

## 1. Description

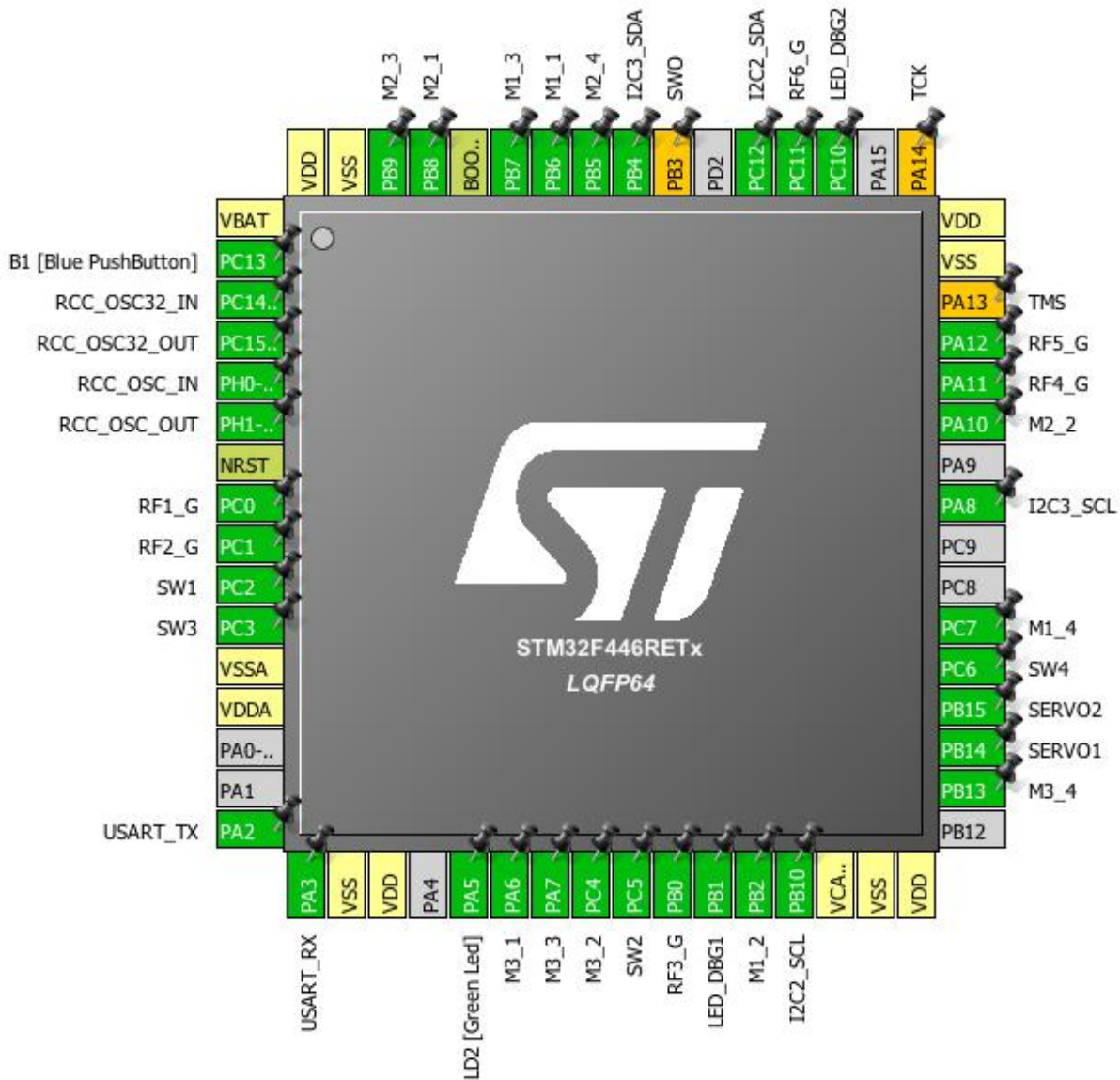
### 1.1. Project

Project Name	firmware_new
Board Name	NUCLEO-F446RE
Generated with:	STM32CubeMX 4.24.0
Date	05/19/2018

### 1.2. MCU

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

## 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 PushButton]
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_EXTI0	RF1_G
9	PC1	I/O	GPIO_EXTI1	RF2_G
10	PC2 *	I/O	GPIO_Output	SW1
11	PC3 *	I/O	GPIO_Output	SW3
12	VSSA	Power		
13	VDDA	Power		
16	PA2	I/O	USART2_TX	USART_TX
17	PA3	I/O	USART2_RX	USART_RX
18	VSS	Power		
19	VDD	Power		
21	PA5 *	I/O	GPIO_Output	LD2 [Green Led]
22	PA6	I/O	TIM3_CH1	M3_1
23	PA7	I/O	TIM3_CH2	M3_3
24	PC4 *	I/O	GPIO_Output	M3_2
25	PC5 *	I/O	GPIO_Output	SW2
26	PB0 *	I/O	GPIO_Input	RF3_G
27	PB1 *	I/O	GPIO_Output	LED_DBG1
28	PB2 *	I/O	GPIO_Output	M1_2
29	PB10	I/O	I2C2_SCL	
30	VCAP_1	Power		
31	VSS	Power		
32	VDD	Power		
34	PB13 *	I/O	GPIO_Output	M3_4
35	PB14	I/O	TIM12_CH1	SERVO1
36	PB15	I/O	TIM12_CH2	SERVO2
37	PC6 *	I/O	GPIO_Output	SW4
38	PC7 *	I/O	GPIO_Output	M1_4
41	PA8	I/O	I2C3_SCL	
43	PA10 *	I/O	GPIO_Output	M2_2

Pin Number LQFP64	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
44	PA11	I/O	GPIO_EXTI11	RF4_G
45	PA12	I/O	GPIO_EXTI12	RF5_G
46	PA13 **	I/O	SYS_JTMS-SWDIO	TMS
47	VSS	Power		
48	VDD	Power		
49	PA14 **	I/O	SYS_JTCK-SWCLK	TCK
51	PC10 *	I/O	GPIO_Output	LED_DBG2
52	PC11 *	I/O	GPIO_Input	RF6_G
53	PC12	I/O	I2C2_SDA	
55	PB3 **	I/O	SYS_JTDO-SWO	SWO
56	PB4	I/O	I2C3_SDA	
57	PB5 *	I/O	GPIO_Output	M2_4
58	PB6	I/O	TIM4_CH1	M1_1
59	PB7	I/O	TIM4_CH2	M1_3
60	BOOT0	Boot		
61	PB8	I/O	TIM4_CH3	M2_1
62	PB9	I/O	TIM4_CH4	M2_3
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



## 5. IPs and Middleware Configuration

### 5.1. I2C2

#### I2C: I2C

##### 5.1.1. Parameter Settings:

###### Master Features:

I2C Speed Mode	<b>Fast Mode *</b>
I2C Clock Speed (Hz)	400000
Fast Mode Duty Cycle	Duty cycle Tlow/Thigh = 2

###### 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

### 5.2. I2C3

#### I2C: I2C

##### 5.2.1. Parameter Settings:

###### Master Features:

I2C Speed Mode	<b>Fast Mode *</b>
I2C Clock Speed (Hz)	400000
Fast Mode Duty Cycle	Duty cycle Tlow/Thigh = 2

###### 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

### 5.3. RCC

High Speed Clock (HSE): Crystal/Ceramic Resonator

Low Speed Clock (LSE) : Crystal/Ceramic Resonator

#### 5.3.1. 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

### 5.4. SYS

Timebase Source: SysTick

### 5.5. TIM3

Clock Source : Internal Clock

Channel1: PWM Generation CH1

Channel2: PWM Generation CH2

#### 5.5.1. Parameter Settings:

##### Counter Settings:

Prescaler (PSC - 16 bits value)	1 *
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	2047 *
Internal Clock Division (CKD)	No Division

#### Trigger Output (TRGO) Parameters:

Master/Slave Mode	Disable (no sync between this TIM (Master) and its Slaves)
Trigger Event Selection	Reset (UG bit from TIMx_EGR)

#### PWM Generation Channel 1:

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

#### PWM Generation Channel 2:

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

## 5.6. TIM4

mode: Clock Source

Channel1: PWM Generation CH1

Channel2: PWM Generation CH2

Channel3: PWM Generation CH3

Channel4: PWM Generation CH4

### 5.6.1. Parameter Settings:

#### Counter Settings:

Prescaler (PSC - 16 bits value)	<b>1</b> *
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	<b>2047</b> *
Internal Clock Division (CKD)	No Division

#### Trigger Output (TRGO) Parameters:

Master/Slave Mode	Disable (no sync between this TIM (Master) and its Slaves)
Trigger Event Selection	Reset (UG bit from TIMx_EGR)

#### PWM Generation Channel 1:

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

#### PWM Generation Channel 2:

Mode	PWM mode 1
------	------------



Pulse (16 bits value)	0
Fast Mode	Disable
CH Polarity	High

#### **PWM Generation Channel 3:**

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

#### **PWM Generation Channel 4:**

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

## **5.7. TIM5**

### **mode: Clock Source**

#### **5.7.1. Parameter Settings:**

##### **Counter Settings:**

Prescaler (PSC - 16 bits value)	<b>9000 *</b>
Counter Mode	Up
Counter Period (AutoReload Register - 32 bits value )	<b>0xFFFFFFFF *</b>
Internal Clock Division (CKD)	No Division

##### **Trigger Output (TRGO) Parameters:**

Master/Slave Mode	Disable (no sync between this TIM (Master) and its Slaves
Trigger Event Selection	Reset (UG bit from TIMx_EGR)

## **5.8. TIM12**

### **mode: Clock Source**

#### **Channel1: PWM Generation CH1**

#### **Channel2: PWM Generation CH2**

#### **5.8.1. Parameter Settings:**

##### **Counter Settings:**

Prescaler (PSC - 16 bits value)	<b>354 *</b>
Counter Mode	Up
Counter Period (AutoReload Register - 16 bits value )	<b>3178 *</b>
Internal Clock Division (CKD)	No Division

#### **PWM Generation Channel 1:**

Mode	PWM mode 1
Pulse (16 bits value)	<b>63 *</b>
Fast Mode	Disable
CH Polarity	High

#### **PWM Generation Channel 2:**

Mode	PWM mode 1
Pulse (16 bits value)	<b>63 *</b>
Fast Mode	Disable
CH Polarity	High

## **5.9. USART2**

**Mode: Asynchronous**

### **5.9.1. Parameter Settings:**

#### **Basic Parameters:**

Baud Rate	<b>921600 *</b>
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**

## 6. System Configuration

### 6.1. GPIO configuration

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
I2C2	PB10	I2C2_SCL	Alternate Function Open Drain	Pull-up	Very High *	
	PC12	I2C2_SDA	Alternate Function Open Drain	Pull-up	Very High *	
I2C3	PA8	I2C3_SCL	Alternate Function Open Drain	Pull-up	Very High *	
	PB4	I2C3_SDA	Alternate Function Open Drain	Pull-up	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	
TIM3	PA6	TIM3_CH1	Alternate Function Push Pull	No pull-up and no pull-down	Low	M3_1
	PA7	TIM3_CH2	Alternate Function Push Pull	No pull-up and no pull-down	Low	M3_3
TIM4	PB6	TIM4_CH1	Alternate Function Push Pull	No pull-up and no pull-down	Low	M1_1
	PB7	TIM4_CH2	Alternate Function Push Pull	No pull-up and no pull-down	Low	M1_3
	PB8	TIM4_CH3	Alternate Function Push Pull	No pull-up and no pull-down	Low	M2_1
	PB9	TIM4_CH4	Alternate Function Push Pull	No pull-up and no pull-down	Low	M2_3
TIM12	PB14	TIM12_CH1	Alternate Function Push Pull	No pull-up and no pull-down	Low	SERVO1
	PB15	TIM12_CH2	Alternate Function Push Pull	No pull-up and no pull-down	Low	SERVO2
USART2	PA2	USART2_TX	Alternate Function Push Pull	Pull-up	Very High *	USART_TX
	PA3	USART2_RX	Alternate Function Push Pull	Pull-up	Very High *	USART_RX
Single Mapped Signals	PA13	SYS_JTMS-SWDIO	n/a	n/a	n/a	TMS
	PA14	SYS_JTCK-SWCLK	n/a	n/a	n/a	TCK
	PB3	SYS_JTDO-	n/a	n/a	n/a	SWO

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
		SWO				
GPIO	PC13	GPIO_EXTI13	<b>External Interrupt Mode with Falling edge trigger detection</b>	No pull-up and no pull-down	n/a	B1 [Blue PushButton]
	PC0	GPIO_EXTI0	<b>External Interrupt Mode with Falling edge trigger detection</b>	<b>Pull-up *</b>	n/a	RF1_G
	PC1	GPIO_EXTI1	<b>External Interrupt Mode with Falling edge trigger detection</b>	<b>Pull-up *</b>	n/a	RF2_G
	PC2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	SW1
	PC3	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	SW3
	PA5	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LD2 [Green Led]
	PC4	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M3_2
	PC5	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	SW2
	PB0	GPIO_Input	Input mode	<b>Pull-up *</b>	n/a	RF3_G
	PB1	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED_DBG1
	PB2	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M1_2
	PB13	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M3_4
	PC6	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	SW4
	PC7	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M1_4
	PA10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M2_2
	PA11	GPIO_EXTI11	<b>External Interrupt Mode with Falling edge trigger detection</b>	<b>Pull-up *</b>	n/a	RF4_G
	PA12	GPIO_EXTI12	<b>External Interrupt Mode with Falling edge trigger detection</b>	<b>Pull-up *</b>	n/a	RF5_G
	PC10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	LED_DBG2
	PC11	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	RF6_G
	PB5	GPIO_Output	Output Push Pull	No pull-up and no pull-down	Low	M2_4

## 6.2. DMA configuration

DMA request	Stream	Direction	Priority
I2C2_RX	DMA1_Stream2	Peripheral To Memory	Low
I2C2_TX	DMA1_Stream7	Memory To Peripheral	<b>High *</b>
I2C3_RX	DMA1_Stream1	Peripheral To Memory	Low
I2C3_TX	DMA1_Stream4	Memory To Peripheral	<b>High *</b>
USART2_RX	DMA1_Stream5	Peripheral To Memory	<b>Very High *</b>
USART2_TX	DMA1_Stream6	Memory To Peripheral	<b>Very High *</b>

### I2C2\_RX: DMA1\_Stream2 DMA request Settings:

Mode: Normal  
 Use fifo: Disable  
 Peripheral Increment: Disable  
 Memory Increment: **Enable \***  
 Peripheral Data Width: Byte  
 Memory Data Width: Byte

### I2C2\_TX: DMA1\_Stream7 DMA request Settings:

Mode: Normal  
 Use fifo: Disable  
 Peripheral Increment: Disable  
 Memory Increment: **Enable \***  
 Peripheral Data Width: Byte  
 Memory Data Width: Byte

### I2C3\_RX: DMA1\_Stream1 DMA request Settings:

Mode: Normal  
 Use fifo: Disable  
 Peripheral Increment: Disable  
 Memory Increment: **Enable \***  
 Peripheral Data Width: Byte  
 Memory Data Width: Byte

I2C3\_TX: DMA1\_Stream4 DMA request Settings:

Mode:	Normal
Use fifo:	Disable
Peripheral Increment:	Disable
Memory Increment:	<b>Enable *</b>
Peripheral Data Width:	Byte
Memory Data Width:	Byte

USART2\_RX: DMA1\_Stream5 DMA request Settings:

Mode:	<b>Circular *</b>
Use fifo:	Disable
Peripheral Increment:	Disable
Memory Increment:	<b>Enable *</b>
Peripheral Data Width:	Byte
Memory Data Width:	Byte

USART2\_TX: DMA1\_Stream6 DMA request Settings:

Mode:	Normal
Use fifo:	Disable
Peripheral Increment:	Disable
Memory Increment:	<b>Enable *</b>
Peripheral Data Width:	Byte
Memory Data Width:	Byte

### 6.3. NVIC configuration

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
DMA1 stream1 global interrupt	true	0	0
DMA1 stream2 global interrupt	true	0	0
DMA1 stream4 global interrupt	true	0	0
DMA1 stream5 global interrupt	true	0	0
DMA1 stream6 global interrupt	true	0	0
I2C2 event interrupt	true	0	0
I2C2 error interrupt	true	0	0
USART2 global interrupt	true	0	0
DMA1 stream7 global interrupt	true	0	0
I2C3 event interrupt	true	0	0
I2C3 error interrupt	true	0	0
PVD interrupt through EXTI line 16	unused		
Flash global interrupt	unused		
RCC global interrupt	unused		
EXTI line 0 interrupt	unused		
EXTI line 1 interrupt	unused		
TIM3 global interrupt	unused		
TIM4 global interrupt	unused		
EXTI line[15:10] interrupts	unused		
TIM8 break interrupt and TIM12 global interrupt	unused		
TIM5 global interrupt	unused		
FPU global interrupt	unused		

\* User modified value

## 7. Power Consumption Calculator report

### 7.1. Microcontroller Selection

Series	STM32F4
Line	STM32F446
MCU	STM32F446RETx
Datasheet	027107_Rev6

### 7.2. Parameter Selection

Temperature	25
Vdd	3.3

### 7.3. Sequence

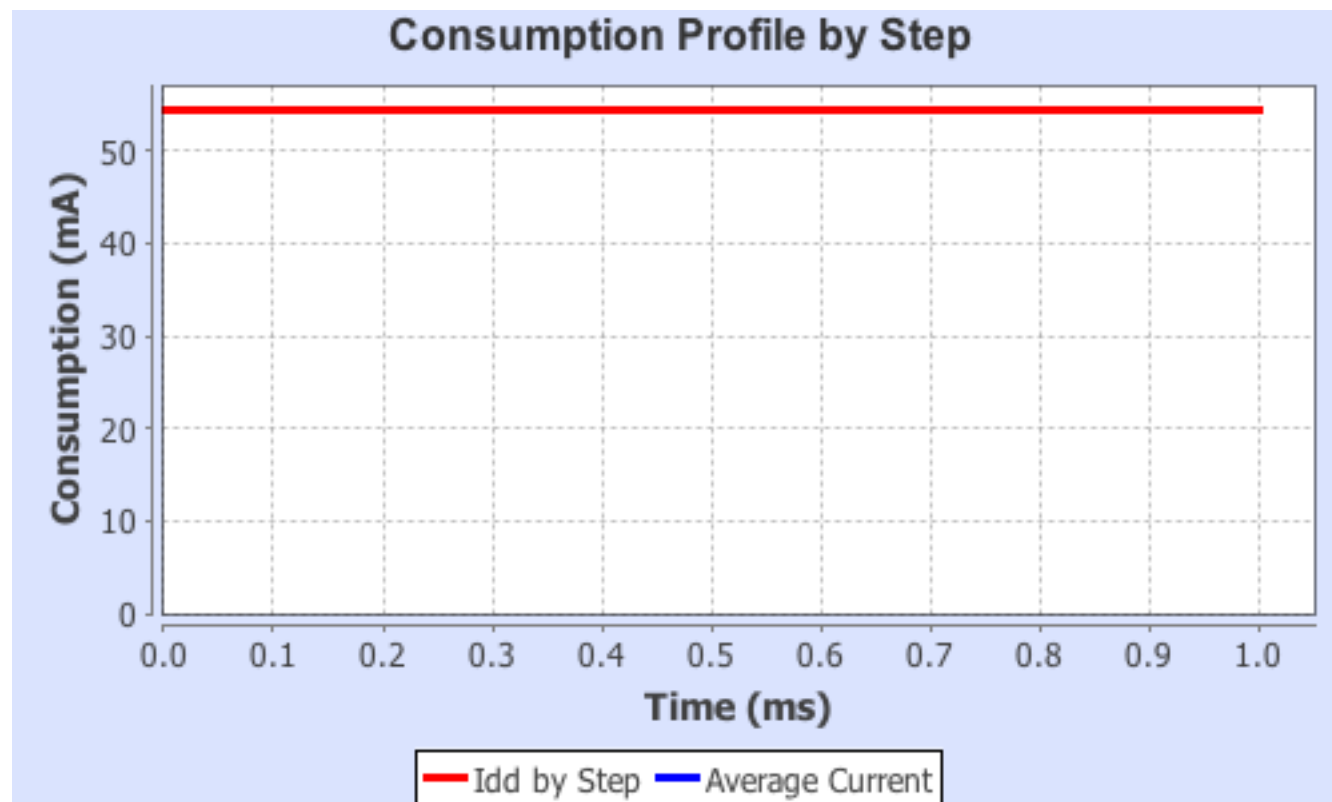
<b>Step</b>	Step1
<b>Mode</b>	RUN
<b>Vdd</b>	3.3
<b>Voltage Source</b>	Vbus
<b>Range</b>	Scale1-High
<b>Fetch Type</b>	RAM/FLASH/REGON/ART/PREFETCH
<b>Clock Configuration</b>	HSE PLL
<b>Clock Source Frequency</b>	4 MHz
<b>CPU Frequency</b>	180 MHz
<b>Peripherals</b>	DMA1 DMA2 GPIOA GPIOB GPIOC I2C2 I2C3 SYS TIM1 TIM2 TIM3 TIM4 TIM12 USART2
<b>Additional Cons.</b>	0 mA
<b>Average Current</b>	54.31 mA
<b>Duration</b>	1 ms
<b>DMIPS</b>	225.0
<b>Ta Max</b>	96.76
<b>Category</b>	In DS Table



#### 7.4. RESULTS

Sequence Time	1 ms	Average Current	54.31 mA
Battery Life	0	Average DMIPS	225.0 DMIPS

#### 7.5. Chart



## 8. Software Project

### 8.1. Project Settings

Name	Value
Project Name	firmware_new
Project Folder	/Users/justinng/Documents/Github/roborodentia2017/firmware_new
Toolchain / IDE	Makefile
Firmware Package Name and Version	STM32Cube FW_F4 V1.18.0

### 8.2. Code Generation Settings

Name	Value
STM32Cube Firmware Library Package	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	No
Delete previously generated files when not re-generated	Yes
Set all free pins as analog (to optimize the power consumption)	No

## ***9. Software Pack Report***