RTX-868-NB-UART-V2 is a SMD multichannel narrow band 5 channel transceiver operating at 868.00 - 868.60 MHz band and RF power up to 25mW or one channel at 869,525MHz operating until 100mW allowing long distances with low power consumption.
The module can be easily interfaced to the application microprocessor via UART bus and few GPIOs, the device can manage variable payload lenght from 1 to 63 bytes.
Due to sleep low power consumption and fast wakeup the device is suitable for key fobs, motor drive control boards, battery powered sensors requiring very low power consumption, low cost application and high radio performance.
Available 5 channel 25KHz wide in GFSK modulation selectable by external pin and data rate of 5000bps.
3,3V operating voltage, receiver mode current consumption is 17mA and 72mA in transmission mode (+15dBm ERP).
Module is available in tape & reel package for SMD assembling. Size is 20 x 20 x 2,5 mm.

Main Features

- **100mW max RF output power**
- **Sensitivity -115dBm**
- **Blocking category 1,5**
- **Channels: 5 max**
- **No encoding or preamble requested**
- **UART data rate: 9600 bps**
- **Reduced dimensions (20 x 20 x 2.5 mm)**

Specification

Absolute maximum ratings

	Min.	Typ.	Max.	Unit
Supply Voltage	1.8	3	3.6	V
Input Voltage	-0,5		Vcc+0,6	V
Output Voltage	-0,5		Vcc+0,6	V
Operating temperature	-20		+70	°C
Storage temperature	-40		+100	°C

Table 1: Absolute maximum ratings

DC Characteristics

	Min.	Typ.	Max.	Unit
DC levels				
Supply Voltage pin 9	1.8	3	3.6	V
Current consumption (Rx continuous) [1]		17		mA
Current consumption (Tx continuous) [1]	60	80	100	mA
High level voltage in input	Vccx0.8		Vcc	V
Low level voltage in input	0		0.8	V
Pin output current	8			mA

Table 2: DC Characteristics

RF Characteristics

	Min.	Typ.	Max.	Unit
Transmission				
Frequency [1]	868.2		868.4	MHz
Frequency high power version [1]		869.525		MHz
RF channels for version 868MHz [2]		5		
RF power [1]		15	16	dBm
RF power high power version		18	20	dBm
ERP with Aurel antenna “ANT 868 SMA”		15		dBm
Modulation		GFSK		
Deviation GFSK modulation		±6		kHz
Channel bandwidth -3dB		12		kHz
Data-rate		5000		bps
Temperature Frequency error 20°C from Freq. channel	-9		+9	KHz
Temperature Frequency stability -20+70°C	-9		+9	kHz
RF spurious emissions < 1GHz			-36	dBm
RF spurious emissions > 1GHz			-30	dBm
RF spurious, adjacent channel			-40	dBc
Pin 1 ESD contact discharge protection (61000-4-2)		8		kV

Pin 1 ESD air discharge protection (61000-4-2)		15		KV
Other pin than pin1 ESD contact discharge protection		2		KV
Reception	**Min.**	**Typ.**	**Max.**	**Unit**
RX sensitivity	-113	-114	-116	dBm
RX Bandwidth		50		kHz
Data-Rate		5000		bps
Adjacent 1 channel rejection (f0±100kHz)		-34	-37	dB
Blocking category [3]		1,5		
Blocking test at ±2MHz [3]		-12		dBm
Blocking test at ±10MHz [3]		3		dBm
Blocking test at ±5% [3]		5		dBm
RSSI dynamics			80	dB
Timing				
SLEEP → RX-ON Condition: VCC = 3V (pin 9) SLEEP (pin14) High → Low		22		ms
RX → TX (from last front on UART RX and Low → High transition on busy pin)[5]		2	3	ms
TX → RX (busy pin High → Low and start RX)			1	ms
off → RX-ON Condition: VCC = 0 → 3V (pin 9) SLEEP = 0 (pin14)		48		ms

Table 3: RF Characteristics

Note 1: Test carried out with 50 ohm load on pin 1 (antenna) and power setup to 20dBm .
Note 2: See Table 7 for frequency channel values.
Note 3: Test performed in accordance with 5.18 of ETSI EN 300 220-1 V3.1.1 (2017-02)
Note4: Oscillator calibration procedure, performed with jump temperature > ±20°C
Note5: See the time diagram table 1

Pinout

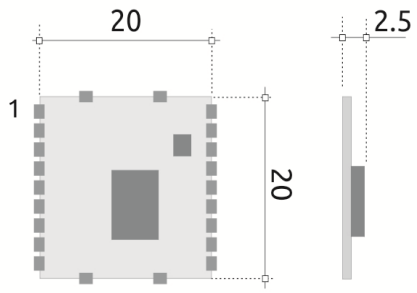


Figure 1: Pin-out and mechanical drawing

1) ANTENNA	12) GND
2) GND	13) NC
3) BUSY	14) SLEEP
4) UART RX	15) RESET
5) UART TX	16) RSSI
6) CH0	17) NC
7) CH1	18) NC
8) CH2	19) NC
9) VCC	20) GND
10) GND	21) GND
11) GND	22) GND

DXF drawing and Altium compatible PCB footprint are available.

Pin number	Name	Description
1	ANTENNA	Antenna connection, 50 ohm impedance
2	GND	Ground connection
3	BUSY	Uart activity output. When this pin is to high level it isn't possible to send UART data to it (E.g. raised during RF packet transmission or in the calibration procedure)
4	UART RX	Module input for UART data. High impedance input, not internal pull-up or pull-down.
5	UART TX	Module output pin for UART data.
6	CH0	RF channel selection, input active low, internal pull-up.
7	CH1	RF channel selection, input active low, internal pull-up.
8	CH2	RF channel selection, input active low, internal pull-up.
9	VCC	Connection to supply voltage 2,1V-3,6V / 100mA
10	GND	Ground connection
11	GND	Ground connection
12	GND	Ground connection
13	NC	Not used, keep unconnected
14	SLEEP	Sleep input, active High. Input 50K pull-up. [(1)] Drive it to Low level in order to put module in RX mode. Keep low for normal operation
15	RESET	Input reset, active low. Connect to low level to reset the microcontroller, keep open in normal condition.
16	RSSI	Input, active low in order to activate RSSI function. Internal pull-up.
17	NC	Not used, keep unconnected
18	NC	Not used, keep unconnected
19	NC	Not used, keep unconnected
20	GND	Ground connection
21	GND	Ground connection
22	GND	Ground connection

[(1)] User has to connect the pin to open or High level for sleep mode. When the pin sleep (pin14) is connect to Low level it goes in reception mode.

Table 4: Pin function description

UART Operation

The RTX-868-NB-UART-V2 is a radio modem working in packet mode, maximum length is 63 byte.
Data is been exchange between RTX-868-NB-UART-V2 and the host microprocessor using a UART with 9600 bps 8,N,1 configuration.

Transmission

To transmit a packet the host processor has to send UART data on module pin 4. When the last byte is transferred and after about 2-3mS the pin Busy go to high level, the RTX-868-NB-UART-V2 start the RF encapsulation of the data adding preamble, synch word, CRC and start the RF transmission.
In the RF transmission the module can't accept more data on UART, the pin BUSY goes to high level in order to indicates to the user to stop the operation in the RX-UART pin.

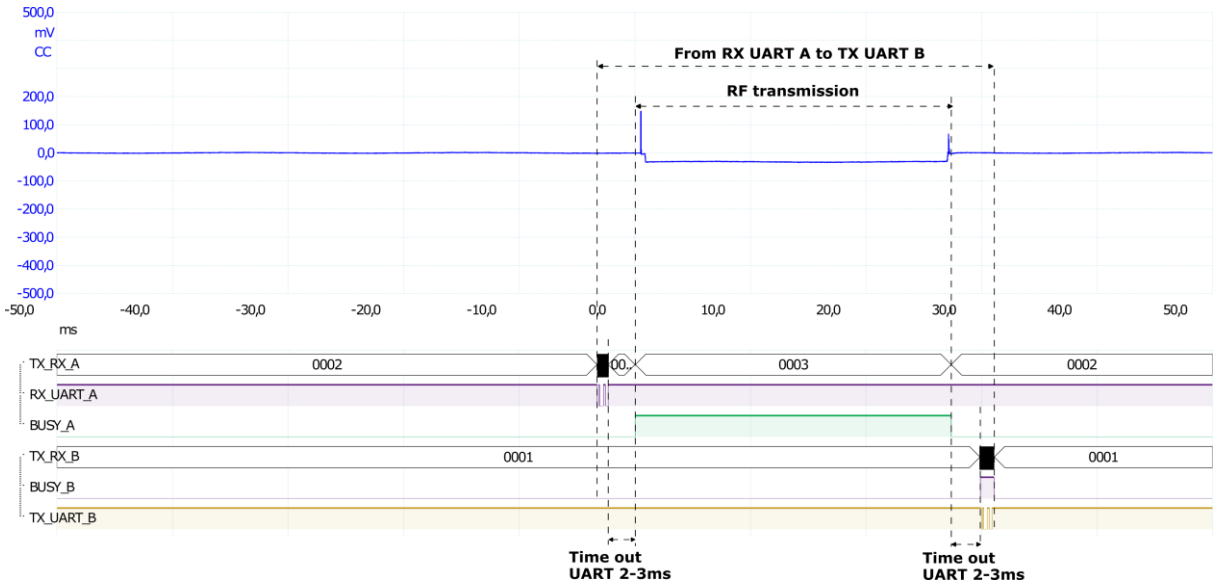
In case that host microprocessor start to send UART data while the module is receiving a RF packet, this received data is discarded.

Reception

When an RF packet is received, the RTX-868-NB-UART-V2 decode the packet, validated it and transmitted it to the host microprocessor via UART TX (pin 5); in the UART transferring operation the host microprocessor can't send data to the module (pin 4 UART RX), this is signalled with high level on the BUSY pin.
The BUSY pin will switch to low level when the module is ready to accept data from UART.

Time Fly

In order to understand the complete path of the message between a couple of RTX-NB-UART-V2 from UART_RX (pin4) of the device A to the UART_TX (pin5) of the device B trough the link RF, the follow diagram shows the flux of the signals and the behaviour of the pins UART_TX, UART_RX, BUSY for both devices. The blue trace is concerning the RF-Transmission detector.



Graph 1

The user can calculate the time fly of the messages using an excel calculator. The tool let to enter the payload length from 1 to 63 Byte and returns the RF fly time and total time included the UART processing of the message in ms.

The tool is available on demand or can be downloaded on www.aurelwireless.com in the web page concerning the RTX-868-NB-UART-V2.

Following 2 simulation example for 1 Byte and 63 Byte length payload:

Time fly calculation 1Byte		
n° Byte to TX	1	1 to 63 max
Time UART_TX + TX_RF	31,24	ms
Time UART_TX to RX_UART	34,28	ms
RF transmission Fly time	27,2	ms

Table 5

Time fly calculation 63 Byte		
n° Byte to TX	63	1 to 63 max
Time UART_TX + TX_RF	194,92	ms
Time UART_TX to RX_UART	262,44	ms
RF transmission Fly time	126,4	ms

Table 6

RF channel selection

CH0, CH1 and CH2 pins allow the user to select the RF channel frequency operation, they are available as shown in Table 7.

Channel setup is read by the module only in the power up phase, after a reset or in sleep mode. It isn't possible to change the channel runtime, RX-ON or TX-ON.

When the pin sleep is connected to Low level it goes in reception mode, together the RF CH pins must to connected to low or high level in order to setup the wanted RF channel.

To limit the consumption in sleep-mode, RF CH Sel pins (pin 6-7-8) are normally in high impedance, the user must connect them to low level

Channel Number	CH2 Pin 8	CH1 Pin 7	CH0 Pin 6	RF channel (MHz)
1	0	0	0	868.1
2	0	0	1/X	868.2
3	0	1/X	0	868.3
4	0	1/X	1/X	868.4
5	1/X	0	0	868.5
6	1/X	0	1/X	869,525

0 = GND, 1 = Vcc, X = Open

Table 7: RF channel selection

NOTE: for high power version only one channel is used, the setting of the pin 6 to 8 doesn't matter

Sleep mode

The module can be put in low power consumption mode driving the sleep pin accordly to the table 4, if no sleep-mode is needed it must be connected to GND.
Driving to high level or open the sleep pin the module enter in sleep mode with a current consumption of about 2uA. In this state no data reception or transmission is allowed.
Driving the pin to low level, in about 22ms the device enter in RX mode ready to use.

RSSI function

The transceiver integrate the RSSI function with 1db resolution and dynamic of 80dB. Connecting the pin n° 16 (RSSI input) to low level, the device active the RSSI hardware resource and return the value in the last byte of the pay-load transmitted on the UART TX pin 5.
The RSSI value returned is a sign binary value from -128dBm (0x80) to +127dBm (0x7F). The value returned is quite reliable and corresponding to the value in dBm of the RF power received of the same packet.

Reset operation

The pin 15 (RESET) of the module is available to reset the internal microcontroller, keep it to low level to reset the microcontroller keep it open for normal operation.
The device is protected for voltage supply drops by a voltage detector, in order to guarantee correct operation every time the device is reset it send on UART TX (pin 5) the message in Asci code with module name and firmware version.
The device integrate a supervision voltage reset circuit, under 1,8V the device is keep in reset mode and the voltage supply of the radio IC is forced to GND.

Device usage

In order to obtain the performances described in the technical specifications and to comply with the operating conditions which characterize the certification, the transceiver should be mounted on a printed circuit taking into account the following:

Power Supply

1. RTX-868-NB-UART-V2 must be supplied from very low voltage safety source protected against the short circuits. Maximum voltage variations allowed: 2.1 ÷ 3.6 V. However it is preferable to maintain a stable voltage to a predetermined value in the range of voltage as specified above, using a “fast transient response” voltage regulator.
2. Decoupling, close to the transceiver, with a ceramic capacitor of minimum 100nF.
3. Connect electrolytic capacitor 100uF, low ESR, close to pin 9 (Vcc).

Input pin interface

Put 100pF capacitors close to the corresponding general purpose digital inputs pins, connected between them and the ground plane.
The RX and TX UART in sleep mode is in High impedance state.

Ground

The ground must surround at the best the welding area of the module and must also be realized in the lower face of the PCB in order to allow the optimal result, with the through holes connecting the two ground planes.

Antenna

Connect pin 1 (antenna) to the coaxial connector or antenna, with 50 ohm constant impedance microstrip width 3.2 mm for PCB with thickness 1.6 mm and width 1.6 mm for PCB with thickness 1mm.
The antenna is a typical rigid copper wire (insulated or not) of 8cm length and cross-section at least of 0.5 mm² placed vertically to the ground plane. Other placements of antenna (bend, coil) will work but performance are not predictable.
As an alternative to connect the module to an external antenna, connect an SMA connector into PCB using 50 ohm microstrip line.

Development board

Here follow a simple diagram circuit to test the RTX-NB-868-UART.
The module is connected to “FT232RL” UART to USB interface IC, the channel are selectable by the dip-switch S1, J2 allows to test the power-down function.
Using a PC with terminal software and an USB cable connected to J3 connector, it is possible transmit and receive data packet.
More details about this application is available on RTX-NB-868-UART Demo board user manual.

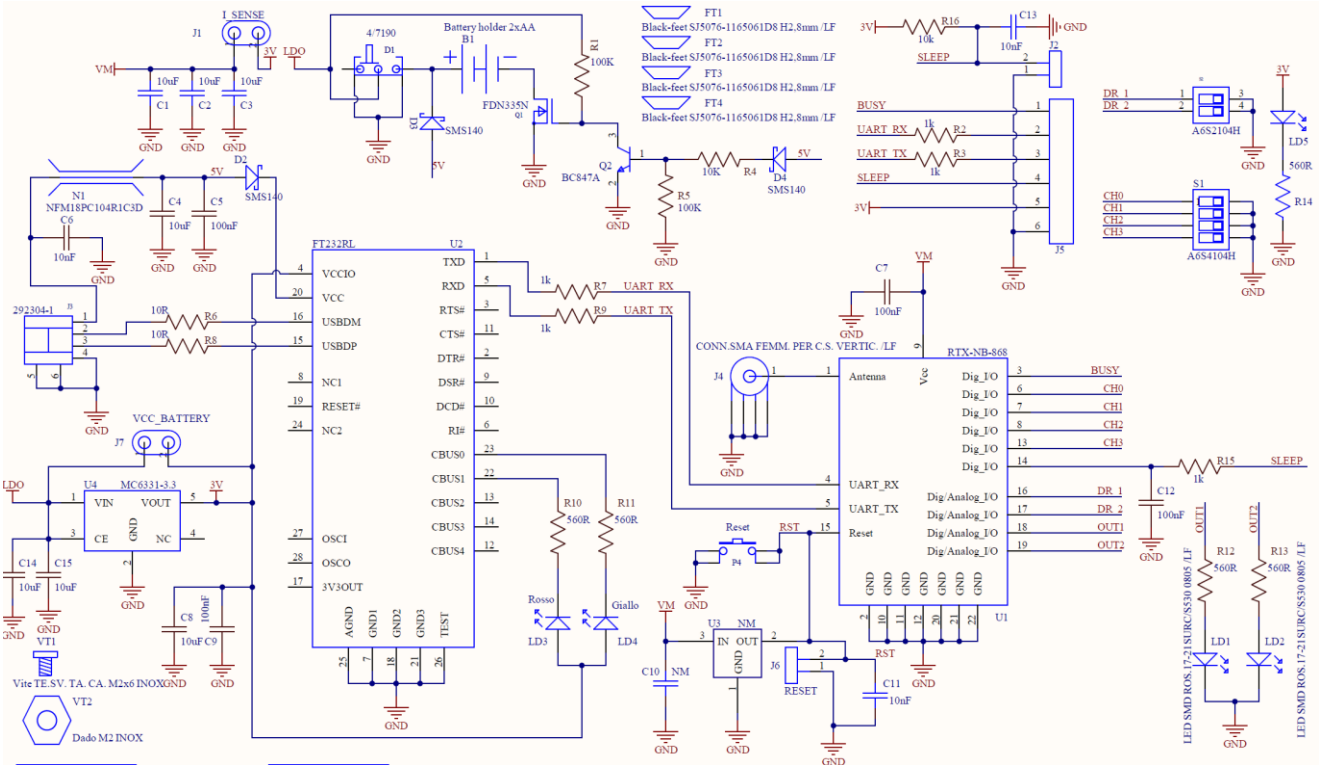
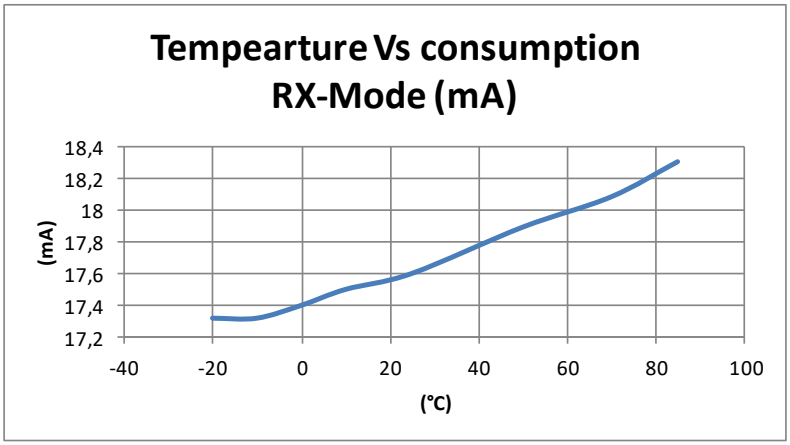
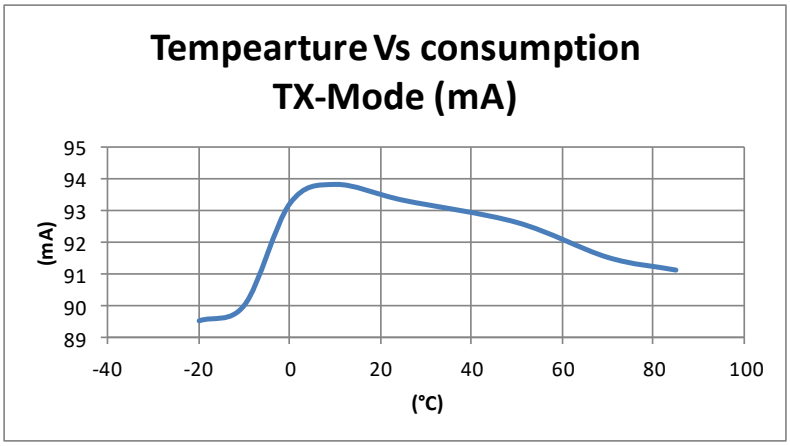


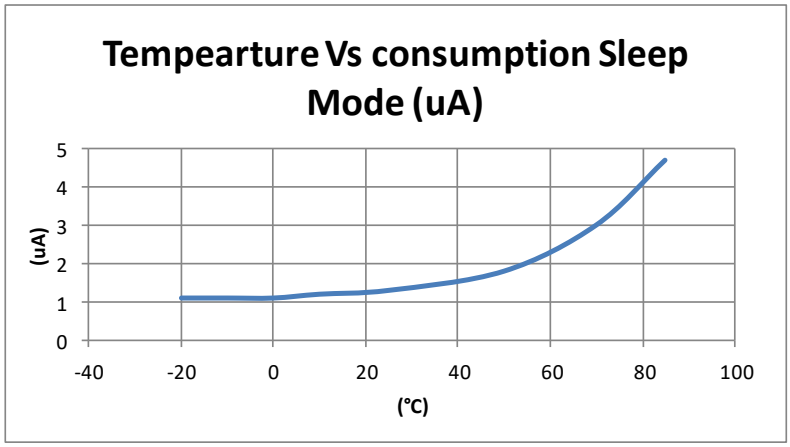
Figure 2: Demo-Board diagram circuit

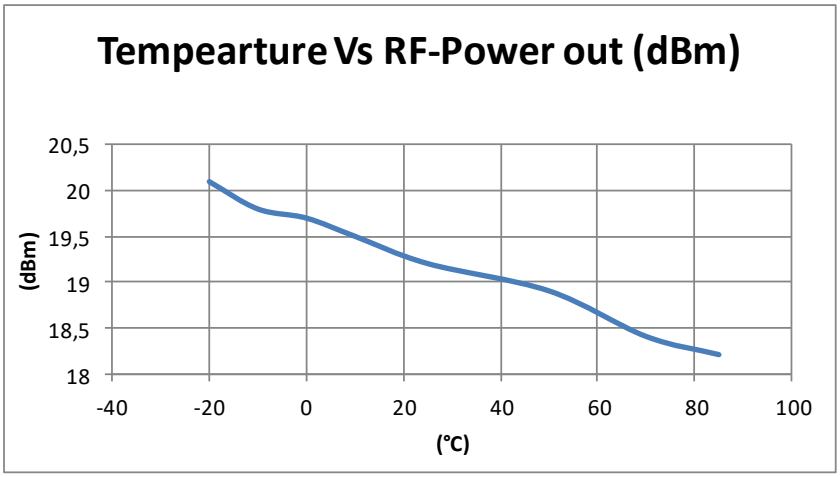
Characteristics versus temperature



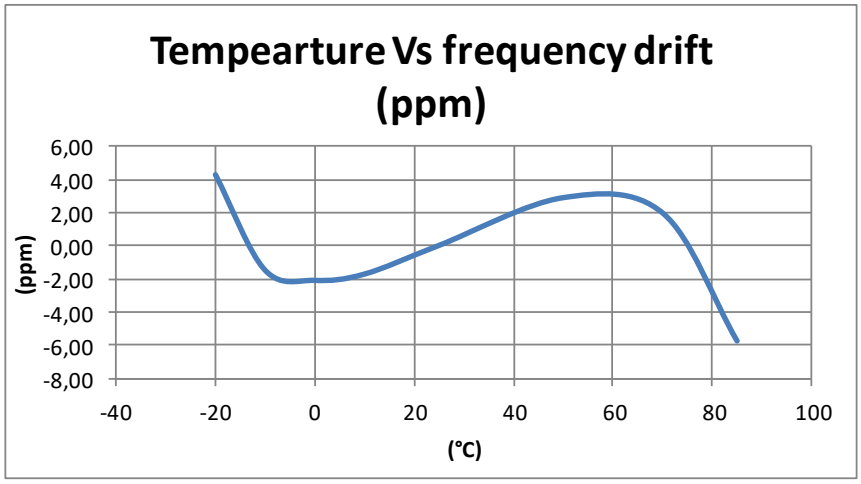


NOTE: the measure has been performed at the max power configuration (+20dBm freq 869,525MHz)

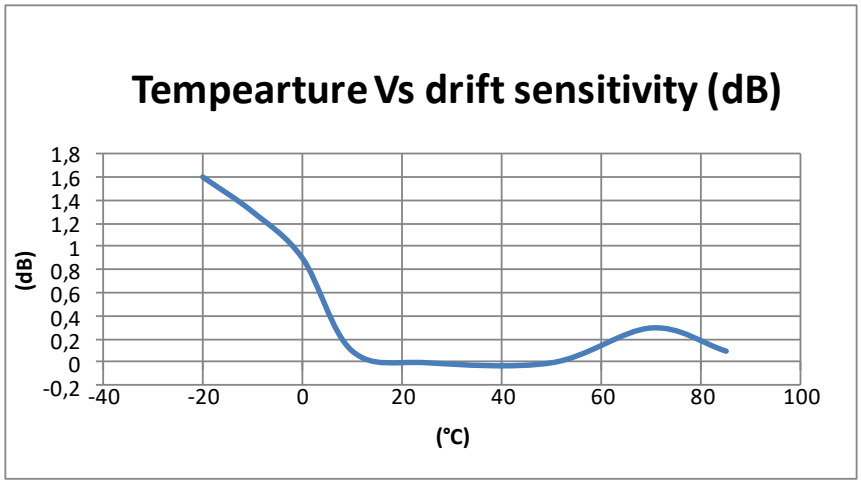




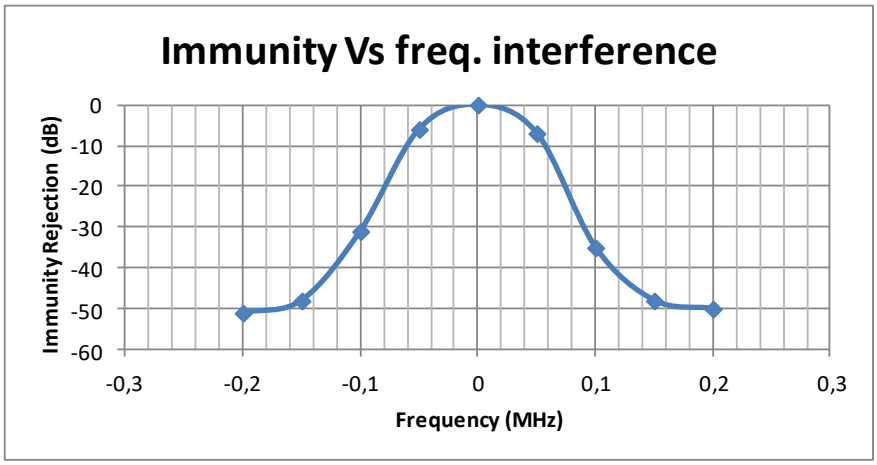
NOTE: the measure has been performed at the max power configuration (+20dBm freq 869,525MHz)



Note: Temperature RF drift frequency from reference at 25°C in ppm



Note: Temperature drift sensitivity from reference at 25°C in dB



NOTE: The graph shows the level of interference permitted before to degrade the sensitivity performance of the receiver (Level interference (dBm) = RX sensitivity(dBm) - Immunity rejection(dB)).

Soldering and assembling layout SMD

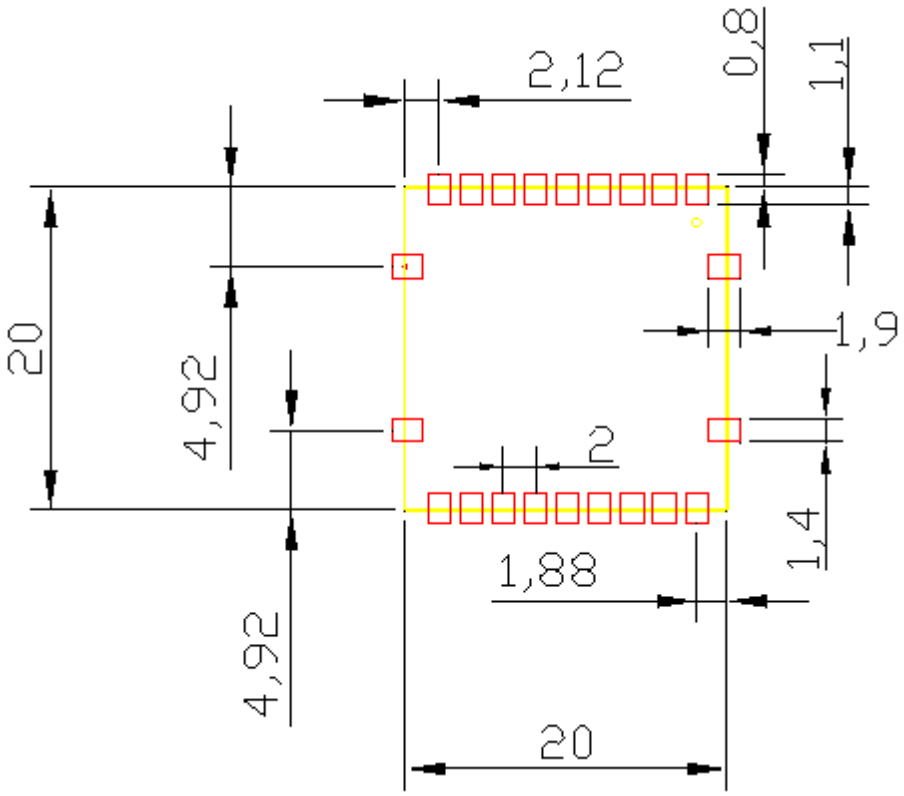


Figure 3: recommended layout for Host board (quote in mm)

In order to ensure the correct assembly of the module you are required to apply a production process observing carefully the following recommendations:

- Soldering paste: Use soldering paste as SAC305 (96,5% Sn, 3% Ag, 0,5% Cu), screen printed according the layout of Picture 8, with a thickness> 150um.
- Assembly: the module can be assembled with automatic machine by using a suction cup tool, applied on bigger integrated circuit
- Soldering: the module can be soldered on host board, through a reflow profile for Lead-free components.
  Jedec standard "J-STD-020E"
  Lo standard Jedec "J-STD-020E" defines temperatures and exposure times, is attached below graph and profile table time / temperature recommended for the purpose.
  For host that provide more reflow cycles it is recommended to perform the soldering of the module at the end of the soldering cycle, taking care to limit excessive vibrations during the terminal phase of reflow soldering paste.

Profile Feature	Pb-Free Assembly
Preheat/Soak Temperature Min (Tsmin) Temperature Max (Tsmax) Time (ts) from (Tsmin to Tsmax)	 150 °C 200 °C 60-140 seconds
Ramp-up rate (TL to Tp)	2 °C/second max.
Liquidous temperature (TL) Time (tL) maintained above TL	217 °C 60-150 seconds
Peak package body temperature (Tp)	240°
Time (tp)* within 5 °C of the specified classification temperature (Tc), see Figure 9.	30* seconds
Ramp-down rate (Tp to TL)	6 °C/second max.
Time 25 °C to peak temperature	5 minutes max.
* Tolerance for peak profile temperature (Tp) is defined as a supplier minimum and a user maximum.	

Table 6: Detailed time / temperatures profile for soldering RTX-NB-868-UART

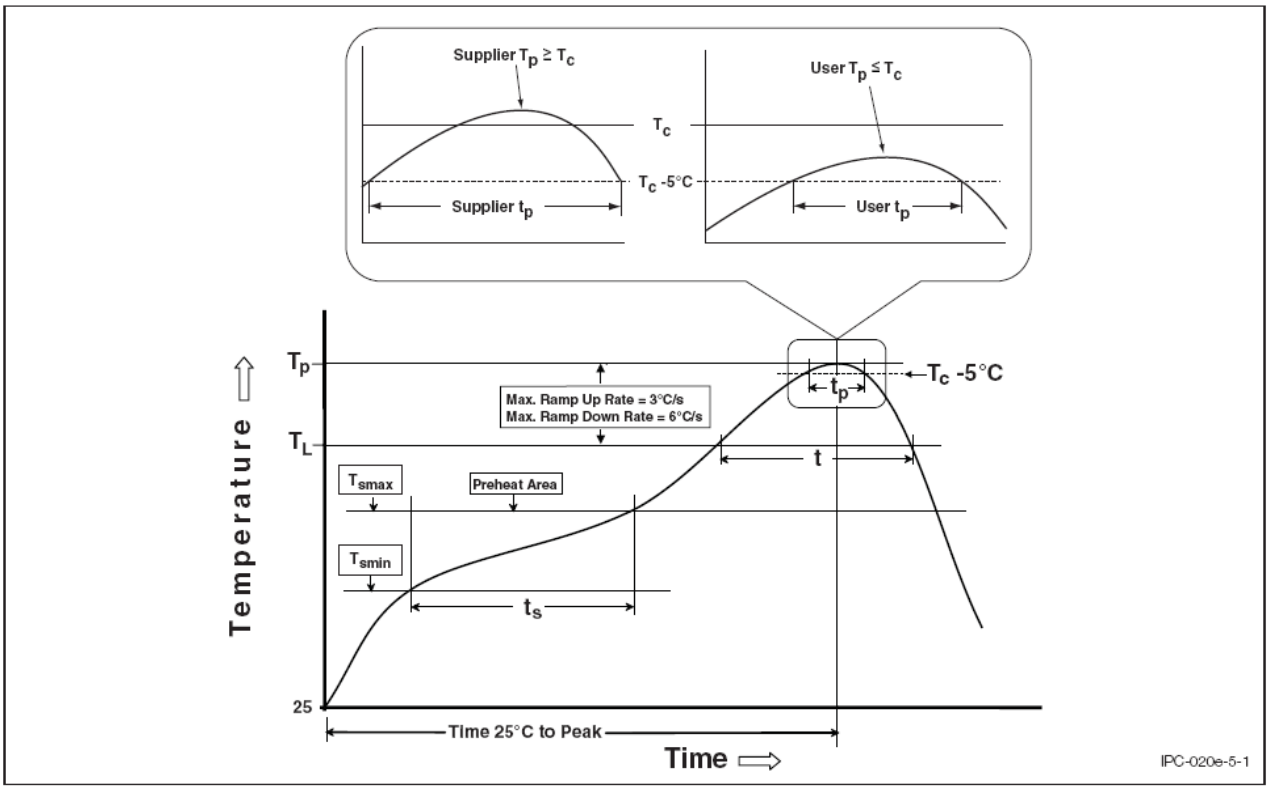


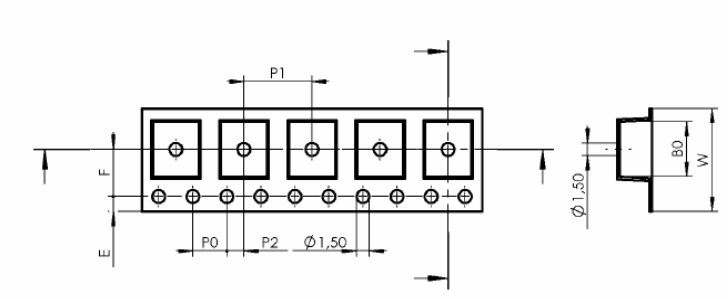
Figure 4: Soldering profile for RTX-NB-868-UART

Specifications Packaging Tape and Reel:

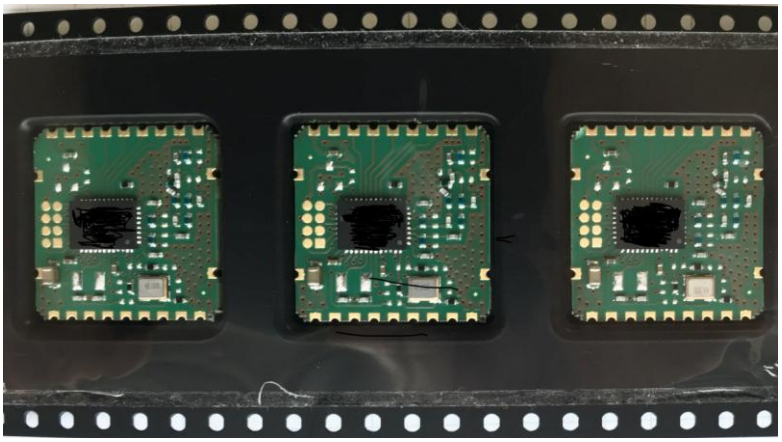
RTX-868-NB-UART-V2 is packed in Tape and Reel composed by an embossed carrier tape and antistatic cover tape.
In this way the modules are ESD protected and can be handled by machines for the automatic assembly of SMD components.

Dimensions:

W = 44 mm
P = 28 mm
T = 0,4 mm
Ao = 20,5 mm
Bo = 20,5 mm
Ko = 2,7 mm



Picture 5: Tape and Reel drawing (in mm)



Picture 6: External aspect of the embossed

Normative reference

RTX-868-NB-UART-V2 transceiver is compliant with the European set of rules **EN 300 220-2**, and **EN 301 489-3**.
The transceiver must be supplied by a very low voltage safety source protected against short circuits.
The usage of the module is foreseen inside enclosures that guarantee the **EN 61000-4-2** normative not directly applicable to the module itself.

This device is compliant with **EN 62479**, connected to the electromagnetic field human exposition, if used with temporal duty cycle not higher than 1% like foreseen in CEPT 70-03 recommendation.

CEPT 70-03 Recommendation

RTX-868-NB-UART-V2 recommendation is referred to the 868.0 – 868.6 MHz harmonized bandwidth and therefore, in order to comply with local regulations, the device must be used on the time scale with maximum duty-cycle time of 1% (equivalent to 36 seconds of usage on 60 minutes).

User manual revision summary

Release date	Revision	Description
01062023	1.0	First preliminary draft
06112024	1.1	Added RSSI function