Getting started with X-NUCLEO-LED16A1 16-channel LED driver expansion board for STM32 Nucleo

Introduction

The X-NUCLEO-LED16A1 is an STM32 Nucleo expansion board designed to provide an application for the 16 channel LED driver LED1642GW. Multiple drivers can also be cascaded by coupling X-NUCLEO-LED16A1 expansion boards.

Depending upon the end application, RGB or single color LEDs can be connected to the board. Separate brightness control is possible for each channel.

It is compatible with the STM32 Nucleo board family and with the Arduino™ UNO R3 connector layout.

Figure 1: X-NUCLEO-LED16A1 expansion board

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1 Getting started

This section describes the hardware and software requirements for the X-NUCLEO-LED16A1 expansion board for STM32 Nucleo.

1.1 System setup

The X-NUCLEO-LED16A1 is an expansion board for use with STM32 Nucleo boards. To function correctly, STM32 Nucleo board must be connected to X-NUCLEO-LED16A1 shown.

Figure 2: STM32 Nucleo development board plus X-NUCLEO-LED16A1 expansion board setup
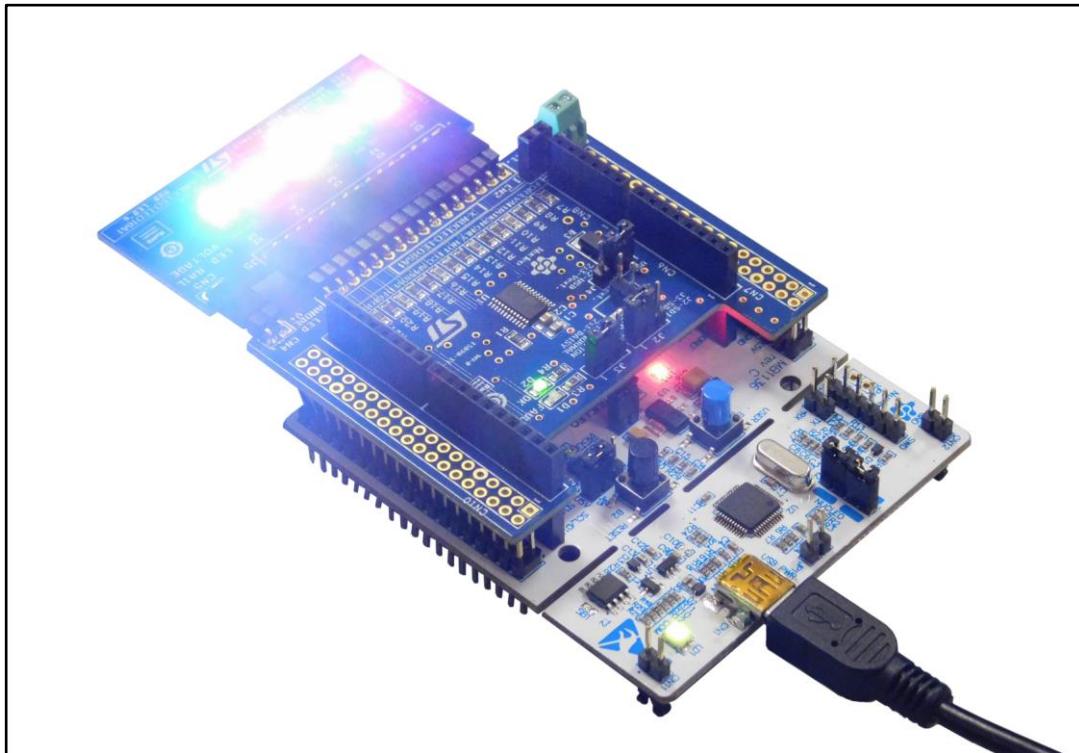
The connection between STM32 Nucleo and X-NUCLEO-LED16A1 is designed for use with any STM32 Nucleo or Arduino UNO R3 Platform.

When mounting X-NUCLEO-LED16A1 on the STM32 Nucleo:

* ensure that all are pins aligned with their corresponding connector.
* handle both boards carefully to avoid damaging or bending the male/female connectors and pins.

1.2 System requirements

The following software and hardware is required:

* An STM32 Nucleo development board (suggested order code: either NUCLEO-F401RE or NUCLEO-L053R8).
* A 16 Channel LED driver expansion board (order code: X-NUCLEO-LED16A1).
* A string of 16 LEDs connected in parallel or X-NUCLEO-LED16A1 expansion board.
* A Windows® (8 and above) PC.

- A USB type A to Mini-B USB cable connect the STM32 Nucleo to the PC to:
  a. power the STM32 Nucleo development and X-NUCLEO expansion boards
  b. install the board firmware package (order code: X-CUBE-LED1642) and run the sample application
- An optional external power supply, 4.8-5.2V/2A (depending on the number of stacked X-NUCLEO-LED16A1 expansion boards).

2   Hardware description

The X-NUCLEO-LED16A1 expansion board for use with STM32 Nucleo development boards has 16 channels which can be individually controlled. The board can be powered through a 5 V USB supply or an external power supply.

Figure 3: X-NUCLEO-LED16A1 block diagram
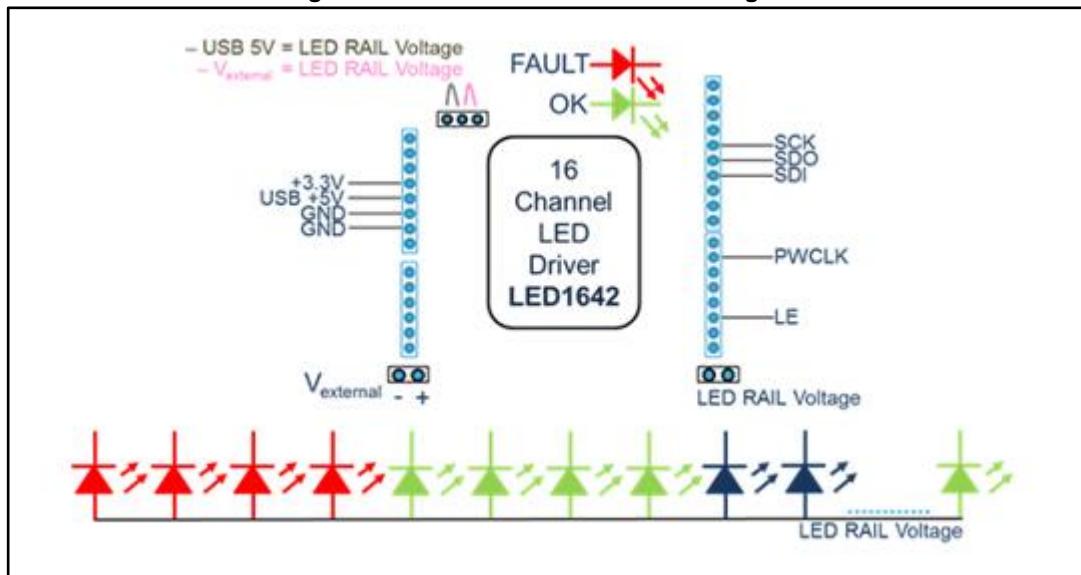
The board features:

- 16 configurable O/P channels
- Output current: from 3 mA to 40 mA
- 20 V current generator rated voltage
- Provision for cascading multiple boards
- Current adjustment:
    - 7-bit global current gain adjustment
    - Current programmable through external resistor
    - 12/16 bit grayscale brightness control
- Selectable LED Bus voltage supply
    - USB
    - $V_{external}$
- Error detection
    - Open LED
    - Shorted LED
- Thermal shutdown
- Compatible with STM32 Nucleo board
- Equipped with Arduino™ UNO R3 connector
- RoHS compliant

2.1 Hardware components

The X-NUCLEO-LED16A1 board features several key components, jumpers and connectors.

Figure 4: X-NUCLEO-LED16A1 (Top)
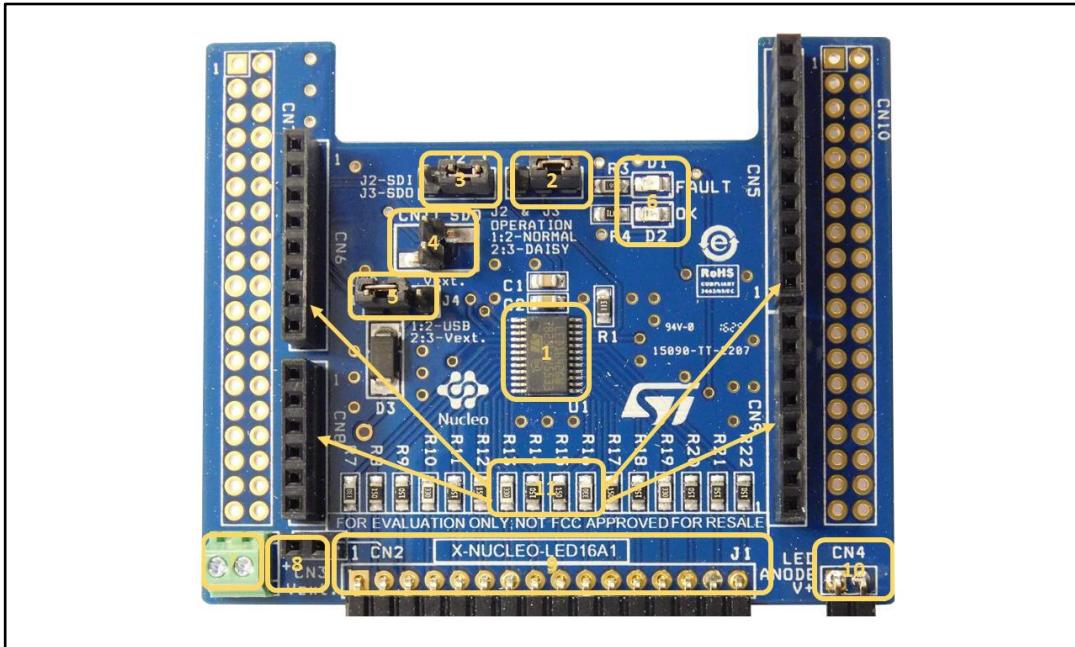
1. LED1642GW LED driver – U1
2. Jumper for selecting SDO line termination (daisy chain or MCU) – J3
3. Jumper for selecting SDI line Initiation (daisy chain or MCU) – J2
4. Connector to connect SDO line in case of daisy chain selection – CN11
5. Jumper for selecting LED rail voltage supply (USB or Vexternal) – J4
6. Indication LED's (red – fault, green – OK)
7. Input Connector to external voltage power supply – CN3
8. Connector for a common input external voltage power supply – CN2
9. LED's Cathode are to connected – J1
10. LED Rail Voltage Supply (Common Anode of all J1 Led's) – CN4
11. ArduinoTM UNO R3 connector – CN5,CN6,CN8,CN9
12. Connector to connect SDO line in case of Daisy Chain Selection – CN1

Figure 5: X-NUCLEO-LED16A1 (Bottom)
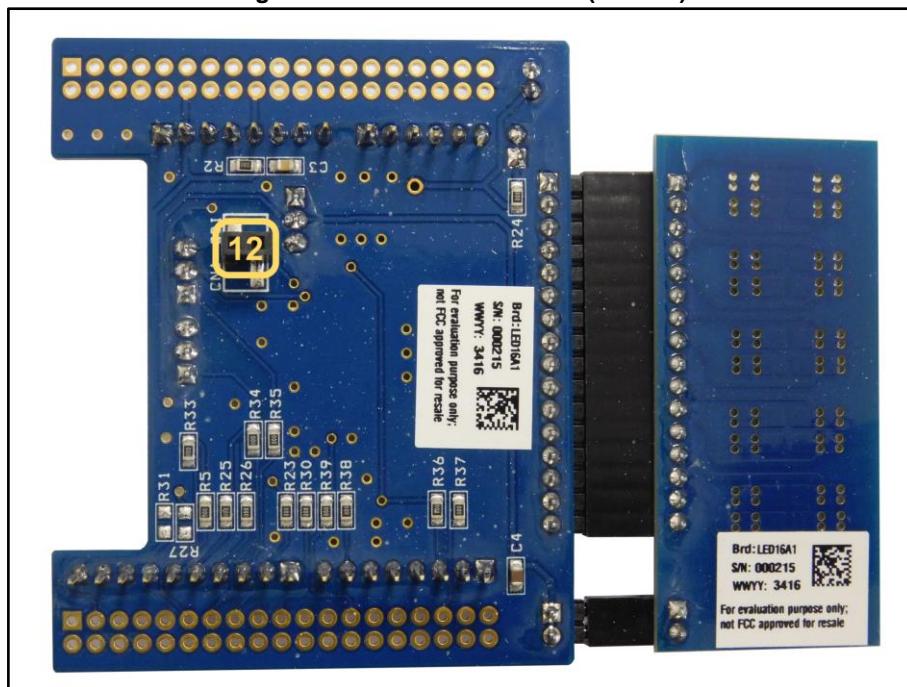
Figure 6: X-NUCLEO-LED16A1 RGB LEDs
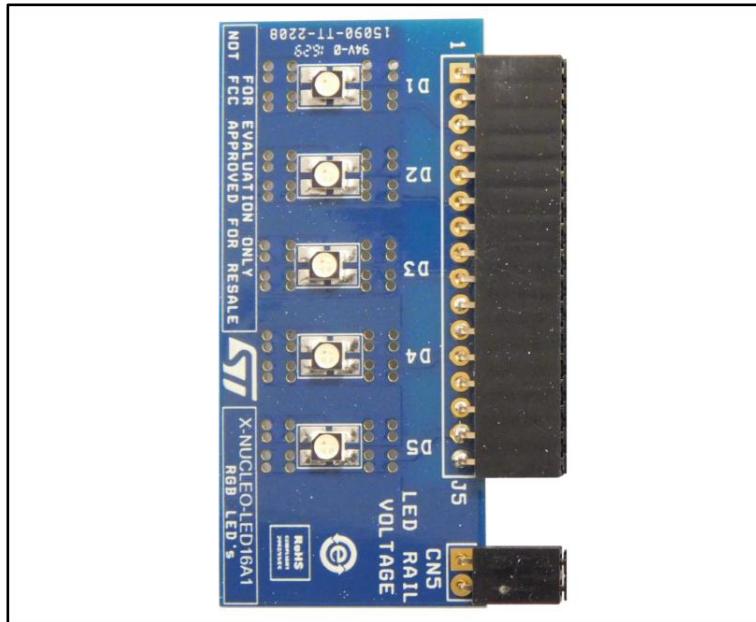

2.2 Hardware functional overview

Once the proper firmware is installed on the STM32 Nucleo board and the jumpers and connectors are configured correctly, supplying power causes the green OK LED (D2) on the X-NUCLEO-LED16A1 expansion board and predefined LED patterns run every eight seconds:

1. All LEDs ON at full bightness
2. LED train forward – single LED
3. LED train reverse

4. LED brigntness – maximum at centre LED
5. Error detection – red FAULT LED (D1) lights up
6. LED brigntness – low to high
7. Different LED – solid color
8. Random LED – random brightness
9. All LEDs ON with less bightness

You can also cycle through the LED sequences by pressing the blue B1 USER button on the STM32 Nucleo board.

Incorrect jumper configurations causes the red LED (FAULT) to light up.

2.3 Jumper settings

2.3.1 LED rail voltage source selection

The X-NUCLEO-LED16A1 LED rail voltage source can be set according to the settings in the following table.

Table 1: LED Rail Voltage Source Selection

Jumper	USB 5V supply[1]			External supply[2]		
	Pin1	Pin2	Pin3	Pin1	Pin2	Pin3
J4	YES	YES	NO	NO	YES	YES

Notes:

[1]Ensure output power consumption is below the USB power rating

[2]External voltage supply should be between 4.8 and 5.2 V, capable enough of delivering current as per number of boards used and LED1642GW configuration

2.3.2 SDI-SDO configuration for daisy chain selection

The X-NUCLEO-LED16A1 board can be stacked to operate the LED1642GW LED driver in the daisy chain configuration figured below.

Figure 7: Daisy chain configuration
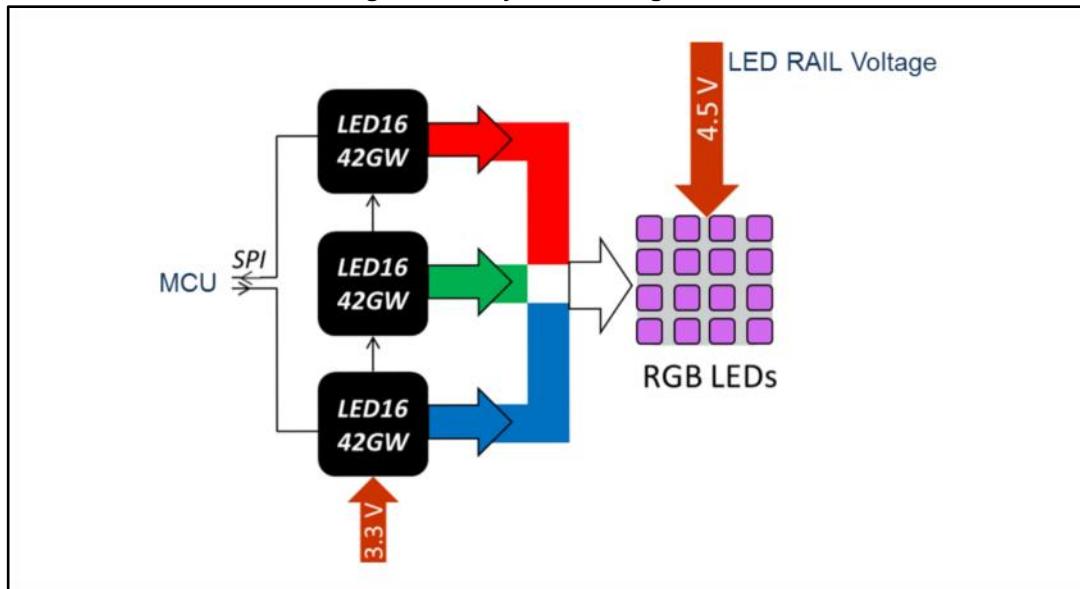
The X-NUCLEO-LED16A1 expansion board lets you configure the SDI and SDO lines of SPI through Jumpers J2 and J3, as per the following tables.

Table 2: SDI line source selection

Jumper[1]	SDI-MCU			SDI-SDO of adjacent board		
	Pin1	Pin2	Pin3	Pin1	Pin2	Pin3
J2	YES	YES	NO	NO	YES	YES

Notes:

[1]first board stacked on STM32 Nucleo always has 1:2 setting

Table 3: SDO line destination selection

Jumper[1]	SDO-MCU			SDO-SDI of adjacent board		
	Pin1	Pin2	Pin3	Pin1	Pin2	Pin3
J3	YES	YES	NO	NO	YES	YES

Notes:

[1]last board stacked on STM32 Nucleo always has 1:2 setting

2.4 Fault management

The X-NUCLEO-LED16A1 detects fault conditions according to the LED1642GW configuration register. Open Circuit, short circuit and combined error tests can be performed; error detection events will light the red FAULT LED on the board.

2.5 Connector descriptions

- **CN3** – Connection of external LED rail voltage supply.
- **CN4 - CN5 (RGB LEDs board)** – All 16 LED anode terminals are fed the LED rail voltage via connectors CN4 and CN5, as figured below.

Figure 8: X-NUCLEO-LED16A1 connections
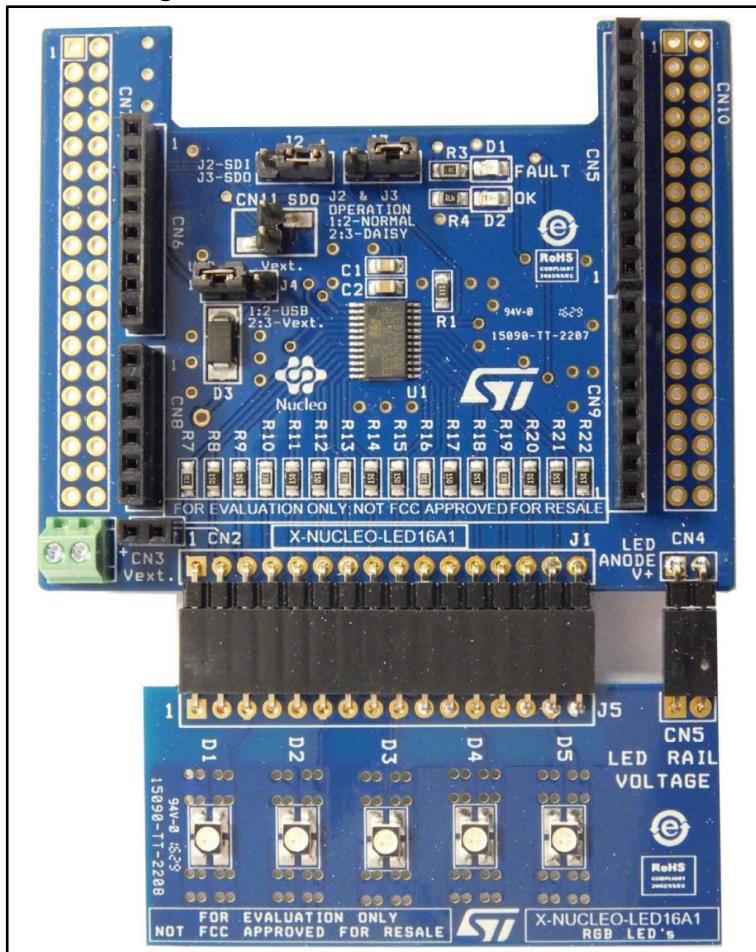
- **CN2** – Passes the external voltage power supply (from CN3) to subsequent boards in daisy chain configurations.

> To supply different rail voltages to different X-NUCLEO-LED16A1 boards in the daisy chain, open resistance R24 and supply the individual voltages through CN3 on each board.

- **CN10 and CN11** – In daisy chain configurations these connectors are for transferring SPI data between adjacent X-NUCLEO-LED16A1 boards. The behavior of these connectors depends on jumper J2 and J3 settings.

Table 4: Input output connector table

Connector	Pin	Signal
CN2	1	Common rail voltage for multiple boards
	2	
CN3	+	+ External Voltage
	-	- External Voltage
CN4	1	+ LED Rail Voltage
	2	

The default pin assignments for X-NUCLEO-LED61A1 (Arduino) connectors are shown below.

Table 5: X-NUCLEO connector (Arduino) table

Connector	Pin	Signal
CN5	7	GND
CN6	6	
CN6	7	
CN6	2	+3.3V
CN6	4	
CN6	5	+5V
CN5	2	FAULT/OK LED CONTROL
CN5	4	SDI
CN5	5	SDO
CN5	6	SCK
CN9	3	LE
CN9	7	PWCLK

3 BoM, schematics and layout

3.1 Bill of materials

Table 6: X-NUCLEO-LED16A1 bill of materials

Item	Q.ty	Reference	Part / Value	Description	Manufacturer	Order code
1	1	U1	LED1642GWXTTR	16 Channel LED Driver	ST	LED1642GWXTTR
2	1	D3	STPS1L30A	Schottky	ST	STPS1L30A
3	14	R2, R5, R23, R24, R25, R26, R30, R33, R34, R35, R36, R37, R38, R39	0 Ω		ANY	ANY
4	5	R7, R10, R13, R16, R19	33 Ω		ANY	ANY
5	11	R8, R9, R11, R12, R14, R15, R17, R18, R20, R21, R22	15 Ω		ANY	ANY
6	1	R3	560 Ω ±5%		ANY	ANY
7	1	R4	470 Ω ±5%		ANY	ANY
8	1	R1	11 kΩ ±5%		ANY	ANY
9	2	R27,R31	DNM			
10	2	C1,C3	100 nF 16 V ±10%	Ceramic	ANY	ANY
11	1	C2	10 µF 16 V ±10%	Ceramic	ANY	ANY
12	1	C4	10 µF 35 V ±10%	Ceramic	ANY	ANY
13	1	D1	LED (RED)		ANY	ANY
14	1	D2	LED (GREEN)		ANY	ANY
15	1	J1	16-Pin BergStick Male	2.54mm Pitch, Right Angle	ANY	ANY
16	3	J2, J3, J4	3-Pin BergStick Male	2.54mm Pitch	ANY	ANY
17	1	CN1	2-Pin BergStick Female	2.54mm Pitch	Sullins Connector Solutions	NPTC021KFXC-RC/S5594-ND (DIGIKEY)
18	1	CN2	CON2	2.54mm Pitch	SAMTEC	SSQ-102-03-F-S

Item	Q.ty	Reference	Part / Value	Description	Manufacturer	Order code
19	1	CN11	2-Pin BergStick Male	2.54mm Pitch	Molex	0878980204/WM9852-ND(Digikey)
20	1	CN3	Terminal Block	2.54mm Pitch	On Shore Technology Inc.	OSTVN02A150/ED10561-ND(Digikey)
21	1	CN4	2-Pin BergStick Male	2.54mm Pitch, Right Angle	ANY	ANY
22	1	CN5	CON10		SAMTEC	SSQ-110-03-F-S
23	2	CN6, CN9	CON8		SAMTEC	SSQ-108-03-F-S
24	2	CN7, CN10	DNM		SAMTEC	SSQ-119-04-L-D
25	1	CN8	CON6		SAMTEC	SSQ-106-03-F-S
26	3	Female Straight Black Open Top 2 Way			R.S.	674-2397

Table 7: X-NUCLEO-LED16A1 - RGB LEDs bill of materials

Item	Q.ty	Reference	Part / Value	Description	Manufacturer	Order code
1	5	D1, D2, D3, D4, D5	RGB LEDs	Common Anode	Wurth Elektronik	150141M173100
2	1	J5	16-Pin BergStick Female	2.54mm Pitch, Right Angle	ANY	ANY
3	1	CN5	2-Pin BergStick Female	2.54mm Pitch, Right Angle	ANY	ANY

3.2   Schematic diagram

Figure 9: X-NUCLEO-LED16A1 circuit schematic
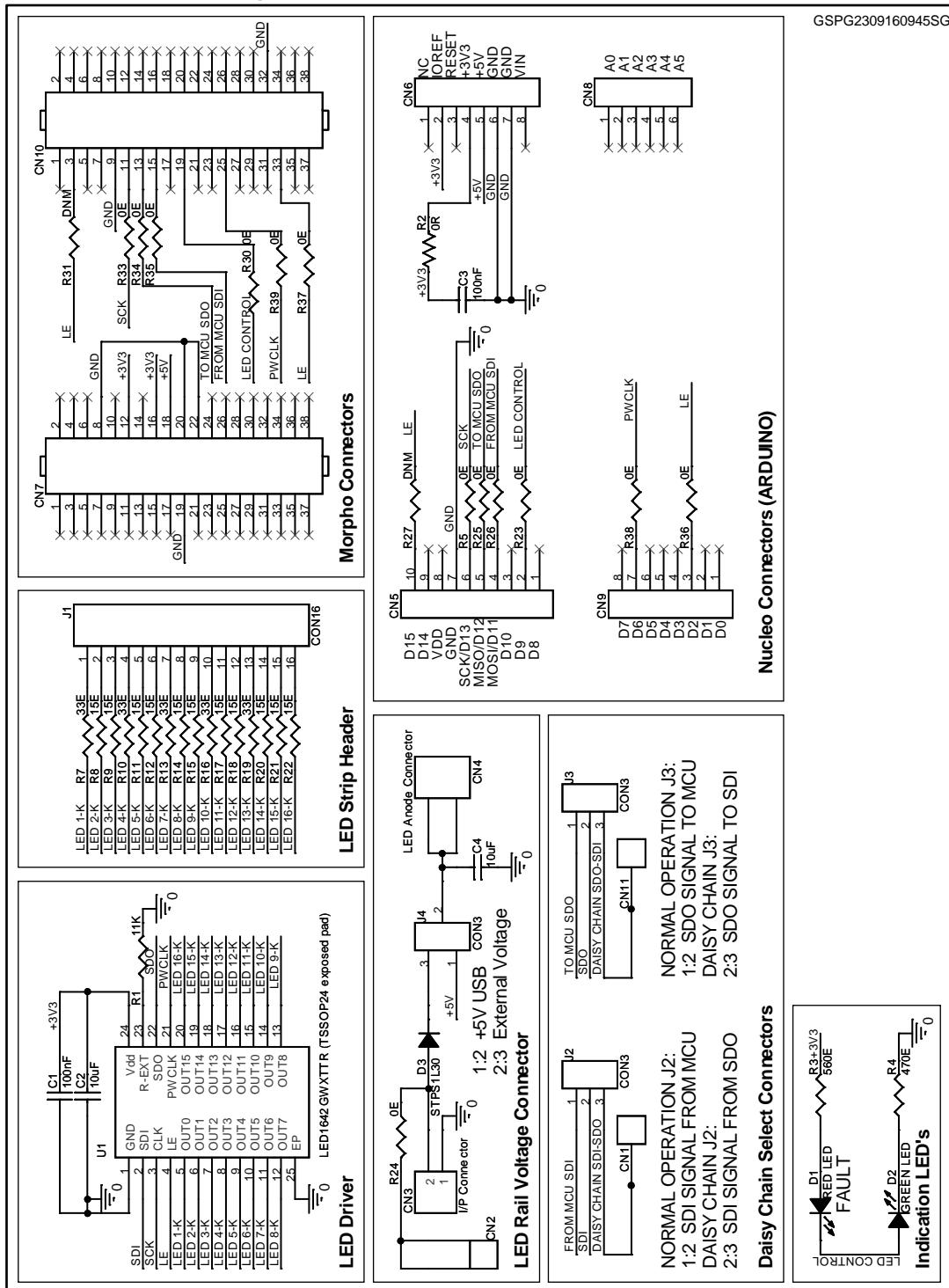
3.3   Layout

Figure 10: X-NUCLEO-LED16A1 layout (top)
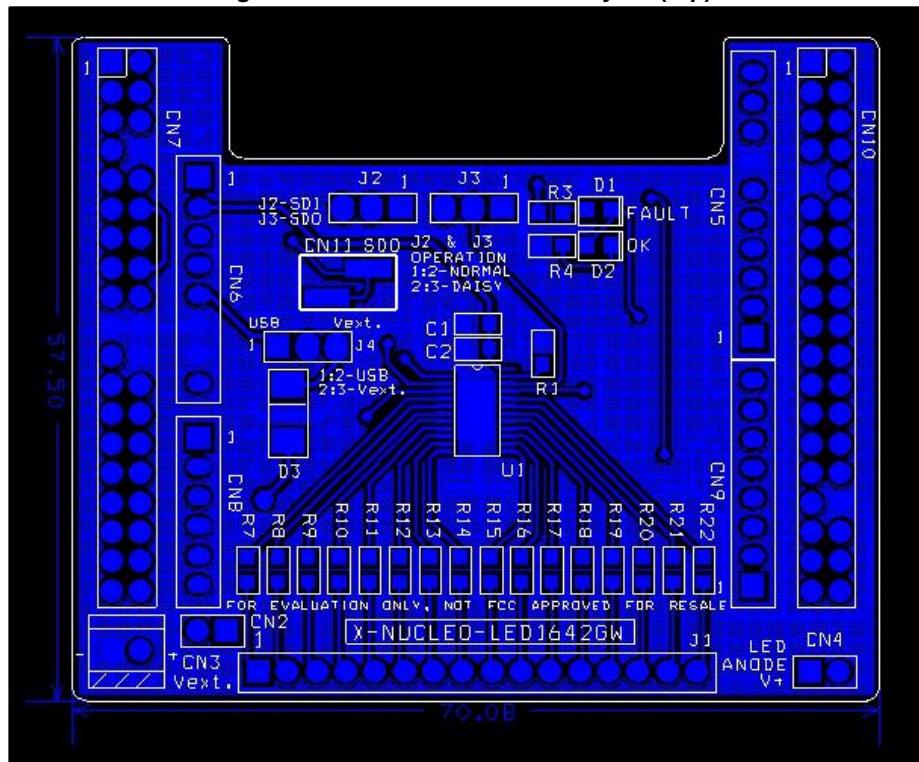
Figure 11: X-NUCLEO-LED16A1 layout (bottom)
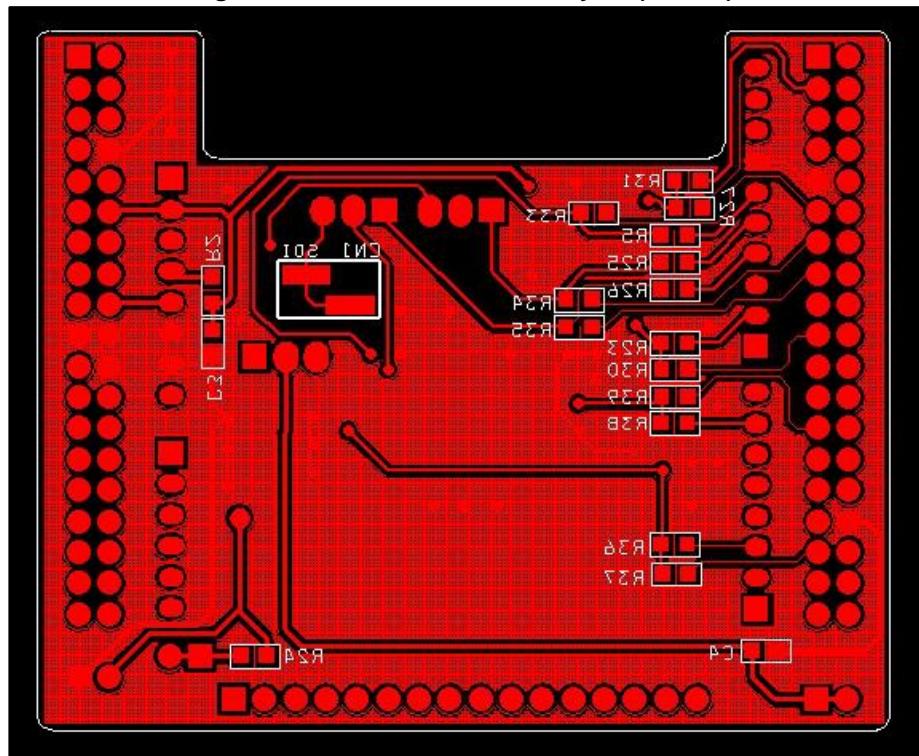
4 Revision history

Table 8: Document revision history

Date	Version	Changes
21-Nov-2016	1	Initial release.

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