FCC ID: 2ADPZ-INETBOXA IC: 12552-INETBOXA

EMI – TEST REPORT

- FCC Part 15.247, RSS210 -

Test Report No. : **T39073-00-06TK**	21. April 2015 Date of issue

Type / Model Name : iNet Box

Product Description : Interface box with Bluetooth LE module

Applicant : Truma Gerätetechnik GmbH & Co. KG

Address : Wernher-von-Braun-Strasse 12

85640 PUTZBRUNN, GERMANY

Manufacturer : Feo Elektronik GmbH

Address : Zwergerstrasse 15

88214 RAVENSBURG, GERMANY

Licence holder : Truma Gerätetechnik GmbH & Co. KG

Address : Wernher-von-Braun-Strasse 12

85640 PUTZBRUNN, GERMANY

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

DAkkS Deutsche Akkreditierungsstelle D-PL-12030-01-00

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September, 2014)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September, 2014)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

FCC Rules and Regulations Part 1, Subpart I - Procedures Implementing the National Environmental Policy Act of 1969

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable device

OET Bulletin 65, 65A, 65B Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

KDB 447498 D01 v05r02	Mobile and portable devices RF Exposure procedures and equipment authorisation policies, February 7, 2014.
ANSI C63.4: 2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ANSI C95.1: 2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
CISPR 16-4-2: 2013	Uncertainty in EMC measurement
KDB 558074 D01 v03r02	Guidance for performing compliance measurements on DTS operating under §15.247, June 5, 2014.

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

2.2 Equipment type, category

Bluetooth 4.0 Low Energy device, fixed equipment.

2.3 Short description of the equipment under test (EUT)

The EUT uses a TI Bluetooth chipset which is compliant to Bluetooth 4.0 Low Energy capability. A temporary connector is not implemented. Therefore all tests were performed radiated. A special test software was used to state the needed EUT test mode for TX continuous and RX continuous. Other parts of the EUT than the Bluetooth section were inactive during tests. The communication with the Bluetooth section was performed via an USB to serial converter or a serial to TTL adaptor.

Items	Description
BT version	4.0 Low Energy
BT chipset type	Texas Instruments CC2564B
Modulation	GFSK
Frequency range	2400 MHz to 2483.5 MHz
Channel numbers	40
Data rate (kbps)	1000
Antenna type	PCB

Number of tested samples: 2
Serial number: Pre-production sample
Serial number: INB -A- 26084108 Bluetooth LE test with companion device

EUT configuration:
(The CDF filled by the applicant can be viewed at the test laboratory.)

2.4 Variants of the EUT

None

2.5 Antennas

The following antennas shall be used with the EUT:

Number	Characteristic	Certification name	Plug	Frequency range (MHz)	Gain (dBi)
1	Omni	PCB antenna	none	2.4 - 2.4835	3.3

2.6 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan BT-Standard 802.15.1:

Channel	Frequency	Channel	Frequency
37	2402	18	2442
0	2404	19	2444
1	2406	20	2446
2	2408	21	2448
3	2410	22	2450
4	2412	23	2452
5	2414	24	2454
6	2416	25	2456
7	2418	26	2458
8	2420	27	2460
9	2422	28	2462
10	2424	29	2464
38	2426	30	2466
11	2428	31	2468
12	2430	32	2470
13	2432	33	2472
14	2434	34	2474
15	2436	35	2476
16	2438	36	2478
17	2440	39	2480

Note: the marked frequencies are determined for final testing.

2.7 Transmit operating modes

The EUT uses GFSK modulation and may provide following data rates:

- 1000 kbps (kbps = *kilobits per second)*

2.8 Power supply system utilised

Power supply voltage, V_{nom} : 13.2 VDC
Power supply voltage (alternative) : 8 VDC to 30 VDC

2.9 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- Notebook computer Model : Vobis, 15M9
- USB to serial adaptor Model : Prolific 2303
- Notebook computer Model : Toshiba, TECRA A11-127
- Serial to TTL adaptor Model : Feo

2.10 Determination of worst case conditions for final measurement

Measurements are made in all three orthogonal axes and the settings of the EUT are changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in X position.

The tests are carried out in the following frequency band:

2400 MHz – 2483.5 MHz

Preliminary tests were performed to find the worst case mode from all possible combinations between available modulations and data rates. On customer demands the output power was set to P9 (-23 dBm) with the test software.

For the final test the following channels and test modes are selected:

IEEE 802.15.1	Available channels	Tested channels	Power setting	Modulation	Data rate
BT 4.0 LE	00 to 39	37, 18, 39	4 dBm	GFSK	1000 kbps

- TX continuous mode

2.10.1 Test jig

No special test jig was used for testing.

2.10.2 Test software

The special test software "***CC256x Bluetooth Hardware Evaluation Tool***" was used to set test parameters for output power, channel frequency, modulation type and TX continuous transmission.

3 TEST RESULT SUMMARY

BLE device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS Gen, 8.8	AC power line conducted emissions	passed
15.247(a)(2)	RSS210, A8.2(a)	-6 dB EBW	passed
15.247(b)(3)	RSS-210, A8.4(4)	Peak power	passed
15.247(d)	RSS-210, A8.5	Out-of-band emission, radiated	passed
15.247(d)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.247(e)	RSS-210, A8.2(b)	PSD	passed
15.35(c)	RSS-Gen, 6.10	Pulsed operation	passed
15.247(i)	RSS 102, 2.5.2	MPE	passed
15.247(b)(4)	RSS-210, A8.4(4)	Antenna requirement	passed
	RSS-Gen, 6.11	Transmitter frequency stability	passed
	RSS-Gen, 6.6	99 % Bandwidth	passed
OET Bulletin 65	RSS102, 3.2	Co-location, Co-transmission	passed

The mentioned RSS Rule Parts in the above table are related to:
RSS Gen, Issue 4, November 2014
RSS 210, Issue 8, December 2010
RSS 102, Issue 4, March 2010

3.1 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 09 December 2014

Testing concluded on : 13 April 2015

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2015.05.08 12:31:13 +02'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Tobias Kammerer
I`m the author of this document
2015.05.08 12:14:02 +02'00'

Tobias Kammerer
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement protocol for FCC and IC

4.4.1 General information

The Open Area test site is a listed Open Site under the Canadian Test-Sites File-No:

IC 3009A

In compliance with RSS 210 testing for RSS compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.1.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.1.2 Details of test procedures

In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: NONE

5.1.2 Photo documentation of the test set-up

5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):
Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.4 described under item 4.4.3. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

Remarks: Not applicable because the EUT has no AC mains connection.

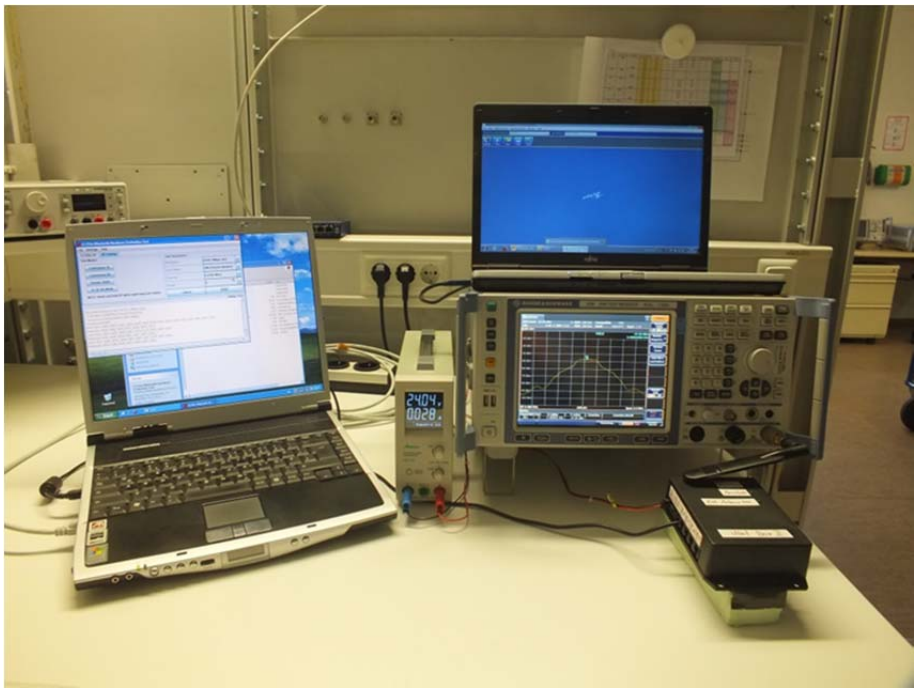
5.2 EBW and OBW

For test instruments and accessories used see section 6 Part **MB**.

5.2.1 Description of the test location

Test location: AREA4

5.2.2 Photo documentation of the test set-up



5.2.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(2):
Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.2.4 Description of Measurement

The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -6 dB. The reference level is the level of the highest signal amplitude observed at the transmitter at either the fundamental frequency or the first order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. An alternative is to use the bandwidth measurement of the analyser.

Spectrum analyser settings for EBW:
RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Sweep time: Auto, Span: 2 EBW;
Spectrum analyser settings for OBW:
RBW: 1-5% OBW, VBW: 3 RBW, Detector: Max peak, Sweep time: Auto, Span: 2 OBW;

5.2.5 Test result

Emission bandwidth:

Channel	Centre frequency (MHz)	6 dB bandwidth (kHz)	Minimum limit (MHz)
37	2402	0.668	0.5
18	2442	0.649	0.5
39	2480	0.657	0.5

Occupied bandwidth:

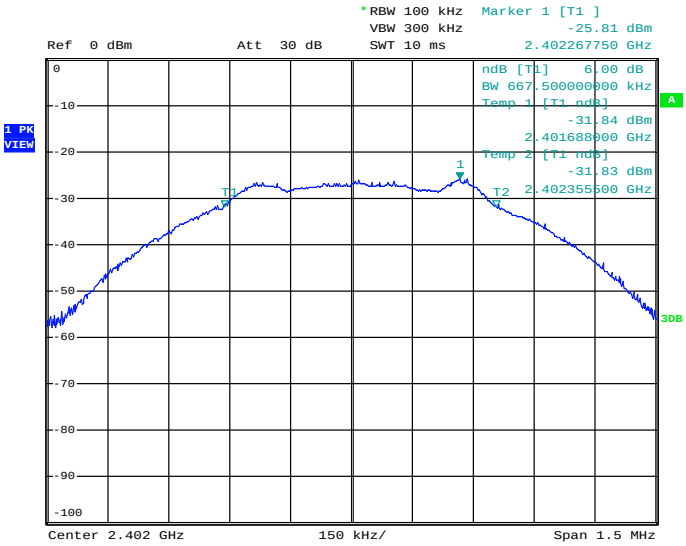
Channel	Centre frequency (MHz)	99 % bandwidth (kHz)
37	2402	1.042
18	2442	1.039
39	2480	1.040

The requirements are **FULFILLED.**

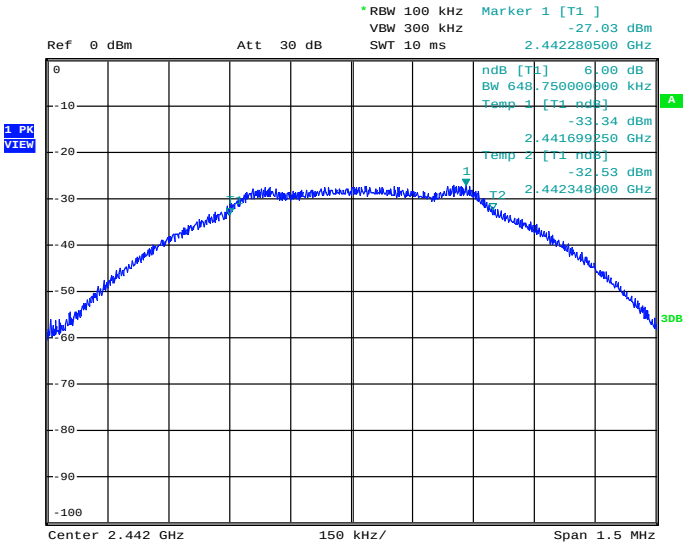
Remarks: For detailed test results please see to following test protocols.

5.2.6 Test protocols EBW

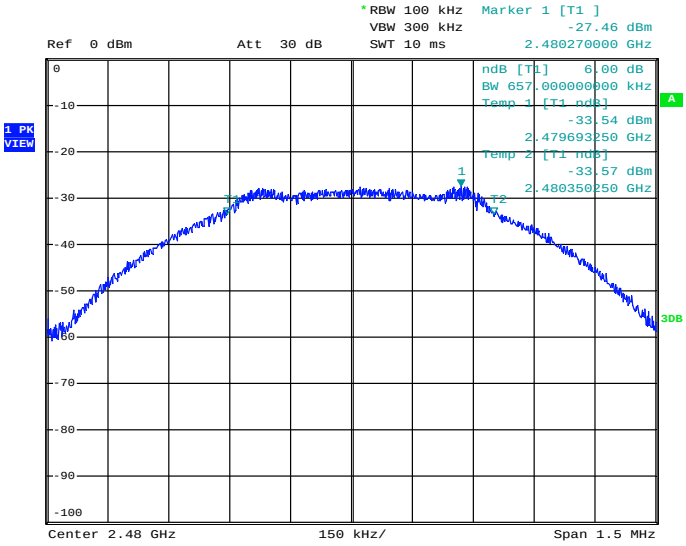
802.15.1, Channel 37



802.15.1, Channel 18

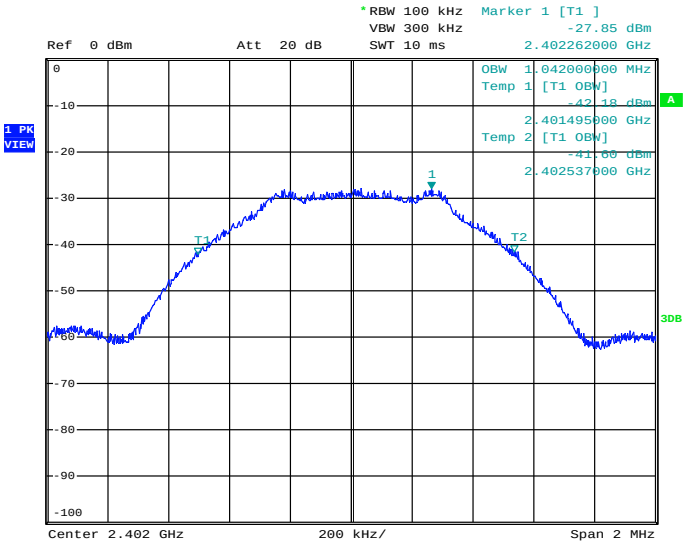


802.15.1, Channel 39

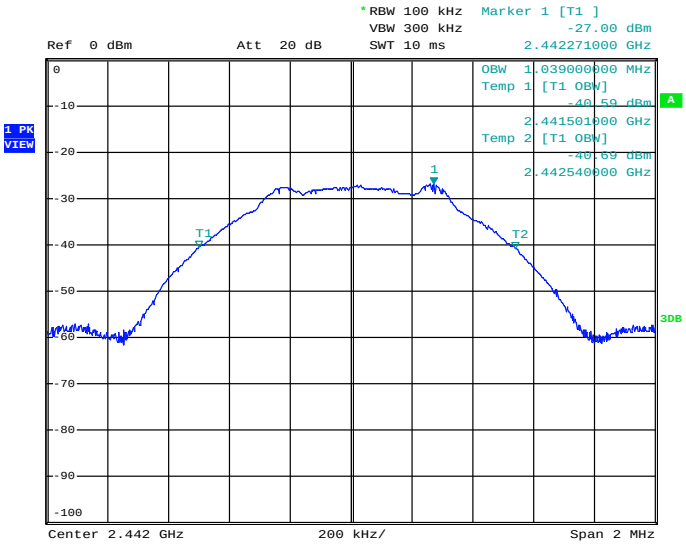


5.2.7 Test protocols OBW

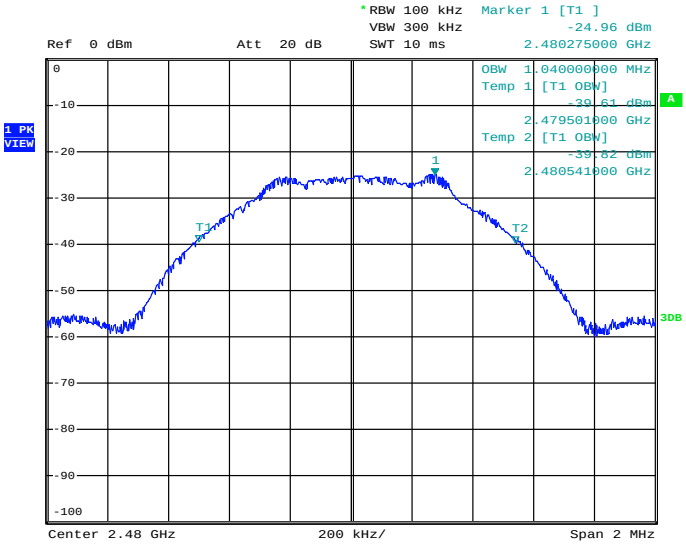
802.15.1, Channel 37



802.15.1, Channel 18



802.15.1, Channel 39



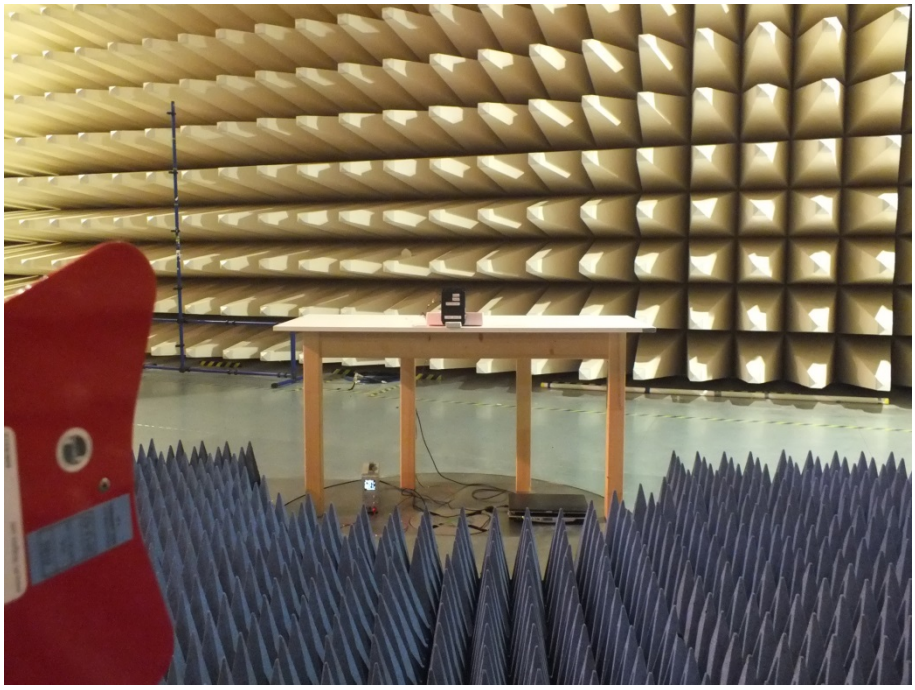
5.3 Maximum peak radiated output power

For test instruments and accessories used see section 6 Part **CPR 3**.

5.3.1 Description of the test location

Test location: Anechoic chamber 1

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15, Section 15.247(b)(3):
For systems using digital modulation in the 2400-2483.5 MHz and 5725 – 5850 MHz bands, the maximum peak output power of the transmitter shall not exceed 1 Watt. The limit is based on transmitting antennas of directional gain that do not exceed 6 dBi.

5.3.4 Description of Measurement

The maximum peak radiated output power is measured using a spectrum analyser following the procedure set out in KDB 558074, item 9.1.1. The EUT is set in TX continuous mode while measuring. The radiated measurement is performed in a fieldstrength measurement. Therefore the formula set out in KDB 558074, item 12.2.2 e) is changed into the following term:

$$E = EIRP - (20*\log_{10} 3) + 104.8$$

5.3.5 Test result

802.15.1, GFSK, TX		Test results radiated			
		Fieldstrength E (dBµV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH37					
T_{nom}	V_{nom}	94.3	-0.9	36.0	-36.9
Middle frequency: CH18					
T_{nom}	V_{nom}	93.4	-1.9	36.0	-37.9
Highest frequency: CH39					
T_{nom}	V_{nom}	93.6	-1.7	36.0	-37.7

Calculated conducted output power

802.15.1, GFSK, TX		Test results conducted		
		EIRP (dBm)	Antenna Gain (dBi)	$P_{conducted}$ (dBm)
Lowest frequency: CH37				
T_{nom}	V_{nom}	-0.9	3.3	-4.2
Middle frequency: CH38				
T_{nom}	V_{nom}	-1.9	3.3	-5.2
Highest frequency: CH39				
T_{nom}	V_{nom}	-1.7	3.3	-5.0

Peak Power Limit according to FCC Part 15, Section 15.247(b)(3):

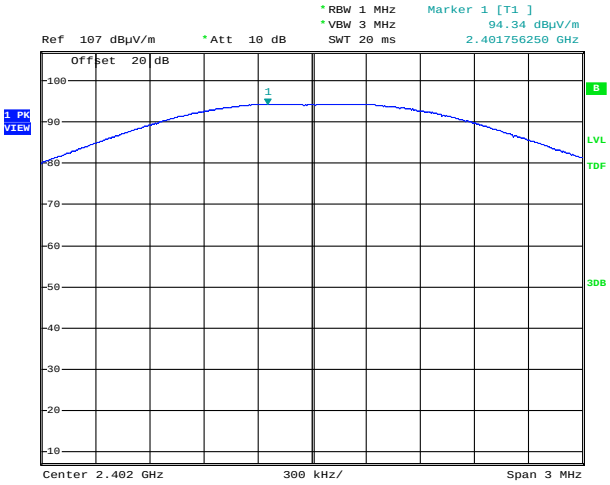
Frequency (MHz)	Peak Power Limit	
	(dBm)	(Watt)
902-928	36	4.0
2400-2483.5	**36**	**4.0**
5725-5850	36	4.0

The requirements are **FULFILLED.**

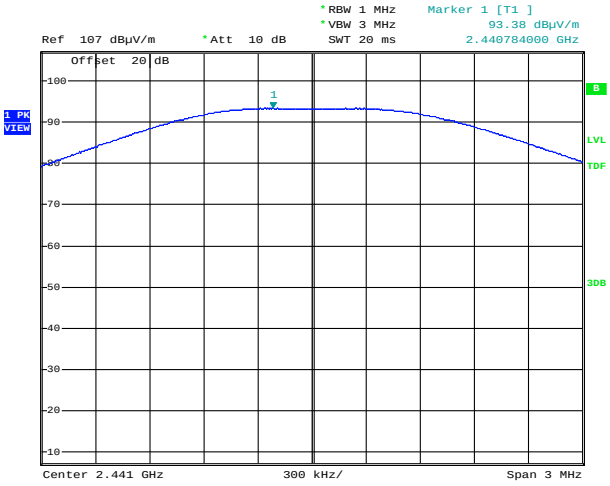
Remarks: For detailed test results please see to following test protocols.

5.3.6 Test protocols

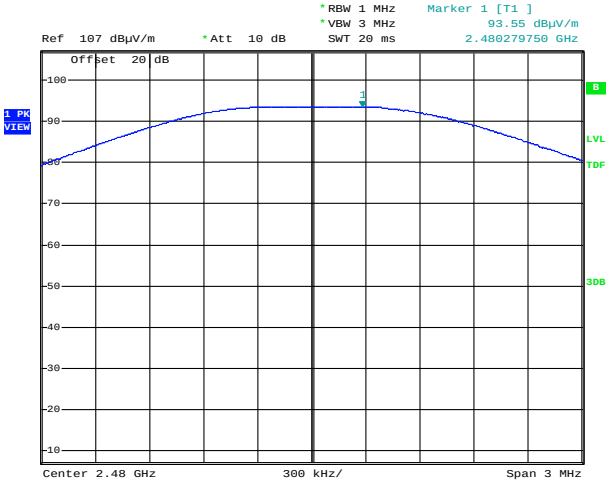
GFSK, CH37



GFSK, CH18



GFSK, CH39



5.4 Spurious emissions radiated

For test instruments and accessories used see section 6 Part **SER1, SER 2, SER 3**.

5.4.1 Description of the test location

Test location: NONE

5.4.2 Applicable standard

According to FCC Part 15, Section 15.247(d):
In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.50 MHz and 5725 – 5850 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a) (see Section 15.205(c)).

5.4.3 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.4. If the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

5.4.4 Test result

Note:
Measurements were performed in the frequency range from 1 GHz up to 25 GHz with the analyser settings for restricted band measurements to show compliance for emissions falling into restricted bands, else the band edge compliance is fulfilled. In the frequency ranges from 9 kHz up to 30 MHz no emission can be detected.
According to FCC Part 15, Section 15.205(a):
In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

Limit according to FCC Part 15, Section 15.247(d) for emissions falling not in restricted bands:
In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.50 MHz and 5725 – 5850 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

Remarks: The device fulfills the radiated emission limits according to FCC §15.209 within the spurious emissions measurements in restricted bands. Also refer section 5.6 of the present document.

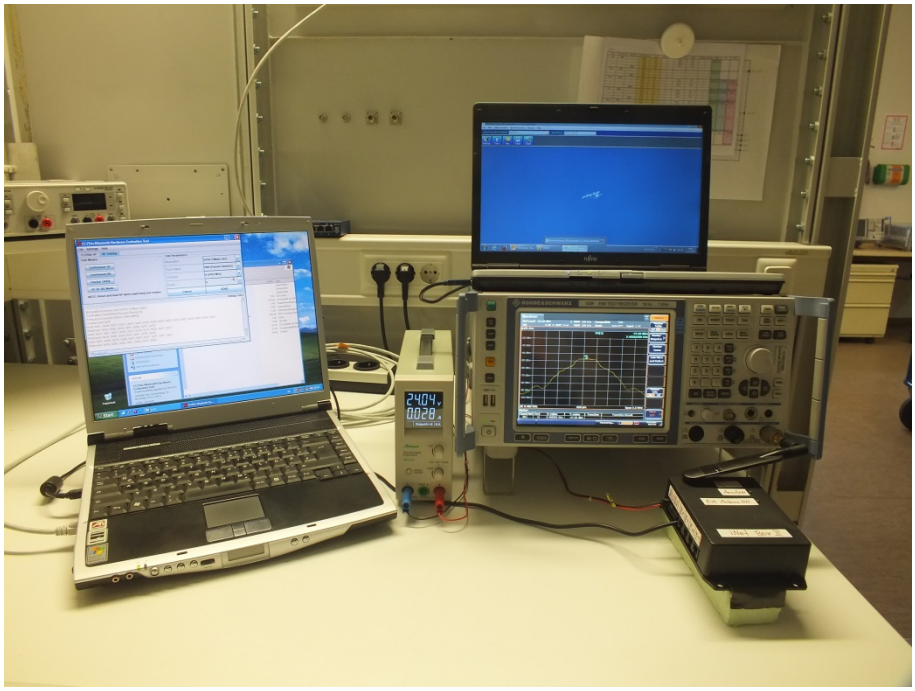
5.5 Power spectral density

For test instruments and accessories used see section 6 Part **MB**.

5.5.1 Description of the test location

Test location: AREA4

5.5.2 Photo documentation of the test set-up



5.5.3 Applicable standard

According to FCC Part 15, Section 15.247(e):
For digitally modulated systems, the power spectral density radiated from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the radiated output power shall be used to determine the power spectral density.

5.5.4 Description of Measurement

The measurement is performed using the procedure 10.2 set out in KDB-558074. The PKPSD is measured radiated. The max peak was located and measured with the spectrum analyser and the marker set to peak. An offset of was set to compensate the near field attenuation. The maximum antenna gain being computed in paragraph 5.9 of this test report is used to calculate the maximum peak power spectral density.

Spectrum analyser settings:
RBW: 3 kHz, VBW: 10 kHz, Detector: Peak, Sweep time: Auto

5.5.5 Test result

Standard 802.15.1

802.15.1, 1000 kbps, 1 TX		Test results conducted		
		PD [Pmax] (dBm/3kHz)	EIRP Limit (dBm/3kHz)	Margin (dB)
Lowest frequency: 2402 MHz				
T_{nom}	V_{nom}	-18.0	14.0	-32.0
Middle frequency: 2442 MHz				
T_{nom}	V_{nom}	-20.2	14.0	-34.2
Highest frequency: 2480 MHz				
T_{nom}	V_{nom}	-20.4	14.0	-34.4

Power spectral density limit according to FCC Part 15, Section 15.247(e):

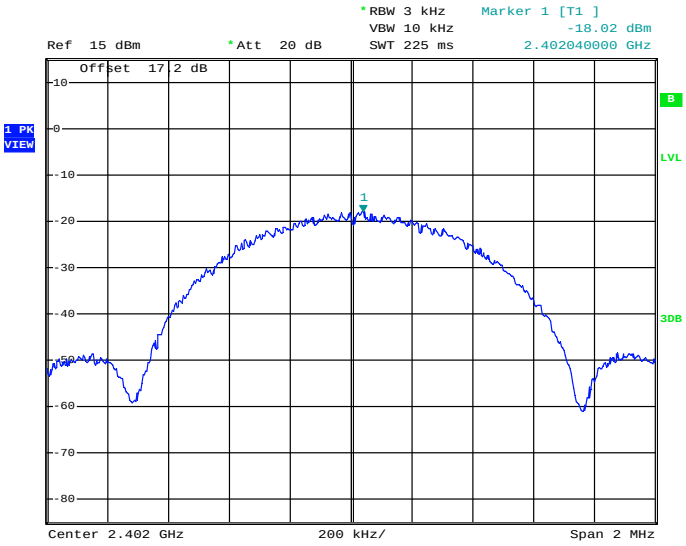
Frequency (MHz)	Power spectral density limit (EIRP) (dBm/3 kHz)
2400 - 2483.5	14

The requirements are **FULFILLED.**

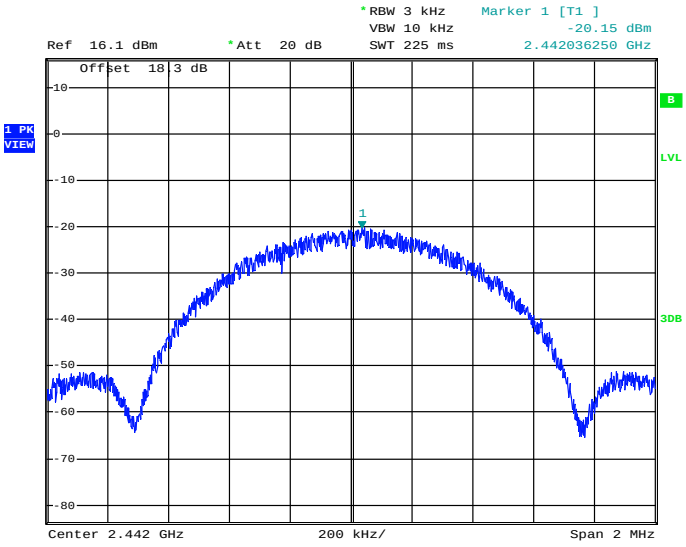
Remarks: For detailed test results please refer to following test protocols.

5.5.6 Test protocols

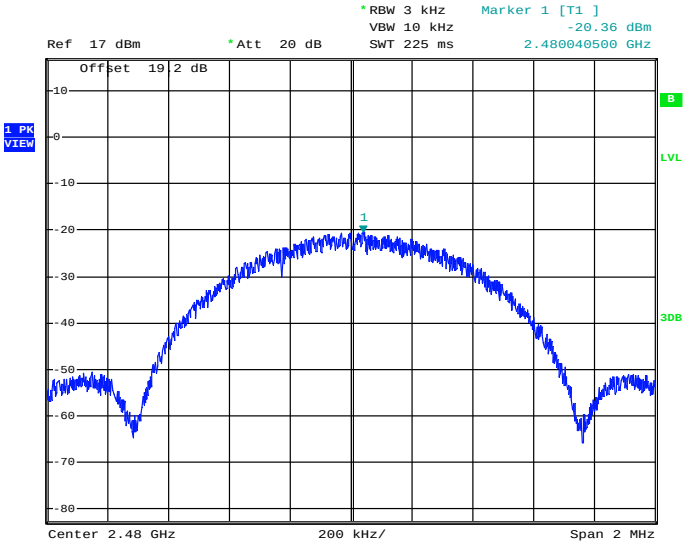
802.15.1, Channel 37 (2402 MHz)



802.15.1, Channel 18 (2442 MHz)



802.15.1, Channel 39 (2480 MHz)



5.6 Radiated emissions in restricted bands

For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

5.6.1 Description of the test location

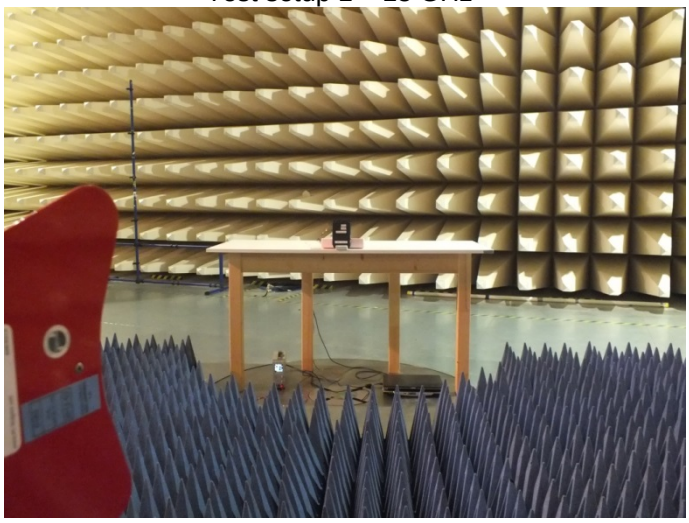
Test location: OATS 1
Test location: Anechoic Chamber 1

Test distance: 3 m

5.6.2 Photo documentation of the test set-up

Test setup 30 – 1000 MHz

Test setup 1 – 18 GHz



5.6.3 Applicable standard

According to FCC Part 15, Section 15.205(a):
In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

5.6.4 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

Test receiver settings for SER2:
RBW: 120 MHz, Detector: Quasi peak, Mes. Time: 1 s,

Spectrum analyser settings for SER3:
RBW: 1 MHz, VBW: 3 MHz, Detector: Max. peak, Trace: Max. hold, Sweep: Auto

5.6.5 Test result

GFSK, 30 MHz – 1000 MHz

Frequency: Hopping							
Test conditions:							
802.15.1, GFSK, TX			Test results				
Start requency (MHz)	Stop frequency (MHz)	RBW (kHz)	Maximum emission		AV Limit (dBµV/m)	Margin (dB)	Detector
			(MHz)	(dBµV/m)			
30	1000	120	39.70	27.2	40.0	-12.8	QP
30	1000	120	51.83	23.2	40.0	-16.8	QP
30	1000	120	79.96	24.7	40.0	-15.3	QP
30	1000	120	95.28	24.9	43.5	-18.6	QP
30	1000	120	266.20	25.2	46.0	-20.8	QP
30	1000	120	345.93	28.4	46.0	-17.6	QP
Measurement uncertainty			±6 dB				

GFSK, 1 GHz – 25 GHz

Lowest frequency: CH37								
Test conditions:								
802.15.1, GFSK, TX			Test results					
Start requency (MHz)	Stop frequency (MHz)	RBW (kHz)	Maximum emission		AV Limit (dBµV/m)	Duty cycle correction (dB)	Margin (dB)	Detector
			(MHz)	(dBµV/m)				
1000	2400	1000	1592.20	45.1	54.0	0	-8.9	PK
2483.5	4000	1000	2654.11	44.0	54.0	0	-10.0	PK
4000	8000	1000	7207.00	59.6	54.0	0	5.6	PK
4000	8000	1000	7207.00	59.6	54.0	-42.0	-36.4	PK
8000	12000	1000	11899.00	51.8	54.0	0	-2.2	PK
12000	18000	1000	17848.50	56.8	54.0	0	2.8	PK
12000	18000	1000	17992.50	48.6	55.0	0	-6.4	RMS
18000	25000	1000	24195.00	56.2	54.0	0	2.2	PK
18000	25000	1000	23922.00	47.2	54.0	0	-6.9	RMS
Measurement uncertainty			±6 dB					

Middle frequency: CH18								
Test conditions:								
802.15.1, GFSK, TX			Test results					
Start requency (MHz)	Stop frequency (MHz)	RBW (kHz)	Maximum emission		AV Limit (dBµV/m)	Duty cycle correction (dB)	Margin (dB)	Detector
			(MHz)	(dBµV/m)				
1000	2400	1000	1596.40	44.4	54.0	0	-9.6	PK
2483.5	4000	1000	2654.11	44.7	54.0	0	-9.3	PK
4000	8000	1000	7324.00	61.3	54.0	0	7.3	PK
4000	8000	1000	7324.00	61.3	54.0	-42.0	-34.7	PK
8000	12000	1000	11929.00	51.9	54.0	0	-2.1	PK
12000	18000	1000	17922.00	57.1	54.0	0	3.1	PK
12000	18000	1000	17844.75	48.8	55.0	0	-6.2	RMS
18000	25000	1000	24195.00	56.2	54.0	0	2.2	PK
18000	25000	1000	23922.00	47.2	54.0	0	-6.9	RMS
Measurement uncertainty			±6 dB					

Highest frequency: CH39								
Test conditions:								
802.15.1, GFSK, TX			Test results					
Start requency (MHz)	Stop frequency (MHz)	RBW (kHz)	Maximum emission		AV Limit (dBµV/m)	Duty cycle correction (dB)	Margin (dB)	Detector
			(MHz)	(dBµV/m)				
1000	2400	1000	1594.30	45.2	54.0	0	-8.9	PK
2483.5	4000	1000	2654.86	43.8	54.0	0	-10.2	PK
4000	8000	1000	7441.00	59.9	54.0	0	5.9	PK
4000	8000	1000	7441.00	59.9	54.0	-42.0	-36.1	PK
8000	12000	1000	11905.00	52.1	54.0	0	-1.9	PK
12000	18000	1000	17979.00	57.3	54.0	0	3.3	PK
12000	18000	1000	17955.75	48.7	55.0	0	-6.3	RMS
18000	25000	1000	24195.00	56.2	54.0	0	2.2	PK
18000	25000	1000	23922.00	47.2	54.0	0	-6.9	RMS
Measurement uncertainty			±6 dB					

Radiated limits according to FCC Part 15 Section 15.209(a) for spurious emissions which fall in restricted bands:

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009-0.490	2400/F (kHz)		300
0.490-1.705	24000/F (kHz)		30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

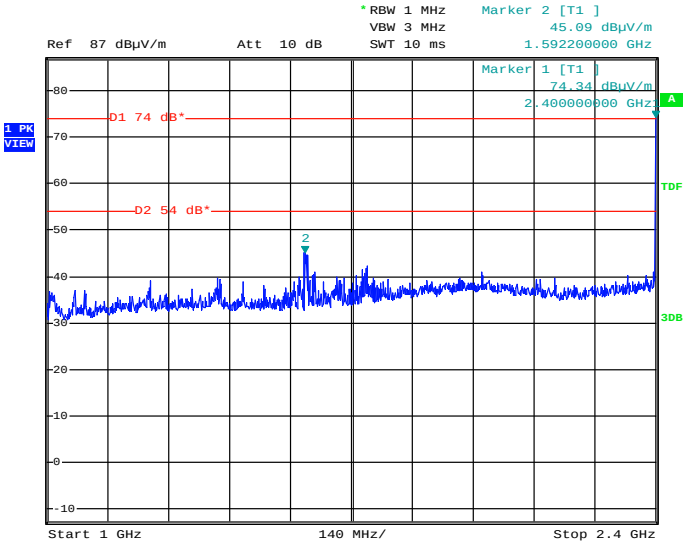
The requirements are **FULFILLED.**

Remarks: The measurement was performed up to the 10th harmonic. For detailed test results please see the following test protocols.

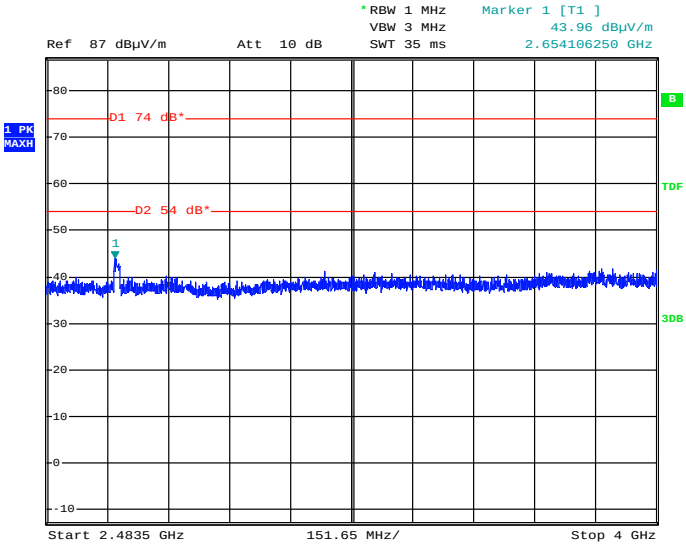
5.6.6 Test protocols radiated emissions SER3

2402 MHz, GFSK

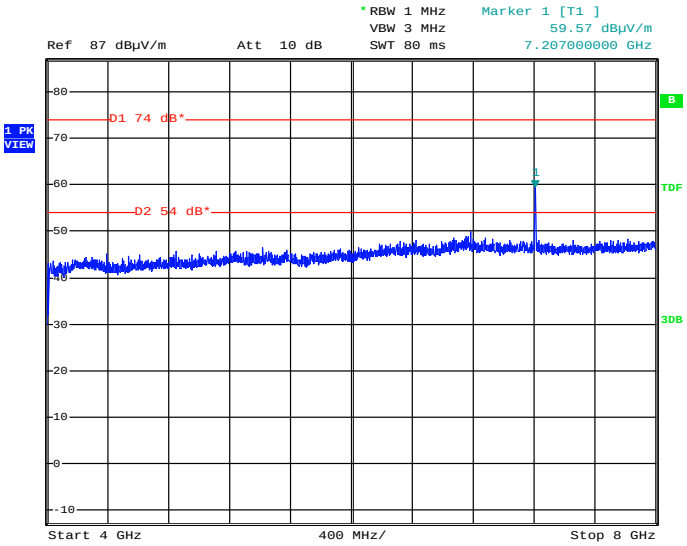
1 – 2.4 GHz



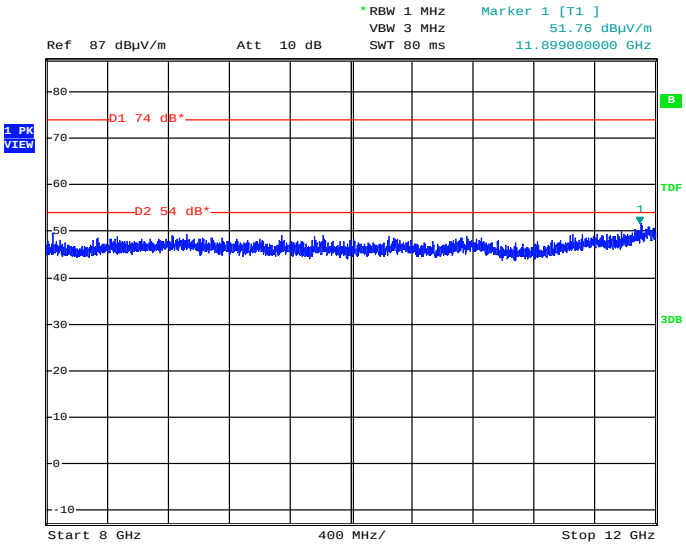
2.4835 - 4 GHz



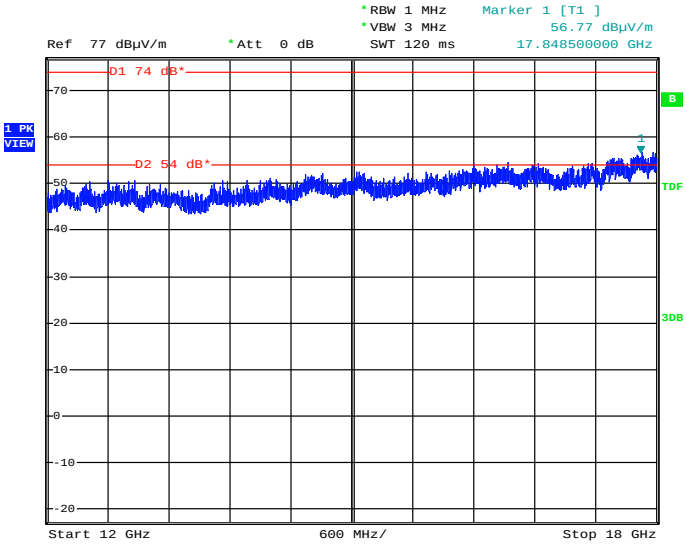
4 - 8 GHz



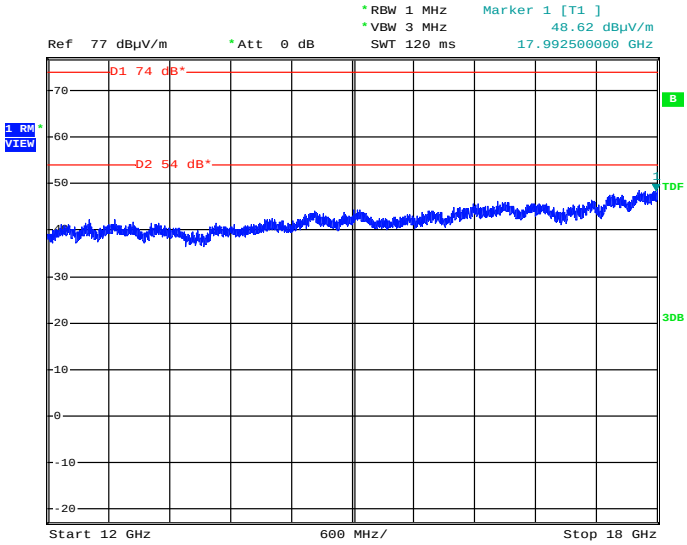
8 - 12 GHz



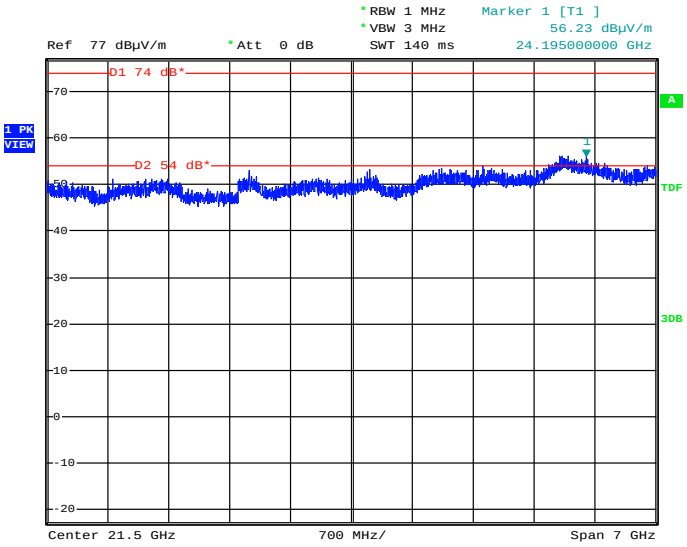
12 - 18 GHz



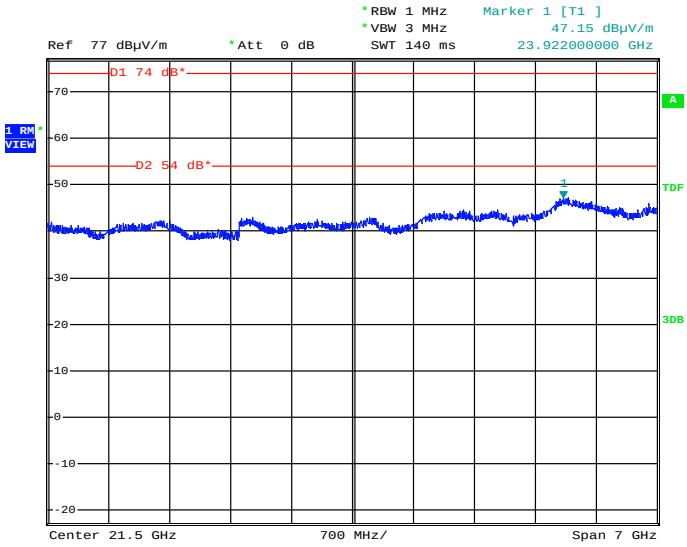
12 - 18 GHz, RMS



18 - 25 GHz

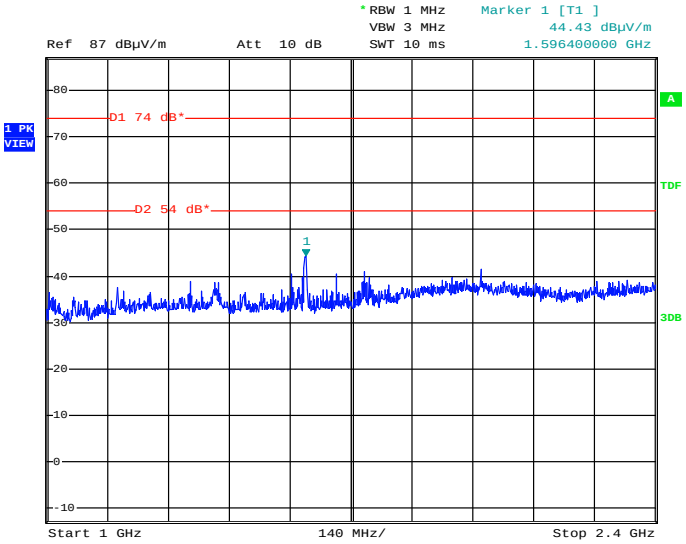


18 - 25 GHz, RMS

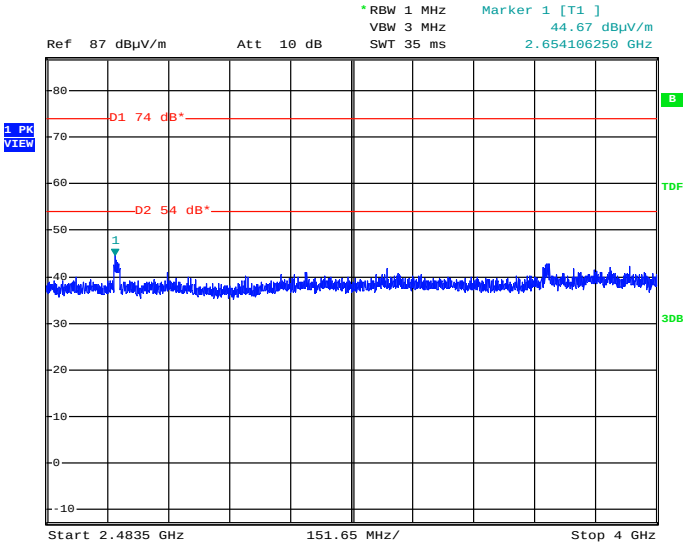


2442 MHz, GFSK

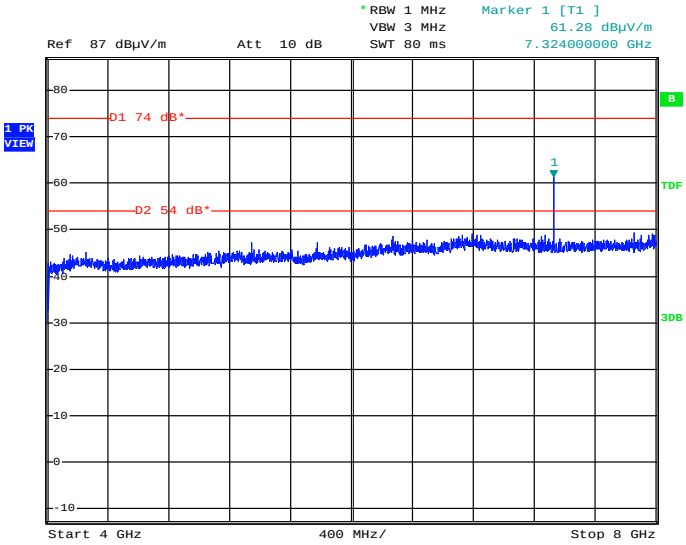
1 – 2.4 GHz



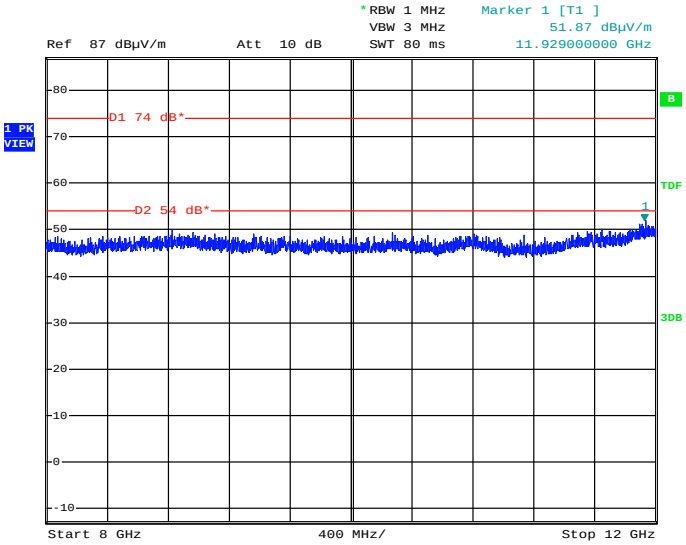
2.4835 - 4 GHz



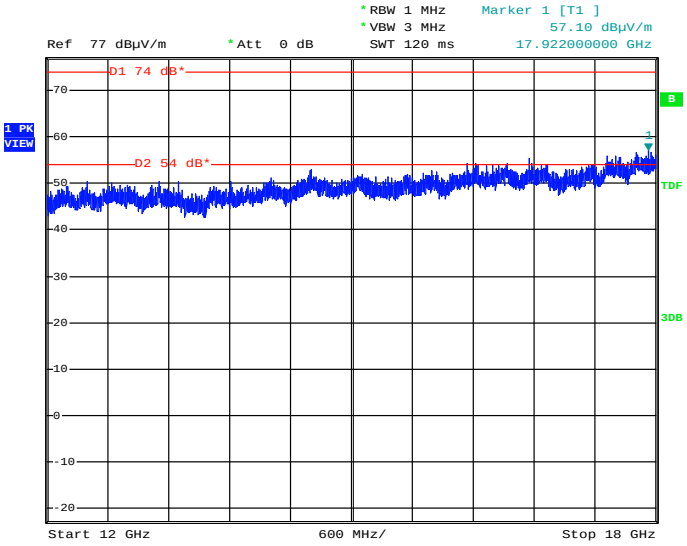
4 - 8 GHz



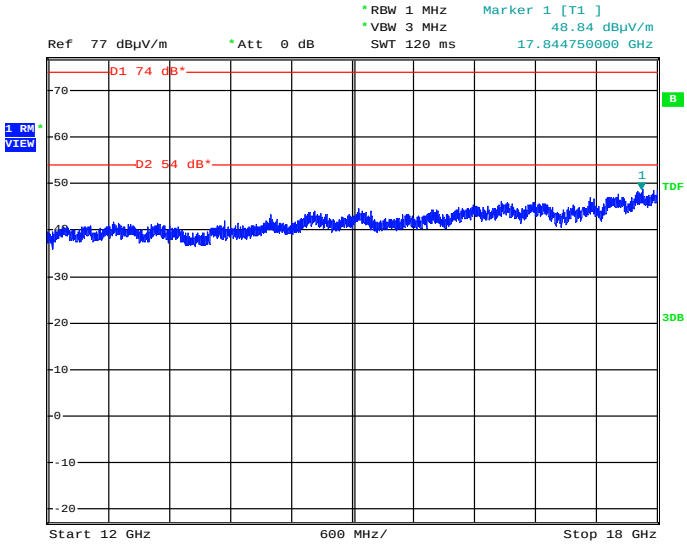
8 - 12 GHz



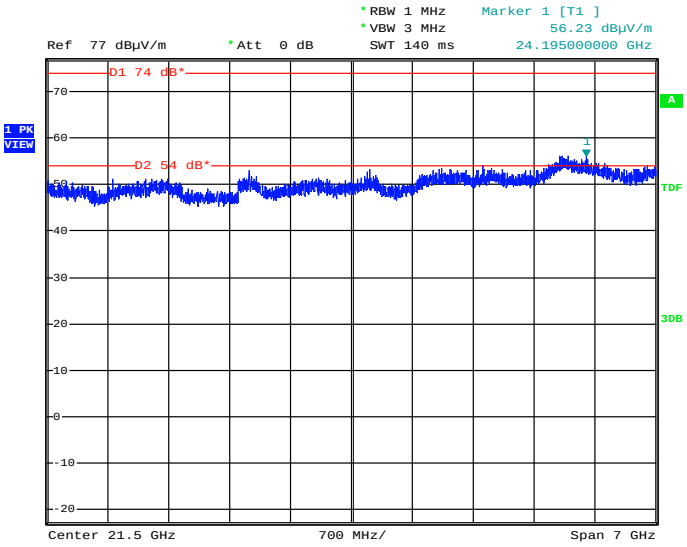
12 - 18 GHz



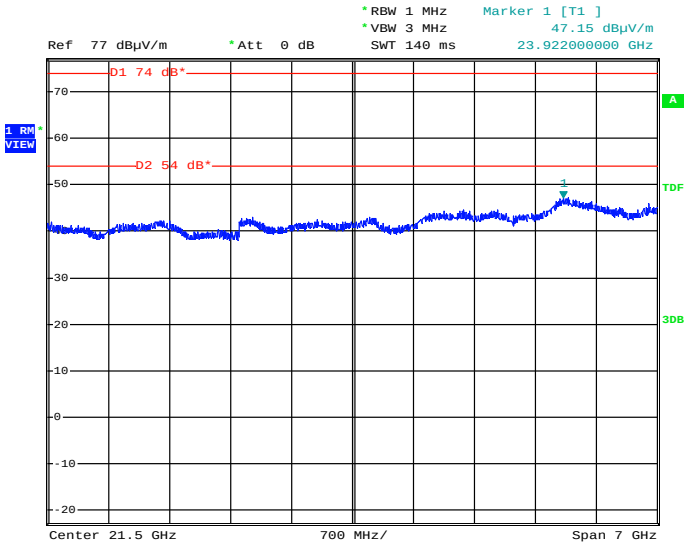
12 - 18 GHz, RMS



18 - 25 GHz

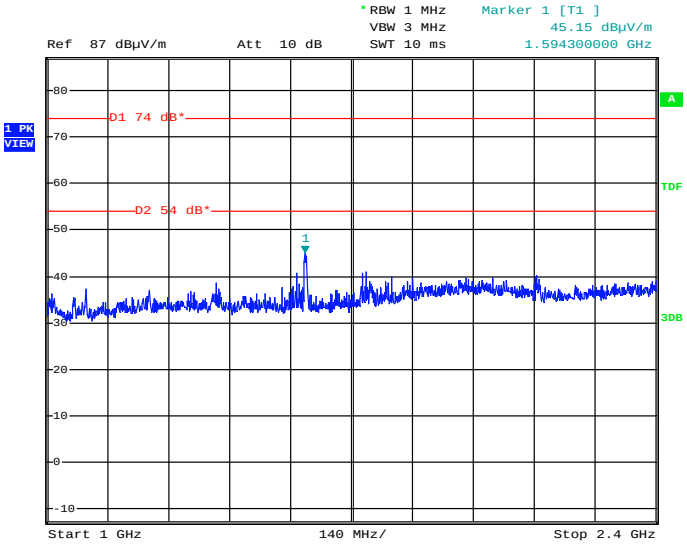


18 - 25 GHz, RMS

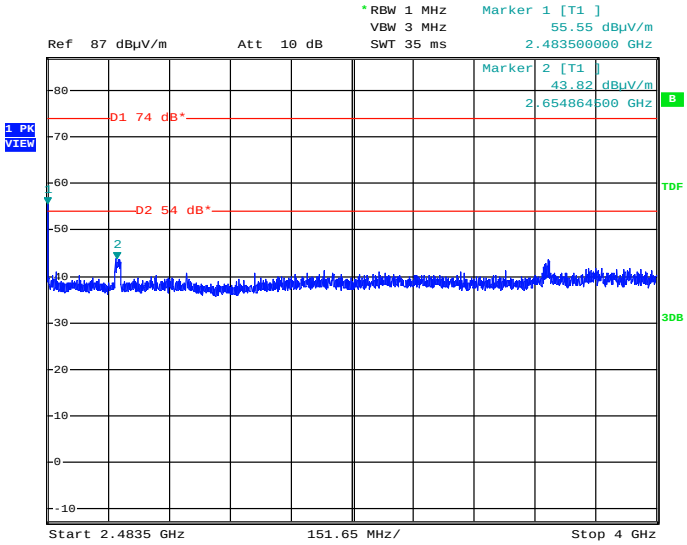


2480 MHz, GFSK

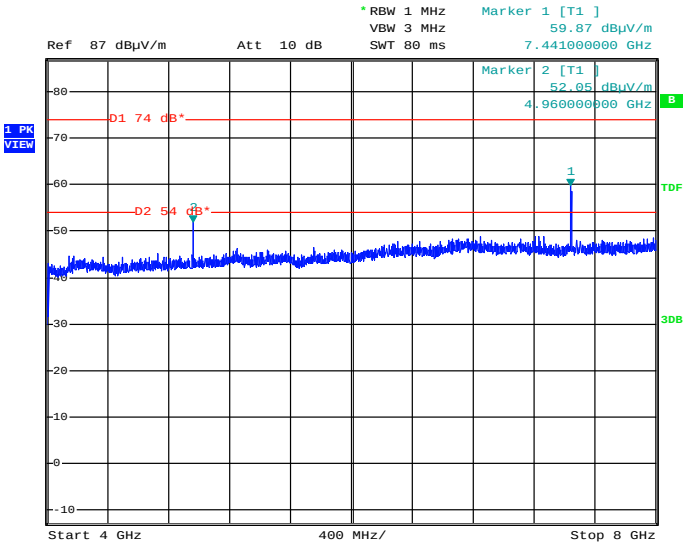
1 – 2.4 GHz



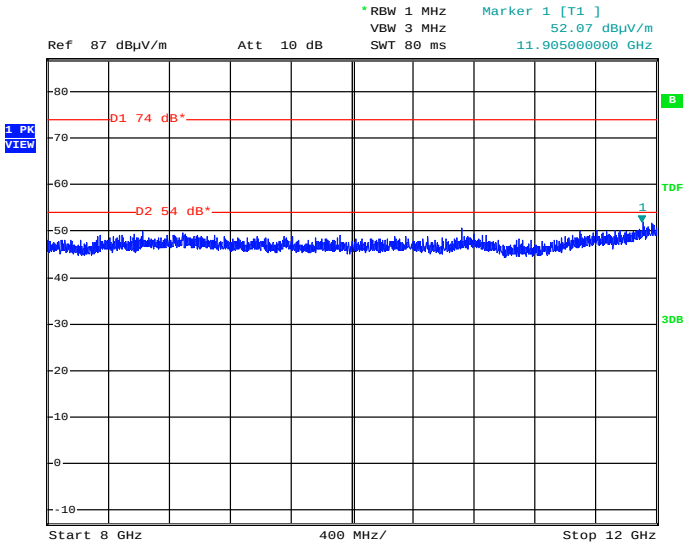
2.4835 - 4 GHz



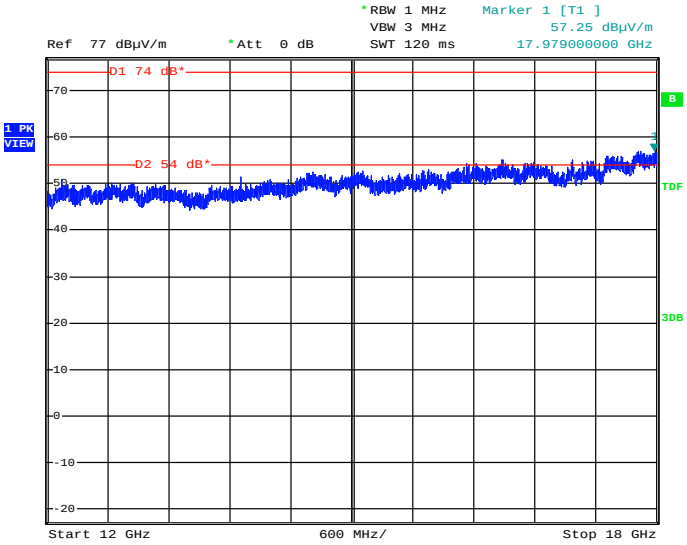
4 - 8 GHz



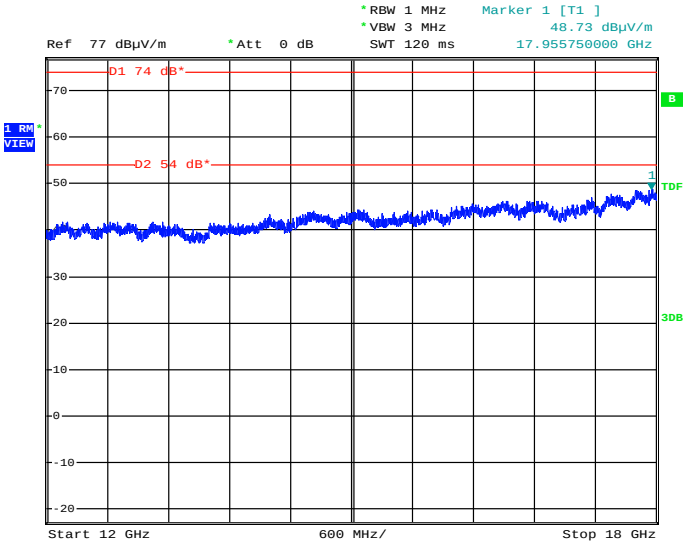
8 - 12 GHz



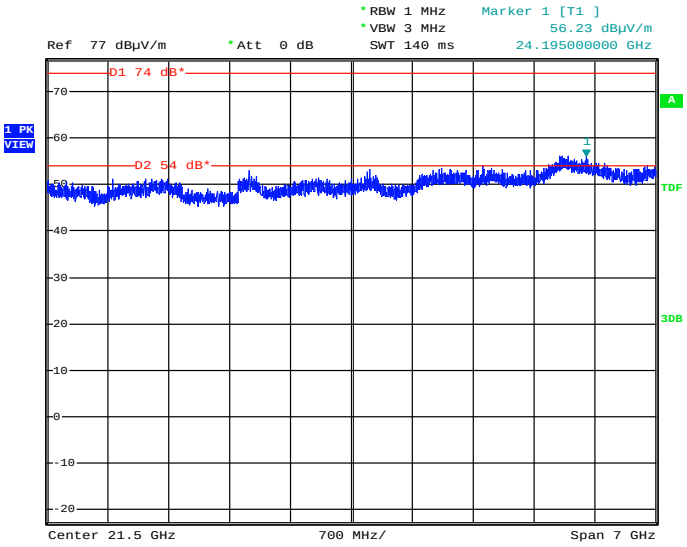
8 - 12 GHz



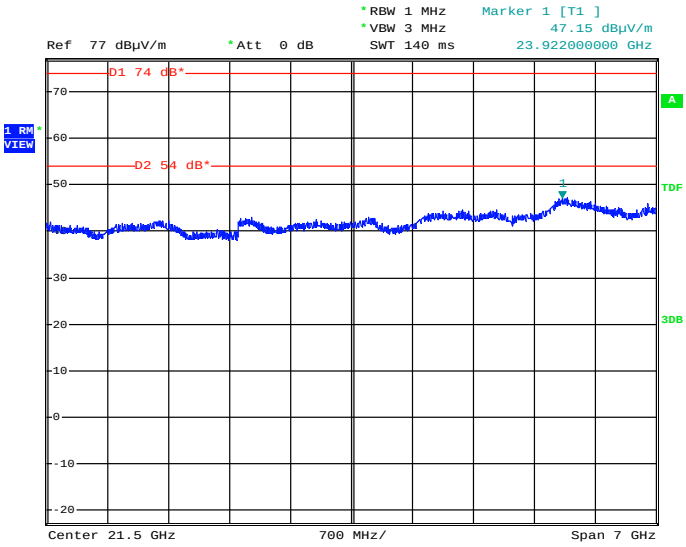
8 - 12 GHz



18 - 25 GHz



18 - 25 GHz, RMS



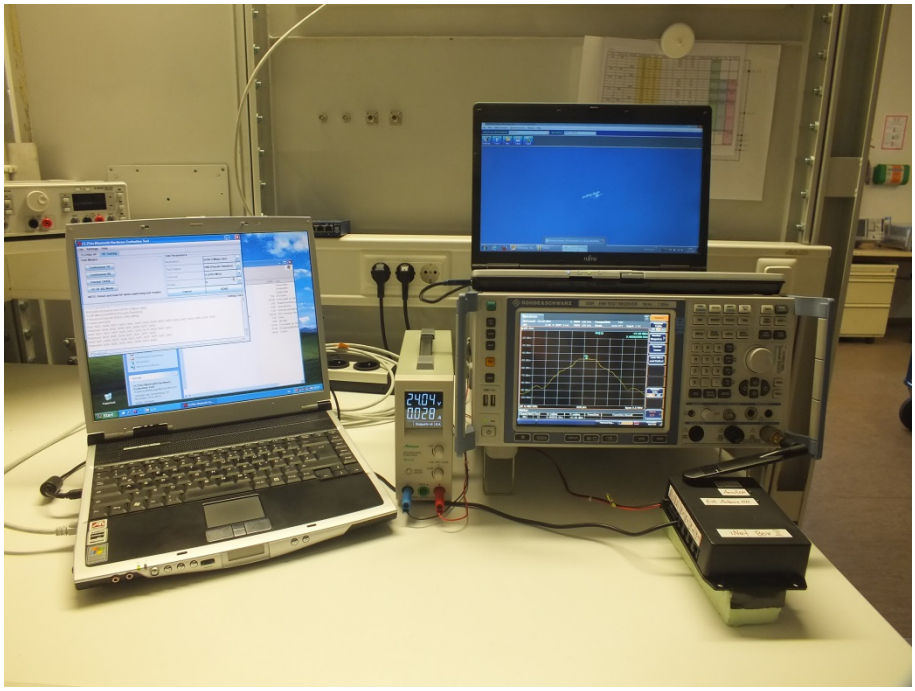
5.7 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part **MB**.

5.7.1 Description of the test location

Test location: AREA4

5.7.2 Photo documentation of the test setup



5.7.1 Applicable standard

According to FCC Part 15A, Section 15.35(c):
When the radiated emission limits are expressed in terms of average value and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete puls train, including blanking intervals, as long as the pulse train does not exceed 0.1s. In cases where the puls train exceeds 0.1s, the measured field strength shall be determined from the average absolute voltage during a 0.1s interval during which the field strength is at its maximum. The exact method of calculating the average field strength shall be submitted. To demonstrate compliance for Bluetooth low energy the EUT was paired with an iPhone 5C to have real time burst emissions for test.

5.7.2 Description of Measurement

The duty cycle factor (dB) is calculated applying the following formula:

$$K_E = 20 \log \frac{(t_{iW}/T_B) * t_{iB}}{T_W}$$

Where:

K_E = pulse operation correction factor
t_{iw} = pulse duration for one complete pulse track
t_{iB} = pulse duration for one pulse
T_w = a period of the pulse track
T_B = a period of one pulse

5.7.3 Test result

GFSK

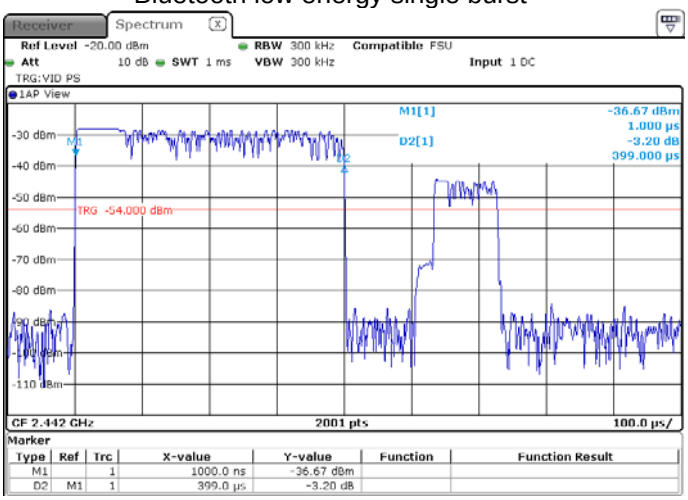
CH	t_{iw} (ms)	T_w (ms)	t_{iB} (ms)	T_B (ms)	K_E (dB)
18	100	100	0.798	100	-42.0

Remarks: The duty cycle has been calculated by averaging the sum of the pulse widths over 100 ms with the highest average value.

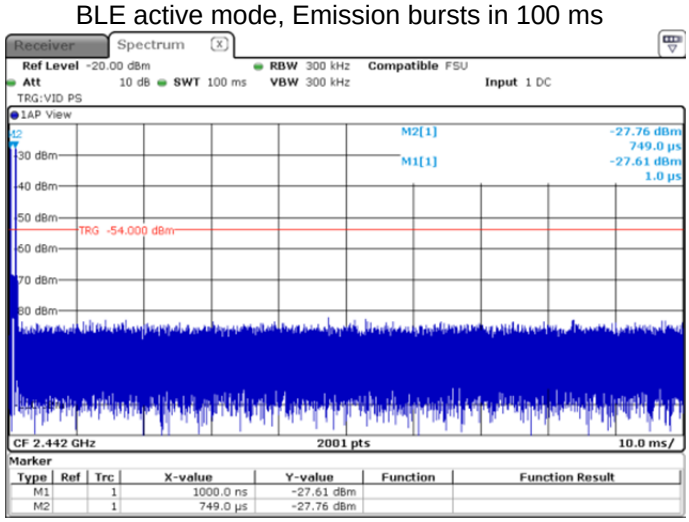
For detailed results, please see the test protocol below.

5.7.4 Test protocol

Bluetooth low energy single burst [1]



BLE active mode, Emission bursts in 100 ms



Note:
[1] The second pulse is the immediate return emission of the companion device within the tested channel frequency. Therefore the second pulse is not taken into consideration for duty cycle calculation.

5.8 Band edge compliance

For test instruments and accessories used see section 6 Part **SER3**.

5.8.1 Description of the test location

Test location: Anechoic chamber 1

5.8.2 Applicable standard

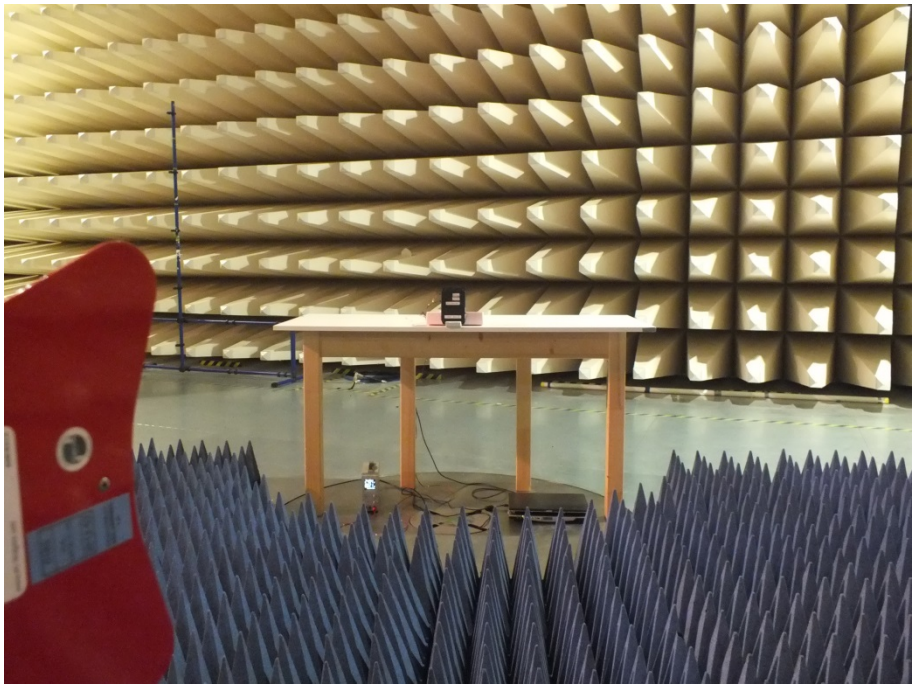
According to FCC Part 15C, Section 15.247(d):
In any 100 kHz bandwidth outside the frequency bands 2400 – 2483.5 MHz and 5725 – 5850 MHz, the digitally modulated radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or an radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.

5.8.3 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT was operating in transmit mode at the assigned frequency according DA 00-705:2000.

Spectrum analyser settings:
RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Trace: Max hold, Sweep: auto

5.8.4 Photo documentation of the test set-up



5.8.5 Test result

GFSK, 1000 kbps

f (MHz)	Band edge frequency (MHz)	Limit (dBc)
2402	2401.420	< -20
2480	2480.630	< -20

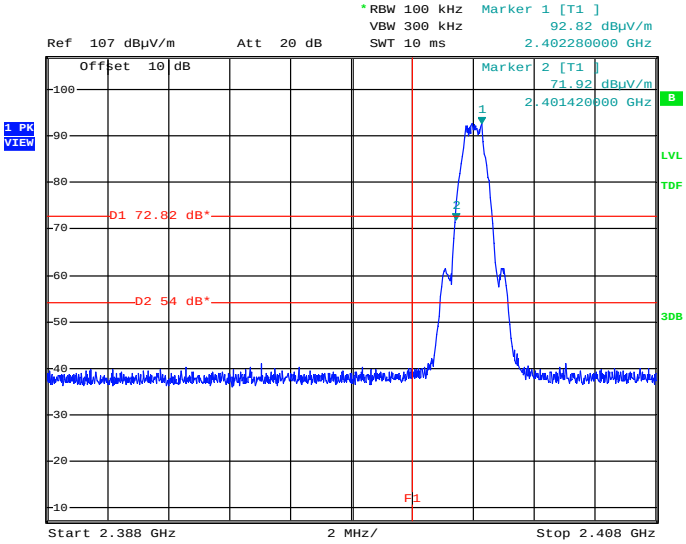
Peak-Limit according to FCC Part 15C, Section 15.247(d):
In any 100 kHz bandwidth outside the frequency band 2400 – 2483.50 MHz, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

The requirements are **FULFILLED.**

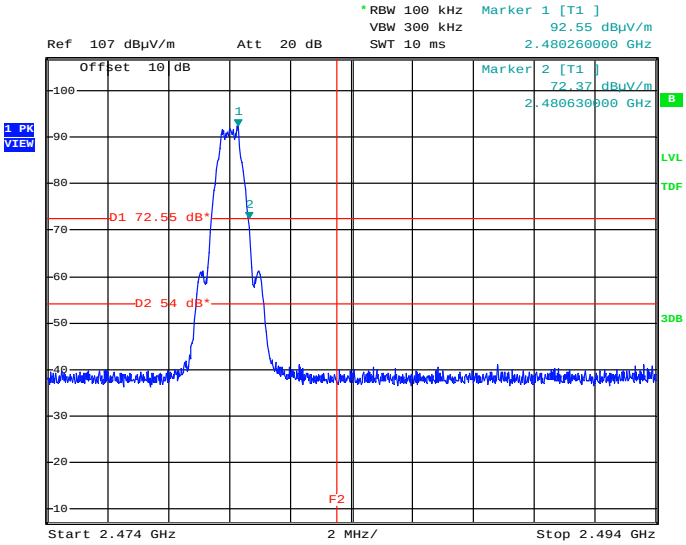
Remarks: For detailed test result please see to following test protocols.

5.8.6 Test protocol

GFSK, CH38



GFSK, CH39



5.9 Antenna application

For test instruments and accessories used see section 6 Part **CPR3** .

5.9.1 Applicable standard

According to FCC Part 15C, Section 15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

Remarks: No power reduction results from the defacto limit, because the antenna gain is lower than 6 dBi.

Antenna application can be viewed in Attachment A.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPR 3	FSP 30	02-02/11-05-001	20/10/2015	20/10/2014		
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	AFS4-01000400-10-10P-4	02-02/17-13-002				
	AMF-4F-04001200-15-10P	02-02/17-13-003				
	3117	02-02/24-05-009	07/05/2015	07/05/2014		
	Sucoflex N-2000-SMA	02-02/50-05-075				
	SF104/11N/11N/1500MM	02-02/50-13-015				
	NSP 3630	02-02/50-14-015				
MB	ESR 7	02-02/03-13-001	03/06/2015	03/06/2014		
	FSP 30	02-02/11-05-001	20/10/2015	20/10/2014		
	NSP 3630	02-02/50-14-015				
SER 2	ESVS 30	02-02/03-05-006	03/07/2015	03/07/2014		
	VULB 9168	02-02/24-05-005	08/04/2015	08/04/2014	12/09/2015	12/03/2015
	S10162-B	02-02/50-05-032				
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
SER 3	FSP 40	02-02/11-11-001	02/10/2015	02/10/2014		
	JS4-18004000-30-5A	02-02/17-05-017				
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	AFS4-01000400-10-10P-4	02-02/17-13-002				
	AMF-4F-04001200-15-10P	02-02/17-13-003				
	3117	02-02/24-05-009	07/05/2015	07/05/2014		
	BBHA 9170	02-02/24-05-014				
	Sucoflex N-2000-SMA	02-02/50-05-075				
	KMS102-0.2 m	02-02/50-11-020				
	SF104/11N/11N/1500MM	02-02/50-13-015				
	NSP 3630	02-02/50-14-015				