

EMI – TEST REPORT

- FCC Part 15.249, RSS210 -

Type / Model Name : Mach-Wireless-SRC

Product Description : Single channel wireless control module

Applicant : Dr. Mach GmbH Co. KG

Address : Flossmannstraße 28

85560 EBERSBERG, GERMANY

Manufacturer : Dr. Mach GmbH Co. KG

Address : Flossmannstraße 28

85560 EBERSBERG, GERMANY

Licence holder : Dr. Mach GmbH Co. KG

Address : Flossmannstraße 28

85560 EBERSBERG, GERMANY

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

POSITIVE

Test Report No. : **T39444-00-01TK**

24. 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.

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ATTACHMENT A as separate supplement

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: 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
CISPR 22: 2008 EN 55022: 2010	Information technology equipment
KDB 447498 D01	General RF Exposure Guidance v05r02

2 EQUIPMENT UNDER TEST

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

2.2 Equipment category

Proprietary wireless transceiver, fixed equipment.

2.3 Short description of the equipment under test (EUT)

The EUT is a 2.4 GHz wireless module on a micro controller module to send I²C-Bus commands within a modulated wireless transmission. A special test hardware is used to simulate a keystroke.

Number of tested samples: 1
 Serial number: 67150216
 Firmware version: V1.06 Mach-Wireless-SRC

EUT configuration:

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

2.4 Variants of the EUT

None

2.5 Operation frequency and channel plan

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2400	22	2421	43	2442	64	2463
2	2401	23	2422	44	2443	65	2464
3	2402	24	2423	45	2444	66	2465
4	2403	25	2424	46	2445	67	2466
5	2404	26	2425	47	2446	68	2467
6	2405	27	2426	48	2447	69	2468
7	2406	28	2427	49	2448	70	2469
8	2407	29	2428	50	2449	71	2470
9	2408	30	2429	51	2450	72	2471
10	2409	31	2430	52	2451	73	2472
11	2410	32	2431	53	2452	74	2473
12	2411	33	2432	54	2453	75	2474
13	2412	34	2433	55	2454	76	2475
14	2413	35	2434	56	2455	77	2476
15	2414	36	2435	57	2456	78	2477
16	2415	37	2436	58	2457	79	2478
17	2416	38	2437	59	2458	80	2479
18	2417	39	2438	60	2459	81	2480
19	2418	40	2439	61	2460	82	2481
20	2419	41	2440	62	2461	83	2482
21	2420	42	2441	63	2462	84	2483

Note: the marked frequencies are determined for final testing.

2.6 Transmit operating modes

The EUT uses GMSK modulation with a data rate of 250 kbps (kbps = kilobits per second)

2.7 Antenna

The following antennas shall be used with the EUT:

Number	Type	Chracteristic	Plug	Frequency range (GHz)	Gain (dBi)
1	PCB-antenna	omni	none	2.4	-3.0

2.8 Power supply system utilised

Power supply voltage, Vnom : 5 VDC (USB powered)
 Power supply voltage (alternative) : Input: 100-240 V, 47-63 Hz, 1 ϕ Power supply, Output: +5 VDC.

2.9 Peripheral devices and interface cables

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

- Arduino controller system with LCD Model : Seeeduino v3.0 (Keyboard simulation)
- Arduino controller system with LCD Model : Seeeduino v3.0 (Companion device)
- _____ Model : _____

2.10 Determination of worst case conditions for final measurement

The EUT is set to the highest output level by firmware. According to the chipset manufacturer the maximum output is 0 dBm and can not be influenced during test performance. 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 with the following settings:

Standard	Available channel	Tested channel	Power setting	Frequency range (MHz)	Modulation	Data rate
proprietary	82	82	0 dBm	2400 - 2483.5	GMSK	250 kbps

2.10.1 Test jig

The device is controlled by an Arduino controller board simulating a continuous keystroke. This effects a continuous stimulation to transmit a signal for test.

2.10.2 Test software

No special test software is used for testing.

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 : 06 March 2015

Testing concluded on : 24 April 2015

Checked by:

Tested by:

Klaus Gegenfurtner
Teamleader Radio

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

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 A4.

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 -15.9 dB at 0.323 MHz

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

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	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

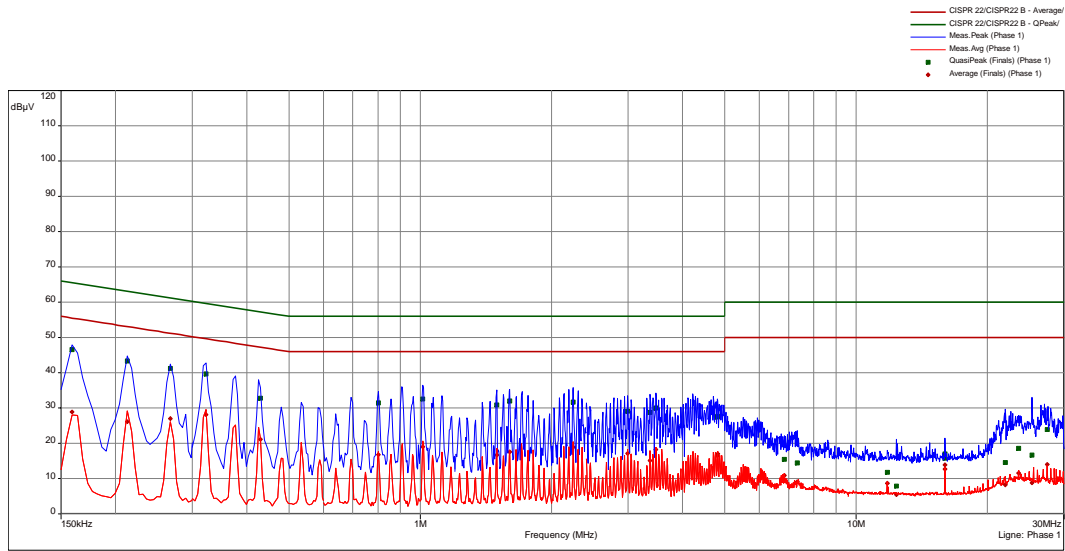
The requirements are **FULFILLED**.

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

5.1.6 Test protocol

Test point L1
Operation mode: TX continuous
Remarks: none

Result: fulfilled

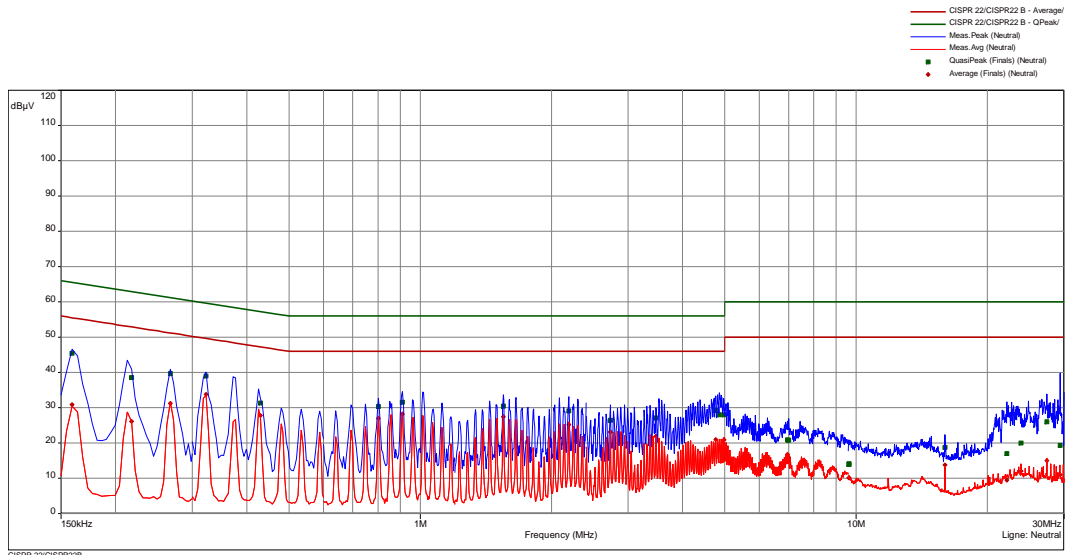


CISPR 22/22B

freq MHz	SR	QP dB(μV)	margin dB	limit dB	AV dB(μV)	margin dB	limit dB	line
0.159	1	46.6	19.0	65.5	28.8	-26.7	55.5	Phase 1
0.213	1	43.4	19.7	63.1	26.1	-27.0	53.1	Phase 1
0.267	1	41.2	20.0	61.2	27.0	-24.2	51.2	Phase 1
0.323	2	39.7	20.0	59.6	28.2	-21.5	49.6	Phase 1
0.431	2	32.8	24.5	57.2	21.1	-26.1	47.2	Phase 1
0.803	3	31.4	24.6	56.0	16.8	-29.2	46.0	Phase 1
1.014	3	32.5	23.5	56.0	19.0	-27.0	46.0	Phase 1
1.497	4	30.9	25.1	56.0	16.7	-29.3	46.0	Phase 1
1.605	4	32.0	24.0	56.0	17.6	-28.4	46.0	Phase 1
2.244	4	31.6	24.4	56.0	18.9	-27.1	46.0	Phase 1
2.994	5	29.2	26.8	56.0	17.1	-28.9	46.0	Phase 1
3.368	5	28.8	27.2	56.0	15.1	-30.9	46.0	Phase 1
3.476	5	30.0	26.0	56.0	18.2	-27.8	46.0	Phase 1
4.809	6	27.5	28.5	56.0	16.4	-29.6	46.0	Phase 1
4.814	6	27.7	28.3	56.0	17.1	-28.9	46.0	Phase 1
6.839	6	15.4	44.6	60.0	10.9	-39.2	50.0	Phase 1
7.325	6	14.5	45.5	60.0	9.1	-40.9	50.0	Phase 1
11.787	7	11.8	48.2	60.0	8.7	-41.3	50.0	Phase 1
12.377	7	7.9	52.1	60.0	5.4	-44.6	50.0	Phase 1
15.999	7	17.0	43.0	60.0	13.9	-36.1	50.0	Phase 1
16.004	7	15.7	44.3	60.0	12.7	-37.3	50.0	Phase 1
22.017	8	14.5	45.5	60.0	8.2	-41.8	50.0	Phase 1
23.619	8	18.6	41.4	60.0	11.6	-38.4	50.0	Phase 1
25.320	8	16.7	43.3	60.0	8.8	-41.2	50.0	Phase 1
27.422	8	23.9	36.1	60.0	14.0	-36.0	50.0	Phase 1

Test point: L1
Operation mode: TX continuous
Remarks: none

Result: fulfilled



freq	SR	QP	margin	limit	AV	margin	limit	line
MHz		dB(μV)	dB	dB	dB(μV)	dB	dB	
0.159	9	45.4	20.1	65.5	30.8	-24.7	55.5	Neutral
0.218	9	38.6	24.3	62.9	26.2	-26.7	52.9	Neutral
0.267	9	39.7	21.5	61.2	31.2	-20.0	51.2	Neutral
0.323	10	39.0	20.6	59.6	33.8	-15.9	49.6	Neutral
0.431	10	31.4	25.9	57.2	27.8	-19.5	47.2	Neutral
0.803	11	30.3	25.7	56.0	27.0	-19.0	46.0	Neutral
0.911	11	31.6	24.4	56.0	28.3	-17.8	46.0	Neutral
1.551	12	30.5	25.6	56.0	27.5	-18.6	46.0	Neutral
2.195	12	29.2	26.8	56.0	25.2	-20.8	46.0	Neutral
2.729	13	26.5	29.5	56.0	23.1	-22.9	46.0	Neutral
3.476	13	27.1	28.9	56.0	21.9	-24.1	46.0	Neutral
4.763	13	29.2	26.8	56.0	21.1	-24.9	46.0	Neutral
4.859	14	28.0	28.0	56.0	19.1	-26.9	46.0	Neutral
4.976	14	28.0	28.0	56.0	20.9	-25.1	46.0	Neutral
6.956	14	20.9	39.1	60.0	16.7	-33.3	50.0	Neutral
7.001	14	20.8	39.2	60.0	16.0	-34.1	50.0	Neutral
9.623	15	13.9	46.1	60.0	10.1	-39.9	50.0	Neutral
9.627	15	14.1	45.9	60.0	10.2	-39.9	50.0	Neutral
15.999	15	18.8	41.2	60.0	13.8	-36.2	50.0	Neutral
22.170	16	17.1	42.9	60.0	9.4	-40.6	50.0	Neutral
23.885	16	20.0	40.0	60.0	12.0	-38.0	50.0	Neutral
27.413	16	26.0	34.0	60.0	15.1	-34.9	50.0	Neutral
29.406	16	19.3	40.7	60.0	11.1	-38.9	50.0	Neutral

5.2 Field strength of fundamental

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

5.2.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.2.2 Photo documentation of the test set-up



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 set up 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
AV measurement: RBW: 1 MHz

VBW: 1 MHz
VBW: 10 Hz

Detector: Max peak
Detector: Max peak

5.2.3 Test result

2481 MHz, 250 kbps, TX		Test results radiated			
		Fieldstrength Reading (dBμV/m)	Fieldstrength Limit AV (dBμV/m)	Margin (dB)	Detector
T_{nom}	V_{nom}	89.8	94.0	-4.2	Pk

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

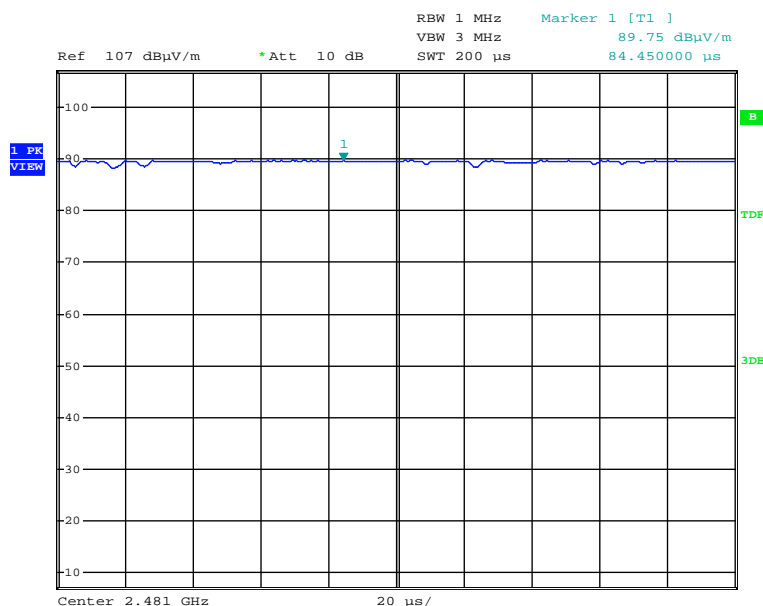
Frequency (MHz)	Field strength of fundamental	
	(mV/m)	dB(μV/m)
902 - 928	50	94
2400 - 2483.5	50	94
5725-5875	50	94
24000 - 24250	250	108

Peak-Limit according to FCC Part 15C, Section 15.249(e):

However the peak fieldstrength shall not exceed the maximum permitted average limit by more than 20 dB.

The requirements are **FULFILLED**.

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



5.3 Out-of-band emission, radiated

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

5.3.1 Description of the test location

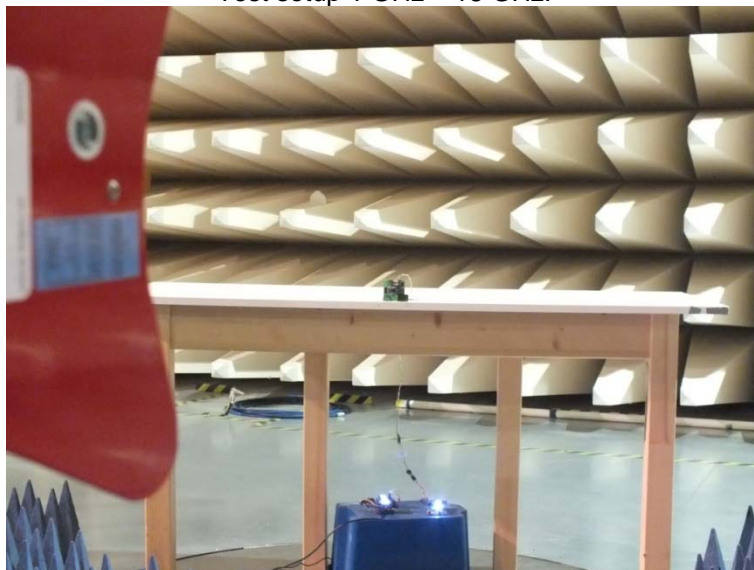
Test location: OATS 1
Test location: Anechoic chamber 2
Test distance: 3 m

5.3.2 Photo documentation of the test set-up

Test setup 30 MHz – 1000 MHz:



Test setup 1 GHz – 18 GHz:



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 9 kHz 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 ANSI C63.10, Item 6.3. 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 EUT is measured in TX continuous mode unmodulated under normal conditions.

5.3.1 Test result $f < 30$ MHz

Note:

Pre-measurements were performed in the frequency range 9 kHz to 30 MHz. No emission could be detected.

5.3.2 Test result 30 MHz – 1000 MHz

CH82								
Test conditions:								
TX, 0 dBm			Test results					
Start frequency (MHz)	Stop frequency (MHz)	RBW (kHz)	Maximum emission		QP Limit (dBµV/m)	Duty cycle correction (dB)	Margin (dB)	Detector
			(MHz)	(dBµV/m)				
30	1000	120	52.00	10.9	40.0	0.0	-29.1	QP
30	1000	120	64.00	27.4	40.0	0.0	-12.6	QP
30	1000	120	96.00	28.6	45.5	0.0	-16.9	QP
30	1000	120	192.00	27.2	43.5	0.0	-16.3	QP
30	1000	120	240.00	28.0	46.0	0.0	-18.1	QP
30	1000	120	900.00	28.7	46.0	0.0	-17.3	QP
Measurement uncertainty				±6 dB				

5.3.3 Test result $f > 1$ GHz

CH82								
Test conditions:								
TX, 0 dBm			Test results					
Start frequency (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	1765.45	46.3	54.0	0.0	-7.7	PK
2483.5	4000	1000	2483.50	61.0	54.0	-31.2	-24.2	PK
4000	8000	1000	4962.38	50.5	54.0	0.0	-3.5	PK
8000	12000	1000	11969.50	47.1	54.0	0.0	-6.9	PK
12000	18000	1000	16102.50	53.4	54.0	0.0	-0.6	PK
18000	25000	1000	24892.38	55.0	54.0	0.0	1.0	PK
18000	25000	1000	24814.50	45.7	54.0	0.0	-8.3	RMS
Measurement uncertainty				±6 dB				

Limit according to FCC Part 15C, Section 15.209:

Frequency (MHz)	15.209 Limits ($\mu\text{V/m}$)	Measurement distance (m)
0.009 - -0.49	$2400/f(\text{kHz})$	300
0.49 – 1.705	$24000/f(\text{kHz})$	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):

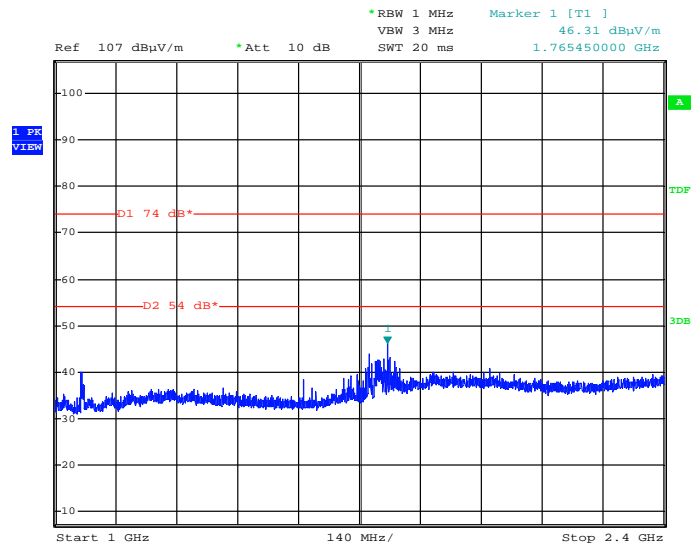
Fundamental frequency (MHz)	Field strength of harmonics	
	($\mu\text{V/m}$)	$\text{dB}(\mu\text{V/m})$
902 - 928	500	54
2400 - 2483.5	500	54
5725 - 5875	500	54
24000 - 24250	2500	68

The requirements are **FULFILLED**.

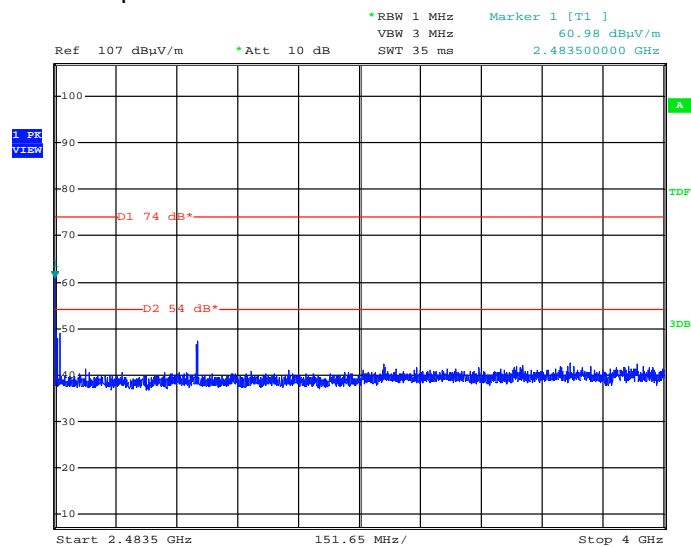
Remarks: The measurement was performed up to the 10th harmonic (25000 MHz). For detailed test result
please refer to following test protocols.

5.3.4 Test protocols

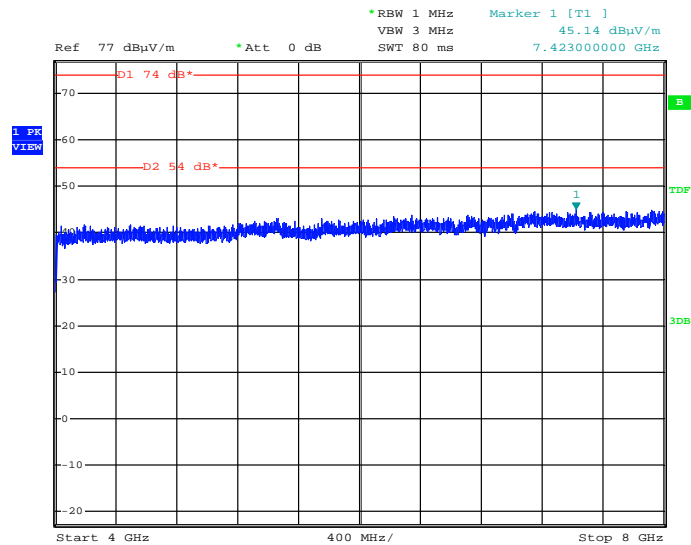
Spurious emissions from 1 to 2.4 GHz



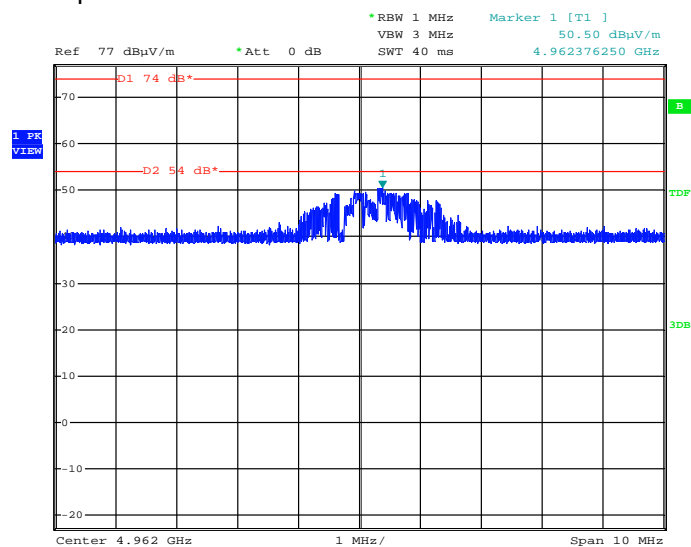
Spurious emissions from 2.4835 to 4 GHz



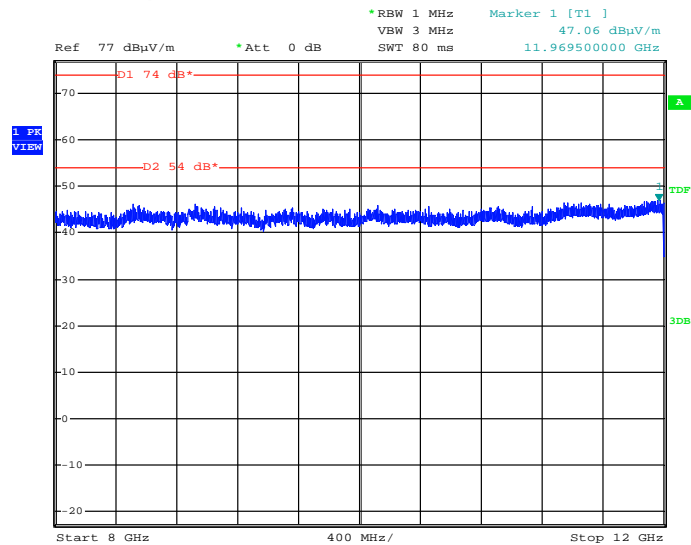
Spurious emissions from 4 to 8 GHz



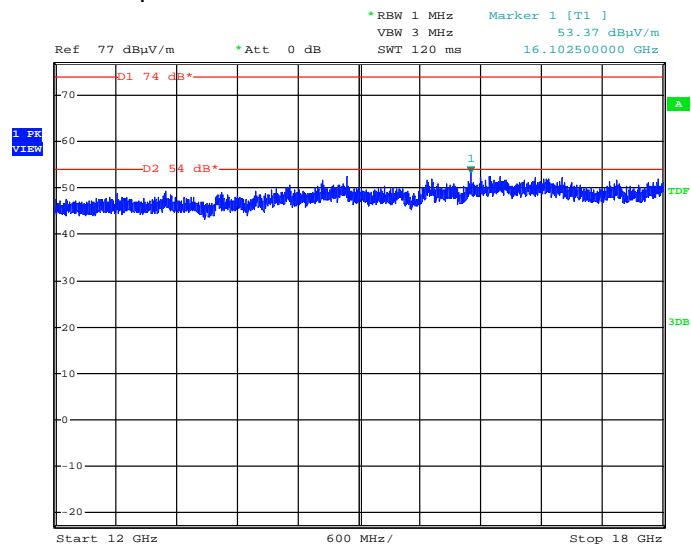
Spurious emissions of the harmonic at 4962 MHz



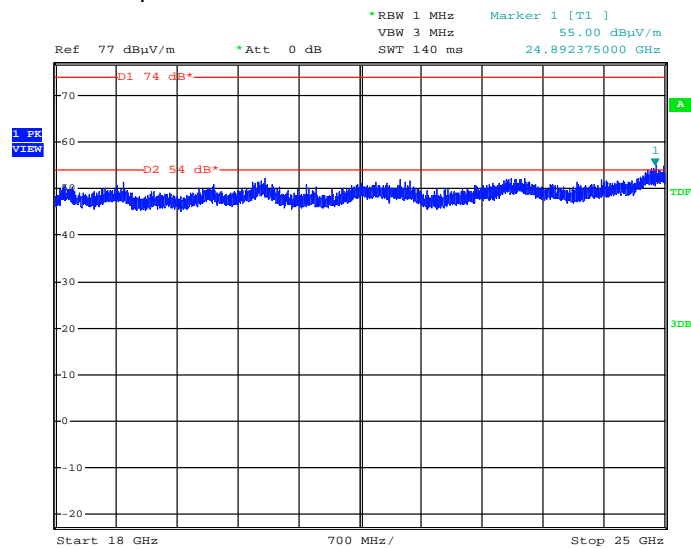
Spurious emissions from 8 to 12 GHz



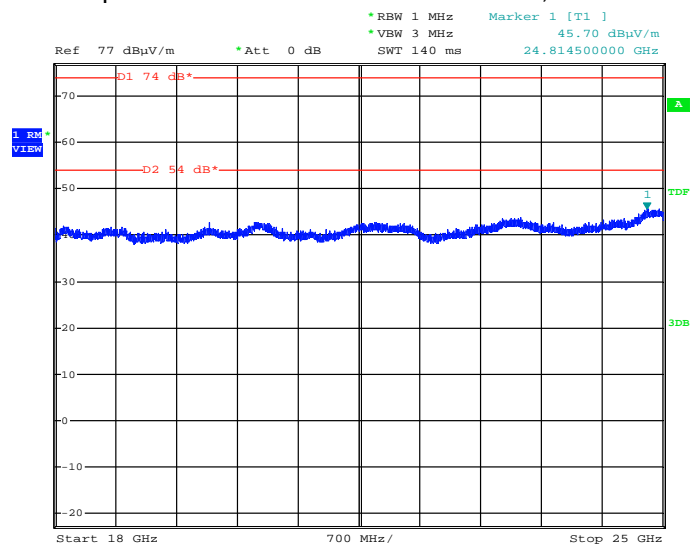
Spurious emissions from 12 to 18 GHz



Spurious emissions from 18 to 25 GHz



Spurious emissions from 18 to 25 GHz, RMS



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



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: 30 kHz, VBW: 100 kHz, Span: 1.5 MHz, Trace mode: max. hold, Detector: max. peak;

5.4.5 Test result

Operating frequency band (MHz)	20 dB Bandwidth (MHz)	Measured 20 dB Bandwidth (MHz)
$f_{low} > 2400$	$f_{low} = 2480.7349$	0.5440
$f_{high} < 2483.5$	$f_{high} = 2481.2789$	

Operating frequency band (MHz)	99% Bandwidth (MHz)	Measured 99% Bandwidth (MHz)
$f_{low} > 2400$	$f_{low} = 2480.7541$	0.5026
$f_{high} < 2483.5$	$f_{high} = 2481.2567$	

80% bandwidth of the permitted band:

66.8 MHz

Limit according to FCC Part 15C, Section 15.215(c):

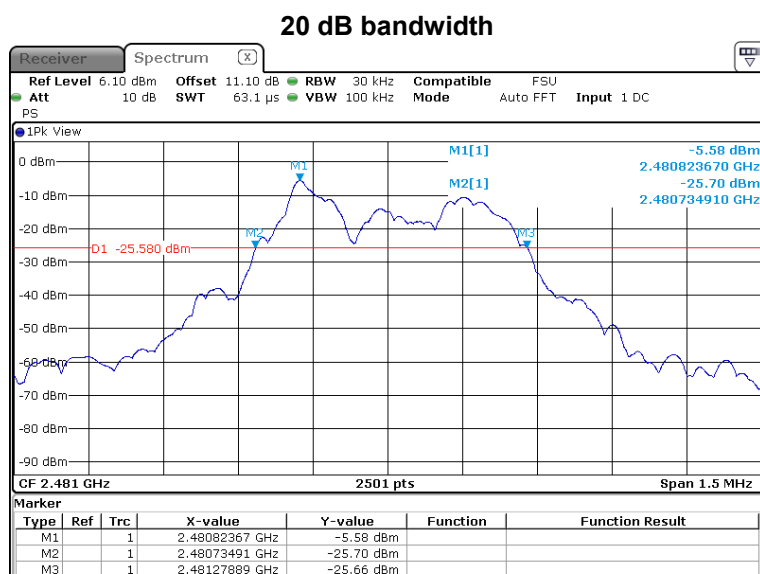
If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within the central 80% of the permitted band in order to minimize the possibility of out-of-band operation. Due to the channelising of the operating band into 16 channels with channel bandwidth of 5 MHz the limit central 80% of the permitted band can not be applied. Therefore the stability of the EUT will be shown staying within the central 80% of the operating channel.

The requirements are **FULFILLED**.

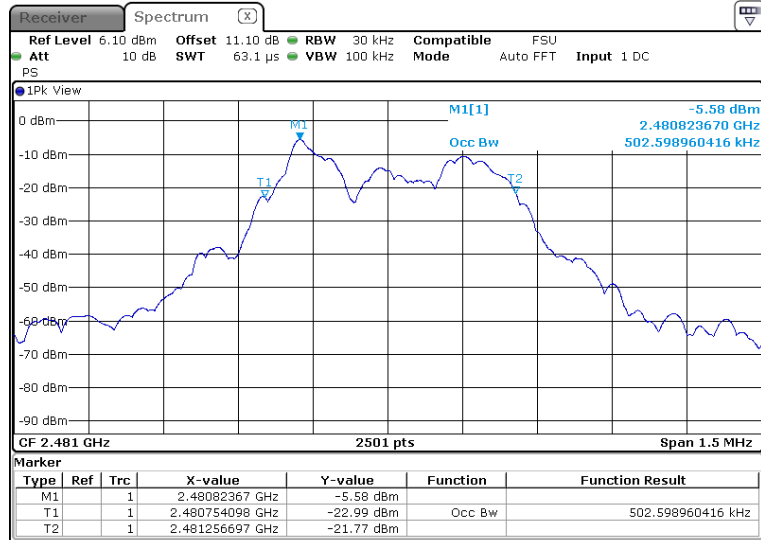
Remarks: For detailed test result please refer to following test protocols.

The OBW99 is measured for RSS only.

5.4.6 Test protocols



OBW 99%



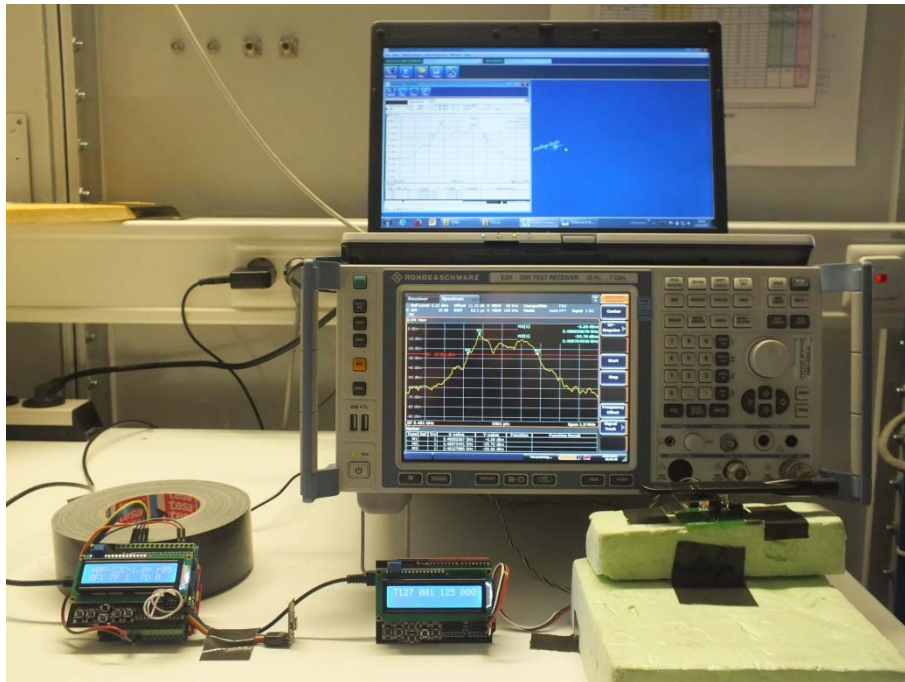
5.5 Correction for pulsed operation (duty cycle)

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



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:

$$KE = 20 \log ((t_{iw}/T_w) * (t_{iB}/T_B))$$

KE: 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

5.5.5 Test result

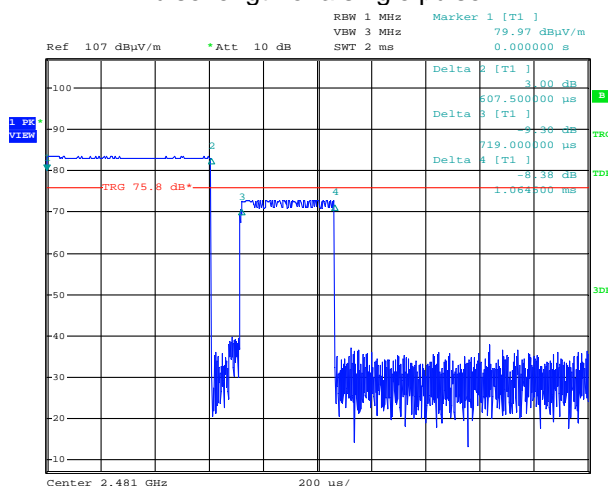
CH	t_{iw} (ms)	T_w (ms)	t_{iB} (ms)	T_B (ms)	K_E (dB)
82	22	22	0.607	22	-31.2

Remarks:

5.5.6 Test protocol

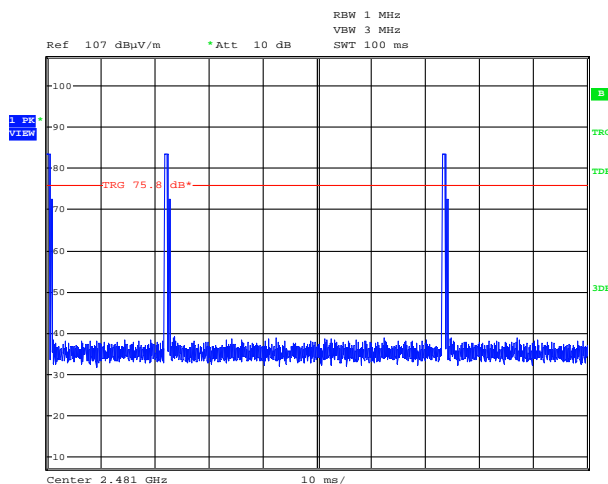
Correction for Pulse Operation (Duty Cycle) FCC Part 15A, Section 15.35(c)

Pulse length of a single pulse



Note: Deltamarkers 3 and 4 show the response of the companion device

Pulsetrain of 100 ms



5.6 RF exposure consideration for SAR test exclusion

According to KDB 447498 D01 General RF Exposure Guidance v05r02 chapter 4.3.1 the 1-g SAR number is calculated for a distance of **5** mm using the following formula.

$$\left(\frac{\text{max. } P_{\text{channel}} \text{ (mW)}}{\text{Distance (mm)}} \right) * \sqrt{f \text{ (GHz)}} \leq 3$$

Where:

Max. P_{channel} = EIRP (mW)
 Distance = 5 mm
 f (GHz) = Channel frequency (MHz) divided by thousand

5.6.1 Test result

Channel frequency (MHz)	EIRP (dBm)	EIRP (mW)	1-g SAR (1)	Limit 1-g SAR (1)
2481	-5.5	0.28	0.09	3.0

The limits for SAR test exclusion threshold are given in KDB 447498 D01 General RF Exposure Guidance Appendix A.

The requirements are **FULFILLED**.

Remarks:

5.8 Antenna application

5.8.1 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.

5.8.2 Result

The EUT use an integrated PCB antenna. 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: The 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.
A 4	ESCI	02-02/03-05-004	12/11/2015	12/11/2014		
	ESH 2 - Z 5	02-02/20-05-004	18/10/2015	18/10/2013	09/08/2015	09/02/2015
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	SP 103 /3.5-60	02-02/50-05-182				
CPR 3	FSP 40	02-02/11-11-001	02/10/2015	02/10/2014		
	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				
	311702-02/24-05-009	07/05/2015	07/05/2014			
	Sucoflex N-2000-SMA	02-02/50-05-075				
	SF104/11N/11N/1500MM	02-02/50-13-015				
DC	ESR 7	02-02/03-13-001	03/06/2015	03/06/2014		
MB	ESR 7	02-02/03-13-001	03/06/2015	03/06/2014		
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 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				
	311702-02/24-05-009	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				