



1. Description

1.1. Project

Project Name	Ch2i_RAK3172_LoRaWAN_End_Node
Board Name	custom
Generated with:	STM32CubeMX 6.9.0
Date	08/06/2023

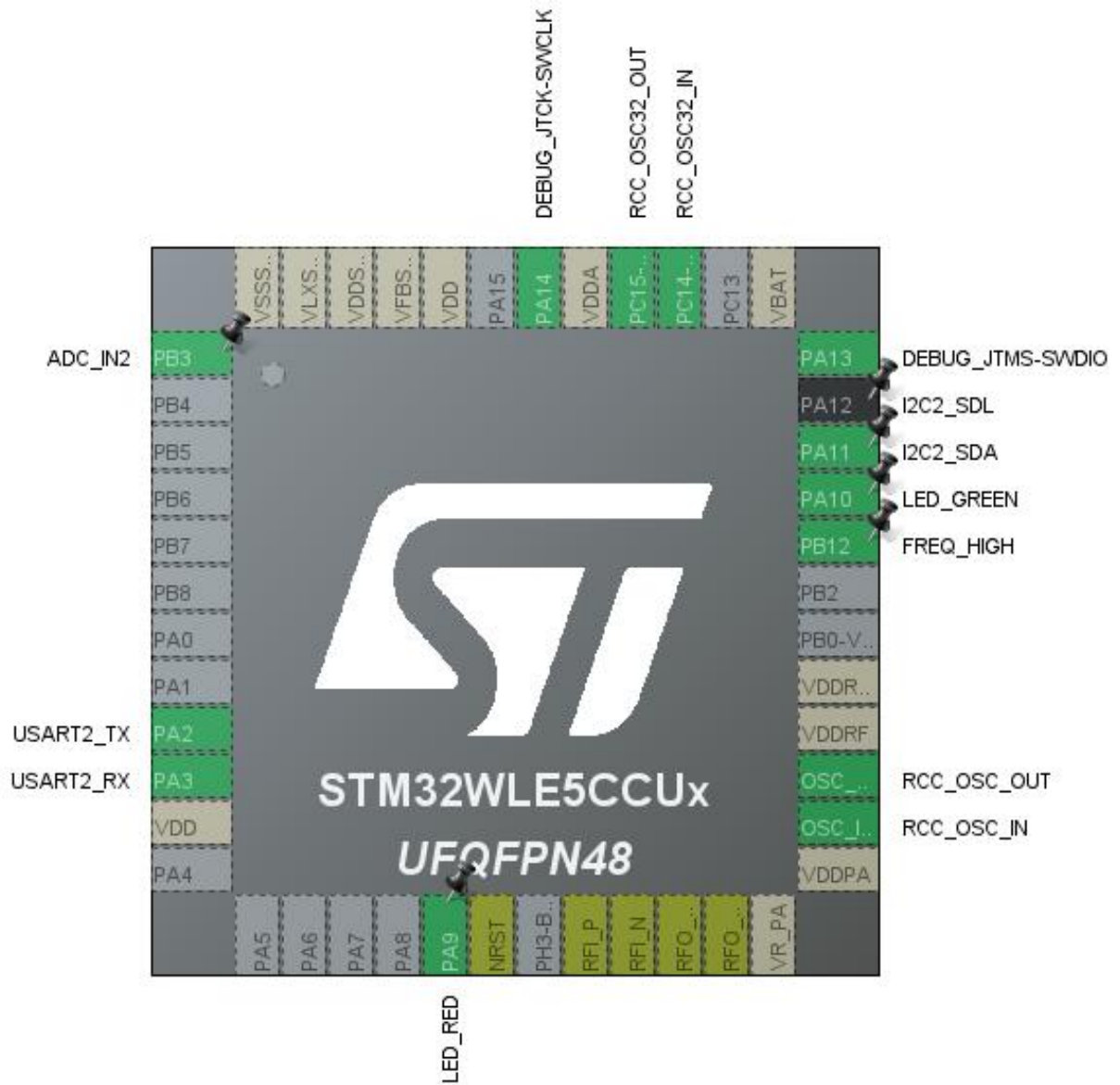
1.2. MCU

MCU Series	STM32WL
MCU Line	STM32WLEx
MCU name	STM32WLE5CCUx
MCU Package	UFQFPN48
MCU Pin number	48

1.3. Core(s) information

Core(s)	ARM Cortex-M4
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2. Pinout Configuration

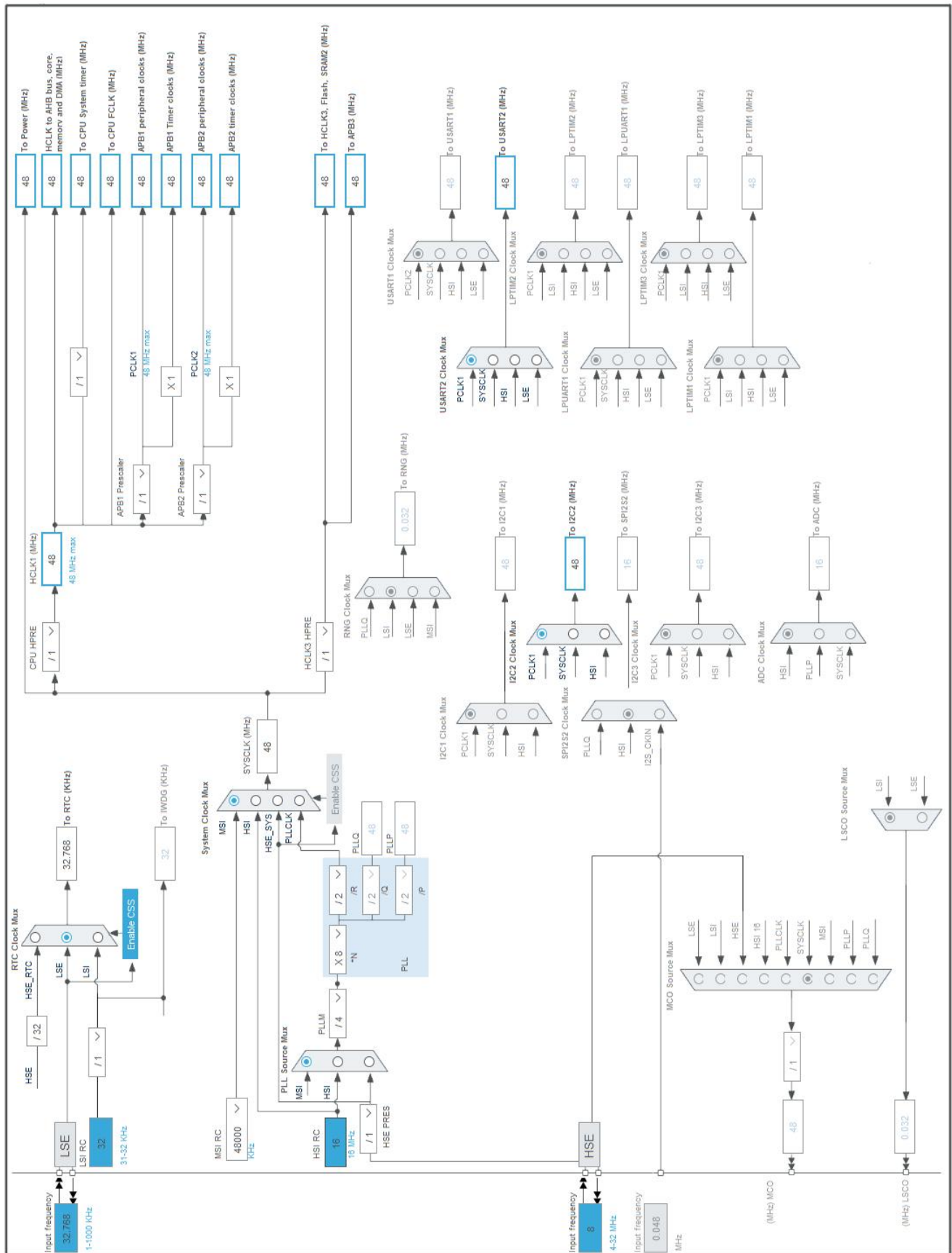


3. Pins Configuration

Pin Number UFQFPN48	Pin Name (function after reset)	Pin Type	Alternate Function(s)	Label
1	PB3	I/O	ADC_IN2	
9	PA2	I/O	USART2_TX	
10	PA3	I/O	USART2_RX	
11	VDD	Power		
17	PA9 *	I/O	GPIO_Output	LED_RED
18	NRST	Reset		
20	RFI_P	MonoIO		
21	RFI_N	MonoIO		
22	RFO_LP	MonoIO		
23	RFO_HP	MonoIO		
24	VR_PA	Power		
25	VDDPA	Power		
26	OSC_IN	MonoIO	RCC_OSC_IN	
27	OSC_OUT	MonoIO	RCC_OSC_OUT	
28	VDDRF	Power		
29	VDDRF1V55	Power		
32	PB12 *	I/O	GPIO_Input	FREQ_HIGH
33	PA10 *	I/O	GPIO_Output	LED_GREEN
34	PA11	I/O	I2C2_SDA	I2C2_SDA
35	PA12	I/O	I2C2_SCL	I2C2_SDL
36	PA13	I/O	DEBUG_JTMS-SWDIO	
37	VBAT	Power		
39	PC14-OSC32_IN	I/O	RCC_OSC32_IN	
40	PC15-OSC32_OUT	I/O	RCC_OSC32_OUT	
41	VDDA	Power		
42	PA14	I/O	DEBUG_JTCK-SWCLK	
44	VDD	Power		
45	VFBSMPS	Power		
46	VDDSMPS	Power		
47	VLXSMPS	Power		
48	VSSMPS	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	Ch2i_RAK3172_LoRaWAN_End_Node
Project Folder	D:\Projects\Ch2i_RAK3172_LoRaWAN_End_Node
Toolchain / IDE	STM32CubeIDE
Firmware Package Name and Version	STM32Cube FW_WL V1.3.0
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	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_DMA_Init	DMA
4	MX_RTC_Init	RTC
5	MX_SUBGHZ_Init	SUBGHZ
6	MX_USART2_UART_Init	USART2
7	MX_ADC_Init	ADC
8	MX_LoRaWAN_Init	LORAWAN
9	MX_I2C2_Init	I2C2

1. Power Consumption Calculator report

1.1. Microcontroller Selection

Series	STM32WL
Line	STM32WLEx
MCU	STM32WLE5CCUx
Datasheet	DS13105_Rev7

1.2. Parameter Selection

Temperature	25
Vdd	3.0

1.3. 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

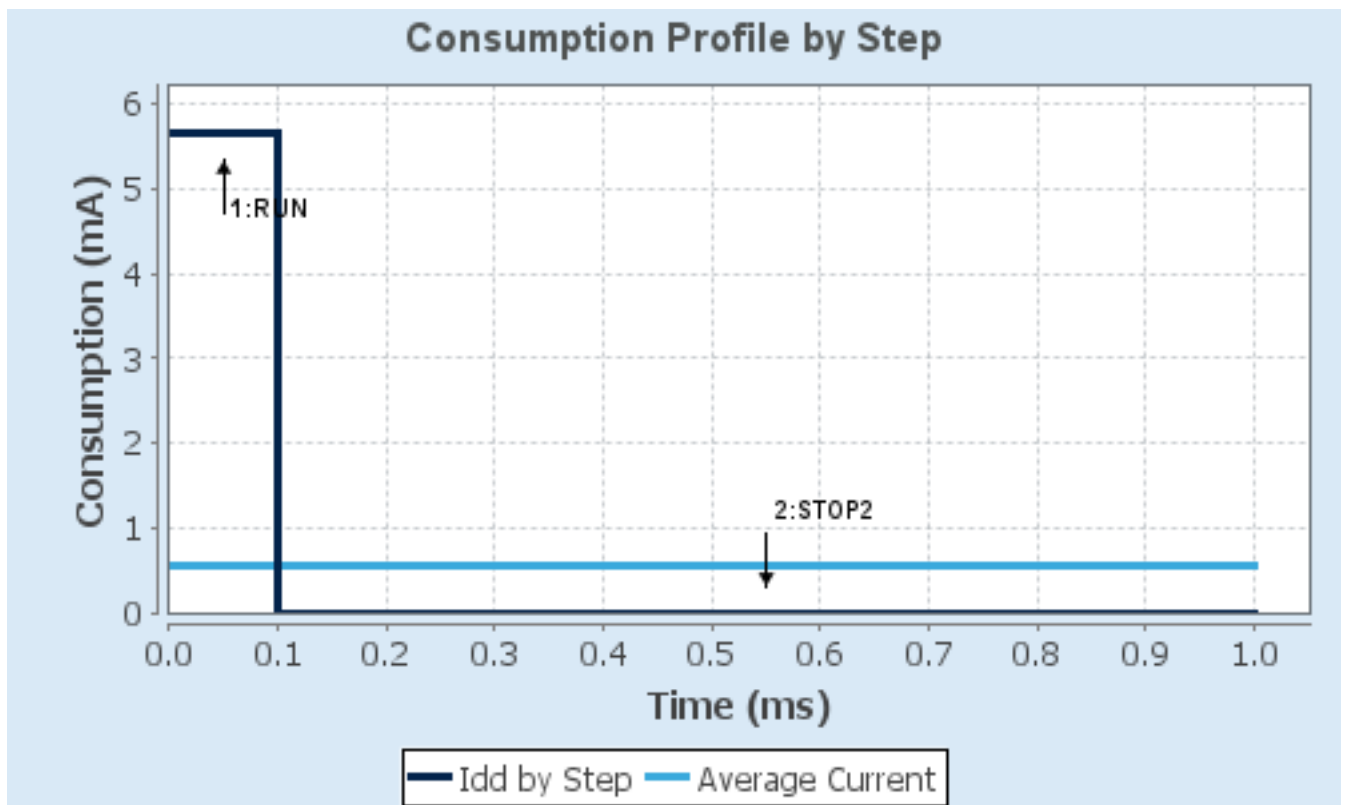
1.4. Sequence

Step	Step1	Step2
Mode	RUN	STOP2
Vdd	3.0	3.0
Voltage Source	Battery	Battery
Range	Range1-Medium/SMPS-OFF	NoRange
Fetch Type	SRAM1	NA
CPU Frequency	48 MHz	0 Hz
Clock Configuration	MSI	ALL CLOCKS OFF
Clock Source Frequency	48 MHz	0 Hz
Peripherals		
Additional Cons.	0 mA	0 mA
Average Current	5.65 mA	885 nA
Duration	0.1 ms	0.9 ms
DMIPS	60.0	0.0
Ta Max	124.53	125
Category	In DS Table	In DS Table

1.5. Results

Sequence Time	1 ms	Average Current	565.8 μ A
Battery Life	1 month, 21 days, 1 hour	Average DMIPS	60.0 DMIPS

1.6. Chart



2. Peripherals and Middlewares Configuration

2.1. ADC

mode: IN2

mode: Temperature Sensor Channel

mode: Vrefint Channel

2.1.1. Parameter Settings:

ADC_Settings:

Clock Prescaler

Synchronous clock mode divided by 4 *

Resolution

ADC 12-bit resolution

Calibration

Disable

Data Alignment

Right alignment

Scan Conversion Mode

Disabled

End Of Conversion Selection

End of single conversion

Low Power Auto Wait

Disabled

Auto Off

Enabled *

Continuous Conversion Mode

Disabled

Discontinuous Conversion Mode

Disabled

External Trigger Conversion Source

Regular Conversion launched by software

External Trigger Conversion Edge

None

DMA Continuous Requests

Disabled

Overrun behaviour

Overrun data overwritten *

Sequencer

Sequencer set to fully configurable

SamplingTime Common 1

160.5 Cycles *

SamplingTime Common 2

160.5 Cycles *

Oversampling Mode

Disabled

Trigger Frequency

Low frequency *

ADC_Regular_ConversionMode:

Enable Regular Conversions

Disable

2.2. ADV_TRACE

mode: Enabled

2.3. DEBUG

JTAG and Trace: Serial Wire

2.4. I2C2

I2C: I2C

2.4.1. Parameter Settings:

Timing configuration:

I2C Speed Mode	Fast Mode *
I2C Speed Frequency (KHz)	400
Rise Time (ns)	0
Fall Time (ns)	0
Coefficient of Digital Filter	0
Analog Filter	Enabled
Timing	0x2010091A *

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

2.5. MISC

mode: Enabled

2.6. RCC

High Speed Clock (HSE): Crystal/Ceramic Resonator

Low Speed Clock (LSE) : Crystal/Ceramic Resonator

2.6.1. Parameter Settings:

System Parameters:

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

RCC Parameters:

HSI Calibration Value	64
MSI Calibration Value	0
MSI Auto Calibration	Enabled
HSE Startup Timeout Value (ms)	100

LSE Startup Timeout Value (ms)	5000
LSE Drive Capability	LSE oscillator low drive capability
Power Parameters:	
Power Regulator Voltage Scale	Power Regulator Voltage Scale 1

2.7. RTC

mode: Activate Clock Source

mode: Activate Calendar

Alarm A: Internal Alarm A

2.7.1. Parameter Settings:

General:

Asynchronous Predivider value

Bin Mode

SSRU Underflow Interrupt

Alarm A:

Free running 32 bit value

Binary AutoControl

Free running 32 bit mask

RTC_PREDIV_A *

Free running Binary mode *

Enabled

0

RTC_ALARMSUBSECONDBIN_AUTOCLR_NO *

SS[31:0] are compared and must match to activate alarm.

2.8. SEQUENCER

mode: Enabled

2.9. SUBGHZ

mode: Activated

2.9.1. Parameter Settings:

Baudrate Prescaler Value

4 *

2.10. SYS

Timebase Source: None

2.11. TIMER

mode: Enabled

2.12. TINY_LPM

mode: Enabled

2.13. USART2

Mode: Asynchronous

2.13.1. 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
ClockPrescaler	1
Fifo Mode	Enable *
Txfifo Threshold	1 eighth full configuration
Rxfifo Threshold	1 eighth full configuration

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

2.14. LORAWAN

mode: Enabled

2.14.1. LoRaWAN application:

Application selection:

Application	End Node skeleton *
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Application configuration recommendations

!! Please read carefully Information panel below!!

board settings:

Send Tx on Timer or Button Evt

TX_ON_TIMER

Probes Lines in Platform Settings

false

lora_app:

Active region

LORAMAC_REGION_AS923

Transmit duty cycle

10000

Application user port

2

Switch class port

3

Default class

CLASS_A

Default handler message state

Confirmed message *

Handler Adaptive Data Rate

On

Default activation type

OTAA

Force rejoin at each reboot

true

Default Tx output power

TX_POWER_0

Default Unicast ping slots periodicity

4

Default response timeout for class b and class c confirmed downlink frames in milli seconds.

8000

sys_conf:

Trace verbose level

VLEVEL_H *

Enable Application Logging

true

Disable Low Power Mode

false

Enable Sensor

false

2.14.2. LoRaWAN commissioning:

Commissioning:

Public network

true

Current network ID

0

se-identity:

LoRaWAN device EUI

00,00,00,00,00,00,00,00

App/Join EUI

01,01,01,01,01,01,01,01

Application key

2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,0
9,CF,4F,3C

Network key

2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,0
9,CF,4F,3C

Device Address

00,00,00,00

Network session key

2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,0
9,CF,4F,3C

Application session key

2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,0
9,CF,4F,3C

lorawan_conf:

Enable Key read access true

2.14.3. LoRaWAN middleware:

lorawan_conf:

Region(s) selection please select the desired region(s) in the list below

Region Asia freq: 923 **true ***

Region Australia freq: 915 false

Region China freq: 470 false

Region China freq: 779 false

Region Europe freq: 433 false

Region Europe freq: 868 **false ***

Region Korea freq: 920 false

Region India freq: 865 false

Region USA freq: 915 **false ***

Region Russia freq: 864 false

Enable LoRaMAC ClassB **true ***

Enable the context management storage false

Select the LoRaWAN Link Layer specification version **v1.0.4 ***

Enable the additional LoRaWAN packages false

Select the Default channel plan for region AS923 **AS923-4 ***

radio_conf:

Radio maximum wakeup time (in ms) 1

radio_board_if:

Select radio Driver **Bsp via extSettings ***

mw_log_conf:

Enable Middleware log true

2.14.4. Platform Settings:

RTC	RTC
ADC	ADC
USART	USART2

* User modified value

3. System Configuration

3.1. GPIO configuration

IP	Pin	Signal	GPIO mode	GPIO pull/up pull down	Max Speed	User Label
ADC	PB3	ADC_IN2	Analog mode	No pull-up and no pull-down	n/a	
DEBUG	PA13	DEBUG_JTMS-SWDIO	n/a	n/a	n/a	
	PA14	DEBUG_JTCK-SWCLK	n/a	n/a	n/a	
I2C2	PA11	I2C2_SDA	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	I2C2_SDA
	PA12	I2C2_SCL	Alternate Function Open Drain	No pull-up and no pull-down	Very High *	I2C2_SDL
RCC	OSC_IN	RCC_OSC_IN	n/a	n/a	n/a	
	OSC_OUT	RCC_OSC_OUT	n/a	n/a	n/a	
	PC14-OSC32_IN	RCC_OSC32_IN	n/a	n/a	n/a	
	PC15-OSC32_OUT	RCC_OSC32_OUT	n/a	n/a	n/a	
USART2	PA2	USART2_TX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	
	PA3	USART2_RX	Alternate Function Push Pull	No pull-up and no pull-down	Very High *	
GPIO	PA9	GPIO_Output	Output Push Pull	No pull-up and no pull-down	High *	LED_RED
	PB12	GPIO_Input	Input mode	No pull-up and no pull-down	n/a	FREQ_HIGH
	PA10	GPIO_Output	Output Push Pull	No pull-up and no pull-down	High *	LED_GREEN

3.2. DMA configuration

DMA request	Stream	Direction	Priority
USART2_TX	DMA1_Channel1	Memory To Peripheral	Low

USART2_TX: DMA1_Channel1 DMA request Settings:

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

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
Prefetch 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
RTC Tamper, RTC TimeStamp, LSECSS and RTC SSRU Interrupts	true	0	0
DMA1 Channel 1 Interrupt	true	2	0
USART2 Interrupt	true	2	0
RTC Alarms (A and B) Interrupt	true	0	0
SUBGHZ Radio Interrupt	true	0	0
PVD and PVM detector	unused		
FLASH (CFI) global Interrupt	unused		
RCC Interrupt	unused		
ADC Interrupt	unused		
I2C2 Event Interrupt	unused		
I2C2 Error 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
Prefetch 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	false
RTC Tamper, RTC TimeStamp, LSECSS and RTC SSRU Interrupts	false	true	true
DMA1 Channel 1 Interrupt	false	true	true

Enabled interrupt Table	Select for init sequence ordering	Generate IRQ handler	Call HAL handler
USART2 Interrupt	false	true	true
RTC Alarms (A and B) Interrupt	false	true	true
SUBGHZ Radio Interrupt	false	true	true

* User modified value

4. System Views

4.1. Category view

4.1.1. Current

Middleware									
LORAWAN									
System Core	Analog	Timers	Connectivity	Multimedia	Security	Computing	Trace and Debug	Power and Thermal	Utilities
DMA	ADC	RTC	I2C2				DEBUG		ADV_TRACE
GPIO			SUBGHZ						MISC
IIVIC			USART2						SEQUENCER
RCC									TIMER
SYS									TINY_LPM

5. Docs & Resources

Type	Link
BSDL files	https://www.st.com/resource/en/bsdl_model/stm32wl_bsdl.zip
HW Models	https://www.st.com/resource/en/hw_model/stm32wl_reference_board_mb1720-xo_ios_shield.7z
IBIS models	https://www.st.com/resource/en/ibis_model/stm32wl_ibis.zip
System View Description	https://www.st.com/resource/en/svd/stm32wl_svd.zip
Bill of Materials	https://www.st.com/resource/en/bill_of_materials/mb1720_bom.zip
Bill of Materials	https://www.st.com/resource/en/bill_of_materials/mb1789_hp_bom.zip
Bill of Materials	https://www.st.com/resource/en/bill_of_materials/mb1789_lp_bom.zip
Bill of Materials	https://www.st.com/resource/en/bill_of_materials/mb1791_bom.zip
Bill of Materials	https://www.st.com/resource/en/bill_of_materials/mb1792_bom.zip
Bill of Materials	https://www.st.com/resource/en/bill_of_materials/mb1842_bom.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1720_bdp.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1720_manufacturing.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1789_hp_bdp.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1789_hp_manufacturing.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1789_lp_bdp.zip
Board Manufacturing	https://www.st.com/resource/en/board_manufacturing_specification/mb1789_lp_manufacturing.zip

Specifications

Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1791_bdp.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1791_manufacturing.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1792_bdp.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1792_manufacturing.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1842_bdp.zip
Board Manufacturing Specifications	https://www.st.com/resource/en/board_manufacturing_specification/mb1842_manufacturing.zip
Schematic Pack	https://www.st.com/resource/en/schematic_pack/mb1720_schematics.zip
Schematic Pack	https://www.st.com/resource/en/schematic_pack/mb1789_hp_schematic.zip
Schematic Pack	https://www.st.com/resource/en/schematic_pack/mb1789_lp_schematic.zip
Schematic Pack	https://www.st.com/resource/en/schematic_pack/mb1791_schematic.zip
Schematic Pack	https://www.st.com/resource/en/schematic_pack/mb1792_schematic.zip
Schematic Pack	https://www.st.com/resource/en/schematic_pack/mb1842_schematic.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
Presentations	https://www.st.com/resource/en/product_presentation/microcontrollers_stm32wl_series_product_overview.pdf
Presentations	https://www.st.com/resource/en/product_presentation/stm32cubemonitor-wireless-longrange_rfttest.pdf
Presentations	https://www.st.com/resource/en/product_presentation/stm32wba-series-product-overview.pdf
Flyers	https://www.st.com/resource/en/flyer/flnucleolrwan.pdf
Flyers	https://www.st.com/resource/en/flyer/flstm32nucleo.pdf
Flyers	https://www.st.com/resource/en/flyer/flstm32wl.pdf
Flyers	https://www.st.com/resource/en/flyer/flstm32wba.pdf
Flyers	https://www.st.com/resource/en/flyer/flstm32wbxm.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/an3126-audio-and-waveform-generation-using-the-dac-in-stm32-products-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/an4013-stm32-crossseries-timer-overview-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/an4655-virtually-increasing-the-number-of-serial-communication-peripherals-in-stm32-applications-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/an4894-EEPROM-emulation-techniques-and-software-for-stm32-microcontrollers-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5027-interfacing-PDM-digital-microphones-using-stm32-mcus-and-mpus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5036-thermal-management-guidelines-for-stm32-applications-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5225-USB-type-C-power-delivery-using-stm32-mcus-and-mpus-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5406-how-to-build-a-LoRa-application-with-stm32CubeWL-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5407-optimized-RF-

board-layout-for-stm32wl-series-stmicroelectronics.pdf

- Application Notes https://www.st.com/resource/en/application_note/an5408-migrating-from-stm32l0-stm32l1-and-stm32l4-series-associated-with-sx12xx-transceivers-to-stm32wl-series-microcontrollers-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5409-stm32cube-mcu-package-examples-for-stm32wl-series-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5457-rf-matching-network-design-guide-for-stm32wl-series-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5480-how-to-build-a-sigfox-application-with-stm32cubewl-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5543-enhanced-methods-to-handle-spi-communication-on-stm32-devices-stmicroelectronics.pdf
- Application Notes https://www.st.com/resource/en/application_note/an5568-ultralowpower-features-of-stm32wl-series-microcontrollers-stmicroelectronics.pdf
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