TEST REPORT

of the accredited test laboratory

TÜV Nr.: 2023-IN-AT-TICL-E-EX-0-000230-FG-001

Applicant:	PDi Digital GmbH Kalsdorfer Strasse 6 A – 8072 Fernitz-Mellach
Tested Product:	Electronic shelf labelling system
Product Name:	Sepioo D12.2 B NB-IoT Outdoor
Model:	PDNB-1220-C
FCC ID:	2A3HY-PDNB-1220-C
IC ID:	27854-PDNB1220C
Manufacturer:	PDi Digital GmbH Kalsdorfer Strasse 6 A – 8072 Fernitz-Mellach

Output power	0,36 mW eirp 0,13 mW eirp	**power supply:**	3 VDC via Battery
Frequency range:	2402 - 2480 MHz 2401 - 2481 MHz	**Channel separation:**	2 MHz 1 MHz / 2 MHz

Accredited Standards: FCC: 47 CFR Parts 15, 22, 24, 27 and 90 (eCFR 6.11.2023); RSS-130 Issue 2; RSS-132 Issue 4; RSS-133 Issue 4, February 2008; RSS-139 Issue 4, September 2022; RSS-247 Issue 3, August 2023; ANSI C63.10-2013

TÜV AUSTRIA GMBH

Test laboratory for EMC

Ing. Andreas Malek
examined by / Testing Laboratory
TÜV AUSTRIA GMBH

05.12.2023

Ing. Michael Emminger
approved by / Testing Laboratory
TÜV AUSTRIA GMBH

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The results of this test report only refer to the provided equipment.

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Technik

TÜV ®

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Inspection Body,
Certification Body,
Calibration Laboratory,
Verifizierungsstelle

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IC 2932K-1

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Contents

1. Applicant

Company:	PDi Digital GmbH
Department:	/
Address:	A – 8072 Fernitz-Mellach; Kalsdorfer Strasse 6
Contact person:	Mr. Klaus Niederl

EUT received on:	6.11.2023
Tests were performed on:	6.11. to 10.11. and on 23.11.2023

2. Description of EUT

EUT:	Electronic shelf labelling system
Product Name:	Sepioo D12.2 B NB-IoT Outdoor
Model:	PDNB-1220-C
Serial Number:	prototype
Manufacturer:	PDi Digital GmbH
Description:	PDi Digital GmbH provided the following configuration for the measurements: Prototype with special firmware for continuous transmission
Operating mode:	The measurements were carried out at the following running states: test-firmware running, transmitting continuously
Technical data EUT:	Rated voltage: 3VDC Rated frequency: DC Mains voltage during the tests: 3VDC
Climatic conditions in the emc laboratory:	Relative humidity: 33% Temperature: 23°C

3. Standards / Final result

Name	Title	Deviation	Result
FCC: 47 CFR Part 15 (eCFR 6.11.2023)	Radio Frequency Devices	none	OK
FCC: 47 CFR Part 22 (eCFR 6.11.2023)	Public Mobile Services	*)	OK
FCC: 47 CFR Part 24 (eCFR 6.11.2023)	Personal Communications Services	*)	OK
FCC: 47 CFR Part 27 (eCFR 6.11.2023)	Miscellaneous Wireless Communications Services	*)	OK
FCC: 47 CFR Part 90 (eCFR 6.11.2023)	Private Land Mobile Radio Services	*)	OK
RSS-130 Issue 2, February 2019	Equipment Operating in the Frequency Bands 617-652 MHz, 663-698 MHz, 698-756 MHz and 777-787 MHz	*)	OK
RSS-132 Issue 4, January 2023	Cellular Systems Operating in the Bands 824-849 MHz and 869-894 MHz	*)	OK
RSS-133 Issue 4, February 2008	2 GHz Personal Communications Servic	*)	OK
RSS-139 Issue 4, September 2022	Advanced Wireless Services Equipment Operating in the Bands 1710-1780 MHz and 2110-2200 MHz	*)	OK
RSS-247 Issue 3, August 2023	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices	none	OK
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices	none	OK

Result: Opinions and interpretation of testing laboratory
OK: EUT passed
NOK: EUT failed

*) Only out of band emissions for simultaneous transmission with module FCC ID: XMR2020BG95M2, IC: 10224A-2020BG95M2 were tested.

4. TEST RESULTS

4.1. TEST OBJECT DATA (Bluetooth Low Energy, BLE)

General EUT Description
The device is a display for electronic shelf labelling. The device is equipped with a passive NFC chip onboard which does not have its own rf generation. It works as tag and can also receive information from the NFC reader station. This device incorporates different communication protocols. The device uses Bluetooth Low Energy (BLE) protocol and Quuppa protocol which are generated by separate chips, but use a common antenna. Simulatenouts transmission between BLE and Quuppa is not possible. The first part of this test report is for Bluetooth Low Energy (BLE) Protocol, the second part includes measurements for Quuppa protocol. Further, the device contains a licensed module (FCC ID: XMR2020BG95M2, IC: 10224A-2020BG95M2). Simultaneous transmission with BLE and Quuppa is possible and is considered in the respective subsections.

2.1033 (c) Technical description

2.1033 (4) Type of emission: 1M00F1D – Channel spacing 2 MHz

2.1033 (5) Frequency range: 2402 to 2480 MHz (channel center frequencies).

2.1033 (6) Power range and Controls: The maximum peak output power is 0,36 mW and there is no power regulation.

2.1033 (7) Maximum output power rating: 0,36 mW.

2.1033 (8) DC Voltage and Current: 3V DC

RSS-135 This standard does not apply to:
1.1.(a) a receiver that scans radio frequencies for the purpose of enabling its associated transmitter to avoid transmitting in an occupied frequency but which does not have the capability of decoding the message (e.g. converting it to audio voice) contained in the radio signal

Worst case Spurious Emissions: 38,44 dBµV/m Average at 12199,25 MHz.

Tests were performed from November 6th to November 23rd 2023.

4.2. Number of channels and channel spacing § 2.1033

Conducted Measurement

Rated output power: 0,36 mW

There are 40 Channels used, starting at 2402 till 2480 MHz each separated by 2 MHz channel spacing.

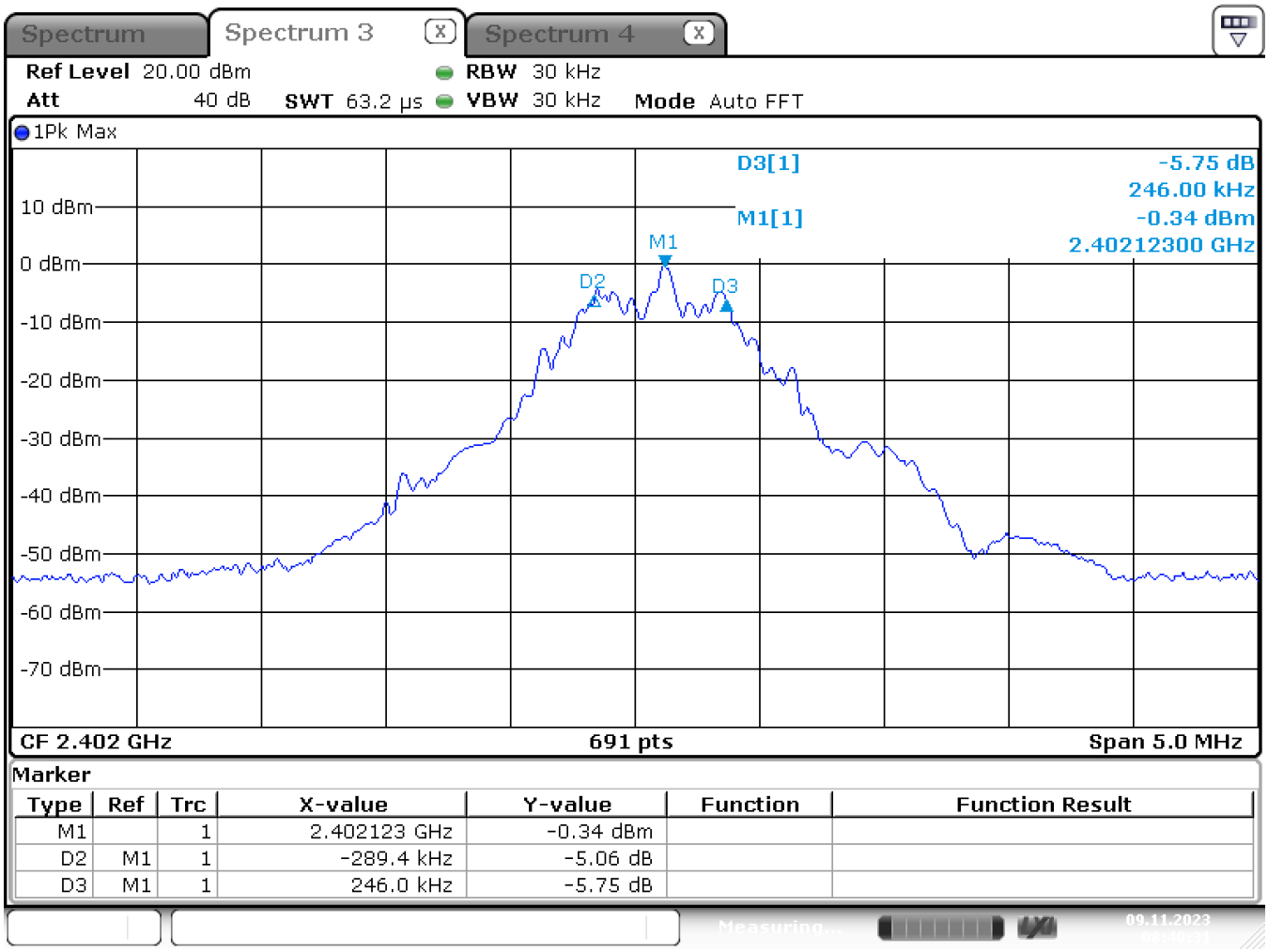
Test Equipment used: N/A

4.3. 6 dB Bandwidth

§ 15.247(a)(2)
5.2.a

Conducted Measurement

Rated output power: 0,36 mW Channel 0 (2402 MHz center frequency)



Date: 9.NOV.2023 08:40:32

6dB Bandwidth: 535,4 kHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2.a)**

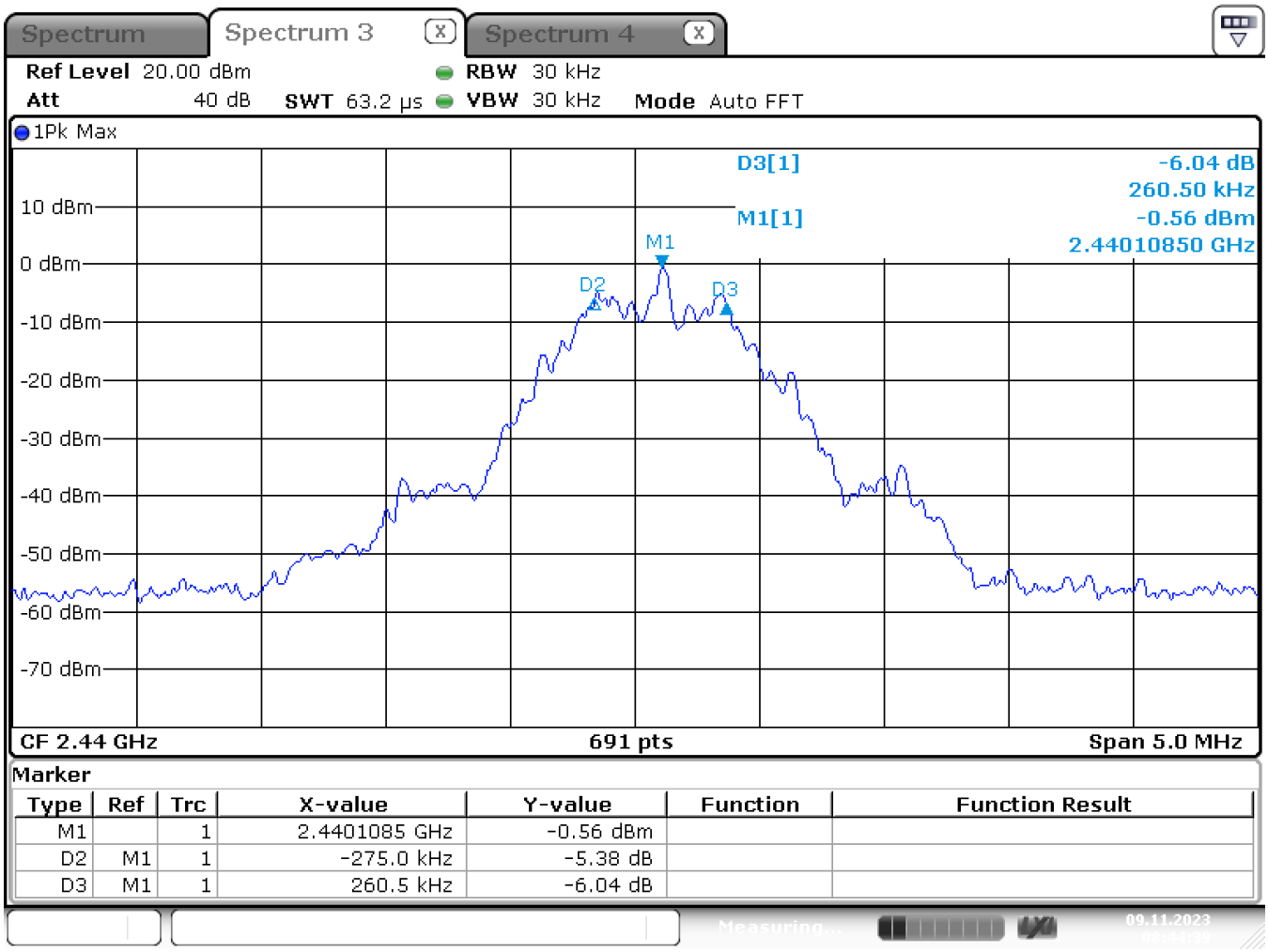
Under normal test conditons	6 dB Bandwidth at least 500 kHz

Test Equipment used: EMV-205;

6 dB Bandwidth **§ 15.247(a)(2)**
5.2.a

Conducted Measurement

Rated output power: 0,36 mW Channel 19 (2440 MHz center frequency)



Date: 9.NOV.2023 08:44:39

6dB Bandwidth: 535,5 kHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2.a)**

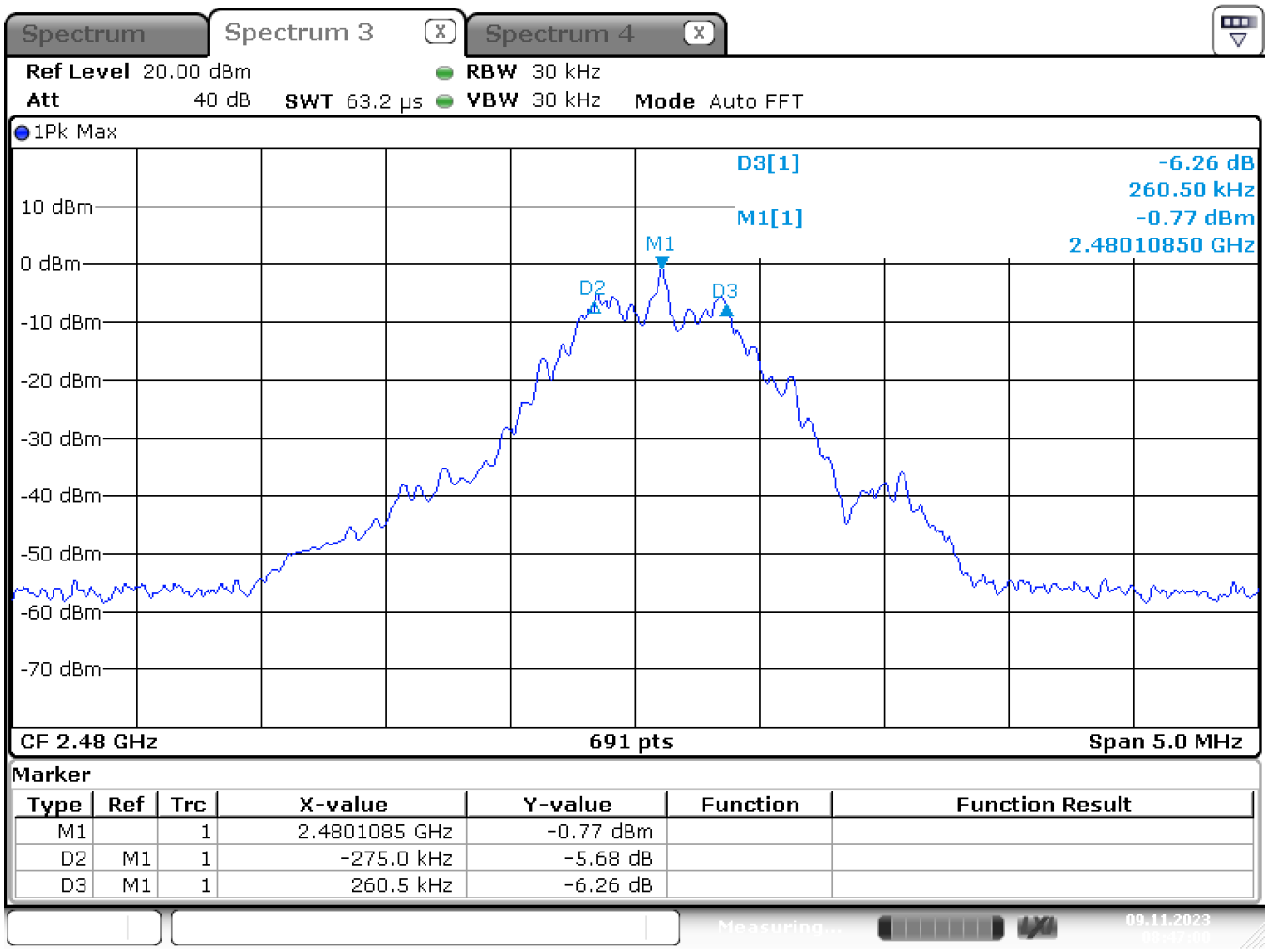
Under normal test conditons	6 dB Bandwidth at least 500 kHz

Test Equipment used: EMV-205;

6 dB Bandwidth **§ 15.247(a)(2)**
5.2.a

Conducted Measurement

Rated output power: 0,36 mW Channel 39 (2480 MHz center frequency)



Date: 9.NOV.2023 08:47:00

6dB Bandwidth: 535,5 kHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2.a)**

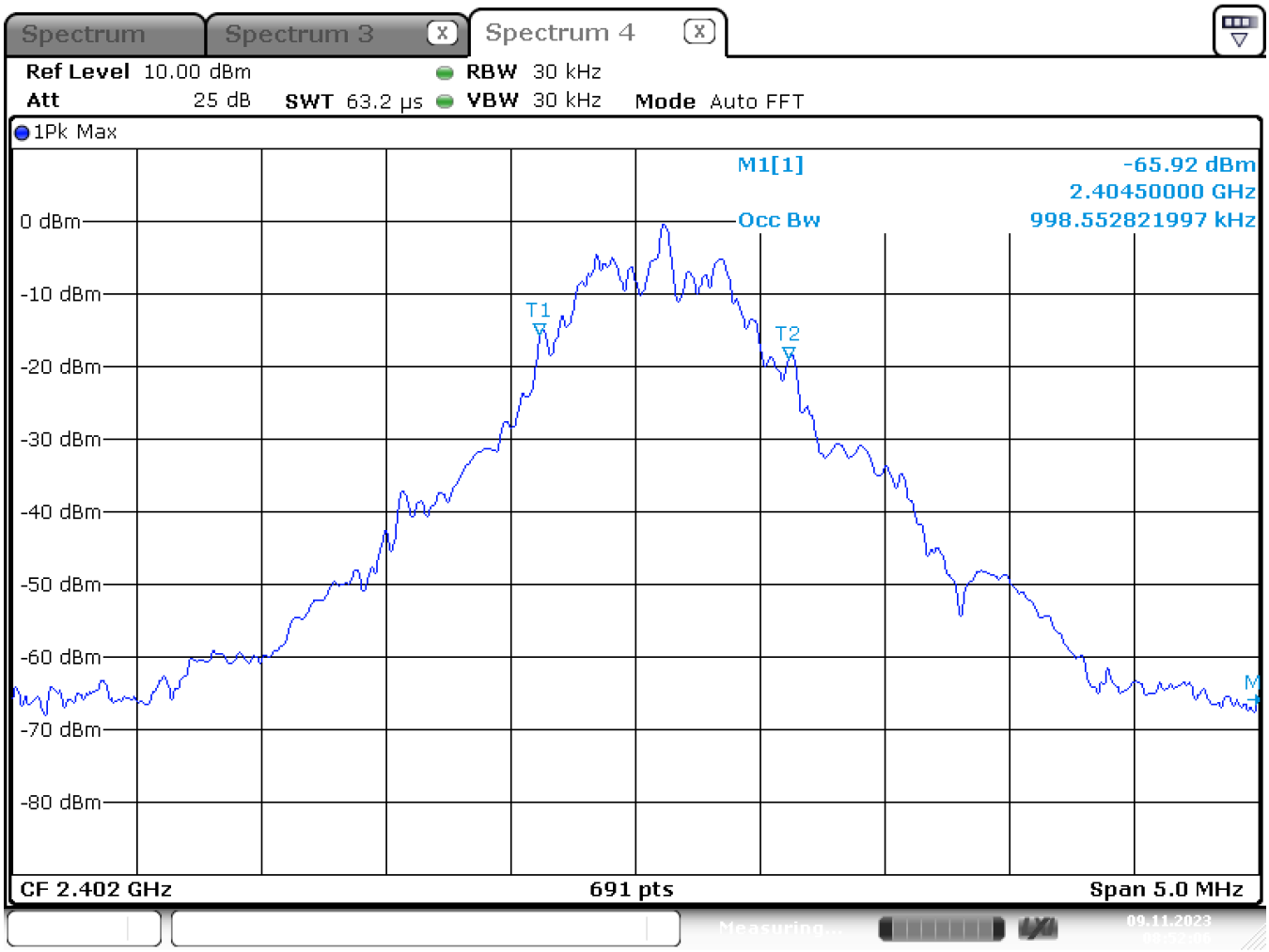
Under normal test conditons	6 dB Bandwidth at least 500 kHz

Test Equipment used: EMV-205;

4.4. 99% Bandwidth RSS 247

Conducted Measurement

Rated output power: 0,36 mW Channel 0 (2402 MHz center frequency)



Date: 9.NOV.2023 08:52:06

99% Bandwidth: 998,6 kHz

LIMIT **RSS 247**

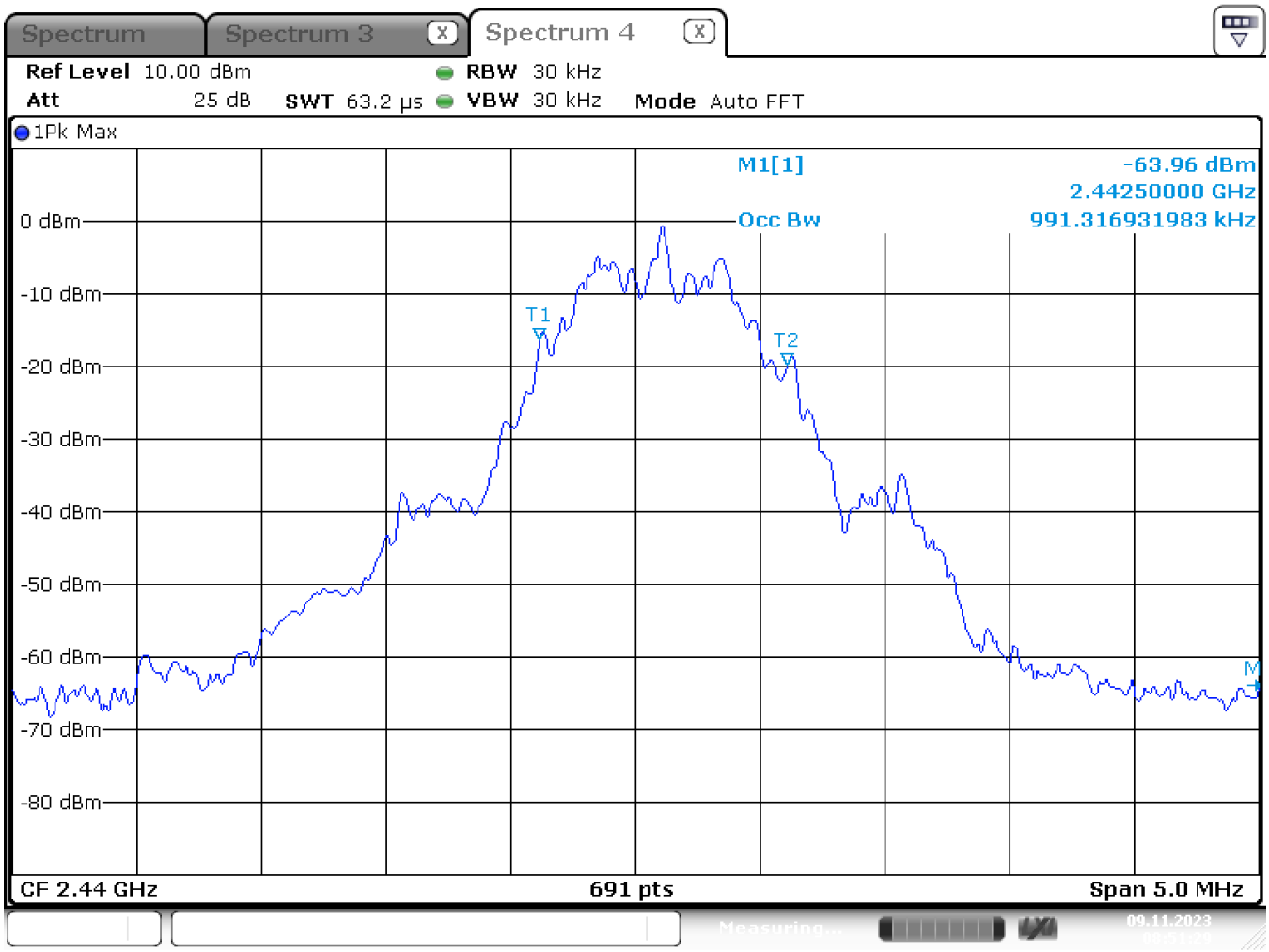
None; for IC reporting purposes only

Test Equipment used: EMV-205;

99% Bandwidth **RSS 247**

Conducted Measurement

Rated output power: 0,36 mW Channel 19 (2440 MHz center frequency)



Date: 9.NOV.2023 08:51:29

99% Bandwidth: 991,3 kHz

LIMIT **RSS 247**

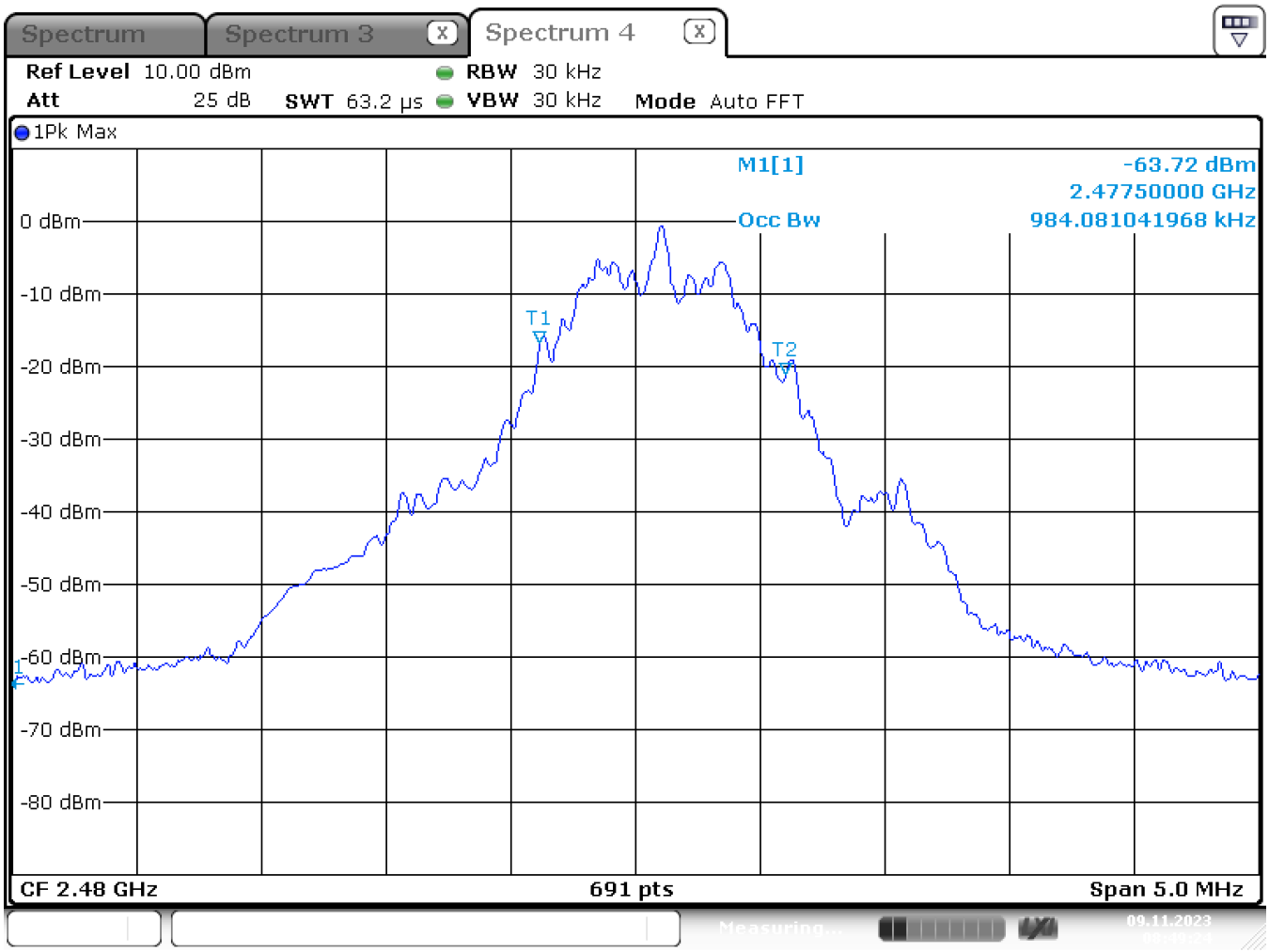
None; for IC reporting purposes only

Test Equipment used:EMV-205;

99% Bandwidth **RSS 247**

Conducted Measurement

Rated output power: 0,36 mW Channel 39 (2480 MHz center frequency)



Date: 9.NOV.2023 08:49:24

99% Bandwidth: 984,1 kHz

LIMIT **RSS 247**

None; for IC reporting purposes only

Test Equipment used: EMV-205;

4.5. Maximum Peak RF Power Output

§ 15.247(b)(3)
5.4.d

Conducted Measurement

Rated output power: 0,36 mW

Test conditions		Transmitter power (mW)		
		2402 MHz	2440 MHz	2480 MHz
T_{nom} (23)°C	V_{nom} (3) V	1,04	0,95	0,91
Measurement uncertainty		± 0,75 dB		

Radiated Measurement

Rated output power: 0,36 mW

Test conditions		Transmitter power (mW) EIRP		
		2402 MHz	2440 MHz	2480 MHz
T_{nom} (23)°C	V_{nom} (3) V	0,36	0,26	0,13
Measurement uncertainty		± 2 dB		

Maximum Gain derived from EIRP and conducted measurement:		Maximum Gain (dBi)		
Test condition		2402 MHz	2440 MHz	2480 MHz
T_{nom} 23 °C	V_{nom} (3)V	-4,55	-5,58	-8,38

LIMIT **SUBCLAUSE 15.247(b)(3) – 5.4.4**

Under normal test conditons	1W conducted (4W eirp)

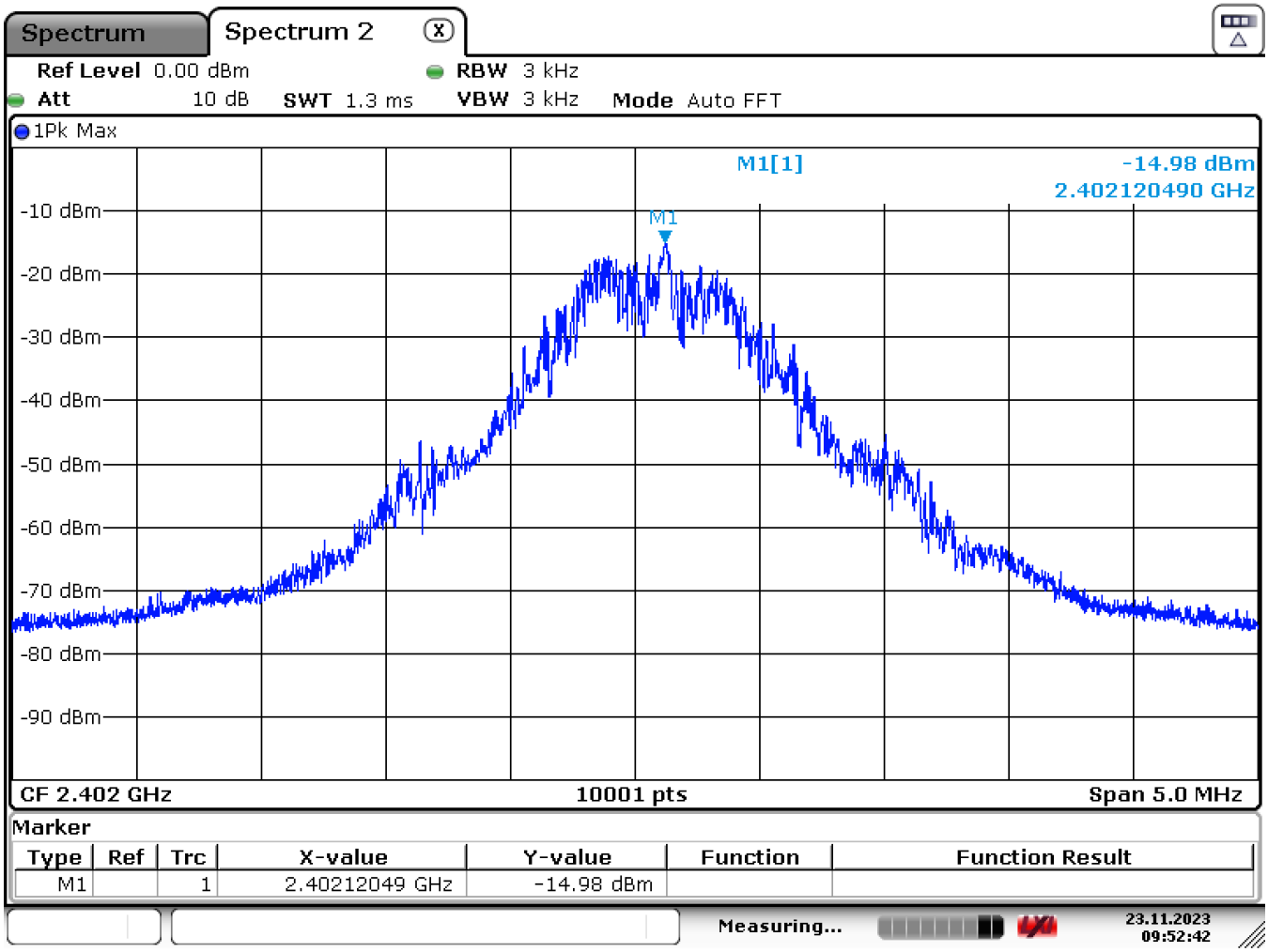
Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1; EMV-205

4.6. Power spectral density

§ 15.247(e)
5.2.b

Conducted Measurement

Rated output power: 0,36 mW Channel 0 (2402 MHz center frequency)



Date: 23.NOV.2023 09:52:42

Power Spectral density: -14,98 dBm @ 2402,12 MHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2 b)**

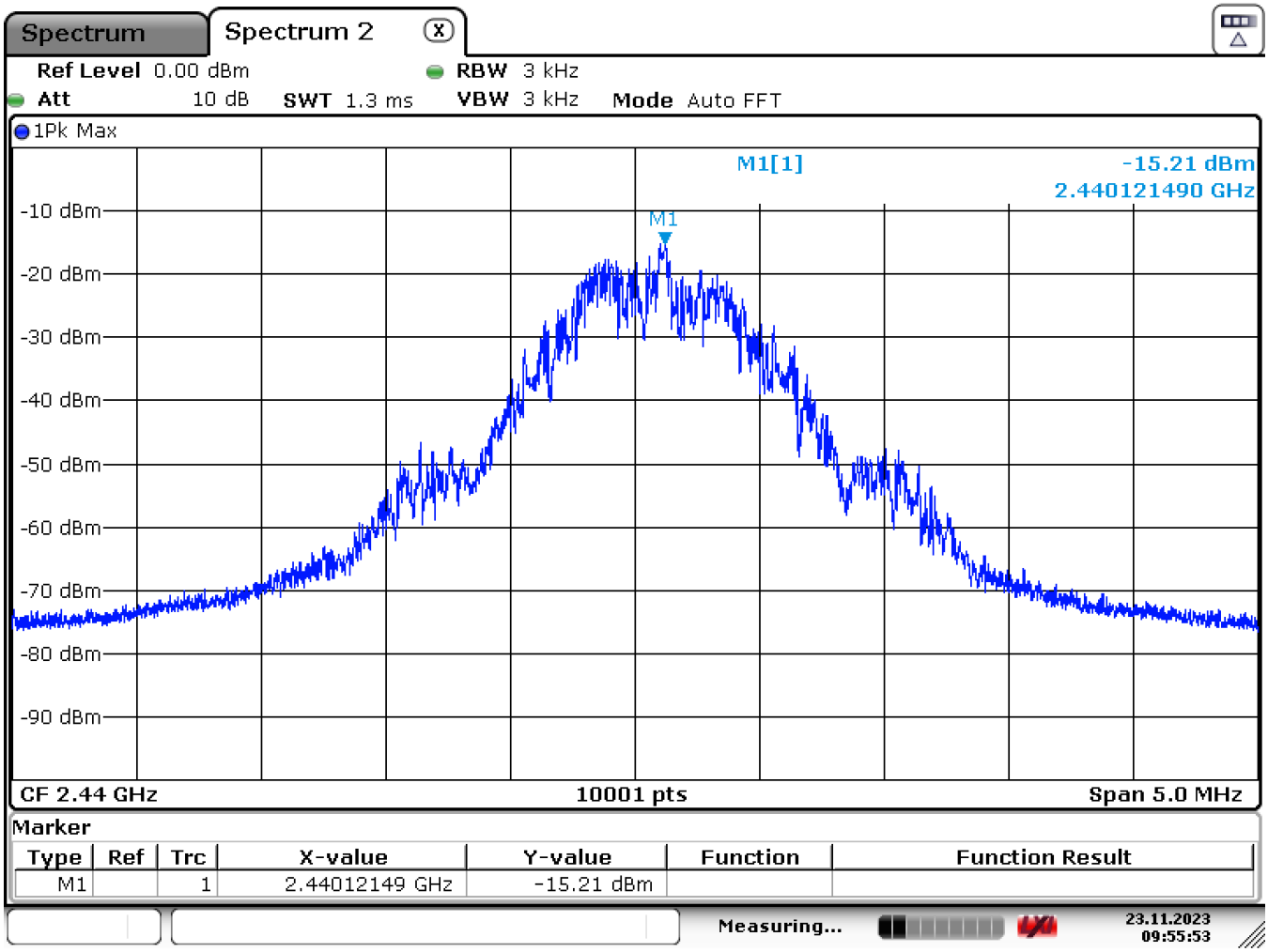
Under normal test conditons	+8dBm in any 3 kHz band

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1;

Power spectral density **§ 15.247(e)**
5.2.b

Conducted Measurement

Rated output power: 0,36 mW Channel 19 (2440 MHz center frequency)



Date: 23.NOV.2023 09:55:53

Power Spectral density: -15,21 dBm @ 2440,12 MHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2 b)**

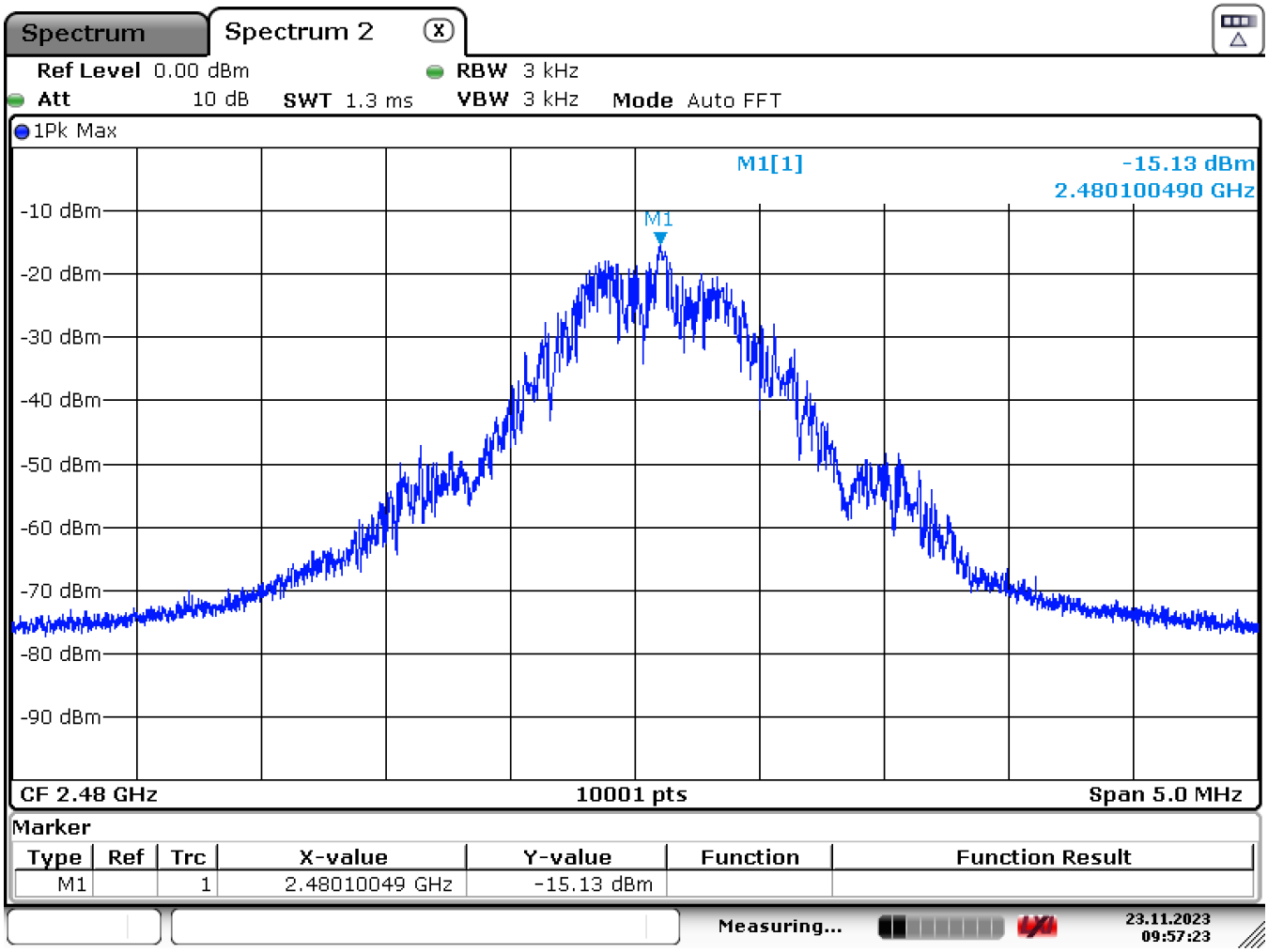
Under normal test conditons	+8dBm in any 3 kHz band

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1;

Power spectral density **§ 15.247(e)**
5.2.b

Conducted Measurement

Rated output power: 0,36 mW Channel 39 (2480 MHz center frequency)



Date: 23.NOV.2023 09:57:23

Power Spectral density: -15,13 dBm @ 2480,10 MHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2 b)**

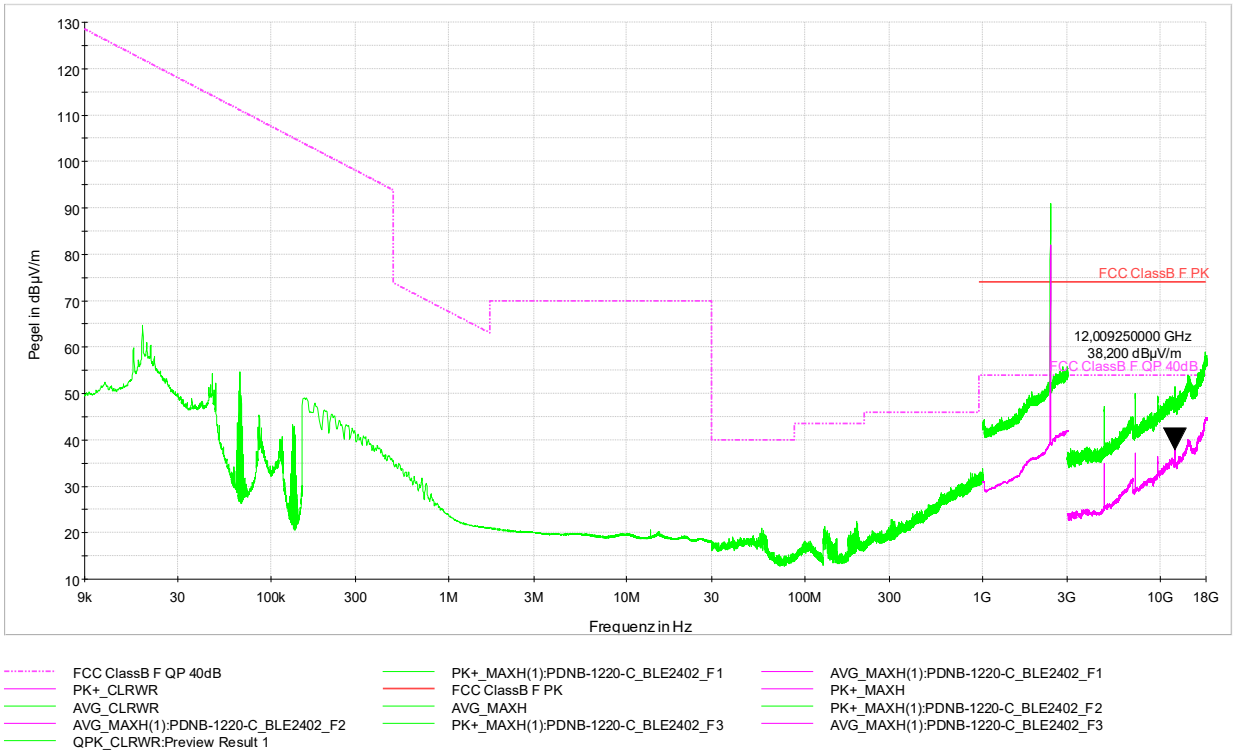
Under normal test conditons	+8dBm in any 3 kHz band

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1;

4.7. Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line):

Setup: CH 0: 2402 MHz



Worst case emission: Average @ 12009,25 MHz: 38,20 dBµV/m
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

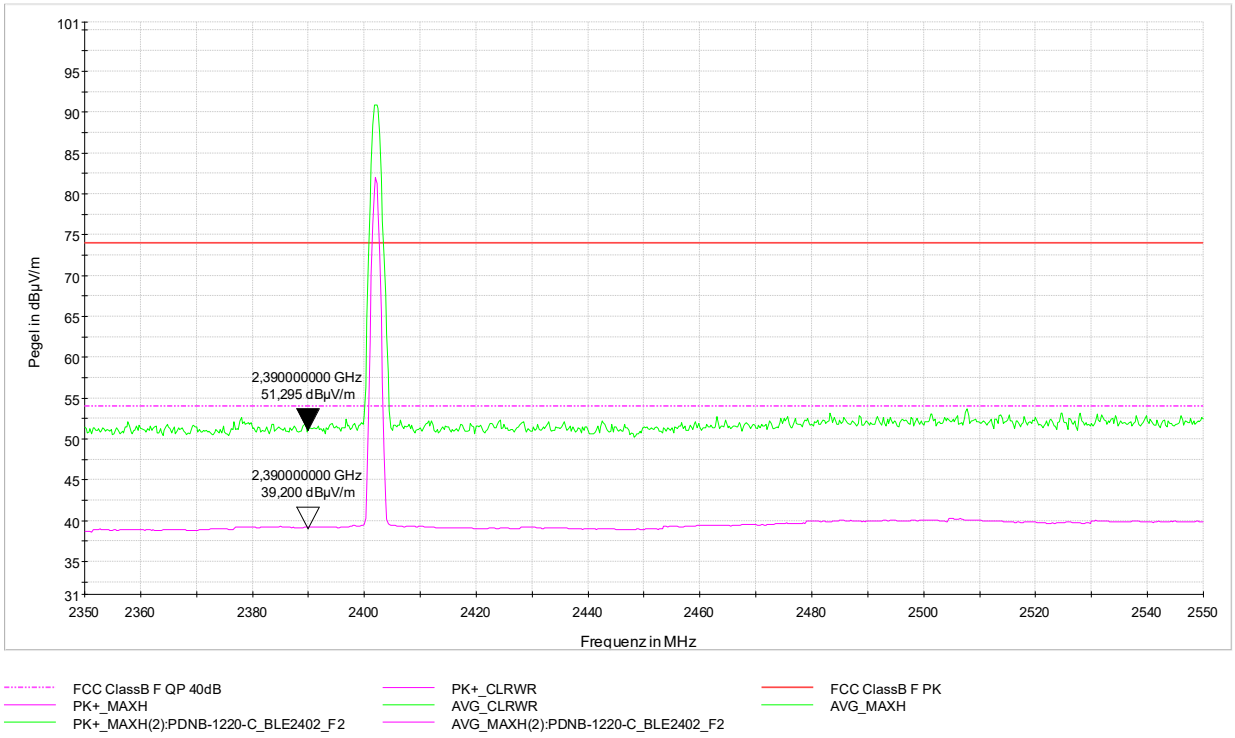
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands § 15.209(a)
Emissions falling within restricted frequency bands RSS-Gen

Measurement with Peak-Detector (green line) and Average detector (magenta line): Band Edge requirement

Setup: CH 0: 2402 MHz



LIMIT SUBCLAUSE 15.209(a) – RSS-Gen

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	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

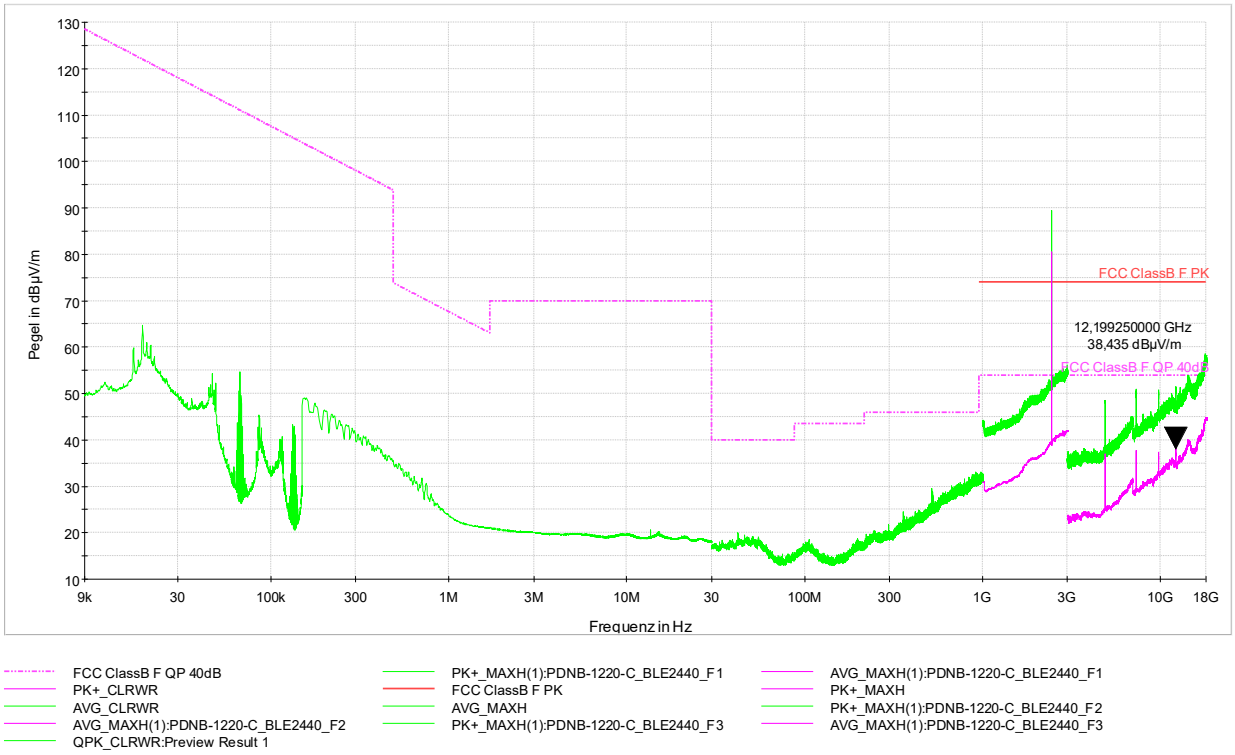
Band edges of the nearest restricted bands: 2390 MHz and 2483,5 MHz.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-131/1; NT-139; NT-207/1;

Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line):

Setup: CH 19: 2440 MHz



Worst case emission: Average @ 12199,25 MHz: 38,44 dBµV/m
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

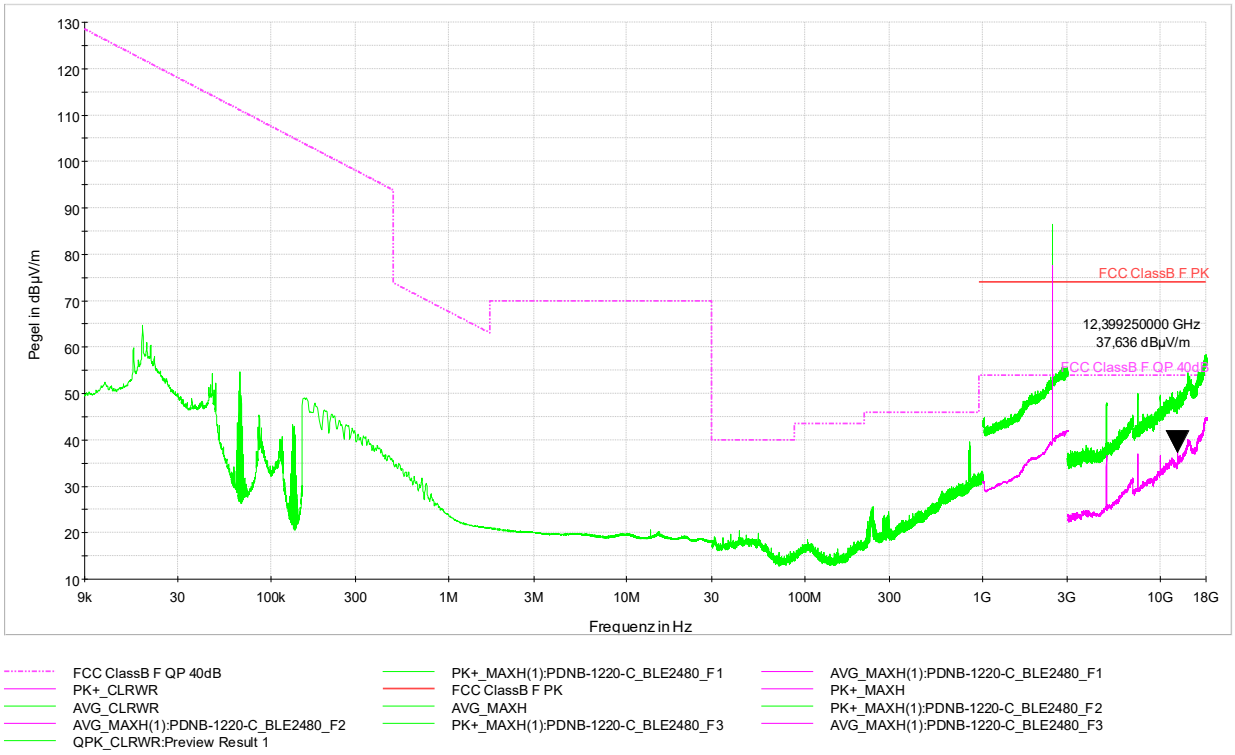
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line):

Setup: CH 39: 2480 MHz



Worst case emission: Average @ 12399,25 MHz: 37,64 dBµV/m
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

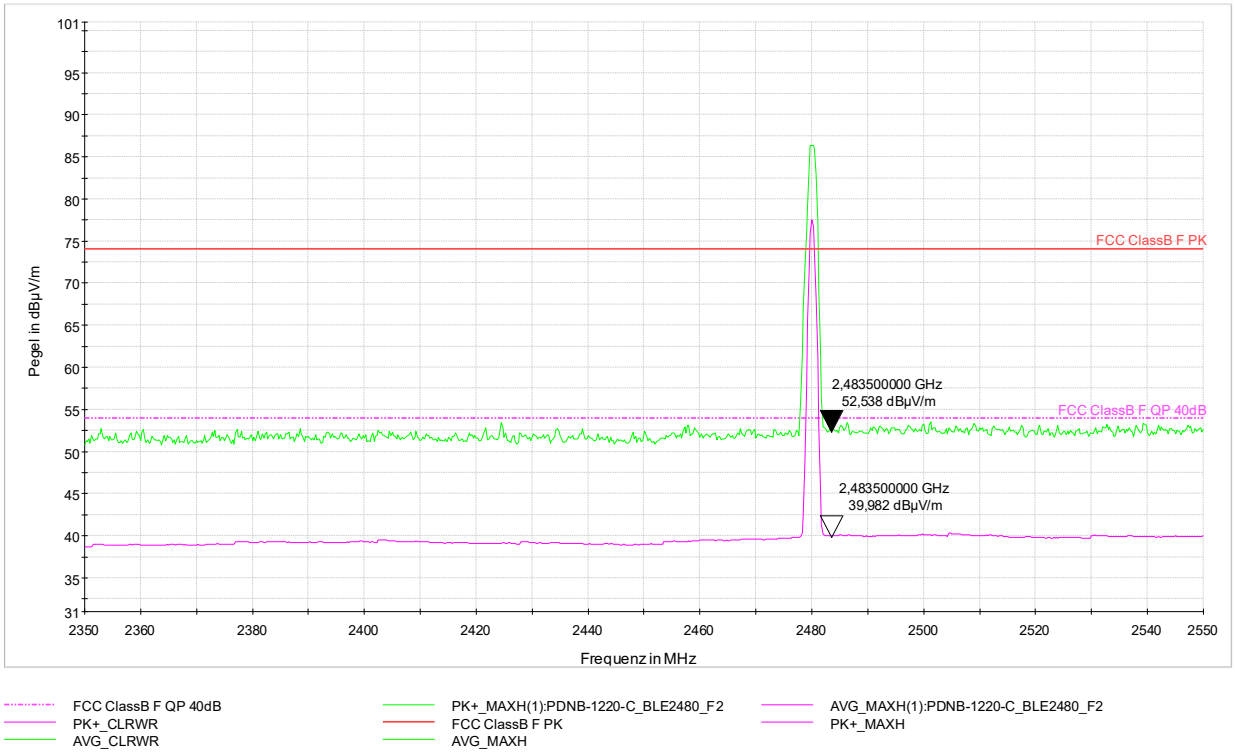
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line): Band Edge requirement

Setup: CH 39: 2480 MHz



LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	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

Band edges of the nearest restricted bands: 2390 MHz and 2483,5 MHz.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-131/1; NT-139; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-139**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B4 / B66 and BLE 2440 MHz

Worst case emission: Peak @ 2132,5 MHz: -29,78 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(h)(1)**

General protection levels. Except as otherwise specified below, for operations in the 1695–1710 MHz, 1710–1755 MHz, 1755–1780 MHz, 1915–1920 MHz, 1995–2000 MHz, 2000–2020 MHz, 2110–2155 MHz, 2155–2180 MHz, and 2180–2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

LIMIT **RSS-139 5.6**

Unwanted emissions shall be measured in terms of average values.
For all equipment, the TRP or total conducted power (sum of conducted power across all antenna connectors) of the unwanted emissions outside the frequency block or frequency block group shall not exceed the limits shown in table 6.

Table 6: Unwanted emission limits

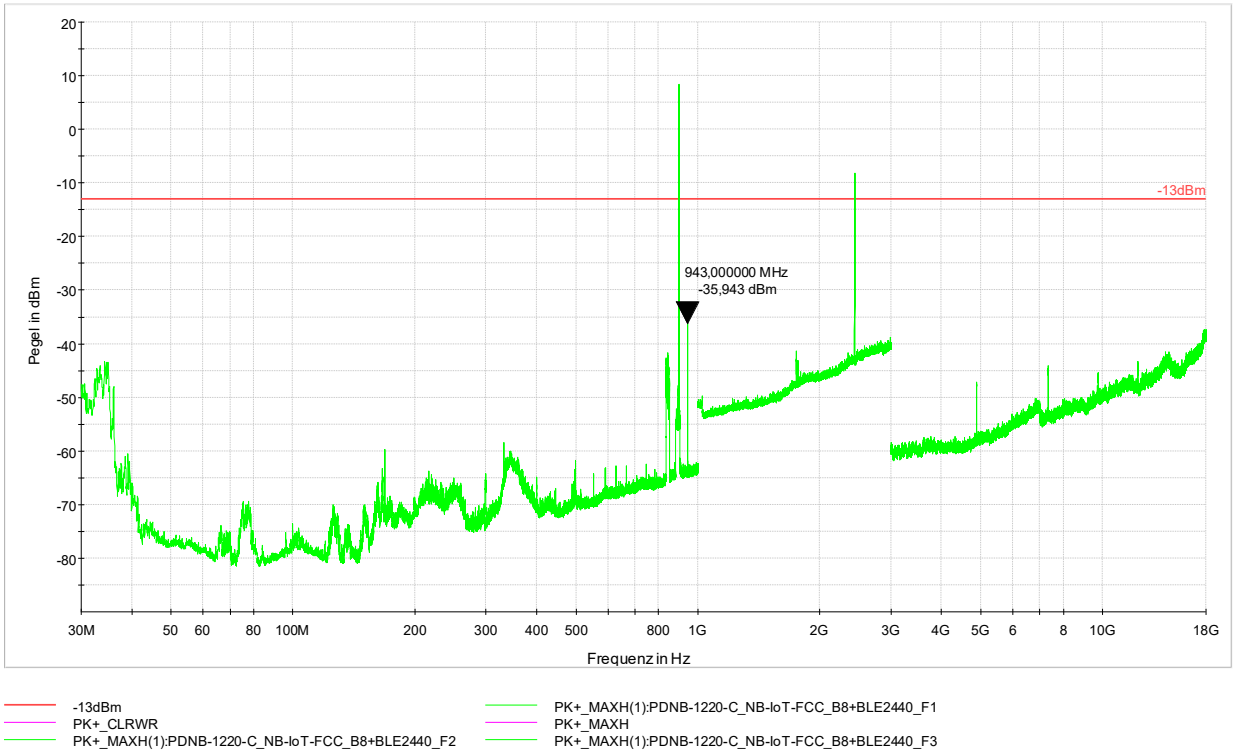
Offset from the edge of the frequency block or frequency block group	Unwanted emission limits
1 MHz	-13 dBm/(1 % of Occupied Bandwidth)
> 1 MHz	-13 dBm/MHz

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.1509**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B8 and BLE 2440 MHz



Worst case emission: Peak @ 943,0 MHz: -35,94 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.1509(a)**

For 900 MHz broadband operations in 897.5–900.5 MHz band by at least 43 + 10 log (P) dB.

LIMIT **RSS-130 4.7.1**

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B12 / B85 and BLE 2440 MHz

Worst case emission: Peak @ 737,5 MHz: -36,03 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(g)**

For operations in the 600 MHz band and the 698–746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

LIMIT **RSS-130 4.7.1**

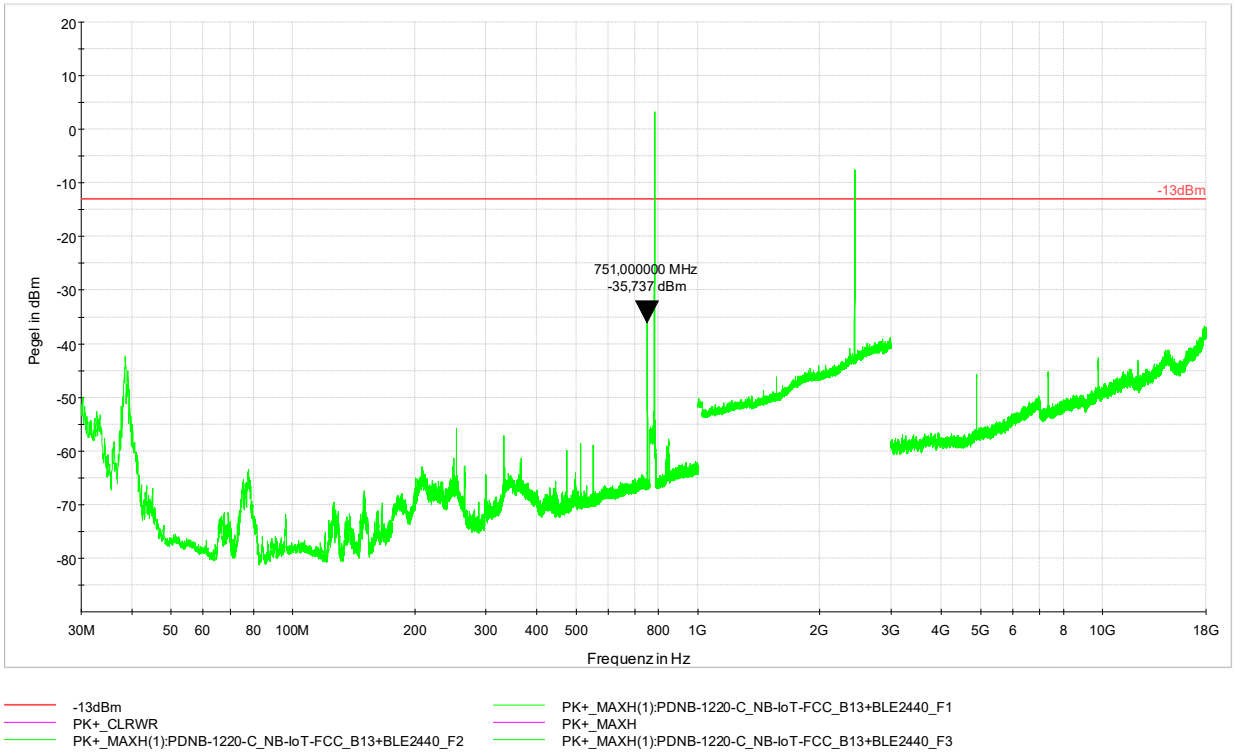
The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B13 and BLE 2440 MHz



Worst case emission: Peak @ 751,00 MHz: -35,74 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(c)(2)**

On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;

LIMIT **RSS-130 4.7.1**

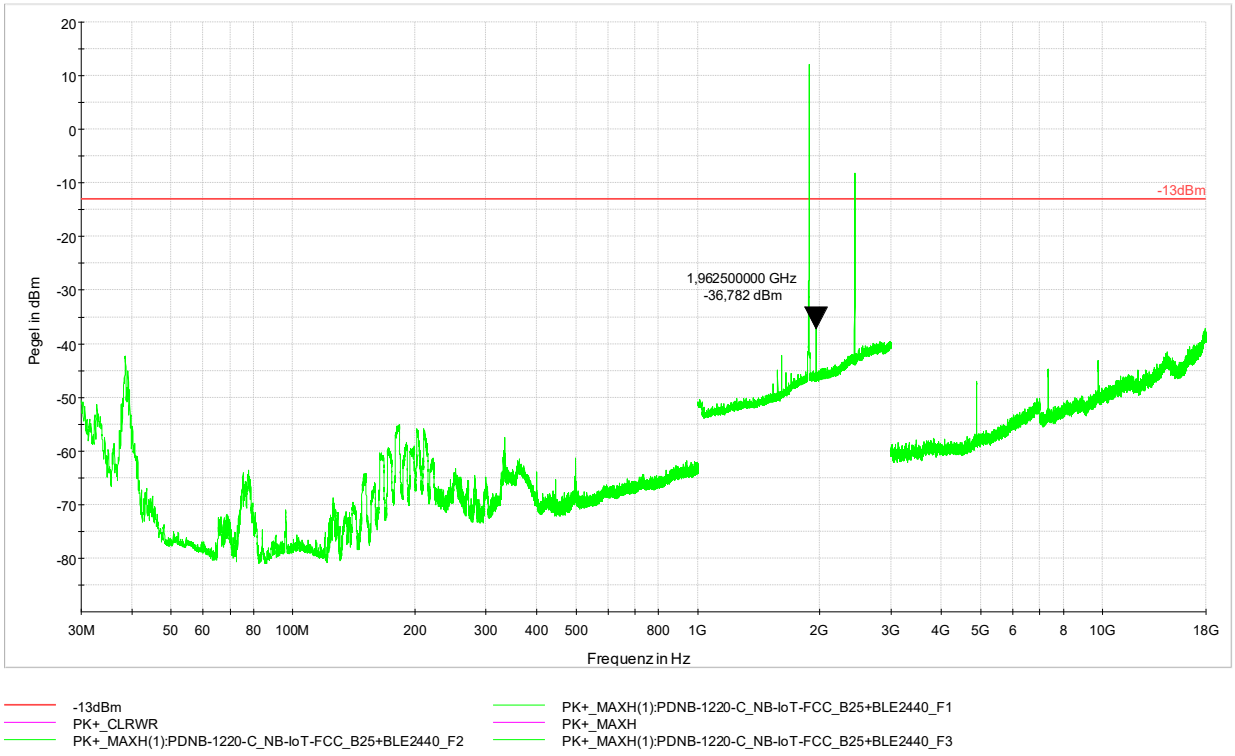
The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 24.238**
Emissions falling within restricted frequency bands **RSS-133**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B25 and BLE 2440 MHz



Worst case emission: Peak @ 1962,5 MHz: -36,78 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 24.238(a)**

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

LIMIT **RSS-133 6.5.1(a)(i) and RSS-133 6.5.1(b)**

In the first 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the power of emissions per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB.

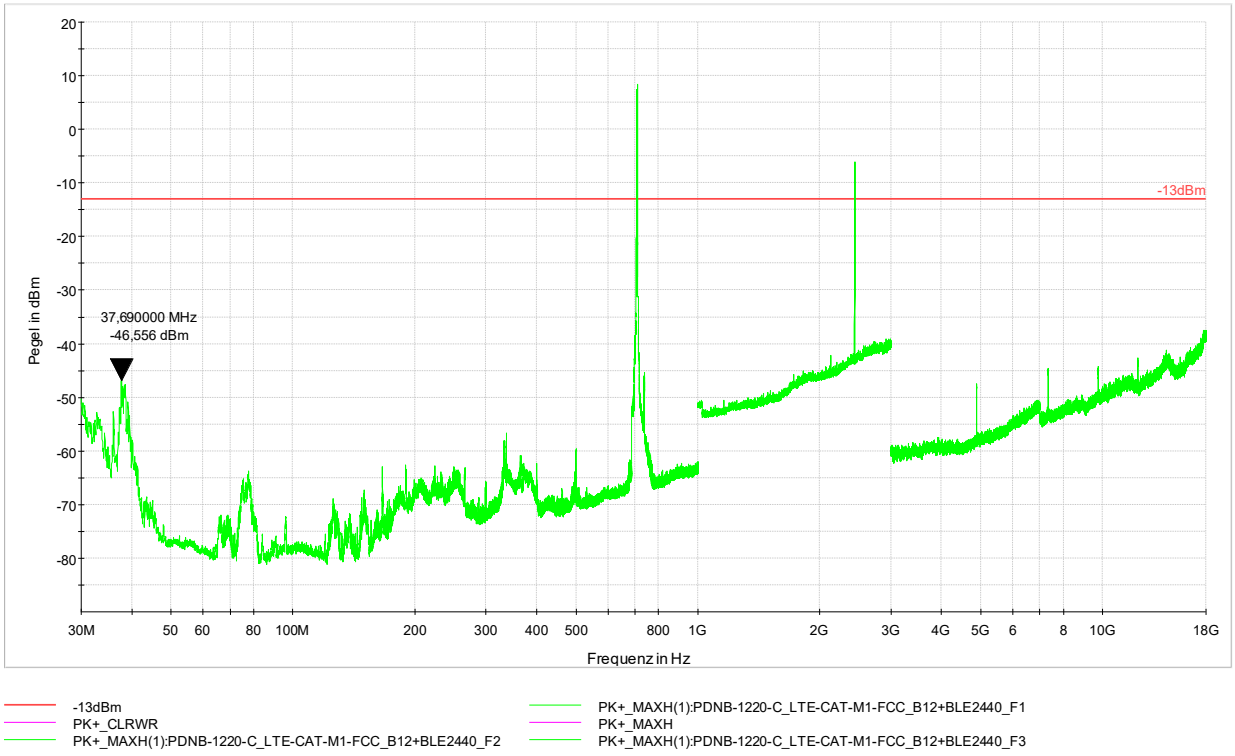
(b) After the first 1.0 MHz (for equipment that complies with (a)(i) of this subsection) or 1.5 MHz (for equipment that complies with (a)(ii) of this subsection), the power of emissions in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB. (Note: If the test result using 1% of the emission bandwidth is used, power integration over 1.0 MHz is required; alternatively, the spectrum analyzer resolution and video bandwidths can be increased to 1.0 MHz for this measurement).

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission LTE CAT-M1 B12 and BLE 2440 MHz



Worst case emission: Peak @ 37,7 MHz: -46,56 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(g)**

For operations in the 600 MHz band and the 698–746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

LIMIT **RSS-130 4.7.1**

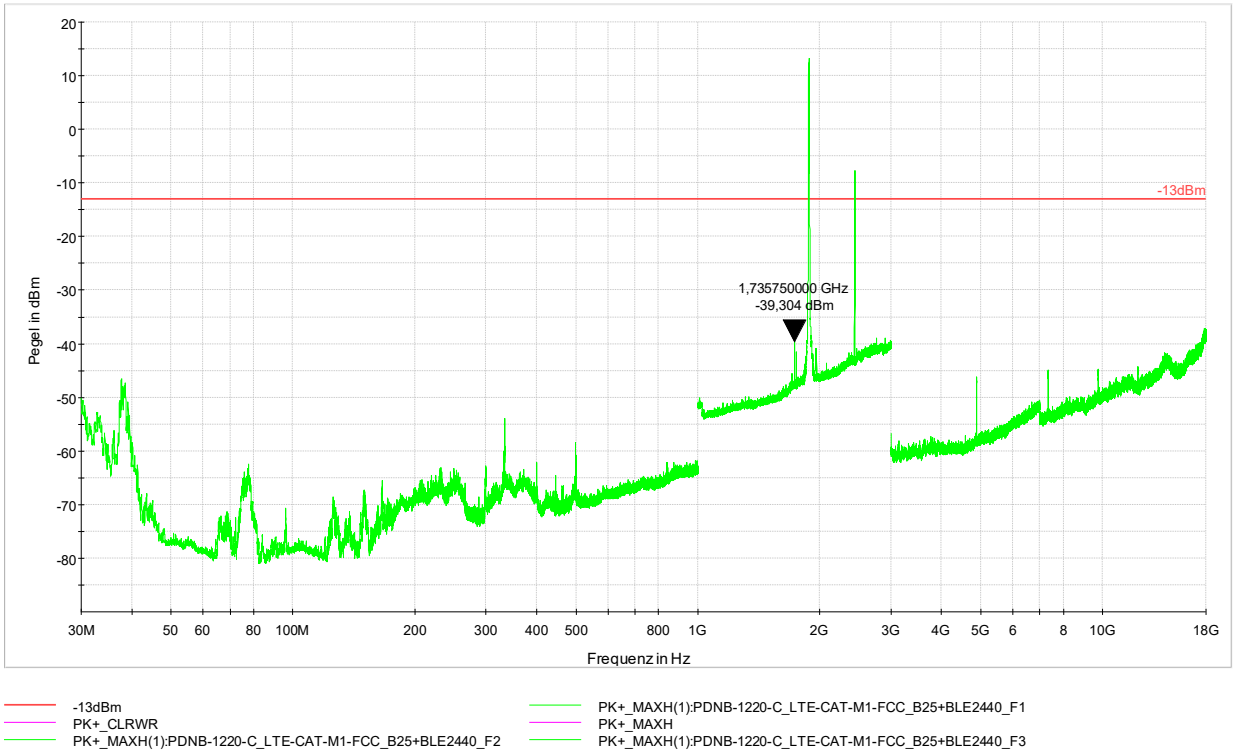
The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 24.238**
Emissions falling within restricted frequency bands **RSS-133**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission LTE CAT-M1 B2/B25 and BLE 2440 MHz



Worst case emission: Peak @ 1735,8 MHz: -39,30 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 24.238(a)**

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

LIMIT **RSS-133 6.5.1(a)(i) and RSS-133 6.5.1(b)**

In the first 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the power of emissions per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB.

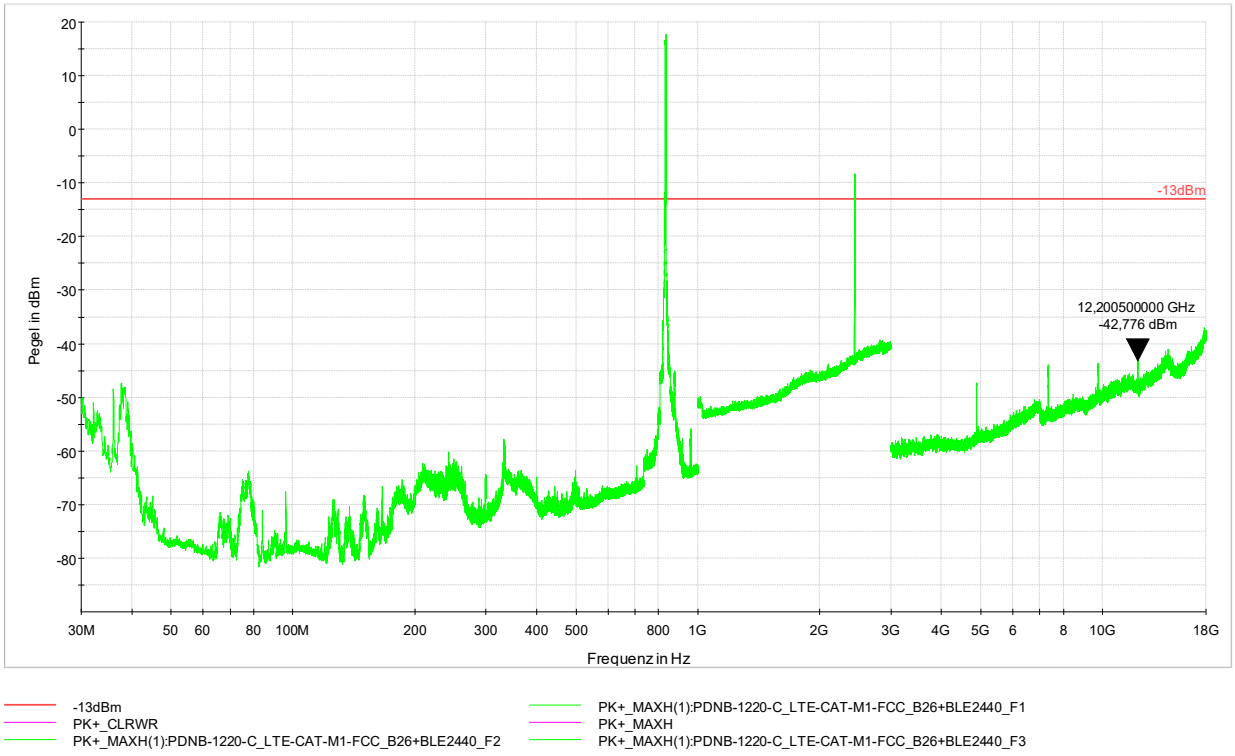
(b) After the first 1.0 MHz (for equipment that complies with (a)(i) of this subsection) or 1.5 MHz (for equipment that complies with (a)(ii) of this subsection), the power of emissions in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB. (Note: If the test result using 1% of the emission bandwidth is used, power integration over 1.0 MHz is required; alternatively, the spectrum analyzer resolution and video bandwidths can be increased to 1.0 MHz for this measurement).

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 22.917, § 90.669**
Emissions falling within restricted frequency bands **RSS-132**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission LTE CAT-M1 B5 (B26 only FCC) and BLE 2440 MHz



Worst case emission: Peak @ 12200,5 MHz: -42,78 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 22.917(a)**

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

LIMIT **FCC Part 90.669(a)**

On any frequency in an MTA licensee's spectrum block that is adjacent to a non-MTA frequency, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 plus 10 log10(P) decibels or 80 decibels, whichever is the lesser attenuation.

Note: The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

LIMIT **RSS-132 5.5**

Equipment shall meet the unwanted emission limits specified below:

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB.

(ii) After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB. If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

p is the output power specified in watts.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

4.8. TEST OBJECT DATA (BLE/Quuppa Protocol)

General EUT Description

2.1033 (c) Technical description

2.1033 (4) Type of emission: 1M02F1D – Channel spacing 2 MHz plus 2 additional 'Quuppa' channels at 2401 and 2481 MHz

2.1033 (5) Frequency range: 2402 to 2482 MHz (channel center frequencies) plus 2 additional 'Quuppa' channels at 2401 and 2481 MHz

2.1033 (6) Power range and Controls: The maximum peak output power is 0,13 mW eirp and there is no power regulation.

2.1033 (7) Maximum output power rating: 0,13 mW eirp.

2.1033 (8) DC Voltage: 3 VDC (internal battery)

RSS-135 This standard does not apply to:

1.1.(a) a receiver that scans radio frequencies for the purpose of enabling its associated transmitter to avoid transmitting in an occupied frequency but which does not have the capability of decoding the message (e.g. converting it to audio voice) contained in the radio signal

Worst case Spurious Emissions: 34,02 dBµV/m Average at 7203,5 MHz.

Tests were performed from November 6th to November 23rd 2023.

4.9. Number of channels and channel spacing § 2.1033

Conducted Measurement

Rated output power: 0,13 mW

There are 40 Channels used, starting at 2402 till 2480 MHz each separated by 2 MHz channel spacing.

Two additional channels are used with the same modulation but for positioning purposes. These channels use 2401 MHz and 2481 MHz as center frequencies.

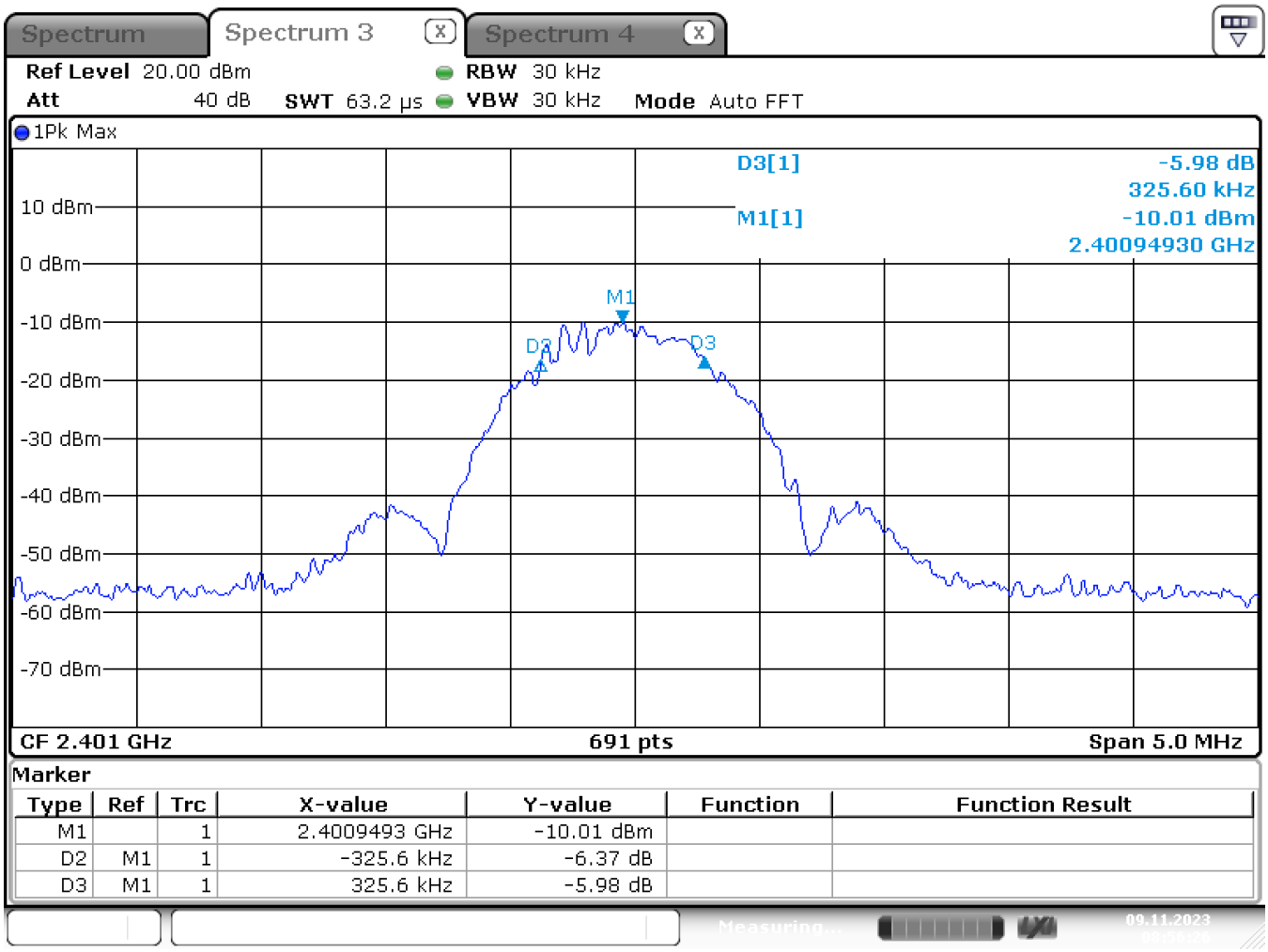
Test Equipment used: N/A

4.10. 6 dB Bandwidth

§ 15.247(a)(2)
5.2.a)

Conducted Measurement

Rated output power: 0,13 mW 2401 MHz center frequency



Date: 9.NOV.2023 08:56:27

6dB Bandwidth: 651,2 kHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2.a)**

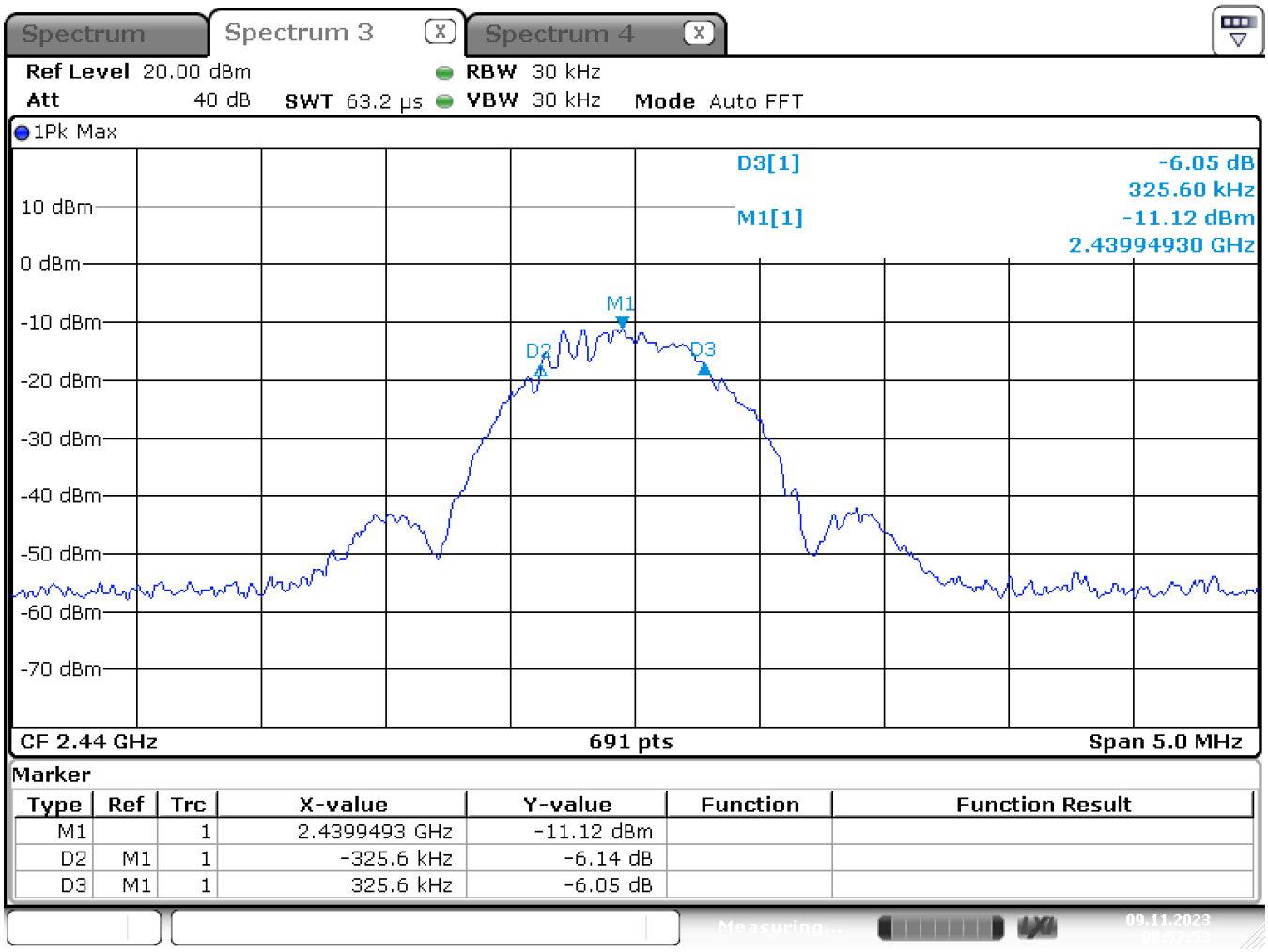
Under normal test conditons	6 dB Bandwidth at least 500 kHz

Test Equipment used: EMV-205;

6 dB Bandwidth **§ 15.247(a)(2) 5.2.a)**

Conducted Measurement

Rated output power: 0,13 mW 2440 MHz center frequency



Date: 9.NOV.2023 08:57:53

6dB Bandwidth: 651,2 kHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2.a)**

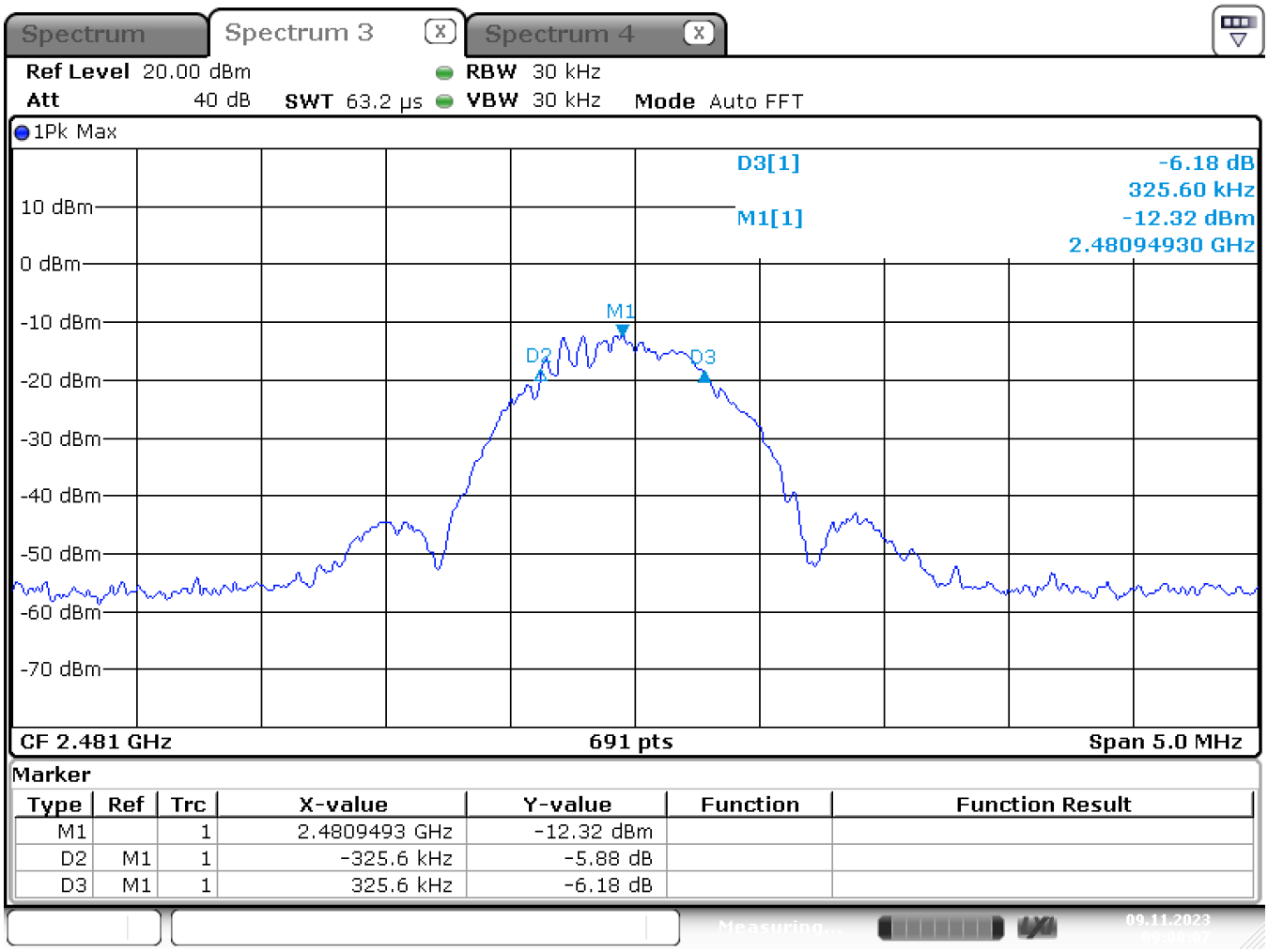
Under normal test conditons	6 dB Bandwidth at least 500 kHz

Test Equipment used: EMV-205;

6 dB Bandwidth **§ 15.247(a)(2) 5.2.a)**

Conducted Measurement

Rated output power: 0,13 mW 2481 MHz center frequency



Date: 9.NOV.2023 09:00:08

6dB Bandwidth: 651,2 kHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2.a)**

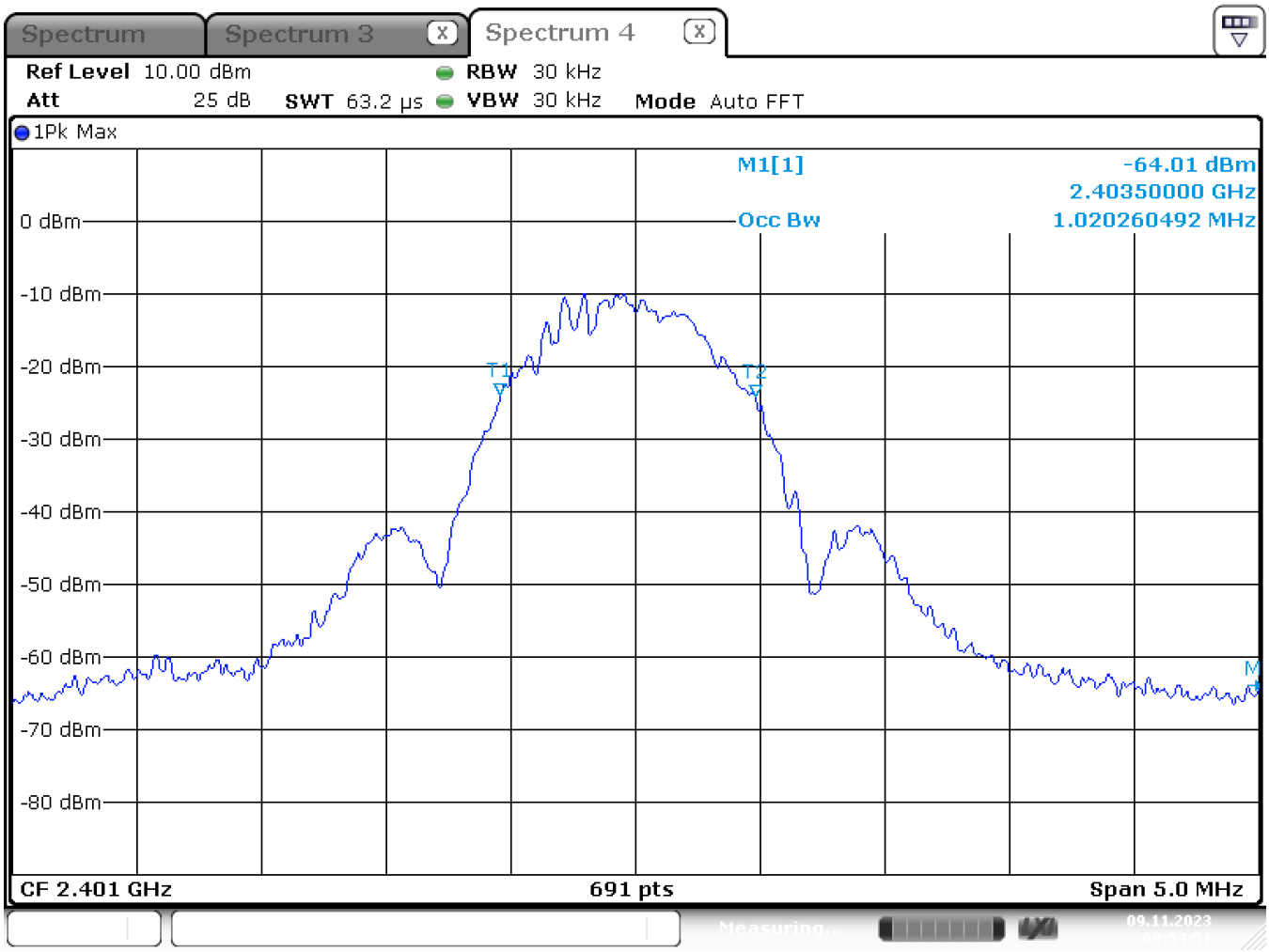
Under normal test conditons	6 dB Bandwidth at least 500 kHz

Test Equipment used: EMV-205;

4.11. 99% Bandwidth RSS 247

Conducted Measurement

Rated output power: 0,13 mW 2401 MHz center frequency



Date: 9.NOV.2023 08:54:52

99% Bandwidth: 1020 kHz

LIMIT **RSS 247**

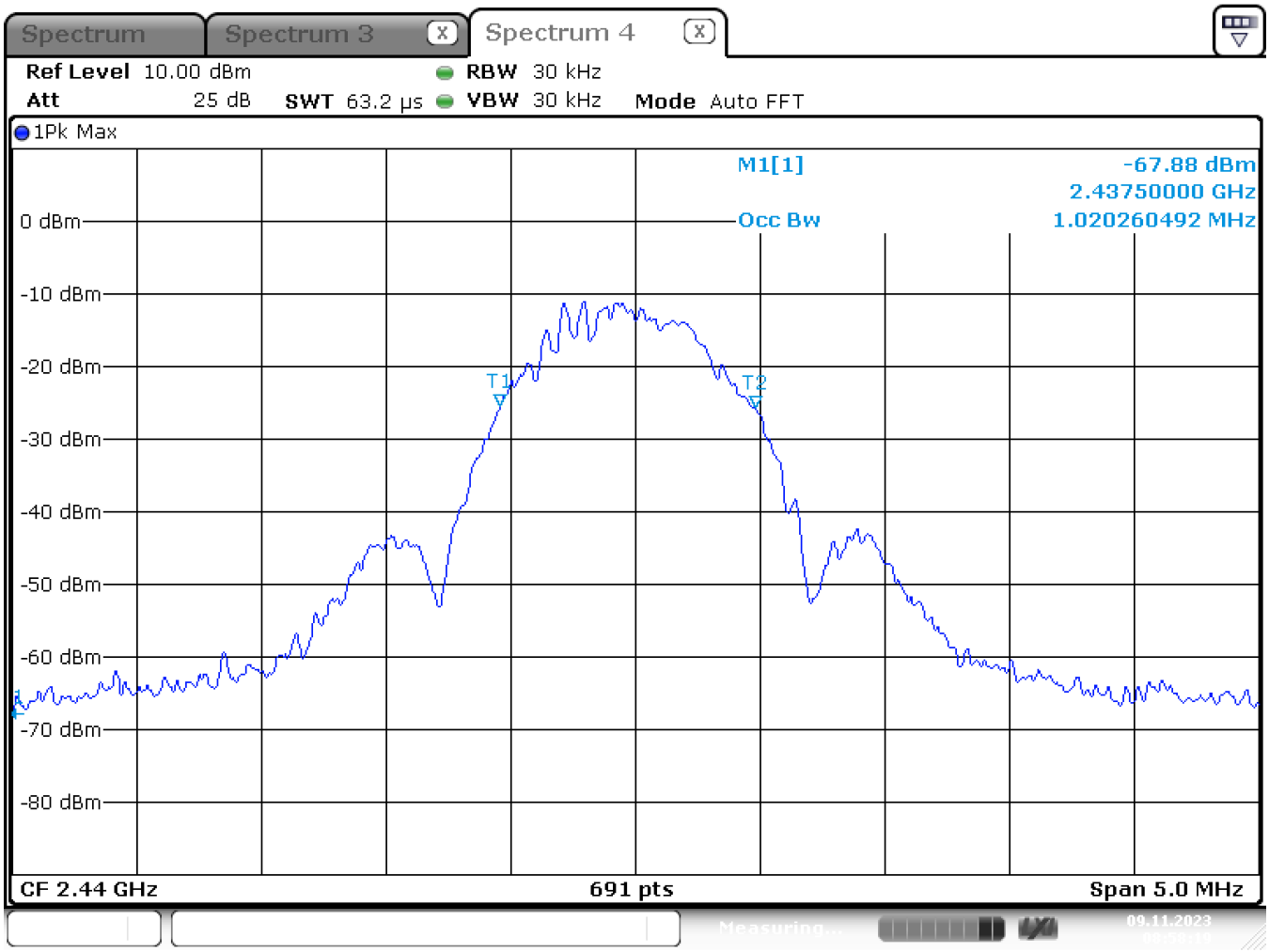
None; for IC reporting purposes only

Test Equipment used: EMV-205;

99% Bandwidth **RSS 247**

Conducted Measurement

Rated output power: 0,13 mW 2440 MHz center frequency



Date: 9.NOV.2023 08:58:19

99% Bandwidth: 1020 kHz

LIMIT **RSS 247**

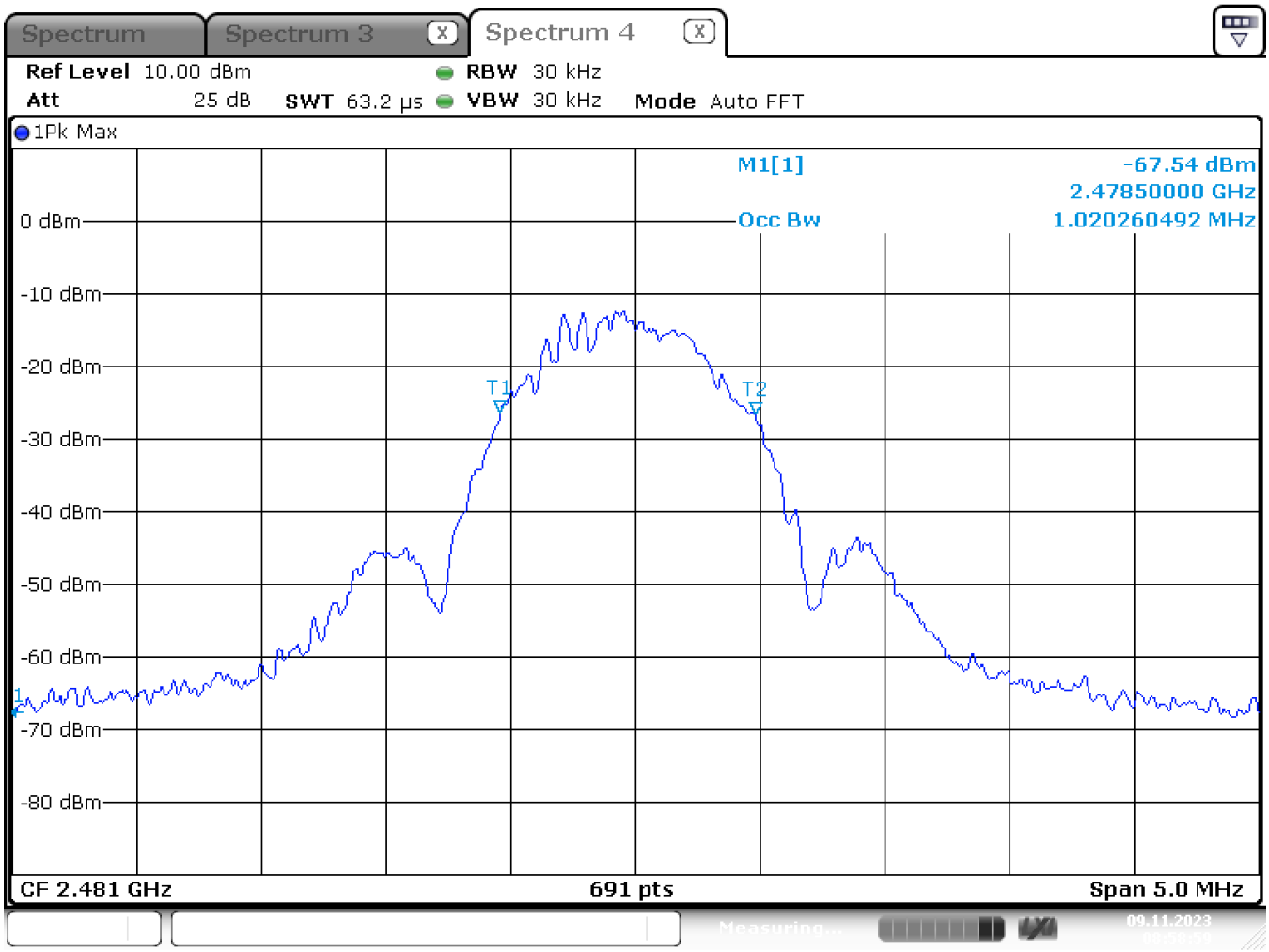
None; for IC reporting purposes only

Test Equipment used:EMV-205;

99% Bandwidth **RSS 247**

Conducted Measurement

Rated output power: 0,13 mW 2481 MHz center frequency



Date: 9.NOV.2023 08:58:59

99% Bandwidth: 1020 kHz

LIMIT **RSS 247**

None; for IC reporting purposes only

Test Equipment used: EMV-205;

4.12. Maximum Peak RF Power Output

§ 15.247(b)(3)
5.4.4

Conducted Measurement

Rated output power: 0,69 mW

Test conditions		Transmitter power (mW)		
		2401 MHz	2440 MHz	2481 MHz
T_{nom} (23)°C	V_{nom} (3) V	0,30	0,23	0,18
Measurement uncertainty		± 0,75 dB		

Radiated Measurement

Rated output power: 0,13 mW

Test conditions		Transmitter power (mW) EIRP		
		2401 MHz	2440 MHz	2481 MHz
T_{nom} (23)°C	V_{nom} (3) V	0,13	0,09	0,04
Measurement uncertainty		± 2 dB		

Maximum Gain derived from EIRP and conducted measurement:		Maximum Gain (dBi)		
Test condition		2401 MHz	2440 MHz	2481 MHz
T_{nom} 23 °C	V_{nom} (3)V	-3,64	-4,23	-6,54

LIMIT **SUBCLAUSE 15.247(b)(3) – 5.4.4**

Under normal test conditons	1W conducted (4W eirp)

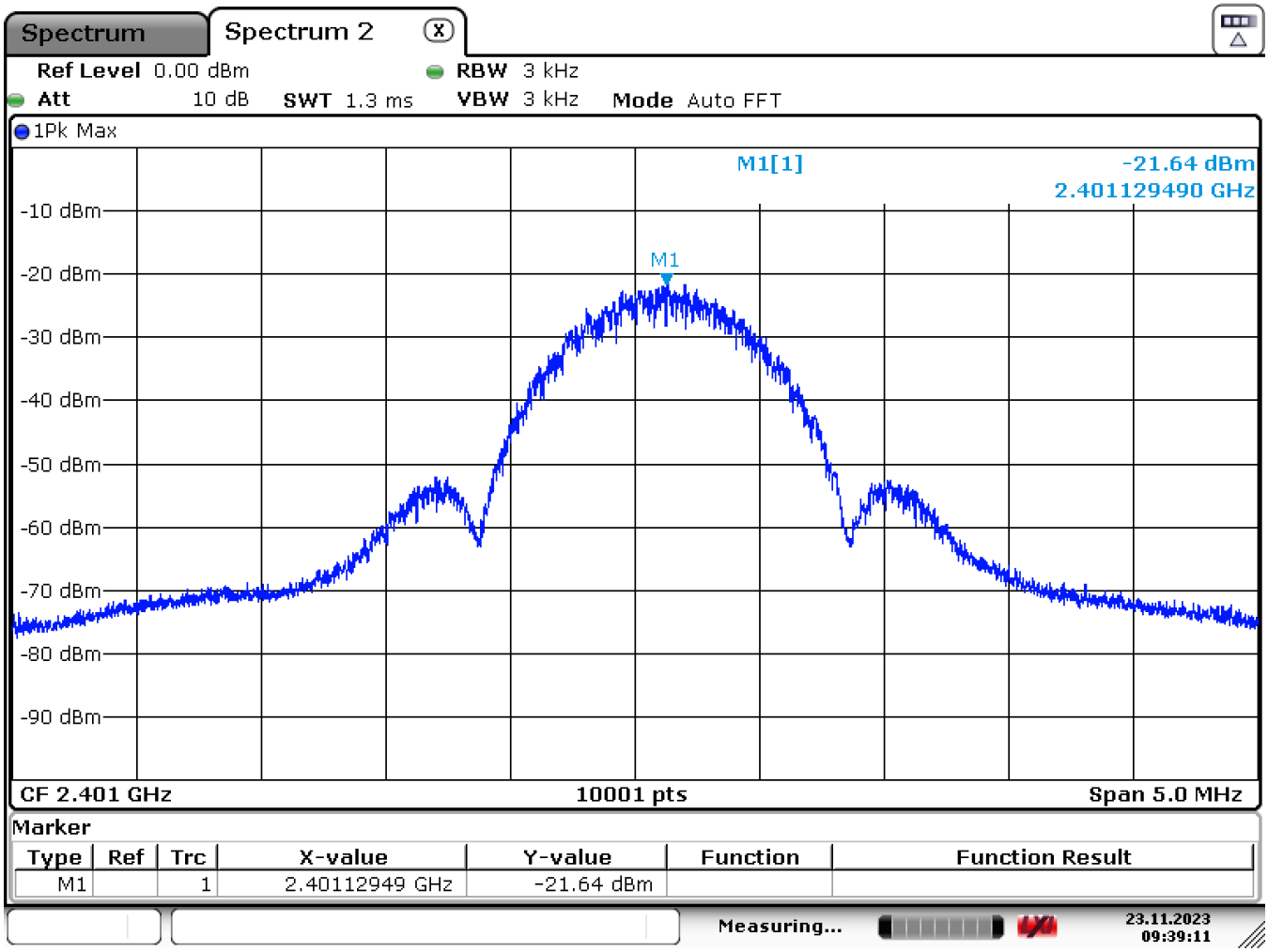
Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1; EMV-205

4.13. Power spectral density (radiated)

§ 15.247(e)
5.2.2

Conducted Measurement

Rated output power: 0,13 mW 2401 MHz center frequency



Date: 23.NOV.2023 09:39:11

Power Spectral density: -21,64 dBm @ 2401,13 MHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2 b)**

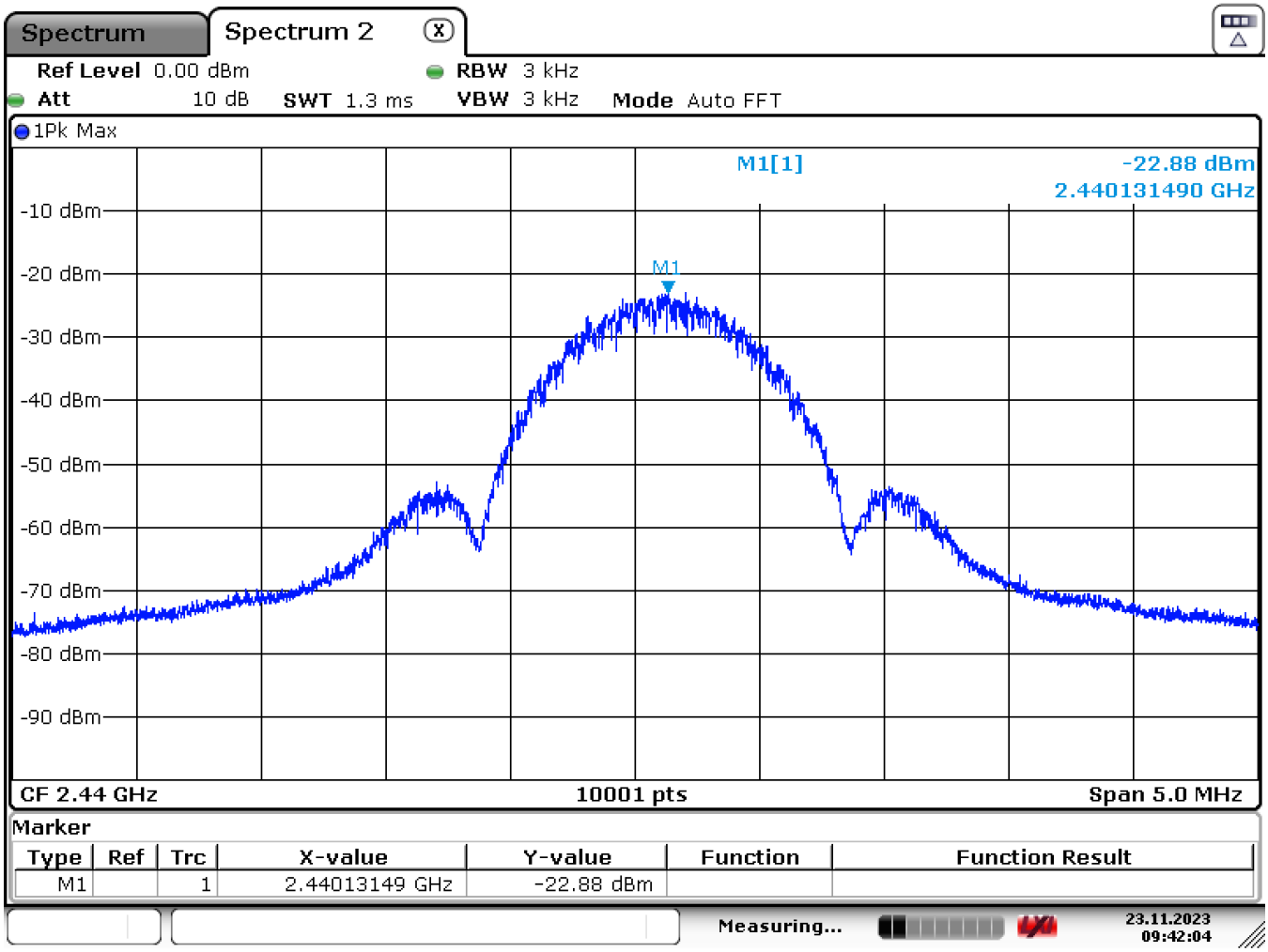
Under normal test conditons	+8dBm in any 3 kHz band

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1;

Power spectral density (radiated) **§ 15.247(e)**
5.2 b)

Conducted Measurement

Rated output power: 0,13 mW 2440 MHz center frequency



Date: 23.NOV.2023 09:42:05

Power Spectral density: -22,88 dBm @ 2440,13 MHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2 b)**

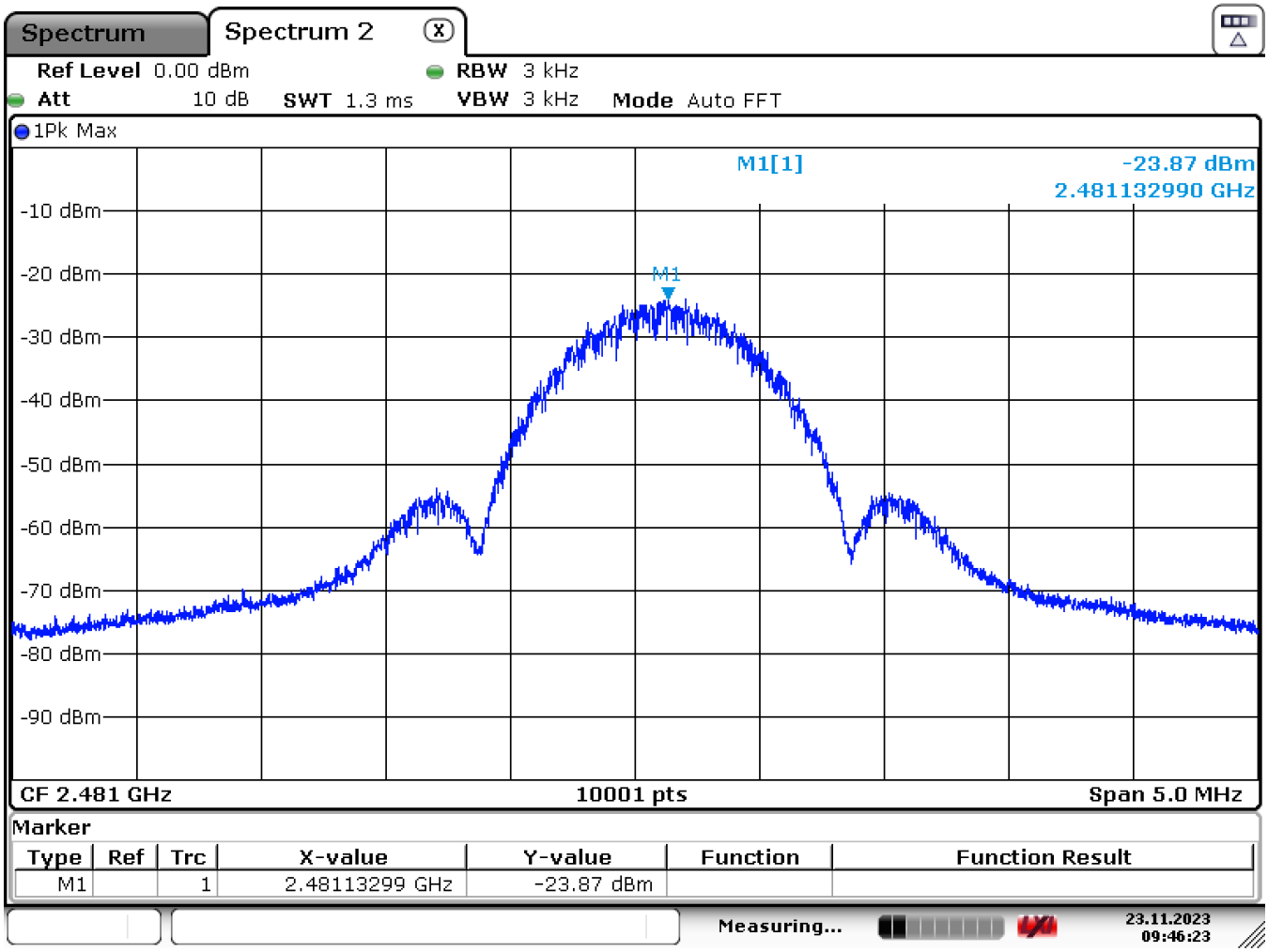
Under normal test conditons	+8dBm in any 3 kHz band

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1;

Power spectral density (radiated) **§ 15.247(e) 5.2 b)**

Conducted Measurement

Rated output power: 0,13 mW 2481 MHz center frequency



Date: 23.NOV.2023 09:46:23

Power Spectral density: -23,87 dBm @ 2481,13 MHz

LIMIT **SUBCLAUSE 15.247(e) – 5.2 b)**

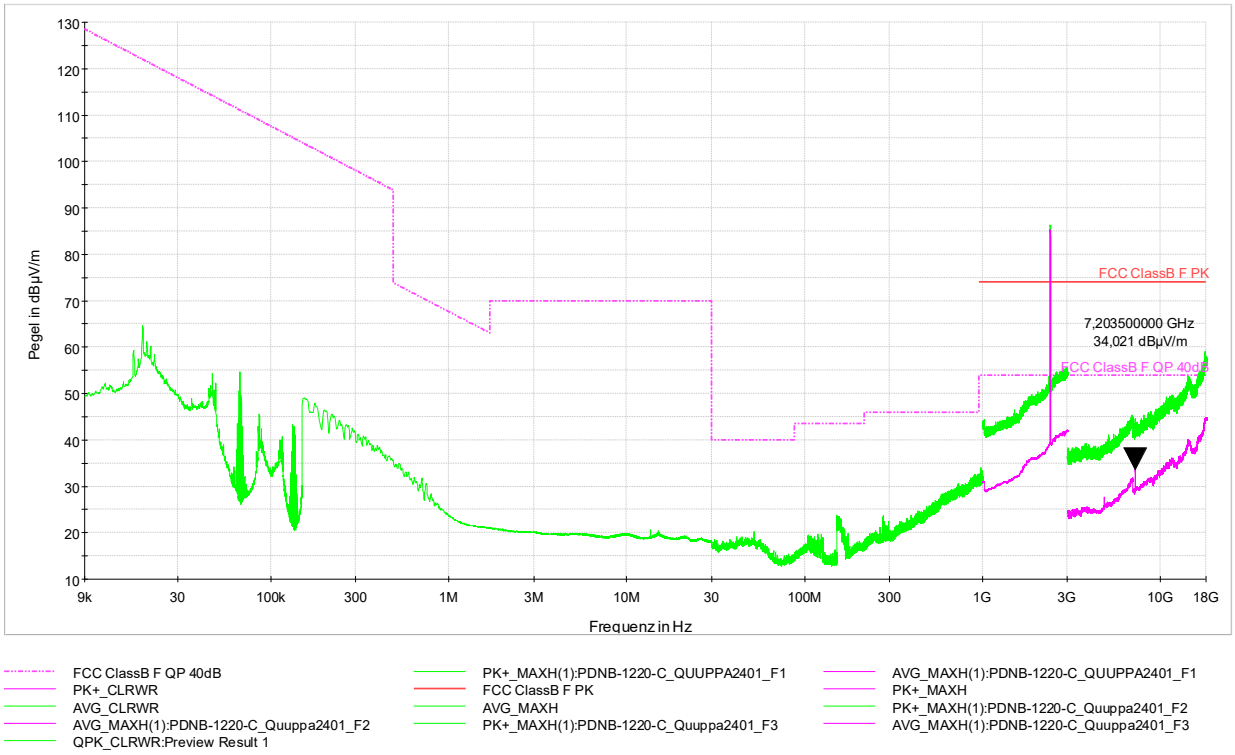
Under normal test conditons	+8dBm in any 3 kHz band

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-139; NT-207/1;

4.14. Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line):

Setup: 2401 MHz



Worst case emission: Average @ 7203,5 MHz: 34,02 dBµV/m
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

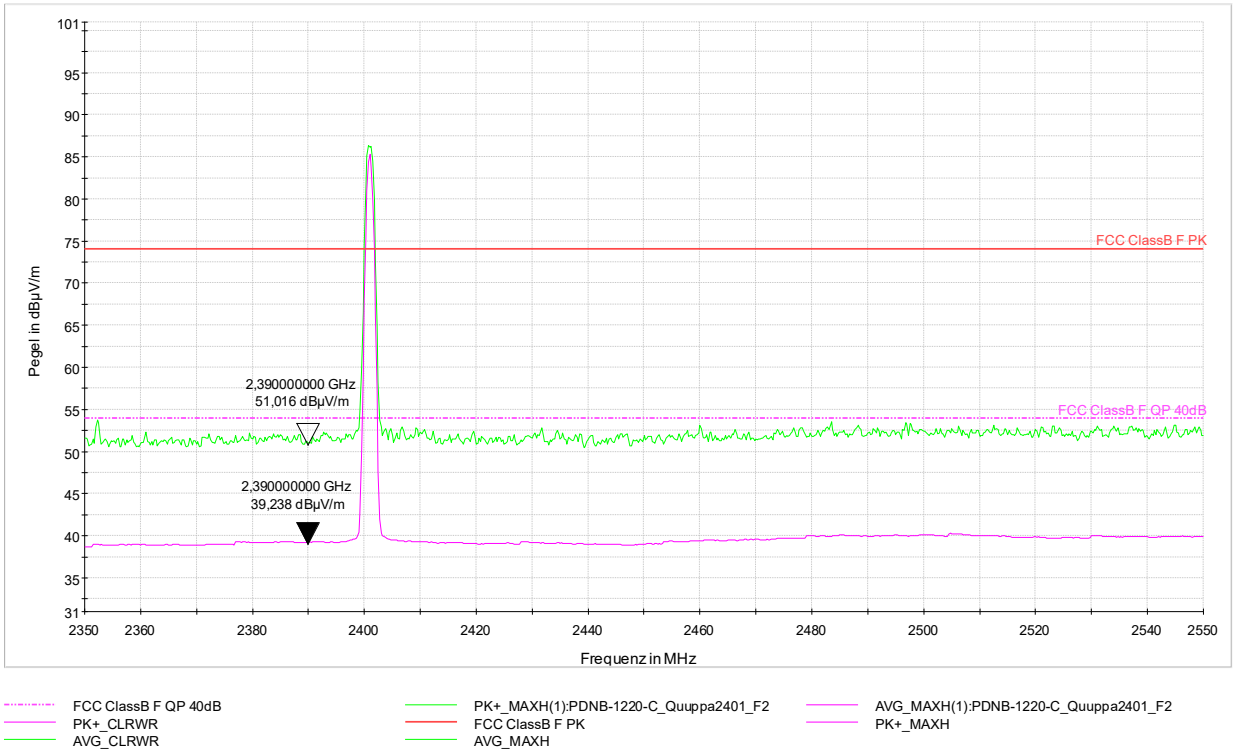
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands § 15.209(a)
Emissions falling within restricted frequency bands RSS-Gen

Measurement with Peak-Detector (green line) and Average detector (magenta line): Band Edge requirement

Setup: 2401 MHz



LIMIT SUBCLAUSE 15.209(a) – RSS-Gen

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	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

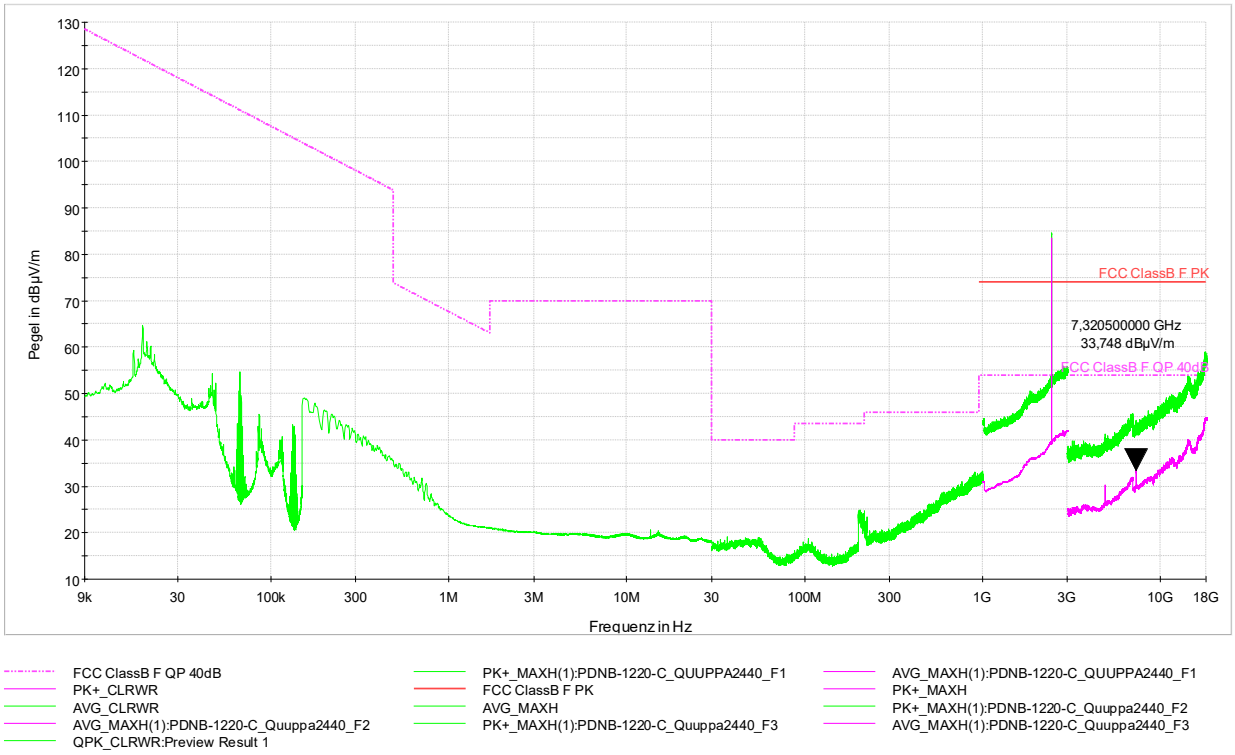
Band edges of the nearest restricted bands: 2390 MHz and 2483,5 MHz.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-131/1; NT-139; NT-207/1;

Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line):

Setup: 2440 MHz



Worst case emission: Average @ 7320,5 MHz: 33,75 dBµV/m
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

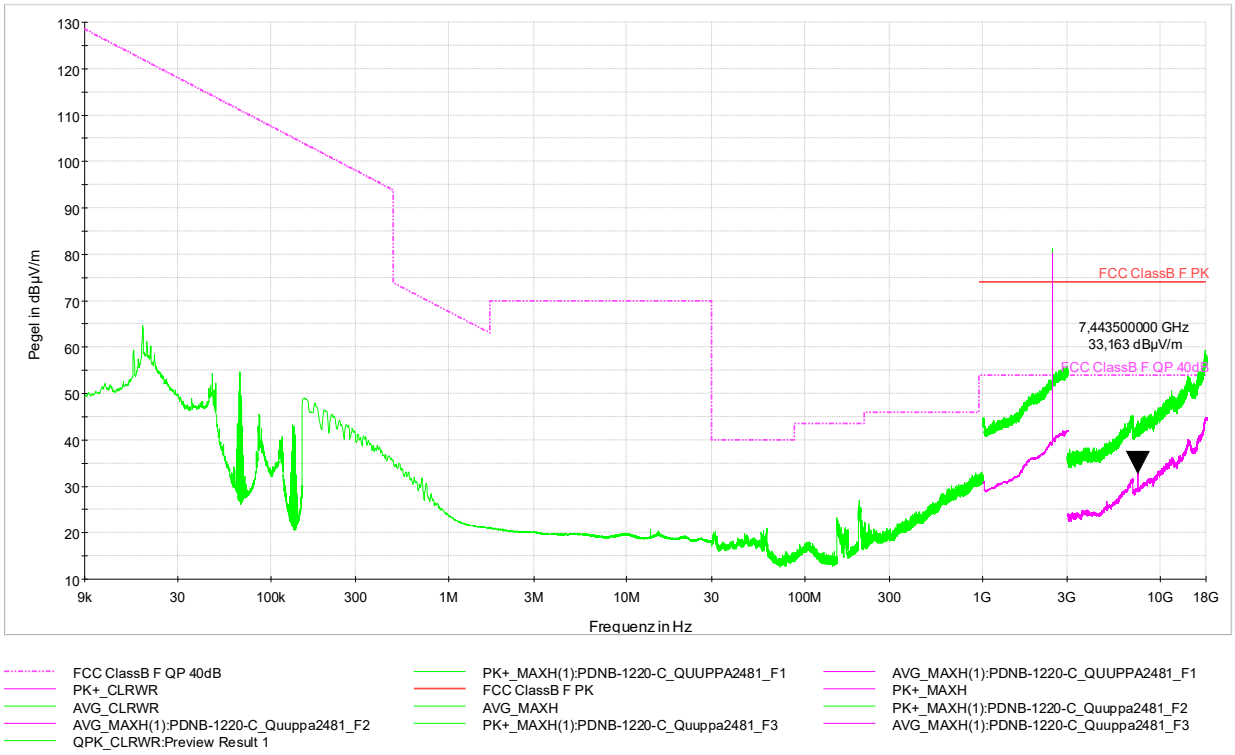
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line):

Setup: 2481 MHz



Worst case emission: Average @ 7443,5 MHz: 33,16 dBµV/m
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

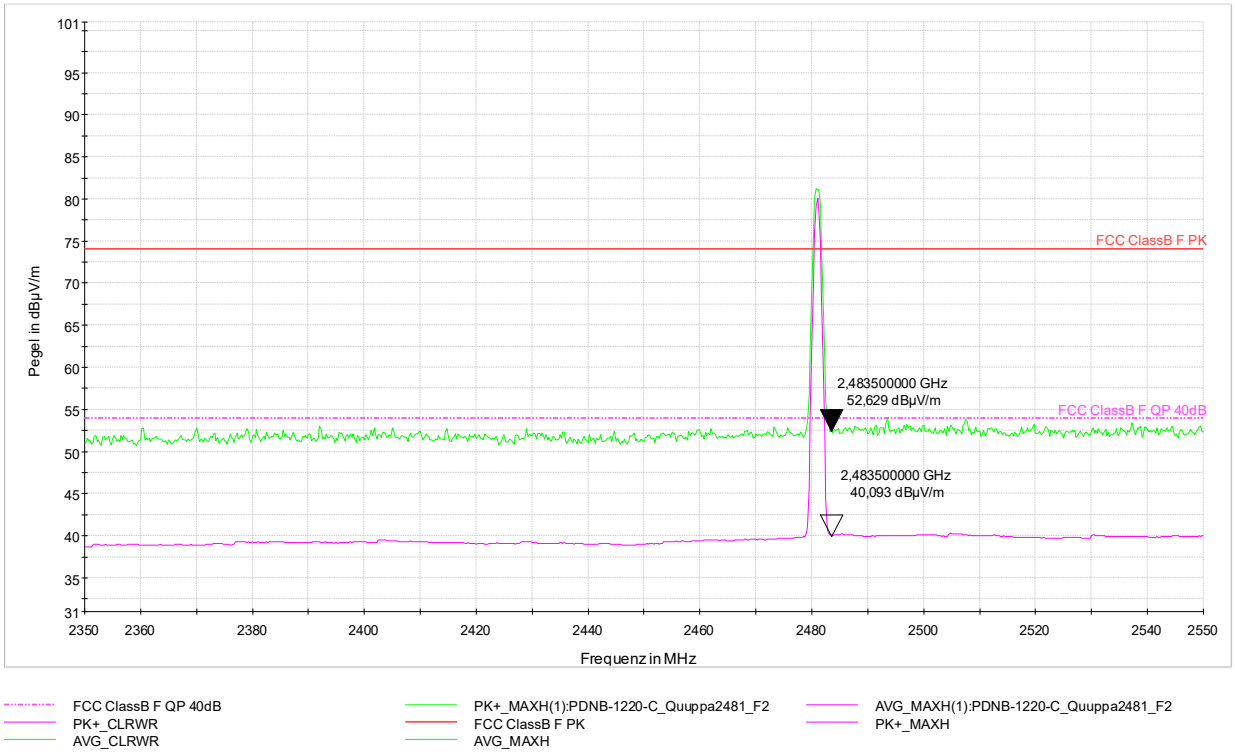
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 15.209(a)**
Emissions falling within restricted frequency bands **RSS-Gen**

Measurement with Peak-Detector (green line) and Average detector (magenta line): Band Edge requirement

Setup: 2481 MHz



LIMIT **SUBCLAUSE 15.209(a) – RSS-Gen**

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	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

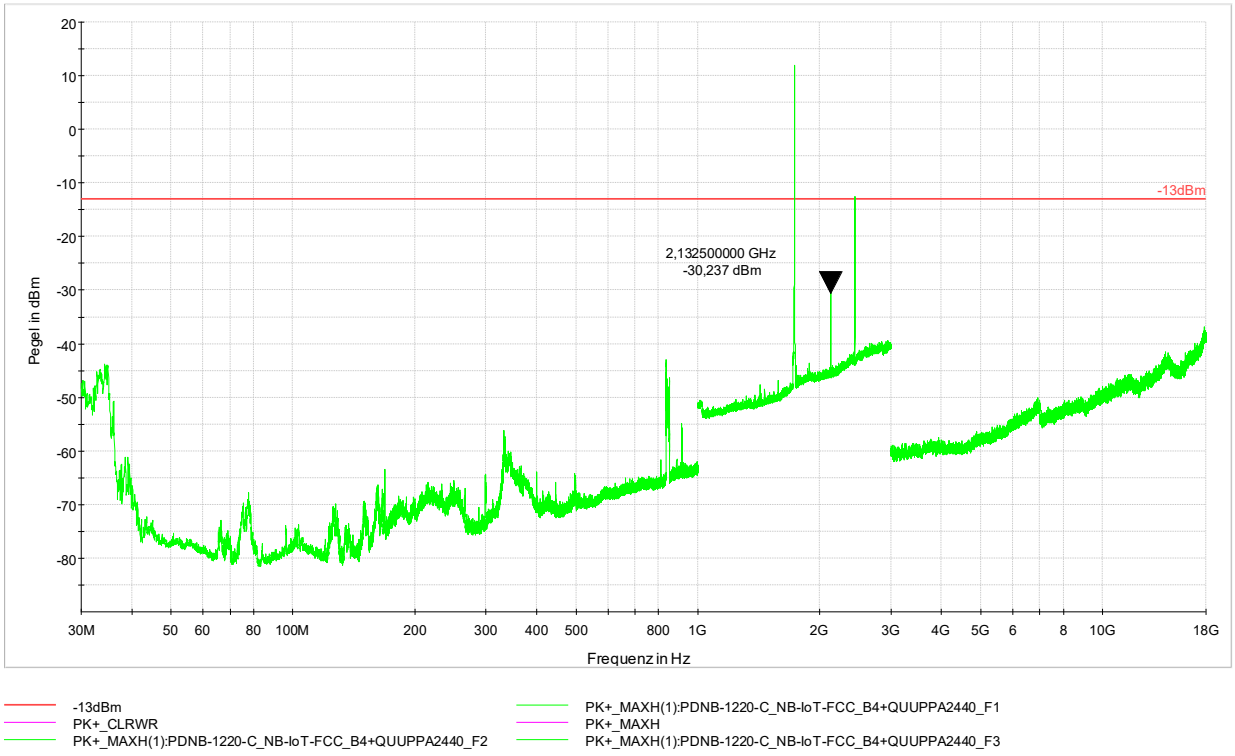
Band edges of the nearest restricted bands: 2390 MHz and 2483,5 MHz.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-131/1; NT-139; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-139**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B4 / B66 and Quuppa 2440 MHz



Worst case emission: Peak @ 2132,5 MHz: -30,24 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(h)(1)**

General protection levels. Except as otherwise specified below, for operations in the 1695–1710 MHz, 1710–1755 MHz, 1755–1780 MHz, 1915–1920 MHz, 1995–2000 MHz, 2000–2020 MHz, 2110–2155 MHz, 2155–2180 MHz, and 2180–2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

LIMIT **RSS-139 5.6**

Unwanted emissions shall be measured in terms of average values.
For all equipment, the TRP or total conducted power (sum of conducted power across all antenna connectors) of the unwanted emissions outside the frequency block or frequency block group shall not exceed the limits shown in table 6.

Table 6: Unwanted emission limits

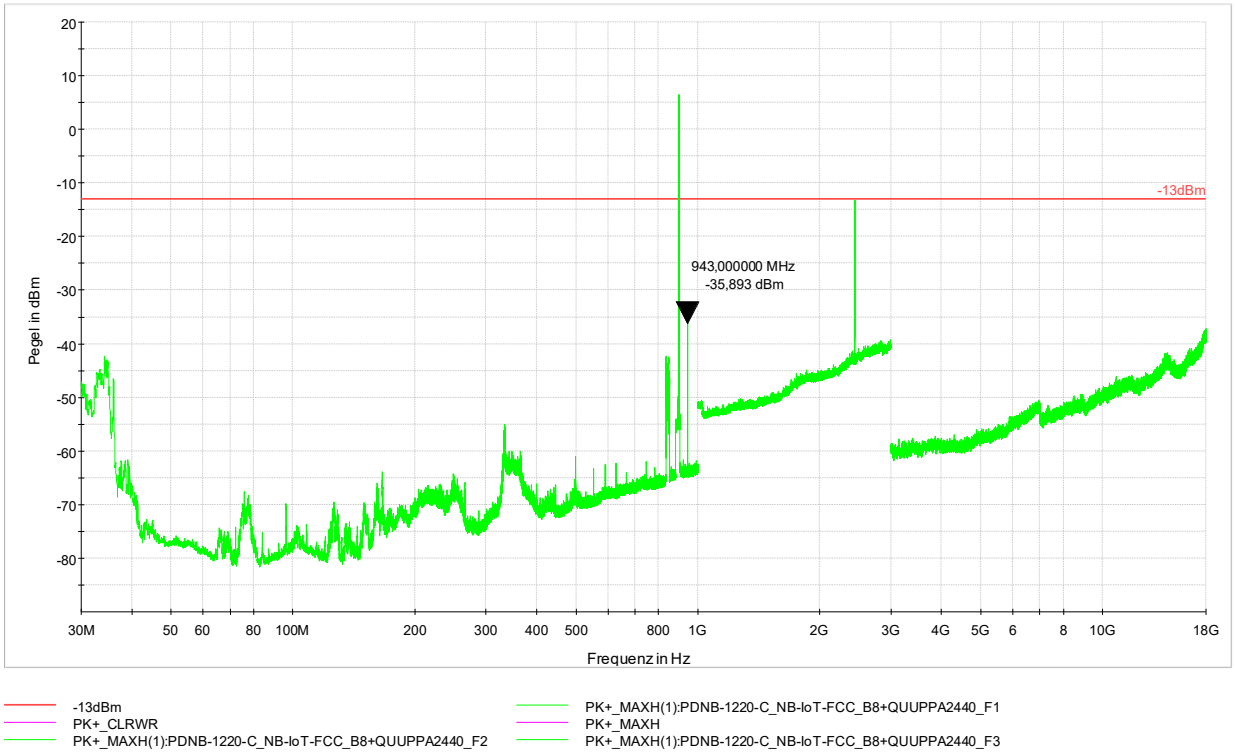
Offset from the edge of the frequency block or frequency block group	Unwanted emission limits
1 MHz	-13 dBm/(1 % of Occupied Bandwidth)
> 1 MHz	-13 dBm/MHz

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.1509**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B8 and Quuppa 2440 MHz



Worst case emission: Peak @ 943,0 MHz: -35,89 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.1509(a)**

For 900 MHz broadband operations in 897.5–900.5 MHz band by at least 43 + 10 log (P) dB.

LIMIT **RSS-130 4.7.1**

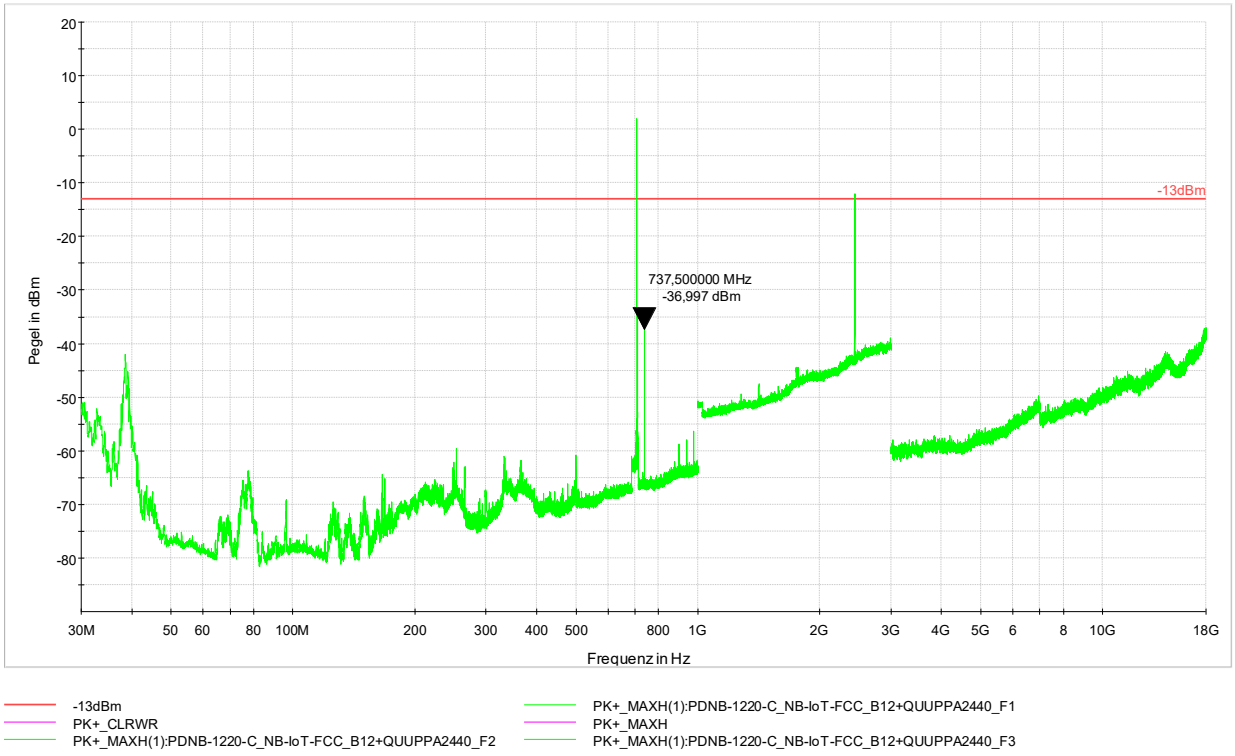
The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B12 / B85 and Quuppa 2440 MHz



Worst case emission: Peak @ 737,5 MHz: -37,00 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(g)**

For operations in the 600 MHz band and the 698–746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

LIMIT **RSS-130 4.7.1**

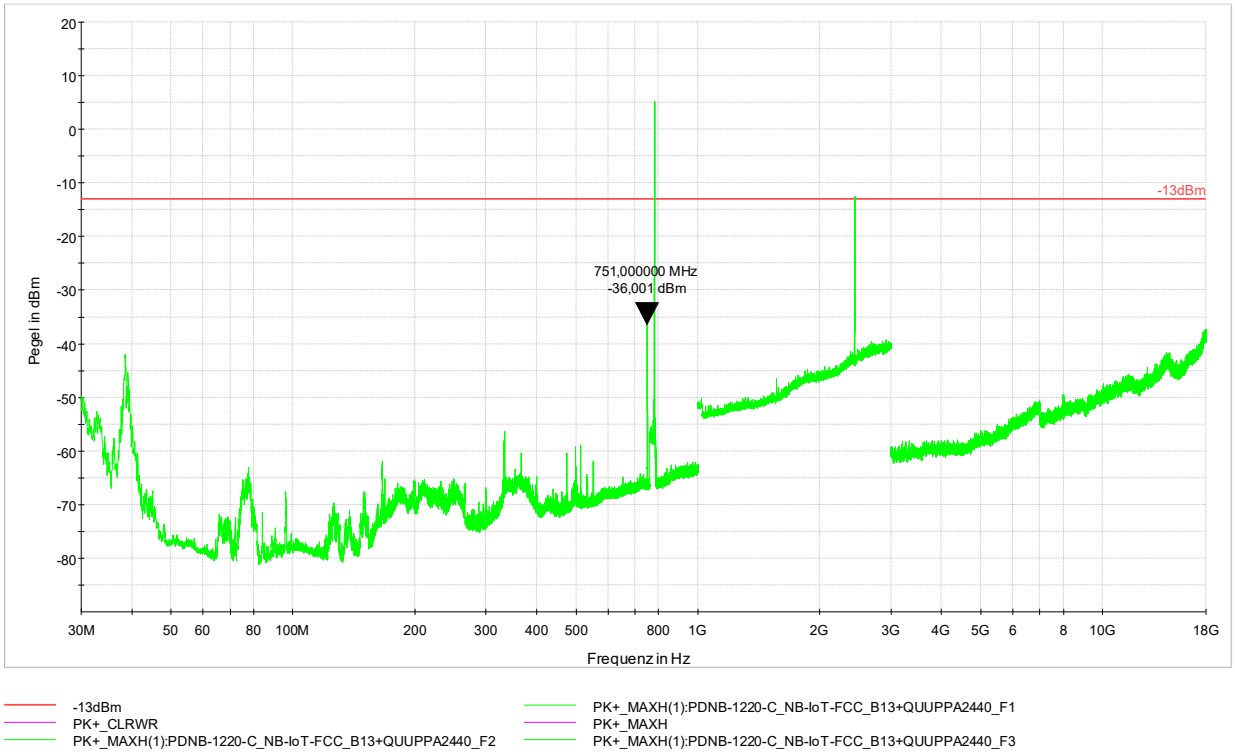
The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B13 and Quuppa 2440 MHz



Worst case emission: Peak @ 751,00 MHz: -36,00 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(c)(2)**

On any frequency outside the 776–788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB;

LIMIT **RSS-130 4.7.1**

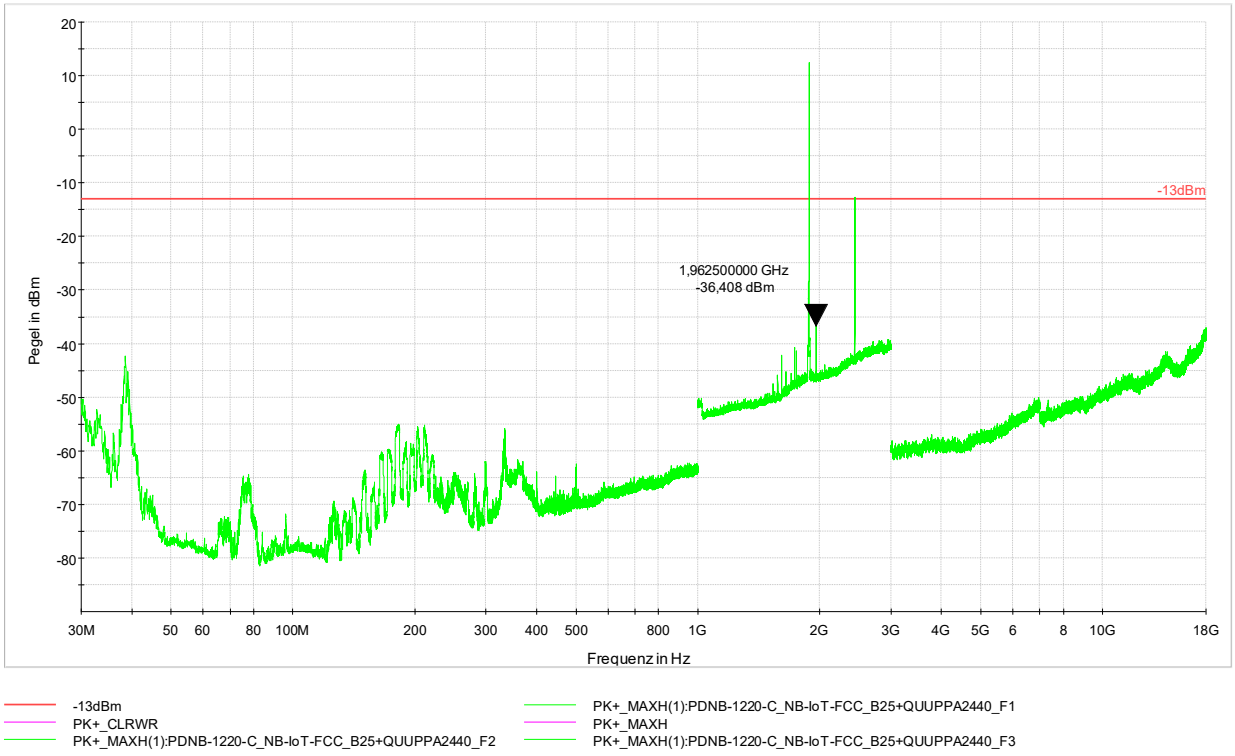
The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 24.238**
Emissions falling within restricted frequency bands **RSS-133**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission NB-IoT B25 and Quuppa 2440 MHz



Worst case emission: Peak @ 1962,5 MHz: -36,41 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 24.238(a)**

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

LIMIT **RSS-133 6.5.1(a)(i) and RSS-133 6.5.1(b)**

In the first 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the power of emissions per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB.

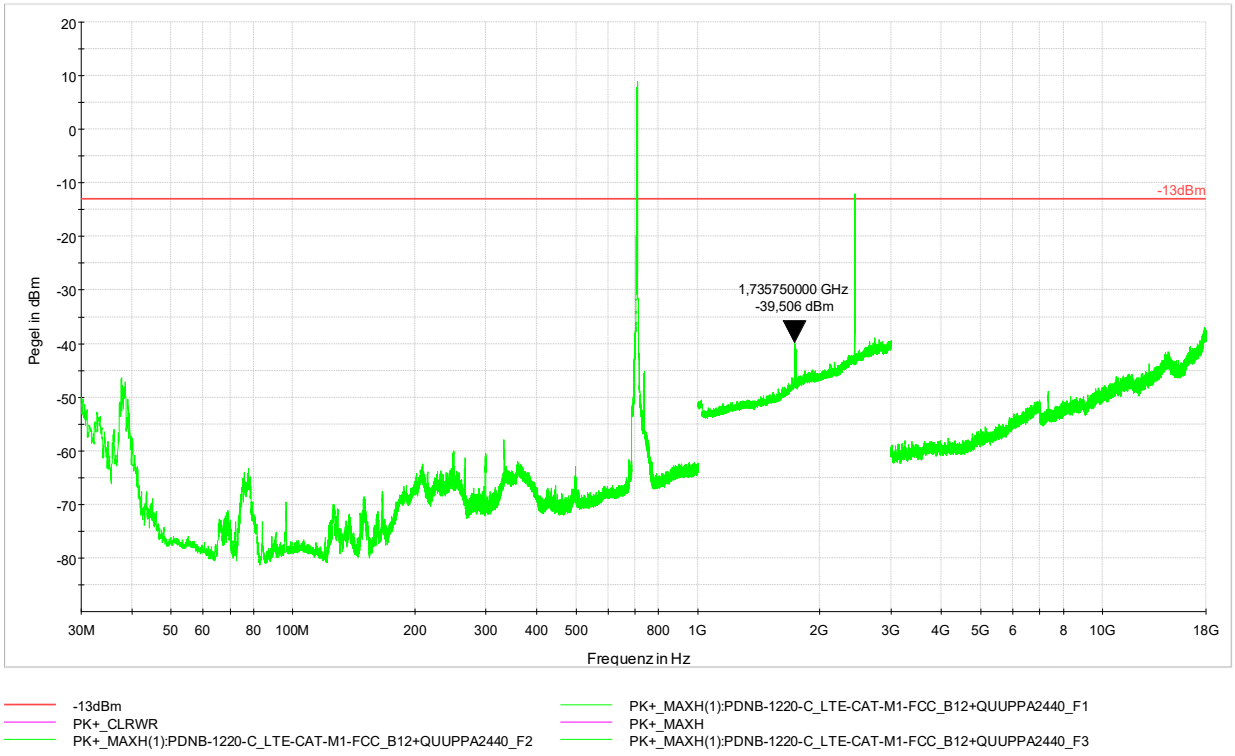
(b) After the first 1.0 MHz (for equipment that complies with (a)(i) of this subsection) or 1.5 MHz (for equipment that complies with (a)(ii) of this subsection), the power of emissions in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB. (Note: If the test result using 1% of the emission bandwidth is used, power integration over 1.0 MHz is required; alternatively, the spectrum analyzer resolution and video bandwidths can be increased to 1.0 MHz for this measurement).

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 27.53**
Emissions falling within restricted frequency bands **RSS-130**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission LTE CAT-M1 B12 and Quuppa 2440 MHz



Worst case emission: Peak @ 1735,8 MHz: -39,51 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 27.53(g)**

For operations in the 600 MHz band and the 698–746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

LIMIT **RSS-130 4.7.1**

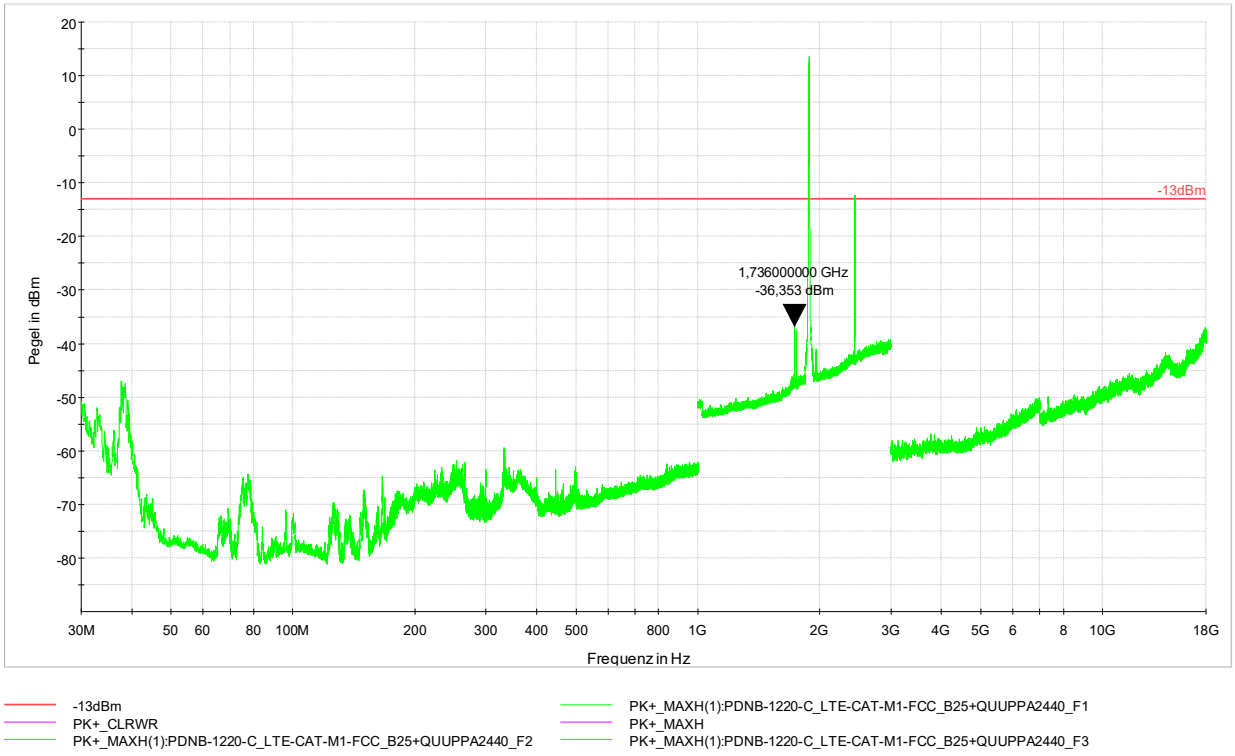
The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 24.238**
Emissions falling within restricted frequency bands **RSS-133**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission LTE CAT-M1 B2/B25 and Quuppa 2440 MHz



Worst case emission: Peak @ 1736,0 MHz: -36,35 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 24.238(a)**

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

LIMIT **RSS-133 6.5.1(a)(i) and RSS-133 6.5.1(b)**

In the first 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the power of emissions per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB.

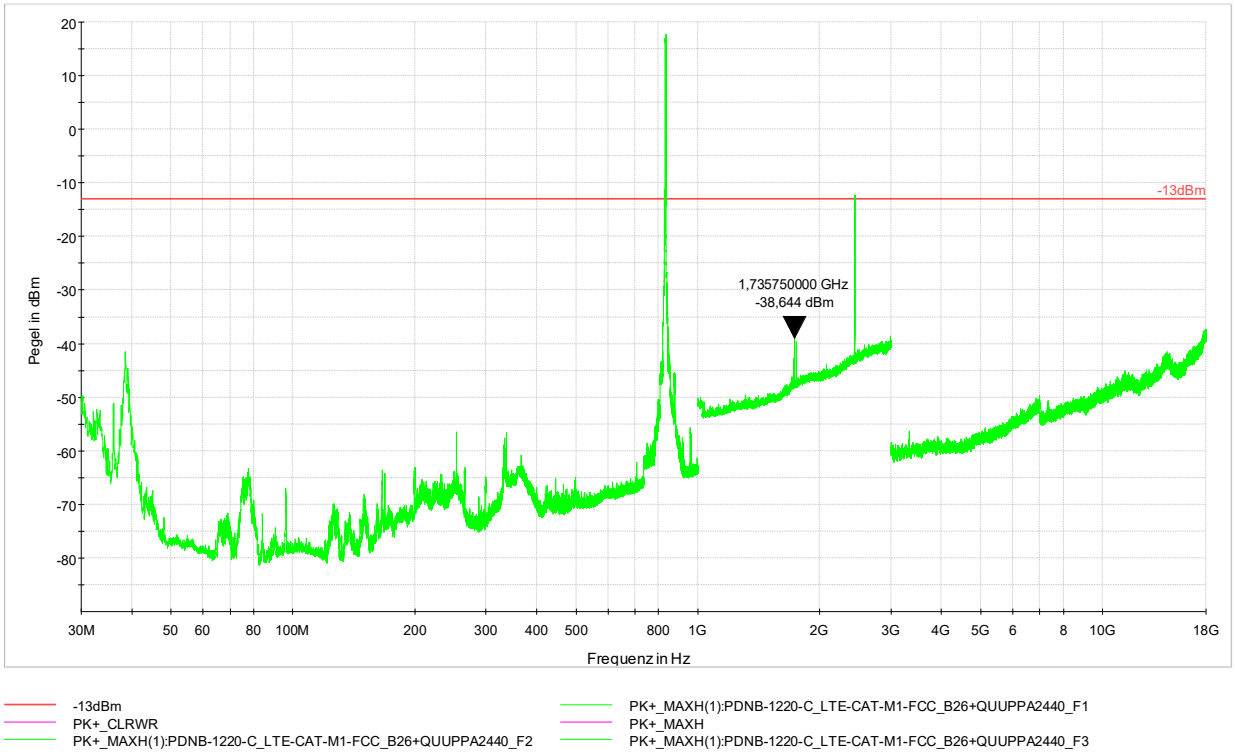
(b) After the first 1.0 MHz (for equipment that complies with (a)(i) of this subsection) or 1.5 MHz (for equipment that complies with (a)(ii) of this subsection), the power of emissions in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in watts) by at least 43 + 10 log10(P), dB. (Note: If the test result using 1% of the emission bandwidth is used, power integration over 1.0 MHz is required; alternatively, the spectrum analyzer resolution and video bandwidths can be increased to 1.0 MHz for this measurement).

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

Emissions in restricted bands **§ 22.917, § 90.669**
Emissions falling within restricted frequency bands **RSS-132**

Measurement with Peak-Detector (green line):

Setup: Simultaneous transmission LTE CAT-M1 B5 (B26 only FCC) and Quuppa 2440 MHz



Worst case emission: Peak @ 1735,8 MHz: -38,64 dBm
Remark: Although the measurement above ends at 18 GHz, all measurements were performed up to the thenth harmonics of the transmitter frequency.

LIMIT **FCC Part 22.917(a)**

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

LIMIT **FCC Part 90.669(a)**

On any frequency in an MTA licensee's spectrum block that is adjacent to a non-MTA frequency, the power of any emission shall be attenuated below the transmitter power (P) by at least 43 plus 10 log10(P) decibels or 80 decibels, whichever is the lesser attenuation.

Note: The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

LIMIT **RSS-132 5.5**

Equipment shall meet the unwanted emission limits specified below:

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB.

(ii) After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB. If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

p is the output power specified in watts.

Test Equipment used: NT-100; NT-110/1; NT-111/1; NT-132; NT-207/1;

4.15 RF Exposure

§1.1307(b)(3)(i)(C)
§1.1307(b)(3)(ii)(B)

The device uses BLE and Quuppa transmissions, both with antenna antenova CU23005-1, but a slightly different feed path. Further, the device uses the licensed module XMR2020BG95M2 with antenna antenova CU23003-1. Simultaneous transmissions of LTE-BLE and LTE-Quuppa are possible, simultaneous transmission between BLE and Quppa is not possible (but would fulfill RF exposure requirements).

Maximum conducted power values for BLE and Quuppa are taken from sections 4.5 and 4.12 of this report.
Gain values for BLE and Quuppa are taken from sections 4.5 and 4.12 of this report.
Production variance is declared by the manufacturer, see operational description exhibit.
For the conducted power values of the LTE module, a worst case assumption of 22 dBm is used (as was done in the module's test report R1907A0448-M1V1).
Gain values for the LTE antenna are taken from antenova CU23003-1 Product Specification Rev.01.
Duty cycles were not measured, a worst case duty cycle of 1 is used for all transmissions.

Calculations are performed for mobile use and 20 cm (0,2 m) minimum separation distance. §1.1307(b)(3)(i)(C) requires a minimum separation distance of at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. For the lowest used frequency (633 MHz for NB-IoT B 71) this results in a distance of 0,075 m, which is fulfilled.

Title 47 §1.1307(b)(3)(i)(C):

(3) Determination of exemption. (i) For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Table 1 to § 1.1307(b)(3)(i)(C)—Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3–1.34	1,920 R^2.
1.34–30	3,450 R^2/f^2.
30–300	3.83 R^2.
300–1,500	0.0128 R^2f.
1,500–100,000	19.2R^2.

Title 47 §1.1307(b)(3)(ii)(B):

For multiple RF sources: Multiple RF sources are exempt in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

Description	f [MHz]	ERPth [W]	conducted [W]	prod. variance [1]	cond P with var [W]	max gain [dBi]	ERP [W]	Fraction ERP/ERPth [1]
BLE	2402	0,768	0,00104	1,58	0,00164	-4,55	0,00035	0,00046
BLE	2440	0,768	0,00095	1,58	0,00150	-5,58	0,00025	0,00033
BLE	2480	0,768	0,00091	1,58	0,00144	-8,38	0,00013	0,00017
Quuppa	2401	0,768	0,00030	1,58	0,00047	-3,64	0,00013	0,00016
Quuppa	2440	0,768	0,00023	1,58	0,00036	-4,23	0,00008	0,00011
Quuppa	2481	0,768	0,00018	1,58	0,00028	-6,54	0,00004	0,00005
LTE Band 2	1850	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
LTE Band 4	1710	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
LTE Band 5	824	0,422	0,15849	1,58	0,25041	-4,6	0,05294	0,12549
LTE Band 12	699	0,358	0,15849	1,58	0,25041	-4,6	0,05294	0,14793
LTE Band 13	777	0,398	0,15849	1,58	0,25041	-4,6	0,05294	0,13308
LTE Band 25	1850	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
LTE Band 26	814	0,417	0,15849	1,58	0,25041	-4,6	0,05294	0,12703
LTE Band 66	1710	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
LTE Band 85	698	0,357	0,15849	1,58	0,25041	-4,6	0,05294	0,14815
NB-IoT Band 2	1850	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
NB-IoT Band 4	1710	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
NB-IoT Band 5	824	0,422	0,15849	1,58	0,25041	-4,6	0,05294	0,12549
NB-IoT Band 12	699	0,358	0,15849	1,58	0,25041	-4,6	0,05294	0,14793
NB-IoT Band 13	777	0,398	0,15849	1,58	0,25041	-4,6	0,05294	0,13308
NB-IoT Band 25	1850	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
NB-IoT Band 66	1710	0,768	0,15849	1,58	0,25041	-0,3	0,14250	0,18555
NB-IoT Band 71	633	0,324	0,15849	1,58	0,25041	-4,6	0,05294	0,16336
NB-IoT Band 85	698	0,357	0,15849	1,58	0,25041	-4,6	0,05294	0,14815

§1.1307(b)(3)(ii)(B) sum:

Worst case BLE	0,00046
Worst case Quuppa	0,00016
Worst case LTE	0,18555
Sum ERP/ERPth	0,18617

The sum is smaller than 1, the device is MPE exempt per §1.1307(b)(3)(ii)(B).

Appendix 1
Test equipment used

☐	Anechoic Chamber with 3m measurement distance	NT-100	☐	Ant. tripod for EN61000-4-3 Model TP1000A	NT-156
☐	Stripline according to ISO 11452-5	NT-108	☐	Power quality analyzer Fluke 1760 (complete set)	NT-160 - NT-173
☐	MA4000 - Antenna mast 1 - 4 m height	NT-110/1	☐	Spectrumanalyzer – FSP7 9 kHz – 7 GHz	NT-200
☐	DS - Turntable 0 - 400 ° Azimuth	NT-111/1	☐	ESCI - Test receiver 9 kHz - 7 GHz	NT-203/1
☐	CO3000 Controller Mast+Turntable	NT-112/1	☐	ESR – Test receiver 20 Hz – 26,5 GHz	NT-207/1
☐	HUF-Z3 - Log. Per. Antenna 200 - 1000 MHz	NT-121	☐	Digital Radio Tester CMW500	NT-208/1
☐	FMZB1513 - Loop Antenna 9 kHz - 30 MHz	NT-122/1	☐	Noise-gen., ITU-R 559-2 20 Hz – 20 kHz	NT-209
☐	HFH-Z6 - Rod Antenna 9 kHz - 30 MHz	NT-123	☐	CMTA - Radiocommunication analyzer ; 0,1 - 1000 MHz	NT-210
☐	Dipole Antenna VHA9103 30 - 300 MHz	NT-124/1a	☐	3271 - Spectrum analyzer 100 Hz - 26,5 GHz	NT-211
☐	Dipole Antenna UHA9105 300 - 1000 MHz	NT-124/1b	☐	Digital Radio Tester Aeroflex 3920	NT-212/1
☐	3115 - Horn Antenna 1 - 18 GHz (immunity)	NT-125	☐	Mixer M28HW 26,5 GHz - 40 GHz	NT-214
☐	3116 - Horn Antenna 18 - 40 GHz	NT-126	☐	RubiSource T&M Timing reference	NT-216
☐	SAS-200/543 - Bicon. Antenna 20 MHz - 300 MHz	NT-127	☐	Radiocommunicationanalyzer SWR 1180 MD	NT-217
☐	AT-1080 - Log. Per. Antenna 80 - 1000 MHz	NT-128	☐	Mixer FS-Z60 40 GHz – 60 GHz	NT-218/1
☐	HK-116 - bicon. Antenna 20 MHz - 300 MHz	NT-129	☐	Mixer FS-Z90 60 GHz – 90 GHz	NT-219/1
☐	HK-116 - bicon. Antenna 20 MHz - 300 MHz	NT-130	☐	DSO9104 Digital scope	NT-220/1
☐	3146 - Log. Per. Antenna 200 – 1000 MHz	NT-131	☐	TPS 2014 Digital scope	NT-222
☐	VULB 9163 Trilog Antenna 30 – 3000 MHz	NT-131/1	☐	Artificial Ear according to IEC 60318	NT-224
☐	Loop Antenna H-Field	NT-132	☐	1 kHz Sound calibrator	NT-225
☐	Horn Antenna 500 MHz - 2900 MHz	NT-133	☐	SRM-3006 Spectrumanalyzer	NT-233/1a
☐	Horn Antenna 500 MHz - 6000 MHz	NT-133/1	☐	E-field probe SRM 75 MHz – 3 GHz	NT-234
☐	Log. per. Antenna 800 MHz - 2500 MHz	NT-134	☐	Field Meter NBM-500 incl. E- and H-Field probes	NT-240a-e
☐	Log. per. Antenna 800 MHz - 2500 MHz	NT-135	☐	Magnetometer HP-01	NT-241/1
☐	BiConiLog Antenna 26 MHz – 2000 MHz	NT-137	☐	EFA-3 H-field- / E-field probe	NT-243
☐	Conical Dipol Antenna PCD8250	NT-138	☐	EHP-50F H-field- / E-field probe	NT-243/1
☐	HF 906 - Horn Antenna 1 - 18 GHz (emission)	NT-139	☐	Field Meter EMR-200 100 kHz – 3 GHz	NT-244
☐	HZ-1 Antenna tripod	NT-150	☐	E-field probe 100 kHz – 3 GHz	NT-245
☐	BN 1500 Antenna tripod	NT-151	☐	H-field probe 300 kHz – 30 MHz	NT-246

Division:
Industry & Energy

Test report number:
2023-IN-AT-TICL-E-EX-0-000230-FG-001

Date: 05.12.2023

Appendix 1 (continued)
Test equipment used

☐	E-field probe 3 MHz – 18 GHz	NT-247
☐	H-field probe 27 MHz – 1 GHz	NT-248
☐	ELT-400 1 Hz – 400 kHz	NT-249
☐	MDS 21 - Absorbing clamp 30 - 1000 MHz	NT-250
☐	FCC-203I EM Injection clamp	NT-251
☐	FCC-203I-DCN Ferrite decoupling network	NT-252
☐	PR50 Current Probe	NT-253
☐	i310s Current Probe	NT-254/1
☐	Fluke 87 V True RMS Multimeter	NT-260
☐	Model 2000 Digital Multimeter	NT-261
☐	Fluke 87 V Digital Multimeter	NT-262/1
☐	ESH2-Z5-U1 Artificial mains network 4x25A	NT-300
☐	ESH3-Z5-U1 Artificial mains network 2x10A	NT-301
☐	ESH3-Z6-U1 Artificial mains network 1x100A	NT-302
☐	ESH3-Z6-U1 Artificial mains network 1x100A	NT-302a
☐	EZ10 T-Artificial Network	NT-305
☐	SMG - Signal generator 0,1 - 1000 MHz	NT-310
☐	SMA100A - Signal generator 9 kHz - 6 GHz	NT-310/1
☐	RefRad Reference generator	NT-312
☐	SMP 02 Signal generator 10 MHz - 20 GHz	NT-313
☐	40 MHz Arbitrary Generator TGA1241	NT-315
☐	Artificial mains network NSLK 8127-PLC	NT-316
☐	PSURGE 4.1 Surge generator	NT-324
☐	IMU4000 Immunity test system	NT-325/1a-e
☐	VCS 500-M6 Surge-Generator	NT-326
☐	Oscillatory Wave Simulator incl. Coupling networks	NT-328a+b+c
☐	BTA-250 - RF-Amplifier 9 kHz - 220 MHz / 250 W	NT-330
☐	Prana N-MT 500 - RF-Amplifier 80 - 1000 MHz / 500 W	NT-332/1
☐	BBA150 RF-Amplifier 1 GHz - 6 GHz	NT-333/1
☐	APA01 – RF-Amplifier 0,5 GHz – 2,5 GHz	NT-334
☐	Preamplifier 1 GHz - 4 GHz	NT-335
☐	Preamplifier for GPS MKU 152 A	NT-336
☐	Preamplifier 1 GHz – 18 GHz	NT-337/1
☐	DC Block 10 MHz – 18 GHz Model 8048	NT-338
☐	2-97201 Electronic load	NT-341
☐	TSX3510P - Power supply 0-30 V / 0 - 10 A	NT-344
☐	TSX3510P - Power supply 0-30 V / 0 - 10 A	NT-345
☐	VDS 200 Mobil-impuls-generator	NT-350
☐	LD 200 Mobil-impuls-generator	NT-351
☐	MPG 200 Mobil-Impuls-Generators	NT-352
☐	EFT 200 Mobil-impuls-generator	NT-353
☐	AN 200 S1 Artificial Network	NT-354
☐	FP-EFT 32M 3 ph. Coupling filter (Burst)	NT-400/1
☐	PHE 4500 - Mains impedance network	NT-401
☐	IP 6.2 Coupling filter for data lines (Surge)	NT-403
☐	TK 9421 High Power Volt. Probe 150 kHz - 30 MHz	NT-409
☐	ESH2-Z3 - Probe 9 kHz - 30 MHz	NT-410
☐	CN-EFT1000 - Capacitive clamp (Burst)	NT-411/1
☐	Highpass-Filter 100 MHz – 3 GHz	NT-412
☐	Highpass-Filter 600 MHz – 4 GHz	NT-413
☐	Highpass-Filter 1250 MHz – 4 GHz	NT-414
☐	Highpass-Filter 1800 MHz – 16 GHz	NT-415

Appendix 1 (continued)
Test equipment used

☐	RF-Attenuator 10 dB DC – 18 GHz / 50 W	NT-417/1
☐	RF-Attenuator 6 dB DC – 18 GHz / 50 W	NT-418
☐	RF-Attenuator 3 dB DC – 18 GHz / 50 W	NT-419
☐	RF-Attenuator 20 dB DC - 1000 MHz / 25 W	NT-421
☐	RF-Attenuator 30 dB DC - 1000 MHz / 1 W	NT-423
☐	RF-Attenuator 30 dB	NT-424
☐	RF-Attenuator 6 dB DC - 1000 MHz / 1 W	NT-425
☐	RF-Attenuator 6 dB DC - 1000 MHz / 1 W	NT-426
☐	RF-Attenuator 6 dB	NT-428
☐	RF-Attenuator 0 dB - 81 dB	NT-429
☐	WRU 27 - Band blocking 27 MHz	NT-430
☐	WHJ450C9 AA - High pass 450 MHz	NT-431
☐	WHJ250C9 AA - High pass 250 MHz	NT-432
☐	RF-Load 150 W	NT-433
☐	Impedance transducer 1:4 ; 1:9 ; 1:16	NT-435
☐	RF-Attenuator DC – 18 GHz 6 dB	NT-436
☐	RF-Attenuator DC – 18 GHz 6 dB	NT-437
☐	RF-Attenuator DC – 18 GHz 10 dB	NT-438
☐	RF-Attenuator DC – 18 GHz 20 dB	NT-439
☐	I+P 7780 Directional coupler 100 - 2000 MHz	NT-440
☐	ESH3-Z2 - Pulse limiter 9 kHz - 30 MHz	NT-441
☐	Power Divider 6 dB/1 W/50 Ohm	NT-443
☐	Directional coupler 0,1 MHz – 70 MHz	NT-444
☐	Directional coupler 0,1 MHz – 70 MHz	NT-445
☐	Tube imitations according to EN 55015	NT-450
☐	FCC-801-M3-16A Coupling decoupling network	NT-458
☐	FCC-801-M2-50A Coupling decoupling network	NT-459
☐	FCC-801-M5-25 Coupling decoupling network	NT-460
☐	FCC-801-T4 Coupling decoupling network	NT-463
☐	FCC-801-C1 Coupling decoupling network	NT-464
☐	SW 9605 - Current probe 150 kHz – 30 MHz	NT-465/1
☐	95242-1 – Current probe 1 MHz – 400 MHz	NT-468
☐	94106-1L-1 – Current probe 100 kHz – 450 MHz	NT-471
☐	WHKX12-2700-3000-18000 3 GHz Highpass filter	NT-472
☐	WHKX10-3870-4500-18000 4,5 GHz Highpass filter	NT-473
☐	CDN S9 USB3.0 Coupling decoupling network	NT-474
☐	CDN S2 XLR3-1 Coupling decoupling network	NT-475
☐	CDN S8 RJ45 Coupling decoupling network	NT-476
☐	GA 1240 Power amplifier according to EN 61000-4-16	NT-480
☐	Coupling networks according to EN 61000-4-16	NT-481 - NT-483
☐	Van der Hoofden Test Head	NT-484
☐	WRCJV12-5820-5850-5950-5980 5,9 GHz Band Reject Filter	NT-490
☐	WHKX10-5670-6300-18000 6 GHz Highpass filter	NT-491
☐	WHK12-935-1000-7000 1 GHz Highpass filter	NT-492
☐	EMC Video/Audiosystem	NT-511/1
☐	EMC32 Version 10.60.20 Test software	NT-520/1
☐	SRM-TS Version 1.3 software for SRM-3000	NT-522
☐	SRM-TS Version 1.3.1 software for SRM-3006	NT-522/1
☐	Spitzenberger und Spies Test software V4.1	NT-525
☐	Vertical coupling plane (ESD)	NT-531
☐	Test cable #4 for EN 61000-4-6	NT-553
☐	Test cable #3 for conducted emission	NT-554
☐	Test cable #5+#6 ESD-cable (2x470k)	NT-555 + NT-556
☐	Test cable #8 Sucoflex 104EA	NT-559
☐	Test cable #9 (for outdoor measurements)	NT-580
☐	Test cable #10 (for outdoor measurements)	NT-581
☐	Test cable #13 Sucoflex 104PE	NT-584
☐	Test cable #21 for SRM-3000	NT-592
☐	Shield chamber	NT-600
☐	Climatic chamber	M-1200

Division:
Industry & Energy

Test report number:
2023-IN-AT-TICL-E-EX-0-000230-FG-001

Date: 05.12.2023

Appendix 1 (continued)
Test equipment used

Division:
Industry & Energy

Test report number:
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☐	Anechoic Chamber 3 m / 5 m measuring distance	EMV-100
☐	Turntabel 6 m diameter	EMV-101
☐	Antenna mast + controller	EMV-102+ EMV-103
☐	EMC Video/Audiosystem	EMV-104
☐	EMC Software EMC32 Version 10.60.20	EMV-105
☐	Hornantenna 1 – 18 GHz HF 907	EMV-110
☐	Antennapre.amp. 1 – 18 GHz BBV 9718 D	EMV-111/1
☐	Trilog Antenna 30-3000 MHz VULB9163	EMV-112
☐	Monopol 9 kHz – 30 MHz VAMP 9243	EMV-113
☐	Antennapre.amp 18 – 40 GHz BBV 9721	EMV-114
☐	Hornantenna 200 – 2000 MHz AH-220	EMV-115
☐	DC Artificial Network PVDC 8300	EMV-150
☐	AC Artificial Network NNLK 8121 RC	EMV-151
☐	AC Artificial Network NNLK 140	EMV- 153a-d
☐	EMI Receiver ESW44	EMV-200/1
☐	Signalgenerator 9 kHz – 40 GHz N5173B	EMV-201
☐	GPS Frequency normal B-88	EMV-202
☐	DC Power supply N5745A	EMV-203
☐	Spektrum Analyzator FSV40	EMV-205
☐	Thd Multimeter Model 2015	EMV-206
☐	Poweramplifier PAS15000	EMV- 207/abc
☐	Inrush Current Source	EMV- 208/abc
☐	Arb.-generator Sycore	EMV-209
☐	Harmonics/Flicker analyzer ARS 16/3	EMV-210
☐	Power Supply Regatron AC	EMV-214
☐	Power Supply Regatron DC	EMV-215
☐	Harmonics/Flicker analyser Zimmer	EMV-216
☐	Flicker Impedanz Newtons4th 753	EMV-218
☐	Comemso	EMV-219
☐	HF- Ampflifier 9 kHz-225 MHz BBL200	EMV-300/1
☐	HF- Amplifier 80 -1000 MHz BBA150	EMV-301
☐	HF- Amplifier 0,8 - 6 GHz BBA150	EMV-302
☐	High Power Ant. 20-200 MHz HPBA-2510	EMV-303/1
☐	High Power Ant. 20-200 MHz S12018-21	EMV-303/2
☐	Log.per Antenna 80-2700 MHz STLP 9128 E special	EMV-304
☐	Log.per Antenna 0,7 – 9 GHz STLP9149	EMV-305
☐	HF- Ampflifier 9 kHz-250 MHz BBA150 (low noise)	EMV-306
☐	ISO11451-2 TLS 10 kHz – 30 MHz	EMV-307
☐	Load Dump Generator LD 200N	EMV-350
☐	Ultra Compact Symulator UCS 200N100	EMV-351
☐	Automotive Power fail module PFM 200N100.1	EMV-352
☐	Voltage Drop Symulator VDS 200Q100	EMV-353
☐	Arb. Generator AutoWave	EMV-354
☐	Ultra Compact Symulator UCS 500N7	EMV-355
☐	Coupling decoupling network CNI 503B7 / 32 A	EMV-356
☐	Coupling decoupling network CNI 503B7 / 63 A	EMV-357
☐	Telecom Surge Generator TSurge 7	EMV-358
☐	Coupling decoupling network CNI 508N2	EMV-359
☐	Coupling decoupling network CNV 504N2.2	EMV-360
☐	Immunity generator NSG4060/NSG4060-1	EMV-361
☐	Coupling network CDND M316-2	EMV-362
☐	Coupling network CT419-5	EMV-363
☐	ESD Generator NSG 437	EMV-364
☐	Pulse Limiter VTSD 9561-F BNC	EMV-405
☐	Transient emission BSM200N40+BS200N100	EMV- 450+451
☐	Cap. Coupling Clamp HFK	EMV-455
☐	Mag. Field System MS100N+MC26100+MC2630	EMV- 456-458

Appendix 1 (continued)
Test equipment used

☐	Coupling network CDN M2-100A	EMV-459
☐	Coupling network CDN M3-32A	EMV-460
☐	Coupling network CDN M5-100A	EMV-461
☐	Current Clamp CIP 9136A	EMV-462
☐	DC Artificial Network HV-AN 150	EMV-464+465
☐	Coupling Clamp EM 101	EMV-466
☐	Decoupling Clamp FTC 101	EMV-467
☐	Power attenuator 10 dB / 250 Watt	EMV-469/2
☐	HV AMN NNHV 8123 800A	EMV-472
☐	HV AMN NNHV 8123 800A	EMV-473