Getting started with X-NUCLEO-53L1A2 long distance ranging and multi target ToF sensor expansion board based on VL53L1 for STM32 Nucleo

Introduction

This document provides detailed hardware information on the X-NUCLEO-53L1A2 expansion board. This expansion board is compatible with the STM32 Nucleo family and the Arduino™ electronic boards. It is designed around the VL53L1 long distance ranging sensor with multi target detection, and is based on the ST patented FlightSense technology.

To allow the user to validate the VL53L1 in an environment as close as possible to its final application, the X-NUCLEO-53L1A2 expansion board is delivered with a holder in which three different height spacers of 0.25 mm, 0.5 mm, and 1 mm can be fitted with the cover glass above the spacer. The height spacers are used to simulate different air gap distances between the VL53L1 sensor and the cover glass.

The X-NUCLEO-53L1A2 expansion board is delivered with two VL53L1 breakout boards.

Figure 1. **X-NUCLEO-53L1A2 expansion board, spacers, cover glass, and breakout boards**

1 Overview

The X-NUCLEO-53L1A2 expansion board features the VL53L1 long distance ranging sensor with multi target detection, based on ST's FlightSense, Time-of-Flight (ToF) technology.

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

Several ST expansion boards can be stacked through the Arduino connectors, which allows, for example, the development of VL53L1 applications with Bluetooth or Wi-Fi interfaces.

The X-NUCLEO-53L1A2 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 VL53L1 and the cover glass.
- Two cover windows to simulate the integration of the VL53L1 into the customer's final product.
- Two VL53L1 breakout boards which can be plugged onto the X-NUCLEO-53L1A2 expansion board or connected through flying wires to the X-NUCLEO-53L1A2 expansion board.
- Two 10-pin connectors to enable the customer to connect the two breakout boards onto the X-NUCLEO-53L1A2 expansion board.

Note: The VL53L1 is delivered with a liner to prevent potential foreign material from penetrating inside the module holes during the assembly process. This liner must be removed at the latest possible step during final assembly, before module calibration.

Table 1. Ordering information

Order code	Description
X-NUCLEO-53L1A2	STM32 Nucleo expansion board - spacers and glass - two breakout boards

2 Document references

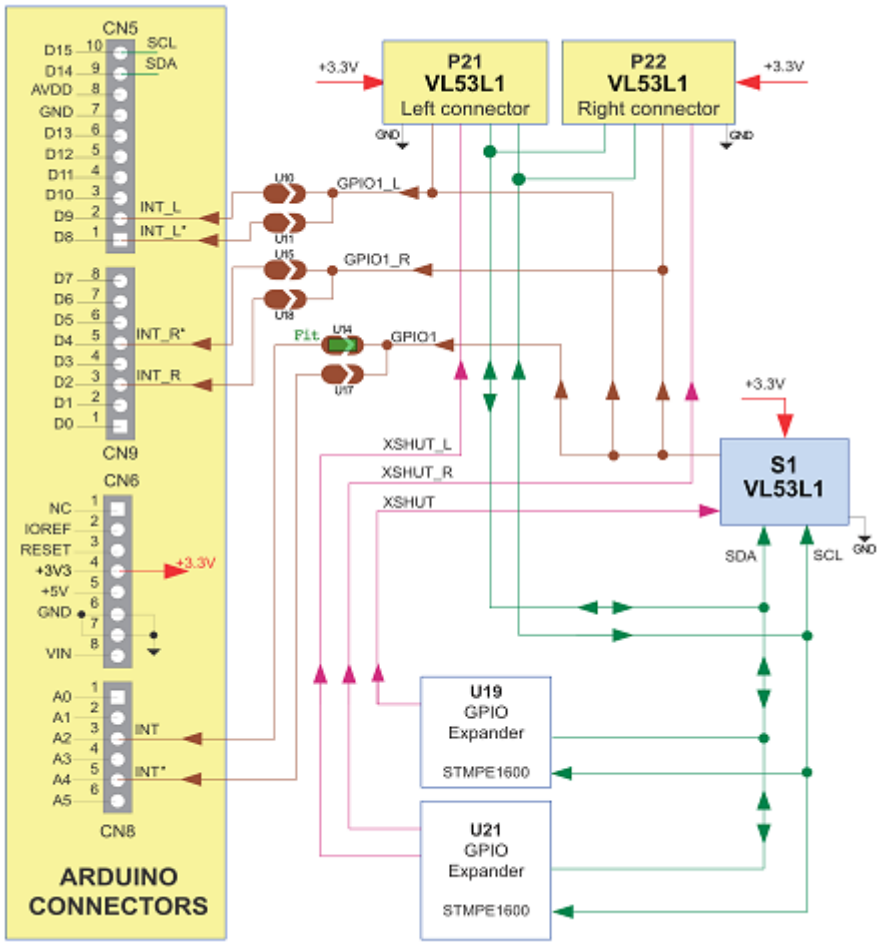
Table 2. **Document references**

Description	DocId
VL53L1 datasheet	DS11786
X-NUCLEO-53L1A2 data brief	DB4214
P-NUCLEO-53L1A2 data brief	DB4261
X-CUBE-53L1A2 data brief	DB4252

3 X-NUCLEO-53L1A2 expansion board

This section describes the X-NUCLEO-53L1A2 expansion board features and provides useful information for understanding the electrical characteristics.

Figure 2. X-NUCLEO-53L1A2 expansion board schematic diagram



3.1 Description

The board allows the user to test the VL53L1 functionality, to program it and to understand how to develop an application using the VL53L1. It integrates:

- 2.8 V regulator to supply the VL53L1
- Level translators to adapt the I/O level to the main board of the microcontroller
- Arduino UNO R3 connectors
- Optional VL53L1 breakout board connectors
- Solder drops to allow different configurations of the expansion board

It is fundamental to program a microcontroller to control the VL53L1 through the I2C bus. The application software and an example of the C-ANSI source code are available on www.st.com/VL53L1.

The X-NUCLEO-53L1A2 expansion board and STM32 Nucleo development board are connected through the Arduino UNO R3 connectors CN5, CN6, CN8, and CN9 as shown in Figure 3. X-NUCLEO-53L1A2 expansion board connector layout and as described in Table 3. Left Arduino connector and Table 4. Right Arduino connector.

The X-NUCLEO-53L1A2 must be plugged onto the STM32 Nucleo development board through the Arduino UNO R3 connectors.

Figure 3. X-NUCLEO-53L1A2 expansion board connector layout

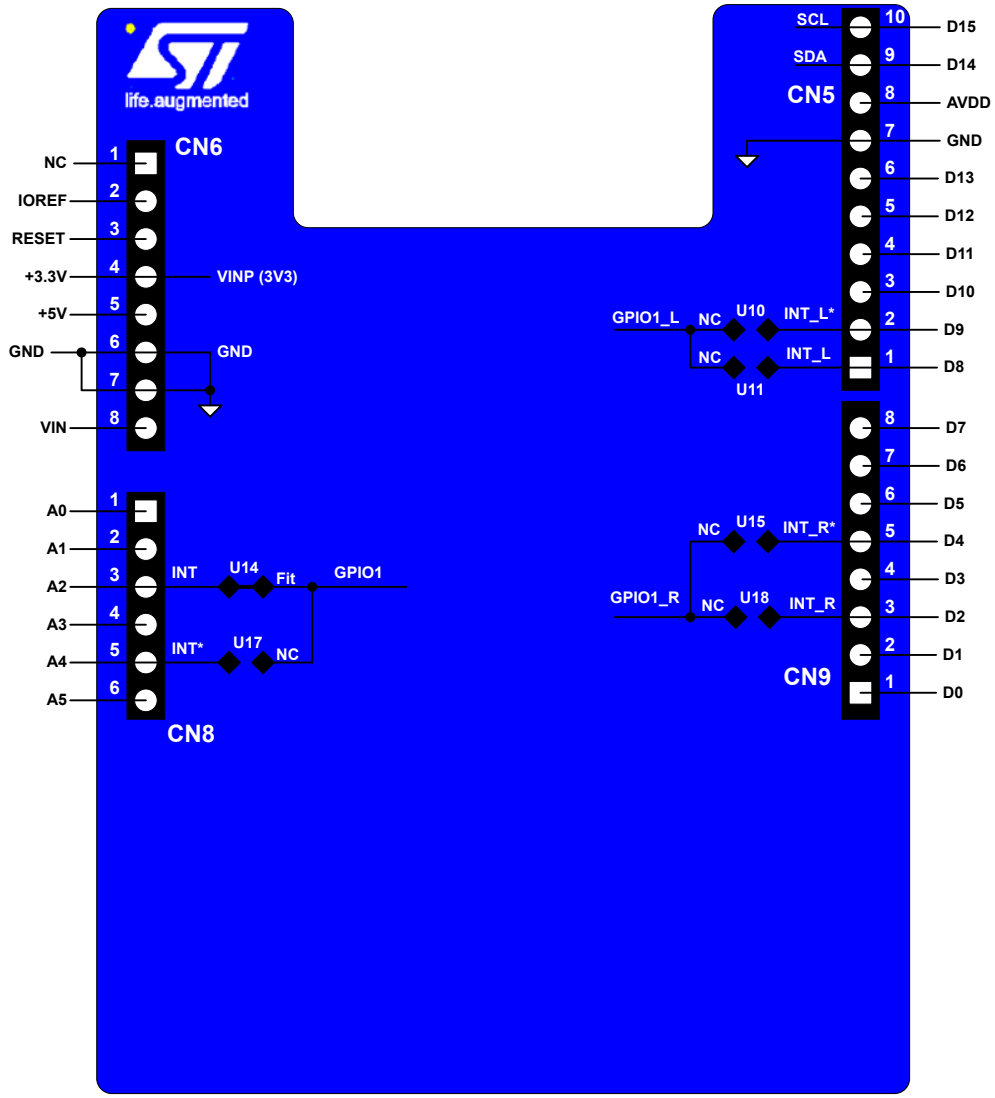


Table 3. Left Arduino connector

CN number	VL53L1 board	Pin number	Pin name	MCU pin	X-NUCLEO-53L1A2 expansion board function
CN6 power		1	NC	NC	
		2	NC	IOREF	Not used
		3	NC	RESET	
	Power	4	3V3	3V3	3.3 V supply
		5	NC	5V	Not used
	Gnd	6	Gnd	Gnd	Gnd
	Gnd	7	Gnd	Gnd	
		8	NC	VIN	Not used
CN8 analog		1	NC	PAO	
		2	NC	PA1	
	GPIO1	3	INT	PA4	Interrupt signal from VL53L1 on board soldered device
		4	NC	PB0	Not used
	GPIO1	5	INT	PC1 (1)	By default not used, interrupt signal from VL53L1 on board soldered device
		6	NC	PC0	Not used

1. *Depends on STM32 Nucleo board solder bridges, see details in Section: Solder drop configurations. These interrupt signals are duplicated, but not used. This offers hardware connection flexibility in case of conflict on the MCU interface management when the expansion board is used superimposed with other expansion boards. In this case, remove the solder drop from the used interrupt and instead, fit the solder drop in "NC".*

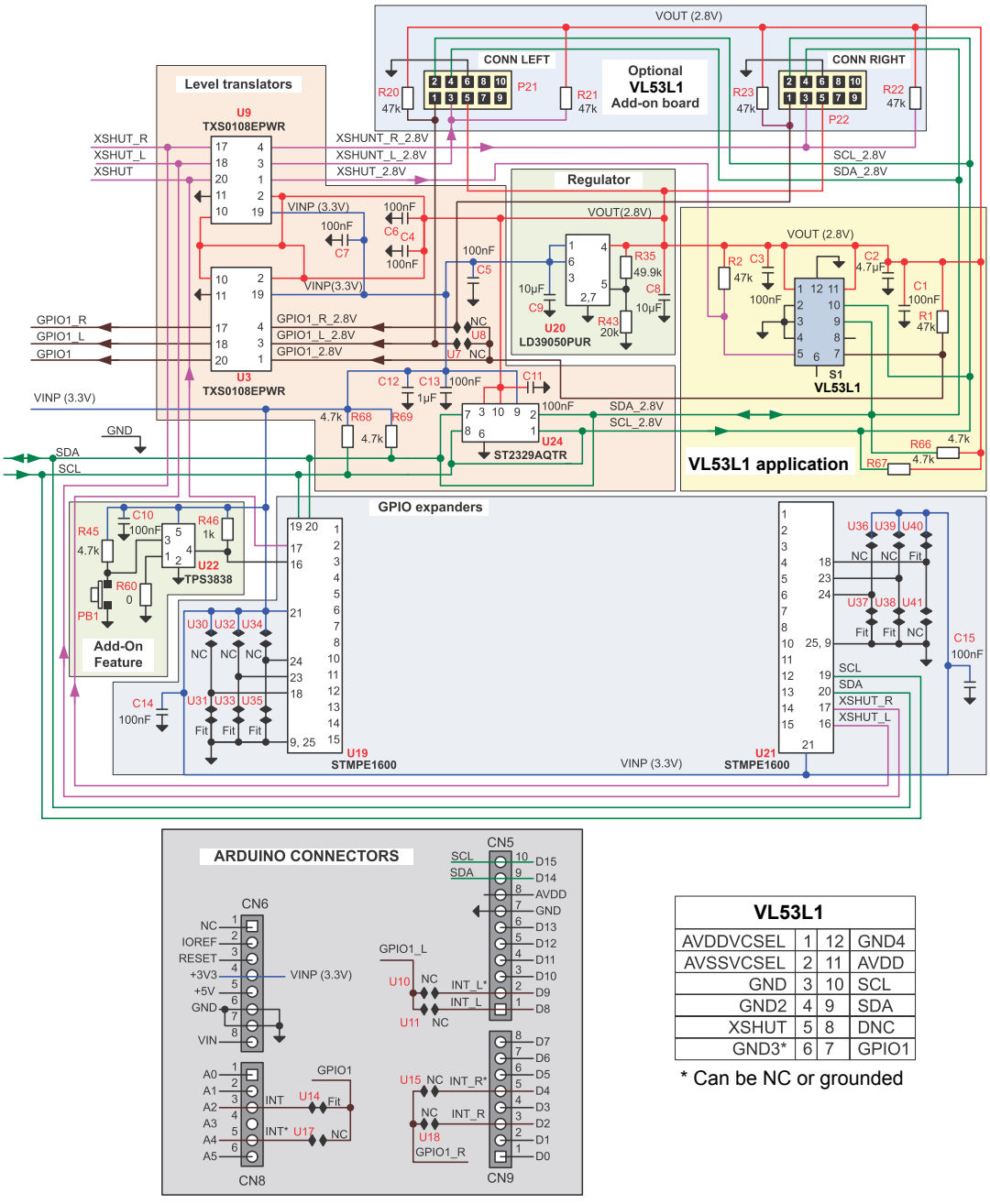
Table 4. Right Arduino connector

CN number	VL53L1 board	Pin number	Pin name	MCU pin	X-NUCLEO-53L1A2 expansion board function
CN5 digital	SCL	10	D15	PB8	I2C1_SCL
	SDA	9	D14	PB9	I2C1_SDA
		8	NC	AVDD	Not used
	Gnd	7	Gnd	Gnd	Gnd
		6	INT_L	PA5	Not used
		5	NC	PA6	
		4	NC	PA7	
		3	NC	PB6	
	GPIO1_L	2	INT_L	PC7	By default not used, interrupt signal from optional VL53L1 left breakout board (1)
	GPIO1_L	1	INT_L	PA9	
CN9 digital		8	NC	PA8	Not used
		7	NC	PB10	
		6	NC	PB4	
		5	INT_R	PB5	By default not used, interrupt signal from optional VL53L1 right breakout board (1)
		4	NC	PB3	Not used
		3	INT_R	PA10	By default not used, interrupt signal from optional VL53L1 right breakout board (1)
		2	NC	PA2	Not used
		1	NC	PA3	

1. *These interrupt signals are duplicated, but not used by default. This offers hardware connection of the breakout board VL53L1 interrupt signals and flexibility in case of conflict on the MCU interface management when the expansion board is used superimposed with other expansion boards. In this case, select, through a solder drop, the MCU port which is free.*

3.2 Electrical schematic

Figure 4. **X-NUCLEO-53L1A2 expansion board schematic**



VL53L1			
AVDDVCSEL	1	12	GND4
AVSSVCSEL	2	11	AVDD
GND	3	10	SCL
GND2	4	9	SDA
XSHUT	5	8	DNC
GND3*	6	7	GPIO1

* Can be NC or grounded

3.3 List of materials

Table 5. **List of materials**

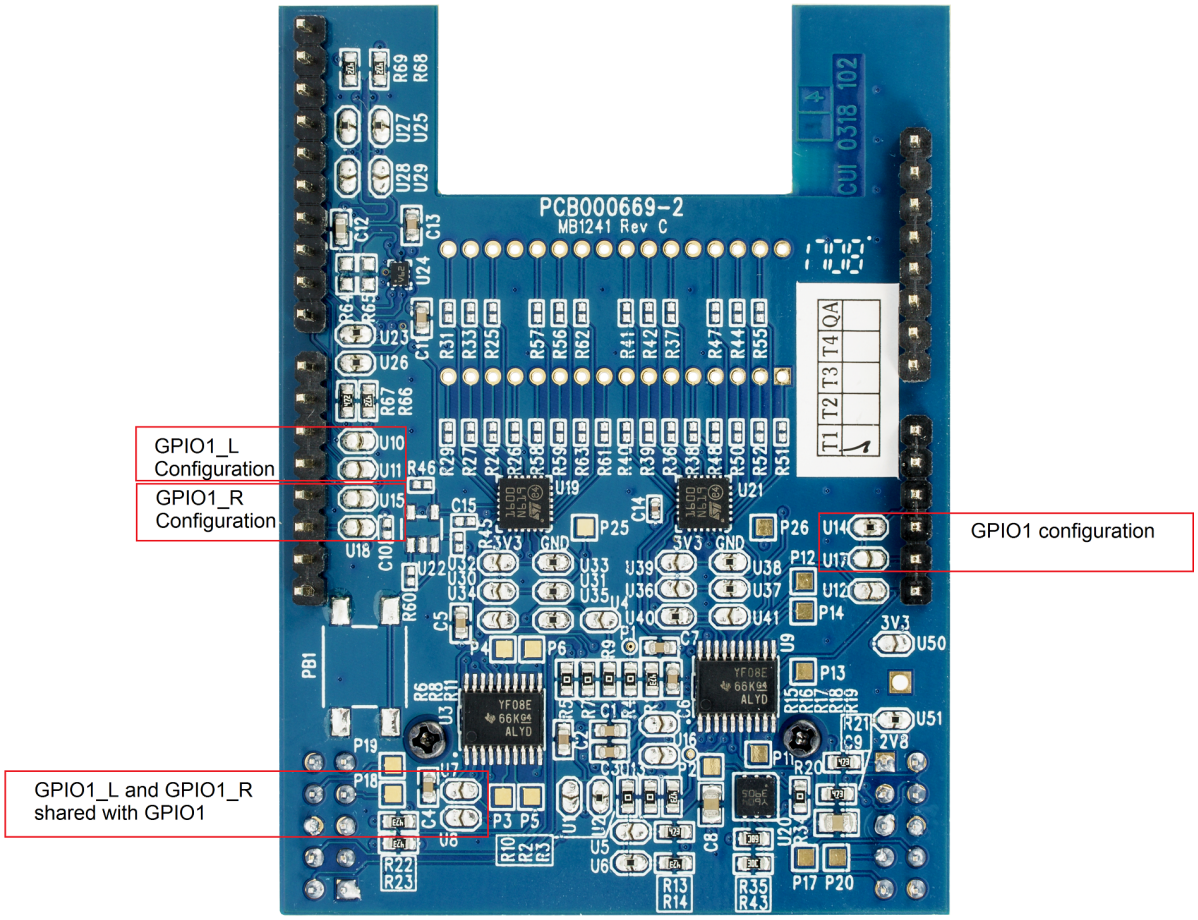
Components	Value	Reference	Supplier	Comments
VL53L1 application				
C1, C3	100 nF	X5R		Supply voltage decoupling
C2	4.7 µF	X5R - 6.3 V		
R1	47 k			Interrupt output pull up
R2	47 k			Reset input pull up
R66, R67	4.7 k			SDA and SCL line pull up at 2.8 V
S1		VL53L1	ST	ToF ranging sensor
VL53L1 breakout board interfaces				
R20	47 k			Left breakout board interrupt output pull up
R21	47 k			Left breakout board reset input pull up
R22	47 k			Right breakout board reset input pull up
R23	47 k			Right breakout board interrupt output pull up
2.8 V regulator application				
C8	10 µF	X5R - 6.3 V		Output voltage decoupling
C9	10 µF	X5R - 6.3 V		Input voltage decoupling
R35	49.9 k			Feedback resistor bridge to set the output voltage to 2.8 V
R43	20 k			
U20		LD39050PUR	ST	Output programmable regulator
Level translator application				
C4, C6, C11	100 nF			2.8 V decoupling capacitor
C5, C7, C13	100 nF			3.3 V decoupling capacitor
C12	1 µF	X5R - 6.3V		
R68, R69	4.7 k			SDA and SCL line pull up at 3.3 V
U3, U9		TXS0108PWR	TI	For all signals except I2C interface
U24		ST2329AQTR	ST	For I2C interface
Add-on feature				
C10	100 nF			Supply decoupling capacitor
R45	4.7 k			Push button pull up
R46	1 k			Output pull up
R60				Delay time setting (def = 10 ms)
PB1				Push button
U22		TPS3838K33	TI	Supervisory circuit
GPIO expander				
C14, C15	100 nF			Supply decoupling capacitor

3.4 Solder drop configurations

Solder drops allow the following configurations of the X-NUCLEO-53L1A2 expansion board:

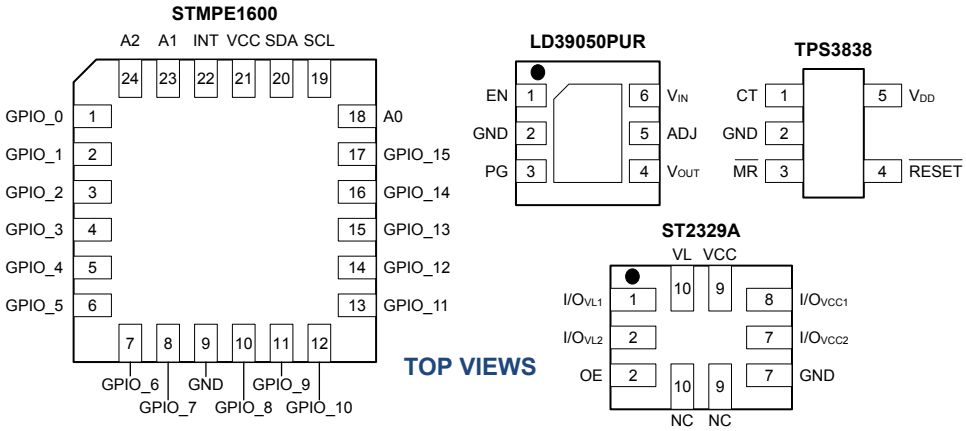
- If the developer wants to make an application with several expansion boards stacked and there is:
  - conflict with the microcontroller port allocation, the GPIO1 can be output on the CN8/A4 (U17 fitted) of the Arduino connector. The default configuration is that GPIO1 is output on the CN8/A2 (U14 fitted) of the Arduino connector.
  - conflict on the I2C addresses, the addresses of the STMPE1600 can be modified (the default addresses are A2, A1, A0, 000, and 001).
- If the developer wants to connect breakout boards (see Figure 5. Interrupt configurations) to the X-NUCLEO-53L1A2 expansion board:
  - the VL53L1 interrupt of the left breakout board can be output on the CN5/D9 (U10 fitted) or CN5/D8 (U11 fitted) of the Arduino connector. By default, the U10 and U11 are not fitted.
  - the VL53L1 interrupt of the right breakout board can be output on the CN9/D4 (U15 fitted) or CN9/D2 (U18 fitted) of the Arduino connector. By default, the U15 and U18 are not fitted.
  - the VL53L1 interrupt of the left and right breakout boards, GPIO1_L and GPIO1_R, can be shared with the VL53L1 interrupt on the main board, GPIO1, by fitting U7 and U8 solder drops. By default U7 and U8 are not fitted.

Figure 5. Interrupt configurations



3.5 Integrated device pinning

Figure 6. Integrated device pinning



A1	Input:output 1. Referenced to VCCA
VCCA	A-port supply voltage
A2	Input:output 2. Referenced to VCCA
A3	Input:output 3. Referenced to VCCA
A4	Input:output 4. Referenced to VCCA
A5	Input:output 5. Referenced to VCCA
A6	Input:output 6. Referenced to VCCA
A7	Input:output 7. Referenced to VCCA
A8	Input:output 8. Referenced to VCCA
OE	3-state output-mode enable

B1	Input:output 1. Referenced to VCCB
VCCB	B-port supply voltage
B2	Input:output 2. Referenced to VCCB
B3	Input:output 3. Referenced to VCCB
B4	Input:output 4. Referenced to VCCB
B5	Input:output 5. Referenced to VCCB
B6	Input:output 6. Referenced to VCCB
B7	Input:output 7. Referenced to VCCB
B8	Input:output 8. Referenced to VCCB
GND	Ground

4 VL53L1 breakout board

The VL53L1 breakout boards are supplied at 2.8 V by the regulator present on the X-NUCLEO-53L1A2 expansion board.

Figure 7. VL53L1 breakout board

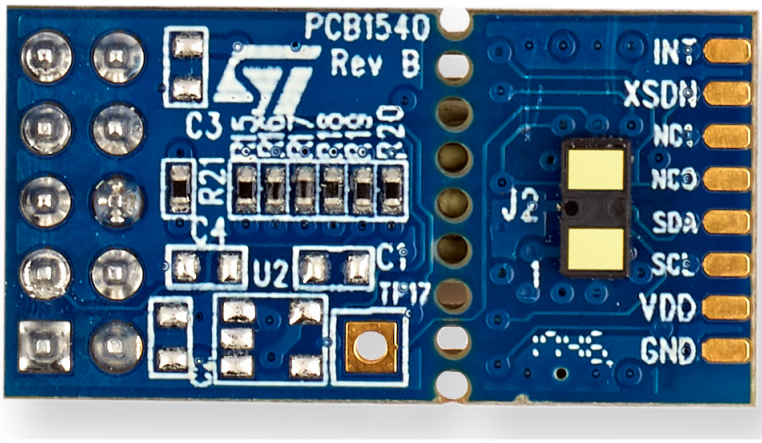
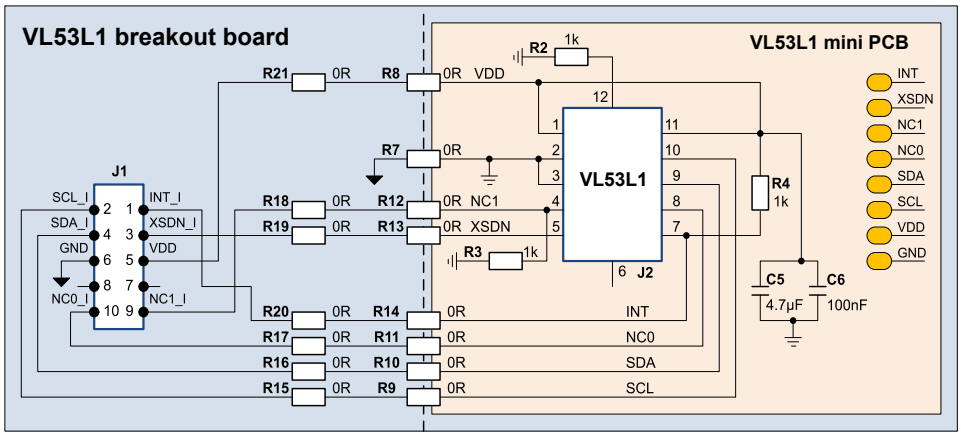


Figure 8. VL53L1 breakout board schematic

VL53L1			
AVDDVCSEL	1	12	GND4
AVSSVCSEL	2	11	AVDD
GND	3	10	SCL
GND2	4	9	SDA
XSHUT	5	8	DNC
GND3*	6	7	GPIO1 (INT)

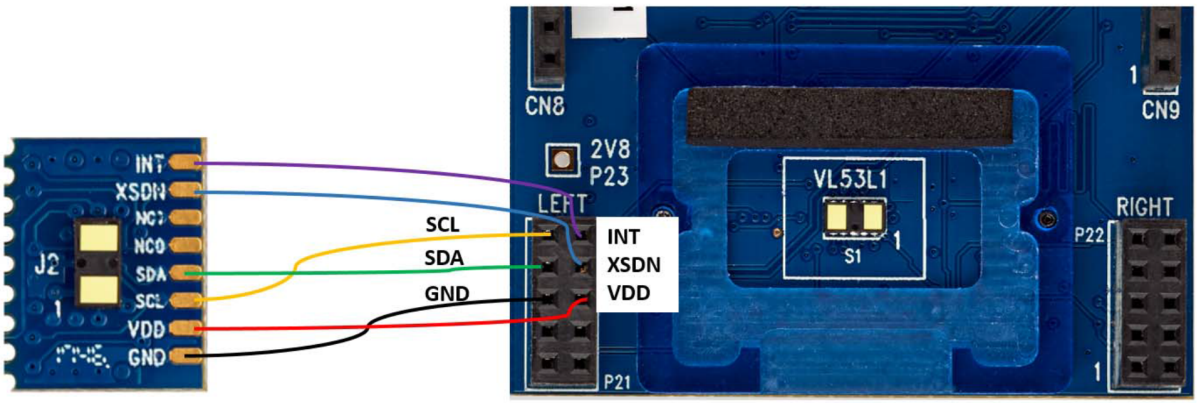
* Could be or N.C. or Gounded



The VL53L1 breakout board can be directly plugged onto the X-NUCLEO-53L1A2 expansion board through the two 10-pin connectors or connected to the board through flying leads.

When connected through flying leads, developers should break off the mini PCB from the breakout board, and use only the VL53L1 mini PCB which is easier to integrate into customer devices, because of its small size.

Figure 9. **VL53L1 mini PCB flying lead connection to X-NUCLEO-53L1A2 expansion board**



5 Safety

5.1 Electrostatic precaution

The user should exercise electrostatic precautions, including using ground straps when using the X-NUCLEO-53L1A2 expansion board. Failure to prevent electrostatic discharge could damage the device.

Figure 10. Electrostatic logo

5.2 Laser considerations

The VL53L1 contains a laser emitter and corresponding drive circuitry. The laser output is designed to remain within Class 1 laser safety limits under all reasonably foreseeable conditions including single faults, in compliance with the IEC 60825-1:2014 (third edition). The laser output remains within Class 1 limits as long as STMicroelectronic's recommended device settings are used and the operating conditions specified in the datasheet are respected. 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.

Figure 11. Class 1 laser product label

Revision history

Table 6. **Document revision history**

Date	Version	Changes
10-Sep-2020	1	Initial release
23-Apr-2021	2	Updated Figure 2. X-NUCLEO-53L1A2 expansion board schematic diagram

Contents