EMI – TEST REPORT

- FCC Part 15.249, RSS210 -

Type / Model Name : OPUS 4 (internal development name), SONNET 2 / SONNET 2 EAS (market name), product codes: Me1510, Me1511, Me1512, Me1513 / Me1520, Me1521, Me1522, Me1523

Product Description : Audio processor for cochlear implant including an inductive remote control receiver and a 2.4 GHz transceiver with integral antenna

Applicant : MED-EL Elektromedizinische Geraete GmbH

Address : Fuerstenweg 77a
6020 INNSBRUCK, AUSTRIA

Manufacturer : MED-EL Elektromedizinische Geraete GmbH

Address : Fuerstenweg 77a
6020 INNSBRUCK, AUSTRIA

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

Test Report No. : T42255-03-01KS	28. February 2019 Date of issue

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

CSA Group Bayern GmbH
Ohmstrasse 1-4 · 94342 STRASSKIRCHEN · GERMANY
Tel.: +49(0)9424-94810 · Fax: +49(0)9424-9481440

FCC ID: VNP-ME1500 IC: 11986A-ME1500

Contents

FCC ID: VNP-ME1500 IC: 11986A-ME1500

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (December, 2018)

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 (December, 2018)

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 C63.10: 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

FCC ID: VNP-ME1500 IC: 11986A-ME1500

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – See Attachment A

2.2 General remarks

The EUT contains an inductive remote control receiver and a 2.4 GHz transceiver with integral antenna. The radio frequency of the inductive link is 9.07 kHz, the 2.4 GHz transceiver operates in the frequency band 2.400 GHz - 2.4835 GHz.
In this test report, only the 2.4Ghz proprietary mode is considered.

2.3 Equipment category

2.4 GHz transceiver, portable equipment.

2.4 Short description of the equipment under test (EUT)

The OPUS 4 (internal development name) is an audio processor for a MED-EL cochlear implant including an inductive remote control receiver and a 2.4 GHz transceiver with integral antenna.

Market name: SONNET 2 / SONNET 2 EAS
Product codes: Me1510, Me1511, Me1512, Me1513 / Me1520, Me1521, Me1522, Me1523*.

The OPUS 4 is a medical device similar to a hearing aid. It is worn behind the ear, converts acoustic signals and drives an implanted MED-EL cochlear implant which – based on the information from the audio processor – directly stimulates the acoustic nerve in the inner ear to evoke auditory sensations.
The inductive remote control receiver picks up commands from an external remote control (FineTuner, not part of this testing) which is an accessory to the OPUS 4 that allows the user to modify various parameters as e.g. volume or microphone sensitivity of the OPUS 4.
Similar to the inductive remote control receiver the 2.4 GHz transceiver can receive commands from an external device (e.g. remote control, remote programmer etc.). Additionally, it can transmit acknowledge messages to this external device (the external device is currently under development and not part of this testing).

* The only difference between the devices with the product code Me152x (x = 0, 1, 2, or 3) and the devices with the product code Me151x is that the devices with the product code Me151x do not contain acoustic hearing aid functionality, i.e. do not contain an acoustic only output ("loudspeaker"). The devices with the product code Me152x are referred to as EAS (electric acoustic stimulation) devices. The product code of the control unit determines the product code of the entire audio processor.
The sub variants Me1510, Me1511, Me1512, and Me1513 do not differ in hardware and / or firmware, they just differ in product code. The same is true for the sub variants Me1520, Me1521, Me1522, and Me1523, i.e. they do not differ in hardware and / or firmware, they just differ in product code. These different sub variants are only introduced for marketing and sales purposes. Given the above, testing of only the variant Me1520 is sufficient and representative for all variants.

Number of tested samples: 1 x OPUS 4 CPU EAS (Me1520), ser. no. 000066

The following peripheral devices were used during the measurements:

Battery pack: 1 x SONNET Battery Pack (Ma060106), ser. no. 048685

Coil: 1 x DL Coil, ser. No. 015442

2.5 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

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

Note: the marked frequencies are determined for final testing.

2.6 EUT operation modes

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

- Cont. TX at CH1, CH19 and CH39

2.7 Antenna

The following antennas shall be used with the EUT:

Number	Type	Certification name	Plug	*f*-range	Gain (dBi)
1	Chip antenna	Fractus FR05-S1-N-0-110	none	2.4 GHz – 2.5 GHz	0.2

2.8 Power supply system utilised

Power supply voltage, V_{nom} : 2.3 VDC Battery

FCC ID: VNP-ME1500 IC: 11986A-ME1500

2.9 Peripheral devices and interface cables

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

- - Model : -
- - Model : -
- Model :

2.10 Determination of worst case conditions for final measurement

Measurements have been made in all three orthogonal axes of the EUT to locate at which position the EUT produces the maximum of the emissions.

The EUT uses GFSK and provides following data rate:

2 Mbps (Mbps = *Megabits per second)*

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

Standard	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
Proprietary	1 to 39	1, 19, 39	4 dBm	GFSK	digital	2 Mbps

2.10.1 Test jig

No special test jig was used.

2.10.2 Test software

The test software for the EUT provides the special test modes continuous TX unmodulated (CW), continuous TX unmodulated (bursts), continuous TX modulated (bursts) and the channel setting.

FCC ID: VNP-ME1500 IC: 11986A-ME1500

3 TEST RESULT SUMMARY

Operating in the 2400 MHz – 2483.5 MHz band:

FCC Rule Part	RSS Rule Part	Description	Result
15.35(c)	RSS-Gen, 8.2	Pulsed operation	passed
15.203	RSS-Gen, 6.8	Antenna requirement	passed
15.204	RSS-Gen, 8.3	External radio frequency power amplifiers	not applicable
15.205(a)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	not applicable
15.215(c)	-	EBW	passed
-	RSS-Gen, 6.7	OBW	passed
15.249(a)	RSS-210, B10(a)	Field strength of fundamental	passed
15.249(d)	RSS-210, B10(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 5, April 2018
RSS-210, Issue 9, August 2016

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 : 01 February 2019

Testing concluded on : 14 February 2019

Checked by:

Klaus Gegenfurtner
I confirm the correctness and integrity of this document.
2019.02.28 11:11:58 +01'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Kathrin Schiebl
I am the author of this document
2019.02.28 09:53:10 +01'00'

Kathrin Schiebl
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%	± 2.5 x 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

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

IC 3009A-1

The Anechoic chamber is a listed test site under the Canadian Test-Sites File-No:

IC 3009A-2

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 (MHz)	Level (dBµV)	+	Factor (dB)	=	Level (dBµV/m)	-	CISPR Limit (dBµV/m)	=	Delta (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.

FCC ID: VNP-ME1500 IC: 11986A-ME1500

5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

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

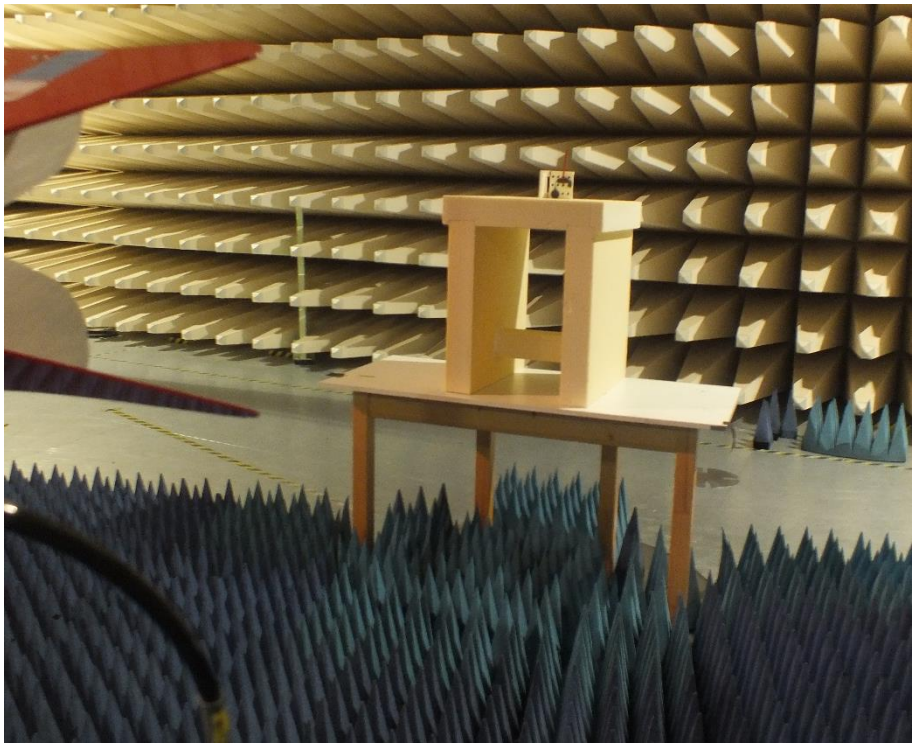
5.2 Field strength of fundamental

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

5.2.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.2.2 Photo documentation of the test set-up



5.2.3 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.

5.2.4 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 modulated under normal conditions.

Analyser settings:
Peak measurement: RBW: 3 MHz VBW: 10 MHz Detector: Max peak

5.2.5 Test result

Frequency	Level PK	Limit PK	Margin PK	Level AV	Limit AV	Margin AV
(MHz)	dB(µV/m)	dB(µV/m)	(dB)	dB(µV/m)	dB(µV/m)	(dB)
2404	95.0	114.0	-19.0	77.8	94.0	-16.2
2440	93.8	114.0	-20.2	76.6	94.0	-17.4
2480	93.4	114.0	-20.6	76.2	94.0	-17.8

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

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

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

The requirements are **FULFILLED.**

Remarks: -

5.3 Out-of-band emission, radiated

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

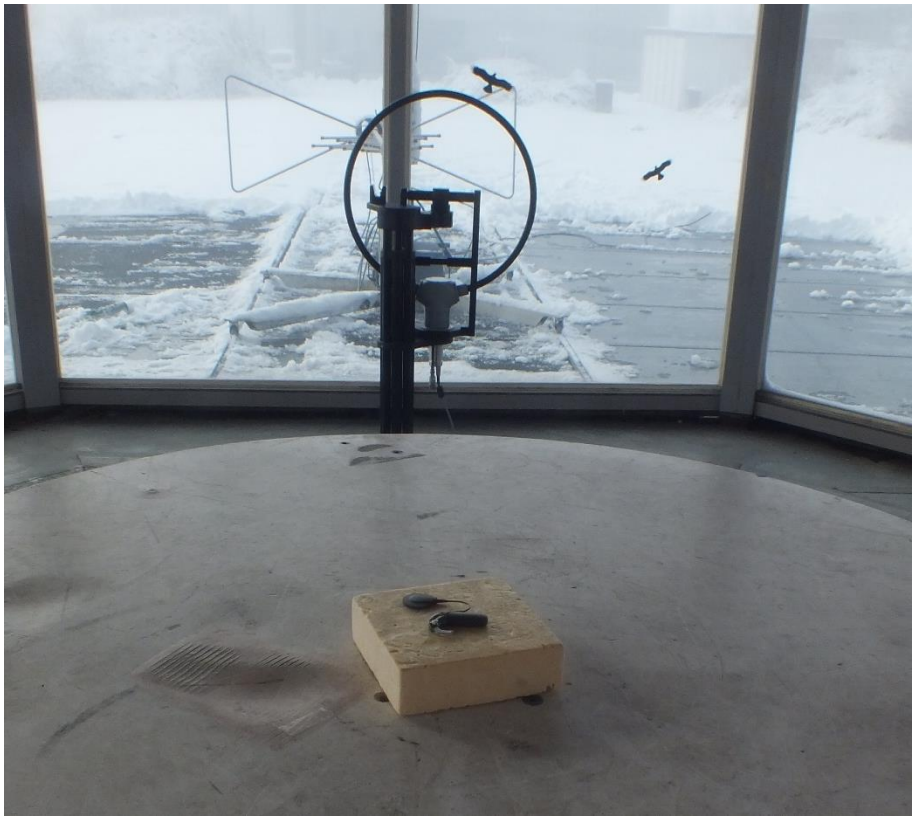
5.3.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 1

Test distance: 3 m

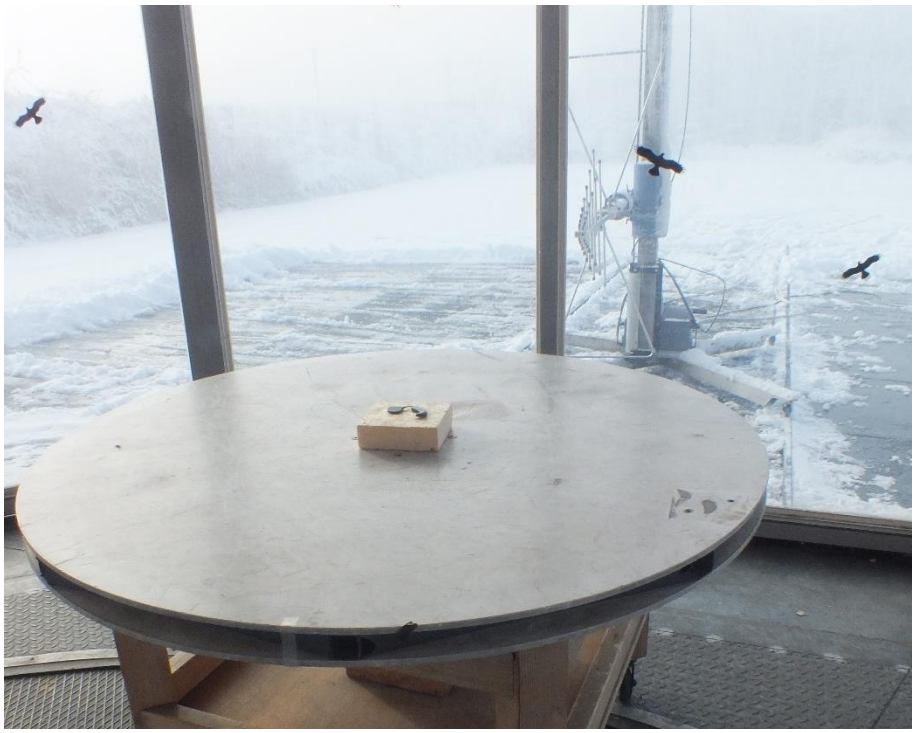
5.3.2 Photo documentation of the test set-up

Test setup 9 kHz – 30 MHz:

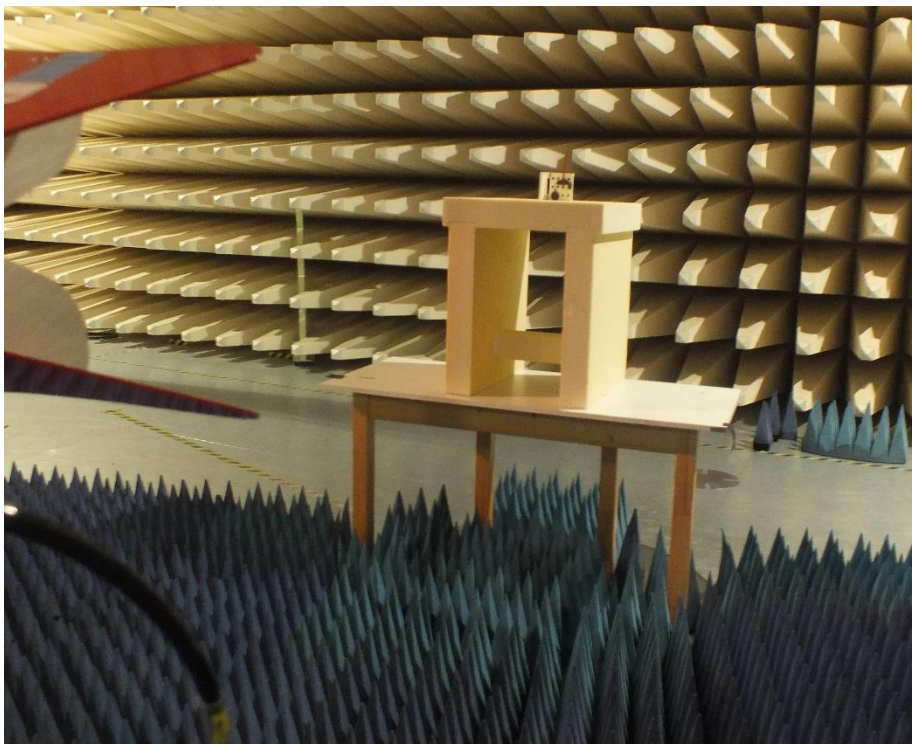


FCC ID: VNP-ME1500 IC: 11986A-ME1500

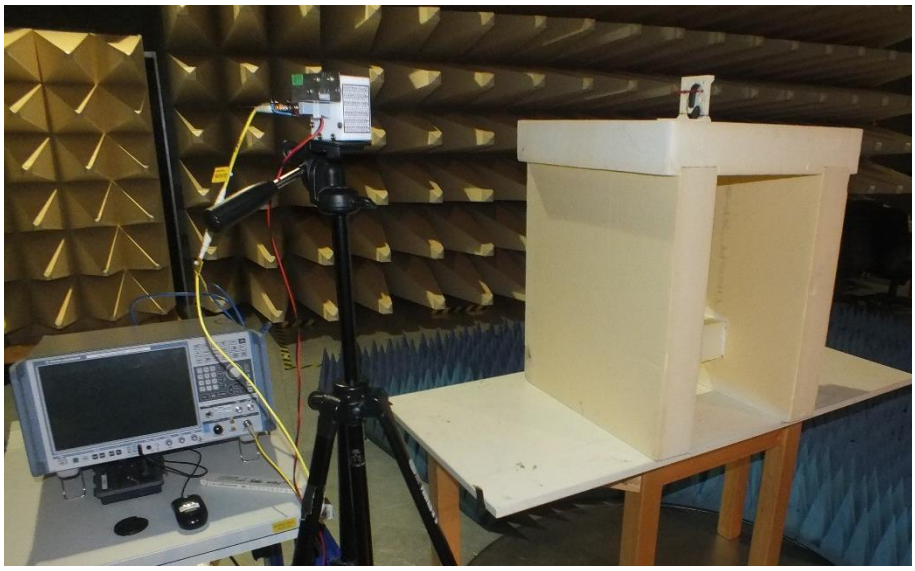
Test setup 30 MHz – 1000 MHz:



Test setup 1 GHz – 18 GHz:



Test setup 18 GHz – 25 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 modulated under normal conditions.

Instrument settings:

9 kHz – 150 kHz	RBW:	200 Hz
150 kHz - 30 MHz	RBW:	9 kHz
30 MHz – 1000 MHz:	RBW:	120 kHz
1000 MHz – 25 GHz	RBW:	1 MHz

FCC ID: VNP-ME1500 IC: 11986A-ME1500

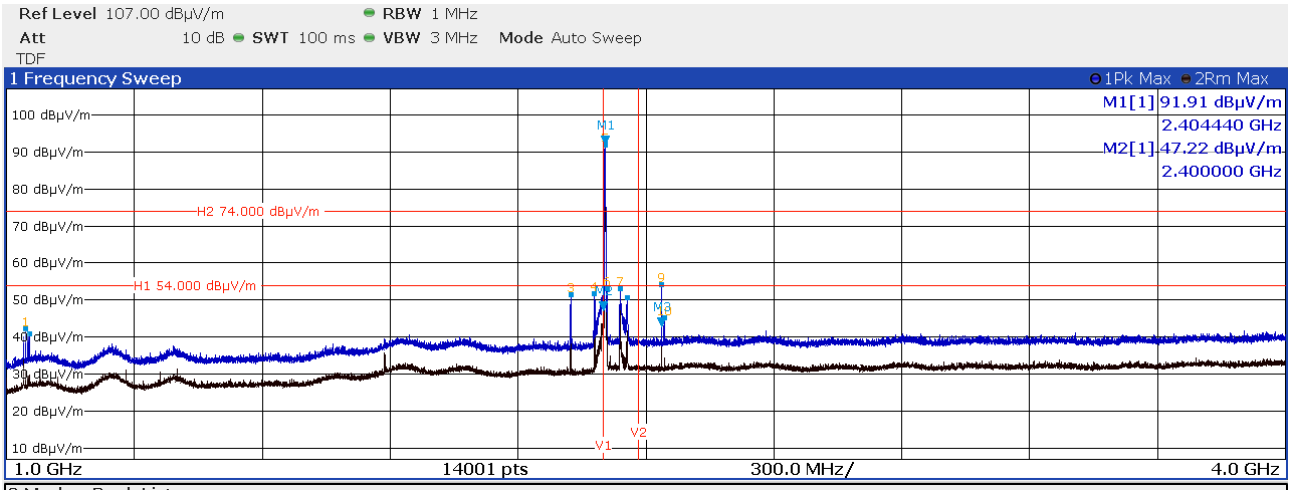
5.3.5 Test result f < 1000 MHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
80.80	9.6	6.4	10.2	10.0	19.8	16.4	40.0	-20.2
85.22	7.0	8.9	9.3	9.5	16.3	18.4	40.0	-21.6
232.90	7.0	7.5	12.0	12.4	19.0	19.9	46.0	-26.1
354.90	7.9	8.0	17.5	17.2	25.4	25.2	46.0	-20.6

Note: In the frequency range 9 kHz to 1000 MHz no emission could be detected. The frequencies mention the noise level. No difference could be detected between the operating frequencies.

5.3.6 Test result f > 1 GHz

Channel 1



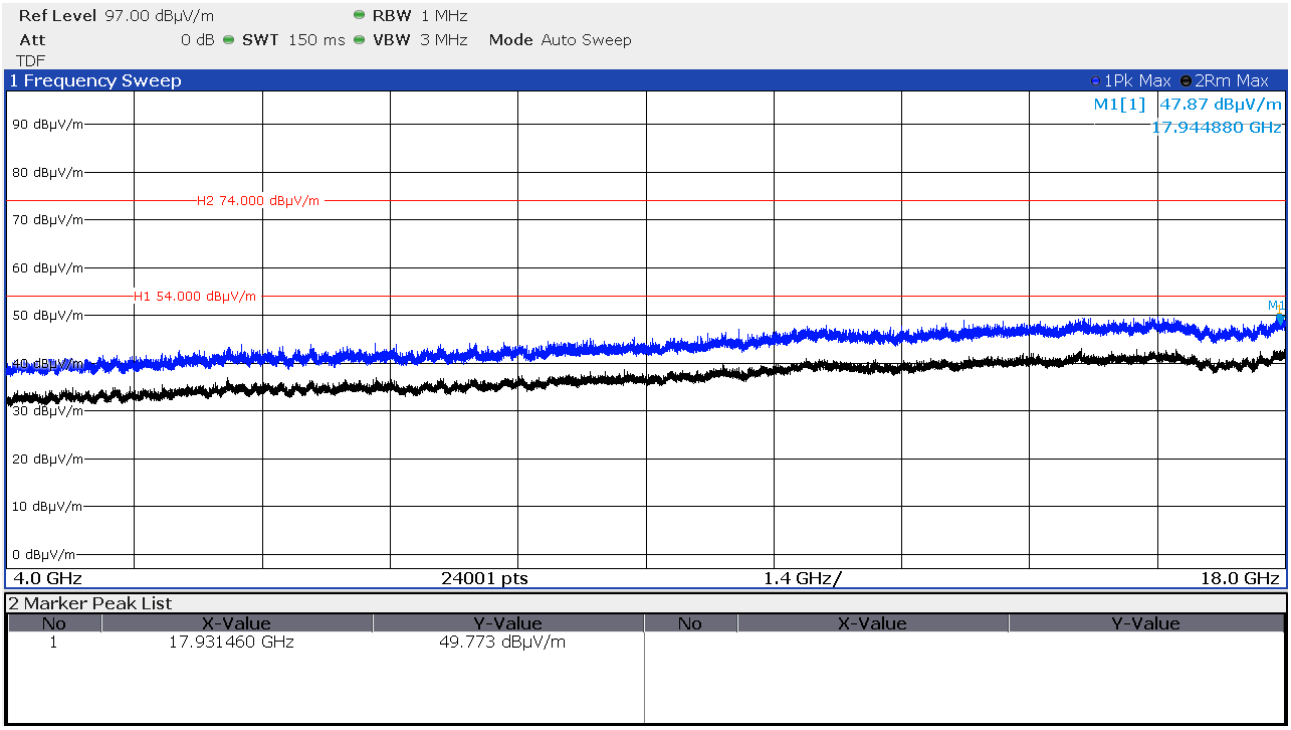
2 Marker Peak List

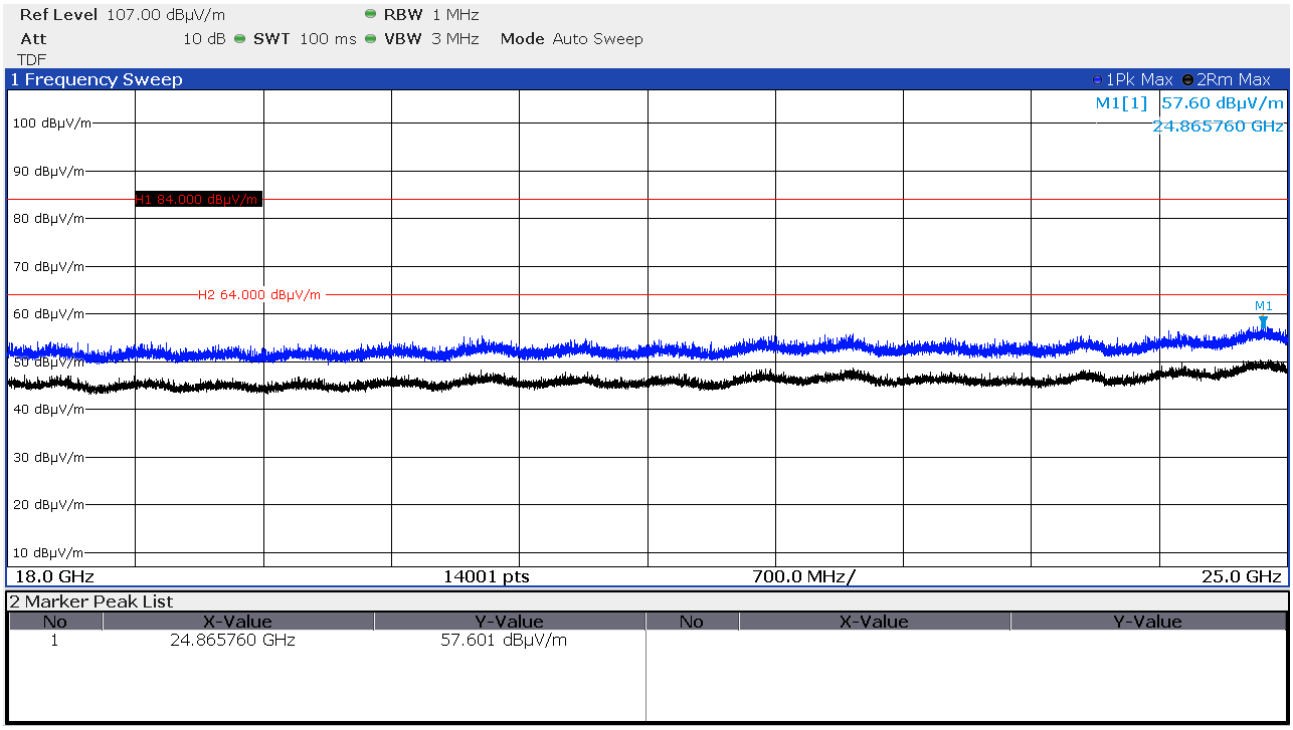
No	X-Value	Y-Value	No	X-Value	Y-Value
1	1.044460 GHz	42.165 dBµV/m	6	2.408510 GHz	53.079 dBµV/m
2	1.053030 GHz	40.919 dBµV/m	7	2.439150 GHz	52.938 dBµV/m
3	2.323660 GHz	51.379 dBµV/m	8	2.455650 GHz	50.682 dBµV/m
4	2.379580 GHz	51.699 dBµV/m	9	2.535780 GHz	54.267 dBµV/m
5	2.404440 GHz	91.906 dBµV/m	10	2.542640 GHz	45.171 dBµV/m

3 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.40444 GHz**	**91.91 dBµV/m**		
M2		1	**2.4 GHz**	**47.22 dBµV/m**		
M3		2	**2.53578 GHz**	**42.67 dBµV/m**		

FCC ID: VNP-ME1500 IC: 11986A-ME1500

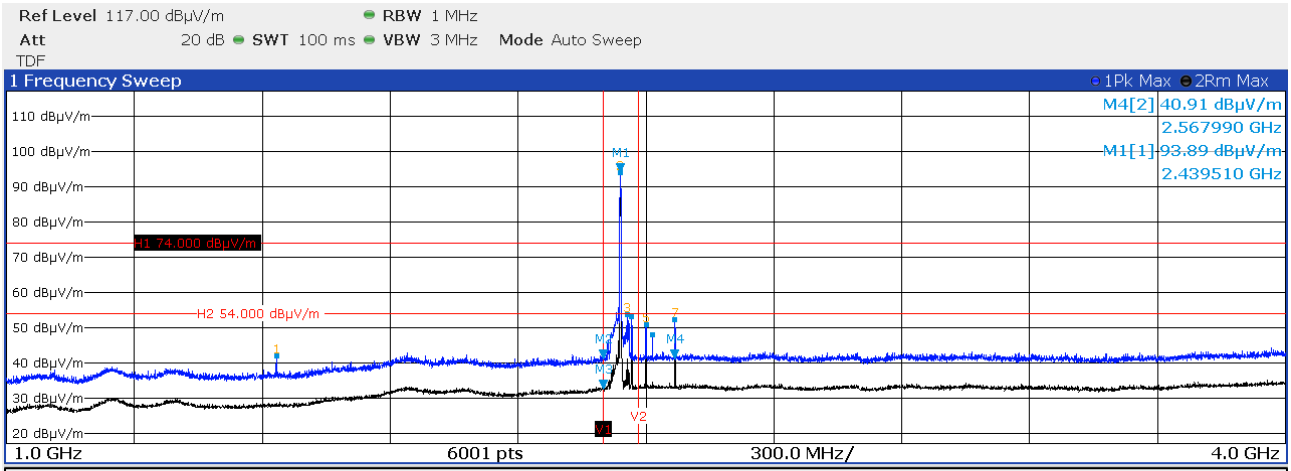




Note: the measurement distance was changed to 1 m for this frequency range, therefore the limit line has to be adjusted and was increased by 10 dB.

FCC ID: VNP-ME1500 IC: 11986A-ME1500

Channel 19

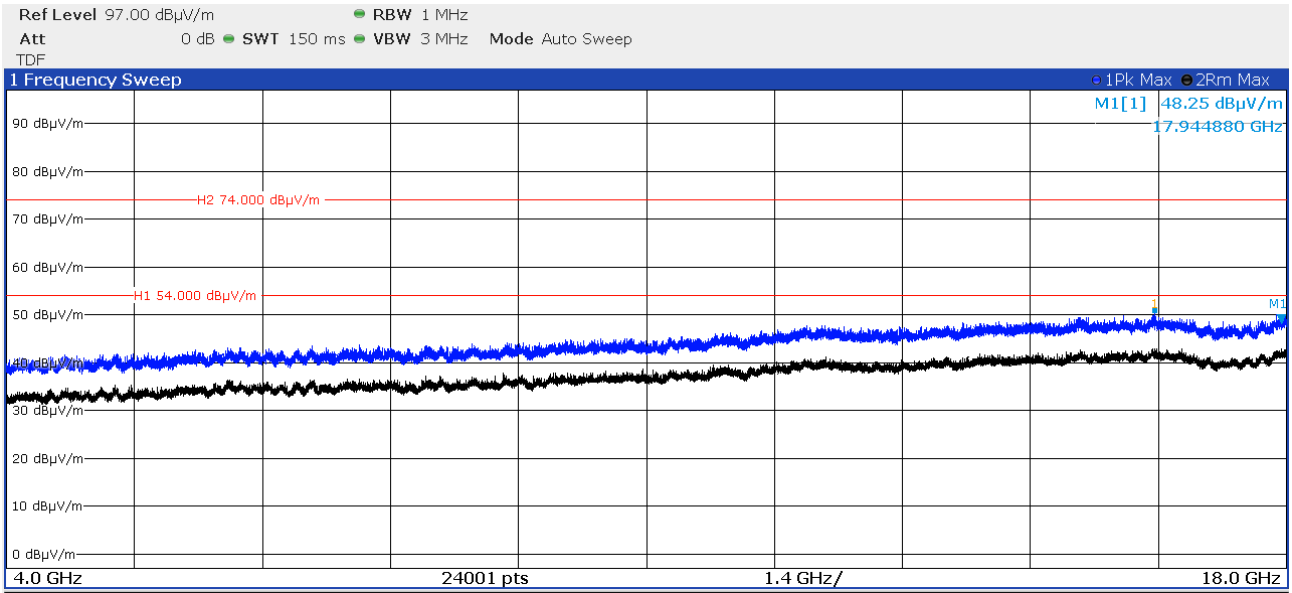


2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	1.633140 GHz	41.825 dBµV/m	5	2.500000 GHz	50.679 dBµV/m
2	2.439510 GHz	93.894 dBµV/m	6	2.515000 GHz	47.923 dBµV/m
3	2.456010 GHz	53.529 dBµV/m	7	2.567990 GHz	52.093 dBµV/m
4	2.466510 GHz	52.946 dBµV/m			

3 Marker Table

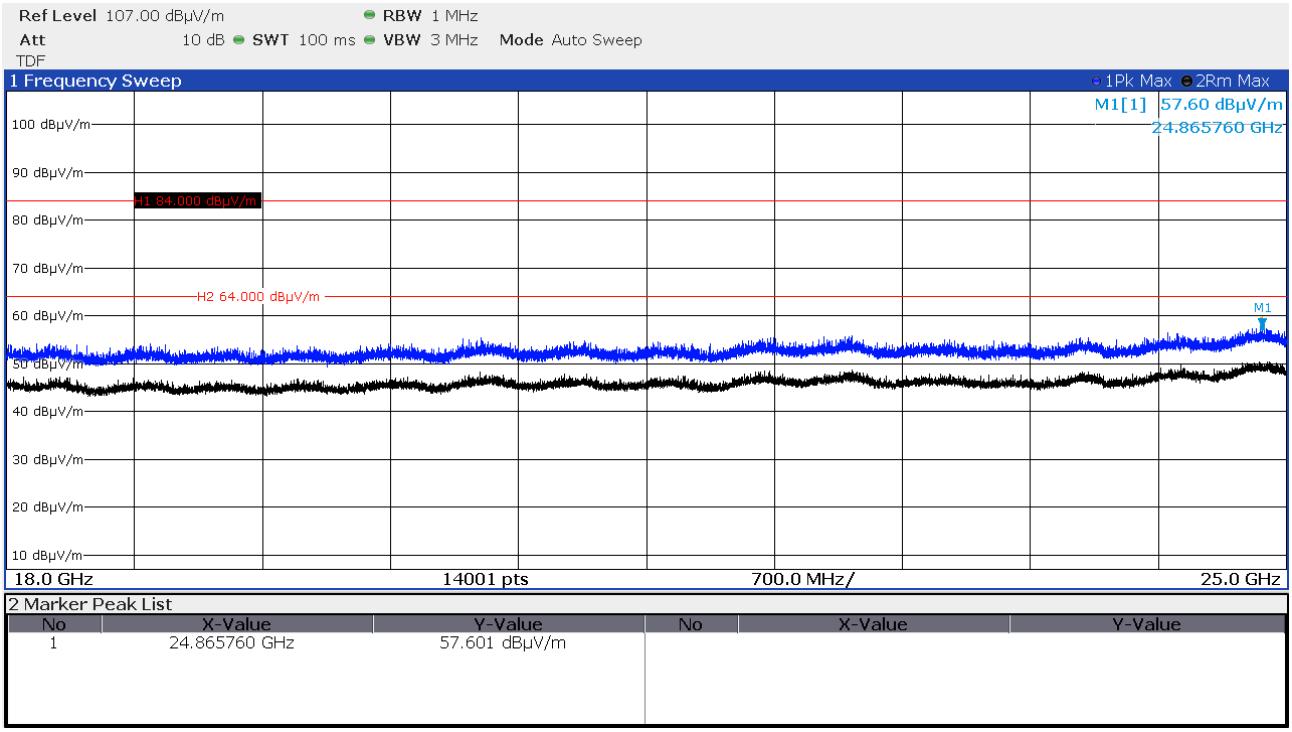
Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.43951 GHz**	**93.89 dBµV/m**		
M2		1	**2.4 GHz**	**40.87 dBµV/m**		
M3		2	**2.4 GHz**	**32.43 dBµV/m**		
M4		2	**2.56799 GHz**	**40.91 dBµV/m**		



2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	16.563600 GHz	50.871 dBµV/m			

FCC ID: VNP-ME1500 IC: 11986A-ME1500

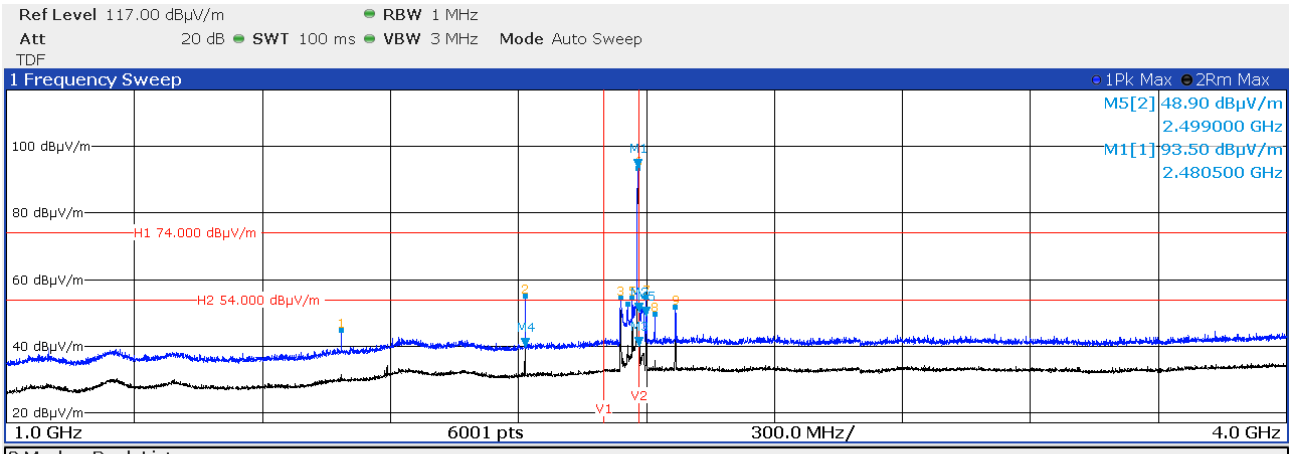


2 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
1	24.865760 GHz	57.601 dBµV/m			

Note: the measurement distance was changed to 1 m for this frequency range, therefore the limit line has to be adjusted and was increased by 10 dB.

Channel 39



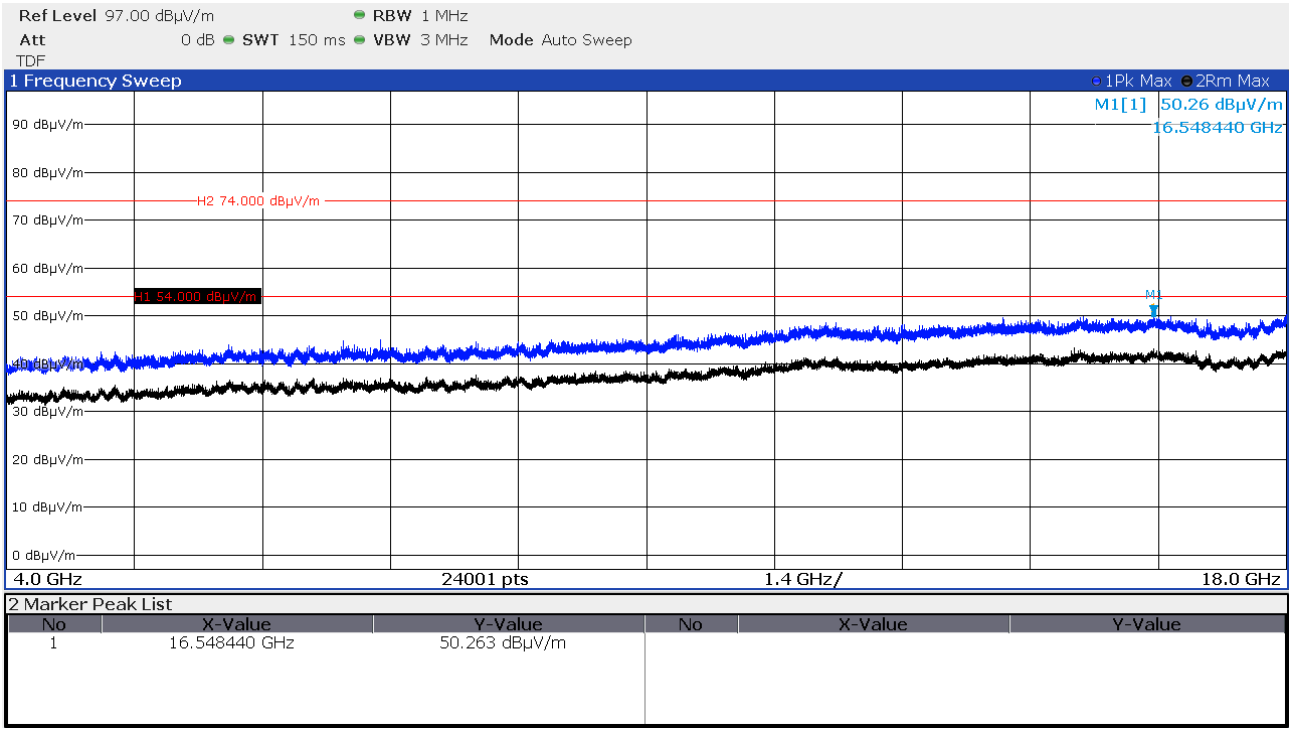
2 Marker Peak List

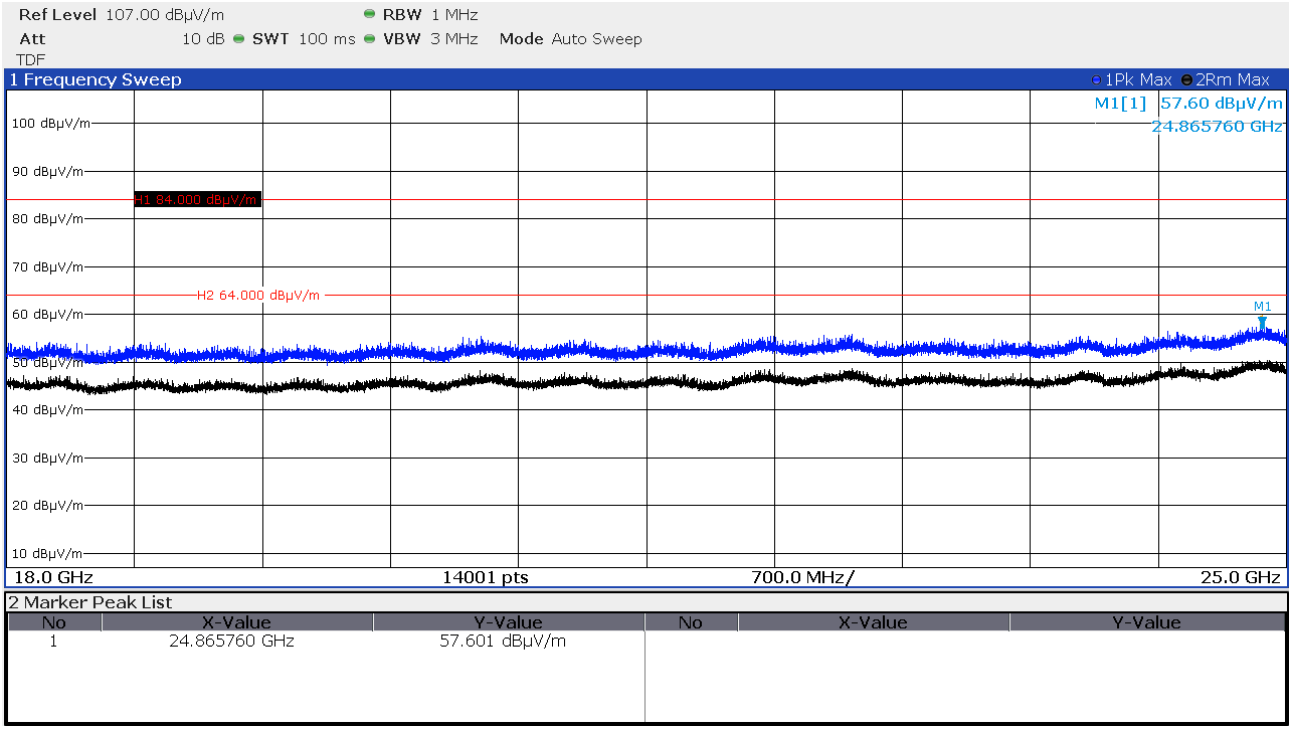
No	X-Value	Y-Value	No	X-Value	Y-Value
1	1.785120 GHz	44.803 dBµV/m	6	2.480500 GHz	93.502 dBµV/m
2	2.215550 GHz	55.002 dBµV/m	7	2.499000 GHz	54.631 dBµV/m
3	2.439510 GHz	54.366 dBµV/m	8	2.519500 GHz	49.667 dBµV/m
4	2.456010 GHz	52.667 dBµV/m	9	2.567990 GHz	51.856 dBµV/m
5	2.466510 GHz	54.556 dBµV/m			

3 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**2.4805 GHz**	**93.50 dBµV/m**		
M2		1	**2.4835 GHz**	**50.11 dBµV/m**		
M3		2	**2.4835 GHz**	**40.10 dBµV/m**		
M4		2	**2.21555 GHz**	**39.72 dBµV/m**		
M5		2	**2.499 GHz**	**48.90 dBµV/m**		

FCC ID: VNP-ME1500 IC: 11986A-ME1500





Note: the measurement distance was changed to 1 m for this frequency range, therefore the limit line has to be adjusted and was increased by 10 dB.

FCC ID: VNP-ME1500 IC: 11986A-ME1500

Limit according to FCC Part 15C, Section 15.209:

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

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

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

The requirements are **FULFILLED.**

Remarks: The measurement was performed up to the 10th harmonic (25000 MHz).

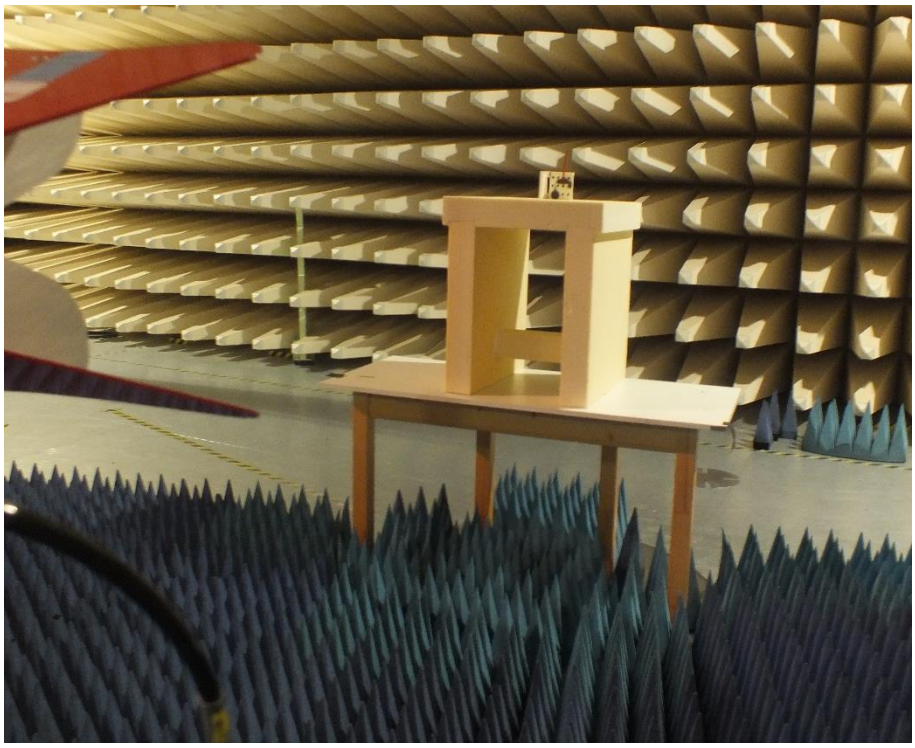
5.4 EBW and OBW

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

5.4.1 Description of the test location

Test location: Anechoic chamber 1

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: 3 MHz, Trace mode: max. hold, Detector: max. peak;

5.4.5 Test result

Centre *f*	99% bandwidth	99% bandwidth	Measured OBW
(MHz)	f_1	f_2	(MHz)
2404.023850	2403.18428	2404.863420	1.679140
2440.020805	2439.17413	2440.867480	1.693350
2480.012770	2479.14719	2480.878350	1.731160

Centre *f*	20dB bandwidth	20dB bandwidth	Measured EBW
(MHz)	f_1	f_2	(MHz)
2404.027000	2403.5625	2404.491500	0.929000
2439.992000	2439.2495	2440.734500	1.485000
2480.025000	2479.5515	2480.498500	0.947000

Operating frequency band	20 dB Bandwidth	
(MHz)	(MHz)	
f_{low} > 2400	f_{low} =	2403.56250
f_{high}< 2483.5	f_{high} =	2480.49850
Operating Band occupancy	76.94	

Operating Band occupancy percentage	92.14	%
Operating channel occupancy percentage	61.98	%

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 39 channels with channel bandwidth of 2 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.**

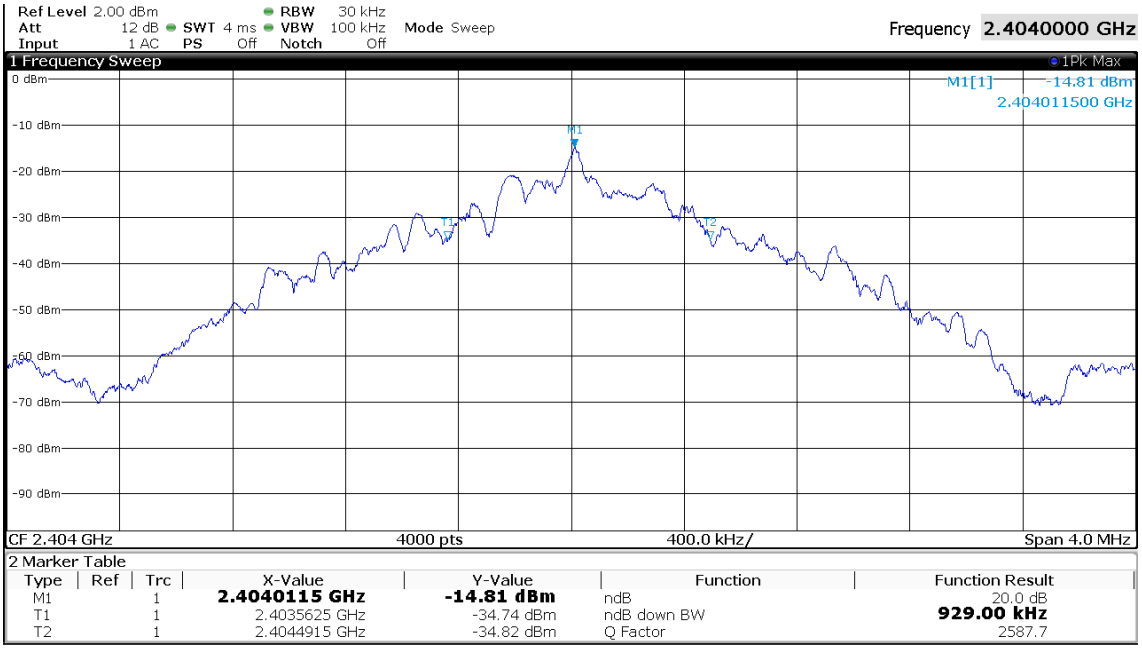
Remarks: For detailed test result please refer to following test protocols.

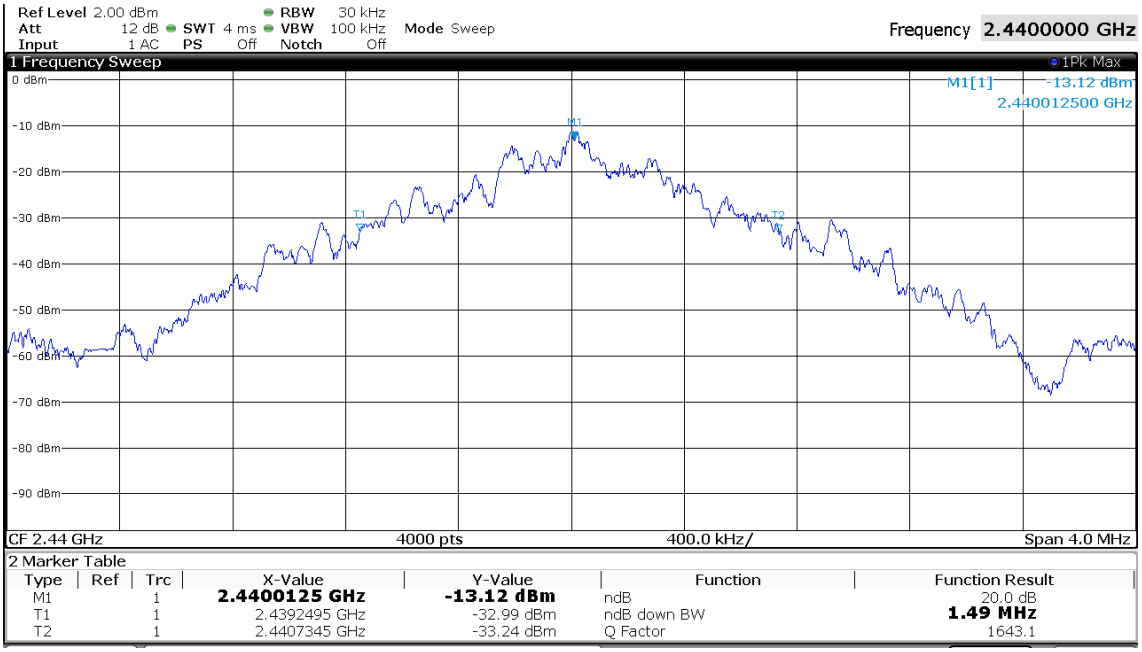
The OBW99 is measured for RSS only.

FCC ID: VNP-ME1500 IC: 11986A-ME1500

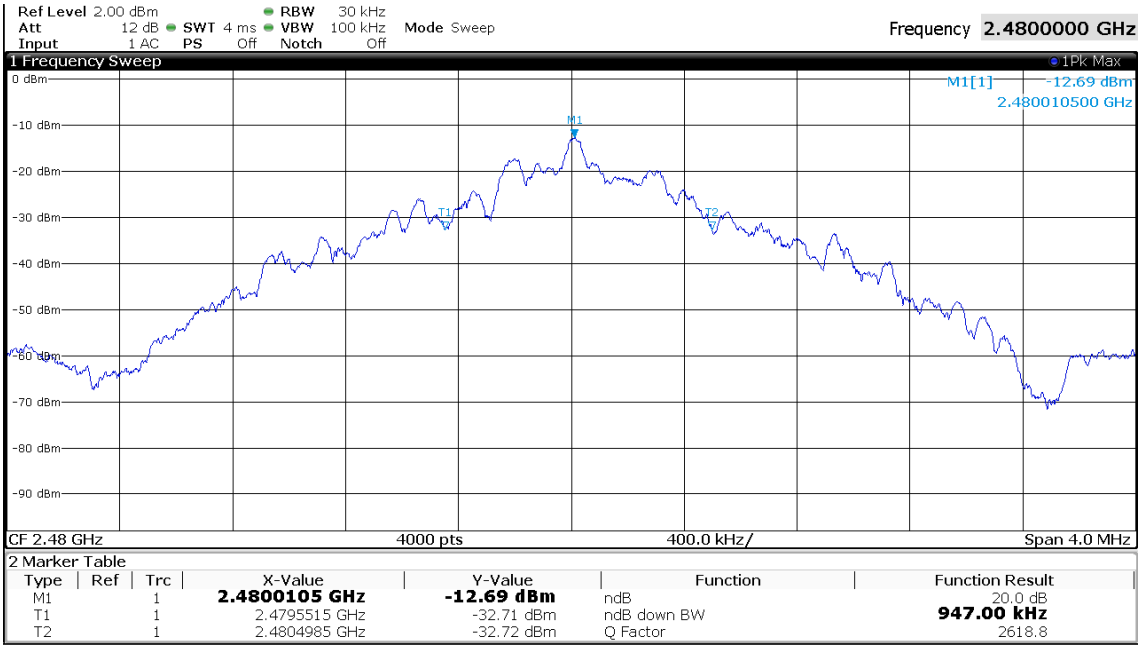
5.4.6 Test protocols

20 dB bandwidth

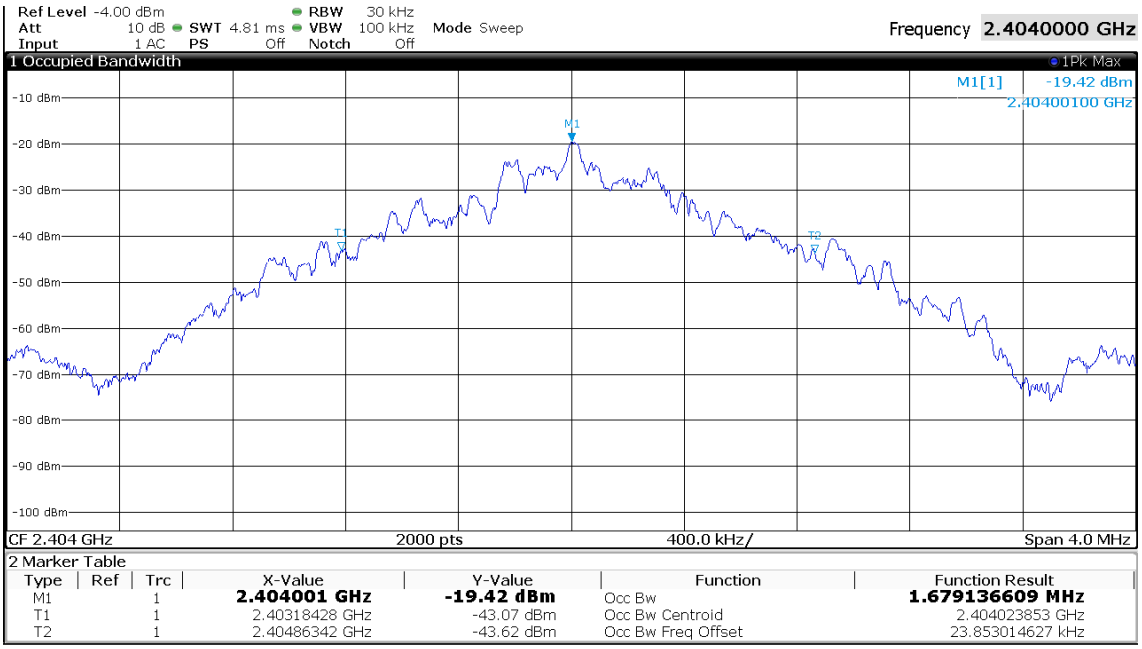




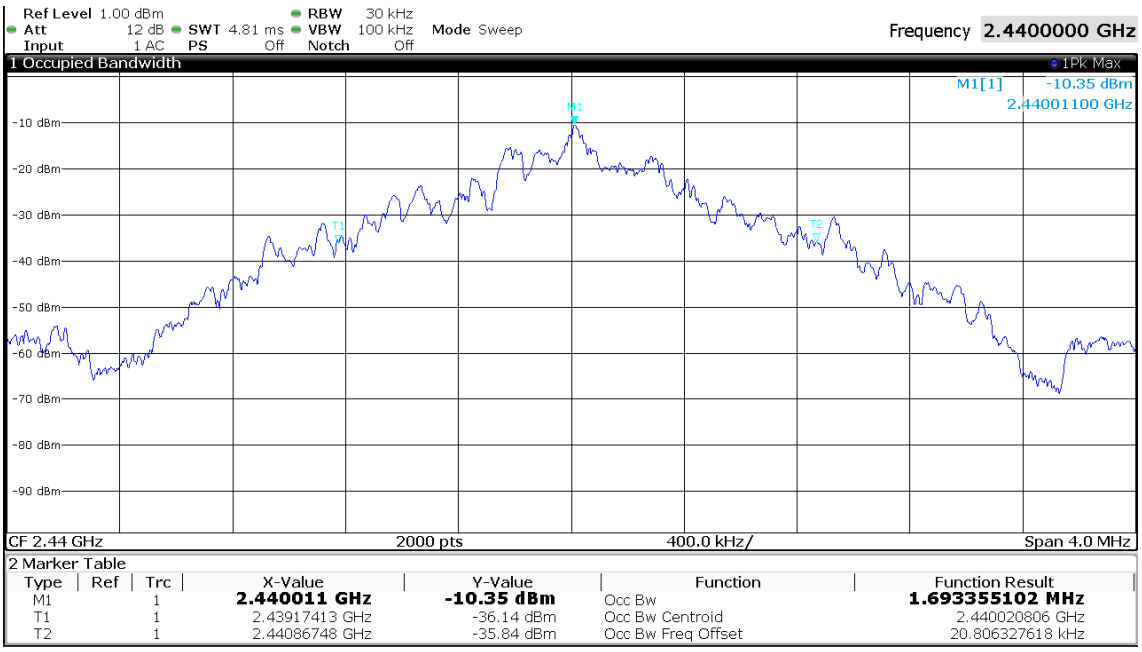
FCC ID: VNP-ME1500 IC: 11986A-ME1500

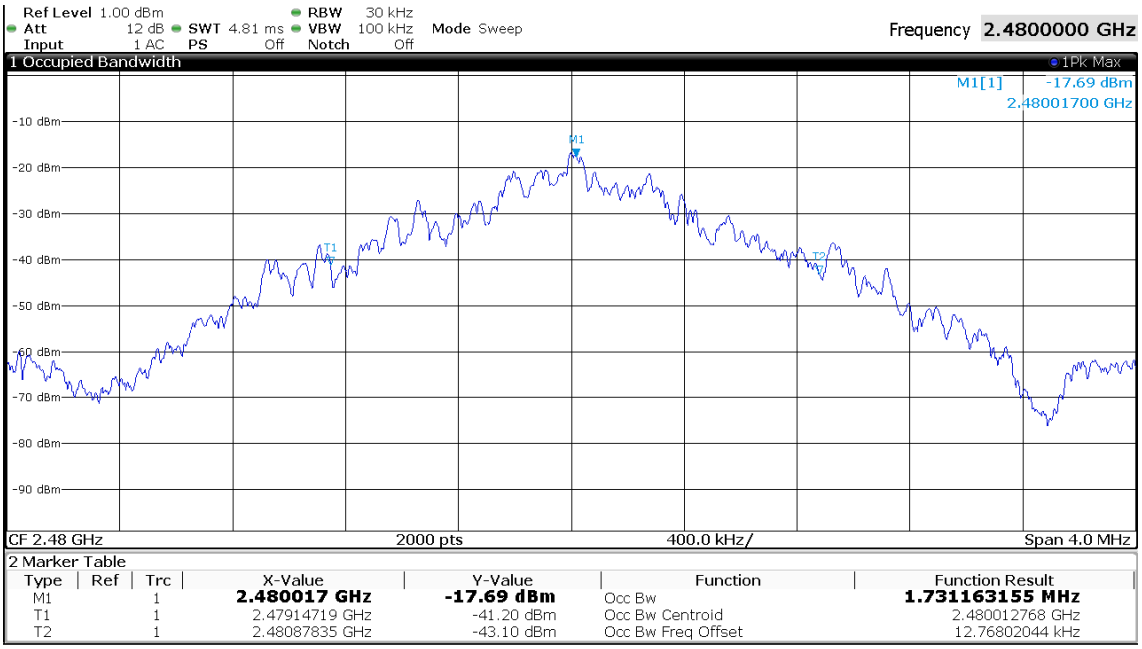


OBW 99%



FCC ID: VNP-ME1500 IC: 11986A-ME1500





FCC ID: VNP-ME1500 IC: 11986A-ME1500

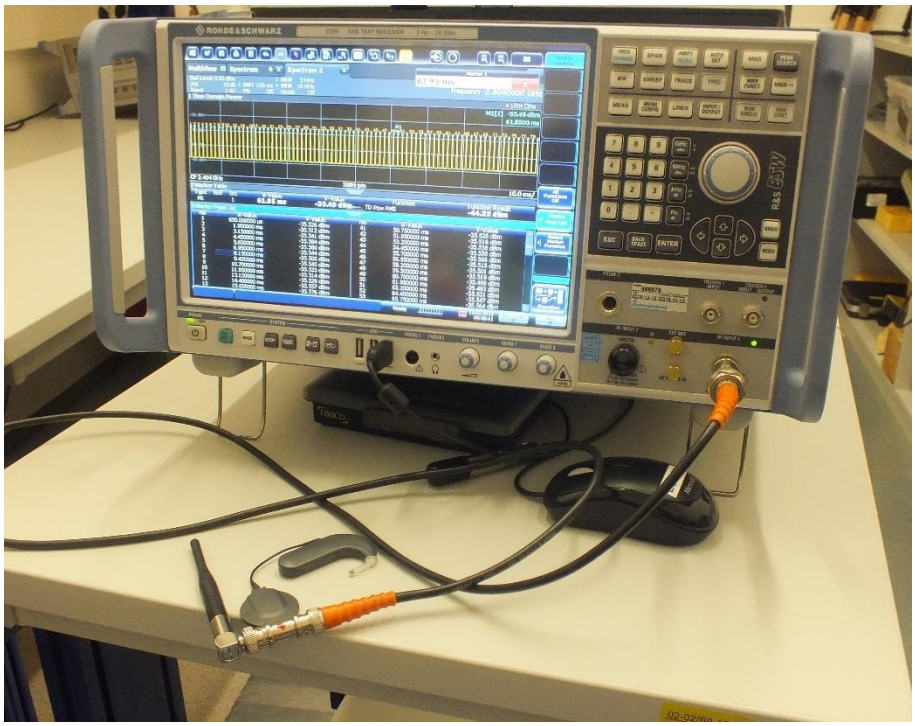
5.5 Correction for pulse operation (duty cycle)

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



5.5.3 Applicable standard

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

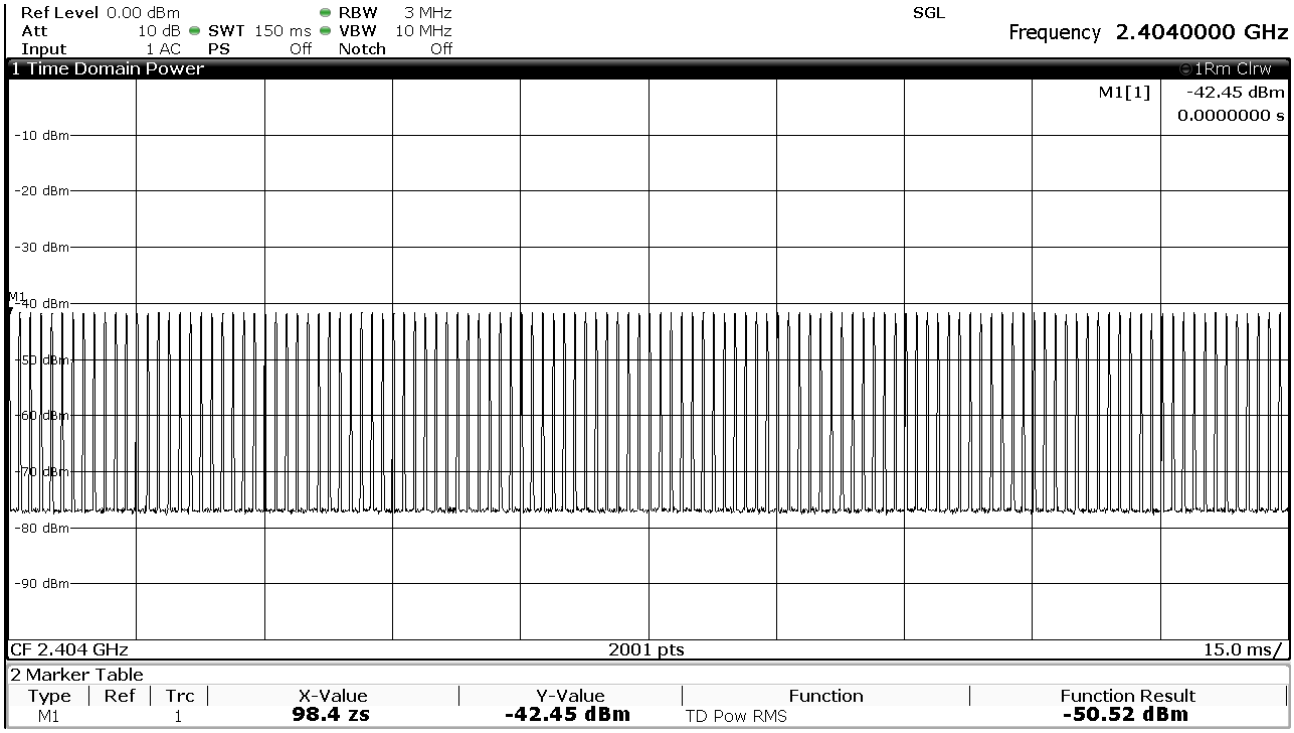
5.5.4 Description of Measurement

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

$$K_E = 20 \log (t_{iw} / 0.1s)$$

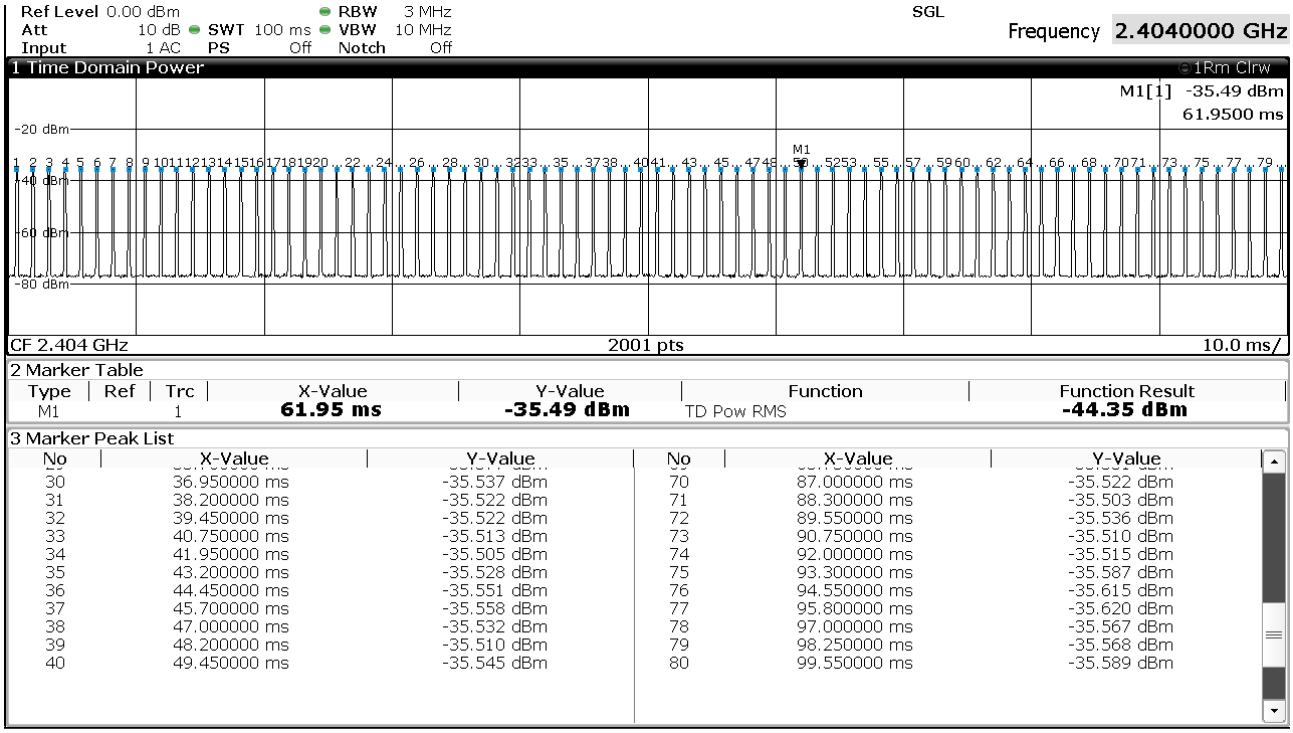
K_E: pulse operation correction factor
t_{iw} pulse duration for one complete pulse track

The pulse train exeeds 0.1s. Thus, the field strength is determined during a 100 ms interval.



FCC ID: VNP-ME1500 IC: 11986A-ME1500

5.5.5 Test result

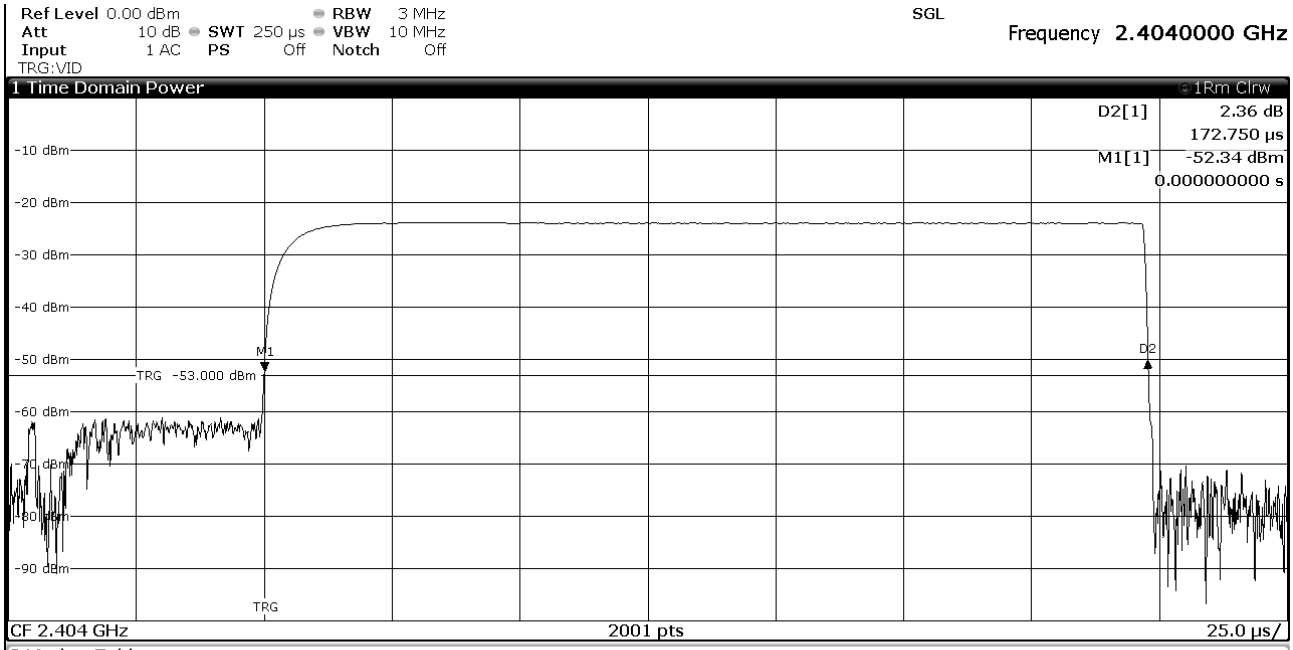


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**61.95 ms**	**-35.49 dBm**	TD Pow RMS	**-44.35 dBm**

3 Marker Peak List

No	X-Value	Y-Value	No	X-Value	Y-Value
30	36.950000 ms	-35.537 dBm	70	87.000000 ms	-35.522 dBm
31	38.200000 ms	-35.522 dBm	71	88.300000 ms	-35.503 dBm
32	39.450000 ms	-35.522 dBm	72	89.550000 ms	-35.536 dBm
33	40.750000 ms	-35.513 dBm	73	90.750000 ms	-35.510 dBm
34	41.950000 ms	-35.505 dBm	74	92.000000 ms	-35.515 dBm
35	43.200000 ms	-35.528 dBm	75	93.300000 ms	-35.587 dBm
36	44.450000 ms	-35.551 dBm	76	94.550000 ms	-35.615 dBm
37	45.700000 ms	-35.558 dBm	77	95.800000 ms	-35.620 dBm
38	47.000000 ms	-35.532 dBm	78	97.000000 ms	-35.567 dBm
39	48.200000 ms	-35.510 dBm	79	98.250000 ms	-35.568 dBm
40	49.450000 ms	-35.545 dBm	80	99.550000 ms	-35.589 dBm



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**98.4 zs**	**-52.34 dBm**	TD Pow RMS	**-25.75 dBm**
D2	M1	1	**172.75 µs**	**2.36 dB**		

FCC ID: VNP-ME1500 **IC: 11986A-ME1500**

K_E = 20 log (13.8 ms / 100 ms) = -17.2 dB

Total length of period	100 ms
Max. On time	13.800 ms
DC	0.1380
Correction factor	-17.2 dB

Remarks: -

5.6 Antenna application

5.6.1 Applicable standard

According to FCC Part 15C, Section 15.203(a):
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section.

5.6.2 Result

The EUT uses an integrated chip 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: -

FCC ID: VNP-ME1500 IC: 11986A-ME1500

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.
CPR 3	FSW43	02-02/11-15-001	19/03/2019	19/03/2018		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	08/05/2019	08/05/2018		
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS11	02-02/50-17-012				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
DC	ESW26	02-02/03-17-002	13/12/2019	13/12/2018		
MB	EA-PS 3032-10B	01-05/50-11-011				
	ESW26	02-02/03-17-002	13/12/2019	13/12/2018		
SER 1	ESCI	02-02/03-15-001	11/06/2019	11/06/2018		
	HFH 2 - Z 2	02-02/24-05-020	09/08/2020	09/08/2017	15/01/2020	15/01/2019
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
	ANT1010A	02-02/50-16-034				
SER 2	ESVS 30	02-02/03-05-006	06/06/2019	06/06/2018		
	VULB 9168	02-02/24-05-005	18/04/2019	18/04/2018		
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	FSW43	02-02/11-15-001	19/03/2019	19/03/2018		
	JS4-18004000-30-5A	02-02/17-05-017				
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	08/05/2019	08/05/2018		
	BBHA 9170	02-02/24-05-014	12/06/2021	12/06/2018	12/12/2019	12/12/2018
	WHJS 1000-10EE	02-02/50-05-070				
	WHK 3.0/18G-10EF	02-02/50-05-180				
	KMS102-0.2 m	02-02/50-11-016				
	KMS102-0.2 m	02-02/50-11-020				
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS11	02-02/50-17-012				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				