

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.

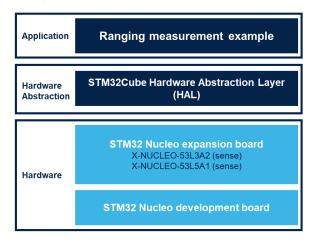


Figure 1. X-CUBE-TOF1 software architecture

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.

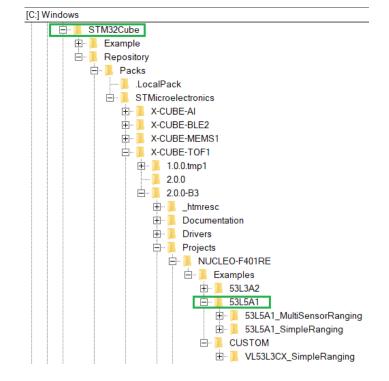


Figure 3. VL53L5CX precompiled projects

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	/ c/char 0	msec/line

Figure 4. Tera Term serial port setup

Figure 5. Tera Term terminal setup

Tera Term: Terminal setup	×
Terminal size 157 × 60 ✓ Term size = win size Auto window resize	New-line Receive: AUTO V Transmit: CR Cancel
Terminal ID: VT100 ~	Help
Coding (receive)	Coding (transmit) 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 -				
Cell Format distance0[: mm]:Sta	atus0	I				
70mm:	øl	73mm:		72mm:	ø	70mm:	0
 73mm:	øł	72mm:	øÏ	72mm:	ø	73mm:	Ø
 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.

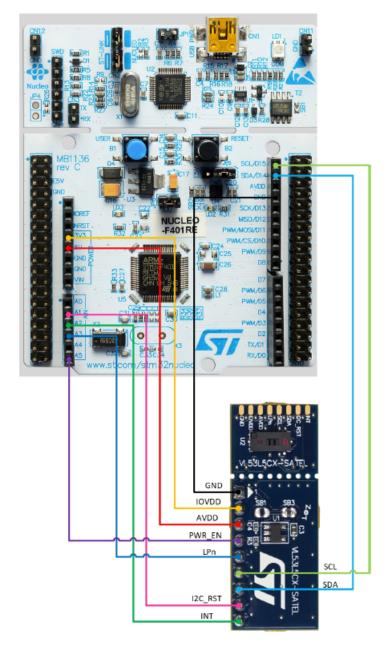


Figure 7. VL53L5CX_SATEL wiring

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 nable	resolu signal screen	tion		rol appl 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.

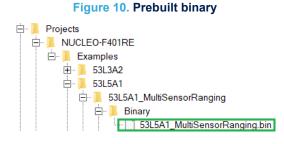
To test this application, two VL53L5CX-SATEL breakout boards, a X-NUCLEO-53L5A1, and a Nucleo F401RE are required. Ranging data are displayed on the serial terminal as shown below. This application is run by loading the prebuilt binary 53L5A1_MultiSensorRanging.bin.

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	 ø	 73mm:	 ø	 72mm:	 ø ¦	 70mm:	 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 1 Format	:			74mm:	0 İ	72mm:	
HT 1 Format istance00 60mm:	:		 0	/4mm: 60mm:	0 0	72mm: 	
l Format listance0[: 	atus0	I I				
l Format listance0[60mm:	: [mm]:St 	atus0 	 	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	~

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	~	
¢ 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			
 Platform proposal BSP 				
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 - Project Setings - Project Mane 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 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 Other	>						osing from the various	combinations of performa	nce and power consumption IPS significantly reduces po	n features, provided by t
Other	>	Boar	ds List: 7 items			prototypes by cho STM32 microcont mode.	osing from the various oller. For the compatit	combinations of performa ble boards, the external SN	nce and power consumption	n features, provided by the wer consumption in Run insion of the functionality
	>	Boar	ds List: 7 items			prototypes by cho STM32 microcont mode.	osing from the various oller. For the compatit	combinations of performa ble boards, the external SN	nce and power consumption IPS significantly reduces po eaders allow the easy expa	n features, provided by the wer consumption in Run
Other	>	Boar	ds List: 7 čems	Constant Con	× cor	prototypes by cho STM32 microcont mode. The ARDUINO [®] U	osing from the various oiler. For the compatit to V3 connectivity sup	combinations of performa be boards, the external Sh port and the ST morpho h	nce and power consumption IPS significantly reduces po eaders allow the easy expa	n features, provided by the wer consumption in Run 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 CubeMX	File	Window	Help		
Home >	STM32F401RETx - NUCLEO-F401RE	Untitled - P	inout & Configuration >		
	Pinout & Configuration		Clock Co	onfiguration	
Q Categories	→ ◎ ►			age Softwar Dacks At-0 Add pack software compon	Pinout view ent to the project

4. Select "X-CUBE-TOF1", then select "53L5A1 Board Extension", next select "53L5A1_SimpleRanging", and finally "OK".

 STMicroelectronics X-CUBE-TOF1 	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 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	~
 Sound Support STM32Cube_Custom_ESP_L STMicroelectronics.X-CUBE-TOUCHGFX 	,	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 CubeMX		File	Window	Help		
Home 🔪	STM32F401RETx	- NUCLEO-F401RE	Vintitled - Pinout 8	& Configuratio	n >	
	Pinout 8	k Configuration			Clock Configuration	
					✓ Software Packs	✓ Pinout
Q Categories	~ A->Z		STMicro	electronics.X-CU	BE-TOF1.2.0.0-B3 Mode and Configuration Mode	
System C	ore		Board Extension 53L5A1			
Analog		>	Device TOF1 Applications]		
Timers		>				
Connectivi	ty	> ♦= ₽				
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	



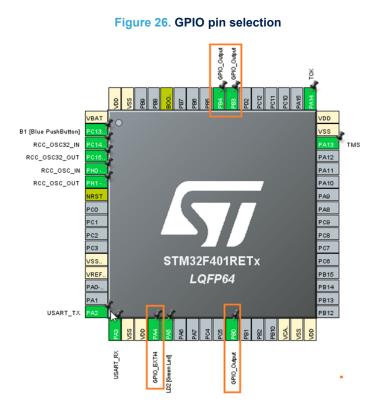
6. Configure the GPIOs for the application.

		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.



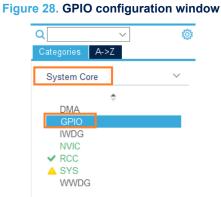
8. Link the GPIOs to the corresponding pin names as shown below.



			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				 ✓ Unknown
53L5A1_LPn_C	GPIO:Output	~	PB4				√ Unknown
53L5A1_PWR_EN_C	GPIO:Output	~	PB0				 ✓ Unknown
					L ^o		
BSP					ß		
BSP	IPs or Components		Found Solutions	12C A		BSP A	PI
Name		~	Found Solutions	12C A			PI S_DRIVER
Name 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	~
PA5	n/a	Low	Output Push Pull	No pull-up and	Low	LD2 [Green Led]	V
PB0	n/a	High	Output Push Pull	No pull-up and	Low	TOF_PWR_EN_C	V
PB3	n/a	Low	Output Push Pull	Pull-down	Low	TOF I2C RST C	~
PB4	n/a	High	Output Push Pull	Pull-up	Low	TOF LPn C	V
PC13-ANTI TA	n/a	n/a	External Interru	No pull-up and	n/a	B1 [Blue Push	V
PB4 PC13-ANTI_TA	n/a	High		Pull-up	Low		V

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	_	0	0						
EXTI line[15:10] interrupts	<u>d</u> 2	0	0						

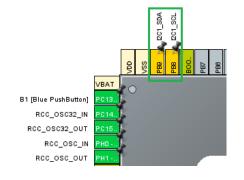


12. Configure the I2C and BSP as shown below.

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".

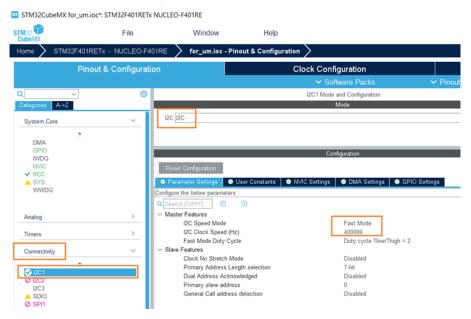


Figure 33. Fast mode selection



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 Project Name For_um Project Location C:180 Application Structure			Brownie		
Code Gene	Advanced Toolchain Folder Location Entroller um/n Toolchain / IDE 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 'r' : change resolution										
's' : enable si 'c' : clear scr	gnal and ambien een	nt									
Cell Format :											
Distance	Emm] :	Status									
70 : 0	71 : 0	2 71 :	øľ	69 :	ø						
70 . 0	70			74	 а						
i 72 : 0	70 : (2 i 69 :	i	71 :							
73 : 0	69 : 0	2 70 :	ø	69 :	ø						
71 : 0	72 : (a 72 :	 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 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. Last modified date	ioc e : 14/06/2021 16:50:34		MX	Start My project from MCU
cube_tof1_2_4	4.ioc e : 14/06/2021 16:00:33		MX	ACCESS TO MCU SELECTOR
test_cube_tof1 Last modified date	_3.ioc a : 14/06/2021 15:45:27		MX	Start My project from ST Board ACCESS TO BOARD SELECTOR
test_cube_2_2 Last modified date	2.ioc a : 14/06/2021 15:31:16		MX	Start My project from Example
			E7	ACCESS TO EXAMPLE SELECTOR

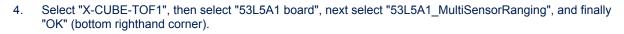
2. Select the F401RE board

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 prototypes by chosing from the various combinations of perform STM32 microcontroller. For the compatible boards, the esternal 5 mode. The ARDUINO [®] Uno V3 connectivity support and the ST morpho			ind power consumpt	tion features, provid	ed by th
		>	Boar	ds List: 7 items			STM32 microcont 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 mode.	roller. For the compa	tible board	s, the external SMPS :	ignificantly reduces	power consumption pansion of the funct	in Run ionality d
Other Peripheral		>	Boar	ds List: 7 Rems			STM32 microcont mode. The ARDUINO® U	roller. For the compa no V3 connectivity su	tible board upport and	s, the external SMPS : the ST morpho heade	ignificantly reduces	power consumption pansion of the funct	in Run ionality c d E

Figure 39. F401RE board

3. Right click "Select Components"





 STMicroelectronics.X-CUBE-TOF1 	\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 🗸 🗸	 53L3A2_SimpleRanging 53L3A2 MultiSensorRanging
> wolfSSL.I-CUBE-wolfSSL		4.7.0 ڬ	 VL53L3CX_SimpleRanging
> FreeRTOS	G)	-	53L5A1 SimpleRanging
> HAL Drivers	$\Rightarrow \oslash$	L	53L5A1_MultiSensorRanging 53L5A1 ThresholdDetection
> MBEDTLS	\rightarrow		 VL53L5CX_SimpleRanging

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
 STMicroelectronics.X-CUBE-TC 	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

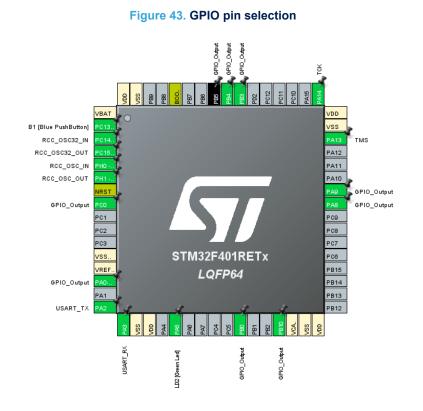
Figure 42. Device TOF1 application box selection

51

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 — 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 ~ Categories A->Z	٥						
System Core	~ [
 DMA GPIO IWDG NVIC ✓ RCC ▲ SYS WWDG 	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 n/a	Low High	Output Push Output Push		Low Low	I2C_RST_R PWR_EN_C	✓ ✓
PB0				Pull-up			
PB0 PB3	n/a	High	Output Push	Pull-up Pull-down	Low	PWR_EN_C	~
PB0 PB3 PB4	n/a n/a	High Low	Output Push Output Push	Pull-up Pull-down Pull-up	Low Low	PWR_EN_C I2C_RST_C	v
PB0 PB3 PB4 PB5	n/a n/a n/a	High Low High	Output Push Output Push Output Push	Pull-up Pull-down Pull-up Pull-up	Low Low Low	PWR_EN_C I2C_RST_C LPn_C	v v
PA9 PB0 PB3 PB4 PB5 PB10 PC0	n/a n/a n/a n/a	High Low High High	Output Push Output Push Output Push Output Push	Pull-up Pull-down Pull-up Pull-up Pull-up	Low Low Low	PWR_EN_C I2C_RST_C LPn_C LPn_R	y y y

Figure 46. Pin name configuration



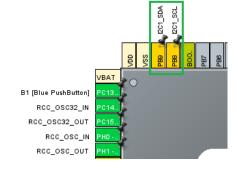
10. Configure the I2C and UART as shown below.

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

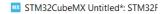
11. Select the pins PB9 and PB8 for SDA and SCL as shown below.

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 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 GPIO IWDG NVIC ✓ RCC ▲ SYS WWDG		Reset Configuration Parameter Settings Configure the below param Search (CrlPF) 	eters :	Configuration MC Settings ● DMA Settings ● G	PIO Settings
Analog	>	 Master Features I2C Speed Mod 		Fast Mode	
Timers	<u> </u>	I2C Speed Mod I2C Clock Spee Fast Mode Duty Slave Features	d (Hz)	400000 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 ▲ SDIO ⊘ SPI1		Primary slave a General Call ad		0 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 Project Name for_um Project Location Crash Application Structure			Browse		
Code Generator	Advanced Toolchain Folder Location Citability umb Toolchain / IDE 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.

Figure	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 Format	: mm]:St;	atus0					
T Format stance0[: mm]:Sta	atus0 60mm:	 	60mm:	0	59mm:	
Stance0	.mm]:Sta 		0 0	60mm: 60mm:	0 	59mm: 61mm:	·
Format stance0[60mm:	.mm]:Sta	60mm:	 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 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 Last modified date :	ic 14/06/2021 16:50:34		MX	Start My project from MCU
cube_tof1_2_4.i	OC 14/06/2021 16:00:33		MX	ACCESS TO MCU SELECTOR
test_cube_tof1_3 Last modified date :	3.ioc 14/06/2021 15:45:27		MX	Start My project from ST Board ACCESS TO BOARD SELECTOR
test_cube_2_2.id Last modified date :			MX	Start My project from Example
Last modified date : test_cube_2_2.id	14/06/2021 15:45:27 DC		- 24	ACCESS TO BOARD SELECTO Start My project from Example

2. Select the F401RE board

and Filters	>	Feat		Large Picture	e Docs	& Resources	Datasheet	📑 Buy	🕞 Start Project
Commercial 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 Commercial Part Number : NUCLEO-F401RE			
Type	>	Product in	s in mass product	ion	Commercial Part				RETX
Other	>			4	STM32 microcontr 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 mode.		e boards, the external SMI		wer consumption in Run
	>	Boards List: 7 item	ns Cverve		STM32 microcontr mode.		e boards, the external SMI	PS significantly reduces po aders allow the easy expan	wer consumption in Run nsion of the functionality
Other Peripheral	>	Boards List: 7 item			STM32 microcontr mode. The ARDUINO® U	no V3 connectivity supp	e boards, the external SMI	PS significantly reduces po 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 CubeMX		File	Window	Help			
Home >	STM32F401RETx	- NUCLEO-F401RE	Untitled - P	Pinout & Configuration	\rangle		
	Pinout 8	& Configuration		c	lock Configuration		
					Software Packs		✓ Pinout
Q Categories	~ A->Z	۵ 🕻			Select Components Manage Software Add packs	Alt-O	Pinout view

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

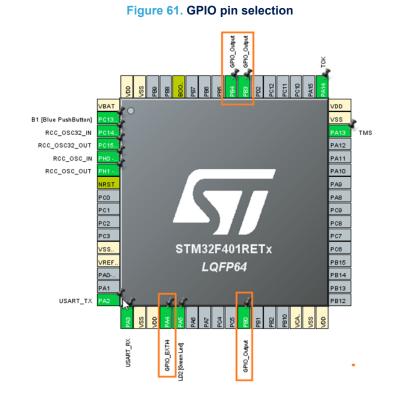
Figure 59. Board selection

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 — 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 ✓ 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.



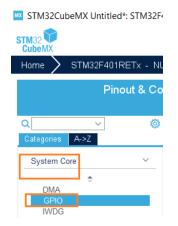
6. Link the GPIOs to the corresponding pin names as shown below.

		Mode		
Board Extensio	n 53L5A1			
Device TOF1 A	pplications			
		Configuration		
Reset Configuration	n			
Parameter Setting 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	 Undefined 		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	V	
PA5	n/a	Low	Output Push	No pull-up an	Low	LD2 [Green L	V	
PB0	n/a	High	Output Push	Pull-up	Low	PWR_EN_C	~	
PB3	n/a	Low	Output Push	Pull-down	Low	I2C RST C	~	
PB4	n/a	High	Output Push	Pull-up	Low	LPn C	_	
	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	_	0	0
EXTI line[15:10] interrupts	<u>d</u> 3	0	0

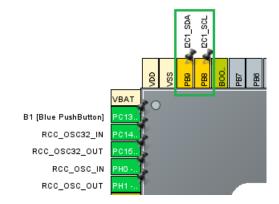
10. Configure the I2C and BSP as shown below.

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

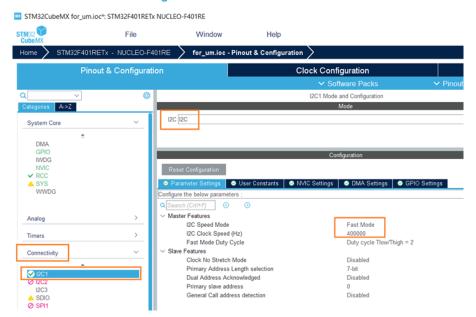


Figure 68. Fast mode selection

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 Project Name Inveshold_um Project Location © tes Application Structure Advanced Toolchain Folder Location E-contremended_um		✓ Do not ger	erate the main()			
Toolchain / IDE 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	Results
	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 : I distance0[mm]:Status0 I								
552mm: 0 512mm: 0 506mm: 1 473mm: 0	576mm:	1	514mm:	0	2mm:	1	448mm:		
	 552mm:	øl	512mm:	ø	506mm:	1	473mm:	ø	
330mm: 0 514mm: 1 502mm: 0 453mm: 0	 330mm:	øÏ	514mm:	1	502mm:	øÏ	453mm:	ø	
292mm: 0 404mm: 1 484mm: 0 456mm: 1	 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 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 Last modified date	DC : 14/06/2021 16:50:34		MX	Start My project from MCU						
cube_tof1_2_4.	ioc : 14/06/2021 16:00:33		MX	ACCESS TO MCU SELECTOR						
test_cube_tof1_ Last modified date	_3.ioc : 14/06/2021 15:45:27		MX	Start My project from ST Board						
test_cube_2_2. Last modified date	ioc : 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 Part Number	~	*	STM32F4 Seri 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 and power consumption fea	tures, provided by the	
	Other Peripheral	>					STM32 microcontroller. For the compatible boards, the external SMPS significantly reduces power consumption in Run mode. 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	
 Device TOF1_Applications 	\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 Name	IPs or Components	Found Solutions	I2C Addr	BSP API
 STMicroelectronics.X-C 	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

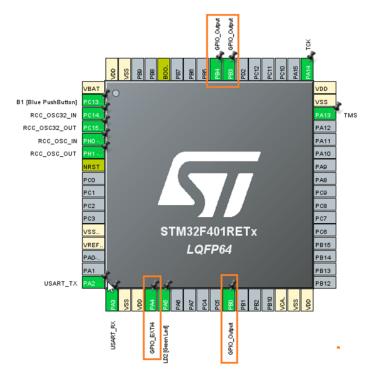
Figure 79. Board support STM32Cube custom BSP drivers

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 Name	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		 ✓ Unknown
53L5A1_LPn_C	GPIO:Output PB4	\sim	Undefined		 ✓ Unknown
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 BSP_BUS_DRIVER
Name 53L5A1 BUS IO driver				_	BSP_BUS_DRIVER
	I2C:I2C	~	No solution	/ N/A	BSP_BUS_DRIVER BSP_COMMON_DRIVER
Name 53L5A1 BUS IO driver BSP BUTTON	I2C:I2C GPIO:EXTI	~	No solution	N/A	BSP_BUS_DRIVER BSP_COMMON_DRIVER
Name 53L5A1 BUS IO driver BSP BUTTON	I2C:I2C GPIO:EXTI	~	No solution	N/A	BSP_BUS_DRIVER 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.

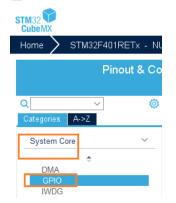
		Mode		
Board Extension	n 53L5A1			
Device TOF1 Apple 100 Period	oplications			
		Configuration		
Reset Configuration				
Parameter Setting	s 🔥 Platform Settings			
Platform proposal				
Application				
Name	IPs or Components	Found Solutions	I2C Addr	BSP API
53L5A1_I2C_RST_C	GPIO:Output ~	PB3	~	Unknown
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	 ✓ Undefined 	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	V			
PA5	n/a	Low	Output Push	No pull-up an	Low	LD2 [Green L	V			
PB0	n/a	High	Output Push	Pull-up	Low	PWR_EN_C	~			
PB3	n/a	Low	Output Push	Pull-down	Low	I2C RST C	~			
PB4	n/a	High	Output Push	Pull-up	Low	LPn C	_			
	n/a	n/a	External Inte	No pull-up an	n/n	B1 [Blue Pus	V			

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	_	0	0						
EXTI line[15:10] interrupts	<u>d</u> 3	0	0						

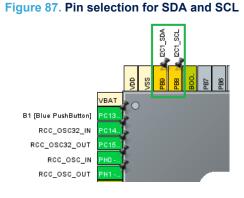
11. Configure the I2C and BSP as shown below.

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

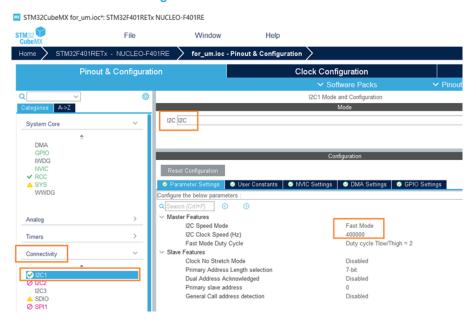


Figure 88. Fast mode selection

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 Protect Name Investing on Project Location Critica Application Structure Advanced Toolsham Folder Location E: Voltmentoda, um		✓ Do not	generate the main()		
Toolchain / IDE 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

- U:	STMicroelectronics VL53L5CX 												
С	ell	For	mat	:									
			Dist	ance	Emm] :			St	atu	5			
_													
H		53	:	Ø	58	:	Ø	63	:	0 	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.

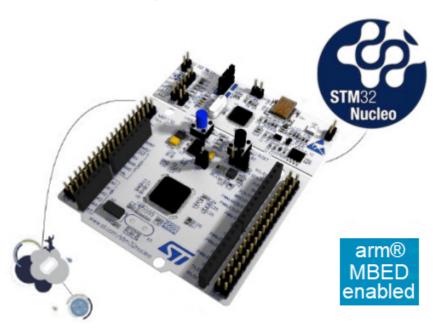


Figure 94. STM Nucleo board

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.

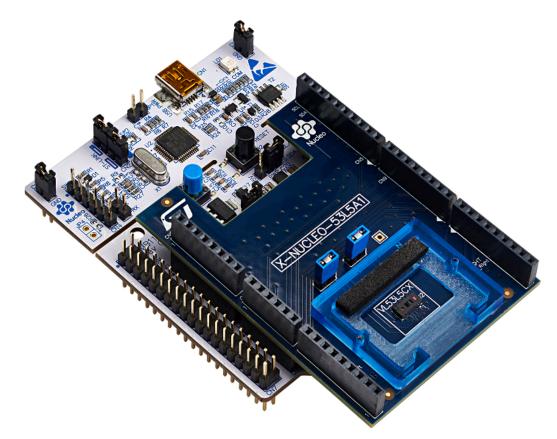


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The STM32 Nucleo board integrates the ST-LINK/V2-1 debugger/programmer. Developers can download the relevant version of the ST-LINK/V2-1 USB driver by searching STSW-LINK008 or STSW-LINK009 (depending on your version of Windows) on www.st.com.

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 (I²C) 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

Contents

1	Acronyms and abbreviations				
2	X-CI	UBE-TC	OF1 software expansion for STM32Cube		
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	2.2	Architecture			
	2.3	Folder structure			
	2.4	APIs			
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	3.2	53L5A1_MultiSensorRanging			
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