



## 1. Description

### 1.1. Project

Project Name	semua_inti
Board Name	custom
Generated with:	STM32CubeMX 6.12.1
Date	11/09/2025

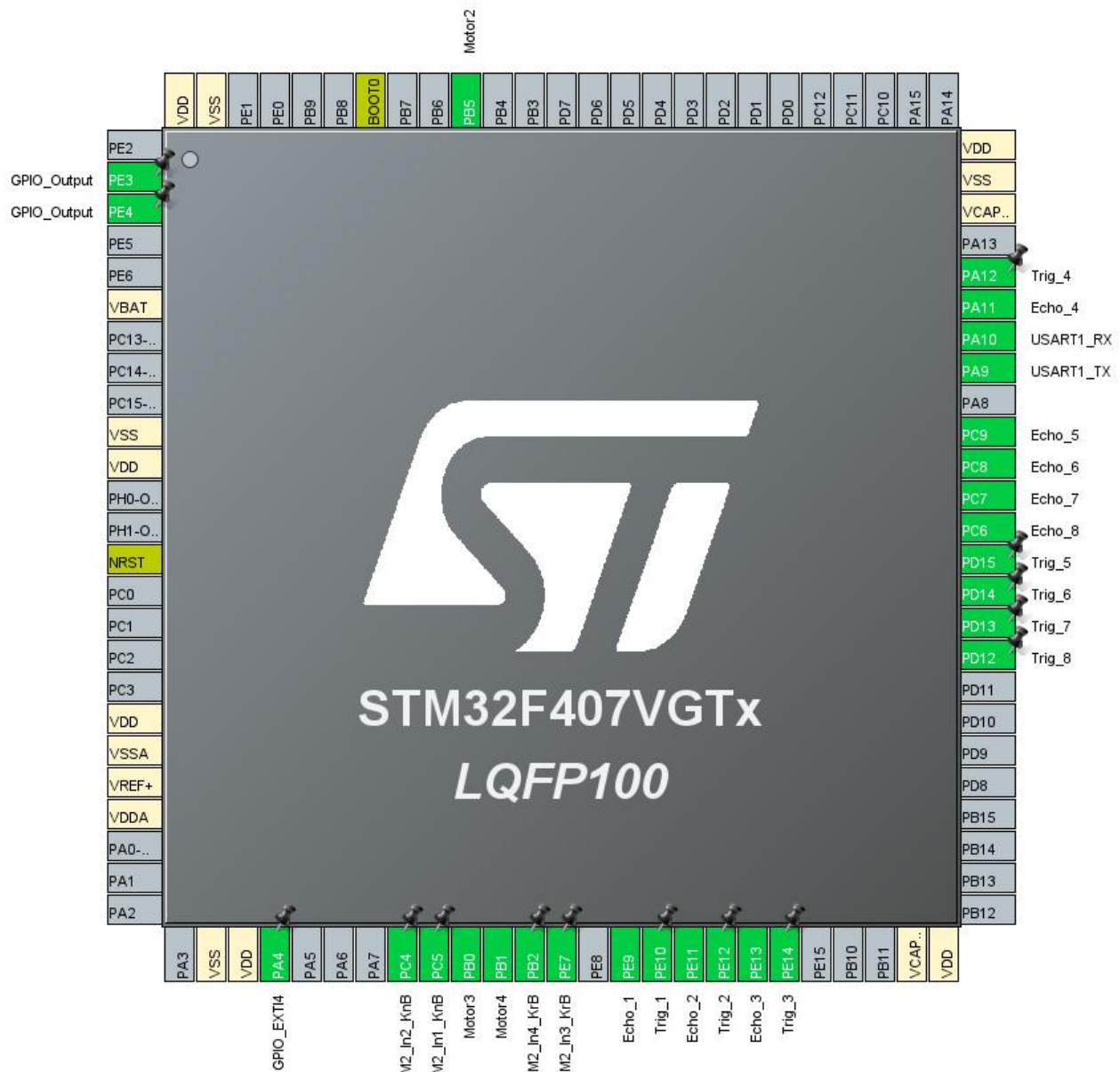
### 1.2. MCU

MCU Series	STM32F4
MCU Line	STM32F407/417
MCU name	STM32F407VGTx
MCU Package	LQFP100
MCU Pin number	100

### 1.3. Core(s) information

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



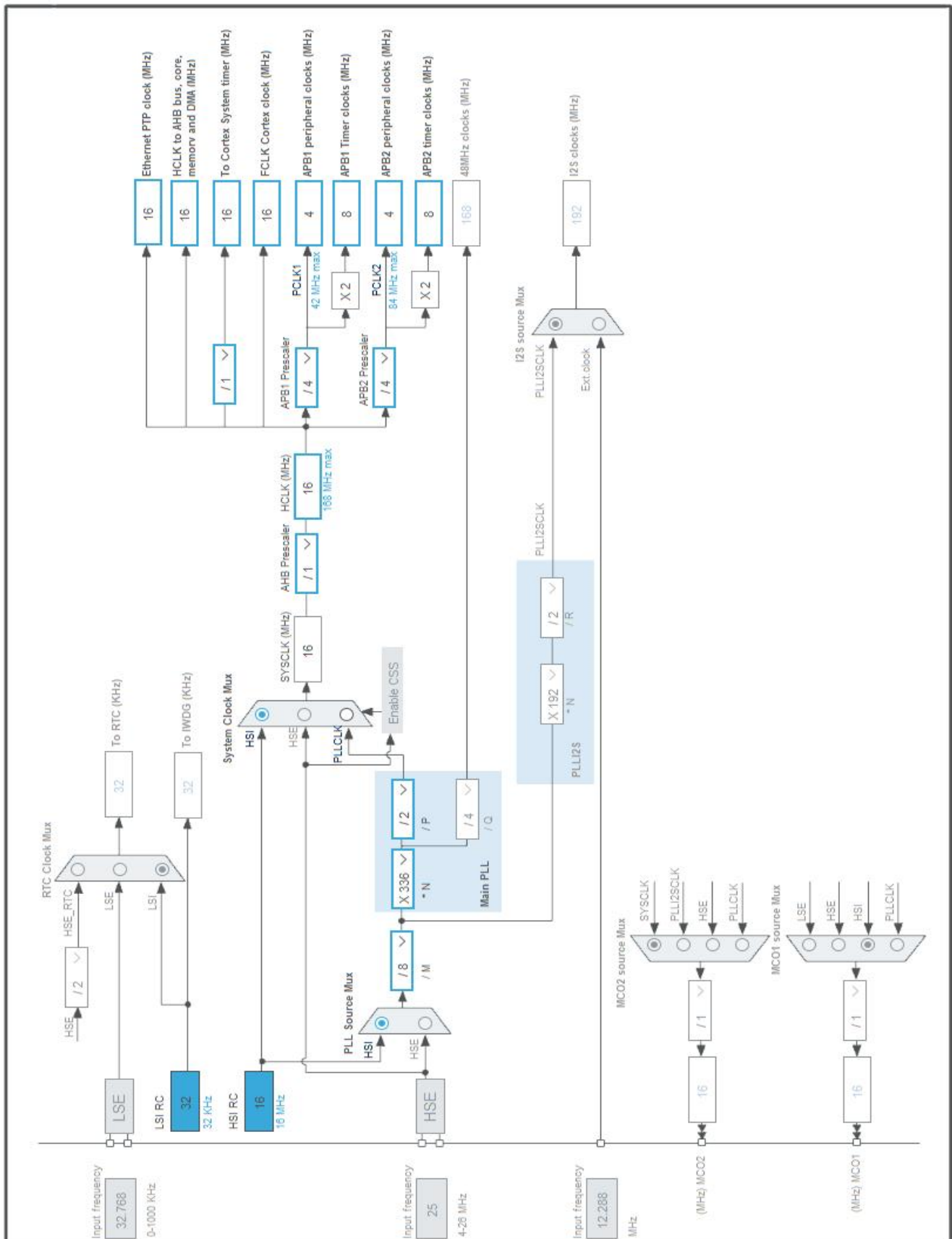
### 3. Pins Configuration

Pin Number LQFP100	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
2	PE3 *	I/O	GPIO_Output	
3	PE4 *	I/O	GPIO_Output	
6	VBAT	Power		
10	VSS	Power		
11	VDD	Power		
14	NRST	Reset		
19	VDD	Power		
20	VSSA	Power		
21	VREF+	Power		
22	VDDA	Power		
27	VSS	Power		
28	VDD	Power		
29	PA4	I/O	GPIO_EXTI4	
33	PC4 *	I/O	GPIO_Output	M2_In2_KnB
34	PC5 *	I/O	GPIO_Output	M2_In1_KnB
35	PB0	I/O	TIM3_CH3	Motor3
36	PB1	I/O	TIM3_CH4	Motor4
37	PB2 *	I/O	GPIO_Output	M2_In4_KrB
38	PE7 *	I/O	GPIO_Output	M2_In3_KrB
40	PE9	I/O	TIM1_CH1	Echo_1
41	PE10 *	I/O	GPIO_Output	Trig_1
42	PE11	I/O	TIM1_CH2	Echo_2
43	PE12 *	I/O	GPIO_Output	Trig_2
44	PE13	I/O	TIM1_CH3	Echo_3
45	PE14 *	I/O	GPIO_Output	Trig_3
49	VCAP_1	Power		
50	VDD	Power		
59	PD12 *	I/O	GPIO_Output	Trig_8
60	PD13 *	I/O	GPIO_Output	Trig_7
61	PD14 *	I/O	GPIO_Output	Trig_6
62	PD15 *	I/O	GPIO_Output	Trig_5
63	PC6	I/O	TIM8_CH1	Echo_8
64	PC7	I/O	TIM8_CH2	Echo_7
65	PC8	I/O	TIM8_CH3	Echo_6
66	PC9	I/O	TIM8_CH4	Echo_5
68	PA9	I/O	USART1_TX	

Pin Number LQFP100	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
69	PA10	I/O	USART1_RX	
70	PA11	I/O	TIM1_CH4	Echo_4
71	PA12 *	I/O	GPIO_Output	Trig_4
73	VCAP_2	Power		
74	VSS	Power		
75	VDD	Power		
91	PB5	I/O	TIM3_CH2	Motor2
94	BOOT0	Boot		
99	VSS	Power		
100	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	STM32F407/417
MCU	STM32F407VGTx
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

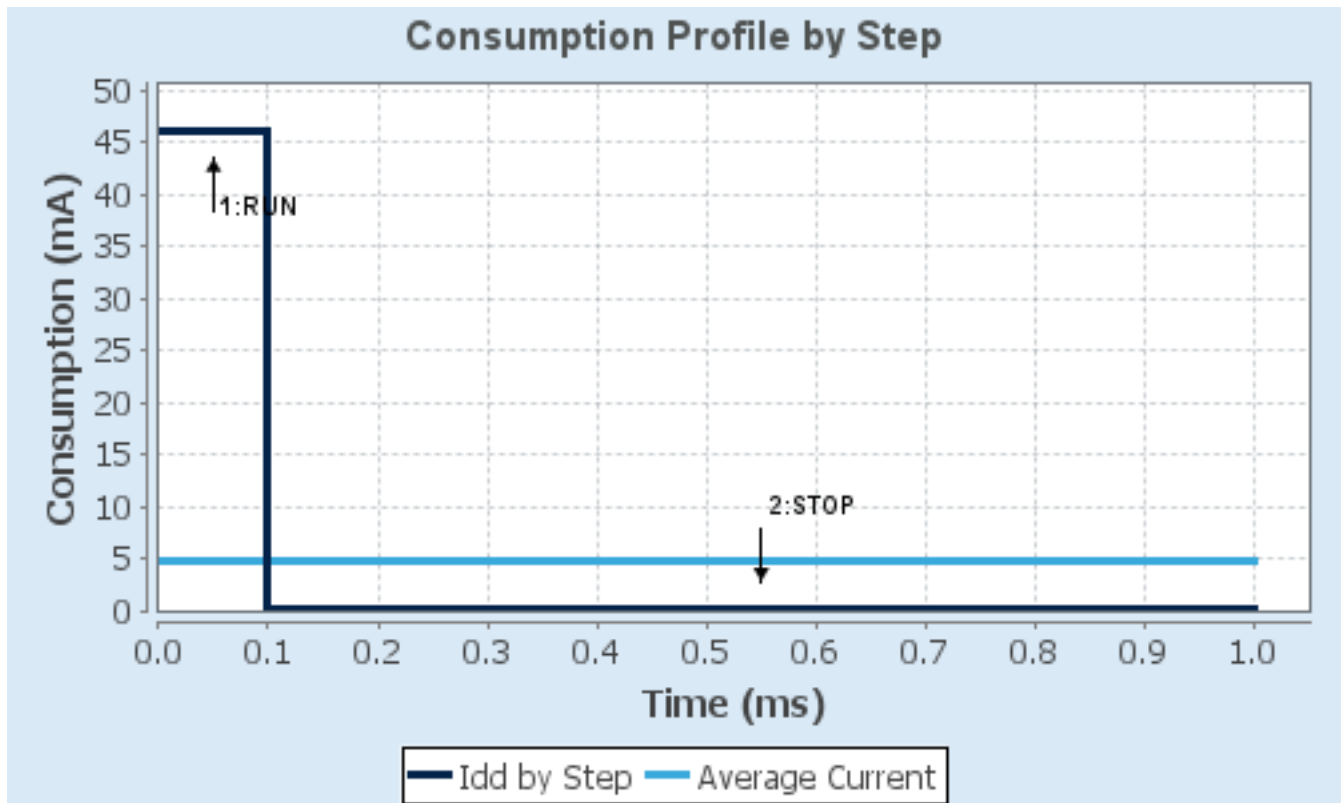
<b>Step</b>	Step1	Step2
<b>Mode</b>	RUN	STOP
<b>Vdd</b>	3.3	3.3
<b>Voltage Source</b>	Battery	Battery
<b>Range</b>	Scale1-High	No Scale
<b>Fetch Type</b>	FLASH	n/a
<b>CPU Frequency</b>	168 MHz	0 Hz
<b>Clock Configuration</b>	HSE PLL	Regulator LP Flash-PwrDwn
<b>Clock Source Frequency</b>	4 MHz	0 Hz
<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>	98.47	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	semua_inti
Project Folder	D:\Capstone\stm32\final\Semua Komponen
Toolchain / IDE	STM32CubeIDE
Firmware Package Name and Version	STM32Cube FW_F4 V1.28.3
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_TIM1_Init	TIM1
4	MX_TIM8_Init	TIM8
5	MX_TIM2_Init	TIM2
6	MX_TIM3_Init	TIM3
7	MX_USART1_UART_Init	USART1

## 3. Peripherals and Middlewares Configuration

### 3.1. RCC

#### 3.1.1. 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
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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### 3.2. SYS

**Timebase Source: SysTick**

### 3.3. TIM1

**Clock Source : Internal Clock**

**Channel1: Input Capture direct mode**

**Channel2: Input Capture direct mode**

**Channel3: Input Capture direct mode**

**Channel4: Input Capture direct mode**

#### 3.3.1. Parameter Settings:

##### Counter Settings:

Prescaler (PSC - 16 bits value)	<b>167 *</b>
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	65535
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)
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Trigger Event Selection Reset (UG bit from TIMx\_EGR)

#### Input Capture Channel 1:

Polarity Selection Rising Edge  
IC Selection Direct  
Prescaler Division Ratio No division  
Input Filter (4 bits value) 0

#### Input Capture Channel 2:

Polarity Selection Rising Edge  
IC Selection Direct  
Prescaler Division Ratio No division  
Input Filter (4 bits value) 0

#### Input Capture Channel 3:

Polarity Selection Rising Edge  
IC Selection Direct  
Prescaler Division Ratio No division  
Input Filter (4 bits value) 0

#### Input Capture Channel 4:

Polarity Selection Rising Edge  
IC Selection Direct  
Prescaler Division Ratio No division  
Input Filter (4 bits value) 0

### 3.4. TIM2

#### Clock Source : Internal Clock

##### 3.4.1. Parameter Settings:

#### Counter Settings:

Prescaler (PSC - 16 bits value) **83 \***  
Counter Mode Up  
Counter Period (AutoReload Register - 32 bits value ) 4294967295  
Internal Clock Division (CKD) No Division  
auto-reload preload **Enable \***

#### Trigger Output (TRGO) Parameters:

Master/Slave Mode (MSM bit) Disable (Trigger input effect not delayed)  
Trigger Event Selection Reset (UG bit from TIMx\_EGR)

### 3.5. TIM3

**Channel2: PWM Generation CH2**

**Channel3: PWM Generation CH3**

**Channel4: PWM Generation CH4**

#### 3.5.1. Parameter Settings:

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

Prescaler (PSC - 16 bits value)	0
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	<b>4199 *</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 2:**

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

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

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

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

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

### 3.6. TIM8

**Clock Source : Internal Clock**

**Channel1: Input Capture direct mode**

## Channel2: Input Capture direct mode

## Channel3: Input Capture direct mode

## Channel4: Input Capture direct mode

### 3.6.1. Parameter Settings:

#### Counter Settings:

Prescaler (PSC - 16 bits value)	167 *
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	65535
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)

#### Input Capture Channel 1:

Polarity Selection	Rising Edge
IC Selection	Direct
Prescaler Division Ratio	No division
Input Filter (4 bits value)	0

#### Input Capture Channel 2:

Polarity Selection	Rising Edge
IC Selection	Direct
Prescaler Division Ratio	No division
Input Filter (4 bits value)	0

#### Input Capture Channel 3:

Polarity Selection	Rising Edge
IC Selection	Direct
Prescaler Division Ratio	No division
Input Filter (4 bits value)	0

#### Input Capture Channel 4:

Polarity Selection	Rising Edge
IC Selection	Direct
Prescaler Division Ratio	No division
Input Filter (4 bits value)	0

## 3.7. USART1

### 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
TIM1	PE9	TIM1_CH1	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_1
	PE11	TIM1_CH2	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_2
	PE13	TIM1_CH3	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_3
	PA11	TIM1_CH4	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_4
TIM3	PB0	TIM3_CH3	Alternate Function Push Pull	No pull-up and no pull-down	Low	Motor3
	PB1	TIM3_CH4	Alternate Function Push Pull	No pull-up and no pull-down	Low	Motor4
	PB5	TIM3_CH2	Alternate Function Push Pull	No pull-up and no pull-down	Low	Motor2
TIM8	PC6	TIM8_CH1	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_8
	PC7	TIM8_CH2	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_7
	PC8	TIM8_CH3	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_6
	PC9	TIM8_CH4	Alternate Function Push Pull	<b>Pull-down *</b>	Low	Echo_5
USART1	PA9	USART1_TX	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	
	PA10	USART1_RX	Alternate Function Push Pull	No pull-up and no pull-down	<b>Very High *</b>	
GPIO	PE3	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	
	PE4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	
	PA4	GPIO_EXTI4	External Interrupt Mode with Rising edge trigger detection	No pull-up and no pull-down	n/a	
	PC4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M2_In2_KnB
	PC5	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M2_In1_KnB
	PB2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M2_In4_KrB
	PE7	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M2_In3_KrB
	PE10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_1
	PE12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_2
	PE14	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_3
	PD12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_8
	PD13	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_7
	PD14	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_6
	PD15	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_5
	PA12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Trig_4

### 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
TIM1 break interrupt and TIM9 global interrupt	true	0	0
TIM1 update interrupt and TIM10 global interrupt	true	0	0
TIM1 trigger and commutation interrupts and TIM11 global interrupt	true	0	0
TIM1 capture compare interrupt	true	0	0
TIM8 break interrupt and TIM12 global interrupt	true	0	0
TIM8 update interrupt and TIM13 global interrupt	true	0	0
TIM8 trigger and commutation interrupts and TIM14 global interrupt	true	0	0
TIM8 capture compare interrupt	true	0	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
EXTI line4 interrupt	unused		
TIM2 global interrupt	unused		
TIM3 global interrupt	unused		
USART1 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

Enabled interrupt Table	Select for init sequence ordering	Generate IRQ handler	Call HAL handler
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
TIM1 break interrupt and TIM9 global interrupt	false	true	true
TIM1 update interrupt and TIM10 global interrupt	false	true	true
TIM1 trigger and commutation interrupts and TIM11 global interrupt	false	true	true
TIM1 capture compare interrupt	false	true	true
TIM8 break interrupt and TIM12 global interrupt	false	true	true
TIM8 update interrupt and TIM13 global interrupt	false	true	true
TIM8 trigger and commutation interrupts and TIM14 global interrupt	false	true	true
TIM8 capture compare 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	Security	Computing
DMA		TIM1 ✓	USART1 ✓			
GPIO ✓		TIM2 ✓				
NVIC ✓		TIM3 ✓				
RCC ✓		TIM8 ✓				
SYS ✓						

## 6. Docs & Resources

Type	Link
BSDL files	<a href="https://www.st.com/resource/en/bsdl_model/stm32f405-415_407-417_bsdl.zip">https://www.st.com/resource/en/bsdl_model/stm32f405-415_407-417_bsdl.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>
Security Bulletin	<a href="https://www.st.com/resource/en/technical_note/tn1489-security-bulletin-tn1489stpsirt-physical-attacks-on-stm32-and-stm32cube-firmware-stmicroelectronics.pdf">https://www.st.com/resource/en/technical_note/tn1489-security-bulletin-tn1489stpsirt-physical-attacks-on-stm32-and-stm32cube-firmware-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-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 [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)
- 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/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)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4031-using-the-stm32f2-stm32f4-and-stm32f7-series-dma-controller-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4031-using-the-stm32f2-stm32f4-and-stm32f7-series-dma-controller-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4073-how-to-improve-adc-accuracy-when-using-stm32f2xx-and-stm32f4xx-microcontrollers-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4073-how-to-improve-adc-accuracy-when-using-stm32f2xx-and-stm32f4xx-microcontrollers-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4076-two-or-three-shunt-resistor-based-current-sensing-circuit-design-in-3phase-inverters-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4076-two-or-three-shunt-resistor-based-current-sensing-circuit-design-in-3phase-inverters-stmicroelectronics.pdf)
- Application Notes [https://www.st.com/resource/en/application\\_note/an4221-i2c-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf](https://www.st.com/resource/en/application_note/an4221-i2c-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf)

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