# *1. Description*

## 1.1. Project

| | |
|---|---|
| Project Name | F4_Sensus191 |
| Board Name | F4_BSP |
| Generated with: | STM32CubeMX 6.14.1 |
| Date | 05/24/2025 |

## 1.2. MCU

| | |
|---|---|
| MCU Series | STM32F4 |
| MCU Line | STM32F405/415 |
| MCU name | STM32F405RGTx |
| MCU Package | LQFP64 |
| MCU Pin number | 64 |

## 1.3. Core(s) information

| | |
|---|---|
| Core(s) | Arm Cortex-M4 |

# 2. Pinout Configuration
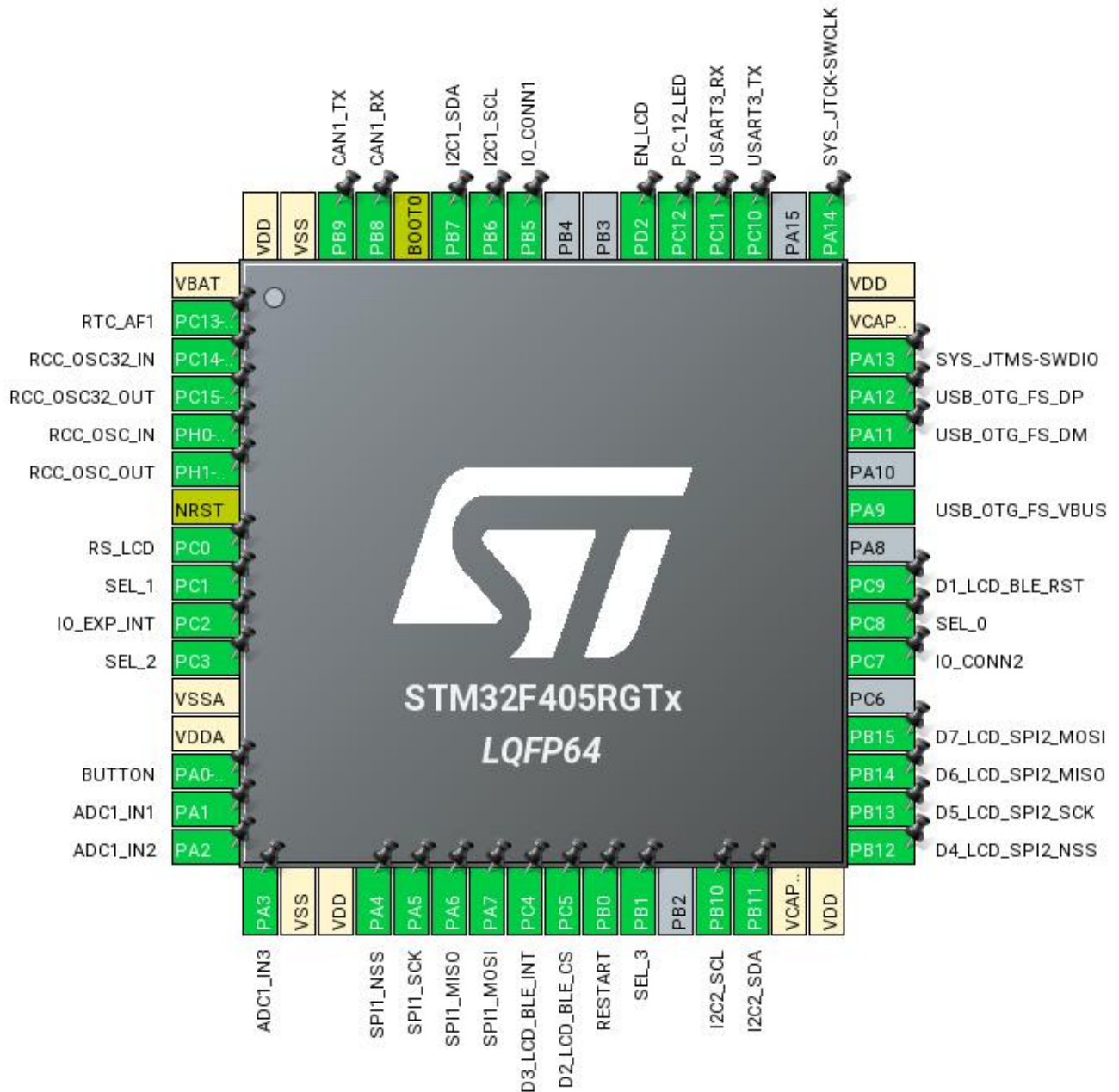
# 3. Pins Configuration

| Pin Number LQFP64 | Pin Name (function after reset) | Pin Type | Alternate Function(s) | Label |
|---|---|---|---|---|
| 1 | VBAT | Power | | |
| 2 | PC13-ANTI_TAMP | I/O | RTC_AF1 | RTC_AF1 |
| 3 | PC14-OSC32_IN | I/O | RCC_OSC32_IN | |
| 4 | PC15-OSC32_OUT | I/O | RCC_OSC32_OUT | |
| 5 | PH0-OSC_IN | I/O | RCC_OSC_IN | |
| 6 | PH1-OSC_OUT | I/O | RCC_OSC_OUT | |
| 7 | NRST | Reset | | |
| 8 | PC0 * | I/O | GPIO_Output | RS_LCD |
| 9 | PC1 * | I/O | GPIO_Output | SEL_1 |
| 10 | PC2 | I/O | GPIO_EXTI2 | IO_EXP_INT |
| 11 | PC3 * | I/O | GPIO_Output | SEL_2 |
| 12 | VSSA | Power | | |
| 13 | VDDA | Power | | |
| 14 | PA0-WKUP | I/O | GPIO_EXTI0 | BUTTON |
| 15 | PA1 | I/O | ADC1_IN1 | ADC1_IN1 |
| 16 | PA2 | I/O | ADC1_IN2 | ADC1_IN2 |
| 17 | PA3 | I/O | ADC1_IN3 | ADC1_IN3 |
| 18 | VSS | Power | | |
| 19 | VDD | Power | | |
| 20 | PA4 * | I/O | GPIO_Output | SPI1_NSS |
| 21 | PA5 | I/O | SPI1_SCK | SPI1_SCK |
| 22 | PA6 | I/O | SPI1_MISO | SPI1_MISO |
| 23 | PA7 | I/O | SPI1_MOSI | SPI1_MOSI |
| 24 | PC4 | I/O | GPIO_EXTI4 | D3_LCD_BLE_INT |
| 25 | PC5 * | I/O | GPIO_Output | D2_LCD_BLE_CS |
| 26 | PB0 * | I/O | GPIO_Output | RESTART |
| 27 | PB1 * | I/O | GPIO_Output | SEL_3 |
| 29 | PB10 | I/O | I2C2_SCL | I2C2_SCL |
| 30 | PB11 | I/O | I2C2_SDA | I2C2_SDA |
| 31 | VCAP_1 | Power | | |
| 32 | VDD | Power | | |
| 33 | PB12 * | I/O | GPIO_Output | D4_LCD_SPI2_NSS |
| 34 | PB13 | I/O | SPI2_SCK | D5_LCD_SPI2_SCK |
| 35 | PB14 * | I/O | GPIO_Output | D6_LCD_SPI2_MISO |
| 36 | PB15 | I/O | SPI2_MOSI | D7_LCD_SPI2_MOSI |
| 38 | PC7 * | I/O | GPIO_Output | IO_CONN2 |

| Pin Number LQFP64 | Pin Name (function after reset) | Pin Type | Alternate Function(s) | Label |
|---|---|---|---|---|
| 39 | PC8 * | I/O | GPIO_Output | SEL_0 |
| 40 | PC9 * | I/O | GPIO_Output | D1_LCD_BLE_RST |
| 42 | PA9 | I/O | USB_OTG_FS_VBUS | |
| 44 | PA11 | I/O | USB_OTG_FS_DM | |
| 45 | PA12 | I/O | USB_OTG_FS_DP | |
| 46 | PA13 | I/O | SYS_JTMS-SWDIO | |
| 47 | VCAP_2 | Power | | |
| 48 | VDD | Power | | |
| 49 | PA14 | I/O | SYS_JTCK-SWCLK | |
| 51 | PC10 | I/O | USART3_TX | USART3_TX |
| 52 | PC11 | I/O | USART3_RX | USART3_RX |
| 53 | PC12 * | I/O | GPIO_Output | PC_12_LED |
| 54 | PD2 * | I/O | GPIO_Output | EN_LCD |
| 57 | PB5 * | I/O | GPIO_Output | IO_CONN1 |
| 58 | PB6 | I/O | I2C1_SCL | I2C1_SCL |
| 59 | PB7 | I/O | I2C1_SDA | I2C1_SDA |
| 60 | BOOT0 | Boot | | |
| 61 | PB8 | I/O | CAN1_RX | CAN1_RX |
| 62 | PB9 | I/O | CAN1_TX | CAN1_TX |
| 63 | VSS | Power | | |
| 64 | VDD | Power | | |

* The pin is affected with an I/O function

# 4. Clock Tree Configuration
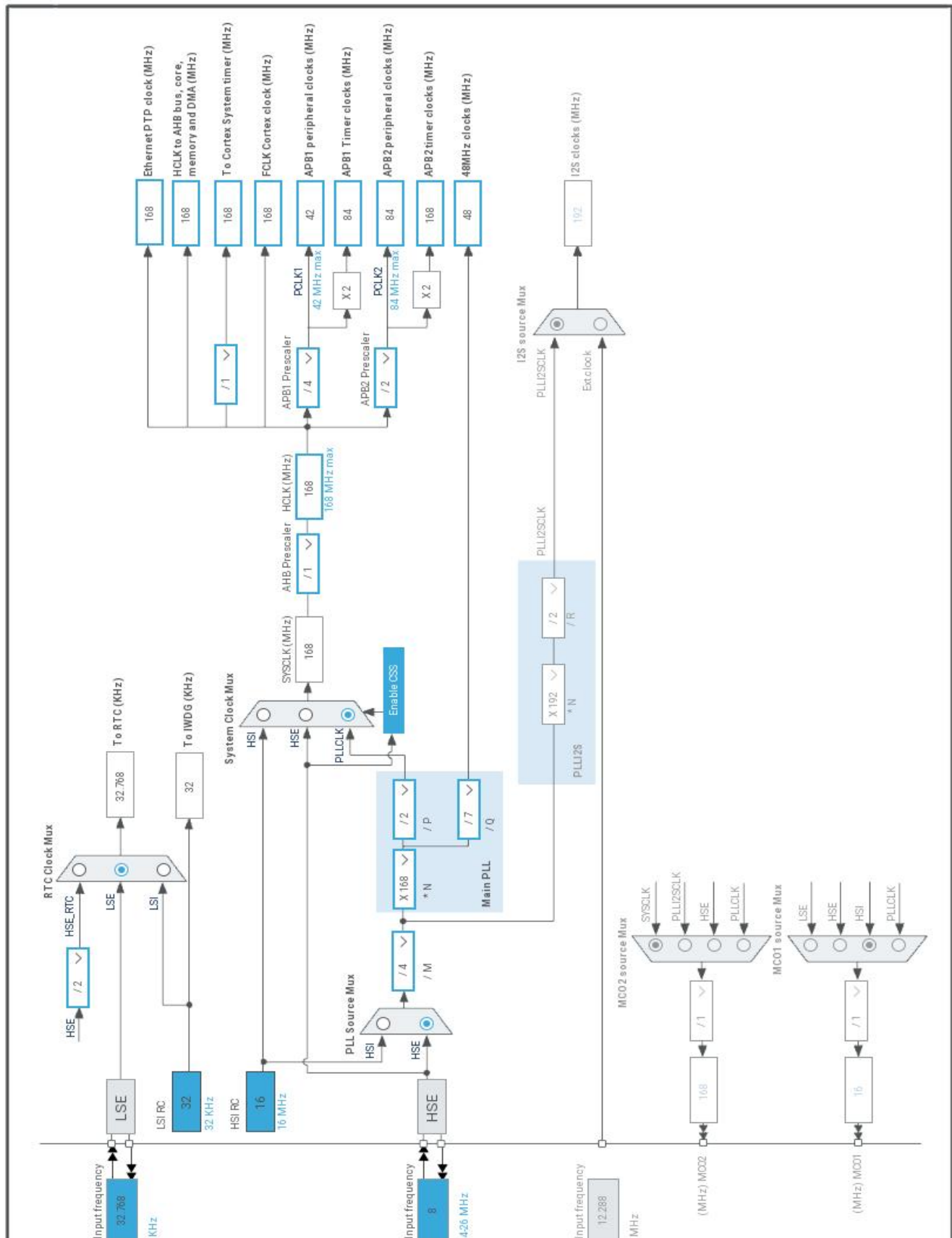
# *1. Power Consumption Calculator report*

## 1.1. Microcontroller Selection

| | |
|---|---|
| Series | STM32F4 |
| Line | STM32F405/415 |
| MCU | STM32F405RGTx |
| Datasheet | DS8626_Rev8 |

## 1.2. Parameter Selection

| | |
|---|---|
| Temperature | 25 |
| Vdd | 3.3 |

## 1.3. Battery Selection

| | |
|---|---|
| Battery | Li-SOCL2(A3400) |
| Capacity | 3400.0 mAh |
| Self Discharge | 0.08 %/month |
| Nominal Voltage | 3.6 V |
| Max Cont Current | 100.0 mA |
| Max Pulse Current | 200.0 mA |
| Cells in series | 1 |
| Cells in parallel | 1 |

## 1.4. Sequence

| Step | Step1 | Step2 |
|---|---|---|
| **Mode** | RUN | STOP |
| **Vdd** | 3.3 | 3.3 |
| **Voltage Source** | Battery | Battery |
| **Range** | Scale1-High | No Scale |
| **Fetch Type** | FLASH | n/a |
| **CPU Frequency** | 168 MHz | 0 Hz |
| **Clock Configuration** | HSE PLL | Regulator_LP Flash-PwrDwn |
| **Clock Source Frequency** | 4 MHz | 0 Hz |
| **Peripherals** | | |
| **Additional Cons.** | 0 mA | 0 mA |
| **Average Current** | 46 mA | 280 µA |
| **Duration** | 0.1 ms | 0.9 ms |
| **DMIPS** | 210.0 | 0.0 |
| **Ta Max** | 98.02 | 104.96 |
| **Category** | In DS Table | In DS Table |

## 1.5. Results

| Sequence Time | 1 ms | Average Current | 4.85 mA |
|---|---|---|---|
| Battery Life | 29 days, 4 hours | Average DMIPS | 210.0 DMIPS |

## 1.6. Chart
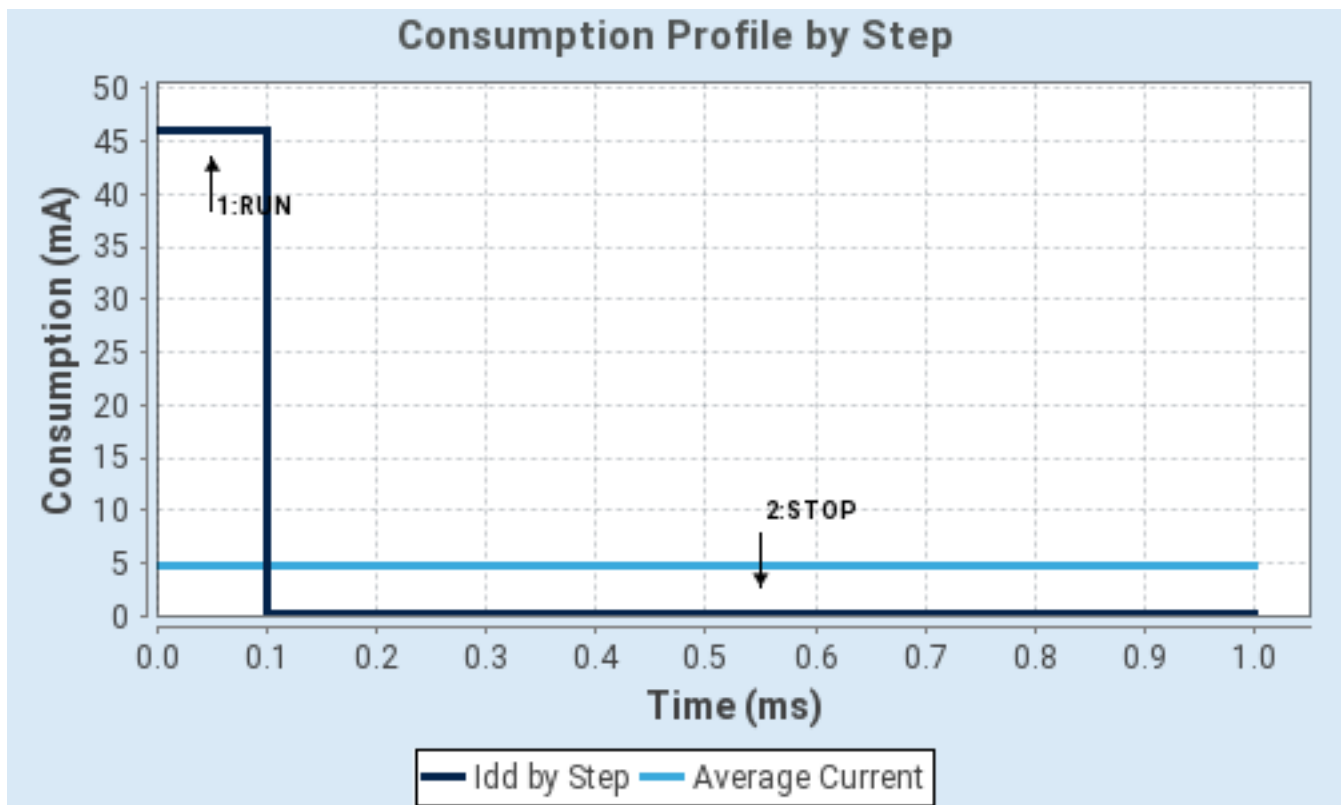
# *2. Software Project*

## 2.1. Project Settings

| Name | Value |
|---|---|
| Project Name | F4_Sensus191 |
| Project Folder | /home/tommaso/Documenti/STM32/workspace/F4_Sensus191 |
| Toolchain / IDE | STM32CubeIDE |
| Firmware Package Name and Version | STM32Cube FW_F4 V1.28.2 |
| Application Structure | Basic |
| Generate Under Root | No |
| Do not generate the main() | No |
| Minimum Heap Size | 0x200 |
| Minimum Stack Size | 0xD00 |

## 2.2. Code Generation Settings

| Name | Value |
|---|---|
| STM32Cube MCU packages and embedded software | Copy all used libraries into the project folder |
| Generate peripheral initialization as a pair of '.c/.h' files | Yes |
| Backup previously generated files when re-generating | No |
| Keep User Code when re-generating | Yes |
| Delete previously generated files when not re-generated | Yes |
| Set all free pins as analog (to optimize the power consumption) | Yes |
| Enable Full Assert | No |

## 2.3. Advanced Settings - Generated Function Calls

| Rank | Function Name | Peripheral Instance Name |
|---|---|---|
| 1 | MX_GPIO_Init | GPIO |
| 2 | MX_DMA_Init | DMA |
| 3 | SystemClock_Config | RCC |
| 4 | MX_RTC_Init | RTC |
| 5 | MX_USB_DEVICE_Init | USB_DEVICE |
| 6 | MX_CAN1_Init | CAN1 |
| 7 | MX_I2C1_Init | I2C1 |
| 8 | MX_TIM3_Init | TIM3 |
| 9 | MX_TIM1_Init | TIM1 |
| 10 | MX_CRC_Init | CRC |
| 11 | MX_TIM6_Init | TIM6 |

| Rank | Function Name | Peripheral Instance Name |
|---|---|---|
| 12 | MX_I2C2_Init | I2C2 |
| 13 | MX_SPI2_Init | SPI2 |
| 14 | MX_ADC1_Init | ADC1 |
| 15 | MX_TIM7_Init | TIM7 |
| 16 | MX_IWDG_Init | IWDG |
| 17 | MX_USART3_UART_Init | USART3 |

# 3. Peripherals and Middlewares Configuration

**3.1. ADC1**

**mode: IN1**

**mode: IN2**

**mode: IN3**

**mode: Temperature Sensor Channel**

3.1.1. Parameter Settings:

**ADCs_Common_Settings:**

| | |
|---|---|
| Mode | Independent mode |

**ADC_Settings:**

| | |
|---|---|
| Clock Prescaler | **PCLK2 divided by 8 \*** |
| Resolution | 12 bits (15 ADC Clock cycles) |
| Data Alignment | Right alignment |
| Scan Conversion Mode | Enabled |
| Continuous Conversion Mode | Disabled |
| Discontinuous Conversion Mode | Disabled |
| DMA Continuous Requests | **Enabled \*** |
| End Of Conversion Selection | **EOC flag at the end of all conversions \*** |

**ADC_Regular_ConversionMode:**

| | |
|---|---|
| Number Of Conversion | **3 \*** |
| External Trigger Conversion Source | Regular Conversion launched by software |
| External Trigger Conversion Edge | None |
| Rank | 1 |
| Channel | Channel 1 |
| Sampling Time | **480 Cycles \*** |
| Rank | **2 \*** |
| Channel | **Channel 2 \*** |
| Sampling Time | **480 Cycles \*** |
| Rank | **3 \*** |
| Channel | **Channel Temperature Sensor \*** |
| Sampling Time | **480 Cycles \*** |

**ADC_Injected_ConversionMode:**

| | |
|---|---|
| Number Of Conversions | 0 |

**WatchDog:**

| | |
|---|---|
| Enable Analog WatchDog Mode | false |

**3.2. CAN1**

**mode: Activated**

3.2.1. Parameter Settings:

**Bit Timings Parameters:**

| | |
|---|---|
| Prescaler (for Time Quantum) | **12 *** |
| Time Quantum | **285.7142857142857 *** |
| Time Quanta in Bit Segment 1 | **11 Times *** |
| Time Quanta in Bit Segment 2 | **2 Times *** |
| Time for one Bit | **4000 *** |
| Baud Rate | **250000 *** |
| ReSynchronization Jump Width | 1 Time |

**Basic Parameters:**

| | |
|---|---|
| Time Triggered Communication Mode | Disable |
| Automatic Bus-Off Management | **Enable *** |
| Automatic Wake-Up Mode | **Enable *** |
| Automatic Retransmission | **Enable *** |
| Receive Fifo Locked Mode | Disable |
| Transmit Fifo Priority | **Enable *** |

**Advanced Parameters:**

| | |
|---|---|
| Operating Mode | Normal |

**3.3. CRC**

**mode: Activated**

**3.4. I2C1**

**I2C: I2C**

3.4.1. Parameter Settings:

**Master Features:**

| | |
|---|---|
| I2C Speed Mode | **Fast Mode *** |
| I2C Clock Speed (Hz) | 400000 |
| Fast Mode Duty Cycle | Duty cycle Tlow/Thigh = 2 |

**Slave Features:**

| | |
|---|---|
| Clock No Stretch Mode | Disabled |
| Primary Address Length selection | 7-bit |
| Dual Address Acknowledged | Disabled |
| Primary slave address | 0 |
| General Call address detection | Disabled |

## 3.5. I2C2
**I2C: I2C**
### 3.5.1. Parameter Settings:

**Master Features:**

| | |
|---|---|
| I2C Speed Mode | Standard Mode |
| I2C Clock Speed (Hz) | 100000 |

**Slave Features:**

| | |
|---|---|
| Clock No Stretch Mode | Disabled |
| Primary Address Length selection | 7-bit |
| Dual Address Acknowledged | Disabled |
| Primary slave address | 0 |
| General Call address detection | Disabled |

## 3.6. IWDG
**mode: Activated**
### 3.6.1. Parameter Settings:

**Clocking:**

| | |
|---|---|
| IWDG counter clock prescaler | **256 *** |
| IWDG down-counter reload value | 4095 |

## 3.7. RCC
**High Speed Clock (HSE): Crystal/Ceramic Resonator**
**Low Speed Clock (LSE) : Crystal/Ceramic Resonator**
### 3.7.1. Parameter Settings:

**System Parameters:**

| | |
|---|---|
| VDD voltage (V) | 3.3 |

| | |
|---|---|
| Instruction Cache | Enabled |
| Prefetch Buffer | Enabled |
| Data Cache | Enabled |
| Flash Latency(WS) | 5 WS (6 CPU cycle) |

**RCC Parameters:**

| | |
|---|---|
| HSI Calibration Value | 16 |
| HSE Startup Timout Value (ms) | 100 |
| LSE Startup Timout Value (ms) | 5000 |

**Power Parameters:**

| | |
|---|---|
| Power Regulator Voltage Scale | Power Regulator Voltage Scale 1 |

## 3.8. RTC
## mode: Activate Clock Source
## mode: Activate Calendar
## Alarm A: Internal Alarm
## Calibration: Calibration 512Hz
### 3.8.1. Parameter Settings:

**General:**

| | |
|---|---|
| Hour Format | Hourformat 24 |
| Asynchronous Predivider value | 127 |
| Synchronous Predivider value | 255 |

**Calendar Time:**

| | |
|---|---|
| Data Format | BCD data format |
| Hours | **12 *** |
| Minutes | **57 *** |
| Seconds | 0 |
| Day Light Saving: value of hour adjustment | Daylightsaving None |
| Store Operation | Storeoperation Reset |

**Calendar Date:**

| | |
|---|---|
| Week Day | Monday |
| Month | January |
| Date | 1 |
| Year | **21 *** |

**Alarm A:**

| | |
|---|---|
| Hours | 0 |
| Minutes | 0 |
| Seconds | 0 |

Sub Seconds                            0

Alarm Mask Date Week day               **Enable \***

Alarm Mask Hours                       **Enable \***

Alarm Mask Minutes                     **Enable \***

Alarm Mask Seconds                     **Enable \***

Alarm Sub Second Mask                  All Alarm SS fields are masked.

Alarm Date Week Day Sel                Date

Alarm Date                             1

**Calibration:**

Calibration                            Signal has a regular waveform at 512Hz

## 3.9. SPI1
## Mode: Full-Duplex Master
### 3.9.1. Parameter Settings:

**Basic Parameters:**

Frame Format                           Motorola
Data Size                              8 Bits
First Bit                              MSB First

**Clock Parameters:**

Prescaler (for Baud Rate)              **128 \***

Baud Rate                              **656.25 KBits/s \***

Clock Polarity (CPOL)                  Low

Clock Phase (CPHA)                     **2 Edge \***

**Advanced Parameters:**

CRC Calculation                        Disabled
NSS Signal Type                        Software

## 3.10. SPI2
## Mode: Half-Duplex Master
### 3.10.1. Parameter Settings:

**Basic Parameters:**

Frame Format                           Motorola
Data Size                              8 Bits
First Bit                              MSB First

**Clock Parameters:**

| | |
|---|---|
| Prescaler (for Baud Rate) | **64 *** |
| Baud Rate | **656.25 KBits/s *** |
| Clock Polarity (CPOL) | Low |
| Clock Phase (CPHA) | 1 Edge |

**Advanced Parameters:**

| | |
|---|---|
| CRC Calculation | Disabled |
| NSS Signal Type | Software |

**3.11. SYS**
**Debug: Serial Wire**
**Timebase Source: SysTick**

**3.12. TIM1**
**Clock Source   : Internal Clock**
**Channel1: Output Compare No Output**
**Channel2: Output Compare No Output**
**Channel3: Output Compare No Output**
**Channel4: Output Compare No Output**
3.12.1. Parameter Settings:

**Counter Settings:**

| | |
|---|---|
| Prescaler (PSC - 16 bits value) | **16799 *** |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value ) | 0xFFFF |
| Internal Clock Division (CKD) | No Division |
| Repetition Counter (RCR - 8 bits value) | 0 |
| auto-reload preload | **Enable *** |

**Trigger Output (TRGO) Parameters:**

| | |
|---|---|
| Master/Slave Mode (MSM bit) | Disable (Trigger input effect not delayed) |
| Trigger Event Selection | Reset (UG bit from TIMx_EGR) |

**Break And Dead Time management - BRK Configuration:**

| | |
|---|---|
| BRK State | Disable |
| BRK Polarity | High |

**Break And Dead Time management - Output Configuration:**

| | |
|---|---|
| Automatic Output State | Disable |
| Off State Selection for Run Mode (OSSR) | Disable |

Off State Selection for Idle Mode (OSSI)          Disable

Lock Configuration                                Off

**Output Compare No Output Channel 1:**

Mode                                              Frozen (used for Timing base)

Pulse (16 bits value)                             **100 \***

Output compare preload                            Disable

CH Polarity                                       High

CH Idle State                                     Reset

**Output Compare No Output Channel 2:**

Mode                                              Frozen (used for Timing base)

Pulse (16 bits value)                             **200 \***

Output compare preload                            Disable

CH Polarity                                       High

CH Idle State                                     Reset

**Output Compare No Output Channel 3:**

Mode                                              Frozen (used for Timing base)

Pulse (16 bits value)                             **625 \***

Output compare preload                            Disable

CH Polarity                                       High

CH Idle State                                     Reset

**Output Compare No Output Channel 4:**

Mode                                              Frozen (used for Timing base)

Pulse (16 bits value)                             **400 \***

Output compare preload                            Disable

CH Polarity                                       High

CH Idle State                                     Reset

**3.13. TIM3**

**Clock Source   : Internal Clock**

3.13.1. Parameter Settings:

**Counter Settings:**

Prescaler (PSC - 16 bits value)                   **42000 \***

Counter Mode                                      Up

Counter Period (AutoReload Register - 16 bits value )   **9999 \***

Internal Clock Division (CKD)                     No Division

auto-reload preload                               **Enable \***

**Trigger Output (TRGO) Parameters:**

| Master/Slave Mode (MSM bit) | Disable (Trigger input effect not delayed) |
|---|---|
| Trigger Event Selection | Reset (UG bit from TIMx_EGR) |

### 3.14. TIM6
### mode: Activated
### 3.14.1. Parameter Settings:

**Counter Settings:**

| Prescaler (PSC - 16 bits value) | **42000 *** |
|---|---|
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value ) | **9999 *** |
| auto-reload preload | **Enable *** |

**Trigger Output (TRGO) Parameters:**

| Trigger Event Selection | Reset (UG bit from TIMx_EGR) |
|---|---|

### 3.15. TIM7
### mode: Activated
### 3.15.1. Parameter Settings:

**Counter Settings:**

| Prescaler (PSC - 16 bits value) | **42000 *** |
|---|---|
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value ) | **199 *** |
| auto-reload preload | **Enable *** |

**Trigger Output (TRGO) Parameters:**

| Trigger Event Selection | Reset (UG bit from TIMx_EGR) |
|---|---|

### 3.16. USART3
### Mode: Asynchronous
### 3.16.1. Parameter Settings:

**Basic Parameters:**

| Baud Rate | 115200 |
|---|---|
| Word Length | 8 Bits (including Parity) |

| Parity | None |
|---|---|
| Stop Bits | 1 |

**Advanced Parameters:**

| Data Direction | Receive and Transmit |
|---|---|
| Over Sampling | 16 Samples |

## 3.17. USB_OTG_FS
## Mode: Device_Only
## mode: Activate_VBUS
## 3.17.1. Parameter Settings:

| Speed | Device Full Speed 12MBit/s |
|---|---|
| Low power | Disabled |
| Link Power Management | Disabled |
| VBUS sensing | Enabled |
| Signal start of frame | Disabled |

## 3.18. STMicroelectronics.X-CUBE-BLE2.3.3.0
## mode: WirelessJjBlueNRGAa2
## 3.18.1. Parameter Settings:

**Log & Debug:**

| BLE2_DEBUG | 0: No debug message |
|---|---|
| PRINT_CSV_FORMAT | 0: .csv format message print disabled |
| BLUENRG2_DEBUG | 0: No debug message |

**Basic Parameters:**

| HCI_READ_PACKET_SIZE | 128 |
|---|---|
| HCI_MAX_PAYLOAD_SIZE | 128 |
| HCI_READ_PACKET_NUM_MAX | **32 \*** |

**Connection Parameters (for expert users):**

| Scan Interval (SCAN_P) | 16384 |
|---|---|
| Scan Window (SCAN_L) | 16384 |
| Supervision Timeout (SUPERV_TIMEOUT) | 60 |
| Min Connection Period (CONN_P1) | 40 |
| Max Connection Period (CONN_P2) | 40 |
| Min Connection Length (CONN_L1) | 2000 |
| Max Connection Length (CONN_L2) | 2000 |

| | |
|---|---|
| Advertising Type (ADV_DATA_TYPE) | Connectable Undirected Advertising (ADV_IND) |
| Min Advertising Interval (ADV_INTERV_MIN) | **1600 *** |
| Max Advertising Interval (ADV_INTERV_MAX) | **1600 *** |
| Min Connection Event Interval (L2CAP_INTERV_MIN) | 9 |
| Max Connection Event Interval (L2CAP_INTERV_MAX) | 20 |
| Timeout Multiplier (L2CAP_TIMEOUT_MULTIPLIER) | 600 |

### 3.18.2. Platform Settings:

| | |
|---|---|
| Exti Line | PC4 |
| BUS IO driver | SPI1 |
| CS Line | PA4 |
| Reset Line | PC9 |

## 3.19. STMicroelectronics.X-CUBE-MEMS1.9.6.0
## mode: BoardOoSupportJjCustom

## 3.20. USB_DEVICE
## Class For FS IP: Communication Device Class (Virtual Port Com)
### 3.20.1. Parameter Settings:

**Basic Parameters:**

| | |
|---|---|
| USBD_MAX_NUM_INTERFACES (Maximum number of supported interfaces) | 1 |
| USBD_MAX_NUM_CONFIGURATION (Maximum number of supported configuration) | 1 |
| USBD_MAX_STR_DESC_SIZ (Maximum size for the string descriptors) | 512 |
| USBD_SELF_POWERED (Enabled self power) | Enabled |
| USBD_DEBUG_LEVEL (USBD Debug Level) | 0: No debug message |

**Class Parameters:**

| | |
|---|---|
| USB CDC Rx Buffer Size | 2048 |
| USB CDC Tx Buffer Size | 2048 |

### 3.20.2. Device Descriptor:

**Device Descriptor:**

| | |
|---|---|
| VID (Vendor IDentifier) | 1155 |
| LANGID_STRING (Language Identifier) | **Italian (Standard) *** |
| MANUFACTURER_STRING (Manufacturer Identifier) | STMicroelectronics |

**Device Descriptor FS:**

| | |
|---|---|
| PID (Product IDentifier) | 22336 |
| PRODUCT_STRING (Product Identifier) | STM32 Virtual ComPort |
| CONFIGURATION_STRING (Configuration Identifier) | CDC Config |
| INTERFACE_STRING (Interface Identifier) | CDC Interface |

**\* User modified value**

# 4. System Configuration

## 4.1. GPIO configuration

| IP | Pin | Signal | GPIO mode | GPIO pull/up pull down | Max Speed | User Label |
|---|---|---|---|---|---|---|
| ADC1 | PA1 | ADC1_IN1 | Analog mode | No pull-up and no pull-down | n/a | ADC1_IN1 |
| | PA2 | ADC1_IN2 | Analog mode | No pull-up and no pull-down | n/a | ADC1_IN2 |
| | PA3 | ADC1_IN3 | Analog mode | No pull-up and no pull-down | n/a | ADC1_IN3 |
| CAN1 | PB8 | CAN1_RX | Alternate Function Push Pull | **Pull-up \*** | **Very High \*** | CAN1_RX |
| | PB9 | CAN1_TX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High \*** | CAN1_TX |
| I2C1 | PB6 | I2C1_SCL | Alternate Function Open Drain | **Pull-up \*** | **Very High \*** | I2C1_SCL |
| | PB7 | I2C1_SDA | Alternate Function Open Drain | **Pull-up \*** | **Very High \*** | I2C1_SDA |
| I2C2 | PB10 | I2C2_SCL | Alternate Function Open Drain | **Pull-up \*** | **Very High \*** | I2C2_SCL |
| | PB11 | I2C2_SDA | Alternate Function Open Drain | **Pull-up \*** | **Very High \*** | I2C2_SDA |
| RCC | PC14-OSC32_IN | RCC_OSC32_IN | n/a | n/a | n/a | |
| | PC15-OSC32_OUT | RCC_OSC32_OUT | n/a | n/a | n/a | |
| | PH0-OSC_IN | RCC_OSC_IN | n/a | n/a | n/a | |
| | PH1-OSC_OUT | RCC_OSC_OUT | n/a | n/a | n/a | |
| RTC | PC13-ANTI_TAMP | RTC_AF1 | n/a | n/a | n/a | RTC_AF1 |
| SPI1 | PA5 | SPI1_SCK | Alternate Function Push Pull | No pull-up and no pull-down | **Very High \*** | SPI1_SCK |
| | PA6 | SPI1_MISO | Alternate Function Push Pull | No pull-up and no pull-down | **Very High \*** | SPI1_MISO |
| | PA7 | SPI1_MOSI | Alternate Function Push Pull | No pull-up and no pull-down | **Very High \*** | SPI1_MOSI |
| SPI2 | PB13 | SPI2_SCK | Alternate Function Push Pull | **Pull-down \*** | **Very High \*** | D5_LCD_SPI2_SCK |
| | PB15 | SPI2_MOSI | Alternate Function Push Pull | **Pull-down \*** | **Very High** | D7_LCD_SPI2_MOSI |

| IP | Pin | Signal | GPIO mode | GPIO pull/up pull down | Max Speed | User Label |
|---|---|---|---|---|---|---|
| | | | | | * | |
| SYS | PA13 | SYS_JTMS-SWDIO | n/a | n/a | n/a | |
| | PA14 | SYS_JTCK-SWCLK | n/a | n/a | n/a | |
| USART3 | PC10 | USART3_TX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | USART3_TX |
| | PC11 | USART3_RX | Alternate Function Push Pull | **Pull-up *** | **Very High** * | USART3_RX |
| USB_OTG_FS | PA9 | USB_OTG_FS_VBUS | Input mode | No pull-up and no pull-down | n/a | |
| | PA11 | USB_OTG_FS_DM | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| | PA12 | USB_OTG_FS_DP | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| GPIO | PC0 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | RS_LCD |
| | PC1 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | SEL_1 |
| | PC2 | GPIO_EXTI2 | **External Interrupt Mode with Falling edge trigger detection** | **Pull-up *** | **n/a** | IO_EXP_INT |
| | PC3 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | SEL_2 |
| | PA0-WKUP | GPIO_EXTI0 | **External Interrupt Mode with Rising/Falling edge** | No pull-up and no pull-down | **n/a** | BUTTON |
| | PA4 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | SPI1_NSS |
| | PC4 | GPIO_EXTI4 | External Interrupt Mode with Rising edge trigger detection | **Pull-down *** | **n/a** | D3_LCD_BLE_INT |
| | PC5 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | D2_LCD_BLE_CS |
| | PB0 | GPIO_Output | Output Push Pull | **Pull-down *** | Low | RESTART |
| | PB1 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | SEL_3 |
| | PB12 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | D4_LCD_SPI2_NSS |
| | PB14 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | D6_LCD_SPI2_MISO |
| | PC7 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | IO_CONN2 |
| | PC8 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | SEL_0 |
| | PC9 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | D1_LCD_BLE_RST |
| | PC12 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | PC_12_LED |
| | PD2 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | **High *** | EN_LCD |
| | PB5 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | IO_CONN1 |

## 4.2. DMA configuration

| DMA request | Stream | Direction | Priority |
|---|---|---|---|
| I2C1_TX | DMA1_Stream7 | Memory To Peripheral | Low |
| I2C1_RX | DMA1_Stream0 | Peripheral To Memory | Low |
| USART3_RX | DMA1_Stream1 | Peripheral To Memory | Low |
| USART3_TX | DMA1_Stream3 | Memory To Peripheral | Low |
| ADC1 | DMA2_Stream0 | Peripheral To Memory | Low |

### *I2C1_TX: DMA1_Stream7 DMA request Settings:*

| | |
|---|---|
| Mode: | Normal |
| Use fifo: | Disable |
| Peripheral Increment: | Disable |
| Memory Increment: | **Enable \*** |
| Peripheral Data Width: | Byte |
| Memory Data Width: | Byte |

### *I2C1_RX: DMA1_Stream0 DMA request Settings:*

| | |
|---|---|
| Mode: | Normal |
| Use fifo: | Disable |
| Peripheral Increment: | Disable |
| Memory Increment: | **Enable \*** |
| Peripheral Data Width: | Byte |
| Memory Data Width: | Byte |

### *USART3_RX: DMA1_Stream1 DMA request Settings:*

| | |
|---|---|
| Mode: | Normal |
| Use fifo: | Disable |
| Peripheral Increment: | Disable |
| Memory Increment: | **Enable \*** |
| Peripheral Data Width: | Byte |
| Memory Data Width: | Byte |

### *USART3_TX: DMA1_Stream3 DMA request Settings:*

| | |
|---|---|
| Mode: | Normal |

| | |
|---|---|
| Use fifo: | Disable |
| Peripheral Increment: | Disable |
| Memory Increment: | **Enable \*** |
| Peripheral Data Width: | Byte |
| Memory Data Width: | Byte |

## *ADC1: DMA2_Stream0 DMA request Settings:*

| | |
|---|---|
| Mode: | **Circular \*** |
| Use fifo: | Disable |
| Peripheral Increment: | Disable |
| Memory Increment: | **Enable \*** |
| Peripheral Data Width: | Half Word |
| Memory Data Width: | Half Word |

## 4.3. NVIC configuration

4.3.1. NVIC

| Interrupt Table | Enable | Preenmption Priority | SubPriority |
|---|---|---|---|
| Non maskable interrupt | true | 0 | 0 |
| Hard fault interrupt | true | 0 | 0 |
| Memory management fault | true | 0 | 0 |
| Pre-fetch fault, memory access fault | true | 0 | 0 |
| Undefined instruction or illegal state | true | 0 | 0 |
| System service call via SWI instruction | true | 0 | 0 |
| Debug monitor | true | 0 | 0 |
| Pendable request for system service | true | 0 | 0 |
| System tick timer | true | 1 | 0 |
| RCC global interrupt | true | 1 | 0 |
| EXTI line0 interrupt | true | 15 | 0 |
| EXTI line2 interrupt | true | 3 | 0 |
| EXTI line4 interrupt | true | 3 | 0 |
| DMA1 stream0 global interrupt | true | 2 | 0 |
| DMA1 stream1 global interrupt | true | 4 | 0 |
| DMA1 stream3 global interrupt | true | 4 | 0 |
| CAN1 TX interrupts | true | 3 | 0 |
| CAN1 RX0 interrupts | true | 1 | 0 |
| TIM1 capture compare interrupt | true | 2 | 0 |
| TIM3 global interrupt | true | 5 | 0 |
| I2C1 event interrupt | true | 2 | 0 |
| USART3 global interrupt | true | 4 | 0 |
| RTC alarms A and B interrupt through EXTI line 17 | true | 7 | 0 |
| DMA1 stream7 global interrupt | true | 2 | 0 |
| TIM6 global interrupt, DAC1 and DAC2 underrun error interrupts | true | 5 | 0 |
| TIM7 global interrupt | true | 5 | 0 |
| DMA2 stream0 global interrupt | true | 4 | 0 |
| USB On The Go FS global interrupt | true | 1 | 0 |
| PVD interrupt through EXTI line 16 | unused | | |
| Flash global interrupt | unused | | |
| ADC1, ADC2 and ADC3 global interrupts | unused | | |
| CAN1 RX1 interrupt | unused | | |
| CAN1 SCE interrupt | unused | | |
| TIM1 break interrupt and TIM9 global interrupt | unused | | |
| TIM1 update interrupt and TIM10 global interrupt | unused | | |
| TIM1 trigger and commutation interrupts and | unused | | |

| Interrupt Table | Enable | Preenmption Priority | SubPriority |
|---|---|---|---|
| TIM11 global interrupt | | | |
| I2C1 error interrupt | | unused | |
| I2C2 event interrupt | | unused | |
| I2C2 error interrupt | | unused | |
| SPI1 global interrupt | | unused | |
| SPI2 global interrupt | | unused | |
| FPU global interrupt | | unused | |

## 4.3.2. NVIC Code generation

| Enabled interrupt Table | Select for init sequence ordering | Generate IRQ handler | Call HAL handler |
|---|---|---|---|
| Non maskable interrupt | false | true | false |
| Hard fault interrupt | false | true | false |
| Memory management fault | false | true | false |
| Pre-fetch fault, memory access fault | false | true | false |
| Undefined instruction or illegal state | false | true | false |
| System service call via SWI instruction | false | true | false |
| Debug monitor | false | true | false |
| Pendable request for system service | false | true | false |
| System tick timer | false | true | true |
| RCC global interrupt | false | true | false |
| EXTI line0 interrupt | false | true | true |
| EXTI line2 interrupt | false | true | true |
| EXTI line4 interrupt | false | true | true |
| DMA1 stream0 global interrupt | false | true | true |
| DMA1 stream1 global interrupt | false | true | true |
| DMA1 stream3 global interrupt | false | true | true |
| CAN1 TX interrupts | false | true | true |
| CAN1 RX0 interrupts | false | true | true |
| TIM1 capture compare interrupt | false | true | true |
| TIM3 global interrupt | false | true | true |
| I2C1 event interrupt | false | true | true |
| USART3 global interrupt | false | true | true |
| RTC alarms A and B interrupt through EXTI line 17 | false | true | true |
| DMA1 stream7 global interrupt | false | true | true |
| TIM6 global interrupt, DAC1 and DAC2 underrun error interrupts | false | true | true |
| TIM7 global interrupt | false | true | true |
| DMA2 stream0 global interrupt | false | true | true |
| USB On The Go FS global interrupt | false | true | true |

**\* User modified value**

# *5. System Views*

5.1. Category view

*5.1.1. Current*

| Middleware |
|---|
| USB_DEVICE ✓ |

| Software Packs | |
|---|---|
| X-CUBE-BLE2 ✓ | X-CUBE-MEMS1 ✓ |

| System Core | Analog | Timers | Connectivity | Multimedia | Security | Computing |
|---|---|---|---|---|---|---|
| DMA ✓ | ADC1 ✓ | RTC ✓ | CAN1 ✓ | | | CRC ✓ |
| GPIO ✓ | | TIM1 ✓ | I2C1 ✓ | | | |
| IWDG ✓ | | TIM3 ✓ | I2C2 ✓ | | | |
| NVIC ✓ | | TIM6 ✓ | SPI1 ✓ | | | |
| RCC ✓ | | TIM7 ✓ | SPI2 ✓ | | | |
| SYS ✓ | | | USART3 ✓ | | | |
| | | | USB_FS ✓ | | | |

# *6. Software Pack Report*

## 6.1. Software Pack selected

| Vendor | Name | Version | Component |
|---|---|---|---|
| STMicroelectronics | X-CUBE-MEMS1 | 9.6.0 | Class : Board Support<br>Group : Custom<br>SubGroup : MOTION_SENSOR<br>Version : 9.6.0<br>Class : Board Support<br>Group : Custom<br>SubGroup : ENV_SENSOR<br>Version : 9.6.0 |
| STMicroelectronics | X-CUBE-BLE2 | 3.3.0 | Class : Wireless<br>Group : BlueNRG-2<br>SubGroup : Controller<br>Version : 3.3.0<br>Class : Wireless<br>Group : BlueNRG-2<br>SubGroup : HCI_TL<br>Variant : Basic<br>Version : 3.3.0<br>Class : Wireless<br>Group : BlueNRG-2<br>SubGroup : HCI_TL_INTERF |

| | | | ACE |
|---|---|---|---|
| | | | Variant : |
| | | | UserBoard |
| | | | Version : 3.3.0 |
| | | | Class : Wireless |
| | | | Group : |
| | | | BlueNRG-2 |
| | | | SubGroup : Utils |
| | | | Version : 3.3.0 |

# 7. Docs  & Resources

| Type | Link |
| --- | --- |
| BSDL files | https://www.st.com/resource/en/bsdl_model/stm32f405-415_407-417_bsdl.zip |
| IBIS models | https://www.st.com/resource/en/ibis_model/stm32f405-415_407-417_ibis.zip |
| System View Description | https://www.st.com/resource/en/svd/stm32f4-svd.zip |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32-stm8_embedded_software_solutions.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32_eval-tools_portfolio.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32_stm8_functional-safety-packages.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/stm32-stm8_software_development_tools.pdf |
| Presentations | https://www.st.com/resource/en/product_presentation/microcontrollers-stm32-family-overview.pdf |
| Brochures | https://www.st.com/resource/en/brochure/products-and-solutions-for-plcs-and-smart-i-os.pdf |
| Flyers | https://www.st.com/resource/en/flyer/flstm32nucleo.pdf |
| Flyers | https://www.st.com/resource/en/flyer/flstm32trust.pdf |
| Product Certifications | https://www.st.com/resource/en/certification_document/stm32_authentication_can.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an1709-emc-design-guide-for-stm8-stm32-and-legacy-mcus-stmicroelectronics.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an2606-stm32-microcontroller-system-memory-boot-mode-stmicroelectronics.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an2945-stm8s-and-stm32-mcus-a-consistent-832bit-product-line-for-painless-migration-stmicroelectronics.pdf |

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driver-enable-signal-for-rs485-and-iolink-communications-with-the-
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waveform-generation-using-the-dac-in-stm32-products-
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used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3155-usart-protocol-
used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3156-usb-dfu-
protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3364-migration-and-
compatibility-guidelines-for-stm32-microcontroller-applications-
stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an3371-using-the-
hardware-realtime-clock-rtc-in-stm32-f0-f2-f3-f4-and-l1-series-of-mcus-
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and-recording-using-the-stm32f4discovery-stmicroelectronics.pdf

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software-decoding-on-stm32-microcontrollers-stmicroelectronics.pdf

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| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an3174-implementing-receivers-for-infrared-remote-control-protocols-using-stm32f10xxx-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an3241-qvga-tftlcd-direct-drive-using-the-stm32f10xx-fsmc-peripheral-stmicroelectronics.pdf |

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| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an3969-eeprom-emulation-in-stm32f40xstm32f41x-microcontrollers-stmicroelectronics.pdf |
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| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an3990-upgrading-stm32f4discovery-board-firmware-using-a-usb-key-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an3997-audio-playback-and-recording-using-the-stm32f4discovery-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an3998-pdm-audio-software-decoding-on-stm32-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4044-floating-point-unit-demonstration-on-stm32-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4323-getting-started-with-stemwin-library-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4365-using-stm32f4-mcu-power-modes-with-best-dynamic-efficiency-stmicroelectronics.pdf |
| Application Notes | https://www.st.com/resource/en/application_note/an4435-guidelines-for- |

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| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4457-implementing-an-emulated-uart-on-stm32f4-microcontrollers-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4499-stm32--nrf51822-bluetooth-low-energy-system-solution-stmicroelectronics.pdf |
| Application Notes for related Tools & Software | https://www.st.com/resource/en/application_note/an4657-stm32-inapplication-programming-iap-using-the-usart-stmicroelectronics.pdf |
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