UM2188
User manual

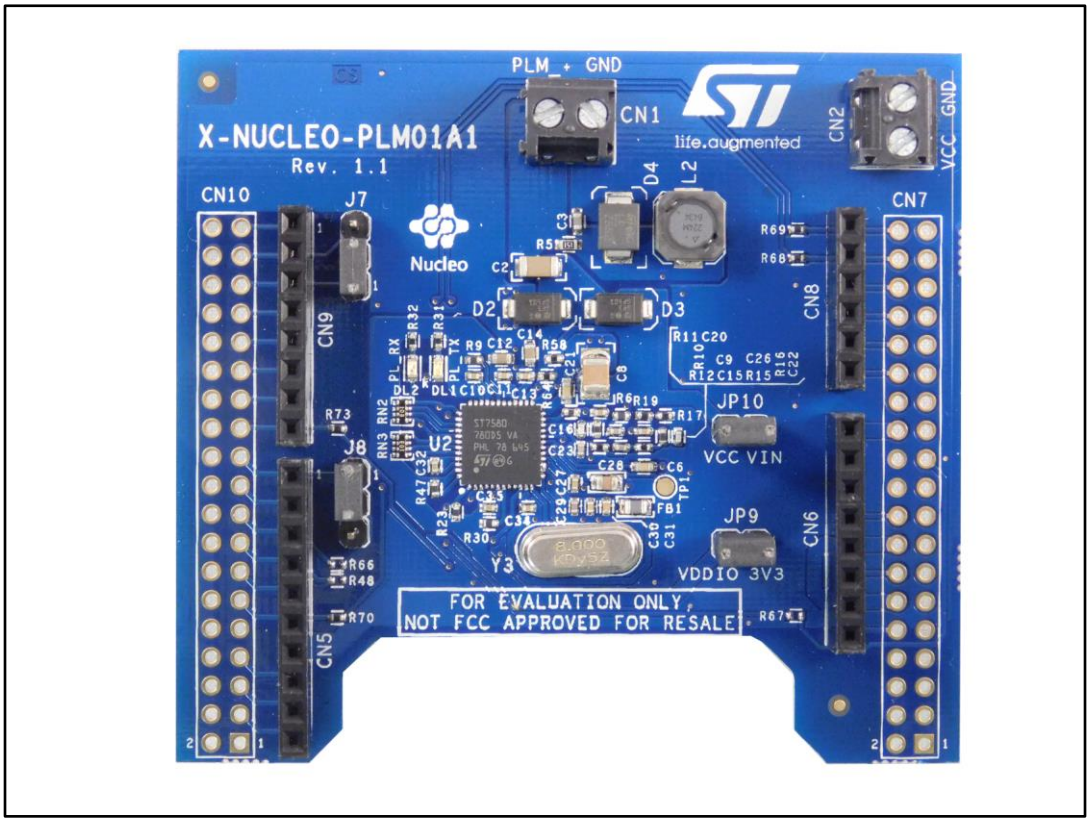
Getting started with the X-NUCLEO-PLM01A1 expansion board based on ST7580 for STM32 Nucleo

Introduction

The X-NUCLEO-PLM01A1 expansion board for STM32 Nucleo is based on the ST7580 FSK, PSK multi-mode power line networking system-on-chip. It provides an affordable and easy-to-use solution for the development of connectivity applications based on power line communication. It lets you easily evaluate the communication features of the ST7580 based on a DC two-wire link between two boards.

You can also perform evaluation on an AC power line by connecting the X-NUCLEO-PLM01A1 to an STEVAL-XPLM01CPL board providing effective AC coupling and isolation. The X-NUCLEO-PLM01A1 is interfaced with the STM32 controller via UART and GPIO pins and is compatible with the Arduino UNO R3 (default configuration) and ST morpho (optional) connectors.

Figure 1: X-NUCLEO-PLM01A1 expansion board



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1 Typical applications

The X-NUCLEO-PLM01A1 expansion board features:

- STM32 Nucleo expansion board based on the ST7580 power line networking system-on-chip
- ST7580 main characteristics:
  - FSK, PSK modem for robust wireline communication up to 28.8 kbps
  - 8-18 V analog supply voltage
  - 3.3 V digital supply
  - Output transmitted signal capability up to 14 V_{p-p}, 1 A_{rms}
  - Frequency range 9-250 kHz
- TX and RX filters on board optimized for the CENELEC B (95-125 kHz) frequency band, suitable for IoT / Smart Home / Smart City applications
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connectors
- Example firmware available for point-to-point communication, compatible with STM32Cube firmware
- RoHS compliant

The X-NUCLEO-PLM01A1 expansion board can be used for the ST7580 device evaluation in multiple applications:

- automatic meter reading
- home and building automation
- smart lighting
- industrial monitoring and control
- wireless fire and security alarm systems

A point-to-point communication protocol demo is available to be tested with the board.[a]

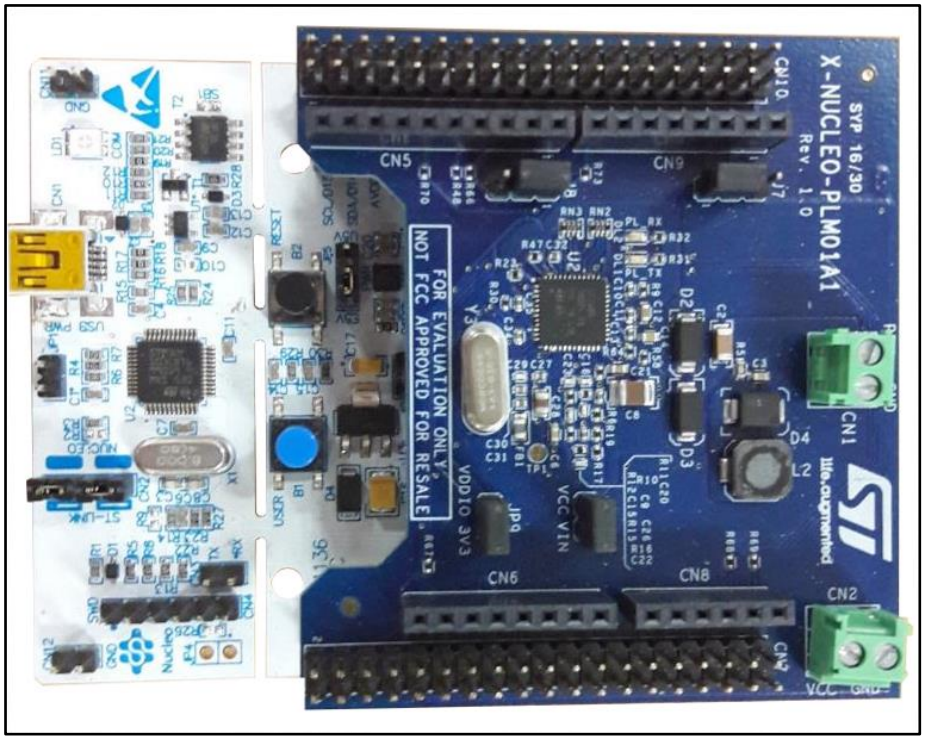
[a] For further details refer to the X-CUBE-PLM1 databrief available at www.st.com.

2 Getting started

2.1 Hardware requirements

The X-NUCLEO-PLM01A1 is an expansion board for the STM32 Nucleo boards. To function correctly, it must be plugged on an STM32 Nucleo board through the Arduino™ UNO R3 connectors as shown in the figure below. Information on STM32 Nucleo is available at *http://www.st.com/stm32nucleo*.

Figure 2: X-NUCLEO-PLM01A1 expansion board connected to an STM32 Nucleo board



The X-NUCLEO-PLM01A1 can be connected to any STM32 Nucleo board, even though complete testing was performed on the NUCLEO-F401RE and NUCLEO-L053R8 development boards.

2.2 System requirements

Using the STM32 Nucleo boards with the X-NUCLEO-PLM01A1 expansion board requires:

- a Windows PC to control the board through a serial terminal;
- a USB type A to Mini-B USB cable to connect the STM32 Nucleo board to the PC;
- a DC power supply to provide V_{CC} = 8-18 V (12 V typical) for ST7580 analog supply.

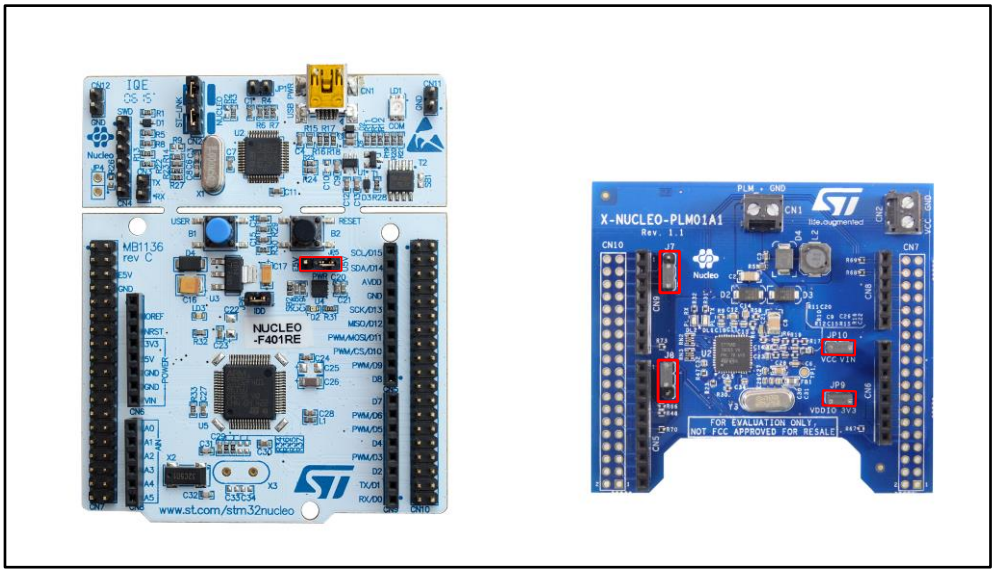
2.3 Board setup

To set up the board:

1 Verify the jumper configuration:
   - on the STM32 Nucleo development board, JP5 closed to pin E5V;
   - on the X-NUCLEO-PLM01A1 expansion board:

a. JP9 and JP10 closed
b. J7 and J8 closed between pin 1 and 2.

Figure 3: X-NUCLEO-PLM01A1 expansion board and STM32 Nucleo board jumper configuration



2 Connect the STM32 Nucleo board to the PC via the USB type A to mini-B USB cable.

3 Program the firmware in the MCU on the STM32 Nucleo board using the firmware example provided.

4 Power the STM32 Nucleo board off by unplugging the USB cable.

5 Connect the X-NUCLEO-PLM01A1 on top of the STM32 Nucleo board, as shown in *Figure 2: "X-NUCLEO-PLM01A1 expansion board connected to an STM32 Nucleo board"*.

6 Connect again the STM32 Nucleo board to the PC via the USB type A to Mini-B USB cable.

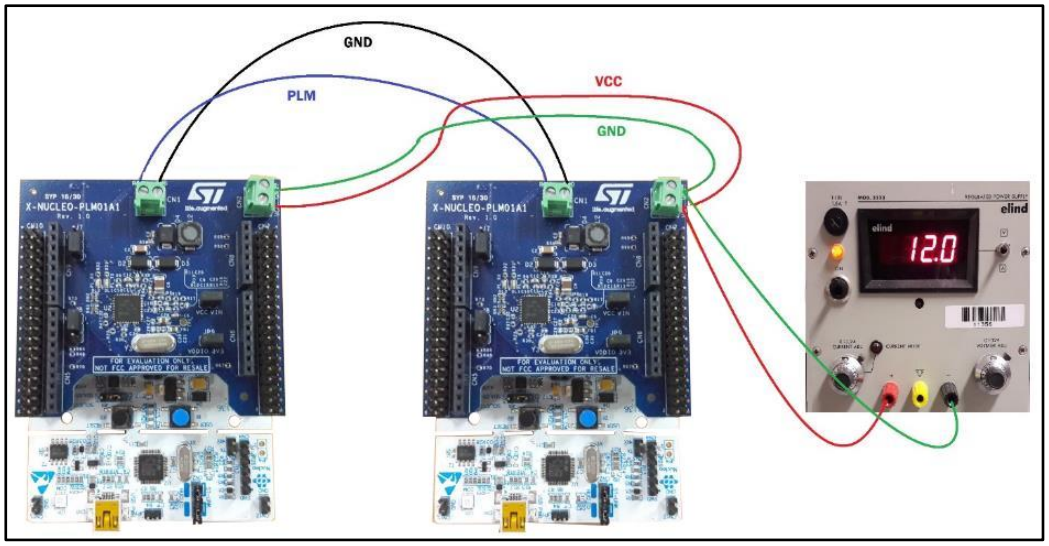
7 Provide 12 V DC on CN2 for the ST7580 analog supply.

The kit is ready to use.

The basic setup for evaluation requires two X-NUCLEO-PLM01A1 expansion boards (as per the above configuration).

The boards are linked to each other through a pair of wires connected to CN1, as shown in the figure below.

Figure 4: X-NUCLEO-PLM01A1 expansion board basic evaluation setup



Pay attention to match PLM and GND when connecting two or more boards, to avoid short-circuiting the PLM signal to GND.

3 Hardware description

3.1 Interconnections details

The tables below show the connection details between the X-NUCLEO-PLM01A1 expansion board and the NUCLEO-L053R8 board.

Table 1: Left connector: connection details

X-NUCLEO-PLM01A1 expansion board signals	NUCLEO-L053R8 MCU port	Pin number	Connector name	Signal name
		1	CN6 power	NC
3V3		2		IOREF
		3		RESET
3V3		4		3V3
		5		5V
GND		6		GND
GND		7		GND
VCC		8		VIN
	PA0	1	CN8 analog	A0
	PA1	2		A1
	PA4	3		A2
	PB0	4		A3
PL_RX_ON	PC1	5		A4
PL_TX_ON	PC0	6		A5

Table 2: Right connector: connection details

X-NUCLEO-PLM01A1 expansion board signals	NUCLEO-L053R8 MCU port	Pin number	Connector name	Signal name
	PB8	10	CN5 digital	D15
	PB9	9		D14
	AVDD	8		AREF
GND	GND	7		GND
T_REQ	PA5	6		D13
	PA6	5		D12
RXD(1)	PA7	4		D11
	PB6	3		D10
	PC7	2		D9
RXD	PA9	1		D8
RXD(1)	PA8	8	CN9 digital	D7
TXD (1)	PB10	7		D6

X-NUCLEO-PLM01A1 expansion board signals	NUCLEO-L053R8 MCU port	Pin number	Connector name	Signal name
TXD	PB4	6		D5
	PB5	5		D4
	PB3	4		D3
	PA10	3		D2
	PA2	2		D1
PLC_RESETN	PA3	1		D0

Notes:

(1)Optional connection

3.2 UART interconnection options

The table below shows the UART connection options between the STM32 Nucleo and the ST7580 device hosted on the X-NUCLEO-PLM01A1 expansion board.

These options can be used to enable different configurations in case a signal conflict occurs when using other expansion boards on top of the X-NUCLEO-PLM01A1 expansion board.

Table 3: ST7580 and STM32 Nucleo UART interface options

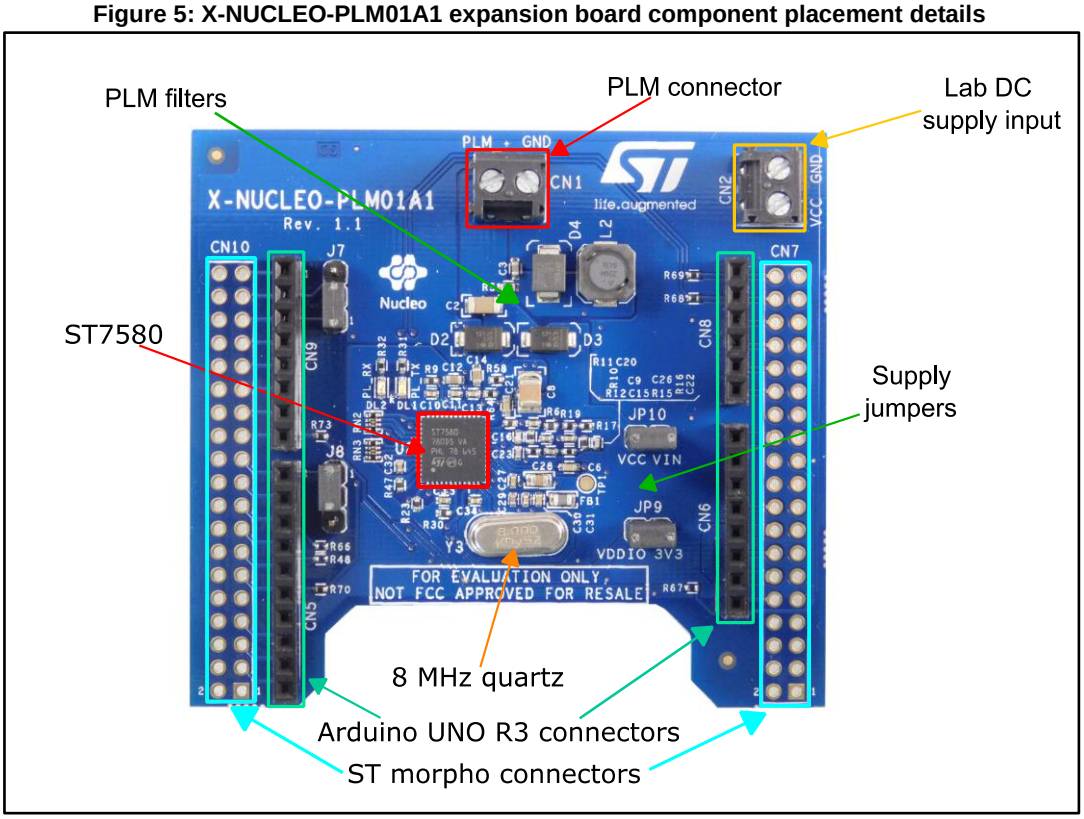
ST7580 signal	Default STM32 port	Optional STM32 port – 1	Optional STM32 port – 2
RXD	USART1_TX = PA9 Close J8 pin 1-2	USART2_TX = PA3 Close J8 pin 2-3	USART1_TX = PB6 Open J8, solder R68 = 0R
TXD	USART1_RX = PA10 Close J7 pin 1-2	USART2_RX = PA2 Close J7 pin 2-3	USART1_RX = PB7 Open J7, solder R67 = 0R

3.3 Current measurement

To monitor the digital and analog consumption jumpers JP9 and JP10 can be respectively used by easily connecting a current probe between pin 1 and 2 of each jumper to perform the measurement.

3.4 X-NUCLEO-PLM01A1 component placement details

Figure 5: X-NUCLEO-PLM01A1 expansion board component placement details



3.5 ST7580 device

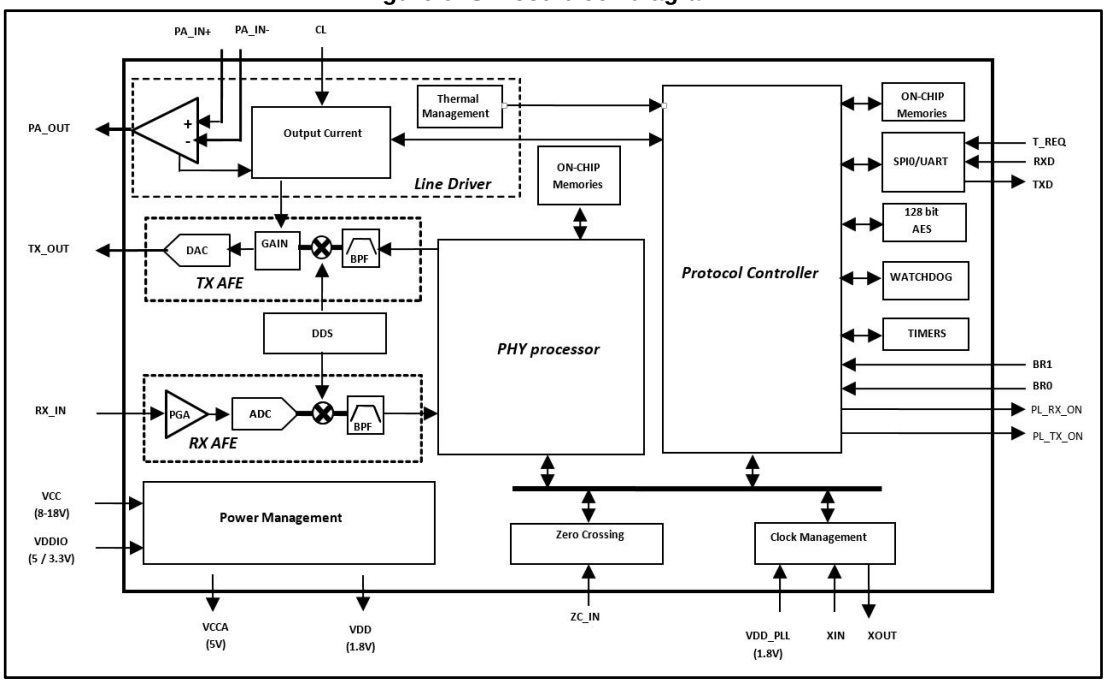
The ST7580 FSK, PSK multi-mode power line networking system on chip is based on a dual digital core architecture (a processor engine and a protocol controller core) to guarantee excellent communication performance with a high level of flexibility. It has been built on a multi-power technology with state-of-the-art VLSI CMOS lithography.

A hardware 128-bit AES encryption block (with customizable key management) is available on chip when secure communication is requested.

The on-chip analog front end featuring analog-to-digital and digital-to-analog conversion, automatic gain control and the integrated power amplifier delivering up to 1 A rms output current make the ST7580 a unique system on chip for power line communication.

Safe and performing operations are guaranteed while keeping power consumption and signal distortion levels very low, thus making the ST7580 an ideal platform for the most stringent application requirements and regulatory standards compliance.

Figure 6: ST7580 block diagram



4 Schematic diagrams

Figure 7: X-NUCLEO-PLM01A1 schematic diagram (1 of 3)

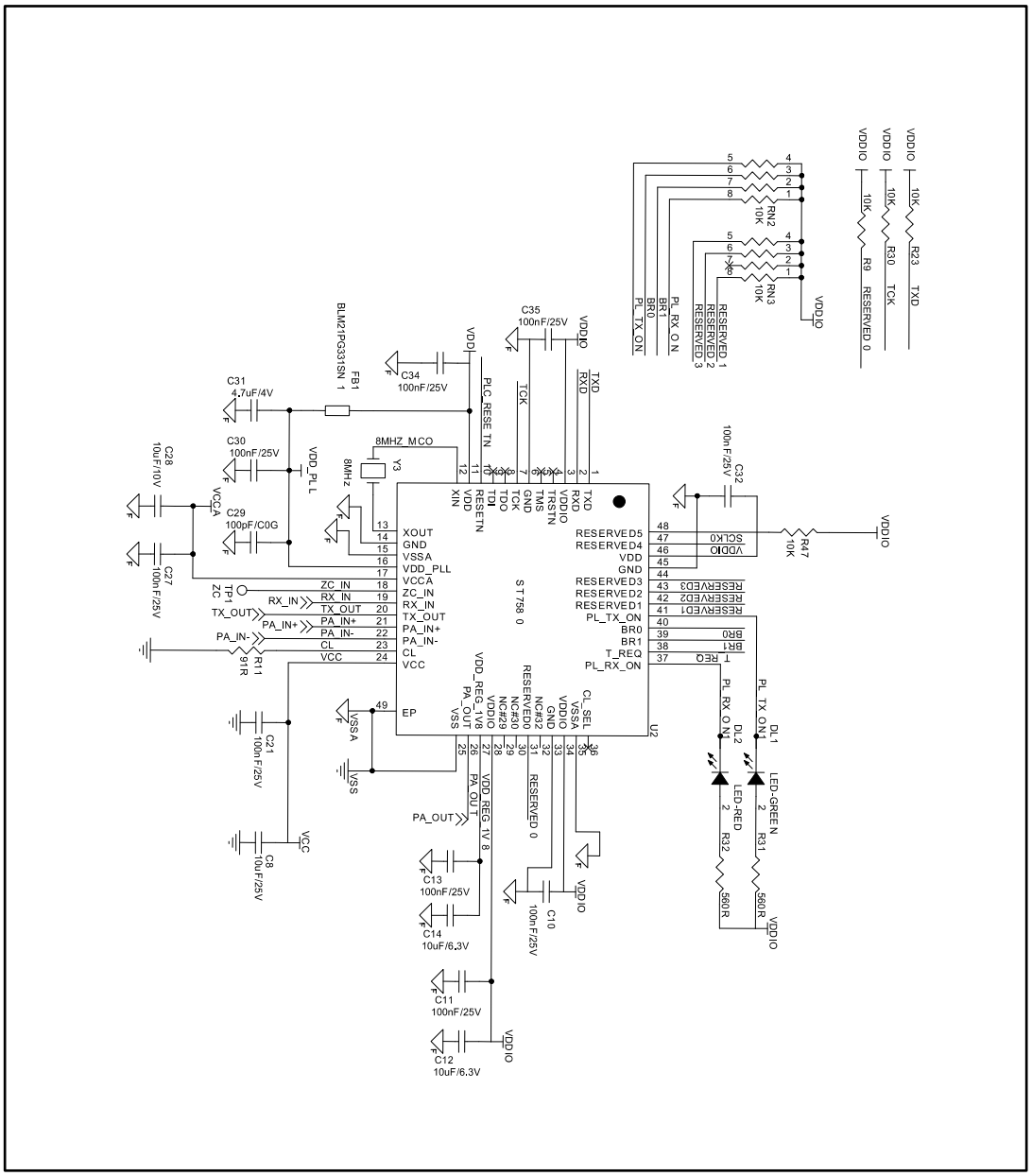


Figure 8: X-NUCLEO-PLM01A1 schematic diagram (2 of 3)

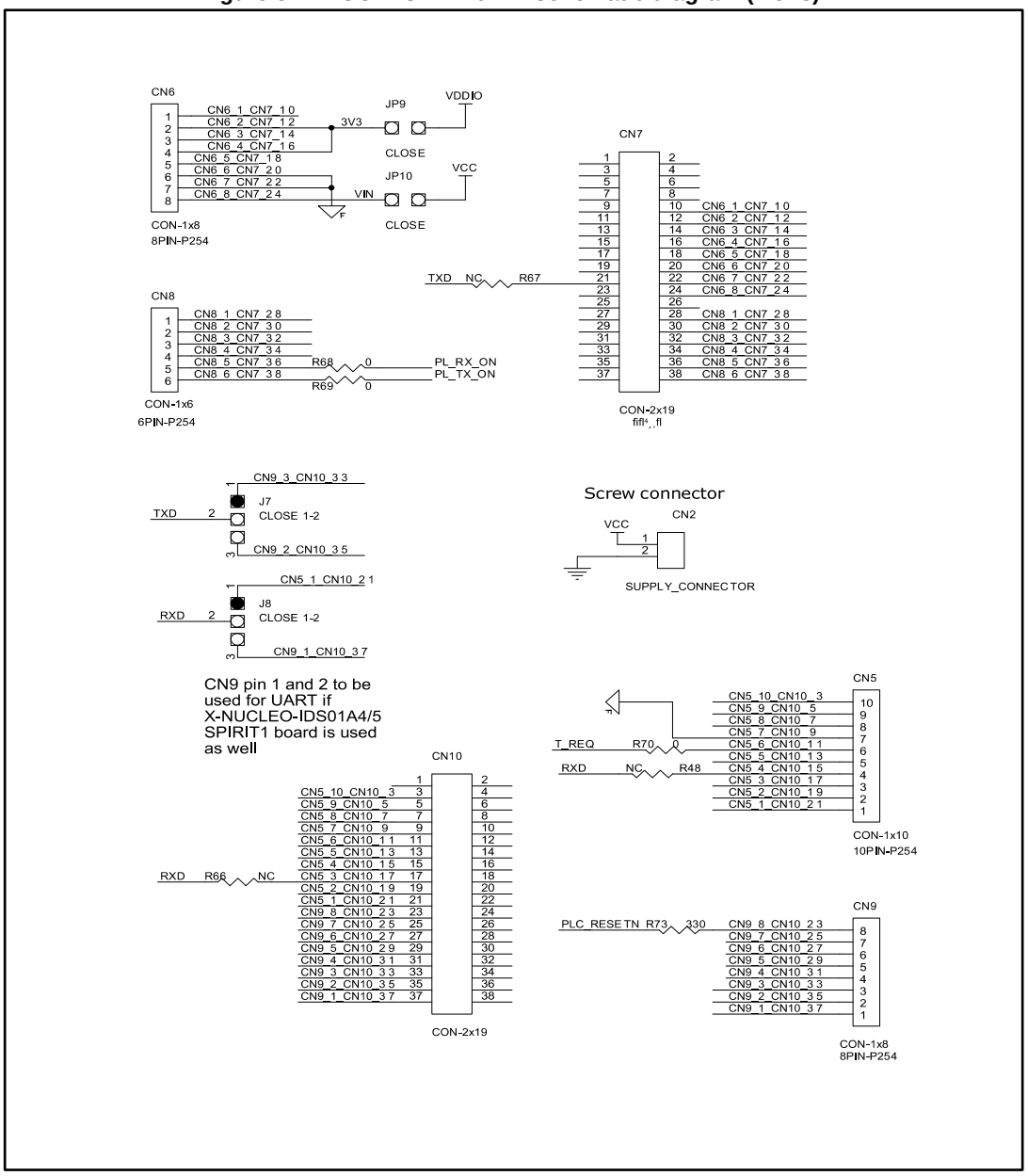
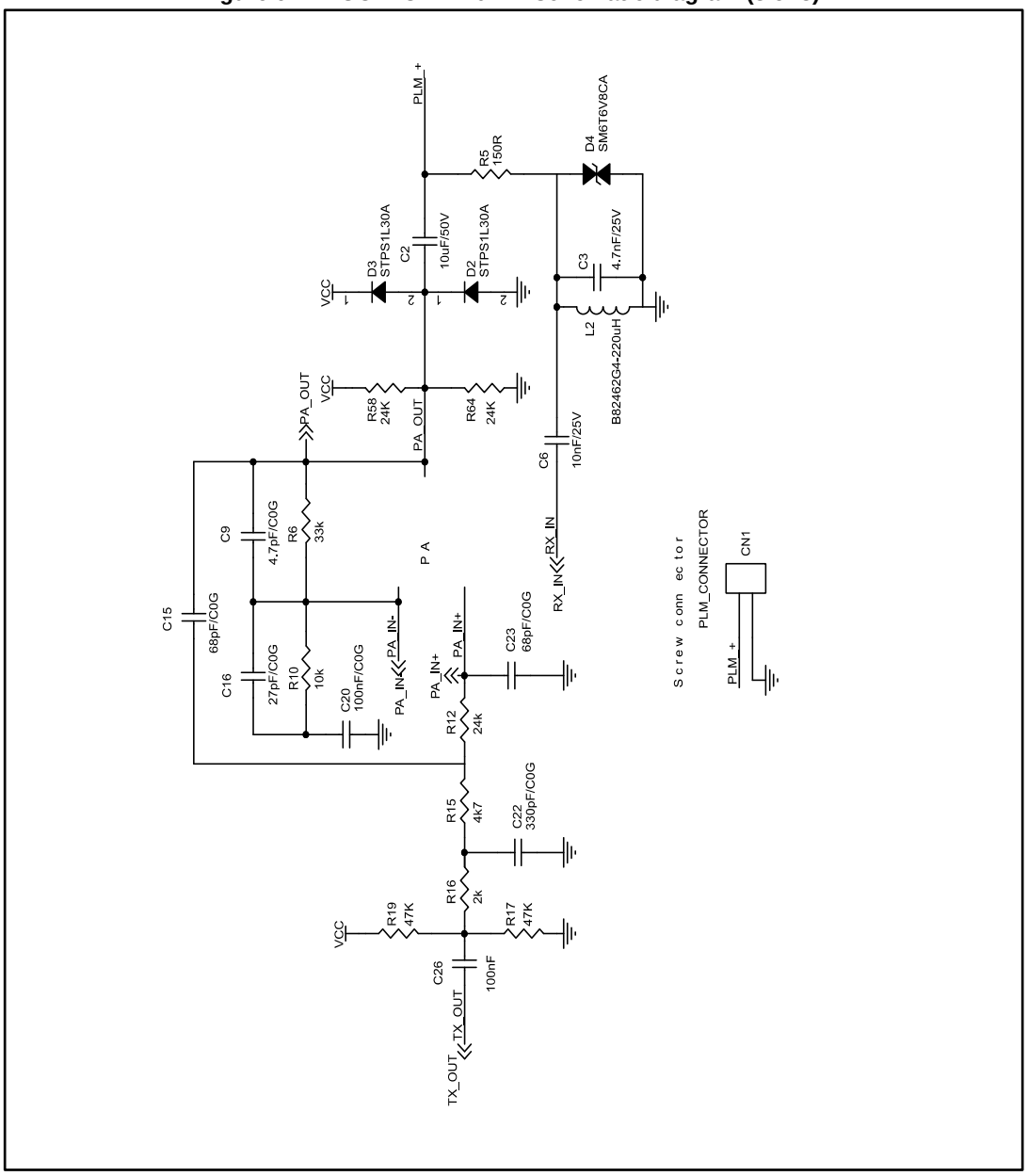


Figure 9: X-NUCLEO-PLM01A1 schematic diagram (3 of 3)



5 Bill of materials

Table 4: X-NUCLEO-PLM01A1 bill of materials

Item	Qty	Ref.	Part / Value	Description	Manufacturer	Order code
1	2	CN1, CN2	Screw connectors	2-way 3.81 mm PCB terminal block	Phoenix Contact	MKDS 1 /2-3.81
2	1	CN5	10 pins 10x1 - 2.54mm pitch	Arduino connector	SAMTEC	SSQ-110-03-F-S
3	2	CN6, CN9	8 pins 8x1 - 2.54mm pitch	Arduino connector	SAMTEC	SSQ-108-03-F-S
4	0	CN7, CN10	38 pins 19x2 - 2.54mm pitch	Morpho connectors	SAMTEC	SSQ-119-04-L-D
5	1	CN8	6 pins 6x1 - 2.54mm pitch	Arduino connector	SAMTEC	SSQ-106-03-G-S
6	1	C2	10 µF, 50 V 1206	Chip capacitor		
7	1	C3	4.7 nF, 25 V 0603	Chip capacitor		
8	1	C6	10 nF, 25 V 0603	Chip capacitor		
9	1	C8	10 µF, 25 V 1210	Chip capacitor		
10	1	C9	4.7 pF, C0G, 0402	Chip capacitor		
11	8	C10, C11, C13, C27, C30, C32, C34, C35	100 nF, 25 V 0402	Chip capacitor		
12	2	C12, C14	10 µF, 6.3 V 0603	Chip capacitor		
13	2	C15, C23	68 pF, C0G 0402	Chip capacitor		
14	1	C16	27 pF, C0G 0402	Chip capacitor		
15	1	C20	100 nF, C0G 0402	Chip capacitor		
16	1	C21	100 nF, 25 V 0603	Chip capacitor		
17	1	C22	330 pF, C0G 0402	Chip capacitor		
18	1	C26	100 nF 0402	Chip capacitor		
19	1	C28	10 µF, 10 V 0805	Chip capacitor		
20	1	C29	100 pF, C0G 0402	Chip capacitor		

Item	Qty	Ref.	Part / Value	Description	Manufacturer	Order code
21	1	C31	4.7 µF, 4 V 0402	Chip capacitor		
22	1	DL1	SMD 0603	Green LED		
23	1	DL2	SMD 0603	Red LED		
24	2	D2,D3	STPS1L30A	SMB		
25	1	D4	SM6T6V8CA	SMB		
26	1	FB1	BLM21PG331SN1 0603	Ferrite bead		
27	2	J7, J8	3x1 2.54 mm pitch	Jumper		
28	2	JP9, JP10	2x1 2.54 mm pitch	Jumper		
29	1	L2	B82462G4224M 6.3x6.3 mm	SMD inductor		
30	2	RN2,RN3	10 K	Resistor array	BOURNS	CAY10-103J4LF
31	1	R5	150 R 0603	Chip resistor		
32	1	R6	33 k 0402	Chip resistor		
33	5	R9,R10,R23,R30,R47	10 K 0402	Chip resistor		
34	1	R11	91 R 0402	Chip resistor		
35	3	R12,R58,R64	24 K 0402	Chip resistor		
36	1	R15	4k7 0402	Chip resistor		
37	1	R16	2 k 0402	Chip resistor		
38	2	R17,R19	47 K 0402	Chip resistor		
39	2	R31,R32	560 R 0402	Chip resistor		
40	0	R48,R66,R67	NOT MOUNTED	Chip resistor		
41	3	R68,R69,R70	0 R 0402	Chip resistor		
42	1	R73	330 R 0402	Chip resistor		
43	1	U2	ST7580	QFN48 with exposed pad		
44	1	Y3	8.0000 MHz HC49U	Quartz crystal	RS	478-9347

6 Revision history

Table 5: Document revision history

Date	Revision	Changes
28-Jun-2017	1	Initial release.

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