The RTX-868-NB-UART-V2 is an SMD multi-channel narrow-band 6 channel transceiver operating in the 868MHz band, with 5 channels operating at the standard normative limit of 25mW and one at 869.525MHz, a frequency band that allows up to 100mW, allowing long distances with low power consumption.
The module can be easily interfaced with the application microprocessor via a UART bus and a few GPIOs. The device can manage a variable payload length from 1 to 63 bytes.
Thanks to its low power consumption in sleep mode and fast wake-up time, the device is ideal for key fobs, motor drive control boards, and battery-powered sensors, offering low application costs and high radio performance.
Six available channels, each 25 kHz wide, using GFSK modulation, selectable via external pins, with a data rate of 5000 bps.
3,3V operating voltage, receiver mode current consumption is 17mA and 72mA in transmission mode (+15dBm ERP).
The module is available in a tape & reel package for SMD assembling. Size is 20 x 20 x 2,5 mm.

Main Features

- **100mW max RF output power**
- **Sensitivity -116dBm**
- **Blocking category 1.5**
- **Channels: 6**
- **No encoding or preamble requested**
- **UART data rate: 9600 bps**
- **Reduced dimensions (20 x 20 x 2.5 mm)**

Ordering Information

Aurel Ordering code	Device name
650201609G	RTX-868-NB-UART-V2

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		869.525	MHz
RF channels with 25mW RF power [2]		5		
RF channels with 100mW RF power [2]		1		
RF power emission for channel 1 to 5 [1]		15	16	dBm
RF power emission for channel 6 [1]		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	**Min.**	**Typ.**	**Max.**	**Unit**
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)[4]		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)
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)
Note 4: See time diagram Graph 1

Pinout

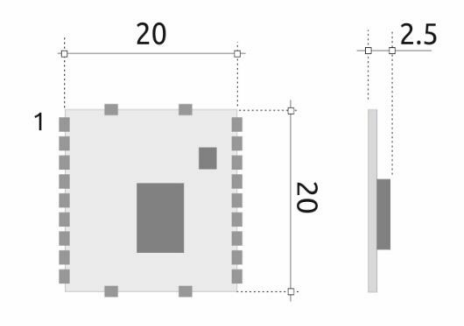


Figure 1: Pin-out and mechanical drawing

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 on request.

Pin description

Pin number	Name	Description
1	ANTENNA	Antenna connection, 50 ohm impedance
2	GND	Ground connection
3	BUSY	UART activity output. When this pin is at a high level it is not possible to send UART data to the module (E.g. raised during RF packet transmission or during internal 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. Set it to a low level to reset the microcontroller; leave it open for normal operation.
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

Table 4: Pin function description

Note 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.

UART Operation

The RTX-868-NB-UART-V2 is a radio modem operating in packet mode with a maximum payload length of 63 bytes. Data is exchanged between the RTX-868-NB-UART-V2 and the host microprocessor using a UART with 9600 bps 8,N,1 configuration.

Transmission

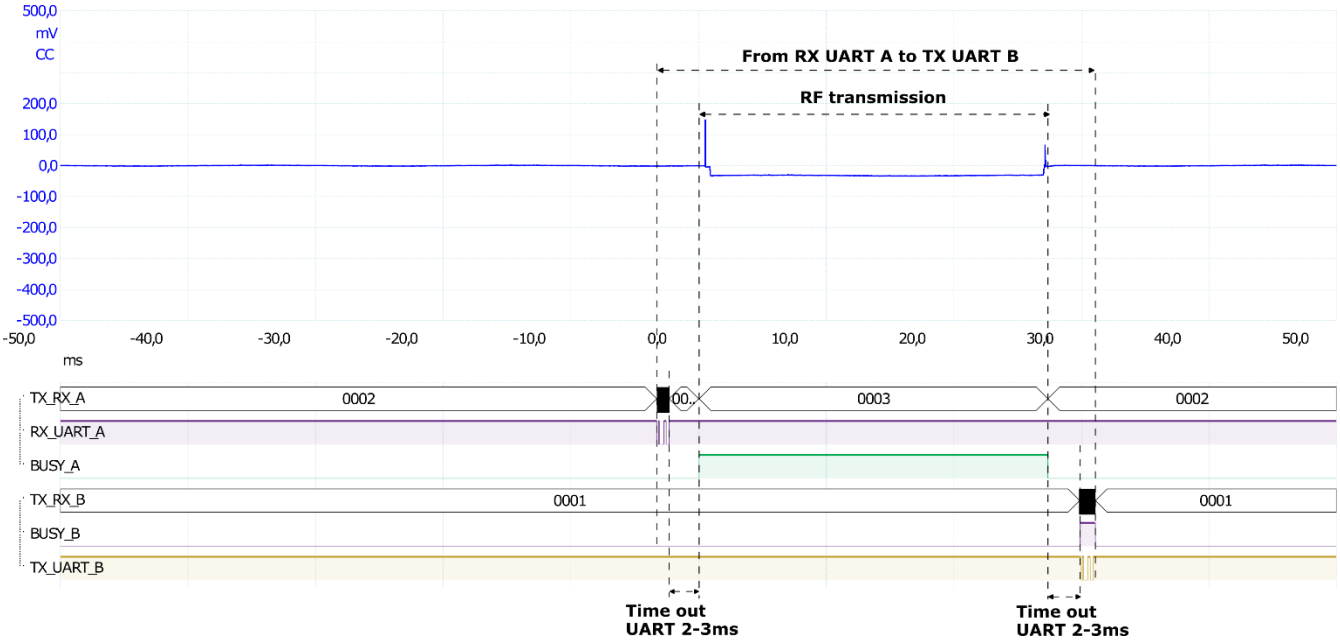
To transmit a packet the host processor must send UART data to the module pin 4. When the last byte is transferred and after a 2-3ms timeout the pin BUSY goes high, at this point the RTX-868-NB-UART-V2 starts the RF encapsulation of the data adding preamble, synch word, CRC and starts the RF transmission.
While the BUSY pin remains high, the module cannot accept any more data on the UART RX.
If the host microprocessor starts to send UART data while the module is receiving an RF packet, the received data will be discarded.

Reception

When an RF packet is received, the RTX-868-NB-UART-V2 decodes the packet, validates and transmits 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 the UART.

Time of Flight

To understand the complete path of the message between a pair of RTX-NB-UART-V2 from UART_RX (pin4) of the device A to the UART_TX (pin5) of the device B through the RF link, the following diagram shows the flow of the signals and the behaviour of the pins UART_TX, UART_RX, BUSY for both devices. The blue trace refers to the RF-Transmission detector.



Graph 1

The user can calculate the time of flight of the messages using an Excel based calculator available on www.aurelwireless.com or on request. The tool allows to set the payload length from 1 to 63 Byte and gives the RF time of flight time and total time included the UART processing of the message in ms.
Following 2 simulation example for 1 Byte and 63 Byte length payload:

Time Of Flight for 1 byte payload		
n° Byte to TX	1	Payload
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 Of Flight for 63 byte payload		
n° Byte to TX	63	Payload
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 as shown in Table 7.
The channel setup only read from the module at the power up, after a reset or in sleep mode. It's not possible to change the channel runtime, during RX-ON or TX-ON.
When the sleep pin is set to a low level, the device enters reception mode, together the RF CH pins must be connected to low or high level in order to select the wanted RF channel.
To minimize power consumption in sleep mode, the RF CH selection pins (pins 6-7-8) are normally in high impedance; the user must connect them to a 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 enter low power consumption mode by setting the sleep pin as indicated in Table 4. If sleep mode is not required, the pin should be connected to GND.
When the sleep pin is set to high level or left open, the module enters sleep mode, with a current consumption of about 2 µA. In this state no data reception or transmission is allowed.
Driving the pin to low level, in about 22ms the device enters in RX mode ready to use.

RSSI function

The transceiver integrates the RSSI function with 1dB resolution and a dynamic range 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.
The device integrates 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

- 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.
- Decoupling, close to the transceiver, with a ceramic capacitor of minimum 100nF.
- 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

A development board is available for quickly testing radio performance and supporting customer application development.
In this development board, the module's UART port is available as a USB connection via an FT232RL interface, so that a PC with serial terminal software can be easily used. The UART port is also available as a jumper in case a direct connection to a microcontroller in the customer application is required during development. Radio channel are quickly selectable by dip-switches and also power-down can be easily activated with a jumper.
More details about this application is available on RTX-NB-868-UART Demo board user manual.

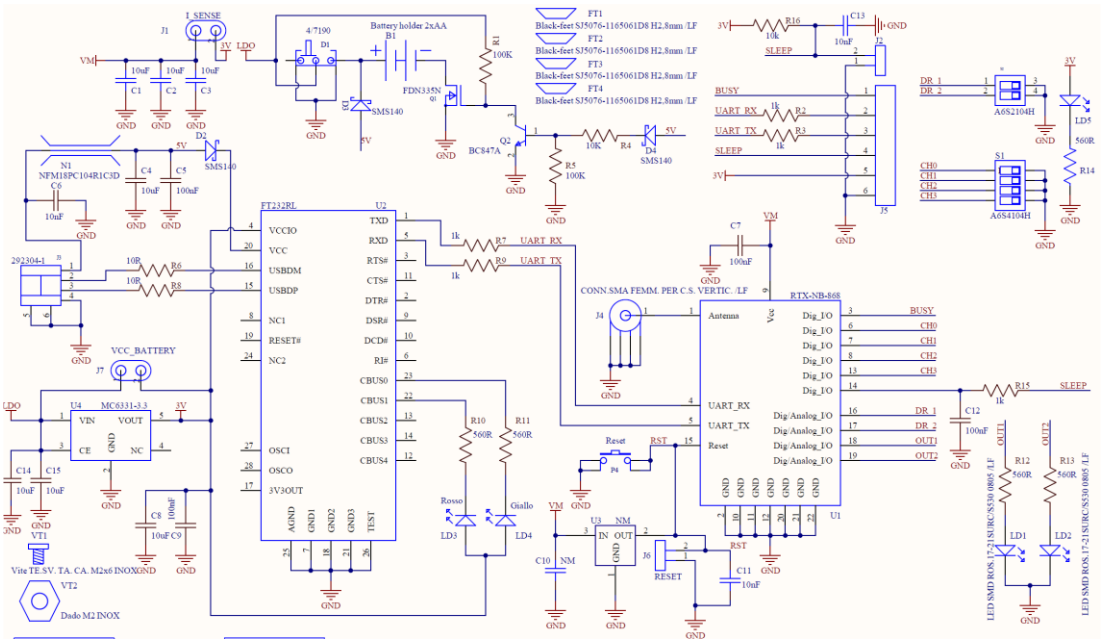
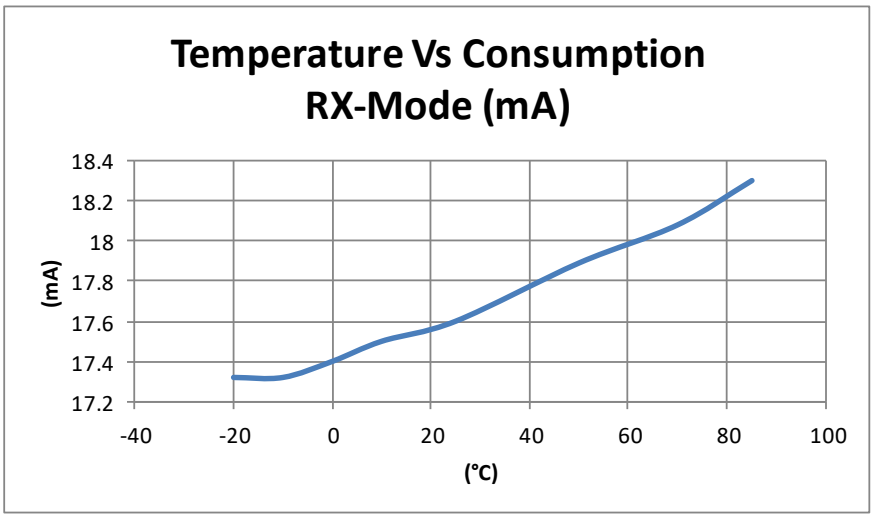
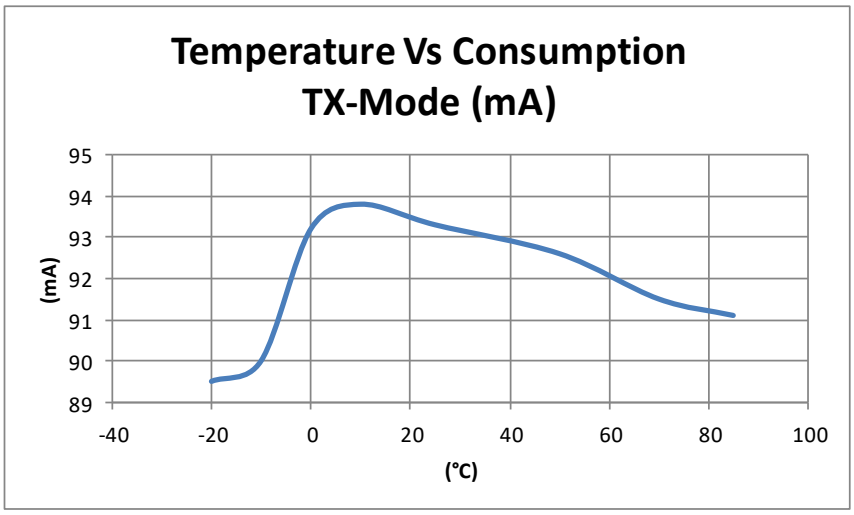


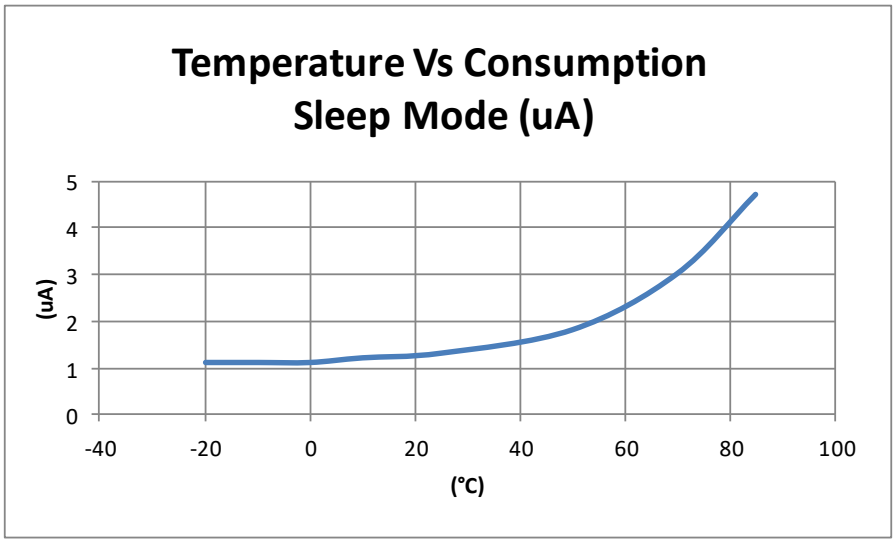
Figure 2: Demo-Board diagram circuit

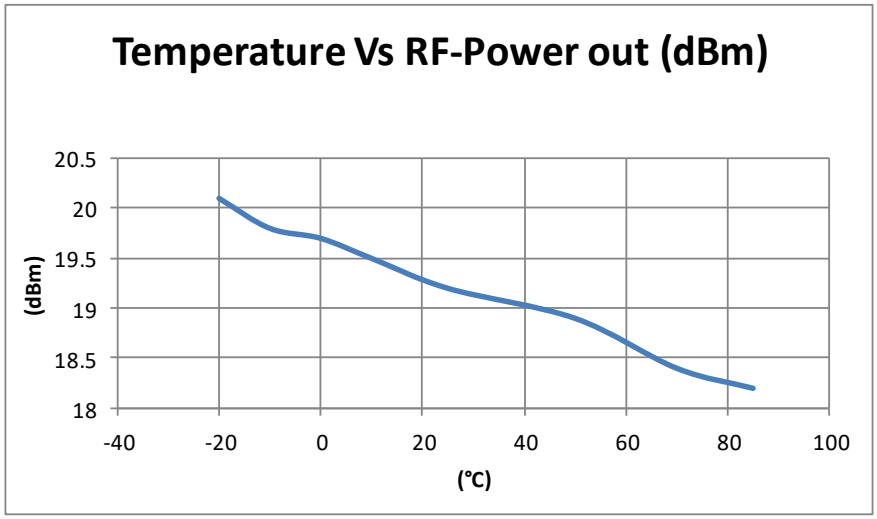
Characteristics versus temperature



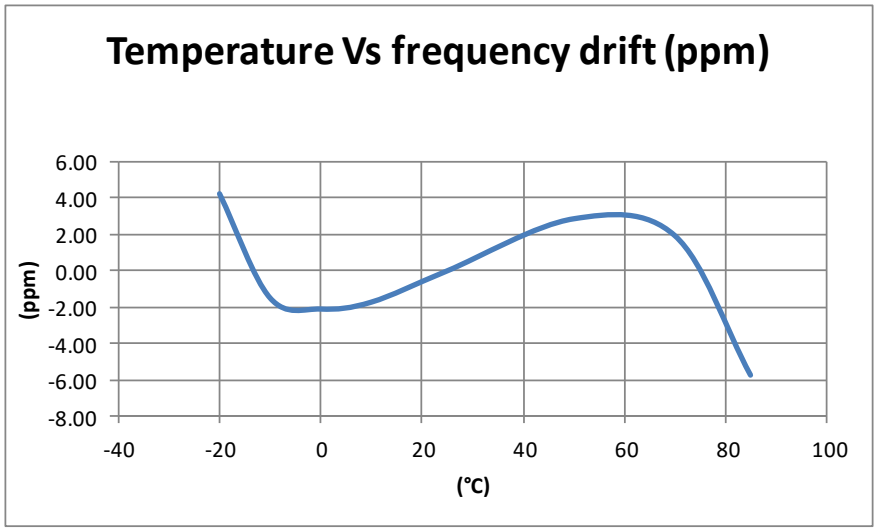


NOTE: the measure has been performed at the max power configuration (+20dBm freq 869,525MHz)

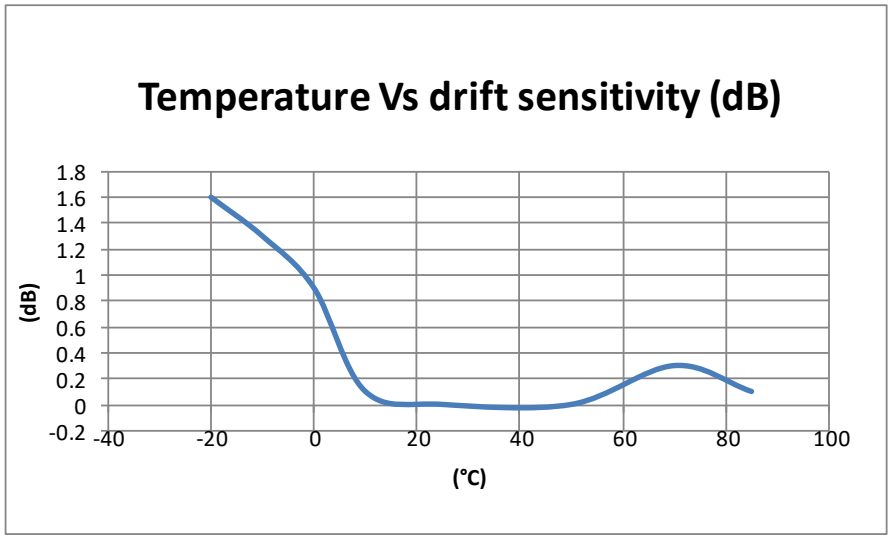




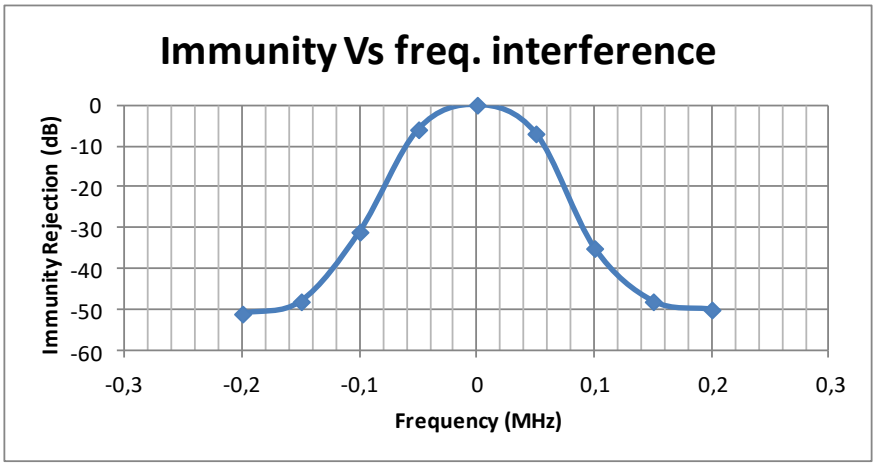
NOTE: the measure has been performed at the max power configuration (+20dBm freq 869,525MHz)



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 sensitivity performance degradation of the receiver (Level interference (dBm) = RX sensitivity(dBm) - Immunity rejection(dB)).

Soldering and assembling layout SMD

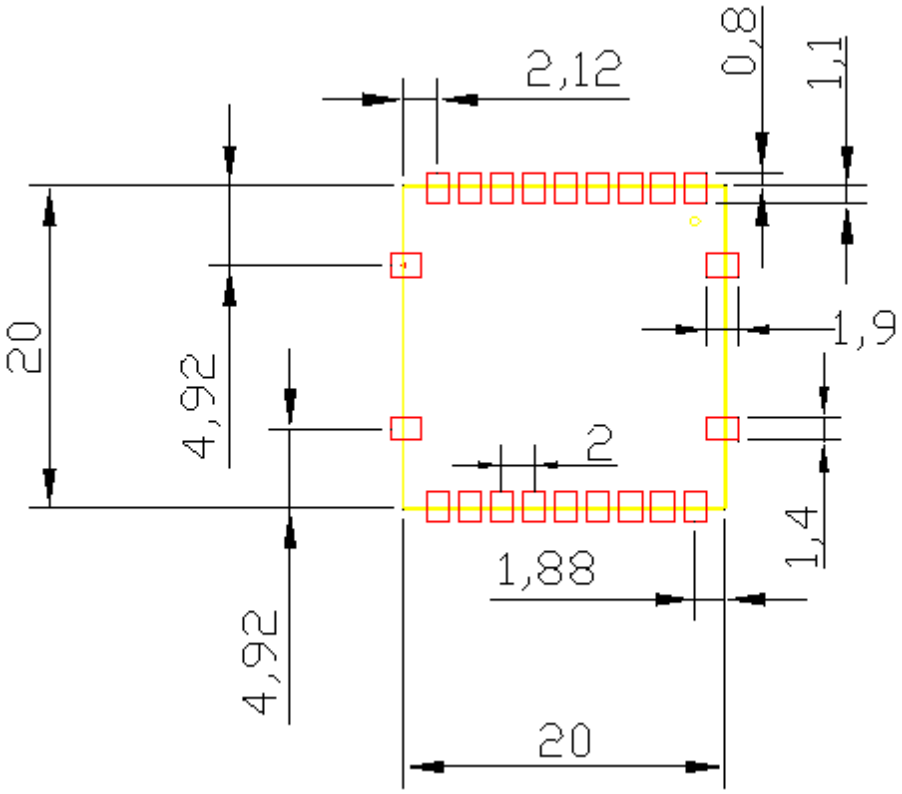


Figure 3: recommended layout for Host board (quote in mm)

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 J-STD-020E

Jedec standard J-STD-020E defines temperatures and exposure times, below time/temperature graph and table with values recommended for the soldering process.

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)(ts)	 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 within 5°C of actual Peak Temperature (Tp)	30* seconds
Ramp-down rate (Tp to TL)	6 °C/second max.
Time 25 °C to peak temperature	5 minutes max.
* Time within 5 °C of actual peak temperature (Tp) specified for the reflow profiles is a “supplier” minimum and “user” maximum	

Table 8: Detailed time / temperatures profile for soldering RTX-NB-868-UART-V2

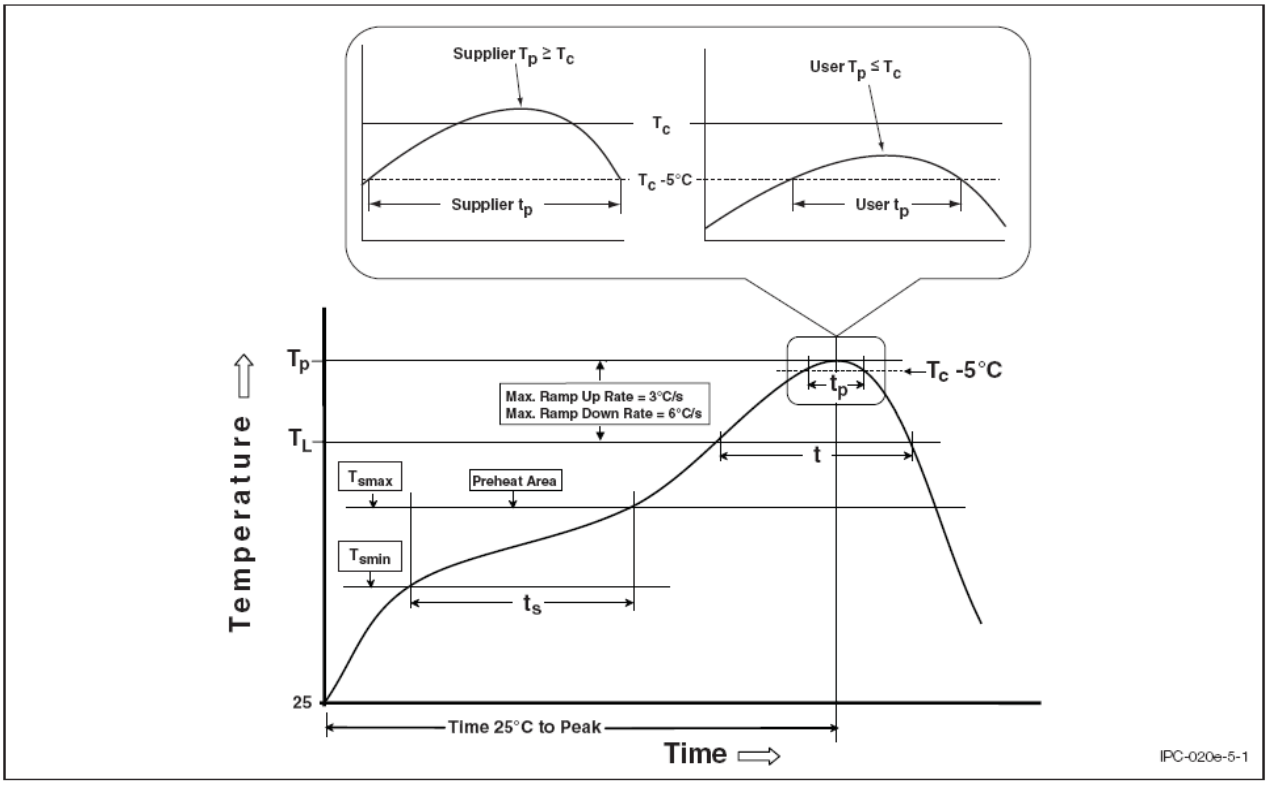


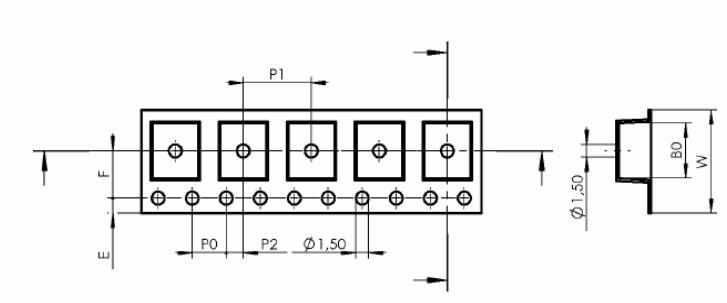
Figure 4: Soldering profile for RTX-NB-868-UART-V2

Specifications Packaging Tape and Reel:

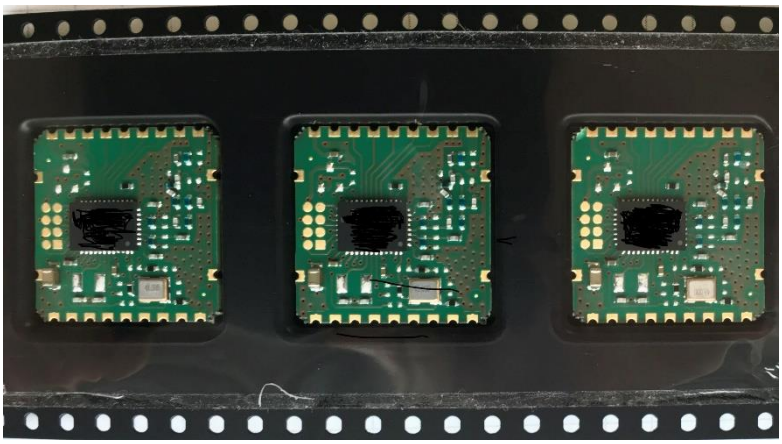
RTX-868-NB-UART-V2 is packed in Tape and Reel composed by an embossed carrier tape and antistatic cover tape.
In this way the modules are ESD protected and can be handled by machines for the automatic assembly of SMD components.

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 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 for channel 1 to 5 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). For channel 6 device can be used with a maximum duty-cycle time of 10% (equivalent to 360 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
03072025	1.2	Typos correction