
STM32
CubeMX

1. Description

1.1. Project

Project Name	AMP_PCBv3
Board Name	NUCLEO-F446RE
Generated with:	STM32CubeMX 6.11.0
Date	04/19/2024

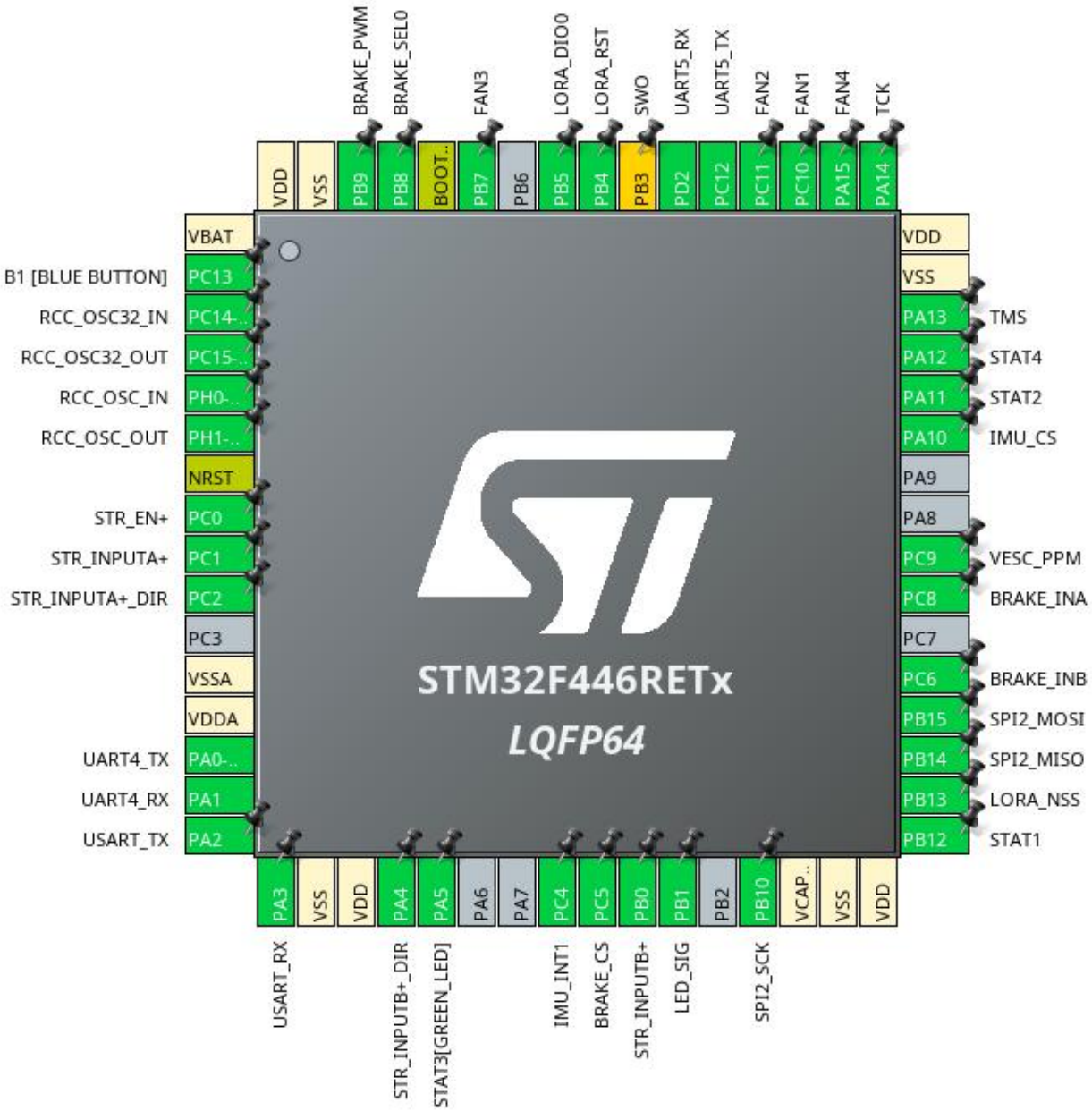
1.2. MCU

MCU Series	STM32F4
MCU Line	STM32F446
MCU name	STM32F446RETx
MCU Package	LQFP64
MCU Pin number	64

1.3. Core(s) information

Core(s)	Arm Cortex-M4

2. Pinout Configuration



3. Pins Configuration

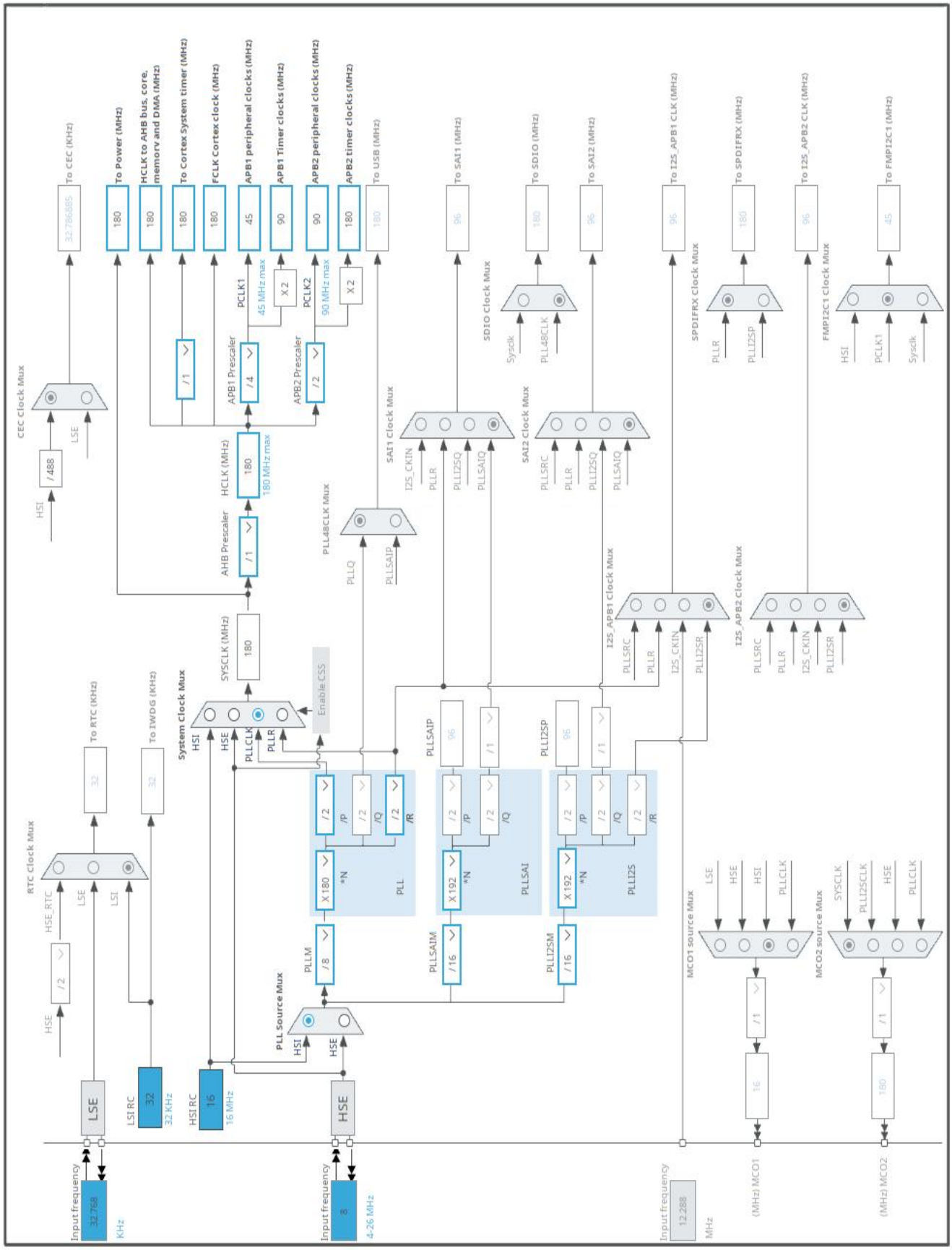
Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	VBAT	Power		
2	PC13	I/O	GPIO_EXTI13	B1 [BLUE BUTTON]
3	PC14-OSC32_IN	I/O	RCC_OSC32_IN	
4	PC15-OSC32_OUT	I/O	RCC_OSC32_OUT	
5	PH0-OSC_IN	I/O	RCC_OSC_IN	
6	PH1-OSC_OUT	I/O	RCC_OSC_OUT	
7	NRST	Reset		
8	PC0 *	I/O	GPIO_Output	STR_EN+
9	PC1 *	I/O	GPIO_Output	STR_INPUTA+
10	PC2 *	I/O	GPIO_Output	STR_INPUTA+_DIR
12	VSSA	Power		
13	VDDA	Power		
14	PA0-WKUP	I/O	UART4_TX	
15	PA1	I/O	UART4_RX	
16	PA2	I/O	USART2_TX	USART_TX
17	PA3	I/O	USART2_RX	USART_RX
18	VSS	Power		
19	VDD	Power		
20	PA4 *	I/O	GPIO_Output	STR_INPUTB+_DIR
21	PA5 *	I/O	GPIO_Output	STAT3[GREEN_LED]
24	PC4	I/O	GPIO_EXTI4	IMU_INT1
25	PC5	I/O	ADC1_IN15	BRAKE_CS
26	PB0	I/O	TIM3_CH3	STR_INPUTB+
27	PB1	I/O	TIM3_CH4	LED_SIG
29	PB10	I/O	SPI2_SCK	
30	VCAP_1	Power		
31	VSS	Power		
32	VDD	Power		
33	PB12 *	I/O	GPIO_Output	STAT1
34	PB13 *	I/O	GPIO_Output	LORA_NSS
35	PB14	I/O	SPI2_MISO	
36	PB15	I/O	SPI2_MOSI	
37	PC6 *	I/O	GPIO_Output	BRAKE_INB
39	PC8 *	I/O	GPIO_Output	BRAKE_INA
40	PC9	I/O	TIM8_CH4	VESC_PPM
43	PA10 *	I/O	GPIO_Output	IMU_CS

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
44	PA11 *	I/O	GPIO_Output	STAT2
45	PA12 *	I/O	GPIO_Output	STAT4
46	PA13	I/O	SYS_JTMS-SWDIO	TMS
47	VSS	Power		
48	VDD	Power		
49	PA14	I/O	SYS_JTCK-SWCLK	TCK
50	PA15 *	I/O	GPIO_Output	FAN4
51	PC10 *	I/O	GPIO_Output	FAN1
52	PC11 *	I/O	GPIO_Output	FAN2
53	PC12	I/O	UART5_TX	
54	PD2	I/O	UART5_RX	
55	PB3 **	I/O	SYS_JTDO-SWO	SWO
56	PB4 *	I/O	GPIO_Output	LORA_RST
57	PB5	I/O	GPIO_EXTI5	LORA_DIO0
59	PB7 *	I/O	GPIO_Output	FAN3
60	BOOT0	Boot		
61	PB8 *	I/O	GPIO_Output	BRAKE_SEL0
62	PB9 *	I/O	GPIO_Output	BRAKE_PWM
63	VSS	Power		
64	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



5. Software Project

5.1. Project Settings

Name	Value
Project Name	AMP_PCBv3
Project Folder	/home/benjaminowen/git/AMP_PCBv3/firmware/AMP_PCBv3
Toolchain / IDE	STM32CubeIDE
Firmware Package Name and Version	STM32Cube FW_F4 V1.28.0
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_USART2_UART_Init	USART2
4	MX_UART4_Init	UART4
5	MX_SPI2_Init	SPI2
6	MX_TIM3_Init	TIM3
7	MX_TIM8_Init	TIM8
8	MX_UART5_Init	UART5
9	MX_TIM1_Init	TIM1
10	MX_ADC1_Init	ADC1
11	MX_TIM2_Init	TIM2

Rank	Function Name	Peripheral Instance Name
12	MX_TIM6_Init	TIM6

1. Power Consumption Calculator report

1.1. Microcontroller Selection

Series	STM32F4
Line	STM32F446
MCU	STM32F446RETx
Datasheet	DS10693_Rev6

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

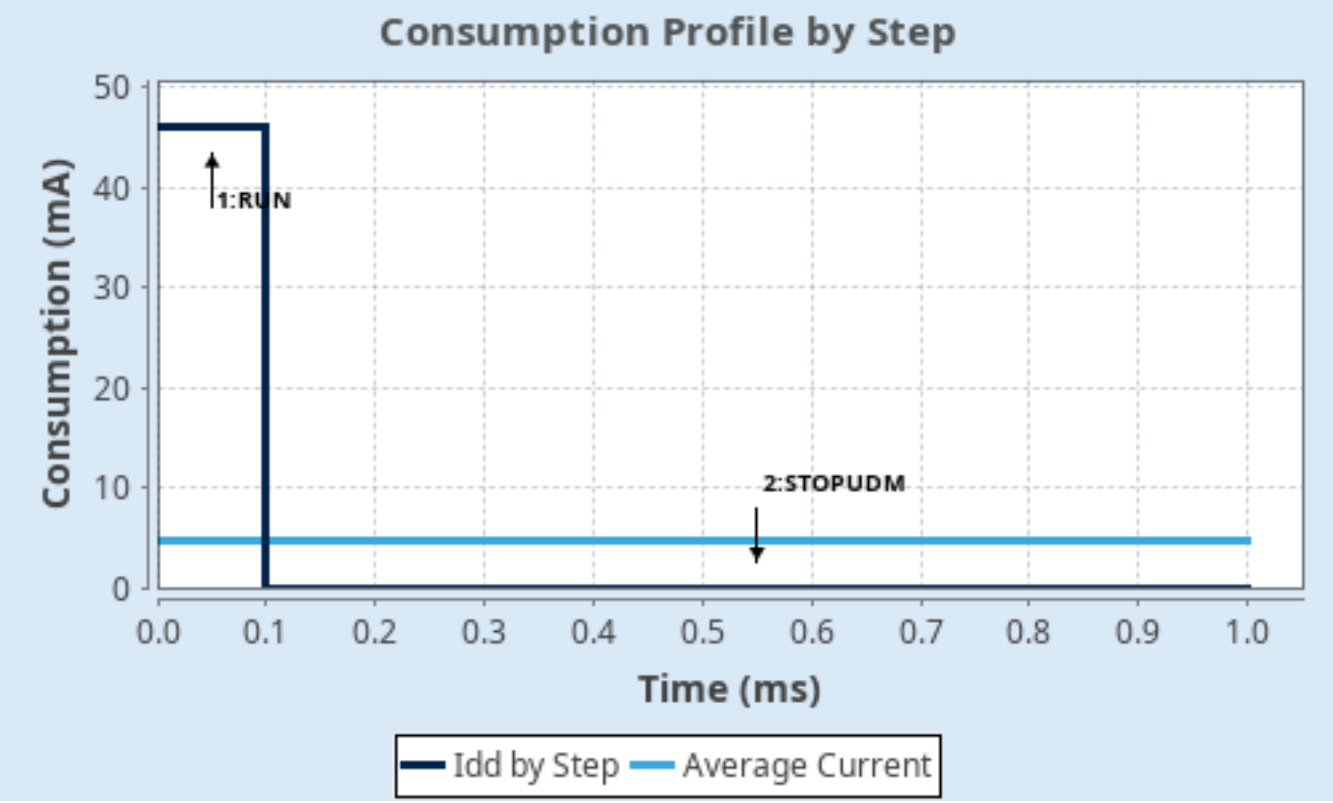
1.4. Sequence

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	RAM/FLASH/REGON/ART/PREFETCH	n/a
CPU Frequency	180 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	46 mA	55 µA
Duration	0.1 ms	0.9 ms
DMIPS	225.0	0.0
Ta Max	98.02	104.99
Category	In DS Table	In DS Table

1.5. Results

Sequence Time	1 ms	Average Current	4.65 mA
Battery Life	1 month	Average DMIPS	225.0 DMIPS

1.6. Chart


Consumption Profile by Step
Consumption (mA)
50
40
30
20
10
0
1:RUN
2:STOPUDM
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Time (ms)
Idd by Step
Average Current

2. Peripherals and Middlewares Configuration

2.1. ADC1

mode: IN15

2.1.1. Parameter Settings:

ADCs_Common_Settings:

Mode	Independent mode

ADC_Settings:

Clock Prescaler	PCLK2 divided by 4
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 15
Sampling Time	3 Cycles

ADC_Injected_ConversionMode:

Number Of Conversions	0

WatchDog:

Enable Analog WatchDog Mode	false

2.2. RCC

High Speed Clock (HSE): Crystal/Ceramic Resonator

Low Speed Clock (LSE) : Crystal/Ceramic Resonator

2.2.1. Parameter Settings:

System Parameters:

VDD voltage (V)	3.3
Instruction Cache	Enabled
Prefetch Buffer	Enabled
Data Cache	Enabled

Flash Latency(WS)	5 WS (6 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 Regulator Voltage Scale	Power Regulator Voltage Scale 1
Power Over Drive	Enabled

2.3. SPI2

Mode: Full-Duplex Master

2.3.1. Parameter Settings:

Basic Parameters:

Frame Format	Motorola
Data Size	8 Bits
First Bit	MSB First

Clock Parameters:

Prescaler (for Baud Rate)	2
Baud Rate	**22.5 MBits/s ***
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

Advanced Parameters:

CRC Calculation	Disabled
NSS Signal Type	Software

2.4. SYS

Debug: Serial Wire

Timebase Source: SysTick

2.5. TIM1

Clock Source : Internal Clock

2.5.1. Parameter Settings:

Counter Settings:

Prescaler (PSC - 16 bits value)	0
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)

2.6. TIM2

Clock Source : Internal Clock

2.6.1. Parameter Settings:

Counter Settings:

Prescaler (PSC - 16 bits value)	0
Counter Mode	Up
Counter Period (AutoReload Register - 32 bits value)	4294967295
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)

2.7. TIM3

Clock Source : Internal Clock

Channel3: Output Compare CH3

Channel4: PWM Generation CH4

2.7.1. Parameter Settings:

Counter Settings:

Prescaler (PSC - 16 bits value)	0
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value)	65535
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)

Output Compare Channel 3:

Mode	Frozen (used for Timing base)
Pulse (16 bits value)	0
Output compare preload	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

2.8. TIM6

mode: Activated

2.8.1. Parameter Settings:

Counter Settings:

Prescaler (PSC - 16 bits value)	**17999 ***
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value)	**10000 ***
auto-reload preload	Disable

Trigger Output (TRGO) Parameters:

Trigger Event Selection	Reset (UG bit from TIMx_EGR)

2.9. TIM8

Clock Source : Internal Clock

Channel4: PWM Generation CH4

2.9.1. Parameter Settings:

Counter Settings:

Prescaler (PSC - 16 bits value)	0
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)

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 Idle Mode (OSSI)	Disable
Lock Configuration	Off

PWM Generation Channel 4:

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

2.10. UART4

Mode: Asynchronous

2.10.1. 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

2.11. UART5

Mode: Asynchronous

2.11.1. 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

2.12. USART2

Mode: Asynchronous

2.12.1. 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**

3. System Configuration

3.1. GPIO configuration

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
ADC1	PC5	ADC1_IN15	Analog mode	No pull-up and no pull-down	n/a	BRAKE_CS
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	
SPI2	PB10	SPI2_SCK	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PB14	SPI2_MISO	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PB15	SPI2_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	TMS
	PA14	SYS_JTCK-SWCLK	n/a	n/a	n/a	TCK
TIM3	PB0	TIM3_CH3	Alternate Function Push Pull	No pull-up and no pull-down	Low	STR_INPUTB+
	PB1	TIM3_CH4	Alternate Function Push Pull	No pull-up and no pull-down	Low	LED_SIG
TIM8	PC9	TIM8_CH4	Alternate Function Push Pull	No pull-up and no pull-down	Low	VESC_PPM
UART4	PA0-WKUP	UART4_TX	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PA1	UART4_RX	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
UART5	PC12	UART5_TX	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PD2	UART5_RX	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
USART2	PA2	USART2_TX	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	USART_TX
	PA3	USART2_RX	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	USART_RX
Single	PB3	SYS_JTDO-	n/a	n/a	n/a	SWO

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
Mapped Signals		SWO				
GPIO	PC13	GPIO_EXTI13	**External Interrupt Mode with Falling edge trigger detection**	No pull-up and no pull-down	n/a	B1 [BLUE BUTTON]
	PC0	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STR_EN+
	PC1	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STR_INPUTA+
	PC2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STR_INPUTA+_DIR
	PA4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STR_INPUTB+_DIR
	PA5	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STAT3[GREEN_LED]
	PC4	GPIO_EXTI4	External Interrupt Mode with Rising edge trigger detection	No pull-up and no pull-down	n/a	IMU_INT1
	PB12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STAT1
	PB13	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LORA_NSS
	PC6	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	BRAKE_INB
	PC8	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	BRAKE_INA
	PA10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	IMU_CS
	PA11	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STAT2
	PA12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	STAT4
	PA15	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	FAN4
	PC10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	FAN1
	PC11	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	FAN2
	PB4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LORA_RST
	PB5	GPIO_EXTI5	External Interrupt Mode with Rising edge trigger detection	No pull-up and no pull-down	n/a	LORA_DIO0
	PB7	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	FAN3
	PB8	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	BRAKE_SEL0
	PB9	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	BRAKE_PWM

3.2. DMA configuration

nothing configured in DMA service

3.3. NVIC configuration

3.3.1. 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
EXTI line 4 interrupt	true	0	0
EXTI line[9:5] interrupts	true	0	0
TIM6 global interrupt and DAC1, DAC2 underrun error interrupts	true	0	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
ADC1, ADC2 and ADC3 interrupts	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		
SPI2 global interrupt	unused		
USART2 global interrupt	unused		
EXTI line[15:10] interrupts	unused		
TIM8 break interrupt and TIM12 global interrupt	unused		
TIM8 update interrupt and TIM13 global interrupt	unused		
TIM8 trigger and commutation interrupts and TIM14 global interrupt	unused		
TIM8 capture compare interrupt	unused		
UART4 global interrupt	unused		
UART5 global interrupt	unused		
FPU global interrupt	unused		

3.3.2. NVIC Code generation

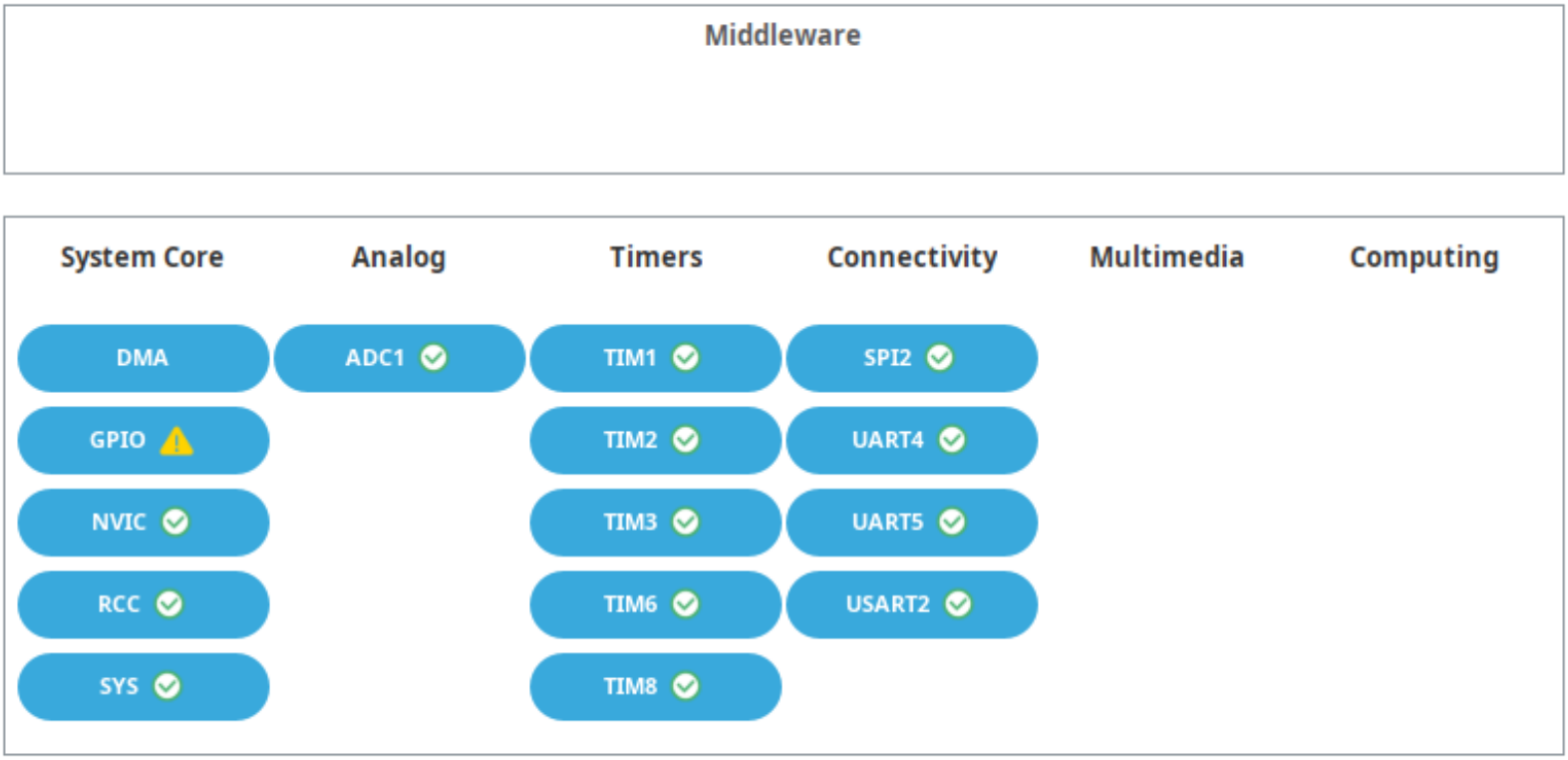
Enabled interrupt Table	Select for init sequence ordering	Generate IRQ handler	Call HAL handler
Non maskable interrupt	false	true	false
Hard fault interrupt	false	true	false
Memory management fault	false	true	false
Pre-fetch fault, memory access fault	false	true	false
Undefined instruction or illegal 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
EXTI line 4 interrupt	false	true	true
EXTI line[9:5] interrupts	false	true	true
TIM6 global interrupt and DAC1, DAC2 underrun error interrupts	false	true	true

*** User modified value**

4. System Views

4.1. Category view

4.1.1. Current



5. Docs & Resources

Type	Link
BSDL files	https://www.st.com/resource/en/bsdl_model/stm32f446_bsdl.zip
IBIS models	https://www.st.com/resource/en/ibis_model/stm32f446_ibis.zip
System View Description	https://www.st.com/resource/en/svd/stm32f4_svd.zip
Presentations	https://www.st.com/resource/en/product_presentation/stm32-stm8_embedded_software_solutions.pdf
Presentations	https://www.st.com/resource/en/product_presentation/stm32_eval-tools_portfolio.pdf
Presentations	https://www.st.com/resource/en/product_presentation/stm32_stm8_functional-safety-packages.pdf
Presentations	https://www.st.com/resource/en/product_presentation/stm32-stm8_software_development_tools.pdf
Presentations	https://www.st.com/resource/en/product_presentation/microcontrollers-stm32-family-overview.pdf
Brochures	https://www.st.com/resource/en/brochure/products-and-solutions-for-plcs-and-smart-i-os.pdf
Flyers	https://www.st.com/resource/en/flyer/flstm32nucleo.pdf
Flyers	https://www.st.com/resource/en/flyer/flstmcsuite.pdf
Flyers	https://www.st.com/resource/en/flyer/flstm32trust.pdf
Product Certifications	https://www.st.com/resource/en/certification_document/stm32_authentication_can.pdf
Application Notes	https://www.st.com/resource/en/application_note/an1181-electrostatic-discharge-sensitivity-measurement-stmicroelectronics.pdf
Application Notes	https://www.st.com/resource/en/application_note/an1709-emc-design-guide-for-stm8-stm32-and-legacy-mcus-stmicroelectronics.pdf
Application Notes	https://www.st.com/resource/en/application_note/an2606-stm32-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
Application Notes	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
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
Application Notes	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
Application Notes	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
Application Notes	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/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
Application Notes	https://www.st.com/resource/en/application_note/an4013-stm32-crossseries-timer-overview-stmicroelectronics.pdf
Application Notes	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/an4221-i2c-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf
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