# UM2359
# User manual

# Getting started with X-NUCLEO-53L1A1 long distance ranging ToF sensor expansion board based on VL53L1X for STM32 Nucleo

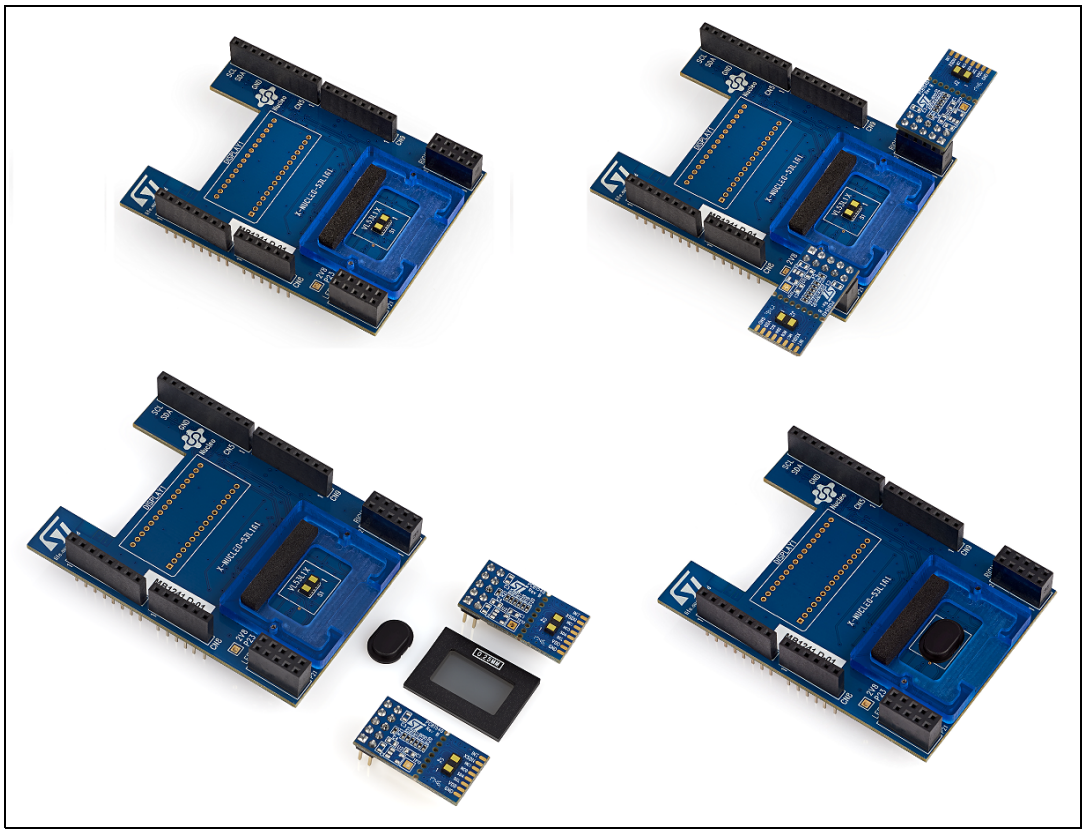
## Introduction

This document provides detailed hardware information on the X-NUCLEO-53L1A1 expansion board. This expansion board is compatible with the STM32 Nucleo family and the Arduino™ electronic boards. It is designed around the VL53L1X ranging sensor and is based on the ST patented FlightSense™ technology.

To allow the user to validate the VL53L1X in an environment as close as possible to its final application, the X-NUCLEO-53L1A1 expansion board is delivered with a holder in which three different height spacers of 0.25, 0.5, 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 VL53L1X sensor and the cover glass.

The X-NUCLEO-53L1A1 expansion board is delivered with two VL53L1X breakout boards.

**Figure 1. X-NUCLEO-53L1A1 expansion board, spacers, cover glass, and breakout boards**



# Contents

# 1 Overview

The X-NUCLEO-53L1A1 expansion board features the VL53L1X ranging sensor, 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 VL53L1X applications with Bluetooth or Wi-Fi interfaces.

The X-NUCLEO-53L1A1 expansion board is delivered with:

- Three spacers of 0.25, 0.5, and 1 mm height, used to simulate different air gaps between the VL53L1X and the cover glass.
- Two cover windows to simulate the integration of the VL53L1X into the customer's final product.
- Two VL53L1X breakout boards which can be plugged onto the X-NUCLEO-53L1A1 expansion board or connected through flying wires to the X-NUCLEO-53L1A1 expansion board.
- Two 10-pin connectors to enable the customer to connect the two breakout boards onto the X-NUCLEO-53L1A1 expansion board.

*Note: The VL53L1X 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-53L1A1 | STM32 Nucleo expansion board - spacers and glass - two breakout boards |

# 2 Document references

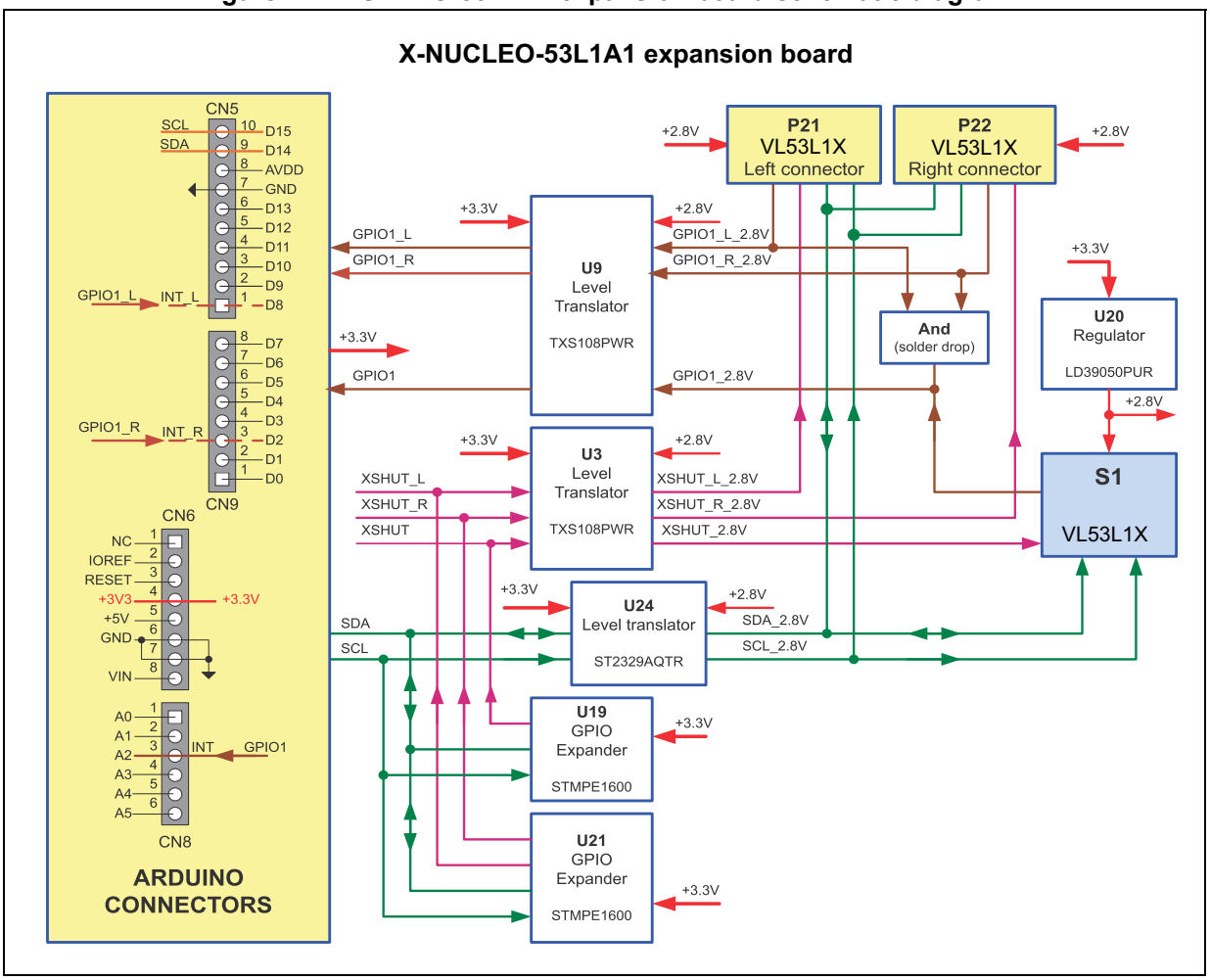
**Table 2. Document references**

| Description | DocID |
|---|---|
| VL53L1X datasheet | DS12385 |
| X-NUCLEO-53L1A1 data brief | DB3479 |
| P-NUCLEO-53L1A1 data brief | DB3477 |
| X-CUBE-53L1A1 data brief | DB3523 |
| Getting started with the X-CUBE-53L1A1 Time-of-Flight long distance ranging sensor software expansion for STM32Cube | UM2371 |

# 3 X-NUCLEO-53L1A1 expansion board

This section describes the X-NUCLEO-53L1A1 expansion board features and provides useful information for understanding the electrical characteristics.

**Figure 2. X-NUCLEO-53L1A1 expansion board schematic diagram**




## 3.1 Overview

The board allows the user to test the VL53L1X functionality, to program it and to understand how to develop an application using the VL53L1X. It integrates:

- 2.8 V regulator to supply the VL53L1X
- Level translators to adapt the I/O level to the main board of the microcontroller
- Arduino UNO R3 connectors
- Optional VL53L1X breakout board connectors
- Solder drops to allow different configurations of the expansion board

It is fundamental to program a microcontroller to control the VL53L1X through the I2C bus. The pplication software and an examples of the C-ANSI source code are available on www.st.com/VL53L1X.

The X-NUCLEO-53L1A1 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* and as described in *Table 3* and *Table 4*.

The X-NUCLEO-53L1A1 must be plugged onto the STM32 Nucleo development board through the Arduino™ UNO R3 connectors.

**Figure 3. X-NUCLEO-53L1A1 expansion board connector layout**

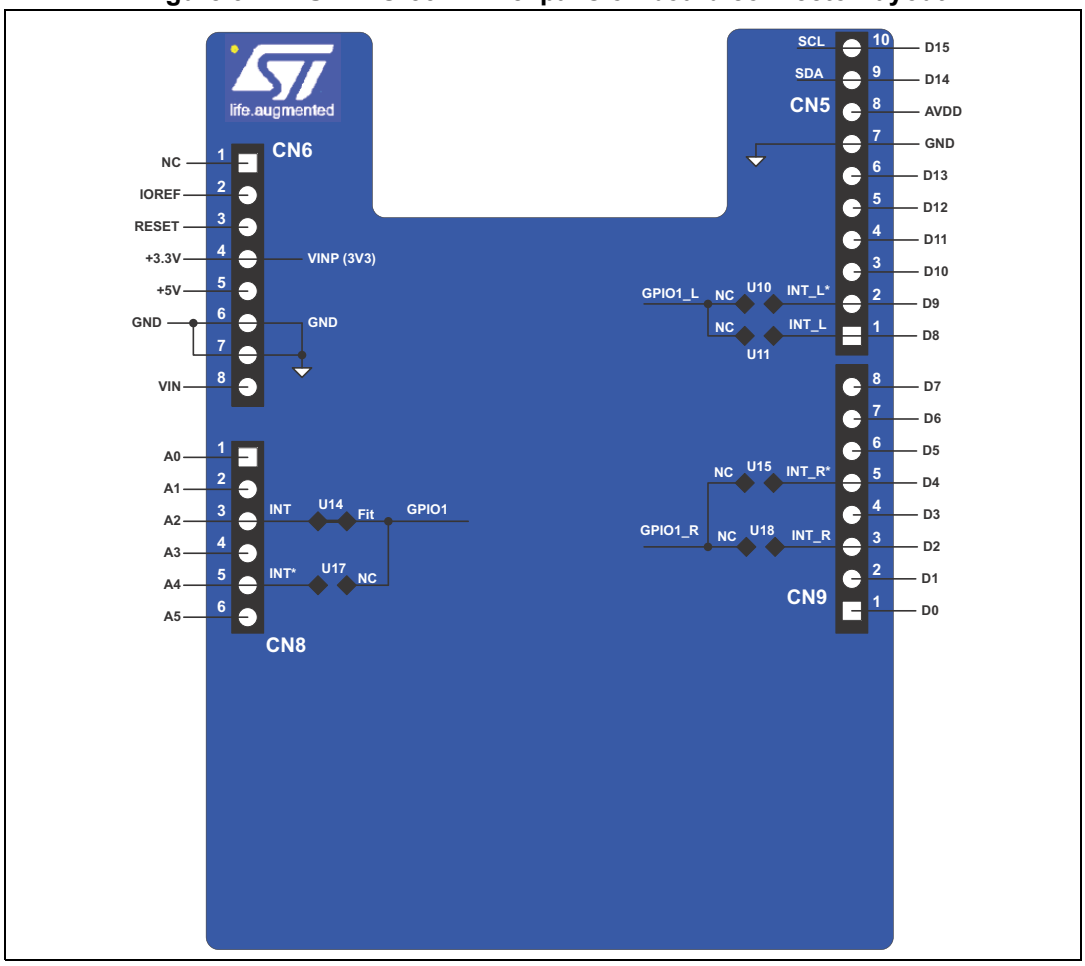


**Table 3. Left Arduino connector**

| CN number | VL53L1X board | Pin number | Pin name | MCU pin | X-NUCLEO-53L1A1 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 | PA0 | |
| | | 2 | NC | PA1 | |
| | GPIO1 | 3 | INT | PA4 | Interrupt signal from VL53L1X on board soldered device |
| | | 4 | NC | PB0 | Not used |
| | GPIO1 | 5 | INT* | PC1 (1) | By default not used, interrupt signal from VL53L1X 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 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**

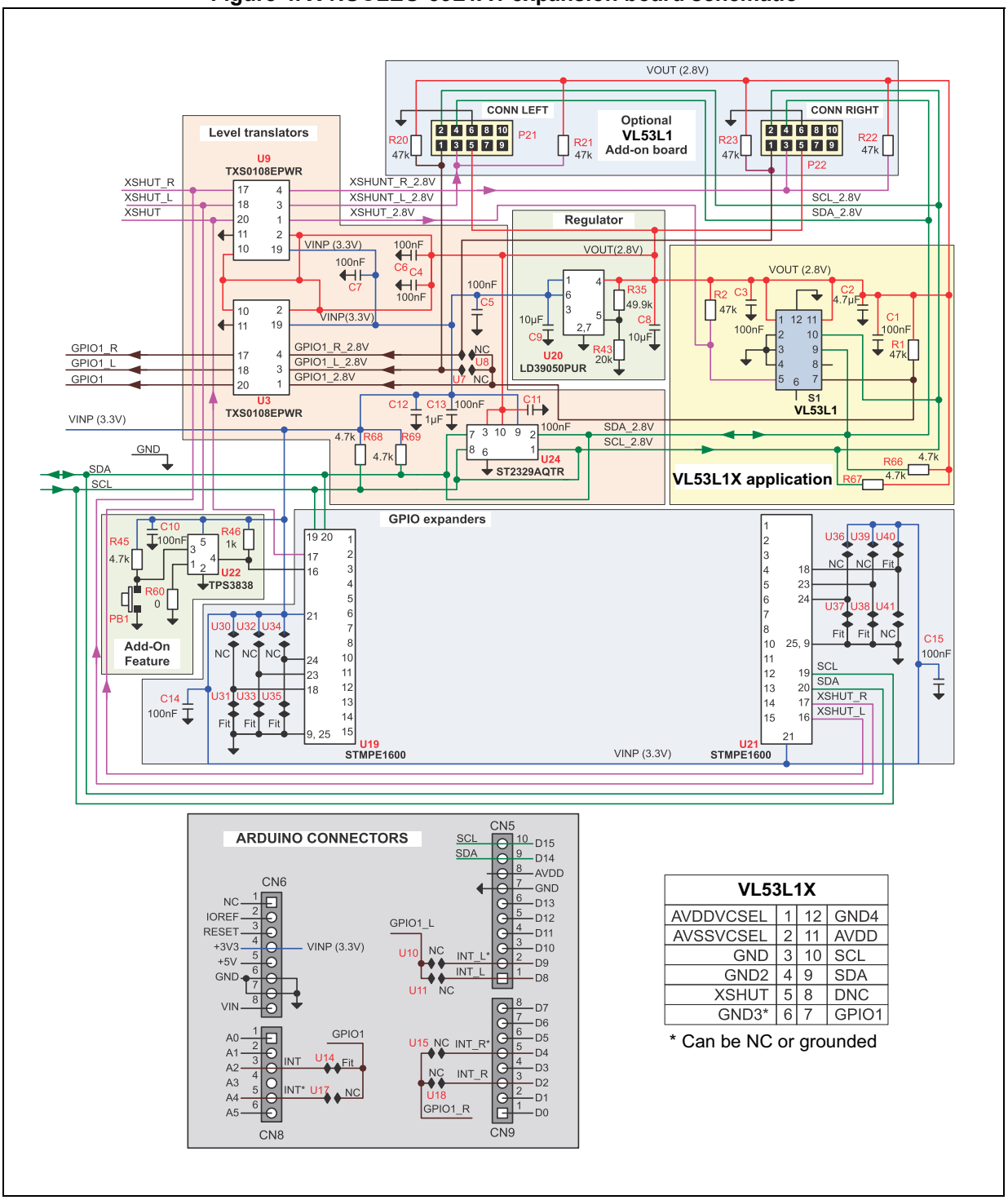
| CN number | VL53L1X board | Pin number | Pin name | MCU pin | X-NUCLEO-53L1A1 expansion board function |
|---|---|---|---|---|---|
| CN5 digital | SCL | 10 | D15 | PB8 | I2C1_SCL |
| | SDA | 9 | D14 | PB9 | I2C1_SDA |
| | | 8 | NC | AVDD | Not used |
| | Gnd | 7 | Gnd | Gnd | Gnd |
| | | 6 | INT_L | 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 VL53L1X left breakout board (1) |
| | GPIO1_L | 1 | INT_L | PA9 | By default not used, interrupt signal from optional VL53L1X left breakout board (1) |
| CN9 digital | | 8 | NC | PA8 | Not used |
| | | 7 | NC | PB10 | |
| | | 6 | NC | PB4 | |
| | GPIO1_R | 5 | INT_R* | PB5 | By default not used, interrupt signal from optional VL53L1X right breakout board (1) |
| | | 4 | NC | PB3 | Not used |
| | GPIO1_R | 3 | INT_R | PA10 | By default not used, interrupt signal from optional VL53L1X 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 VL53L1X 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 and list of materials

### 3.2.1 Electrical schematic

**Figure 4. X-NUCLEO-53L1A1 expansion board schematic**




| VL53L1X | | | |
|---|---|---|---|
| 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

### 3.2.2 List of materials

**Table 5. List of materials**

| Components | Value | Reference | Supplier | Comments |
|---|---|---|---|---|
| **VL53L1X 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 | | VL53L1X | ST | ToF ranging sensor |
| **VL53L1X 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 | 0 | | | Delay time setting (def = 10 ms) |

Table 5. List of materials (continued)

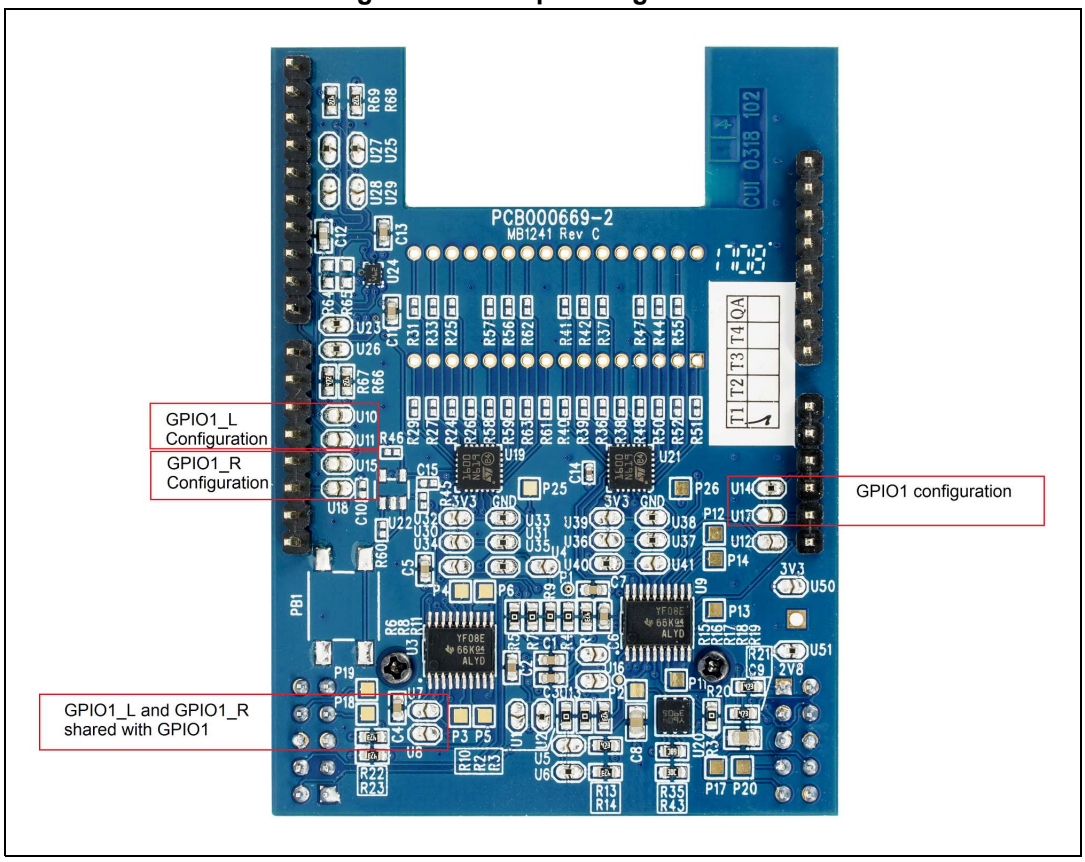
| Components | Value | Reference | Supplier | Comments |
|---|---|---|---|---|
| PB1 | | | | Push button |
| U22 | | TPS3838K33 | TI | Supervisory circuit |
| **GPIO expander** | | | | |
| C14, C15 | 100 nF | | | Supply decoupling capacitor |

## 3.3 Solder drop configurations

Solder drops allow the following configurations of the X-NUCLEO-53L1A1 expansion board:

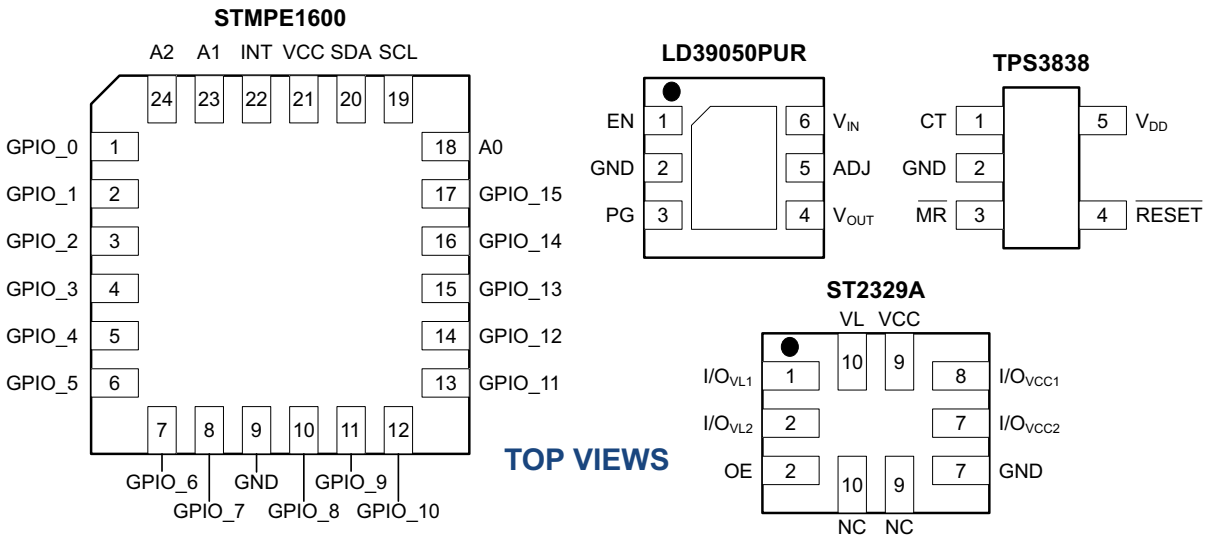
- If the developer wants to make an application with several expansion boards stacked and there is:
  - conflict with the microcontroller port allocation, the GPIO1 can be output on the CN8/A4 (U17 fitted) of the Arduino connector. The default configuration is that GPIO1 is output on the CN8/A2 (U14 fitted) of the Arduino connector.
  - conflict on the I2C addresses, the addresses of the STMPE1600 can be modified (the default addresses A2, A1, A0, 000, and 001).
- If the developer wants to connect breakout boards (see *Figure 5*) to the X-NUCLEO-53L1A1 expansion board:
  - the VL53L1X 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 VL53L1X 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 VL53L1X interrupts of the left and right breakout boards, GPIO1_L and GPIO1_R, can be shared with the VL53L1X 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**



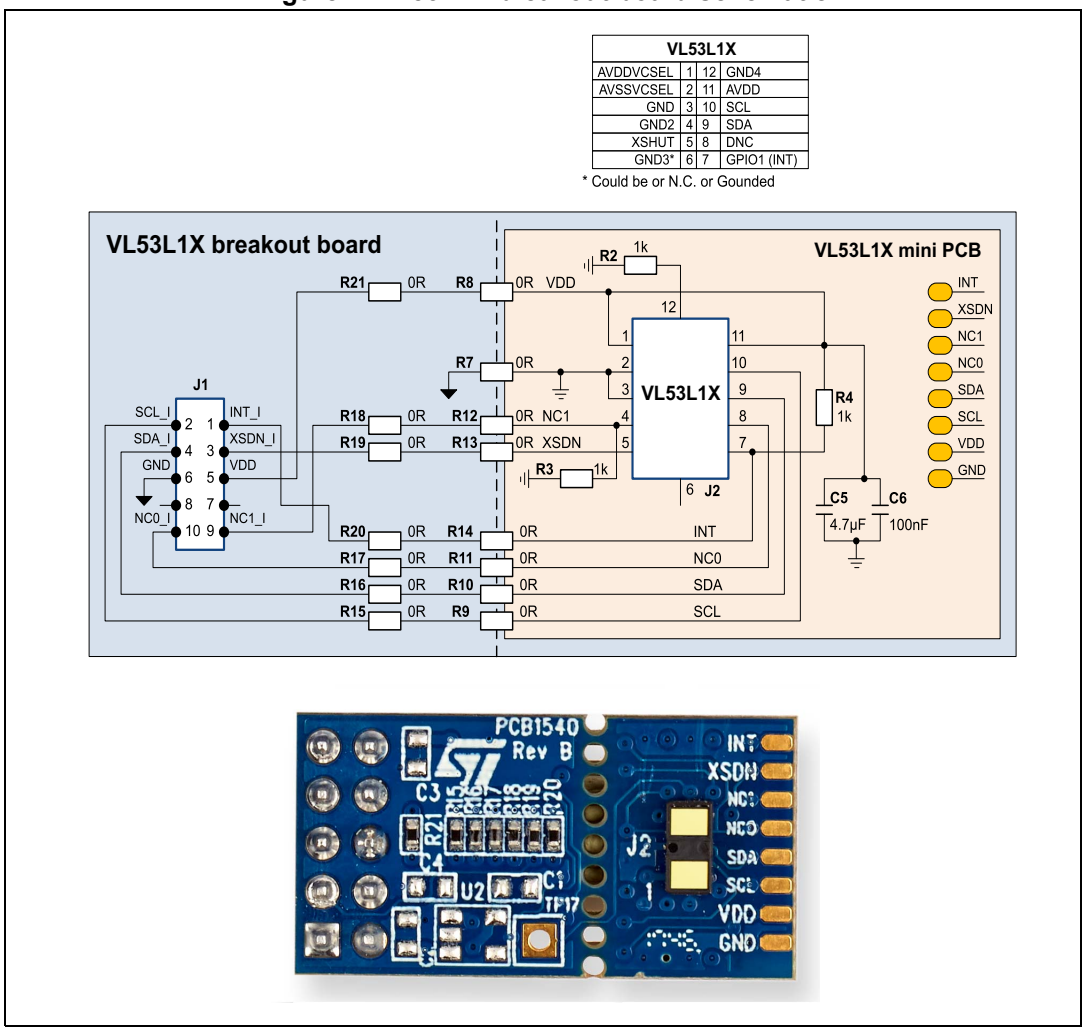

| | |
|---|---|
| A1 | Input:output 1. Referenced to VCCA |
| VCCA | A-port supply voltage |
| A2 | Input:output 2. Referenced to VCCA |
| A3 | Input:output 3. Referenced to VCCA |
| A4 | Input:output 4. Referenced to VCCA |
| A5 | Input:output 5. Referenced to VCCA |
| A6 | Input:output 6. Referenced 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 VL53L1X breakout board

The VL53L1X breakout boards are supplied at 2.8 V by the regulator present on the X-NUCLEO-53L1A1 expansion board.

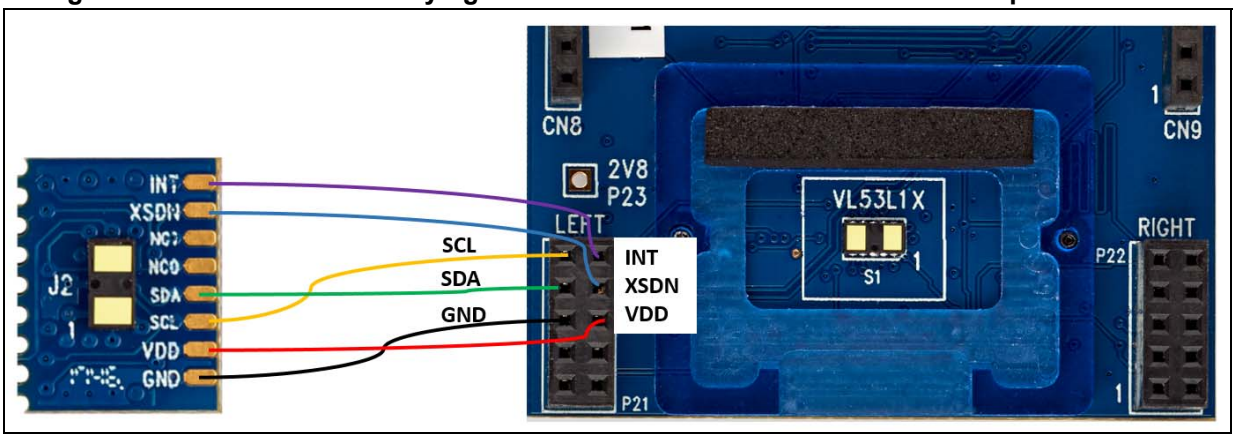
**Figure 7. VL53L1X breakout board schematic**




The VL53L1X breakout boards can be directly plugged onto the X-NUCLEO-53L1A1 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 “VL53L1X mini PCB” which because of its small size, is easier to integrate into customers devices.

**Figure 8. VL53L1X mini PCB flying lead connection to X-NUCLEO-53L1A1 expansion board**



# 5 Safety

## 5.1 Electrostatic precaution

**Figure 9. Electrostatic logo**

The user should exercise electrostatic precautions, including using ground straps when using the X-NUCLEO-53L1A1 expansion board. Failure to prevent electrostatic discharge could damage the device.

## 5.2 Laser considerations

The VL53L1X 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 10. Class 1 laser product label**

# 6 Revision history

Table 6. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 07-03-2018 | 1 | Initial release |