NORDIC ID NUR3-0W5 HARDWARE IMPLEMENTATION GUIDE

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1. GENERAL DESCRIPTION

Nordic ID NUR3-0W5 is a next generation, medium range RAIN UHF RFID reader/writer module. It is compatible with ISO18000-63 (EPC C1G2) standard. Module complies and is pre-certified for CE/RED (ETSI), FCC and IC/ISED. It is also compatible with DRM (dense reader mode) requirements. Maximum output power is +27dBm (0.5W) and it can be adjusted via SW API with 1 dB steps. Maximum sensitivity is -87dBm when measured according to RAIN recommendations.

1.1. KEY FEATURES

- SMT compatible module with small footprint
- ISO 18000-63 (EPC C1G2) full protocol support
- Low power consumption with high noise rejection
- DRM compatible
- High performance with +27dBm output power, adjustable by 1dB steps
- Pre-certified for EU/RED, TELEC and FCC and IC/ISED regions
- UART and USB 2.0 communication
- 6 programmable GPIOs with event trigger
- Increased sensitivity due to automatic leakage cancelation
- Tag replay quality indicators (RSSI, phase rotation value and phase difference value)
- Accurate RF output due to on-board TX power measurement circuitry

1.2. TYPICAL APPLICATION SCHEMATICS

Please refer to the reference design of the NUR3-0W5. It demonstrates a simple schematic around a NUR3-0W5 module to form a 4-port fixed reader with dedicated USB-C port for power supply and dedicated USB-C port for communications. Also, UART-port and GPIO's of the NUR3-0W5 module are available for easy testing and development.

2. ELECTRICAL SPESIFICATIONS

This section provides information about the DC, RF, and performance characteristics of the Nordic ID NUR3-0W5 module.

2.1. ABSOLUTE MAXIMUM RATINGS

Violating below values may cause permanent damage to the module. Also, correct operation of the module is not guaranteed if operating outside of the absolute maximum limits. NUR3-0W5 is ESD sensitive component so it must be handled with care.

Absolute maximum rating	Value
Operating temperature	-20°C to +55°C
Storage temperature	-30°C to +85°C
Supply voltage and enable pad	+6.0V
GPIO pads	+4.0V
Other pads	+4.0V

Table 1. *Absolute maximum ratings of the NUR3-0W5 module.*

2.2. DC CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Units
V_{ext}	Supply voltage	3.6	4.0	5.5	V
I_{ext}	Supply current (reading 27dBm TX power)	-	1.0	1.2	A
I_{source}	GPIO pad source current	-	-	4	mA
I_{sink}	GPIO pad sink current	-	-	2	mA
Vlow	GPIO pad input low-level voltage	-	-	1	V
Vhigh	GPIO pad input high-level voltage	2.3	-	-	V
V_{en}	Module enable voltage	1.2	-	V_{ext}	V

Table 2*. DC characteristics of the NUR3-0W5 module (V_{ext} = 4.0V and ambient temp +25°C).*

2.3. RF CHARACTERISTICS

Symbol	Parameter	Min	Typ	Max	Units
S_{ens}	Receiver sensitivity (S11 better than 15dB)	-	-	-87	dBm
P_{out}	Output power range	-2	-	27	dBm
$P_{tolHigh}$	TX range from 24 to 27dBm	-0.5	P_{out}	+0.5	dB
P_{tolMed}	TX range from 14 to 23dBm	-1	P_{out}	+1	dB
P_{tolLow}	TX range from -2 to 13dBm	-1.5	P_{out}	+1.5	dB
$P_{tolTemp}$	TX variation over full temperature range	-2	P_{out}	+2	dB
P_{adj}	TX power adjustment step	1	1	1	dB
S_{11}	VSWR requirement	-	1.5:1	-	50Ω
$D_{r\rightarrow t}$	Reader-to-tag data rates	40	40	80	kbps
$D_{t\rightarrow r}$	Tag-to-reader data rates	20	64	640	kbps

***Table 3**. RF characteristics of the NUR3-0W5 module (V_{ext} = 4.0V and ambient temp +25°C).*

2.4. PERFORMANCE CHARACTERISTICS

The performance of the NUR3-0W5 reader module is dependent on the test environment, used reader antenna, tag antenna and tag IC. In addition, interferences from other radio sources operating in the same frequency range may decrease the performance. Selected radio and inventory parameters do have a big influence to reading performance as well and those should be optimized to the size of the tag population in question.

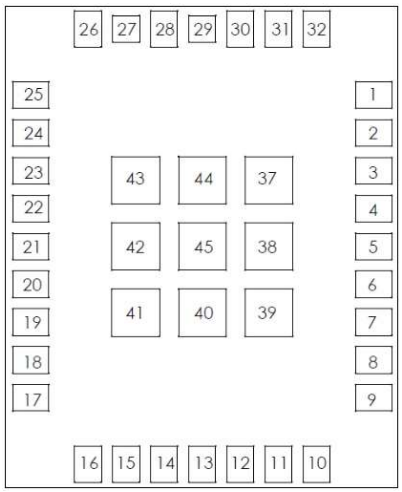
Symbol	Parameter	Min	Typ	Max	Units
R_{dist}	Typical read distance with 5dBi antenna*	-	15	-	m
$R_{rateRob}$	Maximum read rate (Robust RF profile)	-	-	50+	tags/s
$R_{rateNom}$	Maximum read rate (Nominal RF profile)	-	-	250+	tags/s
$R_{rateFast}$	Maximum read rate (Fast RF profile)	-	-	500+	tags/s
$R_{rateHigh}$	Maximum read rate (High speed RF profile)	-	-	900+	tags/s
$R_{rateHigh2}$	Maximum read rate (High speed_2 RF profile)	-	-	1000+	tags/s
O_{temp}	Operation ambient temperature range	-20	-	+55	°C
H_{rel}	Relative humidity	10	-	95	%

***Table 4**. Performance characteristics of the NUR3-0W5 module (V_{ext} = 4.0V and ambient temp +25°C).*

*Measured using Smartrac Belt/R6 tag and 8dBi antenna gain

3. PAD ASSIGNMENTS

3.1. PAD DESIGNATION



Picture 2. *NUR3-0W5 pad numbering (top thru view).*

3.2. SIGNAL-TO-PAD MAPPING

Pad number	Signal name	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	Input	Do not connect
8	UART_RX	Input	3.3V TTL (data from host to module)
9	UART_TX	Output	3.3V TTL (data from module to host)
10	USB_DN	Bidirectional	USB– (USB 2.0 device)
11	USB_DP	Bidirectional	USB+ (USB 2.0 device)
12	USB_5V	Input	Used only for USB detection
13	VCC_3V3_OUT	Supply output	Do not connect
14	EN	Input	Module enable (active high)

15	GND	Supply	Ground
16	RFU1	-	Reserved for future use
17	VEXT	Supply input	Main supply
18	RFU2	-	Reserved for future use
19	RFU3	-	Reserved for future use
20	GND	Supply	Ground
21	GND	Supply	Ground
22	GND	Supply	Ground
23	GND	Supply	Ground
24	GND	Supply	Ground
25	GND	Supply	Ground
26	GND	Supply	Ground
27	RF	Bidirectional	50Ω RF output / input
28	GND	Supply	Ground
29	RFU_RF2	-	Reserved for future use
30	GND	Supply	Ground
31	RFU4	-	Reserved for future use
32	RFU5	-	Reserved for future use
37-45	GND	Supply	Ground

Table 5. *Signal-to-pad mapping of the NUR3-0W5 module.*

3.3. SIGNAL DESCRIPTIONS

Signal name: GND	Pads: 15, 20-26, 28, 30, 33-46, 48, 50
These pads are used for grounding and to improve the thermal performance. They should be connected to Host board GND net.	
Signal name: GPIO_*	Pads: 1-6
These pads 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 2mA.	
Signal name: ERASE	Pad: 7

This pad is used for production testing purposes only. Do not connected.	
Signal name: UART_RX	Pad: 8
This pad 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: UART_RX	Pad: 9
This pad 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	Pad; 10
This pad is used for USB data- (USB 2.0 device port). It is recommended to use external ESD protection component if connected to user accessible USB connector.	
Signal name: USB_DP	Pad: 11
This pad is used for USB data+ (USB 2.0 device port). It is recommended to use external ESD protection component if connected to user accessible USB connector.	
Signal name: USB_5V	Pad: 12
This pad 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	Pad: 13
This pad is connected to internal power regulator output. The pin is used for production testing only and it should not be connected.	
Signal name: EN	Pad: 14
Driving this pad to high will enable the NUR3-0W5 module. It is internally connected to onboard voltage regulator's enable input. The trigger level is 1.2V. From the power off state the module wakeup takes up to 1500ms. If the external power switch is used to toggle ON and OFF, this pad can be connected directly to VEXT.	
Signal name: RFU*	Pads: 16, 18, 19, 27, 29, 31, 32, 49
These pads are reserved for future use. Do not connect.	
Signal name: VEXT	Pad: 17
This pad is used for powering the NUR3-0W5 module. It is recommended to use 200µF (low ESR) 100nF and 100pF capacitor near the VEXT input pad to maintain stable operating voltage for the reader module.	
Signal name: RF	Pad: 47
RF output / input pad. Trace to this pad should be designed to 50Ω impedance level. See more details from the design considerations section.	

Table 6. *Signal descriptions of NUR3-0W5 module.*

4. OEM DESIGN CONSIDERATIONS

This section covers OEM design considerations. Design guidance's presented below needs to be followed to guarantee a proper operation of the Nordic ID NUR3-0W5 UHF RFID module.

4.1. RF OUTPUT AND ANTENNA REQUIREMENTS

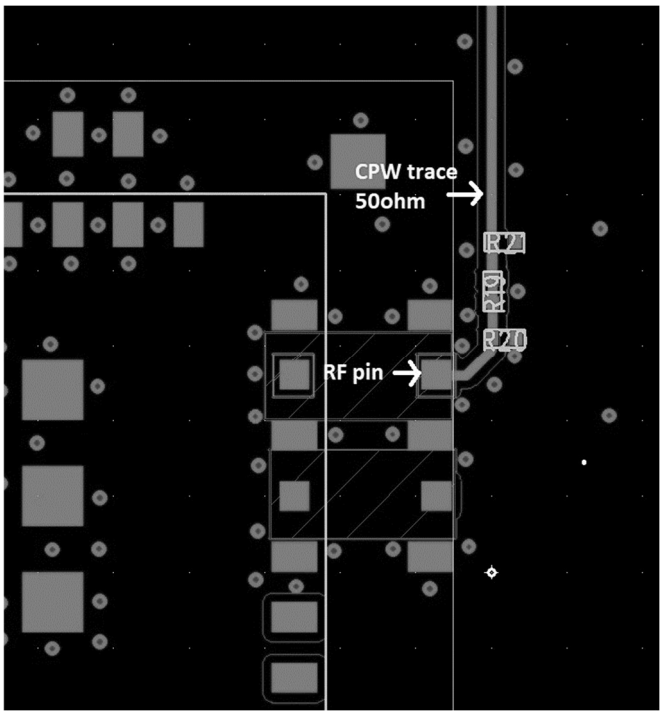
The RF output impedance level is 50Ω so the trace leaving from the RF pad shall be kept in that same impedance level to avoid reflections and mismatch of the RF signal. From the RFID reader module's point of view, it is important that the used antenna has a low VSWR value. The VSWR shall be better than 1.5:1 to avoid decrease in the sensitivity performance of the receiver.

Poor VSWR of the antenna leads to situation where significant portion of the transmitted signal will reflect to the module from the antenna. NUR3-0W5 module has automatic leakage cancellation system that decreases the effect of the reflected signal. The automatic leakage cancellation is automatically on when module is operating in normal mode.

4.1.1. LAYOUT RECOMMENDATIONS

Because Nordic ID NUR3-0W5 module 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 the optimal performance from the device. Poor layout can decrease the output power, sensitivity, and cause mask violations.

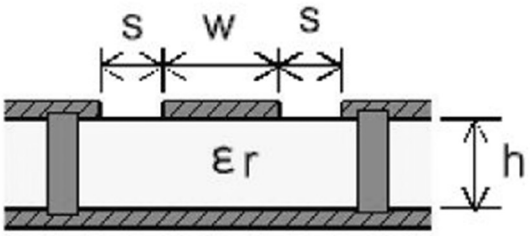
Component places; R2, R19 and R20 are for additional output matching. Additional matching is not used in the reference design. Thus values are as follows: R2 = No assembly, R20 = No assembly and R19 = 100pF 0402 capacitor.



Picture 3. *RF output layout of the reference design.*

4.1.2. TANSMISSION 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.



Picture 4. *Grounded CPW with via stitching.*

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

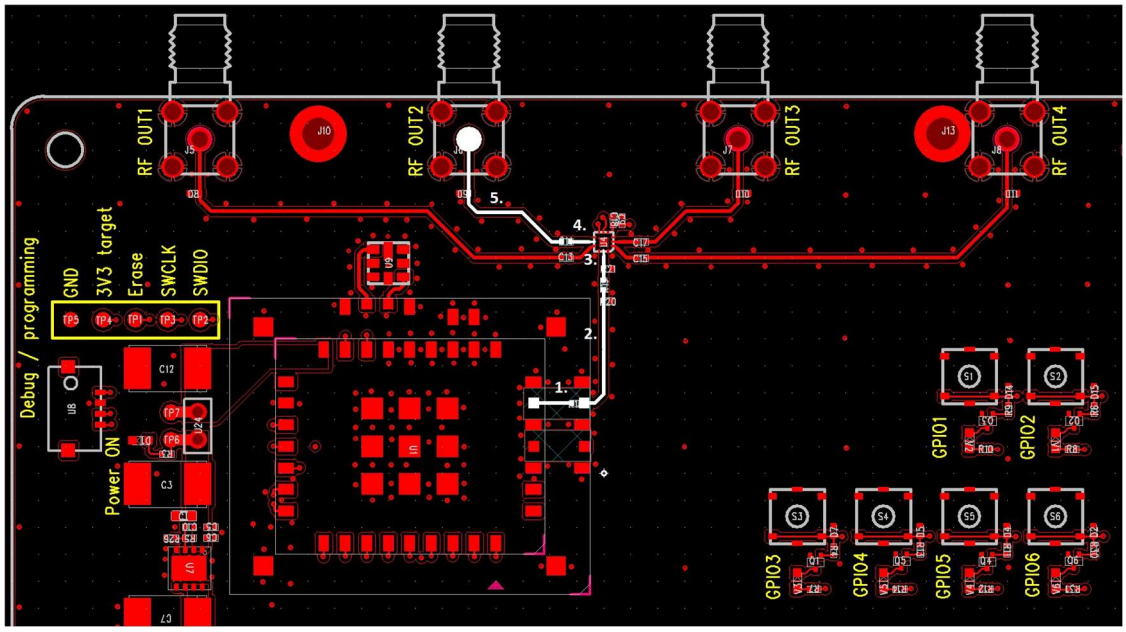
Table 7. *Recommended PCB values for 4-layer board (L2 is GND plane for the transmission line).*

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.

NUR3-0W5 module EVB CPW trace lenth is presented below. At the end of the CPW trace, there is a RP SMA connector in the NUR3-0W5 module's EVB. RP SMA-to-SMA coax cable was used to connect the authorized Sampo S0 antenna to the EVB during the modular approval measurements.

Note that RF-OUT 2 was used in the NUR3-0W5 certification. Other ports were disabled and those were used only for internal testing purposes.



Picture 5. *NUR3-0W5 module EVB RF path used in certifications.*

Trace segment nr.	Segment length (mm)	Impedance (ohm)
1.	3,6	50
2.	12,2	50
3.	2,8	50
4.	2,3	50
5.	16,1	50

Table 8. *Trace lenghts indicated in the picture 5.*

4.1.3. ENSURING CPW TRACE QUALITY

There are two ways the CPW quality can be checked. Those are presented below.

1. Use the reflected power measurement -function available via API and Nordic ID test tools. Result should be equal or less than -5. This function measures how much power is reflected to the module due to mismatch of the load seen in the NUR3-0W5 modules RF output. Note that line needs to be ended with 50-ohm load while doing the measurement.
2. Before NUR3-0W5 module is assembled into the host PCB, one could measure the refection coefficient of the trace using VNA. The attenuation should be equal or better than -10dB. Note that line needs to be ended with 50-ohm load while doing the measurement.

4.2. POWER SUPPLY

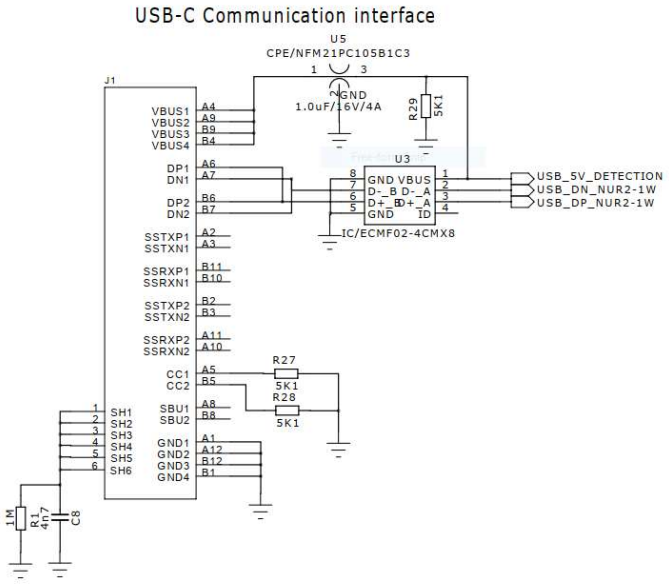
The NUR3-0W5 has internal linear power regulators for getting better power supply noise rejection. However, it is still important to supply low noise and stable power to the NUR3-0W5 module. The

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 VEXT pad.

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

4.3. USB DEVICE PORT

Below picture presents a USB-C communication interface used in NUR3-0W5 modules reference design. Note that it is very important to take propriate measures to ensure proper EMC and ESD protection.



Picture 6. *USB-C reference schematics including EMC and ESD protection.*

4.4. GPIO

All GPIOs can be configured via Nur API as inputs or outputs. IO voltage level is 3.3V and maximum source current is 4mA and sink current is 2mA. When configured as input the state of the GPIO pad in question is accessible vie Nur API. Also, event is generated from the state changes. When GPIO is configured as an output the Nur API can drive the GPIO pin to high or low voltages.

There are also pre-defined functionalities implemented for GPIOs. One of these is the possibility to control external RF switch. Please refer to Nur API for more information GPIOs and pre-defined functionalities.

Proper ESD and EMC measures needs to be considered if GPIO ports of the Nordic ID NUR3-0W5 UHF RFID module are accessible for user.

5. RF AND INVENTORY SETTINGS

Using a proper set of RF and inventory settings is mandatory for reaching the optimal reading performance.

5.1. RF SETTINGS

RF settings are mainly the ones which influences how RF transmitter operates within the Nordic ID NUR3-0W5 UHF reader module. There are certain settings which user can change like TX output power level and used RF link profile.

5.1.1. TX POWER LEVEL

Nordic ID NUR3-0W5 UHF RFID module has the maximum TX output power of 27dBm (500mW). The power can be adjusted by 1dB steps via Nur API. In total, there are 30 steps yielding the minimum output power value of -2dBm.

If you have configured more than one antenna to be used, you can set and store individual output power level for each of the antennas in question. This per antenna output power setting is also available via Nur API. Note that if per antenna power level is set this overrides the general TX power level setting.

5.1.2. LINK PROFILES

Nordic ID NUR3-0W5 UHF RFID module supports 5 different kind of RF profiles. The profiles are Robust, Nominal, Fast, High_speed and High_speed_2. It's important to select the correct RF profile based on use case and environment. More detailed description about the RF profiles can be found below:

Robust

- Robust RF profile is intended to be used when maximum sensitivity is needed. This profile uses link frequency of 160 kHz and Miller 8 coding scheme providing read rates up to 50 tags/s. Due to the low data speed it provides the best sensitivity.

  Note that naming conventions Robust is kept due to backwards compatibility reasons even though the profile is optimized for maximum sensitivity.

Nominal

- Nominal RF-profile is the default setting of Nordic ID NUR3-0W5 UHF RFID module. It uses the link frequency of 250/300 kHz and Miller 4 coding providing read rates up to 250 tags/s. Nominal is recommended profile for DRM use cases.

Fast

- Fast RF-profile is optimizes read speed while still maintaining good sensitivity. It uses the link frequency of 640 kHz and Miller 4 coding providing read rates up to 500 tags/s.

High speed

- High speed RF profile is intended to be used in use cases where the high read rates are required. It uses link frequency of 640 kHz and FM0 coding and provides read rate up to 900 tags/s.

High speed_2

- High speed_2 RF profile is further optimized from High speed by shortening the Tari and PIE values. This profile offers highest read rates which do go up to 1000+ tags/s.

5.1.3. REGION

Nordic ID NUR3-0W5 has pre-defined region settings defining frequency and channel sets for operating under different radio regulations. Globally the regulations vary depending on the country. Refer to Nur API documentation for list of pre-defined countries. When module ships from the production it is locked to pre-selected (based in the SKU) region setting and cannot be changed by the user. Contact Nordic ID support for more information.

5.1.4. ANTENNA CONTROL

There are pre-defined GPIO functionalities called ANTENNA CONTROL1 and ANTENNA CONTROL2 which you can set to a GPIO port of the Nordic ID NUR3-0W5 UHF RFID module. When this functionality is used module will take the control of the external RF switch using one or two control lines. From the table 8 you can see the thru 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

Table 9. *Antenna control truth table.*

When this functionality is used it is possible to control which antenna is used or are antennas automatically toggled by the module. In multiantenna scenarios tag replay metadata includes information which antenna port was used to detect the tag.

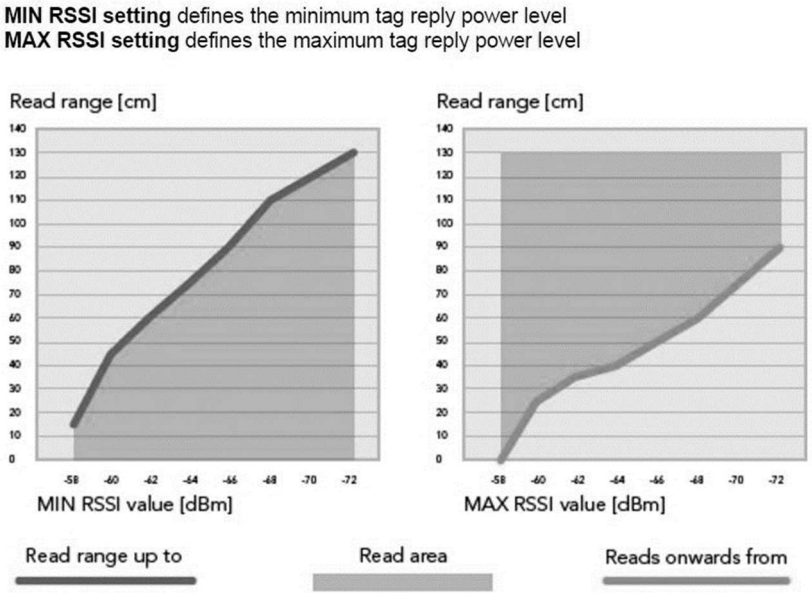
5.1.5. DYNAMIC POWER SAVE MODE

NUR3-0W5 module has dynamic power save modes which can be enabled via Nur API. By default, the power save is off. There are three depths for the dynamic power save mode to select from: 100ms, 500ms and 1000ms. The power save mode works in a way that when module reads continuously (applies only when using inventory stream -command) it goes to sleep if there are no tags in the field. The sleep time is defined by the depth value. After the sleep period is elapsed module starts to read again and so on. If there are one or more tags in the field the module will not go into sleep.

Using dynamic power saving is highly recommended in use cases where reader is reading continuously. This will decrease the interferences to other readers and helps heat mitigation in high ambient temperature environments.

5.1.6. RSSI FILTERS

Nordic ID NUR3-0W5 UHF RFID module has internal RSSI filters which can be used to limit the read range. By applying the filters, you can set the limits which tag replay must met to be registered. MIN RSSI –value means that tag replay signal needs to be equal or stronger than 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. There are separate RSSI filter values for inventory, read and write operations. These can be set individually.



Picture 7. *Read range limited by RSSI filters (100mW TX power level with 0dBi antenna gain used).*

5.2. INVENTORY SETTINGS

By selecting the proper RFID inventory parameters, you can optimize the modules reading performance for different tag populations and use cases.

5.2.1. 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 where 0 means automatic Q-value adjustment. In this automatic mode the reader will adjust Q-value between sequential rounds based on the number of found tags and collisions. By default, the Q-value is set to 0.

Q-value	Response slots	Q-value	Response 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	14	32768

***Table 10**. Relation between the Q-value and the number of response slots for a round.*

5.2.2. ROUNDS

While fixed Q-value (non-zero) is used the Rounds-value defines the number of query rounds done inside one full inventory round. After every full inventory round module will send the read results to the Host. When automatic Q-adjustment is used the Rounds-value adjusts the threshold for exiting the inventory loop. By default, rounds setting is set to 0.

Increasing the Rounds-value can help the reader to find all the tags that are in the readers reading field when using session 0. Because tags which are found in query round 1 do not 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.

Inventory round		
Query round 1	Query round 2	Query round n

***Table 11.** Relation between inventory round and query round (Rounds setting).*

5.2.3. SESSION

There are 4 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 made using a target A. 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 ISO18000-63 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.

Session flag	Persistence: Tag powered	Persistence:
S0	Indefinite	None
S1	500ms < t < 5s	500ms < t < 5s
S2	Indefinite	t > 2s
S3	Indefinite	t > 2s

Table 12. *Persistence characteristics of ISO18000-63 tags.*

5.2.4. TRANSMISSION TIME CONTROL

The NUR3-0W5 module has fixed maximum channel times defined by the radio regulations. While operating under ETSI following regions the maximum channel time is 3950ms and under FCC it is 395ms. Note that Q- and Rounds-values do not change these maximum limits. Channel usage is also randomized.

5.2.5. SELECTING THE RIGHT SETTINGS

General guidance is that Q-value should be adjusted so that there are 1.5 – 2 times more response slots compared to the number of tags simultaneously on the readers field-of-view. If reader will face many different tag populations than automatic Q-adjustment (Q=0) 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 making the mass inventory efficiency much better. Rounds 1 setting is also advised to be used with session 1 or 2 or 3.

6. TAG SIGNAL AND SYSTEM QUALITY INDICATORS

Tag signal quality indicators can be used for multiple use cases like assessment of the distance between the reader antenna and the tag. When parameters are used in a statistical way you could use these to assess is tag stationary or not. Also, you could prevent certain operations, like tag writing, if signal strength is not high enough.

Reflected power value can be used to verify that matching of the system and antenna is in proper level.

6.1. TAG REPLAY QUALITY INDICATORS

Tag replay quality indicator values are reported to the host system together with read data of the tag. Note that to obtain also the tag phase rotation value, you need to enable this functionality first. Please refer to Nur API documentation for more detailed information.

6.1.1. TAG REPLAY RSSI VALUE (SIGNAL STRENGHT INDICATOR)

When reading a tag NUR3-0W5 module also returns received signal strength indication values. Two values are returned for each read tag. One is the absolute power level (dBm) and second is the scaled RSSI value of the tags backscatter signal. Scaled RSSI value is scaled between 0 – 100. 0 corresponds to minimum signal level the module can receive and 100 with maximum.

6.1.2. TAG REPLAY PHASE ROTATION VALUE

Nordic ID NUR3-0W5 UHF RFID module can provide the tag phase rotation value of the tags replay signal (in relation the to the transmitted signal). Dynamic range for this value Is from 0 to 360 degrees.

6.1.3. TAG REPLAY DOPPLER SHIFT VALUE

Nordic ID NUR3-0W5 UHF RFID module can provide a tag phase rotation difference value. This is obtained by measuring the phase rotation angle value at the beginning of the reception of the EPC and at the end of the same reception. Difference between these values is then reported to the Host.

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6.2. REFLECTED POWER VALUE

This measurement can be used to check what is the matching of the antenna(s) and feed line(s). When this function is triggered NUR3-0W5 module puts carrier wave on at 20dBm output power. Absolute power level which is coming back to the receiver port of the module is then measured.

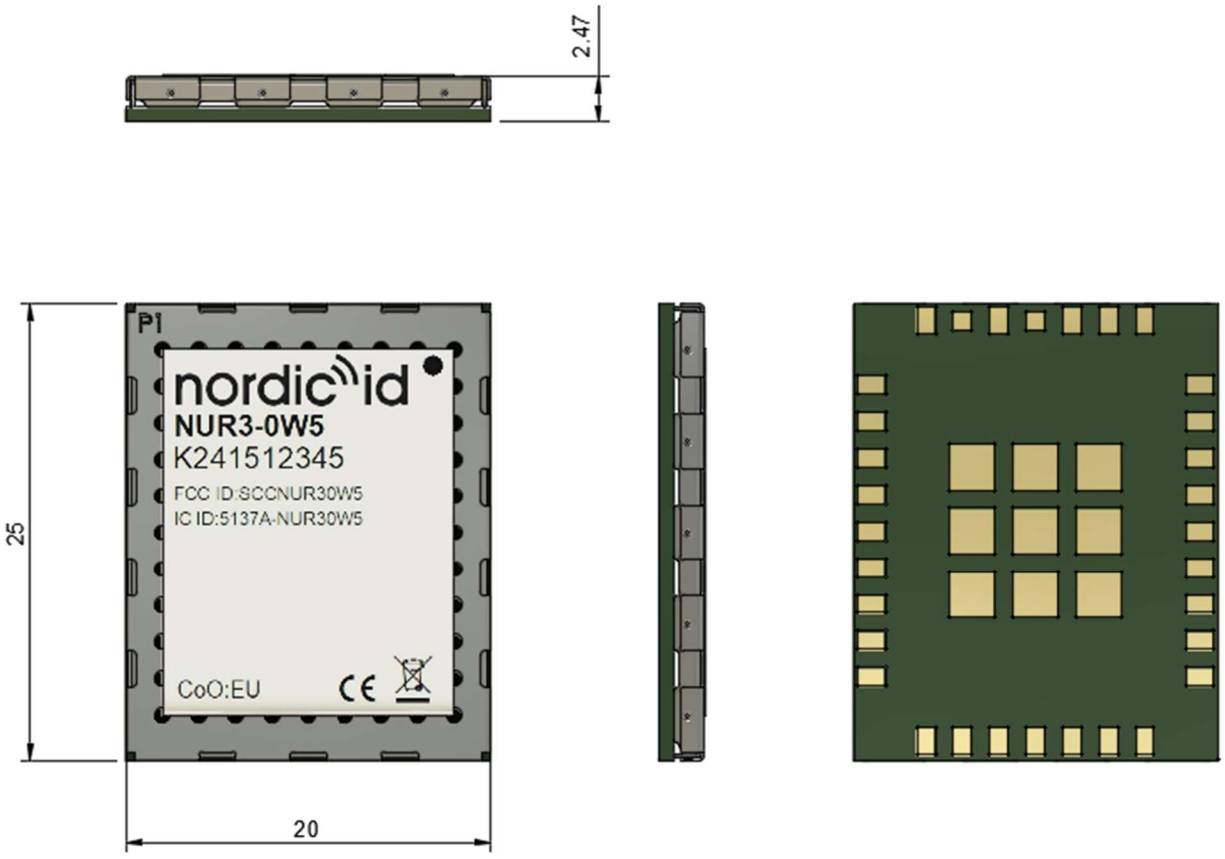
Reflection attenuation = 20 + (- Reported reflected power level by the module) - 12

This feature can also be used for antenna detection. If there is no antenna connected to the port, the reflected power value will be close to the level of transmitted signal.

7. MECHANICAL DIMENSIONS AND LAND PATTERN

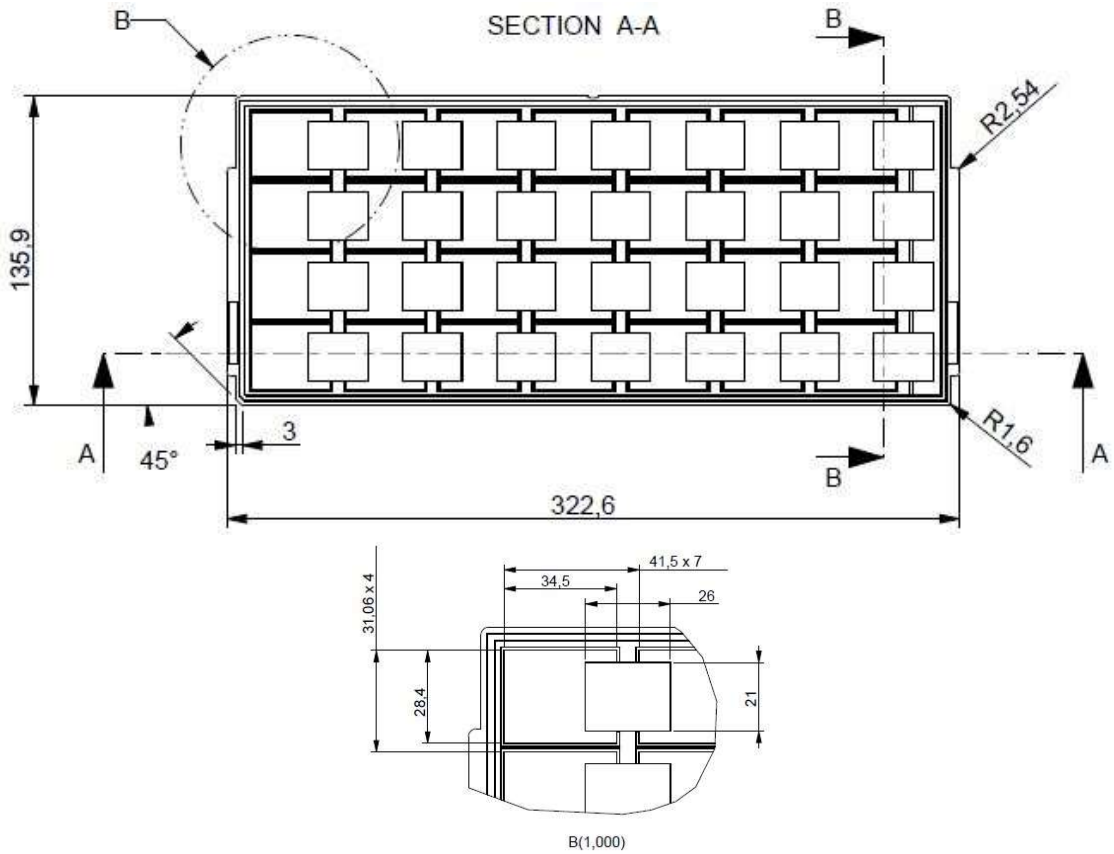
Mechanical dimensions of the NUR3-0W5 module is presented in this section. Please note that land pattern and 3D step file are available by contacting Nordic ID support.

7.1. MECHANICAL DIMENSION



Picture 8. *Mechanical dimension of the NUR3-0W5.*

7.2. PACKING TRAY DIMENSION



***Picture 9**. NUR3-0W5 packing tray dimensions.*

8. SMT ASSEMBLY PROCESS AND THERMAL PROCESSING

Nordic ID NUR3-0W5 UHF RFID module contains single sided assembly of SMT components reflow-soldered on multilayer HDI (high density interconnections) glass-fibre 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.

NUR3-0W5 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 must 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 must be stored and soldered according to the guidelines given below.

8.1. STORAGE CONDITIONS

Long-term storage conditions

Temperature	+15°C to +27°C (optimal)
Temperature gradient	Max. +2°C/hour
Relative humidity	<15% within specified temperatue range

Table 12. *Long-term storage conditions.*

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

Short-term storage conditions

Temperature	+20°C to +27°C
Temperature gradient	Max. +2°C/hour
Relative humidity	<15% within specified temperatue range

Table 13*. Short-term storage conditions.*

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

Table 14. *MSL level and open time of the NUR3-0W5 module.*

8.2. 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 land 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

Table 15*. Soldering process boundary conditions.*

Recommended reflow conditions

Pre-heating 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

Table 16. *Recommended reflow conditions.*

9. REGULATORY INFORMATION

When OEM prefers to leverage Nordic ID's grants and certifications of the NUR3-0W5 UHF RFID module, the host device documentation shall include regulatory compliance information on the NUR3-0W5 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 NUR3-0W5 is integrated.

When leveraging Nordic ID's grants and certifications, antenna shall be considered in view of the fact that the NUR3-0W5 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 NUR3-0W5 module complies with the requirements.

9.1. EUROPEAN UNION AND EFTA COUNTRIES

USER GUIDE REQUIREMENTS

This apparatus complies 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 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 v3.3.1
    - Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W and in the band 915 MHz to 921 MHz with power levels up to 4 W; Harmonised Standard for access to radio spectrum
- article 3.1b: ETSI EN 301 489-1 v2.2.0
    - Tests must be performed when module is integrated in host product.
- article 3.1b: ETSI EN 301 489-3 v2.1.1
    - Tests must be performed when module is integrated in host product.
- article 3.1a: EN 62368-1:2018
    - Tests must be performed when module is integrated in host product.

EN 62479: 2010

- Human exposure

EN 62311: 2008

- Human exposure limits

This apparatus complies EU Directive 2011/65/EU, Reduction of Hazardous Substances (RoHS).

Česky

[Czech]

[Nordic ID] tímto prohlašuje, že tento [RFID Radio module NUR3-0W5] 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 NUR3-0W5] 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 NUR3-0W5] 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 NUR3-0W5] vastavust direktiivi 2014/53/EÜ põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele.

English

Hereby, [Nordic ID], declares that this [RFID Radio module NUR3-0W5] complies 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 NUR3-0W5] 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 NUR3-0W5] 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 NUR3-0W5] jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 2014/53/EU.

Português

[Portuguese]

[Nordic ID] declara que este [RFID Radio module NUR3-0W5] 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 NUR3-0W5] v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 2014/53/ES.

Slovensky

[Slovak]

[Nordic ID] týmto vyhlasuje, že [RFID Radio module NUR3-0W5] spĺňa základné požiadavky a všetky príslušné ustanovenia Smernice 2014/53/ES.

Suomi

[Finnish]

[Nordic ID] vakuuttaa täten että [RFID Radio module NUR3-0W5] 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 NUR3-0W5] 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 when operating in ETSI lower band. NUR3-0W5 has maximum output power of 27dBm. Meaning that 8dBi is the maximum allowed antenna gain without cable losses (ETSI lower band). When module is set to operate in ETSI upper band, maximum ERP power is 36dBm. This means maximum antenna gain of 11dBi.

Formula how to calculate maximum allowed antenna gain when operating in ETSI lower band:

27 dBm – 2.15 (dipole gain) + [antenna gain dBi] – [cable attenuation dB] < 33dBm

Formula how to calculate maximum allowed antenna gain when operating in ETSI upper band:

27 dBm – 2.15 (dipole gain) + [antenna gain dBi] – [cable attenuation dB] < 36dBm

Beamwidth restrictions while operating in ETSI lower band:

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 ≤ 180°

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

Beamwidth restrictions while operating in ETSI upper band:

For transmissions ≤1000 mW e.r.p. there shall be no restriction on beam width.

For transmissions of > 1000 mW e.r.p. to ≤ 2 000 mW e.r.p. beam widths shall be ≤ 180°

For transmissions of > 2 000 mW e.r.p. to 4 000 mW e.r.p. beam widths shall be ≤ 90°

9.2. 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 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 NUR3-0W5 transmitter module is authorized to be used in other devices only by OEM Integrators under the following conditions:

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

1. The transmitter module must not be co-located with any other transmitter, except with those that are within the limits shown in the NUR3-0W5 filing.
2. 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 NUR3-0W5 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.

If OEM integrator must perform some tests for their host product, OEM integrator must contact Nordic ID for further instructions how to put NUR3-0W5 module into required test mode(s). Nordic ID will then provide required tool(s) and instructions.

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 host 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 host product.

In case that OEM integrator / host product manufacturer that integrate NUR3-0W5 module into their product and would like to change defined parameters of the antenna trace as instructed in this document, they must notify Nordic ID for further instructions. In this case, either Nordic ID can make class 2 permissive change or OEM integrator / host product manufacturer can make change in id procedure (new application) followed by a class 2 permissive change application. If host product manufacturer / OEM integrator is responsible of external antenna connector for their product, they must contact Nordic ID for further instructions. Nordic ID will provide list of acceptable unique connectors that must be used.

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

9.2.1. 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 cm / inch) 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."

"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"

9.2.2. LABELING REQUIREMENTS

The host product must be labelled with the following identification information in a visible area:

"**Contains Transmitter Module FCC ID: SCCNUR30W5**"

or

"**Contains FCC ID: SCCNUR30W5**"

9.2.3. APPROVED ANTENNAS

Option 1:

Manufacturer:	Nordic ID Oy
Antenna Description:	TBD
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	TBD
Gain:	TBD

Option 2:

Manufacturer:	Nordic ID Oy
Antenna Description:	TBD
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	TBD
Gain:	TBD

9.3. ISED EN

This device contains licence-exempt transmitter / receiver that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS. 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 regulations of Science and Economic Development Canada, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Science and Economic Development 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 grant given by ISED, the device with the integrated NUR3-0W5 module shall be met the following conditions:

1. The certified antenna types and maximum gain are listed later in this document. User of this device or nearby people must not compromise the minimum separation distance of cm / inch, in any situation.
2. The antenna(s) used with the NUR3-0W5 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 NUR3-0W5's grant given by ISED.
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 host product complies with the other regulatory requirements.

There are no user's documentation requirements other than are required by Science and Economic Development Canada statements outlined in the ISED section in a prominent place in the user's guide.

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

9.3.1. LABELLING REQUIREMENTS FOR THE HOST DEVICE

The host product must be labelled with the following identification information in a visible area:

"**Contains ISED: 5137A-NUR30W5**"

9.3.2. APPROVED ANTENNAS

This radio transmitter 5137A-NUR30W5 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Option 1:

Manufacturer:	Nordic ID Oy
Antenna Description:	TBD
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	TBD
Gain:	TBD

Option 2:

Manufacturer:	Nordic ID Oy
Antenna Description:	TBD
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	TBD
Gain:	TBD

9.4. ISED FR

Cet appareil contient un émetteur / récepteur exempt de licence conforme à la norme RSS d'Innovation, Sciences et Développement économique Canada. Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences pouvant entraîner un fonctionnement non souhaité de l'appareil.

En vertu de la réglementation de Science et Développement économique Canada, cet émetteur radio ne peut fonctionner qu'avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Science et Développement économique Canada. Pour réduire le risque d'interférences radio avec d'autres utilisateurs, le type d'antenne et son gain doivent être choisis de manière à ce que la puissance rayonnée isotrope équivalente (p.i.r.e.) ne soit pas supérieure à celle nécessaire au succès de la communication.

Pour tirer parti de la subvention accordée par l'ISED au Nordic ID, l'appareil avec le module intégré NUR2-1W doit remplir les conditions suivantes:

1. Les types d'antenne certifiés et le gain maximal sont répertoriés plus loin dans ce document. L'utilisateur de cet appareil ou les personnes à proximité ne doivent en aucun cas compromettre la distance de séparation minimale de 30.3 cm / 11.93 inch.
2. La ou les antennes utilisées avec le module NUR3-0W5 ne doivent pas être placées en même temps que tout autre émetteur ou son antenne capable d'émettre en même temps, à l'exception des configurations émetteur-antenne qui sont dans les limites de la subvention NUR3-0W5 accordée par ISED.
3. La conception d'un tracé de circuit d'antenne dans un hôte doit être conforme aux instructions de conception OEM fournies.

Lorsque les conditions ci-dessus sont remplies, aucun test de transmetteur n'est généralement requis, même si l'intégrateur OEM doit démontrer que le produit hôte est conforme aux autres exigences réglementaires.

Il n'existe aucune exigence en matière de documentation utilisateur autre que celle requise par les déclarations de Sciences et Développement économique décrites dans la section ISED à un endroit 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 ISED est sélectionné, le module fonctionne sur la bande de fréquence 902-928Mhz.

9.4.1. EXIGENCES APPLICABLES AUX APPAREILS HÔTES

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

"**Contains ISED: 5137A-NUR30W5**"

9.4.2. TYPES D'ANTENNES ACCEPTABLES

Cet émetteur radio 5137A-NUR30W5 a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antennes énumérés ci-dessous, avec le gain maximal admissible indiqué. Les types d'antenne non inclus dans cette liste et dont le gain est supérieur au gain maximal indiqué pour l'un des types répertoriés ne sont strictement pas autorisés pour une utilisation avec cet appareil.

Option 1:

Manufacturer:	Nordic ID Oy
Antenna Description:	TBD
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	TBD
Gain:	TBD

Option 2:

Manufacturer:	Nordic ID Oy
Antenna Description:	TBD
Frequency range:	902 – 928 MHz
Manufacturer Part Number:	TBD
Gain:	TBD

9.5. TELEC

TBD

9.5.1. APPROVED ANTENNAS

TBD

10. ABOUT NORDIC ID

Nordic ID is at the centre of today's real-time item tracking and reliable RFID technology. We help organizations fight the damaging effects of item loss, facilitate streamlined business procedures, and stay ahead of the competition.

We are ready to help you take advantage of our wide range of products and services designed to fit your needs. Contact us now, and we will help you to tackle your challenges and get your business to the next level.

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11. VERSION HISTORY

Version	Date	Modifications
1.0	22nd May 2024	First release