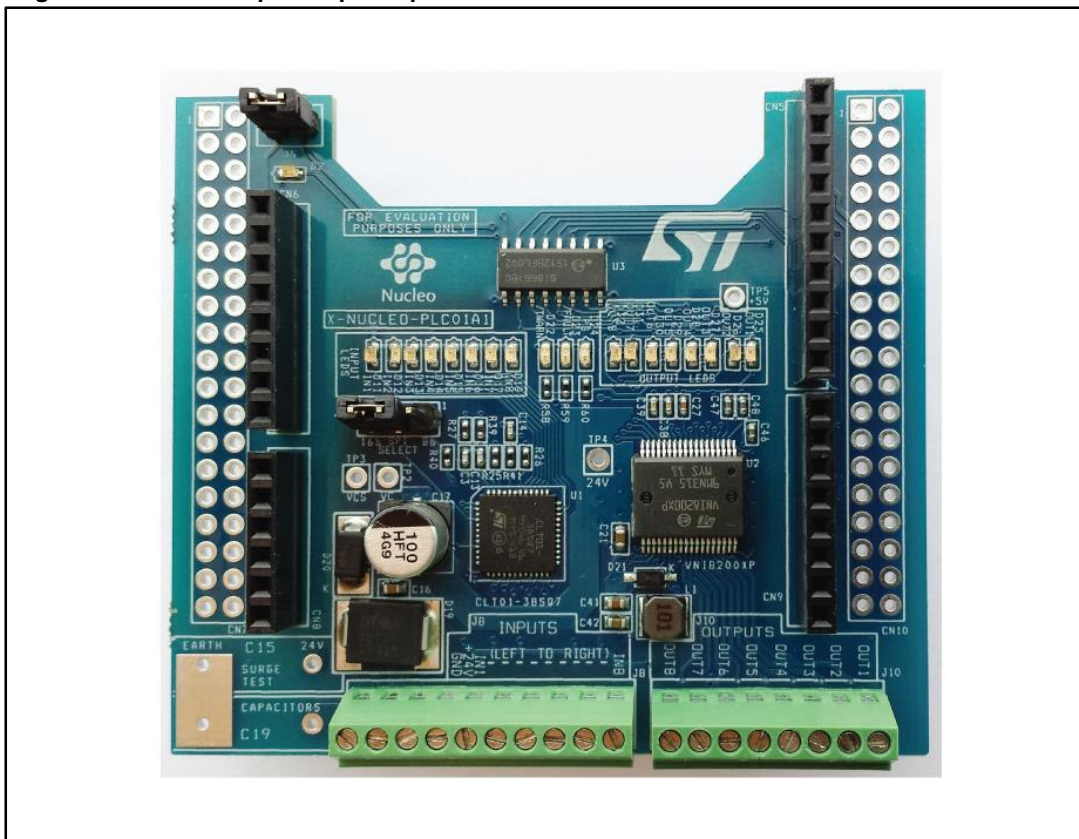


Getting started with the X-NUCLEO-PLC01A1 industrial input/output expansion board for STM32 Nucleo

Introduction

The X-NUCLEO-PLC01A1 is an expansion board designed to build basic PLC (programmable logic controller) applications. Plugged onto any STM32 Nucleo board through the Arduino UNO R3 connectors, it results in a compact industrial PLC capable of managing eight analog inputs and eight outputs through the SPI peripheral. The 24 V power supply makes it possible to manage industrial range inputs (i.e. sensors, valves) and outputs (i.e. lamps, alarms). The board is not intended to utilize all of the features of the CLT01-38SQ7 and the VNI8200XP devices. The X-NUCLEO-PLC01A1 embeds diagnostics and fault LEDs, as well as activity status LEDs for all channels in input and output. Compatibility with the STM32 Nucleo family of boards as well with other expansion boards is assured by the use of Arduino UNO R3 connectors, while the board schematics, bill of materials, Gerber files, drivers and firmware are available for download on www.st.com.

Figure 1: Industrial input/output expansion board based on the CLT01-38SQ7 and VNI8200XP



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1 Description

To perform industrial IO (input/output) management, the X-NUCLEO-PLC01A1 is equipped with CLT01-38SQ7 and VNI8200XP ICs. Both devices on the board work through the SPI peripheral, and as such any STM32 Nucleo board to which it is connected can implement an industrial PLC application. Both devices support 8- and 16-bit SPI interfaces for device command and control diagnostics. The board is equipped with a digital isolator in order to assure SPI safe operation between the X-NUCLEO-PLC01A1 and the STM32 Nucleo board. The VNI8200XP includes advanced protection and fault detection features. CLT01-38SQ7 provides protection and isolation in industrial operating conditions as well as an “energy-less” status indication for each of the eight input channels, with minimal power consumption. It is suited for situations that require test standards IEC61000-4-2 8 kV and 15 kV to be met. Both the CLT01-38SQ7 and the VNI8200XP are designed to meet the most common industrial requirements (i.e. IEC61000-4-2, IEC61000-4-4, IEC61000-4-5 or IEC61131-2). For more thorough evaluation of the individual products, it is recommended to refer to their single respective evaluation boards, available on st.com.

2 Features

The X-NUCLEO-PLC01A1 is a ready-to-use PCB (printed circuit board) including:

- 8x input with CLT01-38SQ7, high-speed protected digital termination array
- 8x output with VNI8200XP, high-side solid state relay
- Status LEDs: Fault, Thermal, Power
- IO (input/output) activity LEDs
- 24 V power supply
- Compatible with Arduino UNO R3 connector

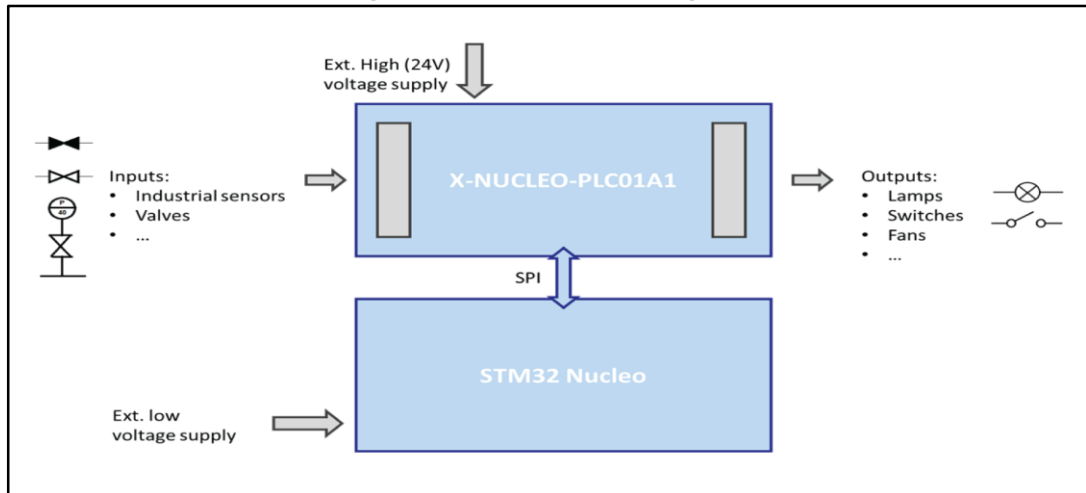
A reverse polarity diode is part of the input stage. As a result, when a 24 V supply is applied to the input connector, the supply voltage on the CLT01-38SQ7 device is given by: $V_{\text{supply}} - V_{\text{FWD}}$, where V_{FWD} is the voltage applied on the reverse diode.

Capacitors C15 and C19 are not mounted. They are only needed to perform common mode surge tests.

3 Hardware and layout description

The X-NUCLEO-PLC01A1 board adds to any STM32 Nucleo board the capabilities of a compact industrial PLC with 8 inputs and 8 outputs. This is possible through SPI management as depicted in the functional block diagram below.

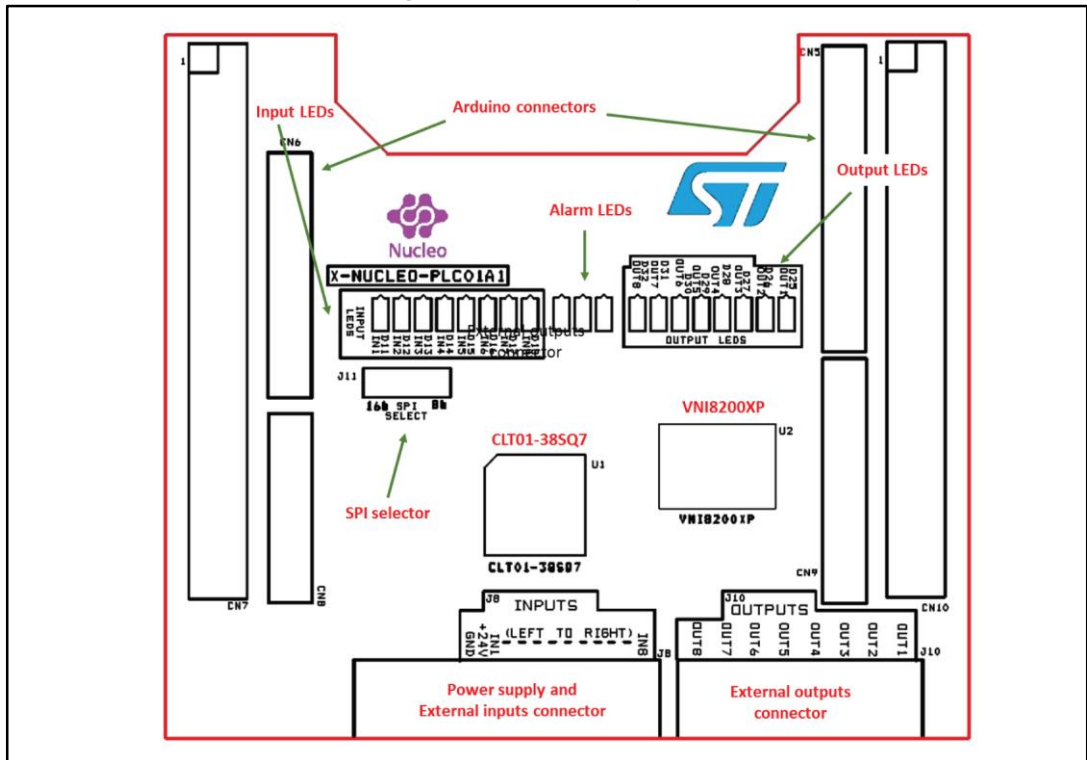
Figure 2: Functional block diagram



4 X-NUCLEO-PLC01A1 assembly drawing

The main components of the board are specified in the drawing below. The X-NUCLEO-PLC01A1 is shaped in such a way as to allow easy access to the STM32-Nucleo board when both boards are connected. Input and output channels are accessible through the screw connectors placed on the low side of the X-NUCLEO-PLC01A1 (connectors J8 and J10, respectively), and each channel is associated to one LED in order to indicate its activity and status. Another three LEDs are provided on the board to provide status and diagnostic information for the VNI8200XP device (temperature warning, fault and Power Good detection). The SPI selector allows the CLT01-38SQ7 device to be managed in 8-bit or 16-bit bus mode.

Figure 3: Top assembly view



5 X-NUCLEO-PLC01A1 board powering and startup

The following steps must be followed to run the X-NUCLEO-PLC01A1:

1. Plug the X-NUCLEO-PLC01A1 onto a STM32 Nucleo board
2. Connect the STM32 Nucleo board to a PC via a standard Type A / mini B USB cable
3. Download the firmware on the STM32 microcontroller hosted on the STM32 Nucleo board
4. Supply 24 V to the X-NUCLEO-PLC01A1 board through the J8 connector
5. The X-CUBE-PLC1 demonstration firmware is ready to run: connect any of the 8 inputs on the J8 connector to see the corresponding output on the J10 connector capable of driving a load (i.e. short-circuit input "x" with the 24 V and connect the corresponding output "x" to a load).

6 Schematic diagrams

Figure 4: X-NUCLEO-PLC01A1 schematic, part 1

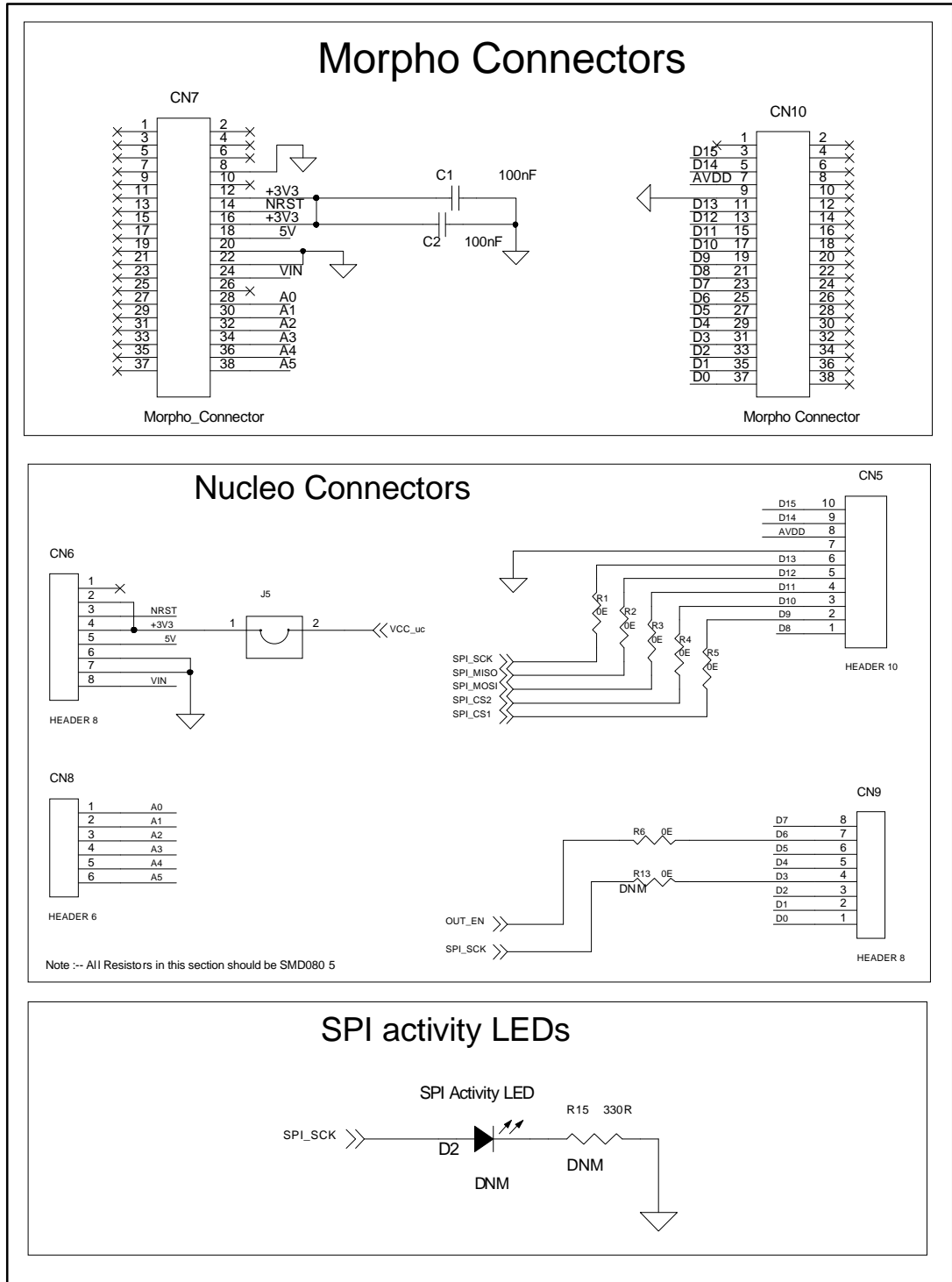


Figure 5: X-NUCLEO-PLC01A1 schematic, part 2

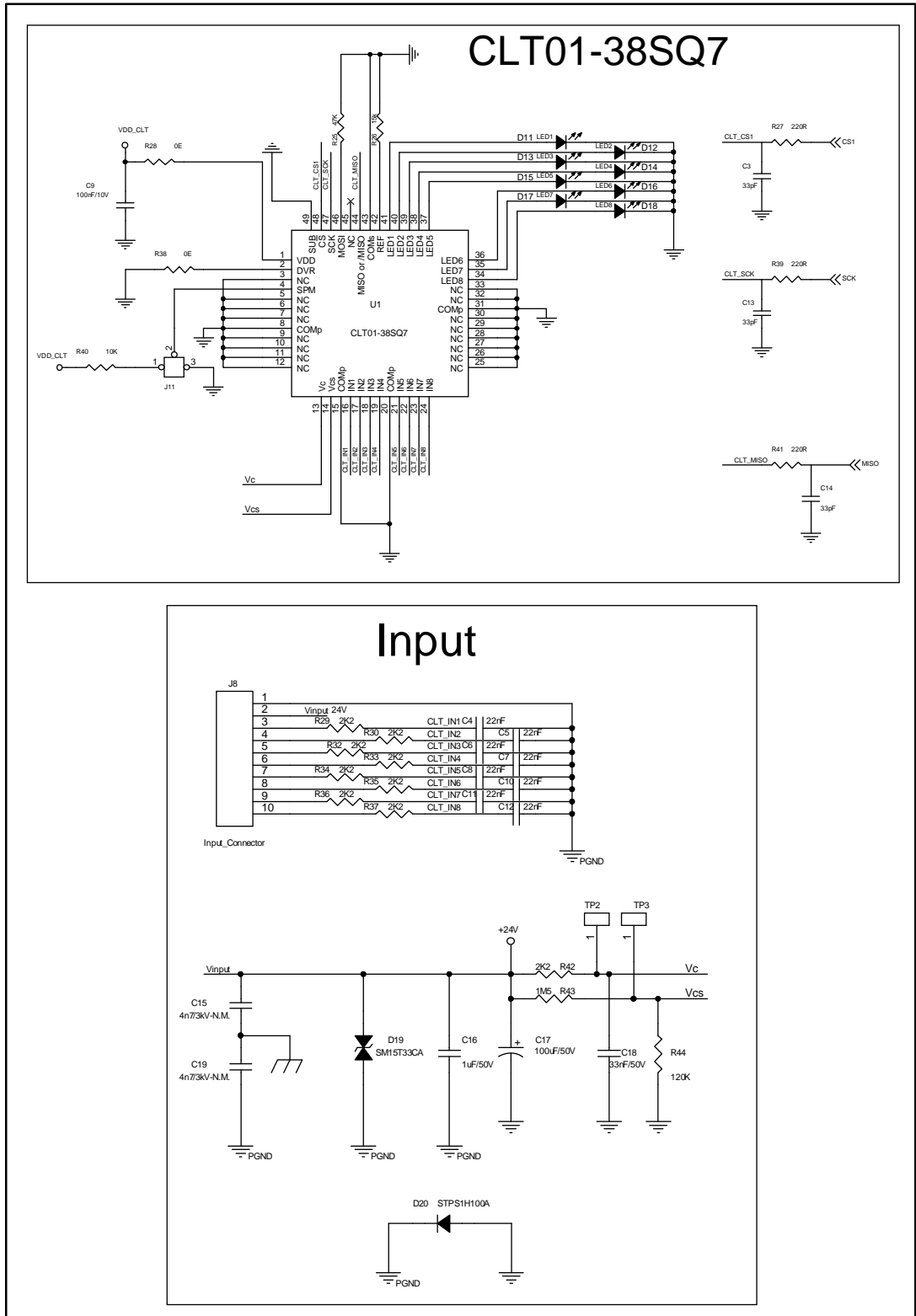


Figure 6: X-NUCLEO-PLC01A1 schematic, part 3

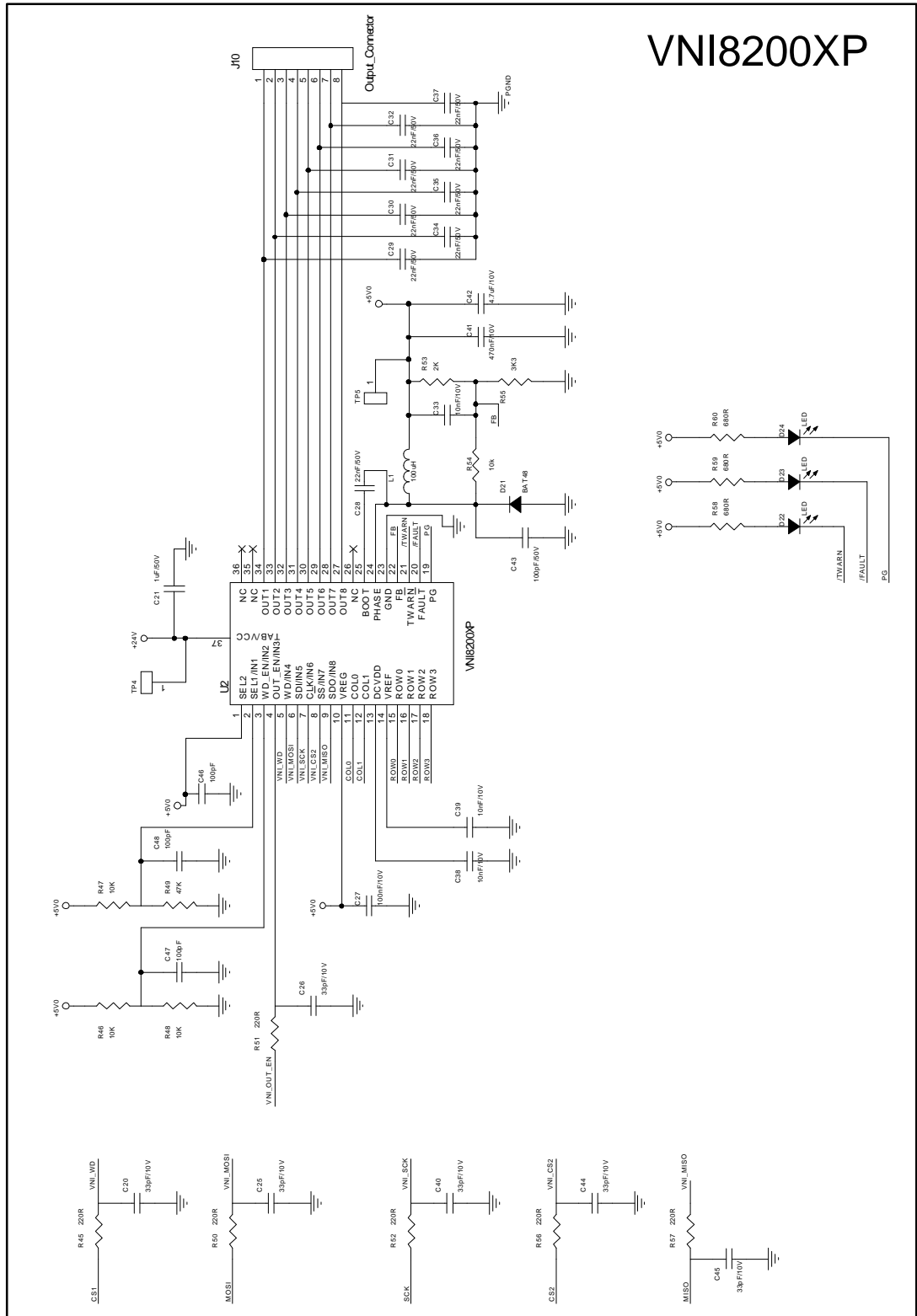
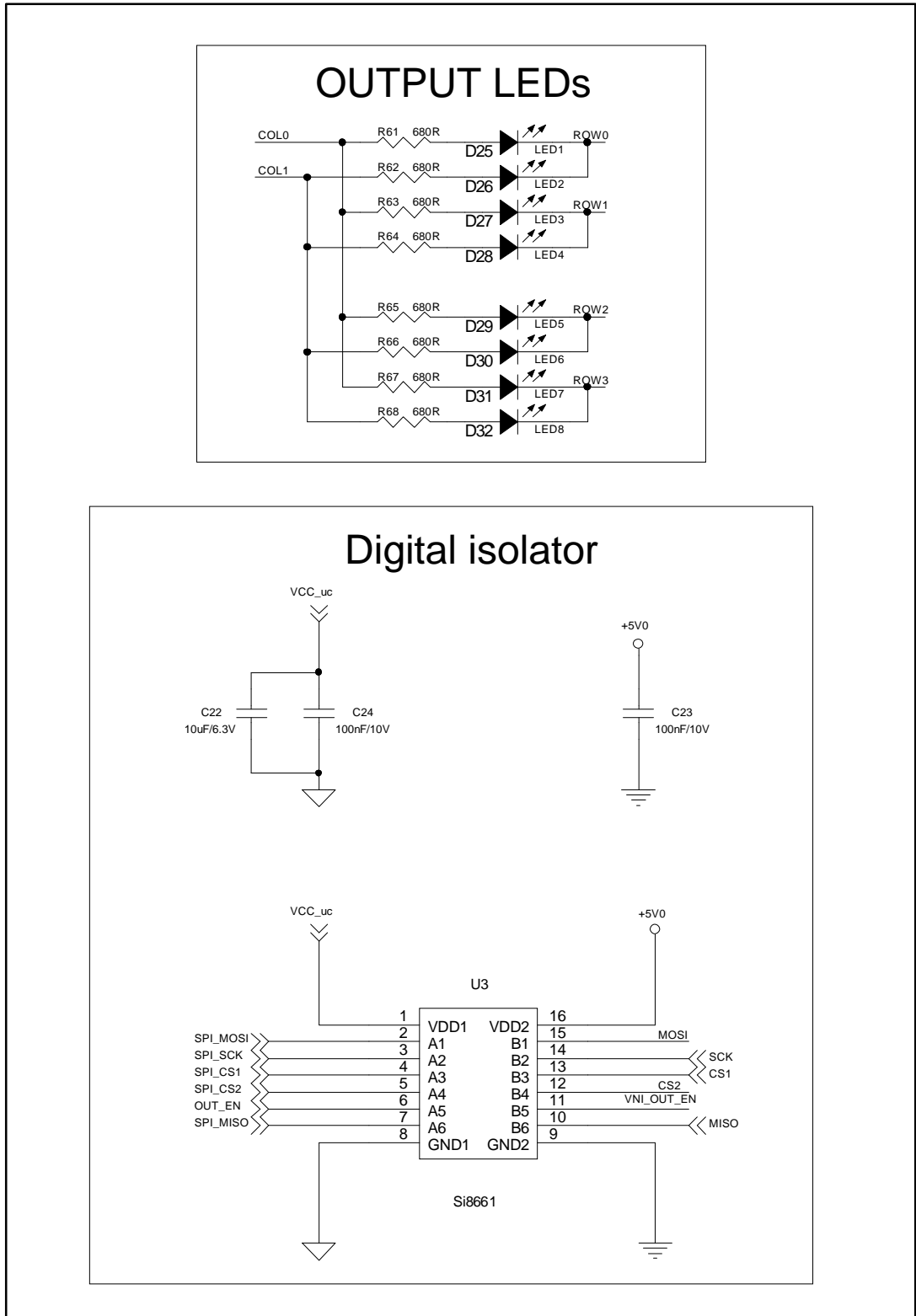


Figure 7: X-NUCLEO-PLC01A1 schematic, part 4



7 Bill of material

Table 1: Bill of material (BOM)

Qty.	Designator	Value	Part number	Comment	Package ref.
4	C9, C23, C24, C27	100 nF	C1005X7R1H104K050 BB		SMD 0402
9	C3, C13, C14, C20, C25, C26, C40, C44, C45	33 pF	C1005C0G1H330J050 BA		SMD 0402
17	C4,C5,C6,C7,C8,C10,C11,C12, C29, C30, C31, C32, C34, C35, C36, C37,C28	22 nF	C1608X7R1H223K080 AA		SMD 0603
2	C15, C19	4.7 nF	VY1472M63Y5UQ63V0	Not mounted	Through Hole 10 mm lead spacing
2	C16, C21	1 μ F	C1608X5R1H105K080 AB		SMD 0603
1	C17	100 μ F	EEE-FTH101XAP		SMD
1	C18	33 nF	C1608X7R1H333K080 AA		SMD 0603
1	C22	10 μ F	T491A106M006AT		SMD 1206
2	C38, C39	10 nF	C1005X7R1H103K050 BB		SMD 0402
1	C33	10 nF	C1608X7R1H103K080 AA		SMD 0603
1	C41	470 nF	C1608X5R1A474K080 AA		SMD 0603
1	C42	4.7 μ F	CGB3B1X5R1A475K055AC		SMD 0603
1	C43	100 pF	C1608C0G1H101J080 AA		SMD 0603
3	C46, C47, C48	100 pF	C1005C0G1H101F050 BA		SMD0402
2	C1, C2	100 nF	C2012X7R1H104K085 AA		SMD 0805
2	CN7, CN10	Morpho connectors	SSQ-119-04-L-D		Through hole 2.54 mm
1	CN5	Header_10	SSQ-110-03-L-S	Mount female type on top, male type on bottom	Through hole 2.54 mm

Qty.	Designator	Value	Part number	Comment	Package ref.
2	CN6, CN9	Header_8	SSQ-108-03-L-S	Mount female type on top, male type on bottom	Through hole 2.54 mm
1	CN8	Header_6	SSQ-106-03-L-S	Mount female type on top, male type on bottom	Through hole 2.54 mm
3	D24, D23, D22	LED	LS L29K-G1J2-1-Z	Red color	SMD 0603
17	D2, D11, D12, D13, D14, D15, D16, D17, D18, D25, D26, D27, D28, D29, D30, D31, D32	LED	LG L29K-G2J1-24-Z	Green color	SMD 0603
1	D21	BAT48	BAT48ZFILM		SOD-123
1	D19	SM15T33CA	SM15T33CA		SMC_B
1	D20	STPS1H100A	STPS1H100A		SMA
1	J5	Jumper_2		Female type jumper to be mounted	Through hole 2.54 mm
1	J8	INPUT_connector	1725711		Through hole 2.54 mm
1	J10	OUTPUT_connector	1725737		Through hole 2.54 mm
1	J11	Jumper_3		Female type jumper to be mounted	Through hole 2.54 mm pitch
1	L1	100 μ H	SRN4018-101M		SMD
1	R15	330 Ω	ERJ-2GEJ331X		SMD 0204
2	R28, R38	0 Ω	ERJ-2GE0R00X		SMD 0204
11	R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68	680 Ω	ERJ-2GEJ681X		SMD 0204

Qty.	Designator	Value	Part number	Comment	Package ref.
2	R25, R49	47 k Ω	ERJ-2GEJ473X		SMD 0204
1	R26	15 k Ω	ERJ-2GEJ153X		SMD 0204
9	R27, R39, R41, R45, R50, R51, R52, R56, R57	220 Ω	ERJ-2GEJ221X		SMD 0204
9	R29, R30, R32, R33, R34, R35, R36, R37, R42	2.2 k Ω	MMA02040C2201FB300		SMD 0204
4	R40, R46, R47, R48	10 k Ω	ERJ-2GEJ103X		SMD 0402
1	R43	1.5 M Ω	MMA02040C1504FB300		SMD 0204
1	R44	120 k Ω	MMA02040C1203FB300		SMD 0204
1	R53	2 k Ω	ERJ-3EKF2001V		SMD 0603
1	R54	10 k Ω	ERJ-3GEYJ103V		SMD 0603
1	R55	3.3 k Ω	ERJ-3EKF3301V		SMD 0603
1	U3	Si Digital Isolator	SI8661BC-B-IS1		16 pin narrow body SOIC
1	U1	CLT01-38SQ7	CLT01-38SQ7		QFN
1	U2	VNI8200XP	VNI8200XP		PowerSS O-36
7	R1, R2, R3, R4, R5, R6, R13	0 Ω		Closed	
2	Jumper		969102-0000-DA		

8 Revision history

Table 2: Document revision history

Date	Version	Changes
17-Jul-2015	1	Initial release.

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