



## 1. Description

### 1.1. Project

|                 |                   |
|-----------------|-------------------|
| Project Name    | densitometer      |
| Board Name      | custom            |
| Generated with: | STM32CubeMX 6.2.1 |
| Date            | 06/24/2021        |

### 1.2. MCU

|                |               |
|----------------|---------------|
| MCU Series     | STM32L0       |
| MCU Line       | STM32L0x2     |
| MCU name       | STM32L052K8Ux |
| MCU Package    | UFQFPN32      |
| MCU Pin number | 32            |

### 1.3. Core(s) information

|         |                |
|---------|----------------|
| Core(s) | Arm Cortex-M0+ |
|---------|----------------|

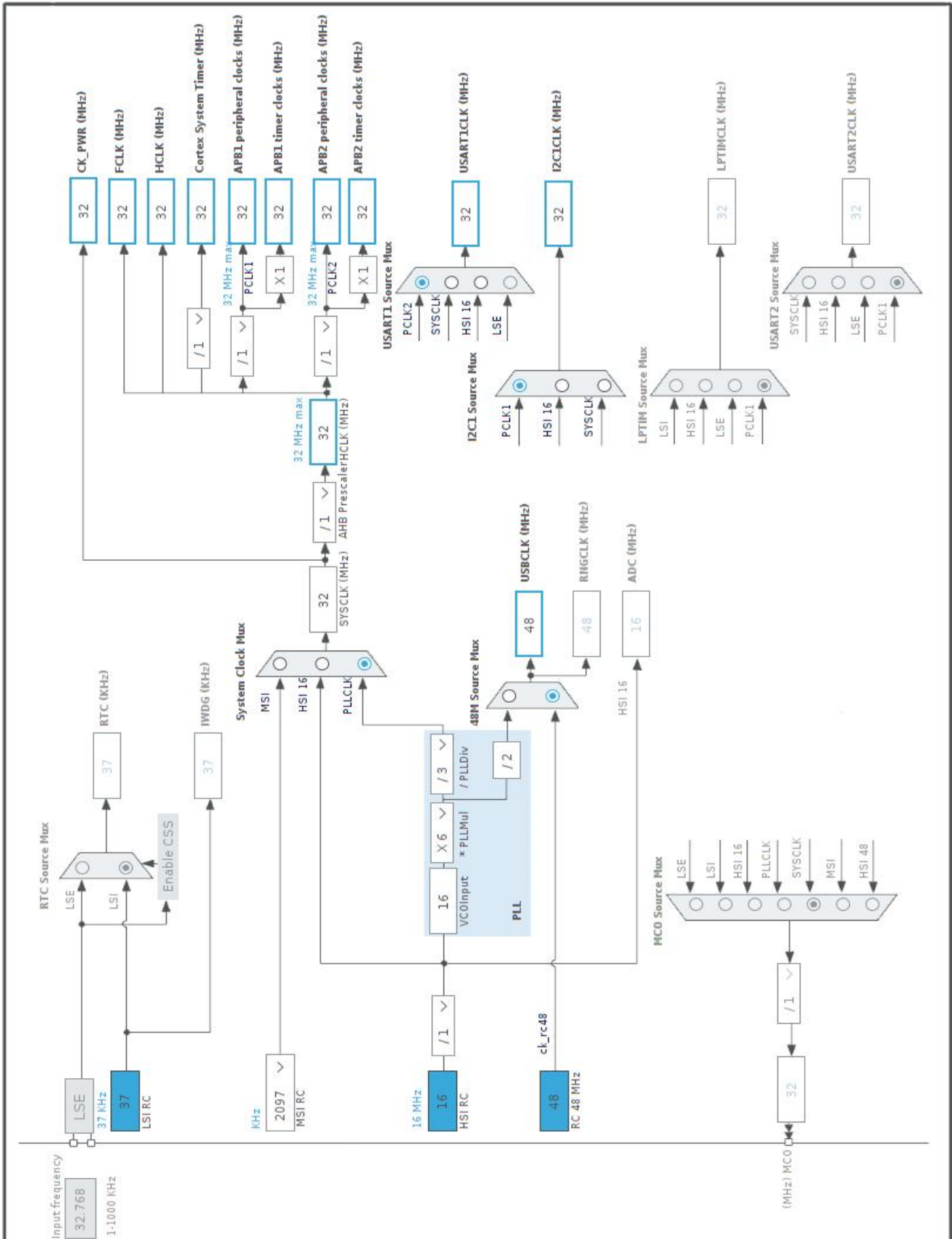


### 3. Pins Configuration

| Pin Number<br>UFQFPN32 | Pin Name<br>(function after<br>reset) | Pin Type | Alternate<br>Function(s) | Label     |
|------------------------|---------------------------------------|----------|--------------------------|-----------|
| 1                      | VDD                                   | Power    |                          |           |
| 4                      | NRST                                  | Reset    |                          |           |
| 5                      | VDDA                                  | Power    |                          |           |
| 8                      | PA2                                   | I/O      | TIM2_CH3                 | RLED_EN   |
| 9                      | PA3                                   | I/O      | TIM2_CH4                 | TLED_EN   |
| 10                     | PA4                                   | I/O      | SPI1_NSS                 | DISP_CS   |
| 11                     | PA5                                   | I/O      | SPI1_SCK                 | DISP_SCK  |
| 12                     | PA6 *                                 | I/O      | GPIO_Output              | DISP_DC   |
| 13                     | PA7                                   | I/O      | SPI1_MOSI                | DISP_MOSI |
| 14                     | PB0 *                                 | I/O      | GPIO_Output              | DISP_RES  |
| 17                     | VDD                                   | Power    |                          |           |
| 18                     | PA8                                   | I/O      | GPIO_EXTI8               | BTN5      |
| 19                     | PA9                                   | I/O      | USART1_TX                |           |
| 20                     | PA10                                  | I/O      | USART1_RX                |           |
| 21                     | PA11                                  | I/O      | USB_DM                   |           |
| 22                     | PA12                                  | I/O      | USB_DP                   |           |
| 23                     | PA13                                  | I/O      | SYS_SWDIO                |           |
| 24                     | PA14                                  | I/O      | SYS_SWCLK                |           |
| 25                     | PA15                                  | I/O      | GPIO_EXTI15              | BTN4      |
| 26                     | PB3                                   | I/O      | GPIO_EXTI3               | BTN3      |
| 27                     | PB4                                   | I/O      | GPIO_EXTI4               | BTN2      |
| 28                     | PB5                                   | I/O      | GPIO_EXTI5               | BTN1      |
| 29                     | PB6                                   | I/O      | I2C1_SCL                 |           |
| 30                     | PB7                                   | I/O      | I2C1_SDA                 |           |
| 31                     | BOOT0                                 | Boot     |                          |           |

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

## 4. Clock Tree Configuration



## 5. Software Project

### 5.1. Project Settings

| Name                              | Value                                   |
|-----------------------------------|---|
| Project Name                      | densitometer                            |
| Project Folder                    | /home/octo/devel/densitometer/docs/cube |
| Toolchain / IDE                   | STM32CubeIDE                            |
| Firmware Package Name and Version | STM32Cube FW_L0 V1.12.0                 |
| 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    | MX_GPIO_Init        | GPIO                     |
| 2    | SystemClock_Config  | RCC                      |
| 3    | MX_I2C1_Init        | I2C1                     |
| 4    | MX_TIM2_Init        | TIM2                     |
| 5    | MX_USART1_UART_Init | USART1                   |
| 6    | MX_USB_DEVICE_Init  | USB_DEVICE               |
| 7    | MX_SPI1_Init        | SPI1                     |

## 6. Power Consumption Calculator report

### 6.1. Microcontroller Selection

|           |               |
|-----------|---------------|
| Series    | STM32L0       |
| Line      | STM32L0x2     |
| MCU       | STM32L052K8Ux |
| Datasheet | DS10182_Rev7  |

### 6.2. Parameter Selection

|             |     |
|-------------|-----|
| Temperature | 25  |
| Vdd         | 3.0 |

### 6.3. Battery Selection

|                   |                  |
|-------------------|------------------|
| Battery           | Li-SOCL2(AAA700) |
| Capacity          | 700.0 mAh        |
| Self Discharge    | 0.08 %/month     |
| Nominal Voltage   | 3.6 V            |
| Max Cont Current  | 10.0 mA          |
| Max Pulse Current | 30.0 mA          |
| Cells in series   | 1                |
| Cells in parallel | 1                |

#### 6.4. Sequence

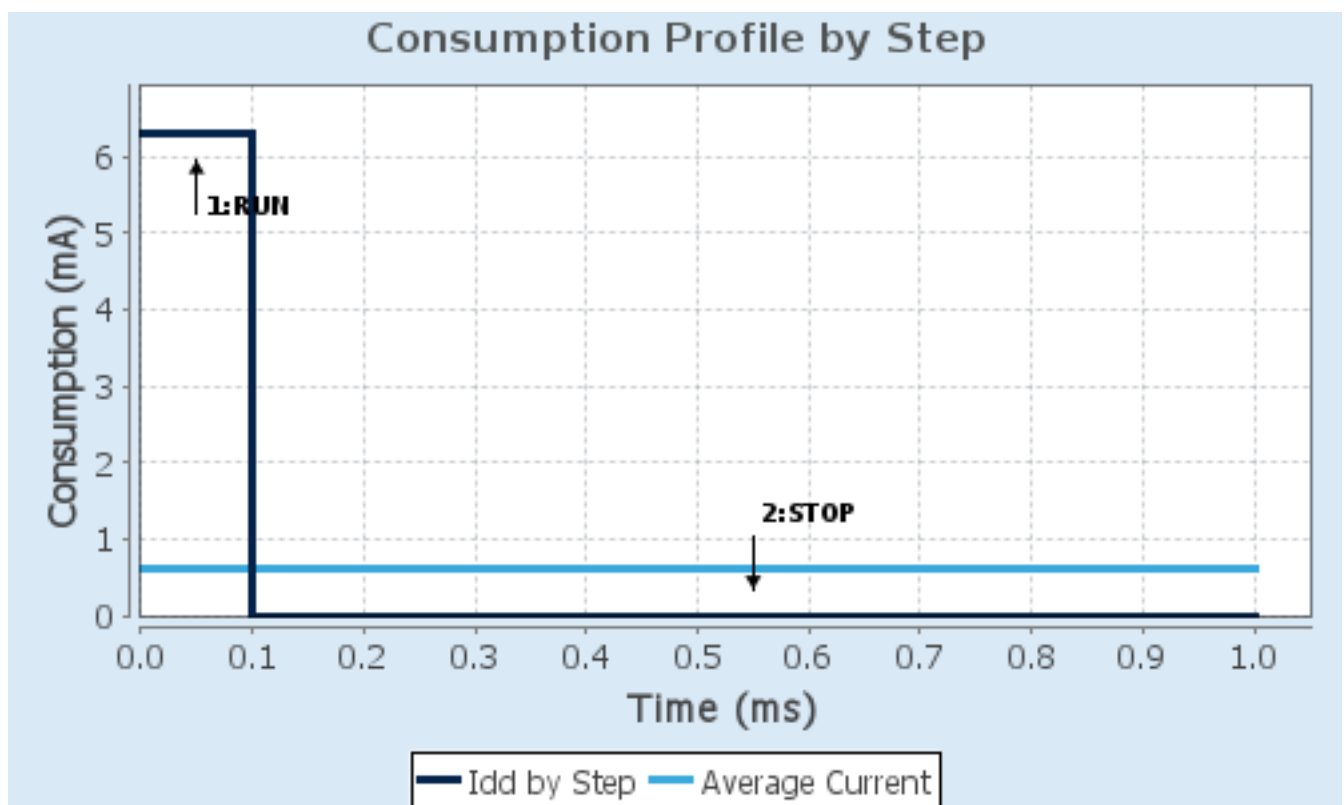
|                               |             |                |
|-------------------------------|-------------|----------------|
| <b>Step</b>                   | Step1       | Step2          |
| <b>Mode</b>                   | RUN         | STOP           |
| <b>Vdd</b>                    | 3.0         | 3.0            |
| <b>Voltage Source</b>         | Battery     | Battery        |
| <b>Range</b>                  | Range1-High | NoRange        |
| <b>Fetch Type</b>             | FLASH       | n/a            |
| <b>CPU Frequency</b>          | 32 MHz      | 0 Hz           |
| <b>Clock Configuration</b>    | HSEBYP PLL  | ALL CLOCKS OFF |
| <b>Clock Source Frequency</b> | 16 MHz      | 0 Hz           |
| <b>Peripherals</b>            |             |                |
| <b>Additional Cons.</b>       | 0 mA        | 0 mA           |
| <b>Average Current</b>        | 6.3 mA      | 410 nA         |
| <b>Duration</b>               | 0.1 ms      | 0.9 ms         |
| <b>DMIPS</b>                  | 30.0        | 0.0            |
| <b>Ta Max</b>                 | 104.28      | 105            |
| <b>Category</b>               | In DS Table | In DS Table    |

#### 6.5. Results

|               |                               |                 |                |
|---------------|-------------------------------|-----------------|----------------|
| Sequence Time | 1 ms                          | Average Current | 630.37 $\mu$ A |
| Battery Life  | 1 month, 15 days,<br>19 hours | Average DMIPS   | 30.4 DMIPS     |

#### 6.6. Chart





## 7. Peripherals and Middlewares Configuration

### 7.1. I2C1

#### I2C: I2C

##### 7.1.1. Parameter Settings:

###### Timing configuration:

|                               |                     |
|-------------------------------|---------------------|
| I2C Speed Mode                | <b>Fast Mode *</b>  |
| I2C Speed Frequency (KHz)     | 400                 |
| Rise Time (ns)                | 0                   |
| Fall Time (ns)                | 0                   |
| Coefficient of Digital Filter | 0                   |
| Analog Filter                 | Enabled             |
| Timing                        | <b>0x00300F38 *</b> |

###### Slave Features:

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

### 7.2. RCC

##### 7.2.1. Parameter Settings:

###### System Parameters:

|                   |                    |
|-------------------|--------------------|
| VDD voltage (V)   | 3.3                |
| Buffer Cache      | Enabled            |
| Prefetch          | Disabled           |
| Preread           | Enabled            |
| Flash Latency(WS) | 1 WS (2 CPU cycle) |

###### RCC Parameters:

|                                |      |
|--------------------------------|------|
| HSI Calibration Value          | 16   |
| MSI Calibration Value          | 0    |
| HSE Startup Timeout Value (ms) | 100  |
| LSE Startup Timeout Value (ms) | 5000 |

###### Power Parameters:

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

### 7.3. SPI1

**Mode: Transmit Only Master**

**Hardware NSS Signal: Hardware NSS Output Signal**

#### 7.3.1. Parameter Settings:

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

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

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

|                           |                       |
|---------------------------|-----------------------|
| Prescaler (for Baud Rate) | 2                     |
| Baud Rate                 | <b>16.0 MBits/s *</b> |
| Clock Polarity (CPOL)     | Low                   |
| Clock Phase (CPHA)        | 1 Edge                |

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

|                 |                 |
|-----------------|-----------------|
| CRC Calculation | Disabled        |
| NSS Signal Type | Output Hardware |

### 7.4. SYS

**mode: Debug Serial Wire**

**Timebase Source: SysTick**

### 7.5. TIM2

**Clock Source : Internal Clock**

**Channel3: PWM Generation CH3**

**Channel4: PWM Generation CH4**

#### 7.5.1. Parameter Settings:

##### **Counter Settings:**

|   |              |
|---|--------------|
| Prescaler (PSC - 16 bits value)                       | <b>1 *</b>   |
| Counter Mode  | Up           |
| Counter Period (AutoReload Register - 16 bits value ) | <b>127 *</b> |
| Internal Clock Division (CKD)                         | No Division  |
| auto-reload preload                                   | Disable      |

##### **Trigger Output (TRGO) Parameters:**

|                             |  |
|-----------------------------|--|
| Master/Slave Mode (MSM bit) | Disable (Trigger input effect not delayed) |
|-----------------------------|--|

Trigger Event Selection

Reset (UG bit from TIMx\_EGR)

### **PWM Generation Channel 3:**

Mode

PWM mode 1

Pulse (16 bits value)

**64 \***

Output compare preload

Enable

Fast Mode

Disable

CH Polarity

High

### **PWM Generation Channel 4:**

Mode

PWM mode 1

Pulse (16 bits value)

**64 \***

Output compare preload

Enable

Fast Mode

Disable

CH Polarity

High

## **7.6. USART1**

### **Mode: Asynchronous**

#### **7.6.1. 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

Single Sample

Disable

##### **Advanced Features:**

Auto Baudrate

Disable

TX Pin Active Level Inversion

Disable

RX Pin Active Level Inversion

Disable

Data Inversion

Disable

TX and RX Pins Swapping

Disable

Overrun

Enable

DMA on RX Error

Enable

MSB First

Disable

## 7.7. USB

### mode: Device (FS)

#### 7.7.1. Parameter Settings:

##### Basic Parameters:

|                    |                     |
|--------------------|---------------------|
| Speed              | Full Speed 12MBit/s |
| Physical interface | Internal Phy        |

##### Power Parameters:

|                       |          |
|-----------------------|----------|
| Low Power             | Disabled |
| Link Power Management | Disabled |

## 7.8. USB\_DEVICE

### Class For FS IP: Communication Device Class (Virtual Port Com)

#### 7.8.1. 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 | 1000 |
| USB CDC Tx Buffer Size | 1000 |

#### 7.8.2. Device Descriptor:

##### Device Descriptor:

|   |                        |
|---|------------------------|
| VID (Vendor Identifier)                       | 1155                   |
| LANGID_STRING (Language Identifier)           | English(United States) |
| 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**

## 8. System Configuration

### 8.1. GPIO configuration

| IP     | Pin  | Signal      | GPIO mode  | GPIO pull/up pull down      | Max Speed   | User Label |
|--------|------|-------------|--|-----------------------------|-------------|------------|
| I2C1   | PB6  | I2C1_SCL    | Alternate Function Open Drain                              | Pull-up                     | Very High * |            |
|        | PB7  | I2C1_SDA    | Alternate Function Open Drain                              | Pull-up                     | Very High * |            |
| SPI1   | PA4  | SPI1_NSS    | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * | DISP_CS    |
|        | PA5  | SPI1_SCK    | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * | DISP_SCK   |
|        | PA7  | SPI1_MOSI   | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * | DISP_MOSI  |
| SYS    | PA13 | SYS_SWDIO   | n/a  | n/a                         | n/a         |            |
|        | PA14 | SYS_SWCLK   | n/a  | n/a                         | n/a         |            |
| TIM2   | PA2  | TIM2_CH3    | Alternate Function Push Pull                               | No pull-up and no pull-down | Low         | RLED_EN    |
|        | PA3  | TIM2_CH4    | Alternate Function Push Pull                               | No pull-up and no pull-down | Low         | TLED_EN    |
| USART1 | PA9  | USART1_TX   | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * |            |
|        | PA10 | USART1_RX   | Alternate Function Push Pull                               | No pull-up and no pull-down | Very High * |            |
| USB    | PA11 | USB_DM      | n/a  | n/a                         | n/a         |            |
|        | PA12 | USB_DP      | n/a  | n/a                         | n/a         |            |
| GPIO   | PA6  | GPIO_Output | Output Push Pull   | No pull-up and no pull-down | Low         | DISP_DC    |
|        | PB0  | GPIO_Output | Output Push Pull   | No pull-up and no pull-down | Low         | DISP_RES   |
|        | PA8  | GPIO_EXTI8  | <b>External Interrupt Mode with Rising/Falling edge</b>    | No pull-up and no pull-down | n/a         | BTN5       |
|        | PA15 | GPIO_EXTI15 | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a         | BTN4       |
|        | PB3  | GPIO_EXTI3  | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a         | BTN3       |
|        | PB4  | GPIO_EXTI4  | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a         | BTN2       |
|        | PB5  | GPIO_EXTI5  | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a         | BTN1       |

## **8.2. DMA configuration**

nothing configured in DMA service



### 8.3. NVIC configuration

#### 8.3.1. NVIC

| Interrupt Table   | Enable | Preenmption Priority | SubPriority |
|---|--------|----------------------|-------------|
| Non maskable interrupt  | true   | 0                    | 0           |
| Hard fault interrupt  | true   | 0                    | 0           |
| System service call via SWI instruction                                   | true   | 0                    | 0           |
| Pendable request for system service                                       | true   | 0                    | 0           |
| System tick timer   | true   | 0                    | 0           |
| EXTI line 2 and line 3 interrupts   | true   | 0                    | 0           |
| EXTI line 4 to 15 interrupts  | true   | 0                    | 0           |
| USB event interrupt / USB wake-up interrupt through EXTI line 18          | true   | 0                    | 0           |
| PVD interrupt through EXTI line 16  | unused |                      |             |
| Flash and EEPROM global interrupt   | unused |                      |             |
| RCC and CRS global interrupt  | unused |                      |             |
| TIM2 global interrupt   | unused |                      |             |
| I2C1 event global interrupt / I2C1 wake-up interrupt through EXTI line 23 | unused |                      |             |
| SPI1 global interrupt   | unused |                      |             |
| USART1 global interrupt / USART1 wake-up interrupt through EXTI line 25   | unused |                      |             |

#### 8.3.2. 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            |
| System service call via SWI instruction                          | false                             | true                 | false            |
| Pendable request for system service                              | false                             | true                 | false            |
| System tick timer  | false                             | true                 | true             |
| EXTI line 2 and line 3 interrupts                                | false                             | true                 | true             |
| EXTI line 4 to 15 interrupts                                     | false                             | true                 | true             |
| USB event interrupt / USB wake-up interrupt through EXTI line 18 | false                             | true                 | true             |

\* User modified value

## 9. System Views

### 9.1. Category view

#### 9.1.1. Current

| Middleware   |        |        |              |          |           |
|--------------|--------|--------|--------------|----------|-----------|
| USB_DEVICE ✓ |        |        |              |          |           |
| System Core  | Analog | Timers | Connectivity | Security | Computing |
| DMA          |        | TIM2 ✓ | I2C1 ✓       |          |           |
| GPIO ✓       |        |        | SPI1 ✓       |          |           |
| NVIC ✓       |        |        | USART1 ✓     |          |           |
| RCC ✓        |        |        | USB ✓        |          |           |
| SYS ✓        |        |        |              |          |           |

## 10. Docs & Resources

| Type               | Link  |
|--------------------|---|
| Datasheet          | <a href="http://www.st.com/resource/en/datasheet/DM00108217.pdf">http://www.st.com/resource/en/datasheet/DM00108217.pdf</a>                   |
| Reference manual   | <a href="http://www.st.com/resource/en/reference_manual/DM00108281.pdf">http://www.st.com/resource/en/reference_manual/DM00108281.pdf</a>     |
| Programming manual | <a href="http://www.st.com/resource/en/programming_manual/DM00104451.pdf">http://www.st.com/resource/en/programming_manual/DM00104451.pdf</a> |
| Errata sheet       | <a href="http://www.st.com/resource/en/errata_sheet/DM00114896.pdf">http://www.st.com/resource/en/errata_sheet/DM00114896.pdf</a>             |
| Application note   | <a href="http://www.st.com/resource/en/application_note/CD00160362.pdf">http://www.st.com/resource/en/application_note/CD00160362.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/CD00167594.pdf">http://www.st.com/resource/en/application_note/CD00167594.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/CD00211314.pdf">http://www.st.com/resource/en/application_note/CD00211314.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/CD00259245.pdf">http://www.st.com/resource/en/application_note/CD00259245.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/CD00264342.pdf">http://www.st.com/resource/en/application_note/CD00264342.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/CD00264379.pdf">http://www.st.com/resource/en/application_note/CD00264379.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00042534.pdf">http://www.st.com/resource/en/application_note/DM00042534.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00072315.pdf">http://www.st.com/resource/en/application_note/DM00072315.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00073742.pdf">http://www.st.com/resource/en/application_note/DM00073742.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00073853.pdf">http://www.st.com/resource/en/application_note/DM00073853.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00081379.pdf">http://www.st.com/resource/en/application_note/DM00081379.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00085385.pdf">http://www.st.com/resource/en/application_note/DM00085385.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00087593.pdf">http://www.st.com/resource/en/application_note/DM00087593.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00108286.pdf">http://www.st.com/resource/en/application_note/DM00108286.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00112257.pdf">http://www.st.com/resource/en/application_note/DM00112257.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00129215.pdf">http://www.st.com/resource/en/application_note/DM00129215.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00145318.pdf">http://www.st.com/resource/en/application_note/DM00145318.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00150625.pdf">http://www.st.com/resource/en/application_note/DM00150625.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00151811.pdf">http://www.st.com/resource/en/application_note/DM00151811.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00158601.pdf">http://www.st.com/resource/en/application_note/DM00158601.pdf</a>     |
| Application note   | <a href="http://www.st.com/resource/en/application_note/DM00160482.pdf">http://www.st.com/resource/en/application_note/DM00160482.pdf</a>     |

Application note [http://www.st.com/resource/en/application\\_note/DM00150423.pdf](http://www.st.com/resource/en/application_note/DM00150423.pdf)

Application note [http://www.st.com/resource/en/application\\_note/DM00209725.pdf](http://www.st.com/resource/en/application_note/DM00209725.pdf)

Application note [http://www.st.com/resource/en/application\\_note/DM00209768.pdf](http://www.st.com/resource/en/application_note/DM00209768.pdf)

Application note [http://www.st.com/resource/en/application\\_note/DM00220769.pdf](http://www.st.com/resource/en/application_note/DM00220769.pdf)

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