1. Description

1.1. Project

Project Name	CW-Keyer-BlackPill
Board Name	custom
Generated with:	STM32CubeMX 6.5.0
Date	06/28/2022

1.2. MCU

MCU Series	STM32F4
MCU Line	STM32F401
MCU name	STM32F401CCUx
MCU Package	UFQFPN48
MCU Pin number	48

1.3. Core(s) information

Core(s)	Arm Cortex-M4

2. Pinout Configuration
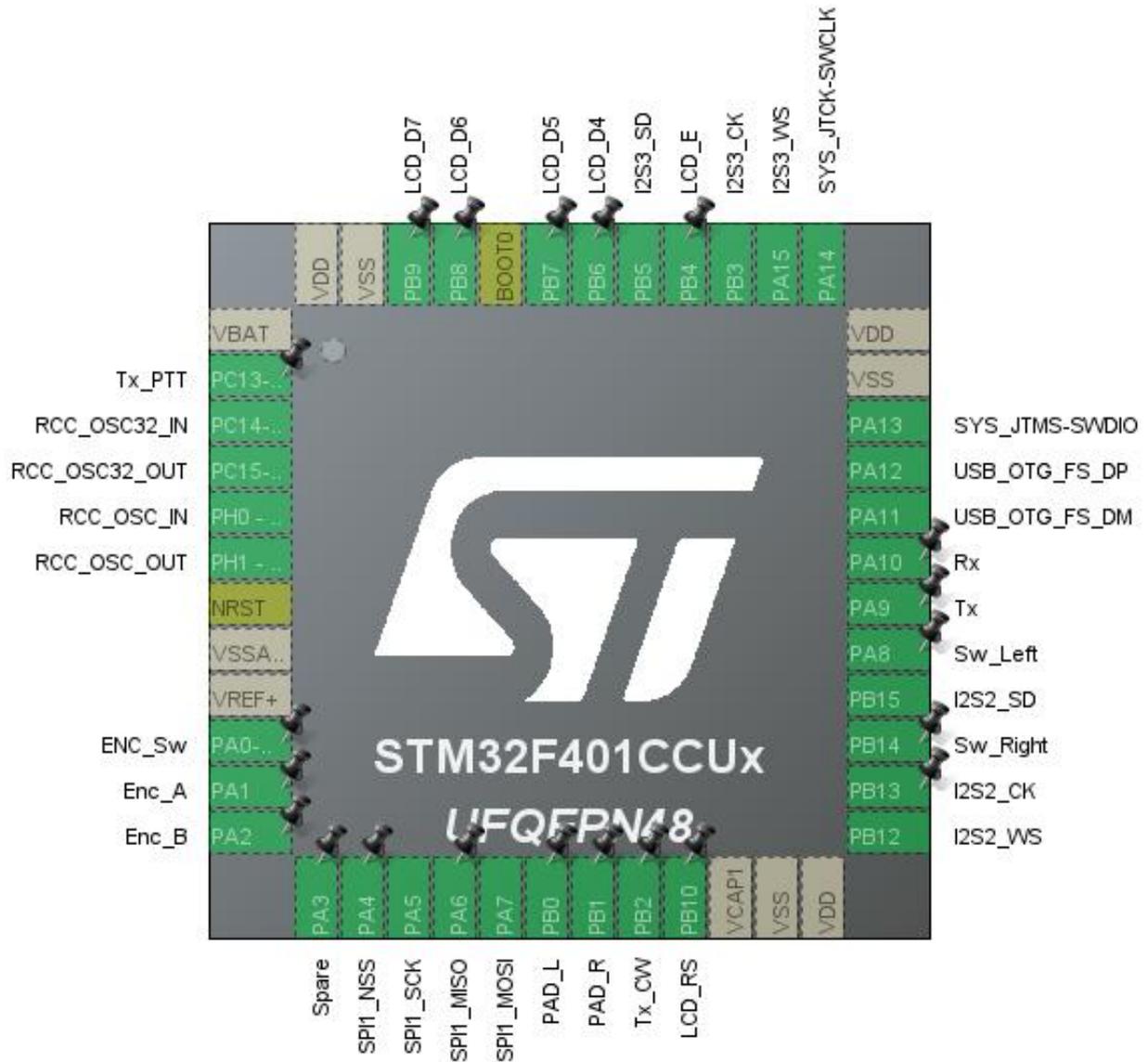
3. Pins Configuration

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	Tx_PTT
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/VREF-	Power		
9	VREF+	Power		
10	PA0-WKUP *	I/O	GPIO_Input	ENC_Sw
11	PA1 *	I/O	GPIO_Input	Enc_A
12	PA2 *	I/O	GPIO_Input	Enc_B
13	PA3 *	I/O	GPIO_Input	Spare
14	PA4	I/O	SPI1_NSS	
15	PA5	I/O	SPI1_SCK	
16	PA6	I/O	SPI1_MISO	
17	PA7	I/O	SPI1_MOSI	
18	PB0 *	I/O	GPIO_Input	PAD_L
19	PB1 *	I/O	GPIO_Input	PAD_R
20	PB2 *	I/O	GPIO_Output	Tx_CW
21	PB10 *	I/O	GPIO_Output	LCD_RS
22	VCAP1	Power		
23	VSS	Power		
24	VDD	Power		
25	PB12	I/O	I2S2_WS	
26	PB13	I/O	I2S2_CK	
27	PB14 *	I/O	GPIO_Input	Sw_Right
28	PB15	I/O	I2S2_SD	
29	PA8 *	I/O	GPIO_Input	Sw_Left
30	PA9 *	I/O	GPIO_Output	Tx
31	PA10 *	I/O	GPIO_Output	Rx
32	PA11	I/O	USB_OTG_FS_DM	
33	PA12	I/O	USB_OTG_FS_DP	
34	PA13	I/O	SYS_JTMS-SWDIO	
35	VSS	Power		
36	VDD	Power		

Pin Number UFQFPN48	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
37	PA14	I/O	SYS_JTCK-SWCLK	
38	PA15	I/O	I2S3_WS	
39	PB3	I/O	I2S3_CK	
40	PB4 *	I/O	GPIO_Output	LCD_E
41	PB5	I/O	I2S3_SD	
42	PB6 *	I/O	GPIO_Output	LCD_D4
43	PB7 *	I/O	GPIO_Output	LCD_D5
44	BOOT0	Boot		
45	PB8 *	I/O	GPIO_Output	LCD_D6
46	PB9 *	I/O	GPIO_Output	LCD_D7
47	VSS	Power		
48	VDD	Power		

* The pin is affected with an I/O function

4. Clock Tree Configuration
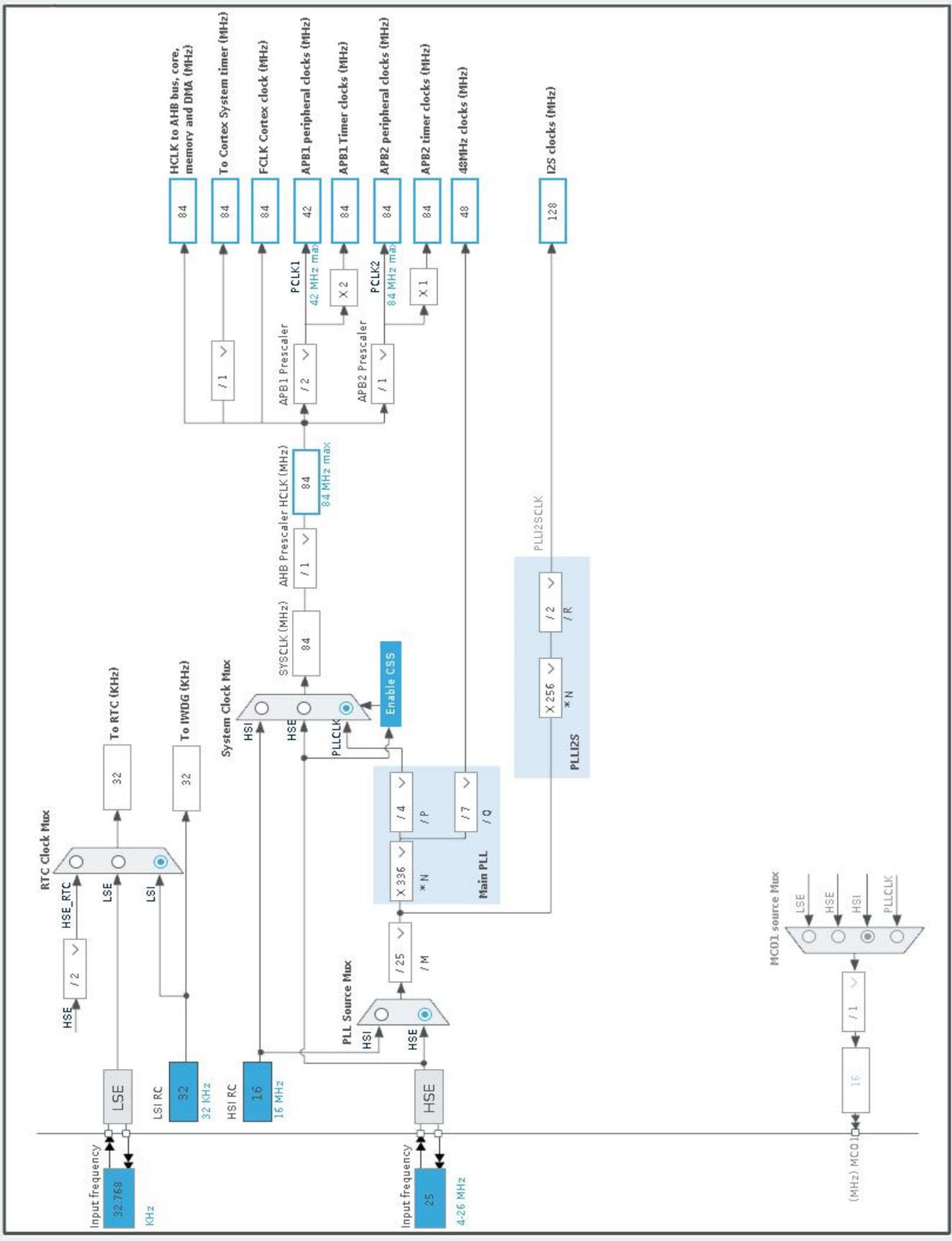
5. Software Project

5.1. Project Settings

Name	Value
Project Name	CW-Keyer-BlackPill
Project Folder	/home/emil/Projects/OrCAD/Files/E47-CW-Keyer-BlackPill/ARM
Toolchain / IDE	Makefile
Firmware Package Name and Version	STM32Cube FW_F4 V1.27.0
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 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)	Yes
Enable Full Assert	No

5.3. Advanced Settings - Generated Function Calls

Rank	Function Name	Peripheral Instance Name
1	MX_GPIO_Init	GPIO
2	SystemClock_Config	RCC
3	MX_SPI1_Init	SPI1
4	MX_RTC_Init	RTC
5	MX_DMA_Init	DMA
6	MX_TIM10_Init	TIM10
7	MX_I2S2_Init	I2S2
8	MX_I2S3_Init	I2S3
9	MX_IWDG_Init	IWDG
10	MX_USB_HOST_Init	USB_HOST

6. Power Consumption Calculator report

6.1. Microcontroller Selection

Series	STM32F4
Line	STM32F401
MCU	STM32F401CCUx
Datasheet	DS9716_Rev8

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
Vdd	3.3	3.3
Voltage Source	Battery	Battery
Range	Scale2-Medium	No Scale
Fetch Type	FLASH/ART/PREFETCH	n/a
CPU Frequency	84 MHz	0 Hz
Clock Configuration	HSE PLL	Regulator_LPLV Flash-PwrDwn
Clock Source Frequency	4 MHz	0 Hz
Peripherals		
Additional Cons.	0 mA	0 mA
Average Current	21.2 mA	10 µA
Duration	0.1 ms	0.9 ms
DMIPS	105.0	0.0
Ta Max	102.76	105
Category	In DS Table	In DS Table

6.5. Results

Sequence Time	1 ms	Average Current	2.13 mA
Battery Life	2 months, 5 days, 14 hours	Average DMIPS	105.0 DMIPS

6.6. Chart

Consumption Profile by Step
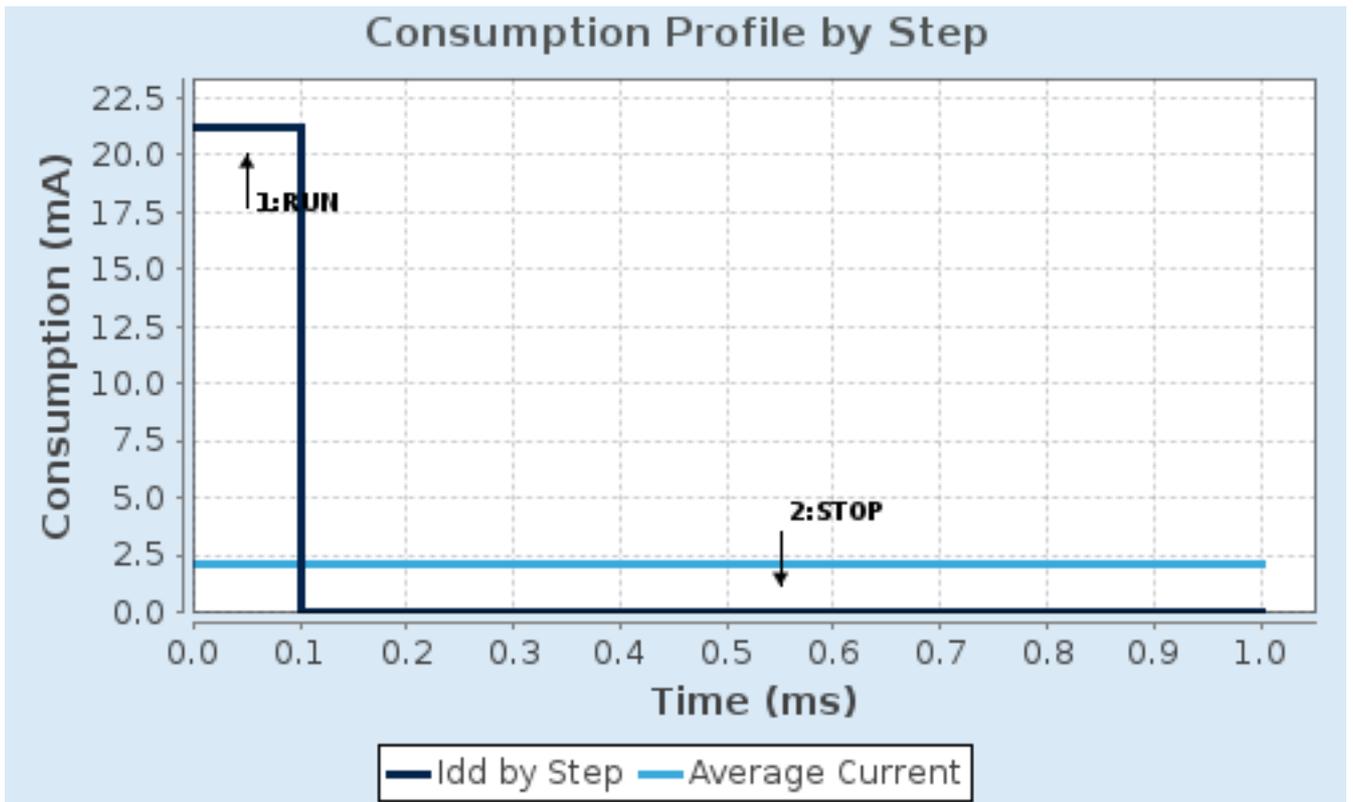
7. Peripherals and Middlewares Configuration

7.1. I2S2

Mode: Half-Duplex Master

7.1.1. Parameter Settings:

Generic Parameters:

Transmission Mode	**Mode Master Receive ***
Communication Standard	I2S Philips
Data and Frame Format	**24 Bits Data on 32 Bits Frame ***
Selected Audio Frequency	**16 KHz ***
Real Audio Frequency	**16.0 KHz ***
Error between Selected and Real	**0.0 % ***

Clock Parameters:

Clock Source	I2S PLL Clock
Clock Polarity	Low

7.2. I2S3

Mode: Half-Duplex Master

7.2.1. Parameter Settings:

Generic Parameters:

Transmission Mode	Mode Master Transmit
Communication Standard	I2S Philips
Data and Frame Format	16 Bits Data on 16 Bits Frame
Selected Audio Frequency	**16 KHz ***
Real Audio Frequency	**16.0 KHz ***
Error between Selected and Real	**0.0 % ***

Clock Parameters:

Clock Source	I2S PLL Clock
Clock Polarity	Low

7.3. IWDG

mode: Activated

7.3.1. Parameter Settings:

Clocking:

IWDG counter clock prescaler	**16** *
IWDG down-counter reload value	4095

7.4. RCC
High Speed Clock (HSE): Crystal/Ceramic Resonator
Low Speed Clock (LSE) : Crystal/Ceramic Resonator
7.4.1. Parameter Settings:

System Parameters:

VDD voltage (V)	3.3
Instruction Cache	Enabled
Prefetch Buffer	Enabled
Data Cache	Enabled
Flash Latency(WS)	2 WS (3 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 2

7.5. RTC
mode: Activate Clock Source
mode: Activate Calendar
7.5.1. Parameter Settings:

General:

Hour Format	Hourformat 24
Asynchronous Predivider value	127
Synchronous Predivider value	255

Calendar Time:

Data Format	BCD data format
Hours	0
Minutes	0

Seconds	0
Day Light Saving: value of hour adjustment	Daylightsaving None
Store Operation	Storeoperation Reset

Calendar Date:

Week Day	Monday
Month	January
Date	1
Year	0

7.6. SPI1
Mode: Full-Duplex Master
Hardware NSS Signal: Hardware NSS Output Signal
7.6.1. Parameter Settings:

Basic Parameters:

Frame Format	Motorola
Data Size	8 Bits
First Bit	MSB First

Clock Parameters:

Prescaler (for Baud Rate)	**4 ***
Baud Rate	**21.0 MBits/s ***
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

Advanced Parameters:

| CRC Calculation | Disabled |
| NSS Signal Type | Output Hardware |

7.7. SYS
Debug: Serial Wire
Timebase Source: TIM9

7.8. TIM10
mode: Activated
7.8.1. Parameter Settings:

Counter Settings:

Prescaler (PSC - 16 bits value)	**168-1 ***
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value)	**1000 ***
Internal Clock Division (CKD)	No Division
auto-reload preload	**Enable ***

7.9. USB_OTG_FS
Mode: Host_Only
7.9.1. Parameter Settings:

Speed	Host Full Speed 12MBit/s
Signal start of frame	Disabled

7.10. FREERTOS
Interface: CMSIS_V1
7.10.1. Config parameters:

API:

FreeRTOS API	CMSIS v1

Versions:

FreeRTOS version	10.3.1
CMSIS-RTOS version	1.02

MPU/FPU:

ENABLE_MPU	Disabled
ENABLE_FPU	**Enabled ***

Kernel settings:

USE_PREEMPTION	**Disabled ***
CPU_CLOCK_HZ	SystemCoreClock
TICK_RATE_HZ	1000
MAX_PRIORITIES	7
MINIMAL_STACK_SIZE	**64 ***
MAX_TASK_NAME_LEN	16
USE_16_BIT_TICKS	Disabled
IDLE_SHOULD_YIELD	Enabled
USE_MUTEXES	**Disabled ***
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 ***
TOTAL_HEAP_SIZE	**7000 ***
Memory Management scheme	heap_4

Hook function related definitions:

USE_IDLE_HOOK	Disabled
USE_TICK_HOOK	Disabled
USE_MALLOC_FAILED_HOOK	Disabled
USE_DAEMON_TASK_STARTUP_HOOK	Disabled
CHECK_FOR_STACK_OVERFLOW	Disabled

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	Disabled

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

7.10.2. Include parameters:

Include definitions:

vTaskPrioritySet	Enabled
uxTaskPriorityGet	Enabled
vTaskDelete	Enabled

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

7.10.3. Advanced settings:

Newlib settings (see parameter description first):

USE_NEWLIB_REENTRANT	Disabled

Project settings (see parameter description first):

Use FW pack heap file	Enabled

7.11. USB_HOST
Class for FS IP: Human Interface Host Class (HID)
7.11.1. Parameter Settings:

Host Configuration:

USBH_MAX_NUM_ENDPOINTS (Maximum number of endpoints)	2
USBH_MAX_NUM_INTERFACES (Maximun number of interfaces)	2
USBH_MAX_NUM_SUPPORTED_CLASS (Maximun number of supported class)	1
USBH_MAX_NUM_CONFIGURATION (Maximun number of supported configuration)	1
USBH_KEEP_CFG_DESCRIPTOR (Keep the configuration into RAM)	Enabled
USBH_MAX_SIZE_CONFIGURATION (Maximun size in bytes for the Configuration Descriptor)	256
USBH_MAX_DATA_BUFFER (Maximun size of temporary data)	512
USBH_DEBUG_LEVEL (USBH Debug Level)	0: No debug message

CMSIS_RTOS:

USBH_USE_OS (Enable the support of an RTOS)   Enabled

USBH_PROCESS_PRIO (The CMSIS-RTOS osPriority value specifies the priority for the USB   priority: normal (default)
Host thread)

USBH_PROCESS_STACK_SIZE (The CMSIS-RTOS stack size requirements in words)   **192 ***

* User modified value

8. System Configuration

8.1. GPIO configuration

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
I2S2	PB12	I2S2_WS	Alternate Function Push Pull	No pull-up and no pull-down	**High ***	
	PB13	I2S2_CK	Alternate Function Push Pull	No pull-up and no pull-down	**High ***	
	PB15	I2S2_SD	Alternate Function Push Pull	No pull-up and no pull-down	**High ***	
I2S3	PA15	I2S3_WS	Alternate Function Push Pull	No pull-up and no pull-down	**High ***	
	PB3	I2S3_CK	Alternate Function Push Pull	No pull-up and no pull-down	**High ***	
	PB5	I2S3_SD	Alternate Function Push Pull	No pull-up and no pull-down	**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	PA4	SPI1_NSS	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PA5	SPI1_SCK	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PA6	SPI1_MISO	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PA7	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	
USB_OTG_FS	PA11	USB_OTG_FS_DM	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
	PA12	USB_OTG_FS_DP	Alternate Function Push Pull	No pull-up and no pull-down	**Very High ***	
GPIO	PC13-ANTI_TAMP	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Tx_PTT
	PA0-WKUP	GPIO_Input	Input mode	**Pull-up ***	n/a	ENC_Sw
	PA1	GPIO_Input	Input mode	**Pull-up ***	n/a	Enc_A

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
	PA2	GPIO_Input	Input mode	**Pull-up ***	n/a	Enc_B
	PA3	GPIO_Input	Input mode	**Pull-up ***	n/a	Spare
	PB0	GPIO_Input	Input mode	**Pull-up ***	n/a	PAD_L
	PB1	GPIO_Input	Input mode	**Pull-up ***	n/a	PAD_R
	PB2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Tx_CW
	PB10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LCD_RS
	PB14	GPIO_Input	Input mode	**Pull-up ***	n/a	Sw_Right
	PA8	GPIO_Input	Input mode	**Pull-up ***	n/a	Sw_Left
	PA9	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Tx
	PA10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	Rx
	PB4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LCD_E
	PB6	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LCD_D4
	PB7	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LCD_D5
	PB8	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LCD_D6
	PB9	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LCD_D7

8.2. DMA configuration

DMA request	Stream	Direction	Priority
SPI2_RX	DMA1_Stream3	Peripheral To Memory	**High ***
SPI3_TX	DMA1_Stream5	Memory To Peripheral	**High ***

SPI2_RX: DMA1_Stream3 DMA request Settings:

Mode:	**Circular ***
Use fifo:	Disable
Peripheral Increment:	Disable
Memory Increment:	**Enable ***
Peripheral Data Width:	**Half Word ***
Memory Data Width:	**Half Word ***

SPI3_TX: DMA1_Stream5 DMA request Settings:

Mode:	**Circular ***
Use fifo:	Disable
Peripheral Increment:	Disable
Memory Increment:	**Enable ***
Peripheral Data Width:	**Half Word ***
Memory Data Width:	**Half Word ***

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
DMA1 stream3 global interrupt	true	5	0
DMA1 stream5 global interrupt	true	5	0
TIM1 break interrupt and TIM9 global interrupt	true	15	0
TIM1 update interrupt and TIM10 global interrupt	true	10	0
USB On The Go FS global interrupt	true	6	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
SPI1 global interrupt	unused		
SPI2 global interrupt	unused		
SPI3 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	false	true
DMA1 stream3 global interrupt	false	true	true
DMA1 stream5 global interrupt	false	true	true

Enabled interrupt Table	Select for init sequence ordering	Generate IRQ handler	Call HAL handler
TIM1 break interrupt and TIM9 global interrupt	false	true	true
TIM1 update interrupt and TIM10 global interrupt	false	true	true
USB On The Go FS global interrupt	false	true	true

* User modified value

9. System Views

9.1. Category view

9.1.1. Current

Middleware

FREERTOS ✓   USB_HOST ⚠

System Core	Analog	Timers	Connectivity	Multimedia	Computing
DMA ✓		RTC ✓	SPI1 ✓	I2S2 ✓	
GPIO ✓		TIM10 ✓	USB_FS ✓	I2S3 ✓	
IWDG ✓					
NVIC ✓					
RCC ✓					
SYS ✓					

10. Docs & Resources

Type   Link