Getting started with the X-NUCLEO-53L8A1 Time-of-Flight expansion board based on the VL53L8 series for STM32 Nucleo

Introduction

The X-NUCLEO-53L8A1 is an expansion board for any STM32 Nucleo development board equipped with the Arduino R3 connectors. It provides a complete evaluation kit that allows you to learn, evaluate, and develop applications based on the VL53L8 series Time-of-Flight sensors.

The expansion board is delivered with a cover glass holder in which you can fit three different spacers of 0.25, 0.5, and 1 mm height below the cover glass to simulate various air gaps. A small oval cover glass fitting the sensor is included.

Several ST expansion boards can be stacked through the Arduino connectors, which allow, for example, the development of VL53L8 applications with Bluetooth or Wi-Fi interfaces.

Figure 1. X-NUCLEO-53L8A1 expansion board

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For further information contact your local STMicroelectronics sales office.

www.st.com

1 Getting started

1.1 Safety considerations

1.1.1 Electrostatic precautions

Warning: *Take electrostatic precautions, including ground straps, when using the X-NUCLEO-53L8A1 expansion board. Failure to prevent electrostatic discharge could damage the device.*

Figure 2. Electrostatic logo

1.1.2 Laser safety considerations

The VL53L8CX contains a laser emitter and the corresponding drive circuitry.

The laser output is designed to remain within Class 1 laser safety limits under all reasonable foreseeable conditions, including single faults, in compliance with the IEC 60825-1:2014.

The laser output power must not be increased by any means and no optics should be used with the intention of focusing the laser beam.

The VL53L8CH contains a laser emitter and corresponding drive circuitry.

The laser output is designed to meet Class 1 laser safety limits under all reasonably foreseeable conditions including single faults in compliance with IEC 60825-1:2014.

- Do not increase the laser output power by any means.
- Do not use any optics to focus the laser beam.

The VL53L8CH complies with:

- IEC 60825-1:2014
- 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1:2014 as described in Laser Notice No.56, dated May 8, 2019
- EN 60825-1:2014 including EN 60825-1:2014/A11:2021
- EN 50689:2021 except for the requirement of clause 5 from EN50689 regarding Child Appealing Products

If designing a Child Appealing Product, please contact ST Technical Application Support.

Caution: Use of controls or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Figure 3. Class 1 laser product label

Figure 4. Laser notice 56: applies to IEC 60825-1:2014
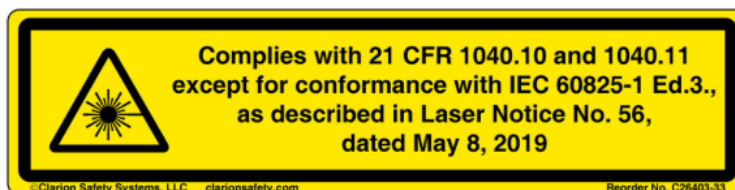
1.2   Features

- Time-of-Flight expansion board based on the VL53L8 series for STM32 Nucleo:
  - VL53L8CX low-power high-performance 8x8 multizone ToF sensor
  - VL53L8CH artificial intelligence enabler, high performance 8x8 multizone ToF sensor
- Hideable behind a dark cover window
- Accurate absolute ranging distance, independent of the reflectance of the target
- Up to 400 cm ranging
- Histogram-based technology
- I²C (up to 1 MHz) or SPI (up to 20 MHz) interface
- Multiobject detection capability
- 0.25, 0.5, and 1 mm spacers to simulate air gaps
- One cover glass to protect the sensor from dust
- Compatible with STM32 Nucleo development boards
- Equipped with Arduino UNO R3 connectors
- Full system software supplied, including code examples and graphical user interface
- RoHS, CE, UKCA, and China RoHS compliant

1.3   VL53L8 series Time-of-Flight sensor characteristics

- Laser wavelength : 940 nm
- Invisible laser radiation
- Maximum laser power emitted : 215 mW
- Integration time : 2 ms minimum

1.4   Spacers and covers

The X-NUCLEO-53L8A1 expansion board is delivered with:

- three spacers of 0.25 mm, 0.5 mm, and 1 mm height, used to simulate different air gaps between the VL53L8 and the rectangular-shaped cover glass;
- two twelve-pin headers that allow connecting the two mini PCB of the SATEL boards to the X-NUCLEO-53L8A1 expansion board through flying wires.

Attention: *The VL53L8 is delivered with a liner to prevent potential foreign material from piercing the module holes during the assembly process. Remove this liner before use.*

1.5   Ordering information

Table 1. Ordering information

Order code	PCB version	Core product
X-NUCLEO-53L8A1A	X$NUCLEO-53L8A1A	VL53L8

1.6 Ordering information for the VL53L8 series Time-of-Flight sensors

This board is equipped with a noncommercial VL53L8CA evaluation purposes only Time of Flight sensor. Its equivalent orderable products are listed in the following table. For a detailed description of each sensor, please refer to its datasheet on the product web page. Additional information is available from the user manual and collateral documents of the target ToF sensor.

Table 2. VL53L8 series ordering information

RPN	CPN	Datasheet	Features
VL53L8CX	VL53L8CXV0GC/1	DS14161	Low-power high-performance 8x8 multizone Time-of-Flight
VL53L8CH	VL53L8CHV0GC/1	DS14310	Artificial intelligence enabler, high performance 8x8 multizone Time-of-Flight sensor

2 Using the expansion board

The X-NUCLEO-53L8A1 expansion board allows the user to test the VL53L8 sensor functionality, to program it and to understand how to develop an application using this sensor.

The X-NUCLEO-53L8A1 integrates:

- the VL53L8 sensor;
- Arduino UNO R3 connectors;
- Connectors for SATEL-VL53L8 optional breakout boards;

Important: *Program a microcontroller to control the VL53L8 through the I2C bus.*

The application software and an example of the C-ANSI source code are available on the sensor web page.

The X-NUCLEO-53L8A1 expansion board can be connected to the STM32 Nucleo development board through the Arduino UNO R3 connectors (CN5, CN6, CN8, and CN9).

I²C (up to 1 MHz) and SPI (up to 20 MHz) interfaces are available on the X-NUCLEO-53L8A1 expansion board.

The user can choose between the two using the J9 jumper to configure the SPI_I2C_N signal as depicted in the following picture.

Figure 5. Use onboard jumper J9 to select between I2C and SPI interfaces
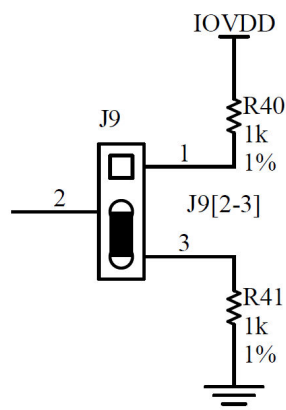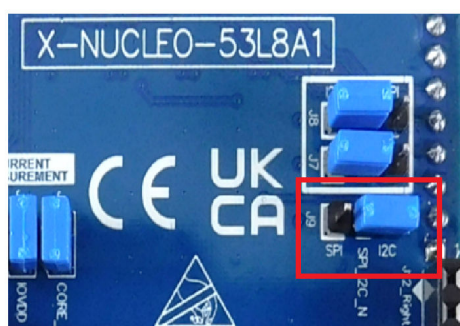
3 Breakout boards

The X-NUCLEO-53L8A1 package does not include the VL53L8 breakout boards.

You can purchase them in a pack of two PCBs as SATEL-VL53L8.

For mechanical integration purposes, it could be interesting to use the mini PCB by breaking the SATEL-VL53L8 along the red line as shown in the figure below. It is easier to integrate this setup into a customer's device thanks to its small size.

Figure 6. SATEL-VL53L8
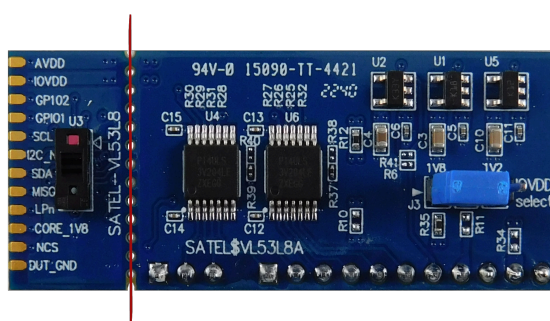
The SATEL-VL53L8 boards cannot be directly plugged onto the X-NUCLEO-53L8A1 through the two 6-pin headers (see Figure 7).

They can be connected to the X-NUCLEO-53L8A1 by using the mini PCB through flying wires (see Figure 9. VL53L8 mini PCB flying wire connection to the X-NUCLEO-53L8A1 expansion in SPI mode. J9 jumper with pin 1 and 2 connected).

The schematic can be duplicated for the sensor on the right allowing the use of both mini PCB.

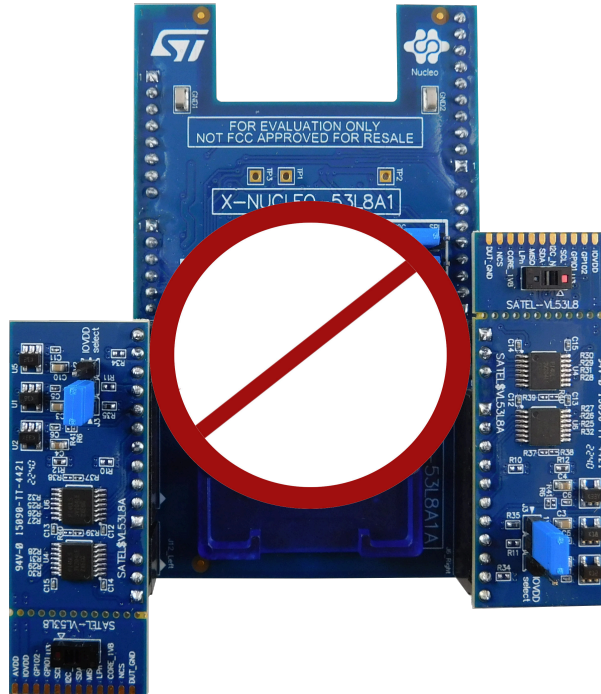**Figure 7. SATEL-VL53L8 breakout boards can not be connected to the X-NUCLEO-53L8A1 expansion board**

Figure 8. VL53L8 mini PCB flying wire connection to the X-NUCLEO-53L8A1 expansion board in I2C mode. J9 jumper with pin 2 and 3 connected
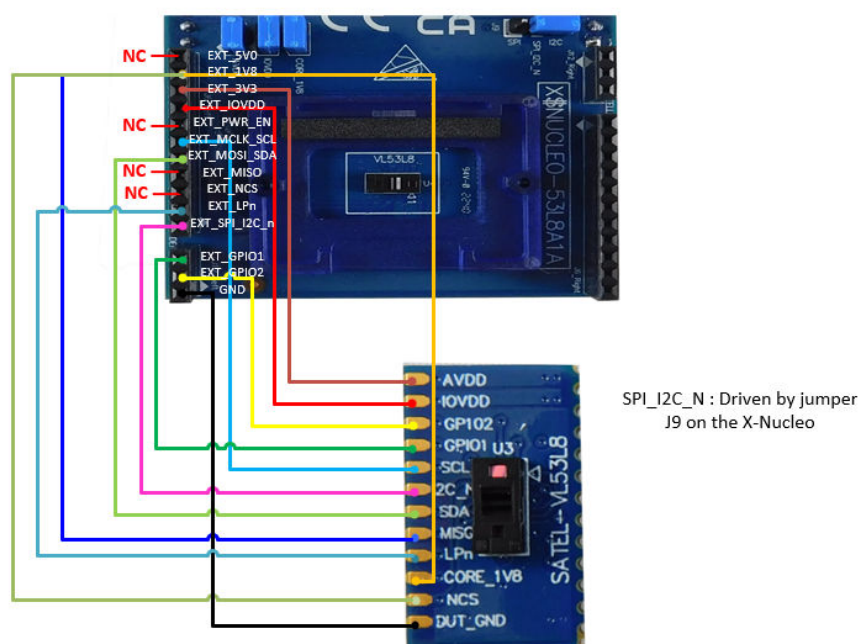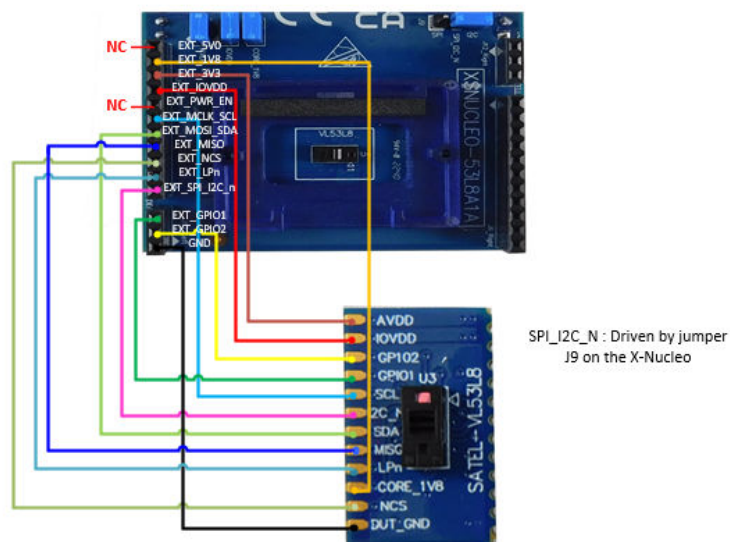
Figure 9. VL53L8 mini PCB flying wire connection to the X-NUCLEO-53L8A1 expansion in SPI mode. J9 jumper with pin 1 and 2 connected

4 Graphical user interface (GUI) and programming example for the X-NUCLEO-53L8A1

To evaluate the VL53L8 device performance, use the related GUI or the X-CUBE-TOF1.

The X-NUCLEO-53L8A1 expansion board requires the NUCLEO-F401RE development board to use the GUI or run the ranging examples included in the X-CUBE-TOF1.

*Important:* *Despite the fact that the X-NUCLEO-53L8A1 can be stacked on any STM32 Nucleo board equipped the Arduino R3 connectors, the GUI is designed to work with the NUCLEO-F401RE only.*

Download the GUI (in the Tools and Software tab of the X-NUCLEO-53L8A1 web page) or the X-CUBE-TOF1 to evaluate the VL53L8.

5 Schematic diagrams

Note: *These schematic diagrams refer to the board latest version.*

Figure 10. X-NUCLEO-53L8A1 circuit schematic (1 of 5)
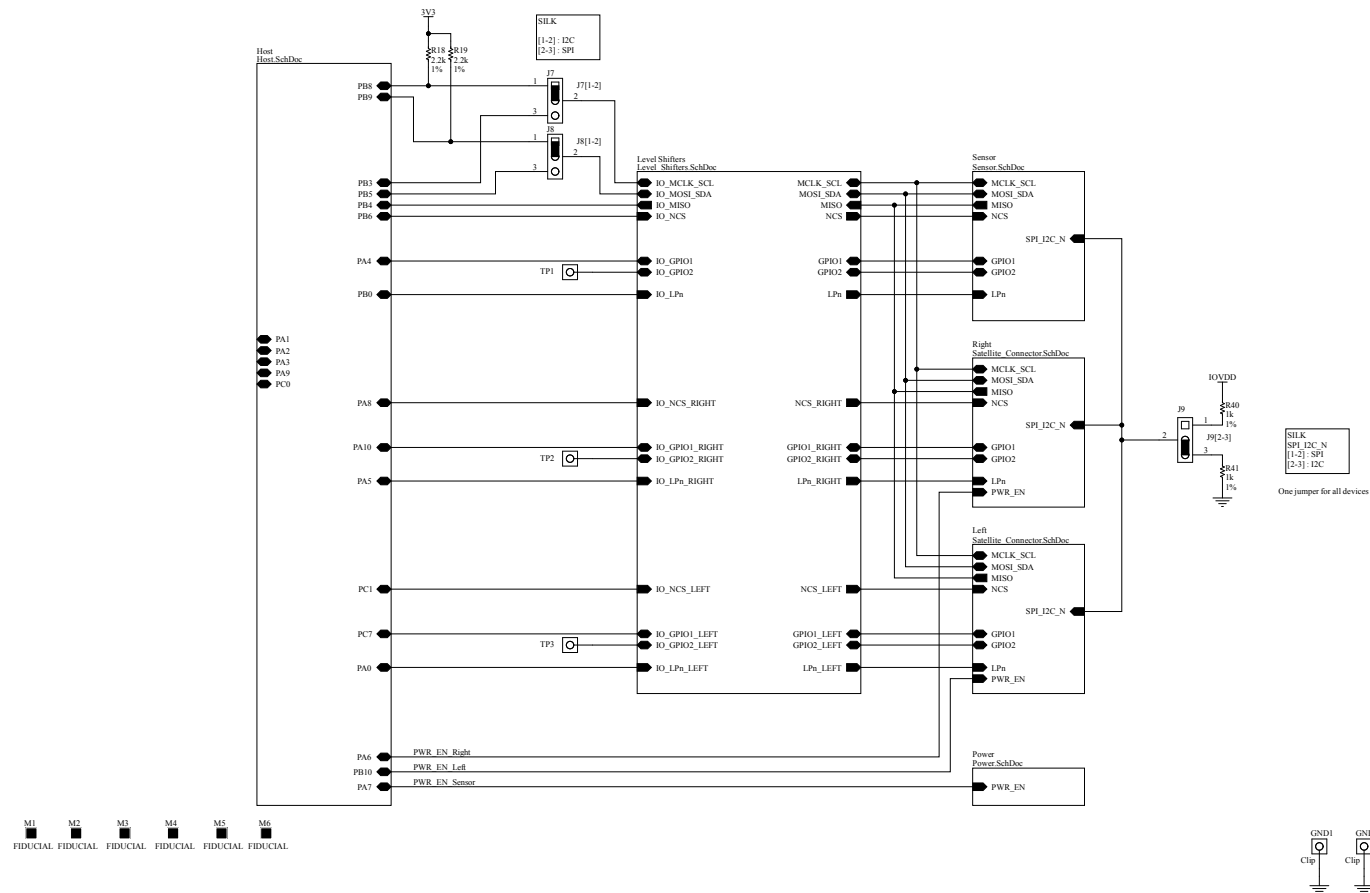
Note: *The display connector is an optional connector to connect an SSD1306 I2C OLED display to output the ranging data or other meaningful information if required. The related application note and example code will be available on st.com.*

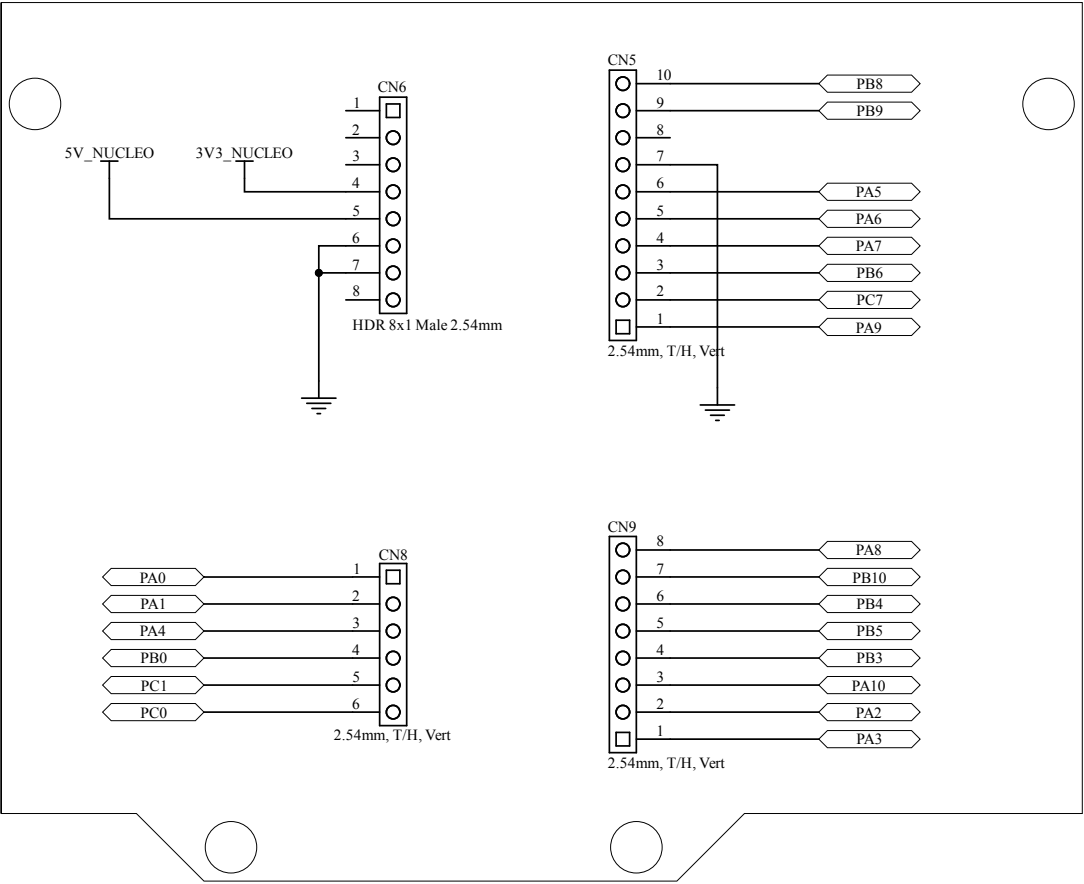**Figure 11. X-NUCLEO-53L8A1 circuit schematic (2 of 5)**

Nucleo Arduino connectors

CN6
1
2
5V_NUCLEO   3V3_NUCLEO   3
4
5
6
7
8
HDR 8x1 Male 2.54mm

CN5
10   PB8
9   PB9
8
7
6   PA5
5   PA6
4   PA7
3   PB6
2   PC7
1   PA9
2.54mm, T/H, Vert

CN8
PA0   1
PA1   2
PA4   3
PB0   4
PC1   5
PC0   6
2.54mm, T/H, Vert

CN9
8   PA8
7   PB10
6   PB4
5   PB5
4   PB3
3   PA10
2   PA2
1   PA3
2.54mm, T/H, Vert

Figure 12. X-NUCLEO-53L8A1 circuit schematic (3 of 5)

Power Section

3.3V LDO for Level shifters

3.3V LDO for AVDD

1.8V LDO for CORE_1V8 and IOVDD

Alternate part #XC6222D331MR-G

Alternate part #XC6222D331MR-G

Alternate part #XC6222B181MR-G 1.8V
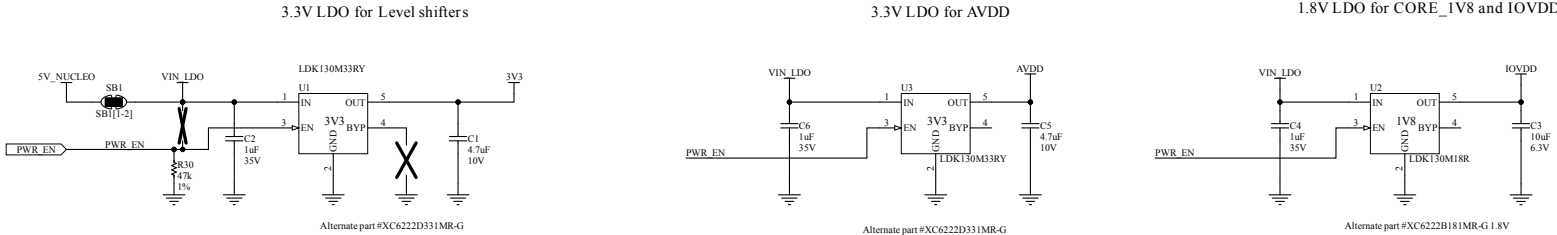
Figure 13. X-NUCLEO-53L8A1 circuit schematic (4 of 5)

SENSOR

NOTE

AVDD = 3V3 +/- 5%
CORE_1V8 = 1V8 +/- 10%
IOVDD = 1V8 +/- 10%

GPIO1: Open drain Interrupt Output
GPIO2: Open drain output/SYNC input

VL53L8CA

SPI_I2C_N LOW: I2C MODE
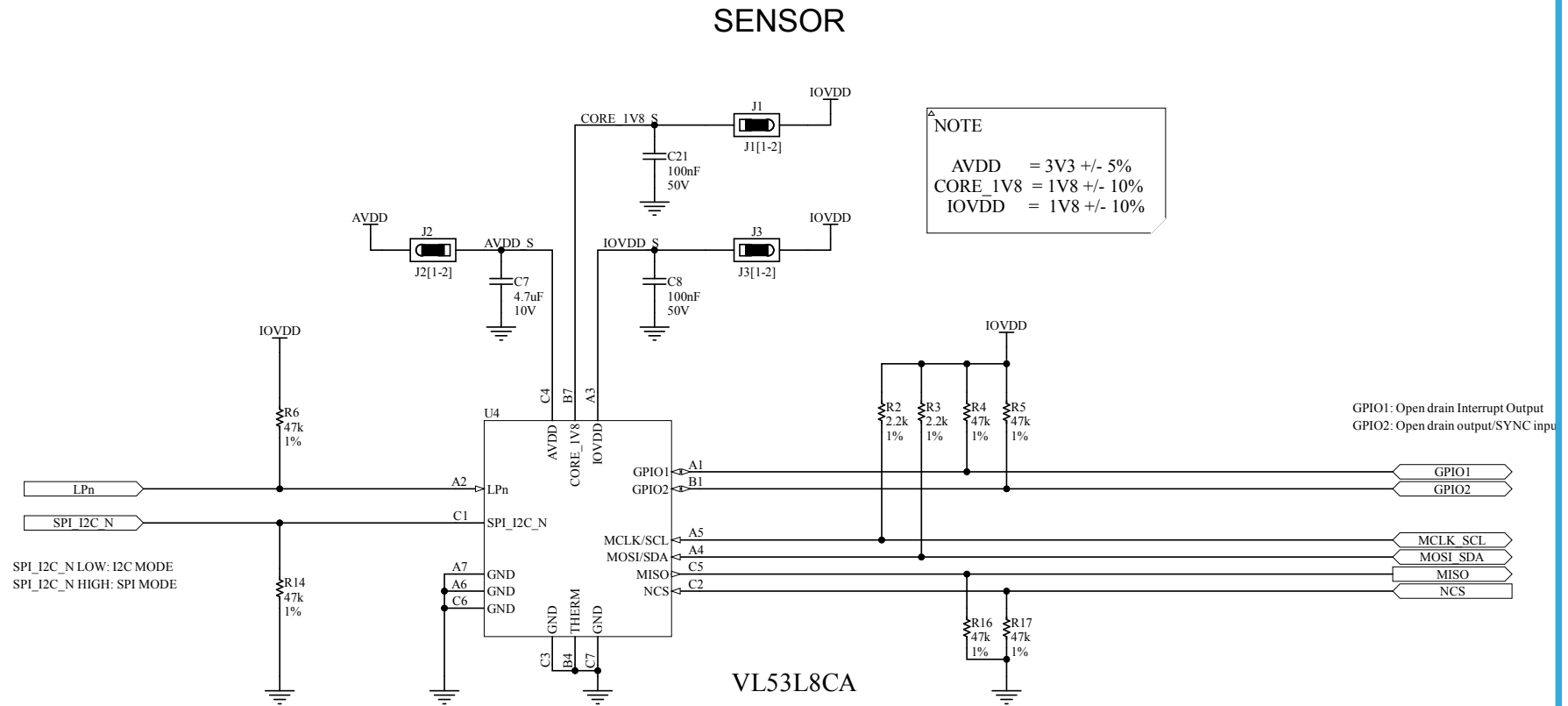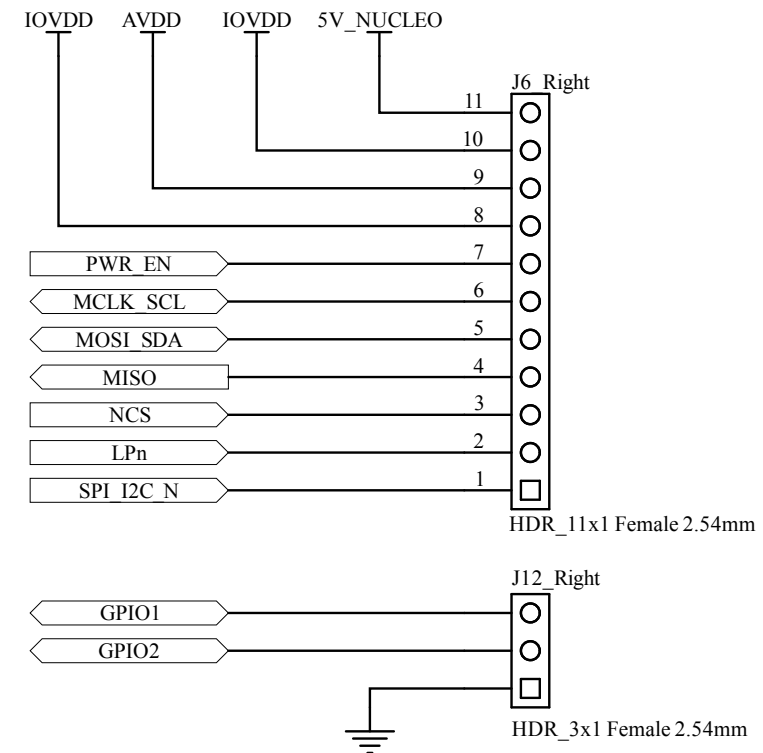SPI_I2C_N HIGH: SPI MODE

Figure 14. X-NUCLEO-53L8A1 circuit schematic (5 of 5)

Satellite board connector

NOTE

CORE_1V8 and IOVDD is
from the same 1.8V regulator

IOVDD   AVDD   IOVDD   5V_NUCLEO

J6_Right

11
10
9
8
PWR_EN   7
MCLK_SCL   6
MOSI_SDA   5
MISO   4
NCS   3
LPn   2
SPI_I2C_N   1

HDR_11x1 Female 2.54mm

J12_Right

GPIO1
GPIO2

HDR_3x1 Female 2.54mm

6 Bill of materials

Table 3. X-NUCLEO-53L8A1 bill of materials

Item	Quantity	Reference	Part/value	Description	Manufacturer	Order code
1	3	C2, C4, C6	1 µF	CAP, CER, 1uF, 35V, X5R, 0402	Murata	GRM155R6YA105KE11D
2	1	C3	10 µF	Capacitance, ceramic, 10 µF, 6.3 V, X5R, 0603	Kemet	C0603C106M9PACTU
3	10	C8, C9, C10, C11, C12, C13, C14, C15, C16, C21	100 nF	Capacitance, ceramic, 100 µF, 50 V, X5R, 0402	Murata	GRM155R61H104KE19
4	1	CN5	2.54 mm, T/H, Vert	Connectors, header, 10POS, 10x1, 2.54 mm, T/H, VERT	Harwin	M20-9991045
5	2	CN6, CN9	2.54 mm, T/H, Vert	Connectors, header, 08 POS, 8x1, 2.54 mm, T/H, VERT	Harwin	M20-9990845
6	1	CN8	2.54 mm, T/H, Vert	Connectors, header, 06 POS, 6x1, 2.54 mm, T/H, VERT	Harwin	M20-9990645
7	2	GND1, GND2	Clip	TESTPOINT, CLIP, TIN, SMD	Harwin	S1751-46R
8	3	J1, J2, J3	2x1 2.54 mm T/H	Connectors, header, 2POS, 2.54 mm, T/H, VERT	Harwin	M20-9990245
9	6	J1[1-2], J2[1-2], J3[1-2], J7[1-2], J8[1-2], J9[2-3]	0.1" Jumper Link	Link, header, 2.54 mm	Harwin	M7571-05
10	2	J6_Left, J6_Right	HDR_11x1 Female 2.54 mm	Connectors, header 11POS, SNGL, 2.54 mm, T/H	Samtec	SSW-111-01-G-S
11	3	J7, J8, J9	2.54 mm T/H	Connectors, header, 3POS, SNGL, 2.54 mm, T/H	Harwin	M20-9990345
12	2	J12_Left, J12_Right	HDR_3x1 Female 2.54 mm	Connectors RCPT 3POS 0.1 Gold PCB	Samtec	SSW-103-01-G-S
13	7	R4, R5, R6, R14, R16, R17, R30	47 k	Resistors, 47 k, 1 %, 1/10 W, 0402	Panasonic	ERJ2RKF4702X
14	4	R2, R3, R18, R19	2.2 k	Resistors, 2.2 k, 1 %, 1/16 W, 0402	Stackpole Electronics	RMCF0402FT2K20
15	4	R20, R22, R23, R26	10 k	Resistors, 10 k, 1 %, 1/16 W, 0402	Yageo	RC0402FR-0710KL
16	2	R40, R41	1 k	Resistors, 1 k, 1 %, 1/16 W, 0402	Yageo	RC0402FR-071KL
17	1	SB1[1-2]	Solder bridge	Link, solder	N/A	N/A
18	2	U1, U3	LDK130M33RY, SOT23-5L	IC, REG, LDO, 3.3 V, 0.3 A, SOT23-5L	ST	LDK130M33RY

Item	Quantity	Reference	Part/value	Description	Manufacturer	Order code
19	1	U2	LDK130M18R, SOT23-5L	IC, REG, LDO, 1.8 V, 0.3 A, SOT23-5L	ST	LDK130M18R
20	1	U4	VL53L8CA	Multi-zone time-of-flight ranging sensor	ST	VL53L8CAV0GC/1
21	4	U5, U6, U7, U8	PI4ULS3V204	IC, 4-bit bi-directional level shifter, TQFN3.5x3.5-14	Diodes Incorporated	PI4ULS3V204ZBEX
22	1	C19	10 nF	Capacitor, ceramic, 10 nF, 25V, X5R, 0402	AVX	04023D103KAT2A
23	1	R1	47 k	Resistor, 47 k, 1 %, 1/10 W, 0402	Panasonic	ERJ2RKF4702X
24	4	R21, R24, R25, R28	10 k	Resistors, 10 k, 1 %, 1/16 W, 0402	Yageo	RC0402FR-0710KL

7 Board versions

Table 4. X-NUCLEO-53L8A1 versions

PCB version	Schematic diagrams	Bill of materials
X\$NUCLEO-53L8A1A[1]	X\$NUCLEO-53L8A1A schematic diagrams	X\$NUCLEO-53L8A1A bill of materials

1. This code identifies the X-NUCLEO-53L8A1 evaluation board first version. It is printed on the board PCB.

8 Regulatory compliance information

Formal Notice Required by the U.S. Federal Communications Commission

For evaluation only; not FCC approved for resale

FCC NOTICE

This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

Formal Product Notice Required by Industry Canada Innovation, Science and Economic Development

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For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Formal product notice required by EU

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

Appendix A References

- VL53L8CX: DS14161
- X-NUCLEO-53L8A1: DB4921
- X-CUBE-TOF1: DB4449
- VL53L8CH: DS14310

Revision history

Table 5. Document revision history

Date	Revision	Changes
03-Mar-2023	1	Initial release.
31-Aug-2023	2	Updated Section Introduction, Section 1.1.2 Laser safety considerations, Section 1.2 Features, Table 2. VL53L8 series ordering information, Section 2 Using the expansion board and Appendix A References.

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