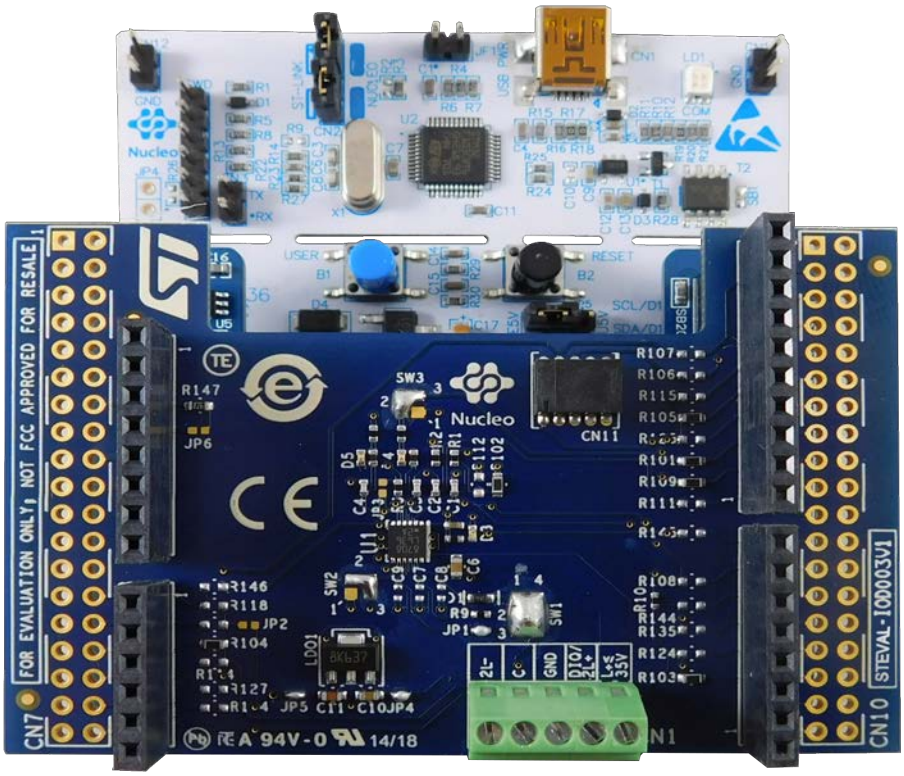
The STEVAL-IOD003V1 evaluation board is designed to be used standalone or with the following STM32 Nucleo boards (visit www.st.com for further information):

- NUCLEO-L073RZ
- NUCLEO-L053R8

The STEVAL-IOD003V1 is connected to the STM32 Nucleo board through the matching Arduino connectors.

The L6362A is supplied by a 24 V rail, either via power supply or through an IO-Link master (for example, P-NUCLEO-IOM01M1). For further details on the STEVAL-IOD003V1 supply architecture, refer to Section 3 Supply section.

Figure 2. **STEVAL-IOD003V1 plus STM32 Nucleo**



1.3 System requirements

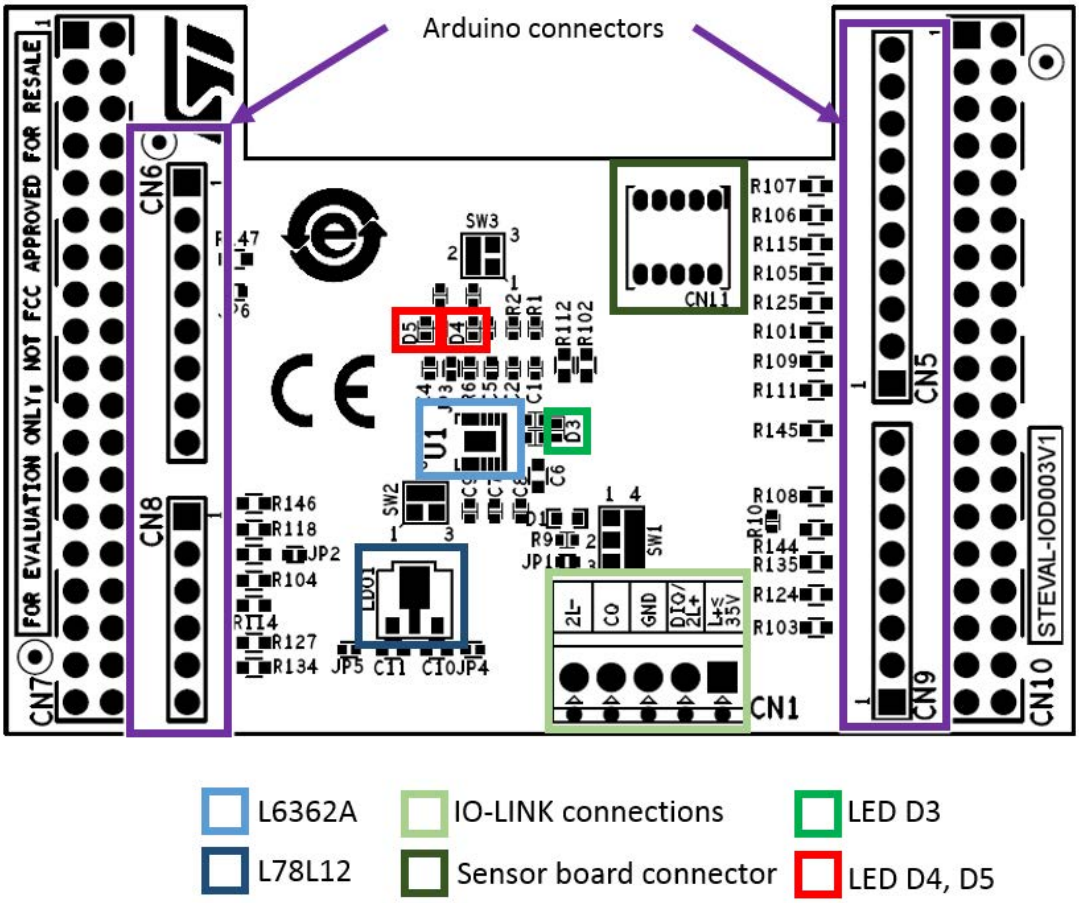
To run the system, you need:

- 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 STSW-IOD003 firmware and software package installed on the PC

2 Digital section

The STEVAL-IOD003V1 digital section is associated with the STM32 interface and digital signals controlling the L6362A.

Figure 3. STEVAL-IOD003V1 expansion board digital interface components



2.1 Arduino connectors

The four Arduino connectors (CN5, CN6, CN8 and CN9) allow the STEVAL-IOD003V1 evaluation board to communicate with the STM32 Nucleo board microcontroller and to access STM32 peripheral and GPIO resources (for further information on the digital supply voltage refer to Section 3 Supply section).

The tables below show the correspondence between the pins of the Arduino connectors used in the STEVAL-IOD003V1 and the micro controller signal.

Table 1. Digital signals on CN5

ST morpho connector	Pin	Signal	STM32L0 port	Drop jumper
CN5	10	I2C_SCL	PB8	R106 (N.M.)
	9	I2C_SDA	PB9	R107 (N.M.)
	8	AVDD	-	-
	7	GND	-	-
	6	OL	PA5	R115 (N.M.)
	5	OL	PA6	R105
	4	OL	PA7	R125 (N.M.)
	3	IN2	PB6	R101
	2	EN	PC7	R109
	1	IN2	PA9	R111 (N.M.)

Table 2. Digital signals on CN6

ST morpho connector	Pin	Signal	STM32L0 port	Drop jumper
CN6	1	Not Used	-	-
	2	Reserved	-	-
	3	NRST	-	JP6 (default = open)
	4	3v3	-	-
	5	5v0	-	-
	6	GND	-	-
	7	GND	-	-
	8	VIN	-	-

Table 3. Digital signals on CN8

ST morpho connector	Pin	Signal	STM32F4 port	Drop jumper
CN8	1	DI/DQ OL	PA0	R118 (N.M.) R146 (N.M.)
	2	DI/DQ	PA1	R126(N.M.)
	3	DIAG	PA4	R104
	4	DIAG	PB0	R114 (N.M.)
	5	I2C_SDA	PC1	R127 (N.M.)
	6	DIAG	PC0	R134 (N.M.)

Table 4. Digital signals on CN9

ST morpho connector	Pin	Signal	STM32F4 port	Drop jumper
CN9	8	OL	PA8	R145 (N.M.)
	7	INTERRUPT	PB10	R108 (N.M.)
	6	DIAG	PB4	R144 (N.M.)
	5	OL	PB5	R135 (N.M.)
	4	DIAG	PB3	R124 (N.M.)
	3	OUT I/Q	PA10	R103
	2	RESERVED	PA2	-
	1	RESERVED	PA3	-

The L6362A pin IN1 defines the polarity of the signal IN2; by default, IN1 is set to 3.3 V (by R102) and the VIN pin supplies the STM32 Nucleo board from the L78L12 (refer to L6362A datasheet on www.st.com for further details).

Table 5. L6362A digital signals

Signal	Functionality
EN	GPIO (out) controlling the L6362A (U1) EN pin
IN2	UART (TX) controlling L6362A output stage (C/Q line on CN1 pin 4)
OUT I/Q	UART (RX) controlling L6362A OUTI/Q pin.
OL	GPIO (external event) controlling L6362A OL pin
DIAG	GPIO (external event) controlling the L6362A DIAG pin. It can be used to implement by software the wake-up sequence detection
DI/DQ	Not used
Additional pins for external sensors on CN11	
INTERRUPT	GPIO (external event) controlling L6362A (U1) IRQ pin(1)
I2C_SCL	I²C clock signal
I2C_SDA	I²C data signal

1. *This connector is compatible with the sensor boards included in the STEVAL-IDP003V1 evaluation kit.*

2.2 LEDs

The STEVAL-IOD003V1 mounts three LEDs for the board status (refer to L6362A datasheet on www.st.com for further details).

Table 6. LEDs functionality

LED	Color	Function
D3	Green	Turns on when the STEVAL-IOD003V1 is supplied by the L+ line.
D4	Red	Turns on when one of the following events is triggered by the L6362A: UVLO (L+ < V_{UVOFF}), OVT (L6362A T_J> T_{JSD}) and CUT-OFF (overload event longer than t_{dOUT}).
D5	Red	Turns on when an overload event (I_{OUT} > I_{OHS}) longer than blanking time (t_{OL}) has been triggered by the L6362A.

2.3 SW1, SW2 and SW3 drop switches

The STEVAL-IOD003V1 mounts three solder bridge switches for easy and quick setting of the board.

Table 7. SW1, SW2 and SW3 functionality

Switch	Configuration	Function	Notes
SW1	CLOSE 1-4 (default)	CQ connected to L6362A OUTH pin	All position closed implement the IO-Link configuration
	CLOSE 2-4 (default)	CQ connected to L6362A OUTI/Q pin	
	CLOSE 3-4 (default)	CQ connected to L6362A OUTL pin	
SW2	CLOSE 1-2	L6362A configured to work with 5.0 V digital signals	
	CLOSE 2-3 (default)	L6362A configured to work with 3.3 V digital signals	MCU on STM32 Nucleo boards are usually supplied by 3.3 V
SW3	CLOSE 1-2	L6362A EN pin, always active	
	CLOSE 2-3 (default)	L6362A EN pin driven by the microcontroller	

2.4 JP1, JP2, JP3, JP4, JP5 and JP6 drop jumpers

The STEVAL-IOD003V1 mounts six solder bridges for easy and quick setting of the board.

Table 8. Jumper functionality

Jumper	Configuration	Function
JP1	CLOSE (default)	L6362A OUTL connected to SW1
	OPEN	This footprint can be used to host a blocking diode equivalent to D1, for NPN loads
JP2	CLOSE	Not used
	OPEN (default)	DI/DQ signal is not used for this application board
JP3	CLOSE	The V_{DD} supplied by the voltage regulator integrated in the L6362A is shorted to the 3v3 rail of the board. Before closing JP3, you must check that JP4 and JP5 are open.
	OPEN (default)	The L6362A V_{DD} supplies only the LED D3
JP4	CLOSE (default)	The LDO1 input pin (L78L12) is connected to L+
	OPEN	LDO1 disconnected from L+
JP5	CLOSE (default)	The LDO1 output pin (L78L12) is connected to the STM32 Nucleo board V_{IN} (see Section 4 Protections)
	OPEN	LDO1 disconnected from V_{IN}
JP6	CLOSE	Connects the microcontroller RST signal to the 3.3 V through a 4.7 kohm resistor
	OPEN (default)	Pull-up of RST signal managed by the STM32 Nucleo

2.5 CN11 interface

The CN11 has been designed to be compatible with the small sensor boards sold together with the STEVAL-IDP003V1 (for the sensor board list, refer to the STEVAL-IDP003V1 data brief on www.st.com): it offers the supply rail (3.3 V and GND), the I²C interface and an interrupt signal.

Table 9. **CN11 pin correspondence**

Pin	Signal
1, 2	GND
3, 4	3.3 V
5, 6	I2C_SCL
7, 8	I2C_SDA
9, 10	INTERRUPT

3 Supply section

The STEVAL-IOD003V1 can be plugged below an STM32 Nucleo development board which is supplied via a USB source connected to its mini-USB connector CN1 (JP5 closed on U5V position).

Alternatively, it is possible to supply the STM32 Nucleo board V_{IN} from the STEVAL-IOD003V1, by closing jumper JP5 on position E5V (close pins 2 and 3) on the STM32 Nucleo board and choosing one of the options below:

- Option 1 (V_{IN} supplied by LDO1)
  - Leave J3 open and close J4 and J5
  - Supply the STEVAL-IOD003V1 via CN1 (6.5 V ≤ L+ ≤ 35 V)
- Option 2 (V_{IN} supplied by the L6362A voltage regulator)
  - Open J4 and J5 and close J3
  - Supply the STEVAL-IOD003V1 via CN1 (6.5 V ≤ L+ ≤ 35 V)

Note: The LDO1 current capability is up to 100 mA, while the L6362A current capability is up to 12 mA (SW2 closed between pins 2-3). These alternative supply solutions are useful to evaluate the system as an IO-Link sensor node: in fact, in this application case, the node is supplied by the L+ rail provided by the IO-Link master.

3.1 CN1 connector description

The connector CN1 allows supplying the STEVAL-IOD003V1 and establishing a wired communication via CQ line with a remote control system.

The acceptable supply voltage between CN1 pin 1 (L+) and 3 (GND) is ≤ 35 V.

By default, in the STEVAL-IOD003V1, the CN1 pin 4 is connected to the L6362A output stage configured in IO-Link mode (pins OUTH, OUTL and I/Q connected together).

In the IO-Link applications, the CN1 pin 4 is connected to an IO-Link master CQ line.

Table 10. CN1 description

Pin	Signal
1	IO-Link L+ supply rail from remote master, acceptable voltage ≤ 35 V
2	Not used
3	GND
4	IO-Link CQ line
5	Not used

4 Protections

The protection section involves the reverse polarity and electromagnetic compatibility (EMC) protections.

When the LDO1 is disconnected (J4 and J5 open), the application board is fully protected against reverse polarity and EMC by the L6362A which embeds a smart reverse polarity protection against the wrong connections of L+, GND and CQ (any combination) to supply rail and ground.

The L6362A is also fully protected against the ESD and burst noise levels according to the IO-Link specification (V1.1.2) and against the impulse voltage withstand test (surge pulse) according to the IEC-60947-5-2.

5 Powering and initializing the evaluation board

To use the STEVAL-IOD003V1 and the related firmware STSW-IOD003:

Step 1. Connect the STEVAL-IOD003V1 to a NUCLEO-L073RZ (or NUCLEO-L053R8) through the Arduino connectors.

Step 2. Open JP3, JP4 and JP5 on the STEVAL-IOD003V1.

Step 3. Connect the micro-USB cable between your laptop/PC and the STM32 Nucleo board (J5 in position U5V as shown in Section 4 Protections).

Step 4. Download the firmware STSW-IOD003 in the microcontroller (for example, via STM32 ST-LINK utility).

Step 5. Connect the STEVAL-IOD003V1 to a 24 V power supply via CN1 pins 1 (+24 V) and 3 (GND).

Step 6. Connect the load (or probes) between pin 4 (CQ) and GND.

Now you can control the system by the dedicated GUI (STSW-IOLINKGUI).

Note: The STSW-IOD003 can be freely downloaded from www.st.com and it is the user reference code to control the L6362A. For a complete IO-Link device solution (physical layer, stack and sensors), refer to P-NUCLEO-IOD01A1.

6 STEVAL-IOD003V1 schematic diagrams

Figure 4. STEVAL-IOD003V1 circuit schematic (1 of 4)

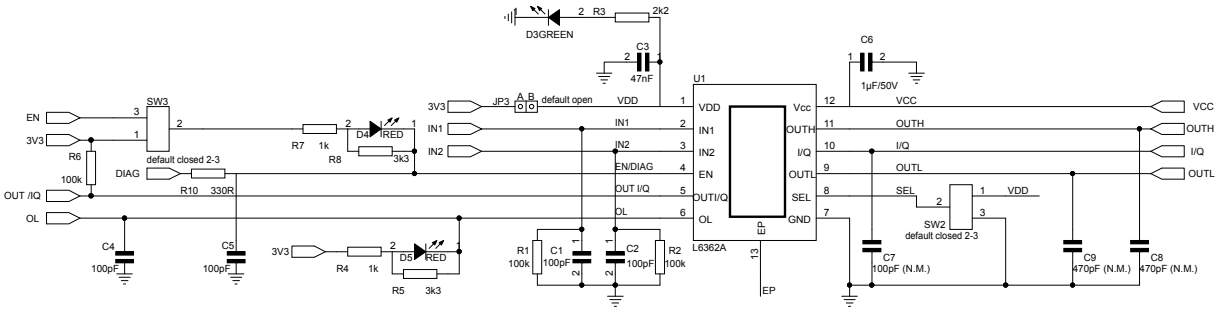


Figure 5. STEVAL-IOD003V1 circuit schematic (2 of 4): Arduino connectors

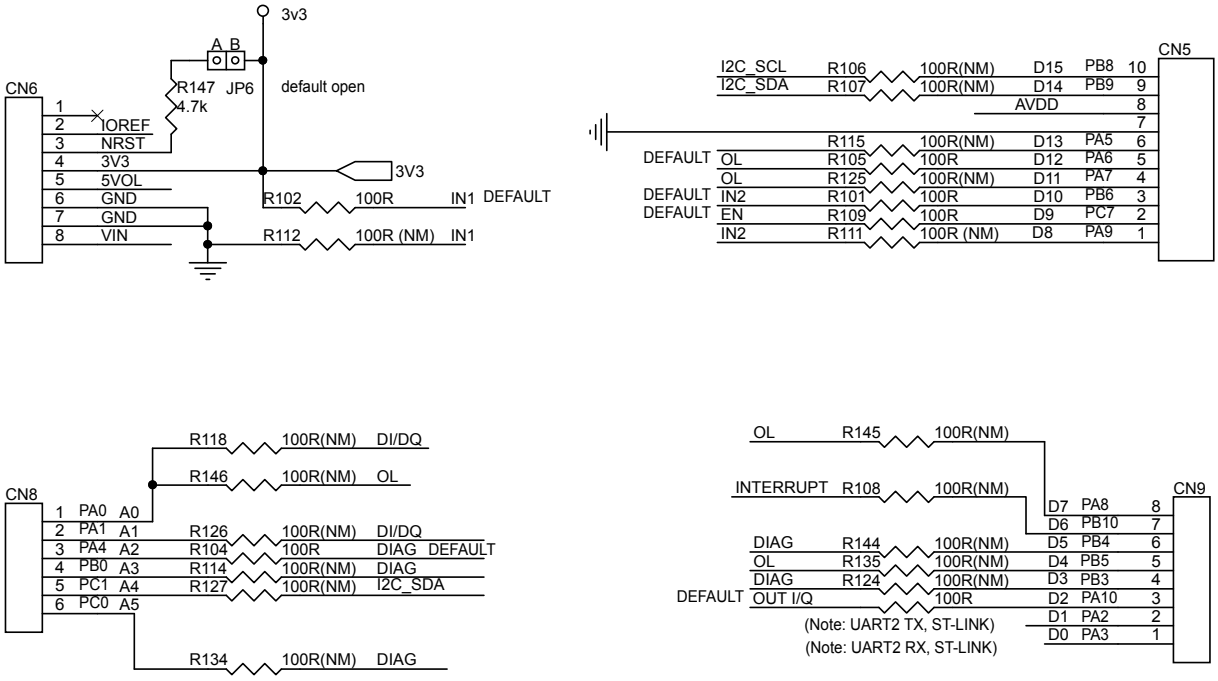


Figure 6. STEVAL-IOD003V1 circuit schematic (3 of 4): ST morpho connectors

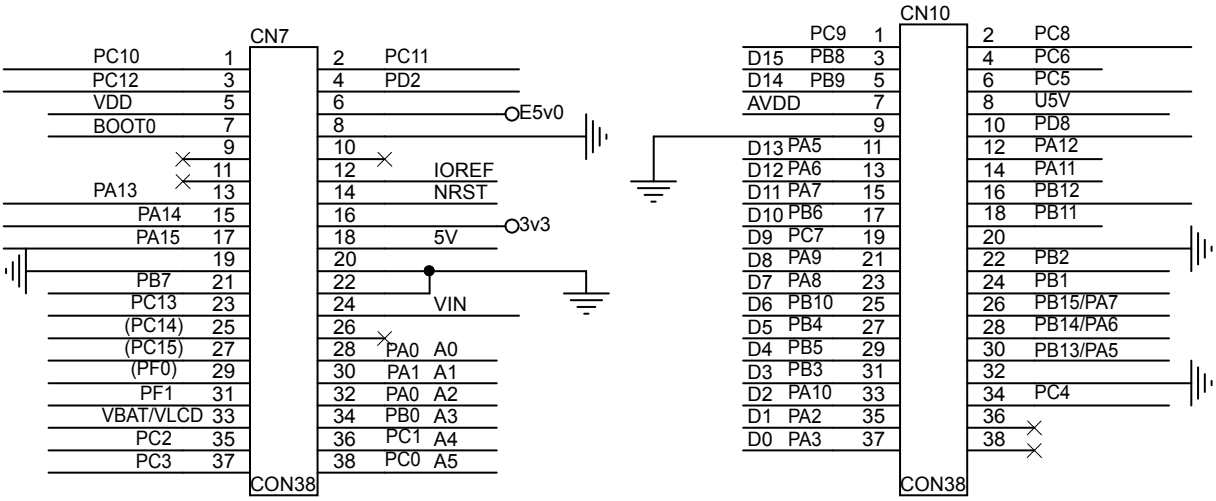
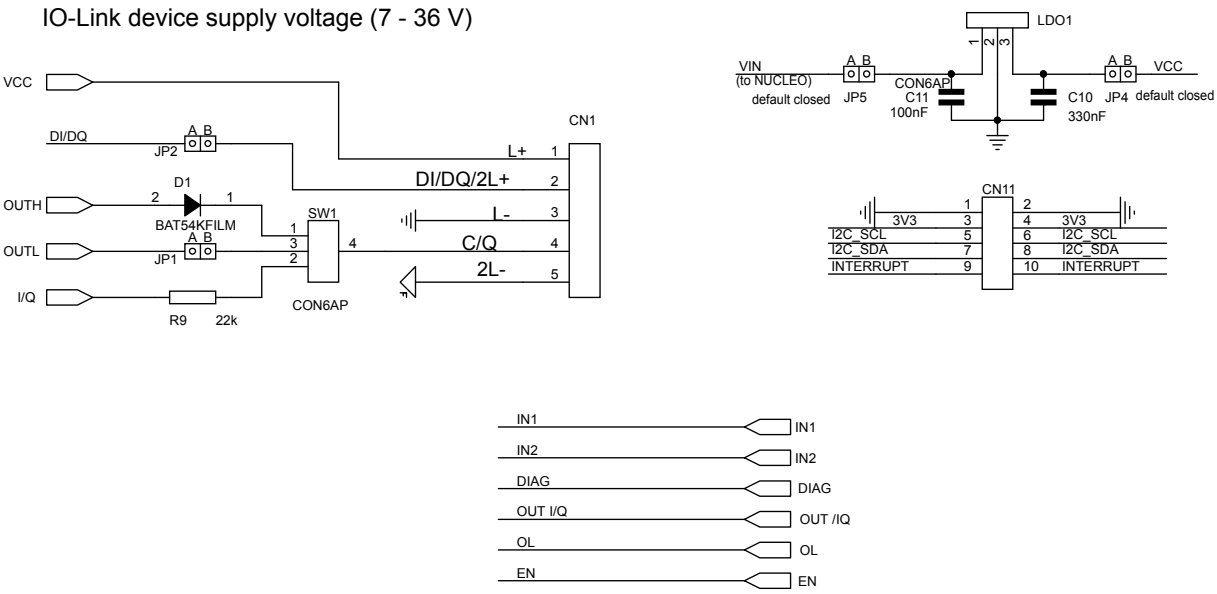


Figure 7. STEVAL-IOD003V1 circuit schematic (4 of 4): supply voltage



7 Bill of materials

Table 11. **STEVAL-IOD003V1 bill of materials**

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	U1	L6362A DFN12L (3x3x10.9mm)	IO-Link communication transceiver device IC	ST	L6362ATR
2	1	C6	1 µF 50 V ±10% 0603 X7R	Capacitor	Taiyo Yuden	UMK107AB7105KA-T
3	4	C1, C2, C4, C5	100 pF 25 V 0402 X7R	Capacitors	Wurth Elektronik	885012205038
4	0	C7	100 pF 50 V 0402 X7R	Capacitor (not mounted)	Wurth Elektronik	885012205055
5	0	C8, C9	470 pF 50 V 0402 X7R	Capacitors (not mounted)	TDK	C1005X7R1H471K
6	1	C3	47 nF 16 V 0402 X7R	Capacitor	TDK	C1005X7R1C473K
7	3	R1, R2, R6	100 kΩ 63 mW 0402	Resistors	Kamaya	RGC1/16SC104DTH
8	1	R3	2.2 kΩ 63 mW 0402	Capacitor	Vishay	CRCW04022K20JNED
9	1	D3	Green LED 0402	AlGaInP	Lite-On	LTST-C281KGKT
10	2	R4, R7	1 kΩ 63 mW 0402	Resistors	TE Connectivity	CRG0402J1K0/10
11	2	R5, R8	3.3 kΩ 63 mW 0402	Resistors	Rohm	MCR01MZPF3301
12	1	D4, D5	Red LED 0402	AlGaInP	Lite-On	LTST-C281KRKT
13	1	R9	22 kΩ 100 mW 0402	Resistor	Kamaya	RMC1/16SK223FTH
14	1	R10	330 Ω 63 mW 0402	Resistor	Vishay	CRCW0402330RFKED
15	1	CN1	5 ways, 1 row (connection to IO-Link master) TH 2.54 mm	Connector	RS-Pro	MB312-25405NIP
16	1	D1	SOD523	Small signal Schottky diode	ST	BAT54KFILM
17	6	JP1, JP2, JP3, JP4, JP5, JP6	402	Drop jumpers	Any	Any
22	1	SW1	JP4SO	Switch	Any	Any
23	2	SW2, SW3	SW2: VDD selector (3v3 or 5v0) SW3: ENABLE selector (3v3 or GPIO) JPSO3	Switches	Any	Any
24	6	R101, R102, R103, R104, R105, R109	100 Ω 0.1 W ±0.5% 0603	Resistors	Panasonic	ERJ3BD1000V

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
25	0	R106, R107, R108, R111, R112, R114, R115, R118, R124, R125, R126, R127, R134, R135, R144, R145, R146	603	Resistors (D.N.M.)	Any	Any
26	1	CN5	10 ways, 1 row TH 2.54 mm	Connector	Samtec	SSQ-110-04-F-S
27	2	CN6, CN9	8 ways, 1row TH 2.54 mm	Connectors	Samtec	SSQ-108-04-F-S
28	0	CN7, CN10	TH 2.54 mm	Connectors (D.N.M.)	Samtec	SSQ-119-04-L-D
29	1	CN8	6 ways, 1 row TH 2.54 mm	Connector	Samtec	SSQ-106-04-F-S
30	1	CN11	10 ways, 2 rows TH 1.27 mm	Connector	Harwin	M50-3200545
31	1	LDO1	L78L12ABUTR SOT-89	0.1 A positive voltage regulators	ST	L78L12ABUTR
32	1	C10	100 nF 25 V ±10% 0603	Capacitor	Wurth Elektronik	885012206071
33	1	C11	330 nF 50 V ±10% 0603	Capacitor	TDK	C1608X5R1H334K080AB
34	1	R147	4.7 kΩ 0.1 W ±1% 0603	Resistor	Rohm	MCR03EZPFX4701

A References

The following resources are freely available on www.st.com:

- L6362A datasheet
- STEVAL-IOD003V1 data brief
- STSW-IOD003 data brief and user manual
- STSW-IOLINKGUI
- P-NUCLEO-IOD01A1 quick start guide and data brief
- STEVAL-IDP003V1 data brief
- P-NUCLEO-IOM01M1 data brief

Revision history

Table 12. **Document revision history**

Date	Revision	Changes
05-Jun-2018	1	Initial release.

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