Test Report

Report Number:

F181014E10

Equipment under Test (EUT):

Stand-alone radio module

NINA-B3 series

Applicant:

u-blox AG

Manufacturer:

u-blox AG

References

[1] MIC Notice:2004 Annex 43

[2] MIC Ordinance Regulating Radio Equipment Article 49.20

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

Test engineer:	Bernward ROHDE		09.10.2018
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		09.10.2018
	Name	Signature	Date

T h i s   t e s t   r e p o r t   i s   o n l y   v a l i d   i n   i t s   o r i g i n a l   f o r m .

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1 Identification

1.1 Applicant

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Country:	Switzerland
Name for contact purposes:	Mr. Filip KRUZELA
Phone:	+46 40 630 71 70
Fax:	N/A
eMail Address:	Filip.Kruzela@u-blox.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	u-blox AG
Address:	Zürcherstr. 68, 8800 Thalwil
Country:	Switzerland
Name for contact purposes:	Mr. Filip KRUZELA
Phone:	+46 40 630 71 70
Fax:	N/A
eMail Address:	Filip.Kruzela@u-blox.com
Applicant represented during the test by the following person:	-

1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

1.4 EUT (Equipment Under Test)

Test object: *	Stand-alone radio module
Model series: *	**NINA-B3**
Model name: *	NINA-B301 (ufl antenna connector) NINA-B302 (u-blox LILY Antenna) NINA-B311 (ufl antenna connector) NINA-B312 (u-blox LILY Antenna)
Serial number: *	C55D4CA6EB899920500 (labelled PT4-B301#3) C55D4CA6EB899910500 (labelled PT4-B301#5)
PCB identifier: *	N/A
Hardware version: *	see list below 2.1.1
Software version: *	Radio test modes nRF5_SDK_15.0.0_a53641a (radio_test_14may.hex)

* declared by the applicant.

Bluetooth LE frequencies				
Channel 00	RX	2402 MHz	TX	2402 MHz
Channel 19	RX	2440 MHz	TX	2440 MHz
Channel 39	RX	2480 MHz	TX	2480 MHz

Proprietary mode frequencies				
Channel 00	RX	2402 MHz	TX	2402 MHz
Channel 38	RX	2440 MHz	TX	2440 MHz
Channel 78	RX	2480 MHz	TX	2480 MHz

802.15.4 mode frequencies				
Channel 00	RX	2405 MHz	TX	2405 MHz
Channel 18	RX	2440 MHz	TX	2440 MHz
Channel 26	RX	2480 MHz	TX	2480 MHz

Ancillary Equipment	
Cables (connected to the EUT):	USB 2.0 type A <-> USB 2.0 type B micro, ~0.2 m[1] +3 m USB extension[2]
Laptop PC:	Fujitsu Lifebook E8420 (PM No. 200599) [2]

[1] provided by the applicant.
[2] provided by the laboratory.

1.5 Technical Data of Equipment

Radio module	
Rated RF output power: *	6.000 mW (Bluetooth Low Energy 1 Mbps, 500 kbps, 125 kbps) 4.500 mW (Bluetooth Low Energy 2 Mbps) 4.000 mW (802.15.4 mode) 6.000 mW Proprietary mode (1 Mbps & 2 Mbps)
Fulfils specification: *	5.0 BLE (Bluetooth Low Energy only) IEEE 802.15.4 Proprietary mode
ITU classification: *	F1D (Bluetooth Low Energy) G1D (802.15.4) F1D (Proprietary mode)
Antenna name: *	See antenna list below 1.5.1
Antenna type: *	See antenna list below 1.5.1
Antenna gain: *	See antenna list below 1.5.1
Maximum Antenna gain:*	+3.0 dBi
Antenna connector: *	U.FL

Supply voltage eval board: *	Unom =	9 V	Umin =	5 V	Umax =	12 V
Supply voltage radio module: *	Unom =	3.3	Umin =	1.7 V	Umax =	3.6 V

Type of modulation (Bluetooth Low Energy): *	GFSK (2 Mbit/s; 1 Mbit/s; 500 kbit/s; 125 kbit/s)
Type of modulation (802.15.4): *	O-QPSK (250 kbit/s)
Type of modulation (Proprietary mode): *	GFSK (2 Mbit/s; 1 Mbit/s)
Operating frequency range:*	2402 MHz to 2480 MHz (Bluetooth Low Energy, Proprietary mode) 2405 MHz to 2480 MHz (802.15.4 mode)
Number of channels: *	40 (Bluetooth Low Energy) 16 (802.15.4 mode) 79 (Proprietary mode 1&2 Mbps)
Nominal channel bandwidth: *	1 / 2 MHz (Bluetooth Low Energy) 2.5 MHz (802.15.4 mode) 1 MHz (proprietary mode)
Channel spacing: *	2 MHz (Bluetooth Low Energy) 5 MHz (802.15.4 mode) 1 MHz (proprietary mode)
Temperature range: *	-40 °C to +85 °C
Lowest / highest Internal clock frequency: *	32.768 kHz to 2480 MHz

*: Declared by the applicant.

1.5.1 Antenna List

Antenna name	Manufacturer	Type	Comment	Gain [dBi]
u-blox LILY Antenna	ProAnt	SMD PIFA	antenna on NINA-B302 and NINA-B312	3
FlatWhip-2400	ProAnt	Monopole	SMA/RSMA	3
InSide-2400	ProAnt	Patch	10cm cable/U.FL	3
Ex-IT 2400 -SMA 28-001 -RP-SMA 28-001 -MHF 28-001	ProAnt	Monopole	SMA RSMA 10 cm cable/U.FL	3
Ex-IT 2400 -SMA 70-002 -RP-SMA 70-002	ProAnt	Monopole	SMA RSMA	3
GW26.0111.HT	Taoglas	Single-band monopole	SMA	3

1.6 Dates

Date of receipt of test sample:	24.05.2018
Start of test:	30.07.2018
End of test:	09.08.2018

2 Operational States

Test Items	Mode	Data Rate for worst case operation mode	Channel frequency
Frequency error	GFSK (BT LE)	1 Mbps	2402, 2440, 2480 MHz
Occupied bandwidth (99 %);	GFSK (BT LE)	2 Mbps	2402, 2440, 2480 MHz
Spread spectrum Bandwidth (90%)	GFSK (BT LE)	500 kbps	2402, 2440, 2480 MHz
	GFSK (BT LE)	125 kbps	2402, 2440, 2480 MHz
Unwanted emission intensity	802.15.4	250 kbps	2405, 2440, 2480 MHz
	Proprietary	1 Mbps	2402, 2440, 2480 MHz
Antenna power error	Proprietary	2 Mbps	2402, 2440, 2480 MHz
Limitation of emission of receiver	Continuous receiving	GFSK (BT LE) 802.15.4 Proprietary	2402, 2440, 2480 MHz 2405, 2440, 2480 MHz 2402, 2440, 2480 MHz
Hopping frequency dwell time[*1]	-	-	-
Carrier sense capability[*2]	-	-	-
Transmission antenna gain[*3]	-	-	-

[*1] Only applicable for FHSS devices.
[*2] Only applicable for devices with an occupied frequency between 26 and 38 MHz.
[*3] This test item is not applicable for test equipment with an EIRP output power of < 12.14 dBm.

2.1.1 Power settings

Test sample	Power setting [dBm]	Hardware Version	Serial	Comment
PT4-B301#3	8	05	C55D4CA6EB899920500	For all data rates and channels
PT4-B301#5	8	05	C55D4CA6EB899910500	For all data rates and channels

3 Additional Information

Power Settings for all measurements and all modes was always 8 dBm.

3.1 Module variants

The modules are offered in two HW versions; a smaller version with an RF pin, and a larger version with an internal PIFA antenna. Both versions are based on the Nordic Semiconductor nRF52840 chip which has an integrated RF core and an application processor.
The modules are also available with or without pre-flashed SW. The NINA-B30 series are sold as 'Open CPU', meaning that the customers create their own SW and the full radio capabilities of the module is available.
The NINA-B31 series are sold with pre-flashed SW developed by u-blox, called 'u-blox connectivity software (uCS)'. This SW limits the radio capabilities of the NINA-B3 to pass world-wide type approvals, and precautions have been taken so that the SW is tamper proof. An end-user will not be able to modify any radio settings that will change the channel plan or maximum output power etc.

Module variant	Filter variant	Hardware revision	Antenna	Software
NINA-B301	PT4	05	RF pin (ufl)	Open CPU for OEM use
NINA-B302	PT2	04	u-blox LILY Antenna	Open CPU for OEM use
NINA-B311	PT4	03	RF pin (ufl)	u-blox connectivity software
NINA-B312	PT2	04	u-blox LILY Antenna	u-blox connectivity software

4 Overview

Applied standard: MIC Notice:2006 Annex 43			
Rule section:	**Test item**	**Status:**	**Refer page:**
3 [1]	Frequency error	Passed	12 et seq.
4 [1]	Occupied bandwidth and Spread-spectrum bandwidth	Passed	15 et seq.
5 [1]	Unwanted emission intensity	Passed	20 et seq.
6 [1]	Antenna power error and antenna power tolerance	Passed	28 et seq.
7 [1]	Limitation of collateral emission of receiver	Passed	37 et seq.
8 [1]	Transmission antenna gain (EIRP antenna power)	Not applicable*	----
9 [1]	Transmission radiation angle width (3 dB bandwidth)	Not applicable *	----
10 [1]	Radio interference prevention capability	Not applicable *4	----
11 [1]	Hopping frequency dwell time	Not applicable *2	----
Article 49.20, section 3.17 [2]	Construction protection	Passed	40
Article 49.20, section 1) k [2]	Carrier Sense	Not applicable *3	----

*   This test item is not applicable for test equipment with an EIRP output power of < 12.14 dBm .

*2 Although Bluetooth LE uses frequency hopping method during the communication, it is not defined as a system using the frequency hopping method according to Radio Equipment Regulations, Article 4.17.49.20. Bluetooth LE is classified as a system using "Digital modulation method other than orthogonal frequency division multiplexing (OFDM) or spread spectrum method".

*3 Only applicable for devices with an occupied frequency between 26 and 38 MHz.

*4 Not applicable, because, as declared by the applicant, the EUT is not connectable to a public communication network

5 Results

5.1 Power supply voltage fluctuation test

5.1.1 Tested sample: PT4-B301#5

Ambient temperature:	23°C
Tested by	P. NEUFELD

Relative humidity:	52%
Date	09.08.2018

5.1.2 Test procedure

The input voltage of the EUT from the external power supply has been varied from minimum input voltage as stated by the applicant to the maximum input voltage as stated by the applicant.
The supply voltage of the EUTs RF circuit was measured during variation of the input voltage.

5.1.3 Test set-up
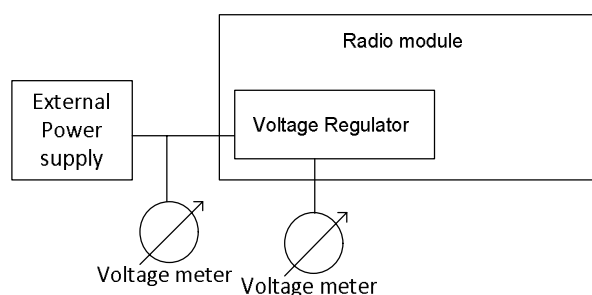
The extreme voltages were supplied by a laboratory power supply to the voltage supply pins of the module. The tests were carried out at a specially prepared EUT. At this EUT the power supply of the radio module and the output of the voltage regulator were connected by electric wires. While changing the voltage at the external power supply, the voltage variation at voltage regulator of the radio modules was measured.

5.1.4 Test results

Operation mode of the EUT: transmit with modulation

Voltage fluctuation test	Nominal voltage	Low voltage	High voltage
Input DC voltage	3.300	1.700	3.630
Regulated voltage @ radio module	1.252	1.251	1.252
Voltage variation	-	-0.08 %	0.00 %
Measurement uncertainty	+/- 0.4 %		

Because the impact of the voltage variation is below 1 %, all following measurements were carried out under normal supply voltage conditions only.

TEST EQUIPMENT USED FOR THE TEST:

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5.2 Frequency error

5.2.1 Tested sample: PT4-B301#3

Ambient temperature:	23°C
Tested by	P. NEUFELD

Relative humidity:	52%
Date	30/31.07.2018 06.08.2018

5.2.2 Test procedure

1. Frequency accuracy of the spectrum analyser shall be less than 10 % of the limits tolerance (5 ppm)
2. The following spectrum analyser setting shall be used:
   RBW = 10 kHz;
   VBW = 30 kHz;
   Span = 1 MHz;
   Center frequency = the center of the actual channel;
   Sweep time = Auto;
   Sweep mode = Continuous sweep;
   Detection mode = Positive peak;
   Marker function = Frequency counter (with 100 Hz resolution).
3. The EUT has to transmit in the absence of modulation and on a fixed channel. If this is not possible, the EUT has to a modulation condition which produces a distinctive frequency spectrum.
4. The frequency of the peak value has to be measured and notice as value f.
5. With f_c = declared center frequency of the actual channel the frequency error will be calculated as follows:
   Frequency error = $(f_c - f) / f_c * 10^6$.

5.2.3 Test set-up
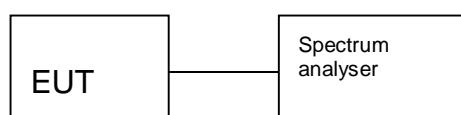
5.2.4 Limit

Frequency tolerance: <= 50 ppm

5.2.5 Test results

Since the EUT could not be operated without modulation, the center frequency was calculated as the middle frequency of the modulated 99% channel bandwidth.

Module in Bluetooth Low Energy mode (1 Mbps)

Frequency error					
Supply voltage			3.3 V DC at EUT		
Operation on channel	Nominal Frequency MHz]	Measured Frequency [MHz]	Frequency Error [ppm]	Limit [ppm]	Test Result
0	2402.000	2402.011	4.68	+/- 50	Passed
19	2440.000	2440.011	4.61	+/- 50	Passed
39	2480.000	2480.015	6.05	+/- 50	Passed
Measurement uncertainty: $<10^{-7}$					

Module in Bluetooth Low Energy mode (2 Mbps)

Frequency error					
Supply voltage			3.3 V DC at EUT		
Operation on channel	Nominal Frequency MHz]	Measured Frequency [MHz]	Frequency Error [ppm]	Limit [ppm]	Test Result
0	2402.000	2402.011	4.68	+/- 50	Passed
19	2440.000	2440.004	-1.54	+/- 50	Passed
39	2480.000	2480.004	1.51	+/- 50	Passed
Measurement uncertainty: $<10^{-7}$					

Module in Bluetooth Low Energy mode (500 kbps)

Frequency error					
Supply voltage			3.3 V DC at EUT		
Operation on channel	Nominal Frequency MHz]	Measured Frequency [MHz]	Frequency Error [ppm]	Limit [ppm]	Test Result
0	2402.000	2402.015	-6.24	+/- 50	Passed
19	2440.000	2440.015	-6.15	+/- 50	Passed
39	2480.000	2480.061	-24.70	+/- 50	Passed
Measurement uncertainty: $<10^{-7}$					

Module in Bluetooth Low Energy mode (125 kbps)

Frequency error					
Supply voltage			3.3 V DC at EUT		
Operation on channel	Nominal Frequency MHz]	Measured Frequency [MHz]	Frequency Error [ppm]	Limit [ppm]	Test Result
0	2402.000	2402.015	-6.24	+/- 50	Passed
19	2440.000	2440.015	-6.15	+/- 50	Passed
39	2480.000	2480.015	-6.05	+/- 50	Passed
Measurement uncertainty: $<10^{-7}$					

Module in 802.15.4 mode

Frequency error					
Supply voltage			3.3 V DC at EUT		
Operation on channel	Nominal Frequency MHz]	Measured Frequency [MHz]	Frequency Error [ppm]	Limit [ppm]	Test Result
11	2405.000	2405.011	4.68	+/- 50	Passed
18	2440.000	2440.011	4.61	+/- 50	Passed
26	2480.000	2480.015	6.05	+/- 50	Passed
Measurement uncertainty: $<10^{-7}$					

Module in Proprietary mode (1 Mbps)

Frequency error					
Supply voltage			3.3 V DC at EUT		
Operation on channel	Nominal Frequency MHz]	Measured Frequency [MHz]	Frequency Error [ppm]	Limit [ppm]	Test Result
0	2402.000	2402.015	6.24	+/- 50	Passed
38	2440.000	2440.015	-6.15	+/- 50	Passed
78	2480.000	2480.015	6.05	+/- 50	Passed
Measurement uncertainty: $<10^{-7}$					

Module in Proprietary mode (2 Mbps)

Frequency error					
Supply voltage			3.3 V DC at EUT		
Operation on channel	Nominal Frequency MHz]	Measured Frequency [MHz]	Frequency Error [ppm]	Limit [ppm]	Test Result
0	2402.000	2402.011	-4.68	+/- 50	Passed
38	2440.000	2440.004	-1.54	+/- 50	Passed
78	2480.000	2480.019	-7.56	+/- 50	Passed
Measurement uncertainty: $<10^{-7}$					

TEST EQUIPMENT USED FOR THE TEST:

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5.3 Occupied bandwidth and spread-spectrum bandwidth

5.3.1 Tested sample: PT4-B301#3

Ambient temperature:	23°C
Tested by	P. NEUFELD

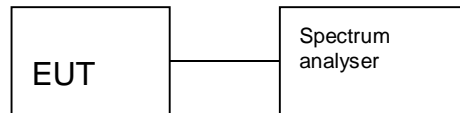| Relative humidity:	52%
Date	30/31.07.2018 06.08.2018

5.3.2 Test procedure

1. The EUT has to transmit with the modulation signal occupies the maximum frequency range, with maximum power and hopping mode on (for FHSS devices) or on a fixed channel (for DSSS or OFDM)
2. The following spectrum analyser setting shall be used:
   RBW = VBW = 300 kHz (WLAN mode) (less than 3% of allowance);
   RBW = VBW = 1 MHz (Bluetooth classic mode) (less than 3% of allowance);
   RBW = VBW = 30 kHz (Bluetooth Low Energy mode) (less than 3% of allowance);
   Span = 30 MHz (802.11b mode) (2 to 3.5 times of allowance);
   Span = 40 MHz (802.11g/20 mode) (2 to 3.5 times of allowance) ;
   Span = 80 MHz (802.11n40 mode) (2 to 3.5 times of allowance) ;
   Span = 200 MHz (Bluetooth classic mode) (2 to 3.5 times of allowance) ;
   Span = 6 MHz (Bluetooth Low Energy mode) (2 to 3.5 times of allowance) ;
   Center frequency = the center of the actual channel;
   Sweep time = Auto;
   Sweep mode = Continuous sweep;
   Detection mode = Positive peak;
   Trance mode = Max hold.
3. For occupied bandwidth:
   a. Use the 99 % bandwidth function of the spectrum analyser to find the lowest frequency, were the sum of total power drops below 0.5 %. This value shall be noted as f_L.
   b. Use the 99 % bandwidth function of the spectrum analyser to find the highest frequency, were the sum of total power drops below 0.5 %. This value shall be noted as f_H.
   c. The occupied bandwidth will be calculated as follows:
      Occupied bandwidth = $f_H - f_L$.
4. For spread spectrum bandwidth:
   a. Use the 90 % bandwidth function of the spectrum analyser to find the lowest frequency, were the sum of total power drops below 5 %. This value shall be noted as f_L.
   b. Use the 90 % bandwidth function of the spectrum analyser to find the highest frequency, were the sum of total power drops below 5 %. This value shall be noted as f_H.
   c. The spread spectrum bandwidth will be calculated as follows:
      spread spectrum bandwidth = $f_H - f_L$.
5. For spread spectrum Factor (DSSS only):
   a. Calculate the spread spectrum factor with spread spectrum bandwidth / modulation rate of the EUT

Examiner: Bernward ROHDE
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5.3.3 Test set-up

```
┌──────────┐         ┌──────────────┐
│          │         │  Spectrum    │
│   EUT    │─────────│  analyser    │
│          │         │              │
└──────────┘         └──────────────┘
```

5.3.4 Limit

Occupied bandwidth: FHSS <= 83.5 MHz
          OFDM, DSSS <= 26 MHz
          others <= 26 MHz

Spreading bandwidth: FHSS >= 500 kHz
          DSSS >= 500 kHz

5.3.5 Test results

Module in Bluetooth Low Energy mode (1 Mbps)

Operation mode of the EUT: Transmit transmitting on a fixed frequency in test mode; measured at the antenna connector.

Occupied bandwidth				
Power supply voltage		3.3 V DC at EUT		
Operation on channel	Measured Occupied Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Test Result
0	1.058	26.000	24.942	Passed
19	1.058	26.000	24.942	Passed
39	1.065	26.000	24.935	Passed
Measurement uncertainty <10^{-7} (frequency), 0.66 dB / -0.72 dB (level)				

Module in Bluetooth Low Energy mode (2 Mbps)

Operation mode of the EUT: Transmit transmitting on a fixed frequency in test mode; measured at the antenna connector.

Occupied bandwidth				
Power supply voltage		3.3 V DC at EUT		
Operation on channel	Measured Occupied Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Test Result
0	2.047	26.000	23.953	Passed
19	2.047	26.000	23.953	Passed
39	2.047	26.000	23.953	Passed
Measurement uncertainty <10^{-7} (frequency), 0.66 dB / -0.72 dB (level)				

Module in Bluetooth Low Energy mode (500 kbps)

Operation mode of the EUT: Transmit transmitting on a fixed frequency in test mode; measured at the antenna connector.

Occupied bandwidth				
Power supply voltage		3.3 V DC at EUT		
Operation on channel	Measured Occupied Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Test Result
0	1.050	26.000	24.950	Passed
19	1.050	26.000	24.950	Passed
39	1.058	26.000	24.942	Passed
Measurement uncertainty <10^{-7} (frequency), 0.66 dB / -0.72 dB (level)				

Module in Bluetooth Low Energy mode (125 kbps)

Operation mode of the EUT: Transmit transmitting on a fixed frequency in test mode; measured at the antenna connector.

Occupied bandwidth				
Power supply voltage		3.3 V DC at EUT		
Operation on channel	Measured Occupied Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Test Result
0	1.080	26.000	24.920	Passed
19	1.080	26.000	24.920	Passed
39	1.080	26.000	24.920	Passed
Measurement uncertainty <10^{-7} (frequency), 0.66 dB / -0.72 dB (level)				

Module in 802.15.4 mode:

Operation mode of the EUT: Transmit transmitting on a fixed frequency in test mode; measured at the antenna connector.

Occupied bandwidth				
Power supply voltage		3.3 V DC at EUT		
Operation on channel	Measured Occupied Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Test Result
11	2.183	26.000	23.817	Passed
18	2.183	26.000	23.817	Passed
26	2.190	26.000	23.810	Passed
Measurement uncertainty <10^{-7} (frequency), 0.66 dB / -0.72 dB (level)				

Spread spectrum bandwidth (Diffusion Bandwidth)			
Power supply voltage	3.3 V DC at EUT		
Bluetooth Modulation	00	18	26
Measured spread spectrum bandwidth	1.440 MHz	1.433 MHz	1.448 MHz
Limit	> 500 kHz	> 500 kHz	> 500 kHz
Result	Passed	Passed	Passed
Measurement uncertainty	<10^{-7} (frequency), 0.66 dB / -0.72 dB (level)		

Module in Proprietary mode (1 Mbps)

Operation mode of the EUT: Transmit transmitting on a fixed frequency in test mode; measured at the antenna connector.

Occupied bandwidth				
Power supply voltage		3.3 V DC at EUT		
Operation on channel	Measured Occupied Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Test Result
0	0.930	26.000	25.070	Passed
18	0.930	26.000	25.070	Passed
78	0.930	26.000	25.070	Passed
Measurement uncertainty <10^{-7} (frequency), 0.66 dB / -0.72 dB (level)				

Module in Proprietary mode (2 Mbps)

Operation mode of the EUT: Transmit transmitting on a fixed frequency in test mode; measured at the antenna connector.

Occupied bandwidth				
Power supply voltage		3.3 V DC at EUT		
Operation on channel	Measured Occupied Bandwidth [MHz]	Limit [MHz]	Margin [MHz]	Test Result
0	1.778	26.000	24.223	Passed
38	1.823	26.000	24.177	Passed
78	1.808	26.000	24.192	Passed
Measurement uncertainty <10^{-7} (frequency), 0.66 dB / -0.72 dB (level)				

TEST EQUIPMENT USED FOR THE TEST:

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5.4 Unwanted emission intensity measurement

5.4.1 Tested sample: PT4-B301#3

Ambient temperature:	23°C
Tested by	P. NEUFELD

Relative humidity:	52%
Date	30/31.07.2018 06.08.2018

5.4.2 Test procedure

1. The EUT has to set to transmit on a fixed channel.
2. The following spectrum analyser setting shall be used:
   RBW = VBW = 100 kHz below 1 GHz and 1 MHz above 1 GHz;
   Sweep time = Auto;
   Sweep mode = Continuous sweep;
   Detection mode = Positive peak;
   Trace mode = Max hold.
     a. Set the spectrum analyser start frequency to 30 MHz and stop frequency to 1000 MHz and mark the peaks.
     b. The limits have to adjusted from dBm / 100 kHz to dBm / 1 MHz by a conversion of - 10 dB, which corresponds to 10*log(100 kHz / 1 MHz).
     c. Set Set the spectrum analyser start frequency to 1000 MHz and stop frequency to 2387 MHz and mark the peaks.
     d. Set the spectrum analyser start frequency to 2496.5 MHz and stop frequency to 12500 MHz and mark the peaks.
3. Measure the side band spurious as follows:
   RBW = VBW = 30 kHz;
   Sweep time = Auto;
   Sweep mode = Continuous sweep;
   Detection mode = Positive peak;
   Trance mode = Max hold.
     a. Set the spectrum analyser start frequency to 2374 MHz and stop frequency to 2400 MHz and mark the peaks.
     b. Set the spectrum analyser start frequency to 2483.5 MHz and stop frequency to 2496.5 MHz and mark the peaks.
     c. The measured values + 15.2 dB (conversion factor from 30 kHz to 1 MHz) shall be below the limit
     d. If the results are above the limit measure the total power in 1 MHz at the maximum values with channel power function of the spectrum analyser.

5.4.3 Test set-up
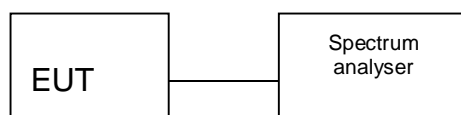
5.4.4 Limit

30 MHz – 2387 MHz 2496.5 MHz – 12500 MHz	<= 2.5 µW
2387 MHz – 2400 MHz 2483.5 MHz – 2496.5 MHz	<= 25 µW

5.4.5 Test results

Module in Bluetooth Low Energy mode (1 Mbps)

Operation on channel 0						
Supply voltage			3.3 V DC at EUT			
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	88.065	-44.6	-36.0	8.6	passed
1 - 2.387	1.00	2370.008	-50.4	-26.0	24.4	passed
2.387 - 2.4	0.03	2399.930	-36.0	-16.0	20.0	passed
2.4835 - 2.4965	0.03	2495.899	-49.9	-16.0	33.9	passed
2.4965 - 12.5	1.00	9607.048	-47.5	-26.0	21.5	passed
Operation on channel 19						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	122.630	-57.6	-36.0	21.6	passed
1 - 2.387	1.00	2312.126	-52.0	-26.0	26.0	passed
2.387 - 2.4	0.03	2392.553	-50.8	-16.0	34.8	passed
2.4835 - 2.4965	0.03	2490.185	-50.3	-16.0	34.3	passed
2.4965 - 12.5	1.00	9761.061	-45.6	-26.0	19.6	passed
Operation on channel 39						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	166.065	-46.5	-36.0	10.5	passed
1 - 2.387	1.00	2352.075	-50.4	-26.0	24.4	passed
2.387 - 2.4	0.03	2393.792	-50.4	-16.0	34.4	passed
2.4835 - 2.4965	0.03	2483.652	-43.5	-16.0	27.5	passed
2.4965 - 12.5	1.00	9921.062	-45.1	-26.0	19.1	passed
Measurement uncertainty: 0.66 dB / -0.72 dB						

Module in Bluetooth Low Energy mode (2 Mbps)

Operation on channel 0						
Supply voltage			3.3 V DC at EUT			
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	88.315	-44.5	-36.0	8.5	passed
1 - 2.387	1.00	2386.774	-49.4	-26.0	23.4	passed
2.387 - 2.4	0.03	2399.965	-18.5	-16.0	2.5	passed
2.4835 - 2.4965	0.03	2485.300	-50.9	-16.0	34.9	passed
2.4965 - 12.5	1.00	9610.054	-47.6	-26.0	21.6	passed
Operation on channel 19						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	126.440	-46.4	-36.0	10.4	passed
1 - 2.387	1.00	2311.636	-52.3	-26.0	26.3	passed
2.387 - 2.4	0.03	2388.644	-49.6	-16.0	33.6	passed
2.4835 - 2.4965	0.03	2487.009	-49.5	-16.0	33.5	passed
2.4965 - 12.5	1.00	9762.056	-45.7	-26.0	19.7	passed
Operation on channel 39						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	165.315	-46.5	-36.0	10.5	passed
1 - 2.387	1.00	2351.930	-50.7	-26.0	24.7	passed
2.387 - 2.4	0.03	2393.565	-49.8	-16.0	33.8	passed
2.4835 - 2.4965	0.03	2483.778	-38.1	-16.0	22.1	passed
2.4965 - 12.5	1.00	9918.053	-44.9	-26.0	18.9	passed
Measurement uncertainty: 0.66 dB / -0.72 dB						

Module in Bluetooth Low Energy mode (500 kbps)

Operation on channel 0						
Supply voltage			3.3 V DC at EUT			
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	88.065	-44.4	-36.0	8.4	passed
1 - 2.387	1.00	2369.763	-50.4	-26.0	24.4	passed
2.387 - 2.4	0.03	2399.825	-37.3	-16.0	21.3	passed
2.4835 - 2.4965	0.03	2486.697	-50.8	-16.0	34.8	passed
2.4965 - 12.5	1.00	9609.058	-47.3	-26.0	21.3	passed
Operation on channel 19						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	128.920	-57.8	-36.0	21.8	passed
1 - 2.387	1.00	2376.177	-52.4	-26.0	26.4	passed
2.387 - 2.4	0.03	2394.591	-50.7	-16.0	34.7	passed
2.4835 - 2.4965	0.03	2484.698	-49.3	-16.0	33.3	passed
2.4965 - 12.5	1.00	9759.046	-45.6	-26.0	19.6	passed
Operation on channel 39						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	166.065	-46.4	-36.0	10.4	passed
1 - 2.387	1.00	2351.765	-50.7	-26.0	24.7	passed
2.387 - 2.4	0.03	2388.505	-50.4	-16.0	34.4	passed
2.4835 - 2.4965	0.03	2484.135	-44.7	-16.0	28.7	passed
2.4965 - 12.5	1.00	9921.062	-45.1	-26.0	19.1	passed
Measurement uncertainty: 0.66 dB / -0.72 dB						

Module in Bluetooth Low Energy mode (125 kbps)

Operation on channel 0						
Supply voltage			3.3 V DC at EUT			
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	87.565	-44.5	-36.0	8.5	passed
1 - 2.387	1.00	2370.263	-50.6	-26.0	24.6	passed
2.387 - 2.4	0.03	2400.000	-34.0	-16.0	18.0	passed
2.4835 - 2.4965	0.03	2492.005	-51.1	-16.0	35.1	passed
2.4965 - 12.5	1.00	9607.053	-47.2	-26.0	21.2	passed
Operation on channel 19						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	124.855	-57.8	-36.0	21.8	passed
1 - 2.387	1.00	2312.261	-52.2	-26.0	26.2	passed
2.387 - 2.4	0.03	2393.629	-50.2	-16.0	34.2	passed
2.4835 - 2.4965	0.03	2486.762	-50.4	-16.0	34.4	passed
2.4965 - 12.5	1.00	9761.056	-45.5	-26.0	19.5	passed
Operation on channel 39						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	165.565	-46.2	-36.0	10.2	passed
1 - 2.387	1.00	2351.760	-50.7	-26.0	24.7	passed
2.387 - 2.4	0.03	2395.317	-49.9	-16.0	33.9	passed
2.4835 - 2.4965	0.03	2483.627	-42.7	-16.0	26.7	passed
2.4965 - 12.5	1.00	9919.053	-45.3	-26.0	19.3	passed
Measurement uncertainty: 0.66 dB / -0.72 dB						

Module in 802.15.4 mode

Operation on channel 11						
Supply voltage			3.3 V DC at EUT			
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	90.315	-44.3	-36.0	8.3	passed
1 - 2.387	1.00	2373.131	-51.0	-26.0	25.0	passed
2.387 - 2.4	0.03	2399.942	-33.1	-16.0	17.1	passed
2.4835 - 2.4965	0.03	2485.864	-50.5	-16.0	34.5	passed
2.4965 - 12.5	1.00	9622.058	-47.5	-26.0	21.5	passed
Operation on channel 18						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	126.480	-46.4	-36.0	10.4	passed
1 - 2.387	1.00	2312.096	-52.3	-26.0	26.3	passed
2.387 - 2.4	0.03	2397.246	-50.1	-16.0	34.1	passed
2.4835 - 2.4965	0.03	2490.458	-50.7	-16.0	34.7	passed
2.4965 - 12.5	1.00	9758.057	-46.2	-26.0	20.2	passed
Operation on channel 26						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	166.315	-46.1	-36.0	10.1	passed
1 - 2.387	1.00	2351.920	-50.6	-26.0	24.6	passed
2.387 - 2.4	0.03	2396.861	-50.5	-16.0	34.5	passed
2.4835 - 2.4965	0.03	2483.924	-25.3	-16.0	9.3	passed
2.4965 - 12.5	1.00	9918.058	-45.2	-26.0	19.2	passed
Measurement uncertainty: 0.66 dB / -0.72 dB						

Module in Proprietary mode (1 Mbps)

Operation on channel 0						
Supply voltage			3.3 V DC at EUT			
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	87.740	-44.5	-36.0	8.5	passed
1 - 2.387	1.00	2370.003	-50.4	-26.0	24.4	passed
2.387 - 2.4	0.03	2399.975	-36.2	-16.0	20.2	passed
2.4835 - 2.4965	0.03	2486.648	-50.3	-16.0	34.3	passed
2.4965 - 12.5	1.00	9607.548	-48.0	-26.0	22.0	passed
Operation on channel 38						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	123.630	-57.9	-36.0	21.9	passed
1 - 2.387	1.00	2312.016	-51.9	-26.0	25.9	passed
2.387 - 2.4	0.03	2391.551	-50.6	-16.0	34.6	passed
2.4835 - 2.4965	0.03	2485.636	-50.5	-16.0	34.5	passed
2.4965 - 12.5	1.00	9759.526	-46.2	-26.0	20.2	passed
Operation on channel 78						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	165.975	-46.2	-36.0	10.2	passed
1 - 2.387	1.00	2351.985	-50.8	-26.0	24.8	passed
2.387 - 2.4	0.03	2395.868	-50.7	-16.0	34.7	passed
2.4835 - 2.4965	0.03	2483.814	-43.1	-16.0	27.1	passed
2.4965 - 12.5	1.00	9920.597	-45.4	-26.0	19.4	passed
Measurement uncertainty: 0.66 dB / -0.72 dB						

Module in Proprietary mode (2 Mbps)

Operation on channel 0						
Supply voltage			3.3 V DC at EUT			
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	87.700	-44.7	-36.0	8.7	passed
1 - 2.387	1.00	2384.310	-50.9	-26.0	24.9	passed
2.387 - 2.4	0.03	2399.980	-22.8	-16.0	6.8	passed
2.4835 - 2.4965	0.03	2493.027	-49.4	-16.0	33.4	passed
2.4965 - 12.5	1.00	9609.084	-47.9	-26.0	21.9	passed
Operation on channel 38						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	126.380	-47.6	-36.0	11.6	passed
1 - 2.387	1.00	2312.071	-52.0	-26.0	26.0	passed
2.387 - 2.4	0.03	2394.044	-50.6	-16.0	34.6	passed
2.4835 - 2.4965	0.03	2486.379	-50.1	-16.0	34.1	passed
2.4965 - 12.5	1.00	9761.091	-46.5	-26.0	20.5	passed
Operation on channel 78						
Frequency Range [GHz]	RBW [MHz]	Frequency [MHz]	Level [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Test Result
0.03 - 1	0.10	165.660	-46.9	-36.0	10.9	passed
1 - 2.387	1.00	2352.035	-50.3	-26.0	24.3	passed
2.387 - 2.4	0.03	2388.541	-50.1	-16.0	34.1	passed
2.4835 - 2.4965	0.03	2484.404	-40.2	-16.0	24.2	passed
2.4965 - 12.5	1.00	9918.942	-46.0	-26.0	20.0	passed
Measurement uncertainty: 0.66 dB / -0.72 dB						

All other emissions were more than 10 dB away from the limit lines.

TEST EQUIPMENT USED FOR THE TEST:

4 - 6

5.5 Antenna power error and antenna power tolerance

5.5.1 Tested sample: PT4-B301#3

Ambient temperature:	23°C
Tested by	P. NEUFELD

Relative humidity:	52%
Date	30/31.07.2018 06.08.2018

5.5.2 Test results

1. Connect the signal generator with RF input of the spectrum analyser and a power meter with the IF output of the spectrum analyser.
2. The following signal generator setting shall be used:
   Frequency = the nominal center frequency;
   Amplitude = 10 dBm;
   Modulation: None.
3. The following spectrum analyser setting shall be used:
   RBW = VBW = 1 MHz;
   Span = Zero;
   Sweep mode = Continuous sweep;
   Detection mode = Positive peak;
   Trace mode = Max hold.
4. The calibrating signal power shall be reduced to 0 dBm and it shall be verified that the power meter reading also reduces by 10 dB.
5. Connect the EUT with the RF input of the spectrum analyser instead of the signal generator.
6. The EUT has to transmit with its maximum output power in the power envelope.With a spectrum analyser span of 3 times the spectrum bandwidth of the EUT find the highest power level and set it to the center frequency. The power meter indicates the measured power density "E".
7. Disconnect the EUT an connect the signal generator to the spectrum analysers RF input.
8. Adjust the output level of the signal generator till the same value of "E" is displayed on the power meter.
9. For DSSS & FHSS: Connect the antenna port of the EUT directly to a high frequency thermal power sensor and read indicated value
10. For OFDM modulated signals calculate the antenna power density by
    $PD = Pt + 10*log(1/x)+Gt$, were x is the duty cycle of the EUT in continuously transmitting mode, Pt is the output power of the signal generator and Gt is the antenna Gain of EUT.
11. For DSSS and FHSS calculate the conducted antenna power (average power per 1 MHz) by reading [dBm] + cable loss [dB] + $10*log_{10}$ (1 MHz / spread spectrum Bandwidth [MHz]) + $10*log_{10}$ $((tx_{on} + tx_{off}) / tx_{on})$
12. The actual measured antenna power shall be between +20 % and -80 % of the manufacturers declared conducted output power density. This value is defined as antenna power tolerance.

Spread Spectrum correction:

Spread Spectum Correction = $10*log_{10}$ (1 MHz / spread spectrum Bandwidth [MHz])

Module in Bluetooth Low Energy mode (1 Mbps, 500 kbps, 125 kbps):

Spread spectrum bandwidth < 1 MHz, therefore no spread spectrum correction

Module in Bluetooth Low Energy mode (2 Mbps):

Spread spectrum bandwidth ch 0 = 1.343 MHz; Spread spectrum correction: -1.3 dB
Spread spectrum bandwidth ch 19 = 1.327 MHz; Spread spectrum correction: -1.2 dB
Spread spectrum bandwidth ch 39 = 1.335 MHz; Spread spectrum correction: -1.3 dB

Module in 802.15.4 mode:

Spread spectrum bandwidth ch 0 = 1.440 MHz; Spread spectrum correction: -1.6 dB
Spread spectrum bandwidth ch 19 = 1.433 MHz; Spread spectrum correction: -1.6 dB
Spread spectrum bandwidth ch 39 = 1.448 MHz; Spread spectrum correction: -1.6 dB

Module in Proprietary mode (1 Mbps & 2 Mbps):

Spread spectrum bandwidth < 1 MHz, therefore no spread spectrum correction

Duty cycle correction:

Module in Bluetooth Low Energy mode (1 Mbps): 0.2
Module in Bluetooth Low Energy mode (2 Mbps): 0.5
Module in Bluetooth Low Energy mode (500 kbps): 0.1
Module in Bluetooth Low Energy mode (125 kbps): 0.1
Module in 802.15.4 mode: 0.1 dB
Module in Proprietary mode (1 Mbps): 0.2
Module in Proprietary mode (2 Mbps): 0.5

5.5.3 Test set-up OFDM
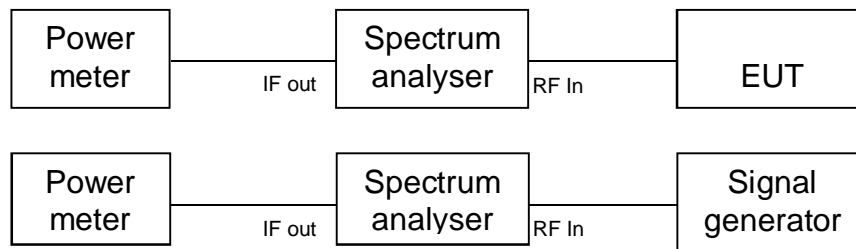
5.5.4 Test set-up FHSS & DSSS
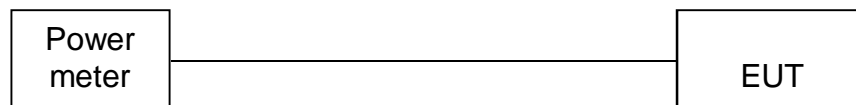
5.5.5 Limit

Item	Limit
Antenna power density	10 mW / MHz for OFDM, DS systems in the range 2400 MHz – 2483.5 MHz 10 mW / MHz for others in the range 2400 MHz – 2483.5 MHz
Antenna power Error	+ 20 %, - 80 % (Based on the rated antenna power density declared by the manufacturer)

5.5.6 Test results

Module in Bluetooth Low Energy mode (1 Mbps)

Operation mode of the EUT: Transmit modulated continuously on a fixed channel,
measured at antenna connector

Power supply voltage	3.3 V DC at EUT		
Operation on channel	0	19	39
Measured power (cable loss included) [dBm]	7.5	7.4	7.1
Spreading bandwidth factor [dB]	0.0	0.0	0.0
Duty cycle factor [dB]	0.2	0.2	0.2
Antenna power conducted [dBm]	7.7	7.6	7.3
Antenna power conducted [mW]	5.888	5.754	5.370
Rated RF output power [mW]	6.000	6.000	6.000
Limit (Antenna Power tolerance) [%]	-1.9	-4.1	-10.5
Limit [mW]	+20 / -80	+20 / -80	+20 / -80
Limit conducted Power [mW]	10.0	10.0	10.0
Maximum antenna gain [dBi]	3.0	3.0	3.0
Maximum effective radiated power EIRP [dBm]	10.7	10.6	10.3
Maximum effective radiated power EIRP [mW]	11.749	11.482	10.715
Result	Passed	Passed	Passed
Measurement uncertainty	+/- 0.2 dB		

Module in Bluetooth Low Energy mode (2 Mbps)

Operation mode of the EUT: Transmit modulated continuously on a fixed channel,
 measured at antenna connector

Power supply voltage	3.3 V DC at EUT		
Operation on channel	0	19	39
Measured power (cable loss included) [dBm]	7.1	7.0	6.7
Spreading bandwidth factor [dB]	-1.3	-1.2	-1.3
Duty cycle factor [dB]	0.5	0.5	0.5
Antenna power conducted [dBm]	6.3	6.3	5.9
Antenna power conducted [mW]	4.266	4.266	3.890
Rated RF output power [mW]	4.500	4.500	4.500
Limit (Antenna Power tolerance) [%]	-5.2	-5.2	-13.5
Limit [mW]	+20 / -80	+20 / -80	+20 / -80
Limit conducted Power [mW]	10.0	10.0	10.0
Maximum antenna gain [dBi]	3.0	3.0	3.0
Maximum effective radiated power EIRP [dBm]	9.3	9.3	8.9
Maximum effective radiated power EIRP [mW]	8.511	8.511	7.762
Result	Passed	Passed	Passed
Measurement uncertainty	+/- 0.2 dB		

Module in Bluetooth Low Energy mode (500 kbps)

Operation mode of the EUT: Transmit modulated continuously on a fixed channel,
 measured at antenna connector

Power supply voltage	3.3 V DC at EUT		
Operation on channel	0	19	39
Measured power (cable loss included) [dBm]	7.5	7.4	7.1
Spreading bandwidth factor [dB]	0.0	0.0	0.0
Duty cycle factor [dB]	0.1	0.1	0.1
Antenna power conducted [dBm]	7.6	7.5	7.2
Antenna power conducted [mW]	5.754	5.623	5.248
Rated RF output power [mW]	6.000	6.000	6.000
Limit (Antenna Power tolerance) [%]	-4.1	-6.3	-12.5
Limit [mW]	+20 / -80	+20 / -80	+20 / -80
Limit conducted Power [mW]	10.0	10.0	10.0
Maximum antenna gain [dBi]	3.0	3.0	3.0
Maximum effective radiated power EIRP [dBm]	10.6	10.5	10.2
Maximum effective radiated power EIRP [mW]	11.482	11.220	10.471
Result	Passed	Passed	Passed
Measurement uncertainty	+/- 0.2 dB		

Module in Bluetooth Low Energy mode (125 kbps)

Operation mode of the EUT: Transmit modulated continuously on a fixed channel,
 measured at antenna connector

Power supply voltage	3.3 V DC at EUT		
Operation on channel	0	19	39
Measured power (cable loss included) [dBm]	7.7	7.6	7.3
Spreading bandwidth factor [dB]	0.0	0.0	0.0
Duty cycle factor [dB]	0.1	0.1	0.1
Antenna power conducted [dBm]	7.8	7.7	7.4
Antenna power conducted [mW]	6.026	5.888	5.495
Rated RF output power [mW]	6.000	6.000	6.000
Limit (Antenna Power tolerance) [%]	0.4	-1.9	-8.4
Limit [mW]	+20 / -80	+20 / -80	+20 / -80
Limit conducted Power [mW]	10.0	10.0	10.0
Maximum antenna gain [dBi]	3.0	3.0	3.0
Maximum effective radiated power EIRP [dBm]	10.8	10.7	10.4
Maximum effective radiated power EIRP [mW]	12.023	11.749	10.965
Result	Passed	Passed	Passed
Measurement uncertainty	+/- 0.2 dB		

Module in 802.15.4 mode

Operation mode of the EUT: Transmit modulated continuously on a fixed channel, measured at antenna connector

Power supply voltage	3.3 V DC at EUT		
Operation on channel	11	18	26
Measured power (cable loss included) [dBm]	7.5	7.4	7.1
Spreading bandwidth factor [dB]	-1.6	-1.6	-1.6
Duty cycle factor [dB]	0.1	0.1	0.1
Antenna power conducted [dBm]	6.0	5.9	5.6
Antenna power conducted [mW]	3.981	3.890	3.631
Rated RF output power [mW]	4.000	4.000	4.000
Limit (Antenna Power tolerance) [%]	-0.5	-2.7	-9.2
Limit [mW]	+20 / -80	+20 / -80	+20 / -80
Limit conducted Power [mW]	10.0	10.0	10.0
Maximum antenna gain [dBi]	3.0	3.0	3.0
Maximum effective radiated power EIRP [dBm]	9.0	8.9	8.6
Maximum effective radiated power EIRP [mW]	7.943	7.762	7.244
Result	Passed	Passed	Passed
Measurement uncertainty	+/- 0.2 dB		

Module in Proprietary mode (1 Mbps)

Operation mode of the EUT: Transmit modulated continuously on a fixed channel,
 measured at antenna connector

Power supply voltage	3.3 V DC at EUT		
Operation on channel	0	38	78
Measured power (cable loss included) [dBm]	7.4	7.2	6.9
Spreading bandwidth factor [dB]	0.0	0.0	0.0
Duty cycle factor [dB]	0.2	0.2	0.2
Antenna power conducted [dBm]	7.6	7.4	7.1
Antenna power conducted [mW]	5.754	5.495	5.129
Rated RF output power [mW]	6.000	6.000	6.000
Limit (Antenna Power tolerance) [%]	-4.1	-8.4	-14.5
Limit [mW]	+20 / -80	+20 / -80	+20 / -80
Limit conducted Power [mW]	10.0	10.0	10.0
Maximum antenna gain [dBi]	3.0	3.0	3.0
Maximum effective radiated power EIRP [dBm]	10.6	10.4	10.1
Maximum effective radiated power EIRP [mW]	11.482	10.965	10.233
Result	Passed	Passed	Passed
Measurement uncertainty	+/- 0.2 dB		

Module in Proprietary mode (2 Mbps)

Operation mode of the EUT: Transmit modulated continuously on a fixed channel,
measured at antenna connector

Power supply voltage	3.3 V DC at EUT		
Operation on channel	0	38	78
Measured power (cable loss included) [dBm]	7.1	7.0	6.7
Spreading bandwidth factor [dB]	0.0	0.0	0.0
Duty cycle factor [dB]	0.5	0.5	0.5
Antenna power conducted [dBm]	7.6	7.5	7.2
Antenna power conducted [mW]	5.754	5.623	5.248
Rated RF output power [mW]	6.000	6.000	6.000
Limit (Antenna Power tolerance) [%]	-4.1	-6.3	-12.5
Limit [mW]	+20 / -80	+20 / -80	+20 / -80
Limit conducted Power [mW]	10.0	10.0	10.0
Maximum antenna gain [dBi]	3.0	3.0	3.0
Maximum effective radiated power EIRP [dBm]	10.6	10.5	10.2
Maximum effective radiated power EIRP [mW]	11.482	11.220	10.471
Result	Passed	Passed	Passed
Measurement uncertainty	+/- 0.2 dB		

TEST EQUIPMENT USED FOR THE TEST:

1 - 6

5.6 Limitation of collateral emissions of receiver
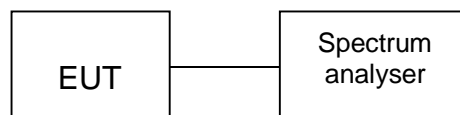
5.6.1 Tested sample: PT4-B301#3

Ambient temperature:	23°C
Tested by	P. NEUFELD

Relative humidity:	52%
Date	30/31.07.2018 06.08.2018

5.6.2 Test procedure

1. The EUT has to set to receive on a fixed channel.
2. The following spectrum analyser setting shall be used:
   RBW = VBW = 100 kHz below 1 GHz and 1 MHz above 1 GHz;
   Sweep time = Auto;
   Sweep mode = Continuous sweep;
   Detection mode = Positive peak;
   Trance mode = Max hold.
3. Set the spectrum analyser start frequency to 30 MHz and stop frequency to 1000 MHz and mark the peaks.
4. Set the spectrum analyzer start frequency to 1000 MHz and stop frequency to 12500 MHz and mark the peaks.

5.6.3 Test set-up

```
┌─────────┐        ┌──────────────┐
│         │        │  Spectrum    │
│   EUT   │────────│  analyser    │
│         │        │              │
└─────────┘        └──────────────┘
```

5.6.4 Limit

30 MHz – 1000 MHz	<= 4 nW
1000 MHz – 12500 MHz	<= 20 nW

5.6.5   Test results

Module in Bluetooth mode (BTLE mode)

Supply voltage			5.0 V DC at EUT		
ch. 0					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	151.690	-74.3	-54.0	20.3	passed
1 - 12.5	3137.995	-66.9	-47.0	19.9	passed
ch. 19					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	574.350	-75.1	-54.0	21.1	passed
1 - 12.5	2431.120	-68.2	-47.0	21.2	passed
ch. 39					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	472.545	-74.8	-54.0	20.8	passed
1 - 12.5	2601.395	-67.4	-47.0	20.4	passed
Measurement uncertainty: 0.66 dB / -0.72 dB					

Module in 802.15.4 mode

Supply voltage			5.0 V DC at EUT		
ch. 11					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	424.985	-74.6	-54.0	20.6	passed
1 - 12.5	2874.050	-67.7	-47.0	20.7	passed
ch. 18					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	556.575	-74.2	-54.0	20.2	passed
1 - 12.5	12151.515	-68.2	-47.0	21.2	passed
ch. 26					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	498.175	-74.4	-54.0	20.4	passed
1 - 12.5	2431.030	-68.7	-47.0	21.7	passed
Measurement uncertainty: 0.66 dB / -0.72 dB					

Module in Proprietary mode (1&2 Mbps)

Supply voltage			5.0 V DC at EUT		
ch. 0					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	433.230	-74.8	-54.0	20.8	passed
1 - 12.5	3145.505	-67.0	-47.0	20.0	passed
ch. 38					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	480.775	-74.1	-54.0	20.1	passed
1 - 12.5	2521.335	-68.3	-47.0	21.3	passed
ch. 78					
Frequency Range [GHz]	Frequency [MHz]	Level [dBm]	Limit [dBm]	Margin [dB]	Test Result
0.03 - 1	662.010	-74.8	-54.0	20.8	passed
1 - 12.5	2910.665	-68.1	-47.0	21.1	passed
Measurement uncertainty: 0.66 dB / -0.72 dB					

TEST EQUIPMENT USED FOR THE TEST:

4 - 6

5.7   Construction protection

5.7.1   Requirement

The high frequency area and the modulator area of the EUT shall be not opened easily.

5.7.2   Test results

The RF modules are constructed with SMD components completely. The RF circuit of the NINA-B3 module is covered by a metal shielding, which is soldered to the PCB.

Therefore the construction protection can be assumed.

6 Report History

No.	Test equipment	Type	Manufacturer	PM. No.	Serial No.	Cal. Date	Cal. Performed by
1	Power meter	NRVD	Rohde & Schwarz	480589	833697/030	28.02.2018	Rohde & Schwarz
2	Thermal power sensor	NRV-Z51	Rohde & Schwarz	480247	825948/004	01.03.2018	Rohde & Schwarz
3	Signal Generator	SMBV 100A	Rohde & Schwarz	255092	481326	28.02.2018	Rohde & Schwarz
4	Spectrum analyzer	FSU 46	Rohde & Schwarz	480956	200125	01.03.2018	Rohde & Schwarz
5	Power supply	TOE 8852	Toellner	480233	51712	Calibration not necessary	
6	Multimeter	971A	Hewlett Packard	480721	JP39009358	31.01.2018	Phoenix Contact

7 Report History

Report Number	Date	Comment
181014E10	09.10.2018	Document created

8 List of Annexes

ANNEX A   TEST SETUP AND EUT PHOTOS   5 pages

    181014_E10_01.jpg: Test setup – antenna port conducted measurements
    181014_E10_02.jpg: EUT on evaluation board - top view
    181014_E10_03.jpg: EUT on evaluation board – bottom view
    181014_E10_04.jpg: EUT (Top / Side / Bottom) – view
    181014_E10_05.jpg: EUT without shielding

ANNEX B   MEASUREMENT RESULTS   100 pages