# 1. Description

1.1. Project

| | |
|---|---|
| Project Name | ECU_BRAINv2_VSC |
| Board Name | custom |
| Generated with: | STM32CubeMX 5.6.0 |
| Date | 05/09/2020 |

1.2. MCU

| | |
|---|---|
| MCU Series | STM32F7 |
| MCU Line | STM32F7x5 |
| MCU name | STM32F765VGTx |
| MCU Package | LQFP100 |
| MCU Pin number | 100 |

# 2. Pinout Configuration
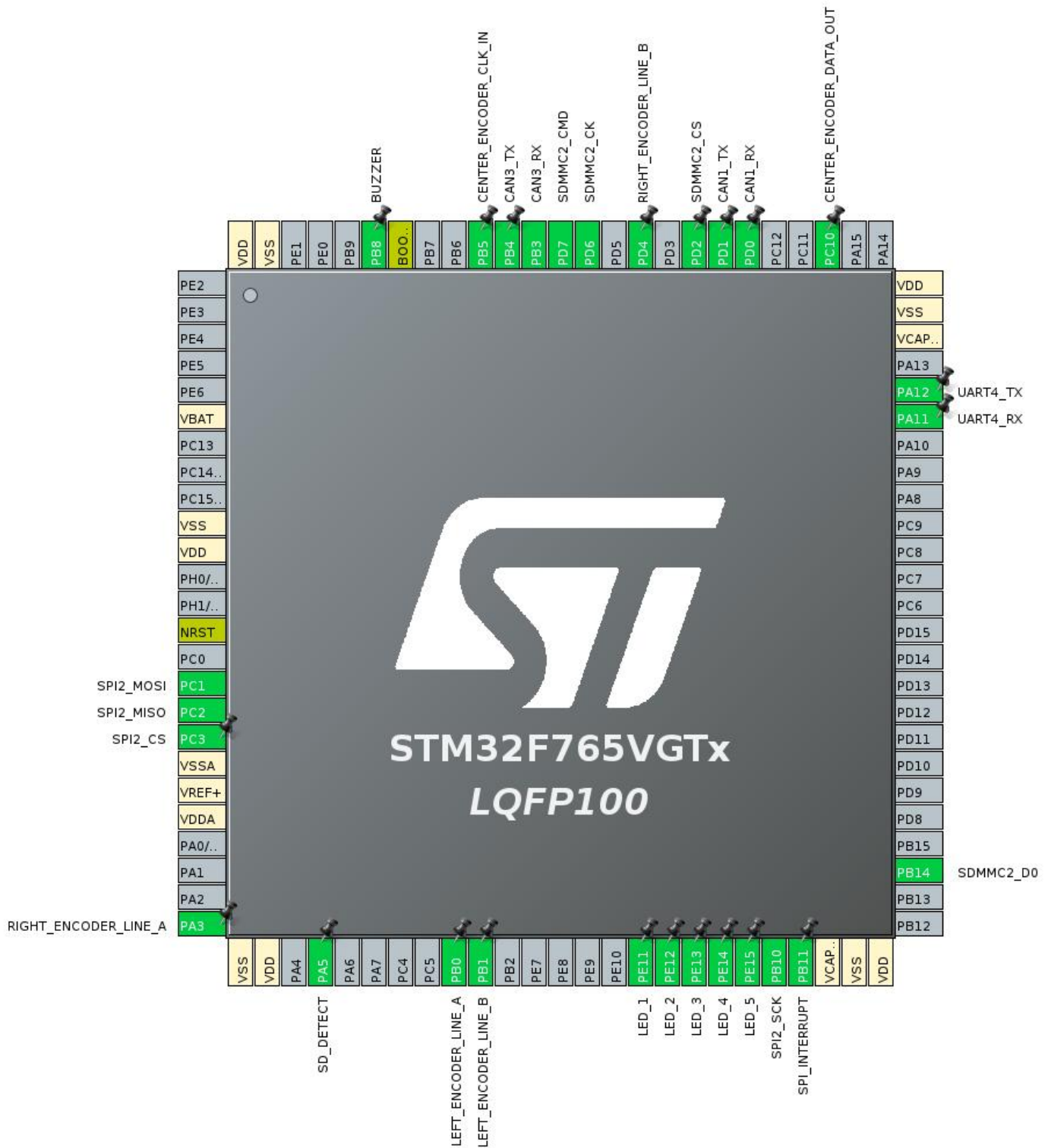
# 3. Pins Configuration

| Pin Number LQFP100 | Pin Name (function after reset) | Pin Type | Alternate Function(s) | Label |
|---|---|---|---|---|
| 6 | VBAT | Power | | |
| 10 | VSS | Power | | |
| 11 | VDD | Power | | |
| 14 | NRST | Reset | | |
| 16 | PC1 | I/O | SPI2_MOSI | |
| 17 | PC2 | I/O | SPI2_MISO | |
| 18 | PC3 * | I/O | GPIO_Output | SPI2_CS |
| 19 | VSSA | Power | | |
| 20 | VREF+ | Power | | |
| 21 | VDDA | Power | | |
| 25 | PA3 | I/O | GPIO_EXTI3 | RIGHT_ENCODER_LINE_A |
| 26 | VSS | Power | | |
| 27 | VDD | Power | | |
| 29 | PA5 * | I/O | GPIO_Input | SD_DETECT |
| 34 | PB0 | I/O | GPIO_EXTI0 | LEFT_ENCODER_LINE_A |
| 35 | PB1 | I/O | GPIO_EXTI1 | LEFT_ENCODER_LINE_B |
| 41 | PE11 * | I/O | GPIO_Output | LED_1 |
| 42 | PE12 * | I/O | GPIO_Output | LED_2 |
| 43 | PE13 * | I/O | GPIO_Output | LED_3 |
| 44 | PE14 * | I/O | GPIO_Output | LED_4 |
| 45 | PE15 * | I/O | GPIO_Output | LED_5 |
| 46 | PB10 | I/O | SPI2_SCK | |
| 47 | PB11 * | I/O | GPIO_Output | SPI_INTERRUPT |
| 48 | VCAP_1 | Power | | |
| 49 | VSS | Power | | |
| 50 | VDD | Power | | |
| 53 | PB14 | I/O | SDMMC2_D0 | |
| 70 | PA11 | I/O | UART4_RX | |
| 71 | PA12 | I/O | UART4_TX | |
| 73 | VCAP_2 | Power | | |
| 74 | VSS | Power | | |
| 75 | VDD | Power | | |
| 78 | PC10 | I/O | GPIO_EXTI10 | CENTER_ENCODER_DATA_OUT |
| 81 | PD0 | I/O | CAN1_RX | |
| 82 | PD1 | I/O | CAN1_TX | |

| Pin Number LQFP100 | Pin Name (function after reset) | Pin Type | Alternate Function(s) | Label |
|---|---|---|---|---|
| 83 | PD2 * | I/O | GPIO_Input | SDMMC2_CS |
| 85 | PD4 | I/O | GPIO_EXTI4 | RIGHT_ENCODER_LINE_B |
| 87 | PD6 | I/O | SDMMC2_CK | |
| 88 | PD7 | I/O | SDMMC2_CMD | |
| 89 | PB3 | I/O | CAN3_RX | |
| 90 | PB4 | I/O | CAN3_TX | |
| 91 | PB5 * | I/O | GPIO_Output | CENTER_ENCODER_CLK_IN |
| 94 | BOOT0 | Boot | | |
| 95 | PB8 | I/O | TIM10_CH1 | BUZZER |
| 99 | VSS | Power | | |
| 100 | VDD | Power | | |

* The pin is affected with an I/O function

# 4. Clock Tree Configuration
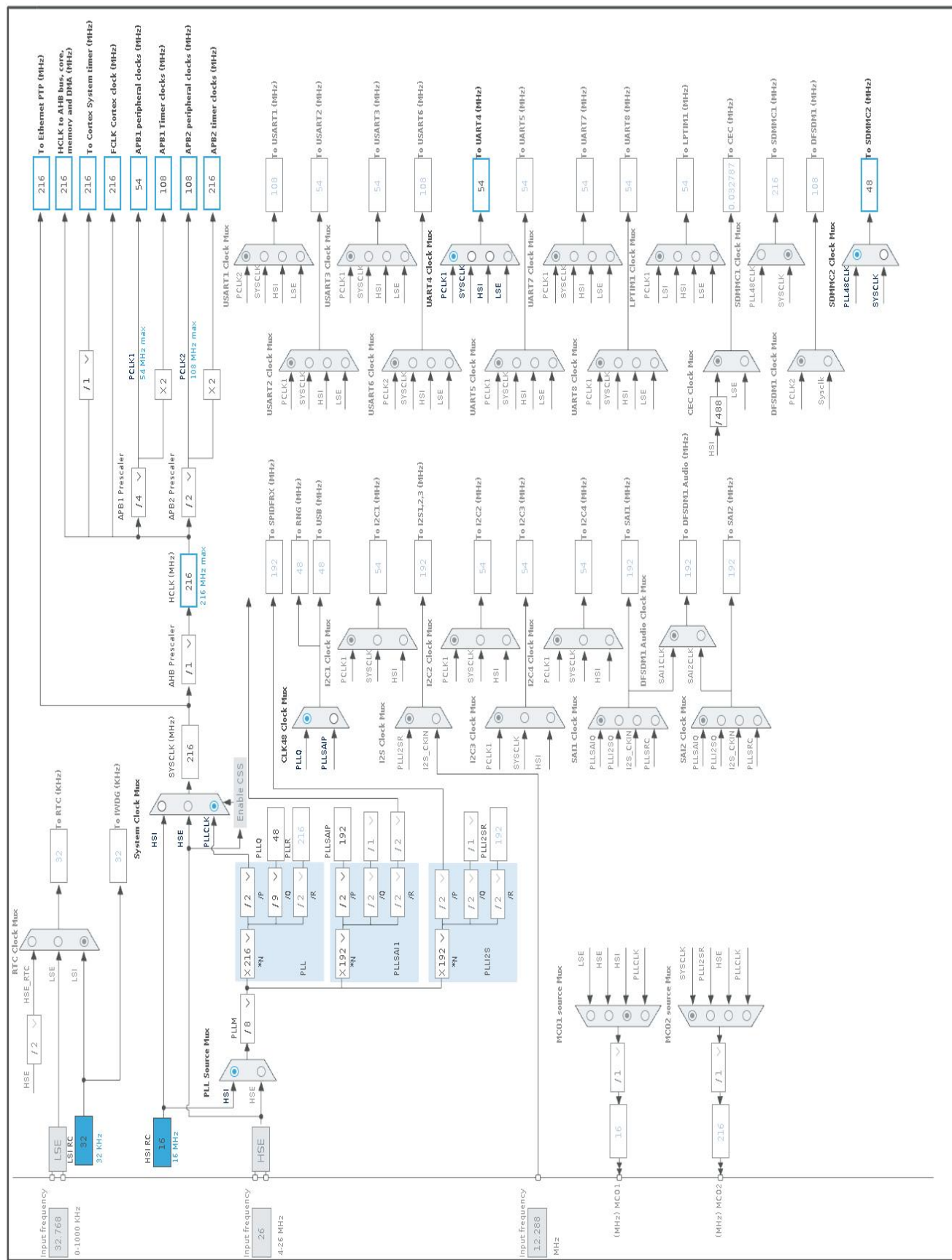
# 5. Software Project

## 5.1. Project Settings

| Name | Value |
|---|---|
| Project Name | ECU_BRAINv2_VSC |
| Project Folder | /home/luca/Documents/git/fenice-sensors/ECU_BRAINv2_VSC |
| Toolchain / IDE | Makefile |
| Firmware Package Name and Version | STM32Cube FW_F7 V1.16.0 |

## 5.2. 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 | No |
| Backup previously generated files when re-generating | No |
| Delete previously generated files when not re-generated | Yes |
| Set all free pins as analog (to optimize the power consumption) | No |

# 6. Power Consumption Calculator report

6.1. Microcontroller Selection

| Series | STM32F7 |
|---|---|
| Line | STM32F7x5 |
| MCU | STM32F765VGTx |
| Datasheet | 029041_Rev4 |

6.2. Parameter Selection

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

6.3. Battery Selection

| Battery | Alkaline(9V) |
|---|---|
| Capacity | 625.0 mAh |
| Self Discharge | 0.3 %/month |
| Nominal Voltage | 9.0 V |
| Max Cont Current | 200.0 mA |
| Max Pulse Current | 0.0 mA |
| Cells in series | 1 |
| Cells in parallel | 1 |

6.4. Sequence

| Step | Step1 | Step2 |
|---|---|---|
| *Mode* | RUN | STOP_UDM (Under Drive) |
| *Vdd* | 3.3 | 3.3 |
| *Voltage Source* | Battery | Battery |
| *Range* | Scale1-High | No Scale |
| *Fetch Type* | ICTM FLASH-SingleBank REGON | n/a |
| *CPU Frequency* | 216 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* | 118 mA | 130 µA |
| *Duration* | 0.1 ms | 0.9 ms |
| *DMIPS* | 462.0 | 0.0 |
| *Ta Max* | 88.26 | 104.98 |
| *Category* | In DS Table | In DS Table |

## 6.5. RESULTS

| Sequence Time | 1 ms | Average Current | 11.92 mA |
|---|---|---|---|
| Battery Life | 2 days, 4 hours | Average DMIPS | 462.24 DMIPS |

## 6.6. Chart

## Consumption Profile by Step
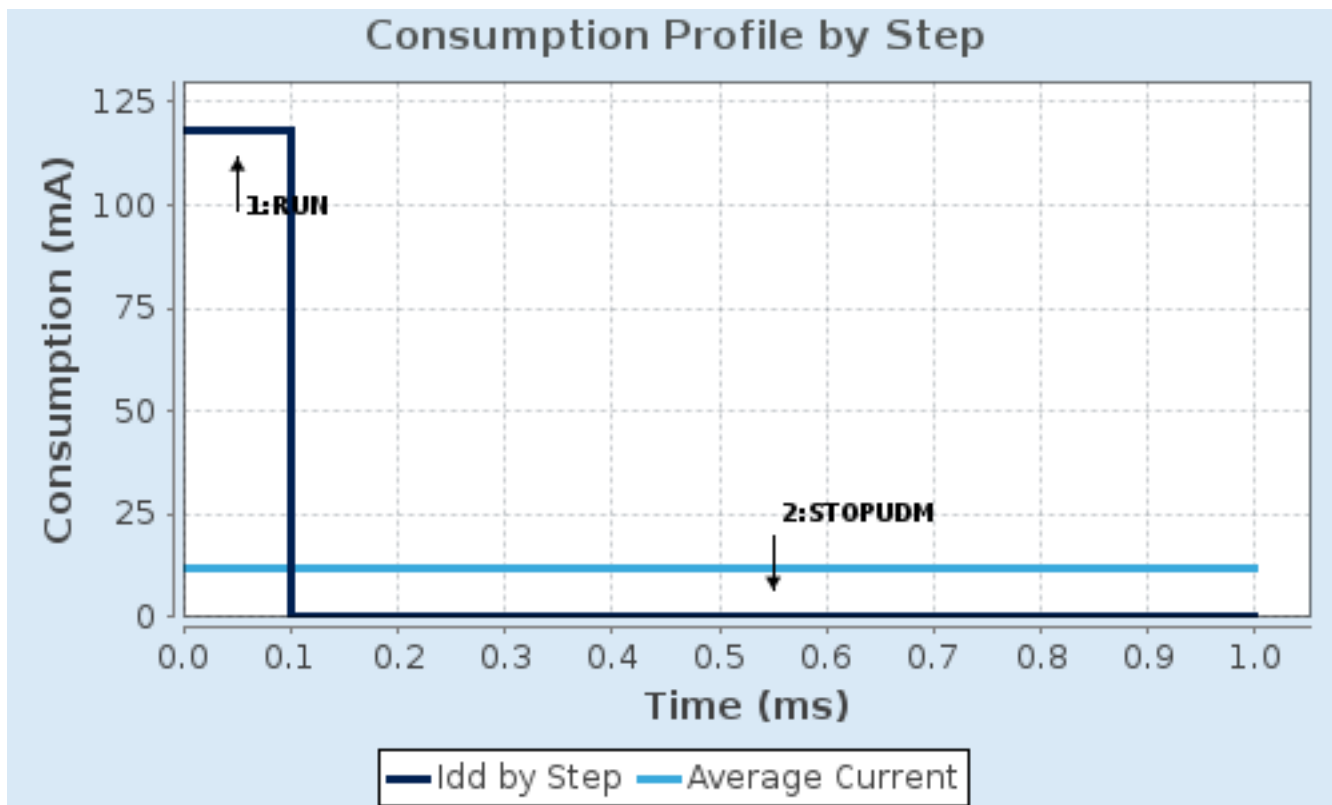
# 7. IPs and Middleware Configuration

## 7.1. CAN1

**mode: Mode**

**7.1.1. Parameter Settings:**

**Bit Timings Parameters:**

| | |
|---|---|
| Prescaler (for Time Quantum) | **3 \*** |
| Time Quantum | **55.55555555555556 \*** |
| Time Quanta in Bit Segment 1 | **15 Times \*** |
| Time Quanta in Bit Segment 2 | **2 Times \*** |
| ReSynchronization Jump Width | 1 Time |

**Basic Parameters:**

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

**Advanced Parameters:**

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

## 7.2. CAN3

**mode: Mode**

**7.2.1. Parameter Settings:**

**Bit Timings Parameters:**

| | |
|---|---|
| Prescaler (for Time Quantum) | **3 \*** |
| Time Quantum | **55.55555555555556 \*** |
| Time Quanta in Bit Segment 1 | **15 Times \*** |
| Time Quanta in Bit Segment 2 | **2 Times \*** |
| ReSynchronization Jump Width | 1 Time |

**Basic Parameters:**

| | |
|---|---|
| Time Triggered Communication Mode | Disable |
| Automatic Bus-Off Management | Disable |
| Automatic Wake-Up Mode | Disable |
| Automatic Retransmission | **Enable \*** |

| | |
|---|---|
| Receive Fifo Locked Mode | Disable |
| Transmit Fifo Priority | Disable |

**Advanced Parameters:**

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

## 7.3. CORTEX_M7

### 7.3.1. Parameter Settings:

**Cortex Interface Settings:**

| | |
|---|---|
| Flash Interface | AXI Interface |
| ART ACCLERATOR | Disabled |
| Instruction Prefetch | Disabled |
| CPU ICache | Disabled |
| CPU DCache | Disabled |

**Cortex Memory Protection Unit Control Settings:**

| | |
|---|---|
| MPU Control Mode | MPU NOT USED |

## 7.4. GPIO

## 7.5. RCC

### 7.5.1. Parameter Settings:

**System Parameters:**

| | |
|---|---|
| VDD voltage (V) | 3.3 |
| Flash Latency(WS) | 7 WS (8 CPU cycle) |

**RCC Parameters:**

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

**Power Parameters:**

| | |
|---|---|
| Power Over Drive | Enabled |
| Power Regulator Voltage Scale | Power Regulator Voltage Scale 1 |

## *7.6. SDMMC2*

**Mode: SD 1 bit**

**7.6.1. Parameter Settings:**

**SDMMC parameters:**

| | |
|---|---|
| Clock transition on which the bit capture is made | Rising transition |
| SDMMC Clock divider bypass | Disable |
| SDMMC Clock output enable when the bus is idle | Disable the power save for the clock |
| SDMMC hardware flow control | The hardware control flow is disabled |
| SDMMCCLK clock divide factor | 0 |

## *7.7. SPI2*

**Mode: Full-Duplex Master**

**7.7.1. Parameter Settings:**

**Basic Parameters:**

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

**Clock Parameters:**

| | |
|---|---|
| Prescaler (for Baud Rate) | **16 *** |
| Baud Rate | **3.375 MBits/s *** |
| Clock Polarity (CPOL) | Low |
| Clock Phase (CPHA) | 1 Edge |

**Advanced Parameters:**

| | |
|---|---|
| CRC Calculation | Disabled |
| NSSP Mode | Enabled |
| NSS Signal Type | Software |

## *7.8. SYS*

**Timebase Source: SysTick**

## *7.9. TIM2*

**Clock Source  : Internal Clock**

### 7.9.1. Parameter Settings:

**Counter Settings:**

| | |
|---|---|
| Prescaler (PSC - 16 bits value) | **108 *** |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 32 bits value ) | **1000 *** |
| 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 TRGO | Reset (UG bit from TIMx_EGR) |

## 7.10. TIM4

### Clock Source   : Internal Clock
### 7.10.1. Parameter Settings:

**Counter Settings:**

| | |
|---|---|
| Prescaler (PSC - 16 bits value) | **10800 *** |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value ) | **9999 *** |
| 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 TRGO | Reset (UG bit from TIMx_EGR) |

## 7.11. TIM5

### mode: Clock Source
### 7.11.1. Parameter Settings:

**Counter Settings:**

| | |
|---|---|
| Prescaler (PSC - 16 bits value) | **10800 *** |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 32 bits value ) | **999 *** |
| 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 TRGO | Reset (UG bit from TIMx_EGR) |

## 7.12. TIM10

**mode: Activated**

**Channel1: PWM Generation CH1**

**7.12.1. Parameter Settings:**

**Counter Settings:**

| | |
|---|---|
| Prescaler (PSC - 16 bits value) | **216 *** |
| Counter Mode | Up |
| Counter Period (AutoReload Register - 16 bits value ) | **999 *** |
| Internal Clock Division (CKD) | No Division |
| auto-reload preload | Disable |

**PWM Generation Channel 1:**

| | |
|---|---|
| Mode | PWM mode 1 |
| Pulse (16 bits value) | **499 *** |
| Output compare preload | Enable |
| Fast Mode | Disable |
| CH Polarity | High |

## 7.13. UART4

**Mode: Asynchronous**

**7.13.1. Parameter Settings:**

**Basic Parameters:**

| | |
|---|---|
| Baud Rate | **2000000 *** |
| 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 |

## *7.14. FATFS*

### mode: SD Card
### 7.14.1. Set Defines:

**Version:**

| | |
|---|---|
| FATFS version | R0.12c |

**Function Parameters:**

| | |
|---|---|
| FS_READONLY (Read-only mode) | Disabled |
| FS_MINIMIZE (Minimization level) | Disabled |
| USE_STRFUNC (String functions) | Enabled with LF -> CRLF conversion |
| USE_FIND (Find functions) | Disabled |
| USE_MKFS (Make filesystem function) | Enabled |
| USE_FASTSEEK (Fast seek function) | Enabled |
| USE_EXPAND (Use f_expand function) | Disabled |
| USE_CHMOD (Change attributes function) | Disabled |
| USE_LABEL (Volume label functions) | Disabled |
| USE_FORWARD (Forward function) | Disabled |

**Locale and Namespace Parameters:**

| | |
|---|---|
| CODE_PAGE (Code page on target) | Latin 1 |
| USE_LFN (Use Long Filename) | Disabled |
| MAX_LFN (Max Long Filename) | 255 |
| LFN_UNICODE (Enable Unicode) | ANSI/OEM |
| STRF_ENCODE (Character encoding) | UTF-8 |
| FS_RPATH (Relative Path) | Disabled |

**Physical Drive Parameters:**

| | |
|---|---|
| VOLUMES (Logical drives) | 1 |
| MAX_SS (Maximum Sector Size) | 512 |
| MIN_SS (Minimum Sector Size) | 512 |
| MULTI_PARTITION (Volume partitions feature) | Disabled |
| USE_TRIM (Erase feature) | Disabled |
| FS_NOFSINFO (Force full FAT scan) | 0 |

**System Parameters:**

| | |
|---|---|
| FS_TINY (Tiny mode) | Disabled |
| FS_EXFAT (Support of exFAT file system) | Disabled |
| FS_NORTC (Timestamp feature) | Dynamic timestamp |
| FS_REENTRANT (Re-Entrancy) | Disabled |
| FS_TIMEOUT (Timeout ticks) | 1000 |
| FS_LOCK (Number of files opened simultaneously) | 2 |

## 7.14.2. Advanced Settings:

**SDIO/SDMMC:**

| | |
|---|---|
| SDMMC instance | SDMMC2 |
| Use dma template | Disabled |
| BSP code for SD | Generic |

**\* User modified value**

# 8. System Configuration

## 8.1. GPIO configuration

| IP | Pin | Signal | GPIO mode | GPIO pull/up pull down | Max Speed | User Label |
|---|---|---|---|---|---|---|
| CAN1 | PD0 | CAN1_RX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| | PD1 | CAN1_TX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| CAN3 | PB3 | CAN3_RX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| | PB4 | CAN3_TX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| SDMMC2 | PB14 | SDMMC2_D0 | Alternate Function Push Pull | No pull-up and no pull-down | Very High | |
| | PD6 | SDMMC2_CK | Alternate Function Push Pull | No pull-up and no pull-down | Very High | |
| | PD7 | SDMMC2_CMD | Alternate Function Push Pull | No pull-up and no pull-down | Very High | |
| SPI2 | PC1 | SPI2_MOSI | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| | PC2 | SPI2_MISO | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| | PB10 | SPI2_SCK | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| TIM10 | PB8 | TIM10_CH1 | Alternate Function Push Pull | No pull-up and no pull-down | Low | BUZZER |
| UART4 | PA11 | UART4_RX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| | PA12 | UART4_TX | Alternate Function Push Pull | No pull-up and no pull-down | **Very High** * | |
| GPIO | PC3 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | SPI2_CS |
| | PA3 | GPIO_EXTI3 | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a | RIGHT_ENCODER_LINE_A |
| | PA5 | GPIO_Input | Input mode | No pull-up and no pull-down | n/a | SD_DETECT |
| | PB0 | GPIO_EXTI0 | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a | LEFT_ENCODER_LINE_A |
| | PB1 | GPIO_EXTI1 | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a | LEFT_ENCODER_LINE_B |
| | PE11 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | LED_1 |
| | PE12 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | LED_2 |
| | PE13 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | LED_3 |
| | PE14 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | LED_4 |
| | PE15 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | LED_5 |

| IP | Pin | Signal | GPIO mode | GPIO pull/up pull down | Max Speed | User Label |
|---|---|---|---|---|---|---|
| | PB11 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | SPI_INTERRUPT |
| | PC10 | GPIO_EXTI10 | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a | CENTER_ENCODER_DATA_OUT |
| | PD2 | GPIO_Input | Input mode | No pull-up and no pull-down | n/a | SDMMC2_CS |
| | PD4 | GPIO_EXTI4 | External Interrupt Mode with Rising edge trigger detection | No pull-up and no pull-down | n/a | RIGHT_ENCODER_LINE_B |
| | PB5 | GPIO_Output | Output Push Pull | No pull-up and no pull-down | Low | CENTER_ENCODER_CLK_IN |

## 8.2. DMA configuration

| DMA request | Stream | Direction | Priority |
|---|---|---|---|
| SPI2_TX | DMA1_Stream4 | Memory To Peripheral | **High \*** |

### SPI2_TX: DMA1_Stream4 DMA request Settings:

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

## 8.3. NVIC configuration

| 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 | 0 | 0 |
| EXTI line3 interrupt | true | 0 | 0 |
| EXTI line4 interrupt | true | 0 | 0 |
| DMA1 stream4 global interrupt | true | 0 | 0 |
| CAN1 TX interrupts | true | 0 | 0 |
| CAN1 RX0 interrupts | true | 0 | 0 |
| CAN1 RX1 interrupt | true | 0 | 0 |
| CAN1 SCE interrupt | true | 0 | 0 |
| TIM2 global interrupt | true | 0 | 0 |
| TIM4 global interrupt | true | 0 | 0 |
| SPI2 global interrupt | true | 0 | 0 |
| TIM5 global interrupt | true | 0 | 0 |
| UART4 global interrupt | true | 0 | 0 |
| CAN3 TX interrupt | true | 0 | 0 |
| CAN3 RX0 interrupt | true | 0 | 0 |
| CAN3 RX1 interrupt | true | 0 | 0 |
| CAN3 SCE interrupt | true | 0 | 0 |
| PVD interrupt through EXTI line 16 | unused | | |
| Flash global interrupt | unused | | |
| RCC global interrupt | unused | | |
| EXTI line0 interrupt | unused | | |
| EXTI line1 interrupt | unused | | |
| TIM1 update interrupt and TIM10 global interrupt | unused | | |
| EXTI line[15:10] interrupts | unused | | |
| FPU global interrupt | unused | | |
| SDMMC2 global interrupt | unused | | |

**\* User modified value**

# 9. Predefined Views - Category view : Current

Middleware

FATFS ✓

| System Core | Analog | Timers | Connectivity | Multimedia | Security | Computing |
|---|---|---|---|---|---|---|

CORTEX_M7 ✓

DMA ✓

GPIO ✓

NVIC ✓

RCC ✓

SYS ✓

TIM2 ✓

TIM4 ✓

TIM5 ✓

TIM10 ✓

CAN1 ✓

CAN3 ✓

SDMMC2 ✓

SPI2 ✓

UART4 ✓

# 10. Software Pack Report