



RF - TEST REPORT

- FCC Part 15.247, RSS-247 -

Model Name : SONNET 3 EAS (market name), Me1720 (product code), OPUS 4++ (internal development name)

Product Description : Audio processor for cochlear implant including 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. : 80208700-00 Rev_1

02. July 2024

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-03
D-PL-12030-01-04

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ATTACHMENTS A, B as separate supplements

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations (May 2024)

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
KDB 558074 D01 v05r02	Guidance for compliance measurements on DTS; FHSS and hybrid system devices operating under Section 15.247 of the FCC rules, April 2, 2019.

ISED Canada Rules and Regulations

RSS-Gen, Issue 5 + Amendment 1 + 2	General Requirements for Compliance of Radio Apparatus
RSS-247, Issue 3	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices

2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 General remarks

None

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

2.5 Equipment type

Bluetooth Low Energy (BLE) device

2.6 Short description of the equipment under test (EUT)

The EUT is an audio processor for a MED-EL cochlear implant including a 2.4 GHz transceiver with integral antenna.

Market names: SONNET 3 / SONNET 3 EAS

Product codes: Me1710, Me1711, Me1712, Me1713 / Me1720, Me1721, Me1722, Me1723*.

The EUT 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 2.4 GHz transceiver can receive commands or data from external devices (e.g., remote control, remote programmer, streaming device, etc.). Additionally, it can transmit responses to external devices (external devices are not part of this testing).

Number of tested samples:	1 (radiated sample)	1 (conducted sample)
Serial number:	000068	000070
Firmware number:	hci_2dBm	hci_2dBm
Type:	Me1720	Me1720
HVIN:	Me172	Me172

FCC ID:	VNP-ME1700
IC ID:	11986A-ME1700

Items	Description
BT type	5.2 Low Energy
BT chipset type	onsemi RSL10
Modulation	GFSK
Frequency range	2400 MHz to 2483.5 MHz
Channel numbers	40
Data rate (Mbps)	1, 2
Power setting	Default (2 dBm)
Antenna type	PCB

*According to the customer the only difference between the devices with the product code Me172x (x = 0, 1, 2, or 3) and the devices with the product code Me171x is that the devices with the product code Me171x do not contain acoustic hearing aid functionality, i.e., do not contain an acoustic only output ("loudspeaker"). The devices with the product code Me172x are referred to as EAS (electric acoustic stimulation) devices.

The sub variants Me1710, Me1711, Me1712, and Me1713 do not differ in hardware and / or firmware, they just differ in product code. The same is true for the sub variants Me1720, Me1721, Me1722, and Me1723, 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.

2.7 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
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.

2.8 Transmit operating modes

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

- 1 Mbps
- 2 Mbps

(Mbps = Megabits per second)

2.9 Antenna

The following antennas shall be used with the EUT:

Characteristic	Model number	Plug	Frequency range (GHz)	Gain (dBi)
Omni	PCB antenna	-	2.4 – 2.4835	-8.0

2.10 Power supply system utilised

Power supply voltage, V_{nom} : 2.2 V/DC (2 x zinc-air batteries type 675)

2.11 Peripheral devices and interface cables

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

- Battery pack _____ Model : SONNET battery pack (Ma060106) _____

2.12 Determination of worst-case conditions for final measurement

Preliminary tests are performed in all three orthogonal axes of the EUT to locate at which position and at what setting of the EUT produce the maximum of the emissions.

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

BLE V5	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
802.15.1	0 - 39	37, 17, 39	P_{def}	DSSS	GFSK	1 Mbps
802.15.1	0 - 36	0, 17, 36	P_{def}	DSSS	GFSK	2 Mbps

Packet payload length: 255 octets; Packet payload: PRBS9

2.12.1 Test jig

No test jig is used.

2.12.2 Test software

The EUT provides the Bluetooth Low Energy Direct Test Mode (DTM) via HCI (V2 commands) as specified in the Bluetooth Core Specification 5.2 Vol 6 Part F. The DTM firmware in the EUT was the BLE Direct Test Mode (DTM) firmware hci_2dBm specified in the MED-EL document PF21-0529 Rev 4.0.

3 TEST RESULT SUMMARY

BLE device using digital modulation and operates in the 2400 MHz – 2483.5 MHz band:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	not applicable ¹
15.247(a)(2)	RSS-247, 5.2(a)	-6 dB EBW	passed
15.247(b)(3) 15.247(b)(4)	RSS-247, 5.4(d)	Maximum peak output power	passed
15.247(d) 15.209	RSS-247, 5.5 RSS-Gen, 8.9	Spurious emissions	passed
15.247(e)	RSS-247, 5.2(b)	PSD	passed
15.35(c)	RSS-Gen, 8.2	Pulsed operation	passed
15.203		Antenna requirement	passed
-	RSS-Gen, 6.7	99 % Bandwidth	passed

Note: ¹not applicable, EUT is battery-powered

3.1 Revision history of test report

Test report No	Rev.	Issue Date	Changes
80208700-00	0	03 June 2024	Initial test report
80208700-00	1	02 July 2024	4.5.3.2.4 correction table height

The test report with the highest revision number replaces the previous test reports.

3.2 Final assessment

The equipment under test fulfils the requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 16 May 2024

Testing concluded on : 23 May 2024

Checked by:

Tested by:

Klaus Gegenfurtner
Teamleader Radio

Sabine Kugler
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 on basis of the ETSI Technical Report TR 100 028 Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1 and Part 2. The results are documented in the quality system acc. to DIN EN ISO/IEC 17025. 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 Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	$\pm 3.29 \text{ dB}$
20 dB Bandwidth	Center frequency of EUT	95%	$\pm 2.5 \times 10^{-7}$
99% Occupied Bandwidth	Center frequency of EUT	95%	$\pm 2.5 \times 10^{-7}$
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	$\pm 3.53 \text{ dB}$
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	$\pm 3.71 \text{ dB}$
Radiated Spurious Emissions	1000 MHz to 10000 MHz	95%	$\pm 2.34 \text{ dB}$
Peak conducted output power	902 MHz to 928 MHz	95%	$\pm 0.35 \text{ dB}$
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	$\pm 2.15 \text{ dB}$

4.4 Conformity Decision Rule

The applied conformity decision rule is based on ILAC G8:09/2019 clause 4.2.1 Binary Statement for Simple Acceptance Rule ($w = 0$).

Details can be found in the procedure CSA_B_V50_29.

4.5 Measurement protocol for FCC and ISCED

4.5.1 General information

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

FCC: DE 0011
ISED: DE0009

4.5.2 General Standard information

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

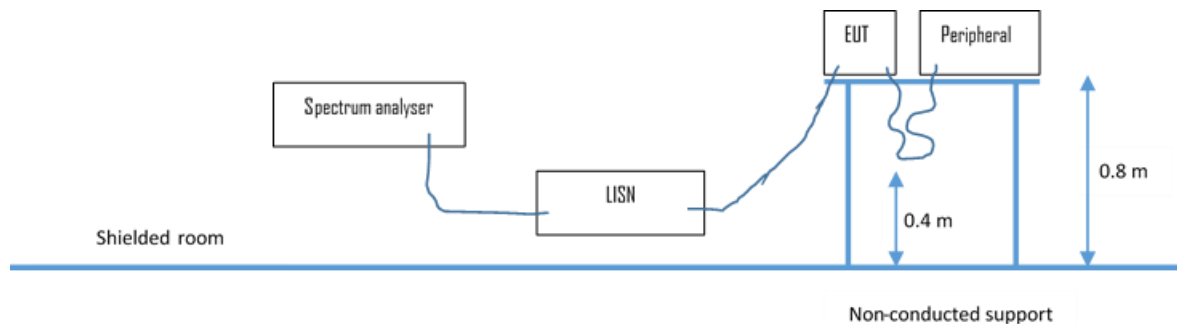
4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions.

4.5.3 Details of test procedures

4.5.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in dB μ V, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between dB μ V and μ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

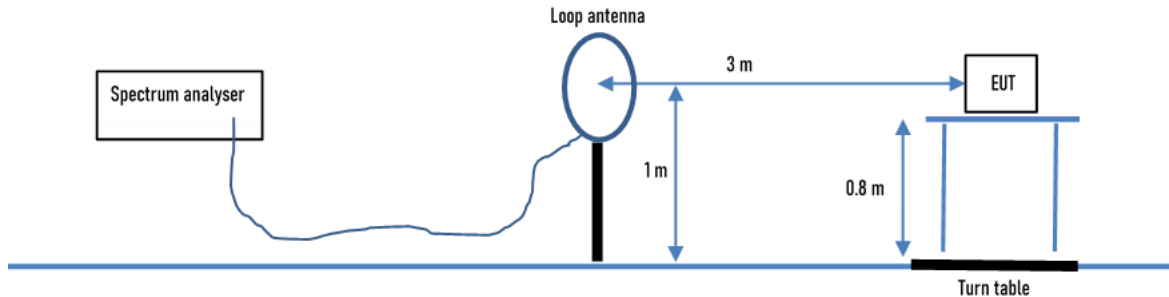
$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50 Ω / 50 μ H (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission is re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

4.5.3.2 Radiated emission

4.5.3.2.1 OATS1 test site (9 kHz - 30 MHz):

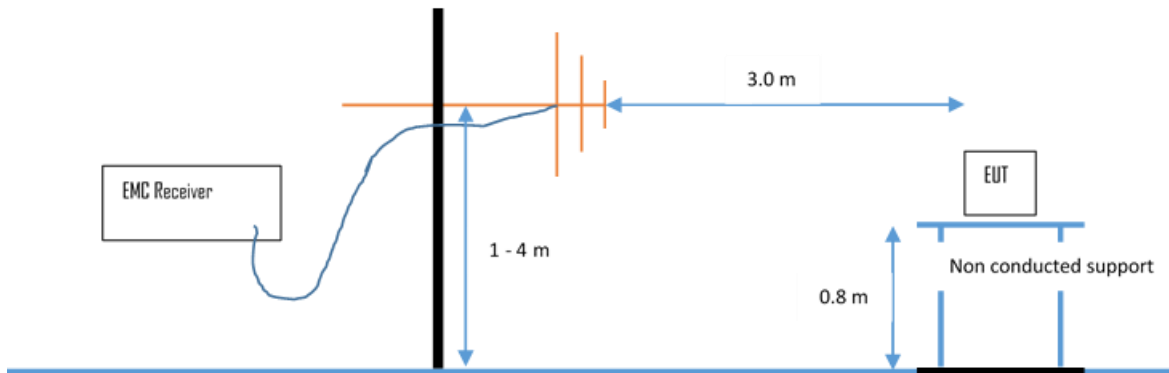
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre 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 along the site axis and the EUT is rotated 360 degrees.

4.5.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



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. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. 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 limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

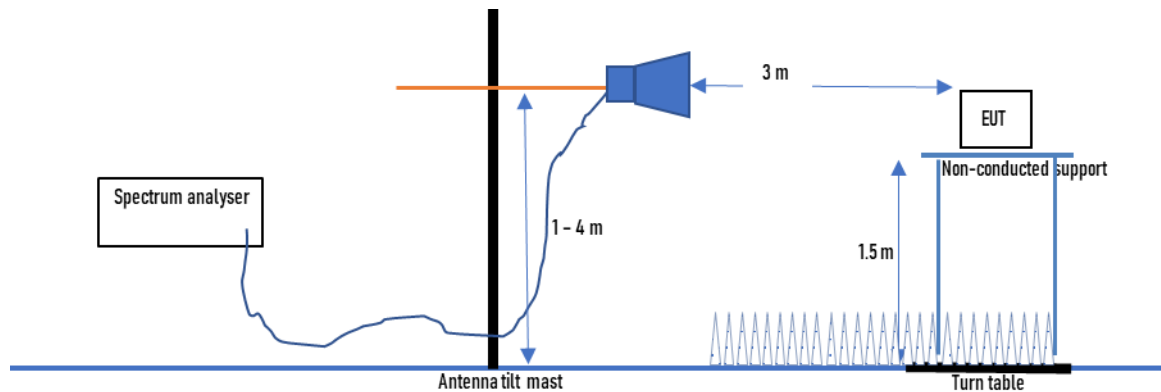
30 MHz – 1000 MHz: RBW: 120 kHz

Example:

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

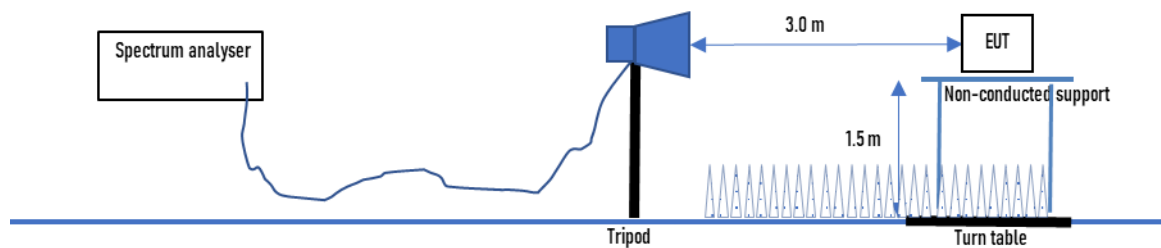
4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz 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 non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

4.5.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)



Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz 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 non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limit is adopted.

5 TEST CONDITIONS AND RESULTS

5.1 EBW and OBW

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

5.1.1 Description of the test location

Test location: Shielded Room S6

5.1.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.1.3 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.

According to RSS-247 5.2(a):

DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz: The minimum 6 dB bandwidth shall be 500 kHz.

5.1.4 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: 5 s, Span: 2 EBW;

Spectrum analyser settings for OBW:

RBW: 1-5% OBW, VBW: 3 RBW, Detector: Max peak, Sweep time: 5 s, Span: 2 OBW;

5.1.5 Test result

6dB bandwidth

Test result conducted - 1 Mbps			
Channel	Centre frequency (MHz)	6 dB bandwidth (kHz)	Minimum limit (kHz)
37	2402	686.63	500
17	2440	699.04	500
39	2480	691.08	500

Test result conducted - 2 Mbps			
Channel	Centre frequency (MHz)	6 dB bandwidth (kHz)	Minimum limit (kHz)
0	2404	1254.87	500
17	2440	1256.99	500
36	2478	1252.82	500

99% bandwidth

Test result conducted - 1 Mbps		
Channel	Centre frequency (MHz)	99 % bandwidth (kHz)
37	2402	1067.637
17	2440	1068.113
39	2480	1068.124

Test result conducted - 2 Mbps		
Channel	Centre frequency (MHz)	99 % bandwidth (kHz)
0	2404	2179.627
17	2440	2179.120
36	2478	2189.167

Emission bandwidth limit according to FCC Part 15, Section 15.247(a)(2):

Frequency (MHz)	6dB EBW Limit
902-928	> 500 kHz
2400-2483.5	> 500 kHz
5725-5850	> 500 kHz

Emission bandwidth limit according to RSS-247 5.2(a):

Frequency (MHz)	6dB EBW Limit
902-928	> 500 kHz
2400-2483.5	> 500 kHz

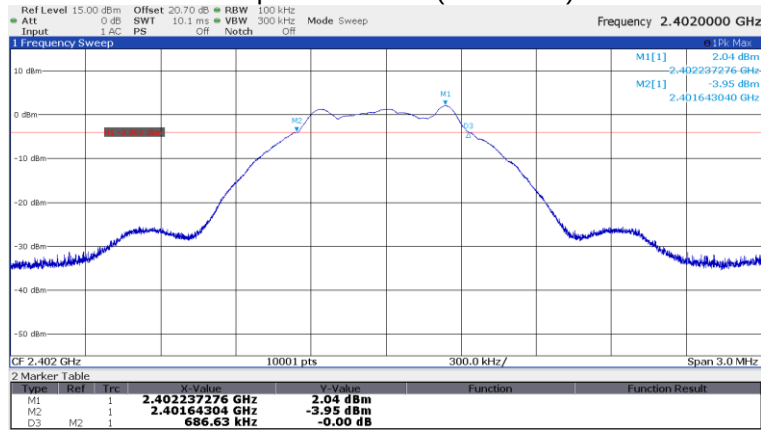
The requirements are **FULFILLED**.

Remarks:

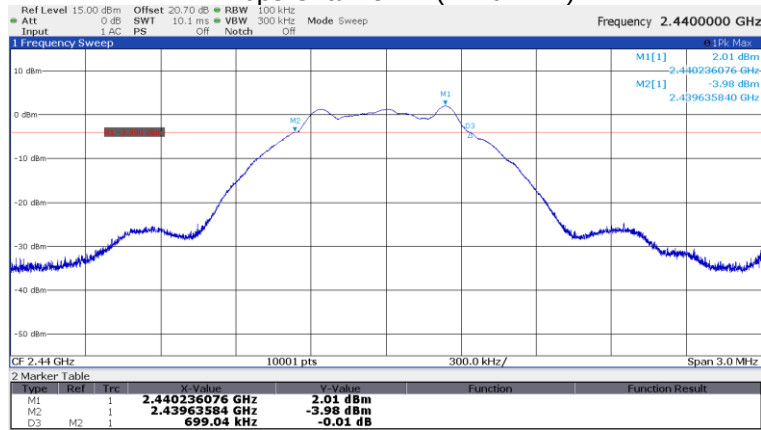
For detailed test result please see the following test protocols

5.1.6 Test protocols EBW

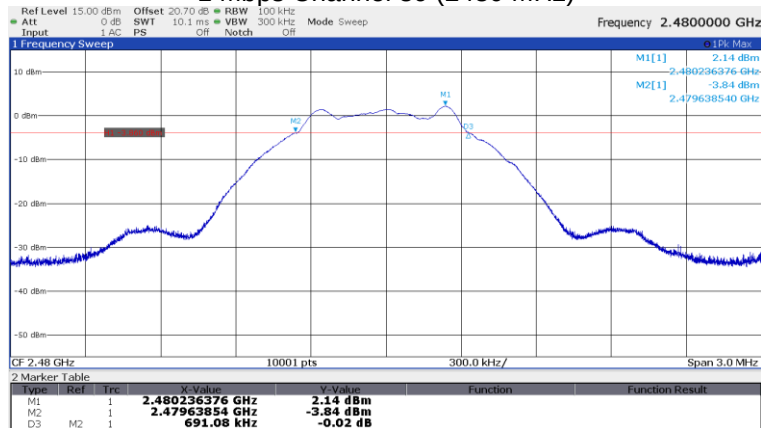
1 Mbps Channel 37 (2402 MHz)



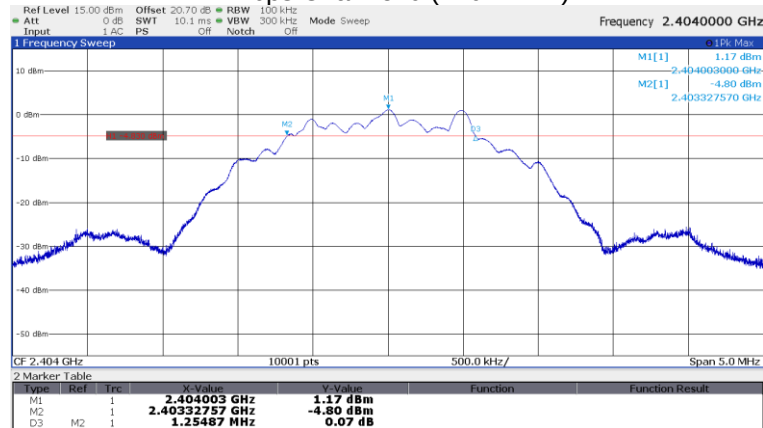
1 Mbps Channel 17 (2440 MHz)



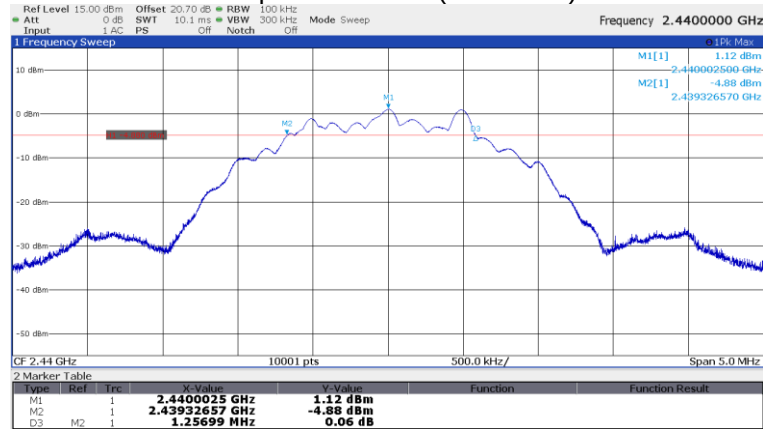
1 Mbps Channel 39 (2480 MHz)



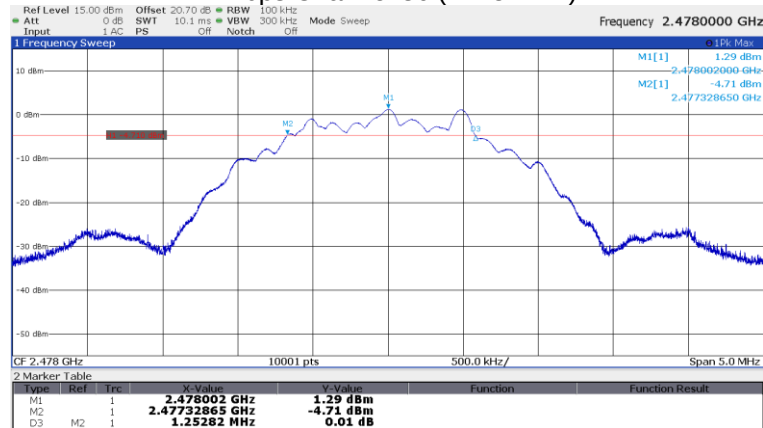
2 Mbps Channel 0 (2404 MHz)



2 Mbps Channel 17 (2440 MHz)

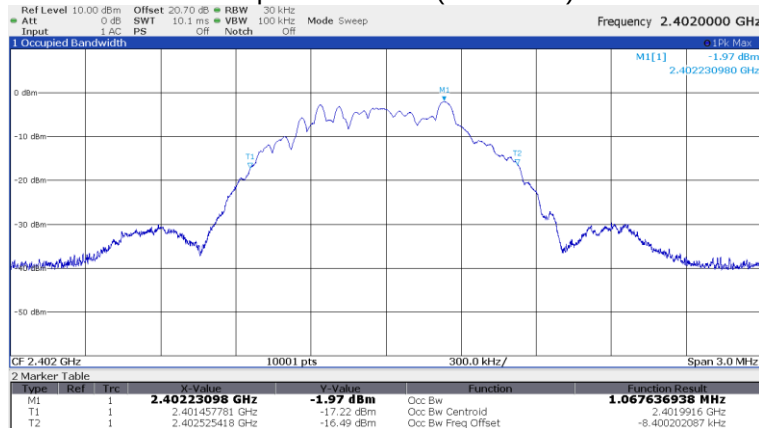


2 Mbps Channel 36 (2478 MHz)



5.1.7 Test protocols OBW

1 Mbps Channel 37 (2402 MHz)



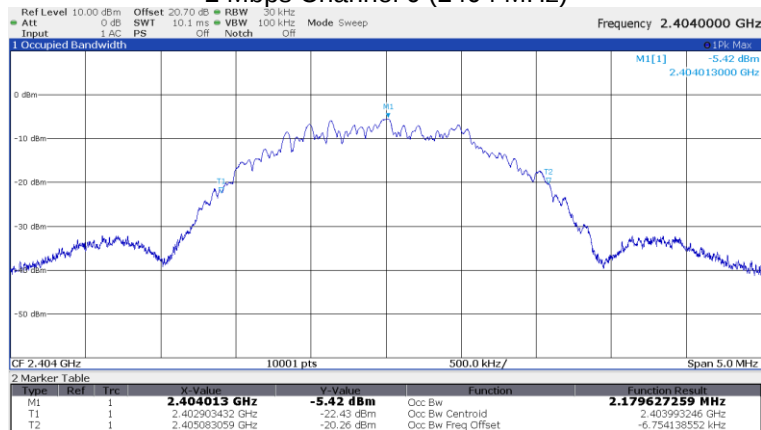
1 Mbps Channel 17 (2440 MHz)



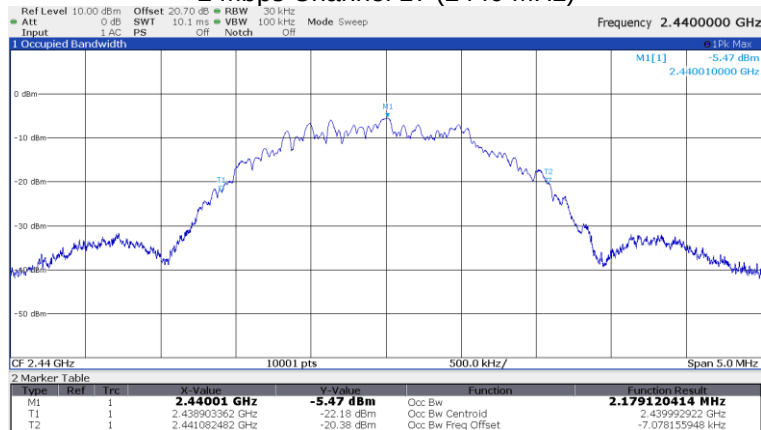
1 Mbps Channel 39 (2480 MHz)



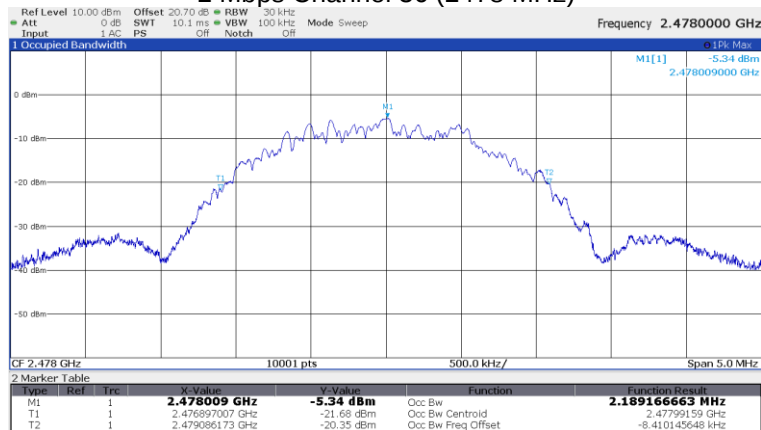
2 Mbps Channel 0 (2404 MHz)



2 Mbps Channel 17 (2440 MHz)



2 Mbps Channel 36 (2478 MHz)



5.2 Maximum peak output power

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

5.2.1 Description of the test location

Test location: Shielded Room S6

5.2.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.2.3 Applicable standard

According to FCC Part 15, Section 15.247(b)(3):

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

According to RSS-247 5.4(d):

For DTSS employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

5.2.4 Description of Measurement

The maximum peak radiated output power is measured using a spectrum analyser following the procedure set out in ANSI C63.10, item 11.9.2.2. The EUT is set in TX continuous mode while measuring.

5.2.5 Test result

Maximum peak conducted output power:

Test results conducted				
BLE 1 Mbps		A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH37				
T_{nom}	V_{nom}	2.1	30.0	-27.9
Middle frequency: CH17				
T_{nom}	V_{nom}	2.0	30.0	-28.0
Highest frequency: CH39				
T_{nom}	V_{nom}	2.2	30.0	-27.8

Test results conducted				
BLE 2 Mbps		A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH0				
T_{nom}	V_{nom}	2.1	30.0	-27.9
Middle frequency: CH17				
T_{nom}	V_{nom}	2.0	30.0	-28.0
Highest frequency: CH36				
T_{nom}	V_{nom}	2.2	30.0	-27.8

Maximum peak EIRP:

Test results conducted						
BLE 1 Mbps		A (dBm)	Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH37						
T_{nom}	V_{nom}	2.1	-8.0	-5.9	36.0	-41.9
Middle frequency: CH17						
T_{nom}	V_{nom}	2.0	-8.0	-6.0	36.0	-42.0
Highest frequency: CH39						
T_{nom}	V_{nom}	2.2	-8.0	-5.8	36.0	-41.8

Test results conducted						
BLE 2 Mbps		A (dBm)	Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH0						
T_{nom}	V_{nom}	2.1	-8.0	-5.9	36.0	-41.9
Middle frequency: CH17						
T_{nom}	V_{nom}	2.0	-8.0	-6.0	36.0	-42.0
Highest frequency: CH36						
T_{nom}	V_{nom}	2.2	-8.0	-5.8	36.0	-41.8

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

Frequency (MHz)	Peak Power Limit	
	(dBm)	(W)
902-928	30	1.0
2400-2483.5	30	1.0
5725-5850	30	1.0

Peak output power limit according to RSS-247 5.4(d):

Frequency (MHz)	Peak Power Limit	
	(dBm)	(W)
902-928	30	1.0
2400-2483.5	30	1.0

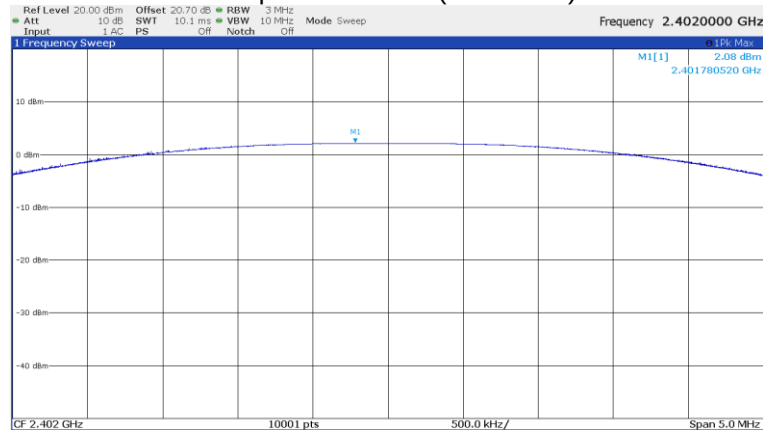
Frequency (MHz)	EIRP Limit	
	(dBm)	(W)
902-928	36	4.0
2400-2483.5	36	4.0

The requirements are **FULFILLED**.

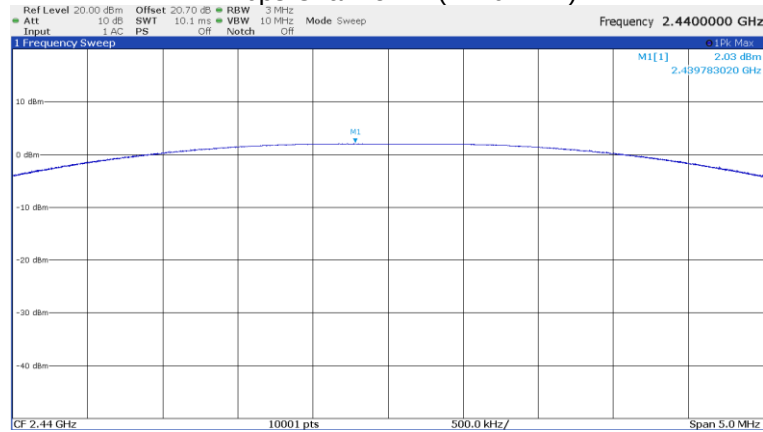
Remarks: For conducted measurement cable loss is taken into account by an offset at the analyser.
For detailed test result please see the following test protocols

5.2.6 Test protocols

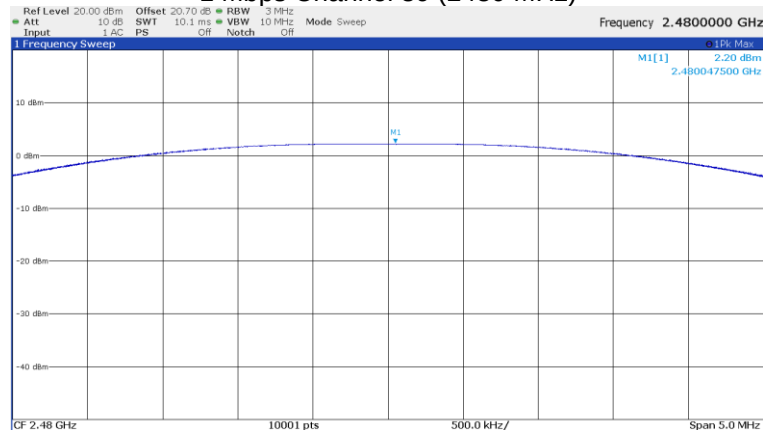
1 Mbps Channel 37 (2402 MHz)



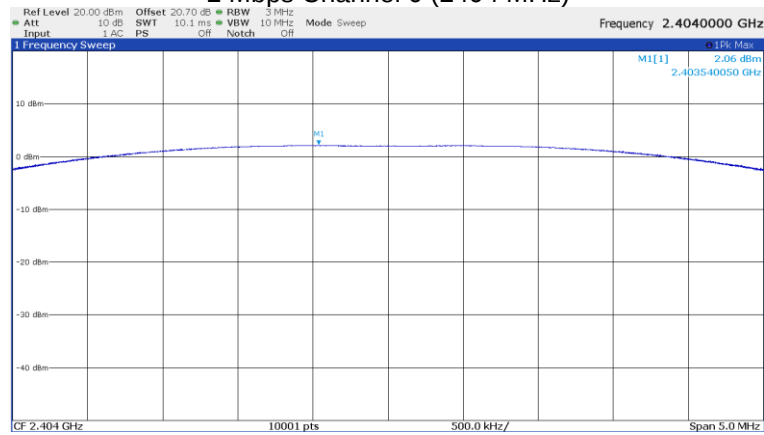
1 Mbps Channel 17 (2440 MHz)



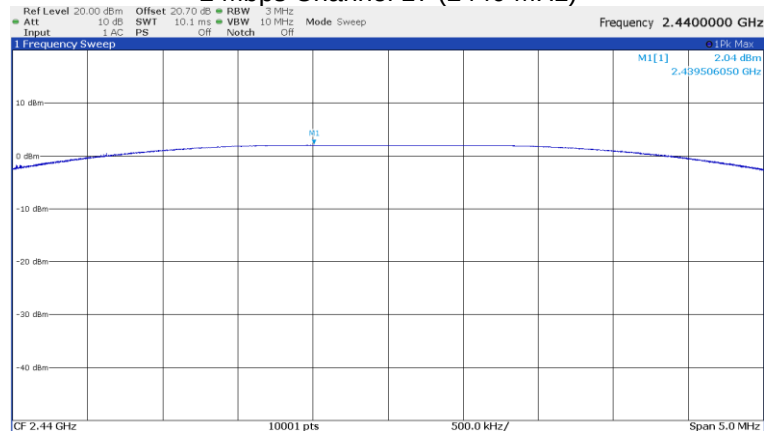
1 Mbps Channel 39 (2480 MHz)



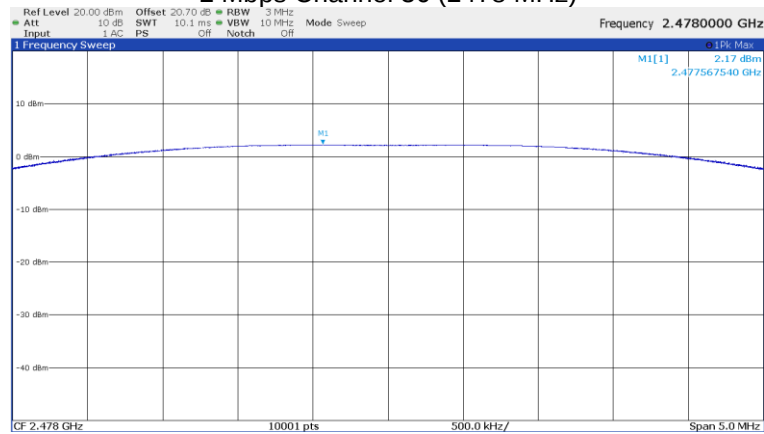
2 Mbps Channel 0 (2404 MHz)



2 Mbps Channel 17 (2440 MHz)



2 Mbps Channel 36 (2478 MHz)



5.3 Power spectral density

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

5.3.1 Description of the test location

Test location: Shielded Room S6

5.3.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.3.3 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.

According to RSS-247 5.2(b):

The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

5.3.4 Description of Measurement

The measurement is performed using the procedure set out in 11.10 of ANSI C63.10. The power measurement was done as peak power measurement. Therefore, the PKPSD is measured. The max peak was located with the spectrum analyser and a marker set to peak.

Spectrum analyser settings:

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

5.3.5 Test result

Test results conducted				
BLE 1 Mbps		PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Lowest frequency: 2402 MHz				
T_{nom}	V_{nom}	-14.5	8.0	-22.5
Middle frequency: 2440 MHz				
T_{nom}	V_{nom}	-14.5	8.0	-22.5
Highest frequency: 2480 MHz				
T_{nom}	V_{nom}	-14.3	8.0	-22.3

Test results conducted				
BLE 2 Mbps		PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Lowest frequency: 2404 MHz				
T_{nom}	V_{nom}	-17.6	8.0	-25.6
Middle frequency: 2440 MHz				
T_{nom}	V_{nom}	-17.6	8.0	-25.6
Highest frequency: 2478 MHz				
T_{nom}	V_{nom}	-17.4	8.0	-25.4

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

Frequency (MHz)	Power spectral density limit (dBm/3 kHz)
902-928	8
2400 - 2483.5	8
5725-5850	8

Power spectral density limit according to RSS-247 5.2(b):

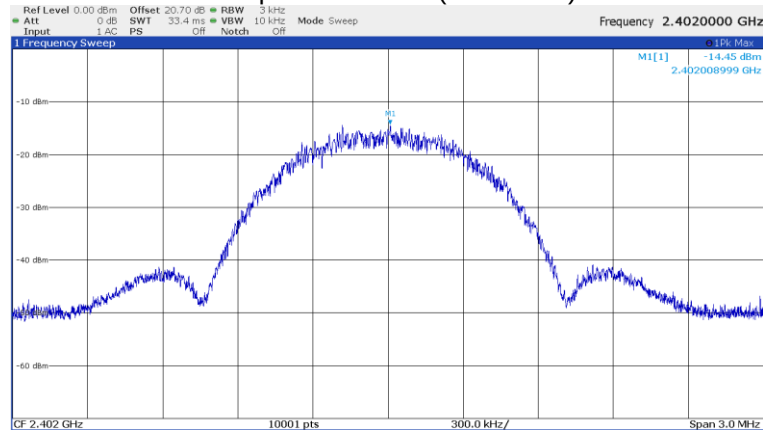
Frequency (MHz)	Power spectral density limit (dBm/3 kHz)
902-928	8
2400 - 2483.5	8

The requirements are **FULFILLED**.

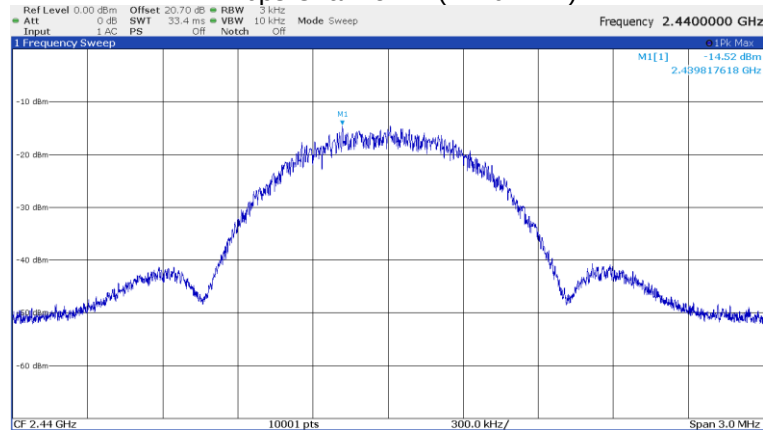
Remarks: For conducted measurement cable loss is taken into account by an offset at the analyser.
For detailed test result please see the following test protocols

5.3.6 Test protocols

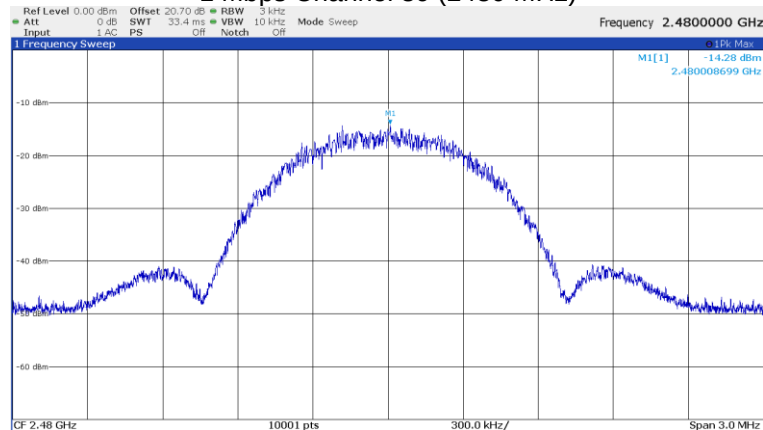
1 Mbps Channel 37 (2402 MHz)



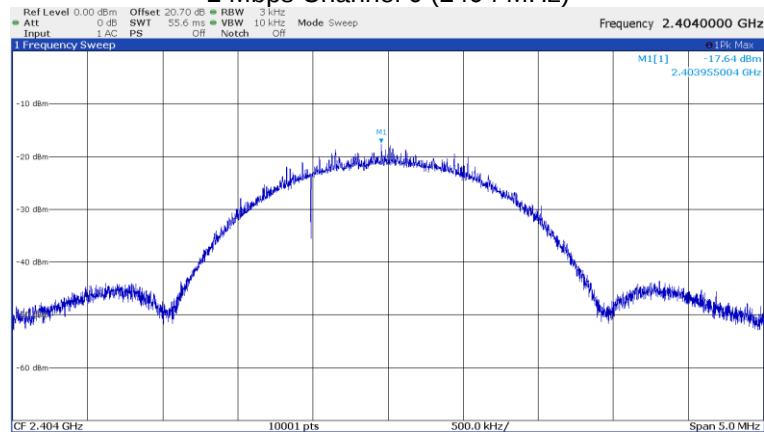
1 Mbps Channel 17 (2440 MHz)



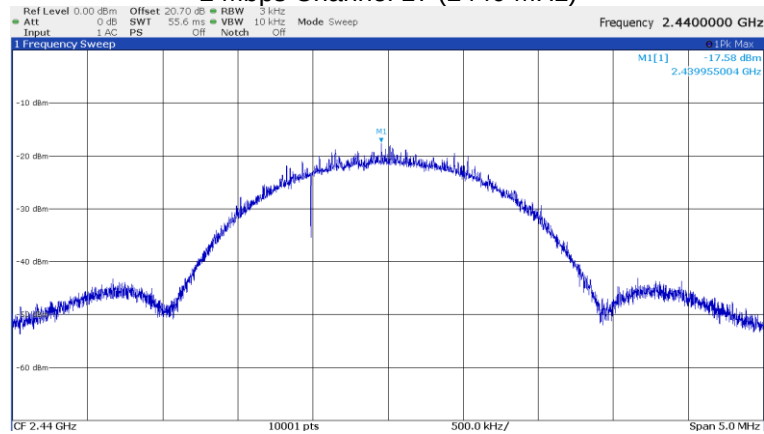
1 Mbps Channel 39 (2480 MHz)



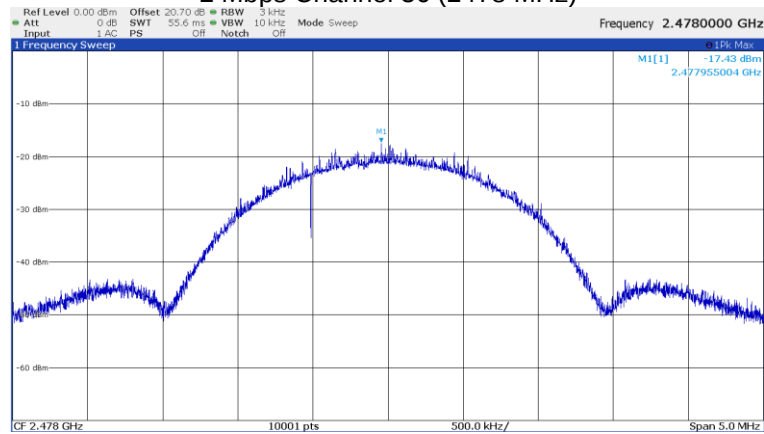
2 Mbps Channel 0 (2404 MHz)



2 Mbps Channel 17 (2440 MHz)



2 Mbps Channel 36 (2478 MHz)



5.4 Spurious emissions radiated

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

5.4.1 Description of the test location

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

5.4.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.4.3 Applicable standard

According to FCC Part 15, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

According to RSS-247 5.5:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

5.4.4 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.10. If the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

Measurements are performed in following order:

1) Measurement of emissions according to General Limit specified in section 15.209(a):

Test receiver settings for SER1, SER2:

9kHz-150kHz	RBW: 200 Hz	Detector: Quasi peak*	Meas. Time: 1 s,
150kHz-30MHz	RBW: 9 kHz	Detector: Quasi peak*	Meas. Time: 1 s,
30MHz-1GHz	RBW: 120 MHz	Detector: Quasi peak	Meas. Time: 1 s,

*AV Detector in the ranges 9-90kHz and 110-490kHz

Spectrum analyser settings for SER3:

1GHz-25GHz	RBW: 1 MHz	Detector: Max. peak	Trace: Max. hold	Sweep: Auto
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2) If emissions outside the Restricted Bands are above General Limit additional measurements of emissions according to Spurious Emissions Limit specified in section 15.247(d) are performed:

Spectrum analyser settings:

RBW: 100 kHz	VBW: 300 kHz	Detector: Max. peak	Trace: Max. hold	Sweep: Auto
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5.4.5 Test result

$f < 30 \text{ MHz}$

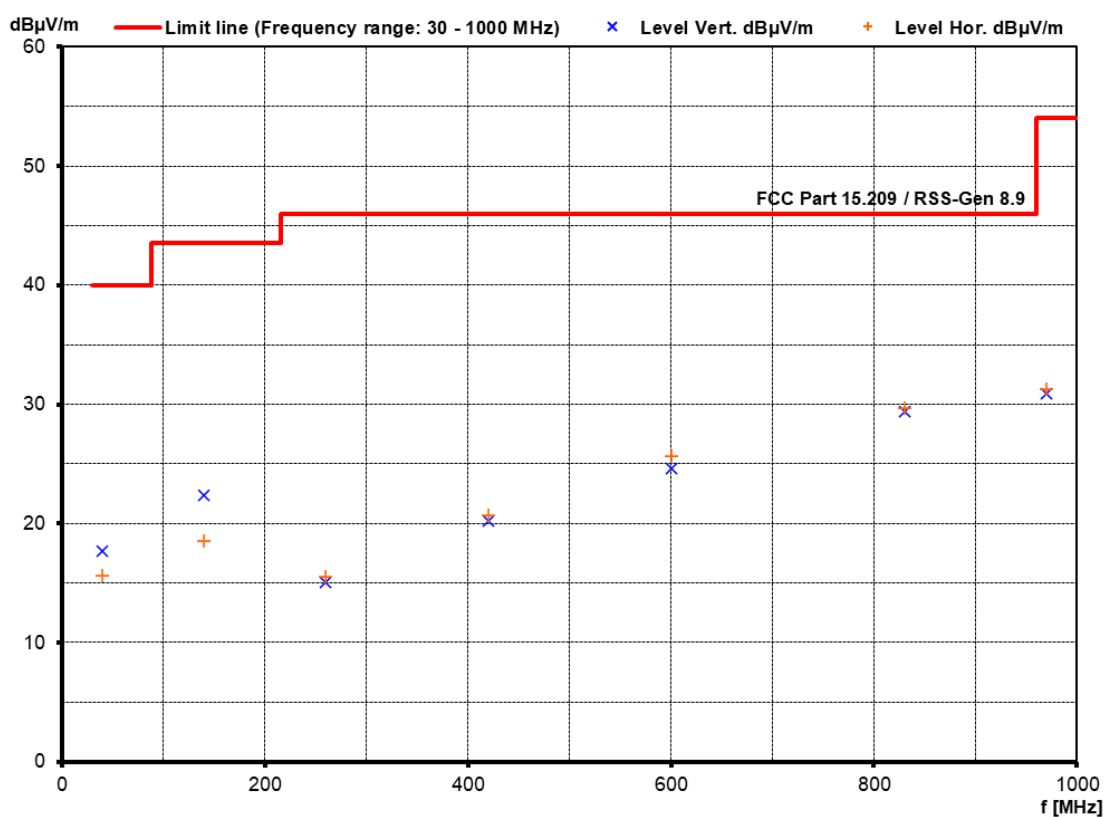
According to FCC 15.209					
Frequency (MHz)	Reading (dB μ V)	Correction (dB)*	Field strength (dB μ V/m)	Limit (dB μ V/m)	Dlimit (dB)
0.009	68.9	-58.8	10.1	48.5	-38.4
0.048	38.3	19.0	-22.7	34.0	-56.7
0.120	29.9	18.1	-32.0	26.0	-58.0
0.560	32.0	17.7	9.7	32.6	-22.9
2.100	33.7	18.3	12.0	30.0	-18.0
24.000	23.8	18.0	1.8	30.0	-28.2

According to RSS-Gen 8.9				
Frequency (kHz)	Field strength (dB μ V/m)	QP calc. (dB μ A/m)	Limit (dB μ A/m)	Dlimit (dB)
9	10.1	-41.4	17.0	-58.4
48	-22.7	-74.2	2.5	-76.7
120	-32.0	-83.5	-5.5	-78.0
560	9.7	-41.8	-18.9	-22.9
2100	12.0	-39.5	-21.9	-17.6
24000	1.8	-49.7	-21.9	-27.8

Note: No emissions detected in the frequency range 9 kHz to 30 MHz. The recorded values are solely noise values of the OATS.

30 MHz < 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)
40.00	0.9	-2.4	16.8	18.0	17.7	15.6	40.0	-22.3
140.00	3.1	0.1	19.3	18.4	22.4	18.5	43.5	-21.1
260.00	-4.0	-3.6	19.1	19.1	15.1	15.5	46.0	-30.5
420.00	-3.6	-3.4	23.8	24.1	20.2	20.7	46.0	-25.3
600.00	-3.7	-3.0	28.3	28.6	24.6	25.6	46.0	-20.4
830.00	-2.6	-2.7	32.0	32.4	29.4	29.7	46.0	-16.3
970.00	-2.8	-2.8	33.7	34.1	30.9	31.3	54.0	-22.7

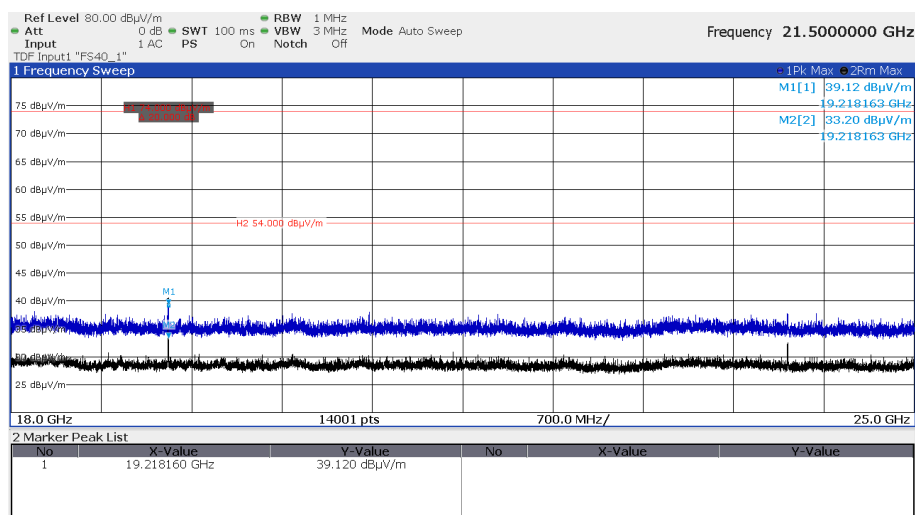
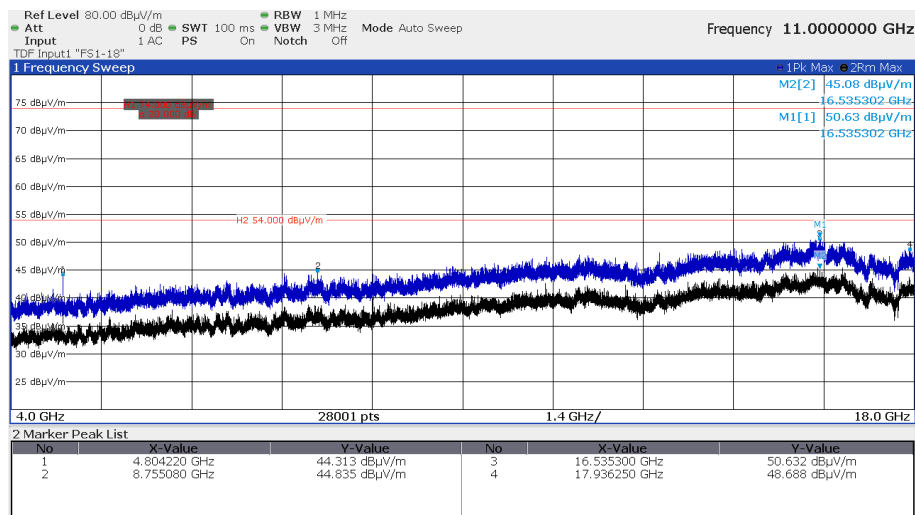
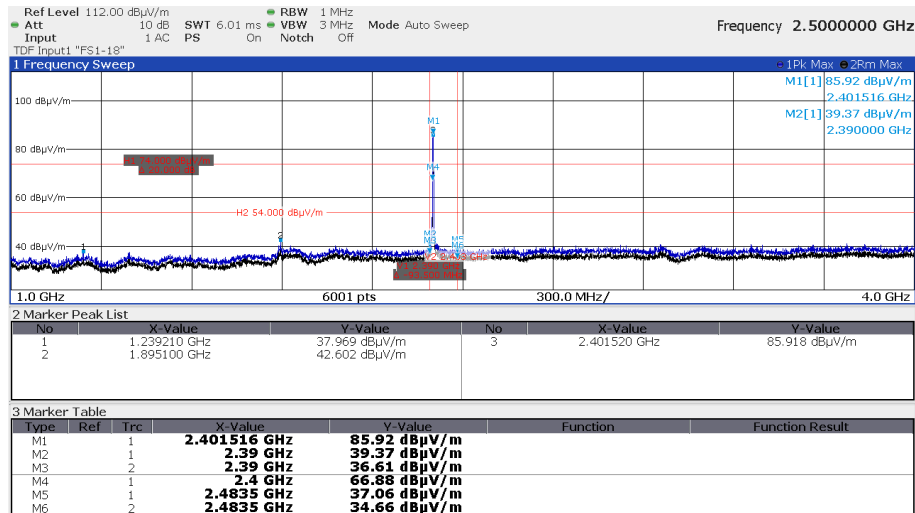


Note: No emissions detected in the frequency range 30 MHz to 1 GHz. The recorded values are solely noise values of the OATS.

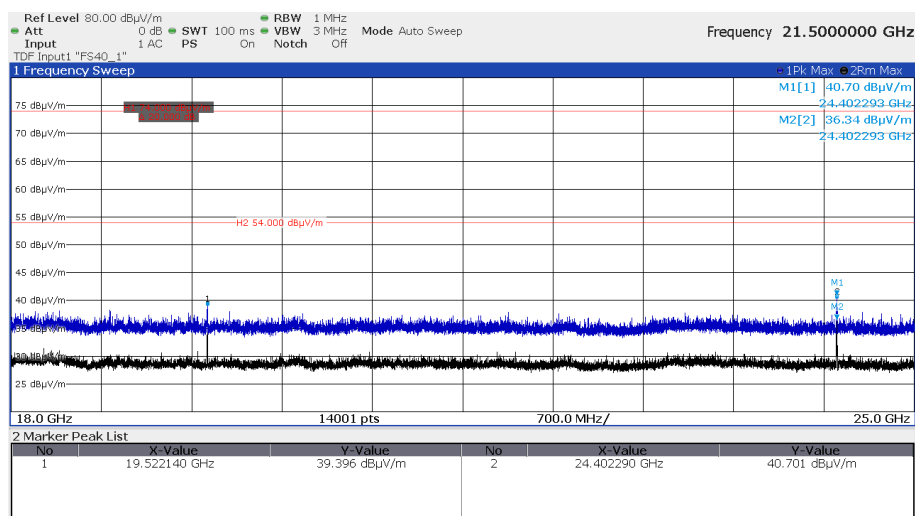
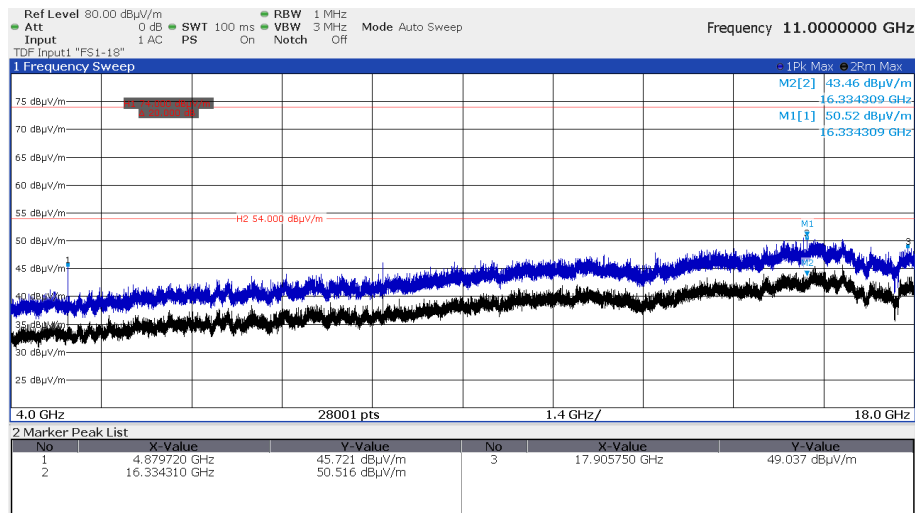
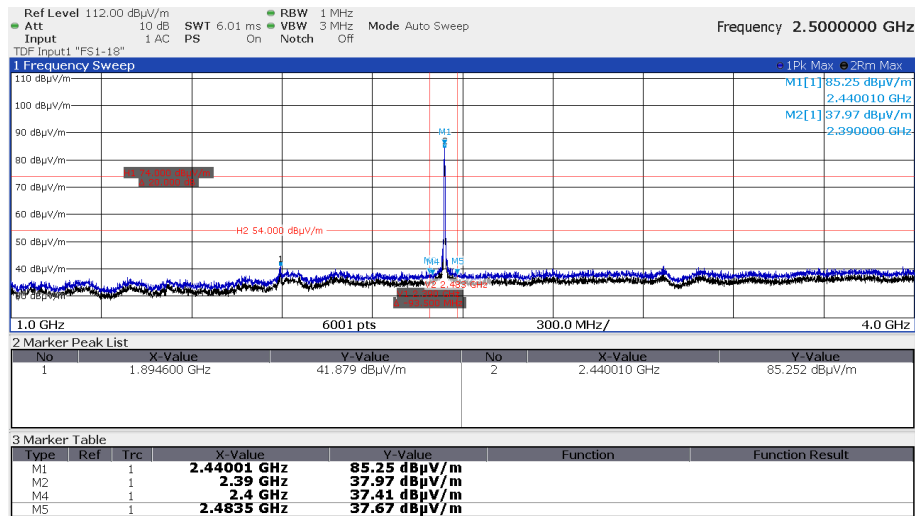
f > 1000 MHz

Measurement of emissions according to General Limit specified in section 15.209(a) / RSS-Gen 8.9:

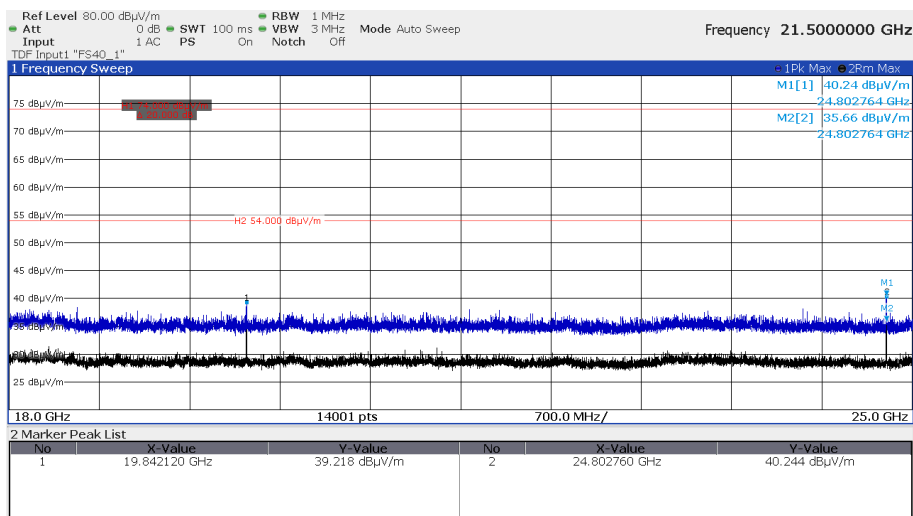
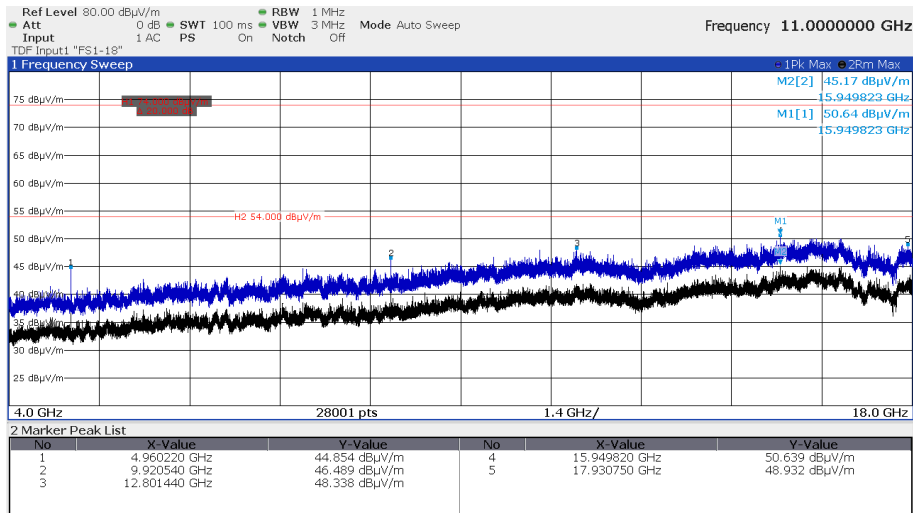
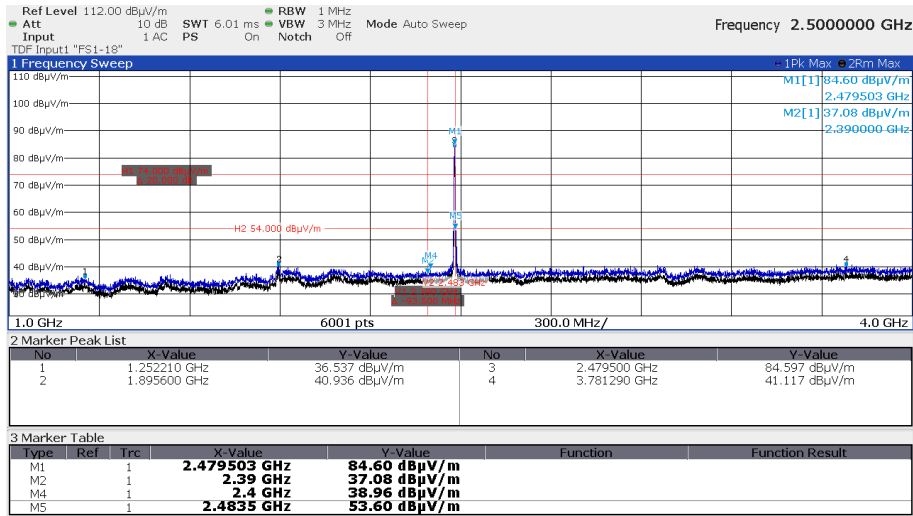
1 Mbps CH37 – 2402 MHz – P_{def}:



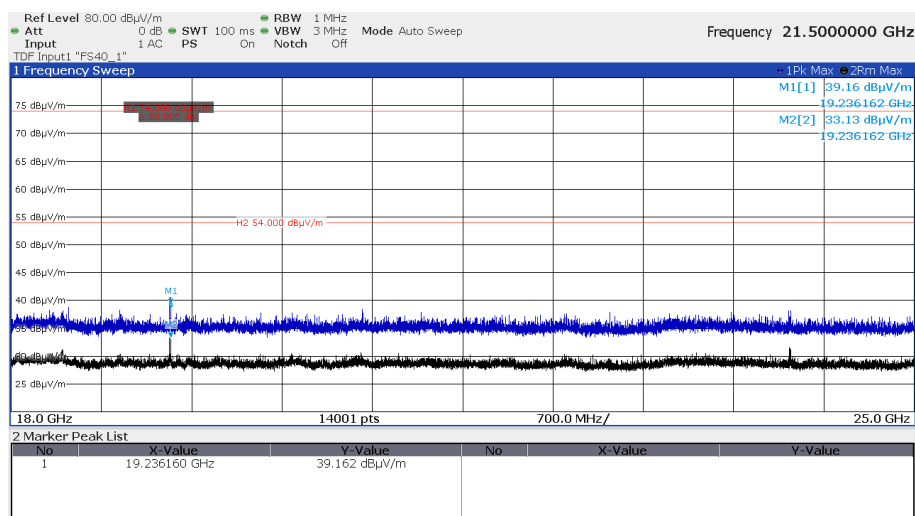
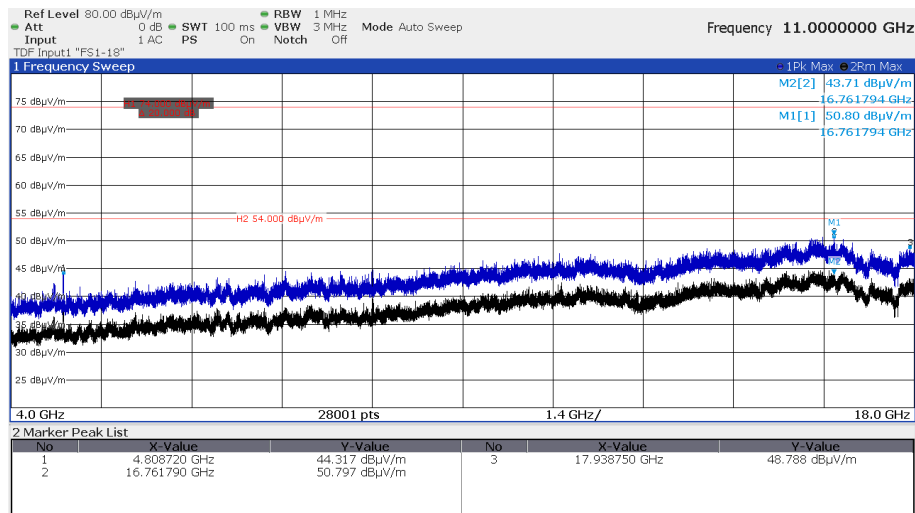
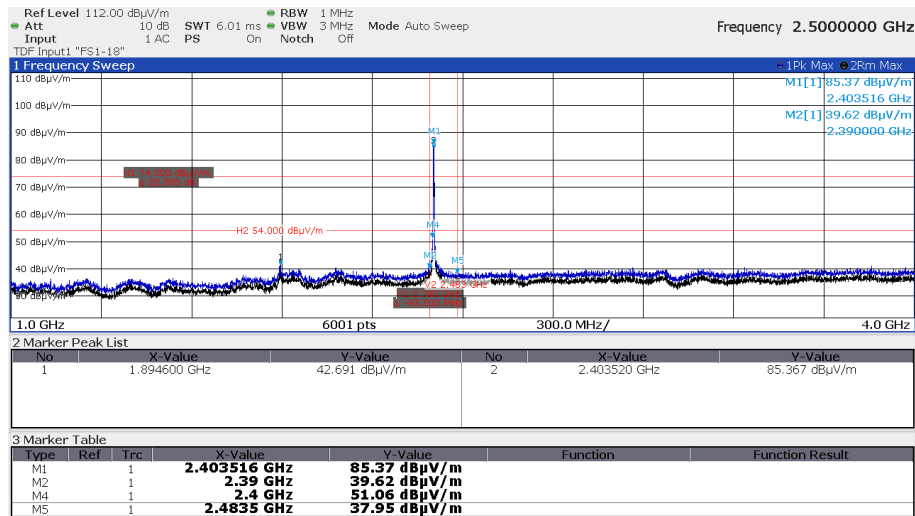
1 Mbps CH17 – 2440 MHz – P_{def}:



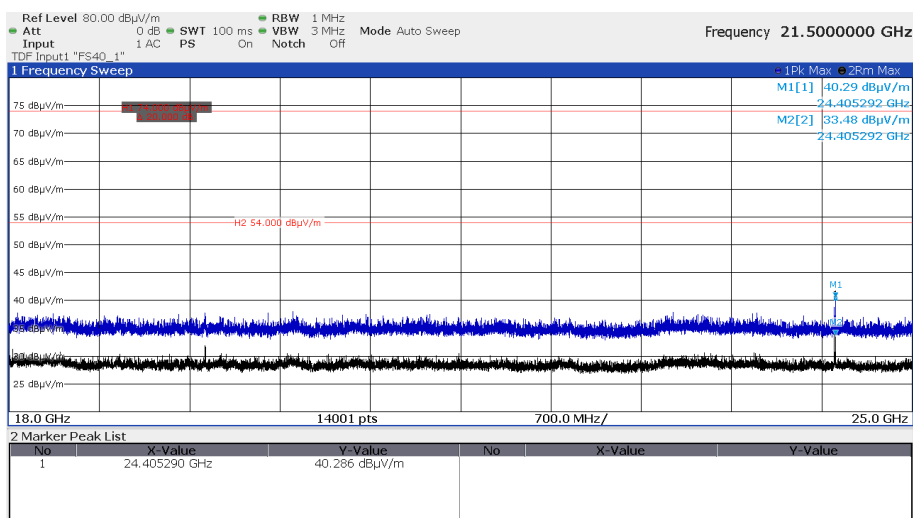
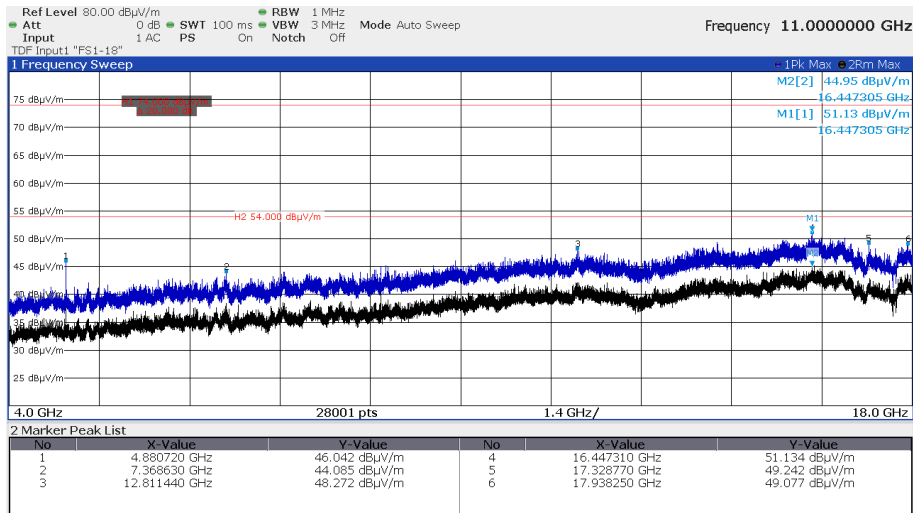
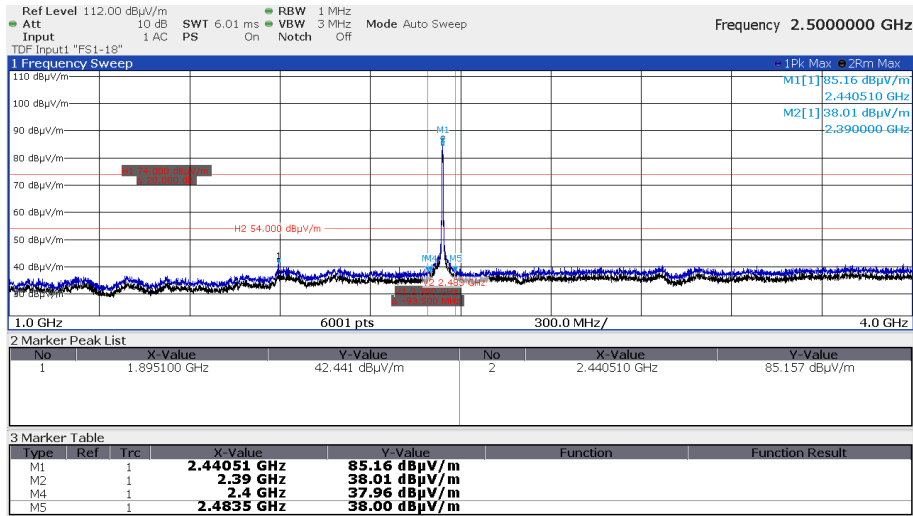
1 Mbps CH39 – 2480 MHz – P_{def}:



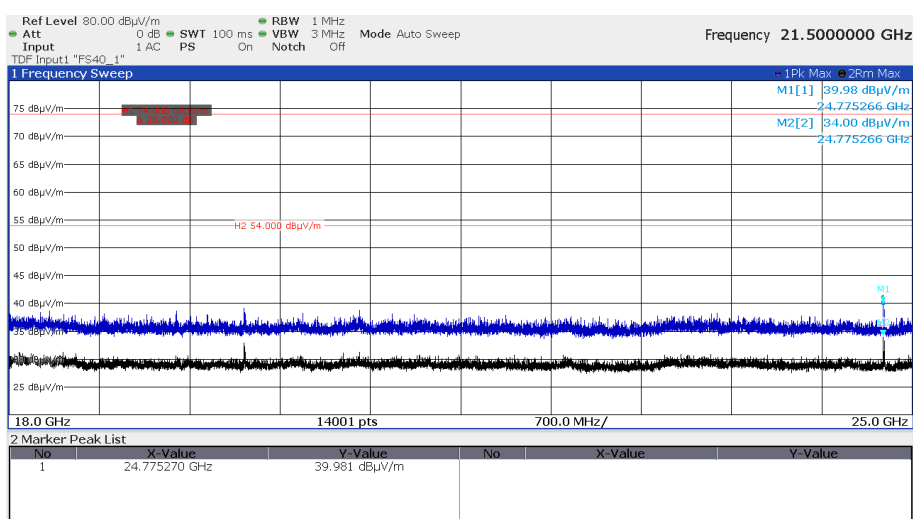
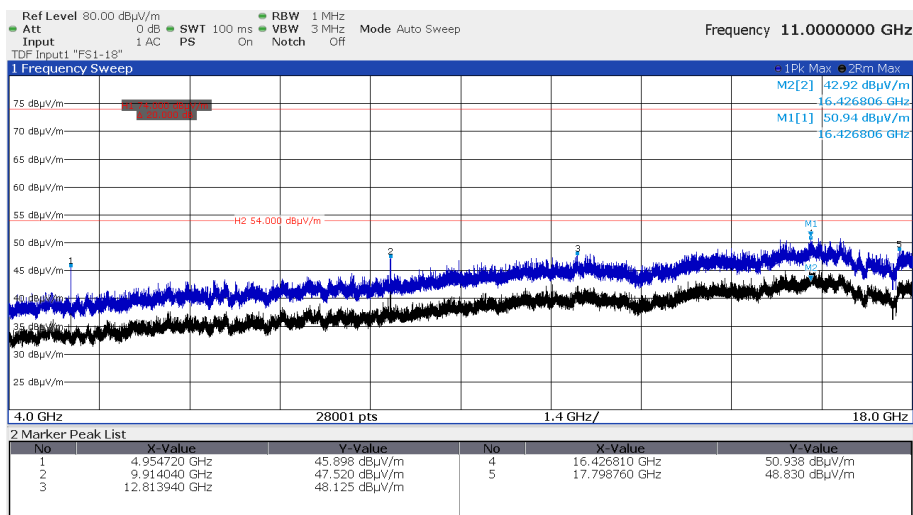
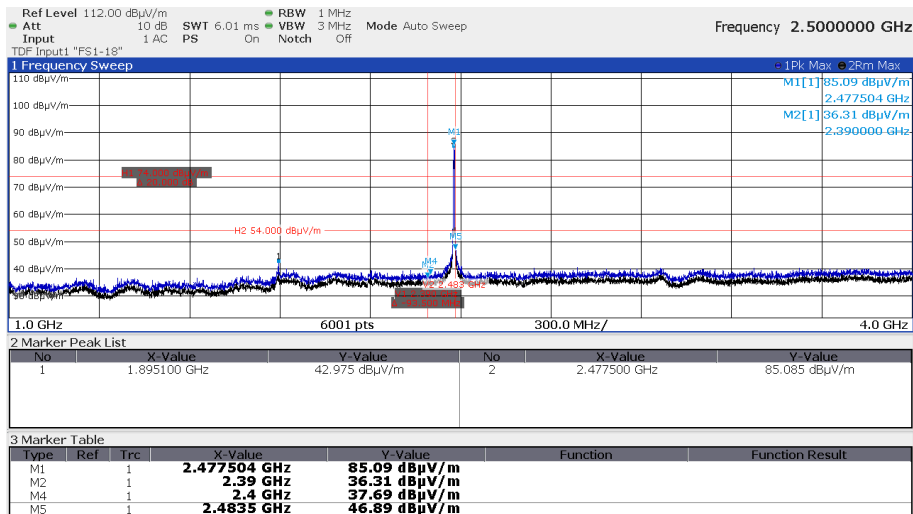
2 Mbps CH0 – 2404 MHz – P_{def}:



2 Mbps CH17 – 2440 MHz – P_{def}:



2 Mbps CH36 – 2478 MHz – P_{def}:



Radiated limits according to FCC Part 15, Section 15.209 for spurious emissions which fall in restricted bands:

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

Radiated limits according to RSS-Gen, 8.9 for spurious emissions which fall in restricted bands:

Frequency (MHz)	RSS-Gen Limits (μA/m)	Measurement distance (m)
0.009 - -0.49	63.7/f(kHz)	300
0.49 – 1.705	63.7/f(kHz)	30
1.705 – 30.0	0.08	30

Frequency (MHz)	RSS-Gen Limits (μV/m)	Measurement distance (m)
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Limit according to FCC Part 15, Section 15.247(d) for emissions falling not in restricted bands:

Frequency (MHz)	Spurious emission limit
Below 1000	20 dB below the highest level of the desired power
Above 1000	20 dB below the highest level of the desired power

Attenuation below the general limits specified in Section 15.209(a) is not required.

Limit according to RSS-247, 5.5 for emissions falling not in restricted bands:

Frequency (MHz)	Spurious emission limit
Below 1000	20 dB below the highest level of the desired power
Above 1000	20 dB below the highest level of the desired power

Attenuation below the general limits specified in RSS-Gen is not required.

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

RSS-Gen, Table 6 – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	12.57675 - 12.57725	399.9 - 410	7.250 - 7.750
0.495 - 0.505	13.36 - 13.41	608 - 614	8.025 – 8.500
2.1735 - 2.1905	16.42 - 16.423	960 - 1427	9.0 - 9.2
3.020 - 3.026	16.69475 - 16.69525	1435 - 1626.5	9.3 - 9.5
4.125 - 4.128	16.80425 - 16.80475	1645.5 - 1646.5	10.6 - 12.7
4.17725 - 4.17775	25.5 - 25.67	1660 - 1710	13.25 - 13.4
4.20725 - 4.20775	37.5 - 38.25	1718.8 - 1722.2	14.47 - 14.5
5.677 - 5.683	73 - 74.6	2200 - 2300	15.35 - 16.2
6.215 - 6.218	74.8 - 75.2	2310 - 2390	17.7 - 21.4
6.26775 - 6.26825	108 – 138	2483.5 - 2500	22.01 - 23.12
6.31175 - 6.31225	149.9 - 150.05	2655 - 2900	23.6 - 24.0
8.291 - 8.294	156.52475 - 156.52525	3260 – 3267	31.2 - 31.8
8.362 - 8.366	156.7 - 156.9	3332 - 3339	36.43 - 36.5
8.37625 - 8.38675	162.0125 - 167.17	3345.8 - 3358	Above 38.6
8.41425 - 8.41475	167.72 - 173.2	3500 - 4400	
12.29 - 12.293	240 – 285	4500 - 5150	
12.51975 - 12.52025	322 - 335.4	5350 - 5460	

The requirements are **FULFILLED**.

Remarks: The measurement was performed up to the 10th harmonic. Only the worst-case plots are listed.

Measurement of emissions according to spurious emissions limit specified in section 15.247(d) /

RSS-247 5.5 not necessary as PK values are below general limit.

5.5 Antenna application

According to FCC Part 15C, Section 15.203:

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. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has an integrated antenna. No other antenna can be used with the device.

The supplied antenna meets the requirements of part 15.203.

The requirements are **FULFILLED**.

Remarks: None

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.
CPC 3	minibend KR-16	02-02/50-16-013				
	SF0915-6200-20 DC-40GHz	02-02/50-23-004			18/10/2024	18/04/2024
	ESW44	09-16/03-24-001	21/11/2024	21/11/2023		
SER 1	ESR 7	02-02/03-17-001	01/08/2024	01/08/2023		
	HFH 2 - Z 2	02-02/24-05-020	01/06/2025	01/06/2022	05/09/2024	05/09/2023
	KK-EF393-21N-16	02-02/50-05-033				
	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 2	VULB 9168	01-02/24-20-001	12/02/2025	12/02/2024		
	ESVS 30	02-02/03-05-006	27/07/2024	27/07/2023		
	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				
	50F-003 N 3 dB	02-02/50-21-010				
SER 3	ESW26	02-02/03-17-002	16/04/2025	16/04/2024		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	LNA-40-18004000-33-5P	02-02/17-20-002				
	BBHA 9170	02-02/24-05-013	21/03/2026	21/03/2023	22/01/2025	22/01/2024
	3117	02-02/24-20-007	15/11/2024	15/11/2023		
	WHK 3.0/18G-10EF	02-02/50-05-180				
	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				
	KMS116-GL140SE-KMS116-	02-02/50-20-026				

- End of test report -