EMI – TEST REPORT

- FCC Part 15.247, RSS-247 -

Type / Model Name : Medical Thermometer/degree°/DS02, DC02

Product Description : clinical thermometer

Applicant : Cosinuss GmbH

Address : Kistlerhofstr. 60

81379 München, GERMANY

Manufacturer : Cosinuss GmbH

Address : Kistlerhofstr. 60

81379 München, GERMANY

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

Test Report No. : T44704-00-01WP	03. September 2019 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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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (February 2019)

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 (February 2019)

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

ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2
KDB 558074 D01 v05	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum, and hybrid systems operating under section 15.247 of the FCC rules, August 24, 2018.

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – Detailed photos see ATTACHMENTS A, B

2.2 Equipment type

BLE device

2.3 Short description of the equipment under test (EUT)

The EUT is a Bluetooth Low Energy wireless clinical thermometer. A single chip antenna is used within the system. The EUT has only one integrated antenna, no temporary connector and no external antenna can be connected. The modulation used by the EUT is GFSK with a data rate of 1 Mbit/s.

Number of tested samples: 1
Serial number: DS02
Firmware version: 1.0

2.4 Variants of the EUT

There are no variants.

2.5 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan BT-Standard 802.15.1:

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

Note: the marked frequencies are determined for final testing.

2.6 Transmit operating modes

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

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

2.7 Antennas

The following antennas shall be used with the EUT:
The EUT has only an integrated PCB antenna, no external antenna shall be connected. The following chip antenna is soldered on the PCB:

Type	Model number	Frequency range (GHz)	Peak gain (dBi)
Chip Antenna	ANT016008LCS2442MA2	2.4 – 2.484	2.5

2.8 Power supply system utilised

Power supply voltage, V_{nom} : 3.7 V DC

2.9 Peripheral devices and interface cables

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

- USB_UART converter Model : FTDI232, supplied by manufacturer
- - Model : -
- - Model : -

2.10 Determination of worst case conditions for final measurement

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

The tests are carried out in the following frequency band:

2400 MHz – 2483.5 MHz

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

Wireless system	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
802.15.1	0 to 39	37,17,39	-1 dBm	DSSS	GFSK	1000 kbps

- TX continuous mode

2.10.1 Test jig

No special test jig was used. However, cables were soldered to the PCB to connect the USB UART converter to control the EUT.

2.10.2 Test software

Special test software was installed on the EUT, allowing the control of the RF part via a special programming cable.

3 TEST RESULT SUMMARY

BLE device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	not applicable
15.247(a)(2)	RSS-247, 6.2.4(1)	-6 dB EBW	passed
15.247(b)(3)	RSS-247, 6.2.4(1)	Maximum peak conducted output power	passed
15.247(b)(4)	-	Defacto limit	passed
15.247(d)	RSS-247, 6.2.4(2)	Out-of-band emission, radiated	passed
15.247(d)	RSS-Gen, 8.9	Emissions in restricted bands	passed
15.247(e)	RSS-247, 6.2.4(1)	PSD	passed
15.35(c)	RSS-Gen, 6.10	Pulsed operation	passed
15.203	RSS-Gen, 6.6	Antenna requirement	passed
-	RSS-Gen, 6.11	Transmitter frequency stability	not applicable
-	RSS-Gen, 6.6	99 % Bandwidth	passed

The mentioned new RSS Rule Parts in the above table are related to:
RSS-Gen, Issue 5, April 2018
RSS-247, Issue 2, February 2017

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 : 15 February 2019

Testing concluded on : 24 July 2019

Checked by:

Juergen Pessinger
2019.09.09 09:27:00
+02'00'

Jürgen Pessinger
Radio Team

Issued by:

Willibald Probst
2019.09.03 16:18:29
+02'00'

Willibald Probst
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.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	± 2.71 dB
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	± 2.71 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	± 2.15 dB
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	± 3.47 dB
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	± 3.53 dB
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	± 4.44 dB
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	± 2.34 dB
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	± 5.13 dB

4.4 Measurement protocol for FCC and ISED

4.4.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011
ISED: DE0009

4.4.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

4.4.2.1 Justification

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

4.4.2.2 Radiated emission (electrical field 30 MHz - 1 GHz)

Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.10.The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees.
The final level in dBµV/m is calculated by taking the reading from the EMI receiver (Level dBµV) and adding the correction factors and cable loss factor (dB). The FCC or CISPR limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency Delta (MHz)	Level (dBµV)	+	Factor (dB)	=	Level (dBµV/m)	-	CISPR Limit (dBµV/m)	=	(dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

4.4.2.3 Radiated emission (electrical field 1 GHz - 40 GHz)

Radiated emissions from the EUT are measured in the frequency range 1 GHz up to the maximum frequency as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table, 1.5 metre above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is following set out in ANSI C63.10. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion, so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyzer set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty and are calculated at the specified test distance.

5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

Remarks: Not applicable as the EUT is DC powered and has no AC mains connections.

5.2 EBW and OBW

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

5.2.1 Description of the test location

Test location: AREA4

5.2.2 Photo documentation of the test set-up

For test setup photos see T44704-00 ATTACHMENT C

5.2.3 Applicable standard

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

5.2.4 Description of Measurement

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

Spectrum analyser settings for EBW:
RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Sweep time: auto, Span: 3 MHz

Spectrum analyser settings for OBW:
RBW: 1-5% OBW, VBW: 3 RBW, Detector: Max peak, Sweep time: auto, Span: 3 MHz

5.2.5 Test result

6 dB BW:

Channel	Centre frequency (MHz)	6 dB bandwidth (kHz)	Minimum limit (MHz)
37	2402	694.60	0.5
17	2440	690.30	0.5
39	2480	681.60	0.5

99% OBW

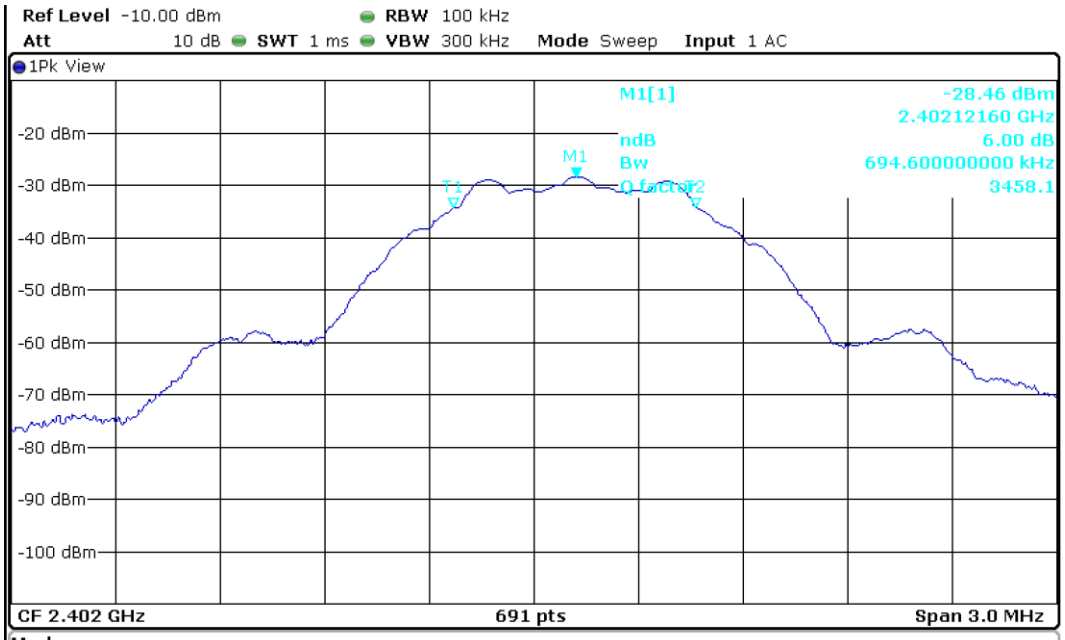
Channel	Centre frequency (MHz)	99 % bandwidth (kHz)
37	2402	1033.28
17	2440	1037.62
39	2480	1033.28

The requirements are **FULFILLED.**

Remarks: For detailed test result please see the following test protocols

5.2.6 Test protocols EBW

2402 MHz:

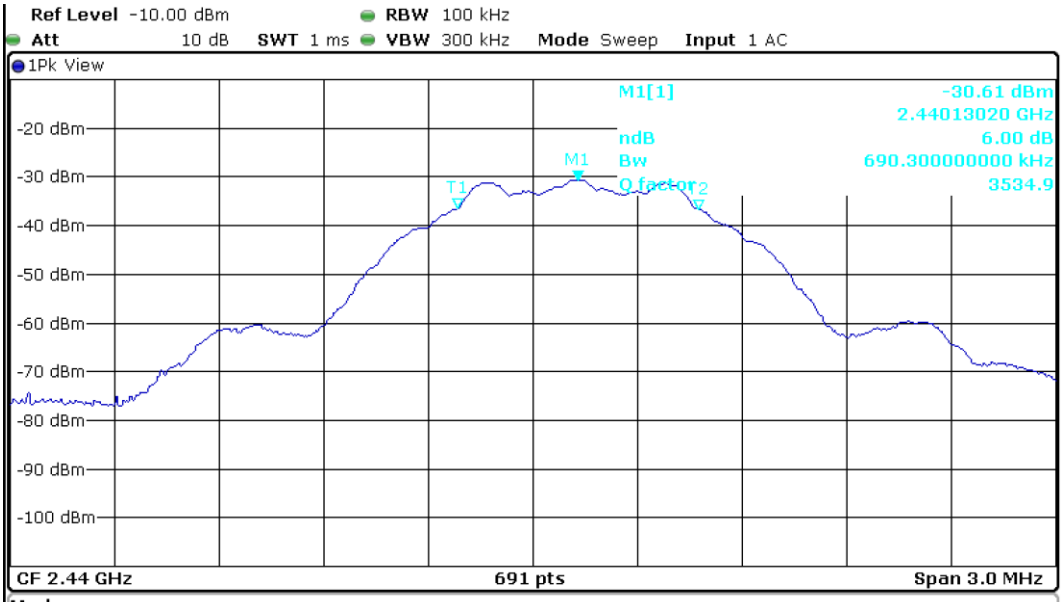


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4021216 GHz	-28.46 dBm	ndB down	694.6 kHz
T1		1	2.4017699 GHz	-34.42 dBm	ndB	6.00 dB
T2		1	2.4024645 GHz	-34.39 dBm	Q factor	3458.1

FCC ID: 2ATBZDS02DC02 **IC: 25048-DS02DC02**

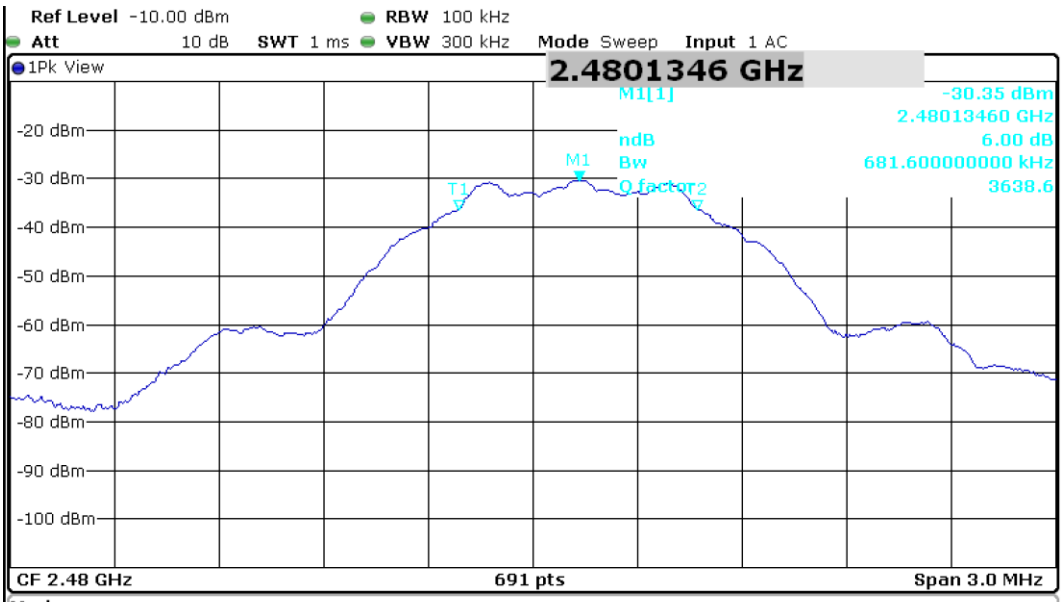
2440 MHz:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4401302 GHz	-30.61 dBm	ndB down	690.3 kHz
T1		1	2.4397829 GHz	-36.51 dBm	ndB	6.00 dB
T2		1	2.4404732 GHz	-36.58 dBm	Q factor	3534.9

2480 MHz:



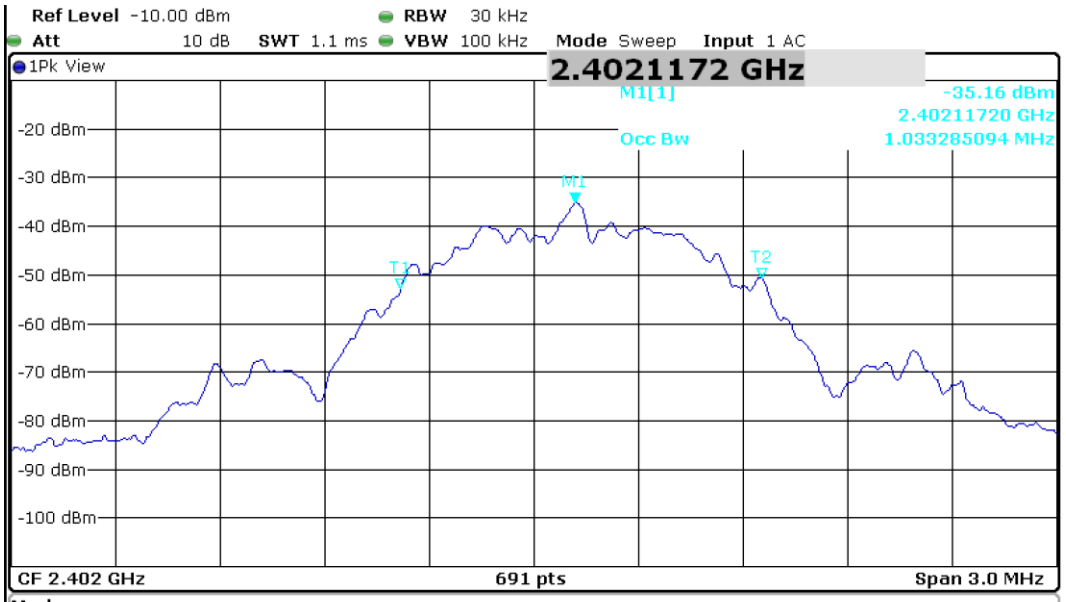
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4801346 GHz	-30.35 dBm	ndB down	681.6 kHz
T1		1	2.4797873 GHz	-36.42 dBm	ndB	6.00 dB
T2		1	2.4804689 GHz	-36.32 dBm	Q factor	3638.6

FCC ID: 2ATBZDS02DC02 **IC: 25048-DS02DC02**

5.2.7 Test protocols OBW

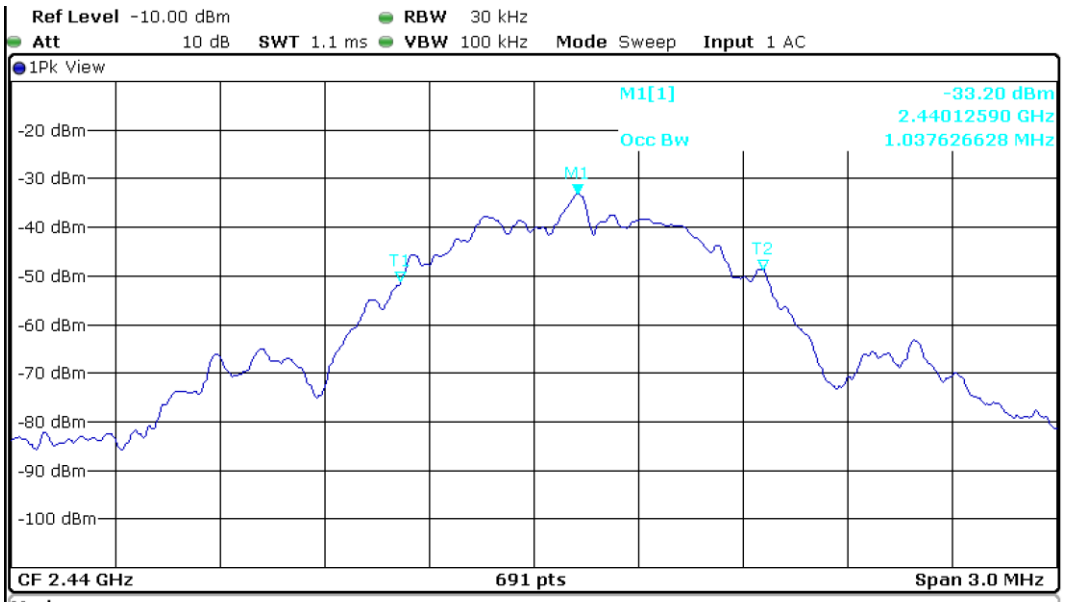
2402 MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4021172 GHz	-35.16 dBm		
T1		1	2.40161795 GHz	-52.87 dBm	Occ Bw	1.033285094 MHz
T2		1	2.40265123 GHz	-50.71 dBm		

2440 MHz:

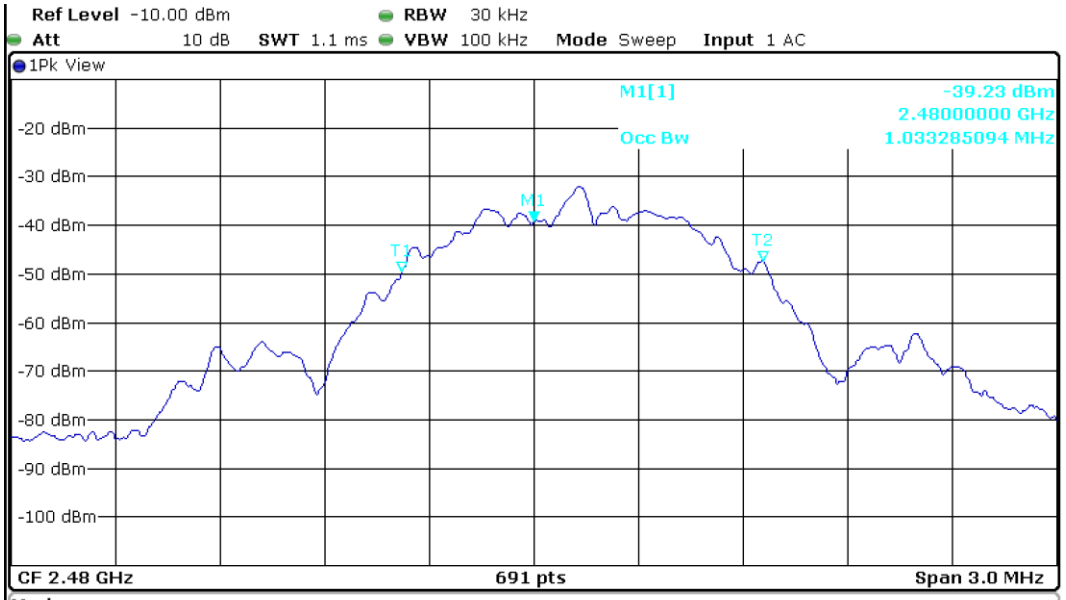


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4401259 GHz	-33.20 dBm		
T1		1	2.43961795 GHz	-51.26 dBm	Occ Bw	1.037626628 MHz
T2		1	2.44065557 GHz	-48.68 dBm		

FCC ID: 2ATBZDS02DC02 **IC: 25048-DS02DC02**

2480 MHz:



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Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48 GHz	-39.23 dBm		
T1		1	2.47962229 GHz	-49.38 dBm	Occ Bw	1.033285094 MHz
T2		1	2.48065557 GHz	-47.42 dBm		

5.3 Maximum peak radiated output power

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

5.3.1 Description of the test location

Test location: Anechoic chamber 1

5.3.2 Photo documentation of the test set-up

For test setup photos see T44704 -00 ATTACHMENT C

5.3.3 Applicable standard

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

5.3.4 Description of Measurement

The maximum peak conducted output power is measured using a spectrum analyser following the procedure set out in KDB 558074, item 8.3.1. The EUT is set in TX continuous mode while measuring.

5.3.5 Test result

802.15.1, 1000 kbps, TX		Test results radiated			
		Fieldstrength E (dBµV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: 2402 MHz					
T_{nom}	V_{nom}	92.8	-2.4	36.0	-38.4
Middle frequency: 2440 MHz					
T_{nom}	V_{nom}	92.2	-3.0	36.0	-39.0
Highest frequency: 2480 MHz					
T_{nom}	V_{nom}	94.2	-1.1	36.0	-37.1

802.15.1, 1000 kbps, TX		Test results conducted (calculated values)				
		EIRP (dBm)	Antenna Gain (dBi)	Conducted Power (dBm)	Conducted Limit (dBm)	Margin (dB)
Lowest frequency: 2402 MHz						
T_{nom}	V_{nom}	-2.4	2.5	-4.9	30.0	-34.9
Middle frequency: 2440 MHz						
T_{nom}	V_{nom}	-3.0	2.5	-5.5	30.0	-35.5
Highest frequency: 2480 MHz						
T_{nom}	V_{nom}	-1.1	2.5	-3.6	30.0	-33.6

FCC ID: 2ATBZDS02DC02 **IC: 25048-DS02DC02**

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

Frequency (MHz)	Peak Power Limit (radiated)		Peak Power Limit (conducted)	
	(dBm)	(W)	(dBm)	(W)
902-928	36	4.0	30	1
2400-2483.5	**36**	**4.0**	**30**	**1**
5725-5850	36	4.0	30	1

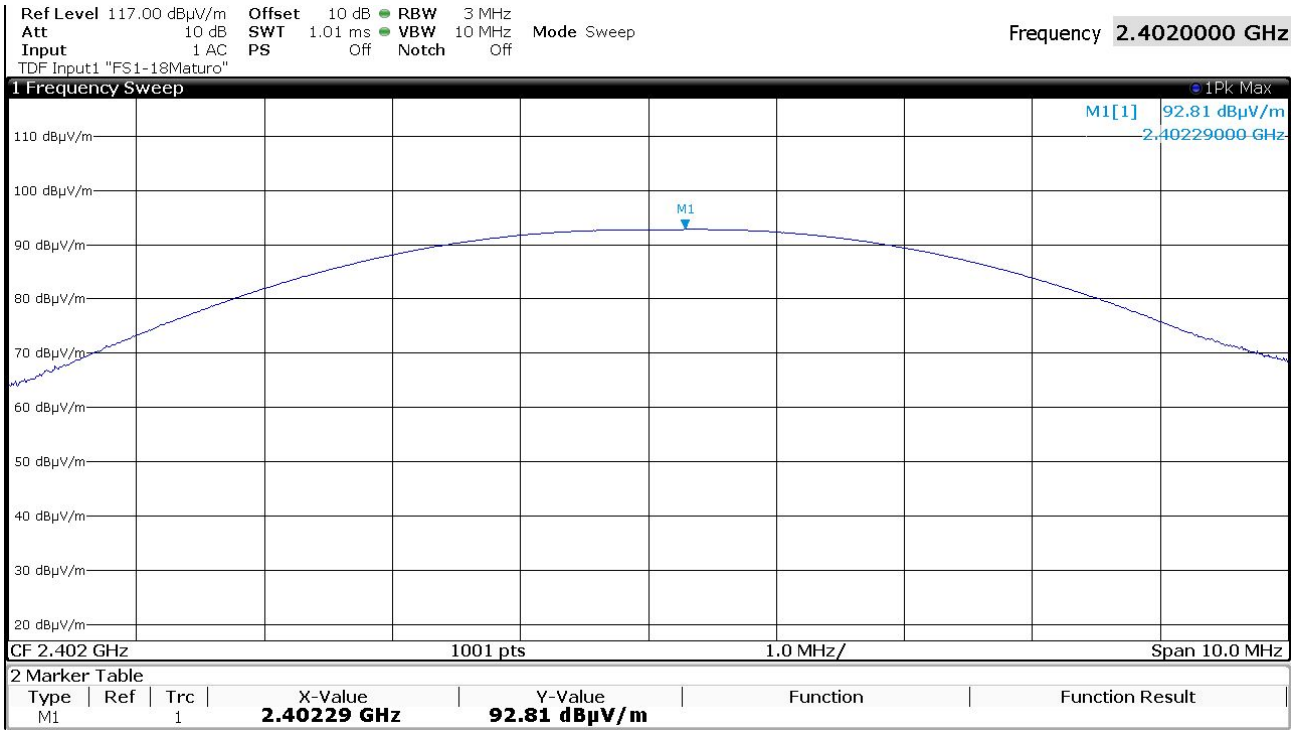
The requirements are **FULFILLED.**

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

-

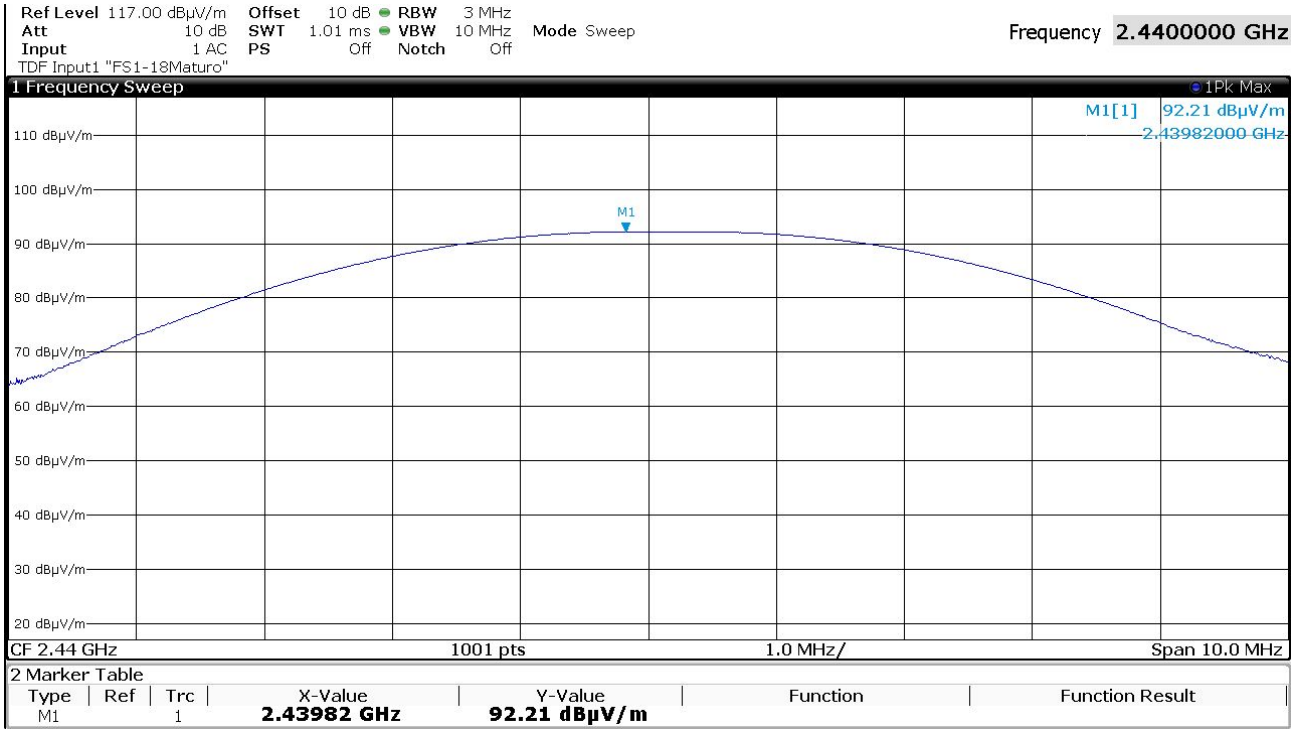
5.3.6 Test protocols

2402 MHz:

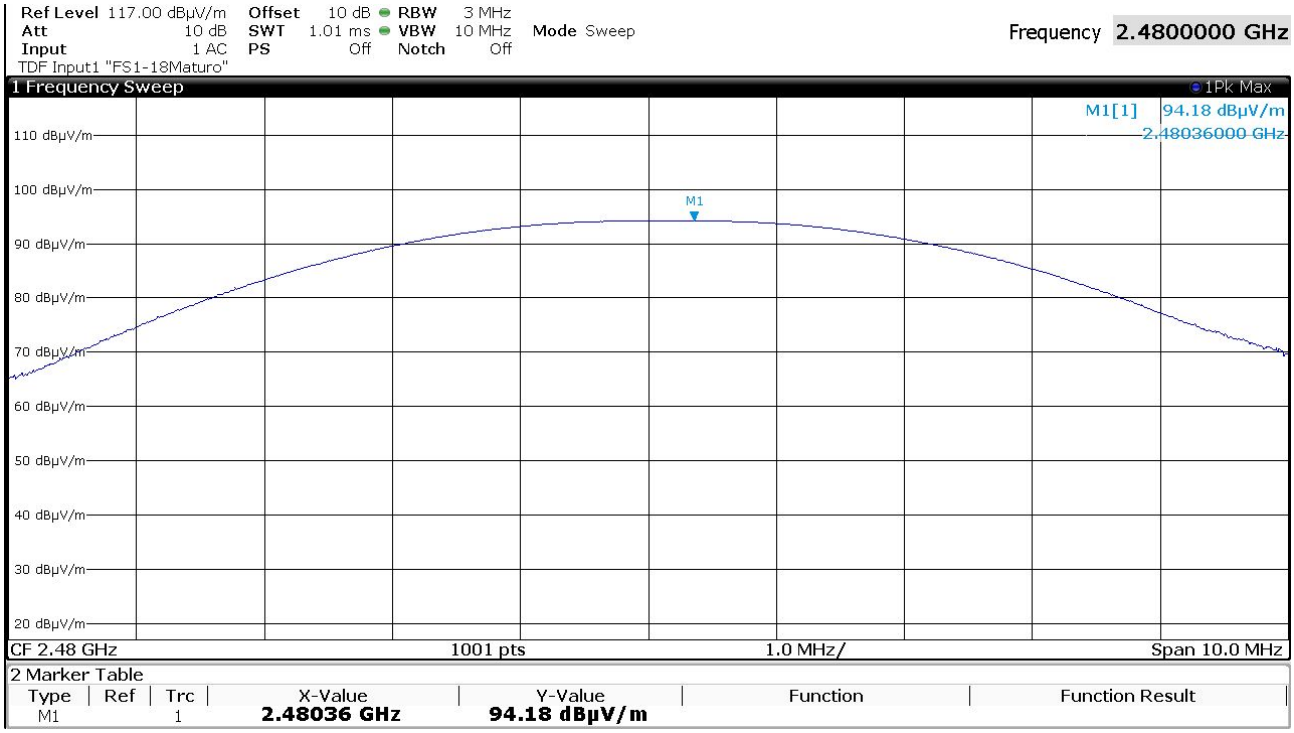


FCC ID: 2ATBZDS02DC02 **IC: 25048-DS02DC02**

2440 MHz:



2480 MHz:



5.4 Power spectral density

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

5.4.1 Description of the test location

Test location: AREA4

5.4.2 Photo documentation of the test set-up

For test setup photos see T44704-00 ATTACHMENT C

5.4.3 Applicable standard

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

5.4.4 Description of Measurement

The measurement is performed using the procedure 8.4 set out in KDB-558074. The max peak was located and measured with the spectrum analyser and the marker set to peak. The measurement has been done relative using an antenna fixture. To adjust the power levels to the levels that have been measured during the measurement of the peak radiated output power an offset has been set.

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

5.4.5 Test result

802.15.1, 1000 kbps, 1 TX		**Test results radiated**			
		PD [Pmax] (dBµV/m /3kHz)	PD [Pmax] (dBm/3kHz)	EIRP Limit (dBm/3kHz)	Margin (dB)
Lowest frequency: 2402 MHz					
T_{nom}	V_{nom}	72.4	-22.8	14.0	-36.8
Middle frequency: 2440 MHz					
T_{nom}	V_{nom}	74.9	-20.3	14.0	-34.3
Highest frequency: 2480 MHz					
T_{nom}	V_{nom}	75.5	-19.8	14.0	-33.8

FCC ID: 2ATBZDS02DC02 IC: 25048-DS02DC02

802.15.1, 1000 kbps, 1 TX		Test results conducted (calculated values)				
		PD radiated [Pmax] (dBm/3kHz)	Antenna Gain (dBi)	PD conducted [Pmax] (dBm/3kHz)	Conducted limit (dBm/3kHz)	Margin (dB)
Lowest frequency: 2402 MHz						
T_{nom}	V_{nom}	-22.8	2.5	-25.3	8.0	-33.3
Middle frequency: 2440 MHz						
T_{nom}	V_{nom}	-20.3	2.5	-22.8	8.0	-30.8
Highest frequency: 2480 MHz						
T_{nom}	V_{nom}	-19.8	2.5	-22.3	8.0	-30.3

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

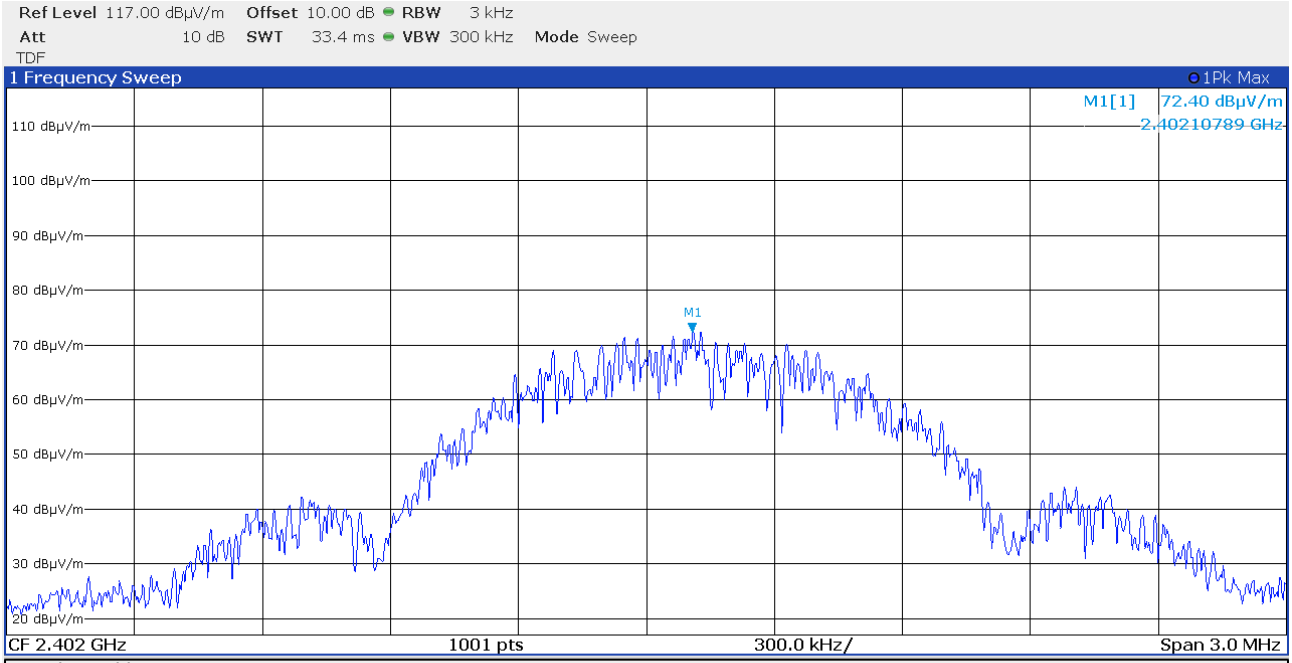
Frequency (MHz)	Power spectral density limit (EIRP) (dBm/3 kHz)	Power spectral density limit (conducted) (dBm/3 kHz)
2400 - 2483.5	14	8

The requirements are **FULFILLED.**

Remarks: For detailed test result please see the following test protocols

5.4.6 Test protocols

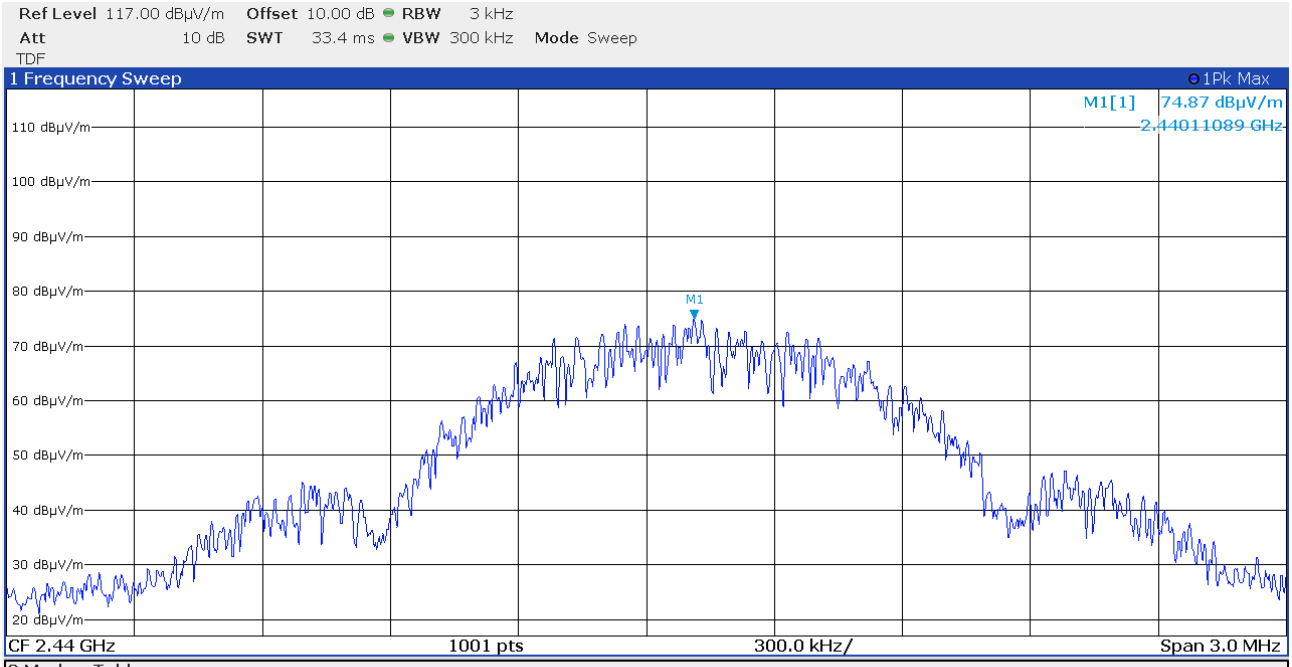
2402 MHz:



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.40210789 GHz**	**72.40 dBµV/m**		

2440 MHz:



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.44011089 GHz**	**74.87 dBµV/m**		

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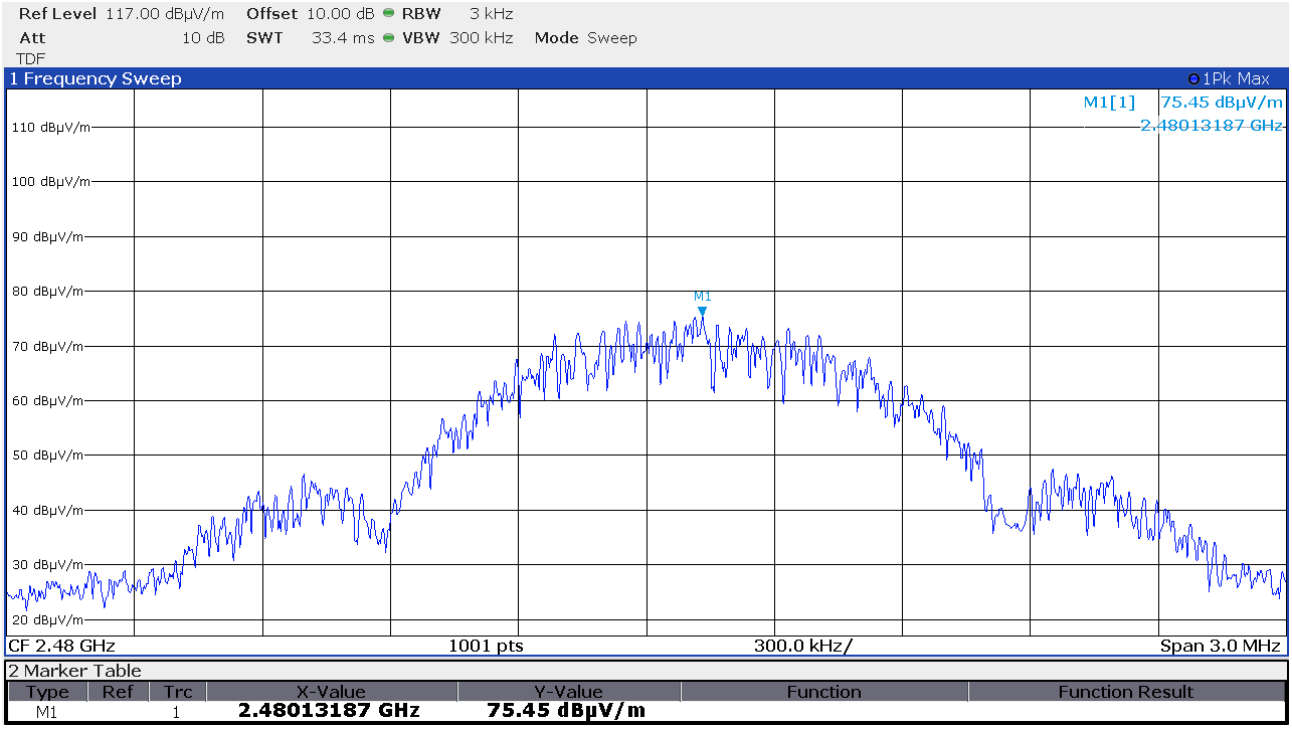
2480 MHz:



5.5 Correction for pulse operation (duty cycle)

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

5.5.1 Description of the test location

Test location: AREA4

5.5.2 Photo documentation of the test set-up

For test setup photos see T44704-00 ATTACHMENT C

5.5.1 Applicable standard

According to FCC Part 15A, Section 15.35(c):
When the radiated emission limits are expressed in terms of average value and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete puls train, including blanking intervals, as long as the pulse train does not exceed 0.1s. In cases where the puls train exceeds 0.1s, the measured field strength shall be determined from the average absolute voltage during a 0.1s interval during which the field strength is at its maximum. The exact method of calculating the average field strength shall be submitted.

5.5.2 Description of Measurement

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

$$\delta(dB) = 20\log(\Delta)$$

with

$$\Delta = \frac{t_{on}}{T}$$

δ is the duty cycle correction factor (dB)
Δ ist the duty cycle (dimensionsless)
t_{on} maximum pulse on time
T period of the pulse train

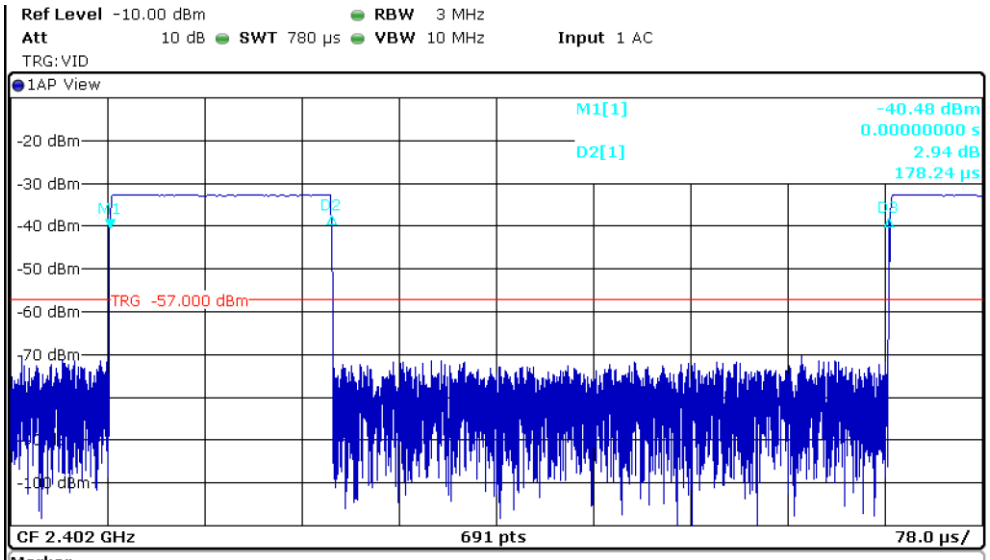
5.5.3 Test result

t_{on} (µs)	T (µs)	δ (dB)
178.24	625.99	-10.9

Remarks: _____

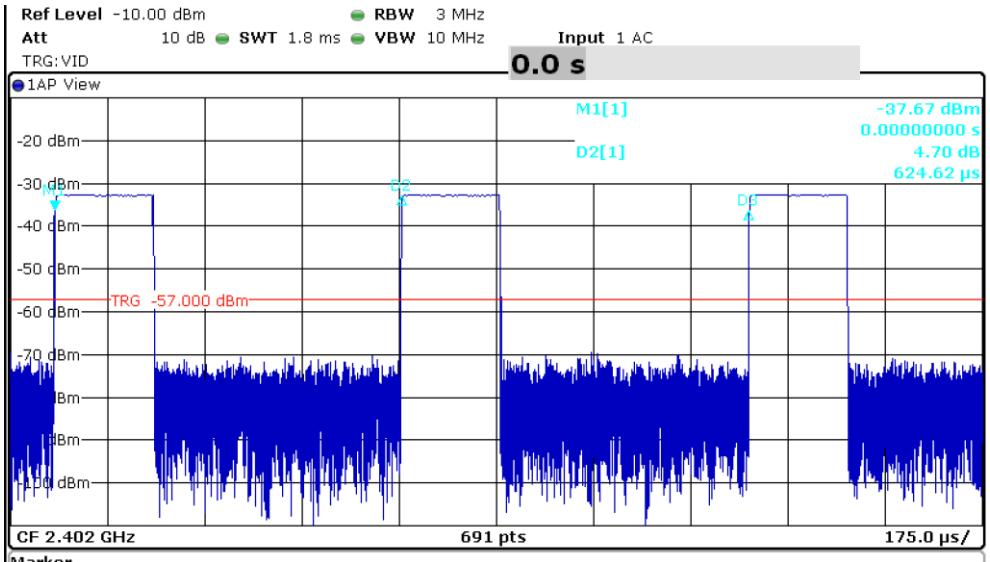
5.5.4 Test protocol

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

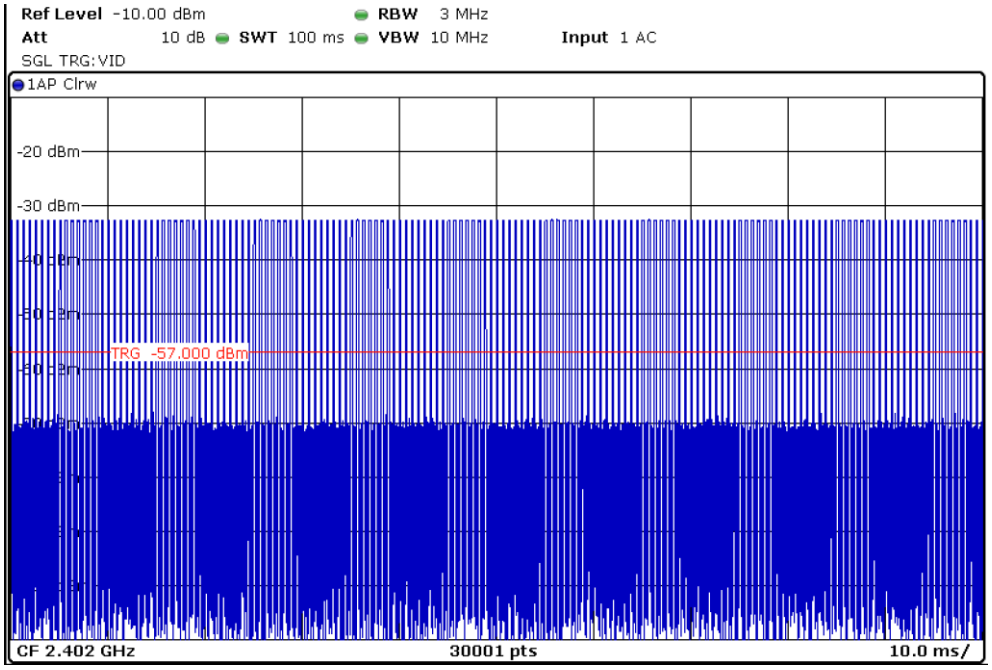


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	0.0 s	-40.48 dBm		
D2	M1	1	178.24 µs	2.94 dB		
D3	M1	1	625.89 µs	2.24 dB		



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	0.0 s	-37.67 dBm		
D2	M1	1	624.62 µs	4.70 dB		
D3	M1	1	1.2498 ms	1.33 dB		

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