X-NUCLEO-53L0A1 ranging and gesture detection sensor expansion board based on VL53L0X for STM32 Nucleo

Introduction

This document provides detailed hardware information on X-NUCLEO-53L0A1 expansion board.
The X-NUCLEO-53L0A1 expansion board is compatible with STM32 Nucleo family and Arduino™ electronic boards.
This product is part of STMicroelectronics offering of expansion boards designed around the VL53L0X ranging and gesture recognition sensor, based on ST patented FlightSense™ technology.

To allow the user to validate the VL53L0X in an environment as close as possible to its final application, the X-NUCLEO-53L0A1 expansion board is delivered with a holder in which 3 different height spacers of 0.25, 0.5 and 1mm, used to simulate the air gap, can be fitted, with the cover glass above the spacer.

To allow the user to quickly access the gesture recognition demonstration, the X-NUCLEO-53L0A1 expansion board is delivered with two VL53L0X satellites. Demonstration software, available on *www.st.com/VL53L0X,* is included in the X-CUBE-53L0A1.

Figure 1. X-NUCLEO-53L0A1 expansion board, spacers, cover glass and satellites
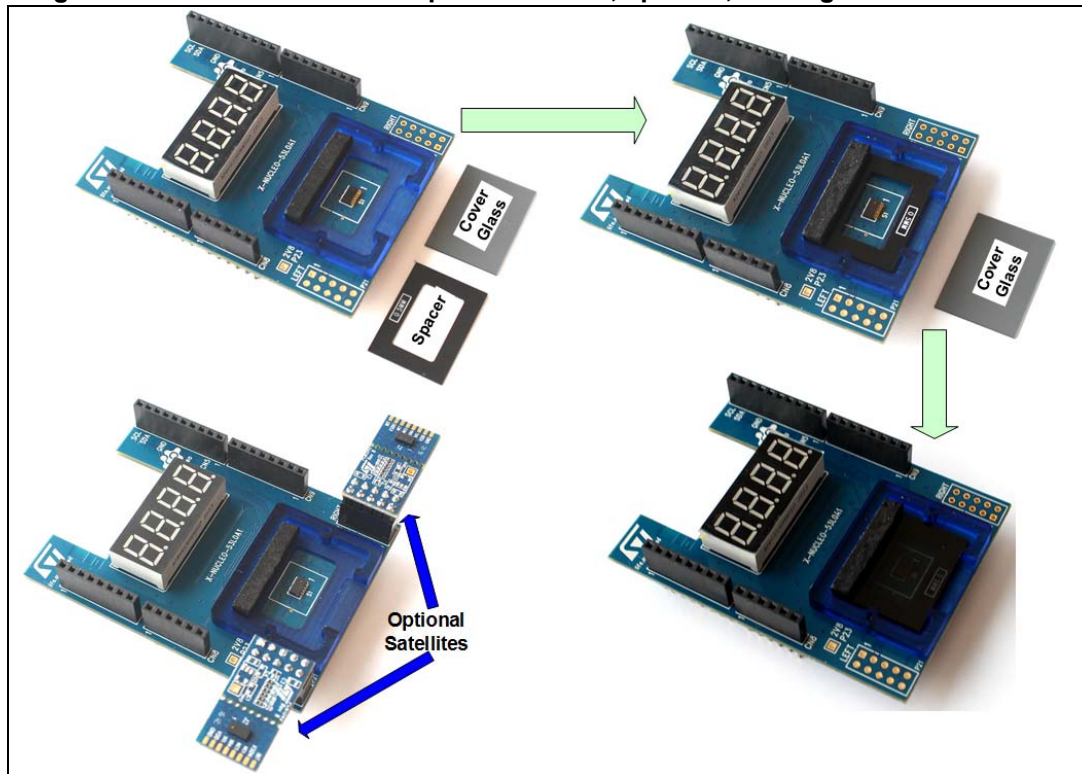
Contents

1 Overview

The X-NUCLEO-53L0A1 expansion board features the VL53L0X ranging and gesture recognition sensor, based on ST's FlightSense™, Time-of-Flight technology.
It is compatible with the STM32 Nucleo board family, and with the Arduino UNO R3 connector layout.
Several ST expansion boards can be superposed through the Arduino connectors, which allows, for example, to develop VL53L0X applications with Bluetooth or Wi-Fi interface.

The X-NUCLEO-53L0A1 expansion board is delivered with:

- Three spacers of 0.25, 0.5 and 1 mm height, used to simulate different airgap between the VL53L0X and the cover glass
- A cover glass to simulate the integration of the VL53L0X into the customer's final product.
- Two VL53L0X satellites, which can be plugged onto the X-NUCLEO-53L0A1 expansion board or connected through flying wires to the X-NUCLEO-53L0A1 expansion board.
- Two 10 pin connectors to enable customer to connect the two satellites onto the X-NUCLEO-53L0A1 expansion board.

Note: *The VL53L0X is delivered with a liner, in order to prevent potential foreign material to penetrate inside the modules holes during assembly process. It must be removed at the latest possible step during final assembly, and anyway before module calibration.*

Table 1. Ordering information

| Ordering code	Description
X-NUCLEO-53L0A1	Expansion board for STM32 Nucleo board family - Spacers and glass - two satellites

2 Document reference

Table 2. Document references

Description	DocID
VL53L0X data brief	DB2846
X-NUCLEO-53L0A1 expansion board data brief	DB2901
P-NUCLEO-53L0A1 pack data brief	DB2905
X-CUBE-53L0A1 data brief	DB2902
Getting started with VL53L0X ranging, gesture detection sensor software expansion for STM32Cube.	UM2046

3 X-NUCLEO-53L0A1 expansion board

This section describes the X-NUCLEO-53L0A1 expansion board features and provides information which could be useful for understanding the electrical characteristics.

Figure 2. X-NUCLEO-53L0A1 expansion board block diagram
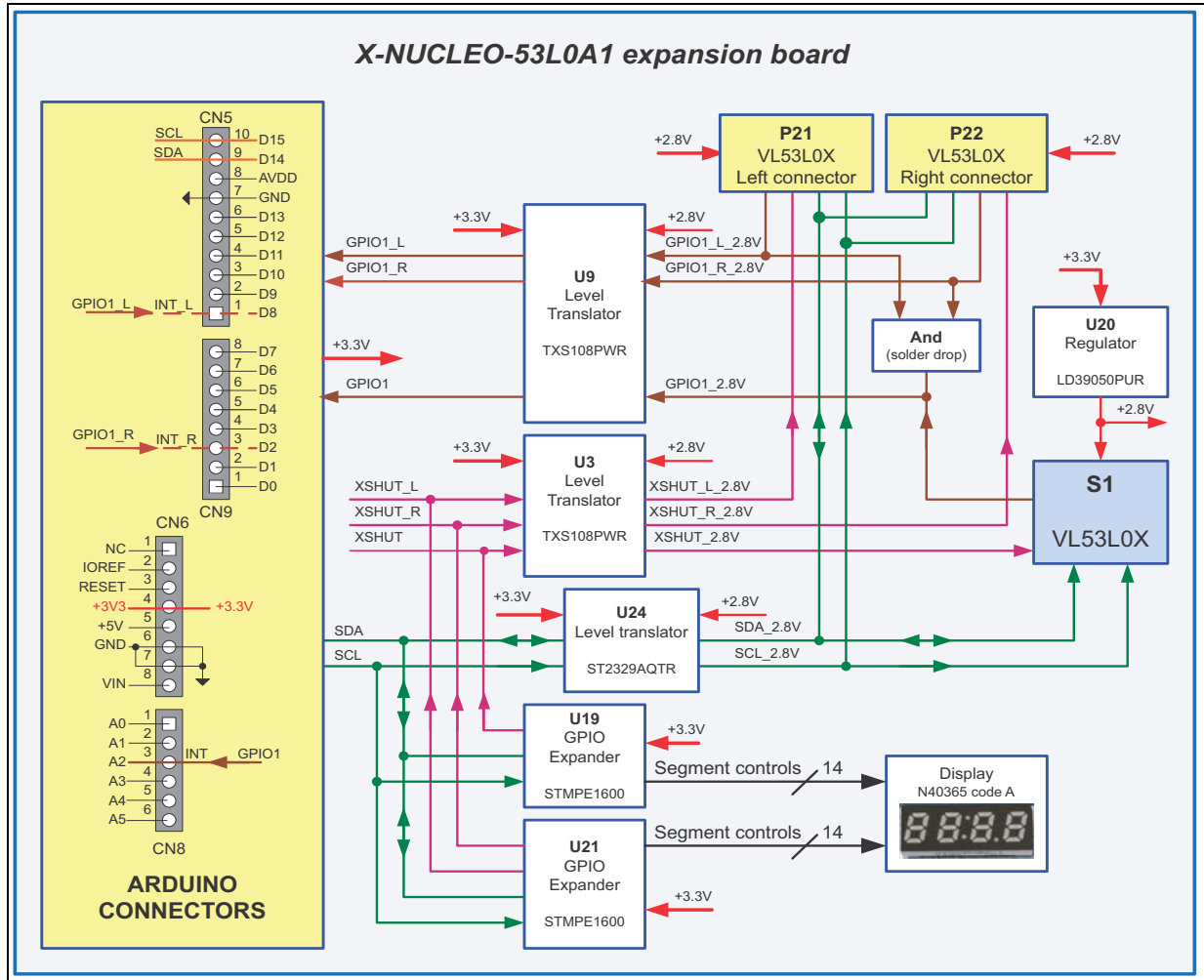
3.1 Overview

The board allows the user to test the VL53L0X functionality, to program it and to understand how to develop an application using VL53L0X. It integrates:

- a 2.8V regulator to supply the VL53L0X.
- level translators to adapt the I/O level to the micro controller main board.
- a 4-Digit display to render the range value in mm
- Arduino UNO R3 connectors
- optional VL53L0X satellite connectors
- solder drops to allow different configurations of the expansion board

It is fundamental to program a micro-controller to control the VL53L0X through the I2C bus and drive the 4-digit display on board. Application software and examples of C-ANSI source code are available on *www.st.com/VL53L0X*.

The X-NUCLEO-53L0A1 expansion board and STM32 Nucleo are connected through Arduino compatible connectors CN5, CN6, CN8 and CN9 as shown in *Figure 3* and described in *Table 3* and *Table 4*.

The Arduino connectors on STM32 Nucleo board support Arduino Uno Revision 3.

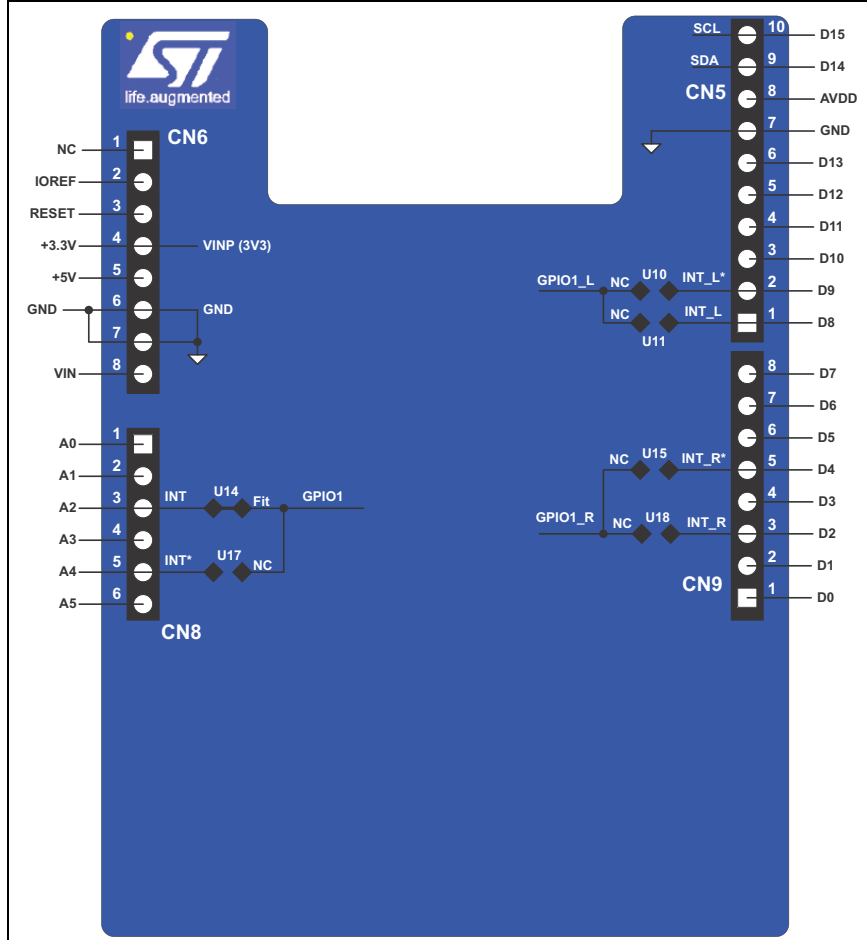**Figure 3. X-NUCLEO-53L0A1 expansion board Arduino connector layout**

Table 3. Arduino left connector on NUCLEO-F401RE board

CN Nb	VL53L0X board	Pin Nb	Pin name	MCU pin	X-NUCLEO-53L0A1 expansion board function
CN6 Power		1	NC	NC	
		2	NC	IOREF	Not used
		3	NC	RESET	Not used
	Power	4	+3V3	+3V3	3.3V supply
		5	NC	+5V	Not used
	Gnd	6	Gnd	Gnd	Gnd
	Gnd	7	Gnd	Gnd	Gnd
		8	NC	VIN	Not used
CN8 Analog		1	NC	PA0	Not used
		2	NC	PA1	Not used
	GPIO1	3	INT	PA4	Interrupt signal from VL53L0X on board soldered device
		4	NC	PB0	Not used
	GPIO1	5	INT*	PC1[(1)]	By default not used Interrupt signal from VL53L0X on board soldered device
		6	NC	PC0	Not used

1. Depends on STM32 Nucleo board solder bridges, see details in *Section 3.3: Solder drop configurations*. These interrupt signals are duplicated, but not used. This offers hardware connection flexibility in case of conflict on MCU interface management when expansion board is used superposed with other expansion boards. In this case remove solder drop from the used interrupt and instead fit the solder drop in "N.C".

**Table 4. Arduino right connector on NUCLEO-F401RE board**

CN Nb	VL53L0X board	Pin Nb	Pin name	MCU pin	X-NUCLEO-53L0A1 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	Not used
		4	NC	PA7	Not used
		3	NC	PB6	Not used
	GPIO1_L	2	INT_L*	PC7	By default not used Interrupt signal from optional VL53L0X left satellite board[1]
	GPIO1_L	1	INT_L	PA9	By default not used Interrupt signal from optional VL53L0X left satellite board[1]
CN9 Digital		8	NC	PA8	Not used
		7	NC	PB10	Not used
		6	NC	PB4	Not used
	GPIO1_R	5	INT_R*	PB5	By default not used Interrupt signal from optional VL53L0X right satellite board[1]
		4	NC	PB3	Not used
	GPIO1_R	3	INT_R	PA10	By default not used Interrupt signal from optional VL53L0X right satellite board[1]
		2	NC	PA2	Not used
		1	NC	PA3	Not used

1. These interrupt signals are duplicated, but not used by default, this offers hardware connection of the satellite board VL53L0X interrupt signals and flexibility in case of conflict on MCU interface management when expansion board is used superposed with other expansion boards. In this case select, through a solder drop, the MCU port which is free.

3.2 Electrical schematic and list of material

3.2.1 Electrical schematic

Figure 4. X-NUCLEO-53L0A1 board schematic
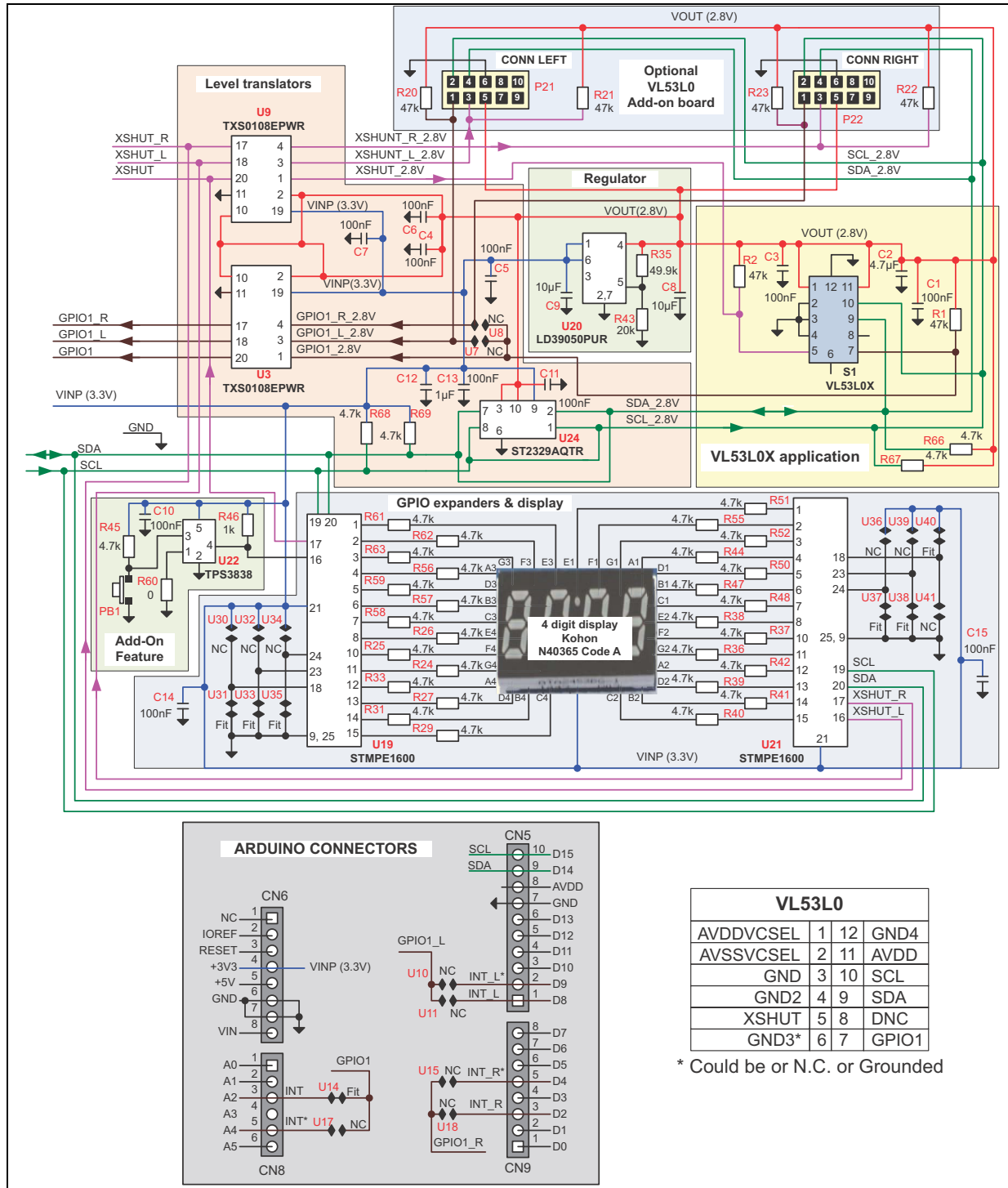
3.2.2 List of materials

Table 5. List of materials

Components	Value	Reference	Supplier	Comments
VL53L0X application				
C1, C3	100nF	X5R		Supply voltage decoupling
C2	4.7µF	X5R - 6.3V		Supply voltage decoupling
R1	47k			Interrupt output pull-up
R2	47k			Reset input pull-up
R66, R67	4.7k			SDA and SCL line pull-up at 2.8V
S1		VL53L0X	ST	Ranging and gesture recognition device
VL53L0X Satellite board interfaces				
R20	47k			Left satellite board interrupt output pull-up
R21	47k			Left satellite board reset input pull-up
R22	47k			Right satellite board reset input pull-up
R23	47k			Right satellite board interrupt output pull-up
2.8V regulator application				
C8	10µF	X5R - 6.3V		Output voltage decoupling
C9	10µF	X5R - 6.3V		Input voltage decoupling
R35	49.9k			Feedback resistor bridge to set the output voltage to 2.8V
R43	20k			
U20		LD39050PUR	ST	Output programmable regulator
Level translator application				
C4, C6, C11	100nF			2.8V decoupling capacitor
C5, C7, C13	100nF			3.3V decoupling capacitor
C12	1µF	X5R - 6.3V		
R68, R69	4.7k			SDA and SCL line pull-up at 3.3V
U3, U9		TXS0108PWR	TI	For all signals except I2C interface
U24		ST2329AQTR	ST	For I2C interface
Add-on feature				
C10	100nF			Supply decoupling capacitor
R45	4.7k			Push-button pull-up
R46	1k			Output pull-up

Table 5. List of materials (continued)

Components	Value	Reference	Supplier	Comments
R60	0			Delay time setting (def = 10ms)
PB1				Push-button
U22		TPS3838K33	TI	Supervisory circuit
GPIO expander and 4 digit-7 segment display application				
C14, C15	100nF			Supply decoupling capacitor
DISPLAY1		KHN40365AG1D	Kohon	
R24,R25, R26, R27, R29, R31, R33, R36, R37, R38, R39, R40, R41, R42, R44, R47, R48, R50, R51, R52, R55, R56, R57, R58, R59, R61, R62, R63	470			Segment current setting
U19, U21		STMPE1600	ST	GPIO expander for VL53L0X XSHUT signals and 4 digit / 7 segment display

3.3 Solder drop configurations

Solder drops allow the following configurations for X-NUCLEO-53L0A1 boards:

- In case the developer wants to do an application with several expansion boards superposed and:
  - there is a conflict on microcontroller port allocation, the GPIO1 can be outputted on CN8/A4 (U17 fitted) of the Arduino connector. The default configuration is GPIO1 is outputted on CN8/A2 (U14 fitted) of the Arduino connector.
  - there is a conflict on I2C addresses, the addresses of the STMPE1600 can be modified.(default addresses A2,A1,A0: 000 and 001).
- In case the developer wants to connect satellites (see *Figure 5*):
  - the VL53L0X interrupt of the left satellite board can be outputted on CN5/D9 (U10 fitted) or CN5/D8 (U11 fitted) of the Arduino connector. By default U10 and U11 are not fitted.
  - the VL53L0X interrupt of the right satellite board can be outputted on CN9/D4 (U15 fitted) or CN9/D2 (U18 fitted) of the Arduino connector. By default U15 and U18 are not fitted.
  - the VL53L0X interrupts of left and right satellite boards, GPIO1_L and GPIO1_R, can be shared with the VL53L0X 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
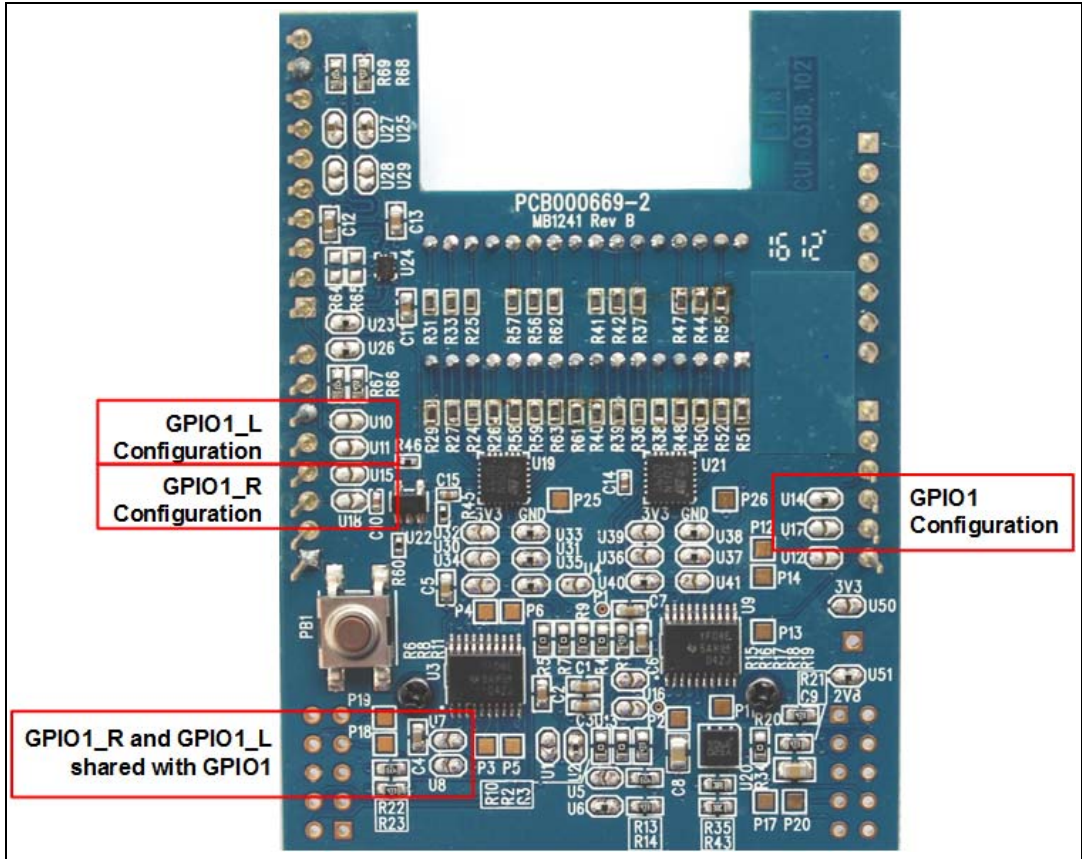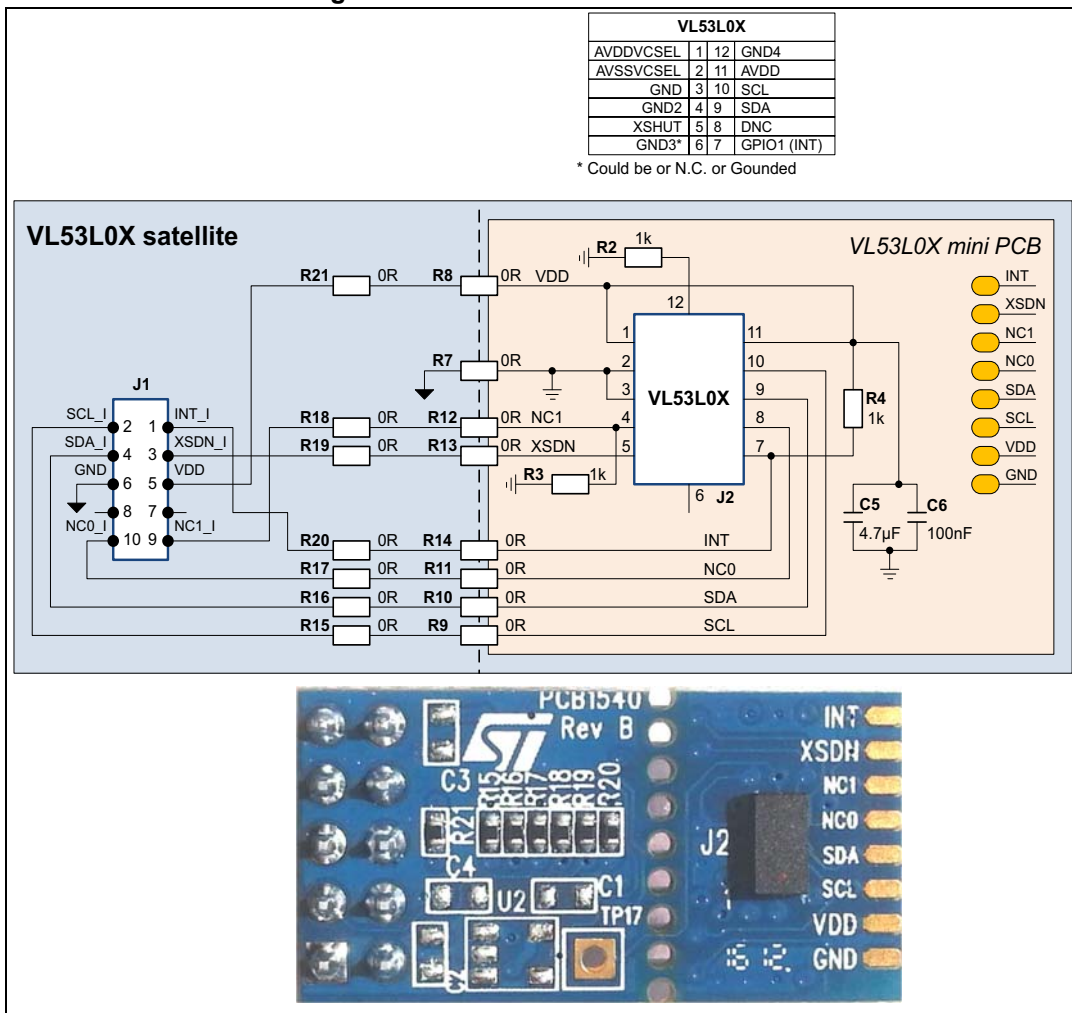
3.4 Integrated device pinning

Figure 6. Integrated device pinning
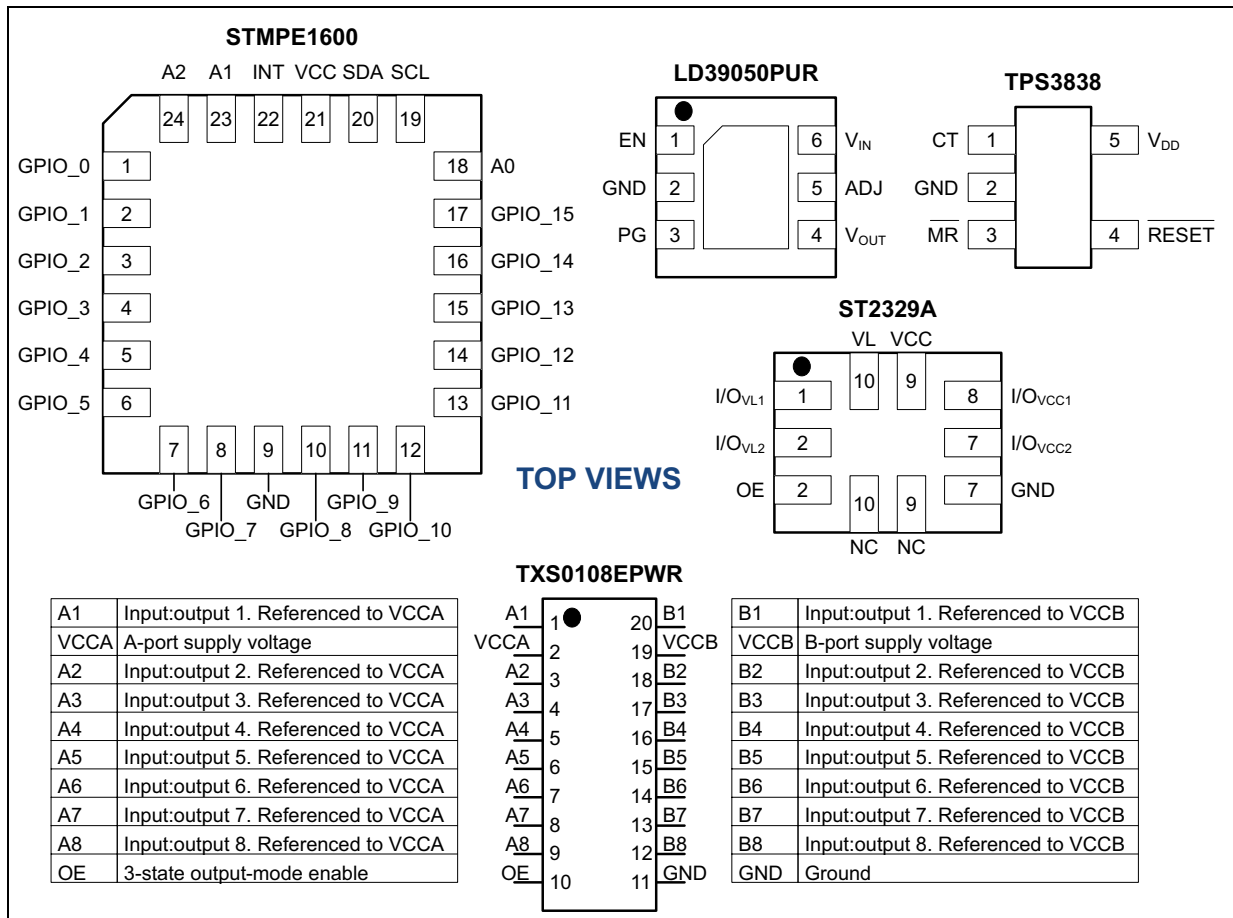
4 VL53L0X satellite

The VL53L0X satellites are supplied at 2.8V by the regulator present on the X-NUCLEO-53L0A1 expansion board.

Figure 7. VL53L0X satellite schematic

The VL53L0X satellites can be directly plugged onto the X-NUCLEO-53L0A1 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 satellite board, and use only the "VL53L0X mini PCB" which benefits from a smaller form factor for an easier integration into customers devices.

Figure 8. VL53L0X mini PCB flying lead connection to X-NUCLEO-53L0A1 expansion board
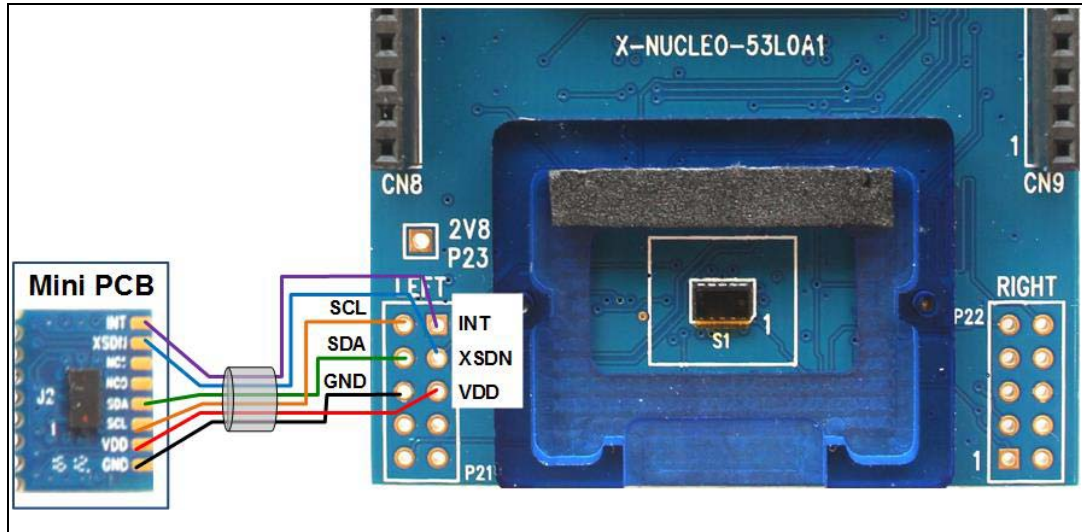
5 Safety

5.1 Electrostatic precaution

Figure 9. Electrostatic logo

You should exercise electrostatic precautions, including using ground straps when using the X-NUCLEO-53L0A1 expansion board. Failure to prevent electrostatic discharge could damage the device.

5.2 Laser considerations

The VL53L0X 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 IEC 60825-1:2014 (third edition). The laser output will remain within Class 1 limits as long as the STMicroelectronics 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 10. Class 1 laser product label

6 Revision history

Table 6. Document revision history

Date	Revision	Changes
18-May-2016	1	Initial release.
25-May-2016	2	Update *Table 2: Document references*

IMPORTANT NOTICE – PLEASE READ CAREFULLY