NUR2-1W HW IMPLEMENTATION GUIDE

Change history:

Version	Date	Author	Remarks
1.0	12.6.2017	Toni Heijari	First released version
1.1	15.06.2017	Rauno Nikkilä	EU standards updated
1.2	09.08.2017	Rauno Nikkilä	Output power values updated in page 7. Modulation info added into page 16.
1.3	07.09.2017	Rauno Nikkilä	Modifications to chapters 11.2, 11.3 and 11.4

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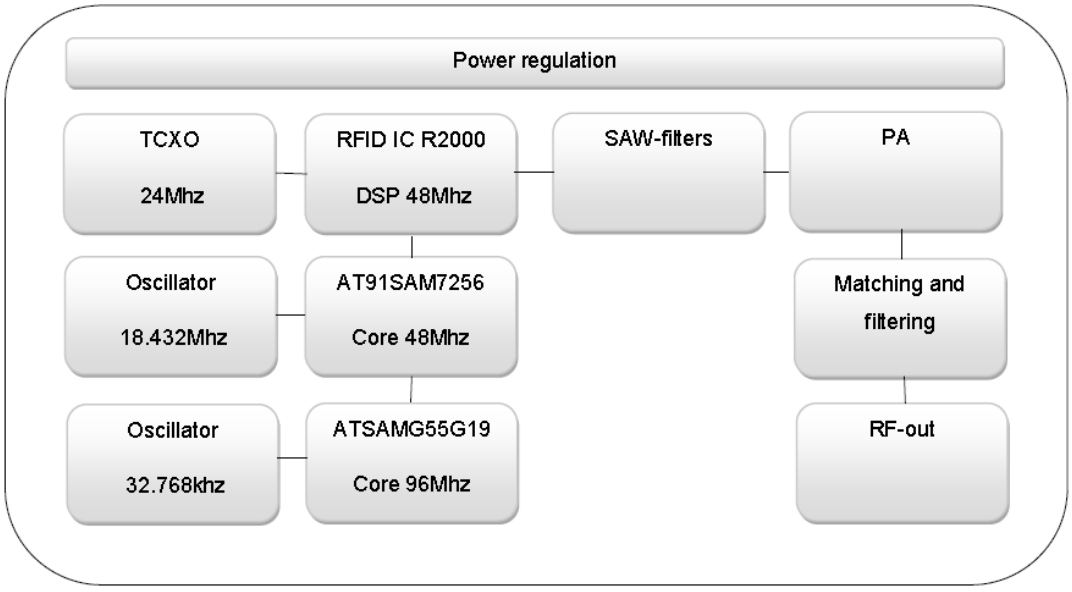
1 GENERAL DESCRIPTION

NUR2-1W is a next generation compact UHF RFID module. It is compatible with ISO18000-63 (EPC C1G2) standard. Module fulfills ETSI, FCC and IC radio regulations. It is also compatible with DRM (dense reader mode) requirements. Maximum output power is +30dBm and it can be adjusted via SW API with 1 dB steps. Maximum sensitivity is -81 dBm.

1.1 BLOCK DIAGRAM

Figure 1. Block diagram of the module



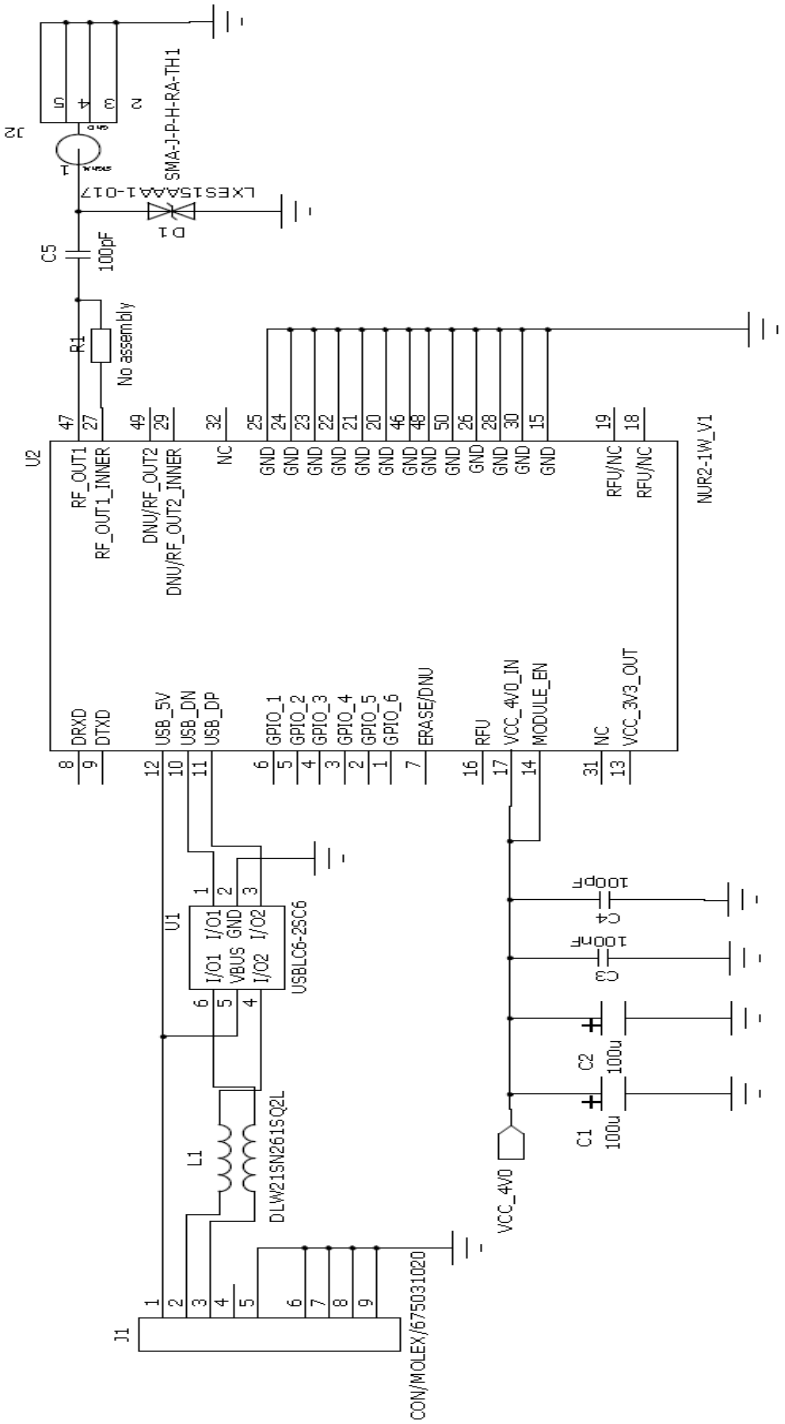
1.2 KEY FEATURES

- SMT compatible module with small footprint
- ISO 18000-63 (EPC C1G2) full protocol support + custom commands
- Low power consumption with high noise rejection
- DRM compatible
- High performance with +30dBm output power, adjustable by 1dB steps
- Approved by ETSI, FCC and IC telecommunication organizations
- UART and USB 2.0 communication
- 6 programmable GPIO with event trigger
- Increased sensitivity with automatic leakage cancelation

1.3 TYPICAL APPLICATION SCHEMATICS

Typical application schematic including: USB connection with ESD protection circuitry, NUR2-1W module and SMA RF-connector.

Figure 2. A simple application schematic.



2 ELECTRICAL CHARACTERISTICS

2.1 ABSOLUTE MAXIMUM RATINGS

Violating these values may cause damage to the module. Also, correct operation is not guaranteed if operating outside these values. NUR2-1W is ESD sensitive component so it must be handled with care.

Table 1. Absolute maximum ratings of the module.

Absolute maximum ratings	Value
Operating temperature	-20°C to +55°C
Storage temperature (package unopened)	-30°C to +85°C
Supply voltage and enable	+6.0V
GPIO pins	+4.0V
Other pins	+4.0V

2.2 DC CHARACTERISTICS

Table 2. DC characteristics (VCC_4V0_IN = 4.0V @ +25°C).

Symbol	Parameter	Min	Typ	Max	Units
V_{ext}	Supply voltage	3.8	4.0	5.5	V
I_{ext}	Supply current	-	1.5	2	A
I_{source}	GPIO source current	-	-	4	mA
I_{sink}	GPIO sink current	-	-	4	mA
V_{low}	GPIO input low-level voltage	-	-	0.8	V
V_{high}	GPIO input high-level voltage	2.0	-	-	V
V_{en}	Module enable voltage	1.2	-	Supply	V

2.3 RF CHARACTERISTICS

Table 3. RF characteristics (VCC_4V0_IN = 4.0V @ +25°C).

Symbol	Parameter	Min	Typ	Max	Units
S_{ens}	Receiver sensitivity*	-	-	-81	dBm
P_{out}	Output power	1	-	30	dBm
P_{adj}	Power adjustment step	-	1	-	dB
S_{11}	VSWR requirement	-	-	1,5:1	@50Ω
$D_{r\rightarrow t}$	Reader to tag data rates	-	40 / 80	-	kbps
$D_{t\rightarrow r}$	Tag to reader data rates	62	150	400	kbps

*Sensitivity is measured at the RF-port of the module.

2.4 PERFORMANCE CHARACTERISTICS

The performance of the reader module is highly dependent on the test environment, reader antenna and tag performance. Interferences from other radio sources operating in the same frequency may decrease the performance. Also, the tag antenna and the tag IC may have significant effect on the values presented below. Selected radio and inventory parameters do have a big influence to reading performance as well.

Table 4. Performance characteristics (VCC_4V0_IN = 4.0V @ +25°C).

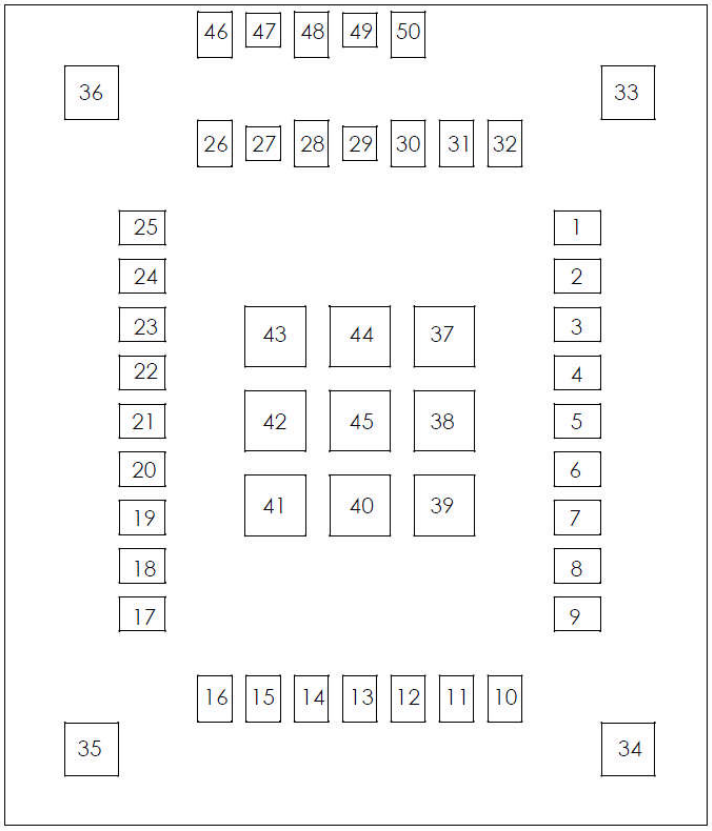
Symbol	Parameter	Min	Typ	Max	Units
R_{dist}	Typical reading distance with 5 dBi antenna*	-	10	-	m
R_{rate}	Typical reading rate (Tari25 / Tari6.25)	-	300	800	tags/s
O_{temp}	Operation temperature	-20	-	+55	°C
H_{rel}	Relative humidity	10	-	95	%

*Measured with Smartrac Belt R6 tag.

3 PIN ASSIGNMENTS

3.1 PIN DESIGNATION

Figure 3. Through top view.



3.2 PIN MAPPING

Table 5. Pin mapping of the module.

Pin number	Signal name	Pin type	Description
1	GPIO_6	Bidirectional	3.3V GPIO
2	GPIO_5	Bidirectional	3.3V GPIO
3	GPIO_4	Bidirectional	3.3V GPIO
4	GPIO_3	Bidirectional	3.3V GPIO
5	GPIO_2	Bidirectional	3.3V GPIO
6	GPIO_1	Bidirectional	3.3V GPIO
7	ERASE/DNU	Input	DNU (do not use)
8	DRXD	Input	Data from Host to Module

9	DTXD	Output	Data from module to Host
10	USB_DN	Bidirectional	USB – (device port)
11	USB_DP	Bidirectional	USB + (device port)
12	USB_5V	Input	Used only for USB detection
13	VCC_3V3_OUT	Supply output	DNU (only for testing purposes)
14	MODULE_EN	Input	Driving high will enable the module
15	GND	Supply input	Ground
16	RFU	Not connected	RFU (do not connect)
17	VCC_4V0_IN	Supply input	Supply voltage input
18	RFU/NC	Bidirectional	RFU (do not connect)
19	RFU/NC	Bidirectional	RFU (do not connect)
20	GND	Supply input	Ground
21	GND	Supply input	Ground
22	GND	Supply input	Ground
23	GND	Supply input	Ground
24	GND	Supply input	Ground
25	GND	Supply input	Ground
26	GND	Supply input	Ground
27	RF_OUT1_INNER	Bidirectional	RFU (do not connect)
28	GND	Supply input	Ground
29	DNU/RF_OUT2_INNER	Bidirectional	RFU (do not connect)
30	GND	Supply input	Ground
31	NC	Not connected	internally not connected
32	NC	Not connected	internally not connected
33-46	GND	Supply input	Ground
47	RF_OUT1	Bidirectional	50Ω RF output/input
48	GND	Supply input	Ground
49	DNU/RF_OUT2	Bidirectional	RFU (do not connect)
50	GND	Bidirectional	Ground

3.3 SIGNAL DESCRIPTION

Table 6. Signal description.

Signal name: GND	**Pin number(s): 15, 20-26, 28, 30, 33-46, 48, 50**
These pins are used for grounding and to improve the thermal performance. They should be connected to Host board GND net.	
Signal name: GPIO_X	**Pin number(s): 1-6**
These pins are used as general purpose IO. They can be configured via SW API as input or output ports. IO voltage level is 3.3V. GPIOs have source current capability of 4mA and sink current capability of 4mA.	
Signal name: ERASE	**Pin number(s): 7**
This pin is used for production testing purposes only. Should not be connected.	
Signal name: DRXD	**Pin number(s): 8**
This pin is used for module UART input signal. Logic level is 3.3V. If UART is used for communication the pin should be connected to the Host MCU serial TX port.	
Signal name: DTXD	**Pin number(s): 9**
This pin is used for module UART output signal. Logic level is 3.3V. If UART is used for communication the pin should be connected to the Host MCU serial RX port.	
Signal name: USB_DN	**Pin number(s): 10**
This pin is used as USB_D- device port. It is advised to use external ESD protection component if connected to user accessible USB connector.	
Signal name: USB_DP	**Pin number(s): 11**
This pin is used as USB_D+ device port. It is advised to use external ESD protection component if connected to user accessible USB connector.	
Signal name: USB_5V	**Pin number(s): 12**
This pin is only used for USB connection detection. It is advised to use external ESD protection component if connected to user accessible USB connector. Current is not drawn from this input pin.	
Signal name: VCC_3V3_OUT	**Pin number(s): 13**
This pin is connected to internal power regulator output. The pin is used for production testing and it should not be used.	
Signal name: MODULE_EN	**Pin number(s): 14**
Driving this pin to high will enable the NUR-10W module. It is internally connected to onboard voltage regulator's enable input. The trigger level is 1.2V and the reader module will wake up in 50ms. If the external power switch is used to toggle ON and OFF, this pin can be connected directly to VCC_3V6_IN.	

Signal name: NC	**Pin number(s): 16, 31, 32**
These pins are internally not connected.	
Signal name: VCC_4V0_IN	**Pin number(s): 17**
This pin is used for power supply input for NUR-10W module. It is recommended to use 200µF (low ESR) 100nF and 100pF capacitor near the VCC_4V0_IN input pin to maintain stable operating voltage for the reader module.	
Signal name: RFU / DNU pins	**Pin number(s): 18, 19, 27, 29, 49**
These pins are reserved for future use. Do not connect these pins.	
Signal name: RF	**Pin number(s): 47**
50Ω impedance RF output / input pin. Trace to this pin should be also matched to 50 Ω. See more details from the design considerations section.	

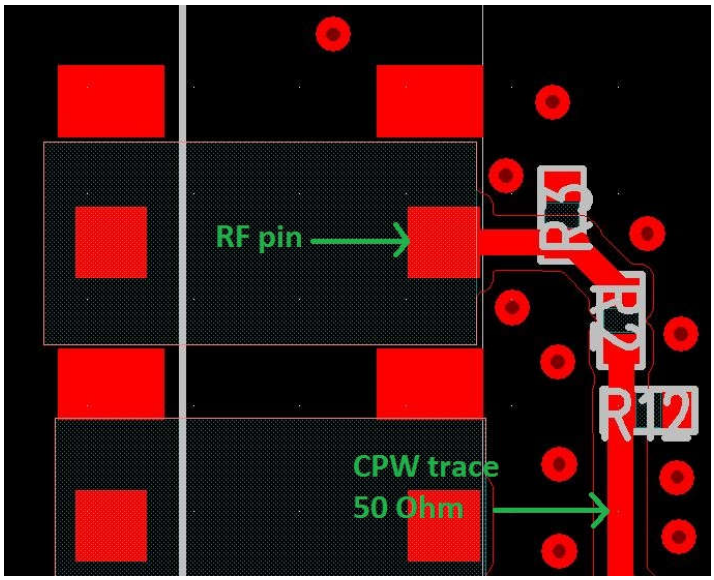
4 OEM DESIGN CONSIDERATIONS

4.1 RF OUTPUT AND ANTENNA REQUIREMENTS

The RF output / input impedance is 50Ω so the trace leaving from the RF pin shall be kept in that same impedance level to avoid reflections and mismatch of the RF signal. From the RFID reader module's point of view it is important that the used antenna has a low VSWR value. The VSWR shall be better than 1.5:1 in order to avoid decrease in the sensitivity performance of the receiver because of the TX power reflecting back from the antenna. In the NUR2-1W module, there is also an automatic leakage cancellation system that decreases the effect of the reflected signal, and it also improves the isolation of the RX signal from the TX signal. The automatic leakage cancellation is automatically on when module is operating in normal mode.

4.1.1 LAYOUT RECOMMENDATIONS

Figure 4. RF output layout of the reference design.



Because NUR2-1W is a wireless device, the RF section must be the top priority in terms of layout. It is very important that layout is made by following the proper RF design guidelines to get to optimal performance from the device. Poor layout can decrease the output power, sensitivity and cause mask violations.

Component places; R2, R3 and R12 are for additional output matching. Additional matching is not used in a reference design. Thus values are as follow: R3 = No assembly, R12 = No assembly and R2 = 100pF 0402 capacitor.

4.1.2 TRANSMISSION LINE

The RF signal from the module is routed to antenna connector using a grounded CPW structure. This is to achieve the maximum isolation and RF shielding to RF lines. Also GND vias should be added along the line to give additional shielding.

Figure 5. Grounded CPW with via stitching.

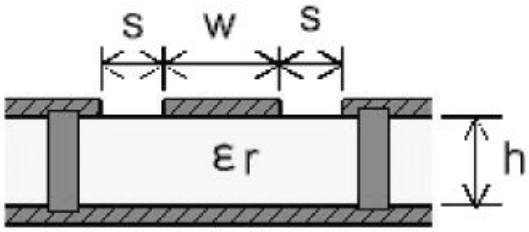


Table 7. Recommended PCB values for 4-layer board (L2 is the GND plane for transmission line)

Parameter	Value	Unit
W	0.35	mm
S	0.2	mm
H	0.18	mm
Er	4	

General recommendations:

1. RF traces must have 50 Ohm impedance because module is only rated to operate in 50 Ohm systems.
2. RF trace bends must be gradual and not have any sharp corners.
3. Grounded CPW structure must have GND via stitching.
4. Only connect antennas which are approved.

4.2 POWER SUPPLY

The NUR2-1W has internal linear power regulators for getting better power supply noise rejection. However, it is still important to supply low noise and stable power to the NUR2-1W module. The voltage ripple should be kept under 200mVpp and it is recommended to add a minimum of 200µF low ESR, 100nF and 100pF capacitors next to the VCC_4V0_IN pin.

VCC_3V3_OUT is internal regulator output and it is used for production testing purposes. This pin should not be used to power external circuits.

4.3 USB DEVICE PORT

USB_DP, USB_DN and USB_5V pins are used to provide 2.0 compliant USB device port. It is advised to use external ESD protection component if connected to user accessible USB connector. Below is the typical schematics used with NUR2-1W module.

Figure 6. Typical schematics for USB connection with ESD protection.

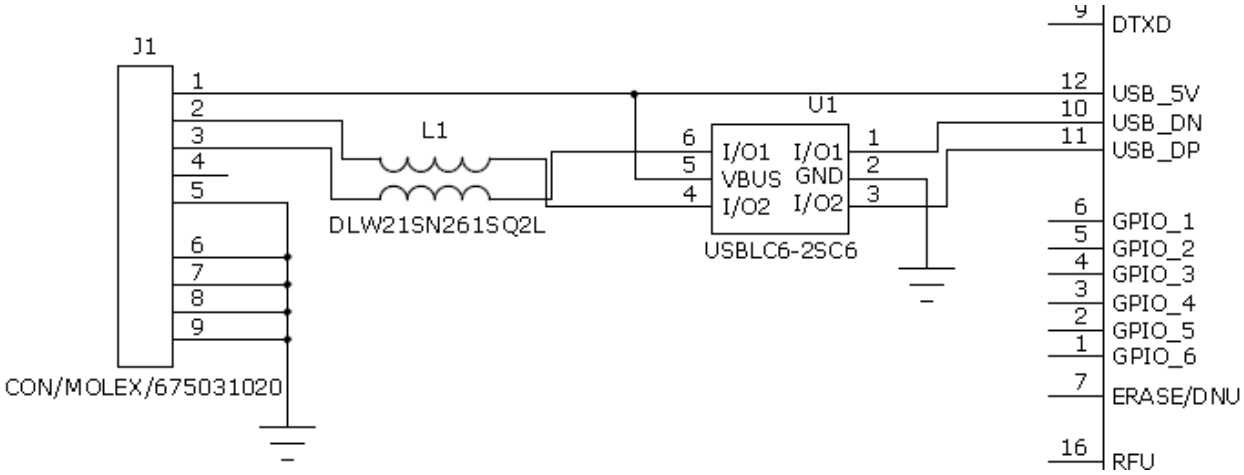


Table 8. Used components.

Ref	Description	Manufacturer	Part code
U1	ESD protection	ST Microelectronics	USBLC6-2SC6
L1	Common mode choke	Murata	DLW21SN371SQ2L

5 RF PARAMETERS

5.1 TX LEVEL

The maximum output power is +30dBm (1000mW). The power can be adjusted by 1dB steps. In total, there are 30 steps meaning the minimum output power value is +1dBm that equals to 1mW of power. When using higher output power levels the antennas VSWR value becomes more and more important factor. High output power combined with antenna with poor VSWR leads to a situation where significant portion of the power is reflected back to the receiver.

5.2 RECEIVER SENSITIVITY

The maximum sensitivity of the module is -81dBm. The receiver can handle +15dBm of power reflecting back to RF_OUT1 pin without having a big impact on the performance. The receiver architecture uses direct conversion and it has an integrated AGC (automatic gain controller). Baseband is made using a DSP.

5.3 MODULATION

It is possible to use ASK (amplitude shift keying) or PR-ASK (phase reversed amplitude shift keying) modulation. Tags that are compliant with ISO18000-6C (EPC C1G2) must support both of these modulations. The PR-ASK modulation can transfer energy more efficiently to the tag because RF envelope is high more than it is using ASK modulation. By default the modulation is set to PR-ASK.

5.4 LINK PROFILES (TBD)

TBD

Table 9. Available link profiles.

Link profile	TBD	TBD
1	x	x
2	x	x
3	x	x

5.5 REGION

The NUR2-1W has predefined region settings defining frequency and channel sets for operating under different radio regulations. Globally the regulations vary depending on the country or part of the world. The below table shows the available options for the region and the respective frequency band they use. Note that the antenna also needs to be working on that same frequency.

Table 10. Pre-programmed countries / regions.

Number	Country / region	Frequency / channel BW
0	ETSI / Europe	865.6 – 867.6 MHz / 200kHz
1	FCC / North-America	902 – 928 MHz / 500 kHz

If you want to use custom frequencies or hop tables you need to feed parameter described below.

Table 11. Custom hop table parameters.

Parameter	Value	Description
Frequency entry	840 000 – 960 000 [kHz]	Defines the center frequency of the first transmit channel.
Channel count	1 - 100	Defines the number of transmit channels
Channel spacing	25 * n [kHz]	Defines the frequency between transmit channels.
Channel time	minimum 100 ms	Defines the time that reading is ON at the same channel
Wait time	maximum 1000 ms	Defines the time that transmitter is silent between frequency hops
Tari	1=12.5us 2=25us	Defines the Tari value
LF	160 000, 256 000 or 320 000	Defines the maximum link frequency that is used

6 READING PARAMETERS

6.1 Q-VALUE

The Q-value defines the amount of open response slots that tags can use per one inventory round. Number of slots can be calculated by formula 2^Q. It is advised to use twice as much slots compared to amount of tags that you have in your readers reading field simultaneously. Selectable values are 0 – 15 and value 0 means automatic Q-value adjustment. When Q=0 is used reader will automatically increase the Q-value when lots of collisions are noticed and decreased the value when there are only few collisions. By default, the Q-value is set to 0.

Table 12. Relation between the Q-value and the number of open slots per round.

Q-value	slots	Q-value	slots
0	automatic	8	256
1	2	9	512
2	4	10	1024
3	8	11	2048
4	16	12	4096
5	32	13	8192
6	64	14	16384
7	128	15	32768

6.2 SESSION

There are four session options which you can use when initializing inventory round. Every session has two target states A and B. By default, Gen2 tags are at state A if tag has not been read recently. When tag is read it flips to state B and doesn't reply to readers query. The table below describes the persistence of tag's state machine when using different session values. For example, when using session 0 the tag will come back to state A immediately when tag power is lost. Usually tag loses the power when reader stops the inventory round or chances the channel. Persistence when tag power is ON is not defined by the ISO18000-6C when using session settings S0, S2 and S3. With session 1 the tag will keep it state over 500ms but less than 5s. With session values 2 and 3 tags will keep it states over 2s when tag power is lost. Time can vary depending what tag IC is used.

Table 13. Persistence characteristics of gen2 tags.

Flag	Persistence: tag power ON	Persistence: tag power OFF
S0	indefinite	none
S1	500ms < t < 5s	500ms < t < 5s
S2	indefinite	t > 2s
S3	indefinite	t > 2s

By changing the target setting from A target to B target reader is able to read also tags that has flipped its state to B state. This would happen if tags would have been read recently using Session 1 2 or 3. NUR2-1W module also supports dual target mode. In that mode reader will change the target mode between inventory rounds. By default, target mode A is used.

6.3 ROUNDS

The rounds setting defines how many query rounds is done inside one inventory round. After every inventory round the reader will send data to the Host. Selectable values are 0 – 10. Zero meaning automatic rounds adjustment. The automatic adjustment decides after every query round whether another round is necessary based on the number of data collisions. By default, rounds setting is set to 0. This setting can help the reader to find all the tags that are in the readers reading field when using session 0. Because tags that are found in query round 1 doesn't replay in the following query rounds. When using session 1/2/3 this does not make any significant difference because tags that are read are quiet anyway.

Table 14. Relation between inventory round and query round.

Inventory round				
Round 1	Round 2	round 3	…	Round 10

6.4 SELECTING THE RIGHT READING PARAMETERS

One approach is to test how many tags are in the readers reading field simultaneously. Keep the reader still at the position that is as close to real reading environment as possible and see how many tags are found. Based on that amount choose your open slot number to be 1.5 – 2 times larger (refer to the section 6.1). If reader will face many different tag populations auto-Q setting will be a good choice.

Besides Q-value one important parameter is session. In general, it could be stated that if the size of tag population is measured in thousands rather than in hundreds it is wise to use sessions 2 or 3. Because then every tag will be read only once and that makes large tag population much faster and easier to read. Rounds 1 setting is also advised to be used with session 1 or 2 or 3. With session 0 it might be useful to use higher rounds value than 1 to be able to find all the individual tags. By default, automatic (0) rounds setting is used.

The selected link profile will have also an effect the read speed.

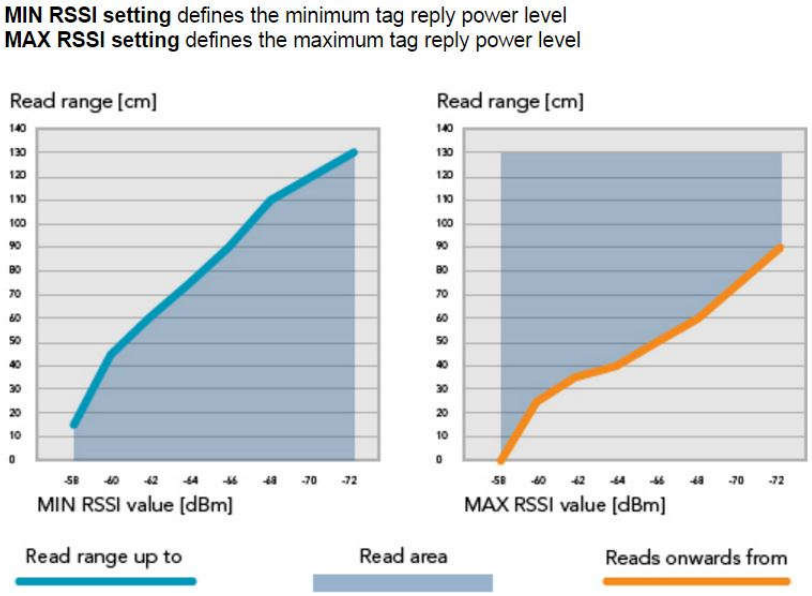
Table 15. Guideline settings to be used with different tag populations.

Settings	Tag population	Simultaneously in the field
Session 0, auto Q, auto Rounds	1 – 100	1 – 100
Session 1, auto Q, Rounds 1	100 – 1 000	under 500
Session 2/3, auto Q, Rounds 1	100 – 1 000	over 500
Session 2/3, auto Q, Rounds 1	over 1 000	over 500

6.5 RSSI FILTERS

NUR2-1W module has internal RSSI filters which can be used to limit the read area. By applying the filters, you can set the limits which tag replay must met in order to be registered. MIN RSSI –value means that tag replay signal needs to be equal or stronger then the defined value. Otherwise tag is not read. MAX RSSI value in other hand means that signal strength must be lower than the filter value.

Figure 8. Read range limited by RSSI filter (100mW TX power and 0dBi antenna gain)



6.6 DYNAMIC POWER SAVE MODES (TBD)

TBD

7 GPIO CONFIGURATIONS

NUR2-1W has 5 programmable GPIOs. All of them can be used as an input or output. They can be also configured to have different predefined functions.

7.1 INPUT / OUTPUT

All GPIOs can be configured via SW API to be inputs or outputs. IO voltage level is 3.3V and maximum source current is 4mA and sink current 4mA. When configured as input SW API can check what the state (high / low) of the GPIO pin is. When GPIO is configured as an output the SW API can drive the GPIO pin to high or low.

7.2 PREDEFINED FUNCTIONS

Table 16. NUR2-1W module GPIOs options.

I/O	Function	Action	Trigger
Output	-	-	-
Output	RFON	-	-
Output	Antenna control 1	-	-
Output	Antenna control 2	-	-
Input	-	-	-

RFON (GPIO type: OUTPUT)

When GPIO is configured as “RFON” it drives high state always when power amplifier is turned on. This function can be used for example driving LED indicator.

Antenna control 1 (GPIO type: OUTPUT)

When GPIO is configured as “antenna control 1” it can be used for controlling external multiplexer on the Host board to switch between two antennas. Via the SW API it’s possible to select which antennas are enabled and used or let the module automatically switch between them.

Table 17. 2 Port antenna control truth table.

Case (selected antenna)	antenna control 1
0 (antenna 1)	low
1 (antenna 2)	high

Antenna control 1 & 2 (GPIO type: OUTPUT)

If you want to connect up to 4 antennas and multiplex those using NUR2-1W module you need to configure 2 GPIOs to control the antenna switch. In this case you define one GPIO to be “antenna control 1” and second one to be “antenna control 2”. Via the SW API it’s possible to select which of the connected antennas are enabled and used or let the module automatically switch between them.

Table 18. 4 Port antenna control truth table.

Case (selected antenna)	antenna control 1	antenna control 2
0 (antenna 1)	low	low
1 (antenna 2)	high	low
2 (antenna 3)	low	high
3 (antenna 4)	high	high

8 DIAGNOSTIC FUNCTIONS

8.1 REFLECTED POWER MEASUREMENTS

This measurement can be used to check what is the matching of the antenna(s) and feed line(s). When this function is triggered will NUR2-1W module put carrier wave ON at full power and then measure the absolute power level that is coming to receiver port. There is a fixed difference in actual reflected power level and the level reported by the module. You can calculate the real reflected power level using below formula:

Reflected power level = (Reported reflected power level by the module) +(25)

8.2 CHANNEL SCANNER (TBD)

TBD

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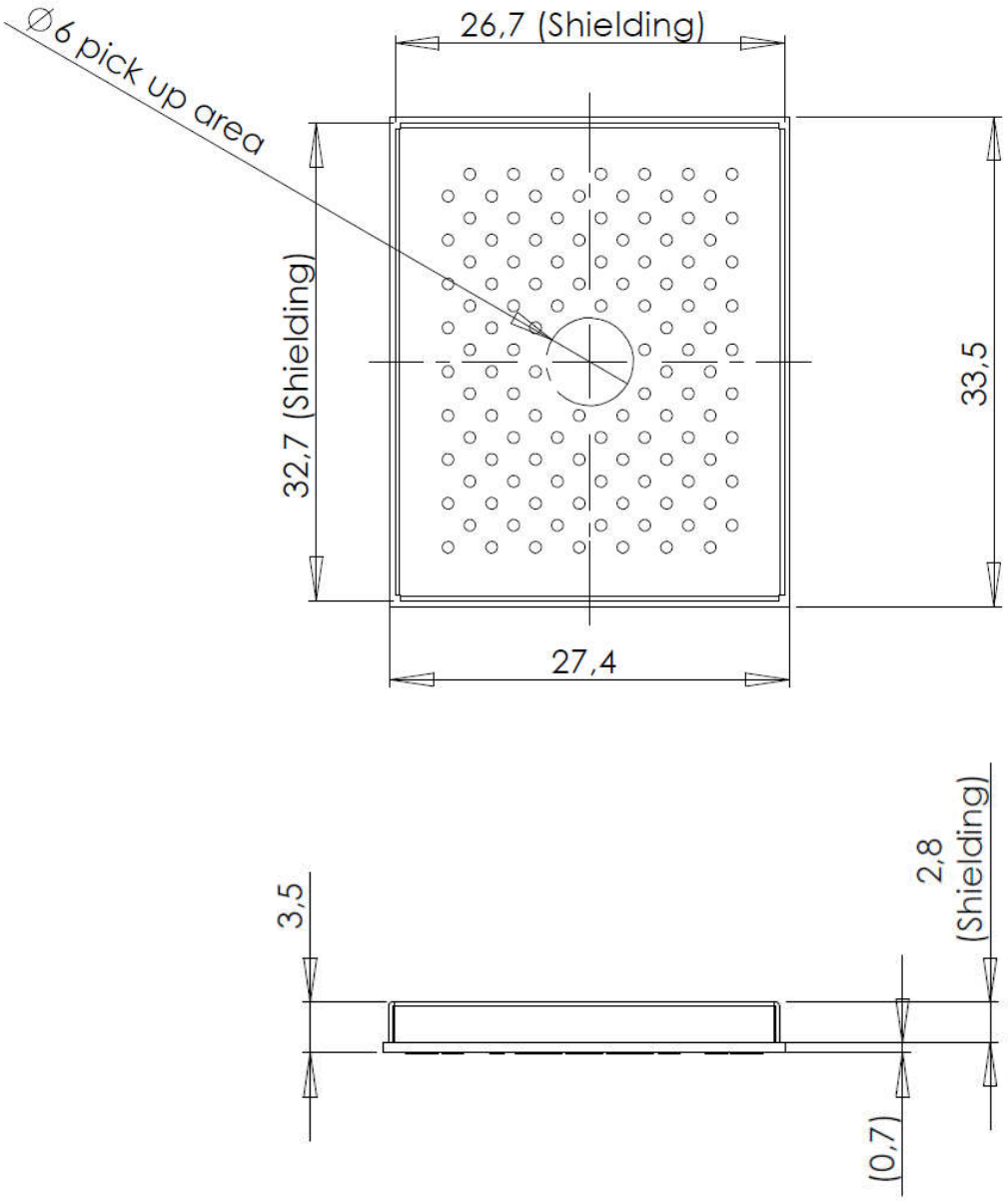
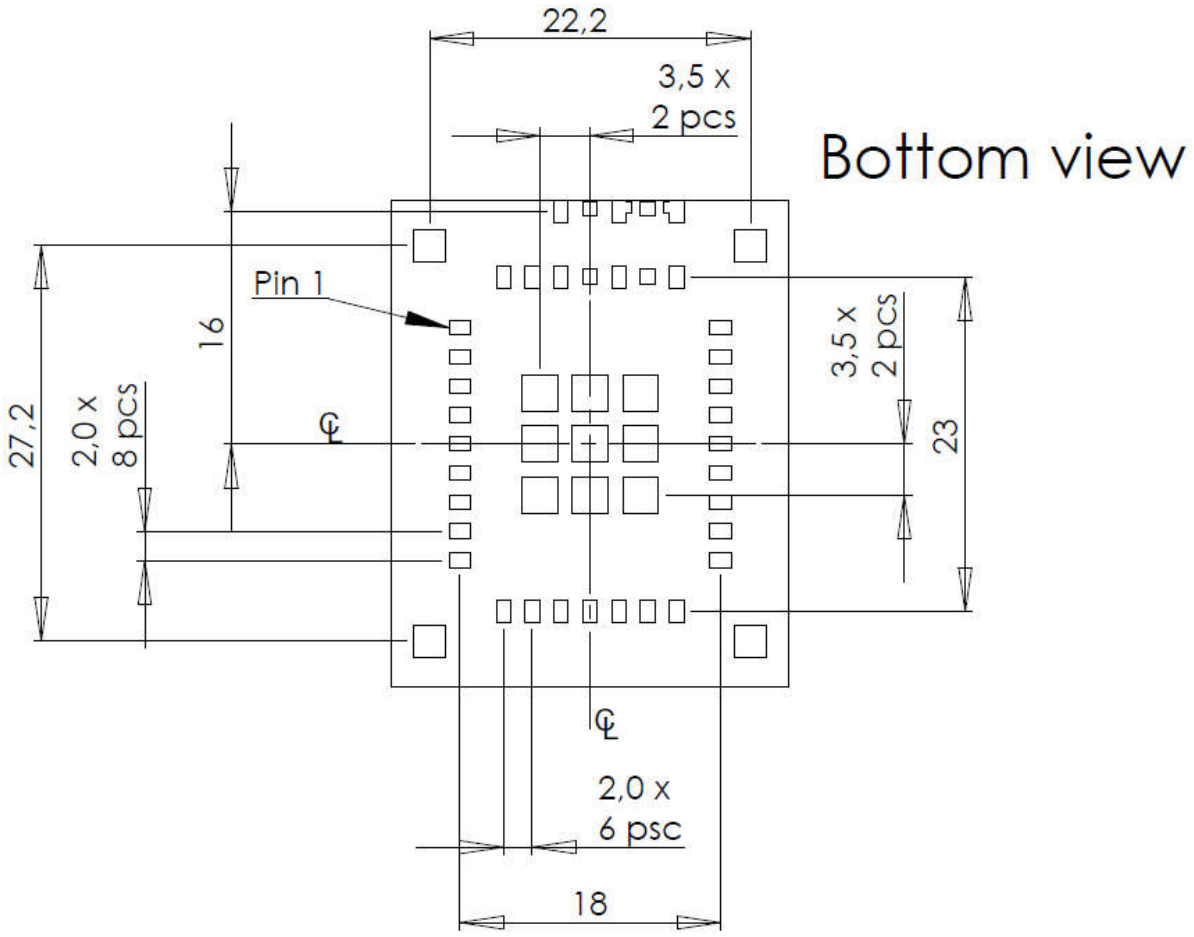
8.3 RECEIVED SIGNAL STRENGTH (RSSI)

When reading a tag NUR2-1W module also returns received signal strength indication values if wanted. Two values are returned per one tag. One is the absolute power level (dBm) and second is the scaled power level value of the tags backscatter signal. Scaled RSSI value is 0 – 100.

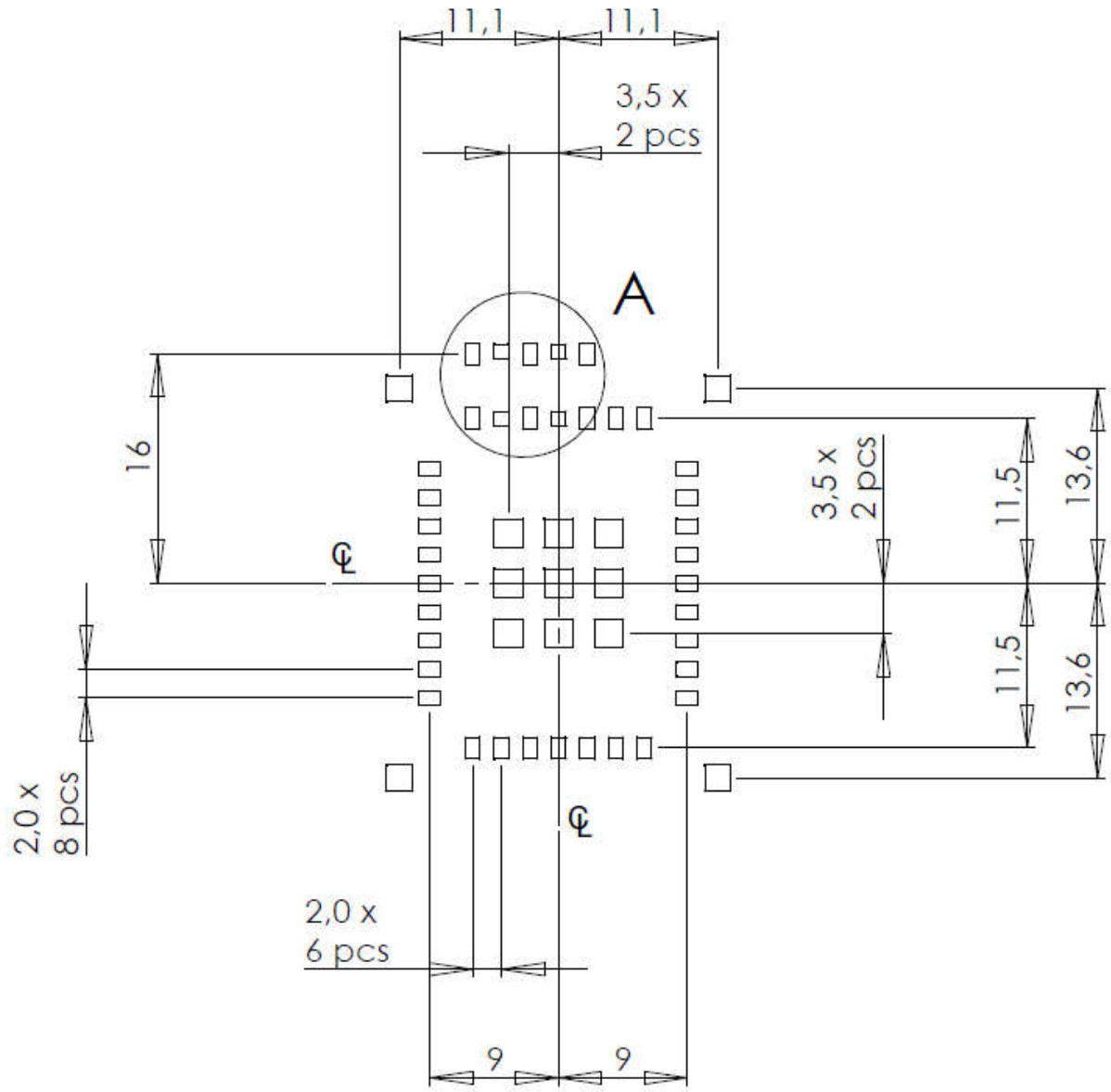
9 DIMENSIONS

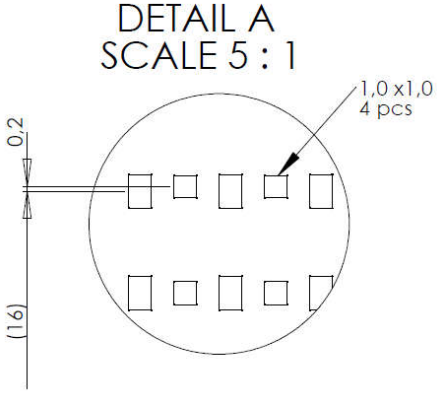
9.1 MECHANICAL DIMENSIONS

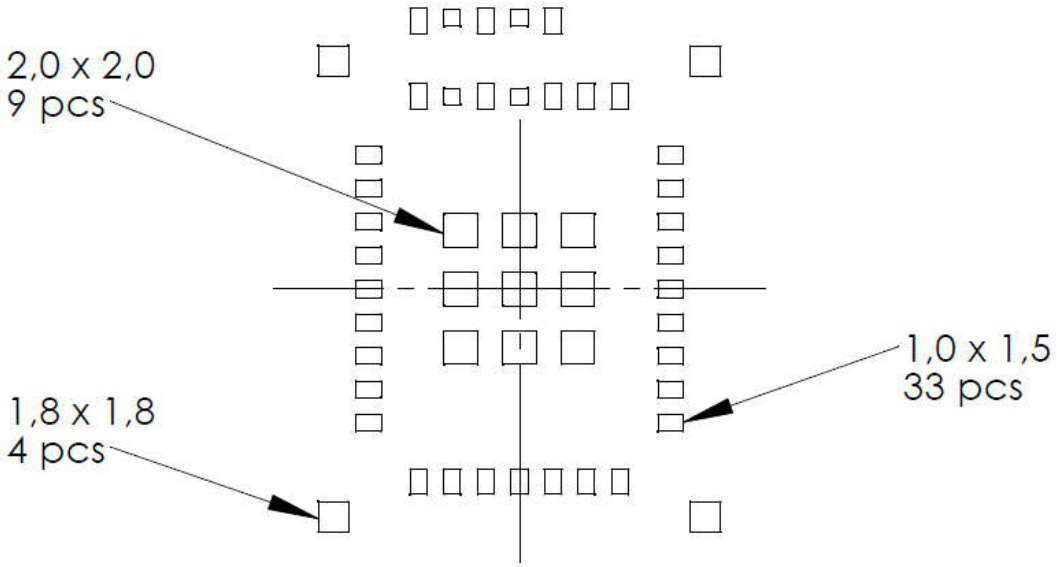


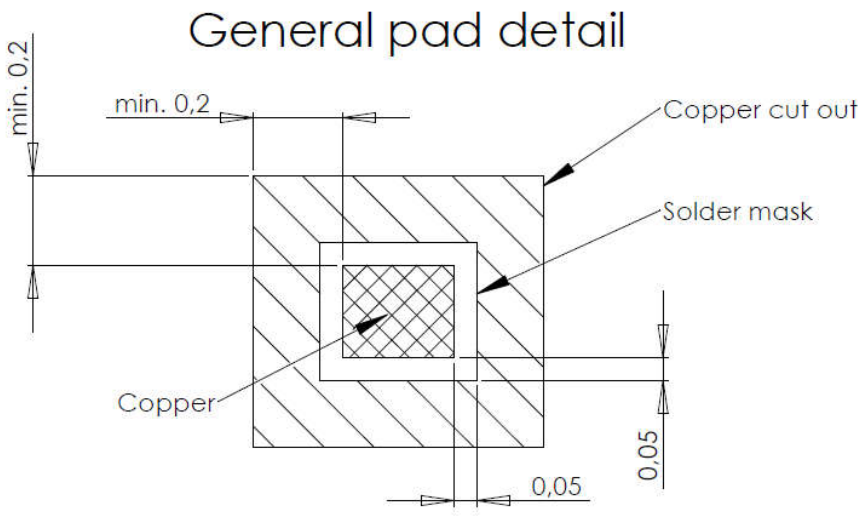

Bottom view
22,2
3,5 x
2 pcs
Pin 1
16
27,2
2,0 x
8 pcs
3,5 x
2 pcs
23
2,0 x
6 psc
18

9.2 LAND PATTERN

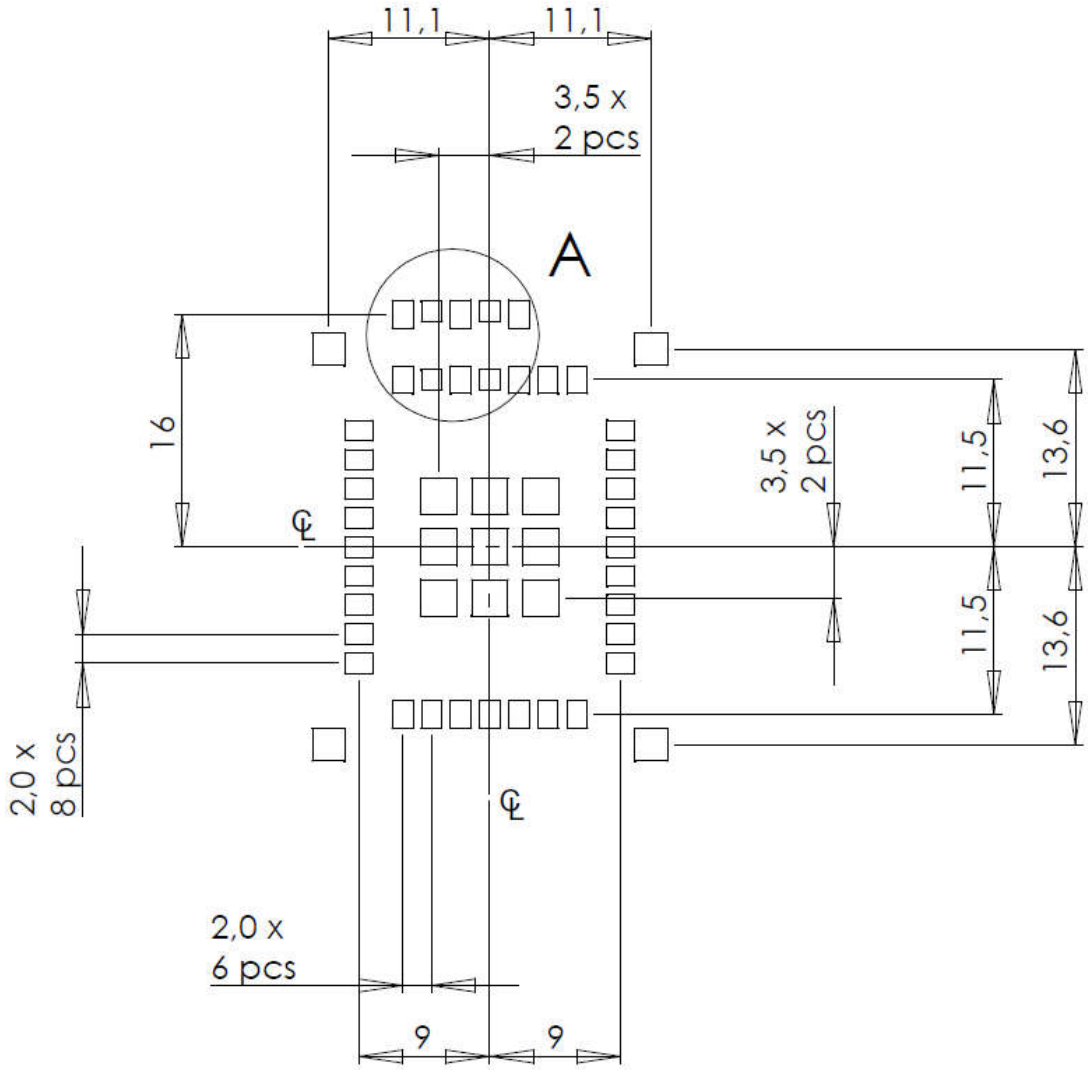


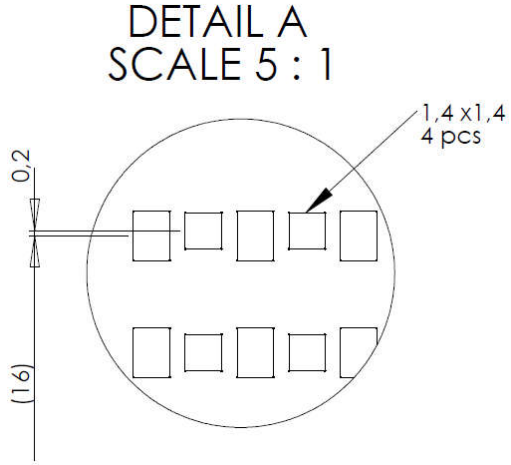


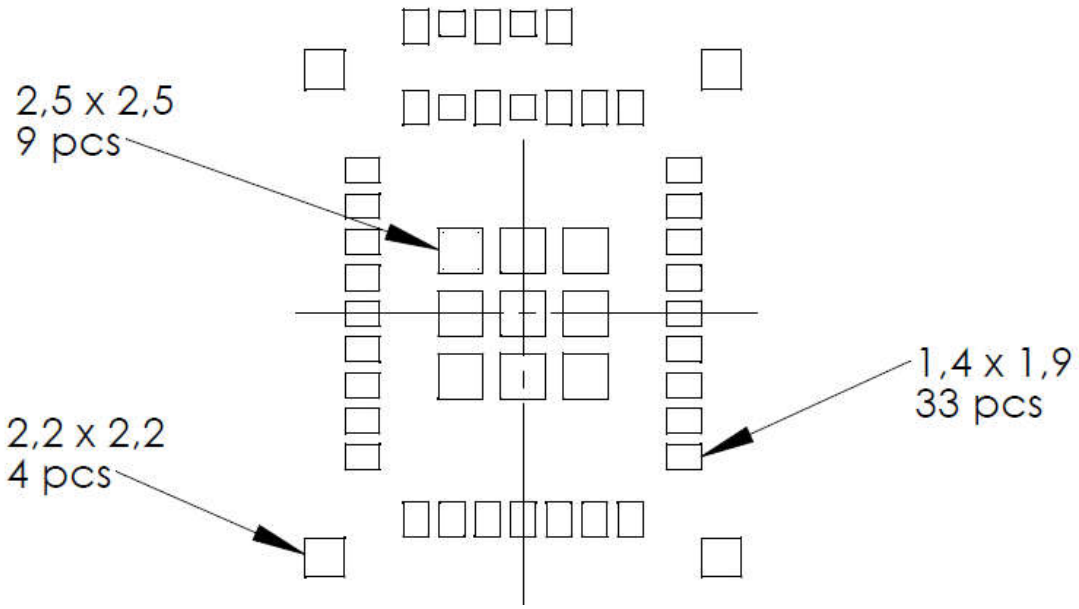

2,0 x 2,0
9 pcs
1,0 x 1,5
33 pcs
1,8 x 1,8
4 pcs


General pad detail
min. 0,2
min. 0,2
Copper cut out
Solder mask
Copper
0,05
0,05

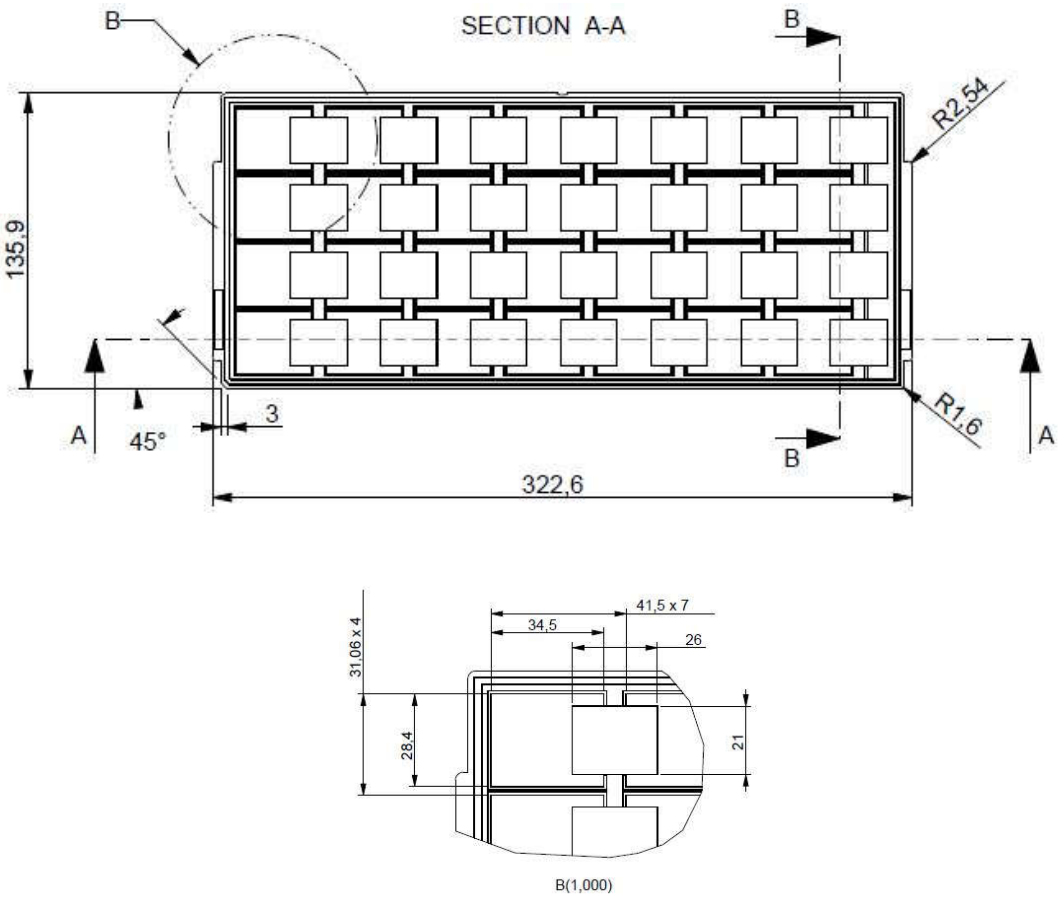
9.3 PASTE STENCIL






2,5 x 2,5
9 pcs
1,4 x 1,9
33 pcs
2,2 x 2,2
4 pcs

9.4 PACKING TRAY DIMENSIONS



All measures are in mm.

10 SMT ASSEMBLY PROCESS AND THERMAL PROCESSING

NUR2-1W module contains single sided assembly of SMT components reflow-soldered on multilayer HDI (high density interconnections) glass-fiber re-enforced epoxy printed board. The bottom side terminations are ENIG (NiP/Au) plated. Soldering alloy used for attaching module components is eutectic SnAgCu. Module internal components soldering has been optimized for minimal thermal stress.

NUR2-1W modules shall be delivered in a special tray packing to protect modules against mechanical, ESD and moisture related stresses. Due to high density interconnections technology, module total water content has to be below 0.1%-w prior to any thermal processing above water boiling point.

The board assembly process of NUR module on motherboard will introduce re-flow of module components. Thus, to avoid degradation of solder joint interfaces, the module has to be stored and soldered according to the guidelines given below.

10.1 STORAGE CONDITIONS

Long-term storage

Store modules in unopened vacuum packs in a dry cabinet under following environmental conditions

Temperature	+15…+27°C (optimal)
Temperature gradient	max. 2°C/hour
Relative humidity	<15% within specified temperature range

Opened and broken packages have to be re-sealed. If open time (floor life out of pack) has been exceeded, or moisture content detected, modules have to be baked prior to re-sealing vacuum pack.

Short-term storage (typically same as production environment)

Temperature	+20…+27°C
Temperature gradient	max. 2°C/hour
Relative humidity	<15% within specified temperature range

Modules may be stored in a dry cabinet without protective packing according to **IPC/JEDEC J-STD-033B.1, table 7-1.**

MSL level and open time

MSL level	5
Open time (floor life out of the bag)	48h

10.2 SOLDERING PROCESS

Boundary conditions

Acceptable soldering methods	Convection reflow in air or nitrogen atmosphere Condensation reflow soldering (vapor phase)
Recommended stencil thickness	125um ±10um
Pad design on motherboard	See recommended pad pattern
Stencil openings	See recommended stencil pattern
Recommended solder alloy	SnAg3.8±0.2Cu0.7±0.2 Note! If using under-eutectic solder alloys, such as SAC305, it may be necessary to increase reflow peak temperature by 5-10°C, due to higher mp. and lower fluidity of non-eutectic SnAgCu alloys. This will increase thermal stress to module and motherboard greatly.
Convection reflow oven heater configuration	Double sided heating required in reflow, recommended in preheating zones.
Maximum absorbed moisture content prior to thermal processing	0.1%-w (Test method IPC-TM-650, 2.6.28) Moisture content and/or moisture absorption rate, Printed Board
Recommended moisture reduction condition	+60°C/12h vacuum pack removed during drying, re-seal after drying, unless modules will be used within allowed open time after drying
Moisture and solvent contamination	No moisture or solvent contamination allowed in solder paste or on solderable surfaces

Recommended reflow conditions

Preheating phase	-max. duration 180s -end temperature 190-200°C

	-delta T on assembly max. 10°C at end of preheating
Soldering phase	-total duration 190s -max. time above 217°C (mp.) 30s -Tpeak max. 235°C, measured at module bottom -Tpeak max. 225°C, measured at motherboard surface, under module
Cooling	Two-stage, double sided cooling recommended 1st stage: 2-5°C/s cooling until melting point 2nd stage: 1-3°C/s after melting point

11 REGULATORY AGENCIES INFORMATION

When OEM prefers to leverage Nordic ID's grants and certifications of the NUR2-1W UHF RFID module, the host device documentation shall include regulatory compliance information on the NUR2-1W module. Corresponding to the applicable regulatory agencies the following sections outline regulatory compliance information needed in the user documentation and external labels for the host devices into which the NUR2-1W is integrated.

When leveraging Nordic ID's grants and certifications, antenna shall be taken into account in view of the fact that the NUR2-1W module has met the essential regulatory requirements with the antennas listed in the context of particular regulatory compliance information (Approved Antennas). Using the antenna that is an approved one, OEM integrator may demonstrate with less effort that the device with the integrated NUR2-1W module is in compliance with the requirements.

11.1 EUROPEAN UNION AND EFTA COUNTRIES

USER'S GUIDE REQUIREMENTS

This apparatus is in compliance with the essential requirements of the Radio Equipment Directive (RED) 2014/53/EU. In order to prove presumption of conformity with the essential requirements of the the Radio Equipment Directive (RED) 2014/53/EU, following requirements and test methods have been applied to the apparatus:

- article 3.2: ETSI EN 302 208 v3.1.1
  - Radio spectrum matters for Radio Frequency Identification (RFID) equipment operating in the band 865 MHz to 868 MHz with power levels up to 2W
- article 3.1b: ETSI EN 301 489-1 v2.2.0
  - Common ElectroMagnetic Compatibility (EMC) requirements
- article 3.1b: ETSI EN 301 489-3 v2.1.1
  - Specific ElectroMagnetic Compatibility (EMC) conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 246 GHz
- article 3.1a: EN 60950-1:2006 + A1:2010 + A11:2009+A12:2011+ A2:2013
  - General requirements for Safety of Information Technology Equipment

  EN 62479: 2010
  - Human exposure

EN 62311: 2008

- Human exposure limits

This apparatus is in compliance with EU Directive 2011/65/EU, Reduction of Hazardous Substances (RoHS).

Česky
[Czech]

[Nordic ID] tímto prohlašuje, že tento [RFID Radio module NUR2-1W] je ve shodě sezákladními požadavky a dalšími příslušnými ustanoveními směrnice 2014/53/ES.

Dansk
[Danish]

Undertegnede [Nordic ID] erklærer herved, at følgende udstyr [RFID Radio module NUR2-1W] overholder de væsentlige krav og øvrige relevante krav i direktiv 2014/53/EF.

Deutsch
[German]

Hiermit erklärt [Nordic ID], dass sich das Gerät [RFID Radio module NUR2-1W] in Übereinstimmung mit den grundlegenden Anforderungen und den übrigen einschlägigen Bestimmungen der Richtlinie 2014/53/EG befindet.

Eesti
[Estonian]

Käesolevaga kinnitab [Nordic ID] seadme [RFID Radio module NUR2-1W] vastavust direktiivi 2014/53/EÜ põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele.

English

Hereby, [Nordic ID], declares that this [RFID Radio module NUR2-1W] is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU.

Español
[Spanish]

Por medio de la presente [Nordic ID] declara que el [RFID Radio module NUR2-1W] cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 2014/53/EU.

Ελληνική
[Greek]

ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ [Nordic ID] ΔΗΛΩΝΕΙ ΟΤΙ [RFID Radio module NUR2-1W] ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 2014/53/ΕΚ.

Français

[French]

Par la présente [Nordic ID] déclare que l'appareil [RFID Radio module NUR2-1W] est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 2014/53/EU.

Italiano

[Italian]

Con la presente [Nordic ID] dichiara che questo [RFID Radio module NUR2-1W] è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 2014/53/EU.

Latviski

[Latvian]

Ar šo [Nordic ID] deklarē, ka [RFID Radio module NUR2-1W] atbilst Direktīvas 2014/53/EK būtiskajām prasībām un citiem ar to saistītajiem noteikumiem.

Lietuvių

[Lithuanian]

Šiuo [Nordic ID] deklaruoja, kad šis [RFID Radio module NUR2-1W] atitinka esminius reikalavimus ir kitas 2014/53/EB Direktyvos nuostatas.

Nederlands

[Dutch]

Hierbij verklaart [Nordic ID] dat het toestel [RFID Radio module NUR2-1W] in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 2014/53/EG.

Malti

[Maltese]

Hawnhekk, [Nordic ID], jiddikjara li dan [RFID Radio module NUR2-1W] jikkonforma mal-ħtiġijiet essenzjali u ma provvedimenti oħrajn relevanti li hemm fid-Dirrettiva 2014/53/EU.

Magyar

[Hungarian]

Alulírott, [Nordic ID] nyilatkozom, hogy a [RFID Radio module NUR2-1W] megfelel a vonatkozó alapvetõ követelményeknek és az 2014/53/EU irányelv egyéb elõírásainak.

Polski

[Polish]

Niniejszym [Nordic ID] oświadcza, że [RFID Radio module NUR2-1W] jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 2014/53/EU.

Português
[Portuguese]

[Nordic ID] declara que este [RFID Radio module NUR2-1W] está conforme com os requisitos essenciais e outras disposições da Directiva 2014/53/EU.

Slovensko
[Slovenian]

[Nordic ID] izjavlja, da je ta [RFID Radio module NUR2-1W] v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 2014/53/ES.

Slovensky
[Slovak]

[Nordic ID] týmto vyhlasuje, že [RFID Radio module NUR2-1W] spĺňa základné požiadavky a všetky príslušné ustanovenia Smernice 2014/53/ES.

Suomi
[Finnish]

[Nordic ID] vakuuttaa täten että [RFID Radio module NUR2-1W] tyyppinen laite on direktiivin 2014/53/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.

Svenska
[Swedish]

Härmed intygar [Nordic ID] att denna [RFID Radio module NUR2-1W] står i överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 2014/53/EG.

LABELING REQUIREMENTS

The '**CE**' marking must be in a visible area on the OEM product.

APPROVED ANTENNAS

Maximum allowed ERP power is 33dBm. NUR2-1W has maximum output power of 30dBm. Meaning that 5dBi is the maximum allowed antenna gain without cable losses.

Formula how to calculate maximum allowed antenna gain:
30 dBm – 2.15 (dipole gain) + [antenna gain dBi] – [cable attenuation dB] < 33dBm

Beamwidth restrictions:
For transmissions ≤500 mW e.r.p. there shall be no restriction on beam width.

For transmissions of > 500 mW e.r.p. to ≤ 1 000 mW e.r.p. beam widths shall be ≤ 180º

For transmissions of > 1 000 mW e.r.p. to 2 000 mW e.r.p. beam widths shall be ≤ 90º

11.2 FCC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note

User of the module cannot change the region setting of the module. When FCC region is set, the module operates in frequency band of 902 – 928Mhz.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This NUR2-1W transmitter module is authorized to be used in other devices only by OEM Integrators under the following conditions:

1. The module can be used only with the approved antenna types (see the section of Approved antennas below) having the antenna gains of 5dBi and 6dBi at the maximum. The approved antennas need the following minimum separation distances when installed:

Product	Uncontrolled/general population	Occupational / controlled environments
NUR2-1W + antenna with 5dBi max. gain	RF exposure evaluation is not required at 20.4cm separation distance @915MHZ	RF exposure evaluation is not required at 20cm separation distance @915MHZ
NUR2-1W + antenna with 6dBi max. gain	RF exposure evaluation is not required at 22.8cm separation distance @915MHZ	RF exposure evaluation is not required at 20cm separation distance @915MHZ

Table 11.2.1

Note. The antenna must be installed such that the minimum separation distance can be maintained between the antenna (radiator) and user's/nearby people's body at all times.

If the antenna being one of the approved antenna types has lower antenna gain than the type's maximum one, the minimum separation distance (d in cm) can be calculated by giving the EIRP (in mW) of the configuration and the maximum permissible exposure ($S = 0.61\ mWcm^{-2}$) to the following formula: $d = \sqrt{(EIRP/(4\pi S))}$. However, despite the fact that the result of the calculation can be below 20 cm, the separation distance of 20 cm is always the minimum.

The EIRP ($EIRP_{dBm} = P_o - L_l + G$) needed for the calculation of minimum separation distance consists of the following factors:

P_o = (Maximum peak output of NUR2-1W transmitter + measurement uncertainty) = + (dBm)
L_l = (Line losses) = known value (dB)
G = (Antenna gain) = known value (dBi)

2. The transmitter module must not be co-located with any other transmitter, except with those that are within the limits shown in the NUR2-1W filing.

3. The transmitter module can only be used with a host antenna circuit trace layout design in strict compliance with the OEM instructions provided.

When the conditions above are met, typically no radio transmitter testing of NUR2-1W is required. However, the OEM integrators have responsibility for testing their end-product for other compliance requirements, for example digital device emissions, PC peripheral requirements.

The antenna used with the NUR2-1W transmitter module shall comply with the gain limit of 6 dBi. The antennas having higher gain may be used, if cable loss compensates the exceeded antenna gain. For example, 2dB antenna cable loss reduces the EIRP of the configuration so that 8dBi antenna may be used. If the cable loss does not cancel out the exceeded gain then the transmitter's conducted output power shall be reduced so that the EIRP of the configuration is kept inside the limits of 4W.

Note.
In the event that these conditions can't be met (for certain configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can't be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

The OEM integrator must be aware not to provide information to the end user regarding how to install or remove this RF module in the user manual of the end product.

For the User's Guide the required FCC statements outlined in the User's Guide Requirements section must be in a prominent location.

USER'S GUIDE REQUIREMENTS

The texts in quotation marks below are the required FCC statements in the user's guide. The note given in brackets is not an FCC statement but it gives the required information on the first required FCC statement.

"To comply with FCC's RF radiation exposure requirements in general population environment, the antenna(s) used for this transmitter must be installed such that a minimum separation distances of 'd' cm (shown in table 11.2.1) is maintained between the radiator (antenna) & user's/nearby people's body at all times and must not be co-located or operating in conjunction with any other antenna or transmitter."

(Note: Use the following formula to find the 'd' in cm: $d = \sqrt{(EIRP/(4 \pi S))}$; let 'EIRP' have the maximum EIRP (in mW) of your transmitter configuration, and let 'S' have the 0.61 (in mW/cm^2) value. In addition, the 'd' value cannot be below separation distances shown in table 11.2.1, although the formula would yield smaller minimum separation distance d. See also the EIRP factors mentioned above.)

"To comply with FCC's RF radiation exposure requirements in controlled environment, the antenna(s) used for this transmitter must be installed such that a minimum separation distances of 'd' cm (shown in table 11.2.1) is maintained between the radiator (antenna) & user's/nearby people's body at all times and must not be co-located or operating in conjunction with any other antenna or transmitter."

(Note: Use the following formula to find the 'd' in cm: $d = \sqrt{(EIRP/(4 \pi S))}$; let 'EIRP' have the maximum EIRP (in mW) of your transmitter configuration, and let 'S' have the 3.050 (in mW/cm^2) value. In addition, the 'd' value cannot be below separation distances shown in table 11.2.1, although the formula would yield smaller minimum separation distance d. See also the EIRP factors mentioned above.)

"This device complies with Part 15 of the FCC Rules"

"Any changes or modifications to the transmitting module not expressly approved by Nordic ID Oy could void the user's authority to operate this equipment"

LABELING REQUIREMENTS

The end product must be labeled with the following identification information in a visible area:

"Contains Transmitter Module FCC ID: SCCNUR21W"

or

"Contains FCC ID: SCCNUR21W"

APPROVED ANTENNAS

Option 1:

Manufacturer:	Nordic ID
Antenna Description:	4 Patch antenna-array
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	ARx5_antenna
Gain:	6dBi

Option 2:

Manufacturer:	Nordic ID
Antenna Description:	Cross Dipole antenna with reflector
Frequency range:	902 – 928 MHz
Manufacturer Product Name:	Medea_ACD_antenna
Gain:	5dBi

Option 3:

Manufacturer:	TBD
Antenna Description:	TBD
Frequency range:	TBD
Manufacturer Product Name:	TBD
Gain:	TBD

11.3 INDUSTRY CANADA

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropic radiated power (e.i.r.p.) is not more than that necessary for successful communication.

To leverage the Nordic ID's IC grant, the device with the integrated NUR2-1W module shall be met the following conditions:

1. The antennas being the approved types with the maximum gain of 5dBi and of 6dBi shall be installed so that the device's user or nearby people or passing people cannot compromise the minimum separation distances shown in table 11.3.1, respectively, in any situation.
   If the antenna being one of the approved antenna types has lower antenna gain than the type's maximum one, the minimum separation distance in general public environment (d in cm) can be calculated by giving the EIRP of the configuration and the exposure limit (S = 0.276 $mWcm^2$) to the following formula: $d = \sqrt{(EIRP/(4 \pi S))}$.
   For controlled environment (d in cm) can be calculated by giving the EIRP of the configuration and the exposure limit (S = 0.629 $mWcm^{-2}$) to the following formula: $d = \sqrt{(EIRP/(4 \pi S))}$.

Product	Uncontrolled/general population	Occupational / controlled environments
NUR2-1W + antenna with 5dBi max. gain	RF exposure evaluation is not required at 30.2 cm separation distance @915MHZ	RF exposure evaluation is not required at 20cm separation distance @915MHZ
NUR2-1W + antenna with 6dBi max. gain	RF exposure evaluation is not required at 33.9cm separation distance @915MHZ	RF exposure evaluation is not required at 20cm separation distance @915MHZ

Table 11.3.1

The EIRP ($EIRPdBm = P_o - L_l + G$) needed for the calculation of minimum separation distance consists of the following factors:

P_o = (Maximum peak output of NUR2-1W transmitter + measurement uncertainty) = + (dBm)
L_l = (Line losses) = known value (dB)
G = (Antenna gain) = known value (dBi)

2. The antenna(s) used with the NUR2-1W module must not be co located in conjunction with any other transmitter or its antenna that is capable of transmitting at the same time, except the transmitter-antenna configurations that are within the limits of the NUR2-1W's IC grant.

3. The design of an antenna circuit trace layout in a host shall comply with the OEM design instructions provided.

When the conditions above are met, typically no transmitter testing is required, although the OEM integrator shall demonstrate that the end-product is in compliance with the other regulatory requirements.

There is no user's documentation requirements other than that the required FCC statements outlined in the FCC section are in a prominent place in the user's guide.

Note

User of the module cannot change the region setting of the module. When FCC region is set, the module operates in frequency band of 902 – 928Mhz.

LABELLING REQUIREMENTS FOR THE HOST DEVICE

The end product must be labeled with the following identification information in a visible area:

"Contains IC: 5137A-NUR21W"

CERTIFIED ANTENNAS

This radio transmitter 5137A-NUR21W has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Option 1:

Manufacturer:	Nordic ID
Antenna Description:	4 Patch antenna-array
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	ARx5_antenna
Gain:	6dBi

Option 2:

Manufacturer:	Nordic ID
Antenna Description:	Cross Dipole antenna with reflector
Frequency range:	902 – 928 MHz
Manufacturer Product Name:	Medea_ACD_antenna
Gain:	5dBi

11.4 INDUSTRIE CANADA

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante..

Le module émetteur NUR2-1W estautorisé à êtreutilisé avec d'autresappareilsuniquement par des intégrateurs OEM sous les conditions suivantes :

1. Les antennes étant les types approuvés avec le gain maximal de 5dBi et de 6dBi doivent être installés de sorte que l'utilisateur du périphérique ou les personnes proches ou les personnes passantes ne puissent pas compromettre les distances minimales de séparation indiquées dans le tableau 11.3.1, respectivement, dans n'importe quelle situation.

   Si l'antenne étant l'un des types d'antennes approuvés a un gain d'antenne inférieur à celui du maximum du type, la distance minimale de séparation dans l'environnement public général (d en cm) peut être calculée en donnant le PIRE de la configuration et la limite d'exposition (S = 0,276 mWcm2) à la formule suivante: d = √ (PIRE / (4πS)).

   Pour l'environnement contrôlé (d en cm), on peut calculer en donnant le PIRE de la configuration et la limite d'exposition (S = 0,629 mWcm-2) à la formule suivante: d = √ (EIRP / (4πS)).

La PIRE ($PIRE_{dBm} = P_o - L_l + G$) nécessaire pour le calcul de la distance minimale de séparation se compose des facteurs suivants :

P_o (Puissance de crête maximale de l'émetteur NUR2-1W + incertitude de mesure) = + (dBm)
L_l (Pertes en lignes) = valeur connue (dB)
G (Gain d'antenne) = valeur connue (dBi)

2. Le module émetteur ne doit pas êtrecolocalisé avec d´autre(s) transmetteur(s), saufsice(s) dernier(s) répond(ent) avec ceux qui sontdans les limitesindiquéesdansl´application de NUR2-1W.

3. Le module émetteurpeutêtreuniquementutilisé avec unschéma du design de configuration de la piste du circuit de l'antennehôteenrespectantstrictement les instructions OEM fournies.

Lorsque les conditions ci-dessus sont remplies, aucun test radio de l'émetteur NUR2-1W ne sera généralement nécessaire, même si l'intégrateur OEM devra démontrer que le produit final est en conformité avec les autres exigences réglementaires.

Il n'existe aucune exigence de documentation de l'utilisateur autre que le fait que les déclarations obligatoires FCC dans la section FCC soient bien en vue dans le guide de l'utilisateur.

Observation:

L'utilisateur du module ne pourra pas changer les paramètres région du module. Quand le paramètre région FCC est sélectionné, le module fonctionne sur la bande de fréquence 902-928Mhz.

EXIGENCES APPLICABLES AUX APPAREILS HÔTES

Le produit fini doit disposer d´étiquette mentionnant les information suivantes d´identification sur une surface visible:

"Contains IC: 5137A-NUR21W"

TYPES D'ANTENNES ACCEPTABLES

Le présent émetteur radio (IC: 5137A-NUR21W) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Option 1:

Manufacturer:	Nordic ID
Antenna Description:	4 Patch antenna-array

Frequency range:	902 – 928 MHz
Manufacturer Part Number:	ARx5_antenna
Gain:	6dBi

Option 2:

Manufacturer:	Nordic ID
Antenna Description:	Cross Dipole antenna with reflector
Frequency range:	902 – 928 MHz
Manufacturer Product Name:	Medea_ACD_antenna
Gain:	5dBi