教你玩转ST MEMS传感器开发板

于洁/Jie YU

MEMS AP FAE

意法半导体亚太区MEMS传感器应用与技术支持部门

概览

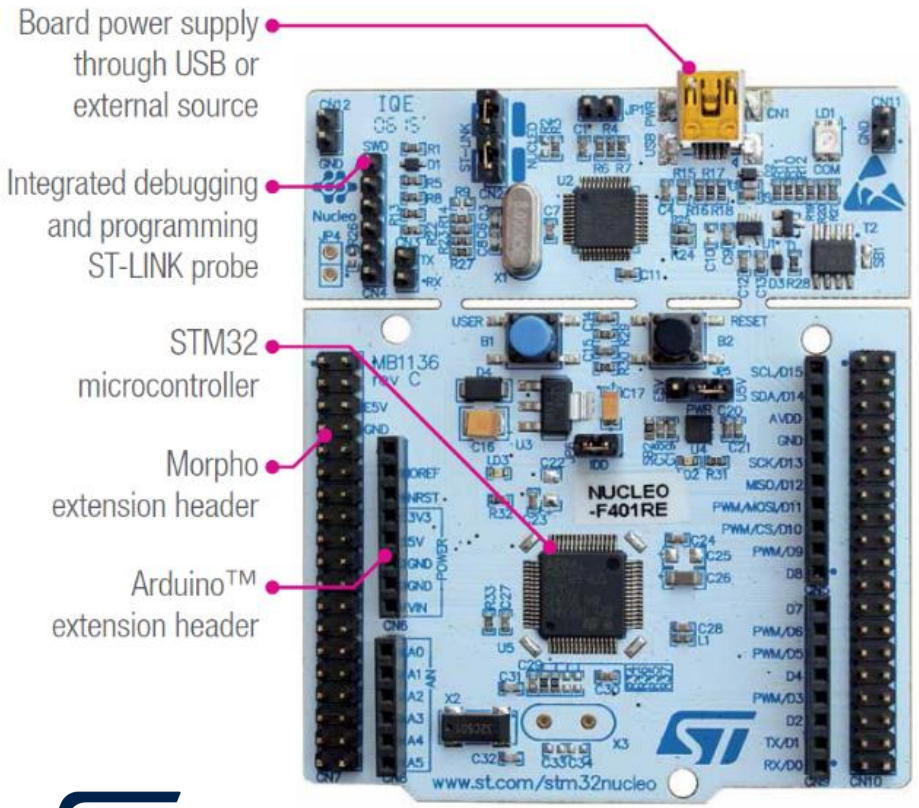
- # Nucleo MEMS传感器扩展板
- # X-CUBE-MEMS1软件扩展包
- # 基于STM32CubeMX的开发设计

Nucleo MEMS传感器扩展板

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STM32 Nucleo 开发板

59 个开发板 (处理 & 安全)



STM32 Nucleo

STM32

STM32 从低功耗到高性能的完整产品系列

High performance MCUs	STM32**F2**	STM32**F4**	STM32**H7**	STM32**F7**	
Mainstream MCUs	STM32**F0**	STM32**G0**	STM32**F1**	STM32**F3**	STM32**G4**
Ultra-low power MCUs	STM32**L0**	STM32**L1**	STM32**L5**	STM32**L4**	STM32**L4+**
Wireless MCUs	STM32**WL**	STM32**WB**			

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STM32 Nucleo 扩展板

69 扩展板涵盖所有应用功能

Sense (18)	Connect (17)	Power Drive (8)	Move / Actuate (18)	HMI (3)	Others (5)
Motion & environmental sensors	BLE	Industrial input / output	Stepper motor driver	Touch controller	EEPROM
Proximity sensor	Sub-GHz	Energy management & battery	DC motor driver	LED drivers	Safe
Microphone	NFC	USB	BLDC motor driver		Interface
	GNSS				



Nucleo MEMS传感器扩展板X-NUCLEO-IKS01A2

- 可通过板上的Arduino UNO R3 连接器与STM32 Nucleo 板连接使用。
- 产品信息（链接）

板载传感器：

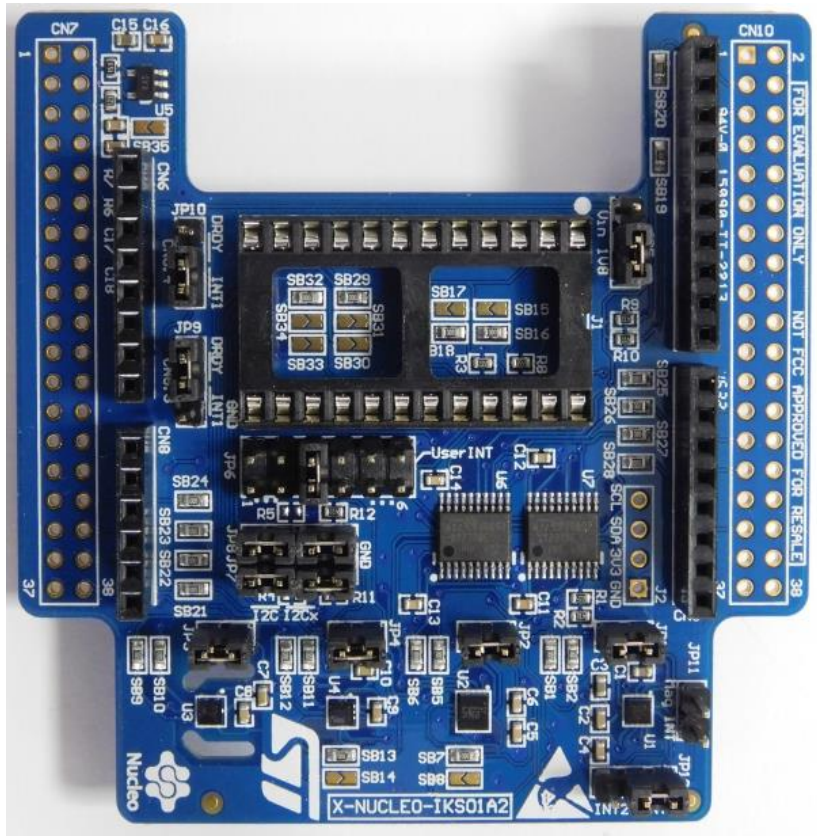
LSM6DSL： 3 轴加速度计 (±2/±4/±8/±16g) + 3 轴陀螺仪 (±125/250/500/1000/2000dps

LSM303AGR： 3 轴磁力计 (±50gauss) + 3 轴加速度计 (±2/±4/±8/±16g)

HTS221： 相对湿度和温度传感器

LPS22HB： 压力传感器 (260-1260hPa)

DIL 24-pin： 可连接各种ST MEMS传感器适配板





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Nucleo MEMS传感器扩展板X-NUCLEO-IKS01A3

- 可通过板上的Arduino UNO R3 连接器与STM32 Nucleo 板连接使用。
- 产品信息（链接）

板载传感器：

LSM6DSO：内嵌状态机的3 轴加速度计 (±2/±4/±8/±16g) + 3 轴陀螺仪 (±125/250/500/1000/2000dps)

LIS2MDL： 3 轴磁力计 (±50gauss)

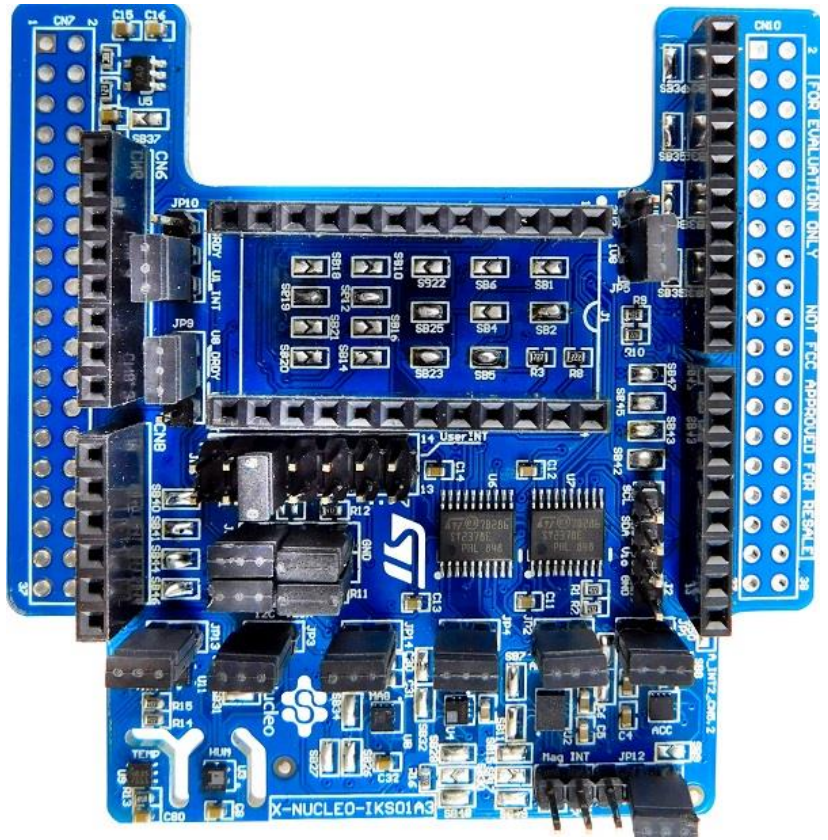
LIS2DW12： 3 轴加速度计 (±2/±4/±8/±16g)

HTS221： 相对湿度和温度传感器

LPS22HH： 压力传感器 (260-1260hPa)

STTS751： 温度传感器

DIL 24-pin： 可连接各种ST MEMS传感器适配板





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Nucleo MEMS传感器扩展板X-NUCLEO-IKS02A1

- X-NUCLEO-IKS01A3 是一款集工业运动MEMS 和环境传感器的评估板。
- 产品信息（链接）

板载传感器：

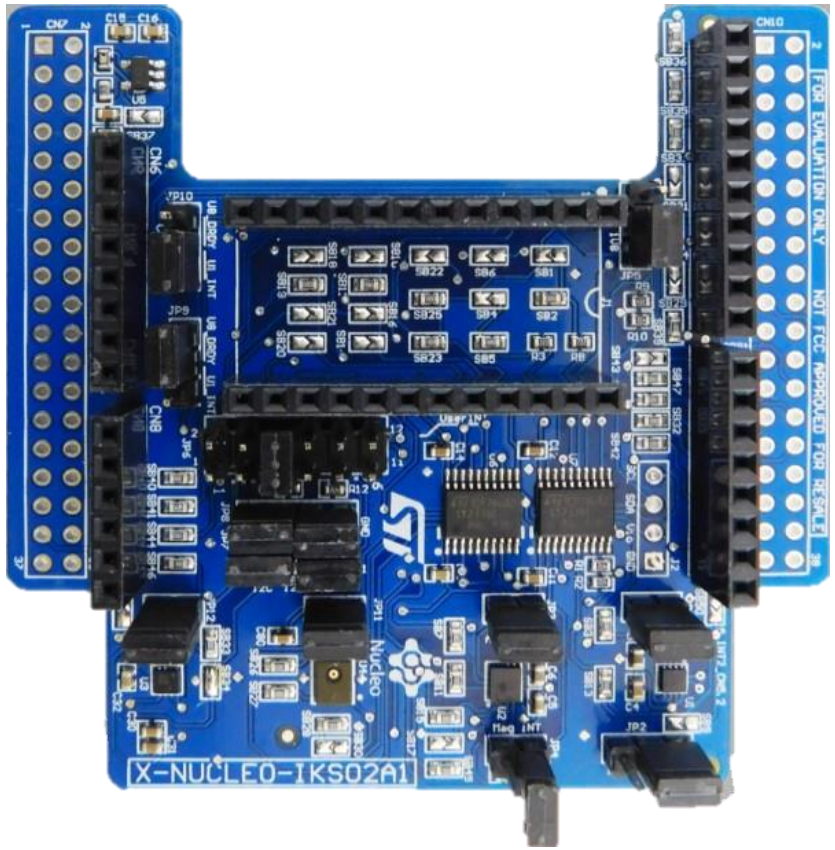
ISM330DHCX： 3 轴加速度计 (±2/±4/±8/±16g) + 3 轴陀螺仪 (±125/250/500/1000/2000dps

IIS2MDC： 3 轴磁力计 (±50gauss)

IIS2DLPC： 3 轴加速度计 (±2/±4/±8/±16g)

IMP34DT05： MEMS数字麦克风（-26dBFS, ±3dB）

DIL 24-pin： 可连接各种ST MEMS传感器适配板

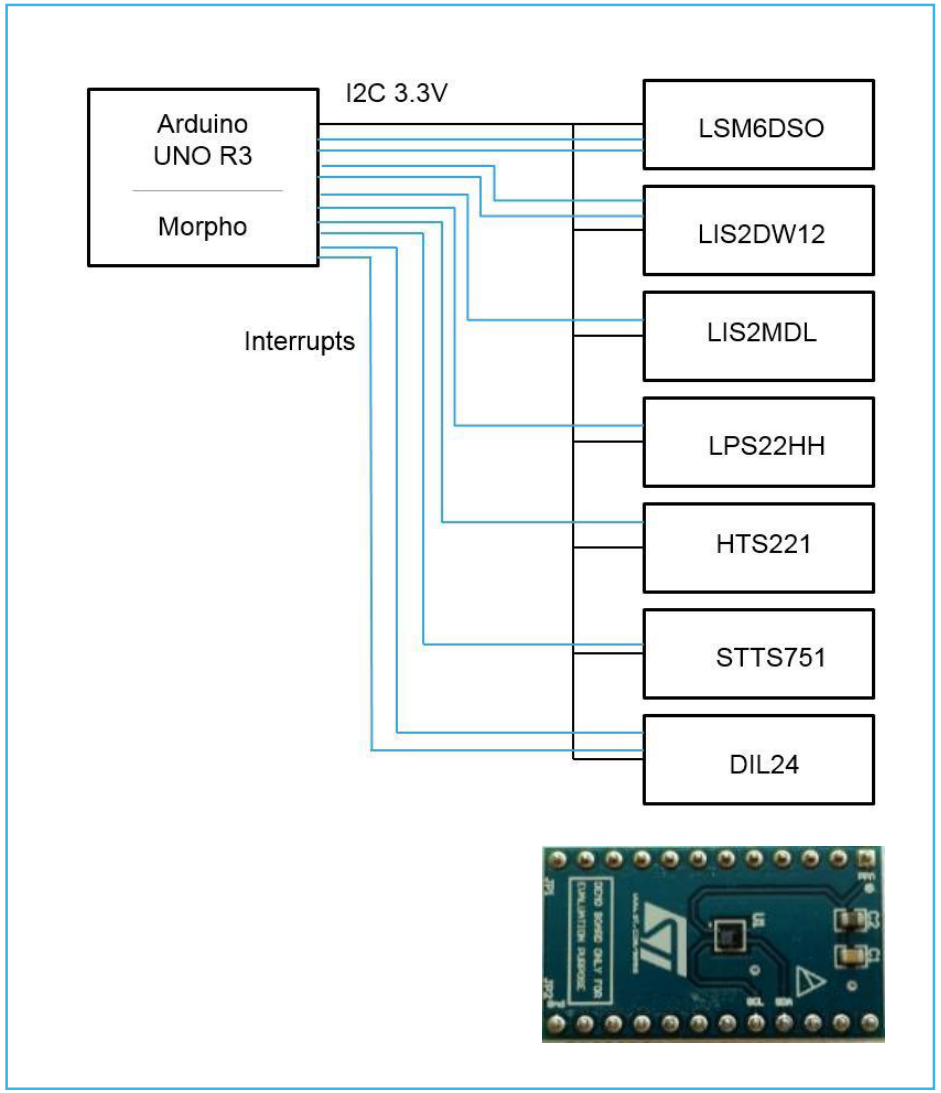




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硬件连接

- 所有传感器都连接到一个专用的I2C总线，STM32可以通过不同的I2C地址选通特定的传感器。
- 每个传感器都有独立的供电电路，可用于功耗测量
- 每个传感器有独立的中断和DRDY信号线与STM32 Nucleo连接
- DIL 24pin插座兼容STEVAL-MKI***V* MEMS适配板

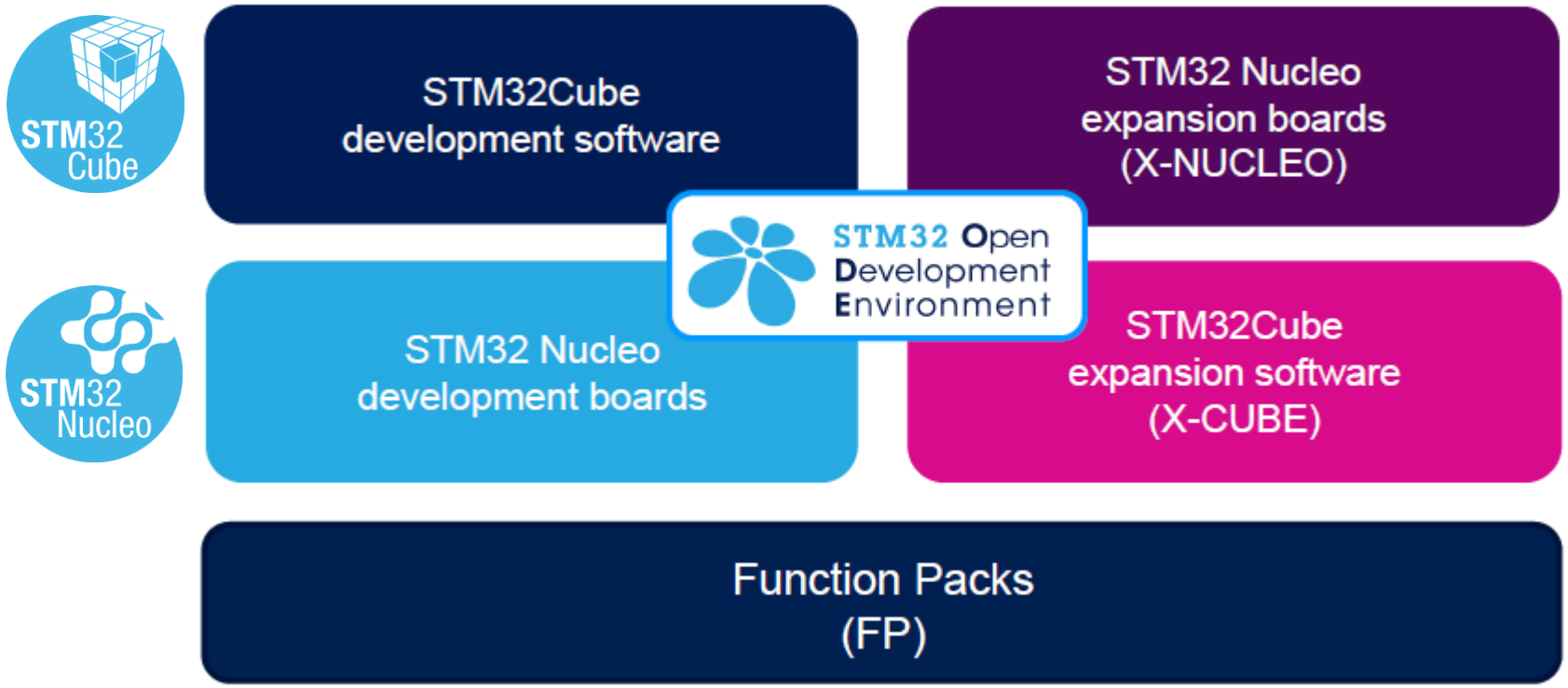


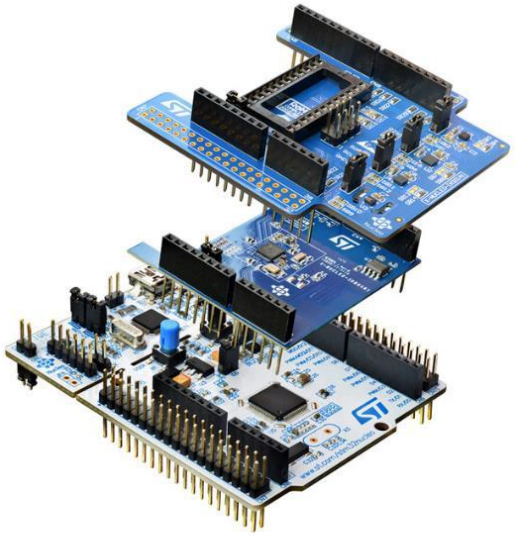
X-CUBE-MEMS1软件扩展包

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X-CUBE-MEMS1 开发软件包

- 基于STM32Cube的传感器和运动算法软件扩展包。







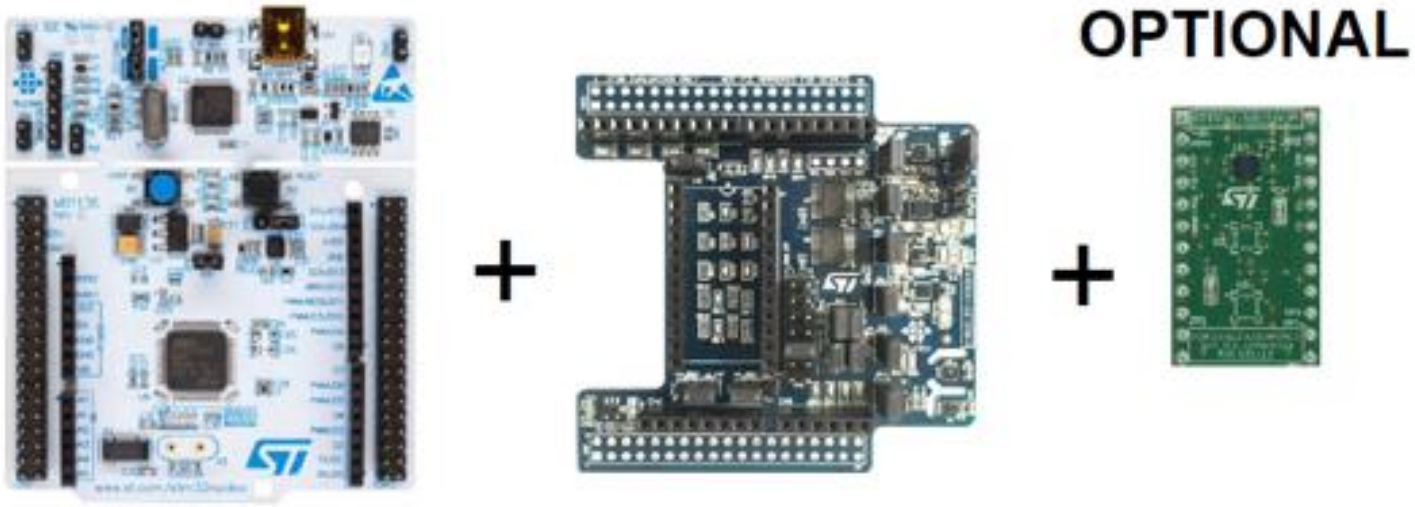
相关资料（链接）

X-CUBE-MEMS1硬件

- **STM32 Nucleo开发板：**
  - STM32L476RG-Nucleo
  - STM32L152RE-Necleo
  - STM32L073RZ-Nucleo
  - STM32F401RE-Nucleo

- **ST MEMS传感器扩展板：**
  - X-NUCLEO-IKS01A2
  - X-NUCLEO-IKS01A3
  - X-NUCLEO-IKS02A1

- **ST MEMS传感器适配板：**
  - 常规消费、工业及汽车级传感器适配板（链接）

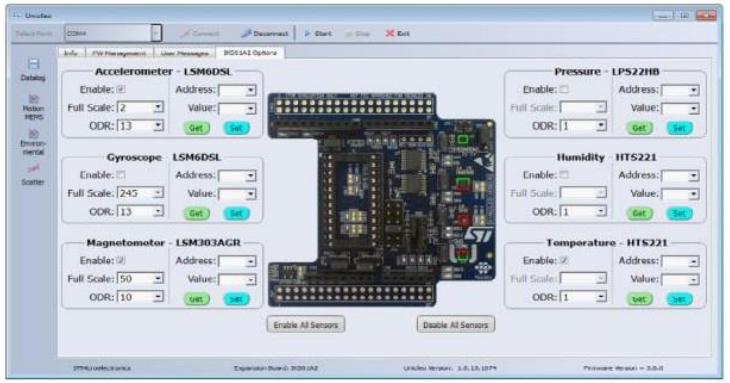


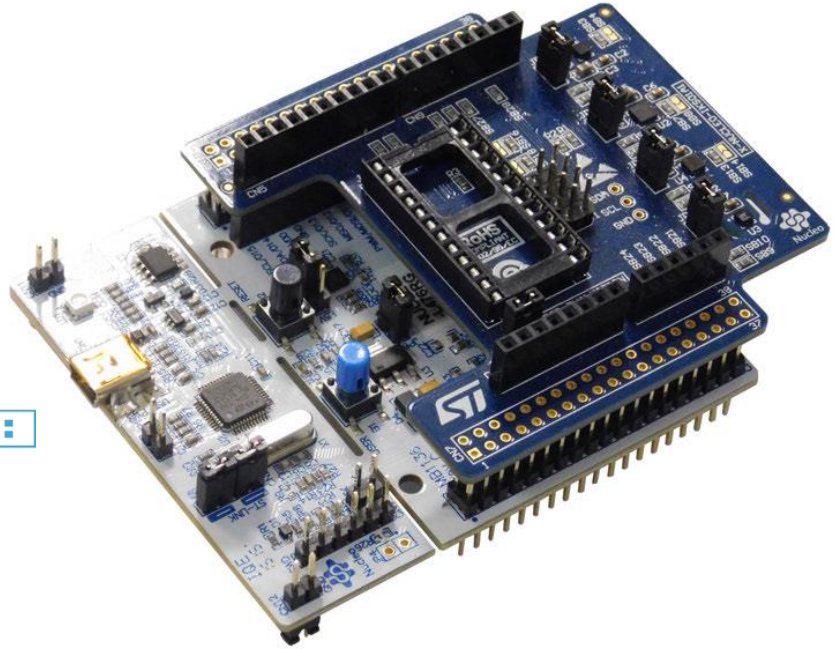
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开发环境的搭建



- X-NUCLEO-IKS0*A* 可通过Arduino UNO R3连接插座安装到STM32 Nucleo主板上
- 通过一个USB type A 转min-B的USB线缆将STM32 Nucleo连接到PC上。
- PC端设置：
  - Windows 10/8/7
  - STLink驱动（链接）
  - X-CUBE-MEMS1开发软件包（链接）
  - Unicleo-GUI安装包（链接）

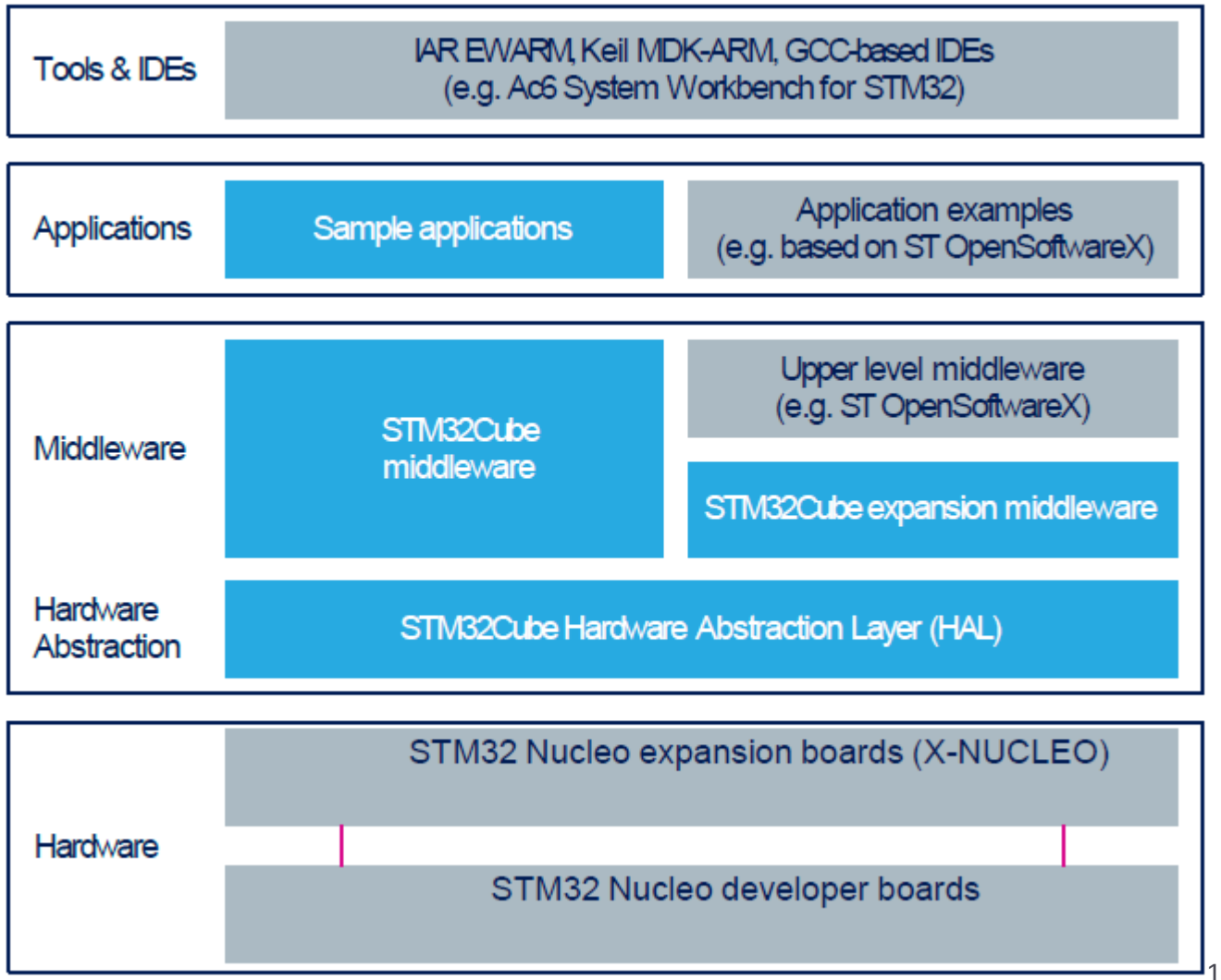




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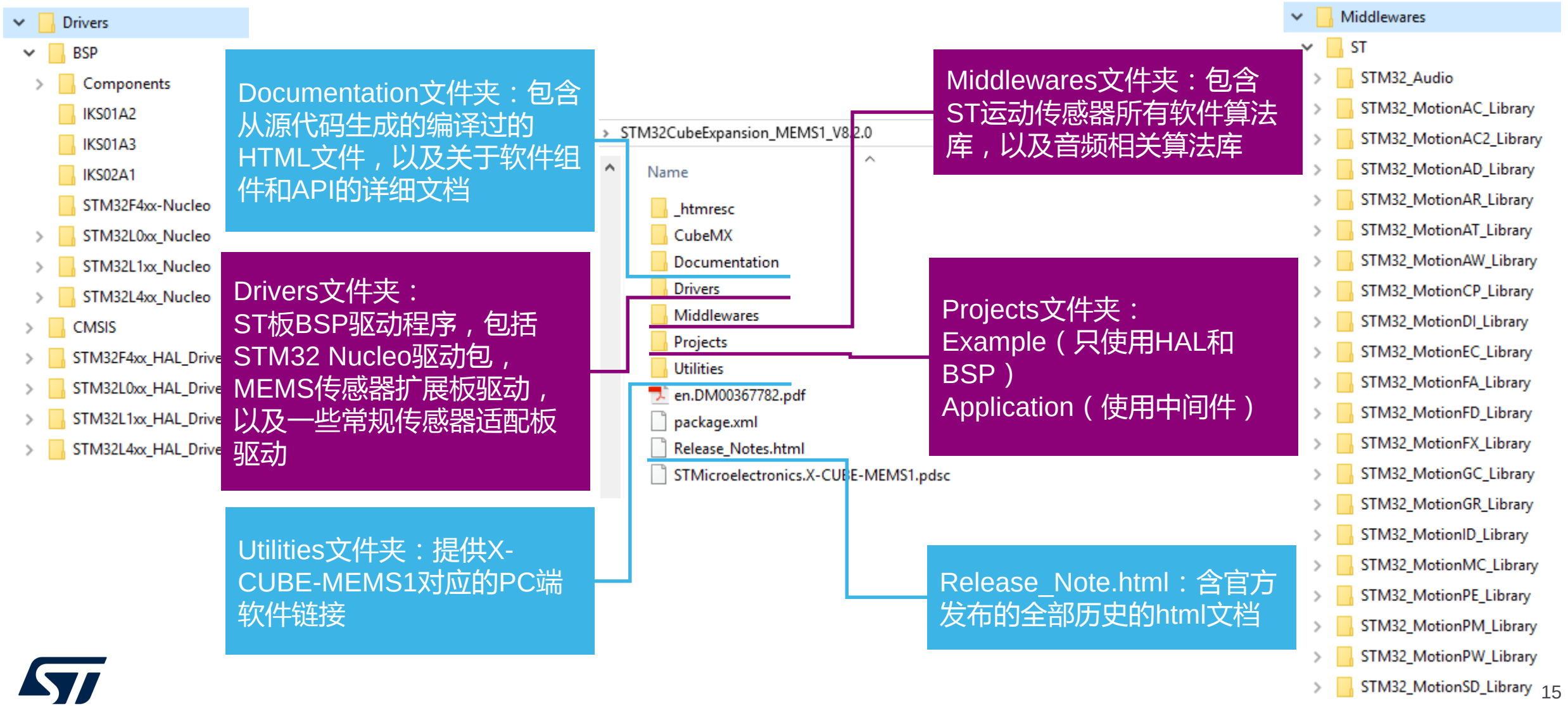
X-CUBE-MEMS1软件架构

- 一组免费的工具嵌入软件块，支持在STM32上进行快速和简单的开发，包括硬件抽象层和中间件。
- 扩展软件免费提供与STM32 Nucleo扩展板一起使用，完全兼容STM32Cube软件框架。它通过高级API和示例应用程序提供了对扩展板功能的抽象访问。
- 兼容多种开发环境——包括IAR EWARM、Keil MDK和基于GCC的环境。



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X-CUBE-MEMS1文件

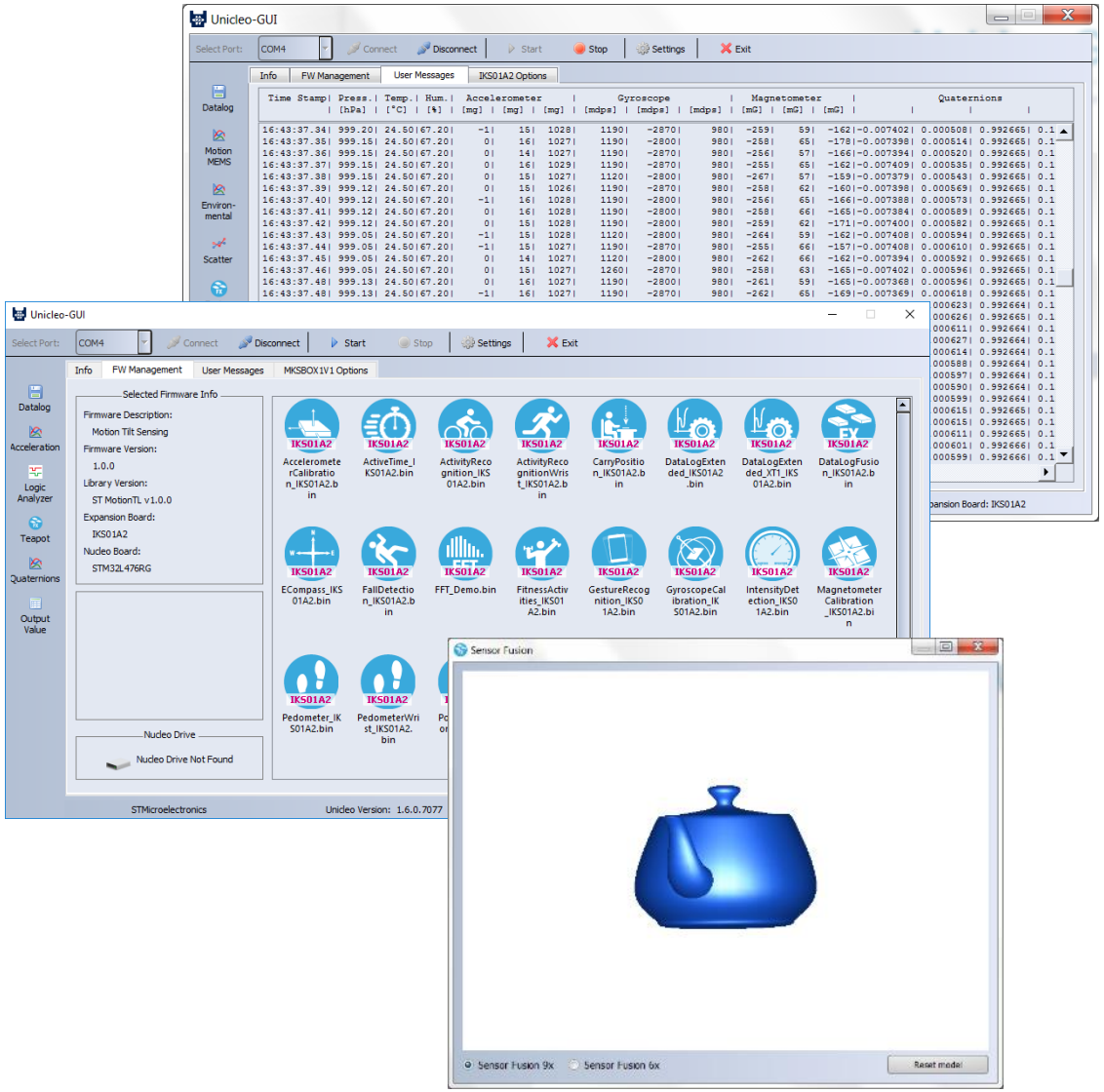


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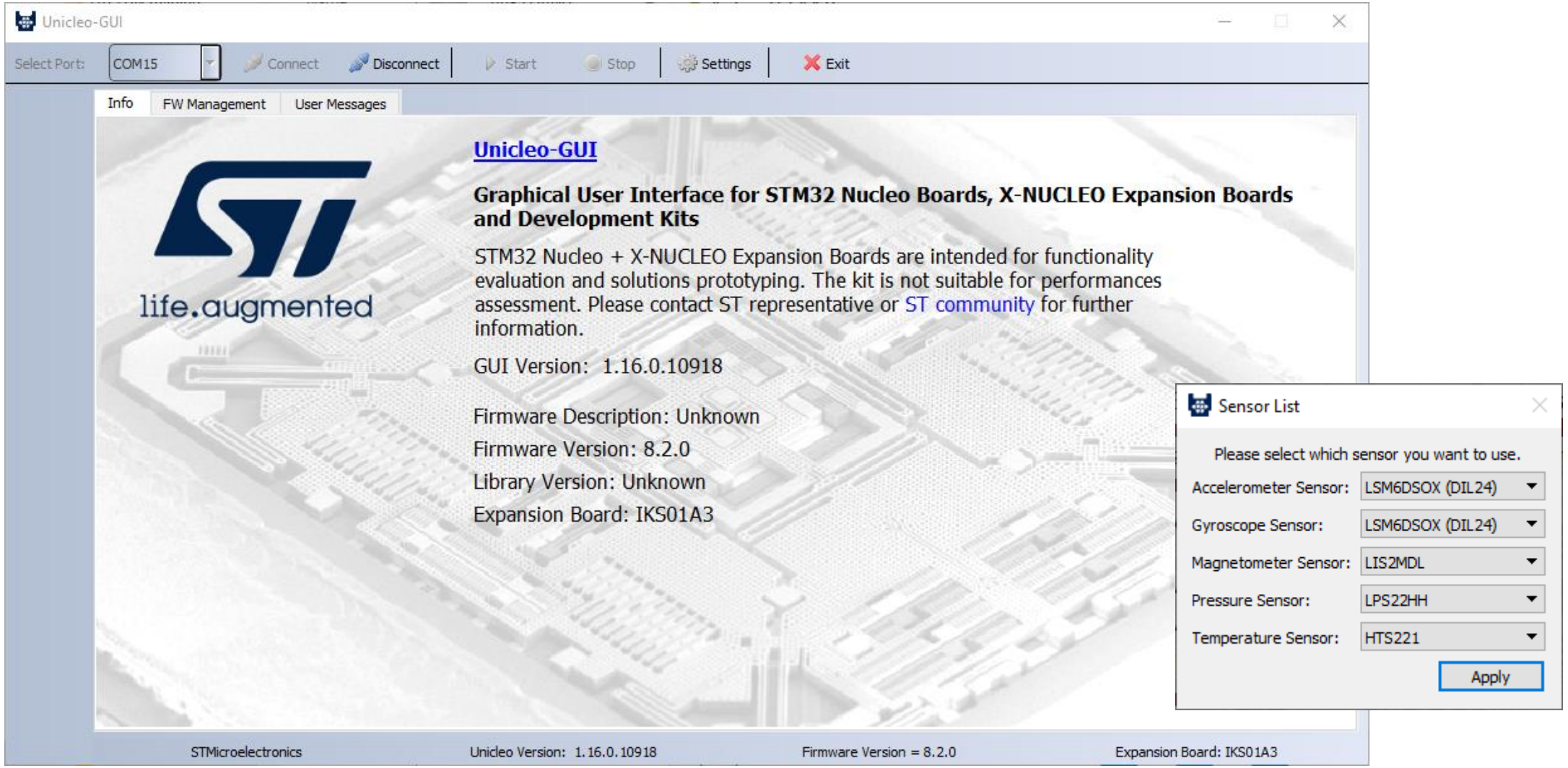
Unicleo-GUI

- Unicleo为X-CUBE-MEMS1和X-CUBE-MEMS-XT1软件扩展包和Nucleo扩展板开发的图形化用户界面工具，
- 主要用于ST传感器及算法评估，
- 参考链接

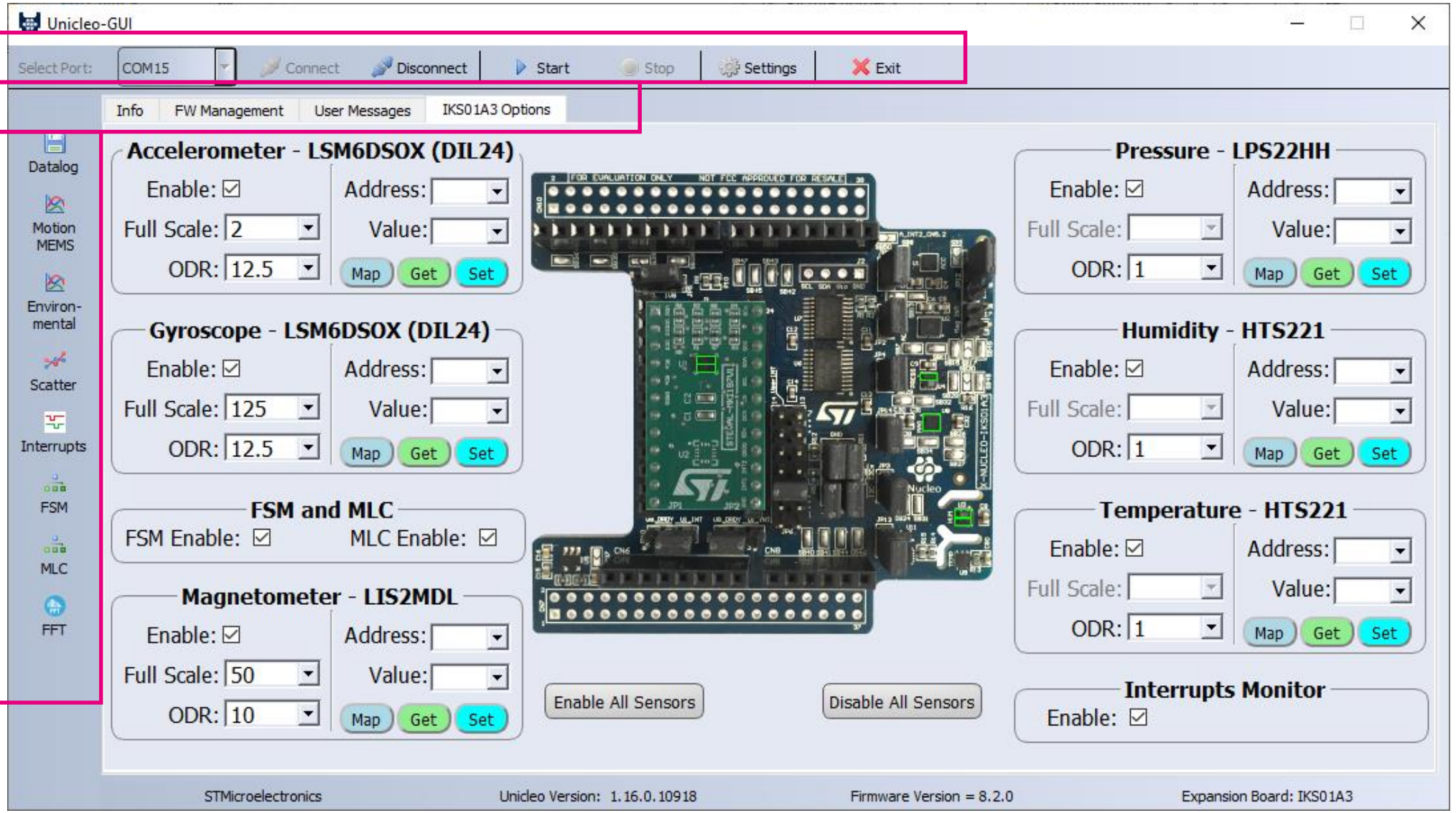




DataLogExtended示例：Info选项卡

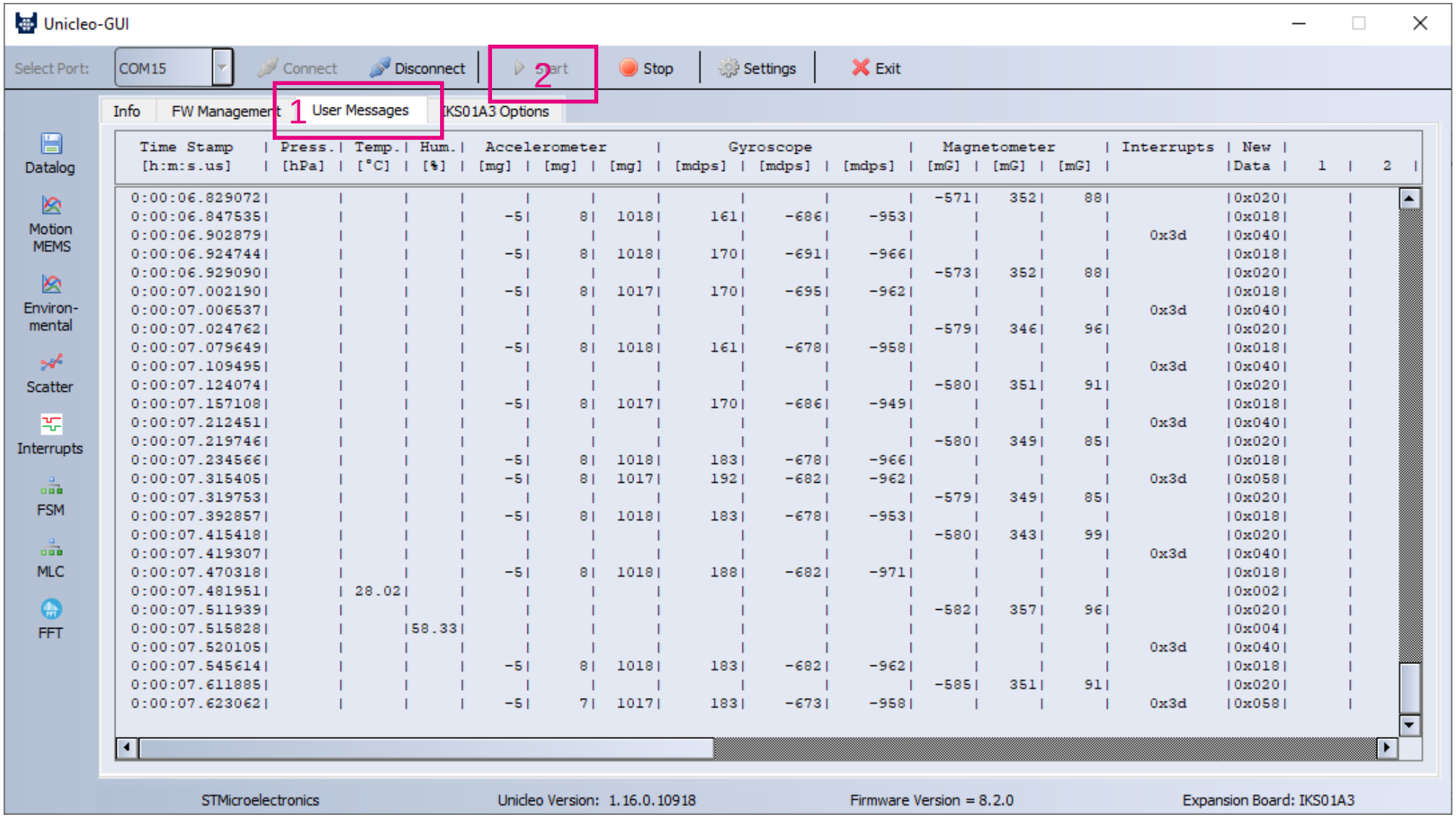


DataLogExtended示例： Unicleo界面



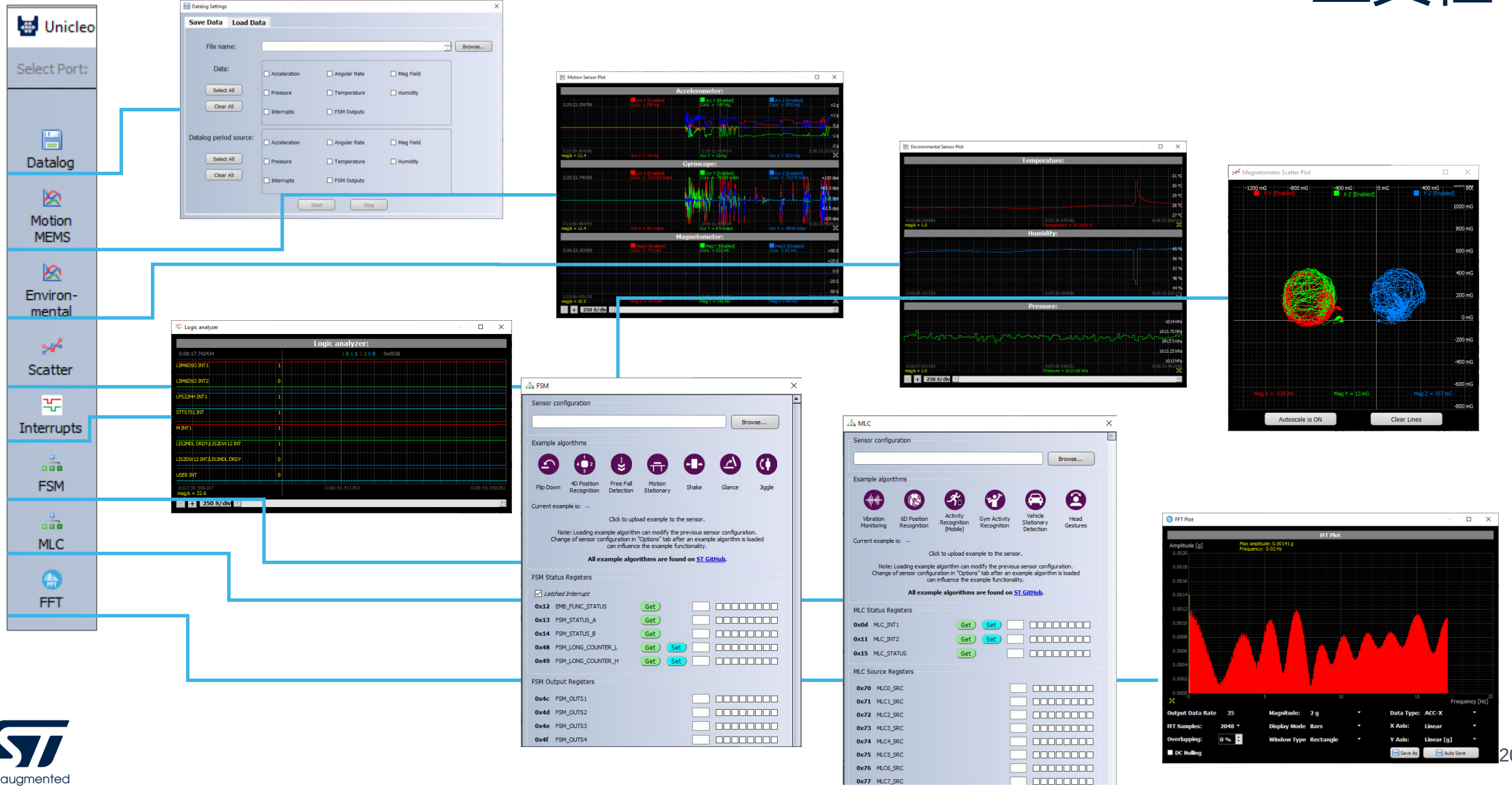
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User Messages选项卡



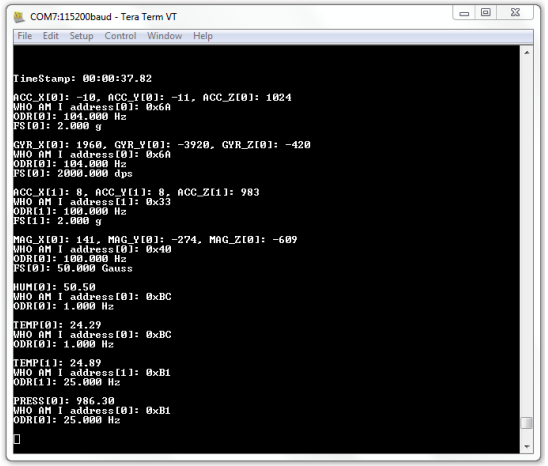
Time Stamp [h:m:s.us]	Press. [hPa]	Temp. [°C]	Hum. [%]	Accelerometer [mg]	[mg]	[mg]	Gyroscope [mdps]	[mdps]	[mdps]	Magnetometer [mG]	[mG]	[mG]	Interrupts	New Data	1	2
0:00:06.829072										-571	352	88		0x020		
0:00:06.847535				-5	8	1018	161	-686	-953					0x018		
0:00:06.902879													0x3d	0x040		
0:00:06.924744				-5	8	1018	170	-691	-966					0x018		
0:00:06.929090										-573	352	88		0x020		
0:00:07.002190				-5	8	1017	170	-695	-962					0x018		
0:00:07.006537													0x3d	0x040		
0:00:07.024762										-579	346	96		0x020		
0:00:07.079649				-5	8	1018	161	-678	-958					0x018		
0:00:07.109495													0x3d	0x040		
0:00:07.124074										-580	351	91		0x020		
0:00:07.157108				-5	8	1017	170	-686	-949					0x018		
0:00:07.212451													0x3d	0x040		
0:00:07.219746										-580	349	85		0x020		
0:00:07.234566				-5	8	1018	183	-678	-966					0x018		
0:00:07.315405				-5	8	1017	192	-682	-962				0x3d	0x058		
0:00:07.319753										-579	349	85		0x020		
0:00:07.392857				-5	8	1018	183	-678	-953					0x018		
0:00:07.415418										-580	343	99		0x020		
0:00:07.419307													0x3d	0x040		
0:00:07.470318				-5	8	1018	188	-682	-971					0x018		
0:00:07.481951		28.02												0x002		
0:00:07.511939										-582	357	96		0x020		
0:00:07.515828			58.33											0x004		
0:00:07.520105													0x3d	0x040		
0:00:07.545614				-5	8	1018	183	-682	-962					0x018		
0:00:07.611885										-585	351	91		0x020		
0:00:07.623062				-5	7	1017	183	-673	-958				0x3d	0x058		

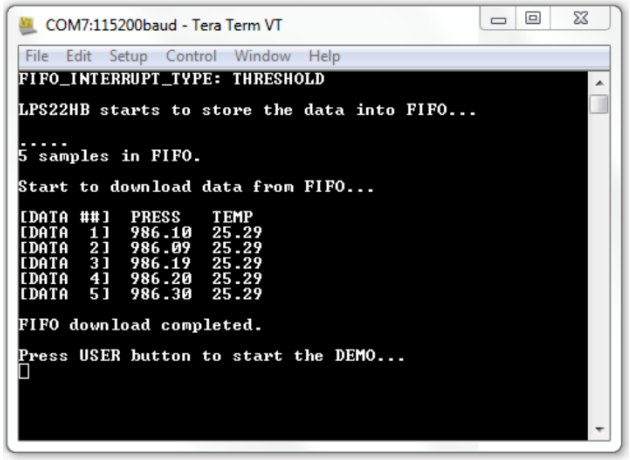
工具栏

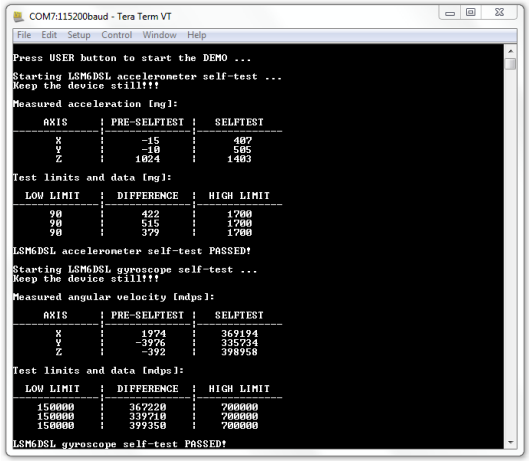

Unicleo
Select Port:
Datalog
Motion MEMS
Environ-mental
Scatter
Interrupts
FSM
MLC
FFT
Datalog Settings
Save Data
Load Data
File name:
Browse...
Data:
Select All
Clear All
Acceleration
Angular Rate
Mag Field
Pressure
Temperature
Humidity
Interrupts
FSM Outputs
Datalog period source:
Start
Stop
Motion Sensor Plot
Accelerometer:
Gyroscope:
Magnetometer:
Environmental Sensor Plot
Temperature:
Humidity:
Pressure:
Magnetometer Scatter Plot
Autoscale is ON
Clear Lines
Logic analyzer
Logic analyzer:
FSM
Sensor configuration
Example algorithms
Flip Down
4D Position Recognition
Free Fall Detection
Motion Stationary
Shake
Glance
Jiggle
Current example is:
Click to upload example to the sensor.
Note: Loading example algorithm can modify the previous sensor configuration.
Change of sensor configuration in "Options" tab after an example algorithm is loaded can influence the example functionality.
All example algorithms are found on ST GitHub.
FSM Status Registers
Latched Interrupt
0x12 EMB_FUNC_STATUS
0x13 FSM_STATUS_A
0x14 FSM_STATUS_B
0x48 FSM_LONG_COUNTER_L
0x49 FSM_LONG_COUNTER_H
FSM Output Registers
0x4c FSM_OUTS1
0x4d FSM_OUTS2
0x4e FSM_OUTS3
0x4f FSM_OUTS4
MLC
Vibration Monitoring
6D Position Recognition
Activity Recognition (Mobile)
Gym Activity Recognition
Vehicle Stationary Detection
Head Gestures
MLC Status Registers
0x0d MLC_INT1
0x11 MLC_INT2
0x15 MLC_STATUS
MLC Source Registers
0x70 MLC0_SRC
0x71 MLC1_SRC
0x72 MLC2_SRC
0x73 MLC3_SRC
0x74 MLC4_SRC
0x75 MLC5_SRC
0x76 MLC6_SRC
0x77 MLC7_SRC
FFT Plot
Output Data Rate
FFT Samples:
Overlapping:
Magnitude:
Display Mode
Window Type
Data Type:
X Axis:
Y Axis:
DC Nulling

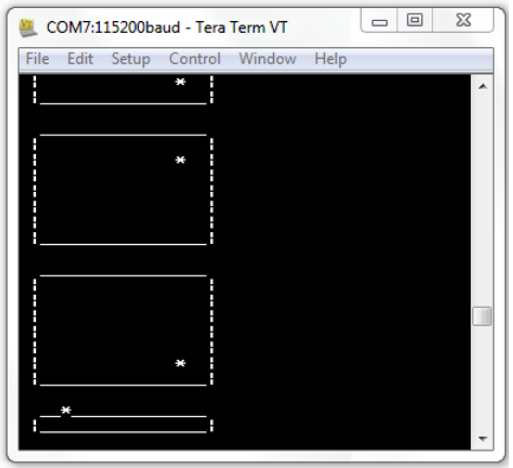
X-CUBE-MEMS1运动传感器示例

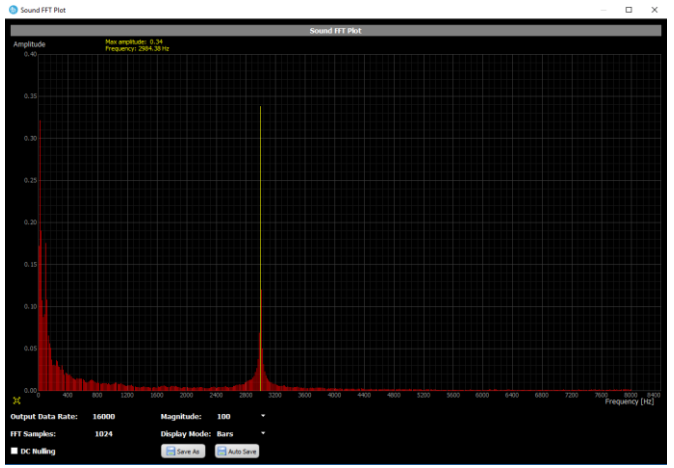
- DataLogExtended
- DataLogTerminal
- LIS2DW12_6DOrientation
- LIS2DW12_SelfTest
- LIS2DW12_WakeUpDetection
- LIS2MDL_SelfTest
- LPS22HH_FIFOMode
- LSM6DSO_6DOrientation
- LSM6DSO_FIFOContinuousMode
- LSM6DSO_FIFOMode
- LSM6DSO_FreeFallDetection
- LSM6DSO_Pedometer
- LSM6DSO_SelfTest
- LSM6DSO_SingleDoubleTap
- LSM6DSO_TiltDetectior
- LSM6DSO_WakeUpDete
- STTS751_TemperatureL

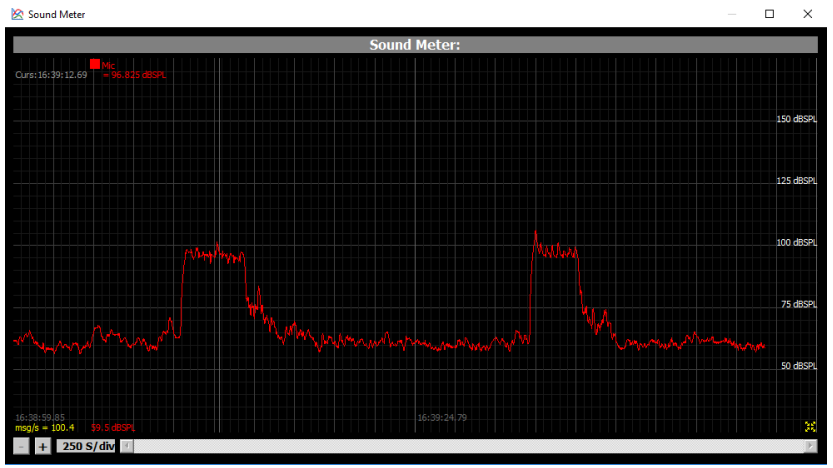






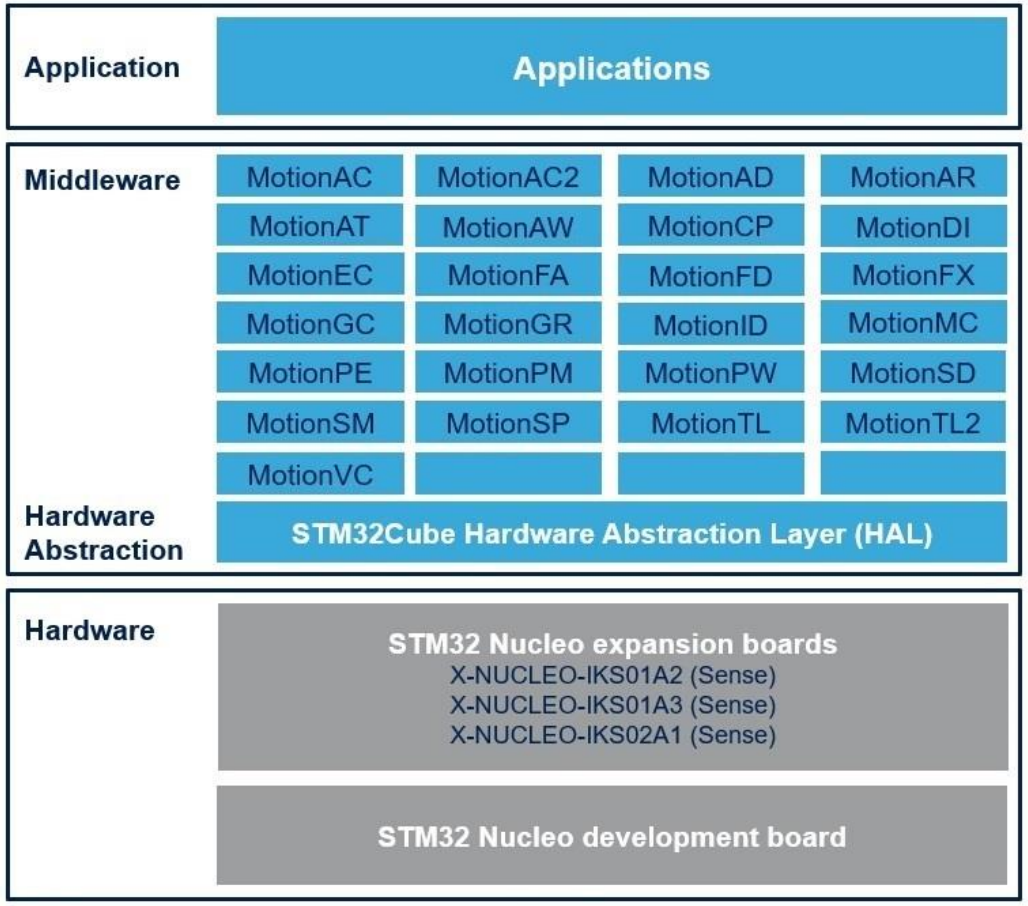






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X-CUBE-MEMS1运动传感器软件算法中间件库





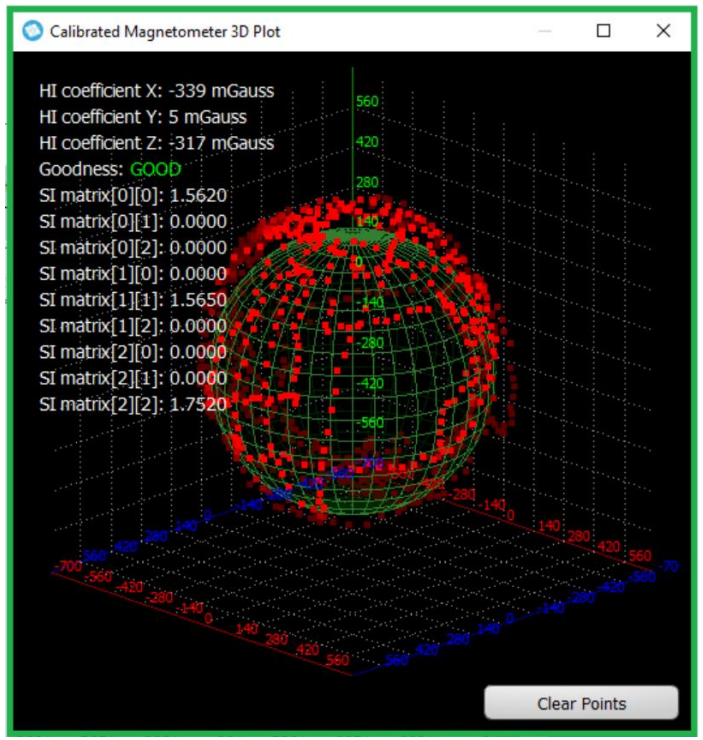
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校准算法库





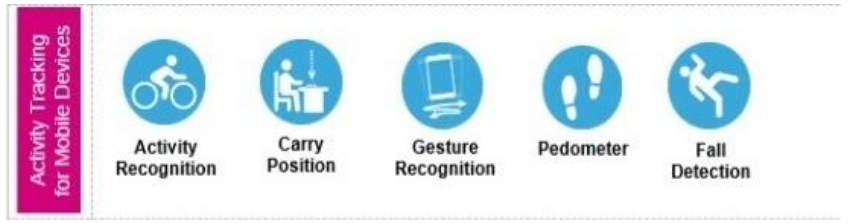


MotionAC/AC2

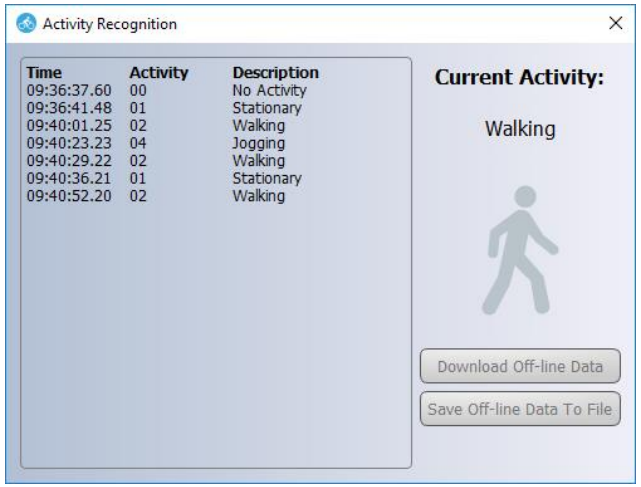
MotionGC

MotionMC

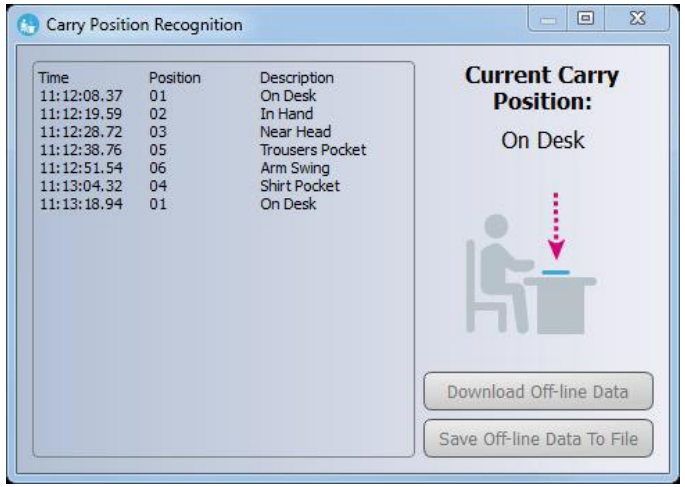
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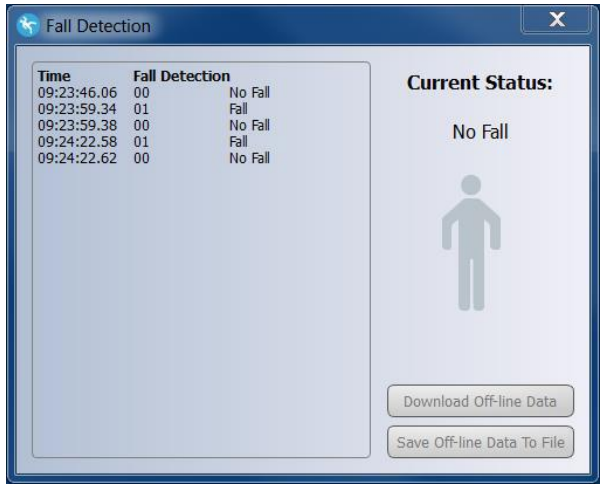
移动设备的活动跟踪



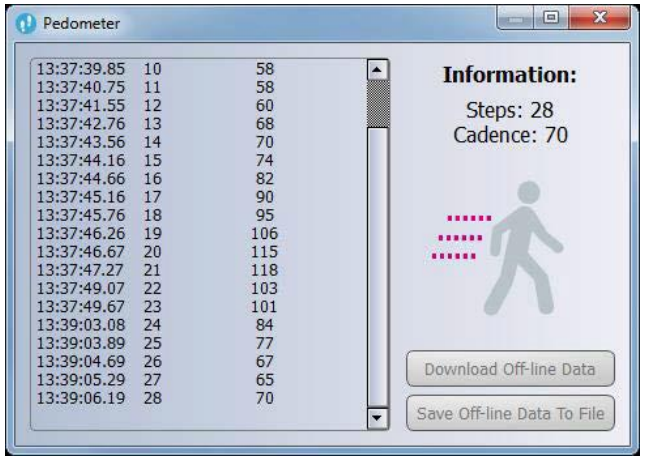
MotionAR



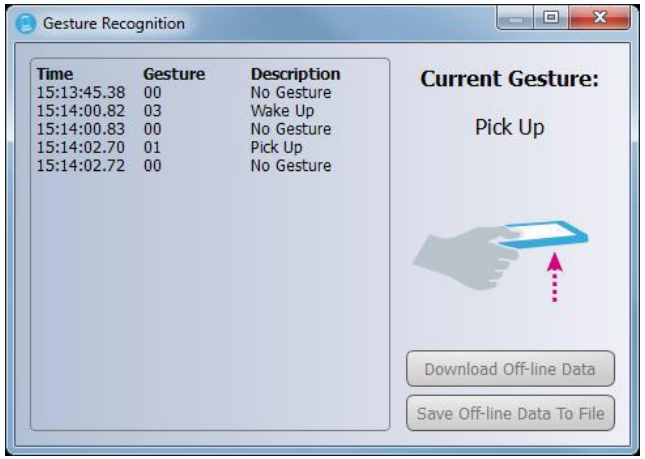
MotionCP



MotionFD



MotionPM

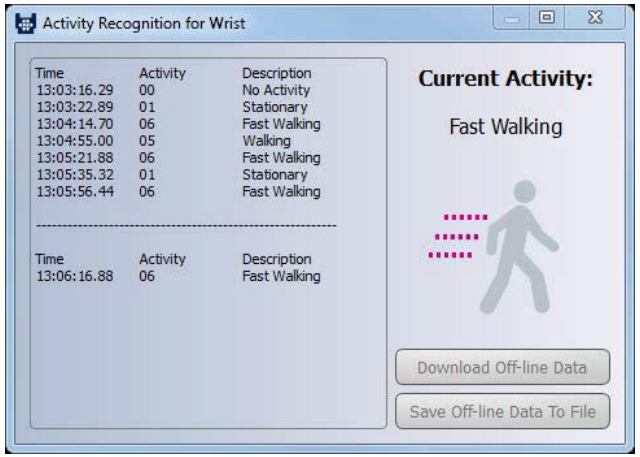


MotionGR

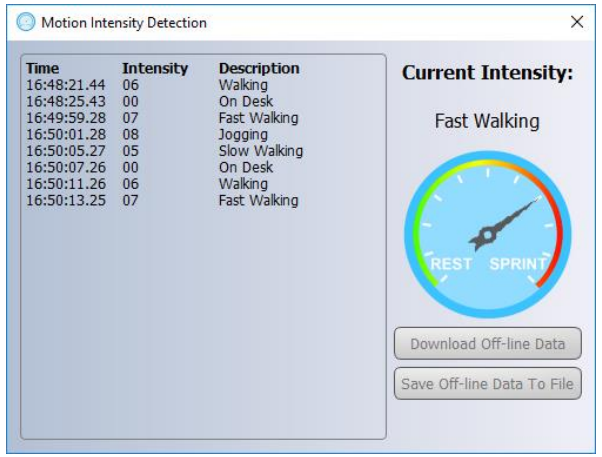
life.augmented



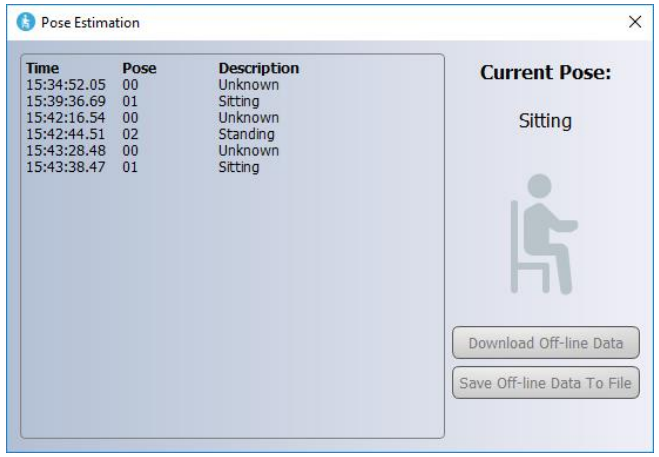
穿戴设备的活动跟踪



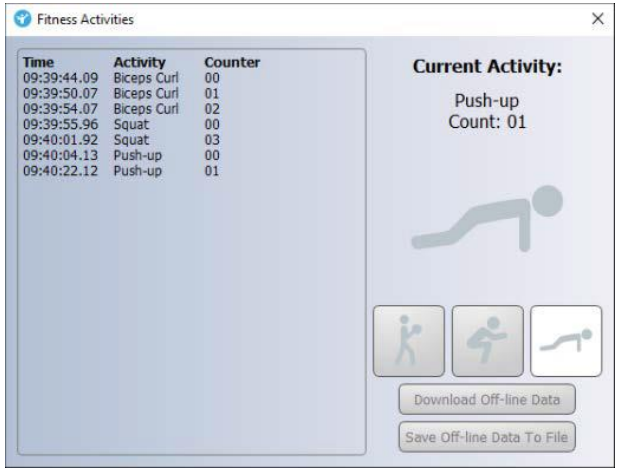
MotionAW



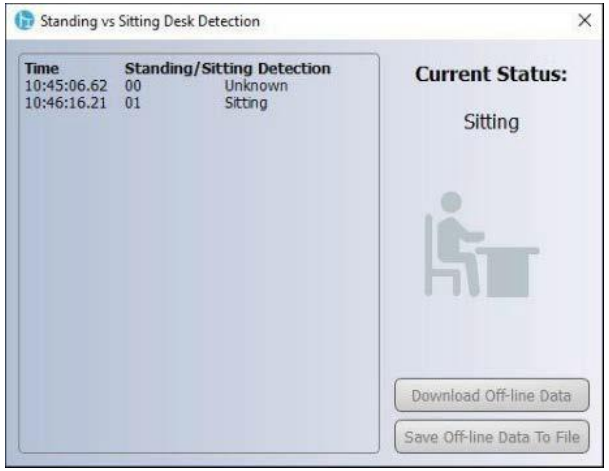
MotionID



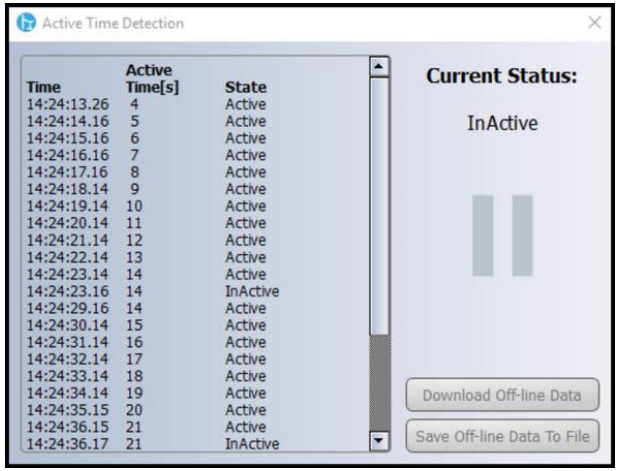
MotionPE



MotionFA

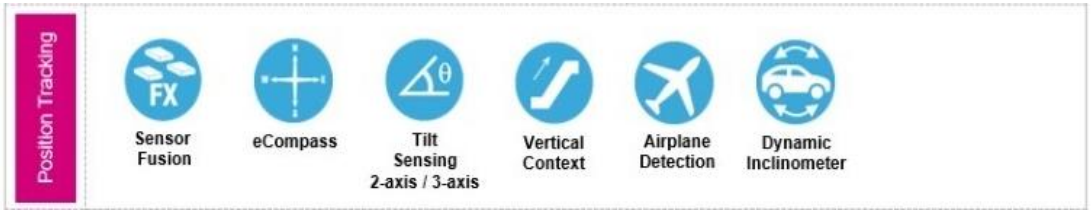


MotionSD

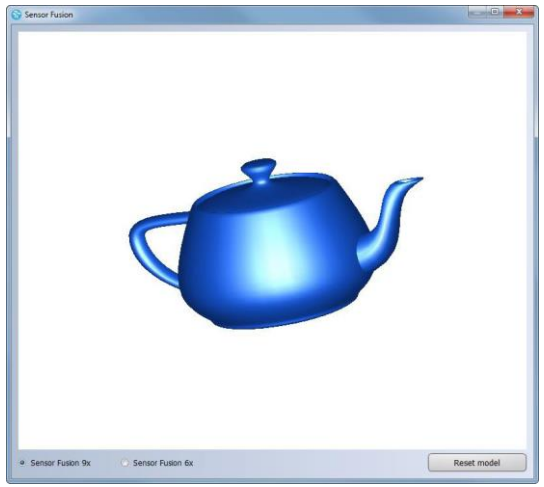


MotionAT

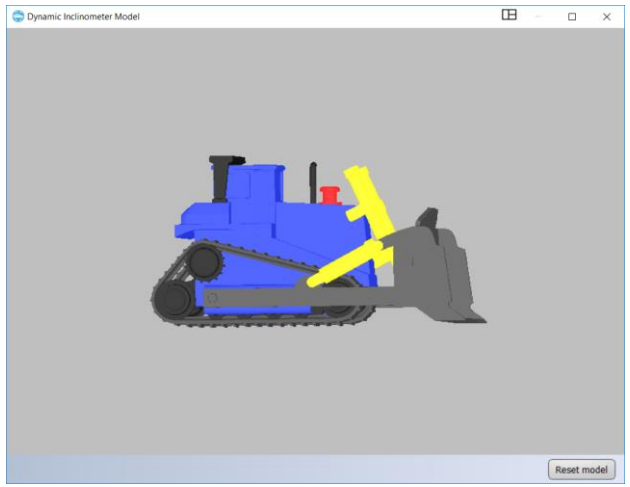
life.augmented



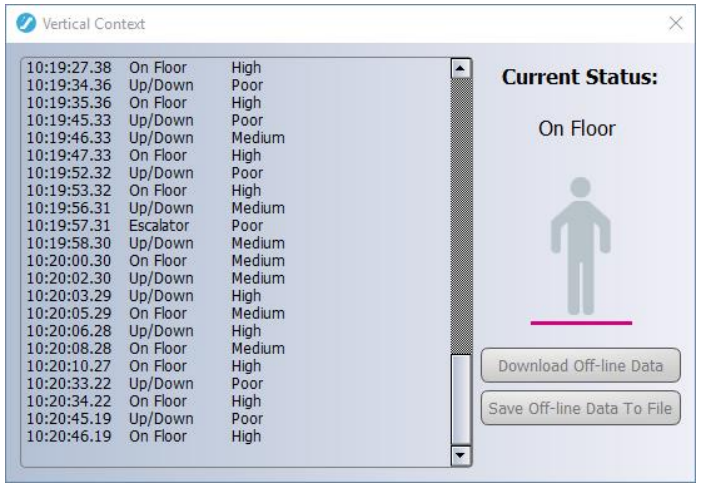
位置跟踪



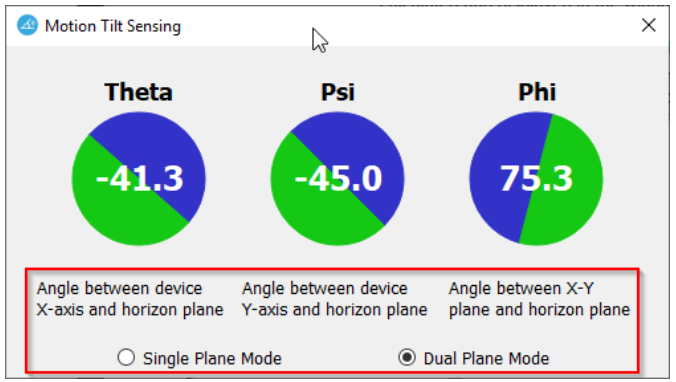
MotionFX



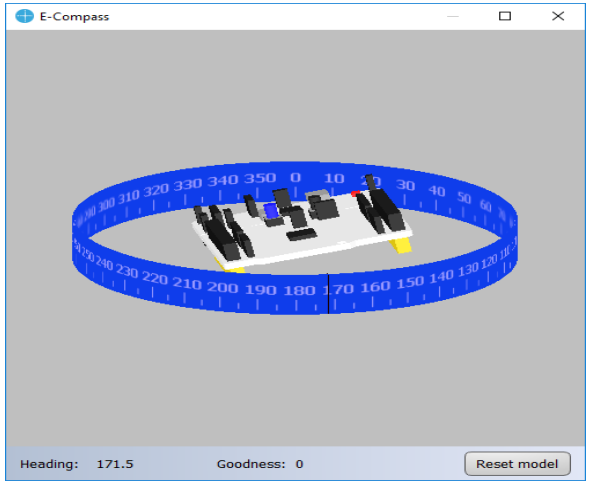
MotionDI



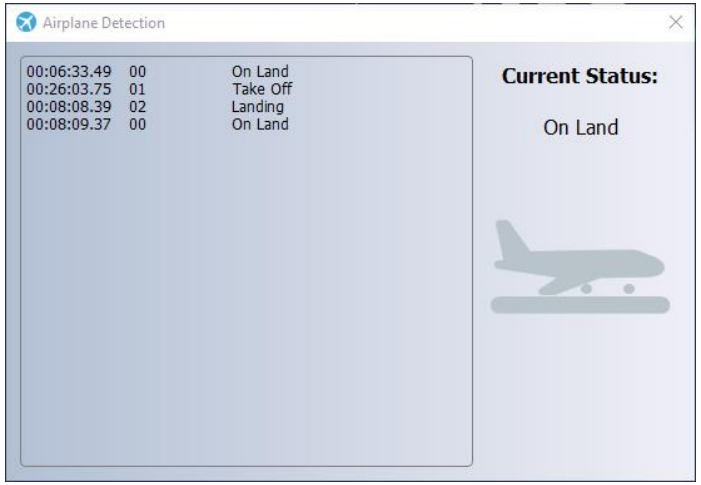
MotionVC



MotionTL



MotionEC



MotionAD

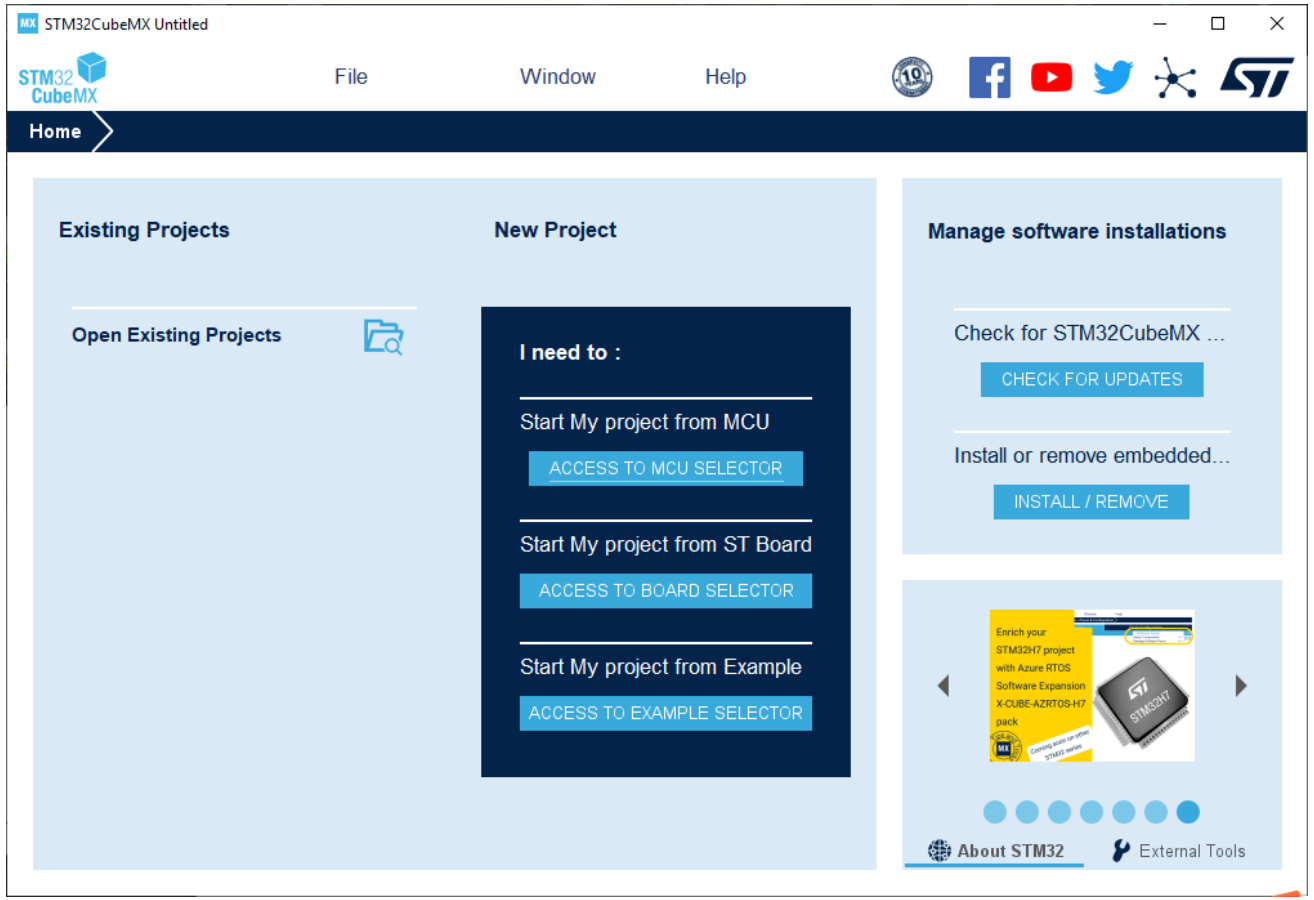
life.augmented

基于STM32CubeMX的开发设计

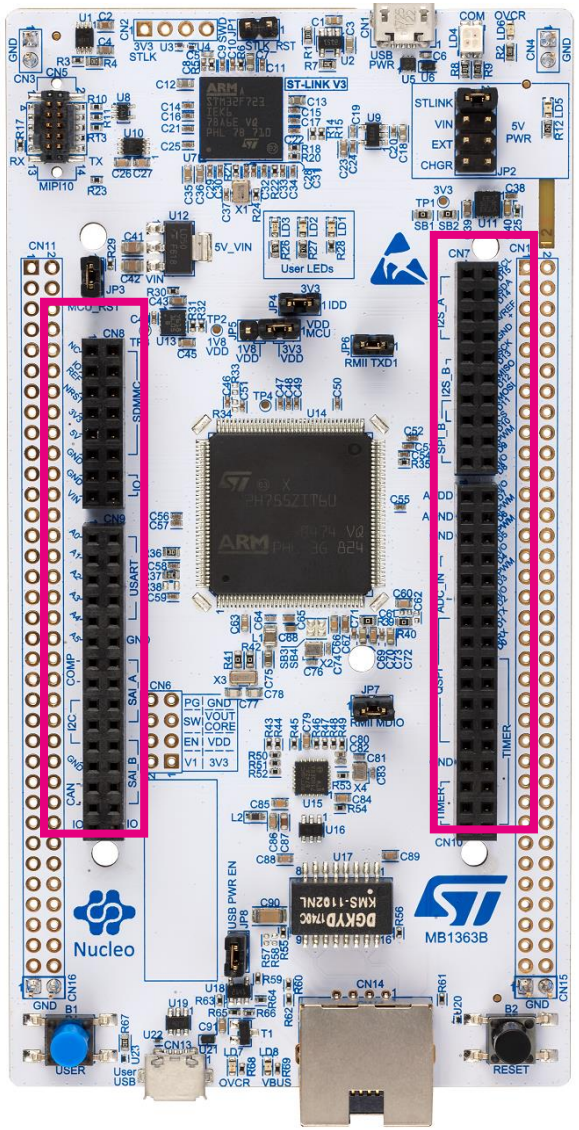
life.augmented

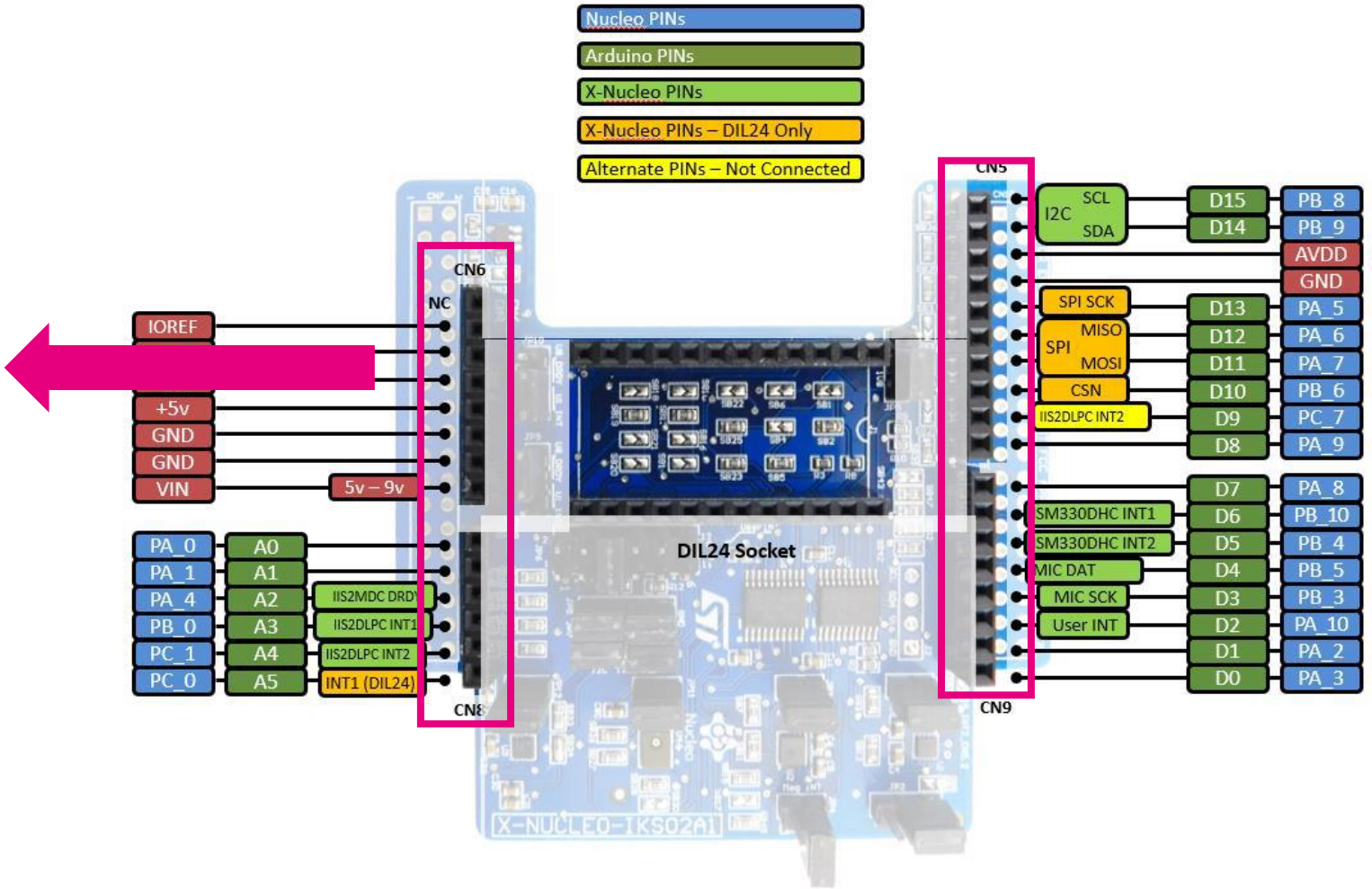
STM32CubeMX: STM32Cube初始化代码生成器

- STM32CubeMX是用于STM32微控制器的代码生成图形工具。它属于STMCube系列，既可作为独立应用，也可作为Eclipse插件集成到集成开发环境（IDE）中。
- 建议使用6.1.0以上版本，下载链接



NUCLEO-L496ZG + X-NUCLEO-IKS01A3



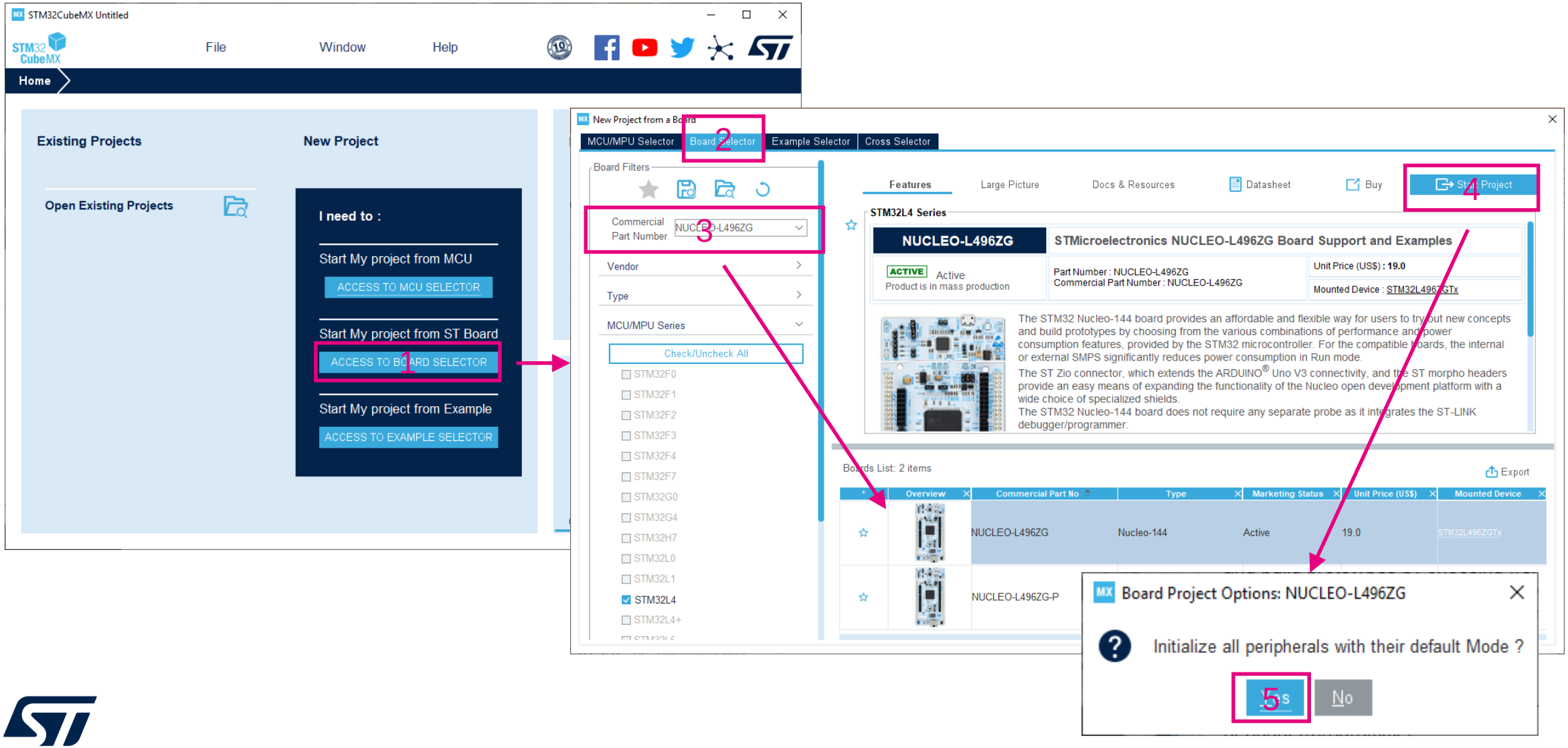


NUCLEO-L496GZ

X-NUCLEO-IKS01A3

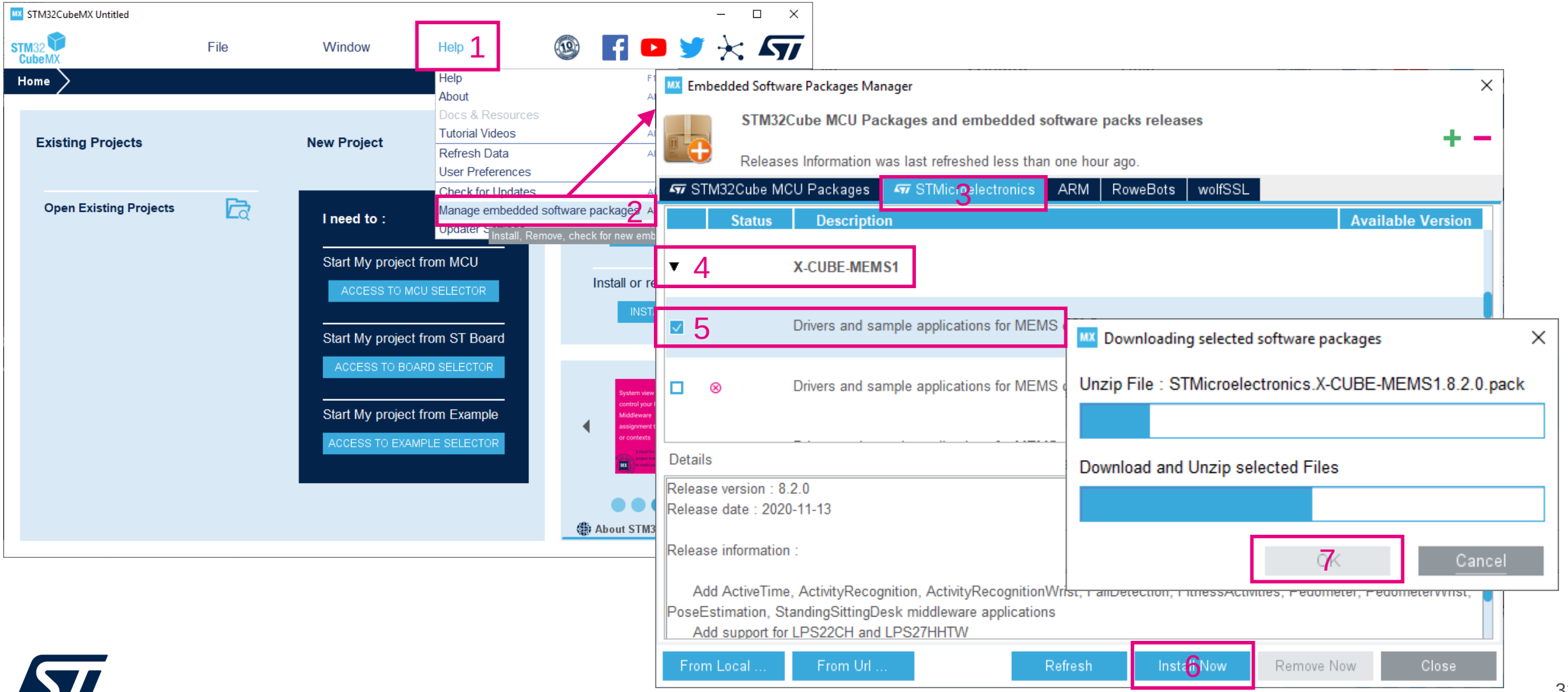
life.augmented

开始新的工程

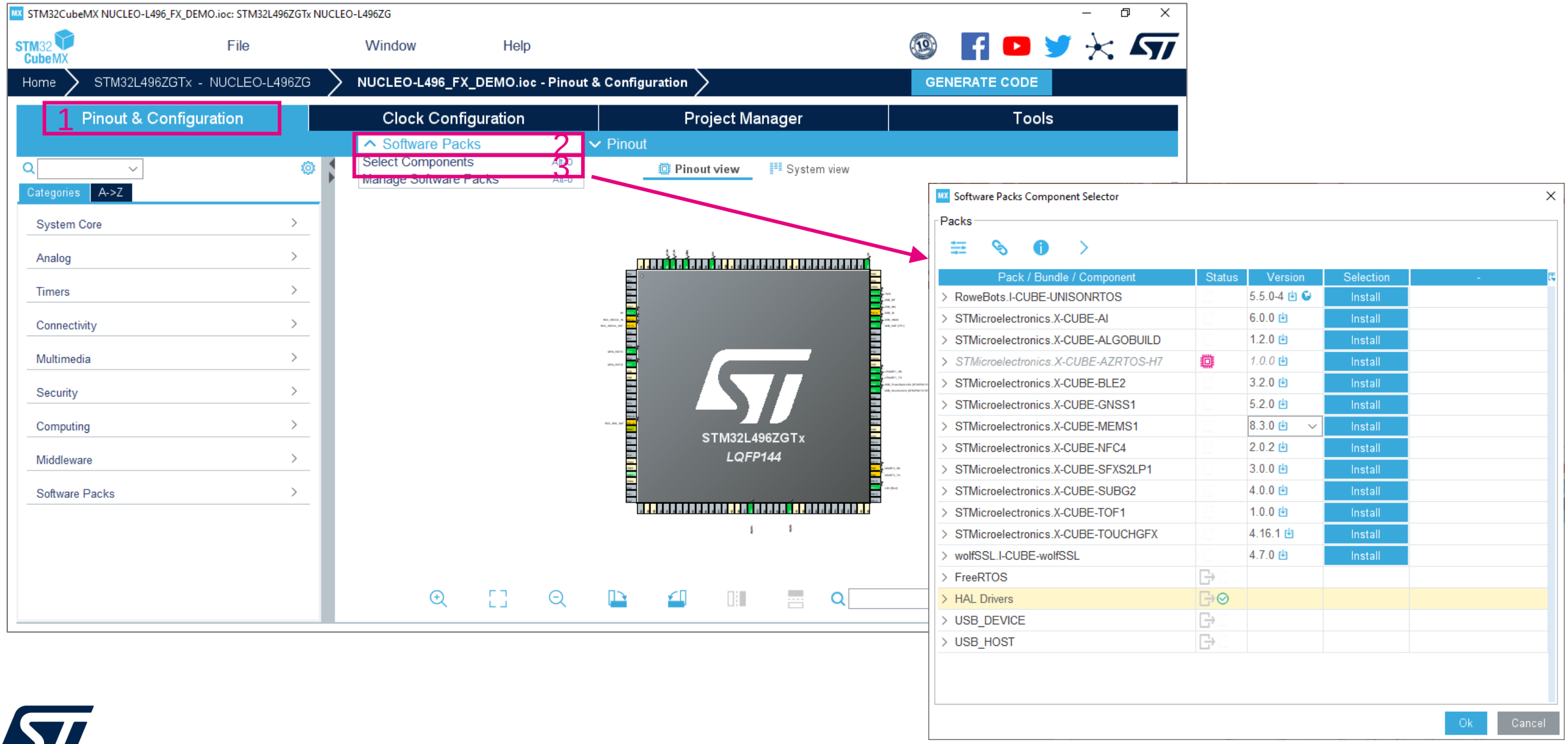


life.augmented

安装X-CUBE-MEMS1软件包



扩展器件选择



life.augmented

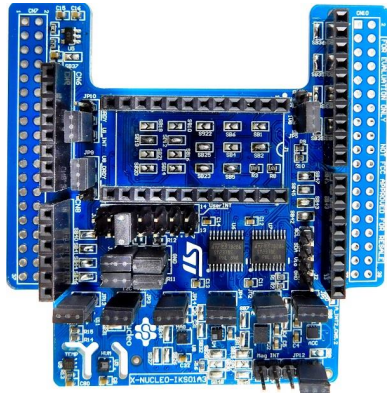
MEMS传感器板选型



MEMS传感器适配板型号

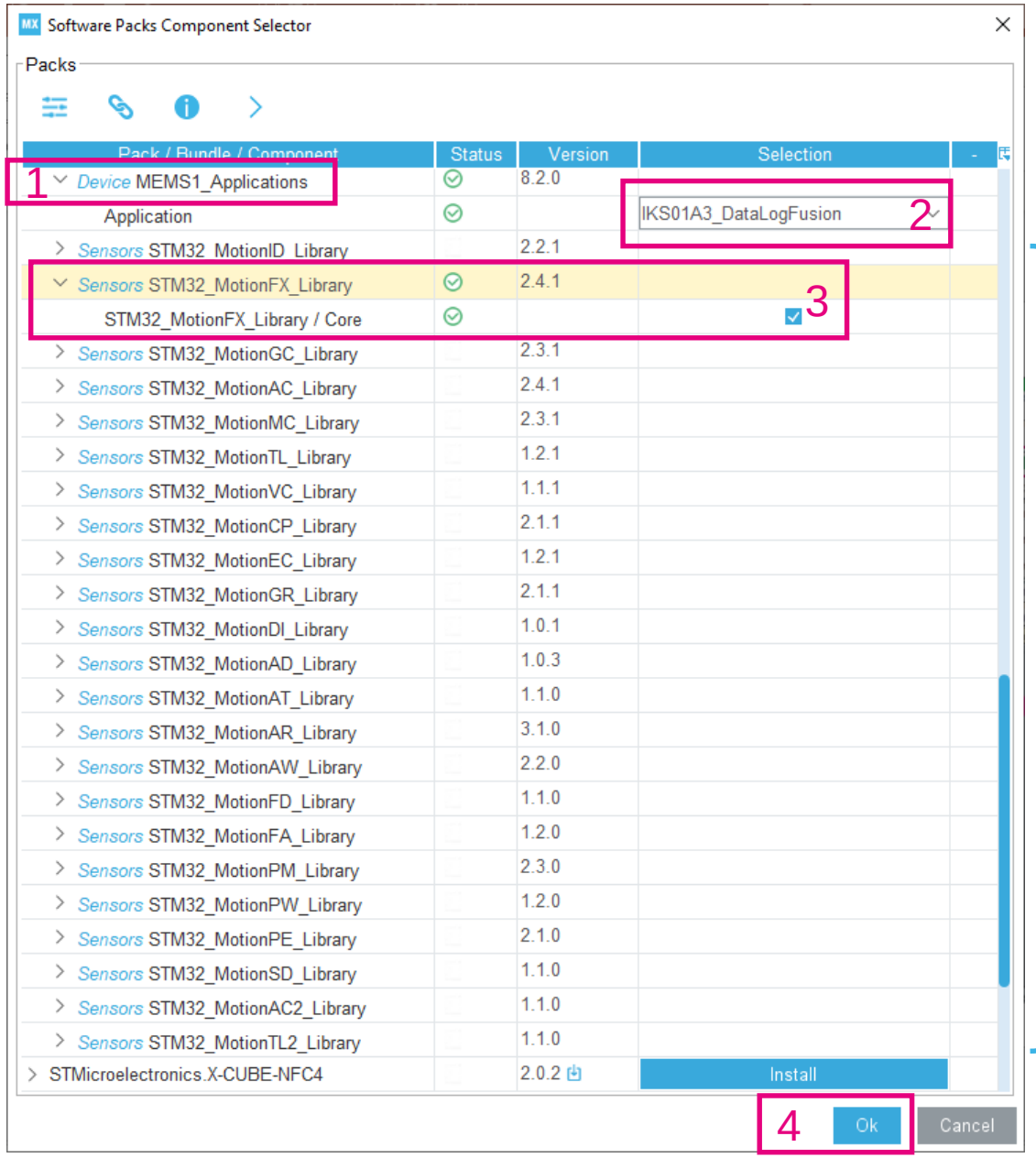


Nucleo MEMS传感器扩展板型号



life.augmented

MEMS运动算法库选择

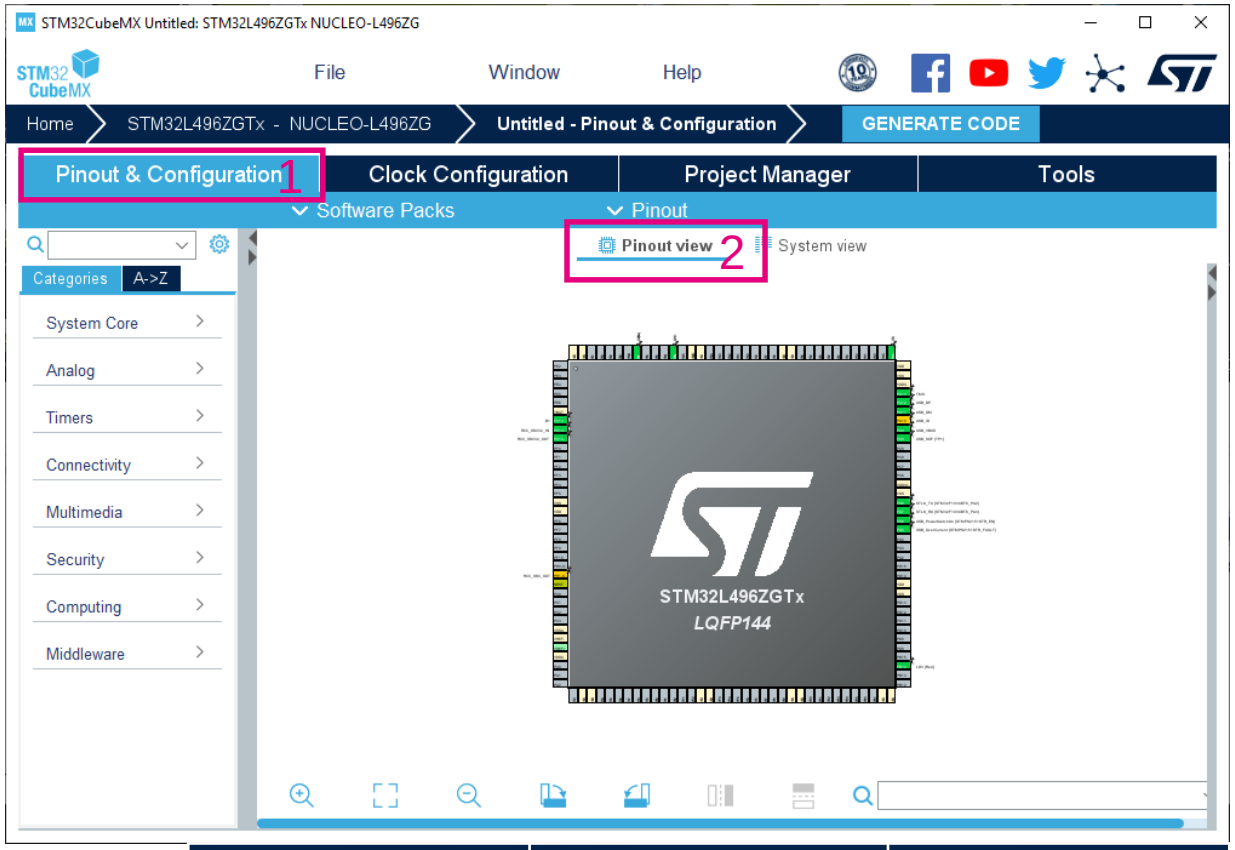


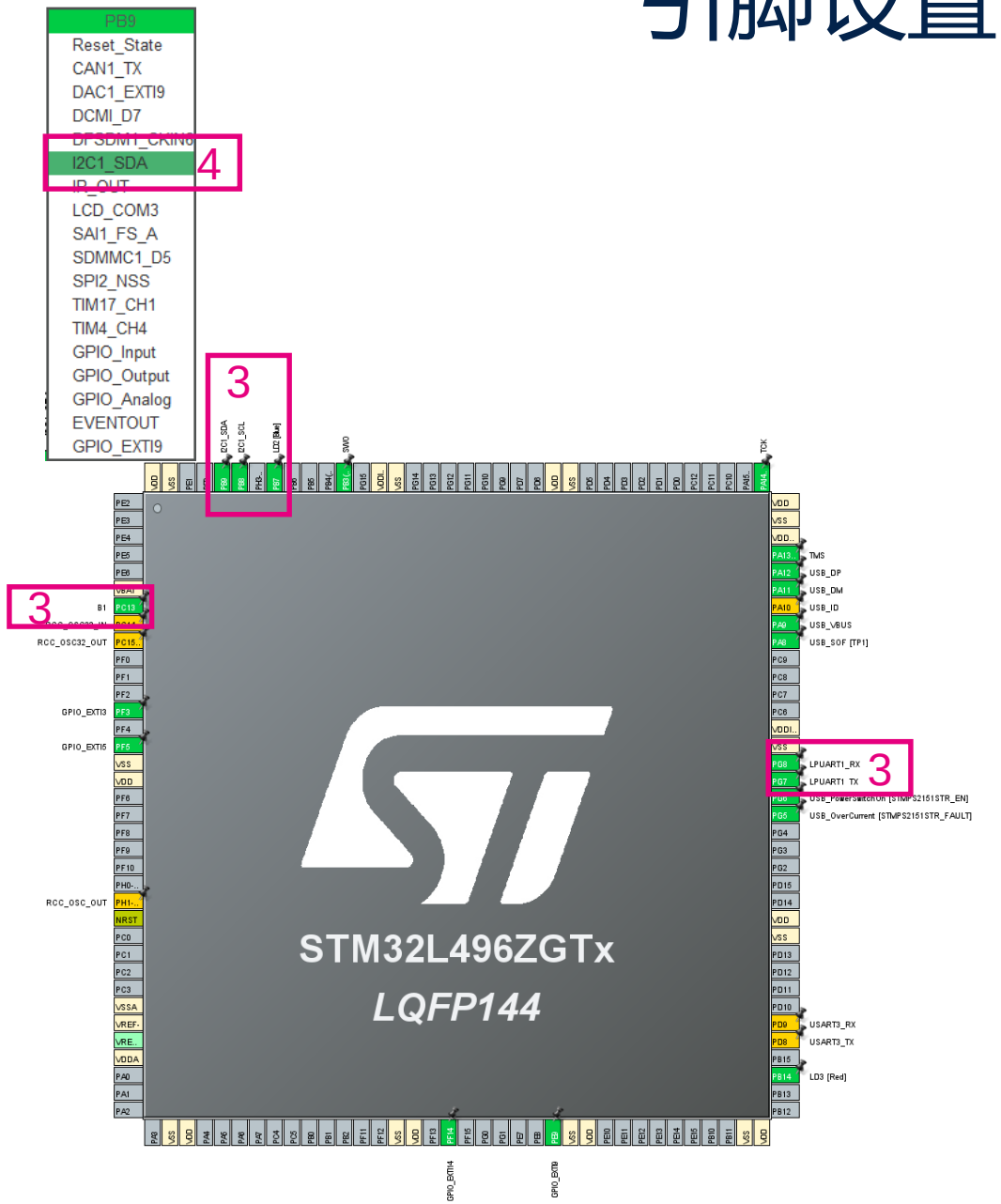
MEMS运动传感器软件算法库



life.augmented

引脚设置

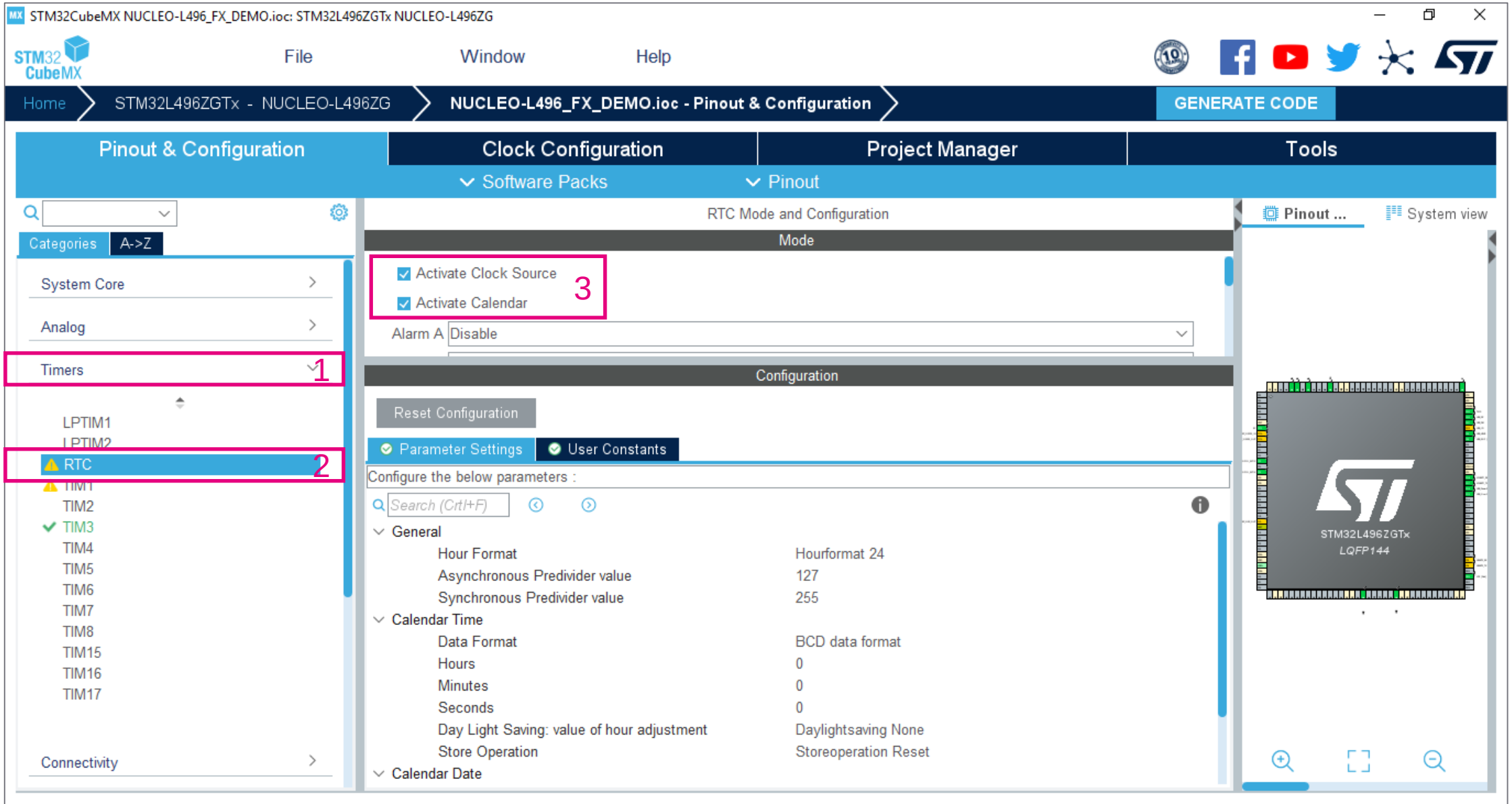




PIN	MODE	LABEL
PC13	GPIO_EXTI13	USER_Btn
PB7	GPIO_Output	LD2 [Blue]
PB8	I2C1_SCL	
PB9	I2C1_SDA	
PG7	LPUART1_TX	STLK_RX
PG8	LPUART1_RX	STLK_TX

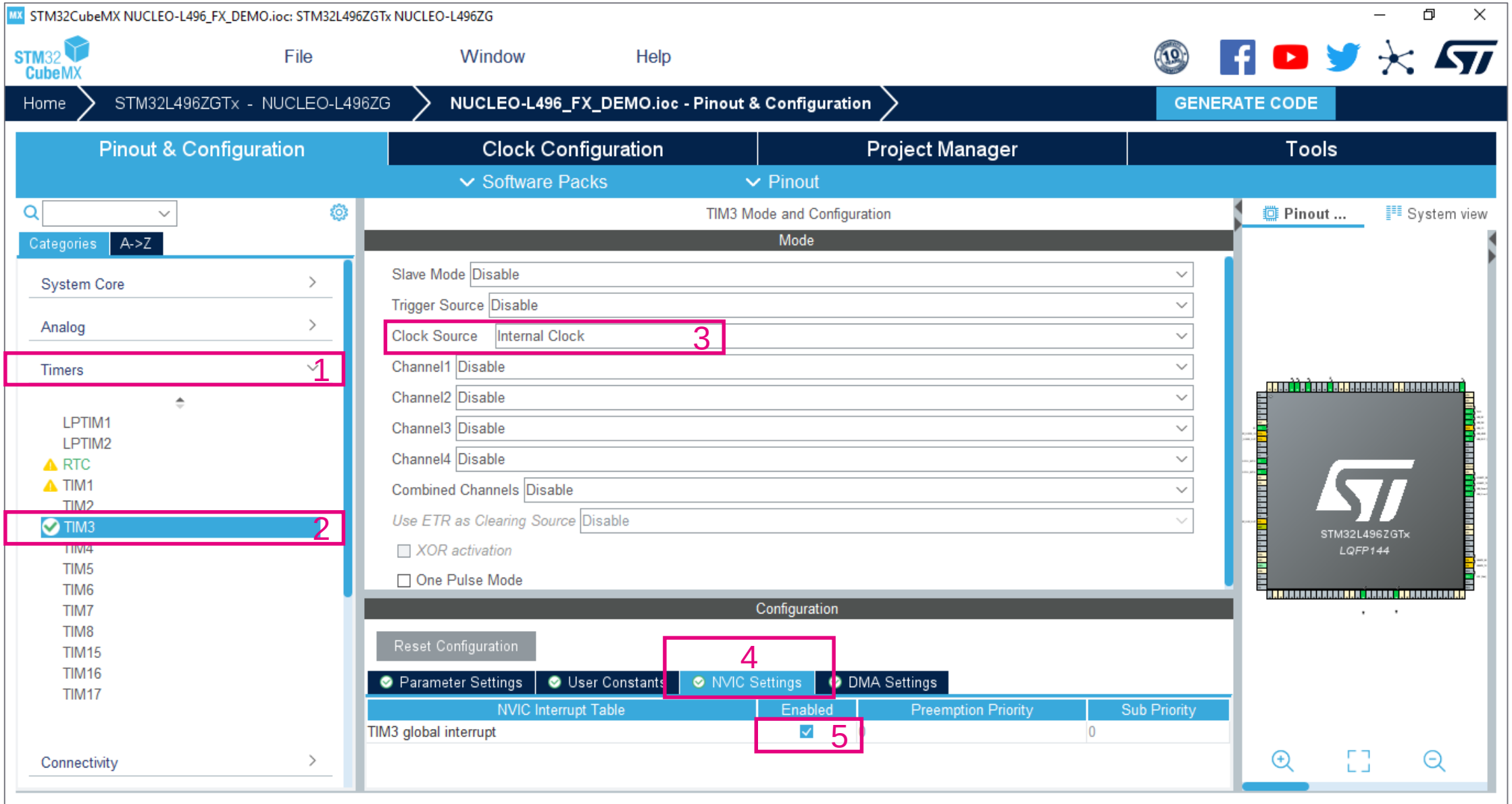
life.augmented

实时时钟



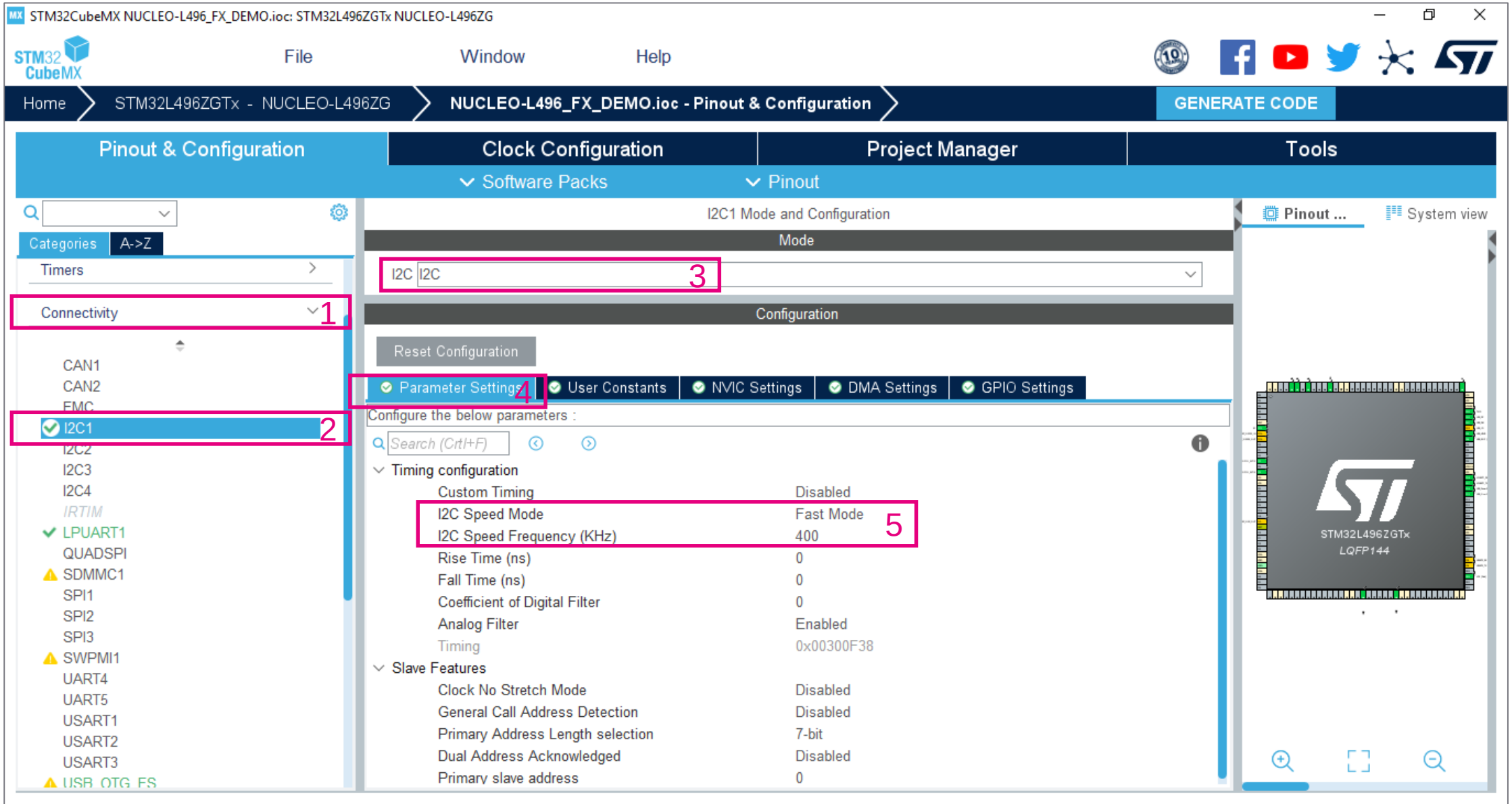
life.augmented

定时器



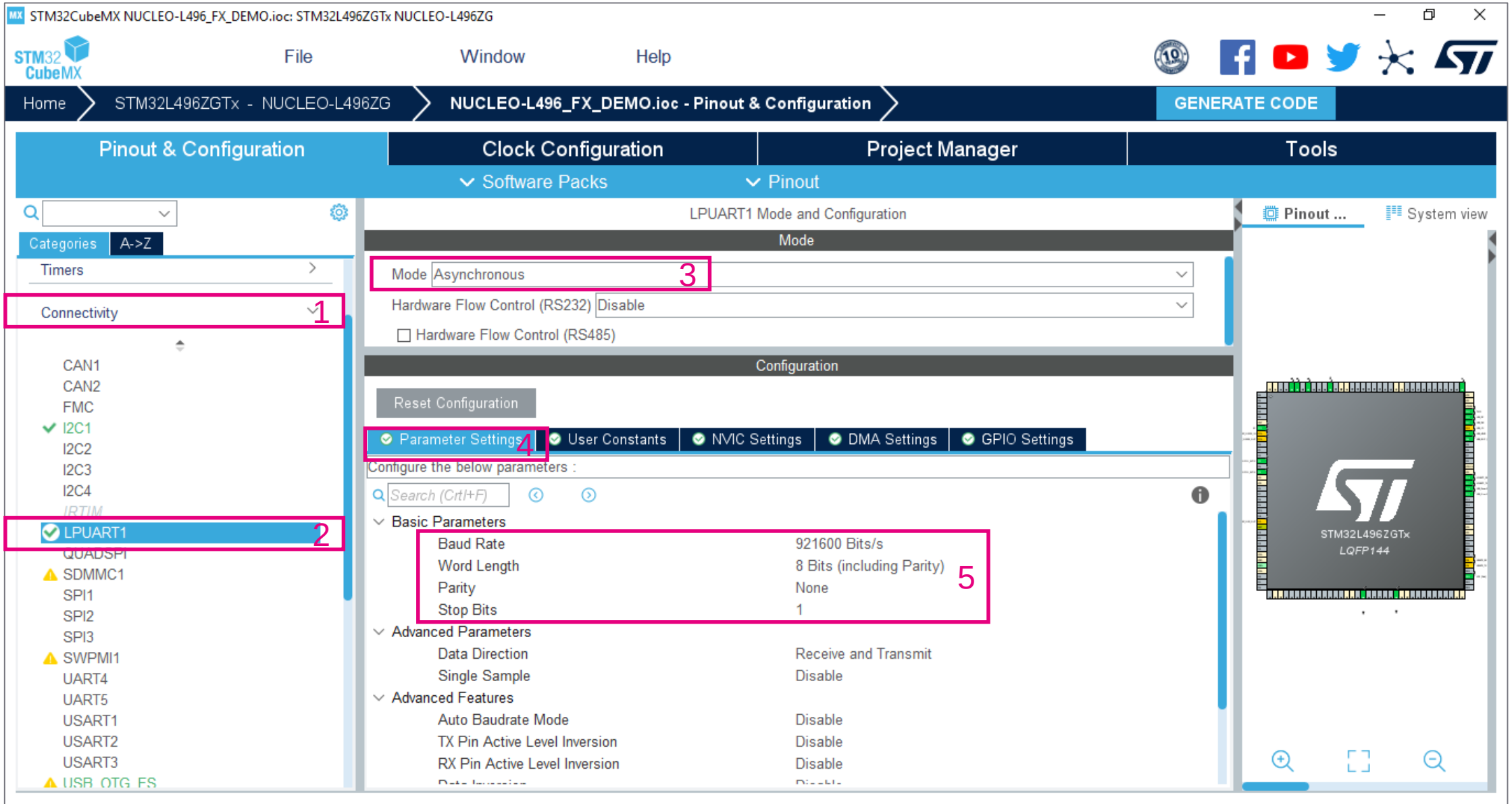
life.augmented

I2C总线



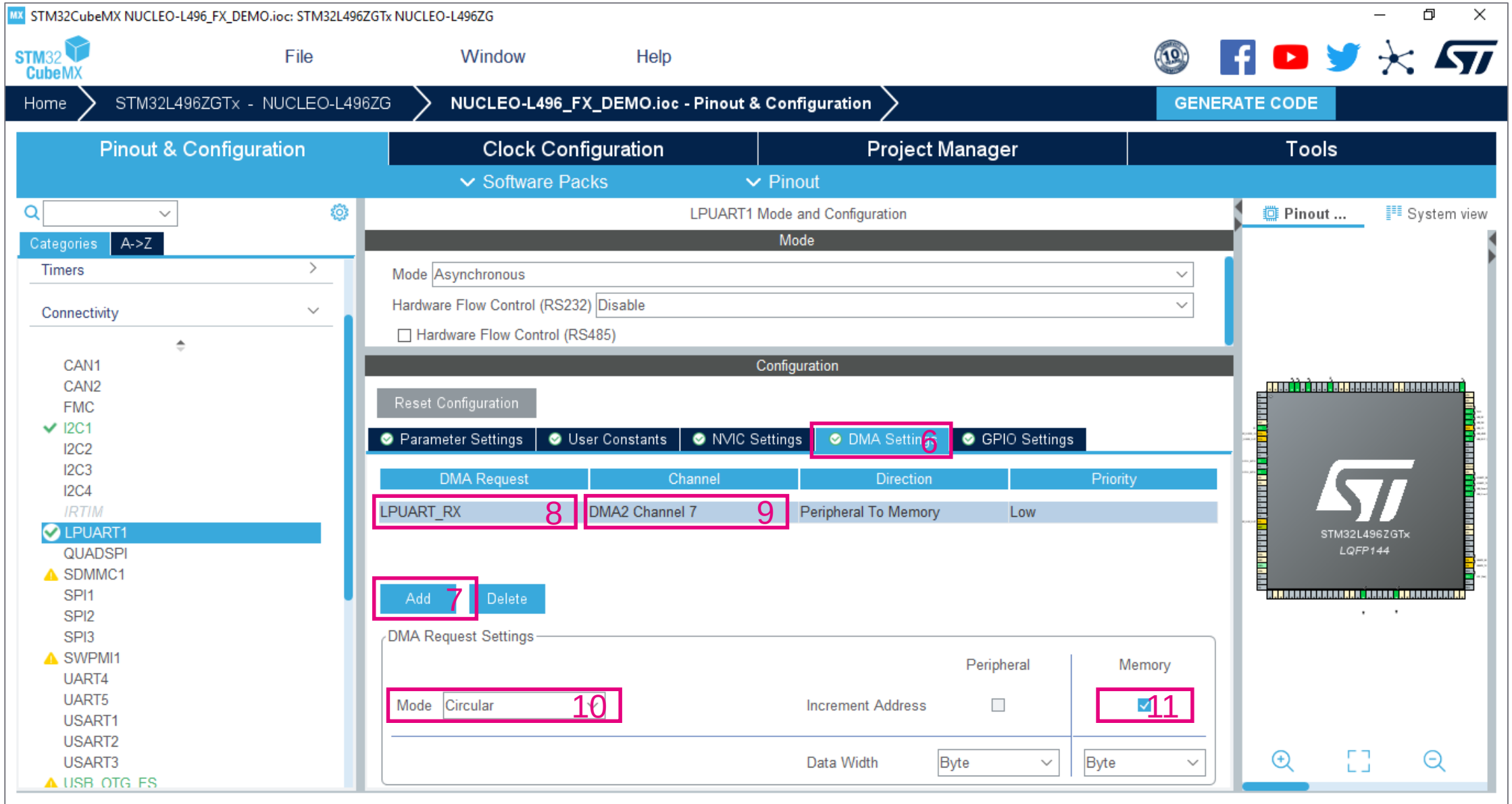
life.augmented

串口（1）



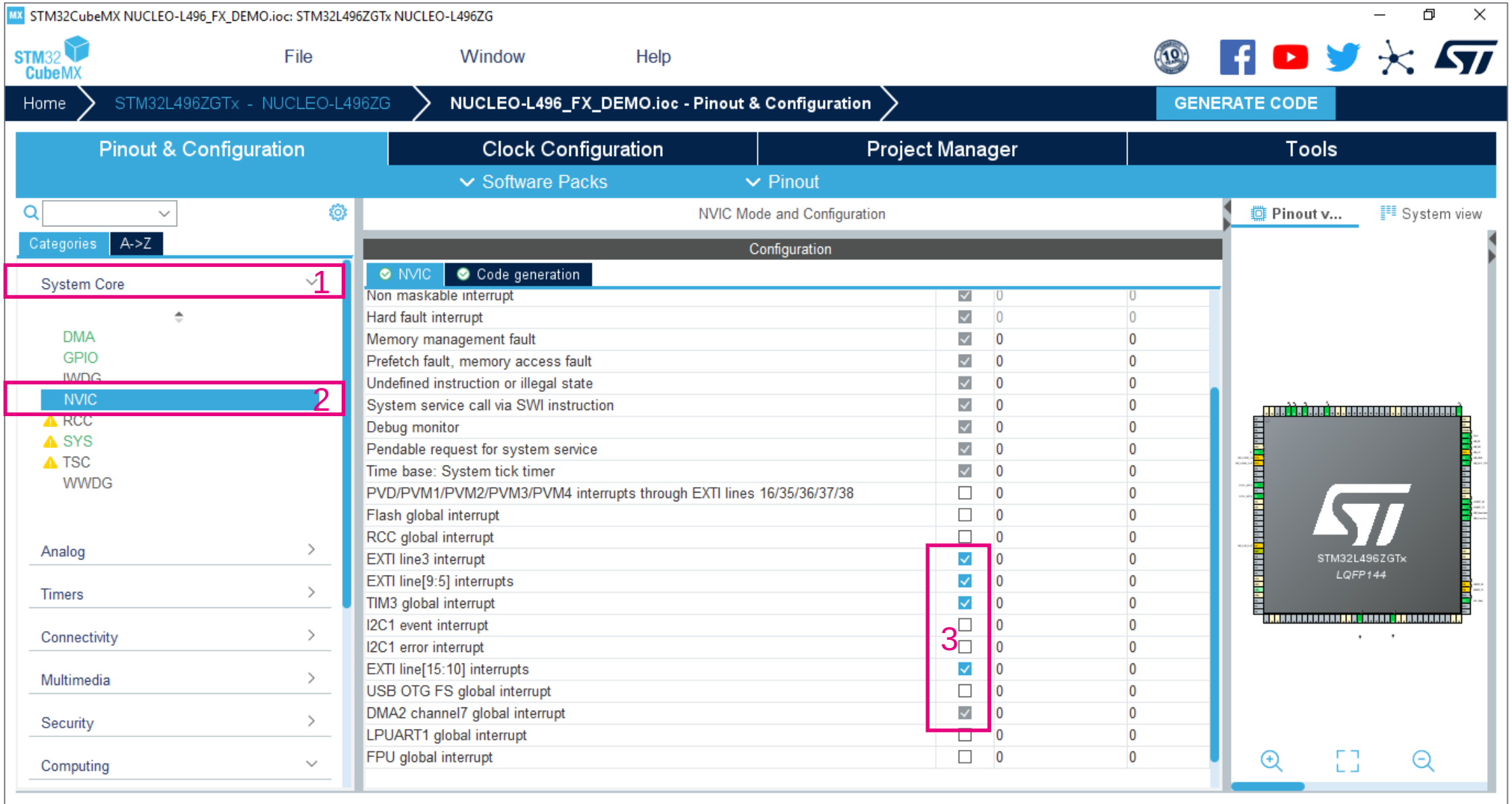
life.augmented

串口（2）



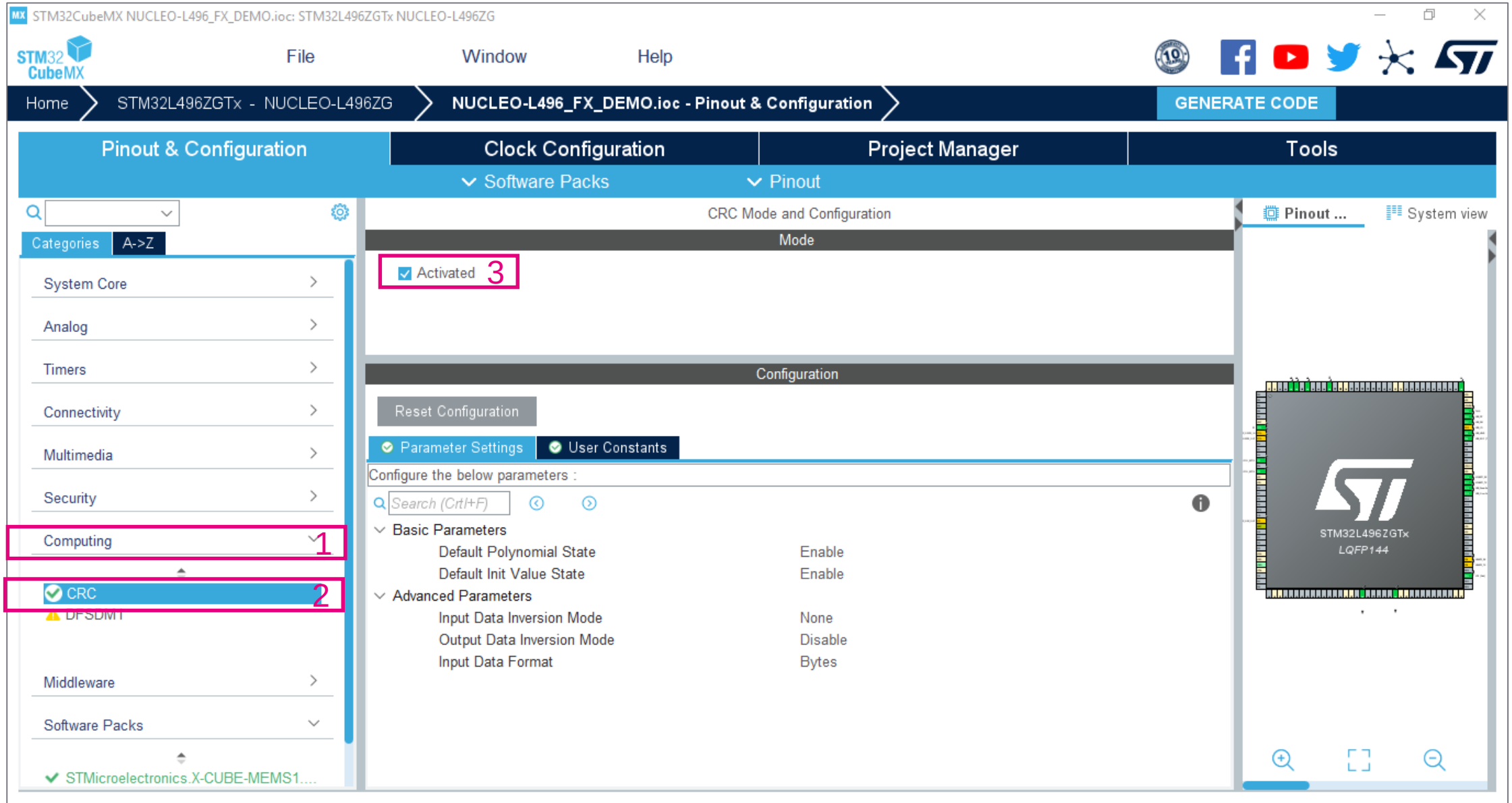
life.augmented

中断配置



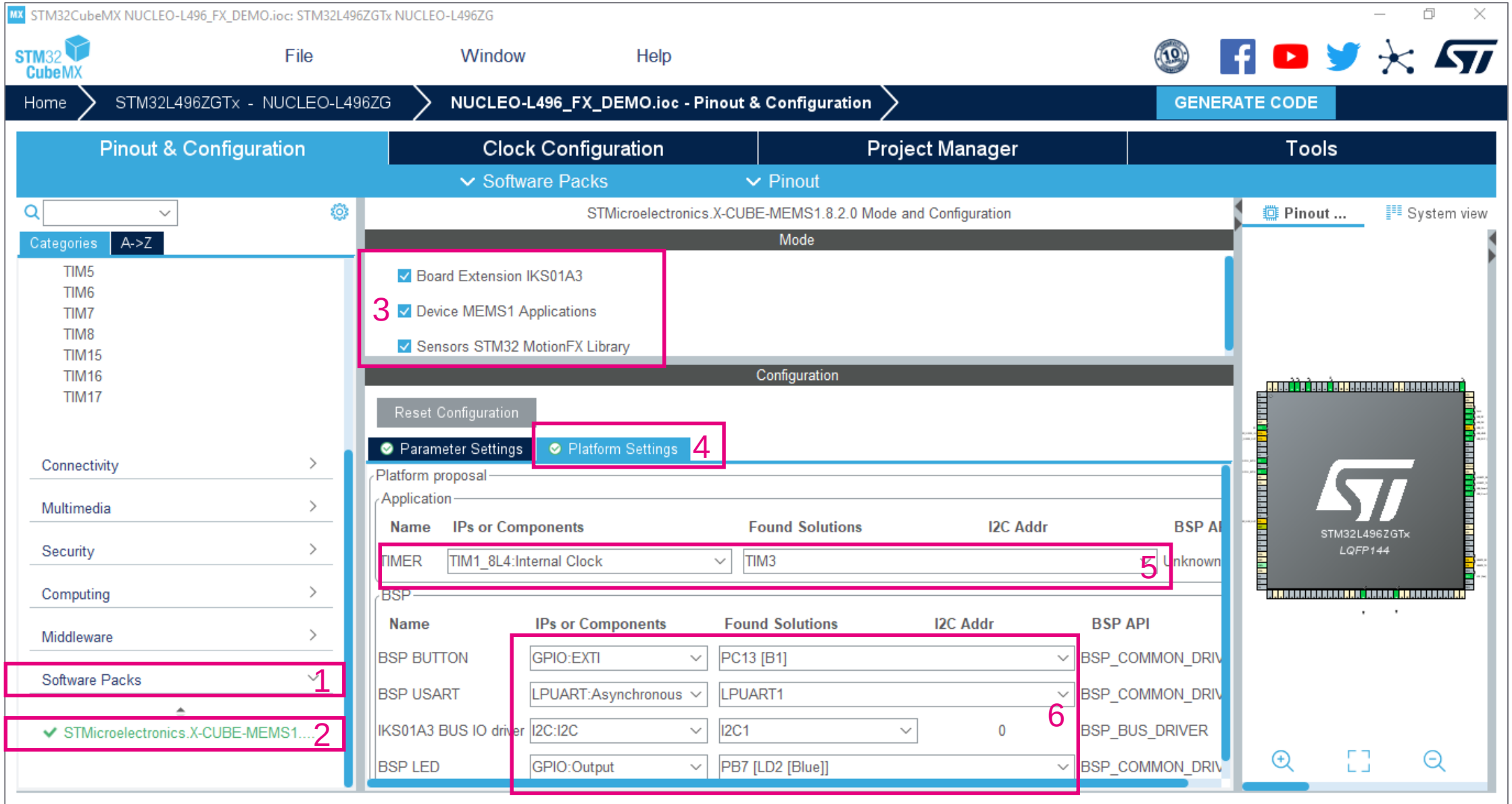
life.augmented

CRC功能



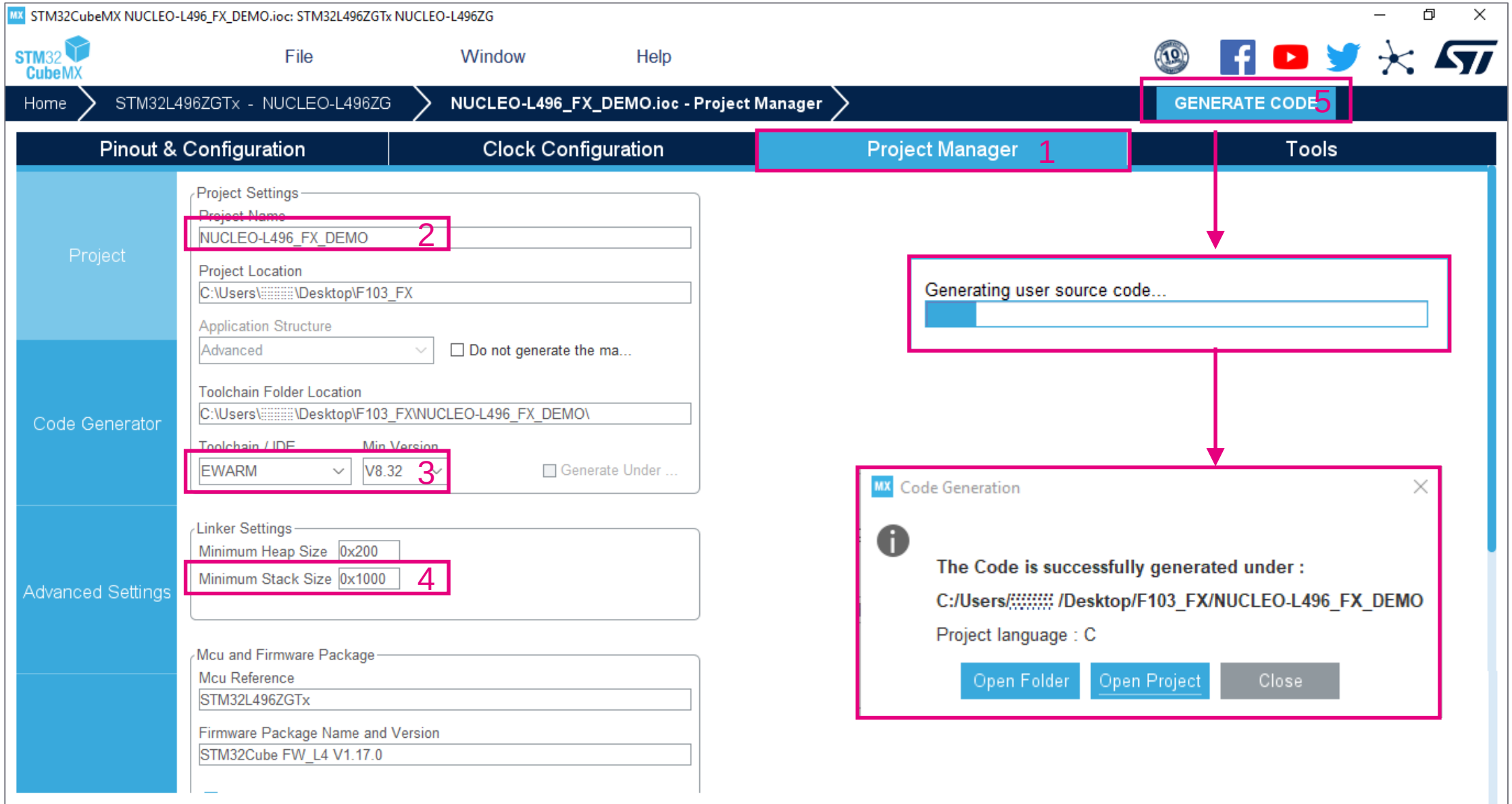
life.augmented

资源配置



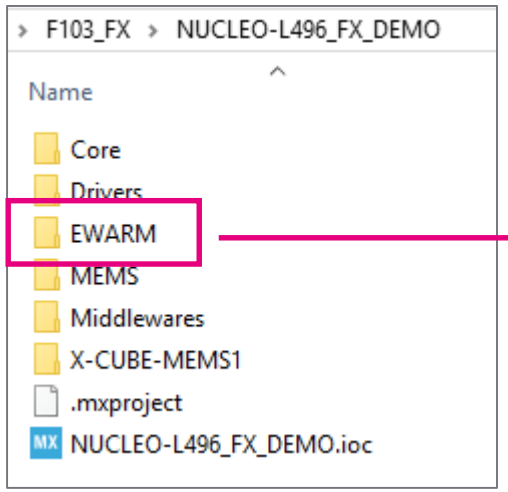
life.augmented

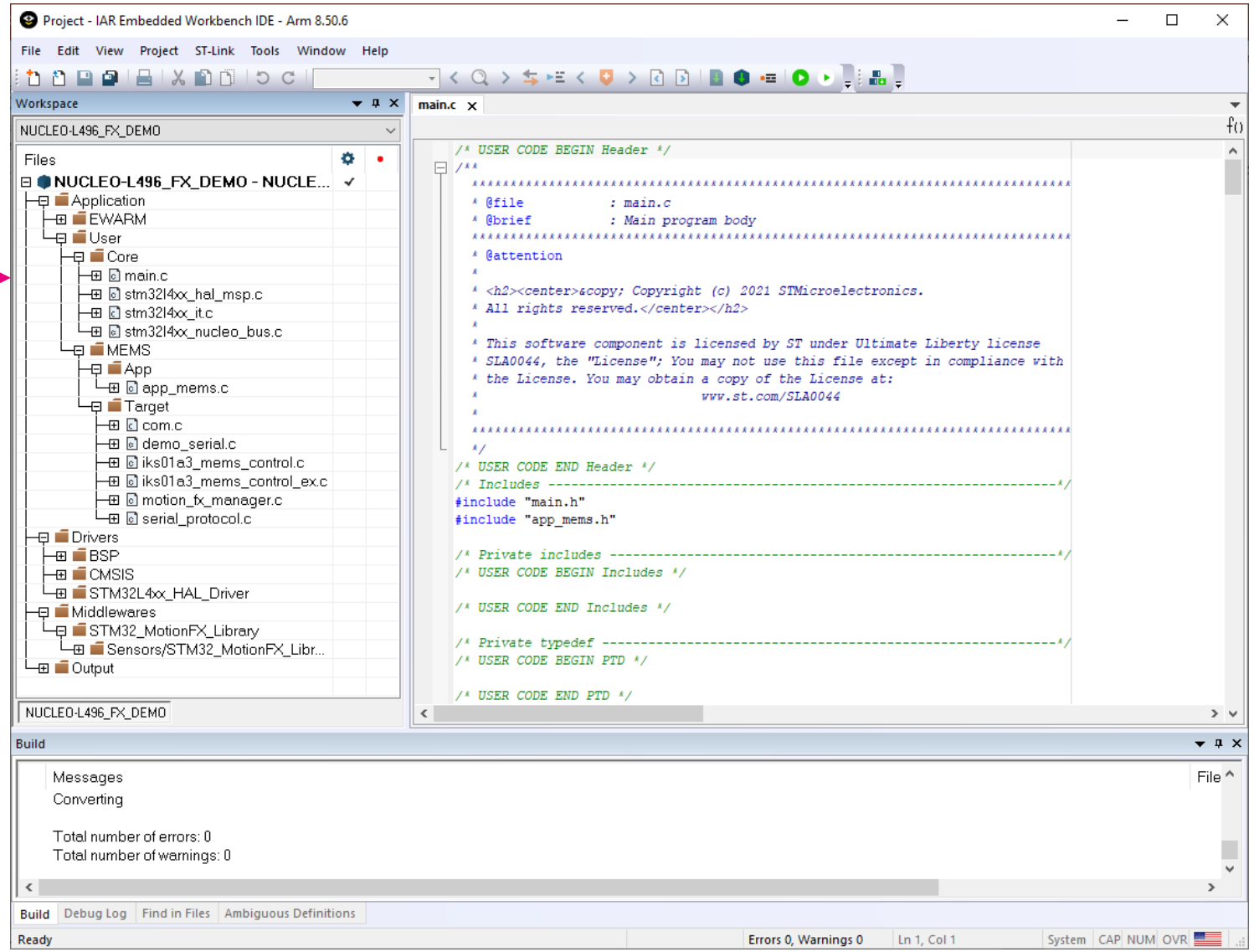
生成工程和代码



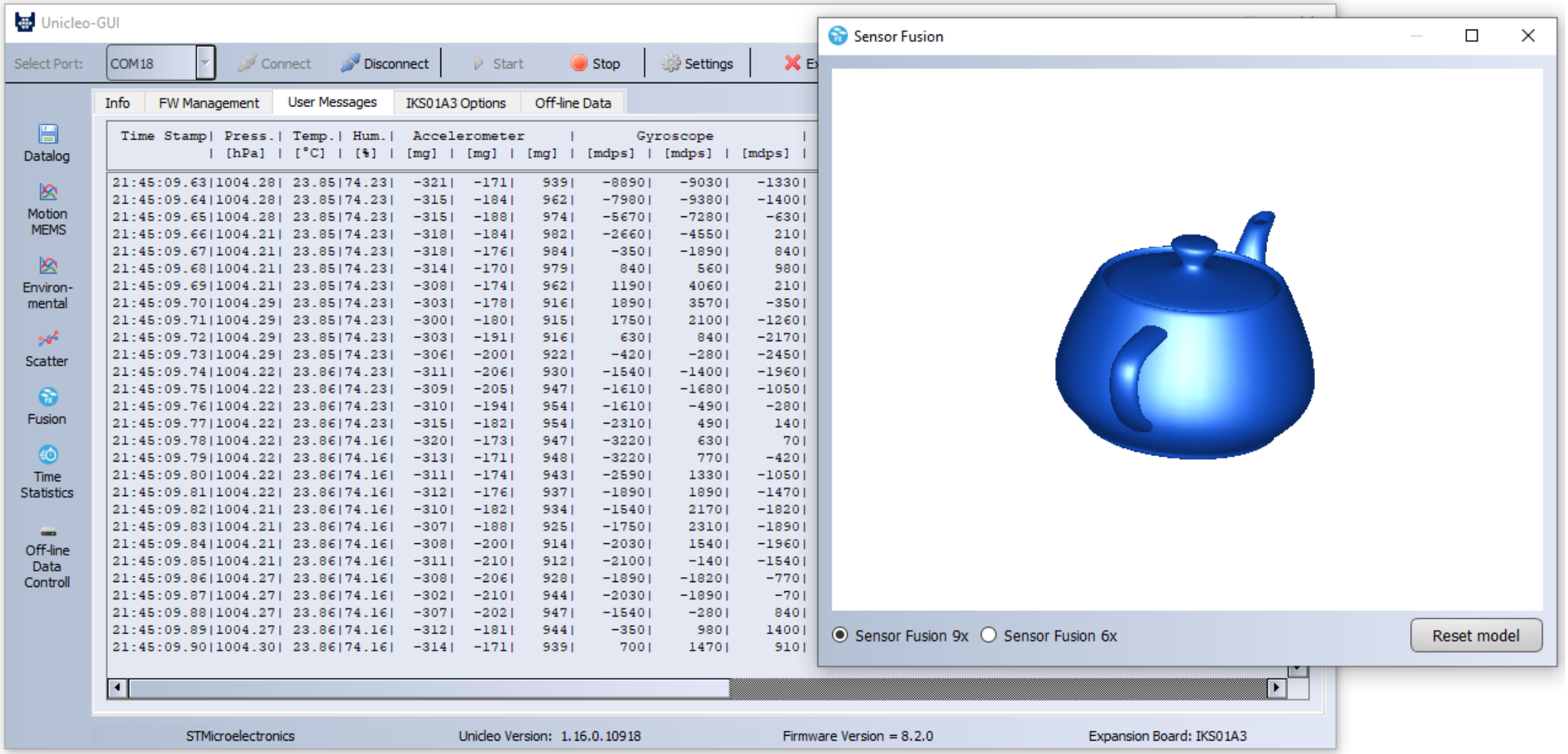
life.augmented

完整工程代码

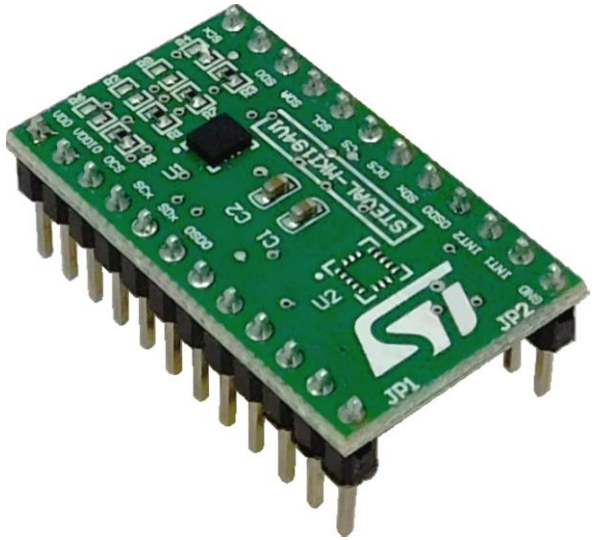

F103_FX › NUCLEO-L496_FX_DEMO
Name
Core
Drivers
EWARM
MEMS
Middlewares
X-CUBE-MEMS1
.mxproject
NUCLEO-L496_FX_DEMO.ioc


Project - IAR Embedded Workbench IDE - Arm 8.50.6
File Edit View Project ST-Link Tools Window Help
Workspace
NUCLEO-L496_FX_DEMO
Files
NUCLEO-L496_FX_DEMO - NUCLE...
Application
EWARM
User
Core
main.c
stm32l4xx_hal_msp.c
stm32l4xx_it.c
stm32l4xx_nucleo_bus.c
MEMS
App
app_mems.c
Target
com.c
demo_serial.c
iks01a3_mems_control.c
iks01a3_mems_control_ex.c
motion_fx_manager.c
serial_protocol.c
Drivers
BSP
CMSIS
STM32L4xx_HAL_Driver
Middlewares
STM32_MotionFX_Library
Sensors/STM32_MotionFX_Libr...
Output
NUCLEO-L496_FX_DEMO
main.c
/* USER CODE BEGIN Header */
/**
* @file : main.c
* @brief : Main program body
* @attention
* <h2> © Copyright (c) 2021 STMicroelectronics.
* All rights reserved. </h2>
* This software component is licensed by ST under Ultimate Liberty license
* SLA0044, the "License"; You may not use this file except in compliance with
* the License. You may obtain a copy of the License at:
* www.st.com/SLA0044
*/
/* USER CODE END Header */
/* Includes */
#include "main.h"
#include "app_mems.h"
/* Private includes */
/* USER CODE BEGIN Includes */
/* USER CODE END Includes */
/* Private typedef */
/* USER CODE BEGIN PTD */
/* USER CODE END PTD */
Build
Messages
Converting
Total number of errors: 0
Total number of warnings: 0
File
Build Debug Log Find in Files Ambiguous Definitions
Ready
Errors 0, Warnings 0
Ln 1, Col 1
System
CAP NUM OVR

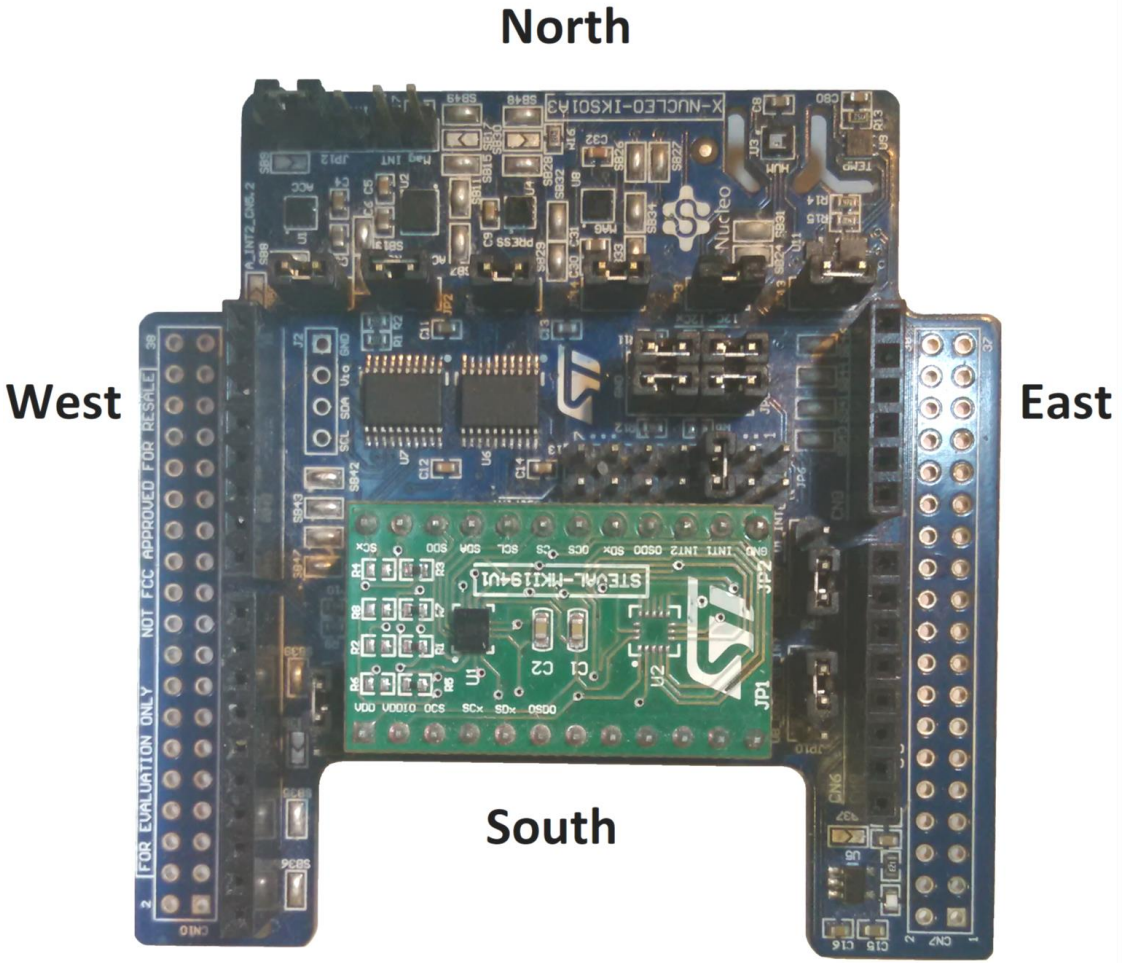
Unicleo-GUI显示



连接DIL24插座上的传感器







- AN5353（链接）

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