



## 1. Description

### 1.1. Project

Project Name	LineTrackingCar
Board Name	custom
Generated with:	STM32CubeMX 6.8.0
Date	04/19/2023

### 1.2. MCU

MCU Series	STM32F4
MCU Line	STM32F411
MCU name	STM32F411CEUx
MCU Package	UFQFPN48
MCU Pin number	48

### 1.3. Core(s) information

Core(s)	Arm Cortex-M4
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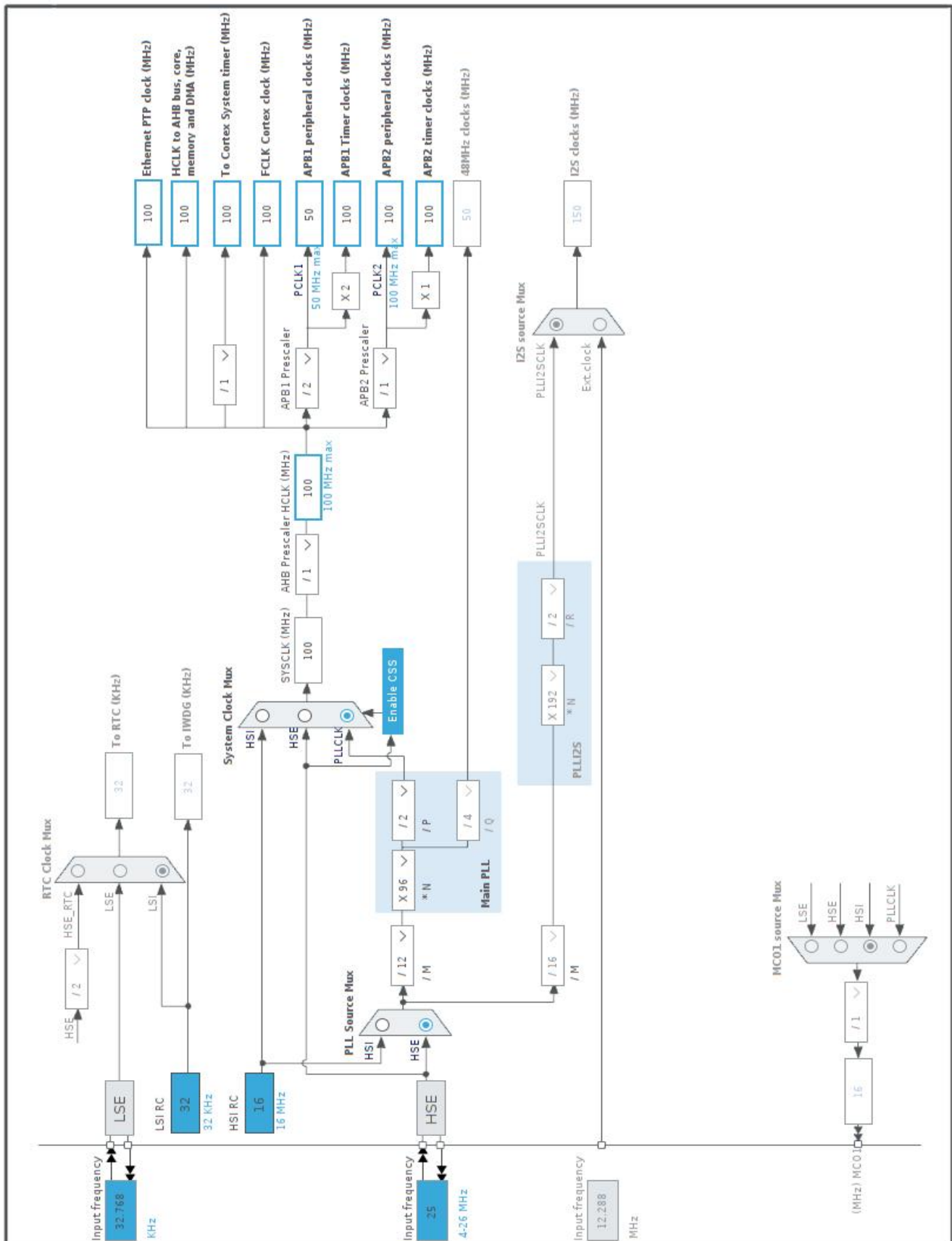
### 3. Pins Configuration

Pin Number UFQFPN48	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	VBAT	Power		
2	PC13-ANTI_TAMP *	I/O	GPIO_Output	LED
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		
8	VSSA	Power		
9	VDDA	Power		
10	PA0-WKUP *	I/O	GPIO_Input	BTN
11	PA1 *	I/O	GPIO_Input	D1
12	PA2 *	I/O	GPIO_Input	D2
13	PA3 *	I/O	GPIO_Input	D3
14	PA4 *	I/O	GPIO_Output	SPI1_CS
15	PA5	I/O	SPI1_SCK	SPI_CLK
16	PA6	I/O	SPI1_MISO	SPI_MISO
17	PA7	I/O	SPI1_MOSI	SPI_MOSI
18	PB0 *	I/O	GPIO_Input	D6
19	PB1 *	I/O	GPIO_Input	D7
20	PB2 *	I/O	GPIO_Output	DIR
22	VCAP1	Power		
23	VSS	Power		
24	VDD	Power		
25	PB12 *	I/O	GPIO_Output	DA
26	PB13 *	I/O	GPIO_Output	NDA
27	PB14 *	I/O	GPIO_Output	DB
28	PB15 *	I/O	GPIO_Output	NDB
29	PA8	I/O	TIM1_CH1	PWM1
30	PA9	I/O	USART1_TX	
31	PA10	I/O	USART1_RX	
34	PA13	I/O	SYS_JTMS-SWDIO	
35	VSS	Power		
36	VDD	Power		
37	PA14	I/O	SYS_JTCK-SWCLK	
38	PA15	I/O	TIM2_CH1	PWM2
40	PB4 *	I/O	GPIO_Input	D4

Pin Number UFQFPN48	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
41	PB5 *	I/O	GPIO_Input	D5
42	PB6 *	I/O	GPIO_Input	D0
44	BOOT0	Boot		
45	PB8 *	I/O	GPIO_Output	LED1
46	PB9 *	I/O	GPIO_Input	BTN2
47	VSS	Power		
48	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	LineTrackingCar
Project Folder	/work/14-LHC/LineTrackingCar
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_DMA_Init	DMA
4	MX_SPI1_Init	SPI1
5	MX_TIM1_Init	TIM1
6	MX_TIM2_Init	TIM2
7	MX_USART1_UART_Init	USART1
8	MX_TIM3_Init	TIM3

## 6. Power Consumption Calculator report

### 6.1. Microcontroller Selection

Series	STM32F4
Line	STM32F411
MCU	STM32F411CEUx
Datasheet	DS10314_Rev6

### 6.2. Parameter Selection

Temperature	25
Vdd	1.7

### 6.3. 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



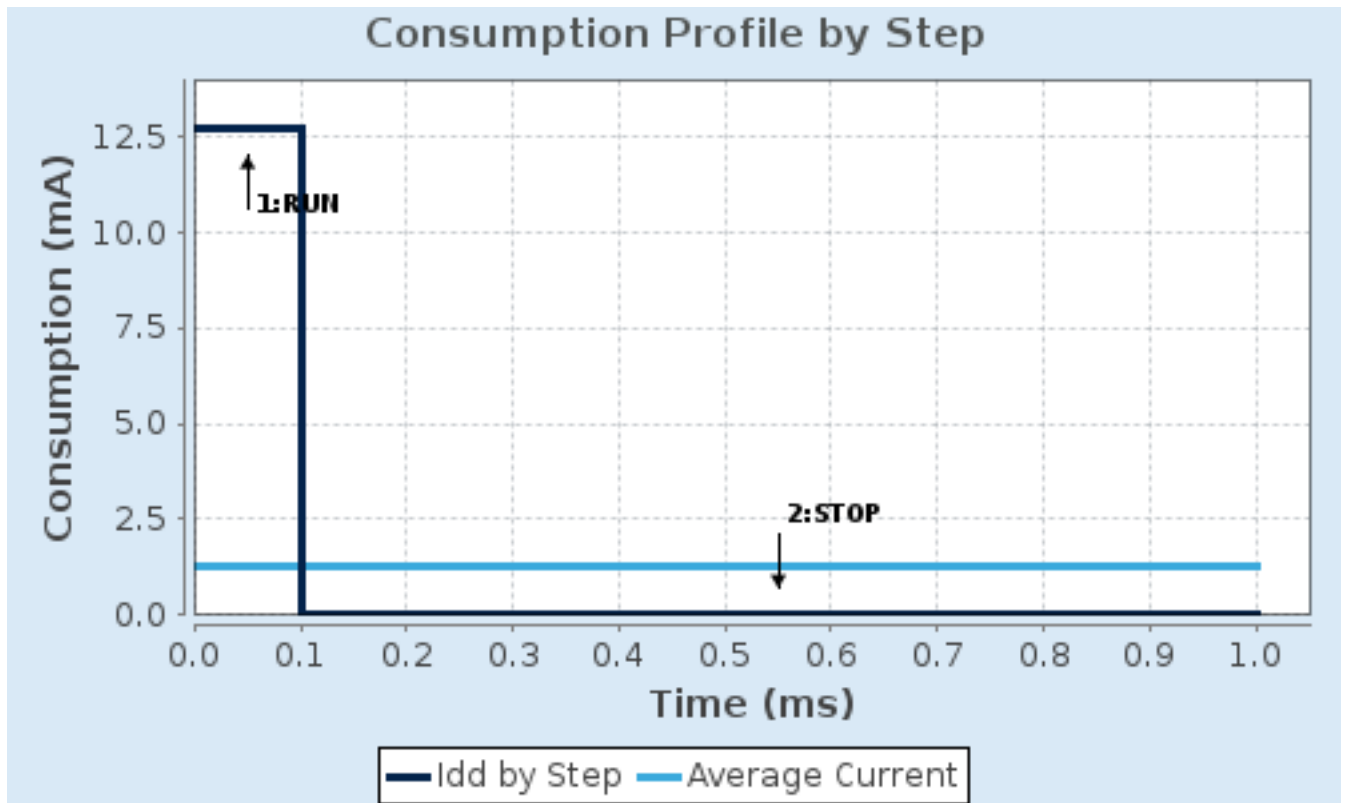
#### 6.4. Sequence

<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>	104.31	105
<b>Category</b>	In DS Table	In DS Table

#### 6.5. Results

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

#### 6.6. Chart



## 7. Peripherals and Middlewares Configuration

### 7.1. RCC

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

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

#### 7.1.1. Parameter Settings:

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

VDD voltage (V)	3.3
Instruction Cache	Enabled
Prefetch Buffer	Enabled
Data Cache	Enabled
Flash Latency(WS)	3 WS (4 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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### 7.2. SPI1

**Mode: Full-Duplex Master**

#### 7.2.1. 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>50.0 MBits/s *</b>
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

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

CRC Calculation	Disabled
NSS Signal Type	Software

### 7.3. SYS

#### Debug: Serial Wire

### 7.4. TIM1

**Clock Source : Internal Clock**

**Channel1: PWM Generation CH1**

#### 7.4.1. Parameter Settings:

##### Counter Settings:

Prescaler (PSC - 16 bits value)	<b>100-1 *</b>
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	<b>1000-1 *</b>
Internal Clock Division (CKD)	No Division
Repetition Counter (RCR - 8 bits value)	0
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)

##### Break And Dead Time management - BRK Configuration:

BRK State	Disable
BRK Polarity	High

##### Break And Dead Time management - Output Configuration:

Automatic Output State	Disable
Off State Selection for Run Mode (OSSR)	Disable
Off State Selection for Idle Mode (OSSI)	Disable
Lock Configuration	Off

##### PWM Generation Channel 1:

Mode	PWM mode 1
Pulse (16 bits value)	0
Output compare preload	Enable
Fast Mode	Disable
CH Polarity	High
CH Idle State	Reset

### 7.5. TIM2

**Clock Source : Internal Clock**  
**Channel1: PWM Generation CH1**

7.5.1. Parameter Settings:

**Counter Settings:**

Prescaler (PSC - 16 bits value)	<b>100-1 *</b>
Counter Mode	Up
Counter Period (AutoReload Register - 32 bits value )	<b>1000-1 *</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

**7.6. TIM3**

**mode: Clock Source**

7.6.1. Parameter Settings:

**Counter Settings:**

Prescaler (PSC - 16 bits value)	<b>100-1 *</b>
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	<b>100-1 *</b>
Internal Clock Division (CKD)	No Division
auto-reload preload	<b>Enable *</b>

**Trigger Output (TRGO) Parameters:**

Master/Slave Mode (MSM bit)	<b>Enable (Trigger delayed for master/slaves simultaneous start)</b> *
Trigger Event Selection	<b>Update Event *</b>

## 7.7. USART1

### Mode: Asynchronous

#### 7.7.1. 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

## 7.8. FREERTOS

### Interface: CMSIS\_V1

#### 7.8.1. Config parameters:

##### API:

FreeRTOS API	CMSIS v1
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##### Versions:

FreeRTOS version	10.3.1
CMSIS-RTOS version	1.02

##### MPU/FPU:

ENABLE_MPU	Disabled
ENABLE_FPU	Disabled

##### Kernel settings:

USE_PREEMPTION	Enabled
CPU_CLOCK_HZ	SystemCoreClock
TICK_RATE_HZ	1000
MAX_PRIORITIES	7
MINIMAL_STACK_SIZE	128
MAX_TASK_NAME_LEN	16
USE_16_BIT_TICKS	Disabled
IDLE_SHOULD_YIELD	Enabled
USE_MUTEXES	Enabled
USE_RECURSIVE_MUTEXES	Disabled
USE_COUNTING_SEMAPHORES	Disabled
QUEUE_REGISTRY_SIZE	8
USE_APPLICATION_TASK_TAG	Disabled

ENABLE_BACKWARD_COMPATIBILITY	Enabled
USE_PORT_OPTIMISED_TASK_SELECTION	Enabled
USE_TICKLESS_IDLE	Disabled
USE_TASK_NOTIFICATIONS	Enabled
RECORD_STACK_HIGH_ADDRESS	Disabled

#### Memory management settings:

Memory Allocation	Dynamic / Static
TOTAL_HEAP_SIZE	<b>30720 *</b>
Memory Management scheme	heap_4

#### Hook function related definitions:

USE_IDLE_HOOK	Disabled
USE_TICK_HOOK	Disabled
USE_MALLOC_FAILED_HOOK	<b>Enabled *</b>
USE_DAEMON_TASK_STARTUP_HOOK	Disabled
CHECK_FOR_STACK_OVERFLOW	<b>Option2 *</b>

#### Run time and task stats gathering related definitions:

GENERATE_RUN_TIME_STATS	Disabled
USE_TRACE_FACILITY	Disabled
USE_STATS_FORMATTING_FUNCTIONS	Disabled

#### Co-routine related definitions:

USE_CO_ROUTINES	Disabled
MAX_CO_ROUTINE_PRIORITIES	2

#### Software timer definitions:

USE_TIMERS	Enabled
TIMER_TASK_PRIORITY	2
TIMER_QUEUE_LENGTH	10
TIMER_TASK_STACK_DEPTH	256

#### Interrupt nesting behaviour configuration:

LIBRARY_LOWEST_INTERRUPT_PRIORITY	15
LIBRARY_MAX_SYSCALL_INTERRUPT_PRIORITY	5

#### Added with 10.2.1 support:

MESSAGE_BUFFER_LENGTH_TYPE	size_t
USE_POSIX_ERRNO	Disabled

### 7.8.2. Include parameters:

#### Include definitions:

vTaskPrioritySet	Enabled
uxTaskPriorityGet	Enabled
vTaskDelete	Enabled

vTaskCleanUpResources	Disabled
vTaskSuspend	Enabled
vTaskDelayUntil	<b>Enabled *</b>
vTaskDelay	Enabled
xTaskGetSchedulerState	Enabled
xTaskResumeFromISR	Enabled
xQueueGetMutexHolder	Disabled
xSemaphoreGetMutexHolder	Disabled
pcTaskGetTaskName	Disabled
uxTaskGetStackHighWaterMark	Disabled
xTaskGetCurrentTaskHandle	Disabled
eTaskGetState	Disabled
xEventGroupSetBitFromISR	<b>Enabled *</b>
xTimerPendFunctionCall	<b>Enabled *</b>
xTaskAbortDelay	Disabled
xTaskGetHandle	Disabled
uxTaskGetStackHighWaterMark2	Disabled

### 7.8.3. Advanced settings:

#### **Newlib settings (see parameter description first):**

USE_NEWLIB_REENTRANT	<b>Enabled *</b>
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#### **Project settings (see parameter description first):**

Use FW pack heap file	Enabled
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**\* User modified value**



## 8. System Configuration

### 8.1. 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	PA5	SPI1_SCK	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	SPI_CLK
	PA6	SPI1_MISO	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	SPI_MISO
	PA7	SPI1_MOSI	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	SPI_MOSI
SYS	PA13	SYS_JTMS-SWDIO	n/a	n/a	n/a	
	PA14	SYS_JTCK-SWCLK	n/a	n/a	n/a	
TIM1	PA8	TIM1_CH1	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	PWM1
TIM2	PA15	TIM2_CH1	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	PWM2
USART1	PA9	USART1_TX	Alternate Function Push Pull	Pull-up *	Very High *	
	PA10	USART1_RX	Alternate Function Push Pull	Pull-up *	Very High *	
GPIO	PC13-ANTI_TAMP	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED
	PA0-WKUP	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	BTN
	PA1	GPIO_Input	Input mode	Pull-up *	n/a	D1
	PA2	GPIO_Input	Input mode	Pull-up *	n/a	D2
	PA3	GPIO_Input	Input mode	Pull-up *	n/a	D3
	PA4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Very High *	SPI1_CS
	PB0	GPIO_Input	Input mode			D6

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
				<b>Pull-up *</b>	<b>n/a</b>	
	PB1	GPIO_Input	Input mode	<b>Pull-up *</b>	<b>n/a</b>	D7
	PB2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	<b>Very High *</b>	DIR
	PB12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	<b>Very High *</b>	DA
	PB13	GPIO_Output	Output Push Pull	No pull-up and no pull-down	<b>Very High *</b>	NDA
	PB14	GPIO_Output	Output Push Pull	No pull-up and no pull-down	<b>Very High *</b>	DB
	PB15	GPIO_Output	Output Push Pull	No pull-up and no pull-down	<b>Very High *</b>	NDB
	PB4	GPIO_Input	Input mode	<b>Pull-up *</b>	<b>n/a</b>	D4
	PB5	GPIO_Input	Input mode	<b>Pull-up *</b>	<b>n/a</b>	D5
	PB6	GPIO_Input	Input mode	<b>Pull-up *</b>	<b>n/a</b>	D0
	PB8	GPIO_Output	Output Push Pull	<b>Pull-up *</b>	<b>Very High *</b>	LED1
	PB9	GPIO_Input	Input mode	<b>Pull-up *</b>	<b>n/a</b>	BTN2

## 8.2. DMA configuration

DMA request	Stream	Direction	Priority
USART1_TX	DMA2_Stream7	Memory To Peripheral	<b>Medium *</b>

### USART1\_TX: DMA2\_Stream7 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

#### 8.3.1. 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	15	0
System tick timer	true	15	0
USART1 global interrupt	true	5	0
DMA2 stream7 global interrupt	true	5	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
TIM1 break interrupt and TIM9 global interrupt	unused		
TIM1 update interrupt and TIM10 global interrupt	unused		
TIM1 trigger and commutation interrupts and TIM11 global interrupt	unused		
TIM1 capture compare interrupt	unused		
TIM2 global interrupt	unused		
TIM3 global interrupt	unused		
SPI1 global interrupt	unused		
FPU global interrupt	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
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	false	false
Debug monitor	false	true	false
Pendable request for system service	false	false	false
System tick timer	false	true	true

Enabled interrupt Table	Select for init sequence ordering	Generate IRQ handler	Call HAL handler
USART1 global interrupt	false	true	true
DMA2 stream7 global interrupt	false	true	true

\* User modified value

## 9. System Views

### 9.1. Category view

#### 9.1.1. Current

Middleware					
FREERTOS					
System Core	Analog	Timers	Connectivity	Multimedia	Computing
DMA		TIM1	SPI1		
GPIO		TIM2	USART1		
NVIC		TIM3			
RCC					
SYS					

## 10. Docs & Resources

Type	Link
BSDL files	<a href="https://www.st.com/resource/en/bsdl_model/stm32f411_bsd1.zip">https://www.st.com/resource/en/bsdl_model/stm32f411_bsd1.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>
BSDL files	<a href="https://www.st.com/resource/en/bsdl_model/stm32f411_bsd1.zip">https://www.st.com/resource/en/bsdl_model/stm32f411_bsd1.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>
Training Material	<a href="https://www.st.com/resource/en/sales_guide/sg_sc2154.pdf">https://www.st.com/resource/en/sales_guide/sg_sc2154.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-">https://www.st.com/resource/en/application_note/an2606-stm32-</a>

microcontroller-system-memory-boot-mode-stmicroelectronics.pdf

- Application Notes [https://www.st.com/resource/en/application\\_note/an2639-soldering-recommendations-and-package-information-for-leadfree-ecopack-mcus-and-mpus-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an2639-soldering-recommendations-and-package-information-for-leadfree-ecopack-mcus-and-mpus-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an2834-how-to-get-the-best-adc-accuracy-in-stm32-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an2834-how-to-get-the-best-adc-accuracy-in-stm32-microcontrollers-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)
- Application Notes [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)
- 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)
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Application Notes for related Tools	<a href="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</a>
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Application Notes for related Tools	<a href="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</a>
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Application Notes for related Tools	<a href="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</a>
& Software	
Application Notes for related Tools	<a href="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</a>
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Application Notes for related Tools	<a href="https://www.st.com/resource/en/application_note/an5054-secure-programming-using-stm32cube programmer-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an5054-secure-programming-using-stm32cube programmer-stmicroelectronics.pdf</a>
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Application Notes for related Tools	<a href="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</a>
& Software	
Application Notes for related Tools	<a href="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</a>
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Application Notes for related Tools	<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>
& Software	
Application Notes for related Tools	<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/an5426-migrating-graphics-middleware-projects-from-stm32cubemx-540-to-stm32cubemx-550-stmicroelectronics.pdf">https://www.st.com/resource/en/application_note/an5426-migrating-graphics-middleware-projects-from-stm32cubemx-540-to-stm32cubemx-550-stmicroelectronics.pdf</a>
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Reference	<a href="https://www.st.com/resource/en/reference_manual/rm0383-">https://www.st.com/resource/en/reference_manual/rm0383-</a>

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