

Getting started with the IO-Link PHY master evaluation board with STM32 Nucleo compatibility

Introduction

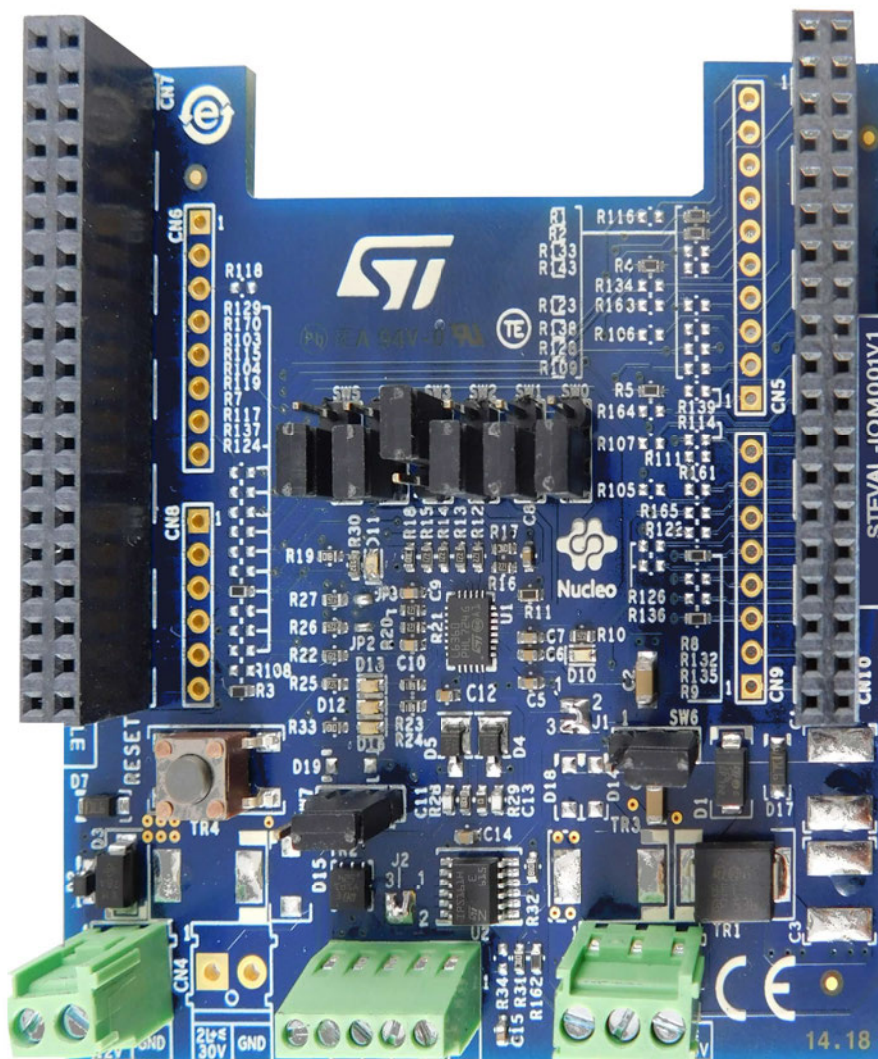
The STEVAL-IOM001V1 industrial IO-Link physical master evaluation board is based on the [L6360](#) transceiver and is designed to comply with applicable industrial EMC standards.

It provides an affordable and easy-to-use development platform for single-port to quad-port IO-Link master applications. By default, the STEVAL-IOM001V1 is configured as IO-Link Port 1.

The evaluation board can be connected to an STM32 Nucleo development board like the [NUCLEO-F446RE](#) or [NUCLEO-F401RE](#) via its ST morpho connectors.

You can obtain the board individually or as part of the [P-NUCLEO-IOM01M1](#) development system, which includes a STEVAL-IOM001V1 evaluation board and a NUCLEO-F446RE development board flashed with IO-Link stack (v1.1).

Figure 1. STEVAL-IOM001V1 IO-Link physical master evaluation board

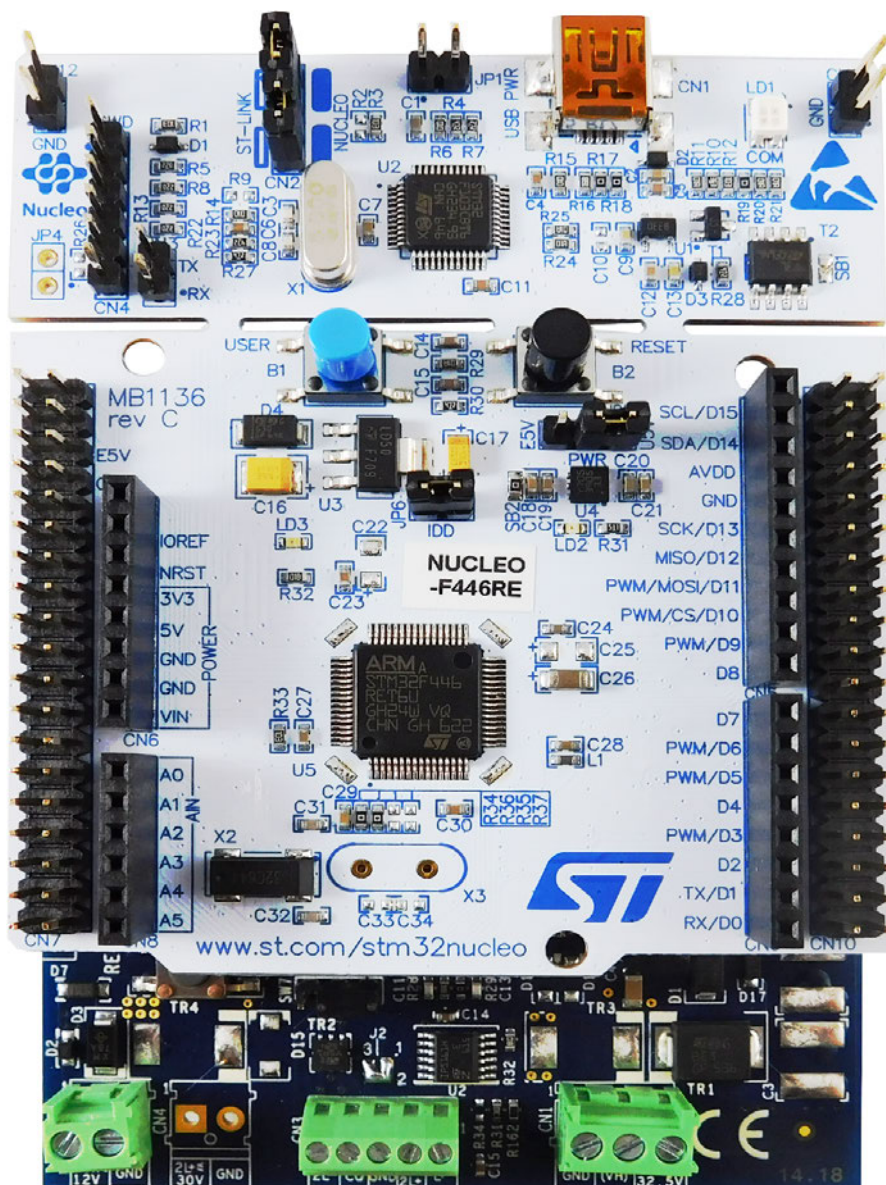


1 Hardware and software requirements

The STEVAL-IOM001V1 is designed to be connected to one of the following STM32 Nucleo boards:

- NUCLEO-F446RE
- NUCLEO-F401RE

Figure 2. STEVAL-IOM001V1 plus STM32 Nucleo board



To complete the system, you need the following items:

- 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-IOM001](#) firmware and software package installed on the user PC
- a 24 V power supply

2 STEVAL-IOM001V1 evaluation board overview

The IO-Link PHY master evaluation board is equipped with the [L6360](#) transceiver featuring the IO-Link physical master and an [IPS161H](#) single high-side switch with extended diagnostic features (for safety integrity level SIL2- and SIL3-compliant systems) to supply an external high capacitance IO-Link load on the L+ rail.

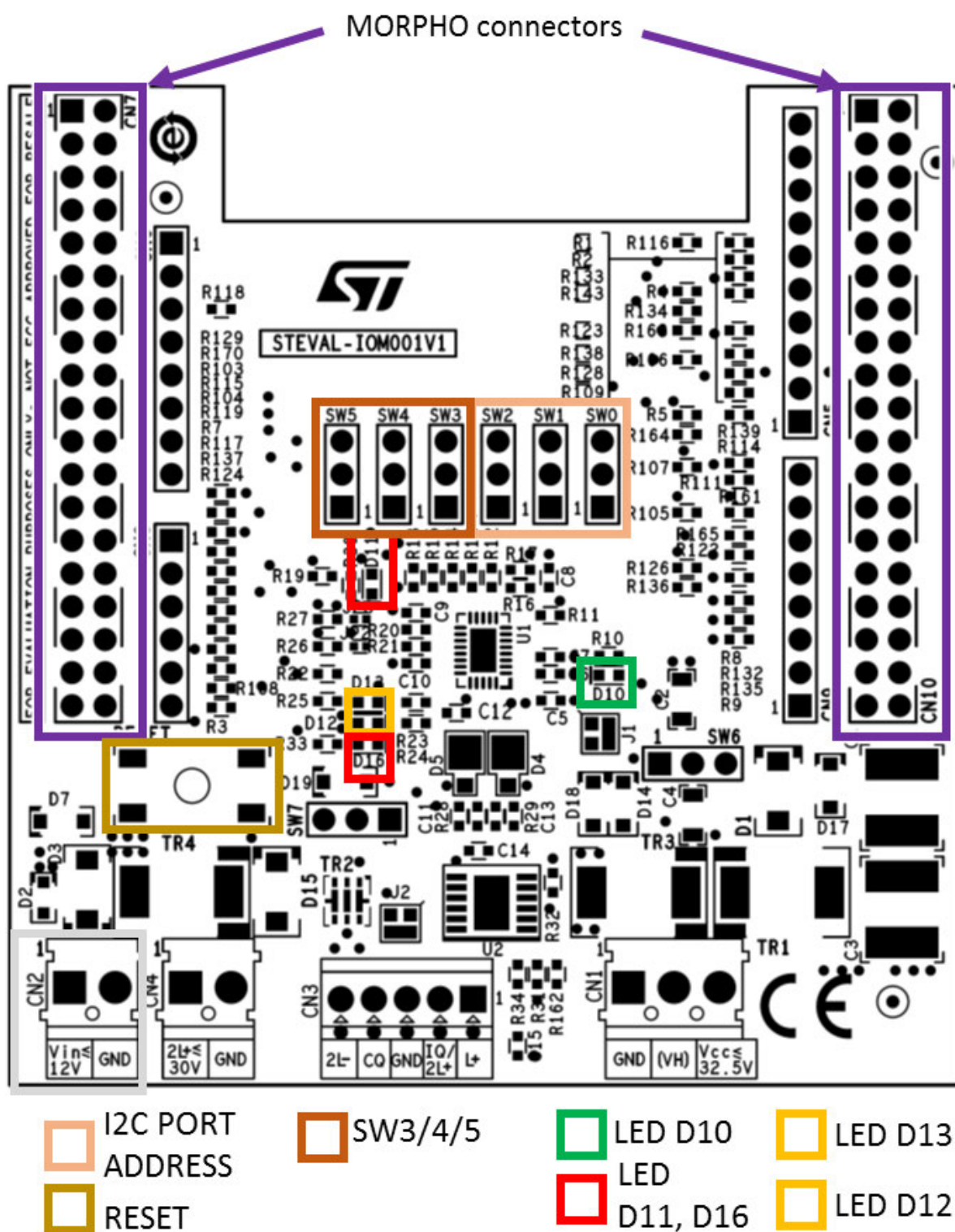
2.1 Features

- IO-Link master PHY based on L6360
- Interrupt diagnostics pin
- I²C and UART interface
- SPI (slave) interface
- 65 mA selectable (3.3 or 5.0 V) linear regulator
- CQ (push-pull) and L+ (high side) switches
- IQ additional IEC61131-2 type 1 digital input
- L+ and CQ overload and overheating protections with non-dissipative cut-off function
- QFN-26L (3.5x5x1 mm) package
- Operating voltage range from 18 to 32.5 V
- Additional high side switch for L+ heavy loads ([IPS161H](#))
- LEDs for status and diagnostics
- Ground and V_{CC} wire break protections
- EMC compliance with IEC61000-4-2, IEC61000-4-3, IEC61000-4-5
- Equipped with ST morpho connectors
- CE certified
- RoHS and China RoHS compliant

2.2 Digital section

The digital section is associated with the STM32 interface and the signals to control the [L6360](#) IO-Link transceiver and [IPS161H](#) high side switch.

Figure 3. STEVAL-IOM001V1 expansion board digital interface components



2.2.1 ST morpho connectors

The STEVAL-IOM001V1 communicates with the STM32 Nucleo board microcontroller and accesses the STM32 peripheral and GPIO resources through ST morpho connectors CN7 and CN10. These connectors also transfer digital supply voltages between the STM32 Nucleo development board and the STEVAL-IOM001V1 expansion board.

The following tables map the correspondence between the ST morpho connectors and microcontroller signals.

Table 1. Digital signals on CN7

Connector pin	Signal	STM32F4 port	Drop jumper	Notes
8, 19, 20, 22	GND	-	-	-
24	VIN	-	-	-
21	OUTCQ	PB7	R129	Not mounted
	OL-OFF		R170	
28	ENCQ	PA0	R103	Not mounted
	INCQ		R115	Not mounted
30	ENL+	PA1	R104	Not mounted
	OUTCQ		R119	Not mounted
32	IRQ	PA4	R7	Mounted
34	IRQ	PB0	R117	Not mounted
35	ENL+	PC2	R124	Not mounted
36	RST	PC1	R108	Not mounted
37	IRQ	PC3	R137	Not mounted
38	ENCQ	PC0	R3	Mounted

Table 2. Digital signals on CN10

Connector pin	Signal	STM32F4 port	Drop jumper	Notes
1	OUTIQ	PC9	R116	Not mounted
2	ENCQ	PC8	R133	Not mounted
3	SCL	PB8	R1	Mounted
4	INCQ	PC6	R134	Not mounted
5	SDA	PB9	R2	Mounted
6	OUTCQ	PC5	R139	Not mounted
9, 20, 32	GND	-	-	-
11	ENCQ	PA5	R143	Not mounted
13	ENL+	PA6	R4	Mounted
15	L+_ON	PA7	R163	Not mounted
17	OUTIQ	PB6	R106	Not mounted
19	OUTCQ	PC7	R109	Not mounted
21	INCQ	PA9	R5	Mounted
22	L+ ON	PB2	R164	Not mounted
23	SCL	PA8	R111	Not mounted
	ENL+		R114	

Connector pin	Signal	STM32F4 port	Drop jumper	Notes
24	IRQ	PB1	R107	Not mounted
25	SCL	PB10	R161	Not mounted
	INCQ		R105	
26	L+ ON	PB15	R165	Not mounted
27	L+_ON	PB4	R162	Mounted
	SDA		R122	Not mounted
28	OUTIQ	PB14	R126	Not mounted
29	RST	PB5	R8	Mounted
30	OUTIQ	PB13	R136	Not mounted
31	SDA	PB3	R132	Not mounted
33	OUTCQ	PA10	R9	Mounted
34	ENL+	PC4	R135	Not mounted

The table below describes the functionality of each signal:

Table 3. Description of digital signals

Signal	Functionality
ENL+	GPIO (out) controlling the ENL+ pin of L6360 (U1)
ENCQ	GPIO (out) controlling the ENCQ pin of L6360 (U1)
INCQ	UART (TX) controlling INCQ pin of L6360 (U1)
OUTCQ	UART (RX) controlling OUTCQ pin of L6360 (U1)
SCL	Serial clock line controlling I2C SCL pin of L6360 (U1)
SDA	Serial data line controlling I2C SDA pin of L6360 (U1)
RST	GPIO (out) controlling the RST pin of L6360 (U1)
IRQ	GPIO (externa event) controlling the IRQ pin of L6360 (U1)
OUTIQ ⁽¹⁾	Not used by default, it can be configured on a UART (RX) to control the OUTIQ pin of L6360 (U1)
L+_ON	GPIO (out) controlling the IN pin of IPS161H (U2)
OL-OFF	GPIO (input) controlling the DIAG pin of IPS161H (U2)

1. Optional.

RELATED LINKS

[2.3 IO-Link port configuration on page 8](#)

2.2.2

I2C Port address

The switches SW0, SW1 and SW2 on the STEVAL-IOM001V1 evaluation board are used to configure the I2C address pins of the **L6360** (SA0, SA1, SA2) mounted on the board. By default, the I2C address is set to 0x00:

- pins 1-2 of SW0/1/2 closed: SA0 = SA1 = SA2 = GND

When multiple STEVAL-IOM001V1 evaluation boards are stacked, each board must be set with a different I2C address. You must set the I2C address in the I2C commands correctly for the SAx configuration of the L6360 to be controlled.

Table 4. I2C address setting

SW2	SW1	SW0	I2C Address
0	0	0	0x00 (default)
0	0	1	0x01
0	1	0	0x02
0	1	1	0x03
1	0	0	0x04
1	0	1	0x05
1	1	0	0x06
1	1	1	0x07

RELATED LINKS

[2.3 IO-Link port configuration on page 8](#)

2.2.3

Reset button

The STEVAL-IOM001V1 evaluation board has a push button reset to force a reset of the internal status and registers of the L6360.

RELATED LINKS

[L6360 datasheet for RST pin details](#)

2.2.4

LEDs

The following table summarizes the main functions of the status indication LEDs on the STEVAL-IOM001V1 evaluation board.

Table 5. LED functionality

LED	Color	Function
D10	GREEN	Turns on when the voltage regulator integrated in the L6360 (pin VDD) is active.
D11	RED	Turns on when the L6360 forces the IRQ pin low.
D12	YELLOW	Turns on/off according to the settings in the LED1 and LED2 registers of the L6360 IC.
D13	YELLOW	
D16	RED	Turns on when the DIAG pin of the IPS161H is activated (open load or fault events).

2.2.5

SW3, SW4 and SW5 digital switches

The STEVAL-IOM001V1 evaluation board includes three additional 3-way switches for quick and easy evaluation.

Table 6. SW3, SW4 and SW5 functionality

Switch	Configuration	Function
SW3	CLOSE 1-2	VDD pin of L6360 supplies 5.0V
	CLOSE 2-3 (default)	VDD pin of L6360 supplies 3.3V
SW4	CLOSE 1-2 (default)	ENCQ pin of L6360 (U1) controlled by ENCQ signal.
	CLOSE 2-3	ENCQ pin of L6360 (U1) connected to VDD.

Switch	Configuration	Function
SW5	CLOSE 1-2 (default)	ENL+ pin of L6360 (U1) controlled by ENL+ signal.
	CLOSE 2-3	ENL+ pin of L6360 (U1) connected to VDD.

RELATED LINKS

[2.3 IO-Link port configuration on page 8](#)

2.3 IO-Link port configuration

You can stack as many as four STEVAL-IOM001V1 evaluation boards to create up to a quad-port IO-Link master; the additional ports (from 2 to 4) must be configured according to the following table to avoid conflicts between I2C addresses and driving signals.

Table 7. IO-Link port configuration

SIGNAL	SOLDER BRIDGE TO UNMOUNT	IO-Link PORT-2 (I2C address: see Table 4)		IO-Link PORT-3 (I2C address: see Table 4)		IO-Link PORT-4 (I2C address: see Table 4)	
		SOLDER BRIDGE TO MOUNT	CN[pin]	SOLDER BRIDGE TO MOUNT	CN[pin]	SOLDER BRIDGE TO MOUNT	CN[pin]
ENCQ	R3	R143	CN5[6]	R123	CN10[12]	R133	CN10[2]
INCQ	R5	R115	CN8[1]	R105	CN9[7]	R134	CN10[4]
OUTCQ	R9	R119	CN8[2]	R139	CN10[6]	R109	CN5[2]
ENL+	R4	R114	CN9[8]	R124	CN7[35]	R135	CN10[34]
RST	R8	R108	CN8[5]	R128	CN10[16]	R138	CN10[14]
OUTIQ	R106 (1)	R116 (1)	CN10[1]	R126 (1)	CN10[30]	R136 (1)	CN10[28]
IRQ	R7	R117	CN8[4]	R107	CN10[24]	R137	CN7[37]
L+ON	R162	R163	CN5[4]	R164	CN10[22]	R165	CN10[26]

1. Modification is only required if OUTIQ is used.

RELATED LINKS

[2.2.1 ST morpho connectors on page 5](#)

[2.2.2 I2C Port address on page 6](#)

[2.2.5 SW3, SW4 and SW5 digital switches on page 7](#)

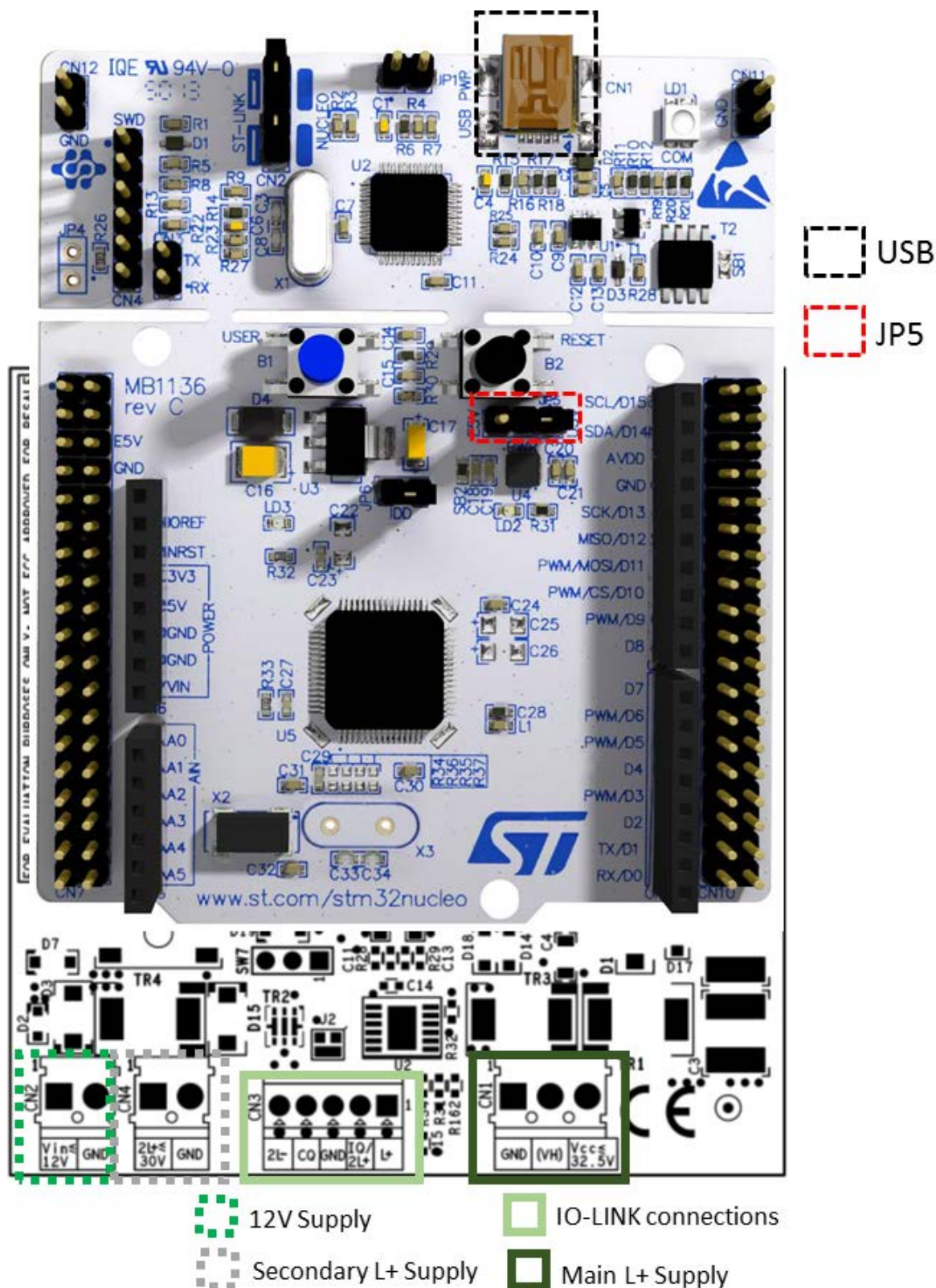
2.4 Supply section

The power to run the STEVAL-IOM001V1 evaluation board plus STM32 Nucleo development board can either be supplied through the mini-USB connector CN1 on the STM32 Nucleo (set JP5 on the U5V position) or through the STEVAL-IOM001V1 evaluation board.

To power the system through the evaluation board:

- On the STM32 Nucleo development board: close jumper JP5 on position E5V (close pins 2 and 3)
- On the STEVAL-IOM001V1 expansion board: connect a 7 V to 12 V supply at screw connector CN2.

Figure 4. Alternative power input sections for the STEVAL-IOM001V1 plus STM32 Nucleo



The VH pin on the L6360 can be supplied up to 32.5 V in the following ways:

1. Default, via the CN1 pin (SW6, pins 2-3 closed):
 - This is the same voltage rail that supplies the L6360 IO-Link transceiver and the IPS161H high side switch are supplied through CN1.
2. An alternative power supply (SW6, pins 1-2):

Connector CN3 can be used to connect the STEVAL-IOM001V1 to a remote IO-Link device according to the IO-Link specifications for port class A/type A and class B/Type B.

The board can supply the remote device through the L+ line, which can be controlled by the L+ switch in the L6360 (ENL+ signal) IC or through the IPS161H (L+_ON signal). The CQ line of CN3 is directly connected to pins CQ_O and CQ_I on the L6360 device.

By default (Type A, SW7 close 1-2), the DI/DQ line of the IO-Link cable is connected to the additional digital input IQ on the L6360.

Alternatively (Type B, SW7 close 2-3), pin 2 of CN3 can supply the second L+ rail (typically used for actuators). For Type B connections, CN4 is use to connect the power supply for 2nd L+ and 2nd ground.

Table 8. CN1, CN2, CN3, CN4 details

CONNECTOR	PIN	SIGNAL
CN1	1	GND
	2	Default (SW6 close2-3): connected to pin 3 of CN1. Alternate (SW6 close1-2): separated supply for VH pin of L6360
	3	Supply ($\leq 32.5V$) for L6360 and IPS161H
CN2	1	Alternative supply (between 7 and 12V) for STM32 Nucleo board
	2	GND
CN3	1	IO-Link L+ supply rail for remote device.
	2	Default (Type A, SW7 close 1-2): IO-Link DI/DQ line. Alternate (Type B SW7 close 2-3): IO-Link 2nd L+ supply rail.
	3	GND
	4	IO-Link CQ line.
	5	2nd ground (reference of 2nd L+ supply rail), Type B only.
CN4	1	Input pin for 2nd L+ power supply.
	2	Input pin for 2nd ground.

2.5 Protection features

The protection section implements reverse polarity protection and Electromagnetic compatibility (EMC) noise protection according to the industrial standards IEC61000-4-2 (ESD), IEC61000-4-4 (Burst) and IEC61000-4-5 (Surge).

Figure 5. STEVAL-IOM001V1 expansion board power section components

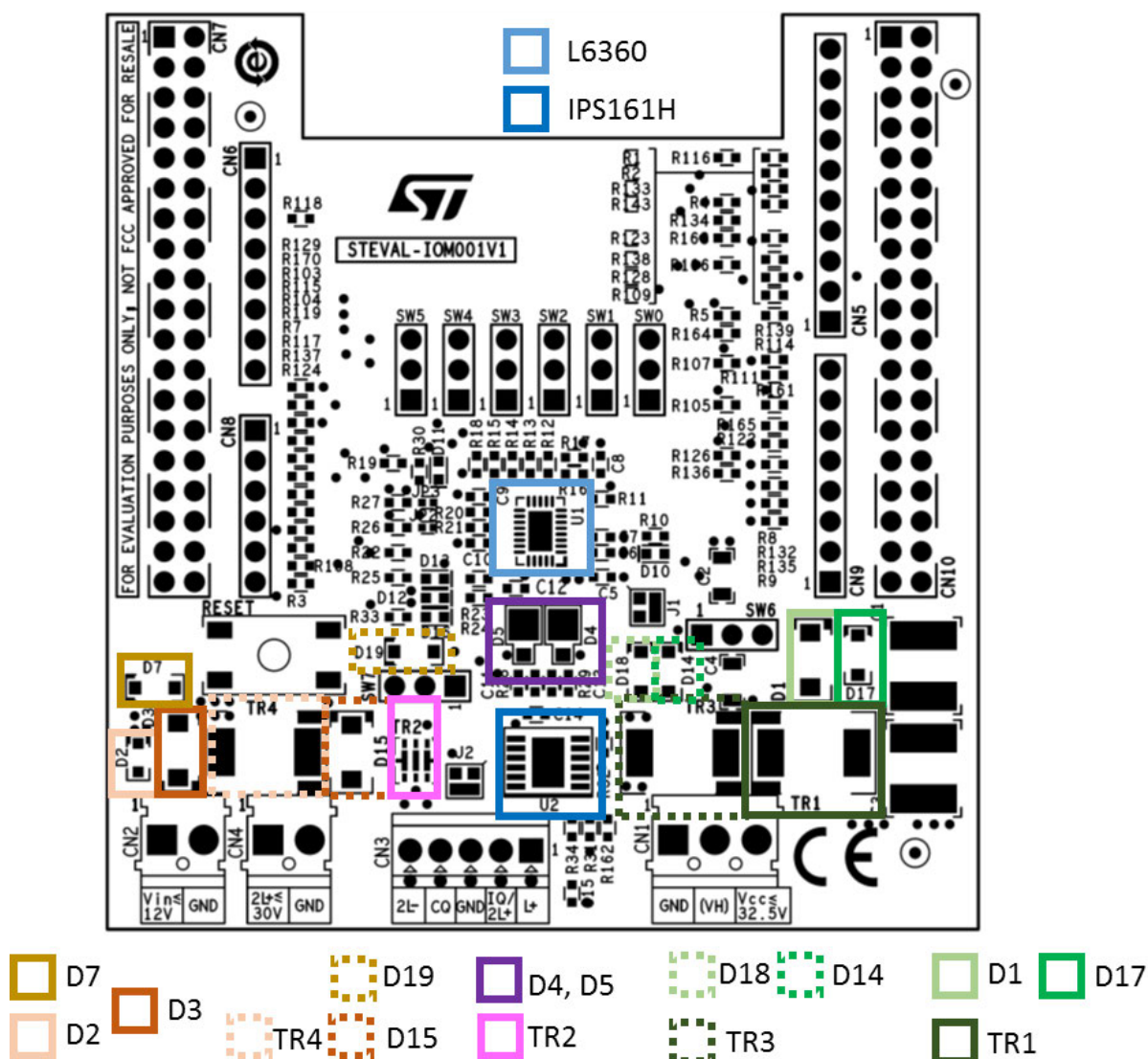


Table 9. Protection device descriptions

Protection device	Description	Notes
TR1	VCC/VH supply surge pulse suppressor	
D1	VCC/VH reverse polarity protection diode	
D17	VCC/VH clamping for negative Surge Pulse protection	
TR2	CQ, IQ and L+ lines surge suppressor.	
D4	Schottky diodes with low VF clamp the disturbance applied to the lines in a reverse polarity direction. Capable of conducting high surge current pulses to avoid high peak	
D5	current flow through the L6360 pins	
D3	VIN supply surge pulse suppressor	Not mounted
D7	VIN Clamping for negative Surge Pulse protection	Not mounted
D2	VIN reverse polarity protection diode	Not mounted
TR4	2nd L+ supply surge pulse suppressor	Not mounted

Protection device	Description	Notes
D15	2nd L+ Clamping for negative Surge Pulse protection	Not mounted
D19	2nd L+ reverse polarity protection diode	Not mounted
TR3	VH supply surge pulse suppressor	Not mounted
D14	VH reverse polarity protection diode	Not mounted
D18	VH clamping for negative Surge Pulse protection	Not mounted

2.6 Powering and initializing the board

Follow the instructions below to start using the STEVAL-IOM001V1 IO-Link physical master evaluation board:

- Step 1.** Connect the STEVAL-IOM001V1 evaluation board to the [NUCLEO-F446RE](#) or [NUCLEO-F401RE](#) development board through the morpho connectors.
- Step 2.** Connect the micro-USB cable between your computer and the STM32 NUCLEO development board Set J5 to position "U5V"
- Step 3.** Download the [STSW-IOM001](#) firmware onto the STM32 Nucleo microcontroller
The firmware is the user reference code to control the L6360 and can be freely downloaded from www.st.com. You can use the STM32 ST-Link utility to load the firmware onto the STM32 Nucleo board.
- Step 4.** Ensure that the STEVAL-IOM001V1 is configured as io-link port-1
- Step 5.** Connect the STEVAL-IOM001V1 to a 24 V power supply through CN1 pins 3 (+24V) and 1 (GND).
- Step 6.** Connect the load (or probes) on the CN3 pins 1 (L+), 2 (IQ), 3 (GND) and 4 (CQ).
- Step 7.** Use the dedicated graphic user interface (STSW-IOLINKGUI) to control the system.

ST offers a complete IO-Link master solution (physical layer and stack) with the [P-NUCLEO-IOM01M1](#). The STEVAL-IOM001V1 can be stacked with the P-NUCLEO-IOM01M1 to create a multi-port IO-Link master (up to quad-port).

RELATED LINKS

[2.3 IO-Link port configuration on page 8](#)

[2.4 Supply section on page 8](#)

Figure 6. STEVAL-IOM001V1 circuit schematic (1 of 4)

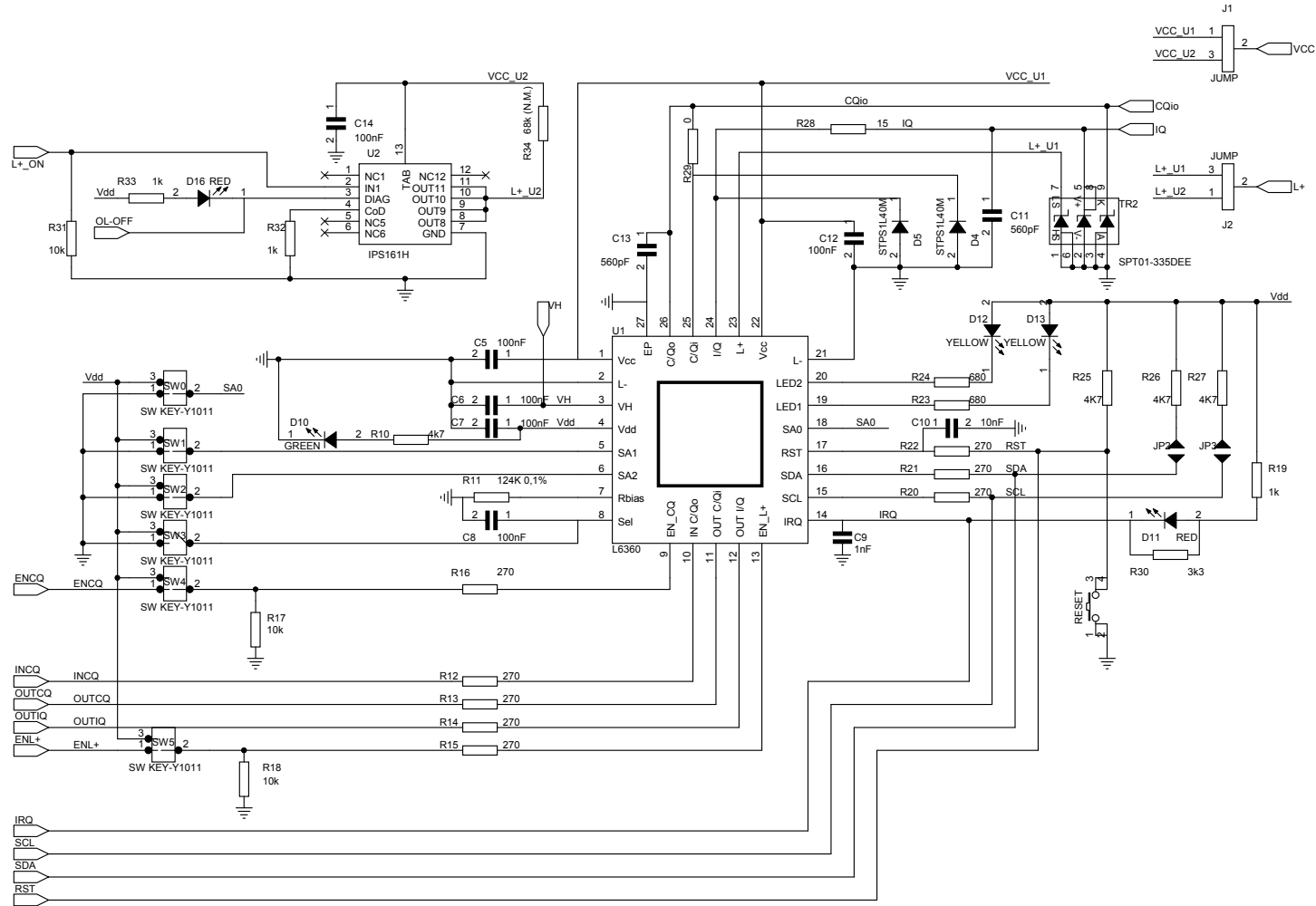


Figure 7. STEVAL-IOM001V1 circuit schematic (2 of 4): Arduino connectors

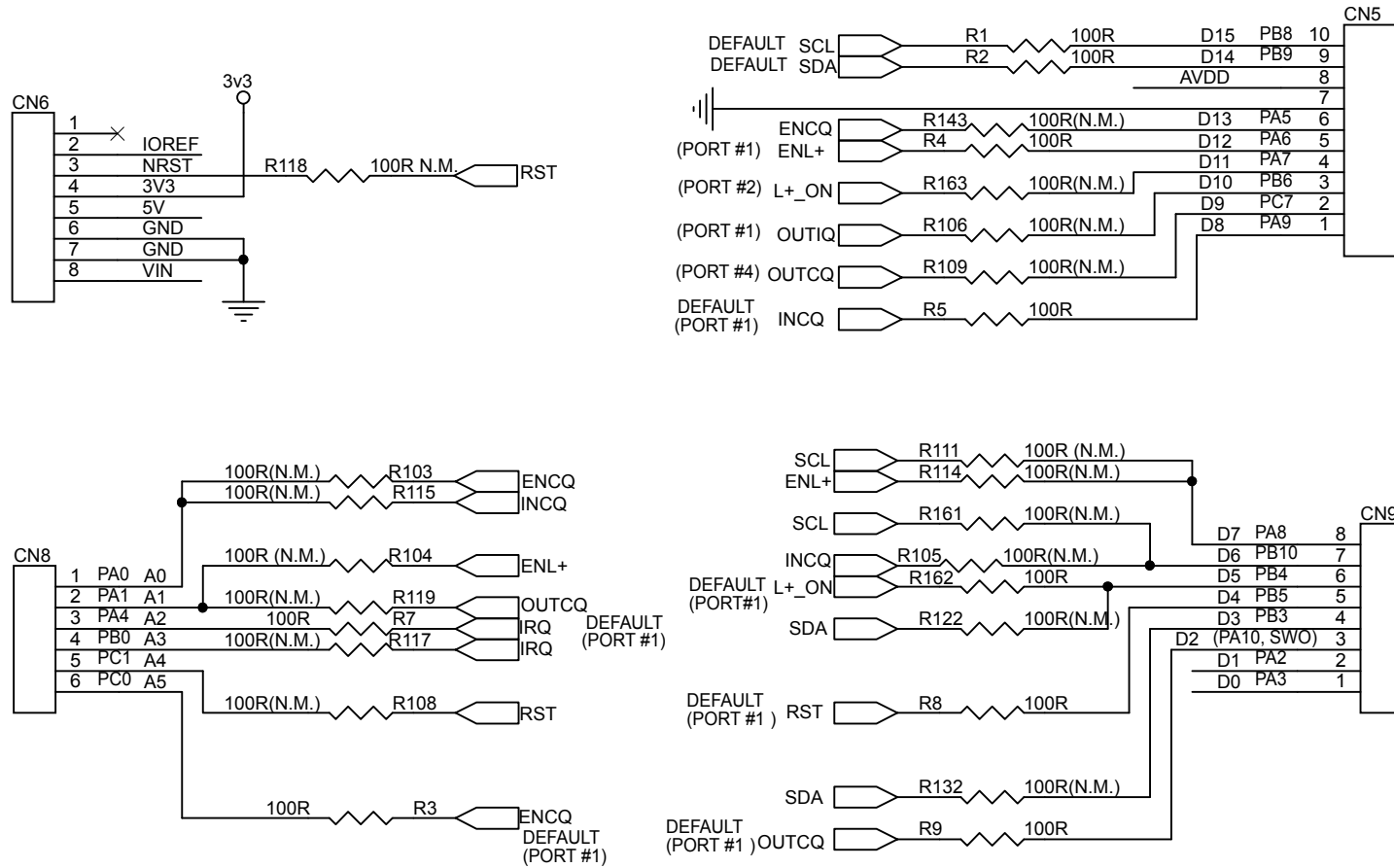


Figure 8. STEVAL-IOM001V1 circuit schematic (3 of 4): ST morpho connectors

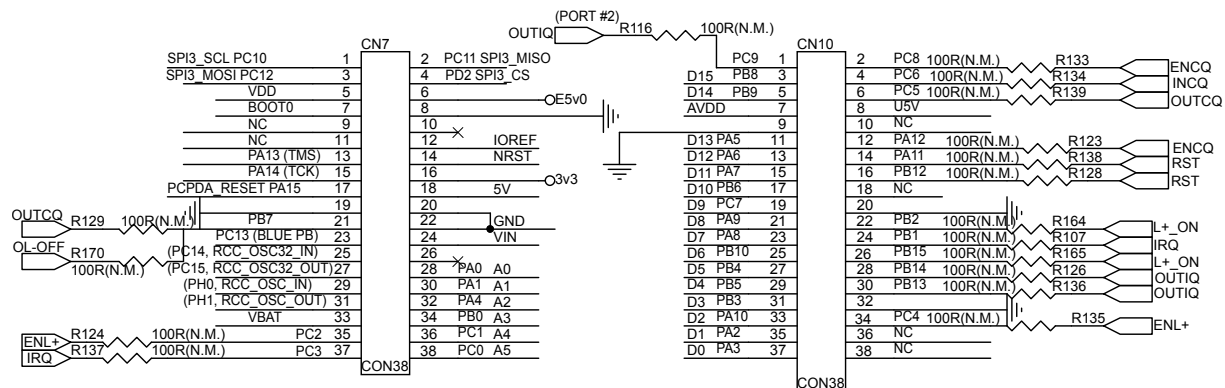
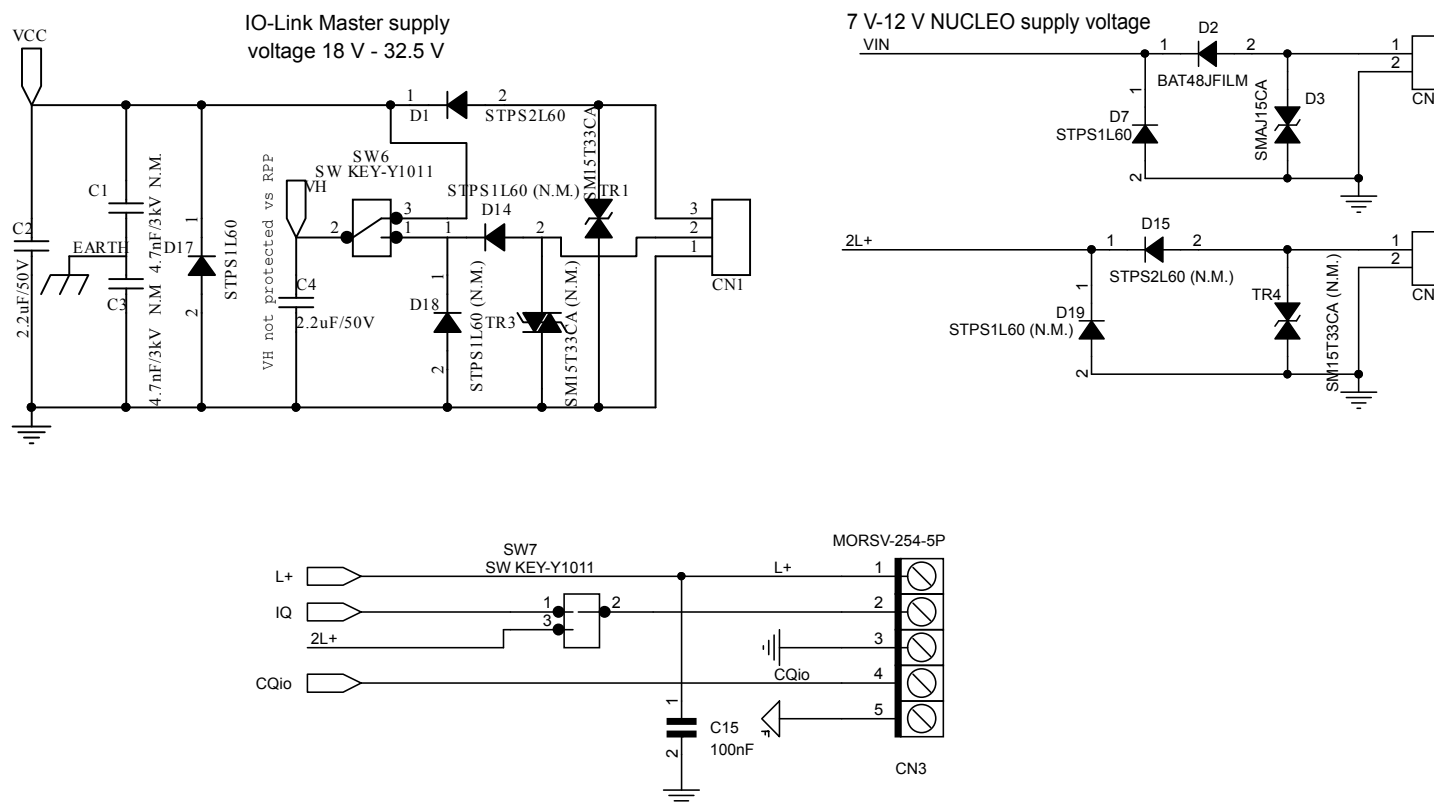


Figure 9. STEVAL-IOM001V1 circuit schematic (4 of 4): supply voltage



4 Bill of materials

Table 10. STEVAL-IOM001V1 bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	U1		IO-Link communication master transceiver IC	ST	L6360TR
2	1	D10		Green LED AlGaInP	OSRAM	LG L29K-G2J1-24
3	2	C2, C4	2.2µF 50V ±10%	X7R	Murata	GRM31C71H225KA88K
4	2	JP2, JP3		Drop Jumper	-	-
5	7	C5, C6, C7, C8, C12, C14, C15	100nF 50V ±10%	X7R	TDK	CGA3E2X7R1H104K080AA
6	1	C9	1nF 16V ±15%	X7R	WURTH	885012206034
7	1	C10	10nF 16V ±10%	X7R	Murata	GRM188R71C103KA01D
8	2	C11, C13	560pF 50V ±10%	X7R	Multicomp	MC0603B561K500CT
9	2	D11, D16		Red LED AlGaInP	OSRAM	LS L29K-G1 J2-1
10	2	D12, D13		Yellow LED 2.4V, 20mA AlGaInP	Kingbright	KPG-0603SYC-TT
11	8	SW0, SW1, SW2, SW3, SW4, SW5, SW6, SW7	-	3-way, 1-row	HARWIN	M20-9990346
11a	8	Jumper shunt connector	-	Jumper shunt connector	ASSMANN WSW	AKSPT/G GREY
12	9	R1, R2, R3, R4 R5, R7, R8, R9, R162	100Ω 0.1W ±0.5%		Panasonic	ERJ3BD1000V
13	0	R34, R103, R104, R105, R106, R107, R108, R109, R111, R114, R115, R117, R118, R119, R122, R123, R124, R126, R128, R129, R132, R133, R134, R135, R136, R137, R138, R139, R143, R161, R162, R163, R164, R165	-	not mounted	-	-
14	3	R19, R32, R33	1kΩ 0.1W ±1%	-	TE Connectivity	CRG0603F1K0
15	1	R11	124kΩ 0.1W 0.1%	-	TE Connectivity	CPF0603B124KE1
16	8	R12, R13, R14, R15, R16, R20, R21, R22	270Ω 0.1W ±1%	-	Vishay	CRCW0603270RFKEA
17	3	R17, R18, R31	10kΩ 0.1W ±1%	-	TE Connectivity	CRG0603F10K
18	1	R30	3.3kΩ 0.1W ±1%	-	TE Connectivity	CRG0603F3K3

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
19	2	R23, R24	680Ω 0.1W ±1%	-	Vishay	CRCW0603680RFKEA
20	4	R10, R25, R26, R27	4k7Ω 0.1W ±1%	-	ROHM	MCR03EZPFX4701
21	1	R28	15Ω 0.1W ±1%	-	Vishay	CRCW060315R0FKEA
22	1	R29	0Ω 0.1W ±1%	-	TE Connectivity	CRG0603ZR
23	0	CN5	Not mounted	10-way, 1-row	SAMTEC	SSQ-110-04-F-S
24	0	CN6, CN9	Not mounted	8-way, 1-row	SAMTEC	SSQ-108-04-F-S
25	2	CN7, CN10		38-way, 2-row	SAMTEC	ESQ-119-24-T-D
26	0	CN8	Not mounted	6-way, 1-row	SAMTEC	SSQ-106-04-F-S
27	1	CN1		3-way, 1-row (L6360 supply)	RS	790-1143
28	1	CN2		2-way, 1-row (STM32 NUCLEO supply)	RS	790-1149
29	0	CN4	Not mounted	2-way, 1-row (Additional supply 2L+)	RS	790-1149
30	1	CN3		5-way, 1-row (connection to IO-Link Slave)	RS-Pro	MB312-25405NIP
31	0	C1, C3	47nF 3kV ±10% Not mounted	X7R	Vishay	HV2220Y472KXHATHV
32	1	TR1		Vcc (VH) TVS surge suppressor	ST	SM15T33CA
33	0	TR3, TR4	Not mounted	VH TVS surge suppressor	ST	SM15T33CA
34	1	TR2		IO-LINK LINE EMC PROTECTION	ST	SPT01-335DEE
35	1	D1		VCC reverse polarity protection 2A, 60V	ST	STPS2L60A
36	0	D14	Not mounted	VH reverse polarity 1A, 60V	ST	STPS1L60ZF
37	0	D15	Not mounted	2L+ reverse polarity 2A, 60V	ST	STPS2L60A
38	1	D2		VIN reverse polarity protection 0.35A, 40V	ST	BAT48JFILM
39	2	D4, D5		SURGE PULSE PROTECTION 1.0A, 0.40V	ST	STPS1L40M
40	1	D3		Vin EMC Suppressor 400W	ST	SMAJ15CA
41	2	D7, D17		Vcc, Vin Free Wheeling diodes 1A, 60V	ST	STPS1L60ZF
42	0	D18, D19	Not mounted	Vcc Free Wheeling Diode 1A, 60V	ST	STPS1L60ZF
43	1	RESET		RESET BUTTON	TE Connectivity	2-1437565-7
44	1	U2		External L+ Switch	ST	IPS161H
45	2	J1, J2		VCC and L+ connection switches	-	-

Revision history

Table 11. Document revision history

Date	Version	Changes
04-Jun-2018	1	Initial release.
23-Apr-2021	2	Updated Section 3 STEVAL-IOM001V1 schematic diagrams.

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IMPORTANT NOTICE – PLEASE READ CAREFULLY

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