FCC ID: RXB-TIRU

EMI – TEST REPORT

- FCC Part 15.247 and RSS 210 -

Deutsche Akkreditierungsstelle D-PL-12030-01-01

Test Report No. :	**T35617-03-00HS**	05 March 2013 Date of issue

Type / Model Name : TIRU

Product Description : Wireless data monitor

Applicant : iQ-mobil solutions GmbH

Address : Industriestr. 7

83607 HOLZKIRCHEN, GERMANY

Manufacturer : iQ-mobil solutions GmbH

Address : Industriestr. 7

83607 HOLZKIRCHEN, GERMANY

Licence holder : iQ-mobil solutions GmbH

Address : Industriestr. 7

83607 HOLZKIRCHEN, GERMANY

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

FCC ID: RXB-TIRU

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Attachment A, T35617-00-xxHS

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September, 2012)

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, 2012)

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

ANSI C63.4: 2009	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: 2009	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: 2003	Uncertainty in EMC measurement
CISPR 22: 2005 EN 55022: 2006	Information technology equipment
KDB 558074 D01 v02	Guidance for performing compliance measurements on DTS operating under Section 15.247, 2012-10-4.

2 SUMMARY

2.1 Test result summary

DTS device using digital modulation and operating in the frequency range 2400 MHz – 2483.5 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS Gen, 7.2.4.	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)	Maximum peak power	passed
15.247(d)	RSS-210, A8.5	Out-of-band emission, radiated	passed
15.247(d)	RSS-Gen, 7.2.2	Emissions in restricted bands	passed
15.247(e)	RSS-210, A8.2(b)	PSD	passed
15.35(c)	RSS-Gen, 4.5	Pulsed operation	not applicable
15.247(i)	RSS 102, 2.5.2	MPE	passed
15.247(b)(4)	RSS-Gen, 7.1.2	Defacto EIRP limit	passed
15.203	RSS-Gen, 7.1.2	Antenna requirement	not applicable
	RSS-Gen, 7.2.6	Transmitter frequency stability	not applicable
	RSS-Gen, 4.6.1	OBW 99%	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 3, December 2010
RSS 210, Issue 8, December 2010
RSS 102, Issue 4, March 2010

2.2 GENERAL REMARKS:

The EUT is considered to be equivalent to DSSS device in the frequency range 2.4 GHz to 2.4835 GHz. The special application for temperature surveillance in industrial plants and chemical, pharmaceutical and medical installations such as lyophilizes, sterilizers, reactors, autoclave, etc. makes necessary that the system is professionally installed to ensure a proper working. The end-user may not have access on power settings. The system is able to provide up to 16 temperature measuring channels.

Operation frequency and channel plan

The firmware supports the following listed channels and is fixed to a maximum output power setting of P=20:

Channel	Frequency
1	2441 MHz

Antennas

The following antennas may be used with the EUT:

Number	Characteristic	Certification name	Plug	*f*-range (GHz)	Gain (dBi)
1	Patch	ANT-P (Art. No. 203.102)	SMA	2.4	8.5
2	Patch	ANT-WL (Art. No. 201.110)	SMA	2.4	8.5
3	Directed	ANT-Y8 (Art. No. 201.150)	SMA	2.4	8
4	Omni	ANT-Y2E (Art. No. 203.162)	SMA	2.4	5

Note: If more than one antenna is necessary for the application, an antenna MUX, Type HF-MUX-e-6 Var.2 (Art. No. 110.116) is used. This MUX is externally power supplied, is controlled by the EUT and supports up to 6 antennas sequentially.

Transmit operating modes

The EUT allows the user to switch the transmission on or off. There are no further operating modes. In case that only one antenna is used, the EUT needs no antenna switch. Therefore max output power and spurious emissions are measured with out antenna switch to relate to the max power.

2.3 FINAL ASSESSMENT:

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

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

Testing commenced on : 28 January 2013

Testing concluded on 28 February 2013

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2013.03.05 16:34:51 +01'00'

Klaus Gegenfurtner
Dipl.-Ing.(FH)
Manager: Radio Group

Tested by:

Hermann Smetana
I am the author of this document
2013.03.05 16:33:12 +01'00'

Hermann Smetana
Dipl.-Ing.(FH)
Radio Expert

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EUT – Please see attachment A

3.1 Power supply system utilised

Power supply voltage : TIRU 12 VDC to 24 VDC, Antenna MUX 24 VDC

3.2 Short description of the equipment under test (EUT)

The EUT is a wireless temperature monitor working together with a temperature tag. The tag is very small and uses the operating RF frequency (2.4 GHz) as power supply. A crystal oscillator is stimulated by a modulated RF carrier. The crystal oscillator is tuned by the temperature and the resulting frequency modulates the reflecting carrier with the temperature information. The EUT reads the frequency deviation and displays the resulting temperature. This info can be transmitted via Ethernet to a host for monitoring or logging.

Number of tested samples: 1
Serial number: L-C003-1911

EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- TX continuous

EUT configuration:

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

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

-	Mini-PC via LAN	Model :	Dell
-	DC-power supply cable, 0.8 m	Model :	Made by manufacturer
-	Ethernet cable, 3 m	Model :	Free trading
-	Control-cable to MUX, 1 m	Model :	Made by manufacturer
-	Antenna-MUX	Model :	HF-MUX-e-6 Var.2
-	USB-Stick	Model :	

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

mikes-testingpartners gmbh
Ohmstrasse 2-4
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. The reader may notice that tolerances within the calibration of the equipment and facilities may cause additional uncertainty. The measurement uncertainty is calculated for all measurements listed in this test report acc. to CISPR 16-4-2 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurement“ and documented in the mikes-testingpartners gmbh quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, mikes-testingpartners 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 diversity and modifications in production process of devices may result in additional deviation. If necessary, refer to the test lab for the actual measurement uncertainty for the specific test. The manufacturer has the sole responsibility of continued compliance of the EUT.

4.4 Measurement protocol for FCC and IC

4.4.1 GENERAL INFORMATION

4.4.1.1 Test methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.

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

IC 3009A-1

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.

4.4.1.2 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 without termination. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.1.3 Details of test procedures

The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". 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 or ANSI C63.10 and applying the CISPR 22 limits.

4.5 Determination of worst case measurement conditions

Measurements have been made in all three orthogonal axes and the settings of the EUT were 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 – 2483.5 MHz

Following conditions were selected for the final test:
The test software for the EUT provides free power setting (P13 to P20). The EUT is set in TX continuous mode modulated as the worst case. This transmitting mode means a duty cycle (X) of X = 1. The frequency range is scanned from 9 kHz to 25000 MHz.
For the spurious emission measurement the MUX is connected with the minimum RF-cable of 20 cm and low pass filter VLF-3000+ (insertion loss 1.8 dB@2441 MHz). The measurement is related to Port1 of the MUX.

TX mode:

Technology	Available channel	Tested channel	Modulation	Modulation type
DSSS	1	1	Digital	TDFM

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

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

5.1.1 Description of the test location

Test location: Shielded Room S2

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 remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin 0.2 dB at 0.3 MHz

Limit according to FCC Part 15, Section 15.207(a):

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

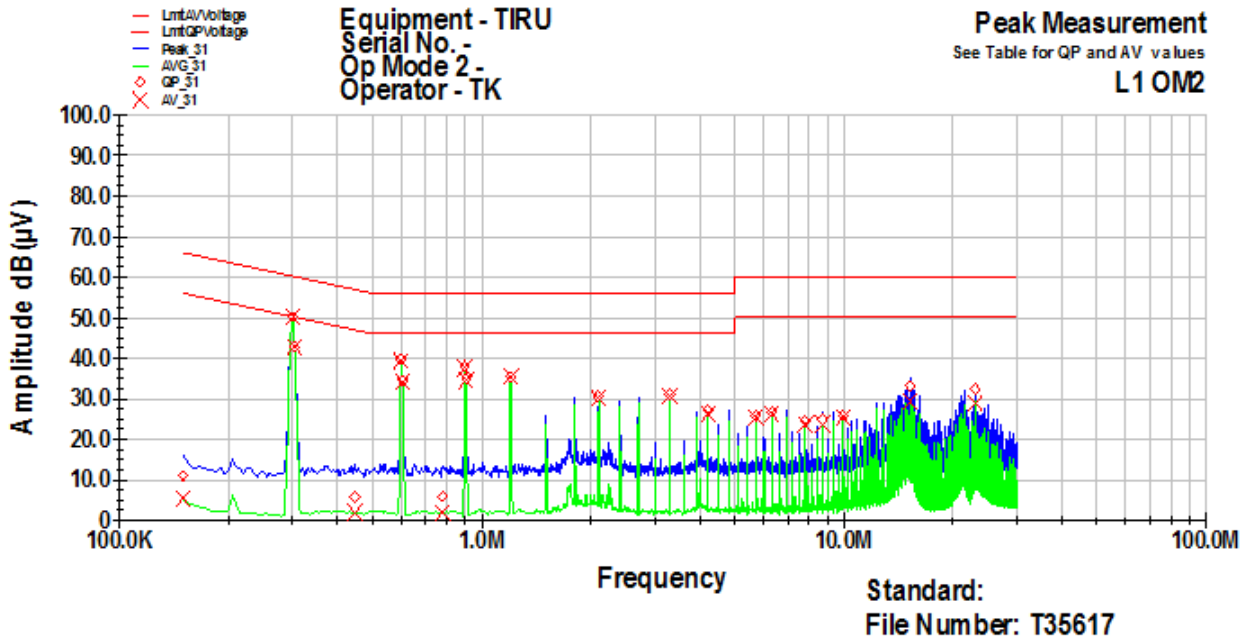
* Decreases with the logarithm of the frequency

The requirements are **FULFILLED.**

Remarks: For detailed test result please refer to following test protocols

5.1.6 Test protocol

Test point L1 Result: passed
Operation mode: TX continuous
Remarks:



Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.15	10.9	-55.1	66.0	5.5	-50.5	56.0
0.3	50.3	-9.9	60.2	50.0	-0.2	50.2
0.305	42.9	-17.2	60.1	42.7	-7.5	50.1
0.445	5.7	-51.3	57.0	1.8	-45.2	47.0
0.6	39.6	-16.4	56.0	39.3	-6.7	46.0
0.605	34.5	-21.5	56.0	34.3	-11.7	46.0
0.78	5.9	-50.1	56.0	2.0	-44.0	46.0
0.9	38.0	-18.0	56.0	37.7	-8.3	46.0
0.905	35.0	-21.0	56.0	34.7	-11.3	46.0
1.2	35.6	-20.4	56.0	35.3	-10.7	46.0
2.105	30.7	-25.3	56.0	30.2	-15.8	46.0
3.305	30.9	-25.1	56.0	30.5	-15.5	46.0
4.21	27.0	-29.0	56.0	26.4	-19.6	46.0
5.715	26.0	-34.0	60.0	25.3	-24.7	50.0
6.315	26.8	-33.3	60.0	26.1	-23.9	50.0
7.82	24.5	-35.5	60.0	23.8	-26.2	50.0
8.72	24.9	-35.1	60.0	23.7	-26.3	50.0
9.925	26.0	-34.0	60.0	25.4	-24.6	50.0
15.25	33.0	-27.0	60.0	29.4	-20.6	50.0
23.13	32.6	-27.4	60.0	28.7	-21.3	50.0

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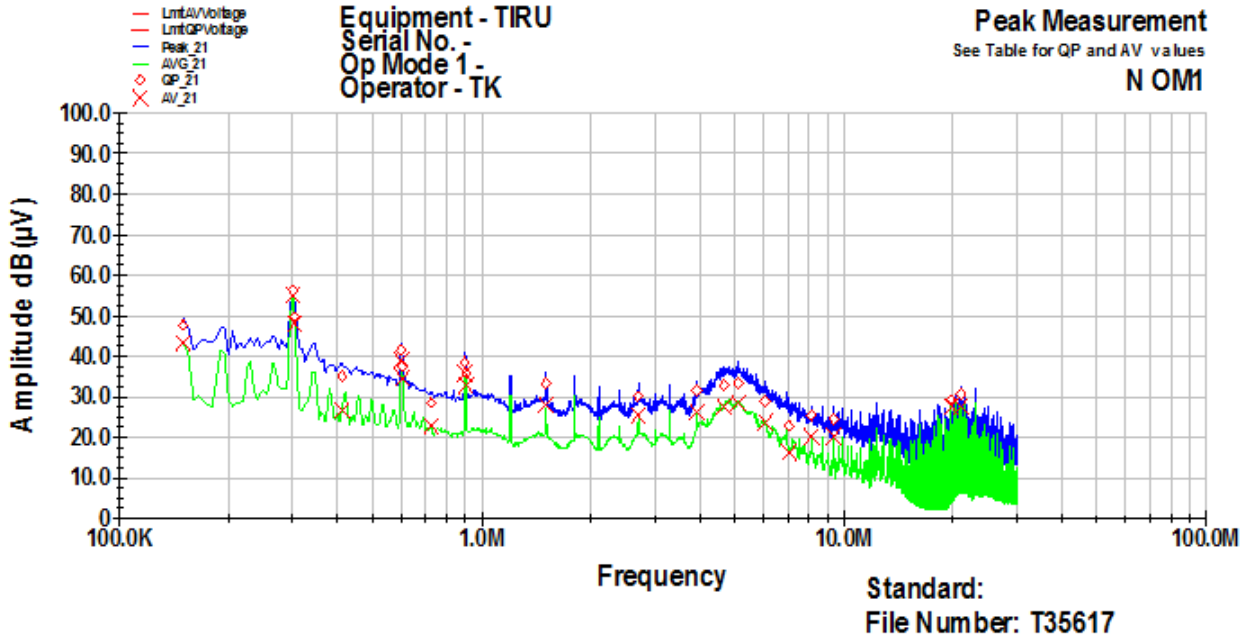
Test point N
Operation mode: TX continuous
Remarks:

Result: passed



Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.155	22.0	-43.8	65.7	10.6	-45.1	55.7
0.3	56.8	-3.4	60.2	49.1	-1.1	50.2
0.305	45.4	-14.7	60.1	44.7	-5.4	50.1
0.415	9.0	-48.5	57.5	2.9	-44.6	47.5
0.6	38.3	-17.7	56.0	37.9	-8.1	46.0
0.605	33.3	-22.7	56.0	32.8	-13.2	46.0
0.8	6.9	-49.1	56.0	2.4	-43.6	46.0
0.9	39.3	-16.7	56.0	38.8	-7.2	46.0
0.905	36.3	-19.7	56.0	35.8	-10.2	46.0
1.2	33.2	-22.8	56.0	32.1	-13.9	46.0
2.405	28.3	-27.7	56.0	27.4	-18.6	46.0
3.305	28.2	-27.8	56.0	26.1	-19.9	46.0
4.51	26.2	-29.8	56.0	25.4	-20.6	46.0
5.11	22.6	-37.4	60.0	20.8	-29.2	50.0
6.915	21.5	-38.5	60.0	16.9	-33.1	50.0
7.52	16.7	-43.3	60.0	11.5	-38.5	50.0
8.12	19.8	-40.2	60.0	17.5	-32.5	50.0
9.32	16.4	-43.6	60.0	13.8	-36.2	50.0
15.335	32.8	-27.2	60.0	31.1	-18.9	50.0
23.125	34.2	-25.8	60.0	32.5	-17.5	50.0

5.2 Emission bandwidth and occupied bandwidth

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:

EBW:	RBW: 100 kHz	VBW: 300 kHz,	Detector: Peak;
OBW:	RBW: 1 MHz	VBW: 3 MHz,	Detector: Peak;

5.2.5 Test result

Channel	Centre frequency	6 dB bandwidth	99% OBW
	(MHz)	(MHz)	(MHz)
1	2441	9.16	33.44

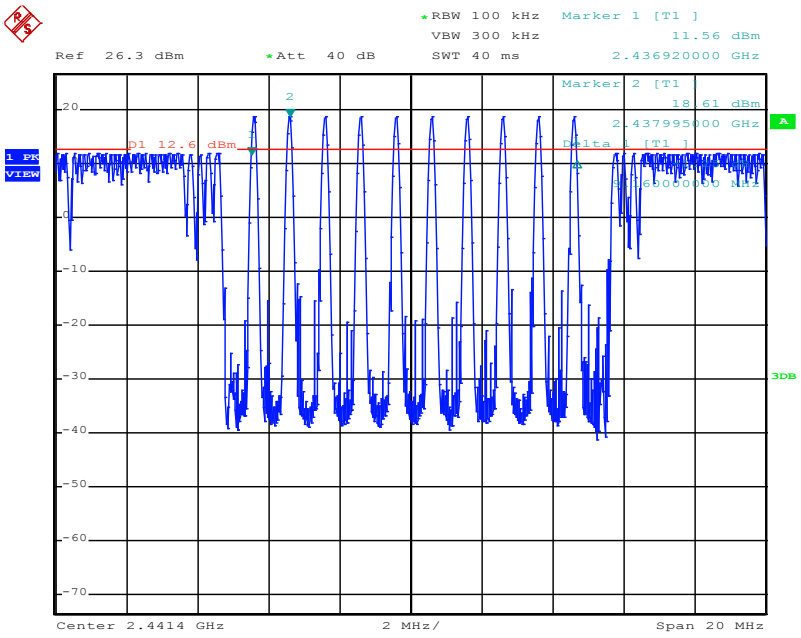
Note: There is no limit for the OBW 99%.

The requirements are **FULFILLED.**

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

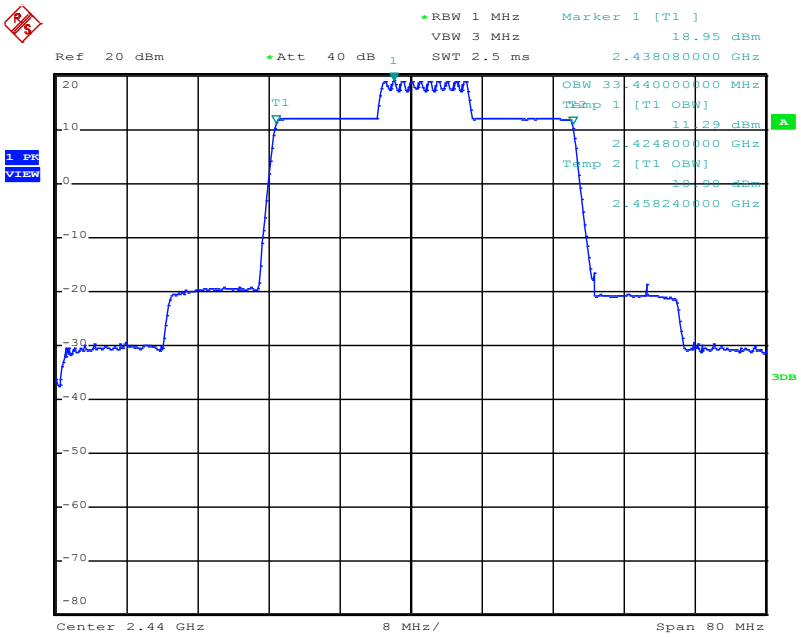
5.2.6 Test protocols emission bandwidth

Channel 1 (2441 MHz)



5.2.7 Test protocols OBW 99%

Channel 1 (2441 MHz)



5.3 Maximum peak conducted output power

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

5.3.1 Description of the test location

Test location: AREA4

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 output power is measured using a spectrum analyser according KDB558074 D01, procedure 8.2.1 Option 1. The EUT is set while measuring in TX continuous mode to max output power without MUX. Due to the duty cycle is lower 98% the alternative 1 is used to calculate to a duty cycle correction factor.
Calculation of the duty cycle correction factor:
On time / (ontime + off time) *100 % = 32.76 ms / 49.86 ms *100 % = 65.70 %;
Correction factor: DC = 10*log (1/x) = 1.82 dB;

Spectrum analyser settings:
RBW: 1 MHz, VBW: 10 MHz, Detector: RMS, Trace mode: average 100 traces,
Span: 1.5 times OBW = 15 MHz, Bins = 501 (2 * 15 MHz / 1 MHz = 30);

5.3.5 Test result

TX		Test results conducted				
Chain 1		A [P20] (dBm)	DC (dB)	A [P20] (dBm)	Limit (dBm)	Margin (dB)
CH1						
T_{nom}	V_{nom}	-21.1	1.8	-19.3	30.0	-49.3

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

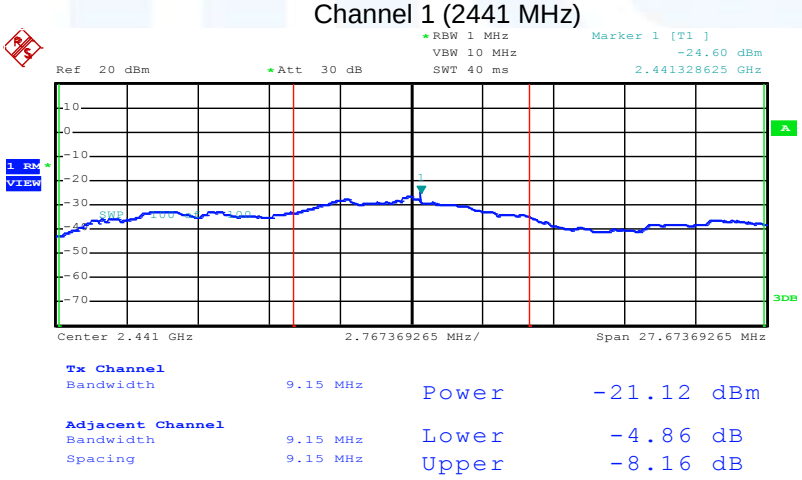
Frequency (MHz)	Peak power limit	
	(dBm)	(Watt)
902 - 928	30	1.0
2400 - 2483.5	30	1.0
5725 - 5850	30	1.0

The requirements are **FULFILLED.**

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

5.3.6 Protocol maximum peak conducted output power

Channel 1 (2441 MHz)



5.4 Spurious emissions conducted, in non-restricted bands

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

5.4.1 Description of the test location

Test location: AREA4

5.4.2 Photo documentation of the test set-up

Without MUX:

With MUX:

5.4.3 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.

5.4.4 Description of measurement

The spurious emissions are measured conducted using a spectrum analyser in a test setup following the procedures set out in KDB 558074 D01 for DTS. The frequency spectrum outside from the operating frequency range (2400 - 2483.5 MHz) is scanned for emissions that exceed the given limit. The measurement is performed at normal test conditions in modulated TX continuous mode.

Spectrum analyser search setting:
RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Trace Mode: Max hold;

5.4.5 Test result

Without MUX:

Frequency: **2441 MHz**						
Test conditions: TX, P20						
Reference power level: **19.2 dBm**						
			Test results			
Start *f*	Stop *f*	RBW	Maximum emission		Limit	Margin
(MHz)	(MHz)	(kHz)	(MHz)	(dBm)	(dBm)	(dB)
30.0	1000.0	100.0	702.8	-39.3	-0.8	-38.5
1000.0	2400.0	100.0	2399.4	-40.5	-0.8	-39.7
2483.5	4000.0	100.0	2493.3	-43.4	-0.8	-42.6
5000.0	15000.0	100.0	7313.7	-44.9	-0.8	-44.1
15000.0	26500.0	100.0	23893.8	-49.8	-0.8	-49.0
Measurement uncertainty			±3 dB			

Note: The measurement was done without the lowpass filter VLF-3000+.

With MUX:

Frequency: **2441 MHz**						
Test conditions: TX, P20						
Reference power level: **17.7 dBm**						
			Test results			
Start *f*	Stop *f*	RBW	Maximum emission		Limit	Margin
(MHz)	(MHz)	(kHz)	(MHz)	(dBm)	(dBm)	(dB)
30.0	1000.0	100.0	703.8	-42.0	-2.3	-39.7
1000.0	2400.0	100.0	2400.0	-43.3	-2.3	-41.0
2400.0	4000.0	100.0	2493.9	-46.2	-2.3	-43.9
5000.0	15000.0	100.0	14980.7	-55.2	-2.3	-52.9
15000.0	26500.0	100.0	24082.0	-50.6	-2.3	-48.3
Measurement uncertainty			±3 dB			

Note: The measurement was done with the low pass filter VLF-3000+.

Limit 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.

Frequency (MHz)	Spurious emission limit
Below 960	30 dB below the highest level of the desired power
Above 960	30 dB below the highest level of the desired power

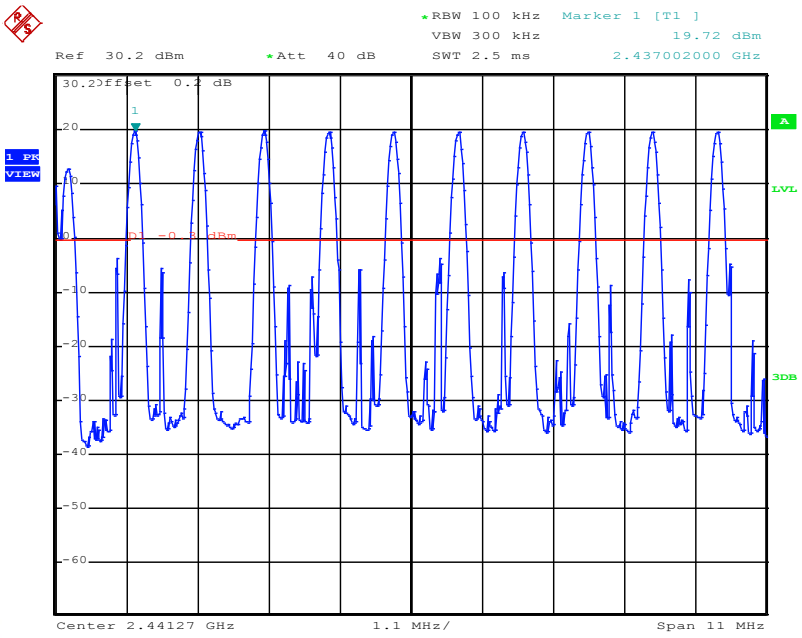
The requirements are **FULFILLED.**

Remarks: All emissions more than 20 dB below the specified limit need not to be reported.

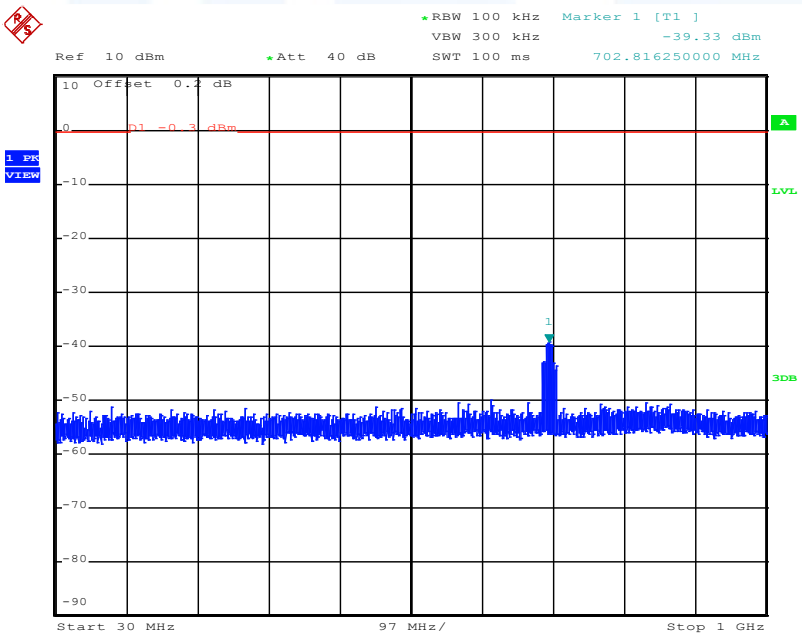
For detailed test results please refer to following test protocols.

5.4.6 Plots of spurious emissions conducted out of operating frequency bands (-30 dBc) without MUX

Determination of the reference level and limit

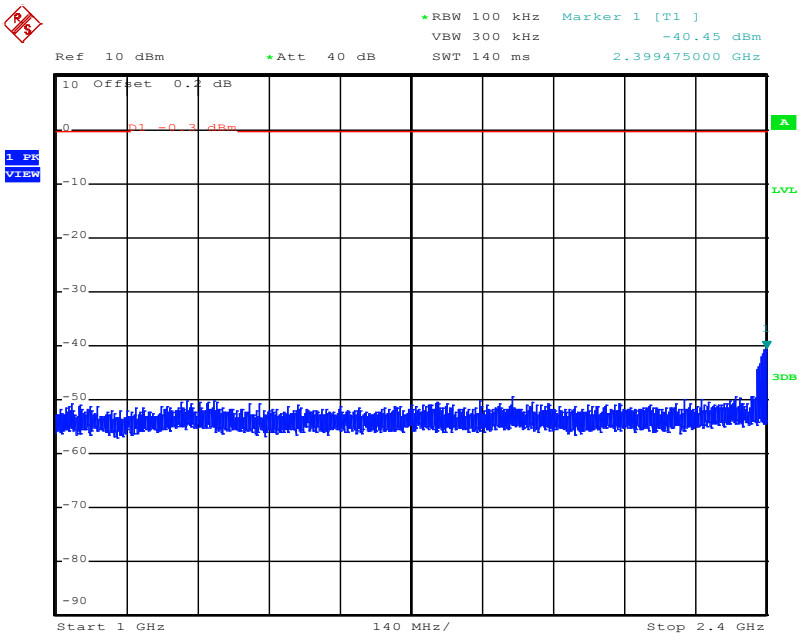


Spurious emissions conducted from 30 MHz to 1 GHz

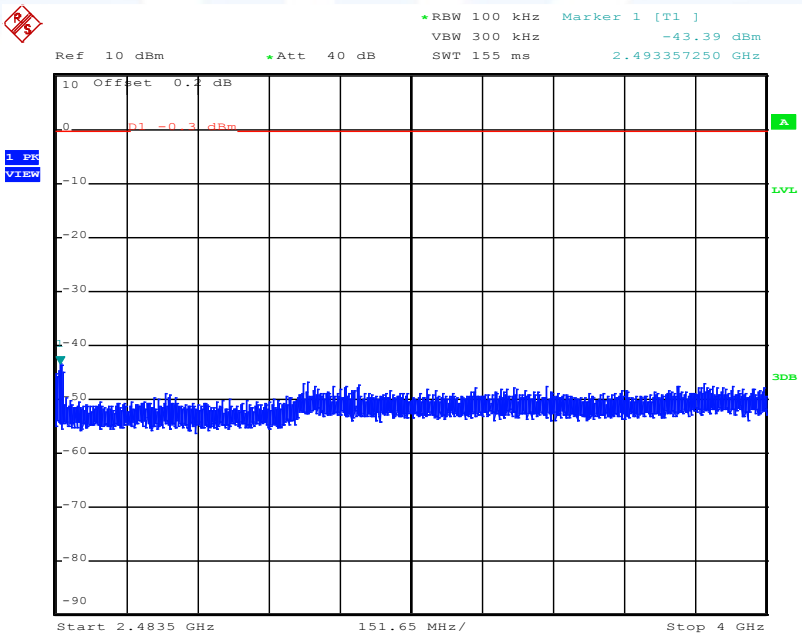


FCC ID: RXB-TIRU

Spurious emissions conducted from 1 GHz to 2.4 GHz

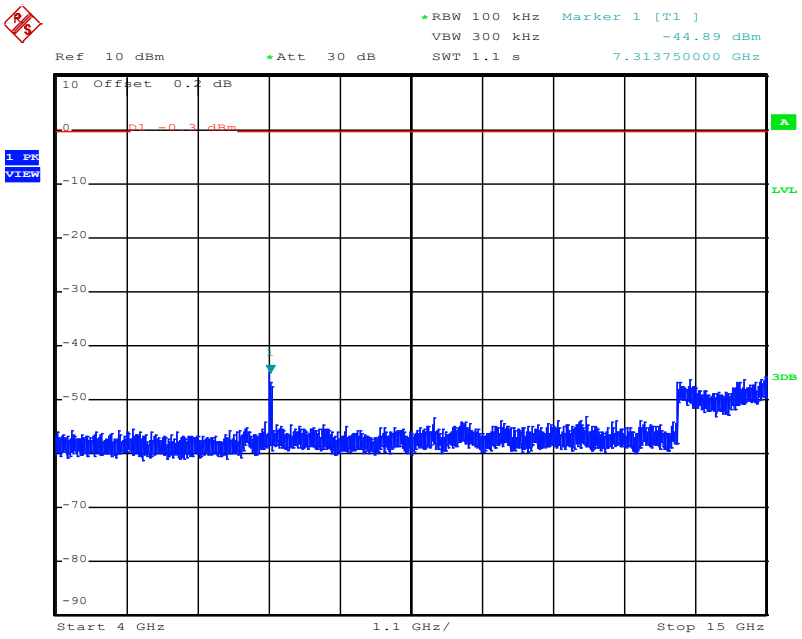


Spurious emissions conducted from 2.4835 GHz to 4 GHz

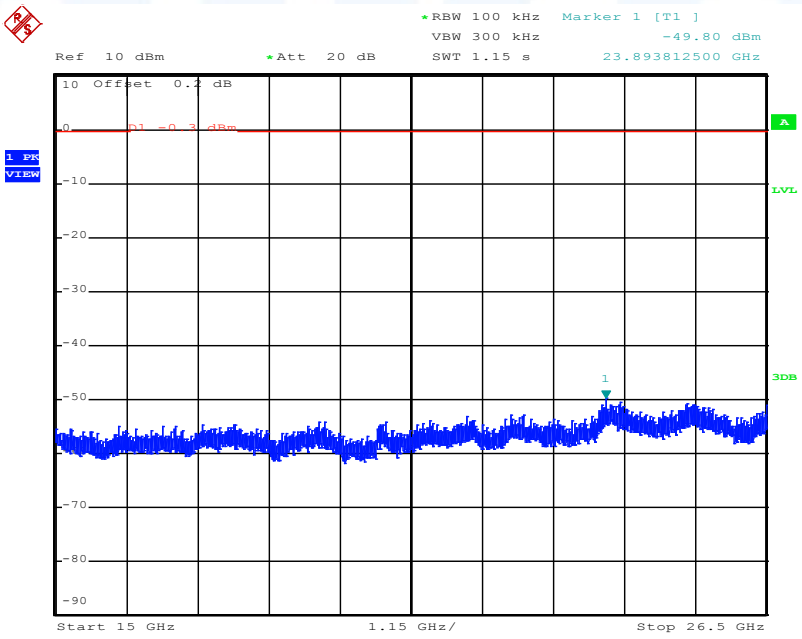


FCC ID: RXB-TIRU

Spurious emissions conducted from 4 GHz to 15 GHz

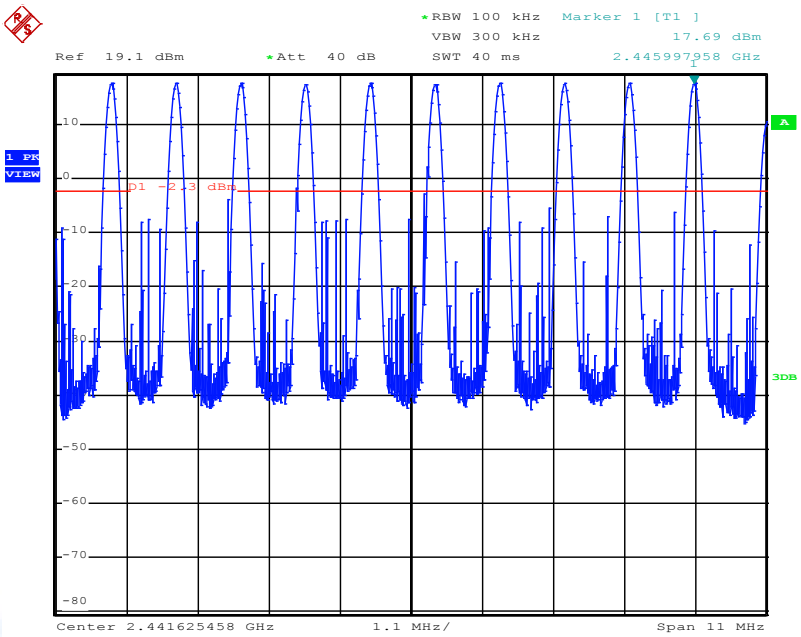


Spurious emissions conducted from 15 GHz to 26.5 GHz

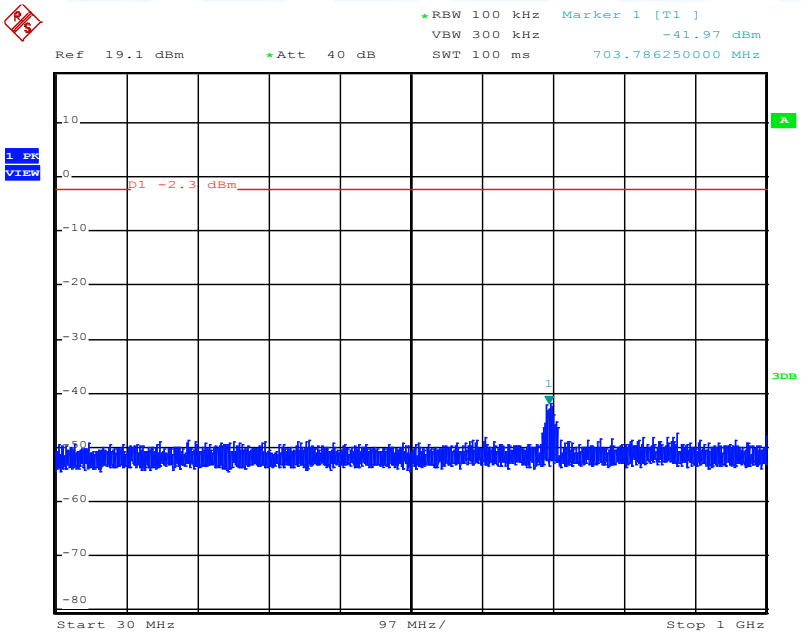


5.4.7 Plots of spurious emissions conducted out of operating frequency bands (-30 dBc) with MUX

Determination of the reference level and limit

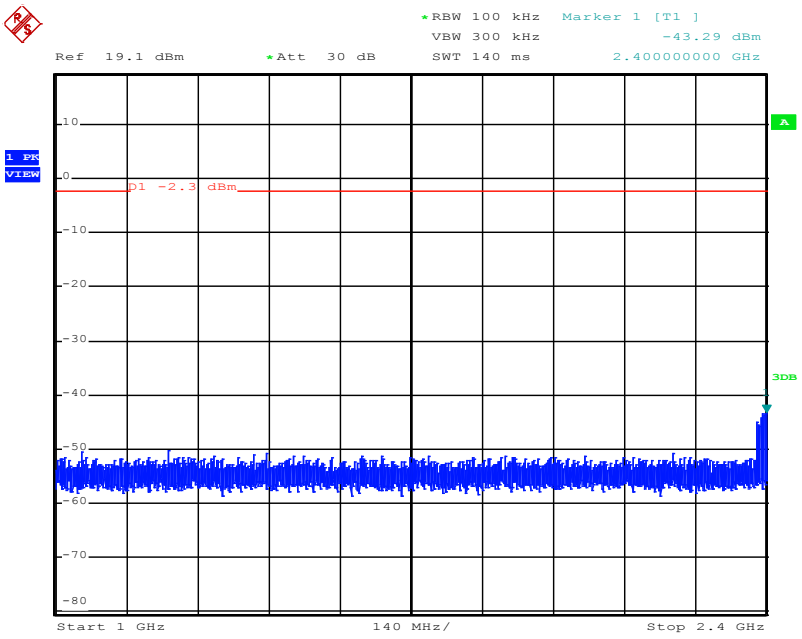


Spurious emissions conducted from 30 MHz to 1 GHz

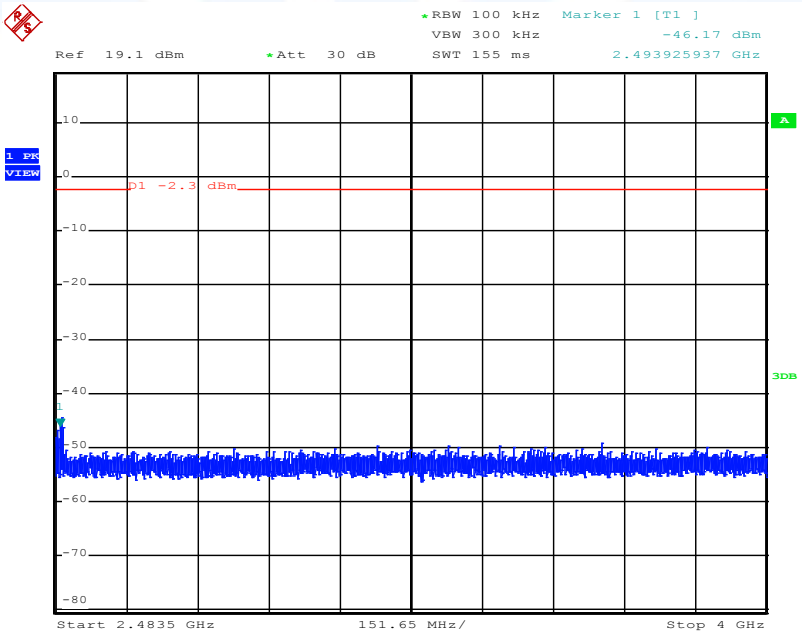


FCC ID: RXB-TIRU

Spurious emissions conducted from 1 GHz to 2.4 GHz

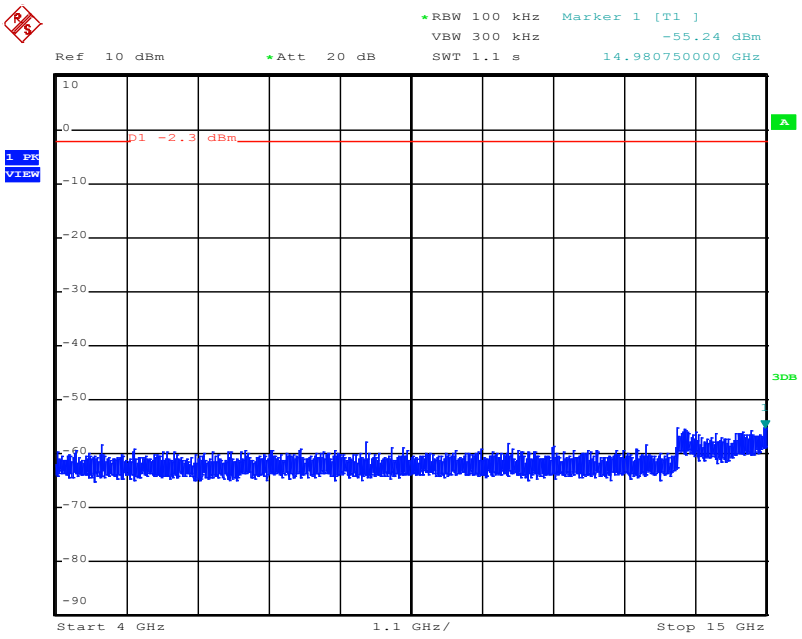


Spurious emissions conducted from 2.4835 GHz to 4 GHz

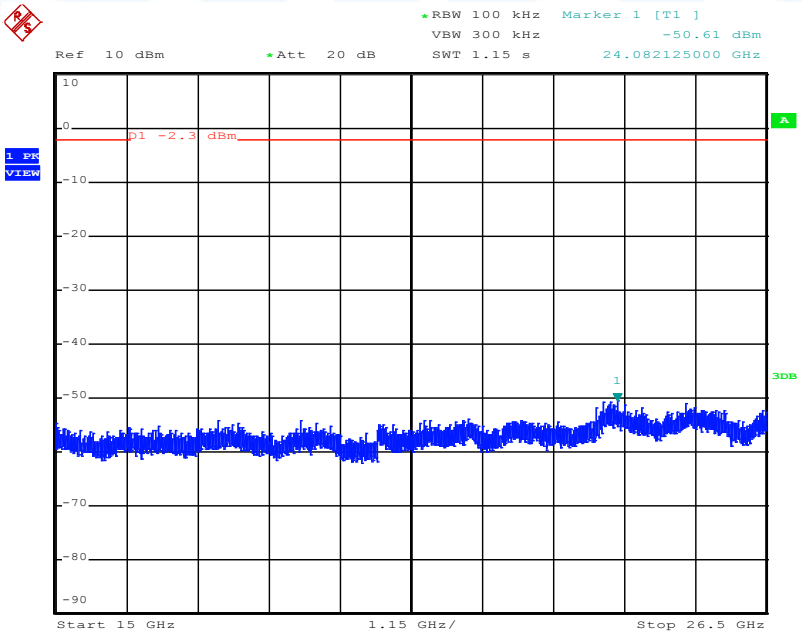


FCC ID: RXB-TIRU

Spurious emissions conducted from 4 GHz to 15 GHz



Spurious emissions conducted from 15 GHz to 26.5 GHz



5.5 Spurious emissions conducted, in restricted bands

For test instruments and accessories used see section 6 Part **SEC 1, SEC 2** and **SEC 3**.

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(d):
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)).

5.5.4 Description of measurement

The spurious emissions falling in the restricted bands are measured conducted using a spectrum analyser in a test setup following the procedures set out in KDB 558074 D01 for DTS. The frequency spectrum outside from the operating frequency range (2400 - 2483.5 MHz) is scanned for emissions that exceed the limit. The conducted limit in EIRP is calculated according KDB 558074 D01, Item 10.2.2.1 from the absolute radiated limit. The measurement is performed at normal test conditions in modulated TX mode. The observed spurious emissions falling into restricted bands are measured again to show the compliance to Section 15.209(a). The MUX is not connected to the TIRU. An antenna cable, 0.2 m is used to connect to the spectrum analyser.

Spectrum analyser setting:

9 kHz < f < 150 kHz:	RBW: 300 Hz,	VBW: 1 kHz,	Detector: Max peak,	Trace Mode: Max hold
150 kHz < f < 30 MHz:	RBW: 10 kHz,	VBW: 30 kHz,	Detector: Max peak,	Trace Mode: Max hold
30 MHz < f < 1000 MHz:	RBW: 100 kHz,	VBW: 300 kHz,	Detector: Max peak,	Trace Mode: Max hold
f > 1000 MHz:	RBW: 1 MHz,	VBW: 3 MHz,	Detector: Max peak,	Trace Mode: Max hold

5.5.5 Test result

G_{out} is the assumed antenna gain out of operating band
GRF is the ground reflexion factor usable from 30 MHz to 1000 MHz

The decision for re-measurement in restricted bands is based on the measurement results in Item 5.4.5. The worst case means the use without a MUX and low pass filter. This case is measured conducted in the following restricted bands: 2310 – 2390 MHz, 2483.5 – 2500 MHz, 2655 – 2900 MHz (for IC only), 4500 – 5150 MHz, 7250 – 7700 MHz and 10600 – 12700 MHz. The following measurement table provide the highest value of the emission in every mentioned restricted band.

PK-measurement							
Frequency: **2441 MHz**							
Test conditions: TX , P20				Test results			
f	A	RBW	GRF	G_{out}	EIRP	PK Limit	Margin
(MHz)	(dBm)	(kHz)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
2389.7	-41.5	1000.0	0.0	8.5	-33.0	-21.2	-11.8
2487.7	-40.2	1000.0	0.0	8.5	-31.7	-21.2	-10.5
2683.2	-49.8	1000.0	0.0	8.5	-41.3	-21.2	-20.1
4889.9	-57.9	1000.0	0.0	8.5	-49.4	-21.2	-28.2
7302.3	-57.7	1000.0	0.0	8.5	-49.2	-21.2	-28.0
12210.4	-54.8	1000.0	0.0	8.5	-46.3	-21.2	-25.1
Measurement uncertainty				±3 dB			

Note: Margin values smaller than -20 dB are re-measured in AV.

AV-measurement							
Frequency: **2441 MHz**							
Test conditions: TX , P20				Test results			
f	A	RBW	GRF	G_{out}	EIRP	AV Limit	Margin
(MHz)	(dBm)	(kHz)	(dB)	(dBi)	(dBm)	(dBm)	(dB)
2389.2	-49.8	1000.0	0.0	8.5	-41.3	-41.2	-0.1
2484.1	-52.7	1000.0	0.0	8.5	-44.2	-40.2	-4.0
Measurement uncertainty				±3 dB			

Limit according to FCC Part 15, Section 15.247(d):
Attenuation below the general limits specified in Section 15.209(a) is not required.

Calculation formula: EIRP = E + 20 log(d) – 104.8;
E: Field strength (dB(mV/m));

Frequency	General limit radiated	Calculated PK limit	Calculated AV limit
(MHz)	(mV/m)	EIRP (dBm)	EIRP (dBm)
Above 960	500	-21.2	-41.2

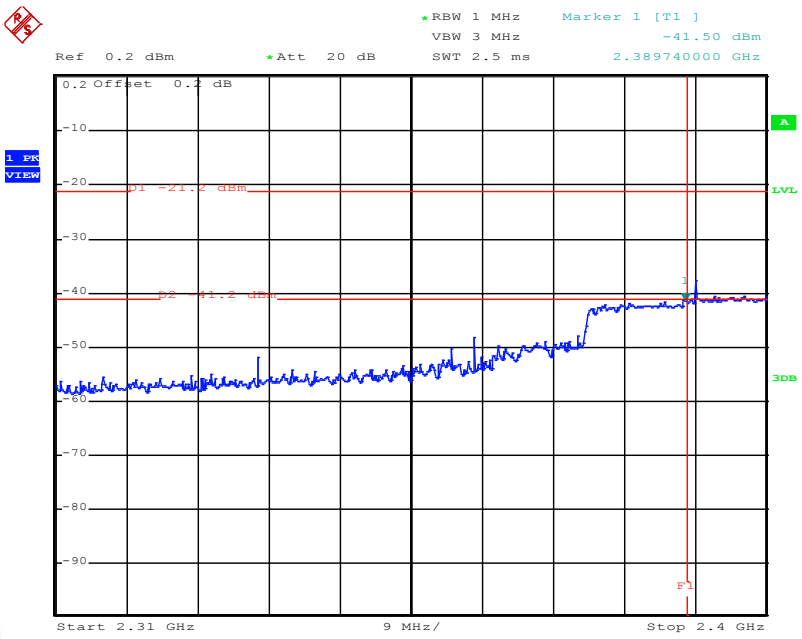
The requirements are **FULFILLED.**

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

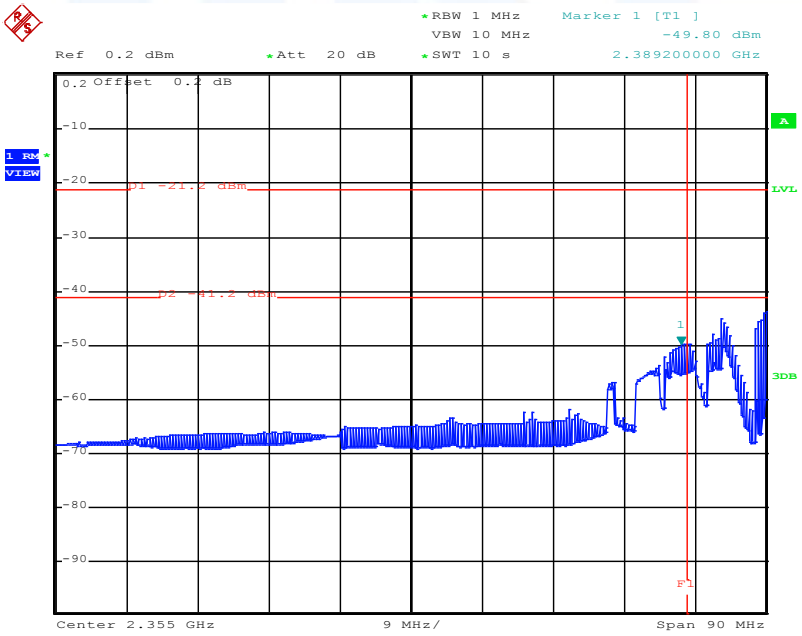
5.5.6 Test protocol emissions in restricted bands

Restricted band 2310 – 2390 MHz:

PK-Measurement P20, cable 0.2 m,



AV-Measurement P20, cable 0.2 m,



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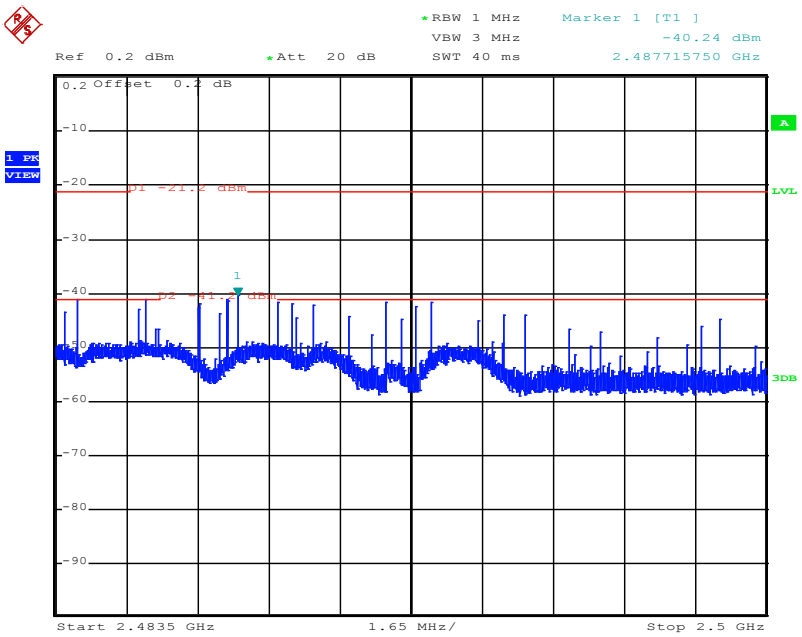
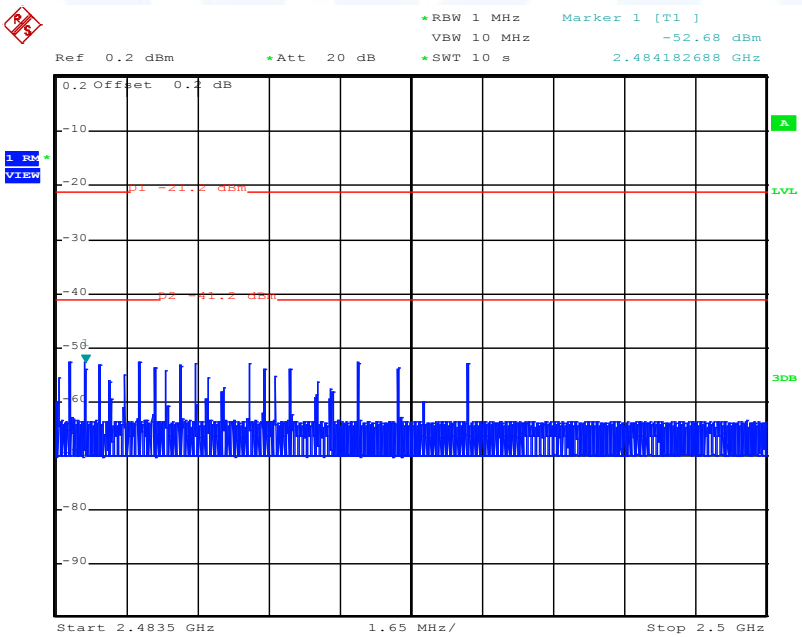
Restricted band 2483.5 – 2500 MHz:

PK-Measurement P20, cable 0.2 m,

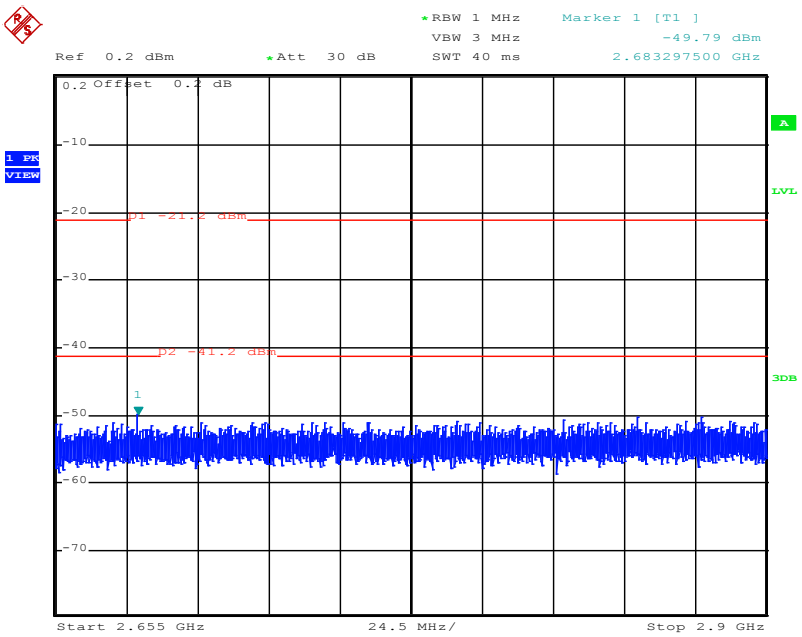


AV-Measurement P20, cable 0.2 m,



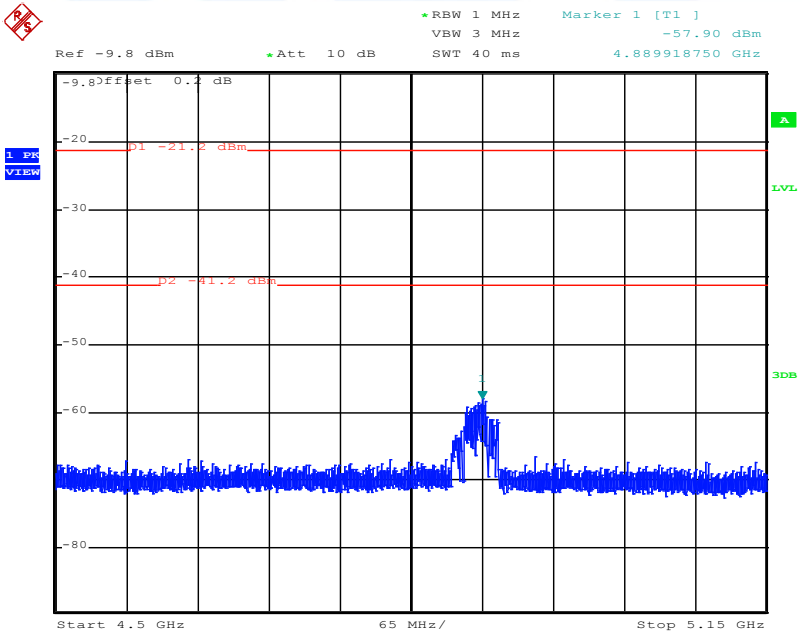
Restricted band 2655 – 2900 MHz:

PK-Measurement P20, cable 0.2 m,



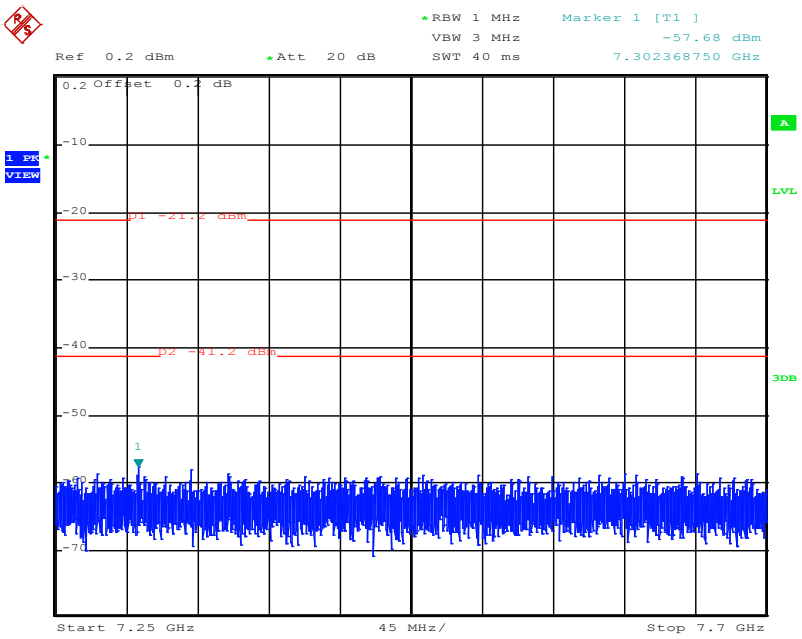
Restricted band 4500 – 5150 MHz:

PK-Measurement P20, cable 0.2 m,



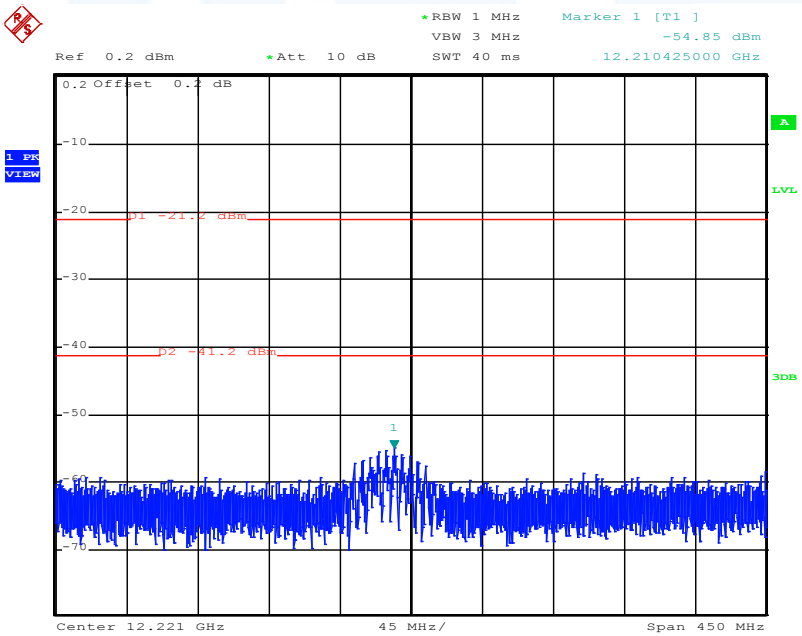
Restricted band 7250 – 7700 MHz:

PK-Measurement P20, cable 0.2 m,



Restricted band 10600 – 12700 MHz:

PK-Measurement P20, cable 0.2 m,



5.1 Spurious emissions radiated, cabinet radiation

For test instruments and accessories used see section 6 Part **SER 1, SER 2, SER 3**.

5.1.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 2

Test distance: 3 m

5.1.2 Photo documentation of the test set-up

Open area test site (Test setup for 9 kHz – 30 MHz)

Open area test site (Test setup for 30 MHz – 1000 MHz)

Anechoic chamber (Test setup for field strength measurement 1GHz – 18 GHz)

Anechoic chamber (Test setup for 18 GHz – 25 GHz)

5.1.3 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)).

5.1.4 Description of Measurement

The radiated power of the spurious emission from the EUT cabinet is measured with terminated antenna connector in a test setup following the procedures set out in KDB 558074 D01. If the emission level of the EUT in peak mode complies with the average limit 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. Up from 4 GHz a HP filter is used.

EMI test receiver settings: f < 1 GHz:
9 kHz < f < 150 kHz: RBW: 200 Hz;
150 kHz < f < 30 MHz: RBW: 9 kHz;
30 MHz < f < 1000 MHz: RBW: 120 kHz;
Spectrum analyser settings f > 1 GHz:
RBW: 1000 kHz, VBW: 3000 kHz, Detector: Max peak, Trace: Max hold, Sweep: Auto;

5.1.5 Test result radiated emissions

f < 1 GHz:
No emission could be detected caused by the transmitter.

f > 1 GHz:

Frequency: **2441 MHz**						
Test conditions: TX , P20, Ant1 terminated						
Cabinet radiation			**Test results**			
Start frequ.	Stop frequ.	RBW	Maximum emission		Limit	Margin
(MHz)	(MHz)	(kHz)	(MHz)	(dBµV/m)	(dBµV/m)	(dB)
1000.0	1800.0	1000.0	1342.0	41.8	54.0	-12.2
1800.0	1900.0	1000.0	1900.0	40.0	54.0	-14.0
1900.0	5150.0	1000.0	2248.0	48.9	54.0	-5.1
5150.0	5300.0	1000.0	5225.0	42.7	54.0	-11.3
5300.0	12000.0	1000.0	11840.0	48.9	54.0	-5.1
12000.0	18000.0	1000.0	17076.0	52.3	54.0	-1.7
18000.0	25000.0	1000.0	24888.0	43.5	54.0	-10.5
Measurement uncertainty			±6 dB			

Note: All emissions above the operating range are into the noise level.

Radiated emission limits according to FCC Part 15 Section 15.209(a):

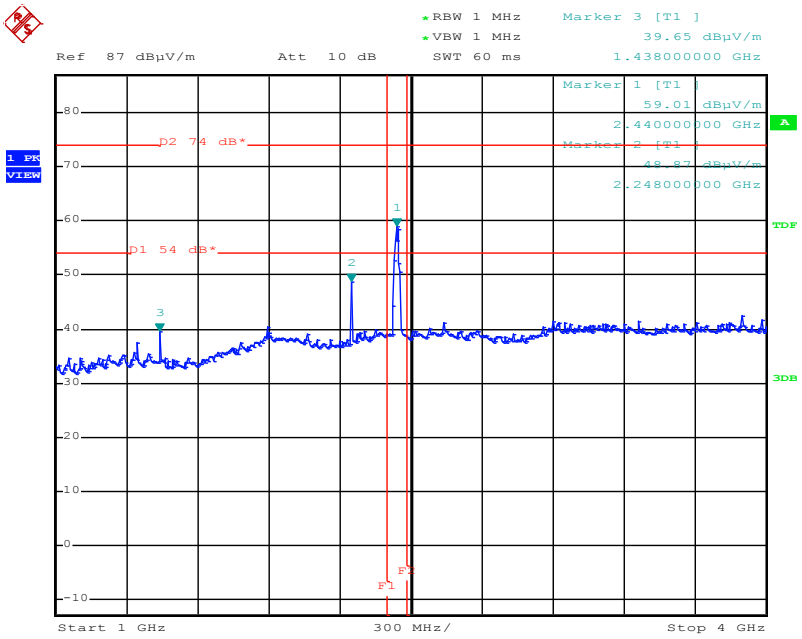
Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(µV/m)	dB(µV/m)	(metres)
0.009-0.490	2400/F (kHz)		300
0.490-1.705	24000/F (kHz)		30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

The requirements are **FULFILLED.**

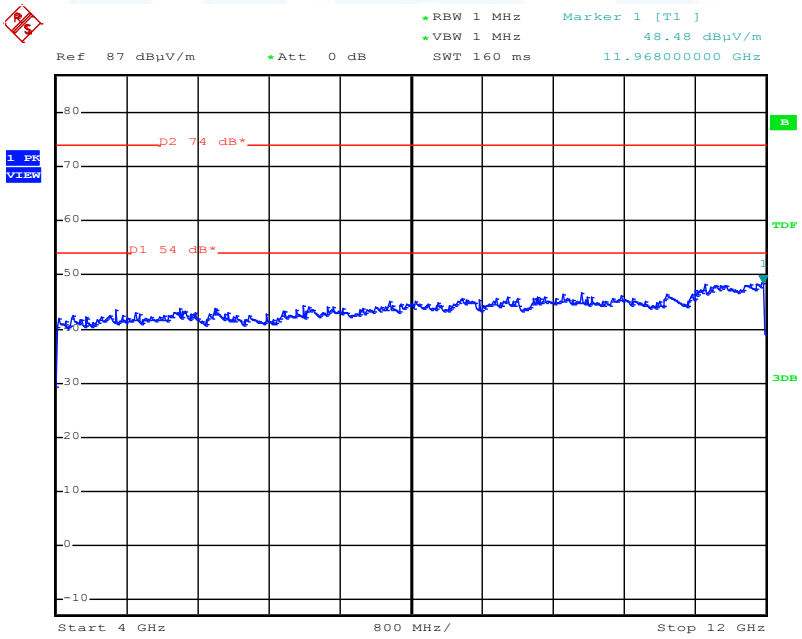
Remarks: The frequency range from 9 kHz to 25 GHz was scanned. For detailed test results please see the following test protocols. Only the worst cases of the plots are listed.

5.1.6 Test protocols of cabinet radiation:

Spurious emissions from 1 GHz to 4 GHz (worst case)



Spurious emissions from 4 GHz to 12 GHz (worst case)



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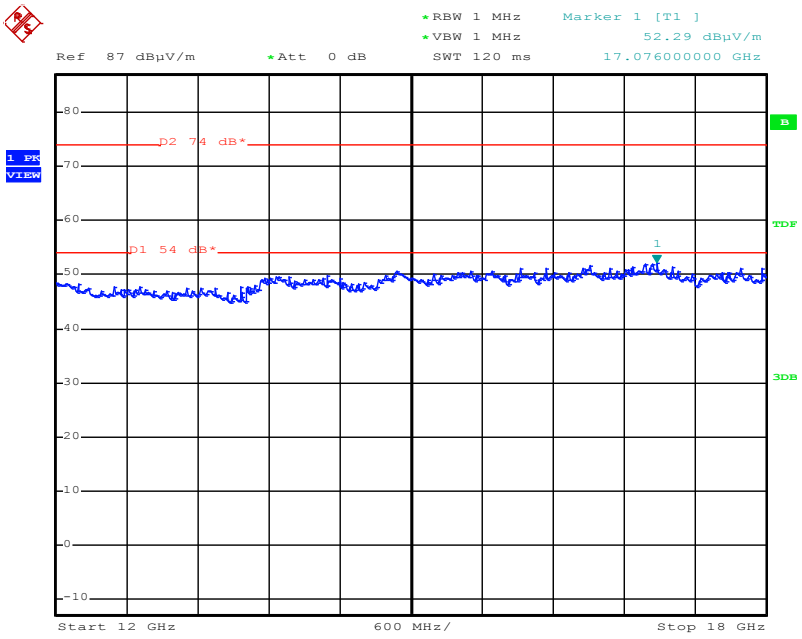
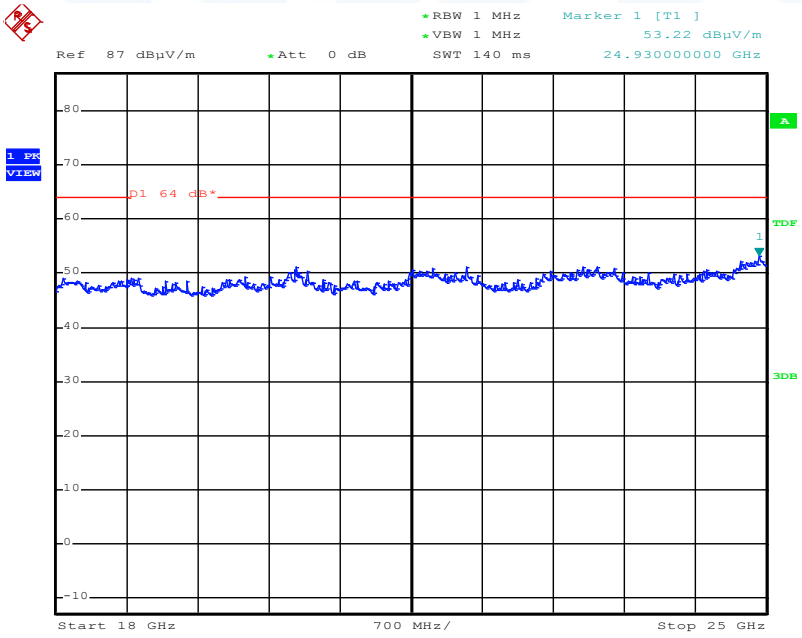
Spurious emissions from 12 GHz to 18 GHz (worst case)



Spurious emissions from 18 GHz to 25 GHz (worst case)
(Limit line calculated for measurement distance of 1 m)



5.2 Power spectral density

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

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(e):
For digitally modulated systems, the power spectral density conducted 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 conducted output power shall be used to determine the power spectral density.

5.2.4 Description of Measurement

The measurement is performed using the procedure set out in KDB-558074 D01. The power measurement is done using the procedure 9.1 Option 2, without MUX. Due to the duty cycle is lower 98% the alternative 1 is used to calculate to 100 %.
Calculation of the duty cycle correction:
On time / (ontime + off time) *100 % = 32.76 ms / 49,9 ms *100 % = 66.66 %;
Correction factor: DC = 10*log (1 + 0.3333) = 1.3 dB;

Spectrum analyser settings:
RBW: 10 kHz, VBW: 100 kHz, Detector: RMS, Trace mode: average 100 traces,
Span: 1.5 times OBW = 15 MHz, Bins = 8000 (2 * 15000 kHz / 10 kHz = 3000);

5.2.5 Test result

TX		Test results conducted				
Chain 1		PD [P20] (dBm/3kHz)	DC (dB)	PD [P20] (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
CH1						
T_{nom}	V_{nom}	-59.2	1.8	-57.4	8.0	-65.4

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

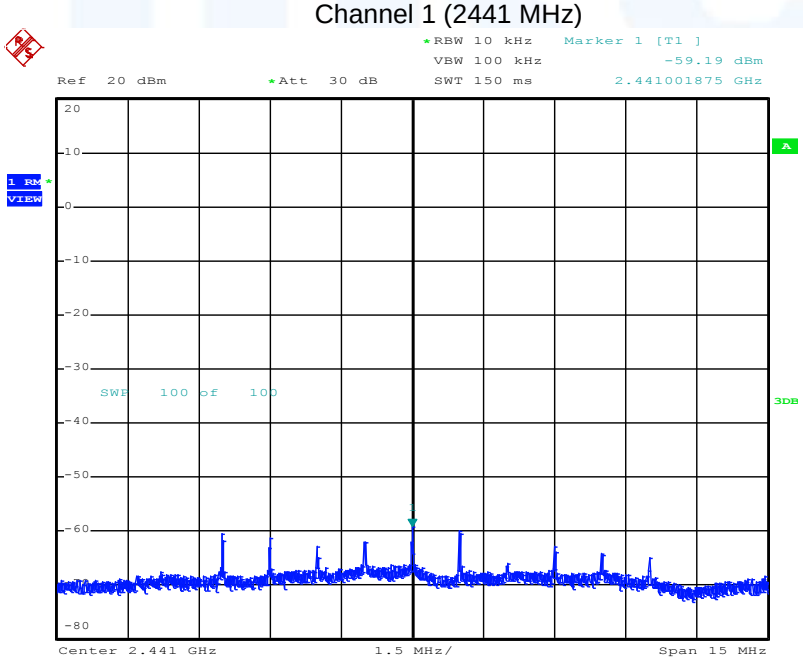
Frequency (MHz)	Power spectral density limit (dBm/3kHz)
2400 – 2483.5	8

The requirements are **FULFILLED.**

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

5.2.6 Power spectral density plot

Channel 1 (2441 MHz)



5.3 Maximum permissible exposure (MPE)

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

5.3.1 Description of the test location

Test location: AREA4

5.3.2 Applicable standard

According to FCC Part 15, Section 15.247(i):
Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.
The test methods used comply with ANSI/IEEE C95.1, "IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz".
This test report shows the compliance with the limits for Maximum Permissible Exposure (MPE) specified in FCC Part 1, Section 1.1310 and the criteria to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in FCC Part 1, Section 1.1307(b).

5.3.3 Description of Measurement

The maximum total power input to the antenna has been measured conducted as described in clause 5.3 of this document. Through the Friis transmission formula, the known maximum gain of the antenna and the maximum power, can be calculated the MPE in a defined distance away from the product.

Friis transmission formula: $$P_d = \frac{P_{out} * G}{4 * \Pi * r^2}$$

where
P_d =power density (mW/cm^2)
P_{out} = output power to antenna (mW)
G = gain of antenna (linear scale)
r = distance between antenna and observation point (cm)

According to FCC Rules 47CFR 2.1093(b) the EUT is not a portable device. The EUT is designed to be used that radiating structures are 20 cm outside of the body of the user. (r = 20 cm)

5.3.4 Test result

Antenna with an antenna gain of 8.5 dBi, Power setting P20, cable length 0.2 m, without MUX:

Channel	Power	A	Antgain	A	G	P	S	Limit S_{eq}
No.		(dBm)	(dBi)	(mW)	linear	(W)	(mW/cm^2)	(mW/cm^2)
1.0	P20	18.8	8.5	75.86	7.08	0.5370	0.1068	1.0

Limits for maximum permissible exposure (MPE):

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 3.0	614	1.63	100	30
3.0 – 30	824/*f*	2.19/*f*	$180/f^2$	30
30 - 300	27.5	0.073	0.2	30
300-1500	---	---	*f*/1500	30
1500-100000	**---**	**---**	**1.0**	**30**

f = Frequency in MHz

The requirements are **FULFILLED.**

Remarks: _____

_____

5.4 Co-location and co-transmission

Applicable standard:
OET Bulletin 65, Edition 97-01, Section 2: Multiple-transmitter sites and Complex Environments

There is no co-location issue.

Remarks: _____

_____

5.5 Antenna application

5.5.1 Antenna requirements

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.

The EUT will be used with following antennas:

Number	Characteristic	Certification name	Plug	*f*-range (GHz)	Gain (dBi)
1.0	Patch	ANT-P (Art. No. 203.102)	SMA	2.4	8.5
2.0	Patch	ANT-WL (Art. No. 201.110)	SMA	2.4	8.5
3.0	Directed	ANT-Y8 (Art. No. 201.150)	SMA	2.4	8.0
4.0	Omni	ANT-Y2E (Art. No. 203.162)	SMA	2.4	5.0

The equipment will be professionally installed by a responsible service person. The user has no access to the power settings of the equipment. After the system is installed it have to be FDA certificated which may strictly prohibit specifically any changes of the system.

5.5.2 Determination of the EIRP limit based on point to multipoint systems

According to FCC Part 15C, Section 15.247(c)(2)(iv):
Transmitter that emit a single directional beam shall operate under the provisions of § (c)(1).

According to FCC Part 15C, Section 15.247(c)(1)(i):
(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.
To calculate the applicable output power limit the following formula of KDB 558074 D01, Item 6.0:

Pout = 30 – Floor[(Gx – 6)/3];

Determination of the limit P_{out} across all applied antennas					
Cond. limit	G	max. G	Limit P_{out}	A [P20]	Margin
(dBm)	(dBi)	(dBi)	(dBm)	(dBm)	(dB)
30.0	8.5	6.0	29.2	18.8	-10.4
30.0	8.0	6.0	29.3	18.8	-10.5
30.0	5.0	6.0	30.3	18.8	-11.5

The equipment needs no power reduction at power setting P20 with all mentioned antennas.

Remarks: _____

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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.
CPC 3	FSP 30	02-02/11-05-001	18/10/2013	18/10/2012		
	HM8143	02-02/50-10-016				
	KMS102-0,2m	02-02/50-11-016				
MB	FSP 30	02-02/11-05-001	18/10/2013	18/10/2012		
	HM8143	02-02/50-10-016				
	KMS102-0,2m	02-02/50-11-016				
SEC 1-3	FSP 30	02-02/11-05-001	18/10/2013	18/10/2012		
	HM8143	02-02/50-10-016				
	KMS102-0,2m	02-02/50-11-016				
SER 1	FMZB 1516	01-02/24-01-018	16/02/2013	16/02/2012		
	ESCI	02-02/03-05-005	03/12/2013	03/12/2012		
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
SER 2	ESVS 30	02-02/03-05-006	26/06/2013	26/06/2012		
	VULB 9168	02-02/24-05-005	16/03/2013	16/03/2012	08/04/2013	08/10/2012
	S10162-B	02-02/50-05-031				
	KK-EF393-21N-16	02-02/50-05-033				
	NW-2000-NB	02-02/50-05-113				
SER 3	FSP 30	02-02/11-05-001	18/10/2013	18/10/2012		
	AFS4-01000400-10-10P-4	02-02/17-05-003				
	AMF-4F-04001200-15-10P	02-02/17-05-004				
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	3117	02-02/24-05-009	18/12/2013	18/12/2012		
	R1 _ 18 - 40 GHz	02-02/30-09-002	08/01/2014	08/01/2013		
	WHJS 1000-10EE	02-02/50-05-070				
	Sucoflex N-1000-SMA	02-02/50-05-072				
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				
	WHK 3.0/18G-10EF	02-02/50-05-180				