



1. Description

1.1. Project

Project Name	Kazan
Board Name	custom
Generated with:	STM32CubeMX 6.9.1
Date	08/15/2023

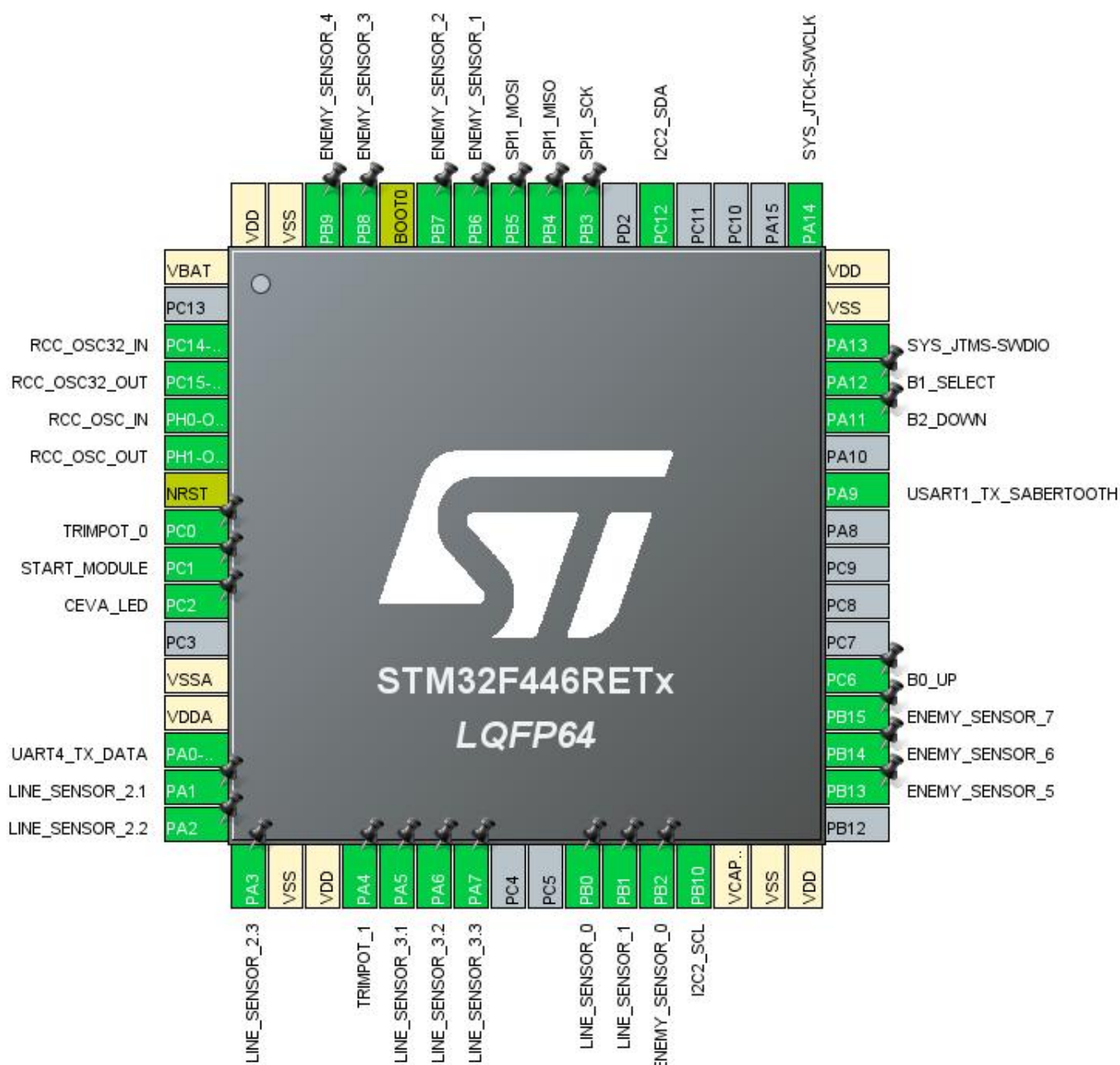
1.2. MCU

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



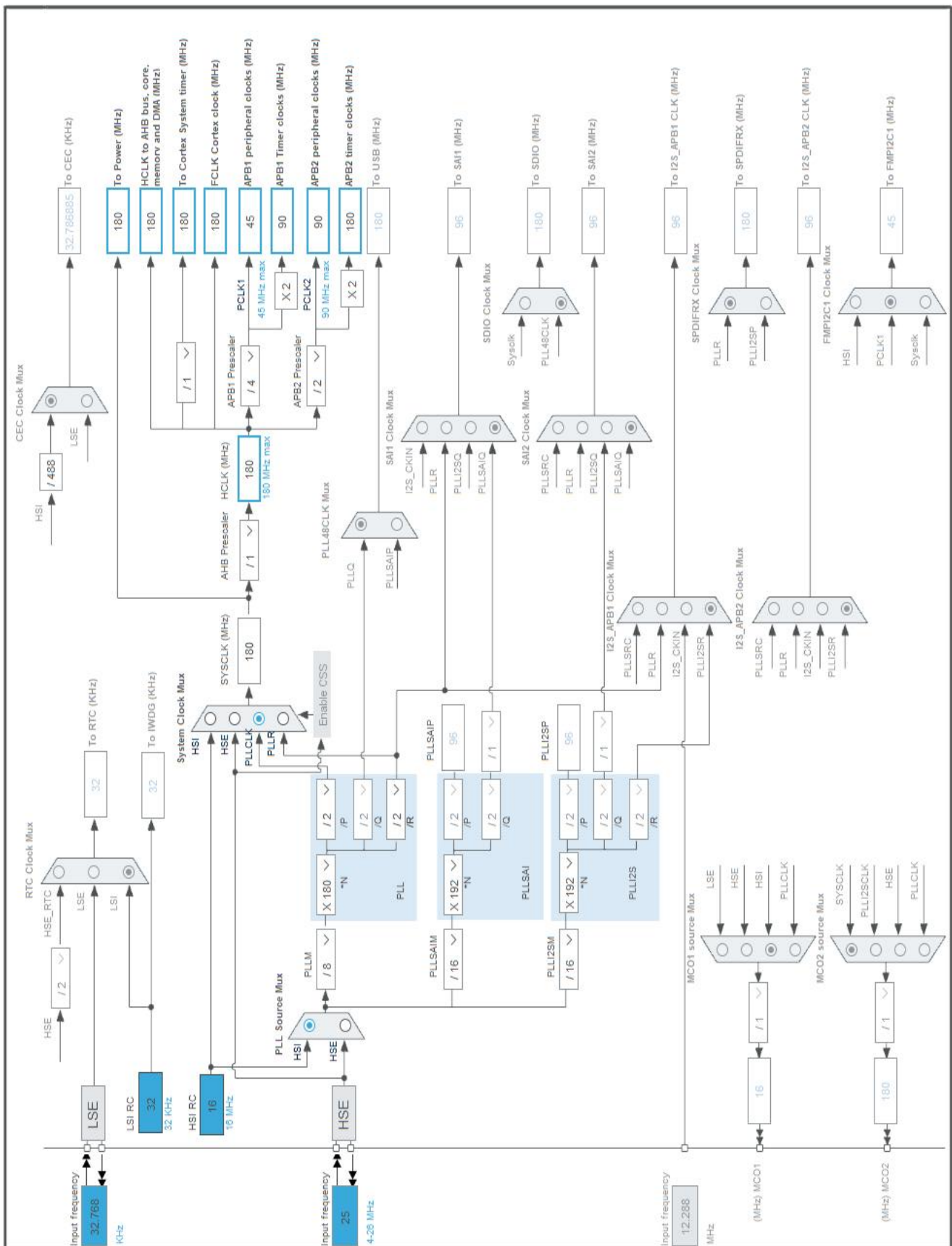
3. Pins Configuration

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	VBAT	Power		
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	ADC2_IN10	TRIMPOT_0
9	PC1 *	I/O	GPIO_Input	START_MODULE
10	PC2 *	I/O	GPIO_Output	CEVA_LED
12	VSSA	Power		
13	VDDA	Power		
14	PA0-WKUP	I/O	UART4_TX	UART4_TX_DATA
15	PA1	I/O	ADC1_IN1	LINE_SENSOR_2.1
16	PA2	I/O	ADC1_IN2	LINE_SENSOR_2.2
17	PA3	I/O	ADC1_IN3	LINE_SENSOR_2.3
18	VSS	Power		
19	VDD	Power		
20	PA4	I/O	ADC2_IN4	TRIMPOT_1
21	PA5	I/O	ADC1_IN5	LINE_SENSOR_3.1
22	PA6	I/O	ADC1_IN6	LINE_SENSOR_3.2
23	PA7	I/O	ADC1_IN7	LINE_SENSOR_3.3
26	PB0	I/O	ADC2_IN8	LINE_SENSOR_0
27	PB1	I/O	ADC2_IN9	LINE_SENSOR_1
28	PB2 *	I/O	GPIO_Input	ENEMY_SENSOR_0
29	PB10	I/O	I2C2_SCL	
30	VCAP_1	Power		
31	VSS	Power		
32	VDD	Power		
34	PB13 *	I/O	GPIO_Input	ENEMY_SENSOR_5
35	PB14 *	I/O	GPIO_Input	ENEMY_SENSOR_6
36	PB15 *	I/O	GPIO_Input	ENEMY_SENSOR_7
37	PC6 *	I/O	GPIO_Input	B0_UP
42	PA9	I/O	USART1_TX	USART1_TX_SABERTOOTH
44	PA11 *	I/O	GPIO_Input	B2_DOWN
45	PA12 *	I/O	GPIO_Input	B1_SELECT

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
46	PA13	I/O	SYS_JTMS-SWDIO	
47	VSS	Power		
48	VDD	Power		
49	PA14	I/O	SYS_JTCK-SWCLK	
53	PC12	I/O	I2C2_SDA	
55	PB3	I/O	SPI1_SCK	
56	PB4	I/O	SPI1_MISO	
57	PB5	I/O	SPI1_MOSI	
58	PB6 *	I/O	GPIO_Input	ENEMY_SENSOR_1
59	PB7 *	I/O	GPIO_Input	ENEMY_SENSOR_2
60	BOOT0	Boot		
61	PB8 *	I/O	GPIO_Input	ENEMY_SENSOR_3
62	PB9 *	I/O	GPIO_Input	ENEMY_SENSOR_4
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	Kazan
Project Folder	D:\Proiecte\STMCUBE\Kazan
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_ADC1_Init	ADC1
4	MX_ADC2_Init	ADC2
5	MX_I2C2_Init	I2C2
6	MX_UART4_Init	UART4
7	MX_SPI1_Init	SPI1
8	MX_USART1_UART_Init	USART1

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

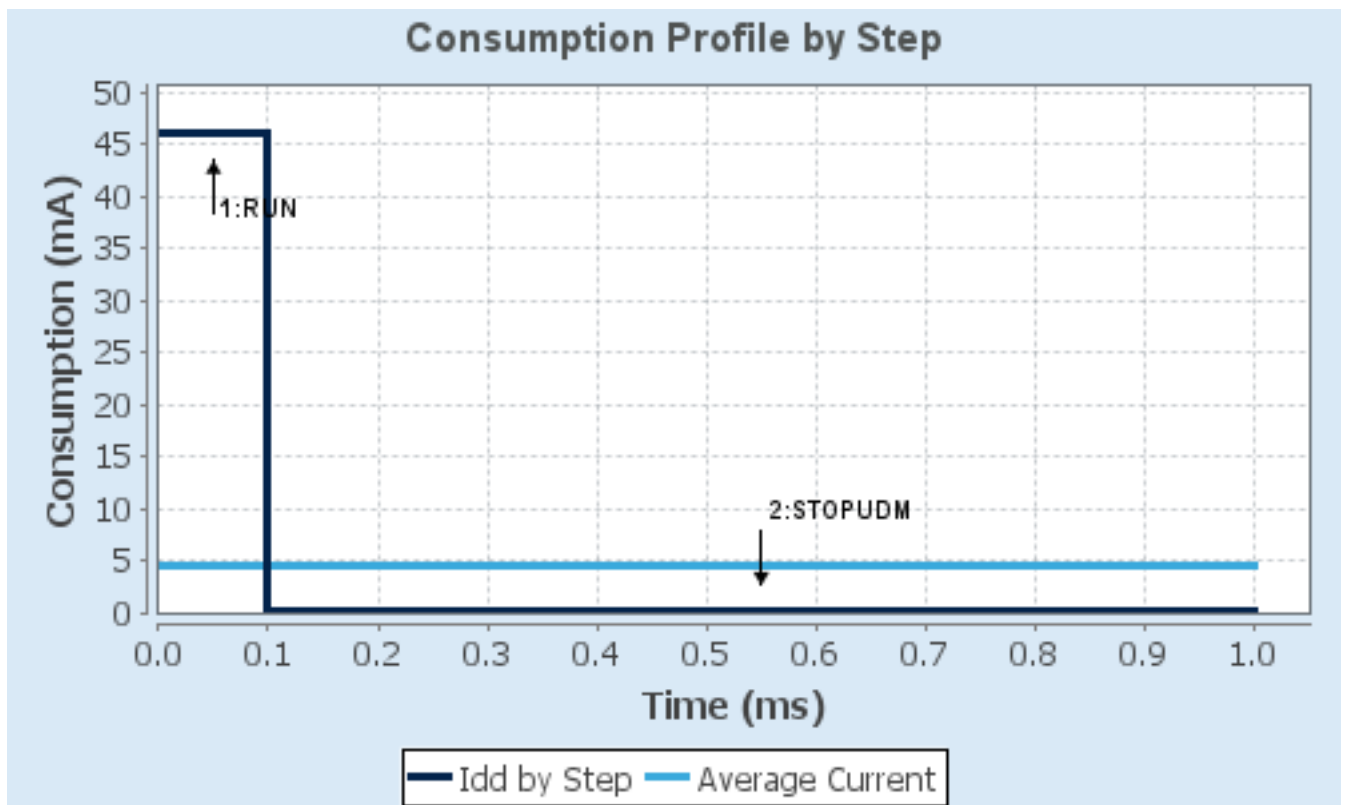
1.4. Sequence

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/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

1.5. Results

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

1.6. Chart



2. Peripherals and Middlewares Configuration

2.1. ADC1

mode: IN1

mode: IN2

mode: IN3

mode: IN5

mode: IN6

mode: IN7

2.1.1. Parameter Settings:

ADCs_Common_Settings:

Mode Independent mode

ADC_Settings:

Clock Prescaler PCLK2 divided by 4

Resolution **6 bits (9 ADC Clock cycles) ***

Data Alignment Right alignment

Scan Conversion Mode Enabled

Continuous Conversion Mode **Enabled ***

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 **6 ***

External Trigger Conversion Source Regular Conversion launched by software

External Trigger Conversion Edge None

Rank 1

Channel Channel 1

Sampling Time 3 Cycles

Rank **2 ***

Channel **Channel 2 ***

Sampling Time 3 Cycles

Rank **3 ***

Channel **Channel 3 ***

Sampling Time 3 Cycles

Rank **4 ***

Channel **Channel 5 ***

Sampling Time 3 Cycles

Rank **5 ***

Channel	Channel 6 *
Sampling Time	3 Cycles
<u>Rank</u>	6 *
Channel	Channel 7 *
Sampling Time	3 Cycles
ADC_Injected_ConversionMode:	
Number Of Conversions	0
WatchDog:	
Enable Analog WatchDog Mode	false

2.2. ADC2

mode: IN4

mode: IN8

mode: IN9

mode: IN10

2.2.1. 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	Enabled
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	4 *
External Trigger Conversion Source	Regular Conversion launched by software
External Trigger Conversion Edge	None
<u>Rank</u>	1
Channel	Channel 4
Sampling Time	28 Cycles *
<u>Rank</u>	2 *
Channel	Channel 8 *
Sampling Time	3 Cycles

<u>Rank</u>	3 *
Channel	Channel 9 *
Sampling Time	3 Cycles
<u>Rank</u>	4 *
Channel	Channel 10 *
Sampling Time	28 Cycles *
ADC_Injected_ConversionMode:	
Number Of Conversions	0
WatchDog:	
Enable Analog WatchDog Mode	false

2.3. I2C2

I2C: I2C

2.3.1. 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

2.4. RCC

High Speed Clock (HSE): Crystal/Ceramic Resonator

Low Speed Clock (LSE) : Crystal/Ceramic Resonator

2.4.1. 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 Timeout Value (ms)	100
LSE Startup Timeout Value (ms)	5000

Power Parameters:

Power Regulator Voltage Scale	Power Regulator Voltage Scale 1
Power Over Drive	Enabled

2.5. SPI1

Mode: Full-Duplex Master

2.5.1. Parameter Settings:

Basic Parameters:

Frame Format	Motorola
Data Size	8 Bits
First Bit	MSB First

Clock Parameters:

Prescaler (for Baud Rate)	2
Baud Rate	45.0 MBits/s *
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

Advanced Parameters:

CRC Calculation	Disabled
NSS Signal Type	Software

2.6. SYS

Debug: Serial Wire

Timebase Source: SysTick

2.7. UART4

Mode: Single Wire (Half-Duplex)

2.7.1. Parameter Settings:

Basic Parameters:

Baud Rate	115200
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Word Length	8 Bits (including Parity)
Parity	None
Stop Bits	1

Advanced Parameters:

Data Direction	Receive and Transmit
Over Sampling	16 Samples

2.8. USART1

Mode: Single Wire (Half-Duplex)

2.8.1. 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	PA1	ADC1_IN1	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_2.1
	PA2	ADC1_IN2	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_2.2
	PA3	ADC1_IN3	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_2.3
	PA5	ADC1_IN5	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_3.1
	PA6	ADC1_IN6	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_3.2
	PA7	ADC1_IN7	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_3.3
ADC2	PC0	ADC2_IN10	Analog mode	No pull-up and no pull-down	n/a	TRIMPOT_0
	PA4	ADC2_IN4	Analog mode	No pull-up and no pull-down	n/a	TRIMPOT_1
	PB0	ADC2_IN8	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_0
	PB1	ADC2_IN9	Analog mode	No pull-up and no pull-down	n/a	LINE_SENSOR_1
I2C2	PB10	I2C2_SCL	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	
	PC12	I2C2_SDA	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	
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	PB3	SPI1_SCK	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	
	PB4	SPI1_MISO	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	
	PB5	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	
UART4	PA0-WKUP	UART4_TX	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	UART4_TX_DATA
USART1	PA9	USART1_TX	Alternate Function Open Drain	No pull-up and no pull-down	Very High	USART1_TX_SABERTOOTH

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
					*	
GPIO	PC1	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	START_MODULE
	PC2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	CEVA_LED
	PB2	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_0
	PB13	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_5
	PB14	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_6
	PB15	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_7
	PC6	GPIO_Input	Input mode	Pull-up *	n/a	B0_UP
	PA11	GPIO_Input	Input mode	Pull-up *	n/a	B2_DOWN
	PA12	GPIO_Input	Input mode	Pull-up *	n/a	B1_SELECT
	PB6	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_1
	PB7	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_2
	PB8	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_3
	PB9	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	ENEMY_SENSOR_4

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	15	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
ADC1, ADC2 and ADC3 interrupts	unused		
I2C2 event interrupt	unused		
I2C2 error interrupt	unused		
SPI1 global interrupt	unused		
USART1 global interrupt	unused		
UART4 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

* User modified value

4. System Views

4.1. Category view

4.1.1. Current

Middleware

System Core

Analog

Timers

Connectivity

Multimedia

Computing

DMA

ADC1 

I2C2 

GPIO 

ADC2 

SPI1 

IIVIC 

UART4 

RCC 

USART1 

SYS 

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
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/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

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

Application Notes https://www.st.com/resource/en/application_note/an4229-how-to-

implement-a-vocoder-solution-using-stm32-microcontrollers-
stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4277-using-stm32-device-pwm-shutdown-features-for-motor-control-and-digital-power-conversion-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4286-spi-protocol-used-in-the-stm32-bootloader-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4488-getting-started-with-stm32f4xxxx-mcu-hardware-development-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4566-extending-the-dac-performance-of-stm32-microcontrollers-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4640-peripherals-interconnections-on-stm32f4057xx-stm32f4157xx-stm32f42xxx-stm32f43xxx-stm32f446xx-and-stm32f469479xx-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4655-virtually-increasing-the-number-of-serial-communication-peripherals-in-stm32-applications-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4658-migration-of-applications-from-stm32f429439-lines-to-stm32f446-line-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4739-stm32cube-firmware-examples-for-stm32f4-series-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4750-handling-of-soft-errors-in-stm32-applications-stmicroelectronics.pdf

Application Notes 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

Application Notes https://www.st.com/resource/en/application_note/an4776-generalpurpose-timer-cookbook-for-stm32-microcontrollers-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4803-highspeed-si-simulations-using-ibis-and-boardlevel-simulations-using-hyperlynx-si-on-stm32-mcus-and-mpus-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4850-stm32-mcus-

spreadspectrum-clock-generation-principles-properties-and-
implementation-stmicroelectronics.pdf

Application Notes https://www.st.com/resource/en/application_note/an4908-stm32-usart-automatic-baud-rate-detection-stmicroelectronics.pdf

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Application Notes https://www.st.com/resource/en/application_note/an5073-receiving-spdif-audio-stream-with-the-stm32f4f7h7-series-stmicroelectronics.pdf

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