



1. Description

1.1. Project

Project Name	sensor_board
Board Name	custom
Generated with:	STM32CubeMX 6.6.1
Date	03/12/2023

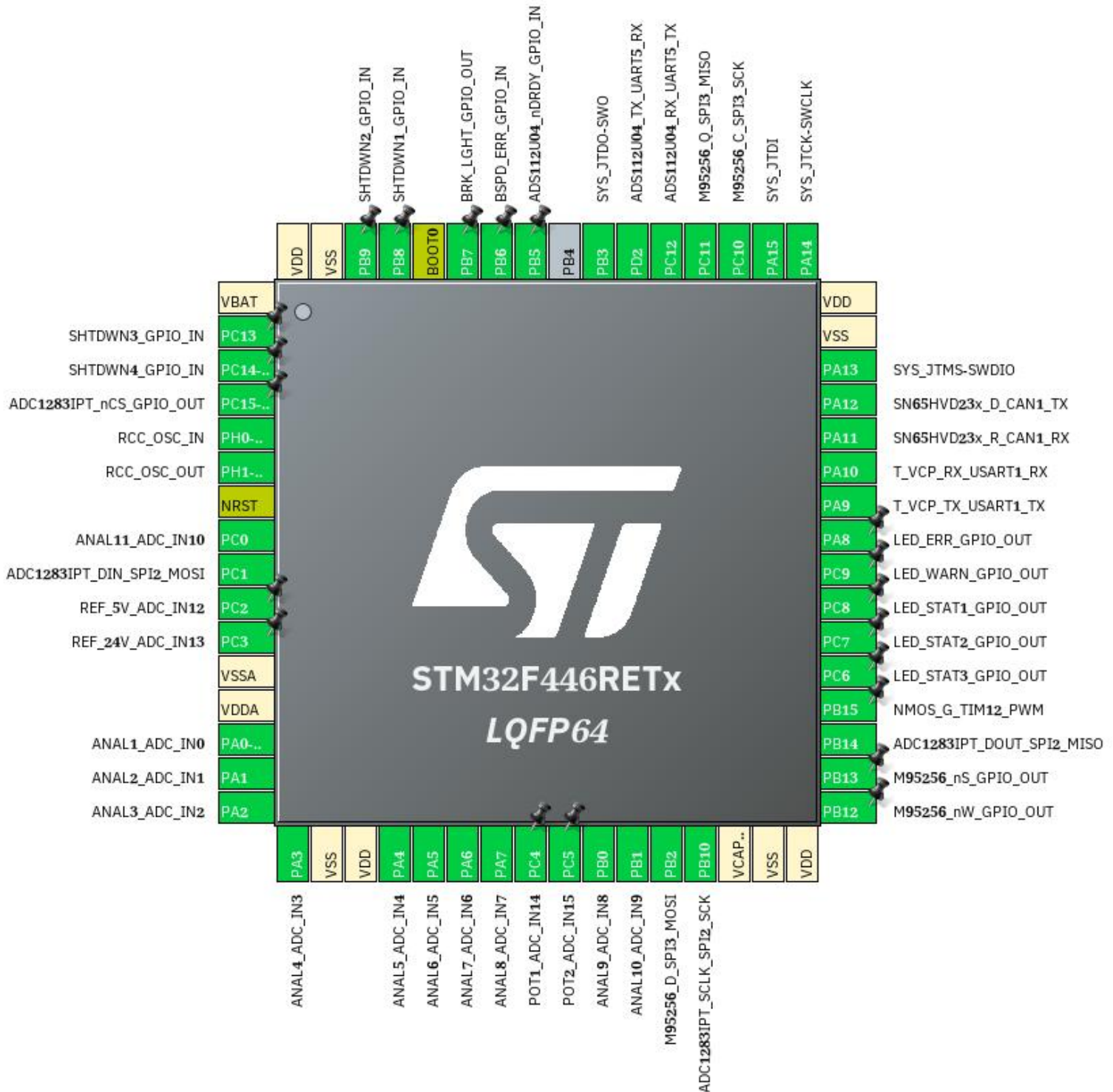
1.2. MCU

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
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2. Pinout Configuration



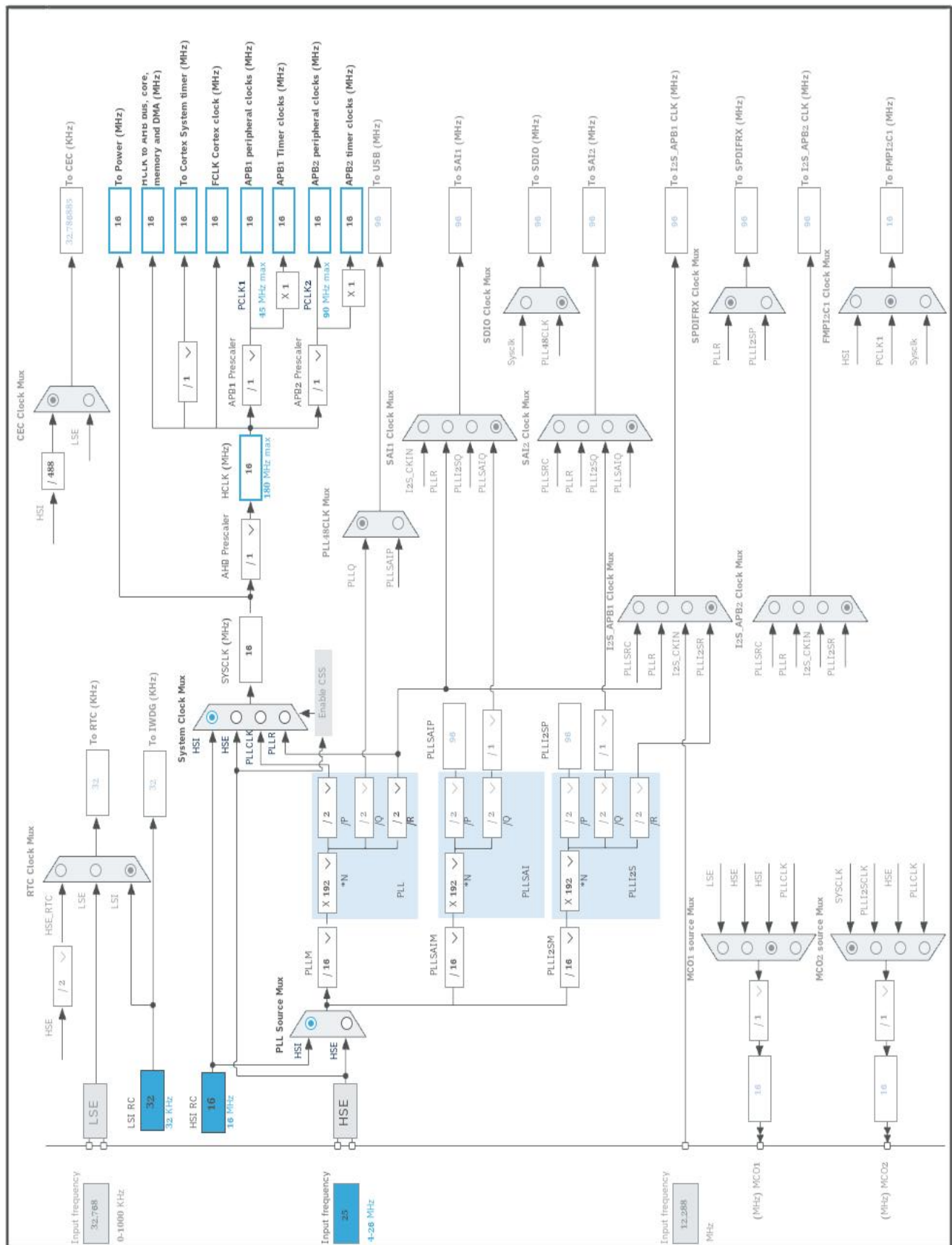
3. Pins Configuration

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	VBAT	Power		
2	PC13 *	I/O	GPIO_Input	SHTDWN3_GPIO_IN
3	PC14-OSC32_IN *	I/O	GPIO_Input	SHTDWN4_GPIO_IN
4	PC15-OSC32_OUT *	I/O	GPIO_Output	ADC1283IPT_nCS_GPIO_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	ADC1_IN10	ANAL11_ADC_IN10
9	PC1	I/O	SPI2_MOSI	ADC1283IPT_DIN_SPI2_MOSI
10	PC2	I/O	ADC3_IN12	REF_5V_ADC_IN12
11	PC3	I/O	ADC3_IN13	REF_24V_ADC_IN13
12	VSSA	Power		
13	VDDA	Power		
14	PA0-WKUP	I/O	ADC1_IN0	ANAL1_ADC_IN0
15	PA1	I/O	ADC1_IN1	ANAL2_ADC_IN1
16	PA2	I/O	ADC1_IN2	ANAL3_ADC_IN2
17	PA3	I/O	ADC1_IN3	ANAL4_ADC_IN3
18	VSS	Power		
19	VDD	Power		
20	PA4	I/O	ADC1_IN4	ANAL5_ADC_IN4
21	PA5	I/O	ADC1_IN5	ANAL6_ADC_IN5
22	PA6	I/O	ADC1_IN6	ANAL7_ADC_IN6
23	PA7	I/O	ADC1_IN7	ANAL8_ADC_IN7
24	PC4	I/O	ADC2_IN14	POT1_ADC_IN14
25	PC5	I/O	ADC2_IN15	POT2_ADC_IN15
26	PB0	I/O	ADC1_IN8	ANAL9_ADC_IN8
27	PB1	I/O	ADC1_IN9	ANAL10_ADC_IN9
28	PB2	I/O	SPI3_MOSI	M95256_D_SPI3_MOSI
29	PB10	I/O	SPI2_SCK	ADC1283IPT_SCLK_SPI2_SCK
30	VCAP_1	Power		
31	VSS	Power		
32	VDD	Power		
33	PB12 *	I/O	GPIO_Output	M95256_nW_GPIO_OUT

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
34	PB13 *	I/O	GPIO_Output	M95256_nS_GPIO_OUT
35	PB14	I/O	SPI2_MISO	ADC1283IPT_DOUT_SPI2_MISO
36	PB15	I/O	TIM12_CH2	NMOS_G_TIM12_PWM
37	PC6 *	I/O	GPIO_Output	LED_STAT3_GPIO_OUT
38	PC7 *	I/O	GPIO_Output	LED_STAT2_GPIO_OUT
39	PC8 *	I/O	GPIO_Output	LED_STAT1_GPIO_OUT
40	PC9 *	I/O	GPIO_Output	LED_WARN_GPIO_OUT
41	PA8 *	I/O	GPIO_Output	LED_ERR_GPIO_OUT
42	PA9	I/O	USART1_TX	T_VCP_TX_USART1_TX
43	PA10	I/O	USART1_RX	T_VCP_RX_USART1_RX
44	PA11	I/O	CAN1_RX	SN65HVD23x_R_CAN1_RX
45	PA12	I/O	CAN1_TX	SN65HVD23x_D_CAN1_TX
46	PA13	I/O	SYS_JTMS-SWDIO	
47	VSS	Power		
48	VDD	Power		
49	PA14	I/O	SYS_JTCK-SWCLK	
50	PA15	I/O	SYS_JTDI	
51	PC10	I/O	SPI3_SCK	M95256_C_SPI3_SCK
52	PC11	I/O	SPI3_MISO	M95256_Q_SPI3_MISO
53	PC12	I/O	UART5_TX	ADS112U04_RX_UART5_TX
54	PD2	I/O	UART5_RX	ADS112U04_TX_UART5_RX
55	PB3	I/O	SYS_JTDO-SWO	
57	PB5	I/O	GPIO_EXTI5	ADS112U04_nDRDY_GPIO_IN
58	PB6 *	I/O	GPIO_Input	BSPD_ERR_GPIO_IN
59	PB7 *	I/O	GPIO_Output	BRK_LGHT_GPIO_OUT
60	BOOT0	Boot		
61	PB8 *	I/O	GPIO_Input	SHTDWN1_GPIO_IN
62	PB9 *	I/O	GPIO_Input	SHTDWN2_GPIO_IN
63	VSS	Power		
64	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	sensor_board
Project Folder	/home/simone/Documents/10.SquadraCorse/Work/sensor_board
Toolchain / IDE	Makefile
Firmware Package Name and Version	STM32Cube FW_F4 V1.27.1
Application Structure	Advanced
Generate Under Root	No
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 all used libraries into the project folder
Generate peripheral initialization as a pair of '.c/.h' files	Yes
Backup previously generated files when re-generating	Yes
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_ADC1_Init	ADC1
4	MX_CAN1_Init	CAN1
5	MX_ADC2_Init	ADC2
6	MX_SPI2_Init	SPI2
7	MX_SPI3_Init	SPI3
8	MX_UART5_Init	UART5
9	MX_USART1_UART_Init	USART1
10	MX_ADC3_Init	ADC3
11	MX_TIM12_Init	TIM12

6. Power Consumption Calculator report

6.1. Microcontroller Selection

Series	STM32F4
Line	STM32F446
MCU	STM32F446RETx
Datasheet	DS10693_Rev6

6.2. Parameter Selection

Temperature	25
Vdd	3.3

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

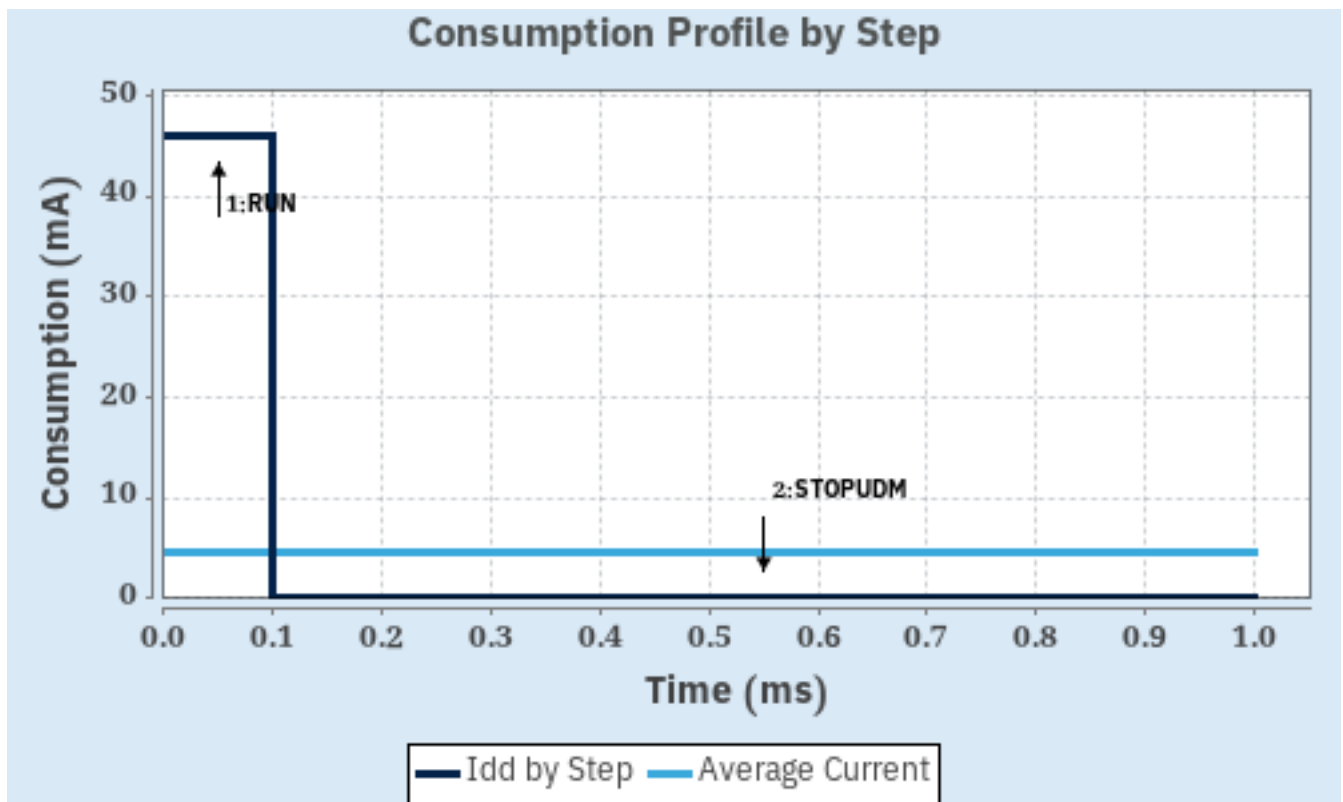
6.4. Sequence

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/P REFETCH	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 μ A
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

6.5. Results

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

6.6. Chart



7. Peripherals and Middlewares Configuration

7.1. ADC1

mode: IN0

mode: IN1

mode: IN2

mode: IN3

mode: IN4

mode: IN5

mode: IN6

mode: IN7

mode: IN8

mode: IN9

mode: IN10

7.1.1. 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 0

Sampling Time 3 Cycles

ADC_Injected_ConversionMode:

Number Of Conversions 0

WatchDog:

Enable Analog WatchDog Mode false

7.2. ADC2

mode: IN14

mode: IN15

7.2.1. 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
<u>Rank</u>	1
Channel	Channel 14
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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7.3. ADC3

mode: IN12

mode: IN13

7.3.1. Parameter Settings:

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 12
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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7.4. CAN1

mode: Activated

7.4.1. Parameter Settings:

Bit Timings Parameters:

Prescaler (for Time Quantum)	16
Time Quantum	1000.0 *
Time Quanta in Bit Segment 1	1 Time
Time Quanta in Bit Segment 2	1 Time
Time for one Bit	3000 *
Baud Rate	333333 *
ReSynchronization Jump Width	1 Time

Basic Parameters:

Time Triggered Communication Mode	Disable
Automatic Bus-Off Management	Disable
Automatic Wake-Up Mode	Disable
Automatic Retransmission	Disable
Receive Fifo Locked Mode	Disable
Transmit Fifo Priority	Disable

Advanced Parameters:

Operating Mode	Normal
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7.5. RCC

High Speed Clock (HSE): Crystal/Ceramic Resonator

7.5.1. 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 3
Power Over Drive	Disabled

7.6. SPI2

Mode: Full-Duplex Master

7.6.1. Parameter Settings:

Basic Parameters:

Frame Format	Motorola
Data Size	8 Bits
First Bit	MSB First

Clock Parameters:

Prescaler (for Baud Rate)	2
Baud Rate	8.0 MBits/s *
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

Advanced Parameters:

CRC Calculation	Disabled
NSS Signal Type	Software

7.7. SPI3

Mode: Full-Duplex Master

7.7.1. Parameter Settings:

Basic Parameters:

Frame Format	Motorola
Data Size	8 Bits
First Bit	MSB First

Clock Parameters:

Prescaler (for Baud Rate)	2
Baud Rate	8.0 MBits/s *
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

Advanced Parameters:

CRC Calculation	Disabled
NSS Signal Type	Software

7.8. SYS

Debug: JTAG (4 pins)

Timebase Source: SysTick

7.9. TIM12

Trigger Source: ITR0

Channel2: PWM Generation CH2

7.9.1. 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
auto-reload preload	Disable
Slave Mode Controller	Slave mode disable

PWM Generation Channel 2:

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

7.10. UART5

Mode: Asynchronous

7.10.1. 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

7.11. USART1

Mode: Asynchronous

7.11.1. 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

* User modified value

8. System Configuration

8.1. 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	ANAL11_ADC_IN10
	PA0-WKUP	ADC1_IN0	Analog mode	No pull-up and no pull-down	n/a	ANAL1_ADC_IN0
	PA1	ADC1_IN1	Analog mode	No pull-up and no pull-down	n/a	ANAL2_ADC_IN1
	PA2	ADC1_IN2	Analog mode	No pull-up and no pull-down	n/a	ANAL3_ADC_IN2
	PA3	ADC1_IN3	Analog mode	No pull-up and no pull-down	n/a	ANAL4_ADC_IN3
	PA4	ADC1_IN4	Analog mode	No pull-up and no pull-down	n/a	ANAL5_ADC_IN4
	PA5	ADC1_IN5	Analog mode	No pull-up and no pull-down	n/a	ANAL6_ADC_IN5
	PA6	ADC1_IN6	Analog mode	No pull-up and no pull-down	n/a	ANAL7_ADC_IN6
	PA7	ADC1_IN7	Analog mode	No pull-up and no pull-down	n/a	ANAL8_ADC_IN7
	PB0	ADC1_IN8	Analog mode	No pull-up and no pull-down	n/a	ANAL9_ADC_IN8
	PB1	ADC1_IN9	Analog mode	No pull-up and no pull-down	n/a	ANAL10_ADC_IN9
ADC2	PC4	ADC2_IN14	Analog mode	No pull-up and no pull-down	n/a	POT1_ADC_IN14
	PC5	ADC2_IN15	Analog mode	No pull-up and no pull-down	n/a	POT2_ADC_IN15
ADC3	PC2	ADC3_IN12	Analog mode	No pull-up and no pull-down	n/a	REF_5V_ADC_IN12
	PC3	ADC3_IN13	Analog mode	No pull-up and no pull-down	n/a	REF_24V_ADC_IN13
CAN1	PA11	CAN1_RX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	SN65HVD23x_R_CAN1_RX
	PA12	CAN1_TX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	SN65HVD23x_D_CAN1_TX
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	
SPI2	PC1	SPI2_MOSI	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	ADC1283IPT_DIN_SPI2_MOSI
	PB10	SPI2_SCK	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	ADC1283IPT_SCLK_SPI2_SCK
	PB14	SPI2_MISO	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	ADC1283IPT_DOUT_SPI2_MISO
SPI3	PB2	SPI3_MOSI	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	M95256_D_SPI3_MOSI
	PC10	SPI3_SCK	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	M95256_C_SPI3_SCK
	PC11	SPI3_MISO	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	M95256_Q_SPI3_MISO

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
SYS	PA13	SYS_JTMS-SWDIO	n/a	n/a	n/a	
	PA14	SYS_JTCK-SWCLK	n/a	n/a	n/a	
	PA15	SYS_JTDI	n/a	n/a	n/a	
	PB3	SYS_JTDO-SWO	n/a	n/a	n/a	
TIM12	PB15	TIM12_CH2	Alternate Function Push Pull	No pull-up and no pull-down	Low	NMOS_G_TIM12_PWM
UART5	PC12	UART5_TX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	ADS112U04_RX_UART5_TX
	PD2	UART5_RX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	ADS112U04_TX_UART5_RX
USART1	PA9	USART1_TX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	T_VCP_TX_USART1_TX
	PA10	USART1_RX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	T_VCP_RX_USART1_RX
GPIO	PC13	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	SHTDWN3_GPIO_IN
	PC14-OSC32_IN	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	SHTDWN4_GPIO_IN
	PC15-OSC32_OUT	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	ADC1283IPT_nCS_GPIO_OUT
	PB12	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M95256_nW_GPIO_OUT
	PB13	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M95256_nS_GPIO_OUT
	PC6	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED_STAT3_GPIO_OUT
	PC7	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED_STAT2_GPIO_OUT
	PC8	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED_STAT1_GPIO_OUT
	PC9	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED_WARN_GPIO_OUT
	PA8	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED_ERR_GPIO_OUT
	PB5	GPIO_EXTI5	External Interrupt Mode with Rising edge trigger detection	No pull-up and no pull-down	n/a	ADS112U04_nDRDY_GPIO_IN
	PB6	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	BSPD_ERR_GPIO_IN
	PB7	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	BRK_LGHT_GPIO_OUT
	PB8	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	SHTDWN1_GPIO_IN
	PB9	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	SHTDWN2_GPIO_IN

8.2. DMA configuration

nothing configured in DMA service

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	0	0
System tick timer	true	15	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
ADC1, ADC2 and ADC3 interrupts	unused		
CAN1 TX interrupt	unused		
CAN1 RX0 interrupt	unused		
CAN1 RX1 interrupt	unused		
CAN1 SCE interrupt	unused		
EXTI line[9:5] interrupts	unused		
SPI2 global interrupt	unused		
USART1 global interrupt	unused		
TIM8 break interrupt and TIM12 global interrupt	unused		
SPI3 global interrupt	unused		
UART5 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	true	false
Debug monitor	false	true	false
Pendable request for system service	false	true	false
System tick timer	false	true	true

* User modified value

9. System Views

9.1. Category view

9.1.1. Current

Middleware					
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System Core	Analog	Timers	Connectivity	Multimedia	Computing
DMA	ADC1 ✓	TIM12 ✓	CAN1 ✓		
GPIO ✓	ADC2 ✓		SPI2 ✓		
NVIC ✓	ADC3 ✓		SPI3 ✓		
RCC ✓			UART5 ✓		
SYS ✓			USART1 ✓		

10. 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
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
Training Material	https://www.st.com/resource/en/sales_guide/sg_sc2154.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/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
- 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
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