



## 1. Description

### 1.1. Project

Project Name	WheelState
Board Name	STM32F411E-DISCO
Generated with:	STM32CubeMX 6.12.1
Date	11/16/2024

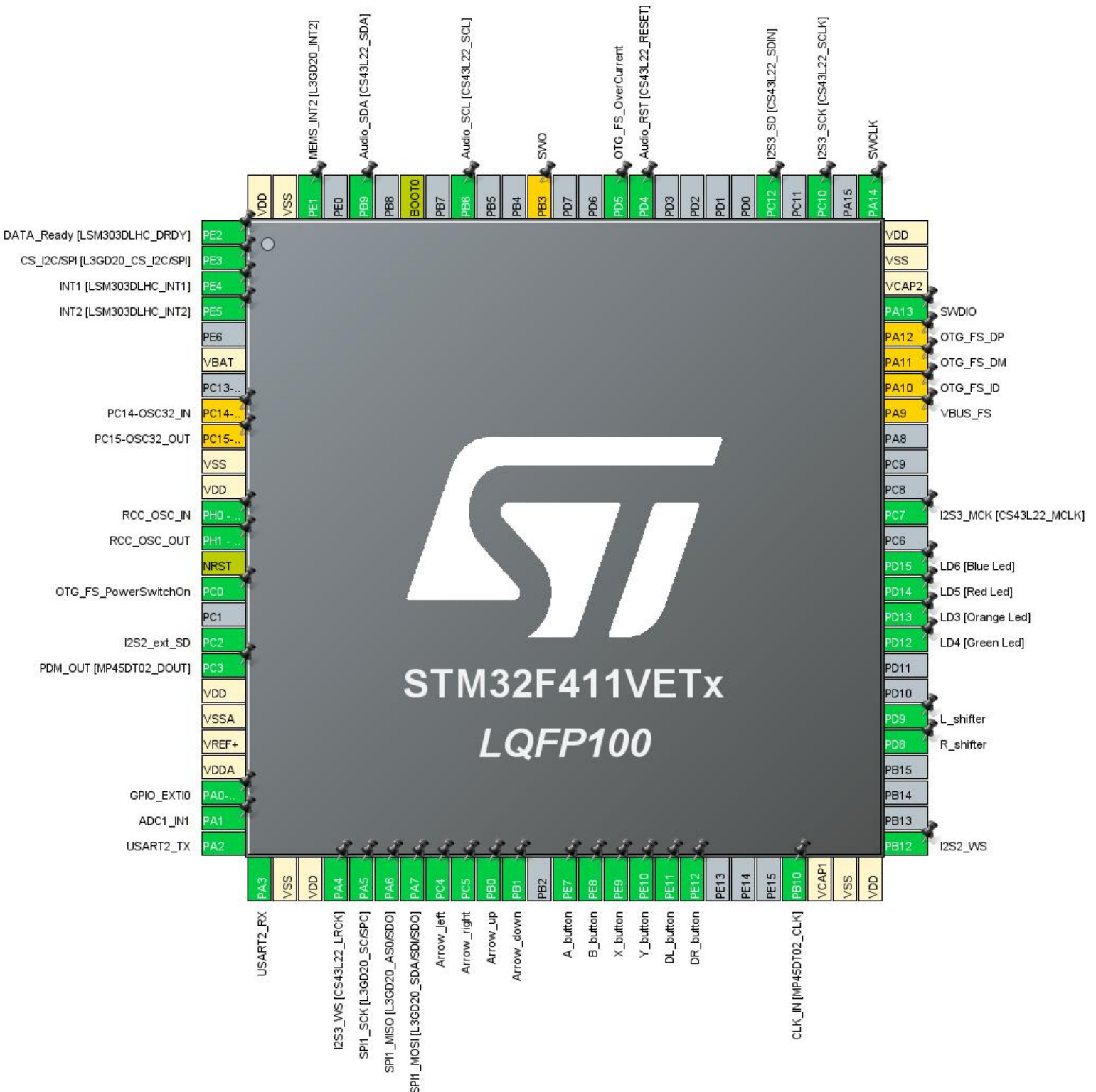
### 1.2. MCU

MCU Series	STM32F4
MCU Line	STM32F411
MCU name	STM32F411VETx
MCU Package	LQFP100
MCU Pin number	100

### 1.3. Core(s) information

Core(s)	Arm Cortex-M4
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## 2. Pinout Configuration



### 3. Pins Configuration

Pin Number LQFP100	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	PE2 *	I/O	GPIO_Input	DATA_Ready [LSM303DLHC_DRDY]
2	PE3 *	I/O	GPIO_Output	CS_I2C/SPI [L3GD20_CS_I2C/SPI]
3	PE4	I/O	GPIO_EXTI4	INT1 [LSM303DLHC_INT1]
4	PE5	I/O	GPIO_EXTI5	INT2 [LSM303DLHC_INT2]
6	VBAT	Power		
8	PC14-OSC32_IN **	I/O	RCC_OSC32_IN	PC14-OSC32_IN
9	PC15-OSC32_OUT **	I/O	RCC_OSC32_OUT	PC15-OSC32_OUT
10	VSS	Power		
11	VDD	Power		
12	PH0 - OSC_IN	I/O	RCC_OSC_IN	
13	PH1 - OSC_OUT	I/O	RCC_OSC_OUT	
14	NRST	Reset		
15	PC0 *	I/O	GPIO_Output	OTG_FS_PowerSwitchOn
17	PC2	I/O	I2S2_ext_SD	
18	PC3	I/O	I2S2_SD	PDM_OUT [MP45DT02_DOUT]
19	VDD	Power		
20	VSSA	Power		
21	VREF+	Power		
22	VDDA	Power		
23	PA0-WKUP	I/O	GPIO_EXTI0	
24	PA1	I/O	ADC1_IN1	
25	PA2	I/O	USART2_TX	
26	PA3	I/O	USART2_RX	
27	VSS	Power		
28	VDD	Power		
29	PA4	I/O	I2S3_WS	I2S3_WS [CS43L22_LRCK]
30	PA5	I/O	SPI1_SCK	SPI1_SCK [L3GD20_SC/SPC]
31	PA6	I/O	SPI1_MISO	SPI1_MISO [L3GD20_AS0/SDO]
32	PA7	I/O	SPI1_MOSI	SPI1_MOSI [L3GD20_SDA/SDI/SDO]
33	PC4 *	I/O	GPIO_Input	Arrow_left
34	PC5 *	I/O	GPIO_Input	Arrow_right

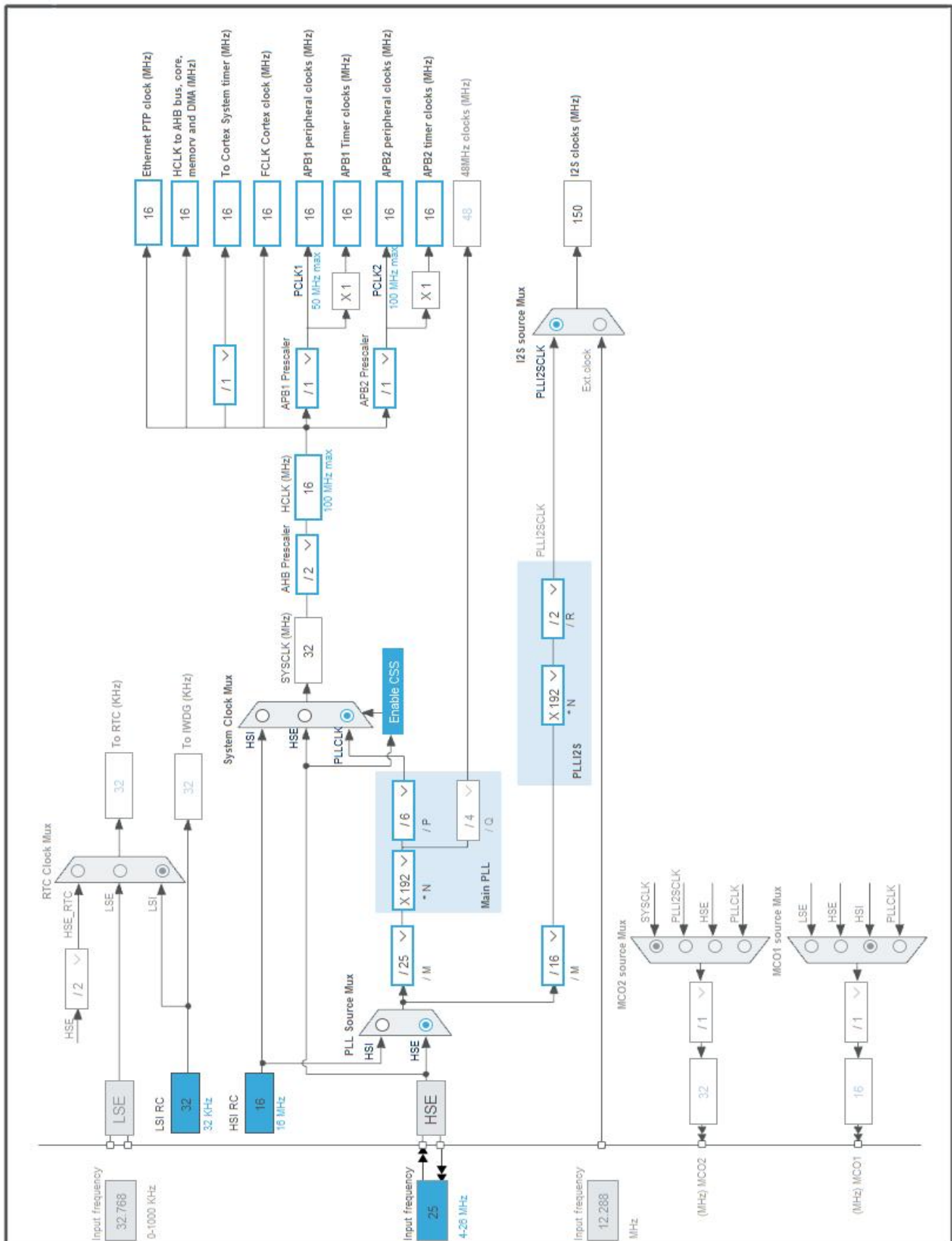
Pin Number LQFP100	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
35	PB0 *	I/O	GPIO_Input	Arrow_up
36	PB1 *	I/O	GPIO_Input	Arrow_down
38	PE7 *	I/O	GPIO_Input	A_button
39	PE8 *	I/O	GPIO_Input	B_button
40	PE9 *	I/O	GPIO_Input	X_button
41	PE10 *	I/O	GPIO_Input	Y_button
42	PE11 *	I/O	GPIO_Input	DL_button
43	PE12 *	I/O	GPIO_Input	DR_button
47	PB10	I/O	I2S2_CK	CLK_IN [MP45DT02_CLK]
48	VCAP1	Power		
49	VSS	Power		
50	VDD	Power		
51	PB12	I/O	I2S2_WS	
55	PD8 *	I/O	GPIO_Input	R_shifter
56	PD9 *	I/O	GPIO_Input	L_shifter
59	PD12 *	I/O	GPIO_Output	LD4 [Green Led]
60	PD13 *	I/O	GPIO_Output	LD3 [Orange Led]
61	PD14 *	I/O	GPIO_Output	LD5 [Red Led]
62	PD15 *	I/O	GPIO_Output	LD6 [Blue Led]
64	PC7	I/O	I2S3_MCK	I2S3_MCK [CS43L22_MCLK]
68	PA9 **	I/O	USB_OTG_FS_VBUS	VBUS_FS
69	PA10 **	I/O	USB_OTG_FS_ID	OTG_FS_ID
70	PA11 **	I/O	USB_OTG_FS_DM	OTG_FS_DM
71	PA12 **	I/O	USB_OTG_FS_DP	OTG_FS_DP
72	PA13	I/O	SYS_JTMS-SWDIO	SWDIO
73	VCAP2	Power		
74	VSS	Power		
75	VDD	Power		
76	PA14	I/O	SYS_JTCK-SWCLK	SWCLK
78	PC10	I/O	I2S3_CK	I2S3_SCK [CS43L22_SCLK]
80	PC12	I/O	I2S3_SD	I2S3_SD [CS43L22_SDIN]
85	PD4 *	I/O	GPIO_Output	Audio_RST [CS43L22_RESET]
86	PD5 *	I/O	GPIO_Input	OTG_FS_OverCurrent
89	PB3 **	I/O	SYS_JTDO-SWO	SWO
92	PB6	I/O	I2C1_SCL	Audio_SCL [CS43L22_SCL]
94	BOOT0	Boot		
96	PB9	I/O	I2C1_SDA	Audio_SDA [CS43L22_SDA]

Pin Number LQFP100	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
98	PE1	I/O	GPIO_EXTI1	MEMS_INT2 [L3GD20_INT2]
99	VSS	Power		
100	VDD	Power		

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

\*\* The pin is affected with a peripheral function but no peripheral mode is activated

## 4. Clock Tree Configuration



## 1. Power Consumption Calculator report

### 1.1. Microcontroller Selection

Series	STM32F4
Line	STM32F411
MCU	STM32F411VETx
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



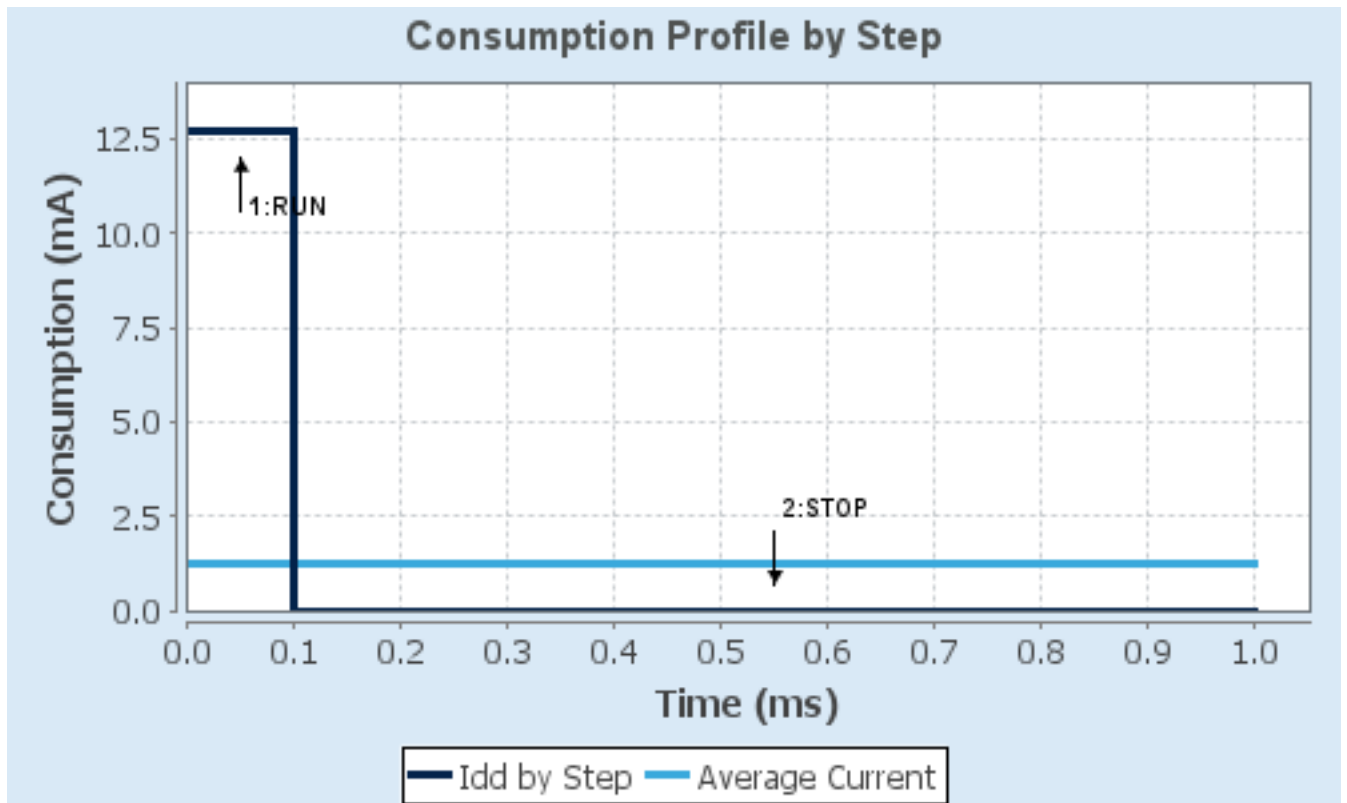
#### 1.4. Sequence

<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>	104.07	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. Software Project

### 2.1. Project Settings

Name	Value
Project Name	WheelState
Project Folder	C:\Users\user\Wheel_State_STM32
Toolchain / IDE	STM32CubeIDE
Firmware Package Name and Version	STM32Cube FW_F4 V1.28.1
Application Structure	Advanced
Generate Under Root	Yes
Do not generate the main()	No
Minimum Heap Size	0x200
Minimum Stack Size	0x400

### 2.2. 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

### 2.3. Advanced Settings - Generated Function Calls

Rank	Function Name	Peripheral Instance Name
1	SystemClock_Config	RCC
2	MX_GPIO_Init	GPIO
3	MX_DMA_Init	DMA
4	MX_I2C1_Init	I2C1
5	MX_I2S2_Init	I2S2
6	MX_I2S3_Init	I2S3
7	MX_SPI1_Init	SPI1
8	MX_ADC1_Init	ADC1
9	MX_USART2_UART_Init	USART2



## 3. Peripherals and Middlewares Configuration

### 3.1. ADC1

mode: IN1

#### 3.1.1. Parameter Settings:

##### **ADCs\_Common\_Settings:**

Mode Independent mode

##### **ADC\_Settings:**

Clock Prescaler PCLK2 divided by 2

Resolution 12 bits (15 ADC Clock cycles)

Data Alignment Right alignment

Scan Conversion Mode Disabled

Continuous Conversion Mode Disabled

Discontinuous Conversion Mode Disabled

DMA Continuous Requests Disabled

End Of Conversion Selection EOC flag at the end of single channel conversion

##### **ADC\_Regular\_ConversionMode:**

Number Of Conversion 1

External Trigger Conversion Source Regular Conversion launched by software

External Trigger Conversion Edge None

Rank 1

Channel Channel 1

Sampling Time 3 Cycles

##### **ADC\_Injected\_ConversionMode:**

Number Of Conversions 0

##### **WatchDog:**

Enable Analog WatchDog Mode false

### 3.2. I2C1

I2C: I2C

#### 3.2.1. Parameter Settings:

##### **Master Features:**

I2C Speed Mode Standard Mode

I2C Clock Speed (Hz) 100000

##### **Slave Features:**

Clock No Stretch Mode Disabled

Primary Address Length selection 7-bit

Dual Address Acknowledged	Disabled
Primary slave address	0
General Call address detection	Disabled

### 3.3. I2S2

#### Mode: Full-Duplex Master

##### 3.3.1. Parameter Settings:

###### Generic Parameters:

Transmission Mode	Mode Master Transmit
Communication Standard	I2S Philips
Data and Frame Format	16 Bits Data on 16 Bits Frame
Selected Audio Frequency	<b>96 KHz *</b>
Real Audio Frequency	<b>95.663 KHz *</b>
Error between Selected and Real	<b>-0.35 % *</b>

###### Clock Parameters:

Clock Source	I2S PLL Clock
Clock Polarity	Low

### 3.4. I2S3

#### Mode: Half-Duplex Master

#### mode: Master Clock Output

##### 3.4.1. Parameter Settings:

###### Generic Parameters:

Transmission Mode	Mode Master Transmit
Communication Standard	I2S Philips
Data and Frame Format	16 Bits Data on 16 Bits Frame
Selected Audio Frequency	<b>96 KHz *</b>
Real Audio Frequency	<b>97.656 KHz *</b>
Error between Selected and Real	<b>1.72 % *</b>

###### Clock Parameters:

Clock Source	I2S PLL Clock
Clock Polarity	Low

### 3.5. RCC

#### High Speed Clock (HSE): Crystal/Ceramic Resonator

##### 3.5.1. 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
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### 3.6. SPI1

#### Mode: Full-Duplex Master

##### 3.6.1. 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>8.0 MBits/s *</b>
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

###### Advanced Parameters:

CRC Calculation	Disabled
NSS Signal Type	Software

### 3.7. SYS

**Debug:** Serial Wire

**Timebase Source:** SysTick

### 3.8. USART2

**Mode:** Asynchronous

#### 3.8.1. 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

\* User modified value



## 4. System Configuration

### 4.1. GPIO configuration

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
ADC1	PA1	ADC1_IN1	Analog mode	No pull-up and no pull-down	n/a	
I2C1	PB6	I2C1_SCL	Alternate Function Open Drain	<b>Pull-up *</b>	Low	Audio_SCL [CS43L22_SCL]
	PB9	I2C1_SDA	Alternate Function Open Drain	<b>Pull-up *</b>	Low	Audio_SDA [CS43L22_SDA]
I2S2	PC2	I2S2_ext_SD	Alternate Function Push Pull	No pull-up and no pull-down	Low	
	PC3	I2S2_SD	Alternate Function Push Pull	No pull-up and no pull-down	Low	PDM_OUT [MP45DT02_DOUT]
	PB10	I2S2_CK	Alternate Function Push Pull	No pull-up and no pull-down	Low	CLK_IN [MP45DT02_CLK]
	PB12	I2S2_WS	Alternate Function Push Pull	No pull-up and no pull-down	Low	
I2S3	PA4	I2S3_WS	Alternate Function Push Pull	No pull-up and no pull-down	Low	I2S3_WS [CS43L22_LRCK]
	PC7	I2S3_MCK	Alternate Function Push Pull	No pull-up and no pull-down	Low	I2S3_MCK [CS43L22_MCLK]
	PC10	I2S3_CK	Alternate Function Push Pull	No pull-up and no pull-down	Low	I2S3_SCK [CS43L22_SCLK]
	PC12	I2S3_SD	Alternate Function Push Pull	No pull-up and no pull-down	Low	I2S3_SD [CS43L22_SDIN]
RCC	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	PA5	SPI1_SCK	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	SPI1_SCK [L3GD20_SC/SPC]
	PA6	SPI1_MISO	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	SPI1_MISO [L3GD20_AS0/SDO]
	PA7	SPI1_MOSI	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	SPI1_MOSI [L3GD20_SDA/SDI/SDO]
SYS	PA13	SYS_JTMS-SWDIO	n/a	n/a	n/a	SWDIO
	PA14	SYS_JTCK-SWCLK	n/a	n/a	n/a	SWCLK
USART2	PA2	USART2_TX	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	
	PA3	USART2_RX	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	
Single Mapped Signals	PC14-OSC32_IN	RCC_OSC32_IN	n/a	n/a	n/a	PC14-OSC32_IN

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
	PC15-OSC32_OUT	RCC_OSC32_OUT	n/a	n/a	n/a	PC15-OSC32_OUT
	PA9	USB_OTG_FS_VBUS	Input mode	No pull-up and no pull-down	n/a	VBUS_FS
	PA10	USB_OTG_FS_ID	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	OTG_FS_ID
	PA11	USB_OTG_FS_DM	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	OTG_FS_DM
	PA12	USB_OTG_FS_DP	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	OTG_FS_DP
	PB3	SYS_JTDO-SWO	n/a	n/a	<b>n/a</b>	SWO
GPIO	PE2	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	DATA_Ready [LSM303DLHC_DRDY]
	PE3	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	CS_I2C/SPI [L3GD20_CS_I2C/SPI]
	PE4	GPIO_EXTI4	<b>External Event Mode with Rising edge trigger detection *</b>	No pull-up and no pull-down	n/a	INT1 [LSM303DLHC_INT1]
	PE5	GPIO_EXTI5	<b>External Event Mode with Rising edge trigger detection *</b>	No pull-up and no pull-down	n/a	INT2 [LSM303DLHC_INT2]
	PC0	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	OTG_FS_PowerSwitchOn
	PA0-WKUP	GPIO_EXTI0	<b>External Event Mode with Rising edge trigger detection *</b>	No pull-up and no pull-down	n/a	
	PC4	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	Arrow_left
	PC5	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	Arrow_right
	PB0	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	Arrow_up
	PB1	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	Arrow_down
	PE7	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	A_button
	PE8	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	B_button
	PE9	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	X_button
	PE10	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	Y_button
	PE11	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	DL_button
	PE12	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	DR_button
	PD8	GPIO_Input	Input mode	<b>Pull-down *</b>	n/a	R_shifter

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
	PD9	GPIO_Input	Input mode	<b>Pull-down *</b>	n/a	L_shifter
	PD12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LD4 [Green Led]
	PD13	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LD3 [Orange Led]
	PD14	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LD5 [Red Led]
	PD15	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LD6 [Blue Led]
	PD4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Audio_RST [CS43L22_RESET]
	PD5	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	OTG_FS_OverCurrent
	PE1	GPIO_EXTI1	<b>External Event Mode with Rising edge trigger detection *</b>	No pull-up and no pull-down	n/a	MEMS_INT2 [L3GD20_INT2]

## 4.2. DMA configuration

DMA request	Stream	Direction	Priority
ADC1	DMA2_Stream0	Peripheral To Memory	Low

### ADC1: DMA2\_Stream0 DMA request Settings:

Mode: Normal  
Use fifo: Disable  
Peripheral Increment: Disable  
Memory Increment: **Enable \***  
Peripheral Data Width: **Word \***  
Memory Data Width: **Word \***

### 4.3. NVIC configuration

#### 4.3.1. NVIC

Interrupt Table	Enable	Preenmption Priority	SubPriority
Non maskable interrupt	true	0	0
Hard fault interrupt	true	0	0
Memory management fault	true	0	0
Pre-fetch fault, memory access fault	true	0	0
Undefined instruction or illegal state	true	0	0
System service call via SWI instruction	true	0	0
Debug monitor	true	0	0
Pendable request for system service	true	0	0
System tick timer	true	0	0
DMA2 stream0 global interrupt	true	0	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
ADC1 global interrupt	unused		
I2C1 event interrupt	unused		
I2C1 error interrupt	unused		
SPI1 global interrupt	unused		
SPI2 global interrupt	unused		
USART2 global interrupt	unused		
SPI3 global interrupt	unused		
FPU global interrupt	unused		

#### 4.3.2. NVIC Code generation

Enabled interrupt Table	Select for init sequence ordering	Generate IRQ handler	Call HAL handler
Non maskable interrupt	false	true	false
Hard fault interrupt	false	true	false
Memory management fault	false	true	false
Pre-fetch fault, memory access fault	false	true	false
Undefined instruction or illegal state	false	true	false
System service call via SWI instruction	false	true	false
Debug monitor	false	true	false
Pendable request for system service	false	true	false
System tick timer	false	true	true
DMA2 stream0 global interrupt	false	true	true

**\* User modified value**

## 5. System Views

### 5.1. Category view

#### 5.1.1. Current

#### Middleware

#### System Core

#### Analog

#### Timers

#### Connectivity

#### Multimedia

#### Computing

DMA 

ADC1 

I2C1 

I2S2 

GPIO 

SP1 

I2S3 

IIVIC 

USART2 

RCC 

SYS 

## 6. Docs & Resources

Type	Link
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