



## 1. Description

### 1.1. Project

|                 |                   |
|-----------------|-------------------|
| Project Name    | BLE_dev           |
| Board Name      | custom            |
| Generated with: | STM32CubeMX 6.9.2 |
| Date            | 03/02/2024        |

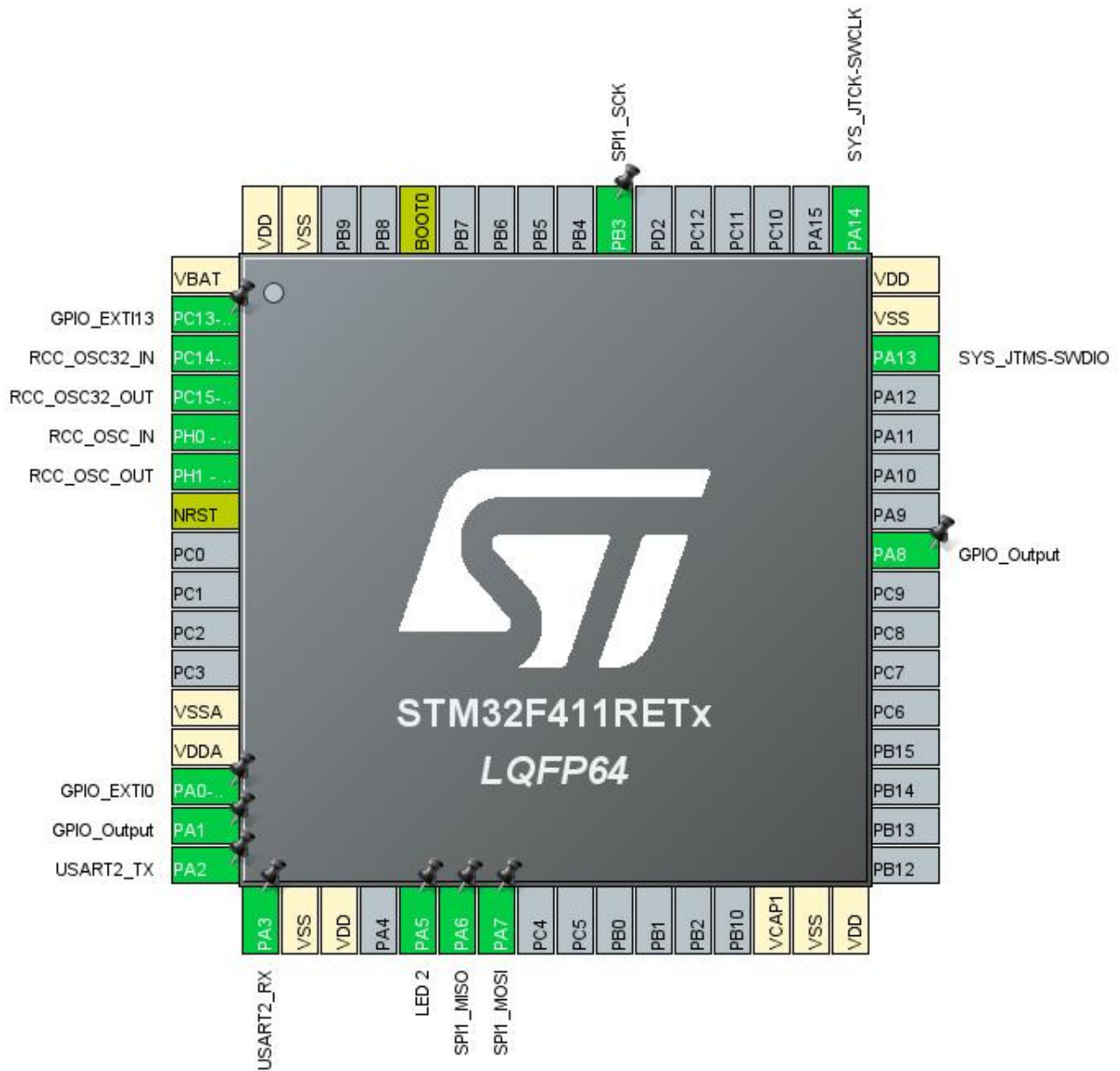
### 1.2. MCU

|                |               |
|----------------|---------------|
| MCU Series     | STM32F4       |
| MCU Line       | STM32F411     |
| MCU name       | STM32F411RETx |
| MCU Package    | LQFP64        |
| MCU Pin number | 64            |

### 1.3. Core(s) information

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

## 2. Pinout Configuration

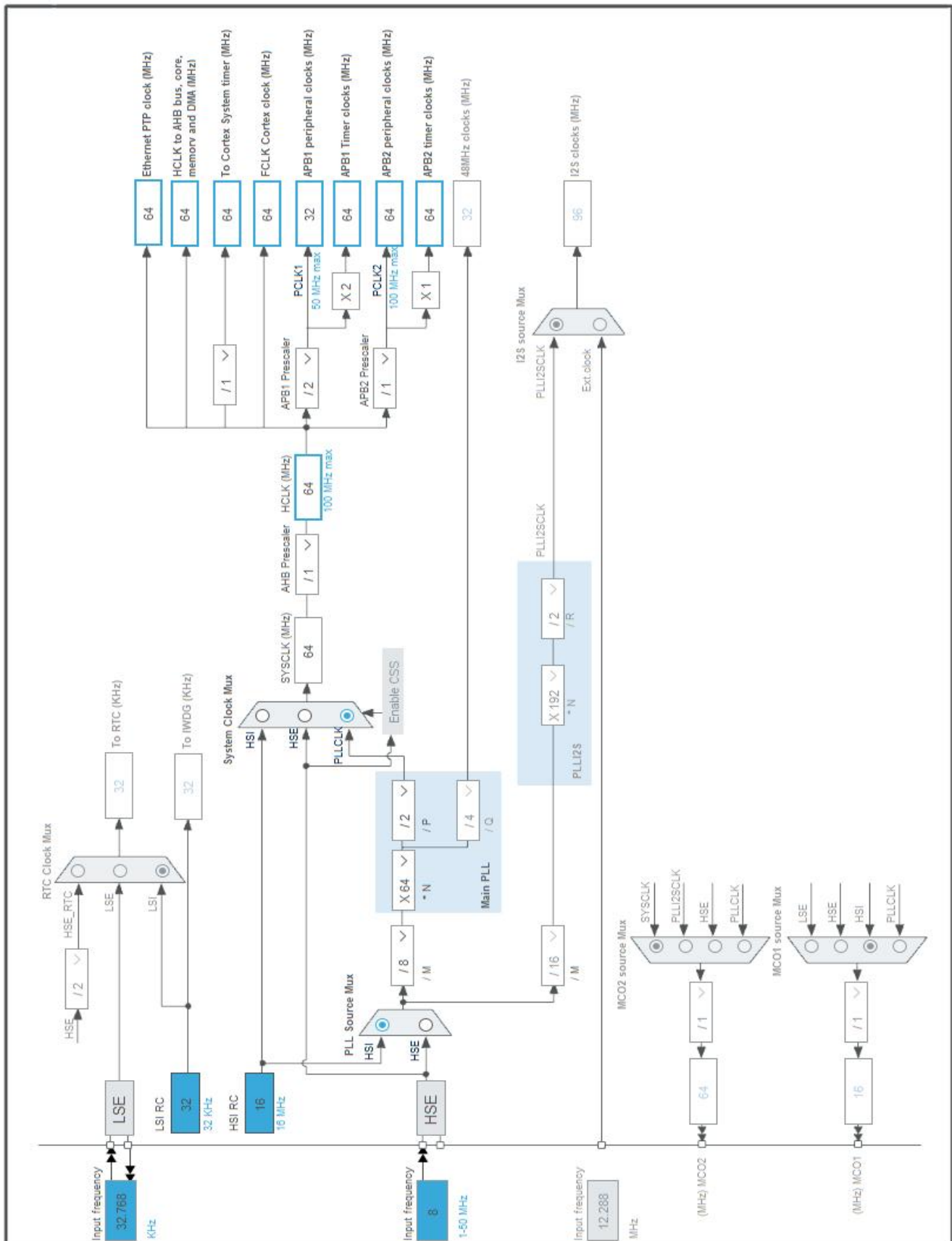


### 3. Pins Configuration

| Pin Number<br>LQFP64 | Pin Name<br>(function after<br>reset) | Pin Type | Alternate<br>Function(s) | Label |
|----------------------|---------------------------------------|----------|--------------------------|-------|
| 1                    | VBAT                                  | Power    |                          |       |
| 2                    | PC13-ANTI_TAMP                        | I/O      | GPIO_EXTI13              |       |
| 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    |                          |       |
| 12                   | VSSA                                  | Power    |                          |       |
| 13                   | VDDA                                  | Power    |                          |       |
| 14                   | PA0-WKUP                              | I/O      | GPIO_EXTI0               |       |
| 15                   | PA1 *                                 | I/O      | GPIO_Output              |       |
| 16                   | PA2                                   | I/O      | USART2_TX                |       |
| 17                   | PA3                                   | I/O      | USART2_RX                |       |
| 18                   | VSS                                   | Power    |                          |       |
| 19                   | VDD                                   | Power    |                          |       |
| 21                   | PA5 *                                 | I/O      | GPIO_Output              | LED 2 |
| 22                   | PA6                                   | I/O      | SPI1_MISO                |       |
| 23                   | PA7                                   | I/O      | SPI1_MOSI                |       |
| 30                   | VCAP1                                 | Power    |                          |       |
| 31                   | VSS                                   | Power    |                          |       |
| 32                   | VDD                                   | Power    |                          |       |
| 41                   | PA8 *                                 | I/O      | GPIO_Output              |       |
| 46                   | PA13                                  | I/O      | SYS_JTMS-SWDIO           |       |
| 47                   | VSS                                   | Power    |                          |       |
| 48                   | VDD                                   | Power    |                          |       |
| 49                   | PA14                                  | I/O      | SYS_JTCK-SWCLK           |       |
| 55                   | PB3                                   | I/O      | SPI1_SCK                 |       |
| 60                   | BOOT0                                 | Boot     |                          |       |
| 63                   | VSS                                   | Power    |                          |       |
| 64                   | VDD                                   | Power    |                          |       |

\* The pin is affected with an I/O function

## 4. Clock Tree Configuration



## 5. Software Project

### 5.1. Project Settings

| Name                              | Value                                                                  |
|-----------------------------------|------------------------------------------------------------------------|
| Project Name                      | BLE_dev                                                                |
| Project Folder                    | C:\Users\Engineer Protobetz\Documents\Programs Directory\Stm32\BLE_dev |
| Toolchain / IDE                   | STM32CubeIDE                                                           |
| Firmware Package Name and Version | STM32Cube FW_F4 V1.27.1                                                |
| Application Structure             | Advanced                                                               |
| Generate Under Root               | Yes                                                                    |
| Do not generate the main()        | No                                                                     |
| Minimum Heap Size                 | 0x200                                                                  |
| Minimum Stack Size                | 0x400                                                                  |

### 5.2. Code Generation Settings

| Name                                                            | Value                                 |
|-----------------------------------------------------------------|---------------------------------------|
| STM32Cube MCU packages and embedded software                    | Copy only the necessary library files |
| Generate peripheral initialization as a pair of '.c/.h' files   | No                                    |
| 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) | No                                    |
| Enable Full Assert                                              | No                                    |

### 5.3. Advanced Settings - Generated Function Calls

| Rank | Function Name       | Peripheral Instance Name |
|------|---------------------|--------------------------|
| 1    | SystemClock_Config  | RCC                      |
| 2    | MX_GPIO_Init        | GPIO                     |
| 3    | MX_USART2_UART_Init | USART2                   |

## 1. Power Consumption Calculator report

### 1.1. Microcontroller Selection

|           |               |
|-----------|---------------|
| Series    | STM32F4       |
| Line      | STM32F411     |
| MCU       | STM32F411RETx |
| Datasheet | DS10314_Rev6  |

### 1.2. Parameter Selection

|             |     |
|-------------|-----|
| Temperature | 25  |
| Vdd         | 1.7 |

### 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

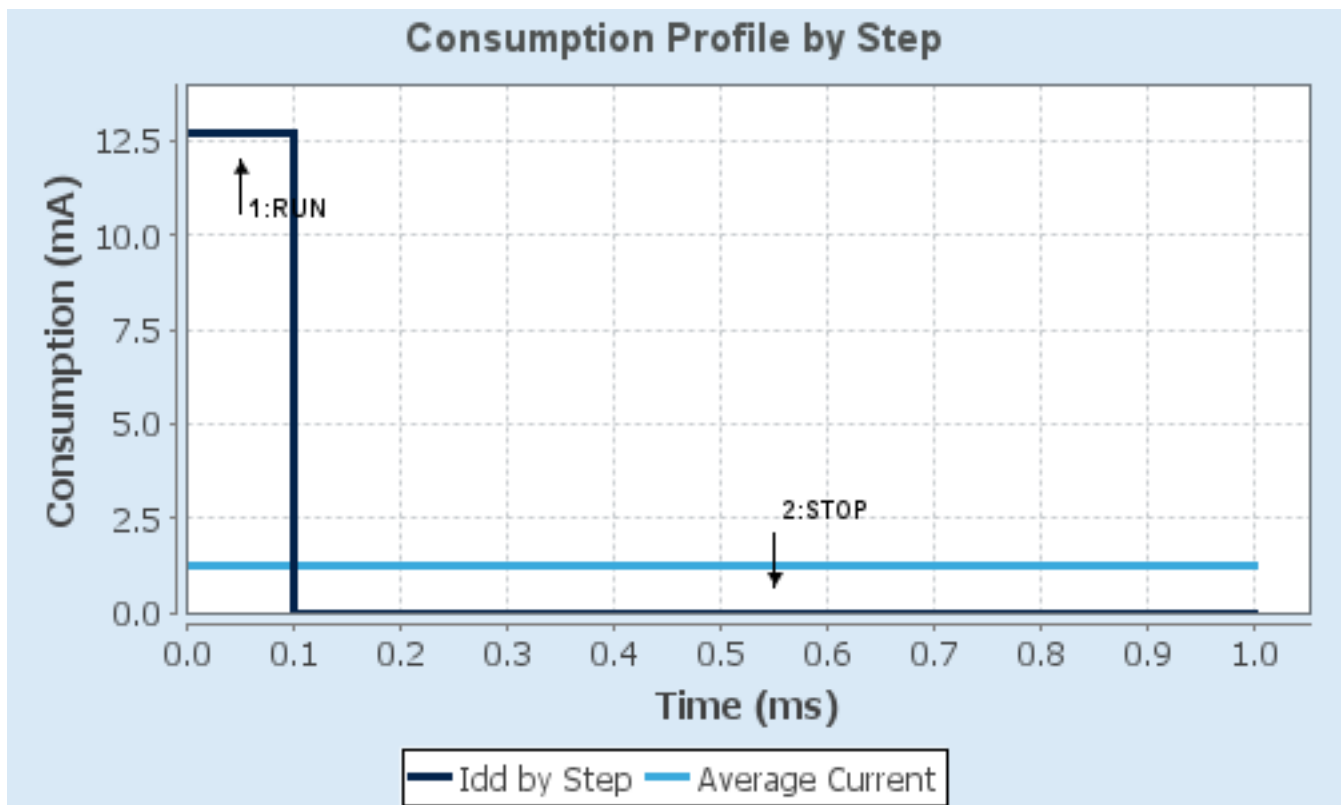
|                               |             |                             |
|-------------------------------|-------------|-----------------------------|
| <b>Step</b>                   | Step1       | Step2                       |
| <b>Mode</b>                   | RUN         | STOP                        |
| <b>Vdd</b>                    | 1.7         | 1.7                         |
| <b>Voltage Source</b>         | Battery     | Battery                     |
| <b>Range</b>                  | Scale1-High | No Scale                    |
| <b>Fetch Type</b>             | SRAM        | n/a                         |
| <b>CPU Frequency</b>          | 100 MHz     | 0 Hz                        |
| <b>Clock Configuration</b>    | HSE PLL     | Regulator_LPLV Flash-PwrDwn |
| <b>Clock Source Frequency</b> | 4 MHz       | 0 Hz                        |
| <b>Peripherals</b>            |             |                             |
| <b>Additional Cons.</b>       | 0 mA        | 0 mA                        |
| <b>Average Current</b>        | 12.7 mA     | 9 $\mu$ A                   |
| <b>Duration</b>               | 0.1 ms      | 0.9 ms                      |
| <b>DMIPS</b>                  | 125.0       | 0.0                         |
| <b>Ta Max</b>                 | 103.99      | 105                         |
| <b>Category</b>               | In DS Table | In DS Table                 |

#### 1.5. Results

|               |                            |                 |             |
|---------------|----------------------------|-----------------|-------------|
| Sequence Time | 1 ms                       | Average Current | 1.28 mA     |
| Battery Life  | 3 months, 19 days, 6 hours | Average DMIPS   | 125.0 DMIPS |

#### 1.6. Chart





## 2. Peripherals and Middlewares Configuration

### 2.1. RCC

**High Speed Clock (HSE): BYPASS Clock Source**

**Low Speed Clock (LSE) : Crystal/Ceramic Resonator**

#### 2.1.1. Parameter Settings:

##### **System Parameters:**

|                   |                    |
|-------------------|--------------------|
| VDD voltage (V)   | 3.3                |
| Instruction Cache | Enabled            |
| Prefetch Buffer   | Enabled            |
| Data Cache        | Enabled            |
| Flash Latency(WS) | 0 WS (1 CPU cycle) |

##### **RCC Parameters:**

|                                |          |
|--------------------------------|----------|
| HSI Calibration Value          | 16       |
| TIM Prescaler Selection        | Disabled |
| HSE Startup Timeout Value (ms) | 100      |
| LSE Startup Timeout Value (ms) | 5000     |

##### **Power Parameters:**

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

### 2.2. SPI1

**Mode: Full-Duplex Master**

#### 2.2.1. Parameter Settings:

##### **Basic Parameters:**

|              |           |
|--------------|-----------|
| Frame Format | Motorola  |
| Data Size    | 8 Bits    |
| First Bit    | MSB First |

##### **Clock Parameters:**

|                           |                         |
|---------------------------|-------------------------|
| Prescaler (for Baud Rate) | <b>64 *</b>             |
| Baud Rate                 | <b>1000.0 KBits/s *</b> |
| Clock Polarity (CPOL)     | Low                     |
| Clock Phase (CPHA)        | <b>2 Edge *</b>         |

##### **Advanced Parameters:**

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

## 2.3. SYS

**Debug: Serial Wire**

**Timebase Source: SysTick**

## 2.4. USART2

**Mode: Asynchronous**

### 2.4.1. 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           |

## 2.5. STMicroelectronics.X-CUBE-BLE2.3.3.0

**mode: WirelessJjBlueNRGAa2**

### 2.5.1. 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 | 10  |

#### **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<br>(ADV_IND) |
| Min Advertising Interval (ADV_INTERV_MIN)        | 2048                                            |
| Max Advertising Interval (ADV_INTERV_MAX)        | 4096                                            |
| Min Connection Event Interval (L2CAP_INTERV_MIN) | 9                                               |
| Max Connection Event Interval (L2CAP_INTERV_MAX) | 20                                              |
| Timeout Multiplier (L2CAP_TIMEOUT_MULTIPLIER)    | 600                                             |

### 2.5.2. Platform Settings:

|               |          |
|---------------|----------|
| Exti Line     | PA0-WKUP |
| BUS IO driver | SPI1     |
| CS Line       | PA1      |
| Reset Line    | PA8      |

\* **User modified value**

### 3. System Configuration

#### 3.1. GPIO configuration

| IP     | Pin            | Signal         | GPIO mode                                                  | GPIO pull/up pull down      | Max Speed   | User Label |
|--------|----------------|----------------|------------------------------------------------------------|-----------------------------|-------------|------------|
| 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         |            |
| SPI1   | PA6            | SPI1_MISO      | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * |            |
|        | PA7            | SPI1_MOSI      | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * |            |
|        | PB3            | SPI1_SCK       | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * |            |
| SYS    | PA13           | SYS_JTMS-SWDIO | n/a                                                        | n/a                         | n/a         |            |
|        | PA14           | SYS_JTCK-SWCLK | n/a                                                        | n/a                         | n/a         |            |
| USART2 | PA2            | USART2_TX      | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * |            |
|        | PA3            | USART2_RX      | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * |            |
| GPIO   | PC13-ANTI_TAMP | GPIO_EXTI13    | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a         |            |
|        | PA0-WKUP       | GPIO_EXTI0     | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a         |            |
|        | PA1            | GPIO_Output    | Output Push Pull                                           | No pull-up and no pull-down | Low         |            |
|        | PA5            | GPIO_Output    | Output Push Pull                                           | No pull-up and no pull-down | Low         | LED 2      |
|        | PA8            | GPIO_Output    | Output Push Pull                                           | No pull-up and no pull-down | Low         |            |

#### 3.2. DMA configuration

nothing configured in DMA service

### 3.3. NVIC configuration

#### 3.3.1. 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   | 15                   | 0           |
| EXTI line0 interrupt                    | true   | 0                    | 0           |
| EXTI line[15:10] interrupts             | true   | 0                    | 0           |
| PVD interrupt through EXTI line 16      | unused |                      |             |
| Flash global interrupt                  | unused |                      |             |
| RCC global interrupt                    | unused |                      |             |
| SPI1 global interrupt                   | unused |                      |             |
| USART2 global interrupt                 | unused |                      |             |
| FPU global interrupt                    | unused |                      |             |

#### 3.3.2. 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             |
| EXTI line0 interrupt                    | false                             | true                 | true             |
| EXTI line[15:10] interrupts             | false                             | true                 | true             |

\* User modified value

## 4. System Views

### 4.1. Category view

#### 4.1.1. Current

## 5. Software Pack Report

### 5.1. Software Pack selected

| Vendor             | Name        | Version | Component                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| STMicroelectronics | X-CUBE-BLE2 | 3.3.0   | Class : Wireless<br>Group :<br>BlueNRG-2<br>SubGroup :<br>Controller<br>Version : 3.3.0<br>Class : Wireless<br>Group :<br>BlueNRG-2<br>SubGroup :<br>HCI_TL<br>Variant : Basic<br>Version : 3.3.0<br>Class : Wireless<br>Group :<br>BlueNRG-2<br>SubGroup :<br>HCI_TL_INTERFACE<br>Variant :<br>UserBoard<br>Version : 3.3.0<br>Class : Wireless<br>Group :<br>BlueNRG-2<br>SubGroup : Utils<br>Version : 3.3.0 |



## 6. Docs & Resources

| Type                    | Link                                                                                                                                                                                                                                                                      |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BSDL files              | <a href="https://www.st.com/resource/en/bsdl_model/stm32f411_bsd.zip">https://www.st.com/resource/en/bsdl_model/stm32f411_bsd.zip</a>                                                                                                                                     |
| IBIS models             | <a href="https://www.st.com/resource/en/ibis_model/stm32f411_ibis.zip">https://www.st.com/resource/en/ibis_model/stm32f411_ibis.zip</a>                                                                                                                                   |
| System View Description | <a href="https://www.st.com/resource/en/svd/stm32f4_svd.zip">https://www.st.com/resource/en/svd/stm32f4_svd.zip</a>                                                                                                                                                       |
| Presentations           | <a href="https://www.st.com/resource/en/product_presentation/stm32-stm8_embedded_software_solutions.pdf">https://www.st.com/resource/en/product_presentation/stm32-stm8_embedded_software_solutions.pdf</a>                                                               |
| Presentations           | <a href="https://www.st.com/resource/en/product_presentation/stm32_eval_tools_portfolio.pdf">https://www.st.com/resource/en/product_presentation/stm32_eval_tools_portfolio.pdf</a>                                                                                       |
| Presentations           | <a href="https://www.st.com/resource/en/product_presentation/stm32_stm8_functional-safety-packages.pdf">https://www.st.com/resource/en/product_presentation/stm32_stm8_functional-safety-packages.pdf</a>                                                                 |
| Presentations           | <a href="https://www.st.com/resource/en/product_presentation/stm32-stm8_software_development_tools.pdf">https://www.st.com/resource/en/product_presentation/stm32-stm8_software_development_tools.pdf</a>                                                                 |
| Presentations           | <a href="https://www.st.com/resource/en/product_presentation/microcontrollers-stm32-family-overview.pdf">https://www.st.com/resource/en/product_presentation/microcontrollers-stm32-family-overview.pdf</a>                                                               |
| Brochures               | <a href="https://www.st.com/resource/en/brochure/products-and-solutions-for-plcs-and-smart-i-os.pdf">https://www.st.com/resource/en/brochure/products-and-solutions-for-plcs-and-smart-i-os.pdf</a>                                                                       |
| Flyers                  | <a href="https://www.st.com/resource/en/flyer/flstm32f4x1.pdf">https://www.st.com/resource/en/flyer/flstm32f4x1.pdf</a>                                                                                                                                                   |
| Flyers                  | <a href="https://www.st.com/resource/en/flyer/flstm32nucleo.pdf">https://www.st.com/resource/en/flyer/flstm32nucleo.pdf</a>                                                                                                                                               |
| Flyers                  | <a href="https://www.st.com/resource/en/flyer/flstmcsuite.pdf">https://www.st.com/resource/en/flyer/flstmcsuite.pdf</a>                                                                                                                                                   |
| Flyers                  | <a href="https://www.st.com/resource/en/flyer/flstm32trust.pdf">https://www.st.com/resource/en/flyer/flstm32trust.pdf</a>                                                                                                                                                 |
| Product Certifications  | <a href="https://www.st.com/resource/en/certification_document/stm32_authentication_can.pdf">https://www.st.com/resource/en/certification_document/stm32_authentication_can.pdf</a>                                                                                       |
| Application Notes       | <a href="https://www.st.com/resource/en/application_note/an1181-electrostatic-discharge-sensitivity-measurement-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an1181-electrostatic-discharge-sensitivity-measurement-stmicroelectronics.pdf</a> |
| Application Notes       | <a href="https://www.st.com/resource/en/application_note/an1709-emc-design-guide-for-stm8-stm32-and-legacy-mcus-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an1709-emc-design-guide-for-stm8-stm32-and-legacy-mcus-stmicroelectronics.pdf</a> |
| Application Notes       | <a href="https://www.st.com/resource/en/application_note/an2606-stm32-microcontroller-system-memory-boot-mode-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an2606-stm32-microcontroller-system-memory-boot-mode-stmicroelectronics.pdf</a>     |
| Application Notes       | <a href="https://www.st.com/resource/en/application_note/an2639-soldering-">https://www.st.com/resource/en/application_note/an2639-soldering-</a>                                                                                                                         |

recommendations-and-package-information-for-leadfree-ecopack-mcus-and-mpus-stmicroelectronics.pdf

Application Notes [https://www.st.com/resource/en/application\\_note/an2867-oscillator-design-guide-for-stm8afals-stm32-mcus-and-mpus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an2867-oscillator-design-guide-for-stm8afals-stm32-mcus-and-mpus-stmicroelectronics.pdf)

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Application Notes [https://www.st.com/resource/en/application\\_note/an3070-managing-the-driver-enable-signal-for-rs485-and-iolink-communications-with-the-stm32s-usart-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3070-managing-the-driver-enable-signal-for-rs485-and-iolink-communications-with-the-stm32s-usart-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an3126-audio-and-waveform-generation-using-the-dac-in-stm32-products-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3126-audio-and-waveform-generation-using-the-dac-in-stm32-products-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an3154-can-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3154-can-protocol-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](https://www.st.com/resource/en/application_note/an3155-usart-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf)

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Application Notes [https://www.st.com/resource/en/application\\_note/an4031-using-the-stm32f2-stm32f4-and-stm32f7-series-dma-controller-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4031-using-the-stm32f2-stm32f4-and-stm32f7-series-dma-controller-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4221-i2c-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4221-i2c-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf)

- Application Notes [https://www.st.com/resource/en/application\\_note/an4229-how-to-implement-a-vocoder-solution-using-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4229-how-to-implement-a-vocoder-solution-using-stm32-microcontrollers-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4277-using-stm32-device-pwm-shutdown-features-for-motor-control-and-digital-power-conversion-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4277-using-stm32-device-pwm-shutdown-features-for-motor-control-and-digital-power-conversion-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4286-spi-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4286-spi-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4488-getting-started-with-stm32f4xxx-mcu-hardware-development-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4488-getting-started-with-stm32f4xxx-mcu-hardware-development-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4566-extending-the-dac-performance-of-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4566-extending-the-dac-performance-of-stm32-microcontrollers-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4616-migrating-from-stm32f401-and-stm32f411-lines-to-stm32l4-series-and-stm32l4-series-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4616-migrating-from-stm32f401-and-stm32f411-lines-to-stm32l4-series-and-stm32l4-series-microcontrollers-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4646-peripheral-interconnections-on-stm32f401-and-stm32f411-lines-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4646-peripheral-interconnections-on-stm32f401-and-stm32f411-lines-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4655-virtually-increasing-the-number-of-serial-communication-peripherals-in-stm32-applications-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4655-virtually-increasing-the-number-of-serial-communication-peripherals-in-stm32-applications-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4739-stm32cube-firmware-examples-for-stm32f4-series-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4739-stm32cube-firmware-examples-for-stm32f4-series-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4750-handling-of-soft-errors-in-stm32-applications-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4750-handling-of-soft-errors-in-stm32-applications-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4759-using-the-hardware-realtime-clock-rtc-and-the-tamper-management-unit-tamp-with-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4759-using-the-hardware-realtime-clock-rtc-and-the-tamper-management-unit-tamp-with-stm32-microcontrollers-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4776-generalpurpose-timer-cookbook-for-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4776-generalpurpose-timer-cookbook-for-stm32-microcontrollers-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4803-highspeed-si-simulations-using-ibis-and-boardlevel-simulations-using-hyperlynx-si-on-stm32-mcus-and-mpus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4803-highspeed-si-simulations-using-ibis-and-boardlevel-simulations-using-hyperlynx-si-on-stm32-mcus-and-mpus-stmicroelectronics.pdf)

- Application Notes [https://www.st.com/resource/en/application\\_note/an4850-stm32-mcus-spreadspectrum-clock-generation-principles-properties-and-implementation-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4850-stm32-mcus-spreadspectrum-clock-generation-principles-properties-and-implementation-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4904-migration-of-microcontroller-applications-from-stm32f1-series-to-stm32f4-access-lines-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4904-migration-of-microcontroller-applications-from-stm32f1-series-to-stm32f4-access-lines-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4908-stm32-usart-automatic-baud-rate-detection-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4908-stm32-usart-automatic-baud-rate-detection-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4989-stm32-microcontroller-debug-toolbox-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4989-stm32-microcontroller-debug-toolbox-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4995-using-an-electromyogram-technique-to-detect-muscle-activity-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4995-using-an-electromyogram-technique-to-detect-muscle-activity-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an5027-interfacing-pdm-digital-microphones-using-stm32-mcus-and-mpus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5027-interfacing-pdm-digital-microphones-using-stm32-mcus-and-mpus-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an5036-thermal-management-guidelines-for-stm32-applications-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5036-thermal-management-guidelines-for-stm32-applications-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an5073-receiving-spdif-audio-stream-with-the-stm32f4f7h7-series-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5073-receiving-spdif-audio-stream-with-the-stm32f4f7h7-series-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an5543-enhanced-methods-to-handle-spi-communication-on-stm32-devices-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5543-enhanced-methods-to-handle-spi-communication-on-stm32-devices-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4899-stm32-microcontroller-gpio-hardware-settings-and-lowpower-consumption-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4899-stm32-microcontroller-gpio-hardware-settings-and-lowpower-consumption-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an5612-esd-protection-of-stm32-mcus-and-mpus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5612-esd-protection-of-stm32-mcus-and-mpus-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an5156-introduction-to-stm32-microcontrollers-security-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5156-introduction-to-stm32-microcontrollers-security-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4838-introduction-to-memory-protection-unit-management-on-stm32-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4838-introduction-to-memory-protection-unit-management-on-stm32-mcus-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an5852-migrating-from-](https://www.st.com/resource/en/application_note/an5852-migrating-from-)

stm32f401-stm32f410-and-stm32f411-to-stm32h503-mcus-stmicroelectronics.pdf

Application Notes [https://www.st.com/resource/en/application\\_note/an4230-random-number-generation-validation-using-nist-statistical-test-suite-for-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4230-random-number-generation-validation-using-nist-statistical-test-suite-for-stm32-microcontrollers-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4879-introduction-to-usb-hardware-and-pcb-guidelines-using-stm32-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4879-introduction-to-usb-hardware-and-pcb-guidelines-using-stm32-mcus-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an5225-introduction-to-usb-typec-power-delivery-for-stm32-mcus-and-mpus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5225-introduction-to-usb-typec-power-delivery-for-stm32-mcus-and-mpus-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an2834-how-to-optimize-the-adc-accuracy-in-the-stm32-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an2834-how-to-optimize-the-adc-accuracy-in-the-stm32-mcus-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an5816-how-to-build-stm32-lpbam-application-using-stm32cubemx-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5816-how-to-build-stm32-lpbam-application-using-stm32cubemx-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an5537-how-to-use-adc-oversampling-techniques-to-improve-signal-to-noise-ratio-on-stm32-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5537-how-to-use-adc-oversampling-techniques-to-improve-signal-to-noise-ratio-on-stm32-mcus-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an1202\\_freertos\\_guide-for\\_related\\_Tools\\_freertos-guide-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an1202_freertos_guide-for_related_Tools_freertos-guide-stmicroelectronics.pdf)  
& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an1602\\_semihosting\\_in\\_for\\_related\\_Tools\\_truestudio-how-to-do-semihosting-in-truestudio-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an1602_semihosting_in_for_related_Tools_truestudio-how-to-do-semihosting-in-truestudio-stmicroelectronics.pdf)  
& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an1801\\_stm32cubeprog\\_for\\_related\\_Tools\\_rammer\\_in\\_truestudio-installing-stm32cubeprogrammer-in-truestudio-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an1801_stm32cubeprog_for_related_Tools_rammer_in_truestudio-installing-stm32cubeprogrammer-in-truestudio-stmicroelectronics.pdf)  
& Software

Application Notes [https://www.st.com/resource/en/application\\_note/atollic\\_editing\\_keyboard\\_for\\_related\\_Tools\\_shortcuts-atollic-editing-keyboard-shortcuts-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/atollic_editing_keyboard_for_related_Tools_shortcuts-atollic-editing-keyboard-shortcuts-stmicroelectronics.pdf)  
& Software

Application Notes [https://www.st.com/resource/en/application\\_note/iar\\_to\\_atollic\\_truestudio\\_for\\_related\\_Tools\\_migration\\_guide-truestudio-for-arm-migration-guide-iar-embedded-workbench-to-truestudio-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/iar_to_atollic_truestudio_for_related_Tools_migration_guide-truestudio-for-arm-migration-guide-iar-embedded-workbench-to-truestudio-stmicroelectronics.pdf)  
& Software

Application Notes [https://www.st.com/resource/en/application\\_note/stm32cubemx\\_installatio](https://www.st.com/resource/en/application_note/stm32cubemx_installatio)

for related Tools    n\_in\_truestudio-stm32cubemx-installation-in-truestudio-  
& Software            stmicroelectronics.pdf

Application Notes    [https://www.st.com/resource/en/application\\_note/an2656-stm32f10xxx-](https://www.st.com/resource/en/application_note/an2656-stm32f10xxx-lcd-glass-driver-firmware-stmicroelectronics.pdf)  
for related Tools    lcd-glass-driver-firmware-stmicroelectronics.pdf  
& Software

Application Notes    [https://www.st.com/resource/en/application\\_note/an2790-tft-lcd-](https://www.st.com/resource/en/application_note/an2790-tft-lcd-interfacing-with-the-highdensity-stm32f10xxx-fsmc-stmicroelectronics.pdf)  
for related Tools    interfacing-with-the-highdensity-stm32f10xxx-fsmc-stmicroelectronics.pdf  
& Software

Application Notes    [https://www.st.com/resource/en/application\\_note/an3078-stm32-](https://www.st.com/resource/en/application_note/an3078-stm32-inapplication-programming-over-the-ic-bus-stmicroelectronics.pdf)  
for related Tools    inapplication-programming-over-the-ic-bus-stmicroelectronics.pdf  
& Software

Application Notes    [https://www.st.com/resource/en/application\\_note/an3116-stm32s-adc-](https://www.st.com/resource/en/application_note/an3116-stm32s-adc-modes-and-their-applications-stmicroelectronics.pdf)  
for related Tools    modes-and-their-applications-stmicroelectronics.pdf  
& Software

Application Notes    [https://www.st.com/resource/en/application\\_note/an3174-implementing-](https://www.st.com/resource/en/application_note/an3174-implementing-receivers-for-infrared-remote-control-protocols-using-stm32f10xxx-microcontrollers-stmicroelectronics.pdf)  
for related Tools    receivers-for-infrared-remote-control-protocols-using-stm32f10xxx-  
& Software            microcontrollers-stmicroelectronics.pdf

Application Notes    [https://www.st.com/resource/en/application\\_note/an3241-qvga-tftlcd-](https://www.st.com/resource/en/application_note/an3241-qvga-tftlcd-direct-drive-using-the-stm32f10xx-fsmc-peripheral-stmicroelectronics.pdf)  
for related Tools    direct-drive-using-the-stm32f10xx-fsmc-peripheral-stmicroelectronics.pdf  
& Software

Application Notes    [https://www.st.com/resource/en/application\\_note/an3307-guidelines-for-](https://www.st.com/resource/en/application_note/an3307-guidelines-for-obtaining-iec-60335-class-b-certification-for-any-stm32-application-stmicroelectronics.pdf)  
for related Tools    obtaining-iec-60335-class-b-certification-for-any-stm32-application-  
& Software            stmicroelectronics.pdf

Application Notes    [https://www.st.com/resource/en/application\\_note/an3364-migration-and-](https://www.st.com/resource/en/application_note/an3364-migration-and-compatibility-guidelines-for-stm32-microcontroller-applications-stmicroelectronics.pdf)  
for related Tools    compatibility-guidelines-for-stm32-microcontroller-applications-  
& Software            stmicroelectronics.pdf

Application Notes    [https://www.st.com/resource/en/application\\_note/an3965-](https://www.st.com/resource/en/application_note/an3965-stm32f40xstm32f41x-inapplication-programming-using-the-usart-stmicroelectronics.pdf)  
for related Tools    stm32f40xstm32f41x-inapplication-programming-using-the-usart-  
& Software            stmicroelectronics.pdf

Application Notes    [https://www.st.com/resource/en/application\\_note/an3969-eeeprom-](https://www.st.com/resource/en/application_note/an3969-eeeprom-emulation-in-stm32f40xstm32f41x-microcontrollers-stmicroelectronics.pdf)  
for related Tools    emulation-in-stm32f40xstm32f41x-microcontrollers-stmicroelectronics.pdf  
& Software

Application Notes    [https://www.st.com/resource/en/application\\_note/an3990-upgrading-](https://www.st.com/resource/en/application_note/an3990-upgrading-stm32f4discovery-board-firmware-using-a-usb-key-stmicroelectronics.pdf)  
for related Tools    stm32f4discovery-board-firmware-using-a-usb-key-stmicroelectronics.pdf

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an3997-audio-playback-for-related-Tools-and-recording-using-the-stm32f4discovery-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3997-audio-playback-for-related-Tools-and-recording-using-the-stm32f4discovery-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an3998-pdm-audio-for-related-Tools-software-decoding-on-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3998-pdm-audio-for-related-Tools-software-decoding-on-stm32-microcontrollers-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4044-floating-point-unit-demonstration-on-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4044-floating-point-unit-demonstration-on-stm32-microcontrollers-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4323-getting-started-for-related-Tools-with-stemwin-library-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4323-getting-started-for-related-Tools-with-stemwin-library-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4365-using-stm32f4-for-related-Tools-mcu-power-modes-with-best-dynamic-efficiency-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4365-using-stm32f4-for-related-Tools-mcu-power-modes-with-best-dynamic-efficiency-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4435-guidelines-for-obtaining-ulcsaiec-607301603351-class-b-certification-in-any-stm32-application-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4435-guidelines-for-obtaining-ulcsaiec-607301603351-class-b-certification-in-any-stm32-application-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4457-implementing-an-emulated-uart-on-stm32f4-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4457-implementing-an-emulated-uart-on-stm32f4-microcontrollers-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4499-stm32--nrf51822-bluetooth-low-energy-system-solution-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4499-stm32--nrf51822-bluetooth-low-energy-system-solution-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4515-using-batch-acquisition-mode-bam-to-maximize-power-efficiency-on-stm32f410-stm32f411-stm32f412-stm32f413-microcontroller-lines-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4515-using-batch-acquisition-mode-bam-to-maximize-power-efficiency-on-stm32f410-stm32f411-stm32f412-stm32f413-microcontroller-lines-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4657-stm32-inapplication-programming-iap-using-the-usart-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4657-stm32-inapplication-programming-iap-using-the-usart-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4666-parallel-synchronous-transmission-using-gpio-and-dma-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4666-parallel-synchronous-transmission-using-gpio-and-dma-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4678-full-duplex-spi-for-related-Tools-emulation-for-stm32f4-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4678-full-duplex-spi-for-related-Tools-emulation-for-stm32f4-microcontrollers-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4701-proprietary-code-readout-protection-on-microcontrollers-of-the-stm32f4-series-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4701-proprietary-code-readout-protection-on-microcontrollers-of-the-stm32f4-series-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4739-stm32cube-firmware-examples-for-stm32f4-series-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4739-stm32cube-firmware-examples-for-stm32f4-series-stmicroelectronics.pdf)

& Software

Application Notes [https://www.st.com/resource/en/application\\_note/an4758-proprietary-code-readout-protection-on-stm32l4-stm32l4-stm32g4-and-stm32wb-series-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4758-proprietary-code-readout-protection-on-stm32l4-stm32l4-stm32g4-and-stm32wb-series-mcus-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4759-using-the-hardware-realtime-clock-rtc-and-the-tamper-management-unit-tamp-with-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4759-using-the-hardware-realtime-clock-rtc-and-the-tamper-management-unit-tamp-with-stm32-microcontrollers-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4841-digital-signal-processing-for-stm32-microcontrollers-using-cmsis-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4841-digital-signal-processing-for-stm32-microcontrollers-using-cmsis-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an4968-proprietary-code-read-out-protection-pcrop-on-stm32f72xxx-and-stm32f73xxx-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4968-proprietary-code-read-out-protection-pcrop-on-stm32f72xxx-and-stm32f73xxx-microcontrollers-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an5054-secure-programming-using-stm32cubeprogrammer-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5054-secure-programming-using-stm32cubeprogrammer-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an5056-integration-guide-for-the-xcubesbsfu-stm32cube-expansion-package-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5056-integration-guide-for-the-xcubesbsfu-stm32cube-expansion-package-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an5360-getting-started-with-projects-based-on-the-stm32mp1-series-in-stm32cubeide-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5360-getting-started-with-projects-based-on-the-stm32mp1-series-in-stm32cubeide-stmicroelectronics.pdf)

Application Notes [https://www.st.com/resource/en/application\\_note/an5361-getting-started-with-projects-based-on-dualcore-stm32h7-microcontrollers-in-stm32cubeide-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an5361-getting-started-with-projects-based-on-dualcore-stm32h7-microcontrollers-in-stm32cubeide-stmicroelectronics.pdf)



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|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Application Notes for related Tools & Software | <a href="https://www.st.com/resource/en/application_note/an5394-getting-started-with-projects-based-on-the-stm32l5-series-in-stm32cubeide-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an5394-getting-started-with-projects-based-on-the-stm32l5-series-in-stm32cubeide-stmicroelectronics.pdf</a>                                                             |
| Application Notes for related Tools & Software | <a href="https://www.st.com/resource/en/application_note/an5418-how-to-build-a-simple-usbp-d-sink-application-with-stm32cubemx-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an5418-how-to-build-a-simple-usbp-d-sink-application-with-stm32cubemx-stmicroelectronics.pdf</a>                                                                                   |
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| Application Notes for related Tools & Software | <a href="https://www.st.com/resource/en/application_note/an5731-stm32cubemx-and-stm32cubeide-threadsafe-solution-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an5731-stm32cubemx-and-stm32cubeide-threadsafe-solution-stmicroelectronics.pdf</a>                                                                                                               |
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Technical Notes & Articles    [https://www.st.com/resource/en/technical\\_note/tn1433-reference-device-marking-schematics-for-stm32-microcontrollers-and-microprocessors-stmicroelectronics.pdf](https://www.st.com/resource/en/technical_note/tn1433-reference-device-marking-schematics-for-stm32-microcontrollers-and-microprocessors-stmicroelectronics.pdf)