
Product : MM002-xx-EU

Doc : Datasheet

Reference : datasheet_MM002-xx-EU

History : V1.1

The logo features the word "NEMEUS" in a bold, green, sans-serif font. Below it, the tagline "Long Range wireless solution" is written in a smaller, white, sans-serif font. The background of the logo is a dark grey circle containing white circuit traces that resemble a printed circuit board (PCB) layout.

NEMEUS
Long Range wireless solution

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Document history

Version	Date	Author	Comments
V0.1	22/09/2015	Gilles Ronco	Initial / Draft
V0.2	25/10/2015	Gilles Ronco	Add consumption for SIGFOX mode Correct /NRST & BOOT0 pads comments
V1.0	29/09/2016	Gilles RONCO	Reflow profile
V1.1	07/12/2016	Gilles RONCO	Change of power supply max value

Table 1 : Document versions

References

[1] Semtech – Datasheet SX1272

Purpose

This document is dedicated to Nemeus MM002-xx-EU radio module description.

Module features

The **MM002-xx-EU** is a family of long-range and low power wireless modules operating in 868MHz unlicensed band. With interferers' robustness and low power consumption, it is the best solution for applications requiring long range, maximum battery lifetime and secure radio link. This module integrates a SX1272 LoRa™ transceiver from Semtech and a low power ARM Cortex M3 controller.



Key product features

- ✓ Size 14,4mm x 26,4mm x 2,5mm
- ✓ Modulations : LoRa™ / SIGFOX™/ FSK
- ✓ Maximum output power +14 dBm (+20dBm as option)
- ✓ Good buildings penetration
- ✓ Long Range protocol stack software (SIGFOX™ / LoRa WAN 1.0 EU Class A & C)
- ✓ Soldered like a SMD component
- ✓ Usable as Modem companion or with embedded customer application software (option)
- ✓ RoHS conform / Pre-Certified EN 300-220
- ✓ Shield ready (option)

Applications

- ✓ Automated Meter Reading
- ✓ Home and Building Automation
- ✓ Industrial Monitoring and Control
- ✓ IoT (Internet of Things)
- ✓ Smart Cities

Module software content

The module software is based on Contiki OS.

Versions

3 versions are available with same external form factor and pinning.

<u>MM002-L-EU</u>	A LoRa™ WAN 1.0 EU Class A & C bidirectional protocol stack version
<u>MM002-S-EU</u>	A SIGFOX™ bidirectional protocol stack version
<u>MM002-LS-EU</u>	A Full bimode bidirectional LoRa™/SIGFOX™ protocol stack version

All LoRa™ versions give possibility to skip LoRa WAN protocol stack and access directly LoRa™ and FSK physical layers.

Extra-protocol or application software can be developed on request.

Interoperability

MM002-xx-EU module interoperability has been confirmed with :

- **SIGFOX™ bidirectional** Network
- **Bouygues Telecom LoRa** Network
- **Orange LoRa** Network
- **Actility** Network server solutions
- **Orbiwise** Network server solutions



General description

The Nemeus-MM002 is a long range, high-performance, pre-certified (EN 300-220) module for wireless bi-directional communication using patented LoRa™ technology from Semtech company. It operates in the license free ISM 868 MHz frequency band and includes all necessary components for an easy integration in existing systems. With high interference robustness, a max sensitivity of -137dBm, a low consumption (less than 2uA in idle mode with RTC), and this module is the best solution for low throughput application requiring a long battery lifetime and a secured radio link. Integration of this module eases fast-time to market.

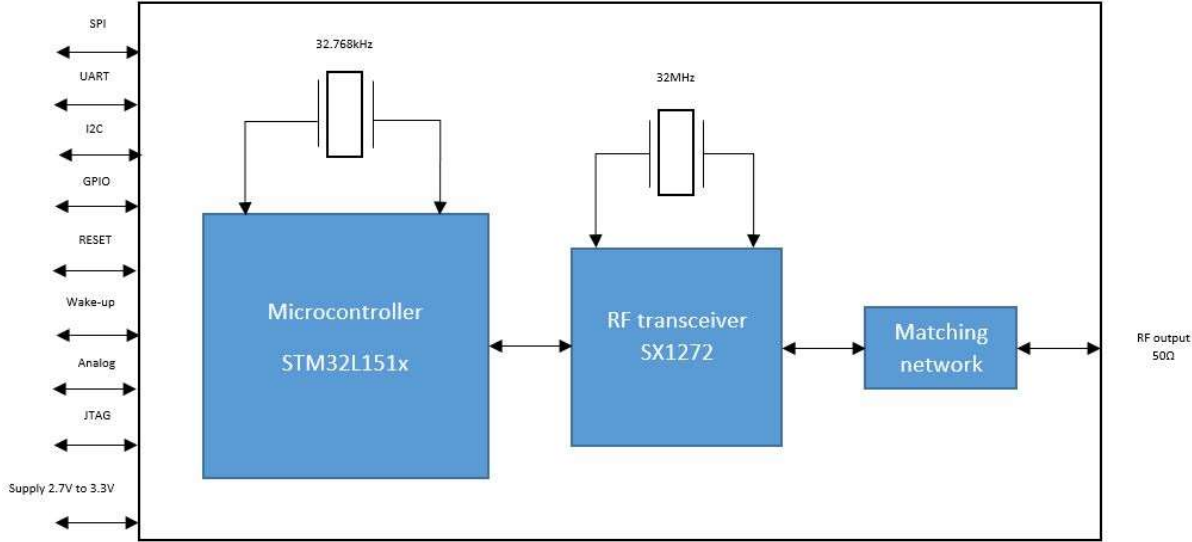
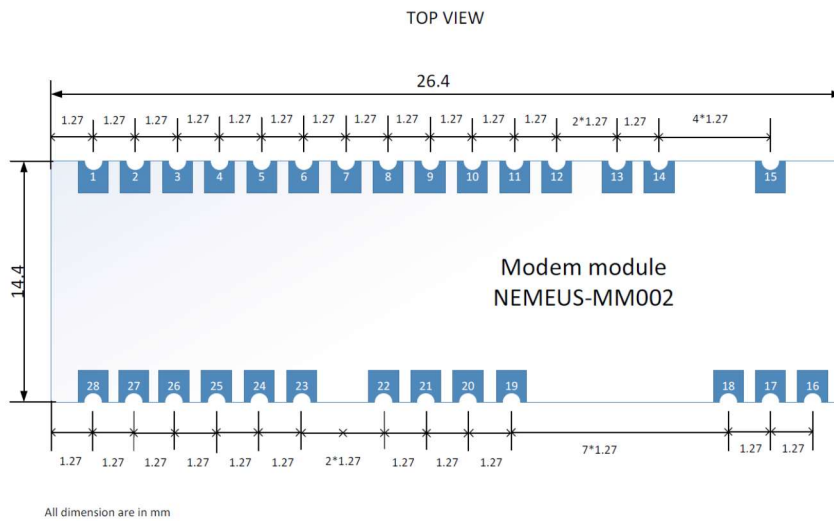


Figure 1. Simplified block diagram

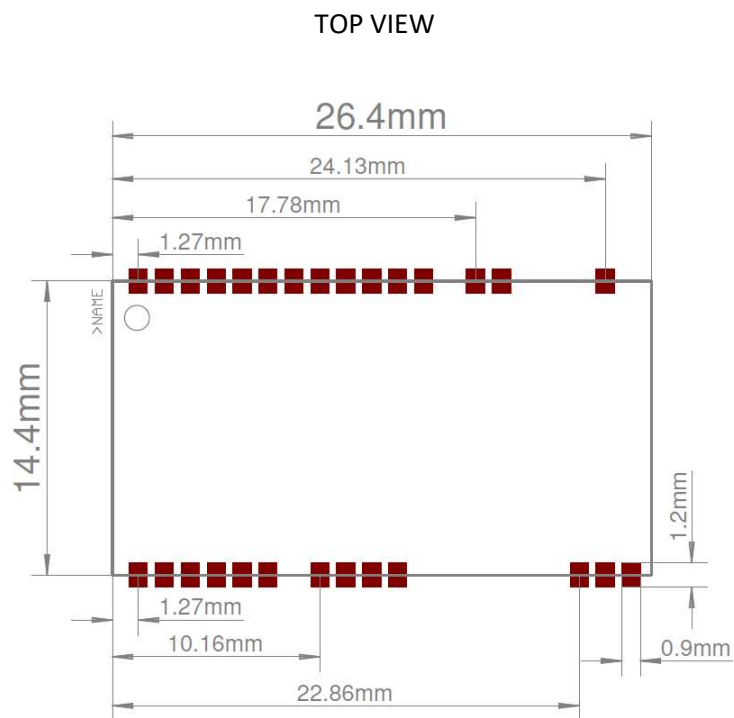
Module pins diagram

The following figure gives the top view of the MM002-xx-EU module.



Pad size on MM002: 0.8x1mm

Footprint recommendations:



Footprint for all pads: 0.9x1.2mm

Design recommendations

With 4 layers PCB design, it is recommended to keep the 1st layer under the module without any layout and have a full ground plane on the 2nd layer (at least under the right part of the module : under RF transceiver part).

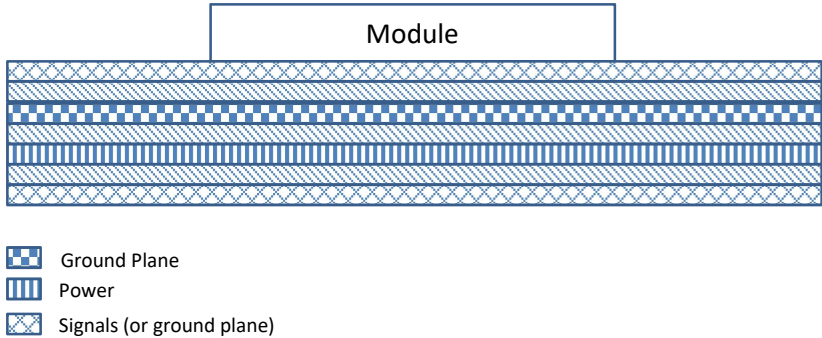


Figure 2 : 4 layer PCB design

All ground pads must be connected to ground.

In case of ground planes on different layers, these one must be connected together through via.

Antenna path

The following figure gives an overview of a design with SMA connector for Antenna.

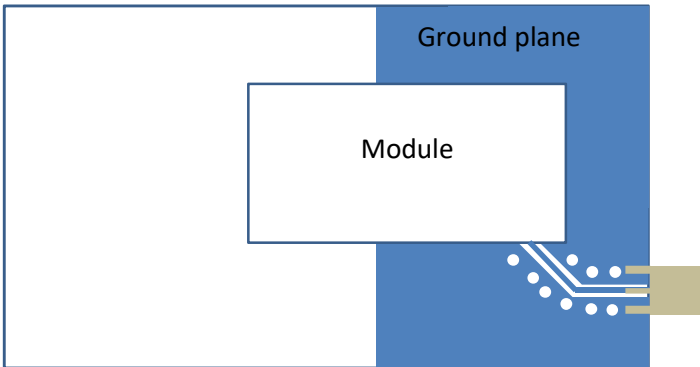


Figure 3 : Antenna path design

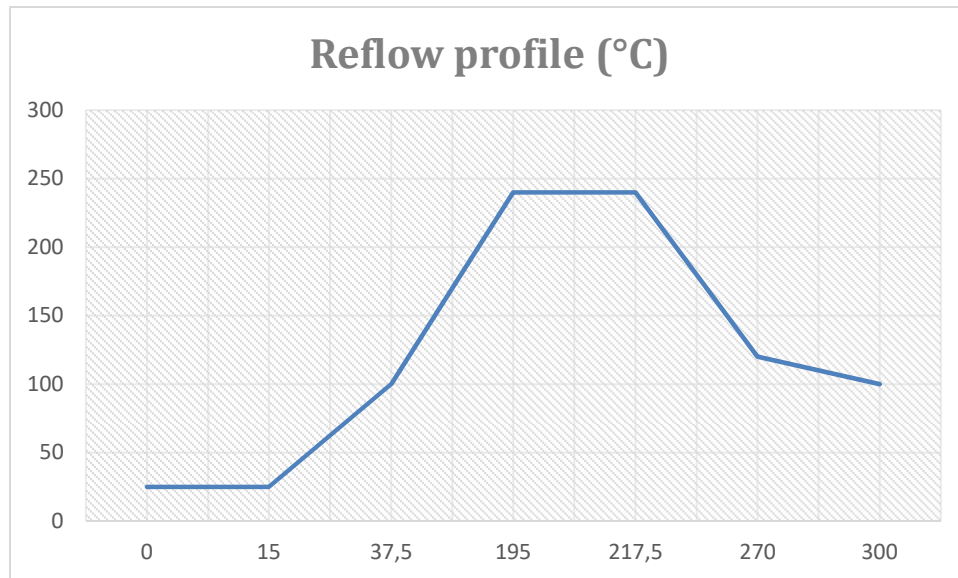
The antenna path must be designed with a 50 ohms line inserted into ground plane for better performance. 1st and 2nd layer ground planes must be connected with via.

Antenna must be kept away from any metal part like batteries, etc ... for better performances.

Reflow temperature profile

The following figure & table give the reflow temperature profile of the MM002 module.

T(s)	0	15	37,5	195	217,5	270	300
Temp(°C)	25	25	100	240	240	120	100



Embedded software

By default, the module is provided with AT command software version allowing to control it from an external micro-controller through an UART interface. This AT command software version give possibility to switch from one protocol stack to another at any time between LoRa™ WAN protocol stack, SIGFOX™ protocol stack, LoRa™ and FSK physical layer stack (based on module option)

AT command specification can be requested to Nemeus company.

Specific software, like embedded application software, can be developed on request by Nemeus team to exploit full pins configuration possibilities and embed application software inside Module to save BOM and consumption.

Module pinning description

Module pins functions can be configured by specific software. Description of possible configurations is provided at the end of this specification for reference.

Whatever the pins configuration made by embedded software, some of them have unique functionality.

Functions class	PAD name	Function	Comment
JTAG¹	8	NJTRST / (GPIO)	JTAG Reset
	9	JTDO / (GPIO)	JTAG Data Output
	10	JTDI / (GPIO)	JTAG Data Input
	11	JTCK-SWCLK / (GPIO)	JTAG Clock
	12	JTMS-SWDAT / (GPIO)	JTAG Mode Select
PWR-UP	2	/NRST	Module is automatically reset at power-up / keep unconnected if reset is not needed when module is powered On
	5	NC	Keep unconnected
Ground	1	GND	Ground
	15	GND	Ground
	16	GND	Ground
	18	GND	Ground
	28	GND	Ground
Power supply	27	VCC	Power supply of the board (3.3v)
Antenna	17	ANT	RF antenna port matched to 50Ω No DC capacitor required

Table 2 : Modem pins with unique functionality

¹ Can be used also as GPIO

Default pinning configuration (modem controlled by AT command)

With AT command modem software, only few pins are configured and used. Other ones have no specific functions and are not driven by embedded software. These extra pins must be kept Unconnected.

Default modem software manages UART2 to communicate with application processor or similar. In this configuration following pins are configured.

Functions class	PAD name	Function	Comment
UART	23	USART2_RX	
	24	USART2_TX	
	25	Wake-up	Used in power saving mode to wake-up the module for UART communication

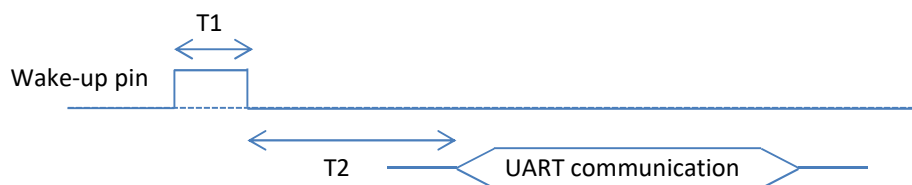
UART

The UART configuration for Modem connection is following:

- Baud Rate : 38400
- Data : 8 bits
- Parity : None
- Stop : 1 bit
- Flow control : None
- End line character : LF

Power saving mode

With embedded software using power saving mode, the Wake-up pin must be used to wake-up the module before any communication through UART. Find below the chronogram for this wake-up pin use.



T1 : 1ms minimum
T2 : 10ms minimum

Electrical characteristics

Absolute maximum rating

Symbol	Description	Min	Max	Unit
VCC	Module power supply	2.7	3.3	V
Temperature		-40	+70	°C
PwIN	RF input power	-	+10	dBm

Operating range

Symbol	Description	Min	Typ.	Max	Unit
VCC	Module power supply	2.7	3.0	3.3	V
Temperature		-20	20	+55	°C
PwIN	RF input power	-	-	+10	dBm

Recommended voltage operation

please use a low noise voltage regulator for VCC, in order to have a voltage ripple less than 10mV and a voltage drop less than 80mV when the TX mode is activated, at +14dBm.

Current consumption

Three states must be considered for current consumption:

- Modem module in IDLE mode with RTC like function
- Modem module in TX mode
- Modem module in RX mode

Conditions: VCC =3.3V, T=25°C

Symbol	Description	Conditions	Min	Typ (LoRa)	Typ (SIGFOX)	Max	Unit
ICC_IDLE			-	< 2uA		-	uA
ICC_TX_7dB	Modem in TX mode	Tx power = +7dBm	-	20 (TBC)	N/A	-	mA
ICC_TX_13dB	Modem in TX mode	Tx power = +13dBm	-	33	N/A	-	mA
ICC_TX_14dB	Modem in TX mode	Tx power = +14dBm	-	39,5	50	-	mA
ICC_RX	Modem in RX mode	-	-	11.7	14	-	mA

Available Pin configuration

Based on STM32L15x uC family, major part of module pins can be configured by embedded software and allow to have up to:

- 2 x UART
- 1 x SPI
- 1 x I2C
- 4 x ADC
- 19 x GPIO
- 1 Wake-up Interrupt

The configuration matrix is given in following table.

Use of such type of interface is done based on development made by Nemeus.

Functions class	1/2 lunc PAD name	Functions	Default function (modem only mode)	Name pins MCU	Reset/ Boot Mode	JTAG/SW	USART1	USART2	SPI1	I2C1	ADC	WKUP	GPIO	
Modem_JTAG	12	JTMS-SWDAT	JTMS-SWDAT	PA13		JTAG/SW							GPIO#1	
	11	JTCK-SWCLK	JTCK-SWCLK	PA14										GPIO#2
	10	JTDI	JTDI	PA15										GPIO#3
	9	JTDO	JTDO	PB3										GPIO#4
	8	NJTRST	NJTRST	PB4										GPIO#5
Modem PWRUP	2	NRST	NRST	NRST	NRESET									
	5	NC	NC	BOOT0	BOOT0									
Sensors pins	25	WKUP1/RTC_TAMP2/ TIM2_CH1_ETR/TIM5_CH1/ USART2_CTS/ADC_IN0/ COMP1_INP		PA0				USART#2			ADC#1	WKUP#1	GPIO#6	
	26	USART2_RTS/ADC_IN1/ TIM2_CH2/LCD_SEG0/ COMP1_INP		PA1							ADC#2		GPIO#7	
	24	TIM2_CH3/TIM5_CH3/ TIM9_CH1/USART2_TX/ LCD_SEG1/ADC_IN2/ COMP1_INP/OPAMP1_VINM		PA2				USART#2			ADC#3		GPIO#8	

Sensors pins	23	TIM2_CH4/TIM5_CH4/ TIM9_CH2/USART2_RX/ LCD_SEG2/ADC_IN3/ COMP1_INP/OPAMP1_VOUT		PA3					USART#2			ADC#4		GPIO#9
	7		USART1_TX	PB6				USART#1						GPIO#10
	6		USART1_RX	PB7				USART#1						GPIO#11
	4	TIM4_CH3/TIM10_CH1/ I2C1_SCL/LCD_SEG16	I2C1_SCL	PB8								I2C#1		GPIO#12
	3	TIM4_CH4/TIM11_CH1/ I2C1_SDA/LCD_COM3	I2C1_SDA	PB9										GPIO#13
	22		SPI1_NSS	PA4										GPIO#14
	20		SPI1_SCK	PA5										GPIO#15
	21		SPI1_MISO	PA6										GPIO#16
	19		SPI1_MOSI	PA7										GPIO#17
	14	USART1_CTS/USB_DM/ SPI1_MISO	USB	PA11										GPIO#18
	13	USART1_RTS/USB_DP/ SPI1_MOSI	USB	PA12										GPIO#19

Ground	1	GND	Ground											
	15	GND	Ground											
	16	GND	Ground											
	18	GND	Ground											
	28	GND	Ground											
Supply	27	VCC	Analog and digital supply											
RF	17	ANT	RF antenna input/output											