



## 1. Description

### 1.1. Project

Project Name	densitometer
Board Name	custom
Generated with:	STM32CubeMX 6.3.0
Date	08/27/2021

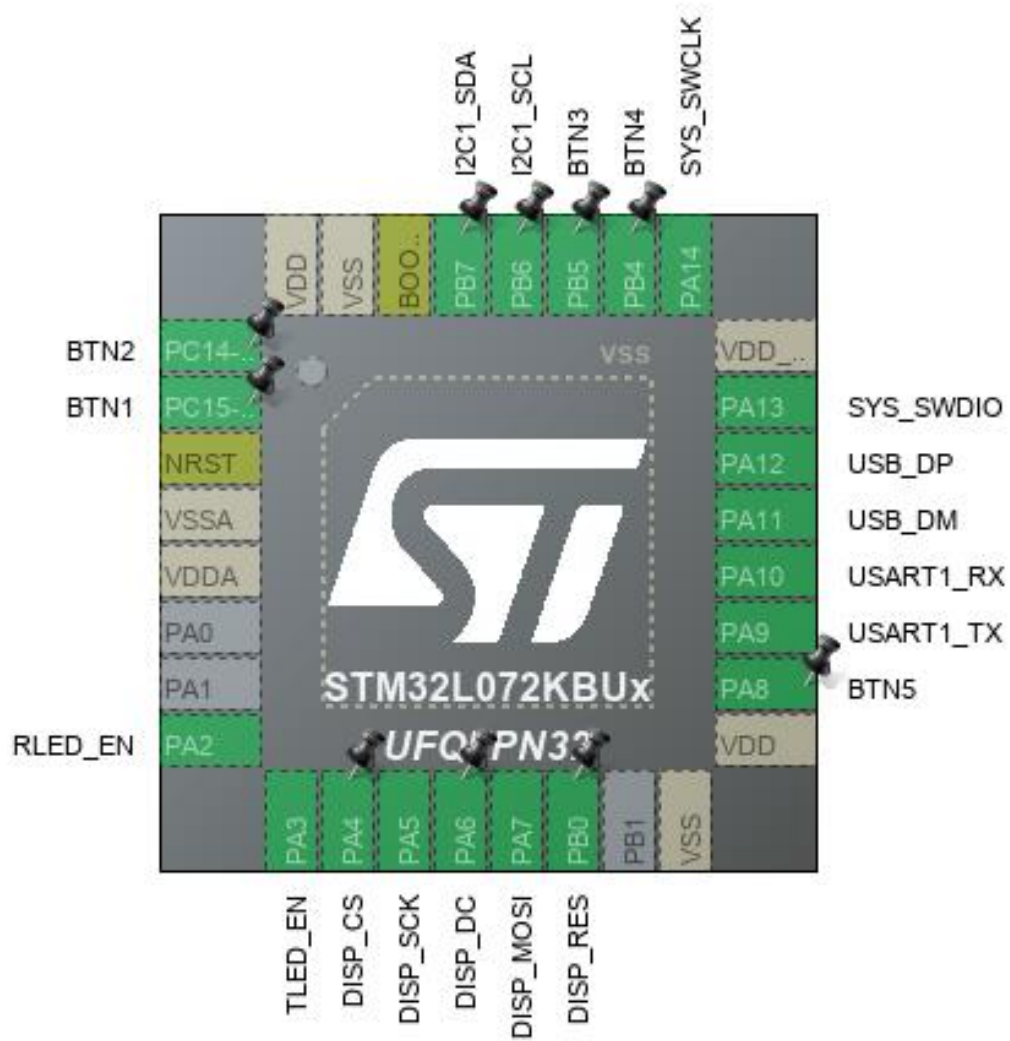
### 1.2. MCU

MCU Series	STM32L0
MCU Line	STM32L0x2
MCU name	STM32L072KBUx
MCU Package	UFQFPN32
MCU Pin number	32

### 1.3. Core(s) information

Core(s)	Arm Cortex-M0+
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## 2. Pinout Configuration

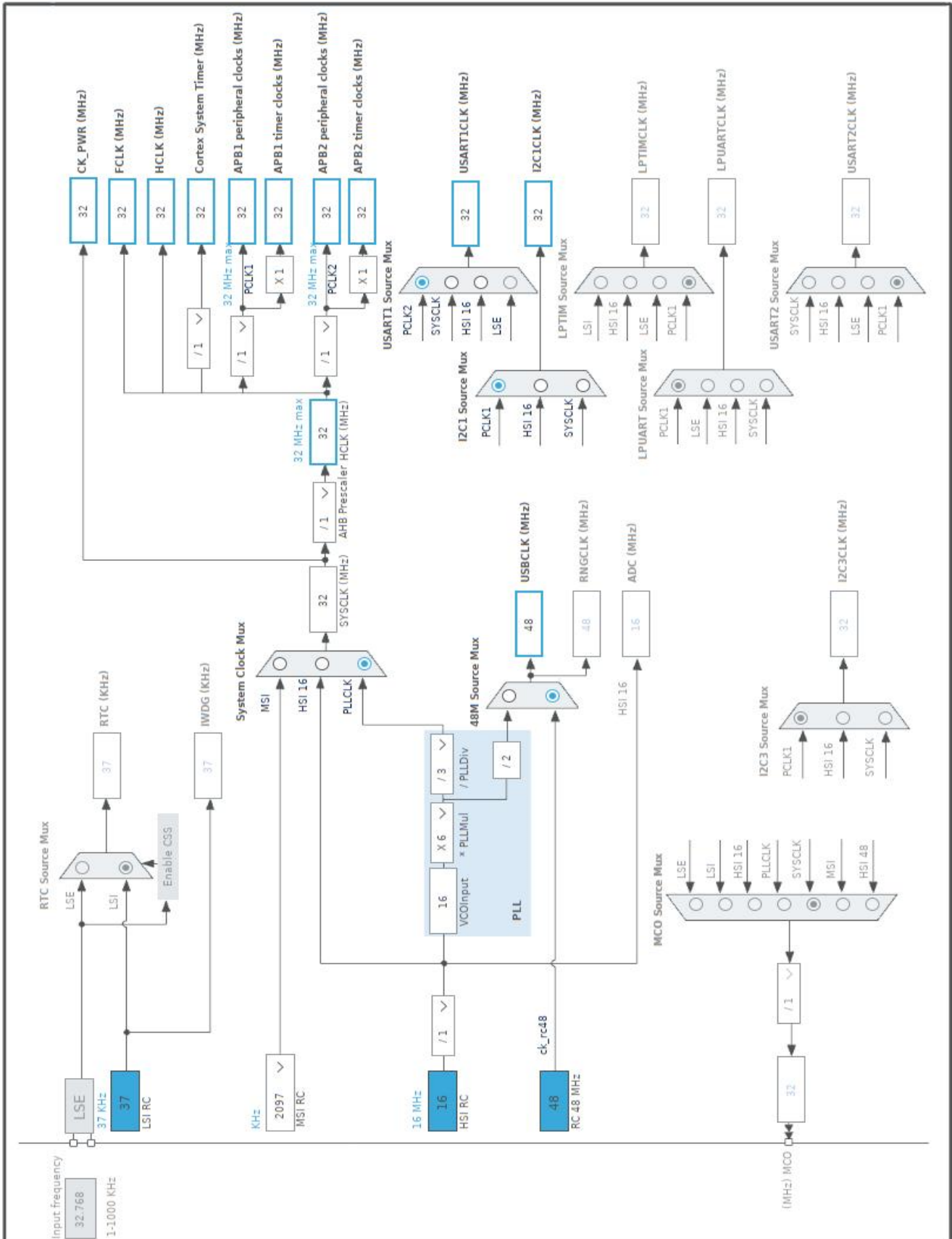


### 3. Pins Configuration

Pin Number UFQFPN32	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	PC14-OSC32_IN	I/O	GPIO_EXTI14	BTN2
2	PC15-OSC32_OUT	I/O	GPIO_EXTI15	BTN1
3	NRST	Reset		
4	VSSA	Power		
5	VDDA	Power		
8	PA2	I/O	TIM2_CH3	RLED_EN
9	PA3	I/O	TIM2_CH4	TLED_EN
10	PA4 *	I/O	GPIO_Output	DISP_CS
11	PA5	I/O	SPI1_SCK	DISP_SCK
12	PA6 *	I/O	GPIO_Output	DISP_DC
13	PA7	I/O	SPI1_MOSI	DISP_MOSI
14	PB0 *	I/O	GPIO_Output	DISP_RES
16	VSS	Power		
17	VDD	Power		
18	PA8	I/O	GPIO_EXTI8	BTN5
19	PA9	I/O	USART1_TX	
20	PA10	I/O	USART1_RX	
21	PA11	I/O	USB_DM	
22	PA12	I/O	USB_DP	
23	PA13	I/O	SYS_SWDIO	
24	VDD_USB	Power		
25	PA14	I/O	SYS_SWCLK	
26	PB4	I/O	GPIO_EXTI4	BTN4
27	PB5	I/O	GPIO_EXTI5	BTN3
28	PB6	I/O	I2C1_SCL	
29	PB7	I/O	I2C1_SDA	
30	BOOT0	Boot		
31	VSS	Power		
32	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	densitometer
Project Folder	/home/octo/devel/densitometer/docs/cube
Toolchain / IDE	STM32CubeIDE
Firmware Package Name and Version	STM32Cube FW_L0 V1.12.1
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)	Yes
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_I2C1_Init	I2C1
4	MX_SPI1_Init	SPI1
5	MX_TIM2_Init	TIM2
6	MX_USART1_UART_Init	USART1
7	MX_USB_DEVICE_Init	USB_DEVICE

## 6. Power Consumption Calculator report

### 6.1. Microcontroller Selection

Series	STM32L0
Line	STM32L0x2
MCU	STM32L072KBUx
Datasheet	DS10689_Rev5

### 6.2. Parameter Selection

Temperature	25
Vdd	3.0

### 6.3. Battery Selection

Battery	Li-SOCL2(AAA700)
Capacity	700.0 mAh
Self Discharge	0.08 %/month
Nominal Voltage	3.6 V
Max Cont Current	10.0 mA
Max Pulse Current	30.0 mA
Cells in series	1
Cells in parallel	1

#### 6.4. Sequence

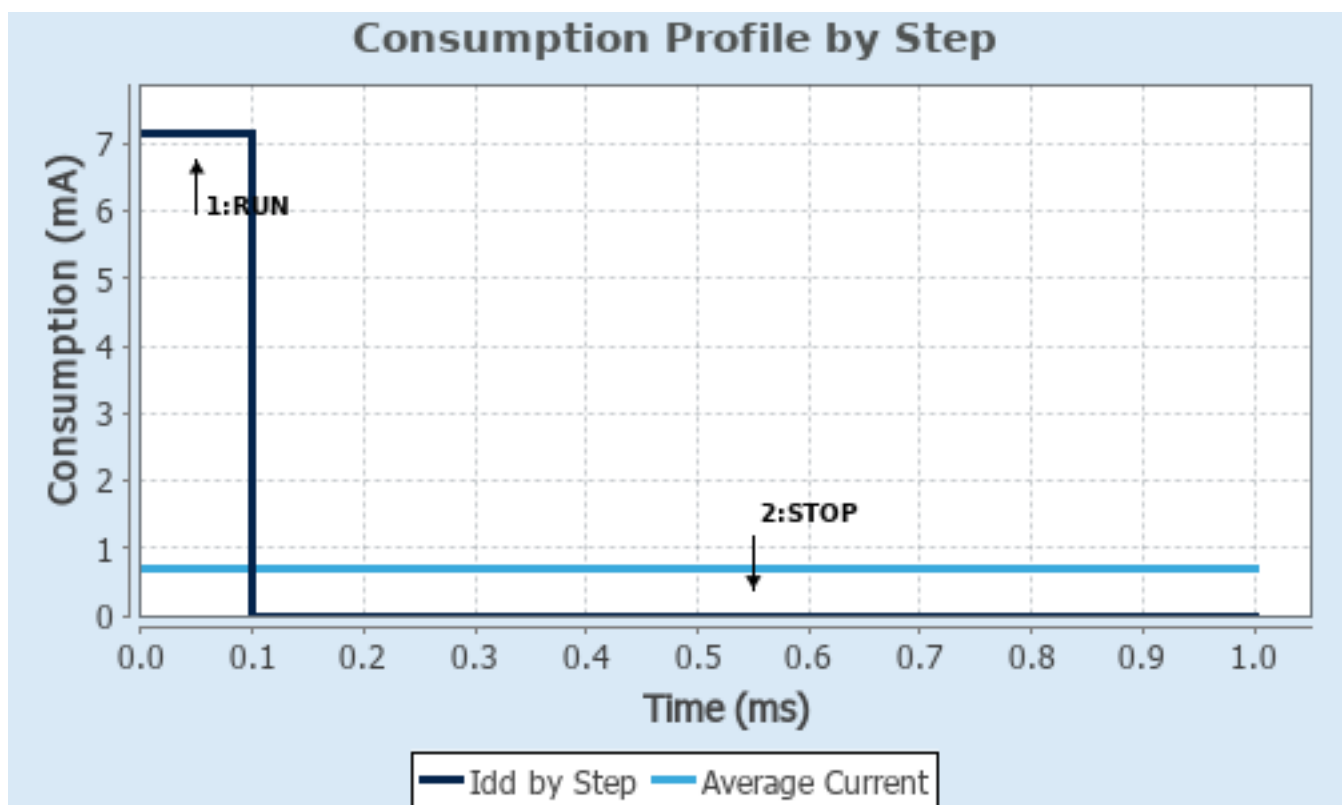
<b>Step</b>	Step1	Step2
<b>Mode</b>	RUN	STOP
<b>Vdd</b>	3.0	3.0
<b>Voltage Source</b>	Battery	Battery
<b>Range</b>	Range1-High	NoRange
<b>Fetch Type</b>	FLASH	n/a
<b>CPU Frequency</b>	32 MHz	0 Hz
<b>Clock Configuration</b>	HSI PLL	ALL CLOCKS OFF
<b>Clock Source Frequency</b>	16 MHz	0 Hz
<b>Peripherals</b>		
<b>Additional Cons.</b>	0 mA	0 mA
<b>Average Current</b>	7.15 mA	430 nA
<b>Duration</b>	0.1 ms	0.9 ms
<b>DMIPS</b>	30.0	0.0
<b>Ta Max</b>	104.23	105
<b>Category</b>	In DS Table	In DS Table

#### 6.5. Results

Sequence Time	1 ms	Average Current	715.39 $\mu$ A
Battery Life	1 month, 10 days, 7 hours	Average DMIPS	30.4 DMIPS

#### 6.6. Chart





## 7. Peripherals and Middlewares Configuration

### 7.1. I2C1

#### I2C: I2C

##### 7.1.1. Parameter Settings:

###### Timing configuration:

I2C Speed Mode	<b>Fast Mode *</b>
I2C Speed Frequency (KHz)	400
Rise Time (ns)	0
Fall Time (ns)	0
Coefficient of Digital Filter	0
Analog Filter	Enabled
Timing	<b>0x00300F38 *</b>

###### Slave Features:

Clock No Stretch Mode	Disabled
General Call Address Detection	Disabled
Primary Address Length selection	7-bit
Dual Address Acknowledged	Disabled
Primary slave address	0

### 7.2. RCC

##### 7.2.1. Parameter Settings:

###### System Parameters:

VDD voltage (V)	3.3
Buffer Cache	Enabled
Prefetch	Disabled
Preread	Enabled
Flash Latency(WS)	1 WS (2 CPU cycle)

###### RCC Parameters:

HSI Calibration Value	16
MSI Calibration Value	0
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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### 7.3. SPI1

**Mode: Transmit Only Master**

#### 7.3.1. Parameter Settings:

**Basic Parameters:**

Frame Format	Motorola
Data Size	8 Bits
First Bit	MSB First

**Clock Parameters:**

Prescaler (for Baud Rate)	2
Baud Rate	<b>16.0 MBits/s *</b>
Clock Polarity (CPOL)	Low
Clock Phase (CPHA)	1 Edge

**Advanced Parameters:**

CRC Calculation	Disabled
NSS Signal Type	Software

### 7.4. SYS

**mode: Debug Serial Wire**

**Timebase Source: TIM6**

### 7.5. TIM2

**Clock Source : Internal Clock**

**Channel3: PWM Generation CH3**

**Channel4: PWM Generation CH4**

#### 7.5.1. Parameter Settings:

**Counter Settings:**

Prescaler (PSC - 16 bits value)	0
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	<b>127 *</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 3:

Mode	PWM mode 1
Pulse (16 bits value)	<b>64 *</b>
Output compare preload	Enable
Fast Mode	Disable
CH Polarity	High

### PWM Generation Channel 4:

Mode	PWM mode 1
Pulse (16 bits value)	<b>64 *</b>
Output compare preload	Enable
Fast Mode	Disable
CH Polarity	High

## 7.6. USART1

### Mode: Asynchronous

#### 7.6.1. 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
Single Sample	Disable

##### Advanced Features:

Auto Baudrate	Disable
TX Pin Active Level Inversion	Disable
RX Pin Active Level Inversion	Disable
Data Inversion	Disable
TX and RX Pins Swapping	Disable
Overrun	Enable
DMA on RX Error	Enable
MSB First	Disable

## 7.7. USB

## mode: Device (FS)

### 7.7.1. Parameter Settings:

#### Basic Parameters:

Speed	Full Speed 12MBit/s
Physical interface	Internal Phy

#### Power Parameters:

Low Power	Disabled
Link Power Management	Disabled

## 7.8. FREERTOS

### Interface: CMSIS\_V2

#### 7.8.1. Config parameters:

#### API:

FreeRTOS API	CMSIS v2
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#### Versions:

FreeRTOS version	10.2.1
CMSIS-RTOS version	2.00

#### MPU/FPU:

ENABLE_MPU	Disabled
ENABLE_FPU	Disabled

#### Kernel settings:

USE_PREEMPTION	Enabled
CPU_CLOCK_HZ	SystemCoreClock
TICK_RATE_HZ	1000
MAX_PRIORITIES	56
MINIMAL_STACK_SIZE	128
MAX_TASK_NAME_LEN	16
USE_16_BIT_TICKS	Disabled
IDLE_SHOULD_YIELD	Enabled
USE_MUTEXES	Enabled
USE_RECURSIVE_MUTEXES	Enabled
USE_COUNTING_SEMAPHORES	Enabled
QUEUE_REGISTRY_SIZE	8
USE_APPLICATION_TASK_TAG	Disabled
ENABLE_BACKWARD_COMPATIBILITY	Enabled
USE_PORT_OPTIMISED_TASK_SELECTION	Disabled
USE_TICKLESS_IDLE	Disabled

USE_TASK_NOTIFICATIONS	Enabled
RECORD_STACK_HIGH_ADDRESS	Disabled

#### Memory management settings:

Memory Allocation	Dynamic / Static
TOTAL_HEAP_SIZE	3072
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	Enabled
USE_STATS_FORMATTING_FUNCTIONS	Disabled

#### Co-routine related definitions:

USE_CO_ROUTINES	Disabled
MAX_CO_ROUTINE_PRIORITIES	2

#### Software timer definitions:

USE_TIMERS	Enabled
TIMER_TASK_PRIORITY	2
TIMER_QUEUE_LENGTH	10
TIMER_TASK_STACK_DEPTH	256

#### Added with 10.2.1 support:

MESSAGE_BUFFER_LENGTH_TYPE	size_t
USE_POSIX_ERRNO	Disabled

### 7.8.2. Include parameters:

#### Include definitions:

vTaskPrioritySet	Enabled
uxTaskPriorityGet	Enabled
vTaskDelete	Enabled
vTaskCleanUpResources	Disabled
vTaskSuspend	Enabled
vTaskDelayUntil	Enabled
vTaskDelay	Enabled
xTaskGetSchedulerState	Enabled
xTaskResumeFromISR	Enabled
xQueueGetMutexHolder	Enabled

xSemaphoreGetMutexHolder	Disabled
pcTaskGetTaskName	Disabled
uxTaskGetStackHighWaterMark	Enabled
xTaskGetCurrentTaskHandle	Disabled
eTaskGetState	Enabled
xEventGroupSetBitFromISR	Disabled
xTimerPendFunctionCall	Enabled
xTaskAbortDelay	Disabled
xTaskGetHandle	Disabled
uxTaskGetStackHighWaterMark2	Disabled

### 7.8.3. Advanced settings:

#### **Newlib settings (see parameter description first):**

USE\_NEWLIB\_REENTRANT                      **Enabled \***

#### **Project settings (see parameter description first):**

Use FW pack heap file                      Enabled

## **7.9. USB\_DEVICE**

### **Class For FS IP: Communication Device Class (Virtual Port Com)**

#### 7.9.1. Parameter Settings:

##### **Basic Parameters:**

USBD_MAX_NUM_INTERFACES (Maximum number of supported interfaces)	1
USBD_MAX_NUM_CONFIGURATION (Maximum number of supported configuration)	1
USBD_MAX_STR_DESC_SIZ (Maximum size for the string descriptors)	512
USBD_SELF_POWERED (Enabled self power)	Enabled
USBD_DEBUG_LEVEL (USBD Debug Level)	0: No debug message

##### **Class Parameters:**

USB CDC Rx Buffer Size	1000
USB CDC Tx Buffer Size	1000

#### 7.9.2. Device Descriptor:

##### **Device Descriptor:**

VID (Vendor Identifier)	1155
LANGID_STRING (Language Identifier)	English(United States)
MANUFACTURER_STRING (Manufacturer Identifier)	STMicroelectronics

**Device Descriptor FS:**

PID (Product Identifier)	22336
PRODUCT_STRING (Product Identifier)	STM32 Virtual ComPort
CONFIGURATION_STRING (Configuration Identifier)	CDC Config
INTERFACE_STRING (Interface Identifier)	CDC Interface

\* User modified value



## 8. System Configuration

### 8.1. GPIO configuration

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
I2C1	PB6	I2C1_SCL	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	
	PB7	I2C1_SDA	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	
SPI1	PA5	SPI1_SCK	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	DISP_SCK
	PA7	SPI1_MOSI	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	DISP_MOSI
SYS	PA13	SYS_SWDI0	n/a	n/a	n/a	
	PA14	SYS_SWCLK	n/a	n/a	n/a	
TIM2	PA2	TIM2_CH3	Alternate Function Push Pull	No pull-up and no pull-down	Low	RLED_EN
	PA3	TIM2_CH4	Alternate Function Push Pull	No pull-up and no pull-down	Low	TLED_EN
USART1	PA9	USART1_TX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	
	PA10	USART1_RX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	
USB	PA11	USB_DM	n/a	n/a	n/a	
	PA12	USB_DP	n/a	n/a	n/a	
GPIO	PC14-OSC32_IN	GPIO_EXTI14	<b>External Interrupt Mode with Rising/Falling edge</b>	No pull-up and no pull-down	n/a	BTN2
	PC15-OSC32_OUT	GPIO_EXTI15	<b>External Interrupt Mode with Rising/Falling edge</b>	No pull-up and no pull-down	n/a	BTN1
	PA4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	DISP_CS
	PA6	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	DISP_DC
	PB0	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	DISP_RES
	PA8	GPIO_EXTI8	<b>External Interrupt Mode with Rising/Falling edge</b>	No pull-up and no pull-down	n/a	BTN5
	PB4	GPIO_EXTI4	<b>External Interrupt Mode with Rising/Falling edge</b>	No pull-up and no pull-down	n/a	BTN4
	PB5	GPIO_EXTI5	<b>External Interrupt</b>	No pull-up and no pull-down	n/a	BTN3

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
			<b>Mode with Rising/Falling edge</b>			

## 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
System service call via SWI instruction	true	0	0
Pendable request for system service	true	3	0
System tick timer	true	3	0
TIM6 global interrupt and DAC1/DAC2 underrun error interrupts	true	3	0
USB event interrupt / USB wake-up interrupt through EXTI line 18	true	3	0
PVD interrupt through EXTI line 16	unused		
Flash and EEPROM global interrupt	unused		
RCC and CRS global interrupt	unused		
EXTI line 4 to 15 interrupts	unused		
TIM2 global interrupt	unused		
I2C1 event global interrupt / I2C1 wake-up interrupt through EXTI line 23	unused		
SPI1 global interrupt	unused		
USART1 global interrupt / USART1 wake-up interrupt through EXTI line 25	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
System service call via SWI instruction	false	false	false
Pendable request for system service	false	false	false
System tick timer	false	false	true
TIM6 global interrupt and DAC1/DAC2 underrun error interrupts	false	true	true
USB event interrupt / USB wake-up interrupt through EXTI line 18	false	true	true

\* User modified value

## 9. System Views

### 9.1. Category view

#### 9.1.1. Current

Middleware					
<div><div>FREERTOS ✓</div><div>USB_DEVICE ✓</div></div>					
System Core	Analog	Timers	Connectivity	Security	Computing
<div>DMA</div>		<div>TIM2 ✓</div>	<div>I2C1 ✓</div>		
<div>GPIO ✓</div>			<div>SPI1 ✓</div>		
<div>NVIC ✓</div>			<div>USART1 ✓</div>		
<div>RCC ✓</div>			<div>USB ✓</div>		
<div>SYS ✓</div>					

## 10. Docs & Resources

Type	Link
Datasheet	<a href="http://www.st.com/resource/en/datasheet/DM00141133.pdf">http://www.st.com/resource/en/datasheet/DM00141133.pdf</a>
Reference manual	<a href="http://www.st.com/resource/en/reference_manual/DM00108281.pdf">http://www.st.com/resource/en/reference_manual/DM00108281.pdf</a>
Programming manual	<a href="http://www.st.com/resource/en/programming_manual/DM00104451.pdf">http://www.st.com/resource/en/programming_manual/DM00104451.pdf</a>
Errata sheet	<a href="http://www.st.com/resource/en/errata_sheet/DM00148855.pdf">http://www.st.com/resource/en/errata_sheet/DM00148855.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/CD00160362.pdf">http://www.st.com/resource/en/application_note/CD00160362.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/CD00167594.pdf">http://www.st.com/resource/en/application_note/CD00167594.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/CD00211314.pdf">http://www.st.com/resource/en/application_note/CD00211314.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/CD00259245.pdf">http://www.st.com/resource/en/application_note/CD00259245.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/CD00264342.pdf">http://www.st.com/resource/en/application_note/CD00264342.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/CD00264379.pdf">http://www.st.com/resource/en/application_note/CD00264379.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00042534.pdf">http://www.st.com/resource/en/application_note/DM00042534.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00072315.pdf">http://www.st.com/resource/en/application_note/DM00072315.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00073742.pdf">http://www.st.com/resource/en/application_note/DM00073742.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00073853.pdf">http://www.st.com/resource/en/application_note/DM00073853.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00081379.pdf">http://www.st.com/resource/en/application_note/DM00081379.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00085385.pdf">http://www.st.com/resource/en/application_note/DM00085385.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00087593.pdf">http://www.st.com/resource/en/application_note/DM00087593.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00108286.pdf">http://www.st.com/resource/en/application_note/DM00108286.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00112257.pdf">http://www.st.com/resource/en/application_note/DM00112257.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00129215.pdf">http://www.st.com/resource/en/application_note/DM00129215.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00145318.pdf">http://www.st.com/resource/en/application_note/DM00145318.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00150423.pdf">http://www.st.com/resource/en/application_note/DM00150423.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00151811.pdf">http://www.st.com/resource/en/application_note/DM00151811.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00158601.pdf">http://www.st.com/resource/en/application_note/DM00158601.pdf</a>
Application note	<a href="http://www.st.com/resource/en/application_note/DM00160482.pdf">http://www.st.com/resource/en/application_note/DM00160482.pdf</a>

Application note [http://www.st.com/resource/en/application\\_note/DM00206898.pdf](http://www.st.com/resource/en/application_note/DM00206898.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00209725.pdf](http://www.st.com/resource/en/application_note/DM00209725.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00209768.pdf](http://www.st.com/resource/en/application_note/DM00209768.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00209772.pdf](http://www.st.com/resource/en/application_note/DM00209772.pdf)  
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Application note [http://www.st.com/resource/en/application\\_note/DM00226326.pdf](http://www.st.com/resource/en/application_note/DM00226326.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00236305.pdf](http://www.st.com/resource/en/application_note/DM00236305.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00257177.pdf](http://www.st.com/resource/en/application_note/DM00257177.pdf)  
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Application note [http://www.st.com/resource/en/application\\_note/DM00315319.pdf](http://www.st.com/resource/en/application_note/DM00315319.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00327191.pdf](http://www.st.com/resource/en/application_note/DM00327191.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00354244.pdf](http://www.st.com/resource/en/application_note/DM00354244.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00355687.pdf](http://www.st.com/resource/en/application_note/DM00355687.pdf)  
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Application note [http://www.st.com/resource/en/application\\_note/DM00660597.pdf](http://www.st.com/resource/en/application_note/DM00660597.pdf)  
Application note [http://www.st.com/resource/en/application\\_note/DM00725181.pdf](http://www.st.com/resource/en/application_note/DM00725181.pdf)