EMI – TEST REPORT

- FCC Part 15.249, RSS210 -

Type / Model Name	:	SE661
Product Description	:	Transceiver unit, 2.4 GHz
Applicant	:	Dr. Johannes Heidenhain GmbH
Address	:	Dr. Johannes-Heidenhain-Str. 5 83301 TRAUNREUT, GERMANY
Manufacturer	:	Dr. Johannes Heidenhain GmbH
Address	:	Dr. Johannes-Heidenhain-Str. 5 83301 TRAUNREUT, GERMANY
Licence holder	:	Dr. Johannes Heidenhain GmbH
Address	:	Dr. Johannes-Heidenhain-Str. 5 83301 TRAUNREUT, GERMANY

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

Test Report No. : T39577-00-02HS	10. June 2015 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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 15.249	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz, and 24.0 - 24.25 GHz
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: 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
CISPR 22: 2008 EN 55022: 2010	Information technology equipment

2 EQUIPMENT UNDER TEST

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

2.2 Equipment type, category

Proprietary device, fixed equipment.

2.3 Short description of the equipment under test (EUT)

The EUT is a 2.4 GHz transceiver system for low power data transmission in 16 channels of the operating band. The system consists of a touch probe and a transceiver unit SE661. The transceiver unit uses for diversity four parallel transceiver trees with RF part, 2 PCB antennas and 2 dedicated antennas. The EUT is tested as a system near a real application.

Number of tested samples: 1
Serial number: X 49 042 158 (Id. Nr. 1087803-01)

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

2.4 Variants of the EUT

There are no variants.

2.5 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2405	8	2445
1	2410	9	2450
2	2415	10	2455
3	2420	11	2460
4	2425	12	2465
5	2430	13	2470
6	2435	14	2475
7	2440	15	2480

Note: the marked frequencies are determined for final testing.

2.6 Transmit operating modes

As worst case the following channels and test modes are selected for the final test:

Standard	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
Proprietary	0 to 15	0, 7, 15	max	O-QPSK	digital	250 kbps

The frequency range was scanned from 30 MHz to 10 times carrier frequency (25000 MHz).

2.7 Antenna

The following integrated antennas are used with the EUT:

- PCB meander antenna.
- Dedicated antenna.

The antennas cannot be unattached by the user.

2.8 Power supply system utilised

Power supply voltage, V_{nom} : 12 or 24 VDC (over the control unit)
Power supply voltage (alternative) : Input: 100-240 V, 47-63 Hz, 1ϕ Power supply, Output: +12 VDC.

2.9 Peripheral devices and interface cables

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

- _____ Model : _____
- _____ Model : _____
- _____ Model : _____

2.10 Determination of worst case conditions for final measurement

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 Y position with a special fixture.

As worst case the following channels and test modes are selected for the final test:

Standard	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
Proprietary	0 to 15	0, 7, 15	max	O-QPSK	digital	250 kbps

- TX continuous carrier
- No data transmission

2.10.1 Test jig

No test jig needs to be used.

2.10.2 Test software

The test software for the EUT provides free channel settings and selection of the antenna path, the special test mode TX and TX continuous, CW and modulated.

3 TEST RESULT SUMMERY

Operating in the 2400 MHz – 2483.5 MHz band:

FCC Rule Part	RSS Rule Part	Description	Result
15.35(c)	RSS-Gen, 6.10	Pulsed operation	passed
15.203	RSS Gen, 8.3	Antenna requirement	passed
15.204	RSS Gen, 8.2	External radio frequency power amplifiers	passed
15.205(a)	RSS Gen, 8.1	Emissions in restricted bands	passed
15.207(a)	RSS Gen, 8.8	AC power line conducted emissions	passed
15.215(c)	-	EBW	passed
-	RSS-Gen, 6.6	OBW	passed
15.249(a)	RSS-210, A2.9(a)	Field strength of fundamental	passed
15.249(d)	RSS-210, A2.9(b)	Out-of-band emission, radiated	passed
-	RSS-Gen, 6.11	Transmitter frequency stability	not applicable

The mentioned RSS Rule Parts in the above table are related to:
RSS Gen, Issue 4, November 2014
RSS 210, Issue 8, December 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 : 07 May 2015

Testing concluded on : 11 May 2015

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2015.06.10 15:44:55 +02'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Hermann Smetana
I am the author of this document
2015.06.10 15:41:19 +02'00'

Hermann Smetana
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

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 unterminated. 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 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: AREA4

5.1.2 Photo documentation of the test set-up – see ATTACHMENT B

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.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin 12.2 dB at 25.001 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

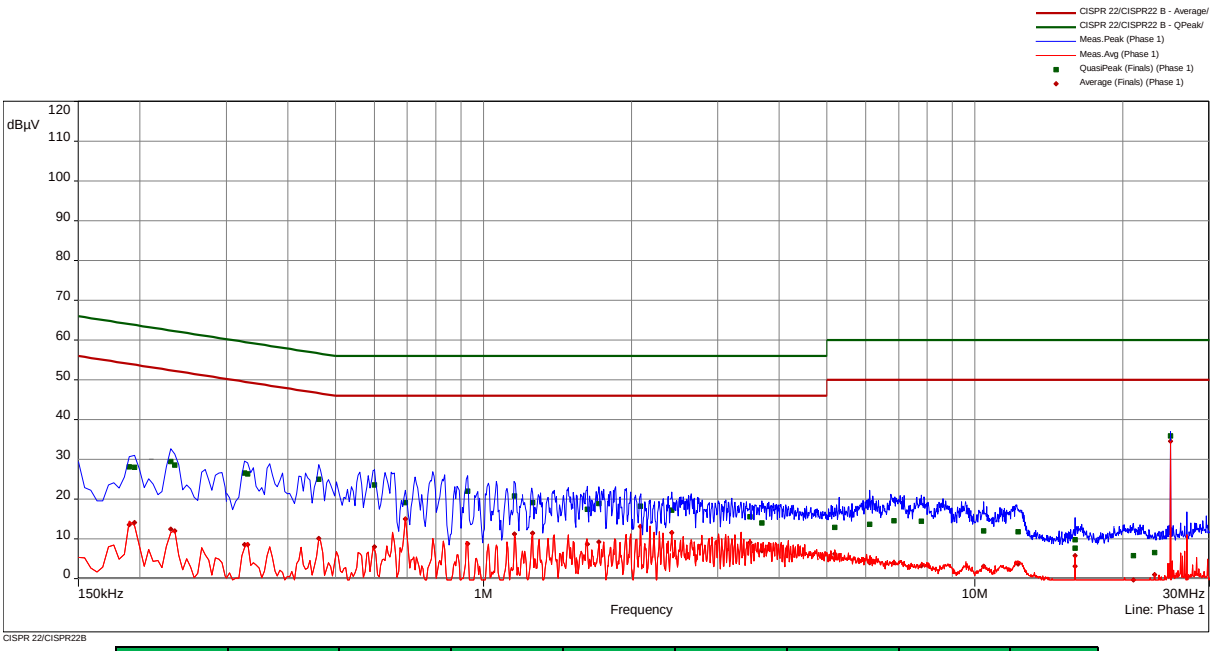
* Decreases with the logarithm of the frequency

The requirements are **FULFILLED.**

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

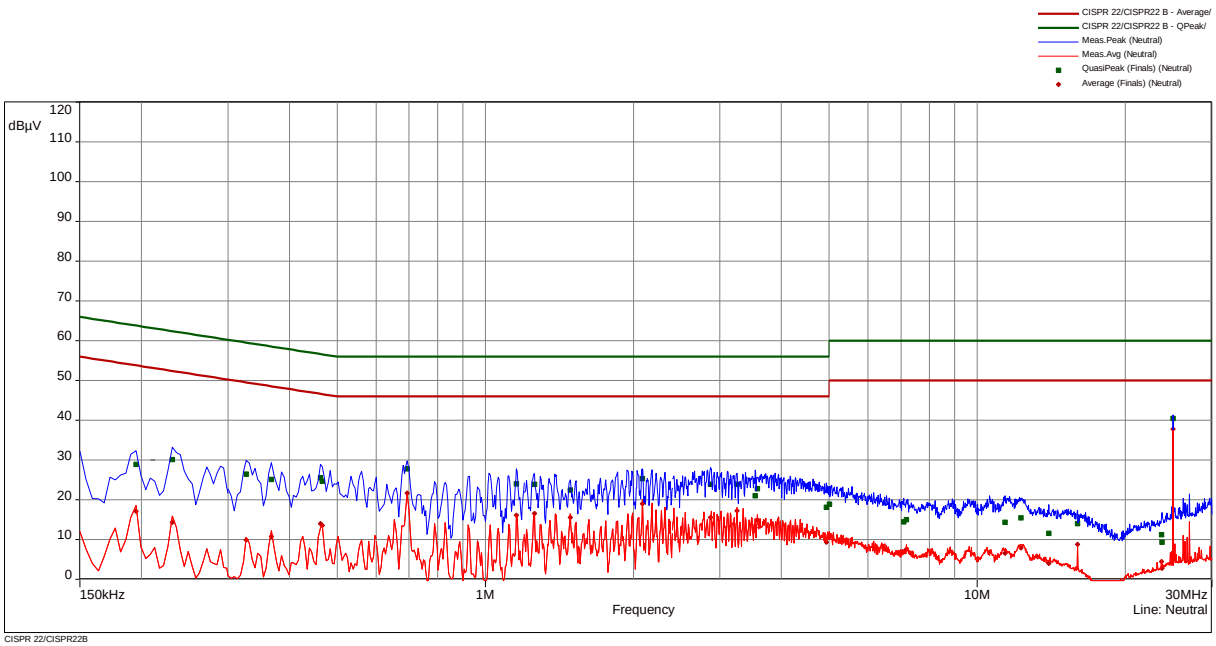
5.1.6 Test protocol

Test point L1 Result: passed
Operation mode: TX normal transmission
Remarks:



freq	SR	QP	margin	limit	AV	margin	limit	line
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB	
0.191	1	28.2	35.9	64.0	13.5	40.5	54.0	Phase 1
0.195	1	28.0	35.8	63.8	14.1	39.7	53.8	Phase 1
0.231	1	29.5	33.0	62.4	12.5	39.9	52.4	Phase 1
0.236	1	28.6	33.6	62.3	12.0	40.3	52.3	Phase 1
0.327	2	26.6	33.0	59.5	8.5	41.0	49.5	Phase 1
0.332	2	26.3	33.1	59.4	8.5	40.9	49.4	Phase 1
0.462	2	25.0	31.6	56.7	10.1	36.6	46.7	Phase 1
0.600	3	23.5	32.5	56.0	8.0	38.0	46.0	Phase 1
0.695	3	19.1	36.9	56.0	15.0	31.0	46.0	Phase 1
0.929	3	22.0	34.0	56.0	8.8	37.2	46.0	Phase 1
1.158	3	20.8	35.2	56.0	11.3	34.7	46.0	Phase 1
1.259	4	19.1	36.9	56.0	11.4	34.6	46.0	Phase 1
1.628	4	17.5	38.5	56.0	8.7	37.3	46.0	Phase 1
1.718	4	18.9	37.1	56.0	9.3	36.8	46.0	Phase 1
2.087	4	18.2	37.8	56.0	13.2	32.8	46.0	Phase 1
2.418	5	17.3	38.7	56.0	11.6	34.4	46.0	Phase 1
3.485	5	15.6	40.4	56.0	9.2	36.8	46.0	Phase 1
3.687	5	14.0	42.0	56.0	7.0	39.0	46.0	Phase 1
5.192	6	12.9	47.1	60.0	6.2	43.8	50.0	Phase 1
6.105	6	13.7	46.3	60.0	4.1	46.0	50.0	Phase 1
6.848	6	14.6	45.4	60.0	4.0	46.0	50.0	Phase 1
7.779	6	14.5	45.6	60.0	3.2	46.8	50.0	Phase 1
10.415	7	12.0	48.0	60.0	3.1	46.9	50.0	Phase 1
12.255	7	11.8	48.2	60.0	3.6	46.4	50.0	Phase 1
15.999	7	9.8	50.2	60.0	5.7	44.3	50.0	Phase 1
16.004	7	7.6	52.4	60.0	3.1	46.9	50.0	Phase 1
21.036	8	5.7	54.3	60.0	-1.2	51.2	50.0	Phase 1
23.192	8	6.6	53.4	60.0	1.1	49.0	50.0	Phase 1
25.001	8	35.9	24.1	60.0	34.5	15.5	50.0	Phase 1

Test point: N Result:
Operation mode: TX normal transmission
Remarks:



freq	SR	QP	margin	limit	AV	margin	limit	line
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB	
0.195	9	28.9	34.9	63.8	17.1	36.7	53.8	Neutral
0.231	9	30.2	32.3	62.4	14.3	38.1	52.4	Neutral
0.327	10	26.5	33.0	59.5	9.9	39.7	49.5	Neutral
0.368	10	25.1	33.4	58.6	10.8	37.8	48.6	Neutral
0.462	10	25.6	31.1	56.7	14.0	32.6	46.7	Neutral
0.467	10	24.7	31.9	56.6	13.5	33.1	46.6	Neutral
0.695	11	27.8	28.3	56.0	21.7	24.3	46.0	Neutral
1.158	11	24.0	32.0	56.0	16.1	29.9	46.0	Neutral
1.259	12	23.9	32.1	56.0	16.5	29.5	46.0	Neutral
1.488	12	22.5	33.5	56.0	15.6	30.5	46.0	Neutral
2.087	12	25.3	30.7	56.0	19.0	27.0	46.0	Neutral
2.868	13	23.9	32.1	56.0	15.5	30.5	46.0	Neutral
3.246	13	23.9	32.1	56.0	17.2	28.8	46.0	Neutral
3.534	13	21.1	34.9	56.0	13.0	33.0	46.0	Neutral
3.575	13	22.8	33.2	56.0	15.0	31.1	46.0	Neutral
4.940	14	18.1	37.9	56.0	9.3	36.7	46.0	Neutral
5.007	14	19.0	41.1	60.0	10.8	39.2	50.0	Neutral
7.091	14	14.4	45.6	60.0	6.9	43.1	50.0	Neutral
7.185	14	15.0	45.0	60.0	7.5	42.5	50.0	Neutral
11.387	15	14.4	45.6	60.0	6.6	43.4	50.0	Neutral
12.282	15	15.4	44.6	60.0	7.9	42.1	50.0	Neutral
13.983	15	11.5	48.5	60.0	4.1	45.9	50.0	Neutral
15.999	15	14.0	46.0	60.0	8.8	41.2	50.0	Neutral
23.696	16	11.2	48.8	60.0	4.4	45.6	50.0	Neutral
23.750	16	9.3	50.7	60.0	2.8	47.2	50.0	Neutral
25.001	16	40.4	19.6	60.0	37.8	12.2	50.0	Neutral

5.2 Field strength of fundamental

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

5.2.1 Description of the test location

Test location: Anechoic chamber 2
Test distance: 3 m

5.2.2 Photo documentation of the test set-up – see ATTACHMENT B

5.2.1 Applicable standard

According to FCC Part 15C, Section 15.249(a):
The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the effective limits.

5.2.2 Description of Measurement

The radiated emission of the fundamental wave from the EUT is measured using a spectrum analyser and appropriate linear polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 6.5. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Analyser settings:
Peak measurement: RBW: 1 MHz VBW: 3 MHz Detector: Max peak

5.2.3 Test result

Frequency	Level PK	Limit PK	Margin PK	Level AV	Limit AV	Margin AV
(MHz)	dB(µV/m)	dB(µV/m)	(dB)	dB(µV/m)	dB(µV/m)	(dB)
2405	98.0	114.0	-16.0	84.3	94.0	-9.7
2440	97.6	114.0	-16.4	83.9	94.0	-10.1
2480	96.9	114.0	-17.1	83.2	94.0	-10.8

Average-Limit according to FCC Part 15C, Section 15.249(a):

Frequency	Field strength of fundamental	
(MHz)	(mV/m)	dB(µV/m)
902 - 928	50	94
2400 - 2483.5	**50**	**94**
5725-5875	50	94
24000 - 24250	250	108

Peak-Limit according to FCC Part 15C, Section 15.249(e):
However the peak field strength shall not exceed the maximum permitted average limit by more than 20 dB.

The requirements are **FULFILLED.**

Remarks: _____

5.3 Spurious emission, radiated

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

5.3.1 Description of the test location

Test location: OATS 1
Test distance: 10 m
Test location: Anechoic chamber 2
Test distance: 3 m

5.3.2 Photo documentation of the test set-up – see ATTACHMENT B

5.3.3 Applicable standard

According to FCC Part 15C, Section 15.249 (d):
Emission radiated outside of the specified frequency bands, except harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated limit in FCC Part 15C, Section 15.209, whichever is the lesser attenuation.

5.3.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to CISPR 22. In the frequency range above 1 GHz a spectrum analyser is used with appropriate linear polarized antennas. If the emission level in peak mode complies with the average limit testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and reported. The frequency range 18 GHz to 25 GHz is measured at 1 m distance for better sensitivity. The measurement results are calculated to 3 m measurement distance. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Instrument settings:

30 MHz – 1000 MHz:	RBW:	120 kHz
1000 MHz – 25 GHz	RBW:	1 MHz

5.3.5 Test result f < 1 GHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB/m)	Correct. Hor. (dB/m)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
50.00	0.8	0.6	15.4	15.1	16.2	15.7	30.0	-13.8
75.00	1.8	0.7	12.5	12.4	14.3	13.1	30.0	-15.7
125.00	12.1	3.2	14.2	13.8	26.3	17.0	30.0	-3.7
150.00	7.5	2.6	15.4	15.3	22.9	17.9	30.0	-7.1
175.00	9.6	3.5	15.0	14.8	24.6	18.3	30.0	-5.4
275.00	11.2	4.9	15.7	16.1	26.9	21.0	37.0	-10.1
325.00	8.3	3.3	17.8	17.9	26.1	21.2	37.0	-10.9
425.00	4.2	1.9	20.9	20.9	25.1	22.8	37.0	-11.9

Note: This measurement is done according CISPR 22, distance 10 m. The measurement meets the limits.

5.3.6 Test result f > 1 GHz

CH0, ANT3:

Frequency	Level PK	Level AV	Limit PK	Margin PK	Limit AV	Margin AV
(MHz)	dB(µV/m)	dB(µV/m)	dB(µV/m)	(dB)	dB(µV/m)	(dB)
1895	44.7	-	74.0	-29.3	54.0	-
4810	63.6	49.9	74.0	-10.4	54.0	-4.1
7215	61.6	47.9	74.0	-12.4	54.0	-6.1
17935	53.1	-	74.0	-20.9	54.0	-
23964	47.5	-	74.0	-26.5	54.0	-

CH7, ANT3:

Frequency	Level PK	Level AV	Limit PK	Margin PK	Limit AV	Margin AV
(MHz)	dB(µV/m)	dB(µV/m)	dB(µV/m)	(dB)	dB(µV/m)	(dB)
1036	44.7	-	74.0	-29.3	54.0	-
1903	44.5	-	74.0	-29.5	54.0	-
3852	43.6	-	74.0	-30.4	54.0	-
4880	62.2	48.5	74.0	-11.8	54.0	-5.5
7320	60.1	46.4	74.0	-13.9	54.0	-7.6
17956	53.4	-	74.0	-20.6	54.0	-
24048	48.1	-	74.0	-25.9	54.0	-

CH15, ANT3:

Frequency	Level PK	Level AV	Limit PK	Margin PK	Limit AV	Margin AV
(MHz)	dB(µV/m)	dB(µV/m)	dB(µV/m)	(dB)	dB(µV/m)	(dB)
2179	42.9	-	74.0	-31.1	54.0	-
2632	45.1	-	74.0	-28.9	54.0	-
3870	44.3	-	74.0	-29.7	54.0	-
4960	58.3	44.6	74.0	-15.7	54.0	-9.4
7440	55.6	41.9	74.0	-18.4	54.0	-12.1
17896	53.4	-	74.0	-20.6	54.0	-
23922	47.7	-	74.0	-26.3	54.0	-

Limit according to FCC Part 15C, Section 15.209:

Frequency (MHz)	15.209 Limits (µV/m)	Measurement distance (m)
0.009 - -0.49	2400/f(kHz)	300
0.49 – 1.705	24000/f(kHz)	30
1.705 – 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Average limit according to FCC Part 15C, Section 15.249(a):

Fundamental frequency	Field strength of harmonics	
(MHz)	(µV/m)	dB(µV/m)
902 - 928	500	54
2400 - 2483.5	500	54
5725 - 5875	500	54
24000 - 24250	2500	68

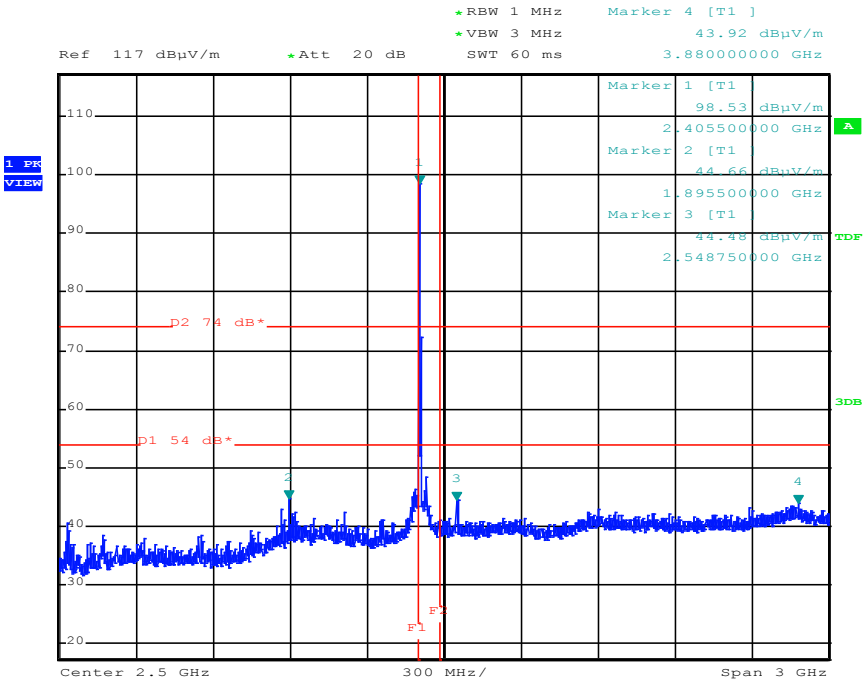
The requirements are **FULFILLED.**

Remarks: The measurement was performed up to the 10th harmonic (25000 MHz). For detailed test result please see the following test protocols.

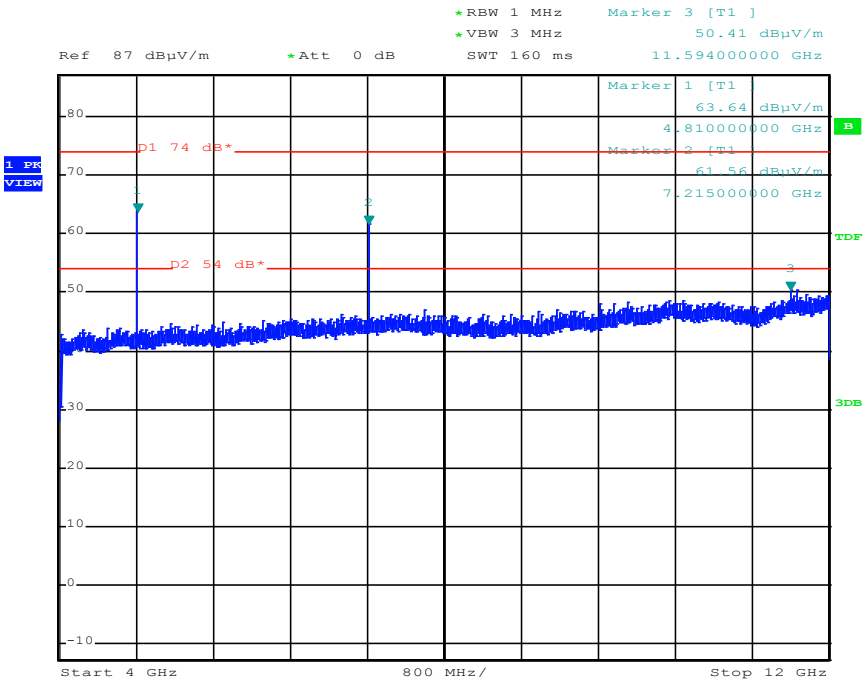
5.3.7 Test protocols

Spurious emissions from 1 to 4 GHz
(Incl. Fundamental carrier)

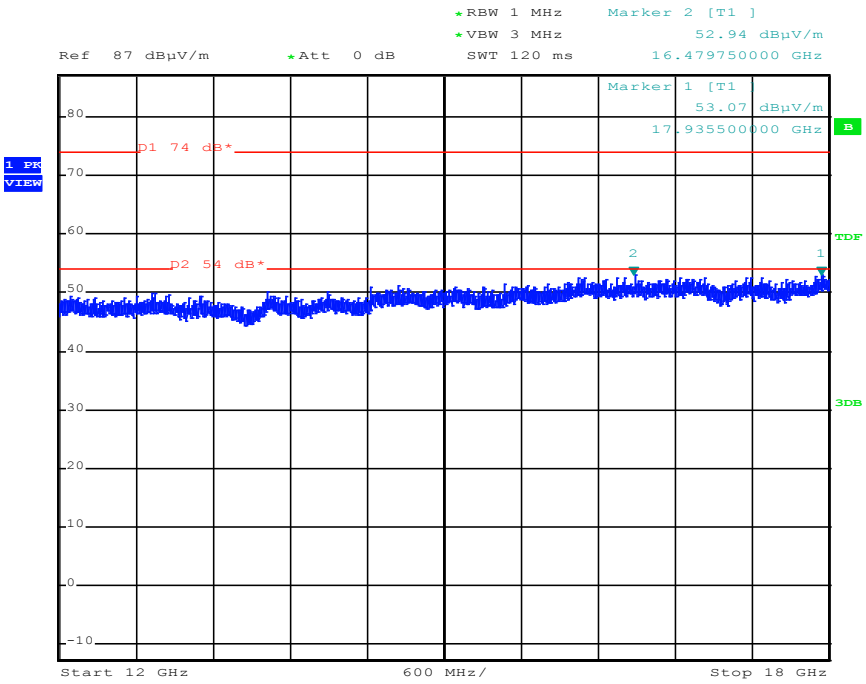
CH0_ANT3



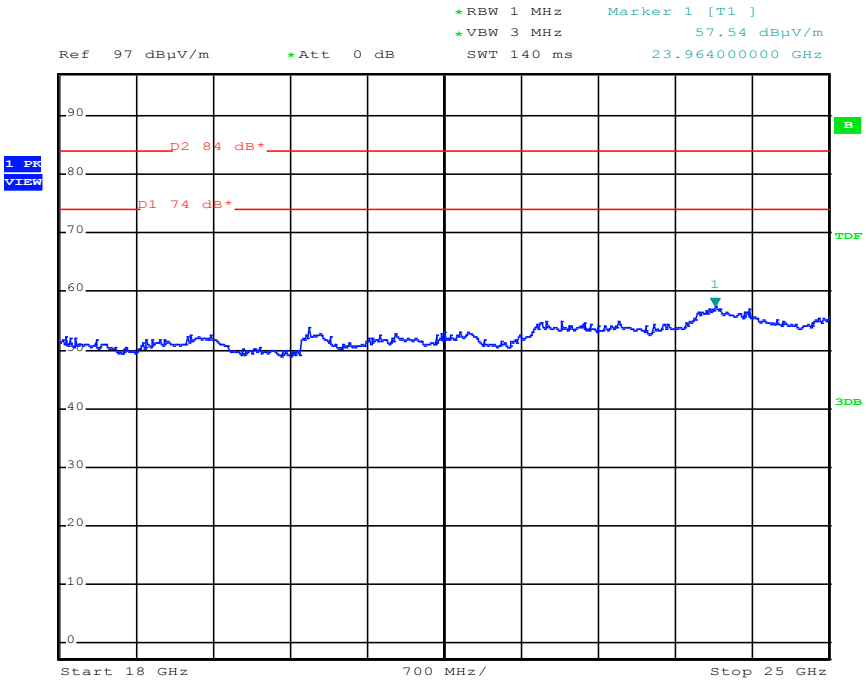
Spurious emissions from 4 to 12 GHz



Spurious emissions from 12 to 18 GHz

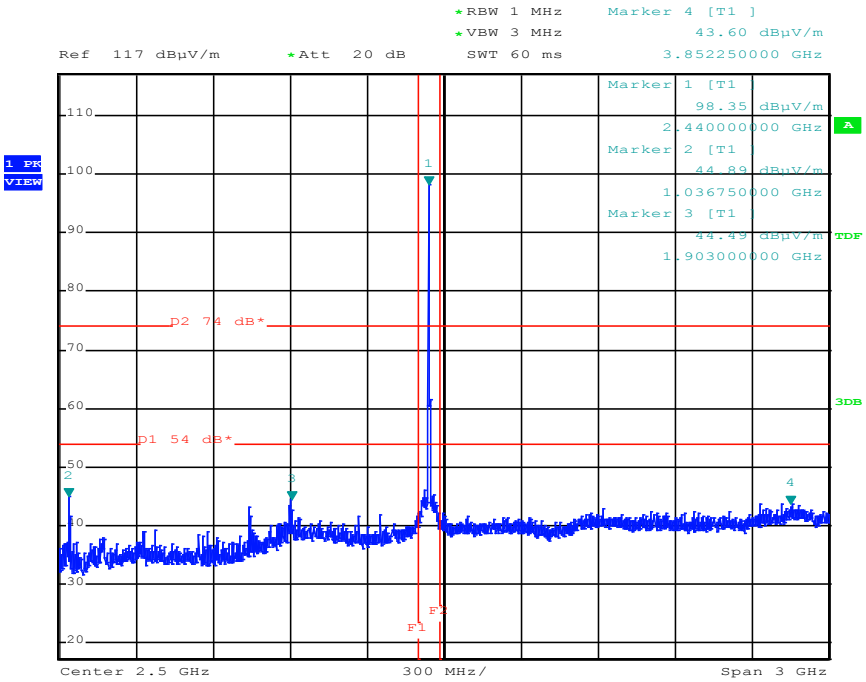


Spurious emissions from 18 to 25 GHz

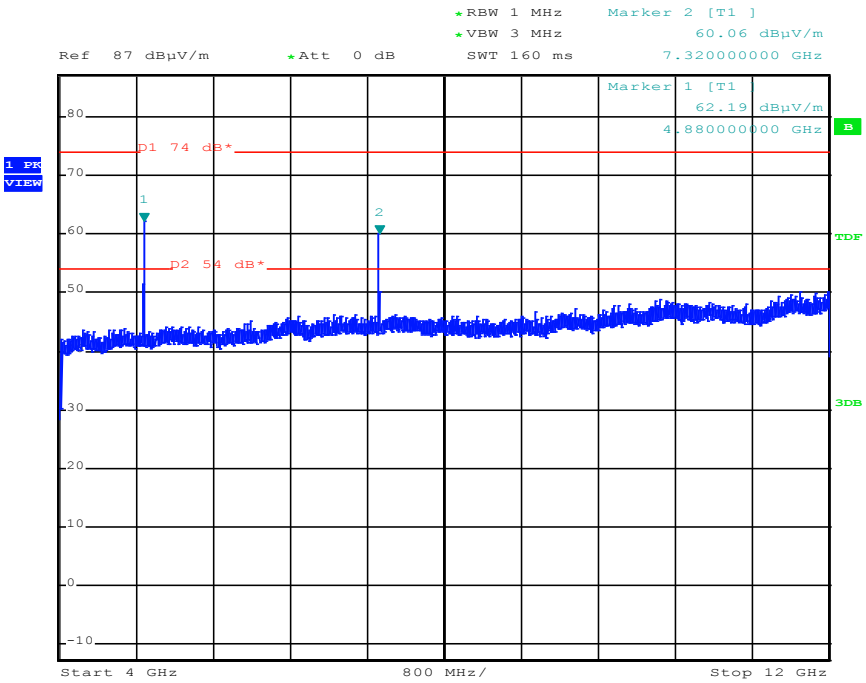


Spurious emissions from 1 to 4 GHz
(Incl. Fundamental carrier)

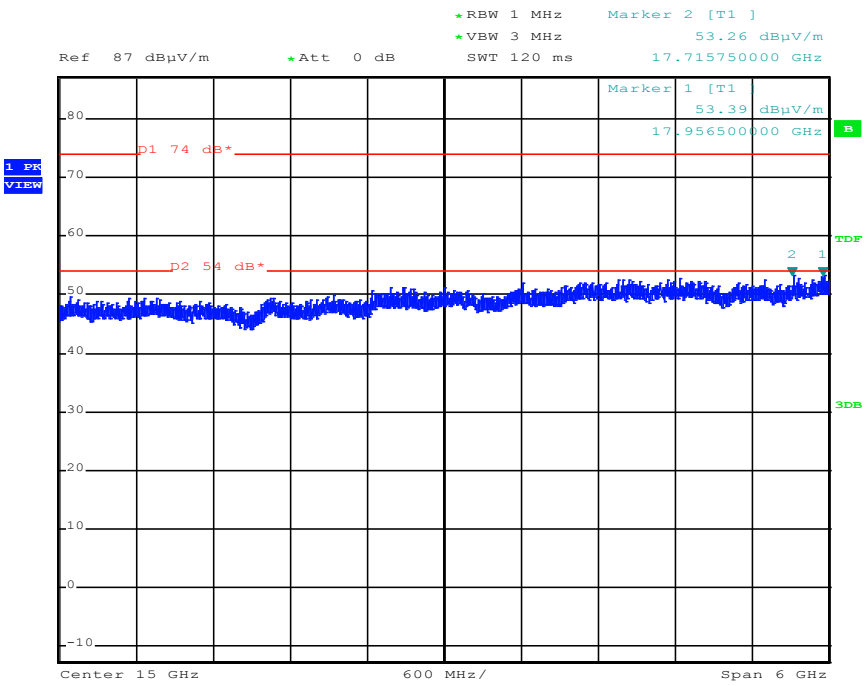
CH7_ANT3



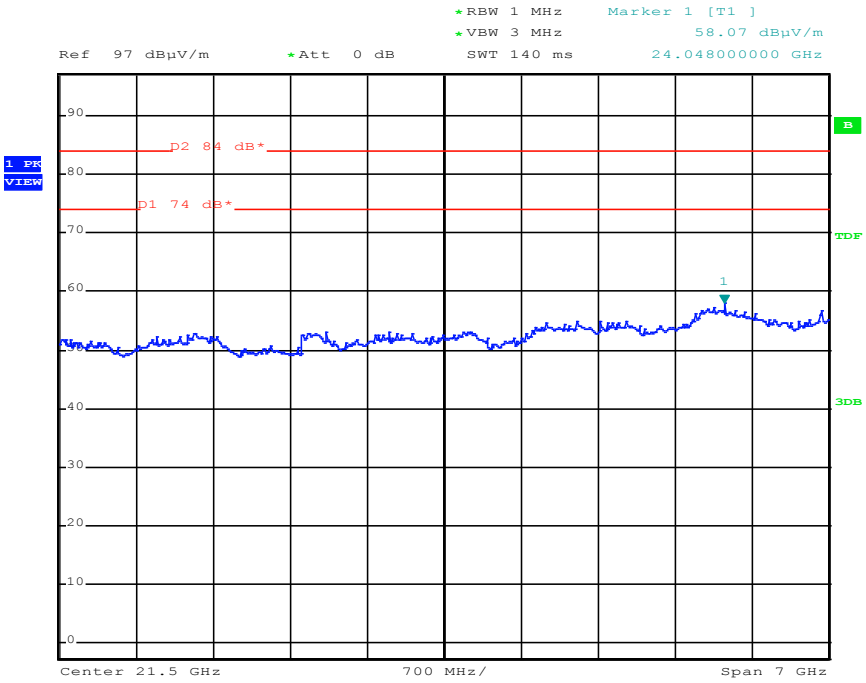
Spurious emissions from 4 to 12 GHz



Spurious emissions from 12 to 18 GHz

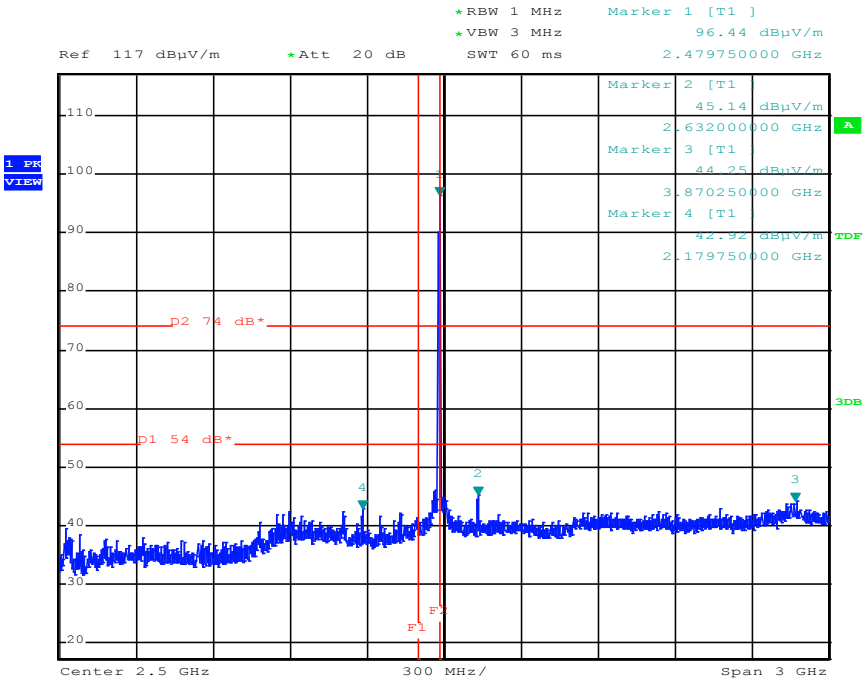


Spurious emissions from 18 to 25 GHz

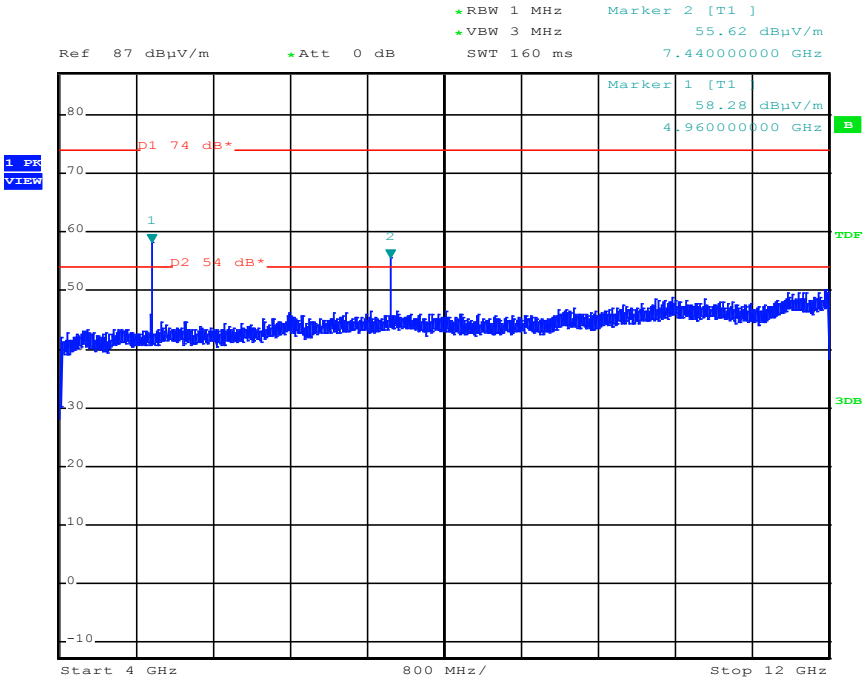


Spurious emissions from 1 to 4 GHz
(Incl. Fundamental carrier)

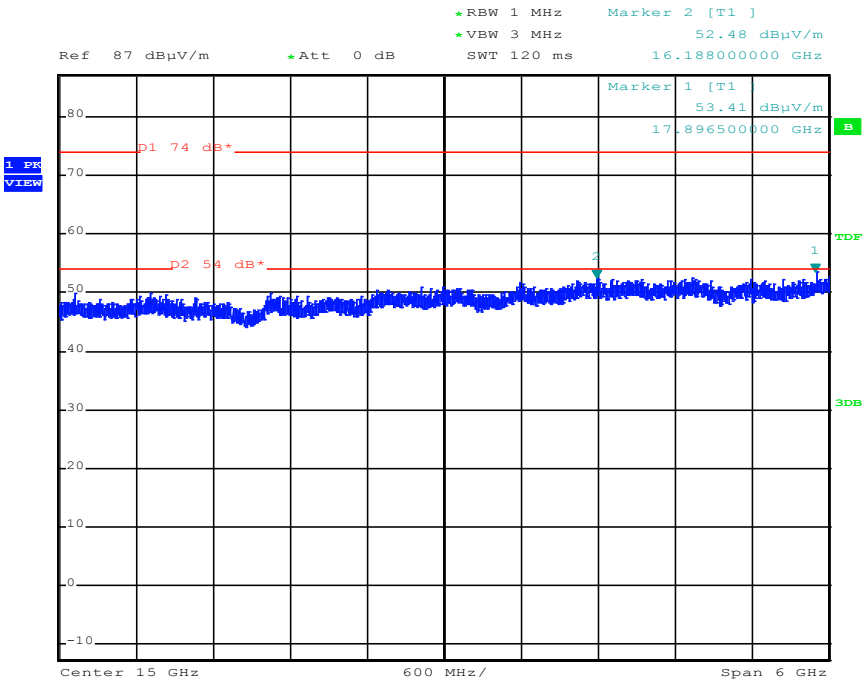
CH15_ANT3



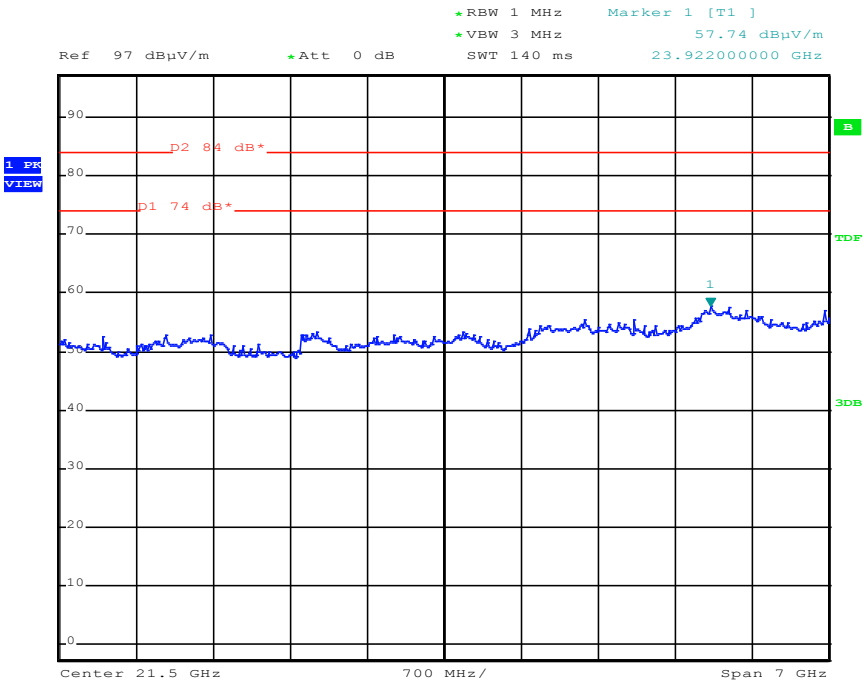
Spurious emissions from 4 to 12 GHz



Spurious emissions from 12 to 18 GHz



Spurious emissions from 18 to 25 GHz



5.4 EBW and OBW

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

5.4.1 Description of the test location

Test location: AREA4

5.4.2 Photo documentation of the test set-up – see ATTACHMENT B

5.4.3 Applicable standard

According to FCC Part 15, Section 15.215(c):
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in Section 15.217 through Section 15.257, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule section under which the equipment is operated.

5.4.4 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio of -20 dB (99%). The x-dB-down (OBW) function of the analyser is used. The measurement is performed with normal modulation in TX continuous mode.

Spectrum analyser settings:
RBW: 100 kHz, VBW: 300 kHz, Span: 5 MHz, Trace mode: max. hold, Detector: max. peak;

5.4.5 Test result

Centre *f* (MHz)	20dB bandwidth f_1	20dB bandwidth f_2	Measured EBW (MHz)
2405.001	2403.671	2406.331	2.660
2440.000	2438.670	2441.330	2.660
2479.995	2478.670	2481.320	2.650

Centre *f* (MHz)	99% bandwidth f_1	99% bandwidth f_2	Measured OBW (MHz)
2405.010	2403.760	2406.260	2.500
2440.010	2438.760	2441.260	2.500
2479.995	2478.750	2481.240	2.490

80 % Channel edge frequency (MHz)	20 dB Bandwidth edge (MHz)
f_{low} > 2402	f_{low} = 2403.671
f_{high}< 2482	f_{high} = 2481.320

80% bandwidth of the permitted channel: 4 MHz

Limit according to FCC Part 15C, Section 15.215(c):
If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.Due to the channelizing of the operating band into 16 channels with channel bandwidth of 5 MHz the limit central 80% of the permitted band cannot be applied. Therefore the stability of the EUT will be shown staying within the central 80% of the operating channel.

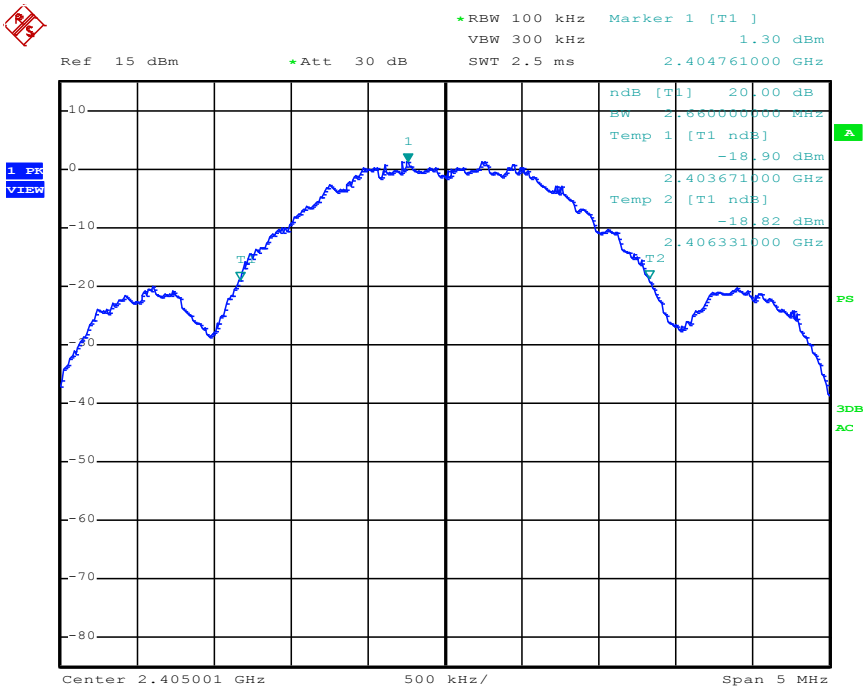
The requirements are **FULFILLED.**

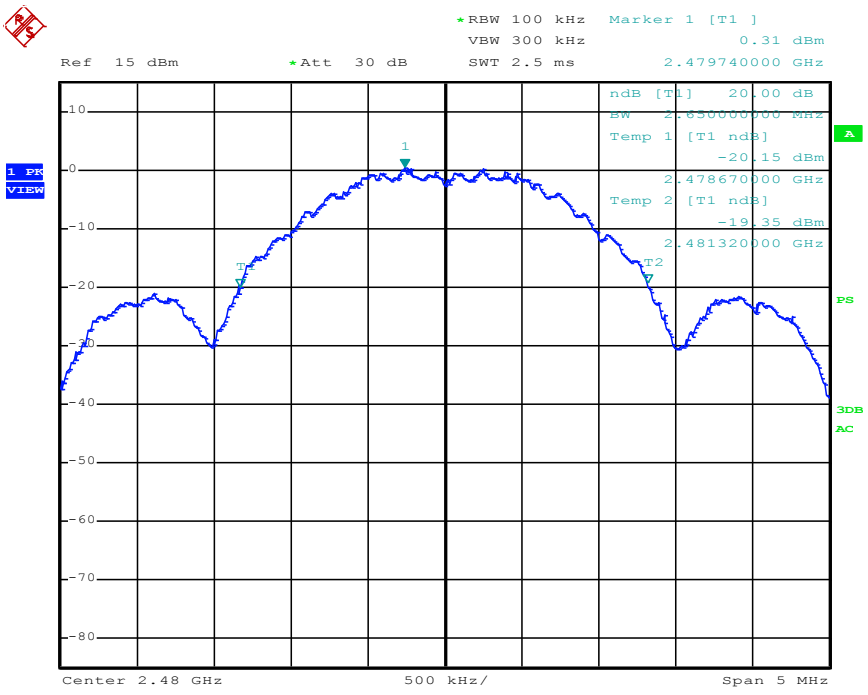
Remarks: For detailed test result please refer to following test protocols.

The OBW99 is measured for RSS only.

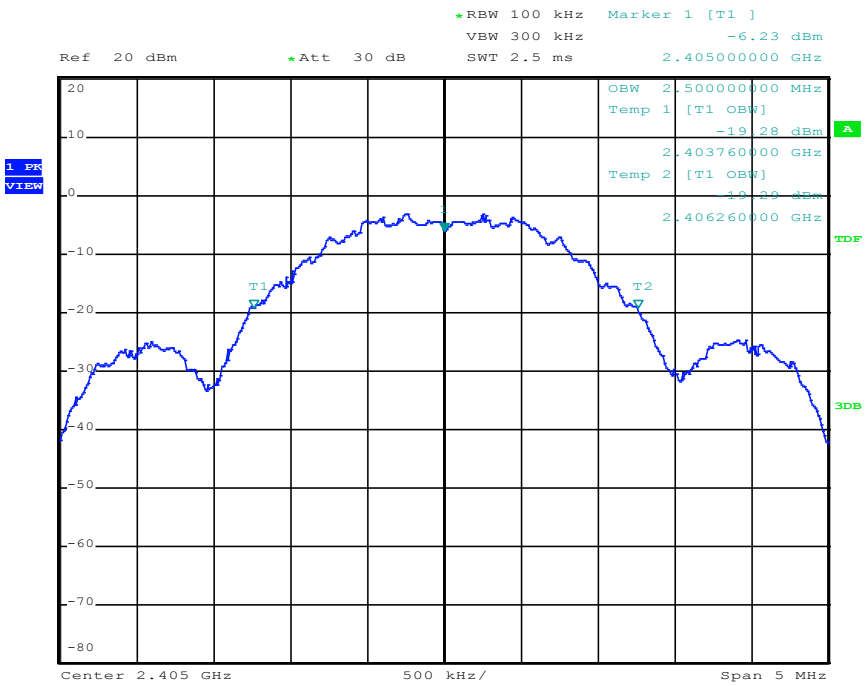
5.4.6 Test protocols

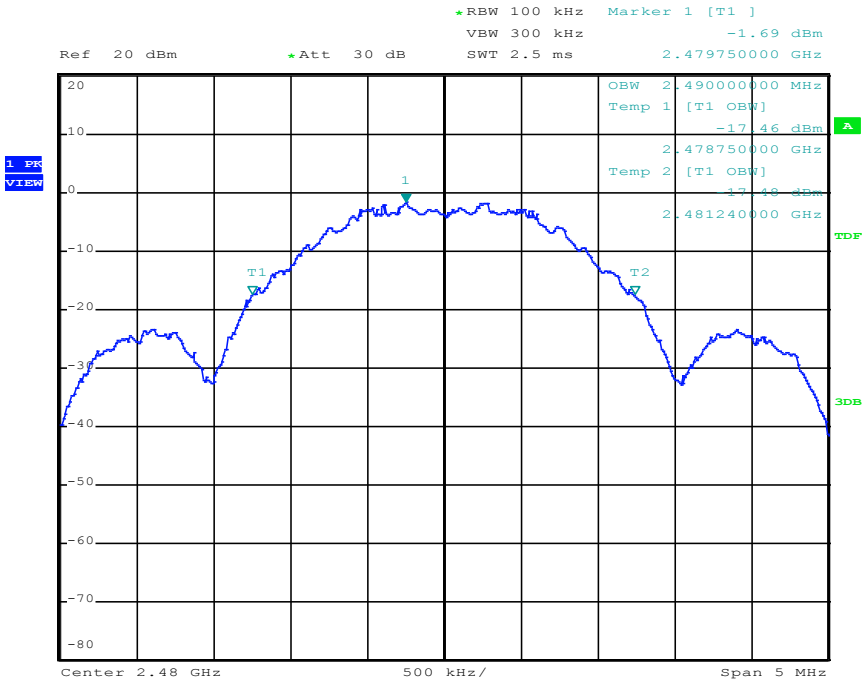
20 dB bandwidth





OBW 99%


RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-6.23 dBm
2.405000000 GHz
Ref 20 dBm
Att 30 dB
OBW 2.500000000 MHz
Temp 1 [T1 OBW]
-19.28 dBm
2.403760000 GHz
Temp 2 [T1 OBW]
-19.29 dBm
2.406260000 GHz
1 PK VIEW
A
TDF
3DB
T1
T2
Center 2.405 GHz
500 kHz/
Span 5 MHz


RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-1.69 dBm
2.479750000 GHz
Ref 20 dBm
Att 30 dB
OBW 2.490000000 MHz
Temp 1 [T1 OBW]
-17.46 dBm
2.478750000 GHz
Temp 2 [T1 OBW]
-17.48 dBm
2.481240000 GHz
1 PK VIEW
A
TDF
3DB
T1
T2
Center 2.48 GHz
500 kHz/
Span 5 MHz

5.5 Correction for pulse operation (duty cycle)

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

5.5.1 Description of the test location

Test location: AREA4

5.5.2 Photo documentation of the test set-up – see ATTACHMENT B

5.5.3 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.

5.5.4 Description of Measurement

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

$$K_E = 20 \log (\text{max On-time}/T_w);$$

K_E: pulse operation correction factor
T_w a period of the pulse track

5.5.5 Test result

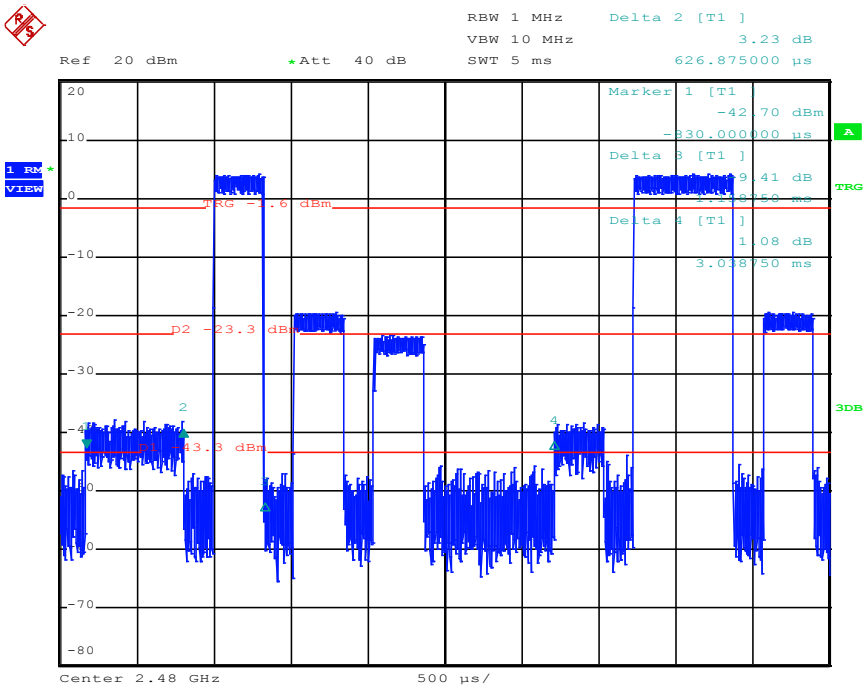
Total length of period	3.038 ms
Max. On time Port4	0.627 ms
DC	0.21
Correction factor	-13.7 dB

Note: The duty cycle for port4 is the max On-time for port4 till it is again transmitting. In the meantime port1, port2 and port3 are permitted to hold the communication with its client.

Remarks: For detailed results, please see the test protocol below.

5.5.6 Test protocol

Correction for Pulse Operation (Duty Cycle)
FCC Part 15A, Section 15.35(c)



5.6 Antenna application

5.6.1 Applicable standard

According to FCC Part 15C, Section 15.203(a):
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.

5.6.2 Result

The EUT use at two RF-legs integrated PCB antennas and at the other two RF-legs dedicated antennas. The dedicated antennas are fixed at the SMA-connector with glue, that the antennas are not detachable. The glue is necessary because the connection has to be oil tight. No other antenna than that furnished by the responsible party or external power amplifier can be applied by a customer.

The antenna of the EUT meets the requirement of FCC Part 15C, Section 15.203 and 15.204.

The requirements are **FULFILLED.**

Remarks: _____

_____

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.
A 4	ESHS 30	02-02/03-05-002	17/07/2015	17/07/2014		
	ESH 2 - Z 5	02-02/20-05-004	18/10/2015	18/10/2013	09/08/2015	09/02/2015
	EMV D 30000/PAS	02-02/30-05-006	08/12/2015	08/12/2014		
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	ESH 3 - Z 2	02-02/50-05-155	19/11/2015	19/11/2014	19/05/2015	19/11/2014
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	12/05/2016	12/05/2015		
	Sucoflex N-2000-SMA	02-02/50-05-075				
	SF104/11N/11N/1500MM	02-02/50-13-015				
DC	FSP 30	02-02/11-05-001	20/10/2015	20/10/2014		
	WK-340/40	02-02/45-05-001	24/06/2015	24/06/2014		
	6543A	02-02/50-05-157				
MB	FSP 30	02-02/11-05-001	20/10/2015	20/10/2014		
	WK-340/40	02-02/45-05-001	24/06/2015	24/06/2014		
	6543A	02-02/50-05-157				
SER 2	ESVS 30	02-02/03-05-006	03/07/2015	03/07/2014		
	VULB 9168	02-02/24-05-005	17/04/2016	17/04/2015	17/10/2015	17/04/2015
	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 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	12/05/2016	12/05/2015		
	Sucoflex N-2000-SMA	02-02/50-05-075				
	SF104/11N/11N/1500MM	02-02/50-13-015				