

## **UM2974**

User manual

## How to use the VL53L5CX with STMicroelectronics' X-CUBE-TOF1 Time-of-Flight sensor software packages for STM32CubeMX

#### Introduction

The X-CUBE-TOF1 expansion software package for STM32Cube runs on the STM32 and includes drivers that recognize the sensors and perform simple ranging on single or multiple devices.

The expansion is built on STM32Cube software technology to ease portability across different STM32 microcontrollers.

The software comes with a sample implementation of the drivers running on different Time-of-Flight sensor evaluation boards connected to a featured STM32 Nucleo development board.

In this user manual, we focus on the VL53L5CX Time-of-Flight 8x8 multizone ranging sensor with wide field of view. For further information on the Time-of-Flight sensors supported by X-CUBE-TOF1, please refer to the software page of www.st.com.

The VL53L5CX evaluation boards supported by the X-CUBE-TOF1 expansion software package include:

- X-NUCLEO-53L5A1 expansion board
- VL53L5CX-SATEL breakout boards

The X-CUBE-TOF1 software provides the following sample applications for the VL53L5CX:

- 53L5A1\_SimpleRanging for X-NUCLEO-53L5A1
- 53L5A1\_MultiSensorRanging for X-NUCLEO-53L5A1 and VL53L5CX-SATEL
- 53L5A1\_ThresholdDetection for X-NUCLEO-53L5A1
- VL53L5CX\_SimpleRanging for VL53L5CX-SATEL

Visit the STM32Cube ecosystem web page on www.st.com for further information.

## 1 Acronyms and abbreviations

| Acronym | Definition                         |
|---------|------------------------------------|
| API     | application programming interface  |
| BSP     | board support package              |
| HAL     | hardware abstraction layer         |
| I2C     | inter-integrated circuit           |
| IDE     | integrated development environment |
| MCU     | microcontroller unit               |
| NVIC    | nested vector interrupt control    |
| PCB     | printed circuit board              |
| SDK     | software development kit           |
| ToF     | Time-of-Flight sensor              |
| USB     | universal serial BUS               |

### 2 X-CUBE-TOF1 software expansion for STM32Cube

#### 2.1 Overview

The X-CUBE-TOF1 software package expands the STM32Cube functionality. The key features are:

- Complete software to build applications using the VL53L5CX evaluation boards listed in Section Introduction.
- Several application examples to show the innovative technology for the accurate distance ranging capability.
- Sample application to transmit real-time sensor data to a PC.
- Pre-compiled binaries available on all evaluation boards listed in Section Introduction connected to a NUCLEO-F401RE or NUCLEO-L476RG development board.
- Package compatible with STM32CubeMX, can be downloaded from, and installed directly into, STM32CubeMX.
- Easy portability across different MCU families, thanks to STM32Cube.
- Free, user-friendly license terms.

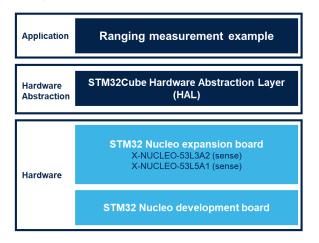
#### 2.2 Architecture

This software is a fully compliant expansion of STM32Cube enabling development of applications using Time-of-Flight sensors.

The software is based on the hardware abstraction layer for the STM32 microcontroller, STM32CubeHAL. The package extends STM32Cube by providing a board support package (BSP) for the sensor expansion board and a sample application for serial communication with a PC.

The software layers used by the application software to access the sensor expansion board are:

- The STM32Cube HAL driver layer. It provides a simple, generic and multi-instance set of APIs (application programming interfaces) to interact with the upper layers (application, libraries and stacks). It includes generic and extension APIs and is based on a generic architecture which allows the layers built on it (such as the middleware layer) to implement their functionalities without dependence on the specific hardware configuration of a given microcontroller unit (MCU). This structure improves library code reusability and guarantees high portability across other devices.
- The BSP layer. It provides supporting software for the peripherals on the STM32 Nucleo board, except for the MCU. It has a set of APIs to provide a programming interface for certain board-specific peripherals (e.g. the LED, the user button etc.), and allows identification of the specific board version. For the sensor expansion board, it provides the programming interface for various Time-of-Flight sensors and provides support for initializing and reading sensor data.



#### Figure 1. X-CUBE-TOF1 software architecture

#### 2.3 Folder structure

#### Figure 2. X-CUBE-TOF1 package folder structure

- Documentation
   Drivers
   Projects
   STM32CubeMX
   \_htmresc
   en.DM00484327.pdf
   readme.txt
- 📀 Release\_notes.html
- Release\_notes.md
- STMicroelectronics.X-CUBE-TOF1.pdsc

The following folders are included in the software package:

- The Documentation folder contains a compiled HTML file generated from the source code and detailed documentation regarding the software components and APIs.
- The Drivers folder contains the HAL drivers, the board-specific drivers for each supported board or hardware platform, including those for the on-board components and the CMSIS layer, which is a vendor- independent hardware abstraction layer for the Cortex-M processor series.
- The Projects folder contains several examples and applications for NUCLEO-L476RG and NUCLEO-F401RE platforms to show the use of sensor APIs provided with three development environments (IAR Embedded Workbench for ARM®, MDK-ARM® Microcontroller Development Kit, STM32CubeIDE).
- The STM32CubeMX folder contains all the templates used by the CubeMX ToF pack.

#### 2.4 APIs

Detailed technical information about the APIs available to the user can be found in the compiled HTML file X-CUBE-TOF1.chm in the Documentation folder of the software package, where all the functions and parameters are fully described.

### 3 VL53L5CX sample application description

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This sample application shows how to use the X-NUCLEO-53L5A1 expansion board and a STM32 Nucleo board to send the ranging data to a serial terminal such as the Tera Term. In this example, the ranging data are displayed on the serial terminal.

Ranging data are read by polling the device for completion or by triggering an interrupt.

This application can be run by loading the prebuilt binary

53L5A1\_SimpleRanging.bin at C:\Users\username\STM32Cube\Repository\Packs\STMicroelectronics\X-CUBE-TOF1\2.0.0-B3\Projects\NUCLEO-F401RE\Examples\53L5A1\53L5A1\_SimpleRanging\Binary as shown in Figure 3. VL53L5CX precompiled projects. The STM32Cube directory is located at C:\Users\YourUserName\STM32Cube as shown below.

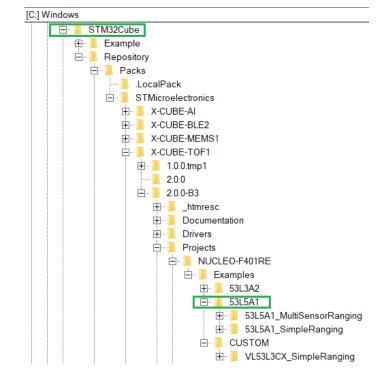


Figure 3. VL53L5CX precompiled projects

1. Flash the Nucleo F401RE board with the prebuilt binary.



2. Open the Tera Term and configure it with the settings below.

| Tera Term: Serial port set | nt?           | ×         |
|----------------------------|---------------|-----------|
| Port:                      | COM4          | ~ ОК      |
| Baud rate:                 | 115200        | ~         |
| Data:                      | 8 bit         | ~ Cancel  |
| Parity:                    | none          | ~         |
| Stop:                      | 1 bit         | ~ Help    |
| Flow control:              | none          | $\sim$    |
| Transmit delay             | /<br>c/char 0 | msec/line |

#### Figure 4. Tera Term serial port setup

#### Figure 5. Tera Term terminal setup

| Tera Term: Terminal setup   | ×  |
|---|--|
| Terminal size<br>157 × 60<br>✓ Term size = win size<br>Auto window resize | New-line<br>Receive: AUTO V<br>Transmit: CR Cancel |
| Terminal ID: VT100 ~  | Help   |
| Coding (receive)  | Coding (transmit)<br>UTF-8 ~                       |
| locale: american  | CodePage: 65001                                    |





3. Wave your hand in front of the sensor to display the ranging data on the serial terminal as shown below.

| STMicroelect                | ronics       | VL53L5CX  | _      |       |   |       |   |
|-----------------------------|--------------|-----------|--------|-------|---|-------|---|
| 53L5A1 Simpl                | e Rangi      | ng Exampl | e<br>- |       |   |       |   |
| Cell Format<br>  distance0[ | :<br>mm]:Sta | atus0     | I      |       |   |       |   |
| 70mm:                       | øl           | 73mm:     |        | 72mm: | ø | 70mm: | 0 |
| <br>  73mm:                 | øł           | 72mm:     | øÏ     | 72mm: | ø | 73mm: | Ø |
| <br>  74mm:                 | øl           | 72mm:     |        | 71mm: | 0 | 72mm: | 0 |
| 71mm:                       | øľ           | 73mm:     | ø      | 74mm: | ø | 71mm: | 0 |

#### Figure 6. VL53L5CX ranging data

#### 3.1 VL53L5CX\_SimpleRanging

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This sample application shows how to run the ranging distance with the VL53L5CX\_SATEL (see figure below) connected directly to the Nucleo without the expansion board X-NUCLEO-53L5A1.

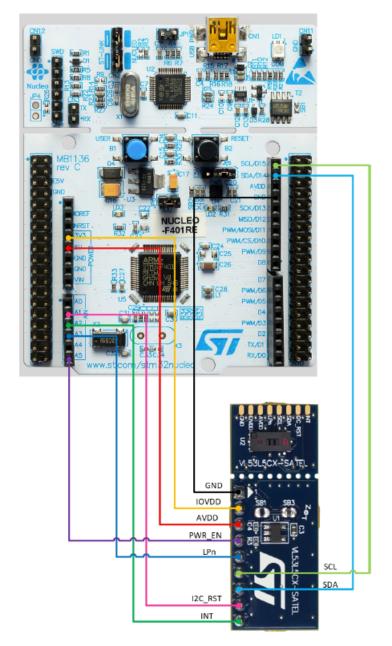


Figure 7. VL53L5CX\_SATEL wiring

To test this application, a breakout board VL53L5CX-SATEL, and a F401RE Nucleo are required. In this example the ranging data are displayed on the serial terminal as shown below. This application can be run by flashing the Nucleo with the prebuilt binary VL53L5CX\_SimpleRanging.bin from C:\Users\user\_name\STM32Cube\Repository\Packs\STMicroelectronics\X-CUBE-TOF1\2.0.0\Projects\NUCLEO-F401RE\Examples\CUSTOM\VL53L5CX\_SimpleRanging\Binary.



#### 1. Open the Tera Term and set the baud rate to 460800

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| Figure                      | 8. Setting the | e baud r | ate     |
|-----------------------------|----------------|----------|---------|
| Tera Term: Serial port setu | ıp             |          | ×       |
|                             |                |          |         |
| Port:                       | COM109         | $\sim$   | ок      |
| Baud rate:                  | 460800         | ~        |         |
| Data:                       | 8 bit          | $\sim$   | Cancel  |
| Parity:                     | none           | $\sim$   |         |
| Stop:                       | 1 bit          | $\sim$   | Help    |
| Flow control:               | none           | $\sim$   |         |
| Transmit delay              | c/char 0       | mse      | ec/line |

#### Figure 9. Ranging results displayed on a terminal

| M    | COM5 - | Tera Te        | rm VT                      |        |      |                |          |   |   |     |   |   |
|------|--------|----------------|----------------------------|--------|------|----------------|----------|---|---|-----|---|---|
| File | e Edit | Setup          | Control                    | Window | w He | lp             |          |   |   |     |   |   |
|      |        |                |                            |        |      | pplicati       | ——       |   |   |     |   |   |
| 'r   | ' : c  | hange<br>nable | resolu<br>signal<br>screen | tion   |      | rol appl<br>nt | .1Cat 10 |   |   |     |   |   |
| Cel  | 1 For  | mat :          |                            |        |      |                |          |   |   |     |   |   |
|      |        | Dista          | ince Emm                   | 1 :    |      |                | Status   |   |   |     |   |   |
|      |        |                |                            |        |      |                |          |   |   |     |   |   |
| !    | 753    | :              | 0                          | 797    | :    | 0              | 114      | : |   | 107 | : | 0 |
| !    | 756    | :              | 0                          | 140    | :    |                | 129      | : | 0 | 126 | : | 0 |
| ¦    | 187    | :              | 0                          | 153    | :    | 0              | 147      | : | 0 | 132 | : | 0 |
| :    | 192    | :              | 0                          | 183    | :    | Ø              | 160      | : | 0 | 119 | : | Ø |
|      |        |                |                            |        |      |                |          |   |   |     |   |   |

#### 3.2 53L5A1\_MultiSensorRanging

This sample application shows how to make three ToF sensors run simultaneously.

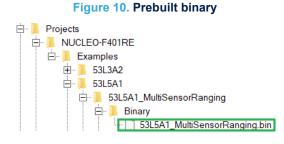
To test this application, two VL53L5CX-SATEL breakout boards, a X-NUCLEO-53L5A1, and a Nucleo F401RE are required. Ranging data are displayed on the serial terminal as shown below. This application is run by loading the prebuilt binary 53L5A1\_MultiSensorRanging.bin.

Note:

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In this application, the ranging data are read by polling a register; no interrupt option is implemented.

1. Flash the Nucleo F401RE board with the prebuilt binary.



- 2. Open the Tera Term and configure it with the settings in Section 3 VL53L5CX sample application description.
- 3. Wave your hand in front of the sensor to display the ranging data on the serial terminal as shown below.

| 71                                   | <br>ø            | <br>73mm: | <br>ø     | <br>72mm:      | <br>ø ¦  | <br>70mm: | <br>0 |
|--------------------------------------|------------------|-----------|-----------|----------------|----------|-----------|-------|
| 71mm:                                | ·                | / 3mm :   |           | / 2mm :        |          | 7 0mm :   |       |
| 73mm:                                |                  | 71mm:     | 0         | 72mm:          |          | 73mm:     | 0     |
| 75mm:                                | ø                | 71mm:     | ø         | 73mm:          | ø        | 73mm:     | 0     |
| 73mm:                                | øľ               | 74mm:     | øľ        | 74             |          | 70        | _     |
| HT<br>1 Format                       | :                |           |           | 74mm:          | 0 İ      | 72mm:     |       |
| HT<br>1 Format<br>istance00<br>60mm: | :                |           | <br>0     | /4mm:<br>60mm: | 0  <br>0 | 72mm:<br> |       |
| l Format<br>listance0[               | :<br>            | atus0     | I<br>I    |                |          |           |       |
| l Format<br>listance0[<br>60mm:      | :<br>[mm]:St<br> | atus0<br> | <br> <br> | 60mm:          |          | 59mm:     |       |

#### Figure 11. VL53L5CX ranging data



The X-NUCLEO-53L5A1 interfaces with the STM32 microcontroller via the I2C pin. Assuming the user wants to interface the X-NUCLEO-53L5A1 expansion board with a STM32 Nucleo 64-pin board (e.g. a Nucleo-F401RE), no particular hardware modification is necessary.

#### 4.1 Use of expansion software without sample applications

This section outlines how to configure the STM32CubeMX with the X-NUCLEO-53L5A1 when the use of the sample applications is not required. With such a setup, only the driver layers are configured.

1. Add the X-CUBE-TOF1 SW pack to the project by clicking on the Software Packs button. Then, Select Components as shown below.

#### Figure 12. Add X-CUBE-TOF1 SW pack to the project

|         | Clock Configuration                  |          | Project Ma            | inager      |
|---------|--------------------------------------|----------|-----------------------|-------------|
|         | ∧ Software Packs                     | 🗸 Pin    | out                   |             |
| <u></u> | Select Components                    |          | Pinout view           | System view |
|         | Manage Software Packs Add pack softw | are comp | ponent to the project |             |

2. From the Software Packs Component Selector window, select the appropriate Board Extension class e.g. in this case 53L5A1.

#### Figure 13. Select Board Extension class

| ✓ STMicroelectronics.X-CUBE-TOF1 | $\odot$ | 2.0.0 ~ |          |
|----------------------------------|---------|---------|----------|
| Board Extension 53L3A2           |         | 2.0.0   |          |
| Board Extension 53L5A1           | $\odot$ | 1.0.0   | <b>~</b> |

3. Enable the I2C1 as shown below.

#### Figure 14. Enable I2C1

| Pinout & Configuration |   | Clock Configuration         |
|------------------------|---|-----------------------------|
|                        |   | ✓ Software Packs            |
| Q ~                    | ۲ | I2C1 Mode and Configuration |
| Categories A->Z        |   | Mode                        |
| System Core            | > | 120 120                     |
| Analog                 | > |                             |
| Timers                 | > |                             |
| Connectivity           | ~ |                             |
| ¢<br>12C1              |   |                             |



4. From the Software Packs dropdown menu, select STMicroelectronics.X-CUBE-TOF1.2.0.0.

Figure 15. Select STMicroelectronics.X-CUBE-TOF1

| Categories A->Z                      |   |
|--------------------------------------|---|
| System Core                          | > |
| Analog                               | > |
| Timers                               | > |
| Connectivity                         | > |
| Multimedia                           | > |
| Computing                            | > |
| Middleware                           | > |
| Software Packs                       | ~ |
| ÷                                    |   |
| STMicroelectronics.X-CUBE-TOF1.2.0.0 |   |

5. From the Mode view, select the Board Extension 53L5A1.

Figure 16. Select Board Extension 53L5A1

| ✓ Software Packs   | ✓ Pinout                                 |
|--------------------|--|
| STMicroelectronics | X-CUBE-TOF1.2.0.0 Mode and Configuration |
|                    | Mode                                     |

Board Extension 53L5A1



6. From the Configuration window, enable the I2C1.

#### Figure 17. Enable I2C1

|  |                   | Configuration   |          |                |
|--|-------------------|-----------------|----------|----------------|
| Reset Configuration                                |                   |                 |          |                |
| Parameter Settings                                 | Platform Settings |                 |          |                |
| <ul> <li>Platform proposal</li> <li>BSP</li> </ul> |                   |                 |          |                |
| Name   | IPs or Components | Found Solutions | I2C Addr | BSP API        |
| 53L5A1 BUS IO driver                               | 12C:12C ~         | I2C1 ~          | 0        | BSP_BUS_DRIVER |

7. Next, click on the Project Manager to name the project and select the appropriate Toolchain/IDE to generate the codes.

#### Figure 18. Name project and select appropriate Toolchain/IDE

| STM32F401RETx - NUCLEO-F401RE     Untitled - Project Manager       Home     STM32F401RETx - NUCLEO-F401RE     Untitled - Project Manager       Pinout & Configuration     Clock Configuration     Project Manager       - Project Setings -<br>Project Setings -<br>Project Mane<br>bet     -     - |               |
|---|---------------|
| Pinout & Configuration         Clock Configuration         Project Manager                Project Setings               Project Name  | 🥸 📑 🕒 🎽       |
| Project Settings     Project Name   | GENERATE CODE |
| Project Name  | Tools         |
| Project Project Location Erowse Application Structure Advanced v Do not generate the main()   |               |
| Toolchain Folder Location  C to teat  Toolchain /IDE  STM20CubeUE   |               |

8. Click on the GENERATE CODE button to generate the source code of the project using the X-CUBE-TOF1 software.

#### Figure 19. Generate source code of project using X-CUBE-TOF1 software





#### 4.2 Use of expansion software with sample applications

#### 4.2.1 How to generate 53L5A1\_SimpleRanging example with CubeMX

1. Open STM32CubeMX and select "Access to board selector".

#### Figure 20. Access to board selector STM32CubeMX Untitled: STM32F401RETx NUCLEO-F401RE File Window Help Home > STM32F401RETx - NUCLEO-F401RE > Untitled - Pinout & Configuration > Existing Projects New Project Recent Opened Projects I need to : test\_tof1\_rev2.ioc MX Last modified date : 14/06/2021 16:50:34 Start My project from MCU ACCESS TO MCU SELECTOR cube\_tof1\_2\_4.ioc MX Last modified date : 14/06/2021 16:00:33 Start My project from ST Board test\_cube\_tof1\_3.ioc MX SS TO BOARD SELEC ACCE Last modified date : 14/06/2021 15:45:27 test\_cube\_2\_2.ioc MX Start My project from Example Last modified date : 14/06/2021 15:31:16 S TO EXAMPLI Other Projects 6

#### 2. Select the F401RE board

New Project from a Roard

| ★ 🗟 🖾                     | 0 |      | Feature          | 5   | Large Picture | Doce  | & Resources   | 🚺 Datasheet  | 📑 Buy   | 🕞 Start Project  |
|---------------------------|---|------|------------------|---|---------------|---|---|--|---|--|
| Commercial<br>Part Number | v | *    | STM32F4 Serie    | JCLEO-F401  | IRE           | STMicroelec   | ronics NUCLEO-F   | 401RE Board Suppo  | rt and Examples   |  |
| Vendor                    | > |      | ACTIVE           | ctive   |               | Part Number : NU  |   |  | Unit Price (US\$): 13.0   |  |
| Type                      | > |      |                  | mass production   |               | Commercial Part   | Number : NUCLEO-F401F   | ξE   | Mounted Device : STM32F401  | RETX   |
| MCU/MPU Series<br>Other   | > |      |                  |   |               |   | osing from the various  | combinations of performa   | nce and power consumption<br>IPS significantly reduces po                               | n features, provided by t  |
| Other                     | > | Boar | ds List: 7 items |   |               | prototypes by cho<br>STM32 microcont<br>mode.                               | osing from the various<br>oller. For the compatit                           | combinations of performa<br>ble boards, the external SN                            | nce and power consumption   | n features, provided by the<br>wer consumption in Run<br>insion of the functionality |
|                           | > | Boar | ds List: 7 items |   |               | prototypes by cho<br>STM32 microcont<br>mode.                               | osing from the various<br>oller. For the compatit                           | combinations of performa<br>ble boards, the external SN                            | nce and power consumption<br>IPS significantly reduces po<br>eaders allow the easy expa | n features, provided by the<br>wer consumption in Run                                |
| Other                     | > | Boar | ds List: 7 čems  | Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Constant<br>Con | × cor         | prototypes by cho<br>STM32 microcont<br>mode.<br>The ARDUINO <sup>®</sup> U | osing from the various<br>oiler. For the compatit<br>to V3 connectivity sup | combinations of performa<br>be boards, the external Sh<br>port and the ST morpho h | nce and power consumption<br>IPS significantly reduces po<br>eaders allow the easy expa | n features, provided by the<br>wer consumption in Run<br>insion of the functionality |

#### Figure 21. F401RE board

3. Right click "Select Components"

|                 |                                       | Figure 2     | 22. Components          |  |                                   |
|-----------------|---------------------------------------|--------------|-------------------------|--|-----------------------------------|
| STM32Cu         | beMX Untitled: STM32F401RETx NUCLEO-F | F401RE       |                         |  |                                   |
| STM32<br>CubeMX | File                                  | Window       | Help                    |  |                                   |
| Home >          | STM32F401RETx - NUCLEO-F401RE         | Untitled - P | inout & Configuration > |  |                                   |
|                 | Pinout & Configuration                |              | Clock Co                | onfiguration                                       |                                   |
|                 |                                       |              |                         |  |                                   |
| Q<br>Categories | → ◎ ►                                 |              |                         | age Softwar Dacks At-0<br>Add pack software compon | Pinout view<br>ent to the project |

4. Select "X-CUBE-TOF1", then select "53L5A1 Board Extension", next select "53L5A1\_SimpleRanging", and finally "OK".

| <ul> <li>STMicroelectronics X-CUBE-TOF1</li> </ul>   | 0  | 2.0.0-83 ~ |                      |   |
|--|----|------------|----------------------|---|
| Board Extension 53L3A2   | 0  | 2.0.0-03   |                      |   |
| Board Extension 53L5A1   | 0  | 1.0.0      |                      |   |
|  | U  | 2.0.0      |                      |   |
| Board Part Ranging / VL53L3CX<br>Board Part Ranging / VL53L5CX                                       |    | 1.0.0      |                      |   |
|  | 0  | 1.0.0      |                      | _ |
| Device TOF1_Applications   | 0  | 1.0.0      | 53L5A1_SimpleRanging |   |
| Application  > Board Support STM32Cube_Custom_BSP_D  | -  | 1.0.0      | poloki_oimpiekanging | ~ |
| <ul> <li>Sound Support STM32Cube_Custom_ESP_L</li> <li>STMicroelectronics.X-CUBE-TOUCHGFX</li> </ul> | ,  | 4.16.1 @ ~ | r Install            |   |
| > wolfSSL1/CUBE-wolfSSL  |    | 4.7.0 0    | Install              |   |
| > FreeRTOS   | Ð  | 4.1.0      | (TSLAI)              |   |
|  | Gø |            |                      |   |
| > MBEDTLS  | G  |            |                      |   |
| > PDM2PCM  | G  |            |                      |   |
| > USB_DEVICE   | B  |            |                      |   |

5. Select "Software Packs", then select "STMicroelectronics X-CUBE-TOF1", next select "Board Extension 53L5A1 box", and finally select the "Device TOF1 Applications".

#### Figure 24. Device TOF1 application box selection

| STM32Cut        | beMX Untitled*: STM   | M32F401RETx NUCLEO-F | 401RE                    |                  |   |          |
|-----------------|-----------------------|----------------------|--------------------------|------------------|---|----------|
| STM32<br>CubeMX |                       | File                 | Window                   | Help             |   |          |
| Home 🔪          | STM32F401RETx         | - NUCLEO-F401RE      | Vintitled - Pinout 8     | & Configuratio   | n >   |          |
|                 | Pinout 8              | k Configuration      |                          |                  | Clock Configuration                             |          |
|                 |                       |                      |                          |                  | ✓ Software Packs                                | ✓ Pinout |
| Q<br>Categories | ~<br>A->Z             |                      | STMicro                  | electronics.X-CU | BE-TOF1.2.0.0-B3 Mode and Configuration<br>Mode |          |
| System C        | ore                   |                      | Board Extension 53L5A1   |                  |   |          |
| Analog          |                       | >                    | Device TOF1 Applications | ]                |   |          |
| Timers          |                       | >                    |                          |                  |   |          |
| Connectivi      | ty                    | > <b>♦=</b> ₽        |                          |                  |   |          |
| Multimedia      | 1                     | >                    |                          |                  |   |          |
| Computing       | 1                     | >                    |                          |                  |   |          |
| Middlewar       | e                     | >                    |                          |                  |   |          |
| Software F      | Packs                 | ×                    |                          |                  |   |          |
| ✓ STMice        | roelectronics.X-CUBE- | TOF1.2.0             |                          |                  |   |          |
|                 |                       |                      |                          |                  | Configuration                                   |          |
|                 |                       | Res                  | et Configuration         |                  |   |          |
|                 |                       | Se Par               | ameter Settings 📔 😌 Use  | er Constants 🗾   | Platform Settings                               |          |



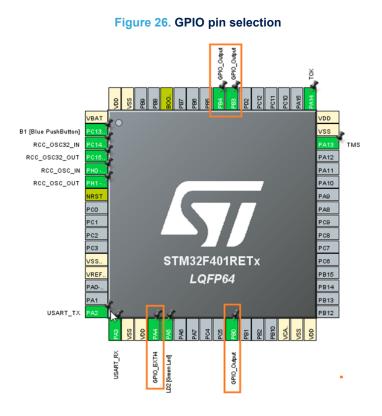
6. Configure the GPIOs for the application.

|                      |                           | Configuration         |             |                |
|----------------------|---------------------------|-----------------------|-------------|----------------|
| Reset Configuration  |                           |                       |             |                |
| Parameter Setting    | s 🛛 📀 User Constants 🗖    | 🛕 Platform Settings 👘 |             |                |
| Platform proposal    |                           |                       |             |                |
| Application          |                           |                       |             |                |
| Name                 | IPs or Components         | Found Solutions       | I2C Addr    | BSP API        |
| 53L5A1_I2C_RST_C     | GPIO:Output PB3 ~         | Undefined             |             | ∨ Unknown      |
| TOF_INT_PIN          | gpio:exti PA4 ~           | Undefined             |             | - Unknown      |
| 53L5A1_LPn_C         | GPIO:Output PB4 ~         | Undefined             |             | √ Unknown      |
| 53L5A1_PWR_EN_C      | GPIO:Output PB0 ~         | Undefined             |             | ✓ Unknown      |
| BSP                  | IPs or Components         | Found Solutions       | I2C Addr BS | IP API         |
|                      |                           |                       |             |                |
| 53L5A1 BUS IO driver |                           | No solution ~         |             | _BUS_DRIVER    |
| BSP BUTTON           | GPIO:EXTI ~               | Undefined             | ✓ BSP       | _COMMON_DRIVER |
| BSP USART            | USART:Asynchronous $\vee$ | Undefined             | ∨ BSP       | _COMMON_DRIVER |
|                      |                           |                       |             |                |
|                      |                           |                       |             |                |
|                      |                           |                       |             |                |
|                      |                           |                       |             |                |

Figure 25. Configuration of GPIOs for application



7. Select the GPIO pins as shown below.



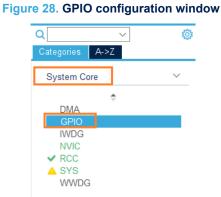
8. Link the GPIOs to the corresponding pin names as shown below.



|                              |                      |         | Configuration   |       |                |        |                               |
|------------------------------|----------------------|---------|-----------------|-------|----------------|--------|-------------------------------|
| Reset Configuration          |                      |         |                 |       |                |        |                               |
| Parameter Setting            | s 🛛 😔 User Constants | 🔥 Platf | orm Settings    |       |                |        |                               |
| Platform proposal            |                      |         |                 |       |                |        |                               |
| Application                  |                      |         |                 |       |                |        |                               |
| Name                         | IPs or Components    |         | Found Solutions |       | I2C Addr       |        | BSP API                       |
| 53L5A1_I2C_RST_C             | GPIO:Output          | ~       | PB3             |       |                |        | ✓ Unknown                     |
| TOF_INT_PIN                  | GPIO:EXTI            | ~       | PA4             |       |                |        | <ul> <li>✓ Unknown</li> </ul> |
| 53L5A1_LPn_C                 | GPIO:Output          | ~       | PB4             |       |                |        | √ Unknown                     |
| 53L5A1_PWR_EN_C              | GPIO:Output          | ~       | PB0             |       |                |        | <ul> <li>✓ Unknown</li> </ul> |
|                              |                      |         |                 |       |                |        |                               |
|                              |                      |         |                 |       | L <sup>o</sup> |        |                               |
| BSP                          |                      |         |                 |       | ß              |        |                               |
| BSP                          | IPs or Components    |         | Found Solutions | 12C A |                | BSP A  | PI                            |
| Name                         |                      | ~       | Found Solutions | 12C A |                |        | PI<br>S_DRIVER                |
| Name<br>53L5A1 BUS IO driver |                      |         |                 |       | ddr            | BSP_BU | S_DRIVER                      |
|                              | I2C:I2C              |         | No solution     |       | ddr            | BSP_BU |                               |



Select "GPIO" to open the GPIO configuration window as shown below. 9.



10. Name and configure the pins as shown below.

#### Figure 29. Pin name configuration

|                     |               |                  | Config           | juration        |              |                 |                 |
|---------------------|---------------|------------------|------------------|-----------------|--------------|-----------------|-----------------|
| Group By Perip      | nerals        |                  |                  |                 |              |                 | ~               |
| 🛛 GPIO 🛛 🛇          | RCC 📀 SYS     | 🔮 USART 🛛 🔮      | NVIC             |                 |              |                 |                 |
|                     |               |                  |                  |                 |              |                 |                 |
| Search Signals      |               |                  |                  |                 |              |                 |                 |
|                     |               |                  |                  |                 |              | Show on         | ly Modified Pin |
|                     |               |                  |                  |                 |              |                 |                 |
| Pin Name 🇢          | Signal on Pin | GPIO output leve | GPIO mode        | GPIO Pull-up/P. | Maximum outp | User Label      | Modified        |
| PA4                 | n/a           | n/a              | External Interru | No pull-up and  | n/a          | TOF_INT_C       | <b>~</b>        |
| PA5                 | n/a           | Low              | Output Push Pull | No pull-up and  | Low          | LD2 [Green Led] | <b>V</b>        |
| PB0                 | n/a           | High             | Output Push Pull | No pull-up and  | Low          | TOF_PWR_EN_C    | <b>V</b>        |
| PB3                 | n/a           | Low              | Output Push Pull | Pull-down       | Low          | TOF I2C RST C   | <b>~</b>        |
| PB4                 | n/a           | High             | Output Push Pull | Pull-up         | Low          | TOF LPn C       | <b>V</b>        |
| PC13-ANTI TA        | n/a           | n/a              | External Interru | No pull-up and  | n/a          | B1 [Blue Push   | <b>V</b>        |
| PB4<br>PC13-ANTI_TA | n/a           | High             |                  | Pull-up         | Low          |                 | <b>V</b>        |

11. Activate the NVIC interrupt vector as shown below.

#### Figure 30. NVIC interrupt vector activation

| Configuration                         |            |                     |              |  |  |  |  |  |  |
|---------------------------------------|------------|---------------------|--------------|--|--|--|--|--|--|
| Group By Peripherals                  |            |                     |              |  |  |  |  |  |  |
| I I I I I I I I I I I I I I I I I I I |            |                     |              |  |  |  |  |  |  |
| NVIC Interrupt Table                  | Enabled    | Preemption Priority | Sub Priority |  |  |  |  |  |  |
| EXTI line4 interrupt                  | <b>_</b>   | 0                   | 0            |  |  |  |  |  |  |
| EXTI line[15:10] interrupts           | <u>d</u> 2 | 0                   | 0            |  |  |  |  |  |  |

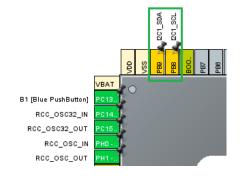


#### 12. Configure the I2C and BSP as shown below.

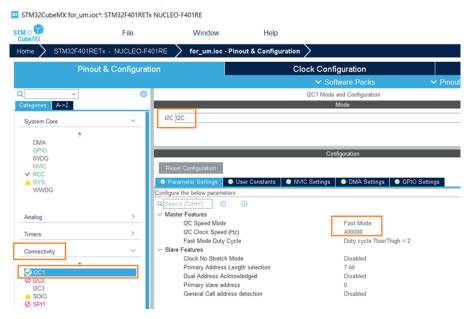
| Figure 31. I2C and BSP configuration |                    |                    |          |                   |  |  |  |  |  |  |
|--------------------------------------|--------------------|--------------------|----------|-------------------|--|--|--|--|--|--|
| BSP                                  |                    |                    |          |                   |  |  |  |  |  |  |
| Name                                 | IPs or Components  | Found Solutions    | I2C Addr | BSP API           |  |  |  |  |  |  |
| 53L5A1 BUS IO driver                 | I2C:I2C ~          | No solution $\sim$ | N/A      | BSP_BUS_DRIVER    |  |  |  |  |  |  |
| BSP BUTTON                           | GPIO:EXTI ~        | Undefined          | ~        | BSP_COMMON_DRIVER |  |  |  |  |  |  |
| BSP USART                            | USART:Asynchronous | Undefined          | ~        | BSP_COMMON_DRIVER |  |  |  |  |  |  |

#### 13. Select the pins PB9 and PB8 for SDA and SCL as shown below.





14. Select "Connectivity", then select "I2C1", next select "Enable I2C", and finally select "Fast Mode".



#### Figure 33. Fast mode selection



15. Select "Project Manager".



16. Name the project, select "Toolchain", and then select "Generate Code" as shown below.

|            |  |                    | Figure 35.                 | Code genera         | ation           |               |
|------------|--|--------------------|----------------------------|---------------------|-----------------|---------------|
| STM32Cubel | MX Untitled*: STM32F401RETx NUCLEO-F   | 401RE              |                            |                     |                 | -             |
| STM32      | File   | Window             | Help                       |                     |                 | 🥸 📑 🖻 🎽       |
| Home > S   | STM32F401RETx - NUCLEO-F401RE  | Vntitled - Project | Manager 🔪                  |                     |                 | GENERATE CODE |
|            | Pinout & Configuration   |                    | Clock Configuration        |                     | Project Manager | Tools         |
| Project    | Project Settings<br>Project Name<br>For_um<br>Project Location<br>C:180<br>Application Structure |                    |                            | Brownie             |                 |               |
| Code Gene  | Advanced<br>Toolchain Folder Location<br>Entroller um/n<br>Toolchain / IDE<br>STM32CubeiDE       | v                  | Ob not generate the main() | Generate Under Root |                 | 4             |

17. Select "Open Project" on the pop-up window when code generation is complete, as shown below.

## Code Generation × API The Code is successfully generated under : wn C:/titi/for\_um Project language : C Open Folder Open Project Close wn

#### Figure 36. Open project



#### 18. Build and run the project. The results should look as shown below.

#### Figure 37. Results

| 💻 COM22 - Tera Term VT   | 💆 COM22 - Tera Term VT   |          |       |      |       |  |  |  |  |  |  |
|--|--|----------|-------|------|-------|--|--|--|--|--|--|
| <u>F</u> ile <u>E</u> dit <u>S</u> etup C <u>o</u> ntrol <u>W</u> indow <u>H</u> elp |  |          |       |      |       |  |  |  |  |  |  |
| STMicroelectronics VL53L5CX  |  |          |       |      |       |  |  |  |  |  |  |
|  |  |          |       |      |       |  |  |  |  |  |  |
| 'r' : change re  | Use the following keys to control application<br>'r' : change resolution |          |       |      |       |  |  |  |  |  |  |
| 's' : enable si<br>'c' : clear scr   | gnal and ambien<br>een   | nt       |       |      |       |  |  |  |  |  |  |
| Cell Format :  |  |          |       |      |       |  |  |  |  |  |  |
| Distance   | Emm] :   | Status   |       |      |       |  |  |  |  |  |  |
|  |  |          |       |      |       |  |  |  |  |  |  |
| 70 : 0   | 71 : 0   | 2 71 :   | øľ    | 69 : | ø     |  |  |  |  |  |  |
| 70 . 0   | 70   |          |       | 74   | <br>а |  |  |  |  |  |  |
| i 72 : 0   | 70 : (   | 2 i 69 : | i     | 71 : |       |  |  |  |  |  |  |
| 73 : 0   | 69 : 0   | 2 70 :   | ø     | 69 : | ø     |  |  |  |  |  |  |
| 71 : 0   | 72 : (   | a   72 : | <br>а | 70 : |       |  |  |  |  |  |  |
|  | /2 :   | /2 :     |       | 70 : |       |  |  |  |  |  |  |



#### 4.2.2 How to generate 53L5A1\_MultipleSensorRanging example with CubeMX

1. Open STM32CubeMX and select "Access to board selector".

| M32CubeMX Untitle                     | ed: STM32F401RETx NUCLEO-F        | 401RE               |               |   |
|---------------------------------------|-----------------------------------|---------------------|---------------|---|
| 2<br>eMX                              | File                              | Window              | Help          |   |
| ne 🔪 STM32F40                         | 1RETx - NUCLEO-F401RE             | Vntitled - Pinout 8 | Configuration | $\rangle$   |
| Existing Projects                     | 5                                 |                     |               | New Project   |
| Recent Opened                         | Projects                          |                     |               | I need to :   |
| test_tof1_rev2.<br>Last modified date | ioc<br>e : 14/06/2021 16:50:34    |                     | MX            | Start My project from MCU                               |
| cube_tof1_2_4                         | 4.ioc<br>e : 14/06/2021 16:00:33  |                     | MX            | ACCESS TO MCU SELECTOR                                  |
| test_cube_tof1 Last modified date     | _3.ioc<br>a : 14/06/2021 15:45:27 |                     | MX            | Start My project from ST Board ACCESS TO BOARD SELECTOR |
| test_cube_2_2<br>Last modified date   | 2.ioc<br>a : 14/06/2021 15:31:16  |                     | MX            | Start My project from Example                           |
|                                       |                                   |                     | E7            | ACCESS TO EXAMPLE SELECTOR                              |

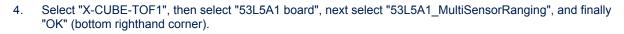
#### 2. Select the F401RE board

| ard Filters 🔂 🔂     | 20 |   |      | Features         |                | Large Picture | Doc  | & Resources  | 8                         | Datasheet                                  | 📑 Buy                 | 🕞 Start                                   | Project                     |
|---------------------|----|---|------|------------------|----------------|---------------|--|--|---------------------------|--|-----------------------|---|-----------------------------|
| Part Number         |    | ~ | *    |                  | JCLEO-F4       | 01RE          | STMicroelec                                | tronics NUCLEO   | -F401RE                   | Board Support a                            | d Examples            |   |                             |
| Vendor              |    | > |      | ACTIVE           | 1510           |               | Part Number : NI                           | CLEO-F401RE  |                           | Uni  | Price (US\$): 13.0    |   |                             |
| Type                |    | > |      | Product is in n  | nass productio | n             |  | Number: NUCLEO-F40   | 1RE                       | Mor  | nted Device : STM32F4 | IQ1RETx                                   |                             |
|                     |    |   |      | the same little  | 100 2000 11    | 100 CON       | prototypes by cho                          | The STM32 Nucleo-64 board provides an affordable and flexible<br>prototypes by chosing from the various combinations of perform<br>STM32 microcontroller. For the compatible boards, the esternal 5<br>mode.<br>The ARDUINO <sup>®</sup> Uno V3 connectivity support and the ST morpho |                           |  | ind power consumpt    | tion features, provid                     | ed by th                    |
|                     |    | > | Boar | ds List: 7 items |                |               | STM32 microcont<br>mode.                   | roller. For the compa  | tible board               | s, the external SMPS :                     | ignificantly reduces  | power consumption                         | in Run                      |
|                     |    | > | Boar | ds List: 7 items | Creme          | a Hara        | STM32 microcont<br>mode.                   | roller. For the compa  | tible board               | s, the external SMPS :                     | ignificantly reduces  | power consumption<br>pansion of the funct | in Run<br>ionality d        |
| Other<br>Peripheral |    | > | Boar | ds List: 7 Rems  |                |               | STM32 microcont<br>mode.<br>The ARDUINO® U | roller. For the compa<br>no V3 connectivity su   | tible board<br>upport and | s, the external SMPS : the ST morpho heade | ignificantly reduces  | power consumption<br>pansion of the funct | in Run<br>ionality c<br>d E |

#### Figure 39. F401RE board

3. Right click "Select Components"





| <ul> <li>STMicroelectronics.X-CUBE-TOF1</li> </ul> | $\odot$               | 2.0.0-B3 🗸 🗸 |   |
|--|-----------------------|--------------|---|
| Board Extension 53L3A2                             |                       | 2.0.0        |   |
| Board Extension 53L5A1                             | $\odot$               | 1.0.0        | ✓   |
| Board Part Ranging / VL53L3CX                      |                       | 2.0.0        |   |
| Board Part Ranging / VL53L5CX                      |                       | 1.0.0        |   |
| V Device TOF1 Applications                         |                       | 1.0.0        |   |
| Application  |                       |              | Not selected $\checkmark$   |
| > Board Support STM32Cube_Custom_BSP_D             |                       | 1.0.0        | Not selected  |
| > STMicroelectronics.X-CUBE-TOUCHGFX               |                       | 4.16.1 ڬ 🗸 🗸 | <ul> <li>53L3A2_SimpleRanging</li> <li>53L3A2 MultiSensorRanging</li> </ul> |
| > wolfSSL.I-CUBE-wolfSSL                           |                       | 4.7.0 ڬ      | <ul> <li>VL53L3CX_SimpleRanging</li> </ul>                                  |
| > FreeRTOS   | G)                    | -            | 53L5A1 SimpleRanging  |
| > HAL Drivers                                      | $\Rightarrow \oslash$ | L            | 53L5A1_MultiSensorRanging<br>53L5A1 ThresholdDetection                      |
| > MBEDTLS  | $\rightarrow$         |              | <ul> <li>VL53L5CX_SimpleRanging</li> </ul>                                  |

#### Figure 41. 53L5A1\_MultiSensorRanging

5. Select "Software Packs", then select "STMicroelectronics X-CUBE-TOF1", next select "Board Extension 53L5A1 box", and finally select the "Device TOF1 Applications box".

| STM32  | File                | Window         | He             | elp                    |                  |            |
|--|---------------------|----------------|----------------|------------------------|------------------|------------|
| Home STM32F401RETx -                             | NUCLEO-F401RE       | Untitled - Pin | out & Config   | uration >              |                  |            |
| Pinout & C                                       | Configuration       |                |                | Clock Conf             | iguration        |            |
|  | g                   |                |                |                        | tware Packs      | ✓ Pine     |
| Q ~ (  | 9                   | STMicroele     | ctronics.X-CUB | E-TOF1.2.0.0-B3 Mode a | nd Configuration |            |
| Categories A->Z                                  |                     |                |                | Mode                   |                  |            |
| System Core >                                    | Board Extensio      | n 53L5A1       |                |                        |                  |            |
| Analog >   | Device TOF1 A       | pplications    |                |                        |                  |            |
| Timers >   |                     |                |                | Configuration          |                  |            |
| Connectivity >                                   | Reset Configuratio  | n              |                |                        |                  |            |
| Multimedia >                                     | Parameter Setting   | S 🔥 Platform   | Settings       |                        |                  |            |
| Computing >                                      | Application         |                |                |                        |                  | ]          |
| Middleware >                                     | Name                | IPs or Compon  |                | Found Solutions        | I2C Addr         | BSP API    |
|  | 53L5A1_I2C_RST_C    | GPIO:Output    | PB3 ~          | Undefined              | ~                | Unknown    |
| Software Packs ~                                 | 53L5A1_PWR_EN_L     | GPIO:Output    | PA0 ~          | Undefined              | ~                | Unknown    |
| <ul> <li>STMicroelectronics.X-CUBE-TC</li> </ul> | 53L5A1_LPn_L        | GPIO:Output    | PB10 ~         | Undefined              | ~                | Unknown    |
|  | 53L5A1_I2C_RST_R    | GPIO:Output    | PA9 ~          | Undefined              | ~                | Unknown    |
|  | 53L5A1_LPn_C        | GPIO:Output    | PB4 ~          | Undefined              | ~                | Unknown    |
|  | 53L5A1_I2C_RST_L    | GPIO:Output    | PA8 ~          | Undefined              | ~                | Unknown    |
|  | 53L5A1_PWR_EN_C     | GPIO:Output    | PB0 ~          | Undefined              | ~                | Unknown    |
|  | 53L5A1_PWR_EN_R     | GPIO:Output    | PC0 ~          | Undefined              | ~                | Unknown    |
|  | 53L5A1 LPn R        | GPIO:Output    | PB5 ~          | Undefined              | ~                | Unknown    |
|  |                     |                | 100            |                        |                  |            |
|  |                     |                |                |                        |                  |            |
|  | BSP                 |                |                |                        |                  |            |
|  | Name                | IPs or Compor  | ients          | Found Solutions        | I2C Addr BSP API |            |
|  | 53L5A1 BUS IO drive | r 12C:12C      | ~              | No solution $\sim$     | N/A BSP_BUS_     | DRIVER     |
|  | BSP USART           | USART:Asynchi  | ronous ~       | Undefined              | V BSP_COM        | MON_DRIVER |

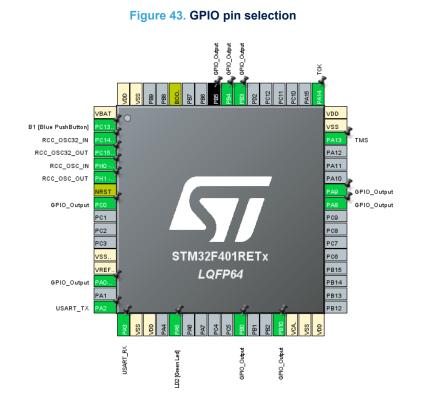
#### Figure 42. Device TOF1 application box selection

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STM32CubeMX Untitled\*: STM32F401RETx NUCLEO-F401RE



6. Select the GPIOs pins as shown below.



7. Link the GPIOs to the corresponding pin names as shown below.

| Reset Configuration                  | 1                     |        |                 |          |        |         |
|--------------------------------------|-----------------------|--------|-----------------|----------|--------|---------|
| Parameter Setting                    | s 🔥 Platform Settings |        |                 |          |        |         |
| Platform proposal —<br>Application — |                       |        |                 |          |        |         |
| Name                                 | IPs or Components     |        | Found Solutions | I2C Addr |        | BSP AP  |
| 53L5A1_I2C_RST_C                     | GPIO:Output           | $\sim$ | PB3             | ht       | $\sim$ | Unknown |
| 53L5A1_PWR_EN_L                      | GPIO:Output           | $\sim$ | PA0-WKUP        |          | $\sim$ | Unknown |
| 53L5A1_LPn_L                         | GPIO:Output           | $\sim$ | PB10            |          | $\sim$ | Unknown |
| 53L5A1_I2C_RST_R                     | GPIO:Output           | $\sim$ | PA9             |          | $\sim$ | Unknown |
| 53L5A1_LPn_C                         | GPIO:Output           | $\sim$ | PB4             |          | $\sim$ | Unknown |
| 53L5A1_I2C_RST_L                     | GPIO:Output           | $\sim$ | PA8             |          | $\sim$ | Unknown |
| 53L5A1_PWR_EN_C                      | GPIO:Output           | $\sim$ | PB0             |          | $\sim$ | Unknown |
| 53L5A1_PWR_EN_R                      | GPIO:Output           | $\sim$ | PC0             |          | $\sim$ | Unknown |
| 53L5A1_LPn_R                         | GPIO:Output           | $\sim$ | PB5             |          | $\sim$ | Unknown |

#### Figure 44. GPIO and pin name correspondance



8. Select "GPIO" to open the GPIO configuration window as shown below.

| Figure 45. GPIO configuration window  |     |  |  |  |  |  |  |
|---|-----|--|--|--|--|--|--|
| Q ~<br>Categories A->Z  | ٥   |  |  |  |  |  |  |
| System Core   | ~ [ |  |  |  |  |  |  |
| <ul> <li>DMA</li> <li>GPIO</li> <li>IWDG</li> <li>NVIC</li> <li>✓ RCC</li> <li>▲ SYS</li> <li>WWDG</li> </ul> | P   |  |  |  |  |  |  |
| Analog  | > P |  |  |  |  |  |  |
| Timers  | > P |  |  |  |  |  |  |
| Connectivity  | >   |  |  |  |  |  |  |

9. Name and configure the pins as shown below.

|  |                          |                             | GPIO Mode ar   | nd Configuration                                      |                   |   |                                  |
|--|--------------------------|-----------------------------|--|---|-------------------|---|----------------------------------|
|  |                          |                             | Config   | uration   |                   |   |                                  |
| Group By Po                                    | eripherals               |                             |  |   |                   |   | ~                                |
|  | ⊘ RCC   ⊘ S              | SYS 🛛 📀 USA                 | RT 🔗 NVIC  | 1   |                   |   |                                  |
|  |                          |                             |  |   |                   |   |                                  |
| Search Sign                                    | als                      |                             |  |   |                   |   |                                  |
| Search (Crti                                   | (+ <i>F</i> )            |                             |  |   |                   | Show only                               | Modified Pins                    |
|  |                          |                             |  |   |                   |   |                                  |
| Pin Name 🌻                                     | Signal on Pin            | GPIO output                 | GPIO mode  | GPIO Pull-up  | Maximum ou        | . User Label                            | Modified                         |
| PA0-WKUP                                       | n/a                      | High                        | Output Push  | Pull-up   | Low               | PWR_EN_L                                | $\checkmark$                     |
| PA5  | n/a                      | Low                         | Output Push  | No pull-up an   | Low               | LD2 [Green L                            | $\checkmark$                     |
| PA8  | n/a                      | Low                         | Output Push  | Pull-down   | Low               | I2C_RST_L                               | ~                                |
|  |                          |                             |  |   |                   |   |                                  |
| PA9  | n/a                      | Low                         | Output Push  | Pull-down   | Low               | I2C_RST_R                               | ~                                |
|  | n/a<br>n/a               | Low<br>High                 | Output Push<br>Output Push                               |   | Low<br>Low        | I2C_RST_R<br>PWR_EN_C                   | ✓<br>✓                           |
| PB0  |                          |                             |  | Pull-up   |                   |   |                                  |
| PB0<br>PB3                                     | n/a                      | High                        | Output Push  | Pull-up<br>Pull-down                                  | Low               | PWR_EN_C                                | <b>~</b>                         |
| PB0<br>PB3<br>PB4                              | n/a<br>n/a               | High<br>Low                 | Output Push<br>Output Push                               | Pull-up<br>Pull-down<br>Pull-up                       | Low<br>Low        | PWR_EN_C<br>I2C_RST_C                   | <b>v</b>                         |
| PB0<br>PB3<br>PB4<br>PB5                       | n/a<br>n/a<br>n/a        | High<br>Low<br>High         | Output Push<br>Output Push<br>Output Push                | Pull-up<br>Pull-down<br>Pull-up<br>Pull-up            | Low<br>Low<br>Low | PWR_EN_C<br>I2C_RST_C<br>LPn_C          | <b>v</b><br><b>v</b>             |
| PA9<br>PB0<br>PB3<br>PB4<br>PB5<br>PB10<br>PC0 | n/a<br>n/a<br>n/a<br>n/a | High<br>Low<br>High<br>High | Output Push<br>Output Push<br>Output Push<br>Output Push | Pull-up<br>Pull-down<br>Pull-up<br>Pull-up<br>Pull-up | Low<br>Low<br>Low | PWR_EN_C<br>I2C_RST_C<br>LPn_C<br>LPn_R | <b>y</b><br><b>y</b><br><b>y</b> |

#### Figure 46. Pin name configuration



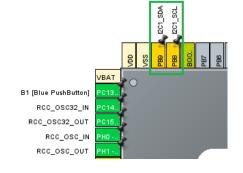
#### 10. Configure the I2C and UART as shown below.

#### Figure 47. I2C and UART configuration

| BSP                  |                    |        |                    |          |                     |
|----------------------|--------------------|--------|--------------------|----------|---------------------|
| Name                 | IPs or Components  |        | Found Solutions    | I2C Addr | BSP API             |
| 53L5A1 BUS IO driver | I2C:I2C            | $\sim$ | No solution $\sim$ | N/A      | BSP_BUS_DRIVER      |
| BSP USART            | USART:Asynchronous | $\sim$ | Undefined          |          | ✓ BSP_COMMON_DRIVER |
|                      |                    |        |                    |          |                     |

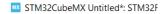
11. Select the pins PB9 and PB8 for SDA and SCL as shown below.

#### Figure 48. Pin selection for SDA and SCL



12. Select "Connectivity"

#### Figure 49. Connectivity selection







13. Select "I2C1", then enable the I2C, and select "Fast Mode" as shown below.

| STM32CubeMX   | for_um.ioc*: STM32F401RET | x NUCLEO-F401RE   |                          |   |              |
|---|---------------------------|---|--------------------------|---|--------------|
| STM32<br>CubeMX                                       | File                      | Window  | Help                     |   |              |
| Home > STM  | 32F401RETx - NUCLEO-F     | 401RE 🔰 for_um.ioc  | - Pinout & Configuration | n >   |              |
|   | Pinout & Configurat       | tion  | с                        | Clock Configuration                                 |              |
|   |                           |   |                          | ✓ Software Packs                                    | Pinout       |
| Q   | ~ (ô                      |   |                          | I2C1 Mode and Configuration                         |              |
| Categories A->2                                       | Z                         |   |                          | Mode  |              |
|   |                           | 12C 12C   |                          |   |              |
| System Core   | ~                         |   |                          |   |              |
| DMA<br>GPIO<br>IWDG<br>NVIC<br>✓ RCC<br>▲ SYS<br>WWDG |                           | Reset Configuration <ul> <li>Parameter Settings</li> <li>Configure the below param</li> <li>Search (CrlPF)</li> </ul> | eters :                  | Configuration<br>MC Settings   ● DMA Settings   ● G | PIO Settings |
| Analog  | >                         | <ul> <li>Master Features</li> <li>I2C Speed Mod</li> </ul>  |                          | Fast Mode   |              |
| Timers  | <u> </u>                  | I2C Speed Mod<br>I2C Clock Spee<br>Fast Mode Duty<br>Slave Features   | d (Hz)                   | 400000<br>Duty cycle Tlow/Thigh =                   | 2            |
| Connectivity  |                           | Clock No Streto   | h Mode                   | Disabled  |              |
| ✓ I2C1  | <u>^</u>                  |   | s Length selection       | 7-bit   |              |
| 0 1202  |                           | Dual Address A  |                          | Disabled  |              |
| I2C3<br>▲ SDIO<br>⊘ SPI1                              |                           | Primary slave a<br>General Call ad  |                          | 0<br>Disabled                                       |              |

Figure 50. Fast mode selection

14. Configure the I2C and BSP as shown below.

#### Figure 51. I2C and BSP configuration

|   | BSP                  |                    |        |                 |        |          |                     |   |
|---|----------------------|--------------------|--------|-----------------|--------|----------|---------------------|---|
| I | Name                 | IPs or Components  |        | Found Solutions |        | I2C Addr | BSP API             |   |
| I | 53L5A1 BUS IO driver | I2C:I2C            | $\sim$ | I2C1            | $\sim$ | 0        | BSP_BUS_DRIVER      |   |
|   | BSP USART            | USART:Asynchronous | $\sim$ | USART2          |        |          | ✓ BSP_COMMON_DRIVER | 2 |

15. Select "Project Manager".

# Figure 52. Project manager STM32CubeMX Unitiled\*: STM32F401RETx NUCLEO-F401RE STM32CubeMX Unitiled\*: STM32F401RETx NUCLEO-F401RE File Window Help CubeMX STM32F401RETx NUCLEO-F401RE File Window Help CubeMX Pinout & Configuration Project Manager V Software Packs



16. Name the project, select "Toolchain", and then select "Generate Code" as shown below.

|                 |  |                   | •                          | •                   |                 |               |
|-----------------|--|-------------------|----------------------------|---------------------|-----------------|---------------|
| STM32CubeMX Unt | itled*: STM32F401RETx NUCLEO-F   | 401RE             |                            |                     |                 | -             |
| STM32           | File   | Window            | Help                       |                     |                 | 🥸 📑 🖻 🎽       |
|                 | 401RETx - NUCLEO-F401RE  | Vintitled - Proje | ect Manager >              |                     |                 | GENERATE CODE |
|                 | Pinout & Configuration   |                   | Clock Configuration        |                     | Project Manager | Tools         |
| Project         | Project Settings<br>Project Name<br>for_um<br>Project Location<br>Crash<br>Application Structure |                   |                            | Browse              |                 |               |
| Code Generator  | Advanced<br>Toolchain Folder Location<br>Citability umb<br>Toolchain / IDE<br>STM32Cube/DE       | v                 | V De not generate the main | Generate Under Root |                 | ۵.            |

17. Select "Open Project" on the pop-up window when code generation is complete, as shown below.

Project language : C

## Figure 54. Open project Code Generation The Code is successfully generated under : C:/titl/for\_um

AP

18. Build and run the project. The results should look as shown below.

| <b>Figure</b> | 55. F | Results |
|---------------|-------|---------|
|---------------|-------|---------|

| 71mm:                       | ø            | 73mm:          | ø      | 72mm:          | øł    | 70mm:          | ( |
|-----------------------------|--------------|----------------|--------|----------------|-------|----------------|---|
| 73mm:                       | øľ           | 71mm:          | øľ     | 72mm:          | ø     | 73mm:          |   |
| 75mm:                       | ø            | 71mm:          | øl     | 73mm:          | ø     | 73mm:          |   |
| 73mm:                       | øľ           | 74mm:          | øl     | 74mm:          | øľ    | 72mm:          |   |
| IT<br>Format                | :<br>mm]:St; | atus0          |        |                |       |                |   |
| T<br>Format<br>stance0[<br> | :<br>mm]:Sta | atus0<br>60mm: | <br>   | 60mm:          | 0     | 59mm:          |   |
| Stance0                     | .mm]:Sta<br> |                | 0<br>0 | 60mm:<br>60mm: | 0<br> | 59mm:<br>61mm: | · |
| Format<br>stance0[<br>60mm: | .mm]:Sta     | 60mm:          | <br>I  |                |       |                |   |

#### Figure 53. Code generation



#### 4.2.3 How to generate the 53L5A1\_ThresholdDetection example with CubeMX

1. Open STM32CubeMX and select "Access to board selector".

| M32CubeMX Untitled                        | I: STM32F401RETx NUCLEO-F    | 401RE               |               |  |
|---|------------------------------|---------------------|---------------|--|
| 2<br>eMX                                  | File                         | Window              | Help          |  |
|   | RETX - NUCLEO-F401RE         | Vntitled - Pinout & | Configuration | >  |
| Existing Projects                         |                              |                     |               | New Project  |
| Recent Opened P                           | rojects                      |                     |               | I need to :  |
| test_tof1_rev2.io<br>Last modified date : | ic<br>14/06/2021 16:50:34    |                     | MX            | Start My project from MCU                                |
| cube_tof1_2_4.i                           | OC<br>14/06/2021 16:00:33    |                     | MX            | ACCESS TO MCU SELECTOR                                   |
| test_cube_tof1_3<br>Last modified date :  | 3.ioc<br>14/06/2021 15:45:27 |                     | MX            | Start My project from ST Board ACCESS TO BOARD SELECTOR  |
| test_cube_2_2.id<br>Last modified date :  |                              |                     | MX            | Start My project from Example                            |
| Last modified date :<br>test_cube_2_2.id  | 14/06/2021 15:45:27<br>DC    |                     | - 24          | ACCESS TO BOARD SELECTO<br>Start My project from Example |

#### 2. Select the F401RE board

| and Filters               | > | Feat                |                   | Large Picture  | e Docs                                      | & Resources   | Datasheet                  | 📑 Buy   | 🕞 Start Project                                      |
|---------------------------|---|---------------------|-------------------|----------------|---|---|----------------------------|---|--|
| Commercial<br>Part Number | ~ | * STM32F4 S         | NUCLEO-F          | 401RE          | STMicroelect                                | ronics NUCLEO-F4  | 01RE Board Suppor          | t and Examples  |  |
| Vendor                    | > | ACTIVE              | Active            |                | Part Number : NU                            | Part Number : NUCLEO-F401RE<br>Commercial Part Number : NUCLEO-F401RE |                            |   |  |
| Type                      | > | Product in          | s in mass product | ion            | Commercial Part                             |   |                            |   | RETX   |
| Other                     | > |                     |                   | 4              | STM32 microcontr<br>mode.                   |   | e boards, the external SMI | PS significantly reduces por                              | wer consumption in Run                               |
|                           | > | Boards List: 7 ker  |                   | B IT I I I I I | STM32 microcontr<br>mode.                   |   | e boards, the external SMI |   | wer consumption in Run                               |
|                           | > | Boards List: 7 item | ns<br>Cverve      |                | STM32 microcontr<br>mode.                   |   | e boards, the external SMI | PS significantly reduces po<br>aders allow the easy expan | wer consumption in Run<br>nsion of the functionality |
| Other<br>Peripheral       | > | Boards List: 7 item |                   |                | STM32 microcontr<br>mode.<br>The ARDUINO® U | no V3 connectivity supp   | e boards, the external SMI | PS significantly reduces po<br>aders allow the easy expan |  |

#### Figure 57. F401RE board

3. Right click "Select Components"

#### Figure 58. Components

| STM32Cul        | beMX Untitled: STM | 132F401RETx NUCLEO- | F401RE       |                        |  |       |             |
|-----------------|--------------------|---------------------|--------------|------------------------|--|-------|-------------|
| STM32<br>CubeMX |                    | File                | Window       | Help                   |  |       |             |
| Home >          | STM32F401RETx      | - NUCLEO-F401RE     | Untitled - P | Pinout & Configuration | $\rangle$                                      |       |             |
|                 | Pinout 8           | & Configuration     |              | c                      | lock Configuration                             |       |             |
|                 |                    |                     |              |                        | Software Packs                                 |       | ✓ Pinout    |
| Q<br>Categories | ~<br>A->Z          | ۵ 🕻                 |              |                        | Select Components<br>Manage Software Add packs | Alt-O | Pinout view |

#### 4. Select the board and application as shown below, then select "OK" (bottom righthand corner).

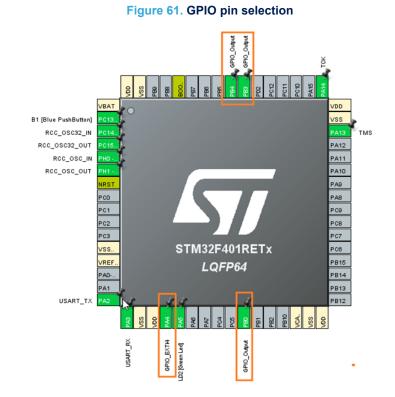
#### Figure 59. Board selection

| STMicroelectronics.X-CUBE-TOF1 | $\odot$ | 2.0.0-B3 V |                             |
|--------------------------------|---------|------------|-----------------------------|
| Board Extension 53L3A2         |         | 2.0.0      |                             |
| Board Extension 53L5A1         | $\odot$ | 1.0.0      |                             |
| Board Part Ranging / VL53L3CX  |         | 2.0.0      |                             |
| Board Part Ranging / VL53L5CX  |         | 1.0.0      |                             |
| Device TOF1_Applications       | $\odot$ | 1.0.0      |                             |
| Application                    | $\odot$ |            | 53L5A1_ThresholdDetection ~ |

#### Figure 60. Application selection

|                                      |                           | Configuration       |              |                |
|--------------------------------------|---------------------------|---------------------|--------------|----------------|
| Reset Configuration                  |                           |                     |              |                |
| Parameter Setting:                   | s 🛛 🤡 User Constants 🗾    | 🝐 Platform Settings |              |                |
| Platform proposal —<br>Application — |                           |                     |              |                |
| Name                                 | IPs or Components         | Found Solutions     | I2C Addr     | BSP API        |
| 53L5A1_I2C_RST_C                     | GPIO:Output PB3 ~         | Undefined           |              | V Unknown      |
| TOF_INT_PIN                          | gpio:exti PA4 ~           | Undefined           |              | v<br>✓ Unknown |
| 53L5A1_LPn_C                         | GPIO:Output PB4 ~         | Undefined           |              | ∨ Unknown      |
| 53L5A1_PWR_EN_C                      | GPIO:Output PB0 ~         | Undefined           |              | ∨ Unknown      |
|                                      |                           |                     |              |                |
| Name                                 | IPs or Components         | Found Solutions     | I2C Addr BSP | API            |
| 53L5A1 BUS IO driver                 | I2C:I2C ~                 | No solution $\sim$  | N/A BSP_E    | BUS_DRIVER     |
| BSP BUTTON                           | GPIO:EXTI ~               | Undefined           | ✓ BSP_0      | COMMON_DRIVER  |
| BSP USART                            | USART:Asynchronous $\vee$ | Undefined           | V BSP_C      | COMMON_DRIVER  |
|                                      |                           |                     |              |                |
|                                      |                           |                     |              |                |
|                                      |                           |                     |              |                |





5. Select the GPIOs pins by referring to the X-NUCLEO-53L5A1 schematic as shown below.



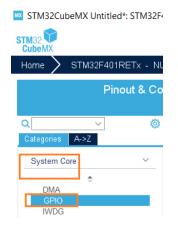
6. Link the GPIOs to the corresponding pin names as shown below.

|  |                        | Mode                          |                  |            |
|--|------------------------|-------------------------------|------------------|------------|
| Board Extensio                         | n 53L5A1               |                               |                  |            |
| Device TOF1 A                          | pplications            |                               |                  |            |
|  |                        |                               |                  |            |
|  |                        |                               |                  |            |
|  |                        |                               |                  |            |
|  |                        | Configuration                 |                  |            |
| Reset Configuration                    | n                      |                               |                  |            |
|  |                        |                               |                  |            |
| Parameter Setting<br>Platform proposal | js 🔥 Platform Settings |                               |                  |            |
| Application                            |                        |                               |                  |            |
| Name                                   | IPs or Components      | Found Solutions               | I2C Addr         | BSP API    |
| 53L5A1_I2C_RST_C                       | GPIO:Output ~          | PB3                           | ~                | Unknown    |
| TOF_INT_PIN                            | GPIO:EXTI ~            | PA4                           | ~                | Unknown    |
| 53L5A1_LPn_C                           | GPIO:Output ~          | PB4                           | ~                | Unknown    |
| 53L5A1_PWR_EN_C                        | GPIO:Output ~          | PB0                           | ~                | Unknown    |
|  |                        |                               |                  | -          |
|  |                        |                               |                  |            |
|  |                        |                               |                  |            |
| BSP                                    |                        |                               |                  |            |
| Name                                   | IPs or Components      | Found Solutions               | I2C Addr BSP API |            |
| 53L5A1 BUS IO drive                    |                        | No solution                   | N/A BSP_BUS_C    | RIVER      |
| BSP USART                              | USART:Asynchronous     | <ul> <li>Undefined</li> </ul> |                  | ION_DRIVER |
| DOI: UGARI                             | COART.Asynchionous     | Undenned                      | • 00F_00WW       | UNITER OF  |

Figure 62. GPIO and pin name correspondance

7. Select "System Core" then "GPIO" to open the GPIO configuration window as shown below.

#### Figure 63. GPIO configuration window





8. Name and configure the pins as shown below.

| Configuration  |               |             |               |               |            |              |          |  |
|--|---------------|-------------|---------------|---------------|------------|--------------|----------|--|
| Group By Peri  | pherals       |             |               |               |            |              | $\sim$   |  |
| 🛛 🛇 GPIO   | 🦻 RCC 🛛 📀 S   | YS 🛛 📀 USAR | RT 📀 NVIC     |               |            |              |          |  |
| Search Signals           Search (Crt1+F)         Show only Modified Pins |               |             |               |               |            |              |          |  |
| Pin Name 🗢   | Signal on Pin | GPIO output | GPIO mode     | GPIO Pull-up  | Maximum ou | . User Label | Modified |  |
| PA4  | n/a           | n/a         | External Inte | No pull-up an | n/a        | INT_C        | <b>V</b> |  |
| PA5  | n/a           | Low         | Output Push   | No pull-up an | Low        | LD2 [Green L | <b>V</b> |  |
| PB0  | n/a           | High        | Output Push   | Pull-up       | Low        | PWR_EN_C     | <b>~</b> |  |
| PB3  | n/a           | Low         | Output Push   | Pull-down     | Low        | I2C RST C    | <b>~</b> |  |
| PB4  | n/a           | High        | Output Push   | Pull-up       | Low        | LPn C        | <b>_</b> |  |
|  | n/a           | n/a         | External Inte | No pull-up an | n/n        | B1 [Blue Pus |          |  |

#### Figure 64. Pin name configuration

9. Activate the NVIC interrupt vector as shown below.

#### Figure 65. NVIC interrupt vector activation

| Configu                     | uration    |                     |              |
|-----------------------------|------------|---------------------|--------------|
| Group By Peripherals        |            |                     | ~            |
| SPI0 SRCC SYS SUSART SNVIC  |            |                     |              |
| NVIC Interrupt Table        | Enabled    | Preemption Priority | Sub Priority |
| EXTI line4 interrupt        | <b>_</b>   | 0                   | 0            |
| EXTI line[15:10] interrupts | <u>d</u> 3 | 0                   | 0            |

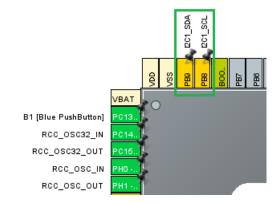
10. Configure the I2C and BSP as shown below.

#### Figure 66. I2C and BSP configuration

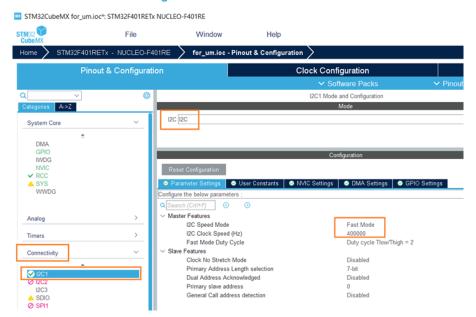
| BSP                  |                    |                    |          |                   |
|----------------------|--------------------|--------------------|----------|-------------------|
| Name                 | IPs or Components  | Found Solutions    | I2C Addr | BSP API           |
| 53L5A1 BUS IO driver | I2C:I2C ~          | No solution $\sim$ | N/A      | BSP_BUS_DRIVER    |
| BSP BUTTON           | GPIO:EXTI ~        | Undefined          | ~        | BSP_COMMON_DRIVER |
| BSP USART            | USART:Asynchronous | Undefined          | ~        | BSP_COMMON_DRIVER |

11. Select the pins PB9 and PB8 for SDA and SCL as shown below.





12. Select "Connectivity" and "I2C1", then enable the I2C and select "Fast Mode" as shown below



#### Figure 68. Fast mode selection

Configure the I2C and BSP as shown below.

#### Figure 69. I2C and BSP configuration

| BSP                  |                    |        |                 |        |          |                     |
|----------------------|--------------------|--------|-----------------|--------|----------|---------------------|
| Name                 | IPs or Components  |        | Found Solutions |        | I2C Addr | BSP API             |
| 53L5A1 BUS IO driver | I2C:I2C            | $\sim$ | I2C1            | $\sim$ | 0        | BSP_BUS_DRIVER      |
| BSP USART            | USART:Asynchronous | $\sim$ | USART2          |        |          | ✓ BSP_COMMON_DRIVER |





13. Select "Project Manager".



14. Name the project, select "Toolchain", and then select "Generate Code" as shown below.

|  |                    |                     | Figure 71. Co       | de generation | n       |               |
|--|--------------------|---------------------|---------------------|---------------|---------|---------------|
| eshold_um.ioc: STM32F401RETx N   | UCLEO-F401RE       |                     |                     |               |         |               |
| File   | Window             | Help                |                     |               |         | 🧕 💽 💽 🔰       |
| 401RETx - NUCLEO-F401RE  | > threshold_um.ioc | - Project Manager > |                     |               |         | GENERATE CODE |
| Pinout & Configuration   |                    | Clock C             | onfiguration        | Project I     | Manager | Tools         |
| Project Settings<br>Project Name<br>Inveshold_um<br>Project Location<br>© tes<br>Application Structure<br>Advanced<br>Toolchain Folder Location<br>E-contremended_um |                    | ✓ Do not ger        | erate the main()    |               |         |               |
| Toolchain / IDE<br>STM32CubeiDE  | Ÿ                  |                     | Generate Under Root |               |         |               |

15. Select "Open Project" on the pop-up window when code generation is complete, as shown below.

#### Figure 72. Open project





16. Build and run the project. The results should look as shown below.

| Fi | ia | ure | 73  | <b>Results</b> |
|----|----|-----|-----|----------------|
|    | ч  | uie | 10. | Nesuits        |

| 53L5A1 Simple Ranging Example         Cell Format :         I distance@[mm]:Status0         I         576mm:       1         576mm:       1         552mm:       0         512mm:       0         552mm:       0 | STMicroelectronics VL53L5CX                |    |        |   |        |    |        |   |  |
|--|--|----|--------|---|--------|----|--------|---|--|
| I distance@[mm]:Status@     I  | 53L5A1 Simple Ranging Example              |    |        |   |        |    |        |   |  |
|  | Cell Format :<br>I distance0[mm]:Status0 I |    |        |   |        |    |        |   |  |
| 552mm: 0 512mm: 0 506mm: 1 473mm: 0  | 576mm:                                     | 1  | 514mm: | 0 | 2mm:   | 1  | 448mm: |   |  |
|  | <br>  552mm:                               | øl | 512mm: | ø | 506mm: | 1  | 473mm: | ø |  |
| 330mm: 0   514mm: 1   502mm: 0   453mm: 0  | <br>  330mm:                               | øÏ | 514mm: | 1 | 502mm: | øÏ | 453mm: | ø |  |
| 292mm: 0 404mm: 1 484mm: 0 456mm: 1  | <br>  292mm:                               | øÏ | 404mm: | 1 | 484mm: | øÏ | 456mm: | 1 |  |

17. An interrupt occurs if the target distance (d) = [200 mm et 600 mm] as shown below.

#### Figure 74. Interrupt

🖻 app\_x-cube-tof1.c 🛛

ITConfig.Criteria = RS\_IT\_IN\_WINDOW; ITConfig.LowThreshold = 200; /\* mm \*/ ITConfig.HighThreshold = 600; /\* mm \*/



### 4.2.4 How to generate VL53L5CX\_SimpleRanging example with CubeMX

Required material for this example is as follows.

- Nucleo F401RE
- VL53L5CX-SATEL
- Dupont wires

The breakout board is connected directly onto the Nucleo F401RE without the X-NUCLEO-53L5A1 expansion board .

1. Open STM32CubeMX and select "Access to board selector".

### Figure 75. Access to board selector

| STM32CubeMX Untitled: STM32F401RETx NUCLEO-F401RE |                                 |                     |               |                                |  |  |  |  |  |  |
|---|---------------------------------|---------------------|---------------|--------------------------------|--|--|--|--|--|--|
| STM32<br>CubeMX                                   | File                            | Window              | Help          |                                |  |  |  |  |  |  |
| Home STM32F401                                    | RETx - NUCLEO-F401RE            | Untitled - Pinout & | Configuration | $\rangle$                      |  |  |  |  |  |  |
| Existing Projects                                 |                                 |                     |               | New Project                    |  |  |  |  |  |  |
| Recent Opened F                                   | Projects                        |                     |               | I need to :                    |  |  |  |  |  |  |
| test_tof1_rev2.in<br>Last modified date           | DC<br>: 14/06/2021 16:50:34     |                     | MX            | Start My project from MCU      |  |  |  |  |  |  |
| cube_tof1_2_4.                                    | ioc<br>: 14/06/2021 16:00:33    |                     | MX            | ACCESS TO MCU SELECTOR         |  |  |  |  |  |  |
| test_cube_tof1_<br>Last modified date             | _3.ioc<br>: 14/06/2021 15:45:27 |                     | MX            | Start My project from ST Board |  |  |  |  |  |  |
| test_cube_2_2.<br>Last modified date              | ioc<br>: 14/06/2021 15:31:16    |                     | MX            | Start My project from Example  |  |  |  |  |  |  |
| Other Projects                                    |                                 |                     | दि            |                                |  |  |  |  |  |  |

### 2. Select the F401RE board

| - N | lew Project from a Board   |                  |         |                   |                 |            |   |  |             |                       |  |                        |  |
|-----|----------------------------|------------------|---------|-------------------|-----------------|------------|---|--|-------------|-----------------------|--|------------------------|--|
| MC  | U/MPU Selector Board Selec | tor Example Sele | ictor C | ross Selector     |                 |            |   |  |             |                       |  |                        |  |
| B   | and Filters                | 3                | -       | Feature           |                 | ge Picture | Docs  | & Resources                            | I           | Datasheet             | 🖬 Buy  | - Start Project        |  |
|     | Commercial<br>Part Number  | ~                | *       | STM32F4 Seri<br>N | UCLEO-F401RE    | E          | STMicroelect  | ronics NUCLE                           | O-F401R     | E Board Support a     | nd Examples  |                        |  |
|     | Vendor                     | >                |         | ACTIVE            | Active          |            | Part Number : NUC   | LEO-F401RE                             |             | Un                    | t Price (US\$) : 13.0                                      |                        |  |
|     | Type                       | >                |         | Product is in     | mass production |            | Commercial Part N   | Commercial Part Number : NUCLEO-F401RE |             |                       | Mounted Device : STM32E401RETx                             |                        |  |
|     | MCU/MPU Series             | >                |         | 1                 |                 | 100        | prototypes by choo  | ising from the vari                    | ious combin | ations of performance | or users to try out new conce<br>and power consumption fea | tures, provided by the |  |
|     | Other<br>Peripheral        | >                |         |                   |                 |            | STM32 microcontroller. For the compatible boards, the external SMPS significantly reduces power consumption in Run<br>mode.<br>The ARDUINO® Uno V3 connectivity support and the ST morpho headers allow the easy expansion of the functionality |  |             |                       |  |                        |  |
|     |                            |                  | Board   | s List: 7 items   |                 |            |   |  |             |                       |  | 📩 Export               |  |
|     |                            |                  |         |                   | Overview        | X Com      | mercial Part No 🍧   | Туре                                   | ×           | Marketing Status      | × Unit Price (US\$)  | X Mounted Device 3     |  |
|     |                            |                  |         | •                 |                 | B-L475E    | -IOT01A2  | Discovery Kit                          |             | NA                    | NA   | 57832L475VGTx          |  |
|     |                            |                  |         | *                 |                 | NUCLEO     | -F401RE   | Nucleo-64                              | D:          | Active                | 13.0   |                        |  |

### Figure 76. F401RE board



3. Right click "Select Components"



4. Select the board and application as shown below, then select "OK" (bottom righthand corner).

| STMicroelectronics.X-CUBE-TOF1               | $\odot$ | 2.0.0-B4 V |                          |
|--|---------|------------|--------------------------|
| Board Extension 53L3A2                       |         | 2.0.0      |                          |
| Board Extension 53L5A1                       |         | 1.0.0      |                          |
| Board Part Ranging / VL53L3CX                |         | 2.0.0      |                          |
| Board Part Ranging / VL53L5CX                | $\odot$ | 1.0.0      |                          |
| <ul> <li>Device TOF1_Applications</li> </ul> | $\odot$ | 1.0.0      |                          |
| Application                                  | $\odot$ |            | VL53L5CX_SimpleRanging 🗸 |
| ✓ Board Support STM32Cube_Custom_BSP_E       | $\odot$ | 1.0.0      |                          |

Figure 78. Board selection

 Select "Software Packs", then select "STMicroelectronics X-CUBE-TOF1", next select "Board Part Ranging box", select the "Device TOF1 Applications box", and finally select "Board Support STM32Cube Custom BSP Drivers".

| Pinc                                       | out & Con | figuration           |                         | Clock Conf               | iguration        |               |
|--|-----------|----------------------|-------------------------|--------------------------|------------------|---------------|
|  |           |                      |                         | ✓ Sof                    | tware Packs      | ✓ Pin         |
| <u>م</u>                                   | ۲         |                      | STMicroelectronics.X-C  | UBE-TOF1.2.0.0-B4 Mode a | nd Configuration |               |
| Categories A->Z                            |           |                      |                         | Mode                     |                  |               |
| System Core                                | >         | Board Part Rang      | ing                     |                          |                  |               |
| Analog                                     | >         | Device TOF1 App      | plications              |                          |                  |               |
|  |           | Board Support S      | TM32Cube Custom BSP Dri | vers                     |                  |               |
| Timers                                     | <u> </u>  |                      |                         |                          |                  |               |
| Connectivity                               | >         |                      |                         |                          | [₂               |               |
| Multimedia                                 | >         |                      |                         |                          |                  |               |
| Computing                                  | >         |                      |                         | Configuration            |                  |               |
| Computing                                  |           | Reset Configuration  |                         |                          |                  |               |
| Middleware                                 | >         | Parameter Settings   | 🛛 📀 User Constants 🗾    | Platform Settings        |                  |               |
| Software Packs                             | ~         | Platform proposal    |                         |                          |                  |               |
| ÷  |           | Application<br>Name  | IPs or Components       | Found Solutions          | I2C Addr         | BSP API       |
| <ul> <li>STMicroelectronics.X-C</li> </ul> | CUBE-TC   |                      | GPIO:Output ~           | Undefined PB3            | i contaŭi        | ✓ Unknown     |
|  |           |                      | GPIO:EXTI ~             | Undefined PA4            |                  | V Unknown     |
|  |           |                      | GPIO:Output             | Undefined PB4            |                  | V Unknown     |
|  |           | VL53L5CX_PWR_EN      |                         |                          |                  | V Unknown     |
|  |           | VL53L5CX_PWR_EN      | GPIO:Output ~           | Undefined PB0            |                  | ✓ Unknown     |
|  |           |                      |                         |                          |                  |               |
|  |           |                      |                         |                          |                  |               |
|  |           |                      |                         |                          |                  |               |
|  |           | BSP                  | IPs or Components       | Found Solutions          | I2C Addr BSP /   | API           |
|  |           | VL53L5CX BUS IO driv |                         | V No solution V          |                  | US_DRIVER     |
|  |           | BSP USART            | USART:Asynchronous      | V Undefined              |                  | OMMON_DRIVER  |
|  |           | DSP USARI            | USART:Asynchronous      |                          | V BSP_C          | UNINUN_DRIVER |

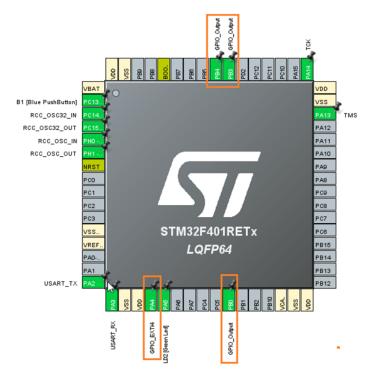
# Figure 79. Board support STM32Cube custom BSP drivers

6. Select the GPIOs pins by referring to the X-NUCLEO-53L5A1 schematic as shown below. Use the same GPIO pin on the expansion board as the central sensor then, the user can choose the other GPIO pins e.g. PB3, PA4, PB4, PB0.

|  |                      |        | Configuration         |          |                                     |
|--|----------------------|--------|-----------------------|----------|-------------------------------------|
| Reset Configuration                        |                      |        |                       |          |                                     |
| Parameter Settings                         | s 🛛 📀 User Constant  | s 🤞    | ዾ Platform Settings 🛛 |          |                                     |
| Platform proposal                          |                      |        |                       |          |                                     |
| Application <b>Name</b>                    | IPs or Components    |        | Found Solutions       | I2C Addr | BSP API                             |
| 53L5A1_I2C_RST_C                           | GPIO:Output PB3      | $\sim$ | Undefined             |          | V Unknown                           |
| TOF_INT_PIN                                | GPIO:EXTI PA4        | $\sim$ | Undefined             |          | <br>✓ Unknown                       |
| 53L5A1_LPn_C                               | GPIO:Output PB4      | $\sim$ | Undefined             |          | <ul> <li>✓ Unknown</li> </ul>       |
| 53L5A1 PWR EN C                            | GPIO:Output PBO      | $\sim$ | Undefined             |          | ✓ Unknown                           |
|  |                      |        |                       |          |                                     |
| BSP  |                      |        |                       |          |                                     |
| BSP  | IPs or Components    |        | Found Solutions       | I2C Addr | BSP API                             |
| Name                                       |                      | ~      | Found Solutions       |          | BSP API<br>BSP_BUS_DRIVER           |
| Name<br>53L5A1 BUS IO driver               |                      |        |                       | _        | BSP_BUS_DRIVER                      |
|  | I2C:I2C              | ~      | No solution           | / N/A    | BSP_BUS_DRIVER<br>BSP_COMMON_DRIVER |
| Name<br>53L5A1 BUS IO driver<br>BSP BUTTON | I2C:I2C<br>GPIO:EXTI | ~      | No solution           | N/A      | BSP_BUS_DRIVER<br>BSP_COMMON_DRIVER |
| Name<br>53L5A1 BUS IO driver<br>BSP BUTTON | I2C:I2C<br>GPIO:EXTI | ~      | No solution           | N/A      | BSP_BUS_DRIVER<br>BSP_COMMON_DRIVER |

### Figure 80. GPIO pin selection (1)

Figure 81. GPIO pin selection (2)



7. Link the GPIOs to the corresponding pin names as shown below.

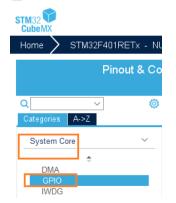
|                              |                       | Mode                            |                  |            |
|------------------------------|-----------------------|---------------------------------|------------------|------------|
| Board Extension              | n 53L5A1              |                                 |                  |            |
| Device TOF1 Apple 100 Period | oplications           |                                 |                  |            |
|                              |                       |                                 |                  |            |
|                              |                       |                                 |                  |            |
|                              |                       |                                 |                  |            |
|                              |                       |                                 |                  |            |
|                              |                       | Configuration                   |                  |            |
| Reset Configuration          |                       |                                 |                  |            |
| Parameter Setting            | s 🔥 Platform Settings |                                 |                  |            |
| Platform proposal            |                       |                                 |                  |            |
| Application                  |                       |                                 |                  |            |
| Name                         | IPs or Components     | Found Solutions                 | I2C Addr         | BSP API    |
| 53L5A1_I2C_RST_C             | GPIO:Output ~         | PB3                             | ~                | Unknown    |
| TOF_INT_PIN                  | GPIO:EXTI ~           | PA4                             | ~                | Unknown    |
| 53L5A1_LPn_C                 | GPIO:Output ~         | PB4                             | ~                | Unknown    |
| 53L5A1_PWR_EN_C              | GPIO:Output ~         | PB0                             | ~                | Unknown    |
|                              |                       |                                 |                  |            |
|                              |                       |                                 |                  |            |
|                              |                       |                                 |                  |            |
|                              |                       |                                 |                  |            |
| BSP                          |                       |                                 |                  |            |
| Name                         | IPs or Components     | Found Solutions                 | I2C Addr BSP API |            |
| 53L5A1 BUS IO driver         | I2C:I2C               | ✓ No solution ✓                 | N/A BSP_BUS_C    | ORIVER     |
| BSP USART                    | USART:Asynchronous    | <ul> <li>✓ Undefined</li> </ul> | V BSP_COMM       | ION_DRIVER |
|                              |                       |                                 |                  |            |

Figure 82. GPIO and pin name correspondance

8. Select "System Core" then "GPIO" to open the GPIO configuration window as shown below.

### Figure 83. GPIO configuration window

MX STM32CubeMX Untitled\*: STM32F4





9. Name and configure the pins as shown below.

| Configuration  |               |             |               |               |            |              |          |  |  |  |
|--|---------------|-------------|---------------|---------------|------------|--------------|----------|--|--|--|
| Group By Peripherals   |               |             |               |               |            |              |          |  |  |  |
| 🛛 🛇 GPIO   | 🦻 RCC 🛛 📀 S   | YS 🛛 📀 USAR | RT 📀 NVIC     |               |            |              |          |  |  |  |
| Search Signals           Search (CrtI+F)         Show only Modified Pins |               |             |               |               |            |              |          |  |  |  |
| Pin Name 🗢   | Signal on Pin | GPIO output | GPIO mode     | GPIO Pull-up  | Maximum ou | . User Label | Modified |  |  |  |
| PA4  | n/a           | n/a         | External Inte | No pull-up an | n/a        | INT_C        | <b>V</b> |  |  |  |
| PA5  | n/a           | Low         | Output Push   | No pull-up an | Low        | LD2 [Green L | <b>V</b> |  |  |  |
| PB0  | n/a           | High        | Output Push   | Pull-up       | Low        | PWR_EN_C     | <b>~</b> |  |  |  |
| PB3  | n/a           | Low         | Output Push   | Pull-down     | Low        | I2C RST C    | <b>~</b> |  |  |  |
| PB4  | n/a           | High        | Output Push   | Pull-up       | Low        | LPn C        | <b>_</b> |  |  |  |
|  | n/a           | n/a         | External Inte | No pull-up an | n/n        | B1 [Blue Pus | <b>V</b> |  |  |  |

### Figure 84. Pin name configuration

10. Activate the NVIC interrupt vector as shown below.

### Figure 85. NVIC interrupt vector activation

| Configuration               |            |                     |              |  |  |  |  |  |  |
|-----------------------------|------------|---------------------|--------------|--|--|--|--|--|--|
| Group By Peripherals        |            |                     | ~            |  |  |  |  |  |  |
| SPI0 SRCC SYS SUSART SNVIC  |            |                     |              |  |  |  |  |  |  |
| NVIC Interrupt Table        | Enabled    | Preemption Priority | Sub Priority |  |  |  |  |  |  |
| EXTI line4 interrupt        | <b>_</b>   | 0                   | 0            |  |  |  |  |  |  |
| EXTI line[15:10] interrupts | <u>d</u> 3 | 0                   | 0            |  |  |  |  |  |  |

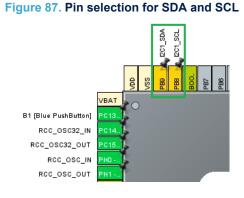
11. Configure the I2C and BSP as shown below.

### Figure 86. I2C and BSP configuration

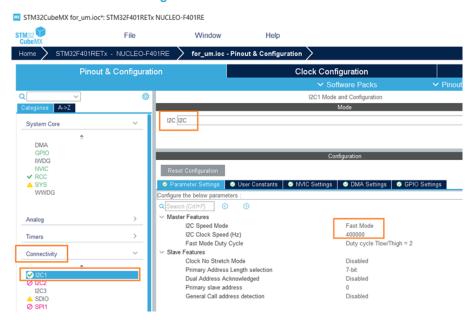
| BSP                  |                    |                    |          |                  |
|----------------------|--------------------|--------------------|----------|------------------|
| Name                 | IPs or Components  | Found Solutions    | I2C Addr | BSP API          |
| 53L5A1 BUS IO driver | I2C:I2C ~          | No solution $\sim$ | N/A      | BSP_BUS_DRIVER   |
| BSP BUTTON           | GPIO:EXTI ~        | Undefined          | ~        | BSP_COMMON_DRIVE |
| BSP USART            | USART:Asynchronous | Undefined          | ~        | BSP_COMMON_DRIVE |



12. Select the pins PB9 and PB8 for SDA and SCL as shown below.



13. Select "Connectivity" and "I2C1", then enable the I2C and select "Fast Mode" as shown below



### Figure 88. Fast mode selection

### Configure the I2C and BSP as shown below.

#### Figure 89. I2C and BSP configuration

| BSP                  |                    |        |                 |   |          |                   |
|----------------------|--------------------|--------|-----------------|---|----------|-------------------|
| Name                 | IPs or Components  |        | Found Solutions |   | I2C Addr | BSP API           |
| 53L5A1 BUS IO driver | I2C:I2C            | $\sim$ | I2C1 ~          | , | 0        | BSP_BUS_DRIVER    |
| BSP USART            | USART:Asynchronous | $\sim$ | USART2          |   | ```      | BSP_COMMON_DRIVER |



14. Select "Project Manager".



15. Name the project, select "Toolchain", and then select "Generate Code" as shown below.

|  |                  |                     | Figure 91. Co       | de generation   |               |
|--|------------------|---------------------|---------------------|-----------------|---------------|
| eshold_um.ioc: STM32F401RETx N   | UCLEO-F401RE     |                     |                     |                 |               |
| File   | Window           | Help                |                     |                 | 😰 📑 💶 🔰       |
| 401RETx - NUCLEO-F401RE  | threshold_um.ioc | - Project Manager > |                     |                 | GENERATE CODE |
| Pinout & Configuration   |                  | Clock               | Configuration       | Project Manager | Tools         |
| Project Settings<br>Protect Name<br>Investing on<br>Project Location<br>Critica<br>Application Structure<br>Advanced<br>Toolsham Folder Location<br>E: Voltmentoda, um |                  | ✓ Do not            | generate the main() |                 |               |
| Toolchain / IDE<br>STM32CubeIDE  | v                |                     | Generate Under Root |                 |               |

16. Select "Open Project" on the pop-up window when code generation is complete, as shown below.

### Figure 92. Open project





17. Build and run the project. The results should look as shown below.

### Figure 93. Results

| -<br>U: | STMicroelectronics VL53L5CX<br> |     |      |      |        |   |   |    |     |         |    |   |   |
|---------|---------------------------------|-----|------|------|--------|---|---|----|-----|---------|----|---|---|
| С       | ell                             | For | mat  | :    |        |   |   |    |     |         |    |   |   |
|         |                                 |     | Dist | ance | Emm] : |   |   | St | atu | 5       |    |   |   |
| _       |                                 |     |      |      |        |   |   |    |     |         |    |   |   |
| H       |                                 | 53  | :    | Ø    | 58     | : | Ø | 63 | :   | 0  <br> | 67 | : | ø |
| Ī       |                                 | 61  | :    | 0    | 57     | : | 0 | 59 | :   |         | 70 | : |   |
| ł       |                                 | 65  | :    | 0    | 65     | : | 0 | 63 | :   | ø       | 65 | : | ø |
| ł       |                                 | 69  | :    | Ø    | 63     | : | Ø | 59 | :   | ø       | 67 | : | ø |
|         |                                 |     |      |      |        |   |   |    |     |         |    |   |   |

# 5 System setup guide

## 5.1 Hardware description

### 5.1.1 STM32 Nucleo

STM32 Nucleo development boards provide an affordable and flexible way for users to test solutions and build prototypes with any STM32 microcontroller line.

The Arduino® connectivity support and ST morpho connectors make it easy to expand the functionality of the STM32 Nucleo open development platform with a wide range of specialized expansion boards to choose from. The STM32 Nucleo board does not require separate probes as it integrates the ST-LINK/V2-1 debugger/ programmer.

The STM32 Nucleo board comes with the comprehensive STM32 software HAL library together with various packaged software examples for different IDEs (IAR EWARM®, Keil MDK-ARM®, STM32CubeIDE, Mbed and GCC/ LLVM ARM®).

All STM32 Nucleo users have free access to the Mbed online resources (compiler, C/C++ SDK and developer community) at www.mbed.org to easily build complete applications.

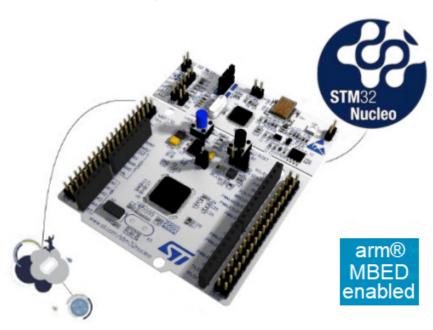


Figure 94. STM Nucleo board

Information regarding the STM32 Nucleo board is available at www.st.com/stm32nucleo.

#### 5.1.2 X-NUCLEO-53L5A1 expansion board

The X-NUCLEO-53L5A1 is an expansion board for any NUCLEO development board. It provides a complete evaluation kit allowing anyone to learn, evaluate, and develop their applications using the VL53L5CX, ranging sensor with multitarget detection ..

The X-NUCLEO-53L5A1 expansion board is delivered with a cover glass holder in which three different spacers of 0.25, 0.5, and 1 mm height can be fitted below the cover glass to simulate various air gaps.

The X-NUCLEO-53L5A1 expansion board 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, the development of VL53L5CX applications with Bluetooth or Wi-Fi interfaces.



#### Figure 95. X-NUCLEO-53L5A1 expansion board





### 5.1.3 VL53L5CX-SATEL breakout boards

The VL53L5CX-SATEL breakout boards can be used for easy integration into customer devices. Thanks to the voltage regulator, the VL53L5CX breakout boards can be used in any application with a 3.3 V to 5 V supply. The PCB section supporting the VL53L5CX module is perforated so that developers can break off the mini PCB for use in a 3.3 V supply application using flying leads. This makes it easy to integrate the VL53L5CX-SATEL breakout boards into development and evaluation devices due to their small form factor.

Figure 96. VL53L5CX-SATEL breakout boards





### 5.2 Software description

The following software components are required in order to establish a suitable development environment for creating applications for the STM32 Nucleo equipped with the sensor expansion board:

- X-CUBE-TOF1: an STM32Cube expansion for sensor application development. The X-CUBE-TOF1 firmware and associated documentation is available on www.st.com.
- Development tool-chain and compiler: The STM32Cube expansion software supports the three following environments:
  - IAR Embedded Workbench for ARM®(EWARM) toolchain + ST-LINK
  - RealView Microcontroller Development Kit (MDK-ARM®-STR) toolchain + ST-LINK
  - STM32CubeIDE for STM32 + ST-LINK

### 5.3 Hardware setup

The following hardware components are required:

- 1. One STM32 Nucleo development platform (suggested order code: NUCLEO-F401RE or NUCLEO-L476RG)
- 2. An X-NUCLEO-53L5A1 expansion board or a VL53L5CX-SATEL breakout board
- 3. One USB type A to mini-B USB cable to connect the STM32 Nucleo to a PC

### 5.4 Software setup

To set up the SDK, run the sample testing scenario based on the GUI utility and customize applications, select one of the integrated development environments supported by the STM32Cube expansion software and follow the system requirements and setup information provided by the IDE provider.

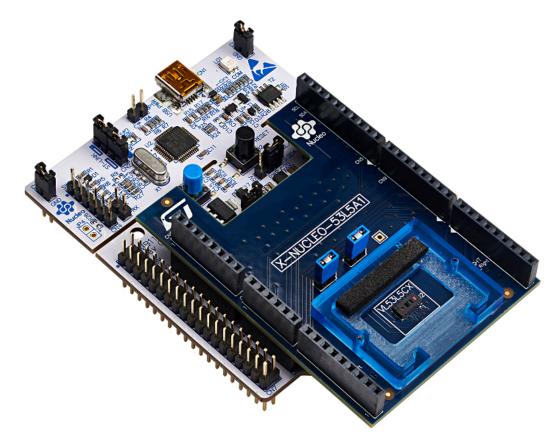


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The STM32 Nucleo board integrates the ST-LINK/V2-1 debugger/programmer. Developers can download the relevant version of the ST-LINK/V2-1 USB driver by searching STSW-LINK008 or STSW-LINK009 (depending on your version of Windows) on www.st.com.

The X-NUCLEO expansion boards can be easily connected to the STM32 Nucleo board through the Arduino UNO R3 extension connector and can interface with the external STM32 microcontroller on STM32 Nucleo via the Inter-Integrated Circuit (I<sup>2</sup>C) transport layer.

### Figure 97. Sensor expansion board plugged to STM32 Nucleo board



# **Revision history**

### Table 1. Document revision history

| Date        | Version | Changes         |
|-------------|---------|-----------------|
| 17-Jan-2022 | 1       | Initial release |

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| Rev | vision                                  | history  | ·   |    |  |

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