

Test report

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RF test report

160583-AU01+W01



Industry
Canada Industrie
Canada

DewertOkin GmbH

Double Drive

OKIMAT 8+2 FURNIBUS



The test result refers exclusively to the model tested.

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3472A-1, expiring 2018-11-09
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1 Summary of test results

System type: Digital transmission system (DTS)

47 CFR part and section	Test	Equivalent to IC radio standard(s)	Page	Result	Note(s)
15.207	AC power line conducted emissions 150 kHz to 30 MHz	RSS-Gen Issue 4, section 8.8	20	Passed	---
15.247(a)(1) KDB 558074, section 8	20 dB bandwidth	RSS-247 Issue 2, section 5.1(b)	25	Passed	---
15.247(a)(2) KDB 558074, section 8	6 dB bandwidth	RSS-247 Issue 2, section 5.2(a)	28	Passed	1
2.202(a) ANSI C63.10	Occupied bandwidth (99 %)	RSS-Gen Issue 4, section 6.6	31	For reference only	1
15.247(b) KDB 558074, section 9	Maximum conducted output power	RSS-Gen Issue 4, section 6.12 RSS-247 Issue 2, section 5.4	34	Passed	---
15.247(e) KDB 558074, section 10	Power spectral density	RSS-247 Issue 2, section 5.2(b)	36	Passed	---
15.247(d) KDB 558074, sections 11 & 12	Antenna-port conducted measurements	RSS-247 Issue 2, section 5.5	---	Not applicable	2
15.247(d) KDB 558074, section 13	Band-edge compliance (radiated)	RSS-247 Issue 2, section 5.5	41	Passed	---
15.247(d) KDB 558074, sections 11 & 12	Spurious radiated emissions 9 kHz to 10 th harmonic	RSS-Gen Issue 4, section 6.13 RSS-247 Issue 2, section 5.5	48	Passed	---
2.1091	RF exposure evaluation for mobile devices	RSS-Gen Issue 4, section 3.2 (exempted form SAR and RF evaluation)	60	Passed	---

Notes:

- 1 For systems using digital modulation techniques the 6 dB bandwidth (DTS bandwidth) is regarded as the occupied bandwidth.
- 2 Spurious radiated emissions 9 kHz to 10th harmonic performed



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2 Referenced publications

<i>Publication</i>	<i>Title</i>
CFR 47 Part 2 October 2016	Code of Federal Regulations, Title 47 (Telecommunication), Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
CFR 47 Part 15 October 2016	Code of Federal Regulations, Title 47 (Telecommunication), Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
KDB Publication no. 447498 October 23, 2015	RF exposure procedures and equipment authorization policies for mobile and portable devices
KDB Publication no. 558074 April 8, 2016	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
ANSI C63.10 June 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen, Issue 4 November 2014	Spectrum Management and Telecommunications - Radio Standards Specification - General Requirements for Compliance of Radio Apparatus
RSS-102, Issue 5 March 2015	Spectrum Management and Telecommunications - Radio Standards Specification - Radio Frequency Exposure Compliance of Radiocommunications Apparatus
RSS-247, Issue 2 February 2017	Spectrum Management and Telecommunications Radio Standards Specification Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices



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3 Equipment under test (EUT)

Product type: Double Drive
Model name: OKIMAT 8+2 FURNIBUS
Serial number(s): D123456 0001
Applicant: DewertOkin GmbH
Manufacturer: DewertOkin GmbH
Version: Hardware: ---
Software: ---
Additional modifications: None
FCC ID: O3YOM1089
IC registration number: 10744A-OM1089
Application frequency band: 2400.0 MHz - 2483.5 MHz
Frequency range: 2403.0 MHz - 2480.0 MHz
Operating frequencies: 2403.0 MHz - 2480.0 MHz
Channel spacing: 1 MHz
Number of RF channels: 78
System type: Digital transmission system (DTS)
Modulation type(s): GFSK
Class of emission: F1D
Antenna type(s): PCB antenna (F-Antenna layouted)
Antenna gain(s): approximately 0 dBi
Power supply: DC supply
Nominal voltage: 24.0 V
Minimum voltage: 24.0 V
Maximum voltage: 29.0 V
Nominal frequency: ---
Temperature range: 0 °C to +40 °C
Device type: Portable Mobile Fixed



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4 Test configuration and mode of operation

4.1 Test configuration

<i>Device</i>	<i>Type designation</i>	<i>Serial or inventory no.</i>	<i>Manufacturer</i>
<i>EUT</i>			
Double Drive	OKIMAT 8+2 FURNIBUS	D123456 0001	DewertOkin GmbH
<i>Peripheral devices</i>			
Power supply (AC/DC)	HE-300 SMPS	H894339 0008	DewertOkin GmbH
AC power source (120 VAC / 60 Hz)	61605	SEB00214	CHROMA A.T.E.

Table 1: Devices used for testing

<i>Port</i>	<i>Classification</i>	<i>Cable type</i>	<i>Cable length</i>	
			<i>used</i>	<i>maximum¹</i>
DC power	dc power	Unshielded	1.5m	---

Table 2: Ports of EUT and appropriate cables

4.2 Mode of operation

EUT was tested in following mode(s) of operation:

SRD-mode

Channel low -> 2403.0 MHz (modulated / unmodulated)
Channel mid -> 2440.0 MHz (modulated / unmodulated)
Channel high -> 2480.0 MHz (modulated / unmodulated)

¹ As specified by applicant



5 Measurement Procedures

5.1 AC power line conducted emissions 150 kHz to 30 MHz

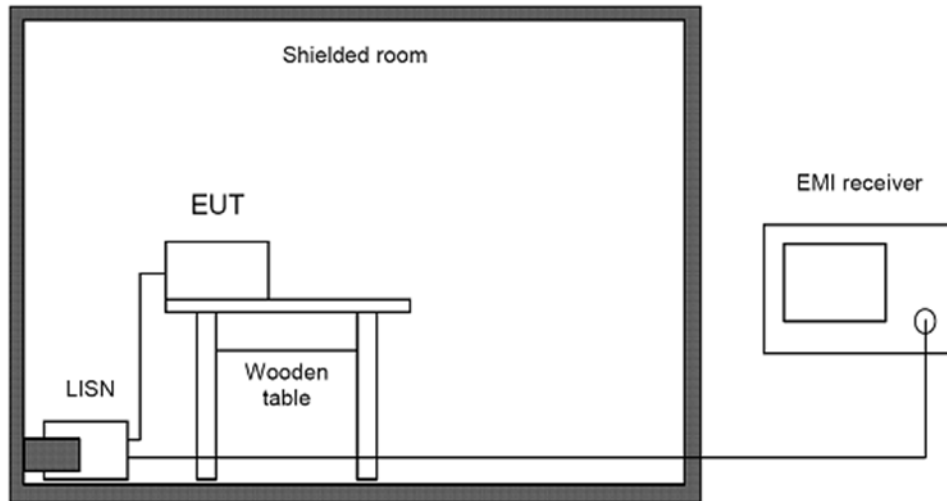


Figure 1: Setup for AC power line conducted emissions test 150 kHz to 30 MHz

The AC power line conducted emissions test method refers to section 6.2 of ANSI C63.10 and shall be as follows:

The tests of conducted emission is carried out in a shielded room using a line impedance stabilization network (LISN) 50 μ H/50 Ohms and a EMI test receiver. The EMI test receiver is connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range from 0.15 MHz to 30 MHz. The EUT is placed on a wooden table and connected to the LISN.

To accelerate the measurement the detector of the EMI test receiver is set to peak. A prescan is performed covering the whole frequency range from 0.15 MHz to 30 MHz. After that all peak values with less margin than 10 dB to quasi-peak limit or exceeding the limit are marked and re-measured with quasi-peak detector. If all values are below the average limit no additional measurement is necessary. In case of there are values between quasi-peak and average limit these values are re-measured using an average detector.

All peripheral devices are additionally decoupled by means of a line stabilization network.

5.2 20 dB bandwidth (DTS)

The 20 dB bandwidth test method for DTS systems shall be analog to the 6 dB bandwidth test method for DTS systems.

For test setup see clause 5.10.

5.3 6 dB bandwidth (DTS)

The 6 dB bandwidth (DTS bandwidth) test method for DTS systems refers to section 8.0 of KDB 558074 D01 and shall be as follows:

Spectrum analyzer settings:

Span = centered on a channel, wide enough to capture the whole channel

RBW = 100 kHz

VBW $\geq 3 \times$ RBW

Sweep time = auto coupled

Detector function = peak

Trace mode = max hold

Reference level: more than $10 \cdot \log(\text{OBW}/\text{RBW})$ dB above peak of spectral envelope

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

If possible, use the automatic bandwidth measurement capability of the spectrum analyzer using the X dB bandwidth mode with X set to 6 dB. Submit this plot(s).

In case of antenna-port conducted tests cannot be performed on an EUT (e.g., portable or handheld devices with integral antenna), then according to section 3.0 of KDB 558074 D01 radiated tests are performed for demonstrating compliance.

For test setup see clause 5.10.

5.4 Occupied bandwidth (99%)

The occupied bandwidth test method refers to section 6.9.3 of ANSI C63.10 and shall be as follows:

Spectrum analyzer settings:

Span = between 1.5 times and 5.0 times of the OBW, centered on a channel

RBW \geq in the range of 1% to 5% of the OBW

VBW \geq approximately three times the RBW

Sweep time = auto coupled

Detector function = peak

Trace mode = max hold

Reference level: more than $10 \cdot \log(\text{OBW}/\text{RBW})$ dB above peak of spectral envelope



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Use the 99% power bandwidth function of the spectrum analyzer and report the measured bandwidth.

In case of antenna-port conducted tests cannot be performed on an EUT (e.g., portable or handheld devices with integral antenna), then according to section 3.0 of KDB 558074 D01 radiated tests are performed for demonstrating compliance.

For test setup see clause 5.10.

5.5 Maximum conducted output power (DTS)

The maximum conducted output power test method for DTS systems refers to section 9.1.1 of KDB 558074 D01 and shall be as follows:

Spectrum analyzer settings:

Span $\geq 3 \times$ RBW, centered on a channel

RBW \geq DTS bandwidth

VBW $\geq 3 \times$ RBW

Sweep time = auto coupled

Detector function = peak

Trace mode = max hold

Reference level: more than $10 \cdot \log(\text{OBW}/\text{RBW})$ dB above peak of spectral envelope

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the maximum conducted output power. Submit this plot(s).

In case of antenna-port conducted tests cannot be performed on an EUT (e.g., portable or handheld devices with integral antenna), then according to section 3.0 of KDB 558074 D01 radiated tests are performed for demonstrating compliance to the conducted emission requirements.

The radiated field strength or power level is then converted to EIRP according to annex G of ANSI C63.10. The equivalent conducted output power is then determined by subtracting the EUT transmit antenna gain from the EIRP (assuming logarithmic representation).

For test setup see clause 5.10.

5.6 Power spectral density

The power spectral density test method refers to section 10.2 of KDB 558074 D01 and shall be as follows:

Spectrum analyzer settings:

Span = 1.5 times the DTS bandwidth, centered on a channel

RBW: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$

VBW $\geq 3 \times$ RBW

Sweep time = auto coupled or $\geq \text{span}/\text{RBW}$ in seconds, whichever is greater

Detector function = peak



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Trace mode = max hold

Reference level: more than $10 \cdot \log(\text{OBW}/\text{RBW})$ dB above peak of spectral envelope

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the power spectral density. Submit this plot(s).

In case of antenna-port conducted tests cannot be performed on an EUT (e.g., portable or handheld devices with integral antenna), then according to section 3.0 of KDB 558074 D01 radiated tests are performed for demonstrating compliance to the conducted emission requirements.

The radiated field strength or power level is then converted to EIRP according to annex G of ANSI C63.10. The equivalent conducted output power is then determined by subtracting the EUT transmit antenna gain from the EIRP (assuming logarithmic representation).

For test setup see clause 5.10.

5.7 Band-edge compliance (radiated)

For test setup and test method see clause 5.10.

5.8 Spurious radiated emissions 9 kHz to 10th harmonic

For test setup and test method see clause 5.10.

5.9 Conducted emissions at antenna connector

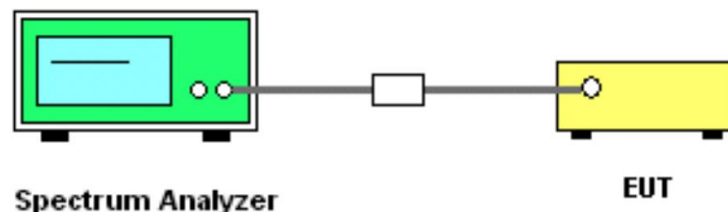


Figure 2: Setup for conducted emission test at antenna connector

The RF signal of the EUT is measured at the antenna connector. In case of no permanent antenna connector, a temporary antenna connector is supplied by the manufacturer. The specific insertion loss of the signal path, which is matched to 50 Ohm, is evaluated within a calibration. The test receiver is set to analyzer mode with pre-selector activated. The measurement readings on the test receiver are corrected by the signal path loss.

5.10 Radiated emissions

5.10.1 Radiated emissions below 30 MHz

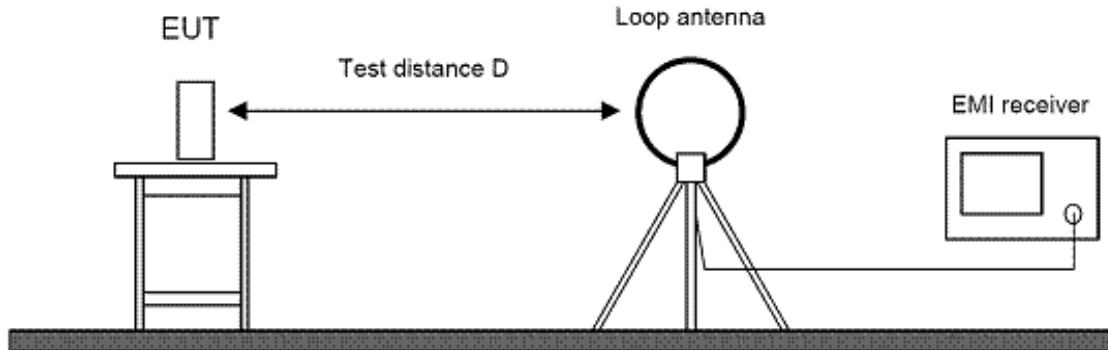


Figure 3: Setup for radiated emission test below 30 MHz

The test method for radiated emissions below 30 MHz refers to section 6.4 of ANSI C63.10 and shall be as follows:

1. EUT is configured according to ANSI C63.10. It is placed on the turntable 0.8 meter above ground. The receiving antenna is located 3 meters from the EUT. The test setup is placed inside a compact diagnostic chamber.
2. EUT and all peripherals are powered on.
3. The loop antenna is set in parallel with the antenna of the EUT.
4. The EMI receiver performs a scan from 9 kHz to 30 MHz with peak detector and measurement bandwidth set to 200 Hz for frequencies up to 150 kHz and 9 or 10 kHz for frequencies above.
5. The turn table is rotated to 8 different positions ($360^\circ / 8$).
6. The antenna is set in line with the antenna of the EUT and steps 4 and 5 are repeated.
7. Then the test setup is placed in an OATS with 3 m distance and all peak values over the limit or with less margin than 10 dB are marked and re-measured with a quasi-peak detector except for the frequency bands 9 to 90 kHz and 110 to 490 kHz, where average detector applies.
8. The turntable is rotated by 360 degrees to determine the position of the highest radiation.
9. The highest value for each frequency is recorded.

5.10.2 Radiated emissions from 30 MHz to 1 GHz

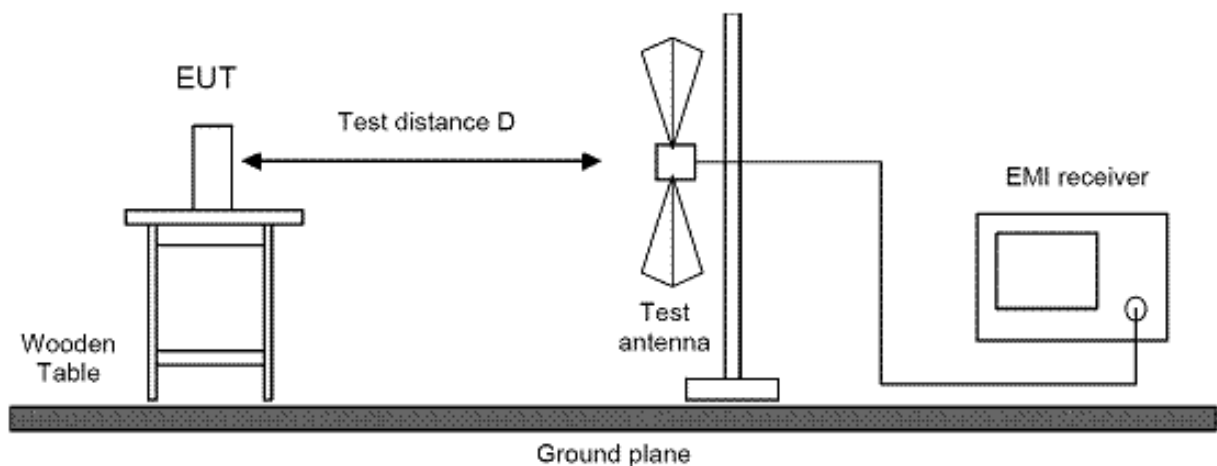


Figure 4: Setup for radiated emission test from 30 MHz to 1 GHz

The test method for radiated emissions from 30 MHz to 1 GHz refers to section 6.5 of ANSI C63.10 and shall be as follows:

1. EUT is configured according to ANSI C63.10. It is placed on the turntable 0.8 meter above ground. The receiving antenna is located 3 meters from the EUT. The test setup is placed inside a compact diagnostic chamber.
2. EUT and all peripherals are powered on.
3. The broadband antenna is set to vertical polarization.
4. The EMI receiver performs a scan from 30 MHz to 1000 MHz with peak detector and measurement bandwidth set to 120 kHz.
5. The turn table is rotated to 6 different positions ($360^\circ / 6$).
6. The antenna polarization is changed to horizontal and steps 4 and 5 are repeated.
7. Then the test setup is placed in an OATS at 3 m distance and all peak values over the limit or with less margin than 10 dB are marked and re-measured with a quasi-peak detector.
8. The turntable is rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the broadband receiving antenna is varied between 1 meter and 4 meters above ground to find the maximum emission field strength of both horizontal and vertical polarization.
10. The highest value for each frequency is recorded.

5.10.3 Radiated emissions from above 1 GHz

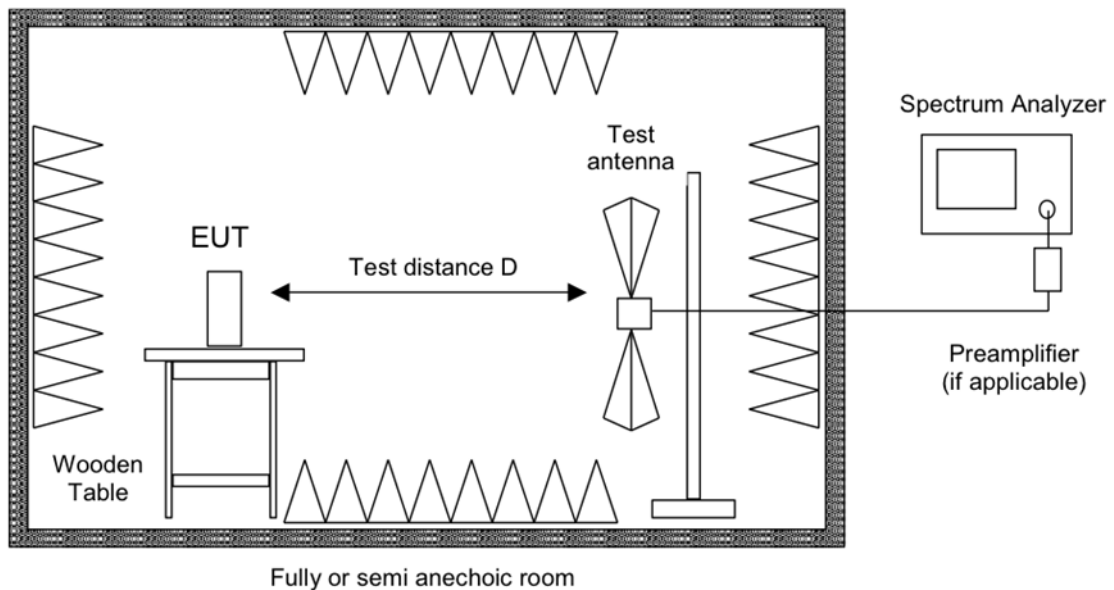


Figure 5: Setup for radiated emission test above 1 GHz

The test method for radiated emissions above 1 GHz refers to section 6.6 of ANSI C63.10 and shall be as follows:

1. EUT is configured according to ANSI C63.10. It is placed on the turntable 1.5 meter above ground. The test setup is placed inside a semi-anechoic chamber with RF absorbers on the floor.
2. EUT and all peripherals are powered on.
3. To identify the critical frequencies, extrapolatory radiated emission tests are performed at a closer distance than 3 meters (e.g. 1 meter). The critical frequencies found are noted.
4. For pre-scan the receiving antenna is located 3 meters from the EUT.
5. The broadband horn antenna is set to vertical polarization.
6. The EMI receiver performs a scan from 1 GHz to the 10th harmonic of the fundamental frequency with peak and average detector activated simultaneously and measurement bandwidth set to 1 MHz. The trace data is recorded using the max hold function.
7. The turntable is rotated in steps of 15°.
8. After a full turn by 360° the antenna polarization is changed to horizontal and steps 4 and 5 are repeated.
9. After the scan all peak values over the limit or with less margin than 10 dB are marked. If critical frequencies recorded during extrapolatory radiated emission tests are not contained, they are added to this list.
10. Emission levels at listed frequencies are maximized by moving the turntable and varying the antenna height until maximum of emission is found.
11. The turntable is rotated by 360 degrees to determine the position of the highest radiation.

12. The height of the broadband receiving antenna is varied between 1 meter and the upper height above ground to find the maximum emission field strength of both horizontal and vertical polarization. For equipment that is tested in multiple orientations, the upper height is limited to 2.5 meters or 0.5 meters above the top of the EUT, whichever is higher. For all other equipment the upper height is 4 meters.
13. The highest value for each frequency is recorded.



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6 Test results

This clause gives details about the test results as collected in the summary of test results on page 6.



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6.1 AC power line conducted emissions 150 kHz to 30 MHz

47 CFR part and section: 15.207
 Equivalent to IC radio standard(s) RSS-Gen Issue 4, section 8.8
 Measurement procedure: See 5.1

Performed by: Martin Müller Date of test: March 1, 2017

Result Test passed Test not passed

6.1.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input checked="" type="checkbox"/> Shielded room	P92007	Siemens Matsushita	E00107
<input type="checkbox"/> EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
<input type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/> EMI test receiver	ESCS 30	Rohde & Schwarz	E00003
<input checked="" type="checkbox"/> Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00004
<input type="checkbox"/> Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00005
<input checked="" type="checkbox"/> Attenuator (10 dB)	50FHB-010-10	JFW Industries	E00471
<input checked="" type="checkbox"/> Measurement software	E10	ib comPLAN	E00443

6.1.2 Limits

Frequency [MHz]	Quasi-peak [dB μ V]	Average [dB μ V]
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50



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6.1.3 Test results

Frequency range	Step size	IF Bandwidth	Detector		Measurement Time		Preamplifier
			Prescan	Final scan	Prescan	Final scan	
150 kHz – 30 MHz	4 kHz	9 kHz	PK	AV	1 ms	1 s	off
150 kHz – 30 MHz	4 kHz	9 kHz	PK	QPK	1 ms	1 s	off

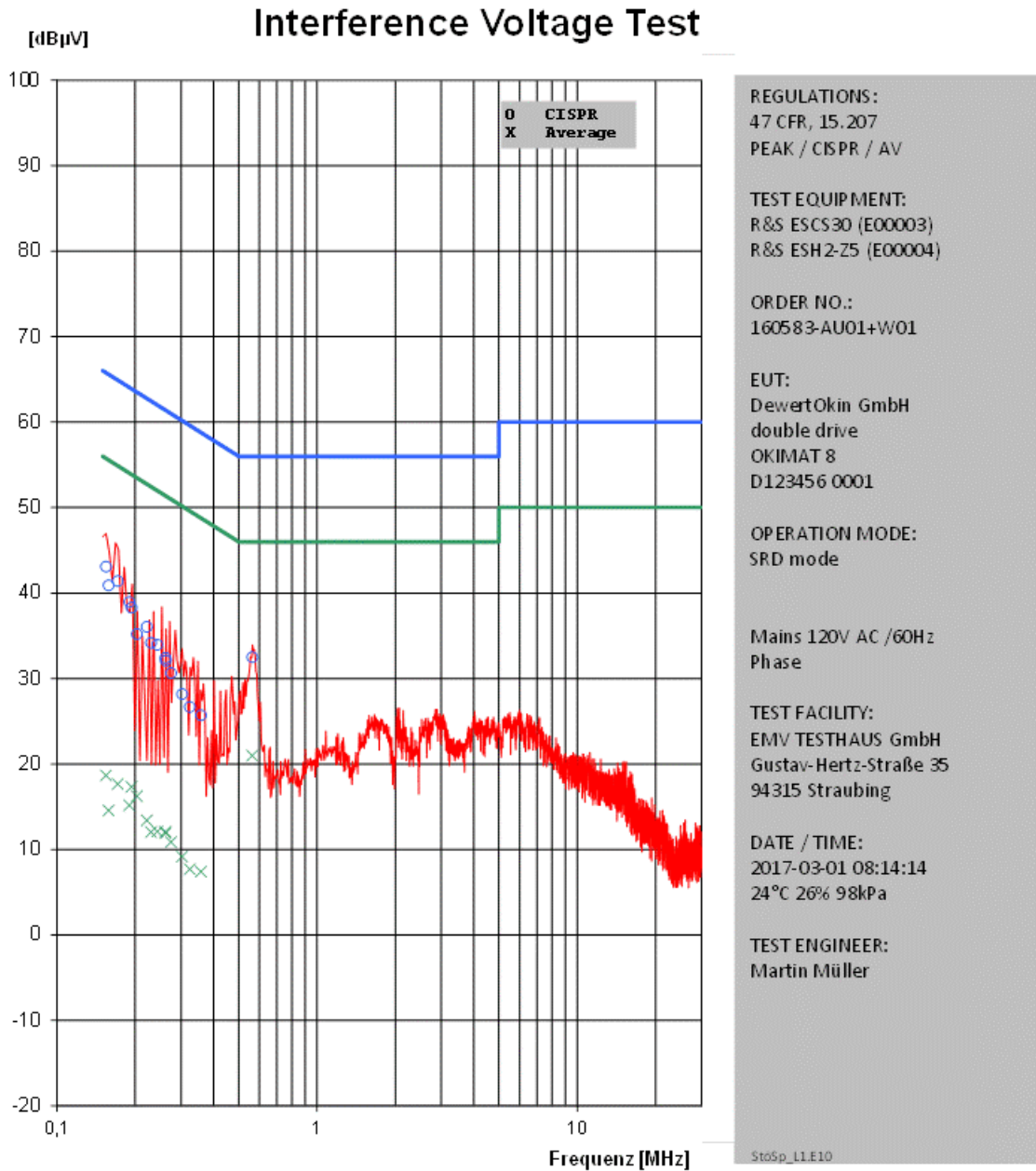


Figure 6: Chart of AC power line conducted emissions 150 kHz to 30 MHz – phase L1



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Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0,15	43,1	65,8	22,7	18,7	55,8	37,1	0,0	
0,16	40,9	65,6	24,7	14,6	55,6	41,0	0,0	
0,17	41,4	64,9	23,5	17,7	54,9	37,2	0,0	
0,19	38,9	64,0	25,1	15,2	54,0	38,9	0,0	
0,19	38,3	63,9	25,6	17,3	53,9	36,5	0,0	
0,20	35,2	63,5	28,3	16,2	53,5	37,3	0,0	
0,22	36,1	62,8	26,7	13,4	52,8	39,4	0,0	
0,23	34,2	62,4	28,3	12,0	52,4	40,4	0,0	
0,24	33,9	62,0	28,0	12,1	52,0	39,9	0,0	
0,26	32,1	61,4	29,3	11,9	51,4	39,5	0,0	
0,26	32,4	61,4	29,0	12,1	51,4	39,3	0,0	
0,28	30,6	61,0	30,3	10,8	51,0	40,1	0,0	
0,30	28,2	60,2	32,0	9,2	50,2	41,0	0,0	
0,32	26,7	59,6	32,9	7,7	49,6	41,9	0,0	
0,36	25,7	58,8	33,1	7,4	48,8	41,4	0,0	
0,56	32,5	56,0	23,5	21,0	46,0	25,1	0,0	

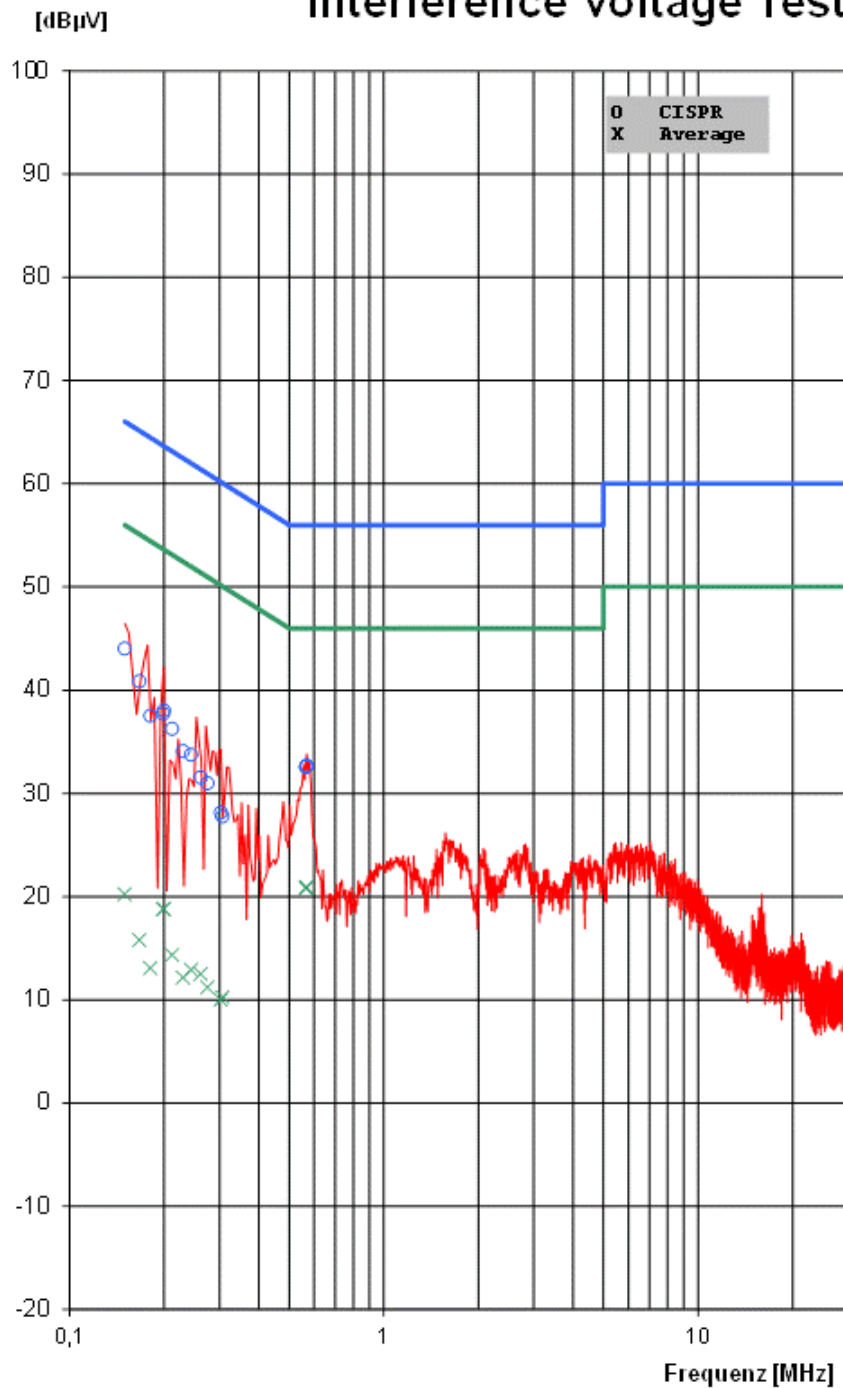
Figure 7: Final results of AC power line conducted emissions 150 kHz to 30 MHz – phase L1



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Interference Voltage Test



REGULATIONS:
 47 CFR, 15.207
 PEAK / CISPR / AV

TEST EQUIPMENT:
 R&S ESCS30 (E00003)
 R&S ESH2-Z5 (E00004)

ORDER NO.:
 160583-AU01+W01

EUT:
 DewertOkin GmbH
 double drive
 OKIMAT 8
 D123456 0001

OPERATION MODE:
 SRD mode

Mains 120V AC /60Hz
 Neutral

TEST FACILITY:
 EMV TESTHAUS GmbH
 Gustav-Hertz-Straße 35
 94315 Straubing

DATE / TIME:
 2017-03-01 08:14:14
 24°C 26% 98kPa

TEST ENGINEER:
 Martin Müller

StoSp_N.E10

Figure 8: Chart of AC power line conducted emissions 150 kHz to 30 MHz – phase N



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Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0,15	44,0	66,0	22,0	20,2	56,0	35,8	0,0	
0,17	40,9	65,1	24,2	15,8	55,1	39,3	0,0	
0,18	37,5	64,4	26,9	13,1	54,4	41,4	0,0	
0,20	38,0	63,6	25,6	18,8	53,6	34,8	0,0	
0,20	37,7	63,7	25,9	18,8	53,7	34,9	0,0	
0,21	36,3	63,1	26,9	14,3	53,1	38,8	0,0	
0,23	34,1	62,4	28,4	12,1	52,4	40,3	0,0	
0,24	33,7	62,0	28,2	12,9	52,0	39,1	0,0	
0,26	31,5	61,4	29,8	12,5	51,4	38,9	0,0	
0,28	31,0	61,0	30,0	11,2	51,0	39,8	0,0	
0,30	28,1	60,2	32,0	10,0	50,2	40,2	0,0	
0,31	27,8	60,1	32,3	10,3	50,1	39,8	0,0	
0,57	32,5	56,0	23,5	20,8	46,0	25,2	0,0	
0,57	32,6	56,0	23,4	20,9	46,0	25,2	0,0	
0,57	32,7	56,0	23,3	20,9	46,0	25,1	0,0	

Figure 9: Final results of AC power line conducted emissions 150 kHz to 30 MHz – phase N



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6.2 20 dB bandwidth

47 CFR part and section: 15.247(a)(1)
Equivalent to IC radio standard(s) RSS-247 Issue 2, section 5.1(b)
Measurement procedure: See 5.2

Performed by: Martin Müller Date of test: April 24, 2017

Result Test passed Test not passed

6.2.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input type="checkbox"/> Laboratory environment	---	---	---
<input checked="" type="checkbox"/> Anechoic Chamber (AC)	---	EMV TESTHAUS GmbH	E00100
<input type="checkbox"/> EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
<input type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/> EMI test receiver	ESW 44	Rohde & Schwarz	E00895
<input checked="" type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00052

6.2.2 Limits for digital transmission systems

None -> results recorded for information only.



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6.2.3 Test results

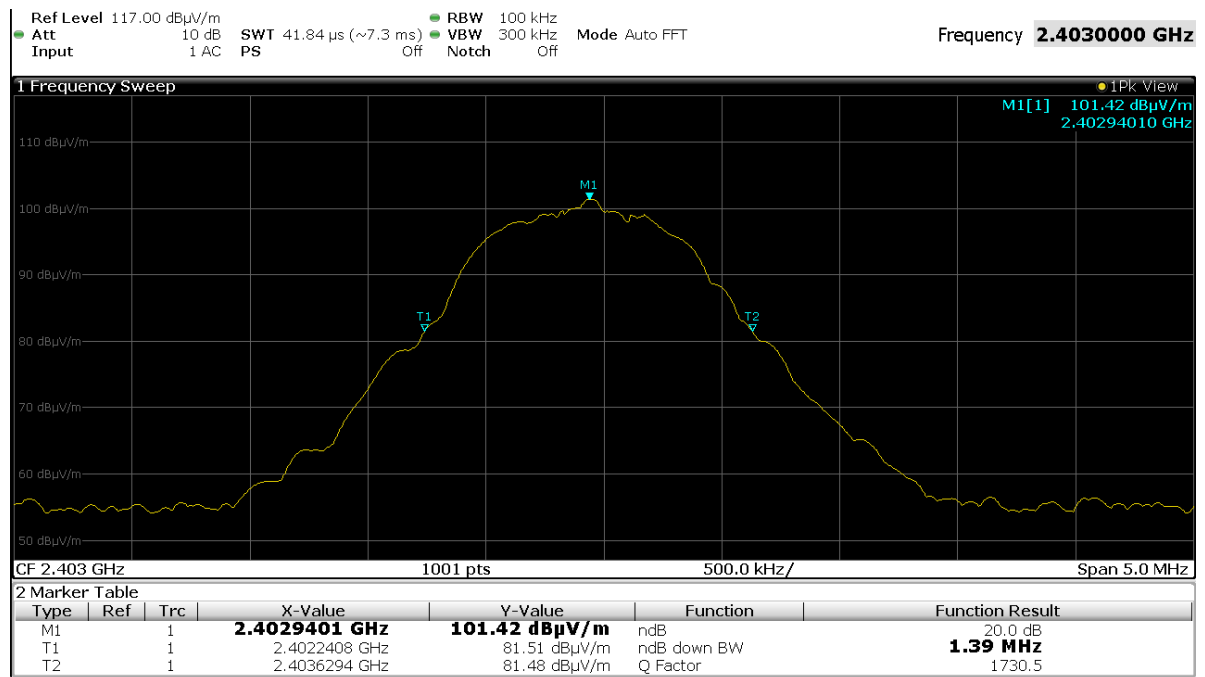


Figure 10: Chart of 20 dB bandwidth test, channel low

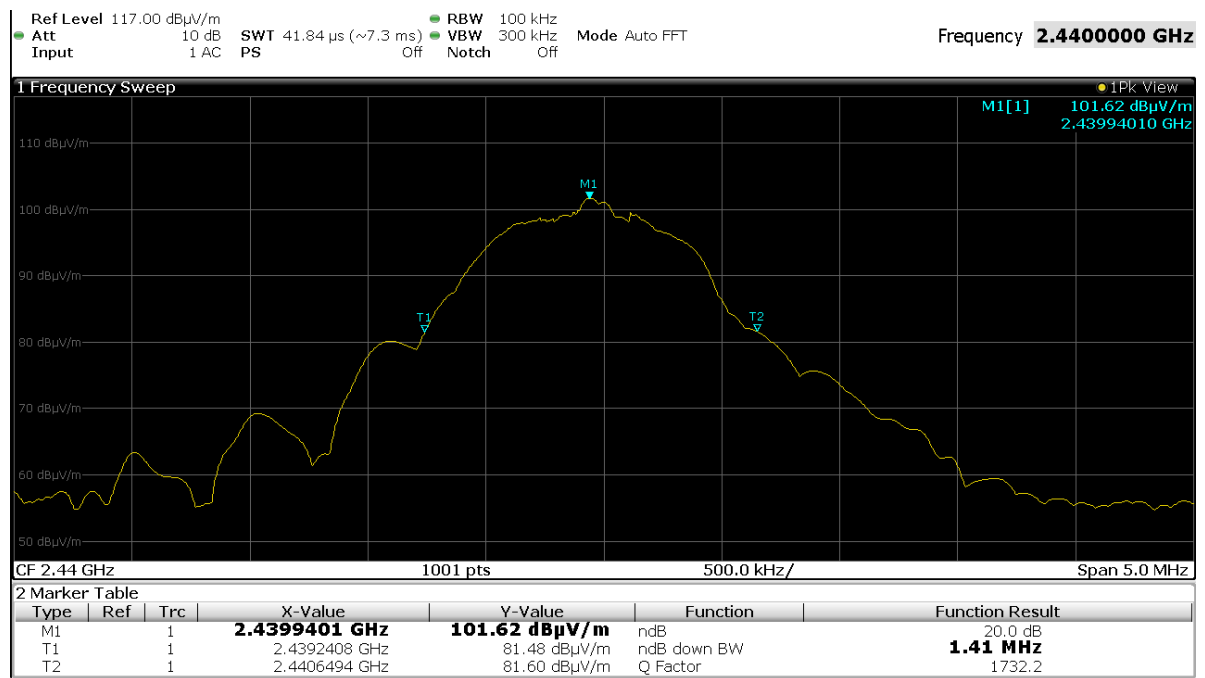


Figure 11: Chart of 20 dB bandwidth test, channel mid



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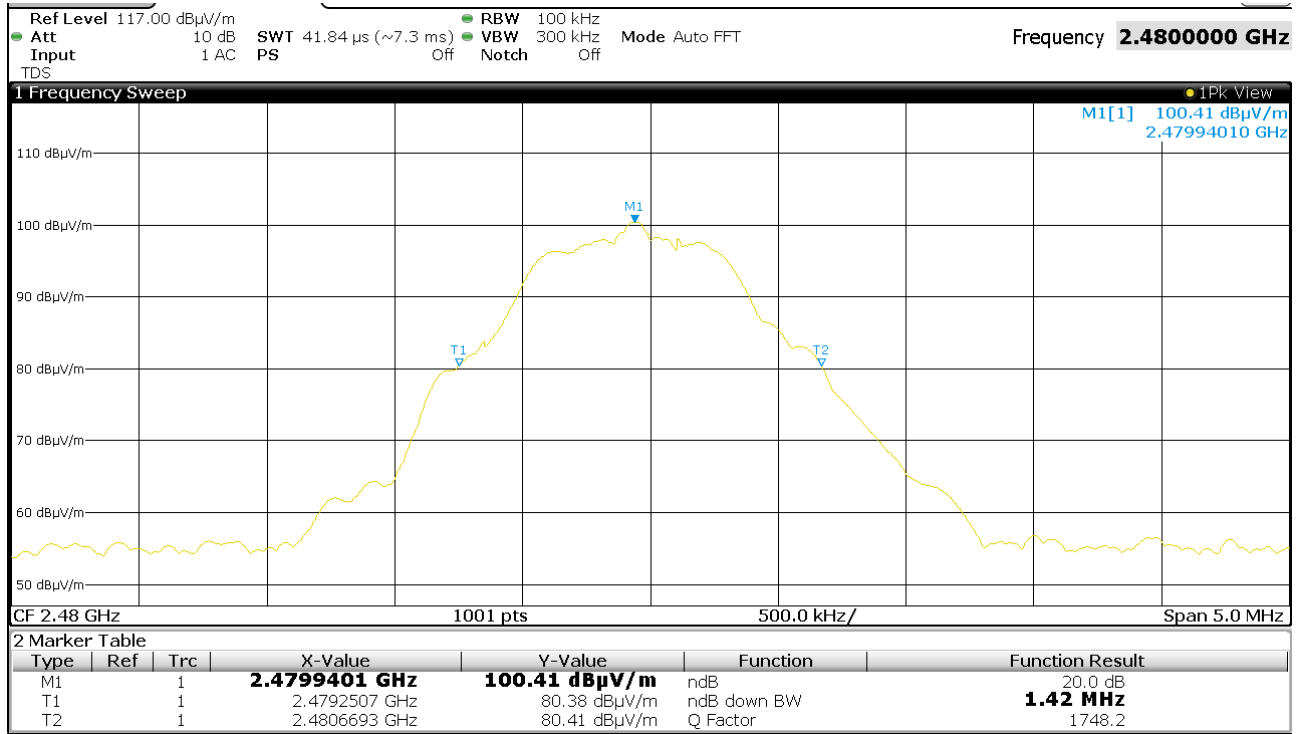


Figure 12: Chart of 20 dB bandwidth test, channel high

f [MHz]	20dB-BW [MHz]	f _{lower} [MHz]	f _{upper} [MHz]	Lower band edge [MHz]	Upper band edge [MHz]	Result
2402.940	1.388	2402.241	2403.629	2400.0	2483.5	within band
2439.940	1.408	2439.241	2440.649	2400.0	2483.5	within band
2479.940	1.418	2479.251	2480.669	2400.0	2483.5	within band

Table 3: Final results of 20 dB bandwidth test



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6.3 6 dB bandwidth

47 CFR part and section: 15.247(a)(2)
Equivalent to IC radio standard(s) RSS-247 Issue 2, section 5.2(a)
Measurement procedure: See 5.3

Performed by: Martin Müller Date of test: April 24, 2017

Result Test passed Test not passed

6.3.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input type="checkbox"/> Laboratory environment	---	---	---
<input checked="" type="checkbox"/> Anechoic Chamber (AC)	---	EMV TESTHAUS GmbH	E00100
<input type="checkbox"/> EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
<input type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/> EMI test receiver	ESW 44	Rohde & Schwarz	E00895
<input checked="" type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00052

6.3.2 Limits for digital transmission systems

The minimum 6 dB bandwidth shall be at least 500 kHz.

In addition the 6 dB bandwidth must be contained within the designated frequency band.



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6.3.3 Test results

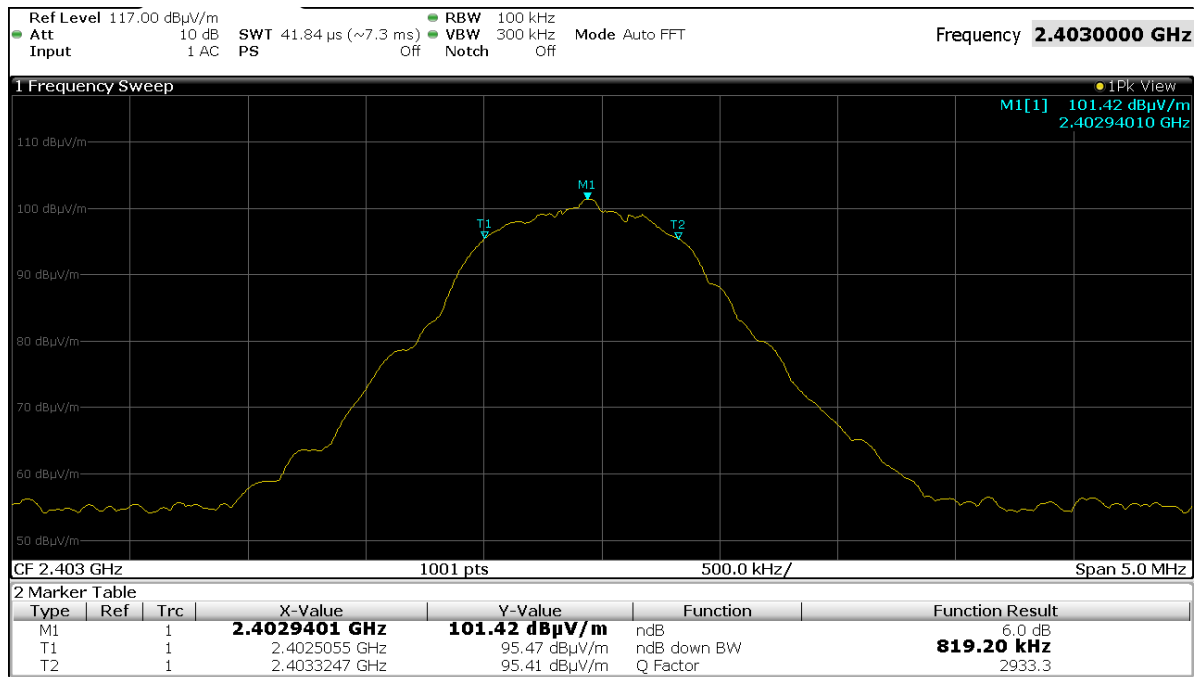


Figure 13: Chart of 6 dB bandwidth test, channel low

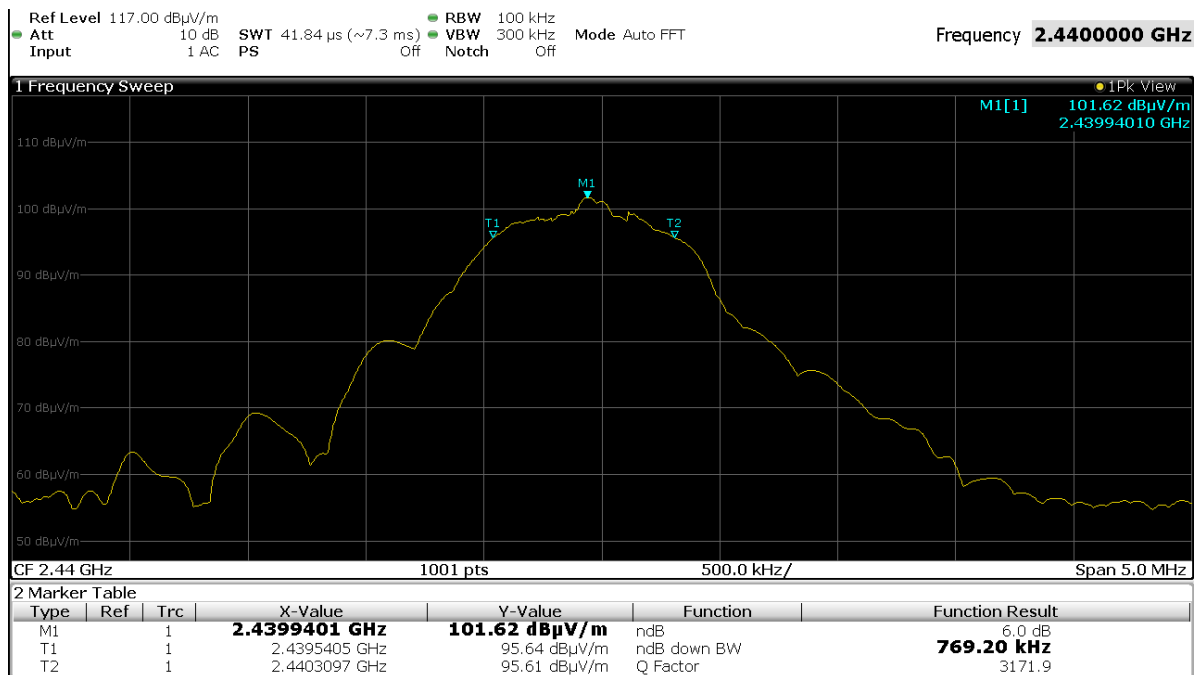


Figure 14: Chart of 6 dB bandwidth test, channel mid



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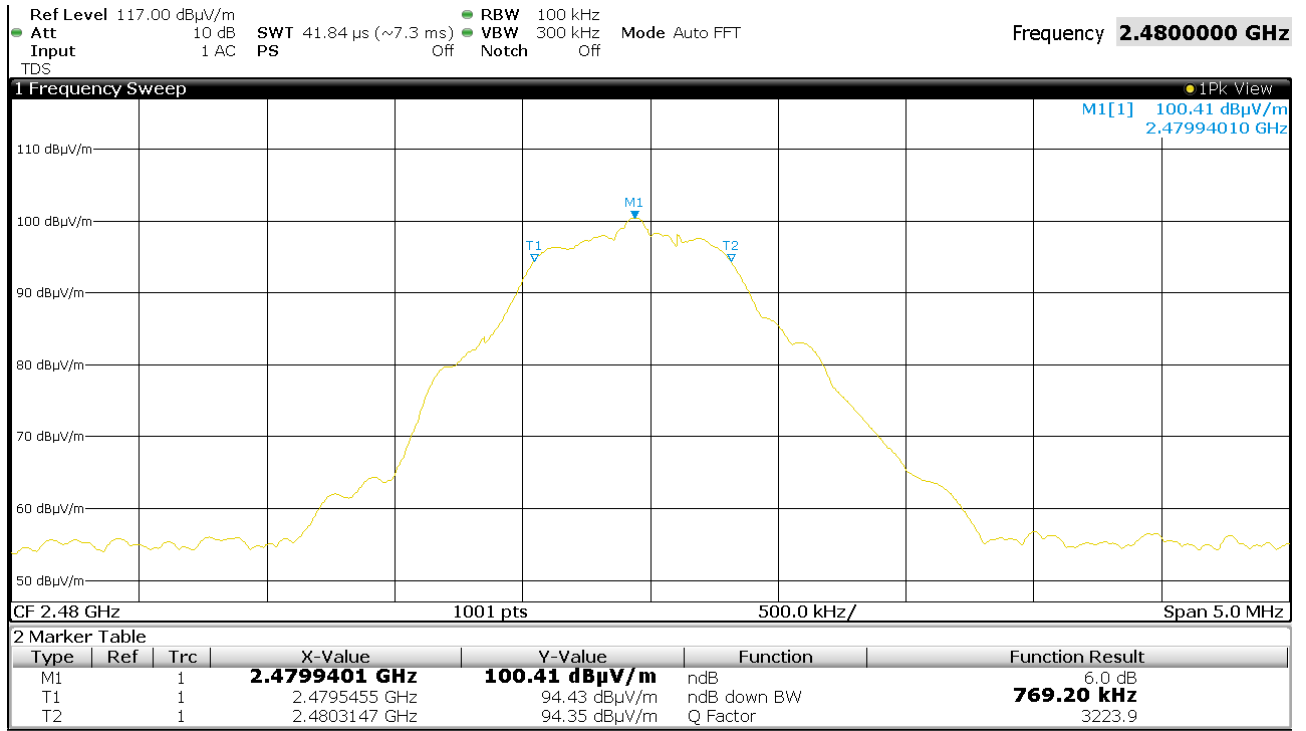


Figure 15: Chart of 6 dB bandwidth test, channel high

f [MHz]	6dB-BW [MHz]	f _{lower} [MHz]	f _{upper} [MHz]	Lower band edge [MHz]	Upper band edge [MHz]	Result
2402.940	0.819	2402.506	2403.325	2400.0	2483.5	Pass
2439.940	0.769	2439.541	2440.310	2400.0	2483.5	Pass
2479.940	0.769	2479.546	2480.315	2400.0	2483.5	Pass

Table 4: Final results of 6 dB bandwidth test



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6.4 Occupied bandwidth

47 CFR part and section: 2.202(a)
Equivalent to IC radio standard(s) RSS-Gen Issue 4, section 6.6
Measurement procedure: See 5.4

Performed by: Martin Müller Date of test: April 24, 2017

Result Test passed Test not passed

6.4.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input type="checkbox"/> Laboratory environment	---	---	---
<input checked="" type="checkbox"/> Anechoic Chamber (AC)	---	EMV TESTHAUS GmbH	E00100
<input type="checkbox"/> EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
<input type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/> EMI test receiver	ESW 44	Rohde & Schwarz	E00895
<input checked="" type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00052

6.4.2 Limits

None -> results recorded for setting the proper reference level.



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6.4.3 Test results

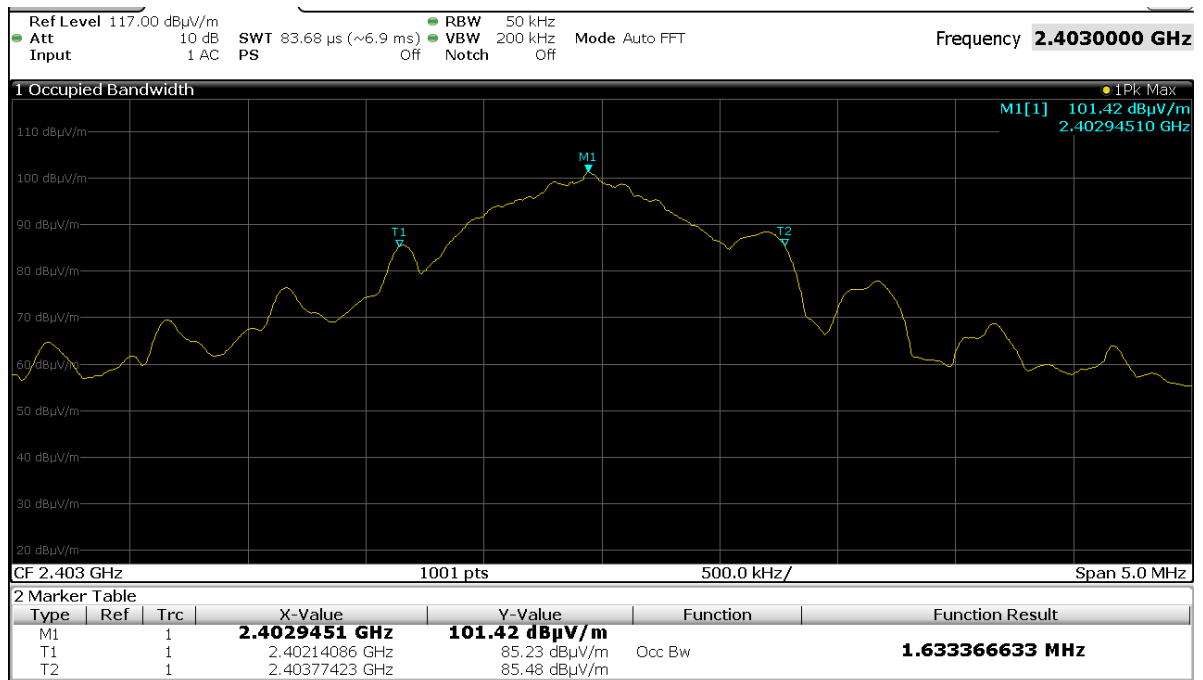


Figure 16: Chart of occupied bandwidth test, channel low

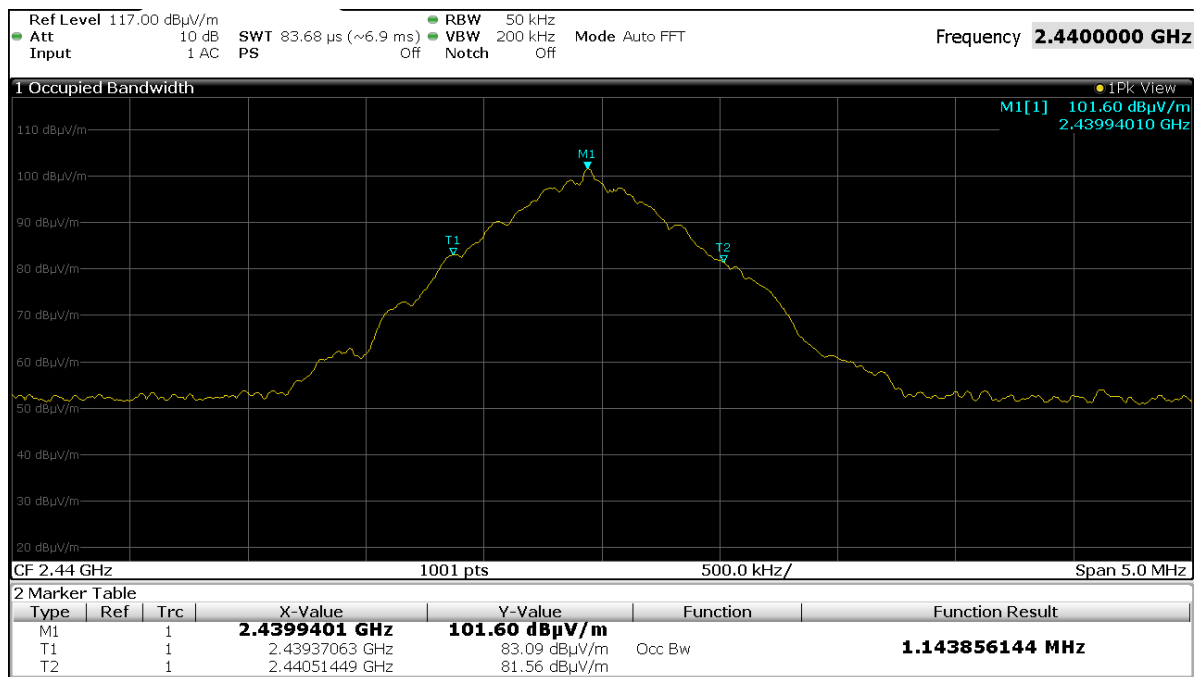


Figure 17: Chart of occupied bandwidth test, channel mid



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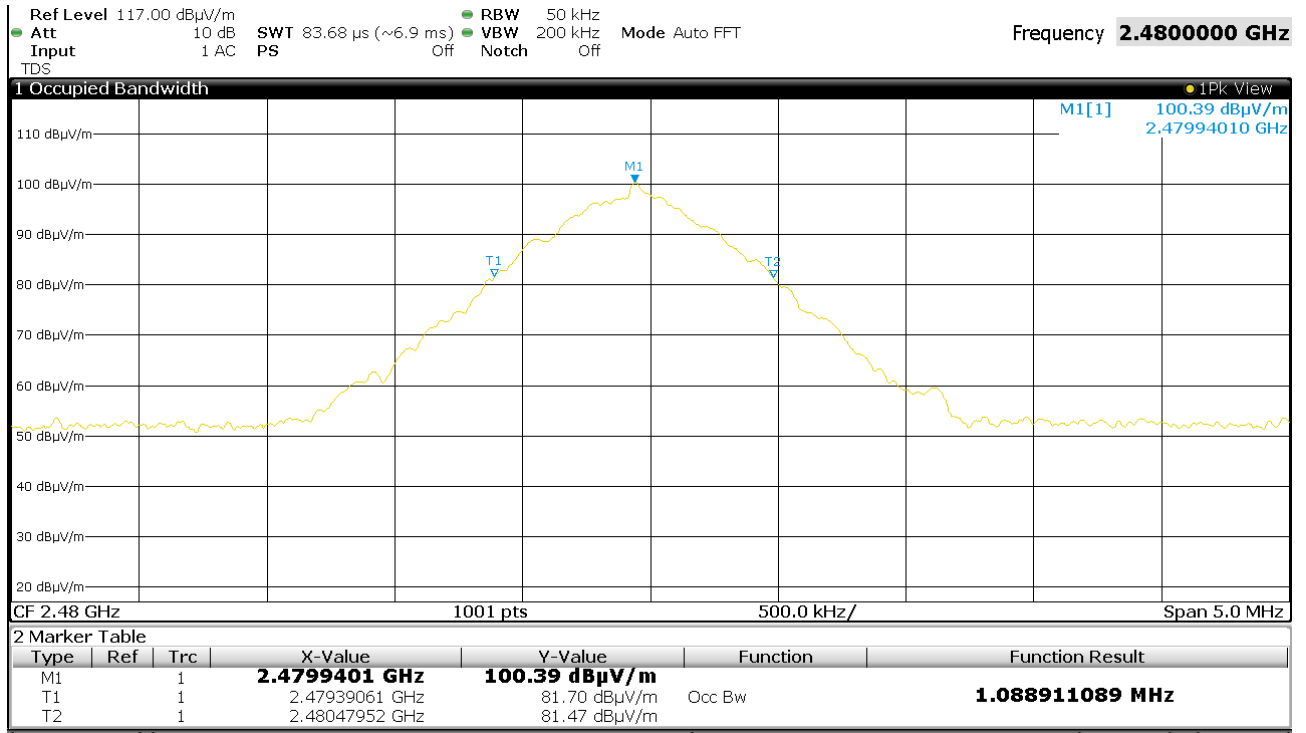


Figure 18: Chart of occupied bandwidth test, channel high

f [MHz]	Occ. BW [MHz]	f _{lower} [MHz]	f _{upper} [MHz]	Lower band edge [MHz]	Upper band edge [MHz]	Result
2402.945	1.633	2402.141	2403.774	2400.0	2483.5	within band
2439.940	1.143	2439.371	2440.514	2400.0	2483.5	within band
2479.940	1.089	2479.391	2480.480	2400.0	2483.5	within band

Table 5: Final results of occupied bandwidth test



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6.5 Maximum conducted output power

47 CFR part and section: 15.247(b)
Equivalent to IC radio standard(s) RSS-Gen Issue 4, section 6.12
RSS-247 Issue 2, section 5.4
Measurement procedure: See 5.5

Performed by: Martin Müller Date of test: April 24, 2017

Result Test passed Test not passed

6.5.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input type="checkbox"/> Laboratory environment	---	---	---
<input checked="" type="checkbox"/> Anechoic Chamber (AC)	---	EMV TESTHAUS GmbH	E00100
<input type="checkbox"/> EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
<input type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/> EMI test receiver	ESW 44	Rohde & Schwarz	E00895
<input checked="" type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00052

6.5.2 Limits for digital transmission systems

1 watt (30 dBm).



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6.5.3 Test results

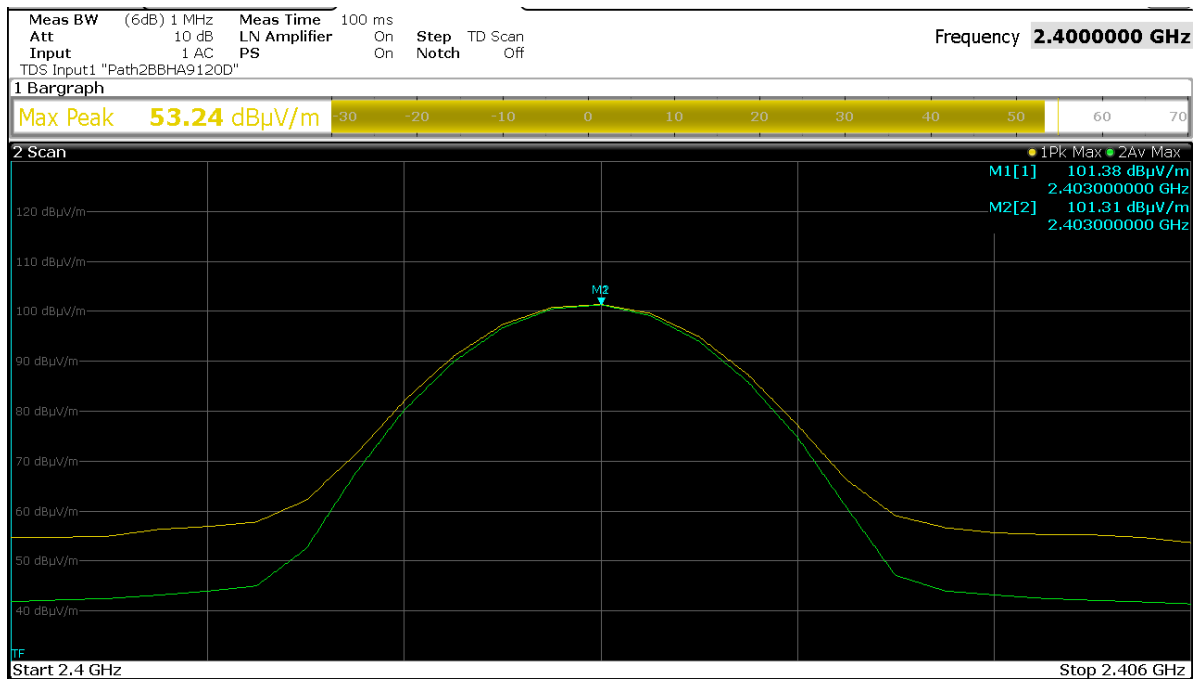


Figure 19: Chart of carrier electric field strength, channel low

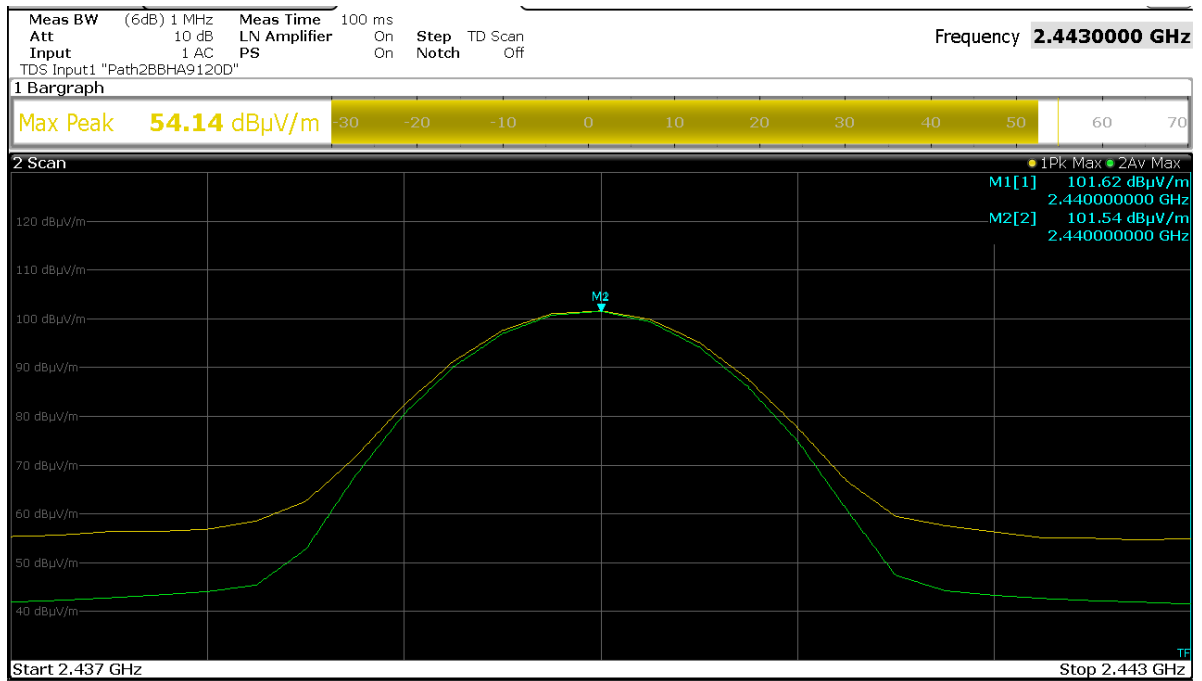


Figure 20: Chart of carrier electric field strength, channel mid

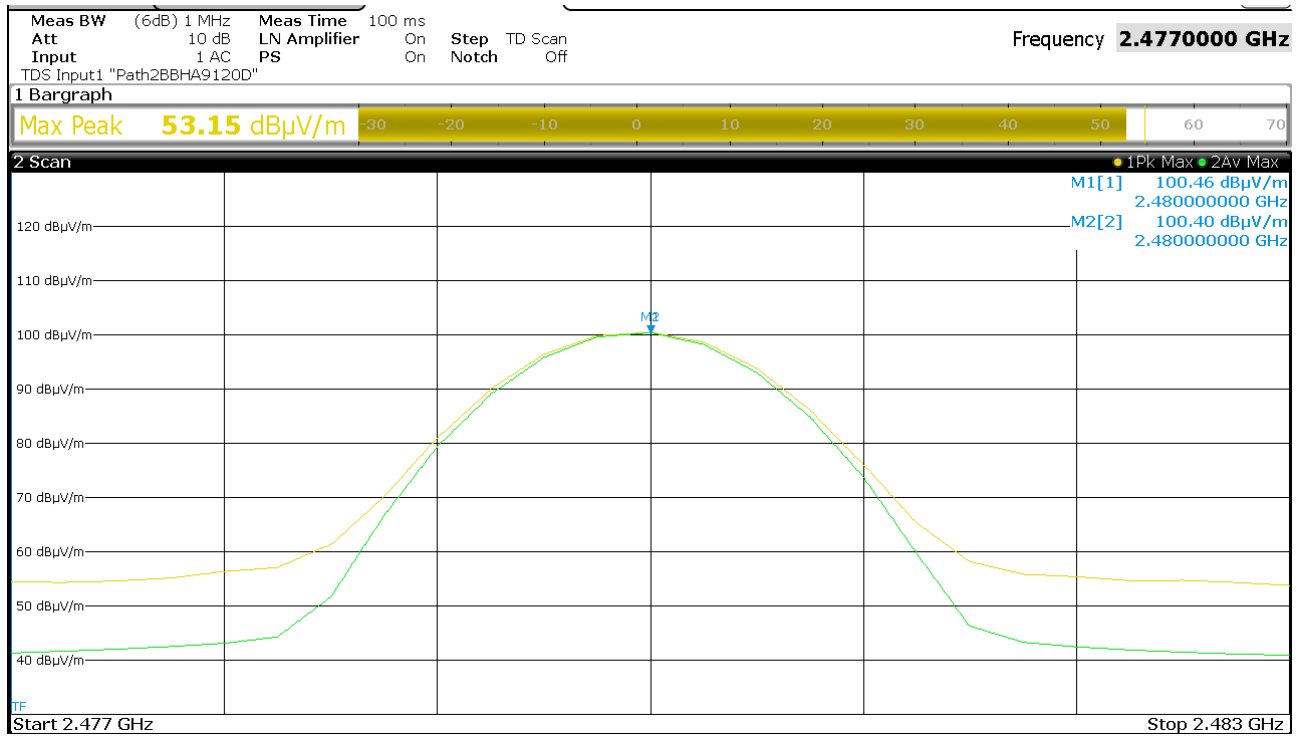


Figure 21: Chart of carrier electric field strength, channel high

Calculation of EIRP according to ANSI C63.10, sections 11.3 and annex G with derived formula as noted in section 12.7.3:

$$\text{EIRP[dBm]} = E[\text{dB}\mu\text{V/m}] + 20 \cdot \log(d_{\text{measure}}[\text{m}]) - 104.77$$

$$\text{With } d_{\text{measure}} = 3 \text{ m} \Rightarrow \text{EIRP[dBm]} = E[\text{dB}\mu\text{V/m}] - 95.23$$

Calculation of "maximum conducted output power":

$$\text{Maximum conducted output power[dBm]} = \text{EIRP[dBm]} - g[\text{dBi}]$$

f [MHz]	E _{meas} [dBµV/m]	EIRP [dBm]	g [dBi]	Maximum conducted output power [dBm]	Limit [dBm]	Result
2403.000	101.38	6.15	0	6.15	30.0	Pass
2440.000	101.62	6.39	0	6.39	30.0	Pass
2480.000	100.46	5.23	0	5.23	30.0	Pass

Table 6: Final results of maximum conducted output power test



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6.6 Power spectral density

47 CFR part and section: 15.247(e)
Equivalent to IC radio standard(s) RSS-247 Issue 2, section 5.2(b)
Measurement procedure: See 5.6

Performed by: Martin Müller Date of test: April 24, 2017

Result Test passed Test not passed

6.6.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input type="checkbox"/> Laboratory environment	---	---	---
<input checked="" type="checkbox"/> Anechoic Chamber (AC)	---	EMV TESTHAUS GmbH	E00100
<input type="checkbox"/> EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
<input type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/> EMI test receiver	ESW 44	Rohde & Schwarz	E00895
<input checked="" type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00052

6.6.2 Limits

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.



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6.6.3 Test results

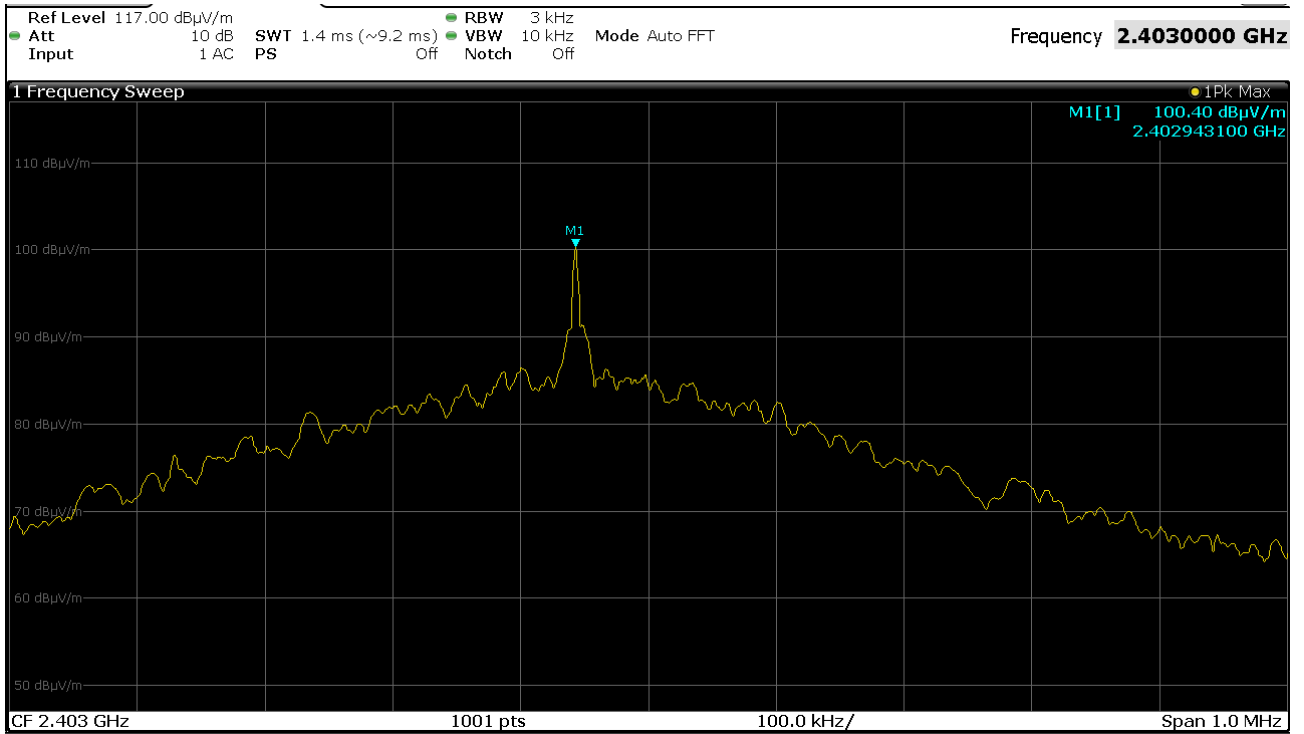


Figure 22: Chart of carrier electric field strength / 3 kHz, channel low - complete carrier

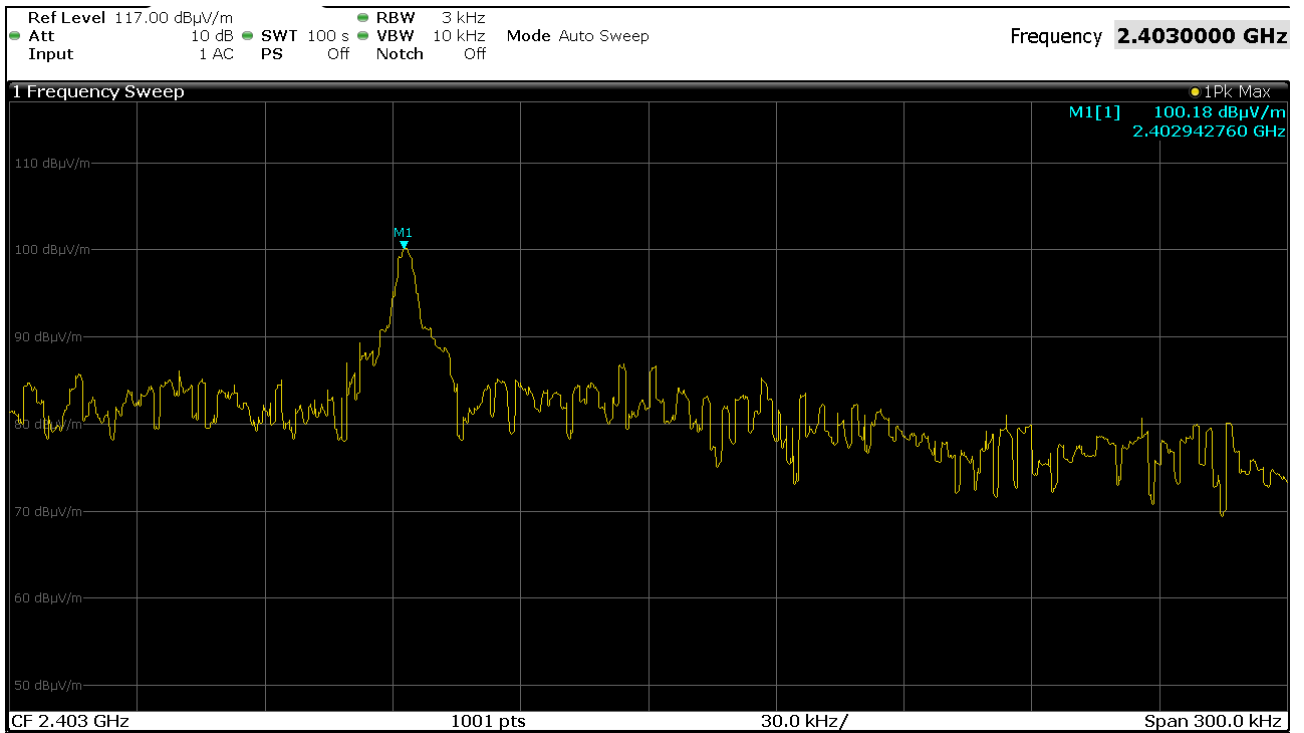


Figure 23: Chart of carrier electric field strength / 3 kHz, channel low - zoom to maximum



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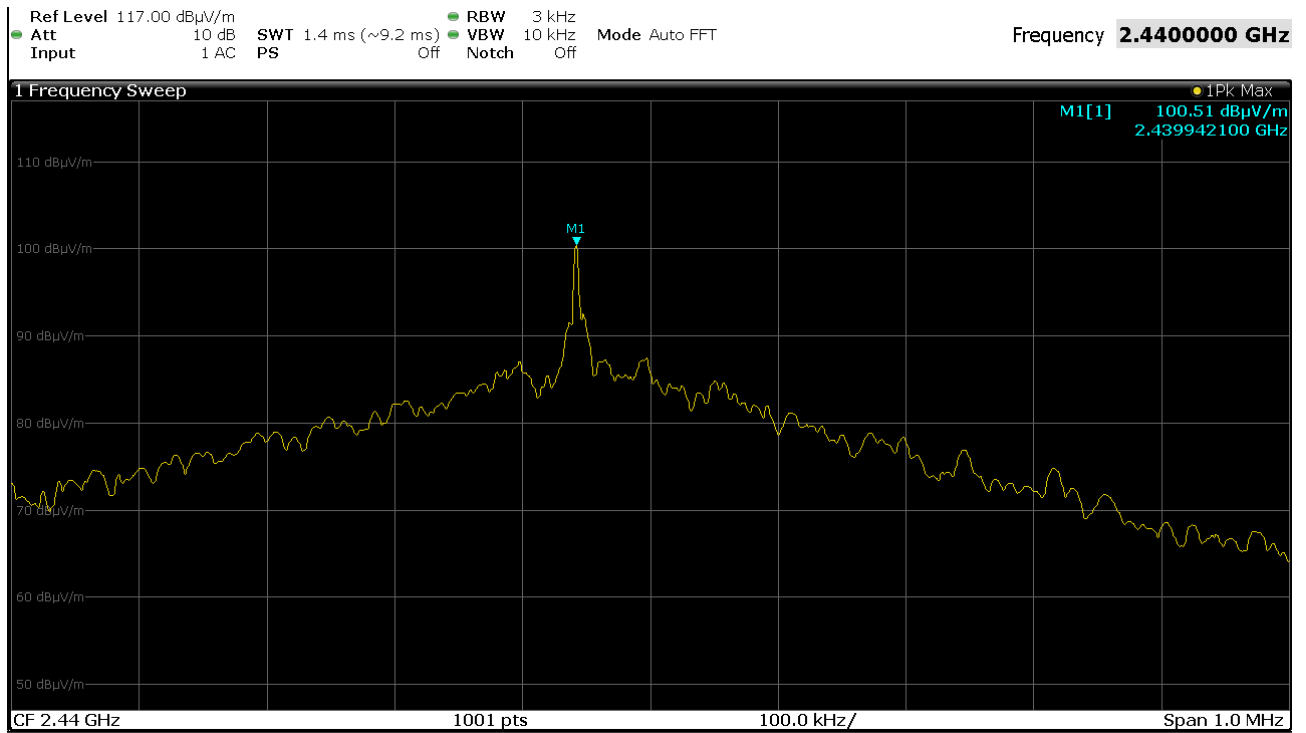


Figure 24: Chart of carrier electric field strength / 3 kHz, channel mid - complete carrier

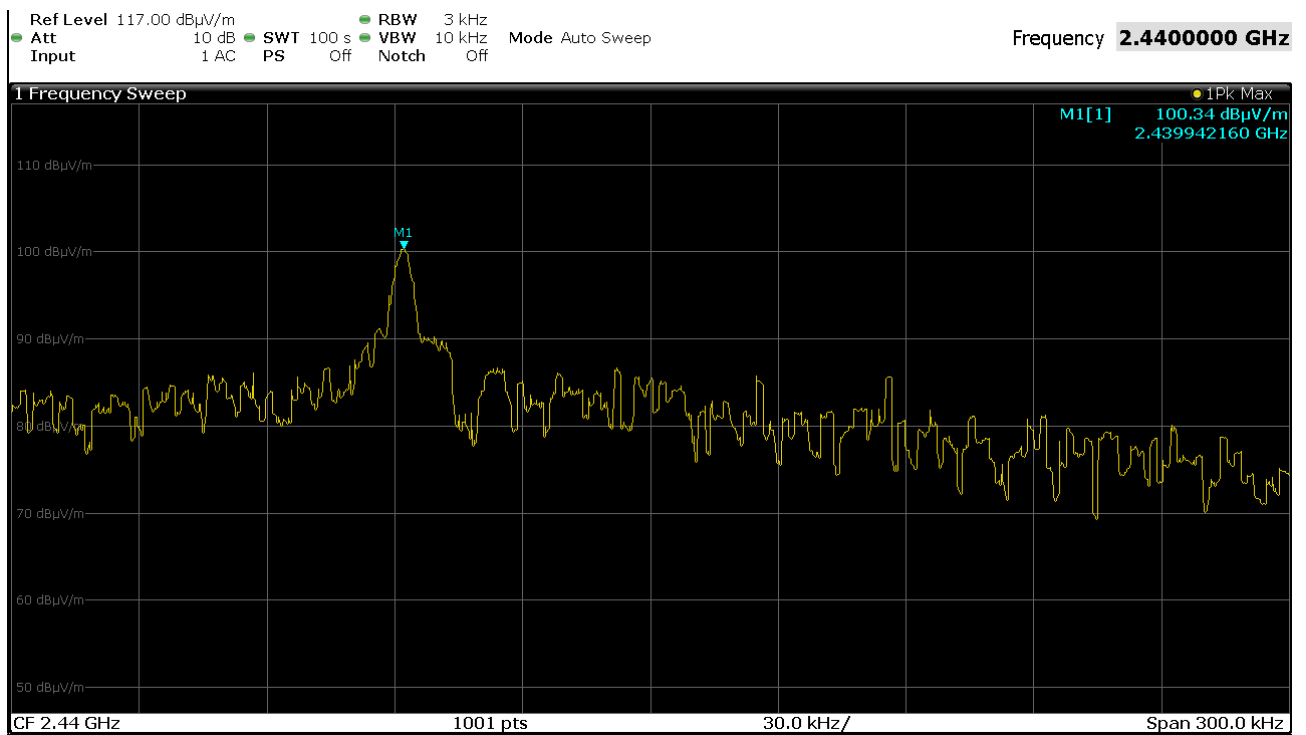


Figure 25: Chart of carrier electric field strength / 3 kHz, channel mid - zoom to maximum



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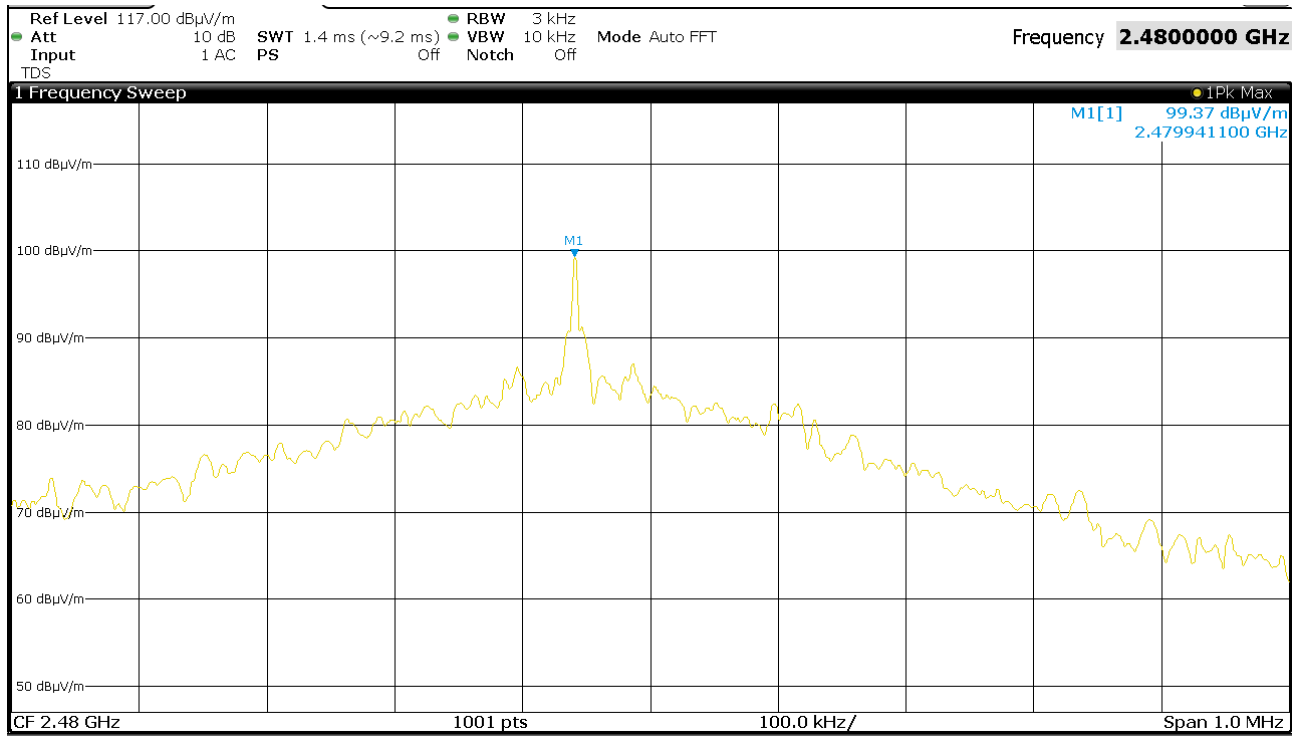


Figure 26: Chart of carrier electric field strength / 3 kHz, channel high - complete carrier

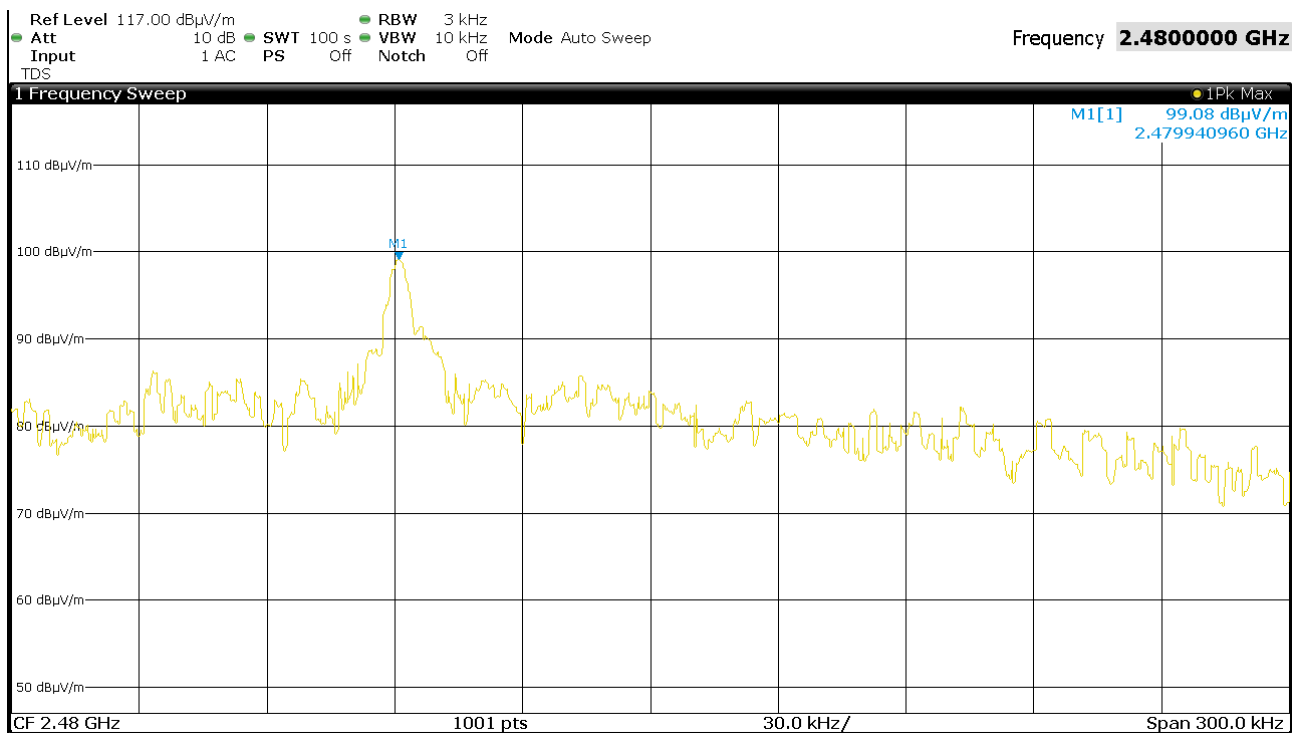


Figure 27: Chart of carrier electric field strength / 3 kHz, channel high - zoom to maximum



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Calculation of EIRP according to ANSI C63.10, sections 11.3 and annex G with derived formula as noted in section 12.7.3:

$$\text{EIRP[dBm]} = \text{E[dB}\mu\text{V/m]} + 20 \cdot \log(d_{\text{measure[m]}}) - 104.77$$

With $d_{\text{measure}} = 3 \text{ m} \Rightarrow \text{EIRP[dBm]} = \text{E[dB}\mu\text{V/m]} - 95.23$

Calculation of “ power spectral density”:

$$\text{Power spectral density[dBm / 3 kHz]} = \text{EIRP[dBm]} - g[\text{dBi}]$$

f [MHz]	E _{meas} [dBμV/m]	EIRP [dBm]	g [dBi]	Power spectral density [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Result
2402.943	100.40	5.17	0	5.17	8.0	Pass
2439.942	100.51	5.28	0	5.28	8.0	Pass
2479.941	99.37	4.14	0	4.14	8.0	Pass

Table 7: Final results of power spectral density test



6.7 Band-edge compliance (radiated)

47 CFR part and section: 15.247 (d)
 Equivalent to IC radio standard(s) RSS-247 Issue 2, section 5.5
 Measurement procedure: See 5.7

Performed by: Martin Müller Date of test: April 24, 2017

Result Test passed Test not passed

6.7.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input type="checkbox"/> Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
<input type="checkbox"/> Open Area Test Site (OATS)	---	EMV TESTHAUS GmbH	E00354
<input type="checkbox"/> Semi Anechoic Chamber (SAC)	---	Albatross Projects	E00716
<input checked="" type="checkbox"/> Anechoic Chamber (AC)	---	EMV TESTHAUS GmbH	E00100
<input type="checkbox"/> EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00001
<input type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input type="checkbox"/> EMI test receiver (SAC)	ESR 7	Rohde & Schwarz	E00739
<input type="checkbox"/> EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00552
<input checked="" type="checkbox"/> EMI test receiver	ESW 44	Rohde & Schwarz	E00895
<input type="checkbox"/> Preamplifier	AMF-5D-00501800	Miteq	W00089
<input type="checkbox"/> Preamplifier	AMF-6F-16002650	Miteq	W00090
<input type="checkbox"/> Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
<input type="checkbox"/> TRILOG broadband antenna (CDC)	VULB 9163	Schwarzbeck	E00012
<input type="checkbox"/> TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
<input type="checkbox"/> TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
<input checked="" type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00052
<input type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00053
<input type="checkbox"/> Horn antenna	BBHA 9170	Schwarzbeck	W00055
<input type="checkbox"/> Measurement software	E10	ib comPLAN	E00443
<input type="checkbox"/> Measurement software	EMC 32	Rohde & Schwarz	E00777



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6.7.2 Limits

- < -20 dBc outside restricted bands
- < 54 dB μ V/m (average detector) inside restricted bands
- < 74 dB μ V/m (peak detector) inside restricted bands



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6.7.3 Test results

Test distance: Prescan: 1 m 3 m m
 Final scan: 3 m 10 m m

Polarisation: horizontal vertical

EUT Position: Position 1 Position 2 Position 3

Frequency range	Step size	IF Band-width	Detector		Measurement Time		Preamplifier
			Prescan	Final scan	Prescan	Final scan	
2.30 GHz – 2.51 GHz	250 kHz	1 MHz	PK	PK	100 ms	100 ms	30 dB
2.30 GHz – 2.51 GHz	250 kHz	1 MHz	AV	AV	100 ms	100 ms	30 dB



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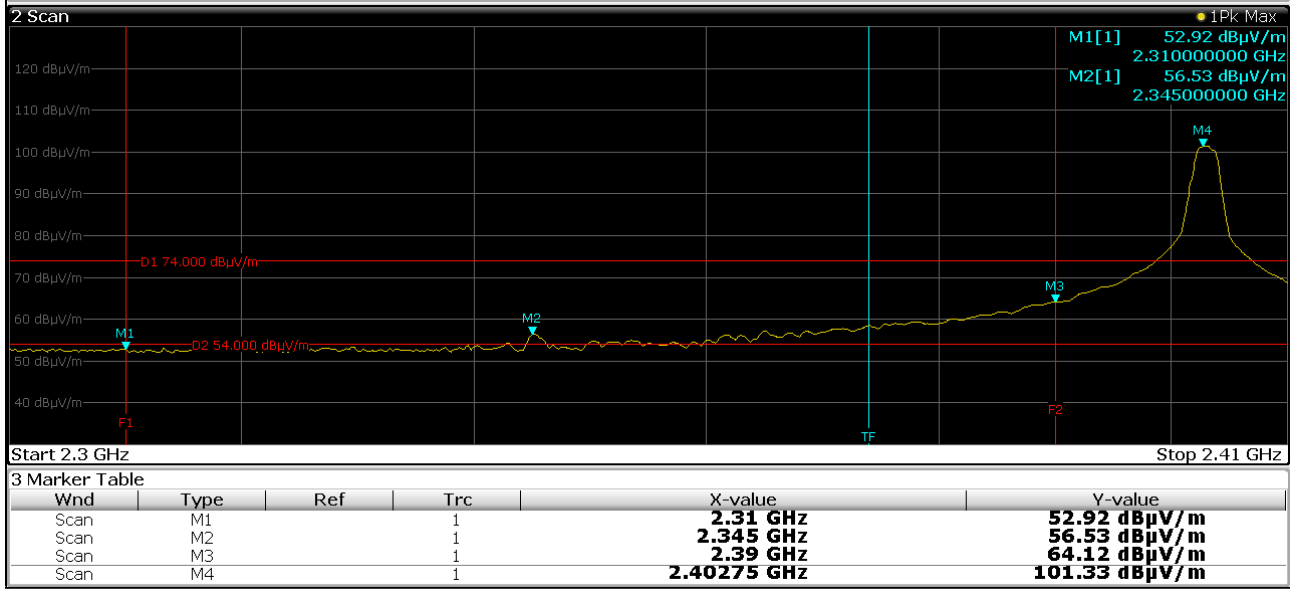


Figure 28: Chart of band edge compliance test, lower band edge - PK

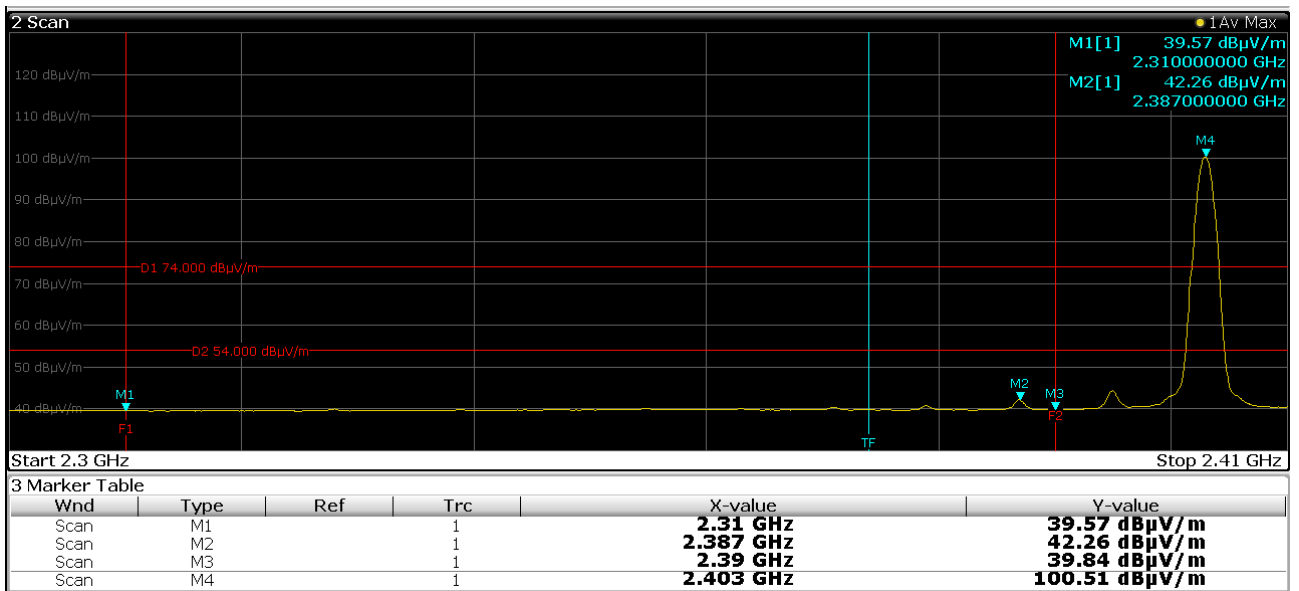


Figure 29: Chart of band edge compliance test, lower band edge - AV



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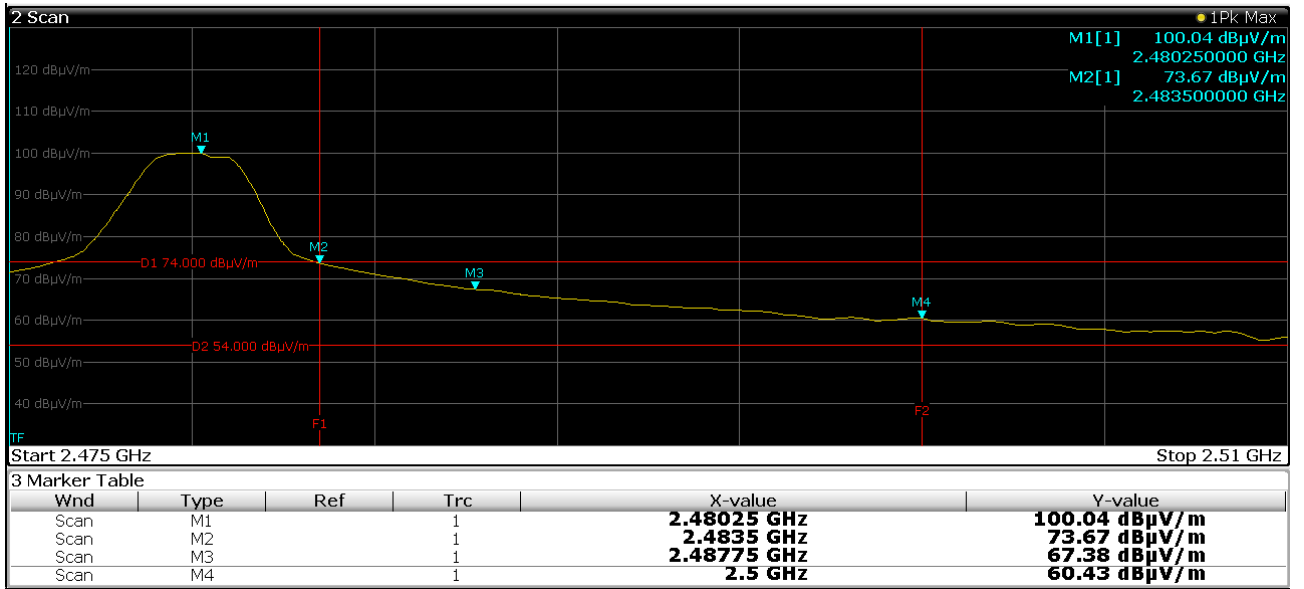


Figure 30: Chart of band edge compliance test, upper band edge - PK

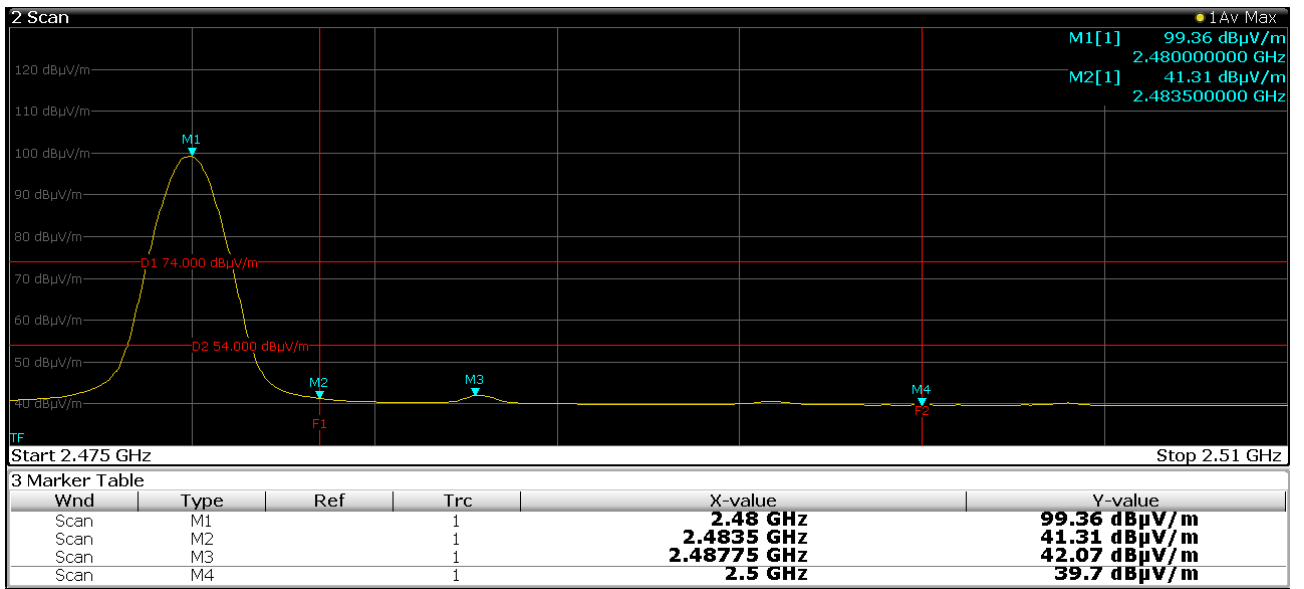


Figure 31: Chart of band edge compliance test, upper band edge - AV

f[MHz]	E _{meas} [dB μ V/m]	Detector	Restricted Band	Limit [dB μ V/m]	Result
2310.000	52.92	PK	Yes	74	Pass
2310.000	39.57	AV		54	Pass
2345.000	56.53	PK		74	Pass
2387.000	42.26	AV		54	Pass
2390.000	64.12	PK		74	Pass
2390.000	39.84	AV		54	Pass
2402.750	101.33	PK	No	----	Carrier
2403.000	100.51	AV		----	Carrier

Table 8: Final result of band edge compliance test, lower band edge

f[MHz]	E _{meas} [dB μ V/m]	Detector	Restricted Band	Limit [dB μ V/m]	Result
2480.250	100.04	PK	No	----	Carrier
2480.000	99.36	AV		----	Carrier
2483.500	73.67	PK	Yes	74	Pass
2483.500	41.31	AV		54	Pass
2487.750	67.38	PK		74	Pass
2487.750	42.07	AV		54	Pass
2500.000	60.43	PK		74	Pass
2500.000	39.70	AV		54	Pass

Table 9: Final result of band edge compliance test, upper band edge



6.8 Spurious radiated emissions 9 kHz to 10th harmonic

47 CFR part and section: 15.247(d)
 Equivalent to IC radio standard(s) RSS-Gen Issue 4, section 6.13
 RSS-247 Issue 2, section 5.5
 Measurement procedure: See 5.8

Performed by: Martin Müller Date of test: April 24, 2017

Result Test passed Test not passed

6.8.1 Test equipment

Type	Designation	Manufacturer	Inventory no.
<input checked="" type="checkbox"/> Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
<input type="checkbox"/> Open Area Test Site (OATS)	---	EMV TESTHAUS GmbH	E00354
<input checked="" type="checkbox"/> Semi Anechoic Chamber (SAC)	---	Albatross Projects	E00716
<input checked="" type="checkbox"/> Anechoic Chamber (AC)	---	EMV TESTHAUS GmbH	E00100
<input checked="" type="checkbox"/> EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00001
<input checked="" type="checkbox"/> EMI test receiver	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/> EMI test receiver (SAC)	ESR 7	Rohde & Schwarz	E00739
<input type="checkbox"/> EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00552
<input checked="" type="checkbox"/> EMI test receiver	ESW 44	Rohde & Schwarz	E00895
<input type="checkbox"/> Preamplifier	AMF-5D-00501800	Miteq	W00089
<input checked="" type="checkbox"/> Preamplifier	AMF-6F-16002650	Miteq	W00090
<input checked="" type="checkbox"/> Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
<input checked="" type="checkbox"/> TRILOG broadband antenna (CDC)	VULB 9163	Schwarzbeck	E00012
<input checked="" type="checkbox"/> TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
<input type="checkbox"/> TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
<input checked="" type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00052
<input type="checkbox"/> Horn antenna	BBHA 9120D	Schwarzbeck	W00053
<input checked="" type="checkbox"/> Horn antenna	BBHA 9170	Schwarzbeck	W00054
<input checked="" type="checkbox"/> Measurement software	E10	ib comPLAN	E00443
<input type="checkbox"/> Measurement software	EMC 32	Rohde & Schwarz	E00777



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6.8.2 Limits < 1 GHz

Frequency [MHz]	Field strength Fs [$\mu\text{V/m}$]	Field strength [dB $\mu\text{V/m}$]	Measurement distance d [m]
0.009 – 0.490	266.6 – 4.9	48.5 – 13.8	300
0.490 – 1.705	48.98 – 14.08	33.8 – 22.97	30
1.705 – 30.0	30	29.54	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Recalculation factor is determined according to ANSI C63.10, section 6.4.4.2 “Extrapolation from the measurement of a single point”:

$$d_{\text{near field}} = 47.77 / f_{\text{MHz}}, \text{ or}$$

$$f_{\text{MHz}} = 47.77 / d_{\text{near field}}$$

The frequency f_{MHz} at which the near field distance is equal to the limit and/or test distance is important for selection of the right formula for determining the recalculation factor:

$$\begin{aligned} f_{\text{MHz}}(300 \text{ m}) &\approx 0.159 \text{ MHz} \\ f_{\text{MHz}}(30 \text{ m}) &\approx 1.592 \text{ MHz} \\ f_{\text{MHz}}(3 \text{ m}) &\approx 15.923 \text{ MHz} \end{aligned}$$

For $9 \text{ kHz} \leq f \leq 159 \text{ kHz}$ and $490 \text{ kHz} < f \leq 1.592 \text{ MHz}$:

$$\text{Recalculation factor} = -40 \log(d_{\text{limit}} / d_{\text{measure}})$$

For $159 \text{ kHz} < f \leq 490 \text{ kHz}$ and $1.592 \text{ MHz} < f \leq 15.923 \text{ MHz}$:

$$\text{Recalculation factor} = -40 \log(d_{\text{near field}} / d_{\text{measure}}) - 20 \log(d_{\text{limit}} / d_{\text{near field}})$$

For $f > 15.923 \text{ MHz}$:

$$\text{Recalculation factor} = -20 \log(d_{\text{limit}} / d_{\text{measure}})$$

The limits in the graphics and value lists are derived from the general radiated emission limits as specified in 15.209 using the recalculation factor as described above.

6.8.3 Limits > 1 GHz

< -20 dBc outside restricted bands

< 54d B $\mu\text{V/m}$ (average detector) inside restricted bands

< 74d B $\mu\text{V/m}$ (peak detector) inside restricted bands



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6.8.4 Test results from 9 kHz to 30 MHz

Test distance: Prescan: 3 m
 Final scan: 3 m 10 m m

Polarisation: parallel in line angle:°

EUT Position: Position 1 Position 2 Position 3

Frequency range	Step size	IF Bandwidth	Detector		Measurement Time		Preamplifier
			Prescan	Final scan	Prescan	Final scan	
9 kHz – 90 kHz	80 Hz	200 Hz	PK	AV	1 ms	1 s	off
90 kHz – 110 kHz	80 Hz	200 Hz	PK	QPK	1 ms	1 s	off
110 kHz – 150 kHz	80 Hz	200 Hz	PK	AV	1 ms	1 s	off
150 kHz – 490 kHz	4 kHz	9 kHz	PK	AV	1 ms	1 s	off
490 kHz – 30 MHz	4 kHz	9 kHz	PK	QPK	1 ms	1 s	off

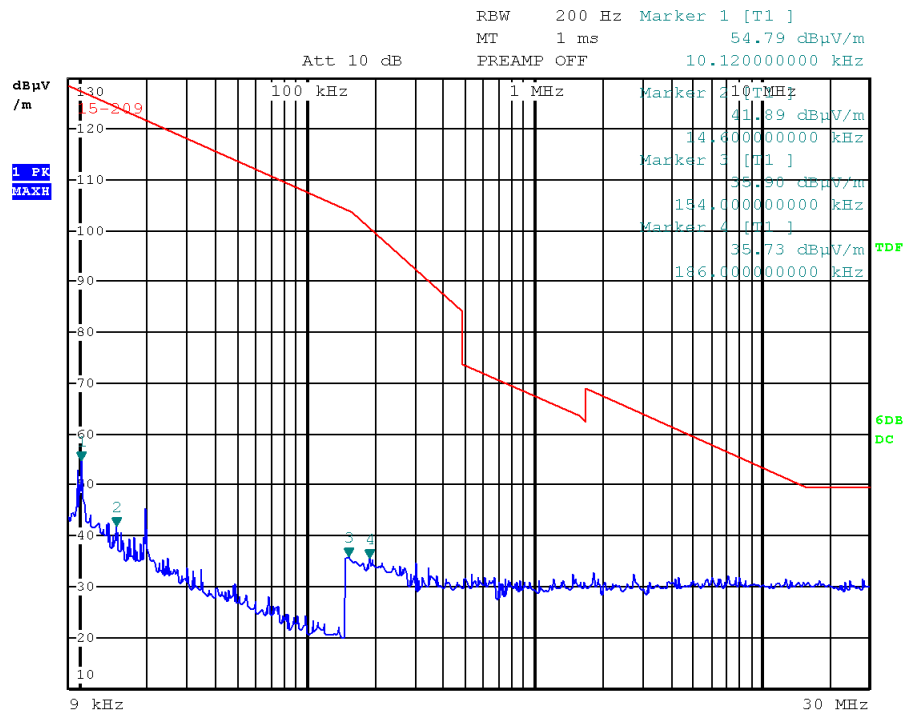


Figure 32: Chart of spurious radiated emission test 9 kHz - 30 MHz, channel low



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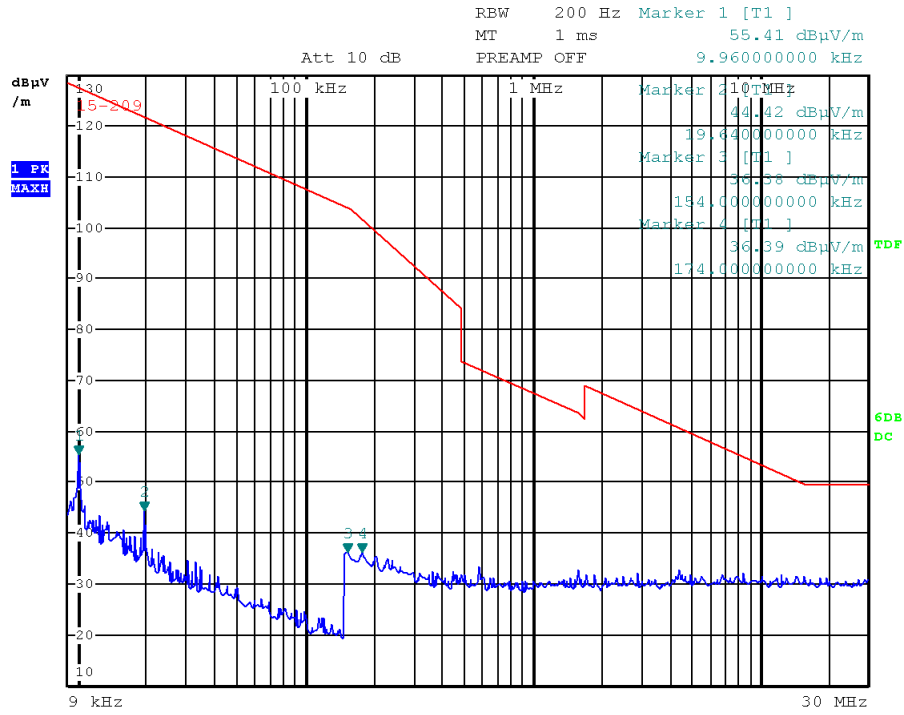


Figure 33: Chart of spurious radiated emission test 9 kHz - 30 MHz, channel mid

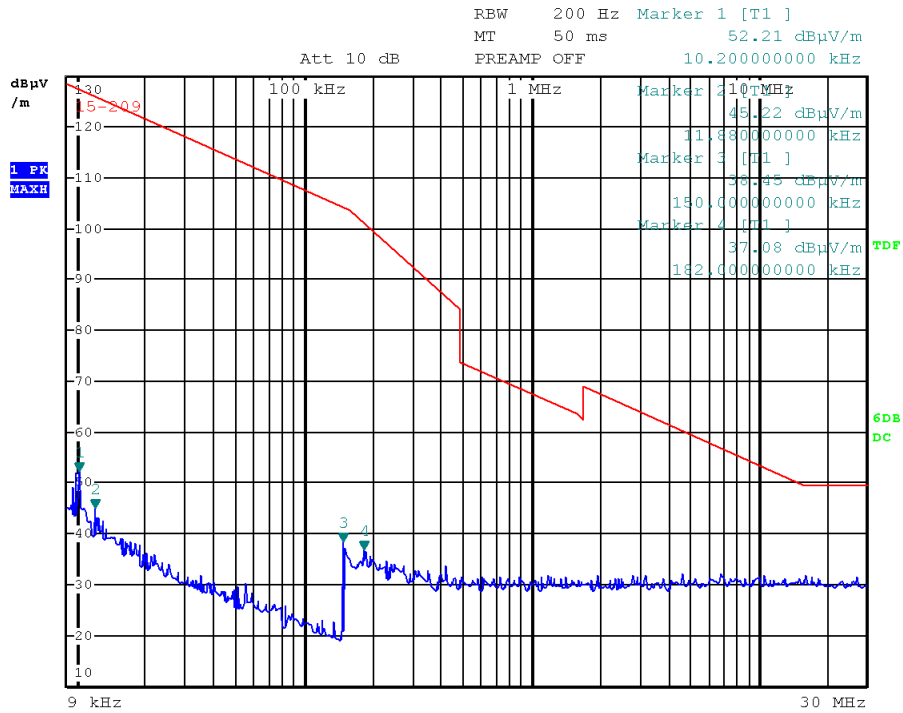


Figure 34: Chart of spurious radiated emission test 9 kHz - 30 MHz, channel high

6.8.5 Test results from 30 MHz to 1 GHz

Test distance: Prescan: 3 m
 Final scan: 3 m 10 m m

Polarisation: horizontal vertical

EUT Position: Position 1 Position 2 Position 3

Frequency range	Step size	IF Bandwidth	Detector		Measurement Time		Preamplifier
			Prescan	Final scan	Prescan	Final scan	
30 MHz – 1 GHz	60 kHz	120 kHz	PK	QPK	1 ms	1 s	20 dB



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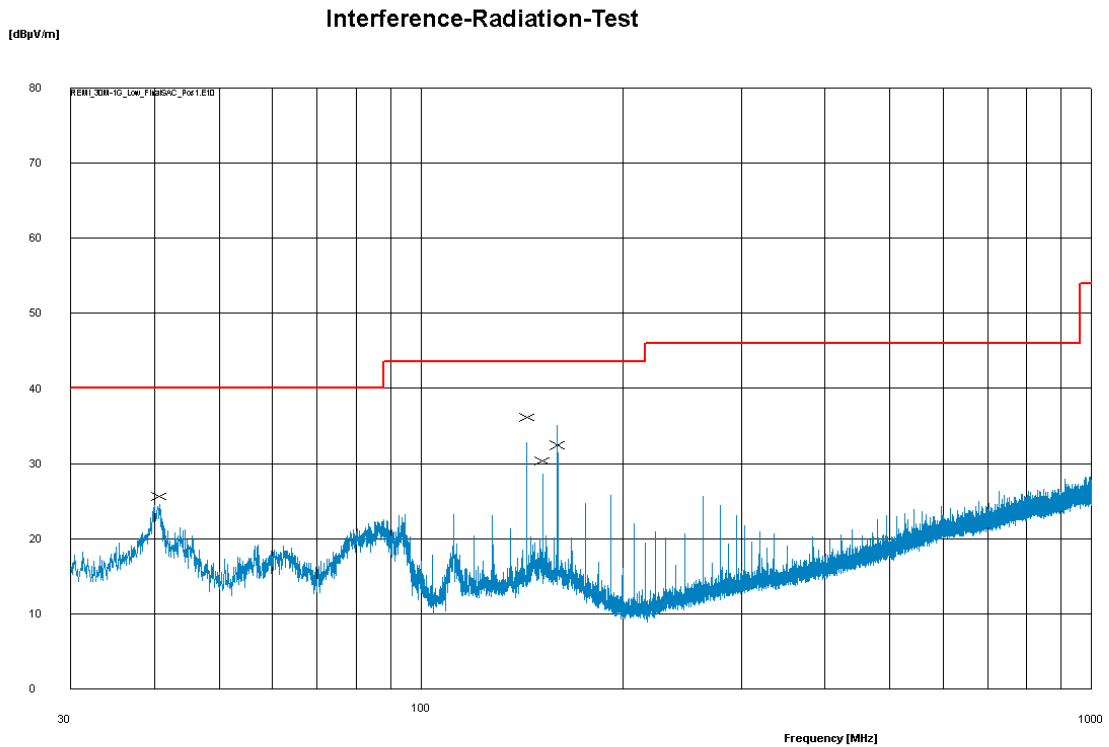


Figure 35: Chart of spurious radiated emission test 30 MHz - 1 GHz, channel low

f [MHz]	E _{final} [dBV/m]	Limit [dBµV/m]	Height [cm]	TT [°]	Polarisation	Result
40.68	25.63	40.00	100.0	267.8	V	Pass
143.76	36.15	43.52	100.0	49.2	V	Pass
151.74	30.35	43.52	100.0	48.4	V	Pass
159.72	32.44	43.52	100.0	190.9	V	Pass

Table 10: Final result of spurious radiated emission test 30 MHz - 1 GHz, channel low

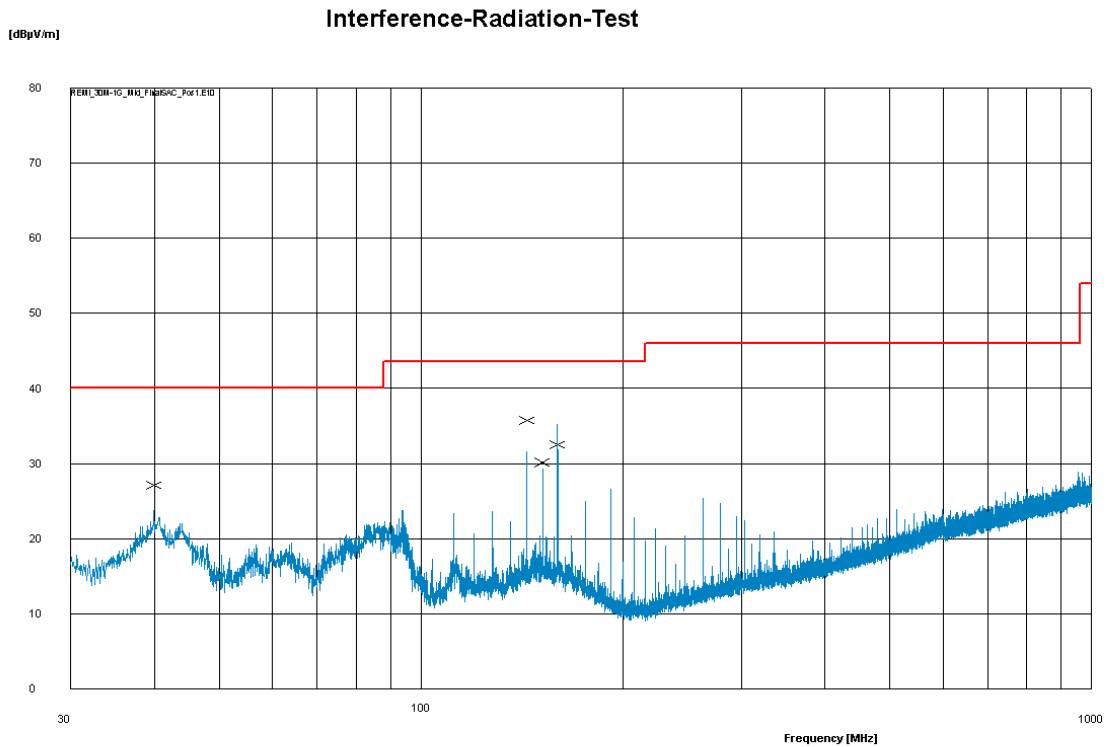


Figure 36: Chart of spurious radiated emission test 30 MHz - 1 GHz, channel mid

f [MHz]	E _{final} [dBV/m]	Limit [dBµV/m]	Height [cm]	TT [°]	Polarisation	Result
39.96	27.13	40.00	102.8	246.5	V	Pass
143.76	35.75	43.52	100.0	44.9	V	Pass
151.74	30.15	43.52	100.0	45.0	V	Pass
159.72	32.54	43.52	100.0	52.5	V	Pass

Table 11: Final result of spurious radiated emission test 30 MHz - 1 GHz, channel mid

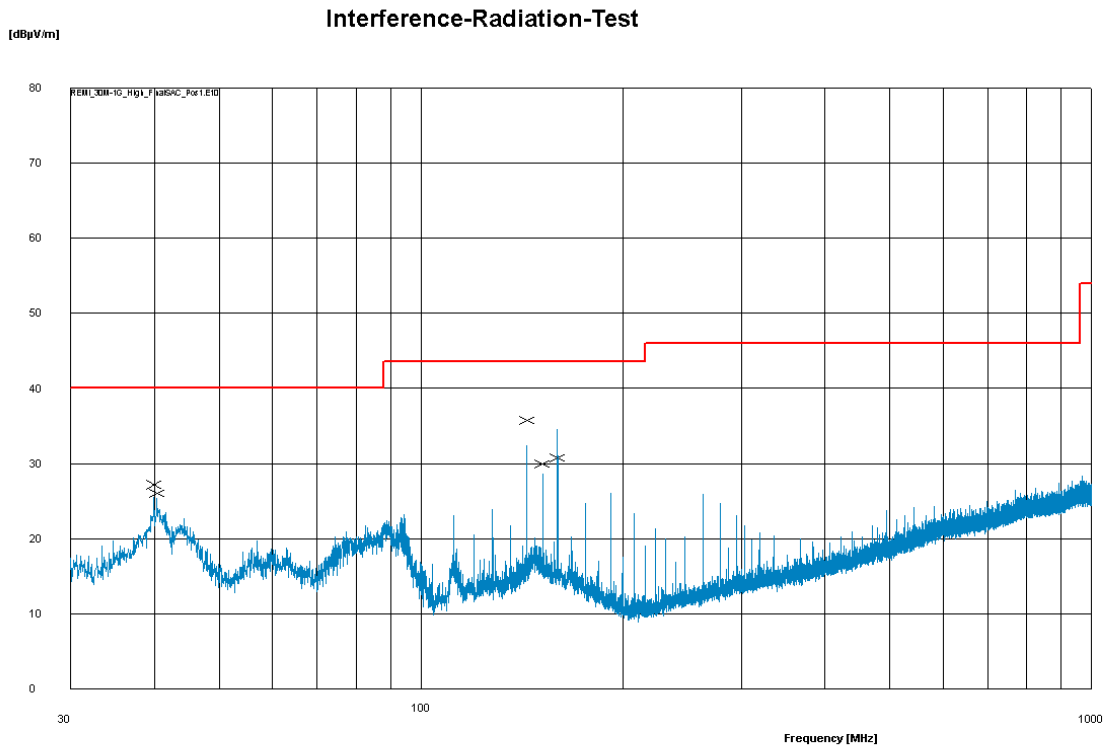


Figure 37: Chart of spurious radiated emission test 30 MHz - 1 GHz, channel high

f [MHz]	E _{final} [dBV/m]	Limit [dBµV/m]	Height [cm]	TT [°]	Polarisation	Result
39.96	27.23	40.00	100.0	260.8	V	Pass
40.38	26.03	40.00	100.0	247.0	V	Pass
143.76	35.75	43.52	100.0	38.4	V	Pass
151.74	29.95	43.52	100.0	45.7	V	Pass
159.72	30.74	43.52	100.0	38.1	V	Pass

Table 12: Final result of spurious radiated emission test 30 MHz - 1 GHz, channel high

6.8.6 Test results from 1 GHz to 10th harmonic

Test distance:	Prescan:	<input checked="" type="checkbox"/> 1 m	<input checked="" type="checkbox"/> 3 m	<input type="checkbox"/> m
	Final scan:	<input checked="" type="checkbox"/> 3 m	<input type="checkbox"/> 10 m	<input type="checkbox"/> m
Polarisation:	<input checked="" type="checkbox"/> horizontal	<input checked="" type="checkbox"/> vertical		
EUT Position:	<input type="checkbox"/> Position 1	<input checked="" type="checkbox"/> Position 2	<input checked="" type="checkbox"/> Position 3	

Frequency range	Step size	IF Bandwidth	Detector		Measurement Time		Preamplifier
			Prescan	Final scan	Prescan	Final scan	
1 GHz – 26 GHz	250 kHz	1 MHz	PK	PK	100 ms	100 ms	30 dB
1 GHz – 26 GHz	250 kHz	1 MHz	AV	AV	100 ms	100 ms	30 dB

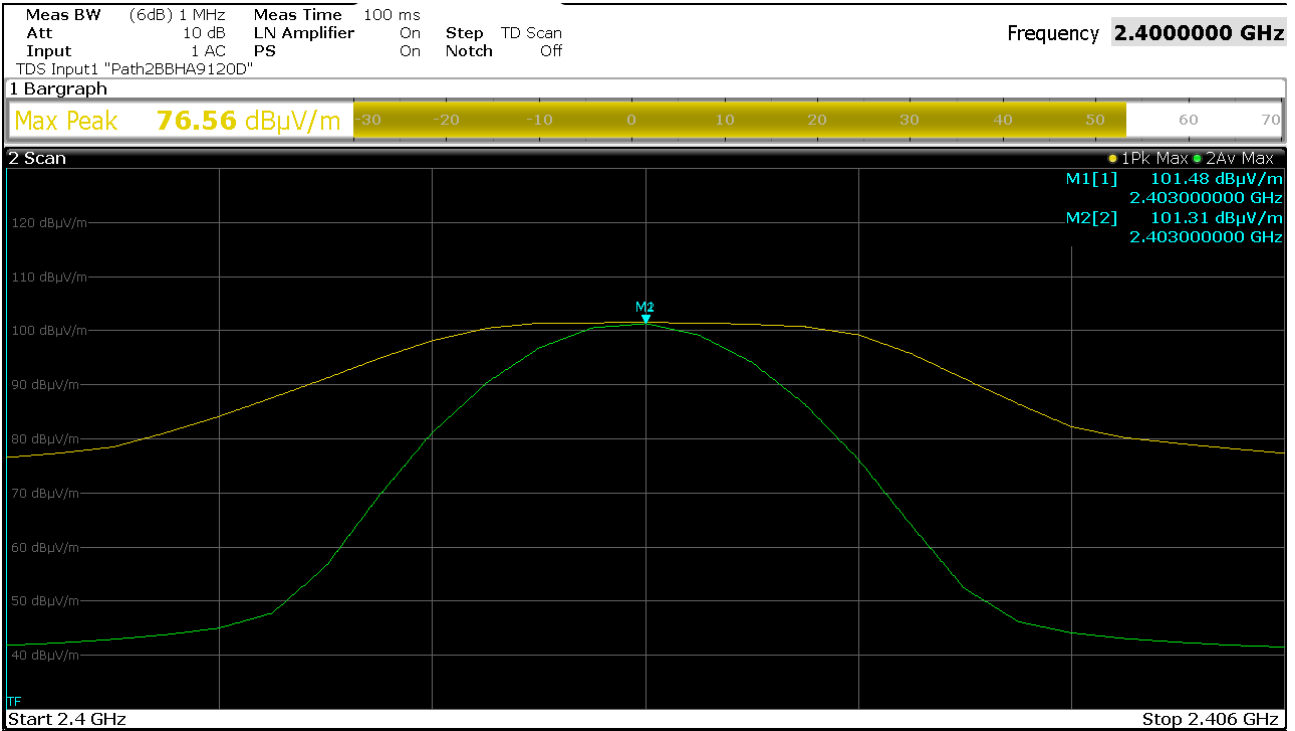


Figure 38: 1st Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel low



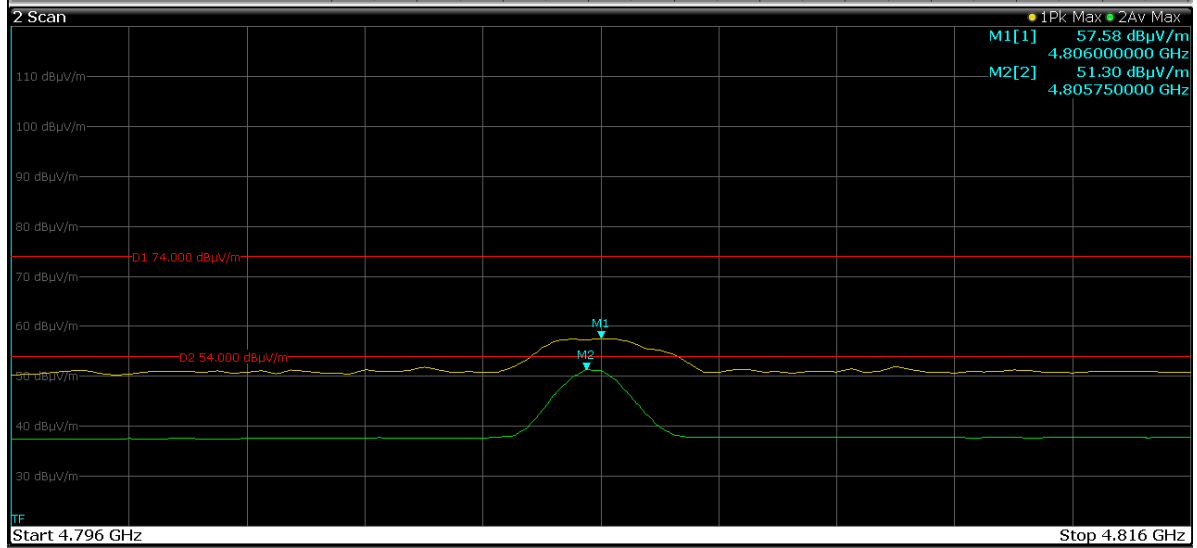


Figure 39: 2nd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel low

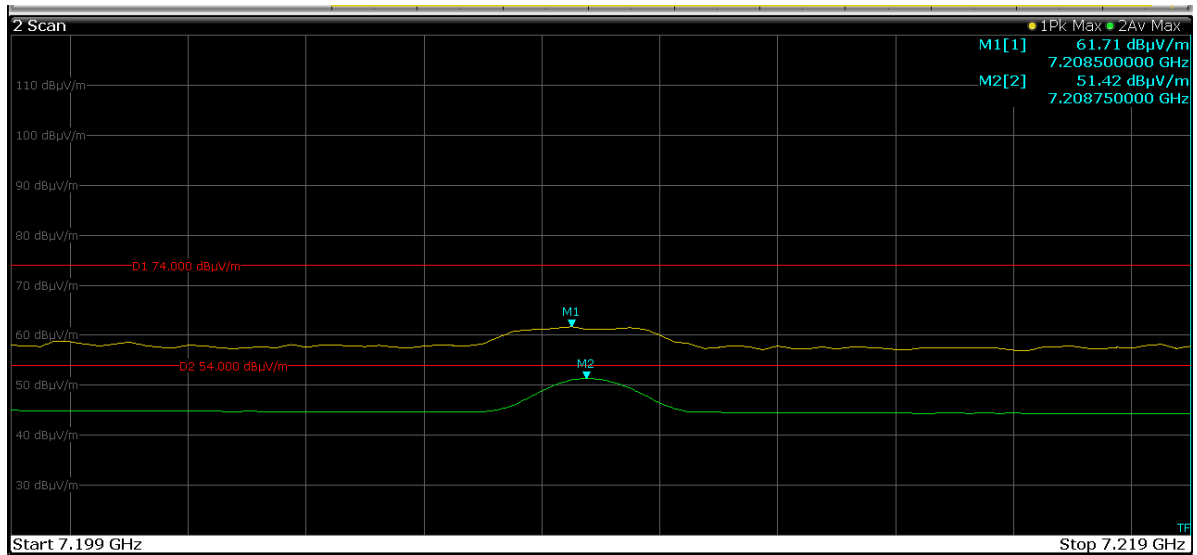


Figure 40: 3rd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel low

Channel low									
f[GHz]	E _{meas} [dBµV/m]	EUT-Pos	Polarization	Table [°]	Height [cm]	Detector	Restr. Band	Limit [dBµV/m]	Result
2.4030	101.48	3	V	29	181	PK	No	---	Carrier
2.4030	101.31					AV		---	Carrier
4.8060	57.58	3	V	330	153	PK	Yes	74	Pass
4.8058	51.30					AV		54	Pass
7.2085	61.71	2	H	19	161	PK	No	74	Pass
7.2088	51.42					AV		54	Pass

Table 13: Final result of spurious radiated emission test 1 GHz to 10th harmonic, channel low



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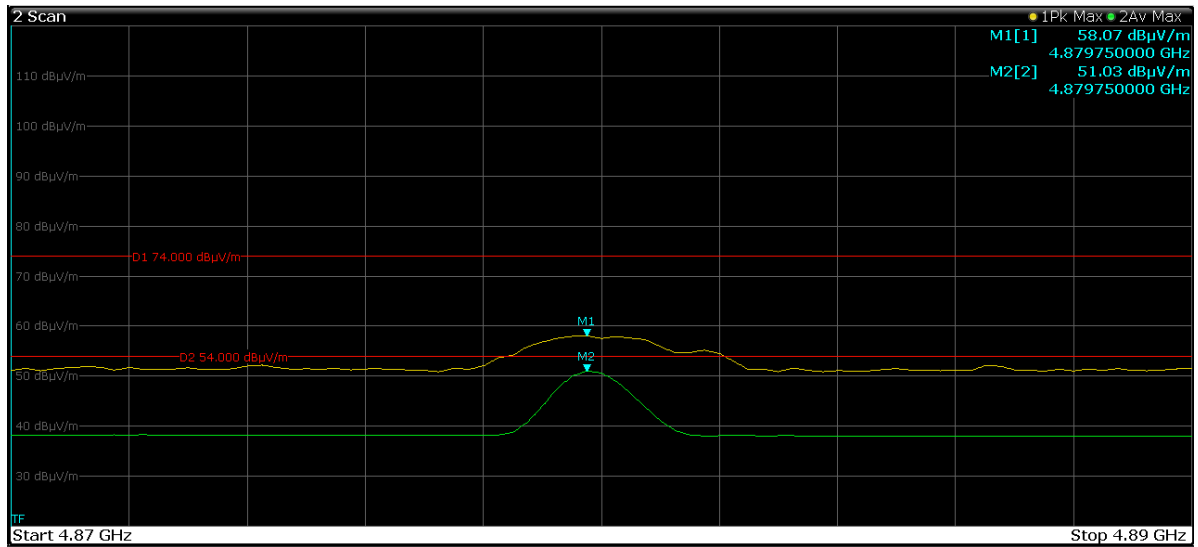


Figure 41: 1st Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel mid

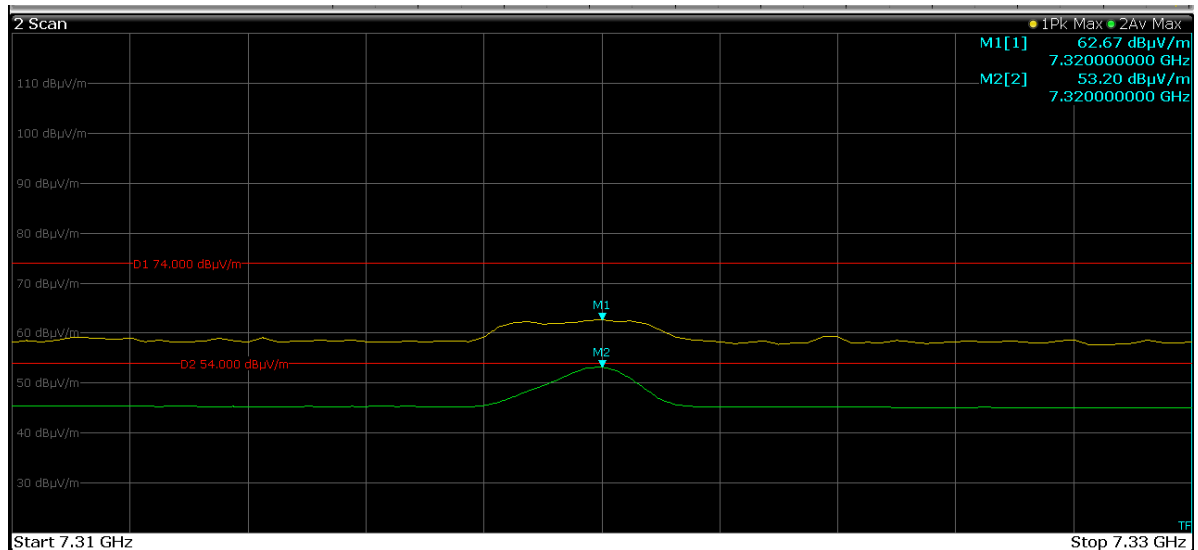


Figure 42: 2nd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel mid

Channel mid									
f[GHz]	E _{meas} [dBµV/m]	EUT-Pos	Polarization	Table [°]	Height [cm]	Detector	Restr. Band	Limit [dBµV/m]	Result
4.8798	58.07	3	V	239	169	PK	Yes	74	Pass
4.8798	51.03					AV		54	Pass
7.3200	62.67	2	H	16	164	PK	Yes	74	Pass
7.3200	53.20					AV		54	Pass

Table 14: Final result of spurious radiated emission test 1 GHz to 10th harmonic, channel mid



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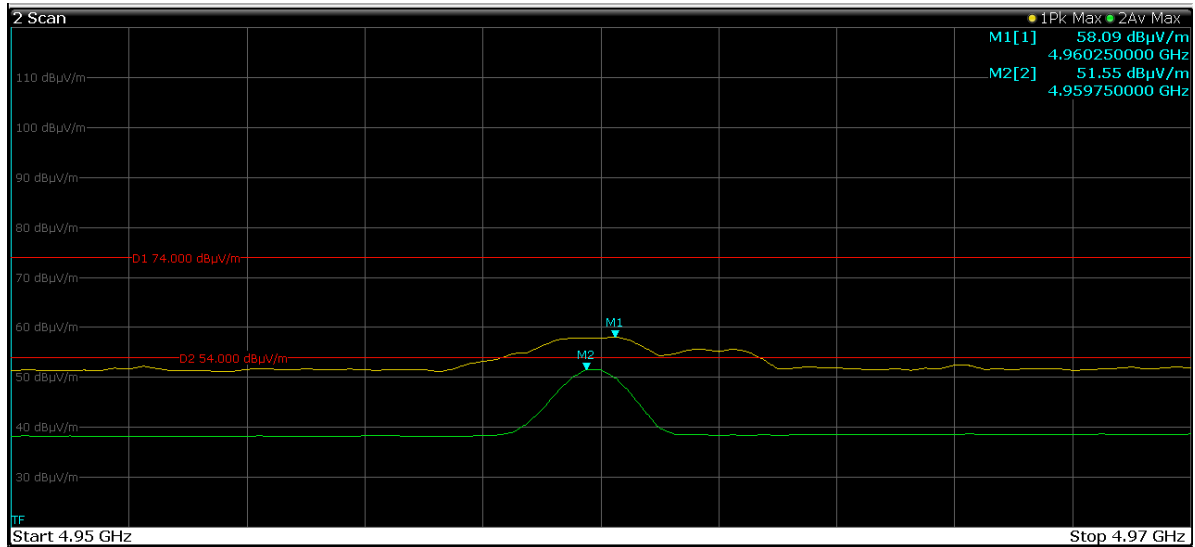


Figure 43: 1st Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel high

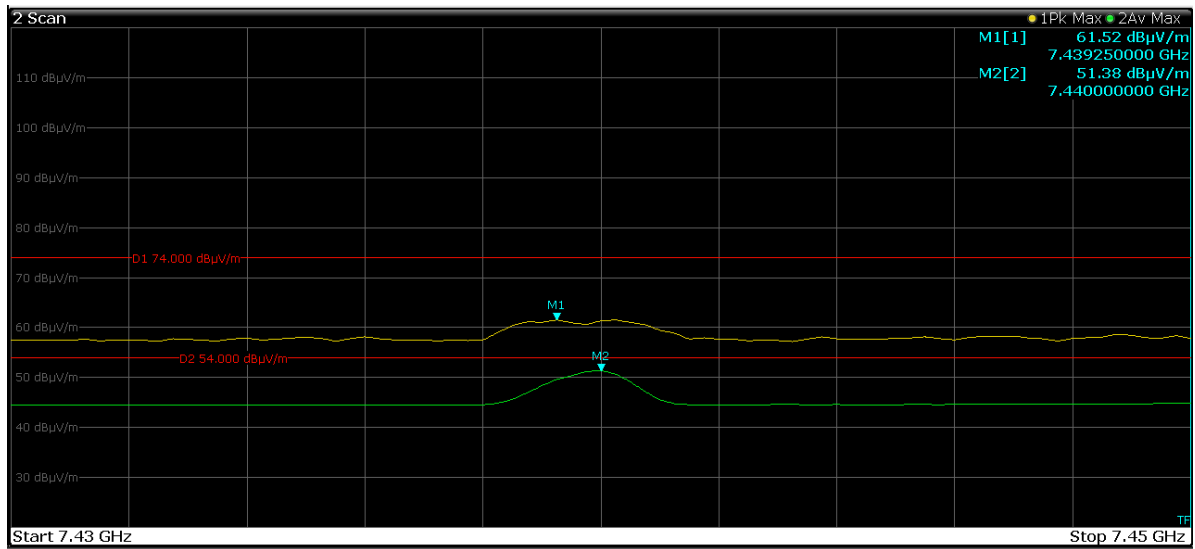


Figure 44: 2nd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel high

Channel high									
f[GHz]	E _{meas} [dBµV/m]	EUT-Pos	Polarization	Table [°]	Height [cm]	Detector	Restr. Band	Limit [dBµV/m]	Result
4.9603	58.09	3	V	96	153	PK	Yes	74	Pass
4.9598	51.55					AV		54	Pass
7.4393	61.52	2	H	37	162	PK	Yes	74	Pass
7.4400	51.38					AV		54	Pass

Table 15: Final result of spurious radiated emission test 1 GHz to 10th harmonic, channel high



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6.9 Radio frequency radiation exposure evaluation for mobile devices

Reference(s): 47 CFR Part 2, §2.1091
KDB 447498 D01, section 7
RSS Gen Issue 4, section 3.2
RSS-102 Issue 5, section 2.5.2

Performed by:	Martin Müller	Date of test:	April 24, 2017
Result:	<input checked="" type="checkbox"/> Test passed	<input type="checkbox"/> Test not passed	

6.9.1 Data of equipment under test (EUT)

Antenna connector (see clause 3):	<input type="checkbox"/> permanent	<input type="checkbox"/> temporary	<input checked="" type="checkbox"/> none
Antenna detachable:	<input type="checkbox"/> yes	<input checked="" type="checkbox"/> no	
Tune-up function:	<input type="checkbox"/> yes	<input checked="" type="checkbox"/> no	
Maximum antenna gain (see clause 3):	logarithmic 0.0 dBi	numeric 1.0	
Maximum conducted output power (see clause 6.5):	logarithmic 6.39 dBm	numeric 4.36 mW	
Maximum equivalent isotropically radiated power:	logarithmic 6.39 dBm	numeric 4.36 mW	
Maximum operation frequency (see clause 3):	2480.000 MHz		

6.9.2 Requirements

This estimation follows the general guidelines for RF Exposure according to KDB 447498.

As noted in §2.1091(b) a mobile device is defined as “a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a **separation distance of at least 20 centimeters** is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.”

According to §2.1091(c) the limits to be used for evaluation are defined in §1.1310.

As specified in §1.1310(d)(2) at operating frequencies less than or equal to 6 GHz, the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 of §1.1310(e) may be used.



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Table 16 below shows the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3 - 3.0	614	1.63	*100	6
3.0 - 30	1842/f	4.89/f	*900/f ²	6
30 - 300	61.4	0.163	1.0	6
300 - 1500			f/300	6
1500 - 100000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3 - 1.34	614	1.63	*100	30
1.34 - 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

Table 16: Limits for maximum permissible exposure (MPE) according to table 1 of §1.1310(e)

Notes:

1. f = frequency in MHz.
2. * = Plane-wave equivalent power density.

Appropriate RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment) can be found in table 4 of RSS-102, section 4:

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10	83	90	-	Instantaneous*
0.1-10	-	0.73/f	-	6**
1.1-10	87/f ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/f ^{0.25}	0.1540/f ^{0.25}	8.944/f ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 f ^{0.3417}	0.008335 f ^{0.3417}	0.02619 f ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/f ^{1.2}
150000-300000	0.158 f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/f ^{1.2}

Note: f is frequency in MHz.

*Based on nerve stimulation (NS).

** Based on specific absorption rate (SAR).

Table 17: RF field strength limits according to table 4 of RSS-102



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6.9.3 Results

Maximum peak value of electric field strength measured at 2440.0 MHz in a distance of 3 m:
 $E_{\text{meas}}(3 \text{ m}) = \underline{101.62 \text{ dB}\mu\text{V/m}}$ (see clause 6.5)

For far-field conditions wave impedance in free space is about $120 \cdot \pi \ \Omega$ (51.5 dB). Therefore, magnetic field strength results in:

$$H_{\text{meas}}(3 \text{ m}) = E_{\text{meas}}(3 \text{ m}) - 51.5 \text{ dB} = 101.62 \text{ dB}\mu\text{V/m} - 51.5 \text{ dB} = \underline{50.12 \text{ dB}\mu\text{A/m}}$$

Worst case field strength is calculated for a separation distance of 20 centimeters.

Using an extrapolation factor of 20 dB/decade ($\sim r^{-1}$) results in:

$$E_{\text{calc}}(20 \text{ cm}) = 101.62 \text{ dB}\mu\text{V/m} - 20 \cdot \log(0.2 \text{ m} / 3 \text{ m}) = 101.62 \text{ dB}\mu\text{V/m} + 23.52 \text{ dB}$$

$$E_{\text{calc}}(20 \text{ cm}) = 125.14 \text{ dB}\mu\text{V/m} = \underline{1.808 \text{ V/m}}$$

Using an extrapolation factor of 20 dB/decade ($\sim r^{-1}$) results in:

$$H_{\text{calc}}(20 \text{ cm}) = 50.12 \text{ dB}\mu\text{A/m} - 20 \cdot \log(0.2 \text{ m} / 3 \text{ m}) = 50.12 \text{ dB}\mu\text{A/m} + 23.52 \text{ dB}$$

$$H_{\text{calc}}(20 \text{ cm}) = 73.64 \text{ dB}\mu\text{A/m} = \underline{4.809 \cdot 10^{-3} \text{ A/m}}$$

Worst case power density is calculated for a separation distance of 20 centimeters by using the respective field strengths for an extrapolation factor of 20 dB/decade ($\sim r^{-1}$):

$$S_{\text{calc}}(20 \text{ cm}) = E_{\text{calc}}(20 \text{ cm}) \cdot H_{\text{calc}}(20 \text{ cm}) = 1.807 \text{ V/m} \cdot 4.808 \cdot 10^{-3} \text{ A/m}$$

$$S_{\text{calc}}(20 \text{ cm}) = \underline{0.0087 \text{ W/m}^2} = \underline{0.00087 \text{ mW/cm}^2}$$

Comparing the calculated results to the limits for general population/uncontrolled exposure at 2400.0 MHz shows that even with worst case calculation using peak values the limits are kept.

E-field			
$E_{\text{calc}}(20 \text{ cm})$ (V/m)	Limit 47 CFR Par 1, §1.1310(e) (V/m)	Limit RSS-102, table 2 (V/m)	
1.808	---	44.898	
H-field			
$H_{\text{calc}}(20 \text{ cm})$ (A/m)	Limit 47 CFR Par 1, §1.1310(e) (A/m)	Limit RSS-102, table 2 (A/m)	
0.0048	---	0.119	
Power density			
$S_{\text{calc}}(20 \text{ cm})$ (mW/cm ²)	Limit 47 CFR Par 1, §1.1310(e) (mW/cm ²)	$S_{\text{calc}}(20 \text{ cm})$ (W/m ²)	Limit RSS-102, table 2 (W/m ²)
0.00087	1.0	0.0087	5.348

Table 18: Calculated results compared to RF field strength limits



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7 Equipment calibration status

Description	Modell number	Serial number	Inventory number(s)	Last calibration	Next calibration
Test receiver	ESCI 3	100013	E00001	2016-02	2018-02
Test receiver	ESCI 3	100328	E00552	2016-09	2018-09
Test receiver	ESCS 30	825442/0002	E00003	2016-04	2018-04
Test receiver	ESU 26	100026	W00002	2016-02	2018-02
Test receiver	ESR 7	101059	E00739	2016-02	2018-02
Test receiver	ESW 44	101538	E00895	2016-12	2018-12
Broadband horn antenna	BBHA 9120D	9120D-592	W00052	2017-04	2020-04
Broadband horn antenna	BBHA 9170	9170-332	W00054	2017-04	2020-04
Preamplifier	AMF-5D-00501800-28-13P	1319793	W00089	2015-06	2017-06
Preamplifier	AMF-6F-16002650-25-10P	1317552	W00090	2015-06	2017-06
LISN	ESH2-Z5	893406/009	E00005	2016-02	2018-02
Loop antenna	HFH2-Z2	871398/0050	E00060	2016-09	2018-09
Broadband antenna	VULB 9163	9163-228	E00012	2016-04	2019-04
Broadband antenna	VULB 9163	9163-114	E00013	2015-09	2017-09
Shielded room	P92007	B83117C1109T211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Open area test site (OATS)	---	---	E00354	2015-10	2017-10
Semi anechoic chamber (SAC)	SAC3	C62128-A520-A643-x-0006	E00716	2015-09	2017-09
Climatic chamber 340 I	VC ³ 4034	58566123250010	C00015	2016-10	2018-10
Cable set shielded room	Cable no. 30	---	E00424	2016-07	2018-07
Cable set CDC	Cables no. 37 and 38	---	E00459 E00460	2015-05	2017-05
Cable set OATS 3 m	Cables no. 19, 34 and 36	---	E00453 E00456 E00458	2015-11	2017-11
Cable set SAC 3 m	Cables no. 57, 58 and 59	---	E00453 E00455 E00458	2015-10	2017-10

Table 19: Equipment calibration status

- Note 1: Expiration date of measurement facility registration by
 - FCC (registration number 221458): 2017-07
 - Industry Canada (test sites number 3472A-1 and 3472A-2): 2018-11
- Note 2: Expiration date of test firm accreditation for OATS and SAC:
 FCC test firm type "accredited": 2017-06



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8 Measurement uncertainties

Description	Max. deviation	k=
Conducted emission AMN (9kHz to 30 MHz)	± 4.1 dB	2
Carrier frequency separation Number of hopping frequencies Time of occupancy (dwell time)	± 5.0 %	2
Bandwidth tests	± 2.0 %	2
Maximum conducted output power	± 1.5 dB	2
Power spectral density	± 3.0 dB	2
Spurious RF conducted emissions	± 3.0 dB	2
Radiated emission open field or semi-anechoic chamber 9 kHz to 30 MHz 30 MHz to 300 MHz 300MHz to 1 GHz	± 4.8 dB ± 5.4 dB ± 5.9 dB	2
Radiated emission anechoic chamber (> 1000 MHz)	± 4.5 dB	2

Table 20: Measurement uncertainty

The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k. For a confidence level of 95 % the coverage factor k is 2.



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9 Revision history

<i>Revision</i>	<i>Date</i>	<i>Issued by</i>	<i>Description of modifications</i>
0	2017-05-02	Martin Müller	First edition

10 Additional documents

- Annex A: Pictures of test setup and EUT-positions
- Annex B: Pictures of EUT (external)
- Annex C: Pictures of EUT (internal)



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