



## 1. Description

### 1.1. Project

Project Name	M1
Board Name	custom
Generated with:	STM32CubeMX 6.14.1
Date	04/26/2025

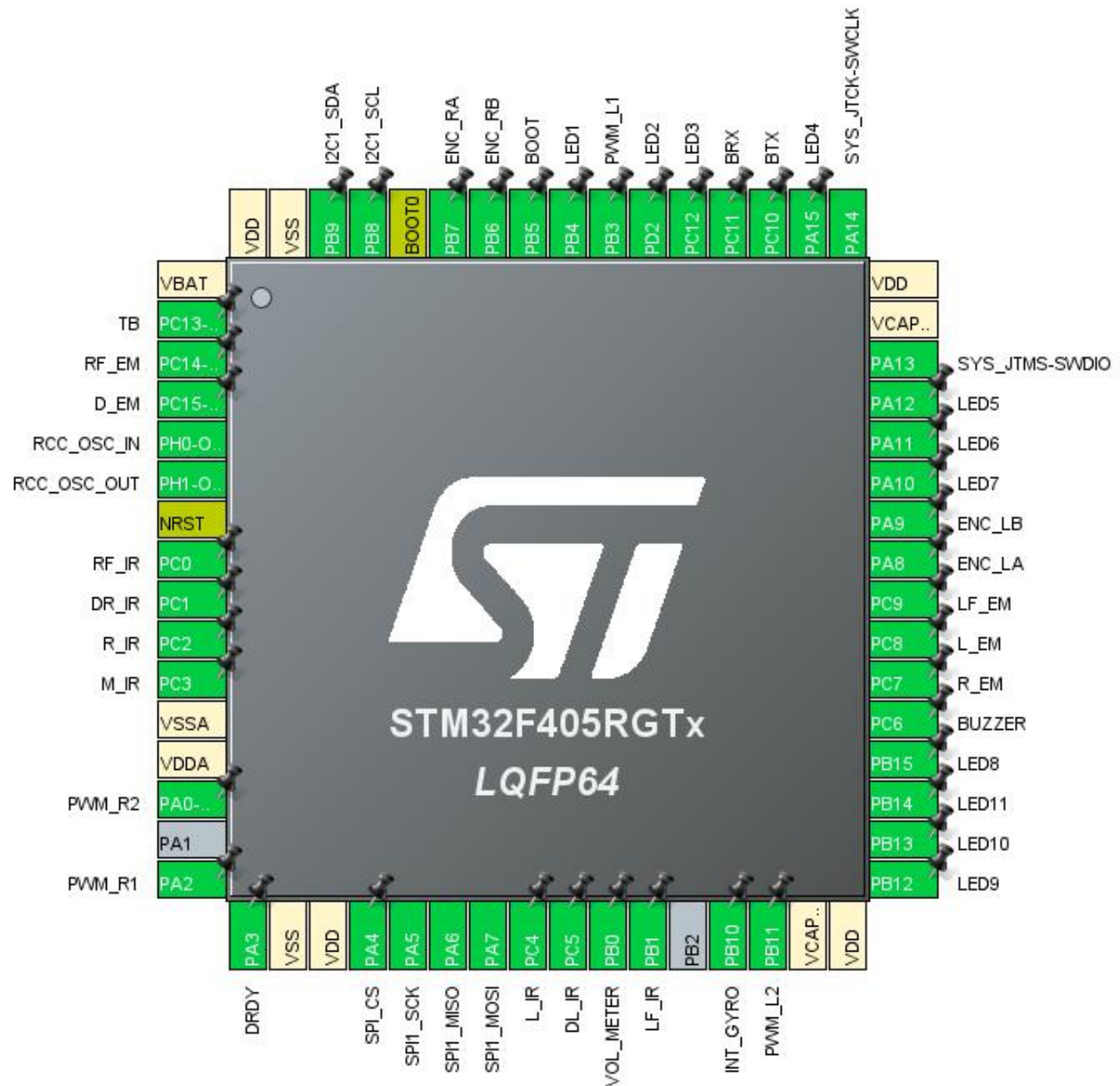
### 1.2. MCU

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

### 1.3. Core(s) information

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



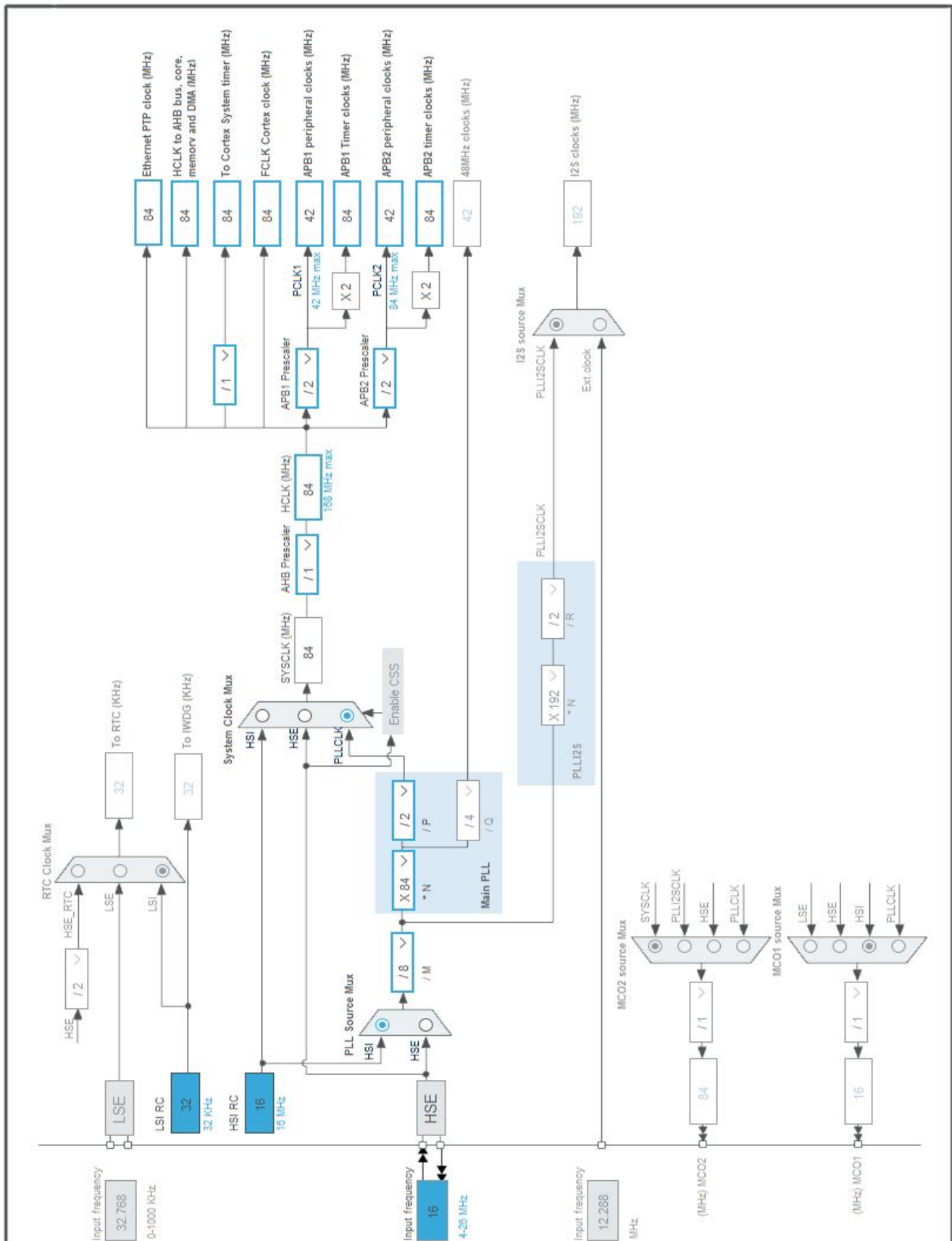
### 3. Pins Configuration

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	VBAT	Power		
2	PC13-ANTI_TAMP *	I/O	GPIO_Input	TB
3	PC14-OSC32_IN *	I/O	GPIO_Output	RF_EM
4	PC15-OSC32_OUT *	I/O	GPIO_Output	D_EM
5	PH0-OSC_IN	I/O	RCC_OSC_IN	
6	PH1-OSC_OUT	I/O	RCC_OSC_OUT	
7	NRST	Reset		
8	PC0	I/O	GPIO_Analog, ADC1_IN10	RF_IR
9	PC1	I/O	ADC1_IN11	DR_IR
10	PC2	I/O	ADC1_IN12	R_IR
11	PC3	I/O	ADC1_IN13	M_IR
12	VSSA	Power		
13	VDDA	Power		
14	PA0-WKUP	I/O	TIM2_CH1	PWM_R2
16	PA2	I/O	TIM2_CH3	PWM_R1
17	PA3	I/O	GPIO_EXTI3	DRDY
18	VSS	Power		
19	VDD	Power		
20	PA4 *	I/O	GPIO_Output	SPI_CS
21	PA5	I/O	SPI1_SCK	
22	PA6	I/O	SPI1_MISO	
23	PA7	I/O	SPI1_MOSI	
24	PC4	I/O	ADC1_IN14	L_IR
25	PC5	I/O	ADC1_IN15	DL_IR
26	PB0	I/O	ADC1_IN8	VOL_METER
27	PB1	I/O	ADC1_IN9	LF_IR
29	PB10	I/O	GPIO_EXTI10	INT_GYRO
30	PB11	I/O	TIM2_CH4	PWM_L2
31	VCAP_1	Power		
32	VDD	Power		
33	PB12 *	I/O	GPIO_Output	LED9
34	PB13 *	I/O	GPIO_Output	LED10
35	PB14 *	I/O	GPIO_Output	LED11
36	PB15 *	I/O	GPIO_Output	LED8
37	PC6 *	I/O	GPIO_Output	BUZZER
38	PC7 *	I/O	GPIO_Output	R_EM

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
39	PC8 *	I/O	GPIO_Output	L_EM
40	PC9 *	I/O	GPIO_Output	LF_EM
41	PA8 *	I/O	GPIO_Input	ENC_LA
42	PA9 *	I/O	GPIO_Input	ENC_LB
43	PA10 *	I/O	GPIO_Output	LED7
44	PA11 *	I/O	GPIO_Output	LED6
45	PA12 *	I/O	GPIO_Output	LED5
46	PA13	I/O	SYS_JTMS-SWDIO	
47	VCAP_2	Power		
48	VDD	Power		
49	PA14	I/O	SYS_JTCK-SWCLK	
50	PA15 *	I/O	GPIO_Output	LED4
51	PC10	I/O	UART4_TX	BTX
52	PC11	I/O	UART4_RX	BRX
53	PC12 *	I/O	GPIO_Output	LED3
54	PD2 *	I/O	GPIO_Output	LED2
55	PB3	I/O	TIM2_CH2	PWM_L1
56	PB4 *	I/O	GPIO_Output	LED1
57	PB5 *	I/O	GPIO_Input	BOOT
58	PB6 *	I/O	GPIO_Input	ENC_RB
59	PB7 *	I/O	GPIO_Input	ENC_RA
60	BOOT0	Boot		
61	PB8	I/O	I2C1_SCL	
62	PB9	I/O	I2C1_SDA	
63	VSS	Power		
64	VDD	Power		

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

## 4. Clock Tree Configuration



## 1. Power Consumption Calculator report

### 1.1. Microcontroller Selection

Series	STM32F4
Line	STM32F405/415
MCU	STM32F405RGTx
Datasheet	DS8626_Rev8

### 1.2. Parameter Selection

Temperature	25
Vdd	3.3

### 1.3. Battery Selection

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

#### 1.4. Sequence

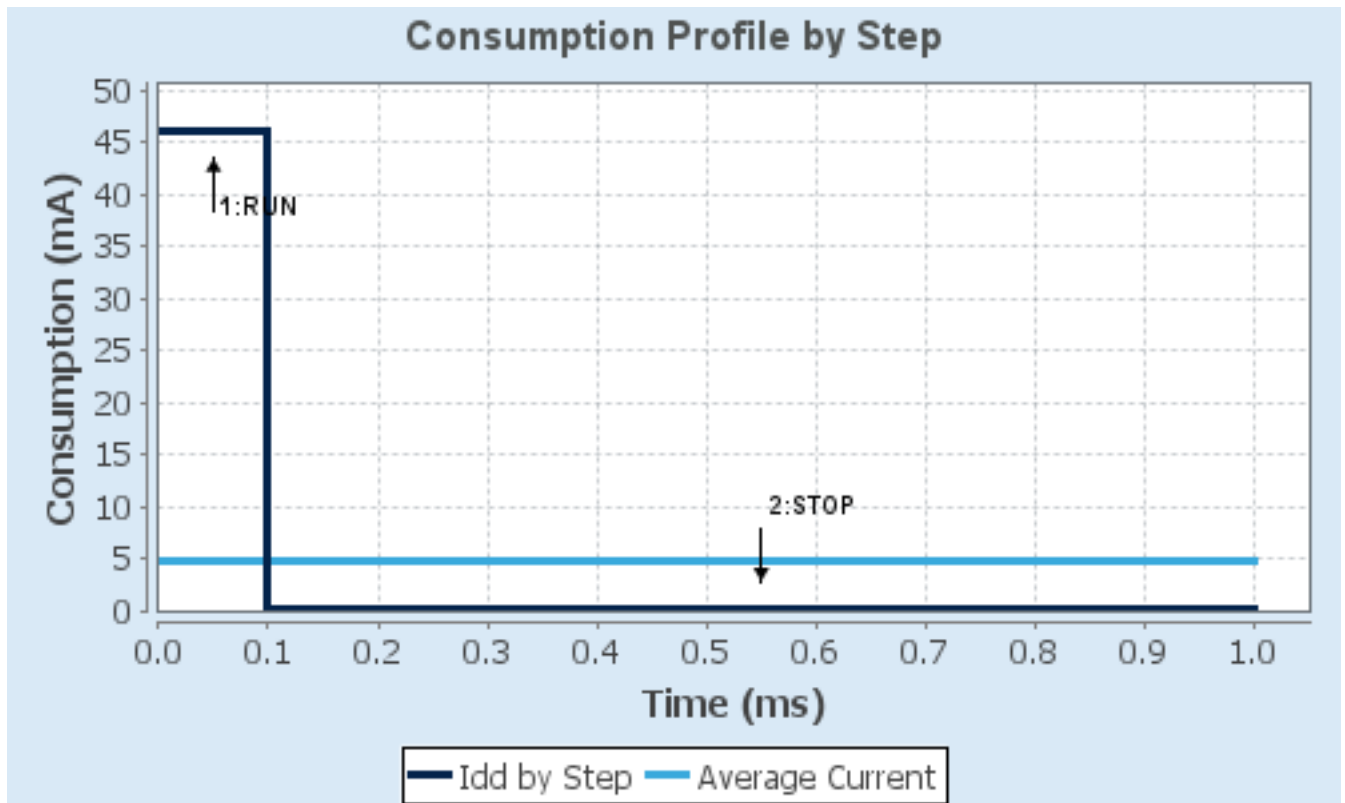
<b>Step</b>	Step1	Step2
<b>Mode</b>	RUN	STOP
<b>Vdd</b>	3.3	3.3
<b>Voltage Source</b>	Battery	Battery
<b>Range</b>	Scale1-High	No Scale
<b>Fetch Type</b>	FLASH	n/a
<b>CPU Frequency</b>	168 MHz	0 Hz
<b>Clock Configuration</b>	HSE PLL	Regulator LP Flash-PwrDwn
<b>Clock Source Frequency</b>	4 MHz	0 Hz
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

#### 1.5. Results

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

#### 1.6. Chart





## 2. Software Project

### 2.1. Project Settings

Name	Value
Project Name	M1
Project Folder	C:\Users\User\STM32CubeIDE\workspace_1.18.1\M1
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_SPI1_Init	SPI1
4	MX_ADC1_Init	ADC1
5	MX_I2C1_Init	I2C1
6	MX_TIM2_Init	TIM2
7	MX_UART4_Init	UART4

### 3. Peripherals and Middlewares Configuration

#### 3.1. ADC1

mode: IN8

mode: IN9

mode: IN10

mode: IN11

mode: IN12

mode: IN13

mode: IN14

mode: IN15

##### 3.1.1. Parameter Settings:

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

Mode	Independent mode
<b>ADC_Settings:</b>	
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
<u>Rank</u>	1
Channel	<b>Channel 10 *</b>
Sampling Time	3 Cycles

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

Number Of Conversions	0
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##### **WatchDog:**

Enable Analog WatchDog Mode	false
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#### 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. RCC

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

### 3.3.1. Parameter Settings:

#### System Parameters:

VDD voltage (V)	3.3
Instruction Cache	Enabled
Prefetch Buffer	Enabled
Data Cache	Enabled
Flash Latency(WS)	2 WS (3 CPU cycle)

#### RCC Parameters:

HSI Calibration Value	16
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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## 3.4. SPI1

### Mode: Full-Duplex Master

### 3.4.1. Parameter Settings:

#### Basic Parameters:

Frame Format	Motorola
Data Size	8 Bits

First Bit	MSB First
<b>Clock Parameters:</b>	
Prescaler (for Baud Rate)	2
Baud Rate	<b>21.0 MBits/s *</b>
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge
<b>Advanced Parameters:</b>	
CRC Calculation	Disabled
NSS Signal Type	Software

### 3.5. SYS

**Debug: Serial Wire**

**Timebase Source: SysTick**

### 3.6. TIM2

**Channel1: PWM Generation CH1**

**Channel2: PWM Generation CH2**

**Channel3: PWM Generation CH3**

**Channel4: PWM Generation CH4**

#### 3.6.1. Parameter Settings:

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

Prescaler (PSC - 16 bits value)	<b>2 *</b>
Counter Mode	Up
Counter Period (AutoReload Register - 32 bits value )	<b>1023 *</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 1:**

Mode	PWM mode 1
Pulse (32 bits value)	0
Output compare preload	Enable
Fast Mode	Disable
CH Polarity	High

##### **PWM Generation Channel 2:**

Mode	PWM mode 1
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Pulse (32 bits value)	0
Output compare preload	Enable
Fast Mode	Disable
CH Polarity	High

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

Mode	PWM mode 1
Pulse (32 bits value)	0
Output compare preload	Enable
Fast Mode	Disable
CH Polarity	High

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

Mode	PWM mode 1
Pulse (32 bits value)	0
Output compare preload	Enable
Fast Mode	Disable
CH Polarity	High

### **3.7. UART4**

#### **Mode: Asynchronous**

##### 3.7.1. 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	PC0	ADC1_IN10	Analog mode	No pull-up and no pull-down	n/a	RF_IR
	PC1	ADC1_IN11	Analog mode	No pull-up and no pull-down	n/a	DR_IR
	PC2	ADC1_IN12	Analog mode	No pull-up and no pull-down	n/a	R_IR
	PC3	ADC1_IN13	Analog mode	No pull-up and no pull-down	n/a	M_IR
	PC4	ADC1_IN14	Analog mode	No pull-up and no pull-down	n/a	L_IR
	PC5	ADC1_IN15	Analog mode	No pull-up and no pull-down	n/a	DL_IR
	PB0	ADC1_IN8	Analog mode	No pull-up and no pull-down	n/a	VOL_METER
	PB1	ADC1_IN9	Analog mode	No pull-up and no pull-down	n/a	LF_IR
I2C1	PB8	I2C1_SCL	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	
	PB9	I2C1_SDA	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	
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	Very High *	
	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 *	
SYS	PA13	SYS_JTMS-SWDIO	n/a	n/a	n/a	
	PA14	SYS_JTCK-SWCLK	n/a	n/a	n/a	
TIM2	PA0-WKUP	TIM2_CH1	Alternate Function Push Pull	No pull-up and no pull-down	Low	PWM_R2
	PA2	TIM2_CH3	Alternate Function Push Pull	No pull-up and no pull-down	Low	PWM_R1
	PB11	TIM2_CH4	Alternate Function Push Pull	No pull-up and no pull-down	Low	PWM_L2
	PB3	TIM2_CH2	Alternate Function Push Pull	No pull-up and no pull-down	Low	PWM_L1
UART4	PC10	UART4_TX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	BTX
	PC11	UART4_RX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	BRX
GPIO	PC13-ANTI_TAMP	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	TB

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
	PC14-OSC32_IN	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	RF_EM
	PC15-OSC32_OUT	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	D_EM
	PC0	GPIO_Analog	Analog mode	No pull-up and no pull-down	n/a	RF_IR
	PA3	GPIO_EXTI3	External Interrupt Mode with Rising edge trigger detection	No pull-up and no pull-down	n/a	DRDY
	PA4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	SPI_CS
	PB10	GPIO_EXTI10	External Interrupt Mode with Rising edge trigger detection	No pull-up and no pull-down	n/a	INT_GYRO
	PB12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED9
	PB13	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED10
	PB14	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED11
	PB15	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED8
	PC6	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	BUZZER
	PC7	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	R_EM
	PC8	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	L_EM
	PC9	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LF_EM
	PA8	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENC_LA
	PA9	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENC_LB
	PA10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED7
	PA11	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED6
	PA12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED5
	PA15	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED4
	PC12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED3
	PD2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED2
	PB4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED1
	PB5	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	BOOT
	PB6	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENC_RB
	PB7	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENC_RA

#### 4.2. DMA configuration

nothing configured in DMA service



### 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	15	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
EXTI line3 interrupt	unused		
ADC1, ADC2 and ADC3 global interrupts	unused		
TIM2 global interrupt	unused		
I2C1 event interrupt	unused		
I2C1 error interrupt	unused		
SPI1 global interrupt	unused		
EXTI line[15:10] interrupts	unused		
UART4 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

**\* User modified value**

## 5. System Views

### 5.1. Category view

#### 5.1.1. Current

Middleware						
System Core	Analog	Timers	Connectivity	Multimedia	Security	Computing
DMA	ADC1 ✓	TIM2 ✓	I2C1 ✓			
GPIO ✓			SPI1 ✓			
NVIC ✓			UART4 ✓			
RCC ✓						
SYS ✓						

## 6. Docs & Resources

Type	Link
BSDL files	<a href="https://www.st.com/resource/en/bsdl_model/stm32f405-415_407-417_bsdل.zip">https://www.st.com/resource/en/bsdl_model/stm32f405-415_407-417_bsdل.zip</a>
IBIS models	<a href="https://www.st.com/resource/en/ibis_model/stm32f405-415_407-417_ibis.zip">https://www.st.com/resource/en/ibis_model/stm32f405-415_407-417_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/flstm32nucleo.pdf">https://www.st.com/resource/en/flyer/flstm32nucleo.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/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/an2945-stm8s-and-stm32-mcus-a-consistent-832bit-product-line-for-painless-migration-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an2945-stm8s-and-stm32-mcus-a-consistent-832bit-product-line-for-painless-migration-stmicroelectronics.pdf</a>

- 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)
- Application Notes [https://www.st.com/resource/en/application\\_note/an3156-usb-dfu-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3156-usb-dfu-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an3364-migration-and-compatibility-guidelines-for-stm32-microcontroller-applications-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3364-migration-and-compatibility-guidelines-for-stm32-microcontroller-applications-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an3371-using-the-hardware-realtime-clock-rtc-in-stm32-f0-f2-f3-f4-and-l1-series-of-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3371-using-the-hardware-realtime-clock-rtc-in-stm32-f0-f2-f3-f4-and-l1-series-of-mcus-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an3997-audio-playback-and-recording-using-the-stm32f4discovery-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3997-audio-playback-and-recording-using-the-stm32f4discovery-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an3998-pdm-audio-software-decoding-on-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an3998-pdm-audio-software-decoding-on-stm32-microcontrollers-stmicroelectronics.pdf)
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