Report on the Radio Testing

For

Motorola Solutions

on

VB400 Body-Worn Camera

Report no. TRA-052112-45-06D

17 September 2021

Report Number: TRA-052112-45-06D
Issue: D

REPORT ON THE RADIO TESTING OF A
Motorola Solutions
VB400 Body-Worn Camera
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 2021-02-01 to 2021-04-19

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Adobe Acrobat version: 2021.007.20091

Date: 17 September 2021

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[1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	14 May 2021	Original
B	09 June 2021	Company name, address and contact details updated
C	25 June 2021	Software Revision added
D	17 September 2021	Section 11.6 updated

2 Summary

TEST REPORT NUMBER:	TRA-052112-45-06D
WORKS ORDER NUMBER:	TRA-052112-01
PURPOSE OF TEST:	Certification
TEST SPECIFICATION:	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	VB400 Body-Worn Camera
FCC IDENTIFIER:	AZ489FT7148
MANUFACTURER/AGENT:	Motorola Solutions Ltd.
ADDRESS:	Motorola Solutions, Caledonian Exchange, 19A Canning Street, Edinburgh, EH3 8EG
CLIENT CONTACT:	Anne Ambler ☎ 0131 510 0232 ✉ anne.ambler@motorolasolutions.com
ORDER NUMBER:	PO-2020AA0085
TEST DATE:	2021-02-01 to 2021-04-19
TESTED BY:	A Tosif Element

2.1 Test Summary

Test Method and Description		*Requirement Clause 47CFR15*	*Applicable to this equipment*	*Result / Note*
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.247 (d)	☒	*Pass*
AC power line conducted emissions		15.207	☒	*Pass*
Occupied bandwidth		15.247 (a) (2)	☒	*Pass*
Conducted carrier power	Peak	15.247 (b) (3)	☒	*Pass*
	Max.		☐	
Out of band emissions		15.247 (d)	☒	*Pass*
Power spectral density		15.247 (e)	☒	*Pass*

General Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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4 Introduction

This report TRA-052112-45-06D presents the results of the Radio testing on a Motorola Solutions, VB400 Body-Worn Camera to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Motorola Solutions by Element, at the address detailed below.

☒ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☐ Element Skelmersdale
Unit 1
Pendle Place
Skemersdale
West Lancashire
WN8 9PN
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

The test laboratory is accredited for the above sites under the US-UK MRA,

Designation number(s):
Element Hull UK2007
Element Skelmersdale UK2020

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada
ITU	International Telecommunication Union
LBT	Listen before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

7 Equipment under Test

7.1 EUT Identification

- Name: VB400 Body-Worn Camera
- Model Number: VB400V3
- Serial Number: 229314 & 229310 #
- Software Revision: V15.0_e07x_rftest6 (RF test firmware)
- Build Level / Revision Number: Not Applicable

229314 was used for conducted testing, while 229310 was used for radiated testing.

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Laptop

7.3 EUT Mode of Operation

The EUT was set to transmit continuously with modulation on required channels.

7.4 EUT Radio Parameters

Frequency of operation:	2402 MHz – 2480 MHz
Antenna type:	Integral
Antenna gain:	-3.9 dBi
Nominal supply voltage:	3.8 Vdc

7.5 EUT Description

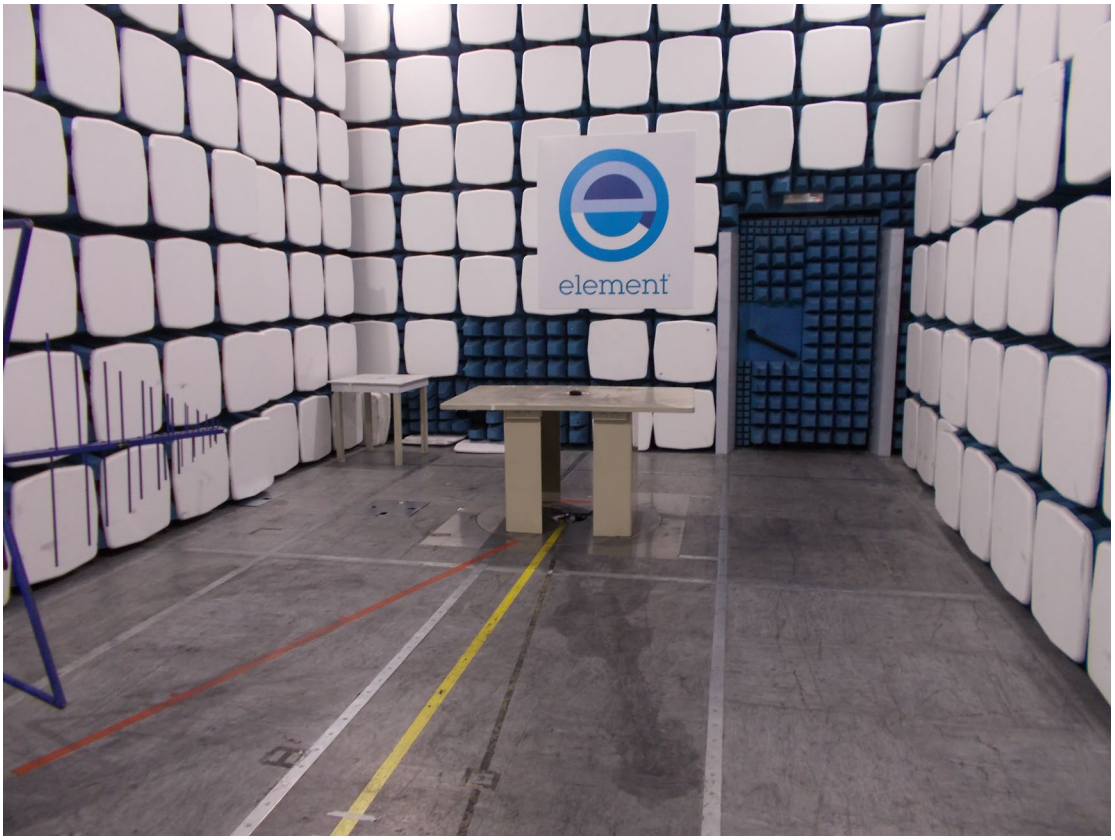
The EUT is a body-worn camera with 2.4 GHz and 5 GHz Wi-Fi, Bluetooth Classic, Bluetooth Low Energy and GPS. This report only covers limited testing of Bluetooth Low Energy.

8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup Photographs

The following photographs shows basic EUT radiated set-up:



9.1 Measurement software

Where applicable, the following software was used to perform measurements contained within this report.

Element Emissions R5

10 General Technical Parameters

10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 3.8 Vdc from internal battery.

10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised.

Variation of supply voltage is required to ensure stability of the declared output power. During carrier power testing the following variations were made:

	Category	***Nominal***	***Variation***
☐	Mains	110 Vac +/-2 %	85 % and 115 %
☒	Battery	New battery	N/A

11 Radiated emissions

11.1 Definitions

Spurious emissions
Emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands
A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
Deviations from Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz; Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak; Above 1 GHz: RMS average and Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 28 % RH	20 % RH to 75 % RH (as declared)

11.3 Test Limit

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

Frequency (MHz)	*Field Strength (µV/m at 3 m)*	*Field Strength (dBµV/m at 3 m)*
30 to 88	100	40.0
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

On frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function. On frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBµV/m at the regulatory distance, using:

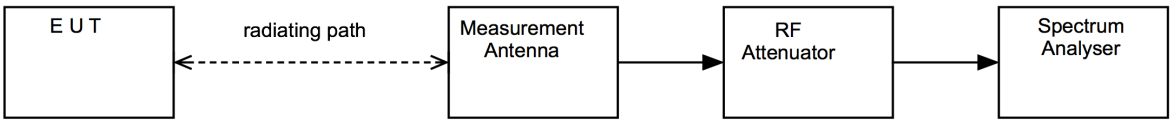
$$FS = PR + CL + AF – PA + DC – CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
CF is the distance factor in dB (where measurement distance different to limit distance);

This field strength value is then compared with the regulatory limit.

Figure i Test Setup



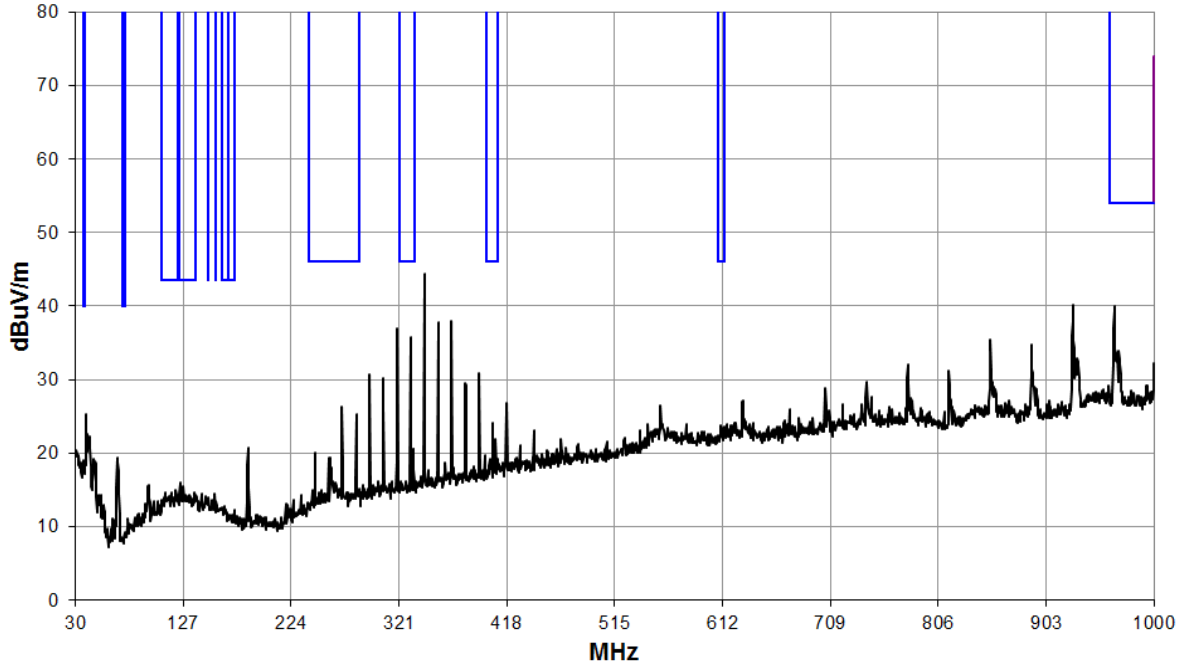
11.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
Ferrite Lined Chamber	Rainford	ATS	REF886	2022-07-29
Spectrum Analyser	R&S	FSU26	REF909	2021-07-09
Pre-Amp (1 - 26.5 GHz)	Agilent	8449B	REF913	2022-02-04
Pre-Amp (9 kHz - 1 GHz)	Sonoma	310	REF927	2021-07-21
Bilog Antenna	Chase	CBL6111B	REF2233	2022-09-15
Horn Antenna	EMCO	3115	RFG129	2022-02-14
Horn Antenna	A Info Inc	LB-180400-25-C-KF	REF2246	2022-07-28
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

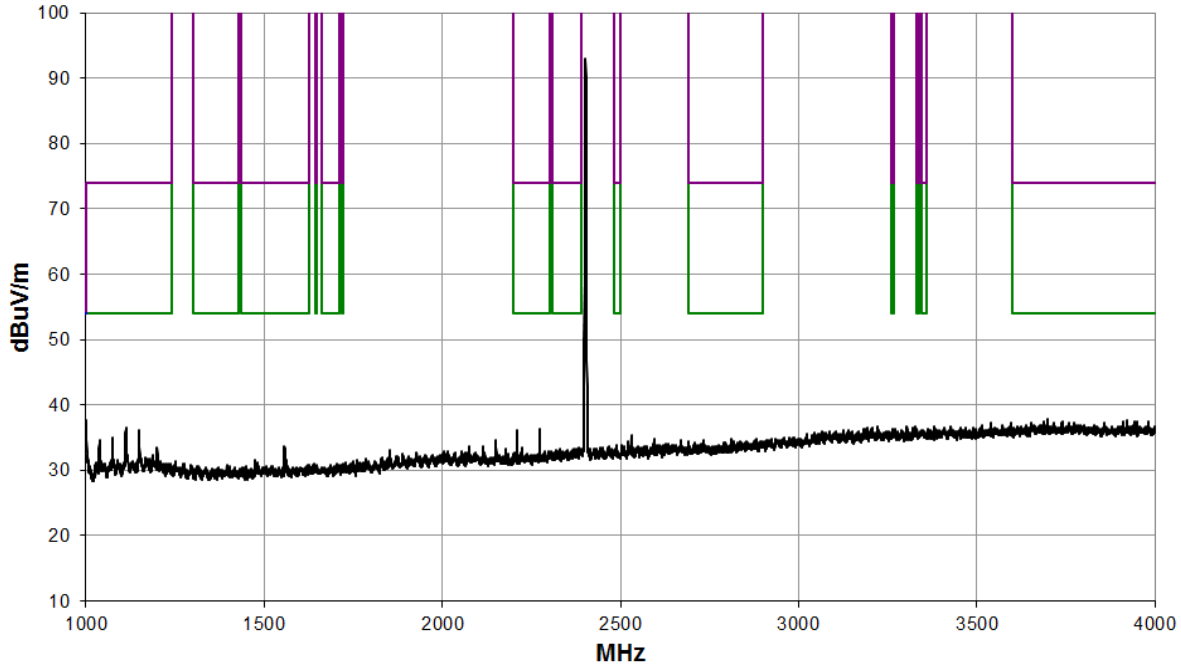
11.6 Test Results

Frequency: 2402 MHz; Power Setting: -4 dBm; Data Rate: 1 Mbps								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
No emissions were detected within 20 dB of the limit								

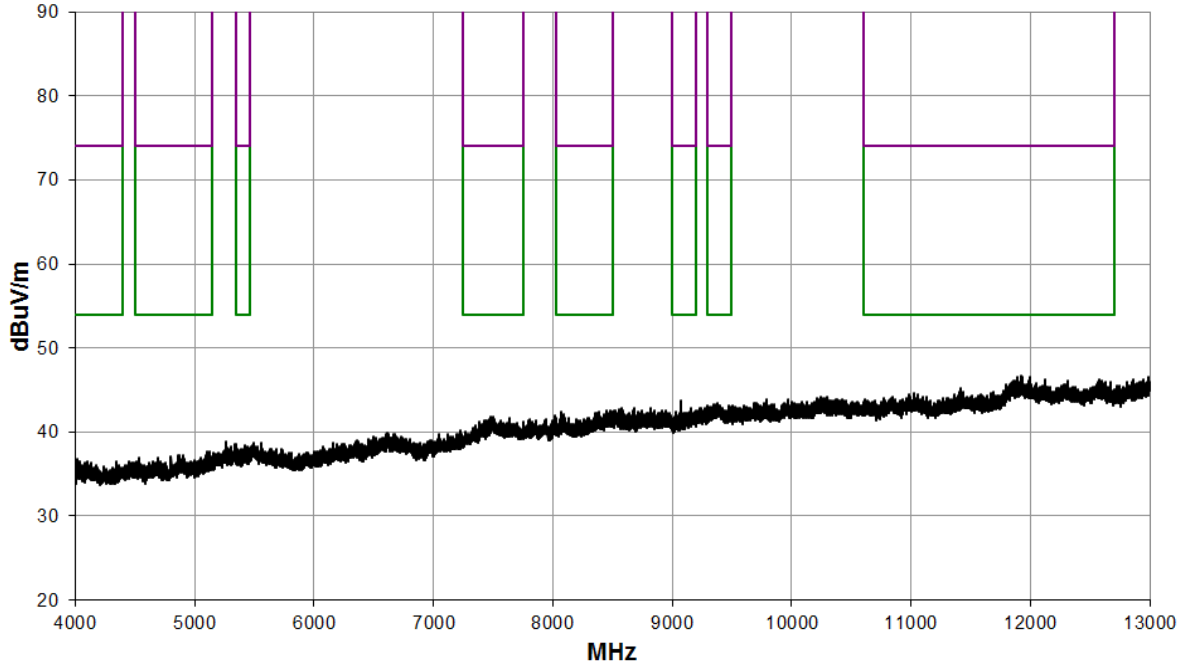
30 MHz – 1 GHz



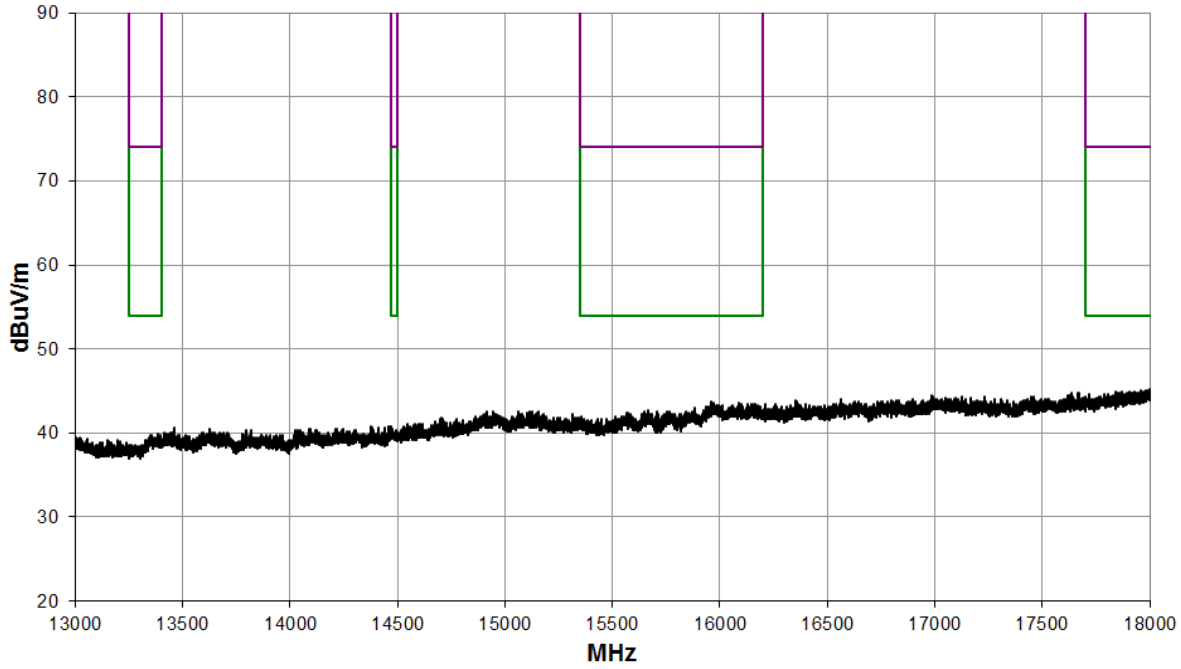
1 GHz – 4 GHz



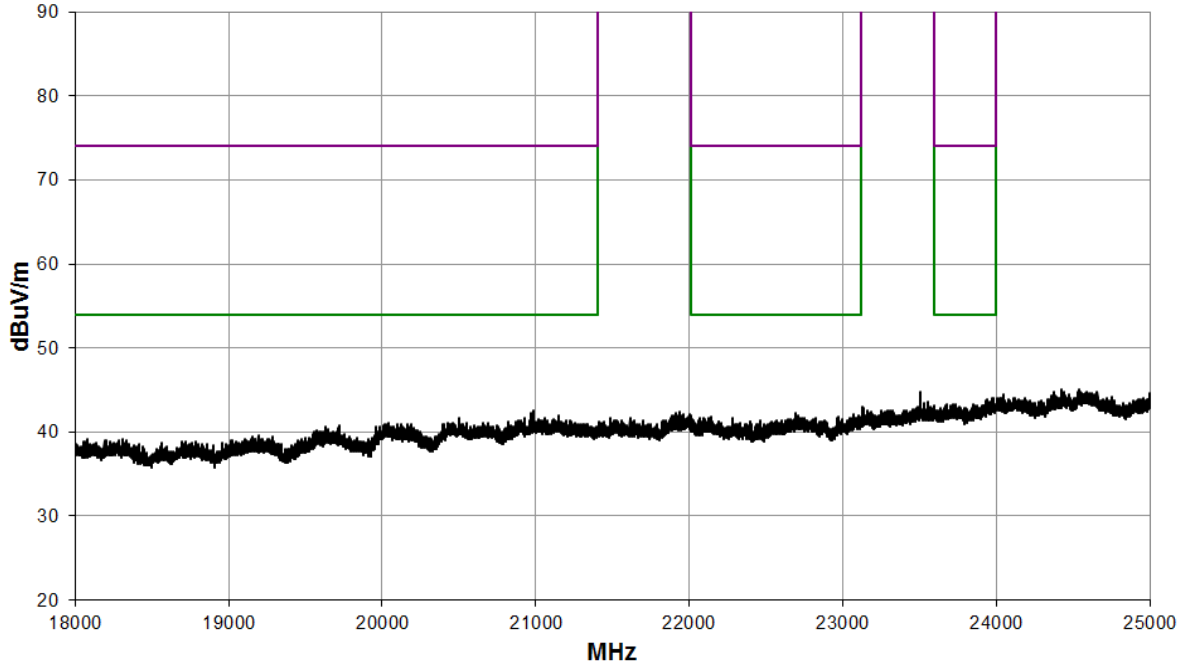
4 GHz – 13 GHz



13 GHz – 18 GHz

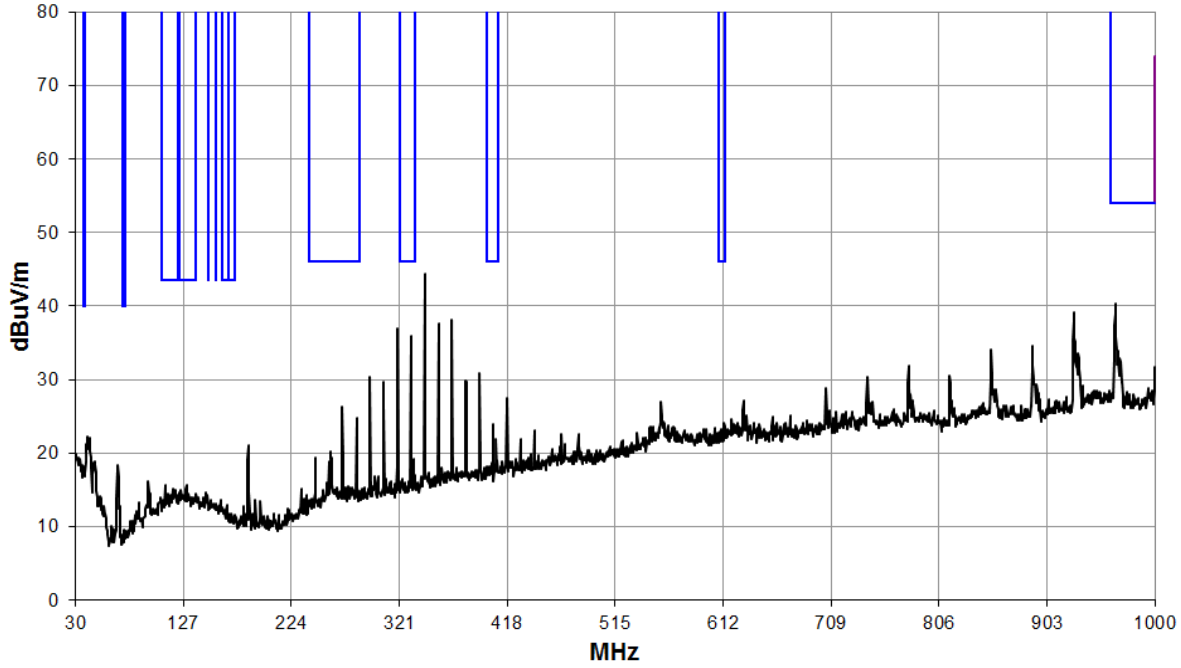


18 GHz – 25 GHz

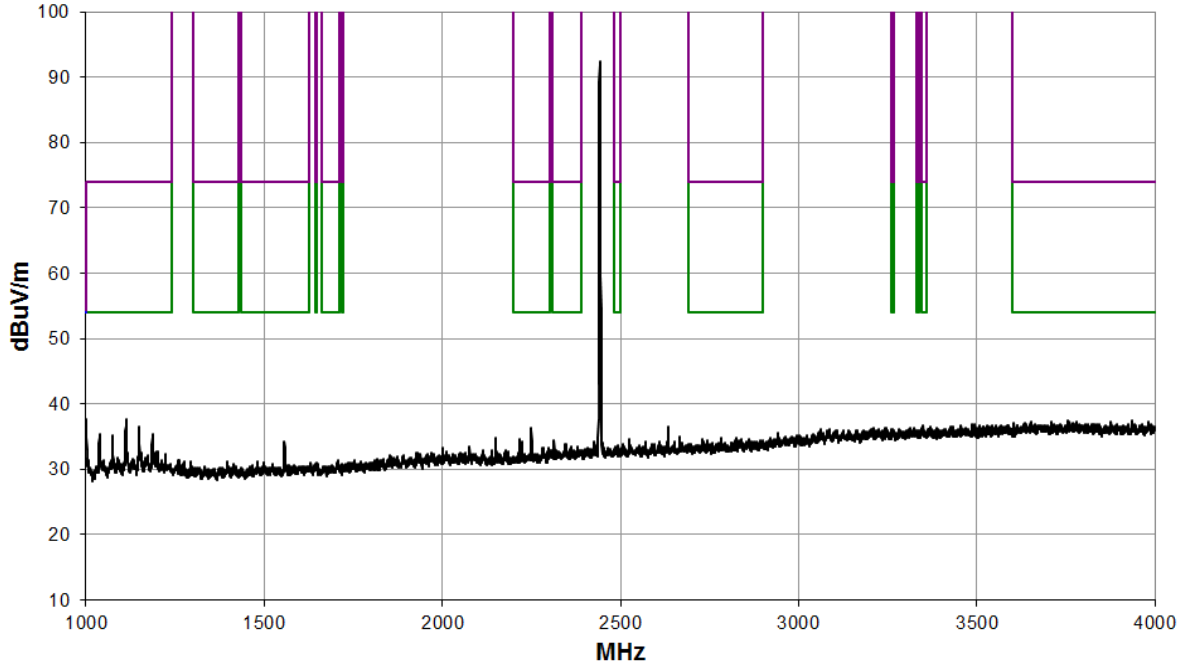


Frequency: 2442 MHz; Power Setting: -4 dBm; Data Rate: 1 Mbps								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
No emissions were detected within 20 dB of the limit								

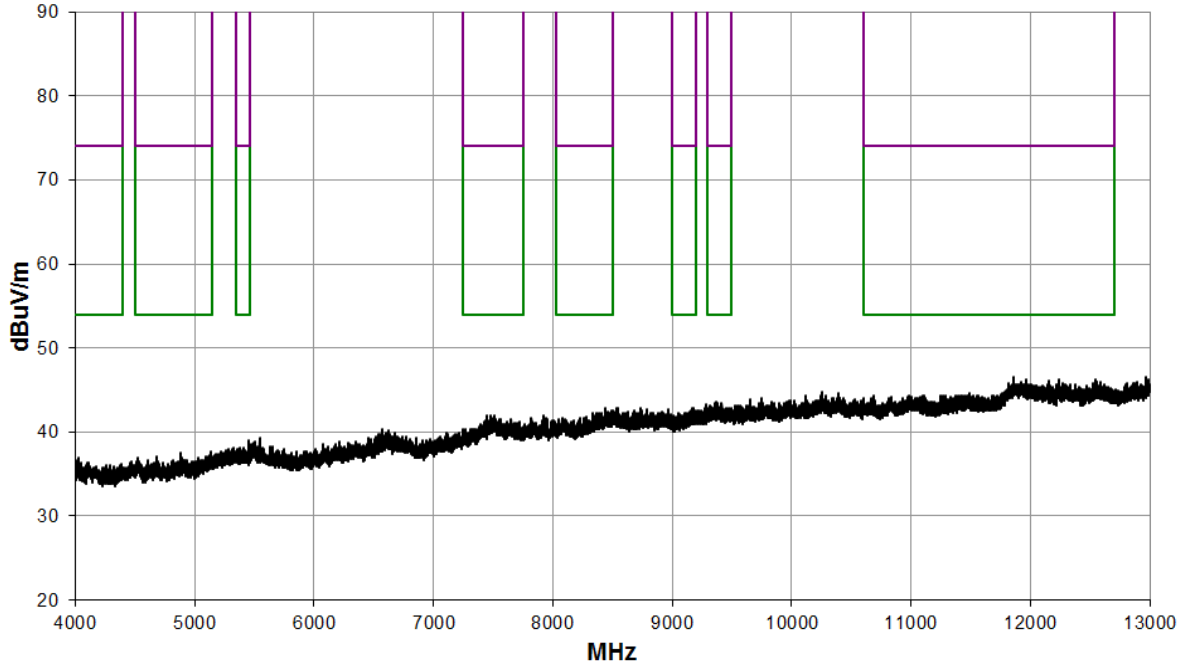
30 MHz – 1 GHz



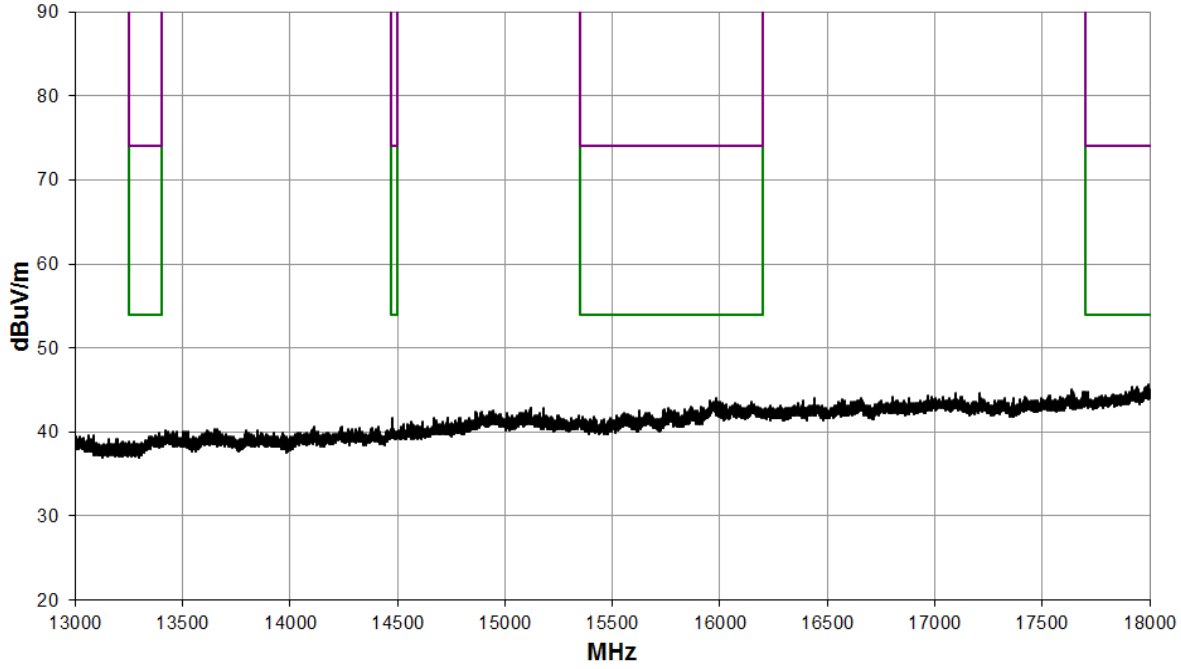
1 GHz – 4 GHz



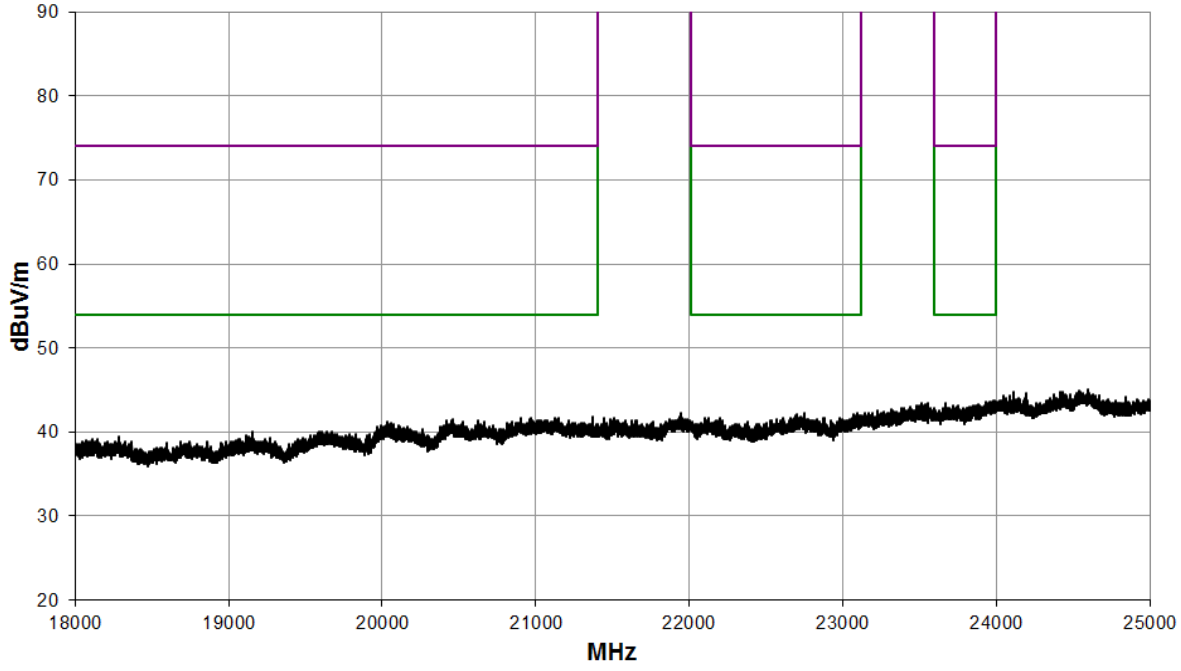
4 GHz – 13 GHz



13 GHz – 18 GHz

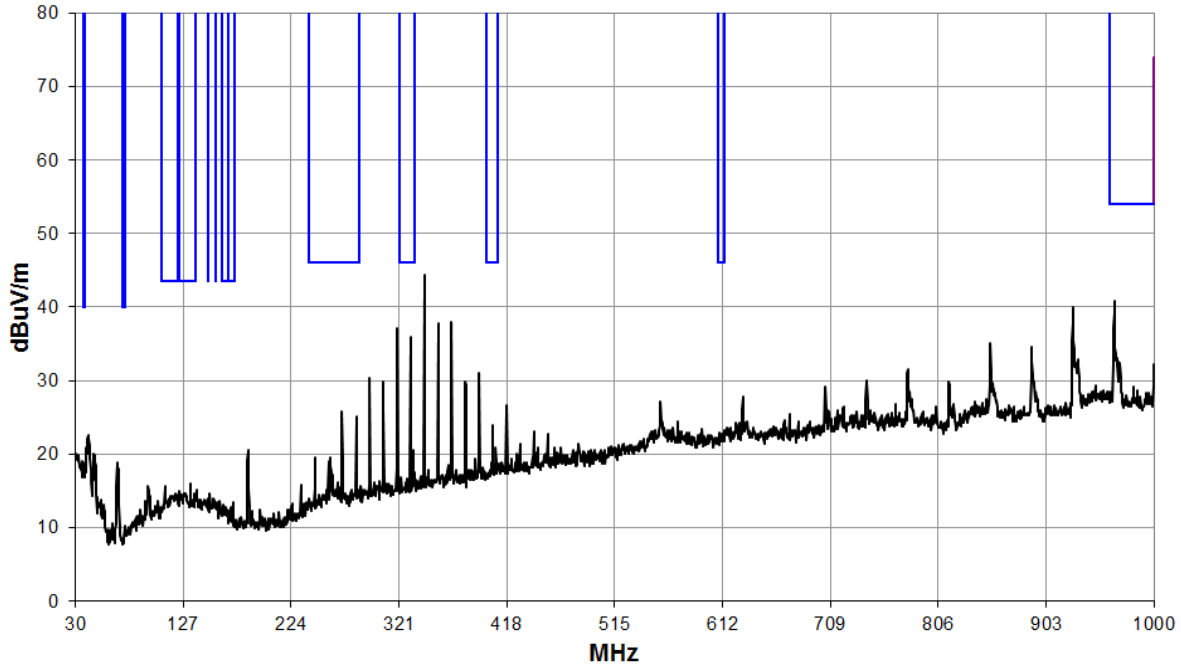


18 GHz – 25 GHz

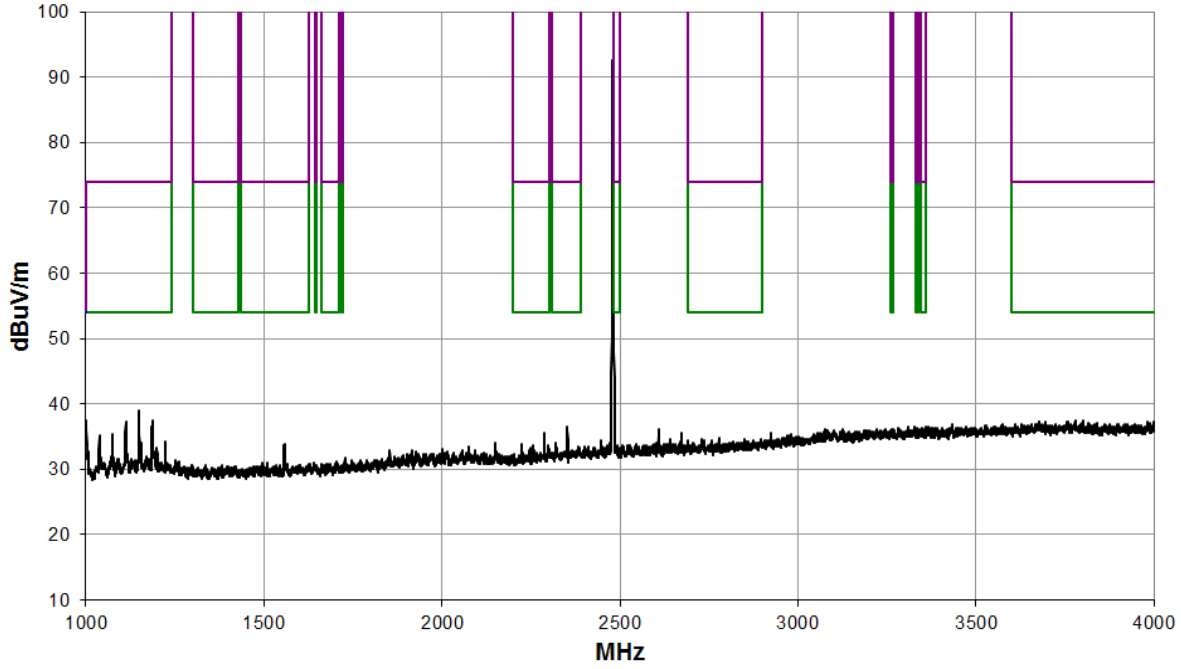


Frequency: 2480 MHz; Power Setting: -4 dBm; Data Rate: 1 Mbps								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
No emissions were detected within 20 dB of the limit								

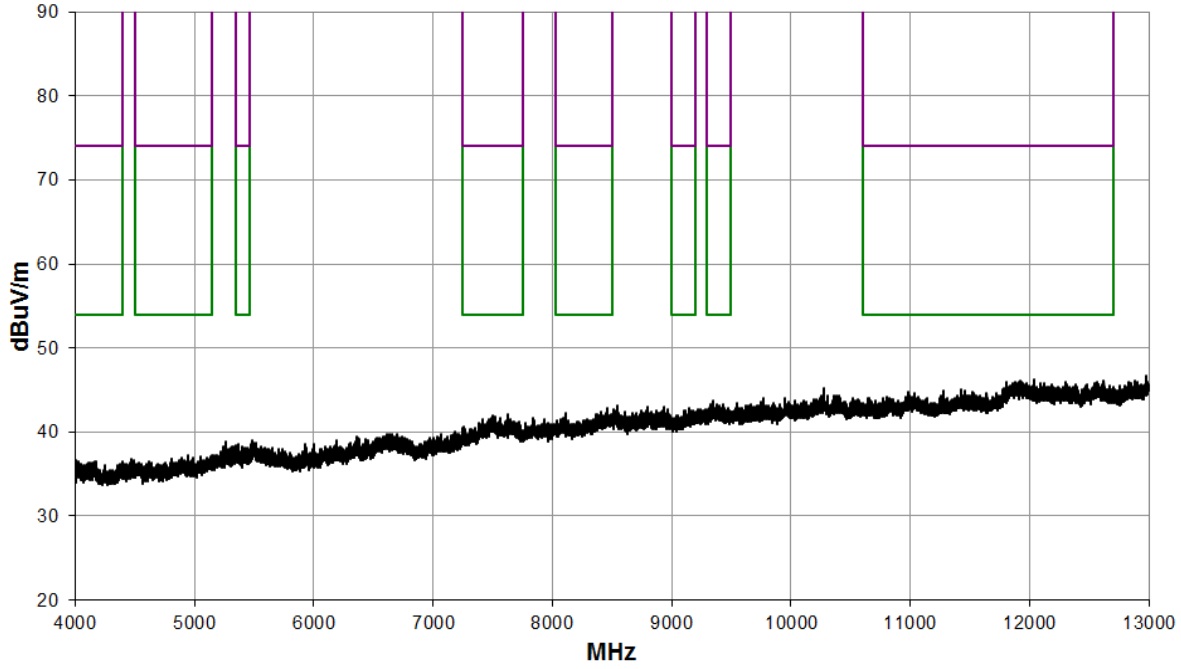
30 MHz – 1 GHz



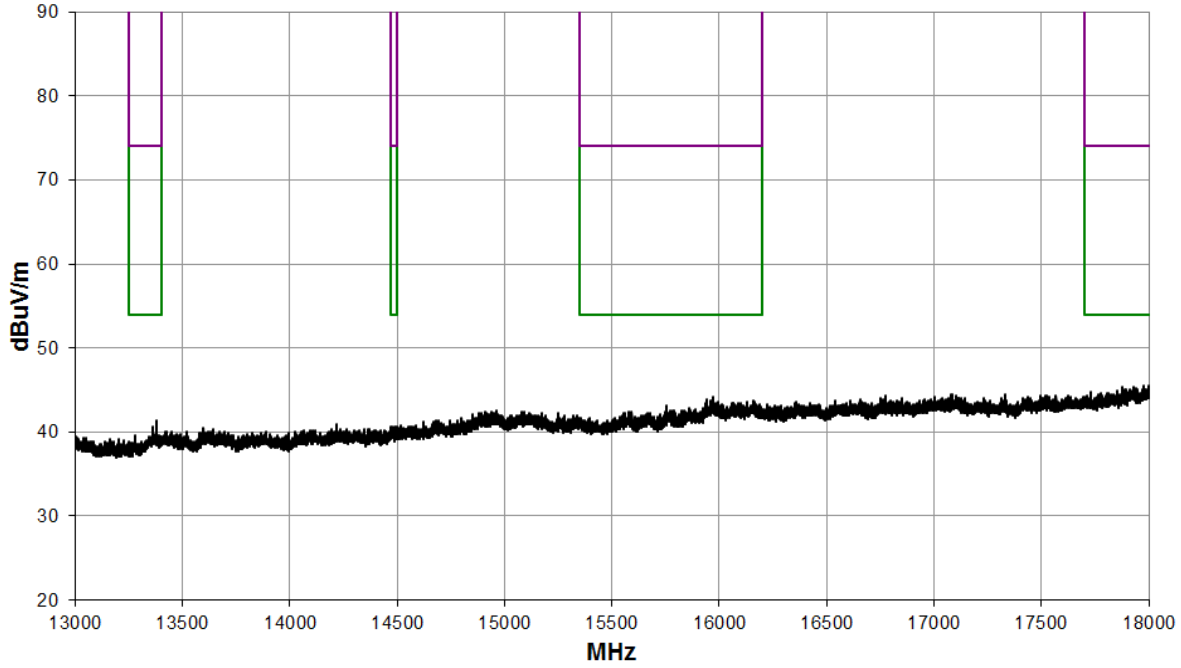
1 GHz – 4 GHz



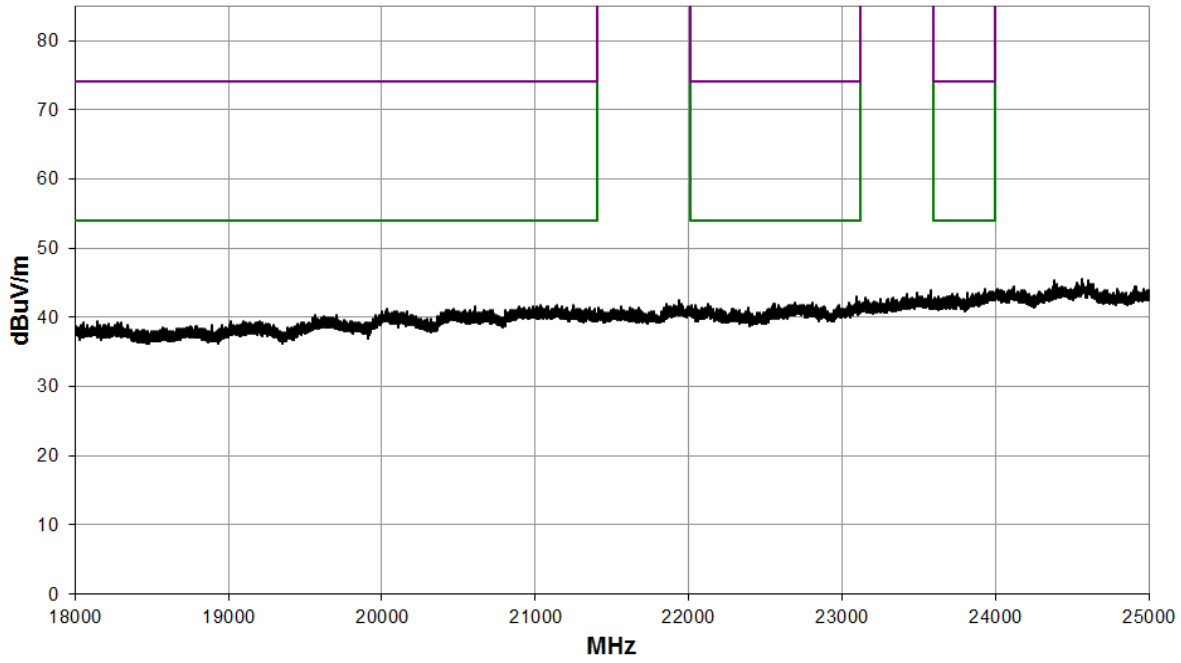
4 GHz – 13 GHz



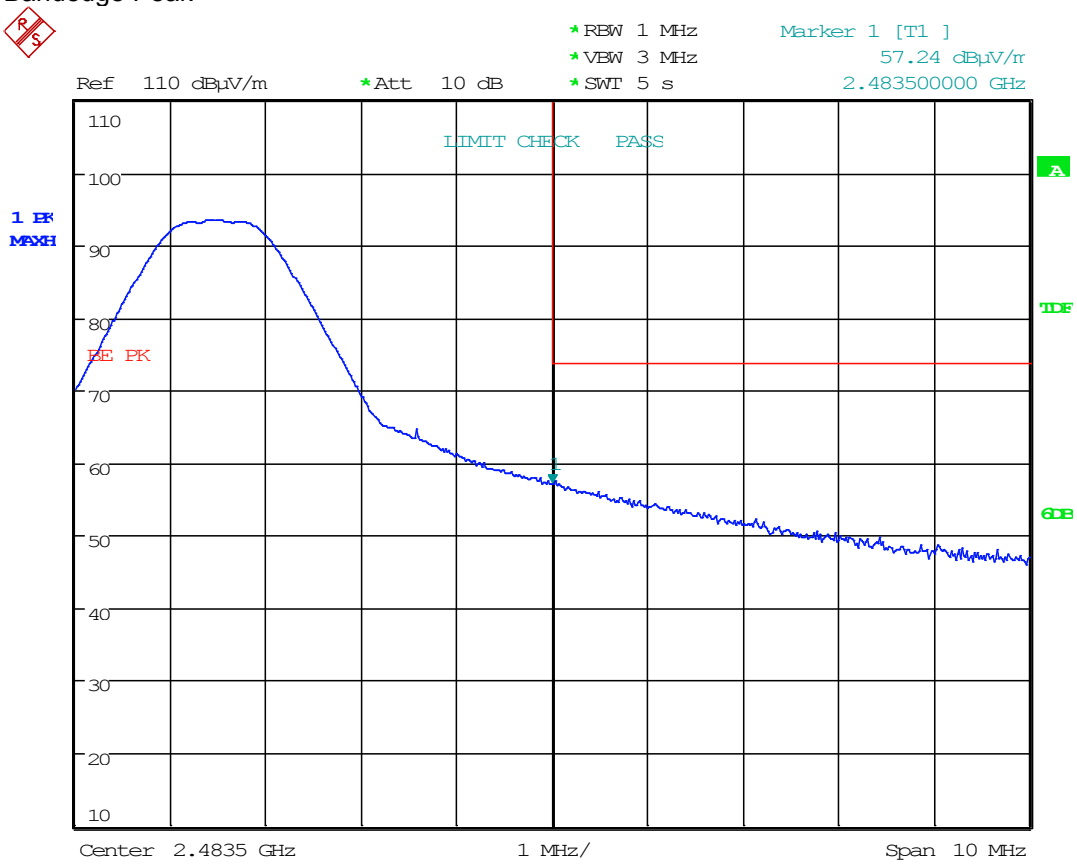
13 GHz – 18 GHz



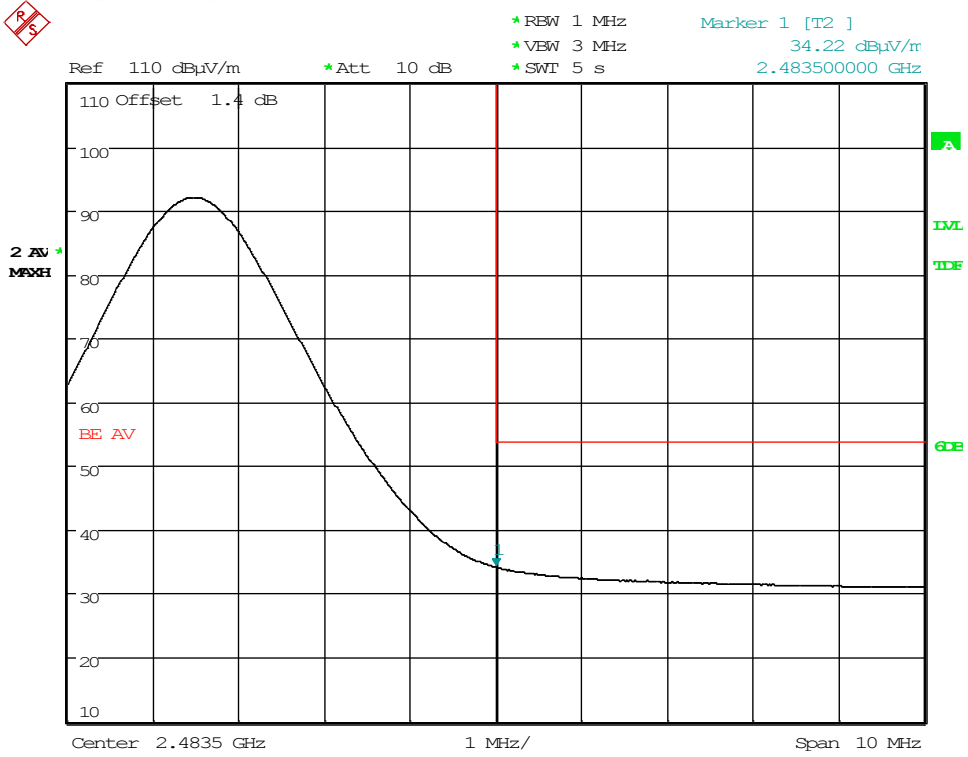
18 GHz – 25 GHz



Bandedge Peak



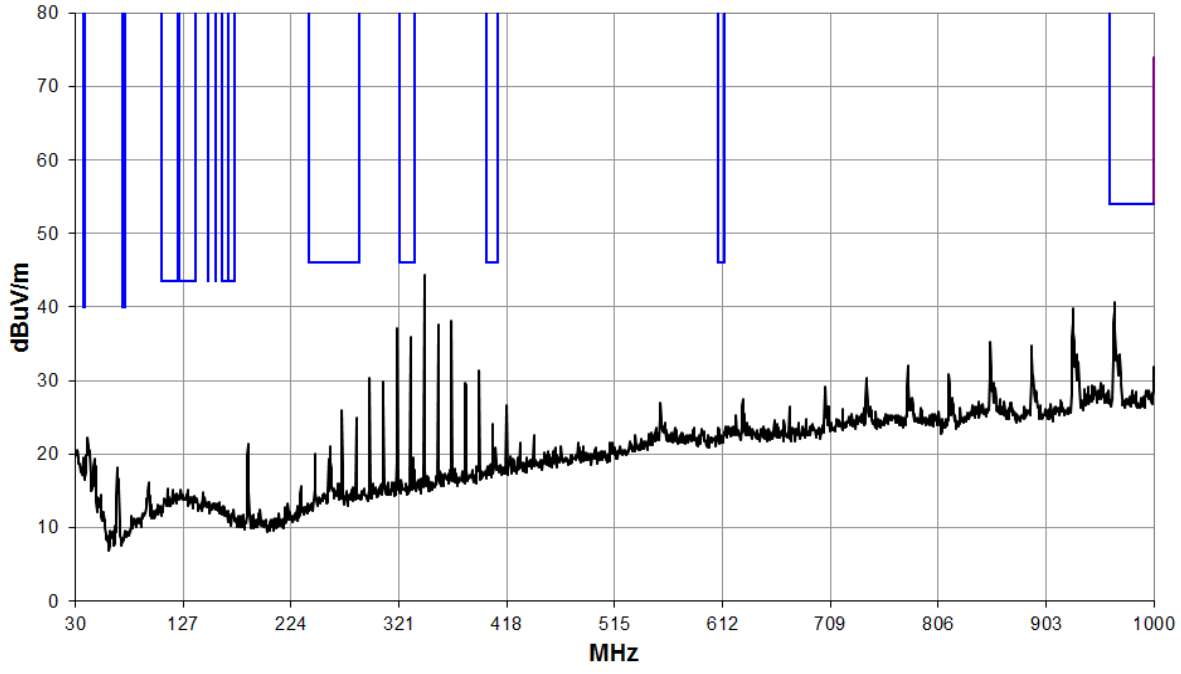
Bandedge Average



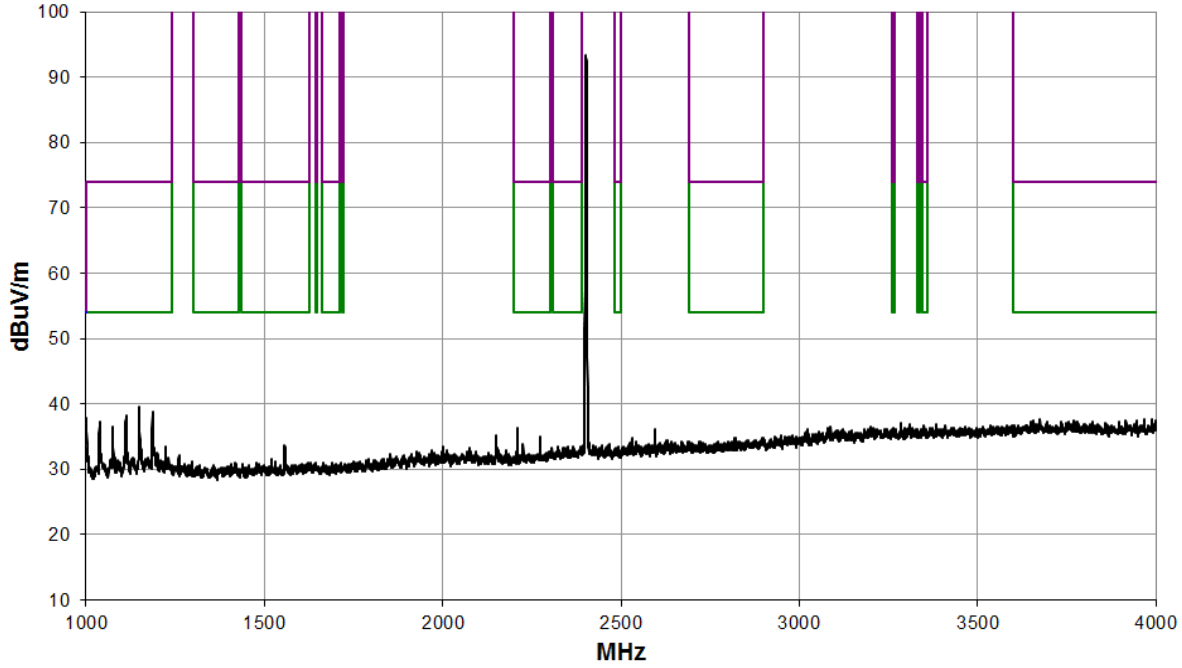
Note: An offset of 1.4 dB was applied to take into account the duty cycle correction.
Duty cycle correction = 20 x log (1 / D) = 20 x log (1 / 0.856)

Frequency: 2402 MHz; Power Setting: -4 dBm; Data Rate: 2 Mbps								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
No emissions were detected within 20 dB of the limit								

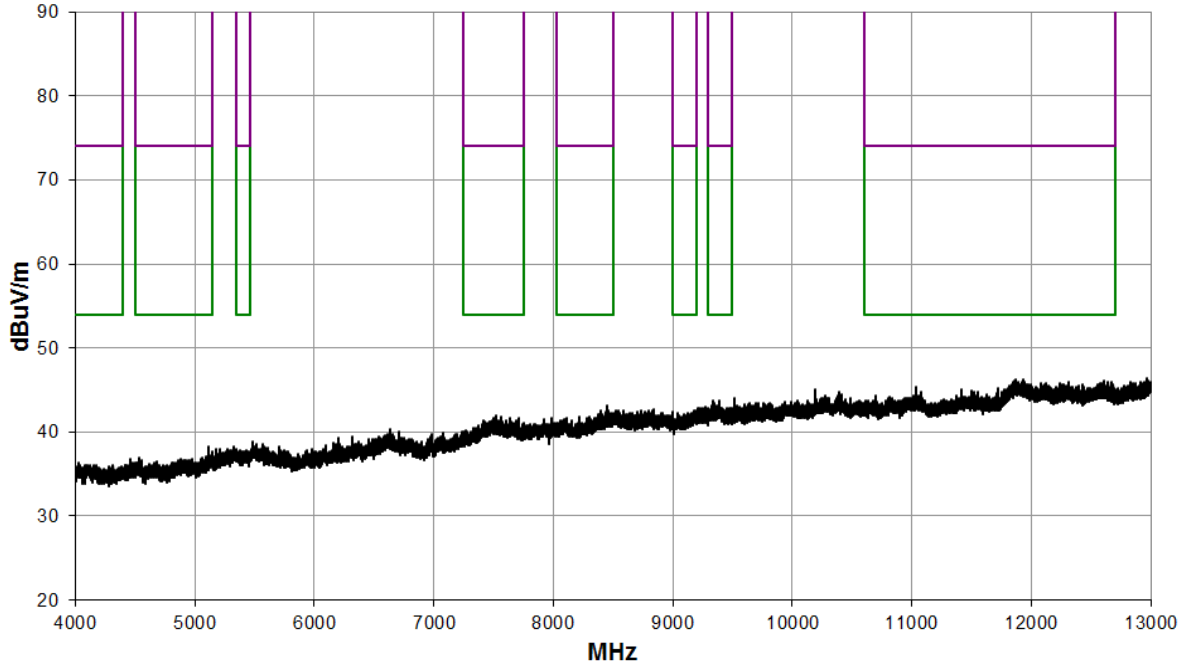
30 MHz – 1 GHz



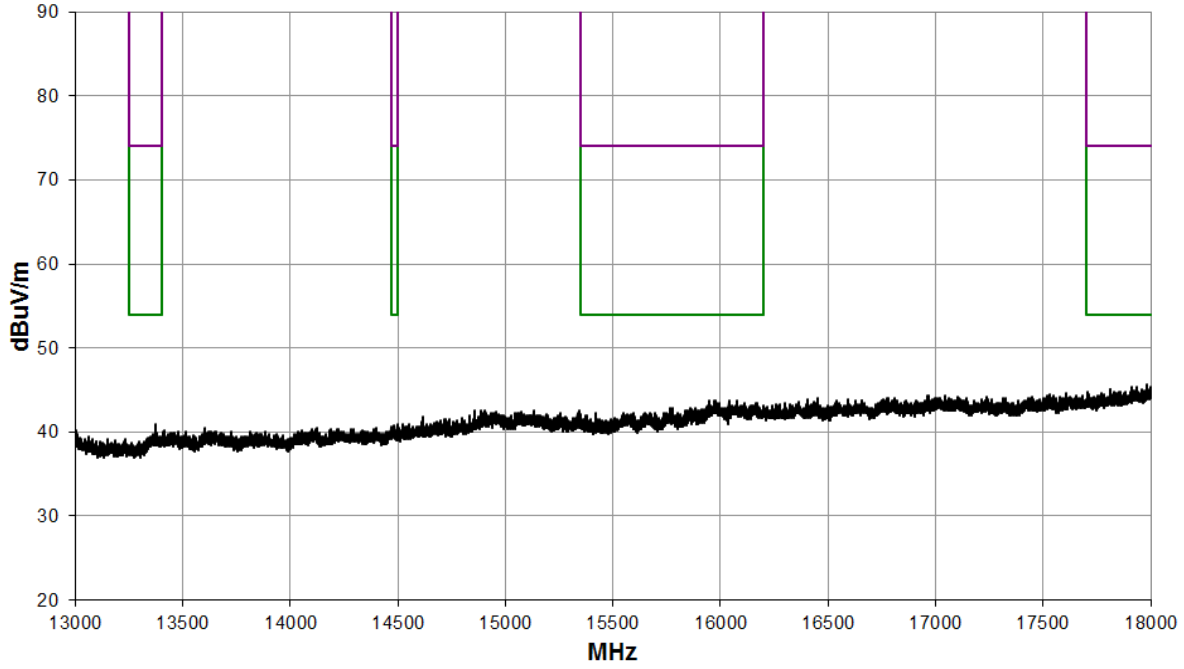
1 GHz – 4 GHz



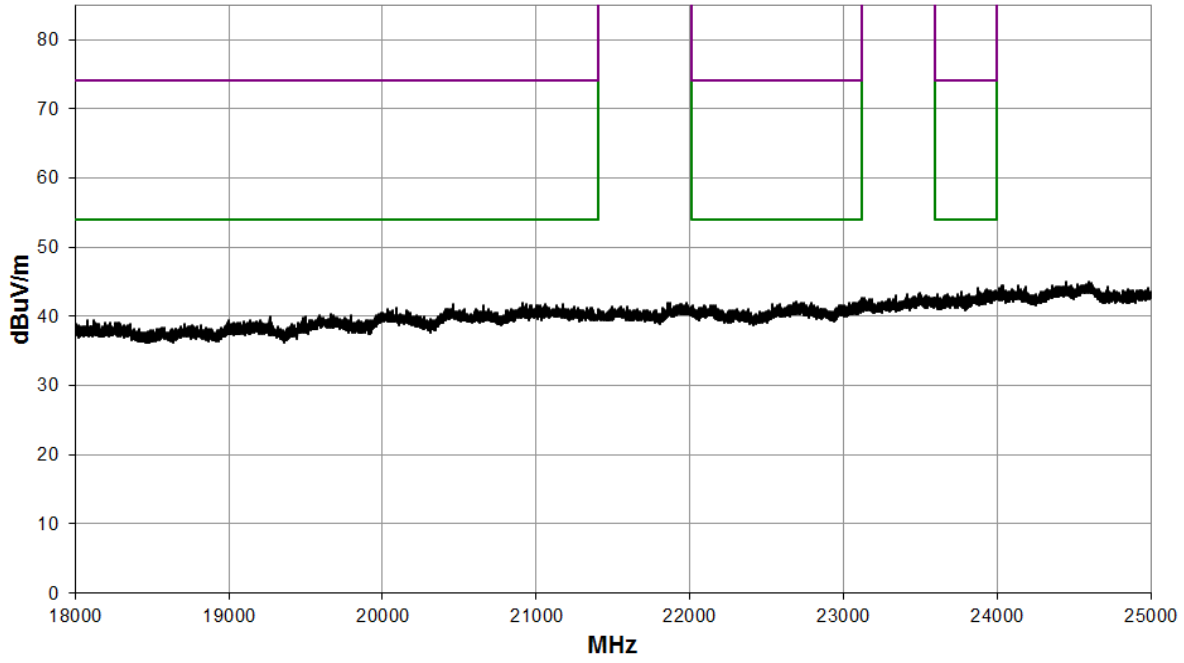
4 GHz – 13 GHz



13 GHz – 18 GHz

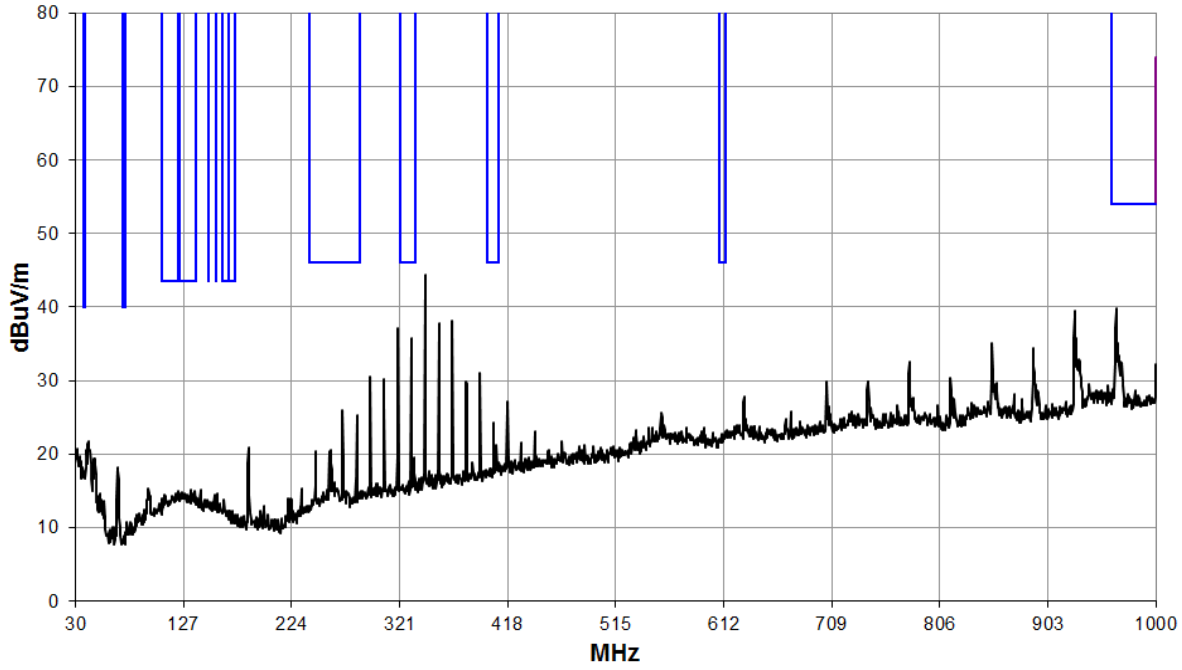


18 GHz – 25 GHz

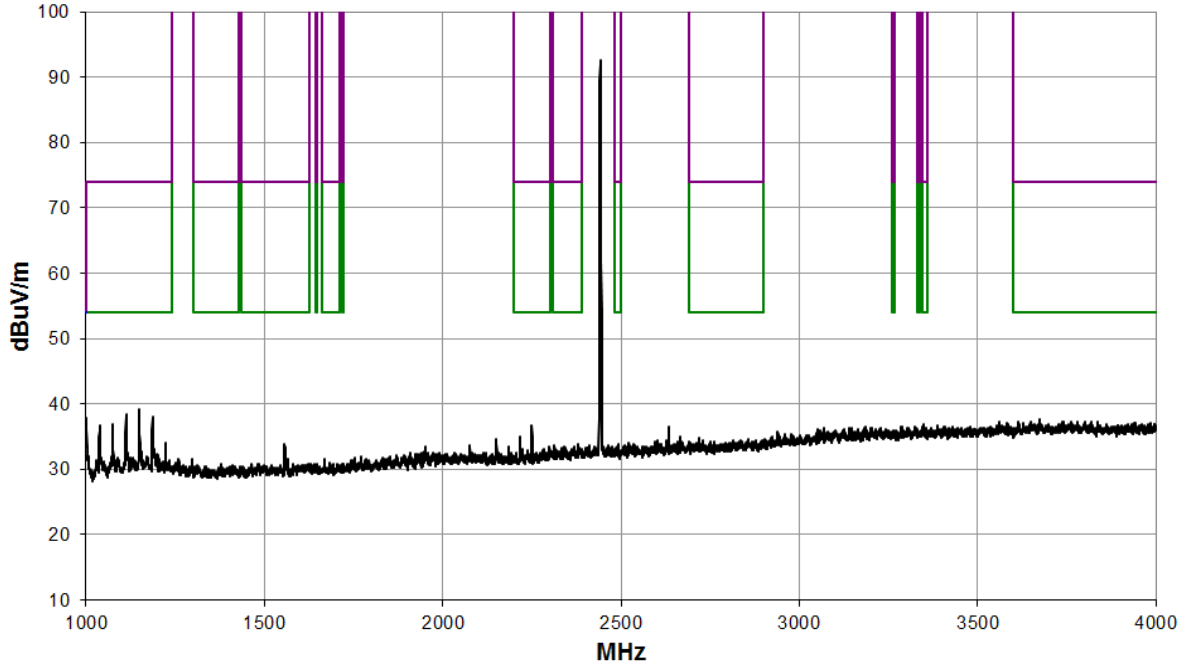


Frequency: 2442 MHz; Power Setting: -4 dBm; Data Rate: 2 Mbps								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
No emissions were detected within 20 dB of the limit								

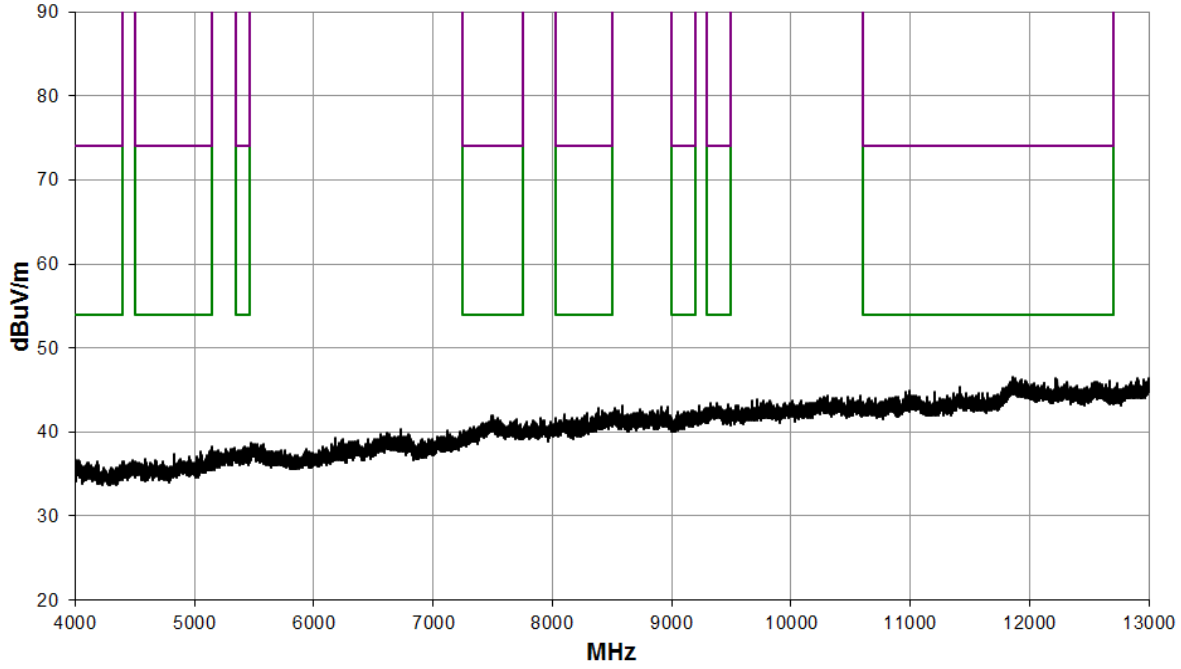
30 MHz – 1 GHz



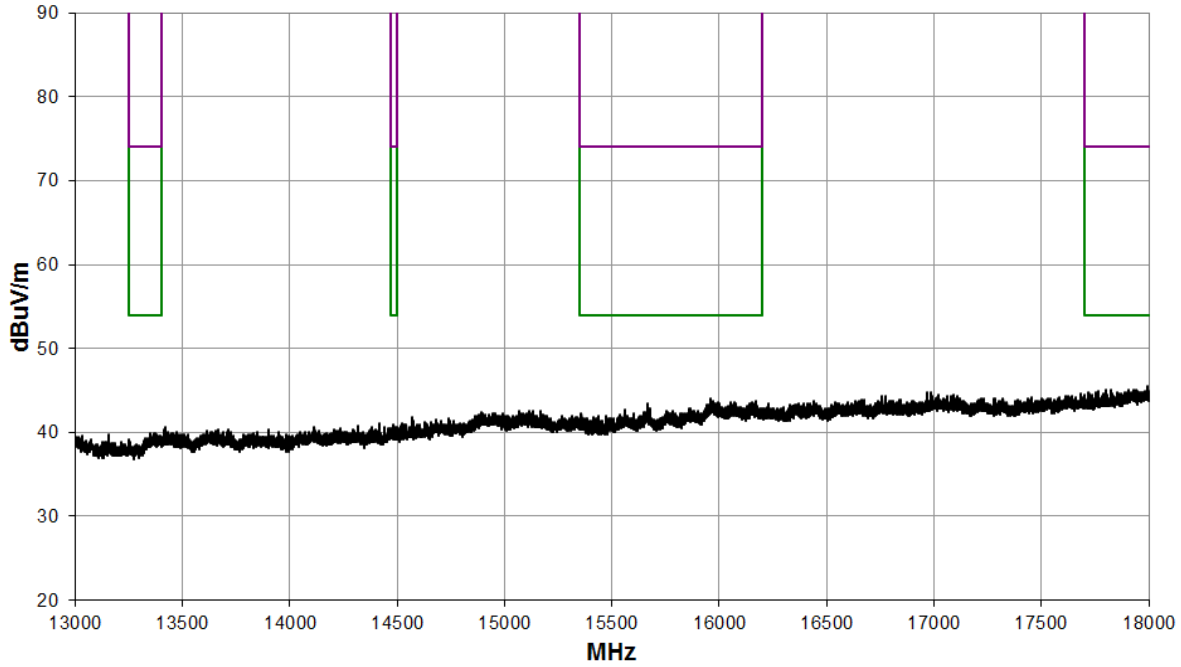
1 GHz – 4 GHz



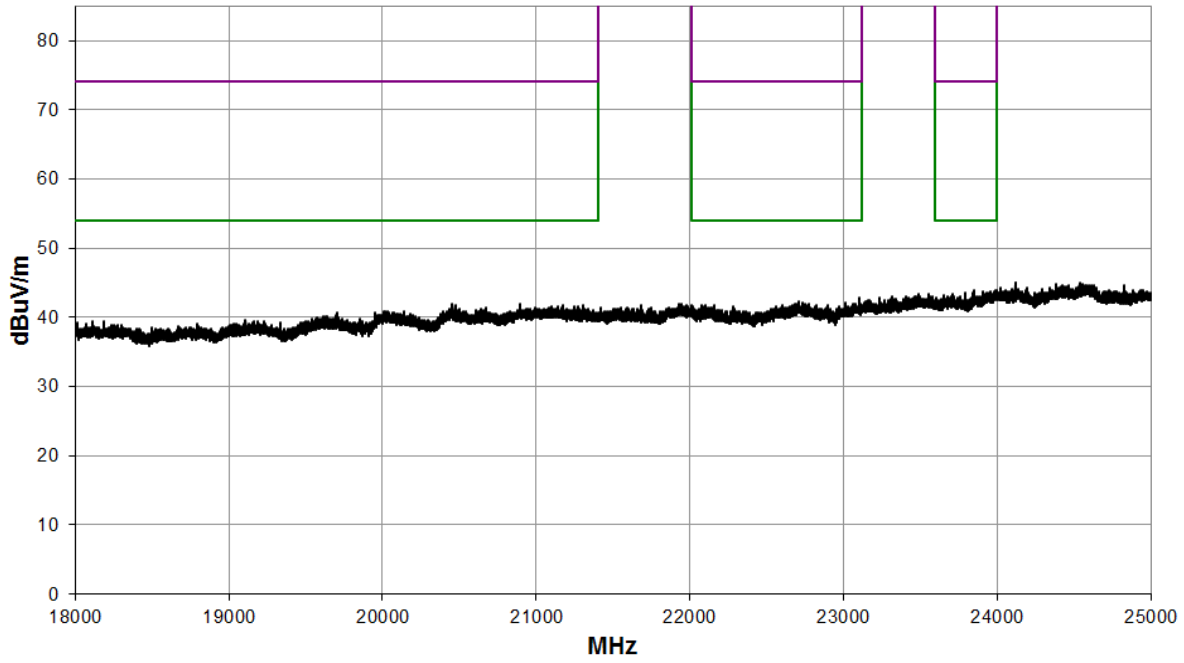
4 GHz – 13 GHz



13 GHz – 18 GHz

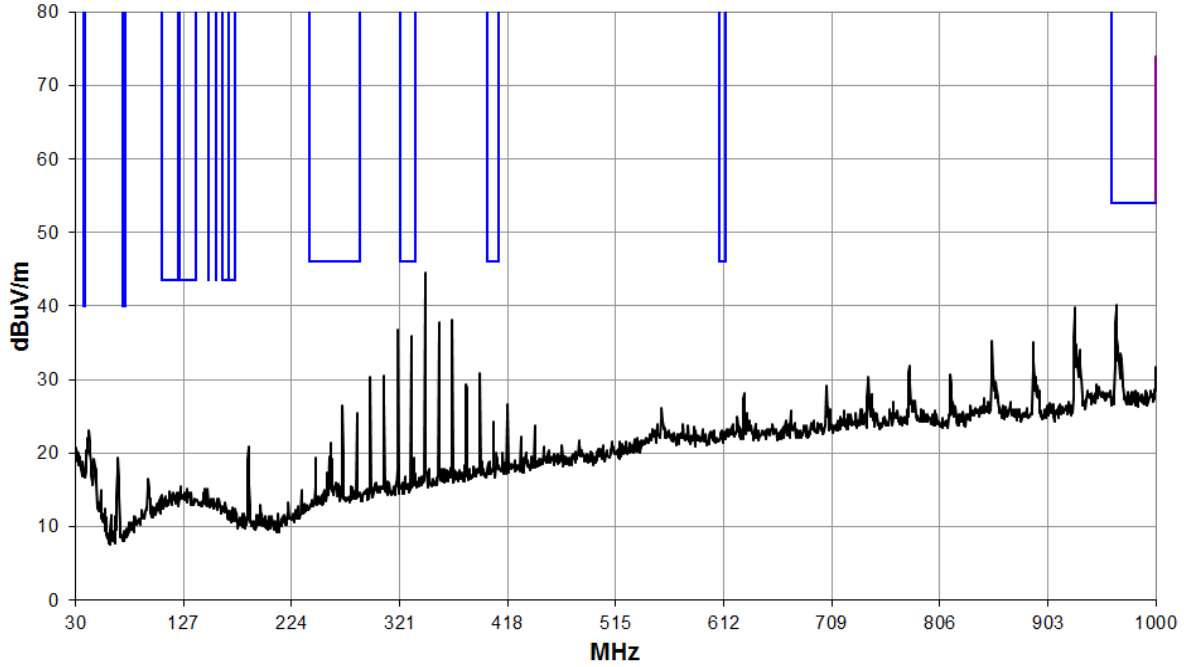


18 GHz – 25 GHz

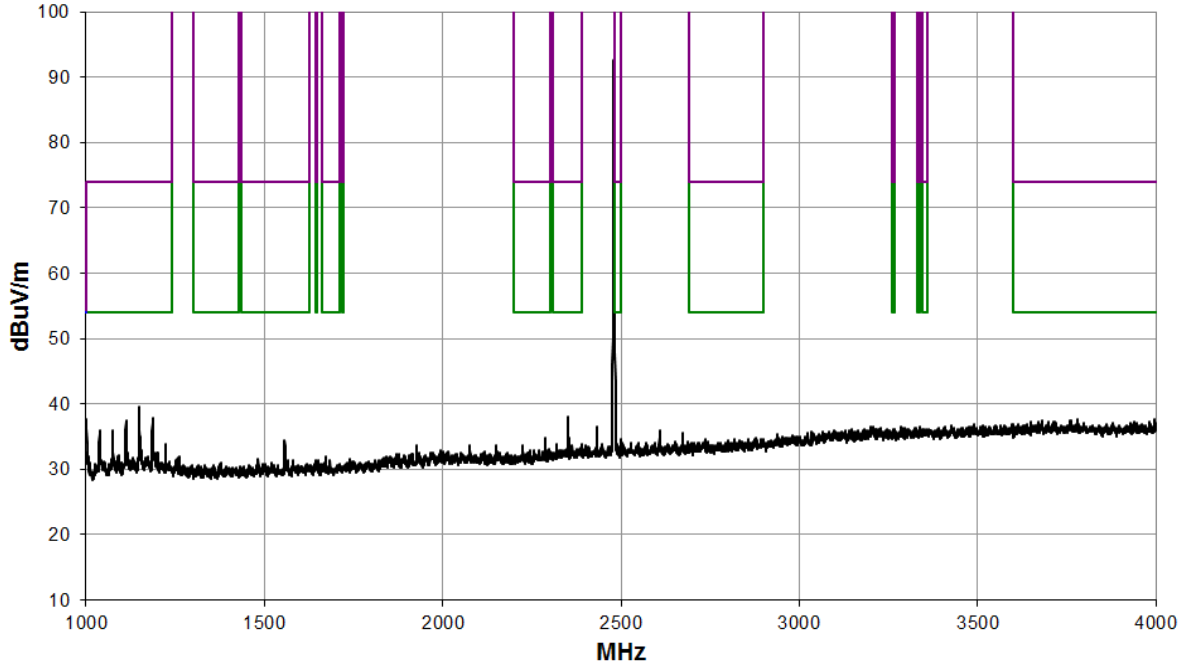


Frequency: 2480 MHz; Power Setting: -4 dBm; Data Rate: 2 Mbps								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
No emissions were detected within 20 dB of the limit								

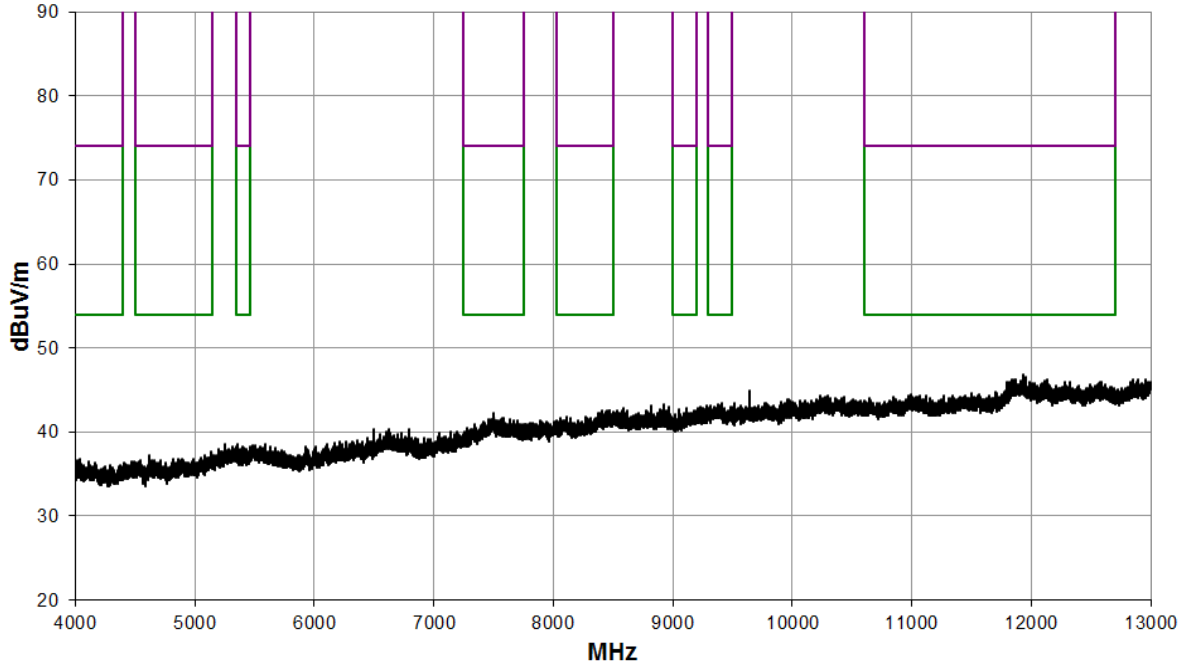
30 MHz – 1 GHz



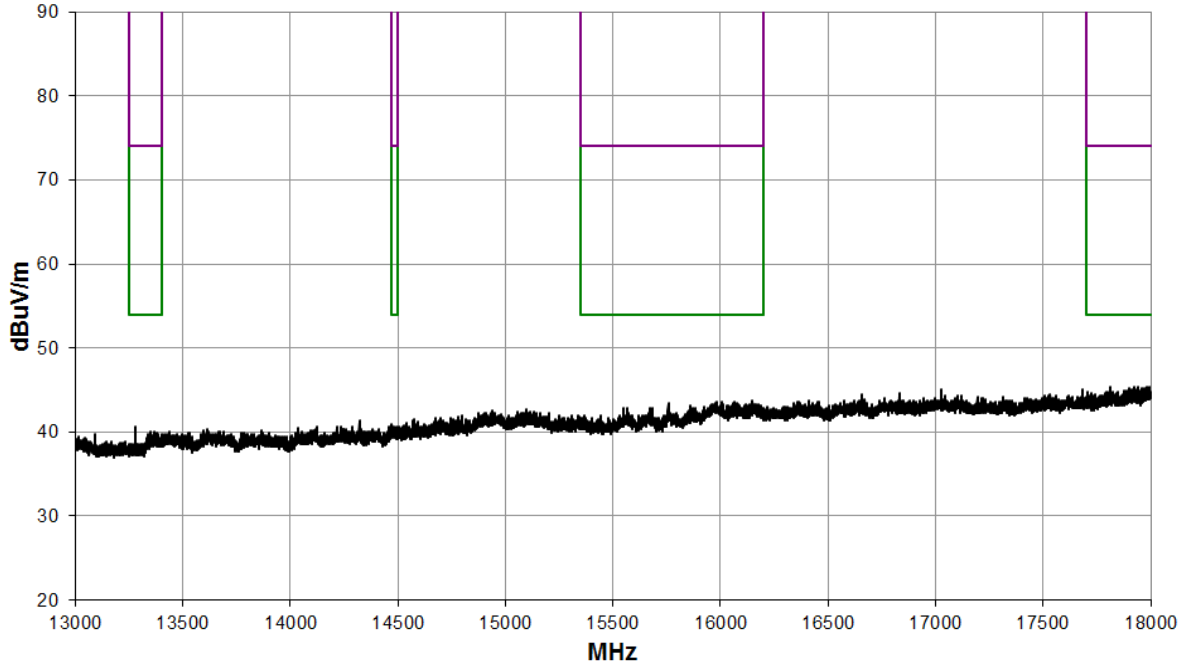
1 GHz – 4 GHz



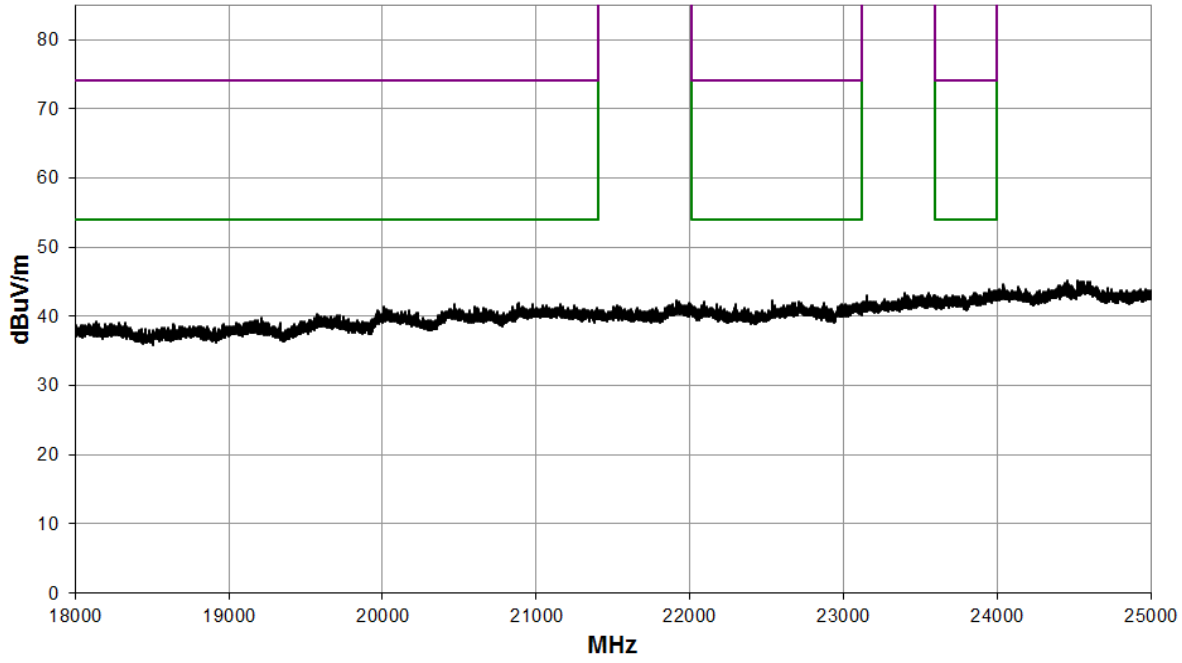
4 GHz – 13 GHz



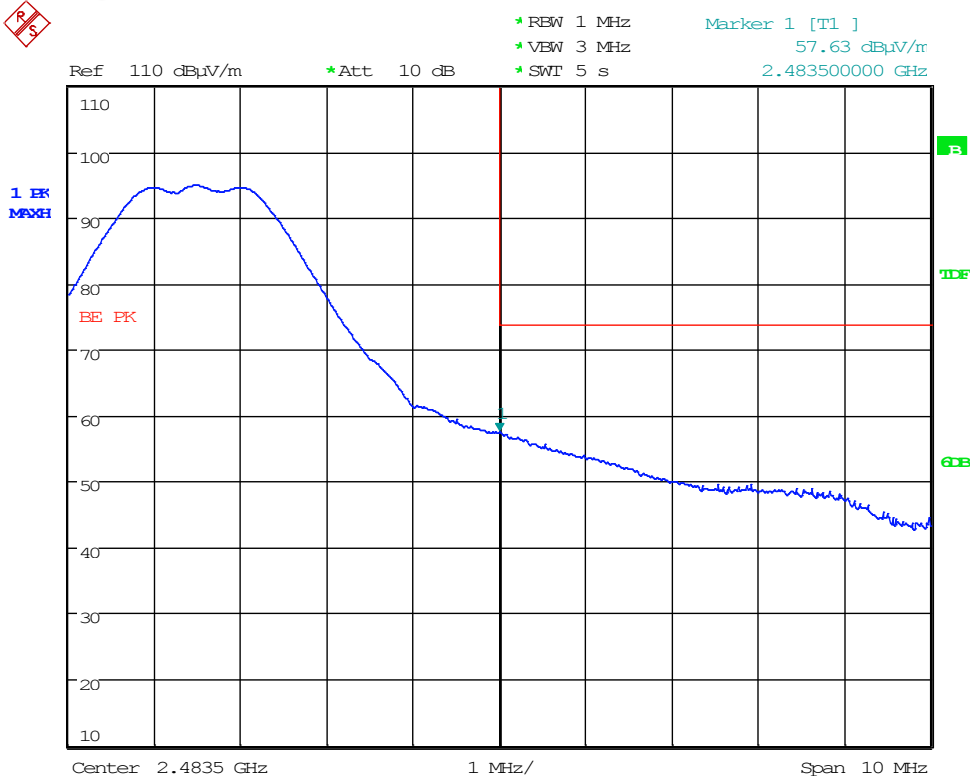
13 GHz – 18 GHz



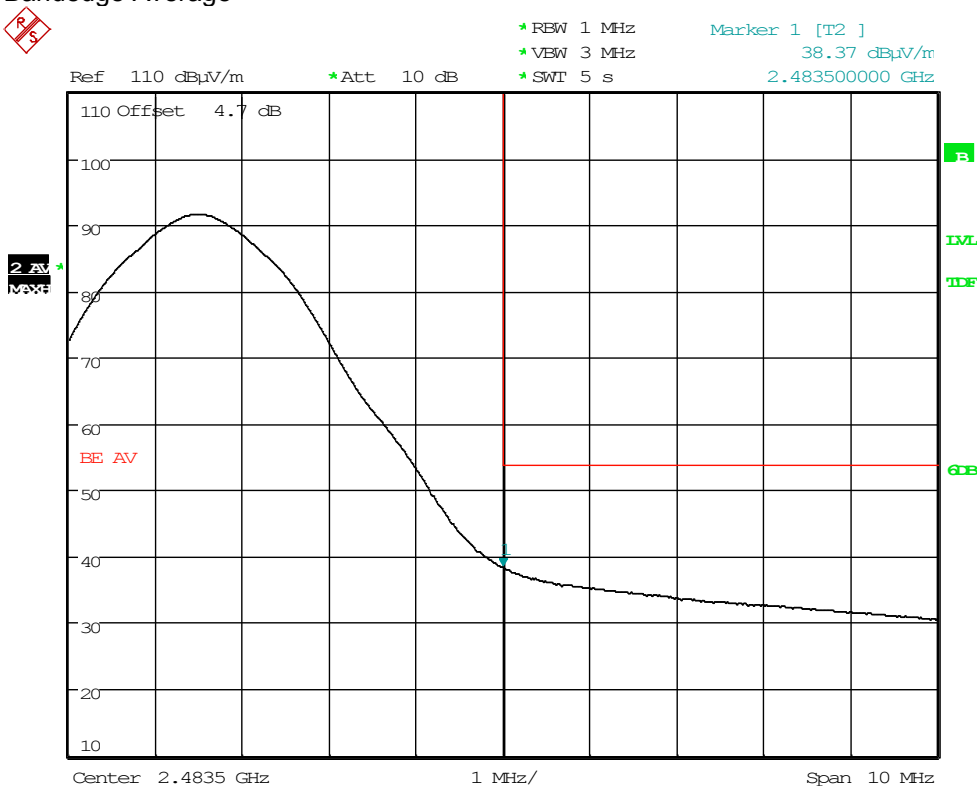
18 GHz – 25 GHz



Bandedge Peak



Bandedge Average



Note: An offset of 4.7 dB was applied to take into account the duty cycle correction.
Duty cycle correction = 20 x log (1 / Duty cycle) = 20 x log (1 / 0.583)

Emissions common in all modes								
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Factor (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Limit (dBµV/m)***	***Margin (dB)***
QP	331.8	46.6	-11.6	0.0	0.0	35.0	46.0	-11.0
QP	964.2	38.7	0.9	0.0	0.0	39.6	54.0	-14.4
AV	1000.9	43.9	-7.3	0.0	0.0	36.6	54.0	-17.4
AV	1149.3	44.7	-5.5	0.0	0.0	39.2	54.0	-14.8
AV	1186.3	41.9	-5.6	0.0	0.0	36.3	54.0	-17.7

12 AC power-line conducted emissions

12.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Screen Room 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
Frequency:	2442 MHz
Data Rate:	1 Mbps
Deviations From Standard:	None
Measurement Detectors:	Quasi-Peak and Average

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 ºC to +35 ºC (as declared)
Humidity: 43 % RH	20 % RH to 75 % RH (as declared)

12.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	***Conducted limit (dBµV)***	
	Quasi-Peak	***Average*** [**]
0.15 to 0.5	66 to 56[*]	56 to 46[*]
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.
**A linear average detector is required.

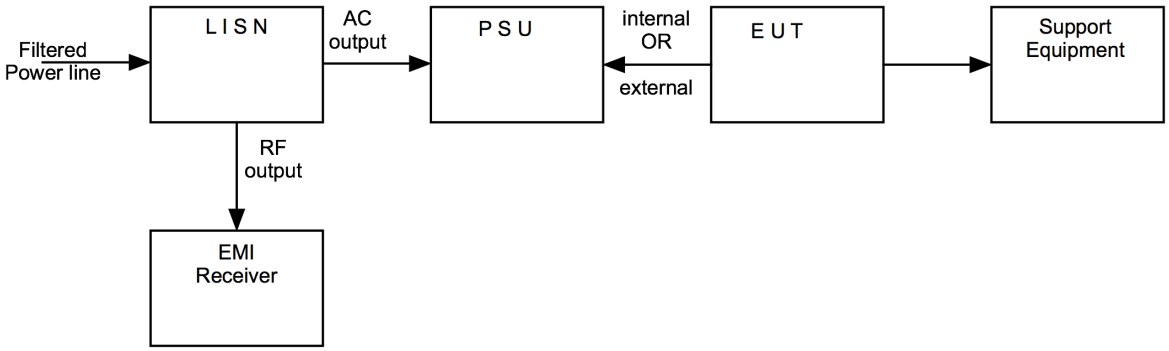
12.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure ii Test Setup



Test Set-up Photograph

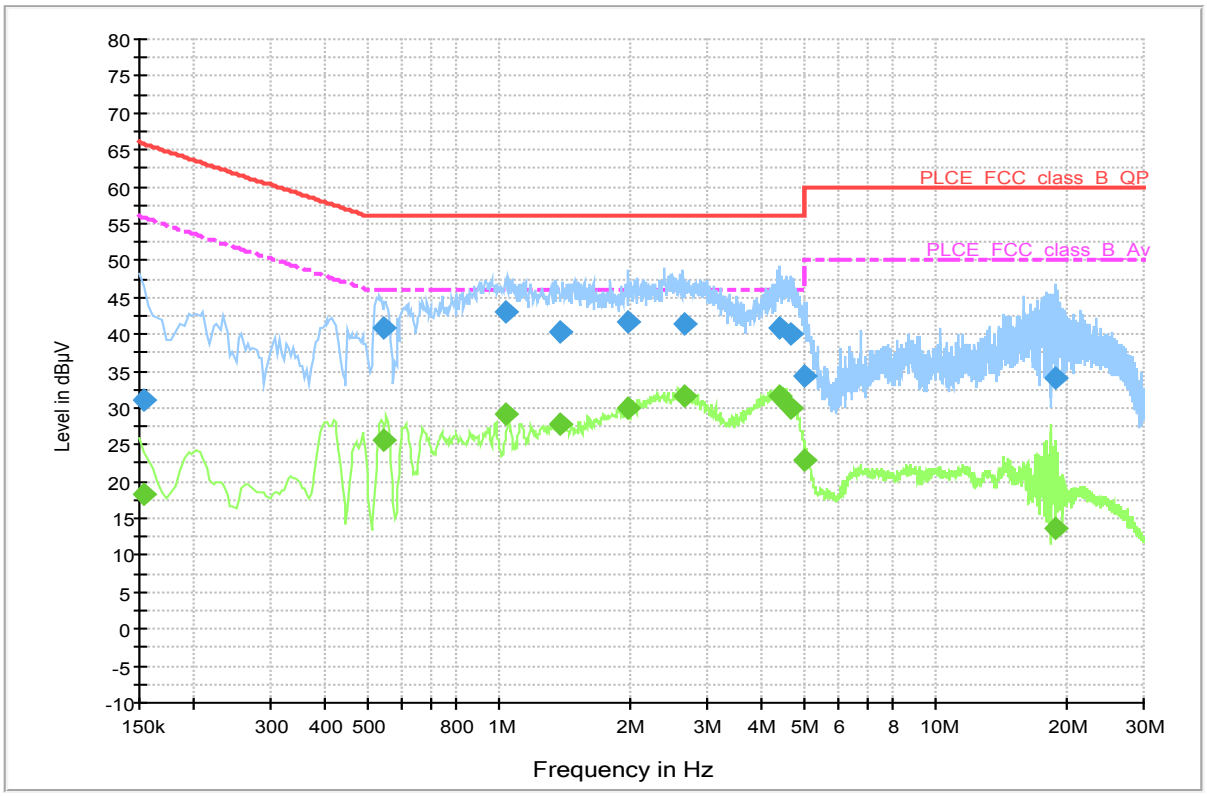
12.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
Measuring Receiver	R&S	ESHS10	RFG125	2021-04-06
Pulse Limiter	R&S	ESH3-Z2	RFG680	2021-06-09
LISN	R&S	ESH3-Z5	RFG732	2021-05-18

12.6 Test Results

Results measured using the quasi-peak detector						
Reference Number	***Frequency (MHz)***	***Conductor***	***Result (dBuV)***	***Limit (dBuV)***	***Margin (dB)***	***Result Summary***
1	0.154	L1	31.1	65.8	34.7	PASS
2	0.543	L1	40.9	56.0	15.1	PASS
3	1.041	L1	43.1	56.0	12.9	PASS
4	1.379	L1	40.4	56.0	15.6	PASS
5	1.973	N	41.7	56.0	14.3	PASS
6	2.657	N	41.5	56.0	14.5	PASS
7	4.405	L1	40.9	56.0	15.1	PASS
8	4.657	L1	40.0	56.0	16.0	PASS
9	4.985	L1	34.2	56.0	21.8	PASS
10	18.881	L1	34.0	60.0	26.0	PASS

Results measured using the average detector						
Reference Number	***Frequency (MHz)***	***Conductor***	***Result (dBuV)***	***Limit (dBuV)***	***Margin (dB)***	***Result Summary***
1	0.154	L1	18.1	55.8	37.7	PASS
2	0.543	L1	25.6	46.0	20.4	PASS
3	1.041	L1	29.2	46.0	16.8	PASS
4	1.379	L1	27.8	46.0	18.2	PASS
5	1.973	N	29.9	46.0	16.1	PASS
6	2.657	N	31.5	46.0	14.5	PASS
7	4.405	L1	31.6	46.0	14.4	PASS
8	4.657	L1	29.9	46.0	16.1	PASS
9	4.985	L1	22.8	46.0	23.2	PASS
10	18.881	L1	13.5	50.0	36.5	PASS


80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
Level in dBµV
PLCE_FCC_class_B_QP
PLCE_FCC_class_B_Av
150k
300
400
500
800
1M
2M
3M
4M
5M
6
8
10M
20M
30M
Frequency in Hz

13 Occupied Bandwidth

13.1 Definition

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 2
Test Standard and Clauses:	6 dB Bandwidth: ANSI C63.10-2013, Clause 11.8 99% Bandwidth: ANSI C63.10-2013, Clause 6.9
Deviations From Standard:	None
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 29 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

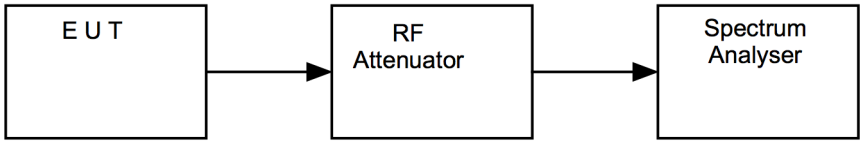
The minimum -6 dB bandwidth shall be at least 500 kHz.

13.4 Test Method

With the EUT connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iii Test Setup

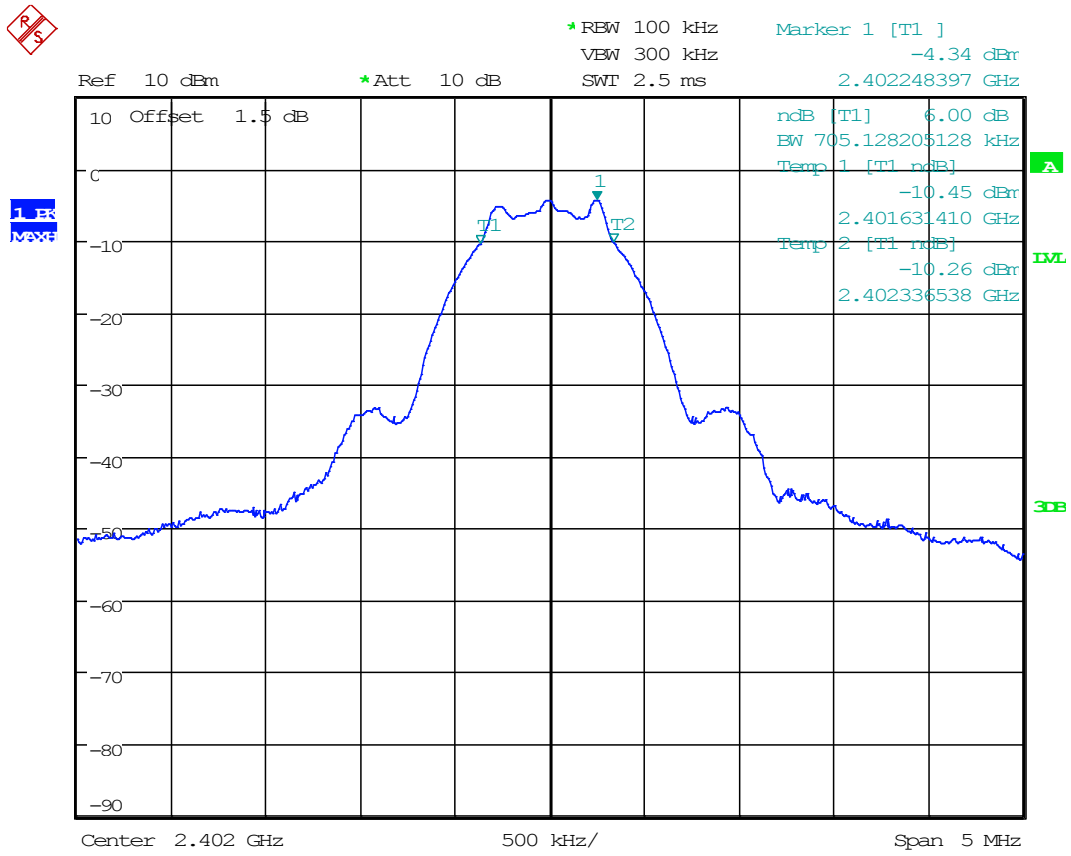


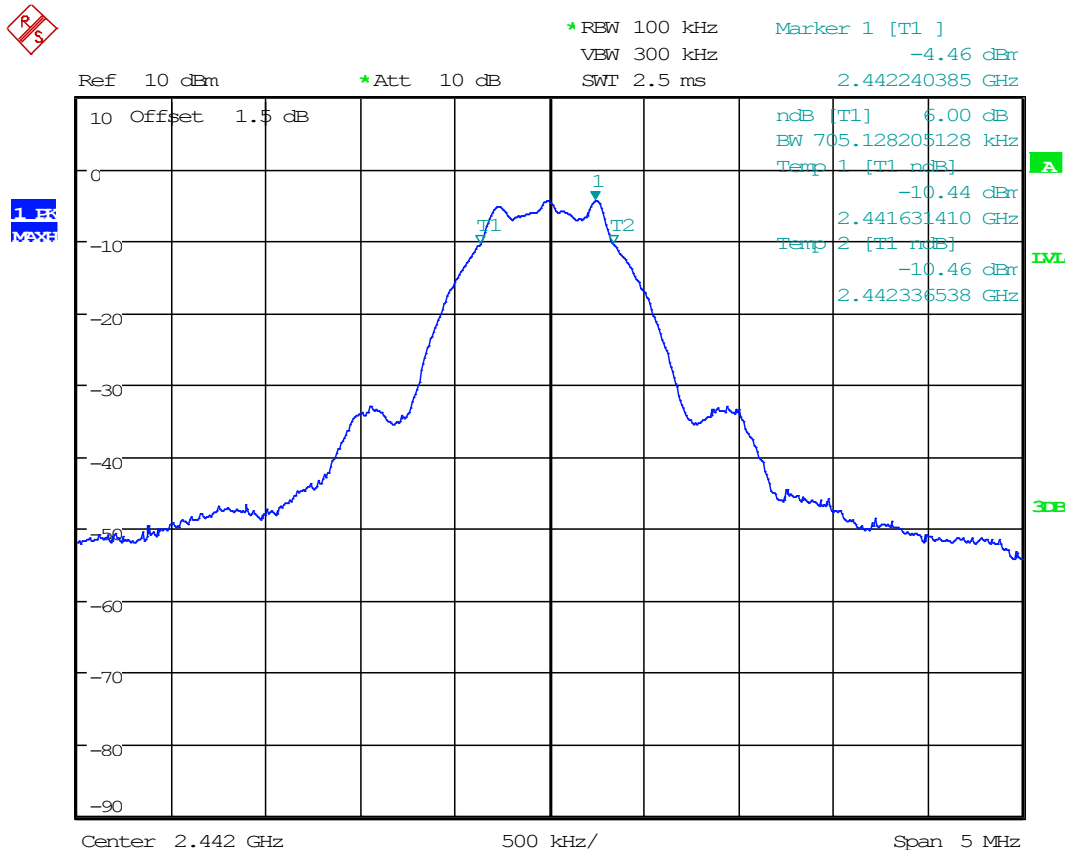
13.5 Test Equipment

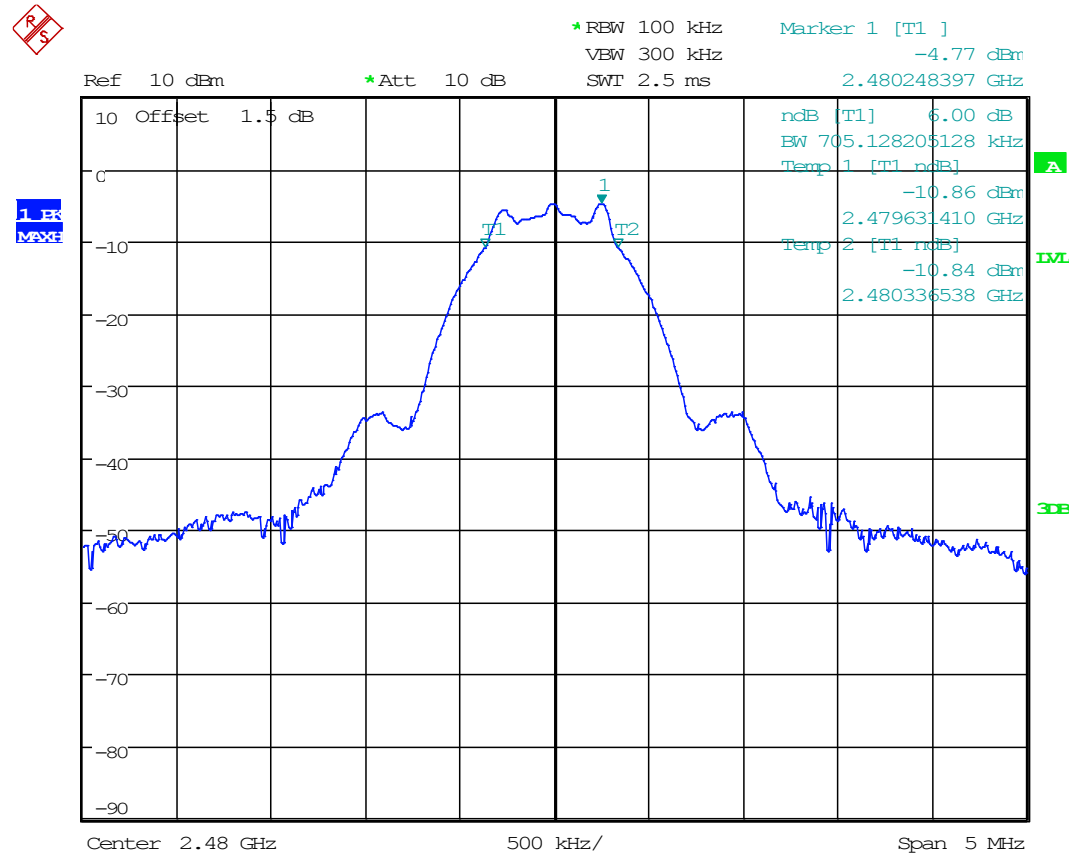
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU50	U544	2021-06-17

13.6 Test Results

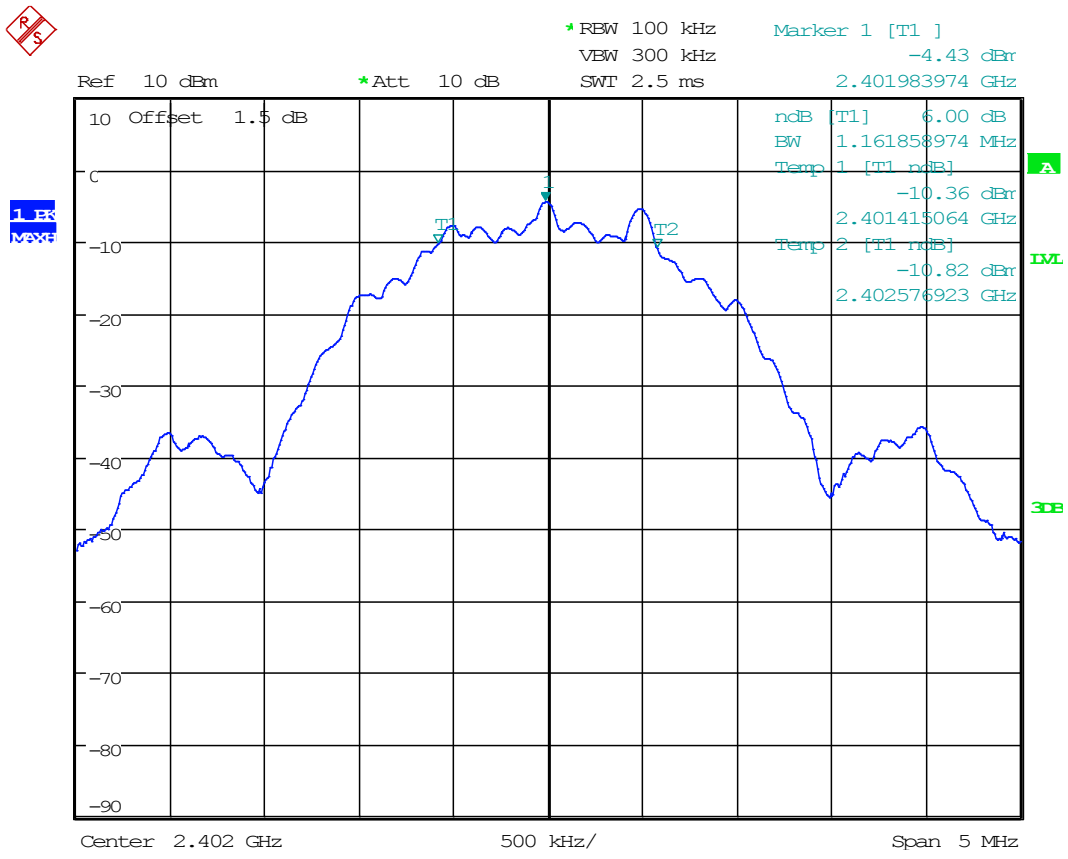
6 dB Bandwidth; Data Rate: 1 Mbps				
Frequency (MHz)	**F_L (MHz)**	**F_H (MHz)**	**Bandwidth (kHz)**	**Result**
2402	2401.631410	2402.336538	705.128	PASS
2442	2441.631410	2442.336538	705.128	PASS
2480	2479.631410	2480.336538	705.128	PASS

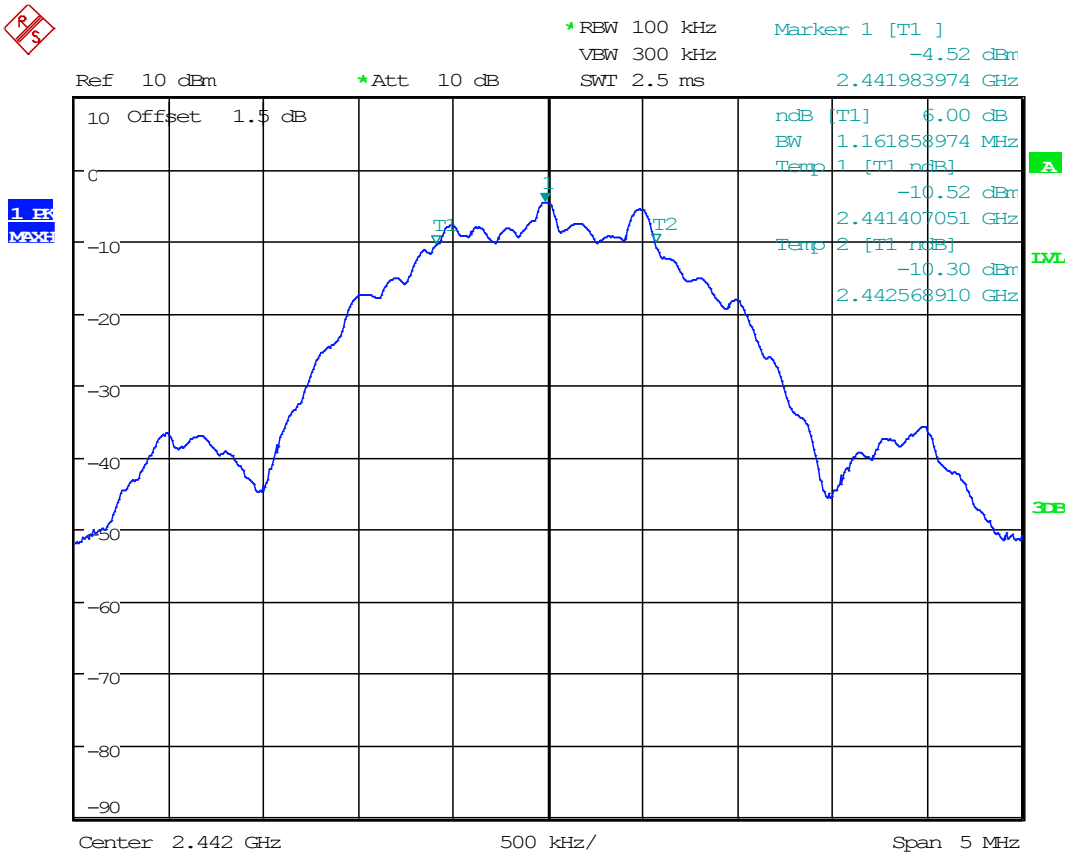


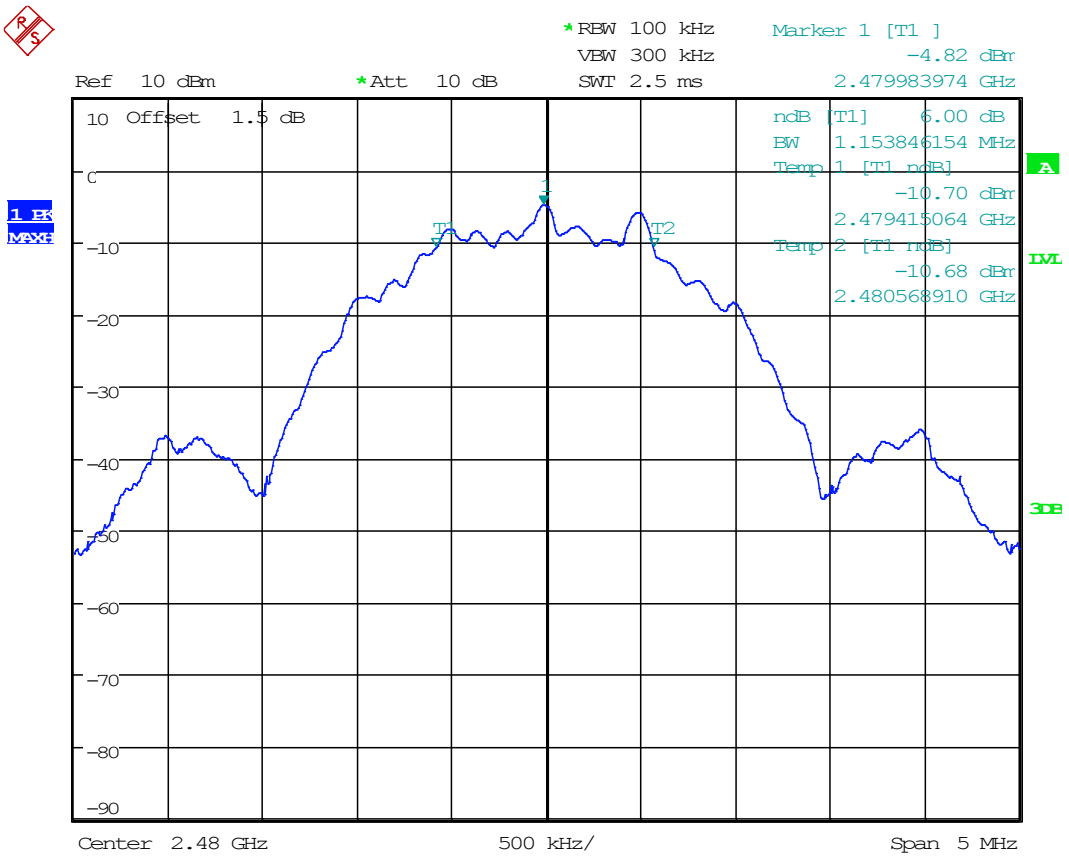

RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.46 dBm
2.442240385 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
ndB [T1] 6.00 dB
BW 705.128205128 kHz
Temp 1 [T1 ndB]
-10.44 dBm
2.441631410 GHz
Temp 2 [T1 ndB]
-10.46 dBm
2.442336538 GHz
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
T1
T2
1
Center 2.442 GHz
500 kHz/
Span 5 MHz


RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.77 dBm
2.480248397 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
ndB [T1] 6.00 dB
BW 705.128205128 kHz
Temp 1 [T1 ndB]
-10.86 dBm
2.479631410 GHz
Temp 2 [T1 ndB]
-10.84 dBm
2.480336538 GHz
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
T1
T2
1
Center 2.48 GHz
500 kHz/
Span 5 MHz

6 dB Bandwidth; Data Rate: 2 Mbps				
Frequency (MHz)	**F_L (MHz)**	**F_H (MHz)**	**Bandwidth (kHz)**	**Result**
2402	2401.415064	2402.576923	1161.859	PASS
2442	2441.407051	2442.568910	1161.859	PASS
2480	2479.415064	2480.568910	1153.846	PASS




RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.52 dBm
2.441983974 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
ndB [T1] 6.00 dB
BW 1.161858974 MHz
Temp 1 [T1 ndB]
-10.52 dBm
2.441407051 GHz
Temp 2 [T1 ndB]
-10.30 dBm
2.442568910 GHz
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
T1
T2
1 PK
MAXH
A
LVL
3DB
Center 2.442 GHz
500 kHz/
Span 5 MHz


RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.82 dBm
2.479983974 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
ndB [T1] 6.00 dB
BW 1.153846154 MHz
Temp 1 [T1 ndB]
-10.70 dBm
2.479415064 GHz
Temp 2 [T1 ndB]
-10.68 dBm
2.480568910 GHz
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
T1
T2
1 PK
MAXH
A
LVL
3DB
Center 2.48 GHz
500 kHz/
Span 5 MHz

14 Maximum peak conducted output power & Effective isotropic radiated power

14.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

The effective isotropic radiated power (EIRP) is defined as the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna.

14.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
Deviations From Standard:	None
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Radiated	**Conducted**	
Temperature: 22 °C	Temperature: 24 °C	Standard Requirement: +15 ºC to +35 ºC
Humidity: 28 %RH	Humidity: 29 %RH	Standard Requirement: 20%RH to 75%RH

14.3 Test Limit

For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W. The EIRP shall not exceed 4 W.

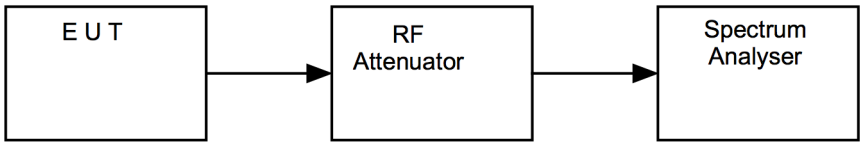
14.4 Test Method

Conducted measurement

With the EUT connected as per Figure xi-a, the power of the EUT was measured at the antenna port.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure xi-a Test Setup



Radiated measurement

With the EUT connected as per Figure xi-b, the EUT fundamental frequency was maximised by rotating the EUT through 360º, in three orthogonal planes, and adjusting the measurement antenna height through 1-4 m.

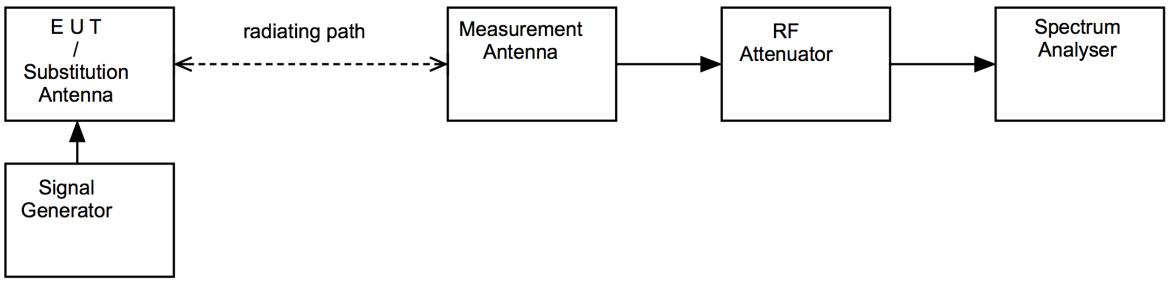
The following formula was used to convert field strength (FS) in volts/metre to EIRP in watt:

$$TP = (FS \times D)^2 / 30$$

Where, D is the distance in metres between the two antennas.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure xi-b Test Setup

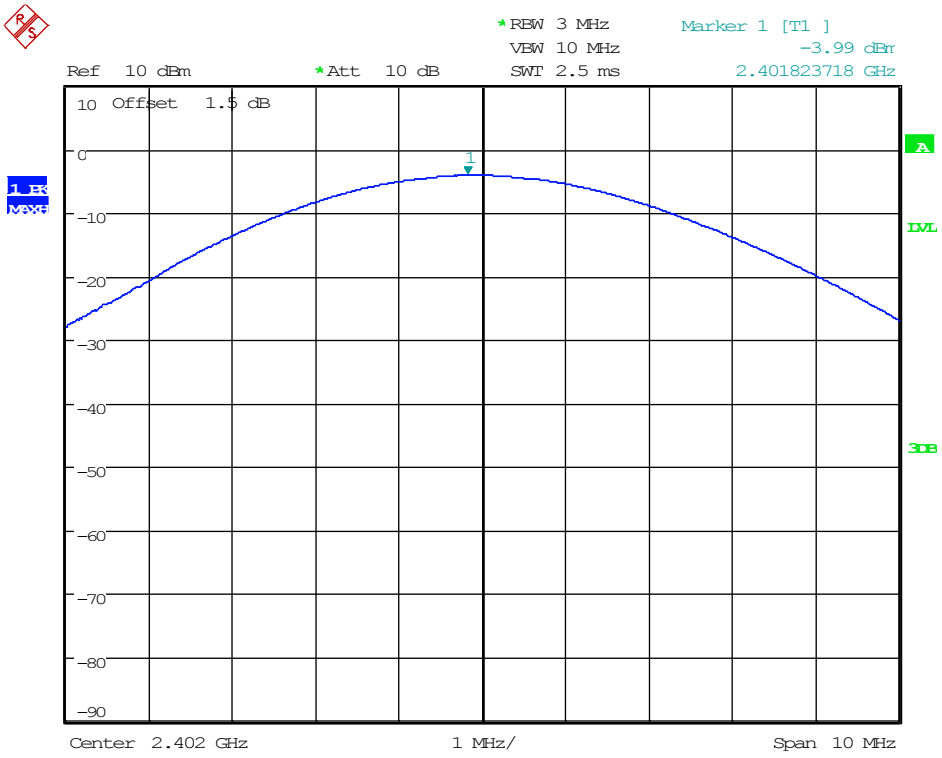


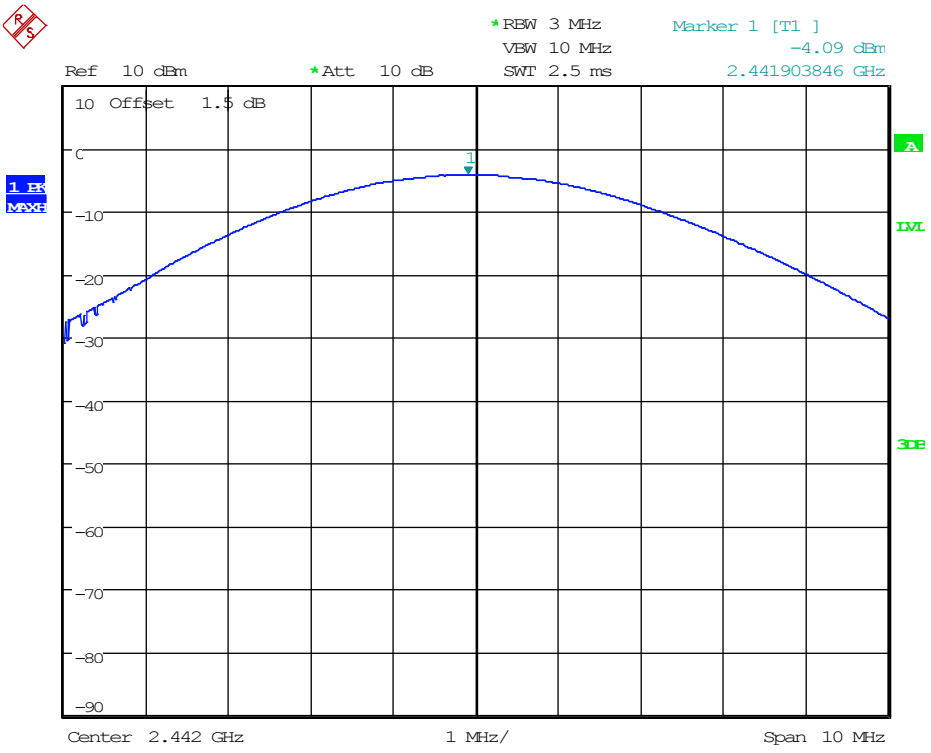
14.5 Test Equipment

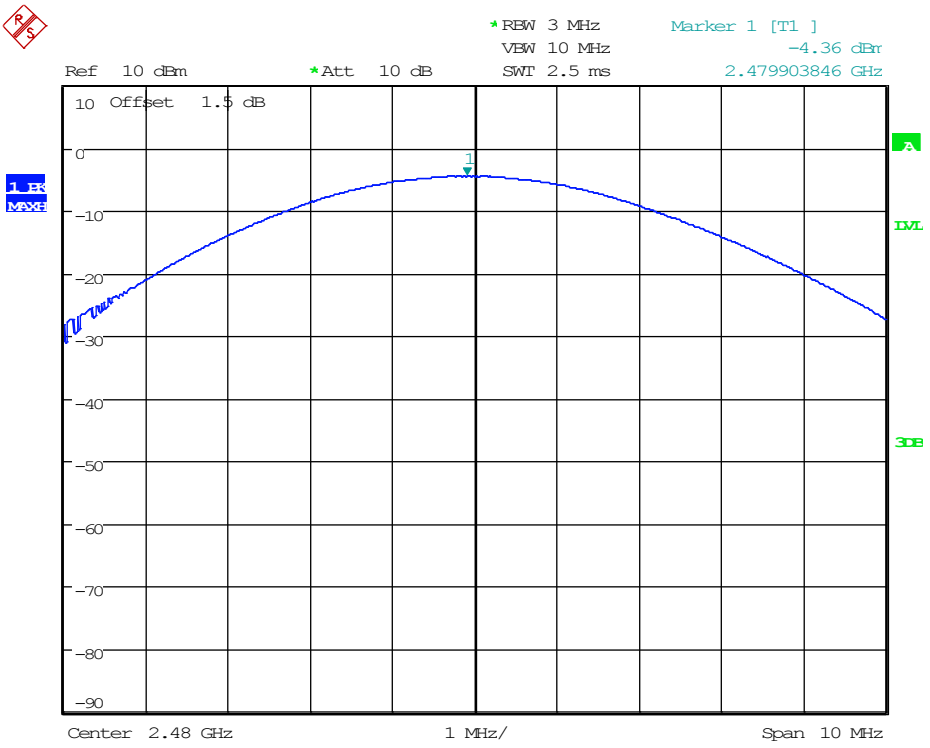
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
Ferrite Lined Chamber	Rainford	ATS	REF886	2022-07-29
Spectrum Analyser	R&S	FSU50	U544	2021-06-17
Pre-Amp (1 - 26.5 GHz)	Agilent	8449B	REF913	2022-02-04
Horn Antenna	EMCO	3115	RFG129	2022-02-14
Radiated Test Software	Element	Emissions R5	REF9000	Cal not required

14.6 Test Results

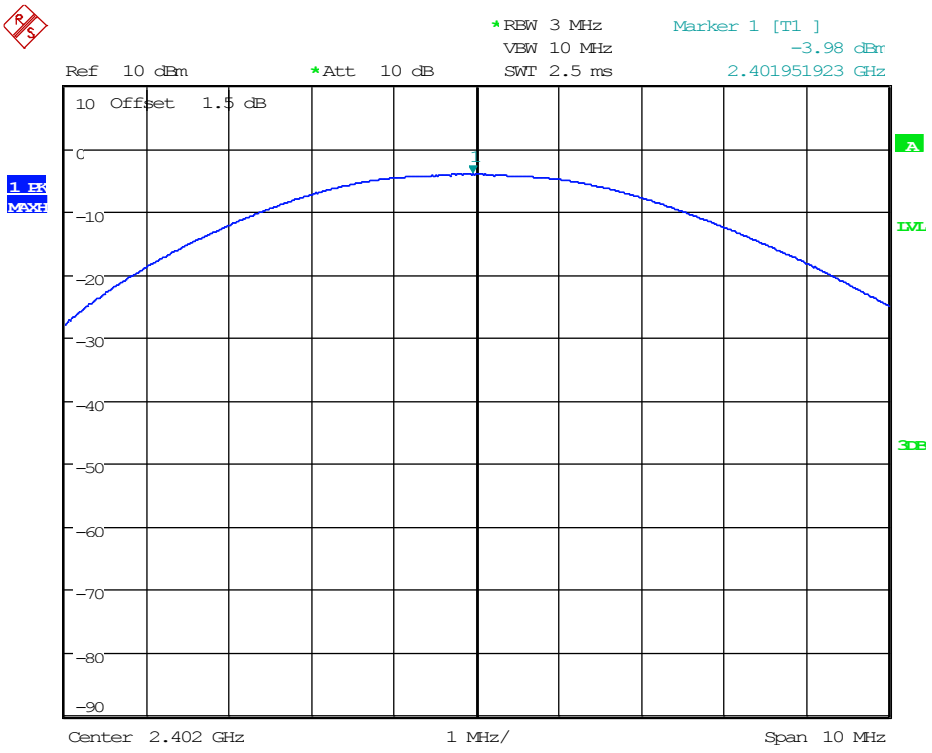
Maximum Peak Conducted Output Power; Data Rate: 1 Mbps			
Frequency (MHz)	***Maximum peak conducted output power (dBm)***	***Maximum peak conducted output power (W)***	***Result***
2402	-3.99	0.00040	PASS
2442	-4.09	0.00039	PASS
2480	-4.36	0.00037	PASS

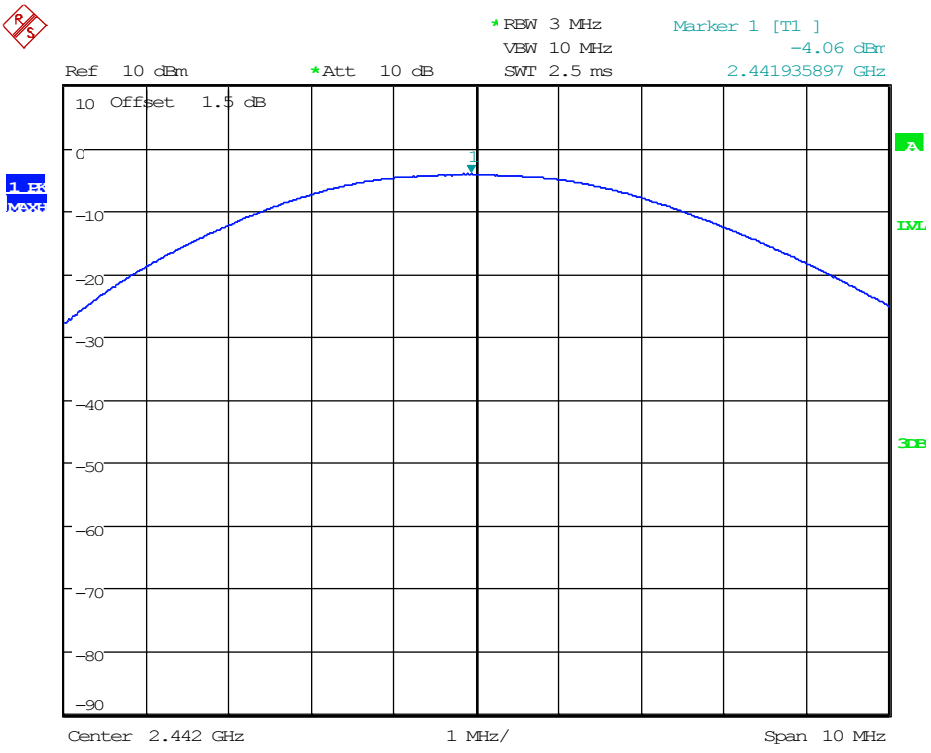


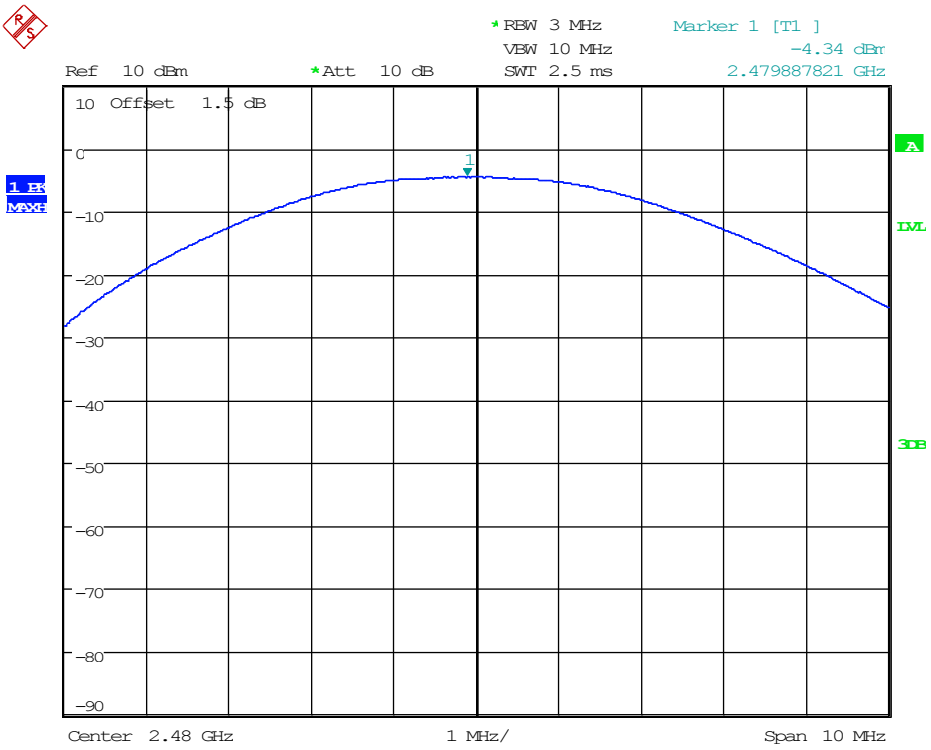

RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
-4.09 dBm
2.441903846 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.442 GHz
1 MHz/
Span 10 MHz


RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
-4.36 dBm
2.479903846 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.48 GHz
1 MHz/
Span 10 MHz

Maximum Peak Conducted Output Power; Data Rate: 2 Mbps			
Frequency (MHz)	***Maximum peak conducted output power (dBm)***	***Maximum peak conducted output power (W)***	***Result***
2402	-3.98	0.00040	PASS
2442	-4.06	0.00039	PASS
2480	-4.34	0.00037	PASS




RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
-4.06 dBm
2.441935897 GHz
Ref 10 dBm
Att 10 dB
Offset 1.5 dB
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
MAXH
A
VIEW
3DB
Center 2.442 GHz
1 MHz/
Span 10 MHz


RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
-4.34 dBm
2.479887821 GHz
Ref 10 dBm
Att 10 dB
Offset 1.5 dB
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
MAXH
A
VIEW
3DB
Center 2.48 GHz
1 MHz/
Span 10 MHz

EIRP; Data Rate: 1 Mbps; Power Setting: -4 dBm					
Frequency (MHz)	***Peak Field Strength (dBµV/m)***	***Peak Field Strength (V/m)***	***Distance (m)***	***EIRP (W)***	***Result***
2402	94.9	0.0556	3	0.00093	PASS
2442	94.3	0.0519	3	0.00081	PASS
2480	94.1	0.0507	3	0.00077	PASS

EIRP; Data Rate: 2 Mbps; Power Setting: -4 dBm					
Frequency (MHz)	***Peak Field Strength (dBµV/m)***	***Peak Field Strength (V/m)***	***Distance (m)***	***EIRP (W)***	***Result***
2402	94.9	0.0556	3	0.00093	PASS
2442	94.3	0.0519	3	0.00081	PASS
2480	94.1	0.0507	3	0.00077	PASS

15 Out-of-band and conducted spurious emissions

15.1 Definition

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

Spurious emission.
Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude out-of-band emissions.

15.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
Deviations From Standard:	None
Measurement Bandwidth:	100 kHz
Video Bandwidth:	300 kHz
Measurement Detector:	Peak
Measurement Range:	9 kHz to 25 GHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 30 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

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, the attenuation required shall be 30 dB instead of 20 dB.

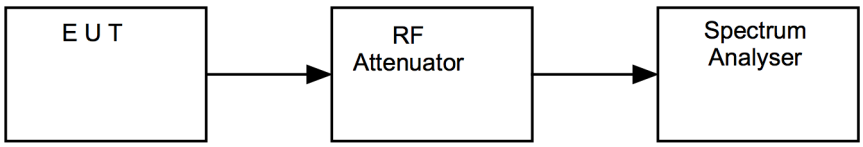
Attenuation below the general field strength limits specified in FCC 47CFR15.209(a) / RSS-Gen is not required.

15.4 Test Method

With the EUT connected as per Figure v, the emissions from the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

Figure v Test Setup

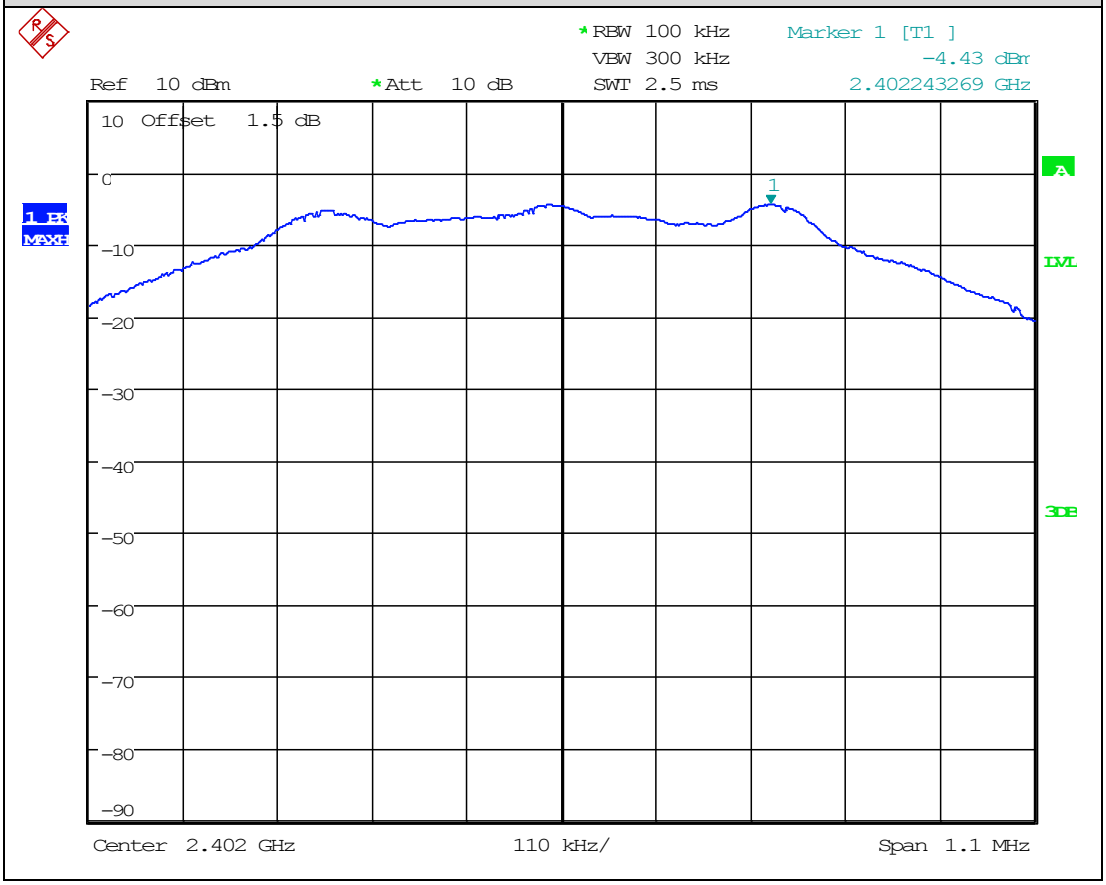


15.5 Test Equipment

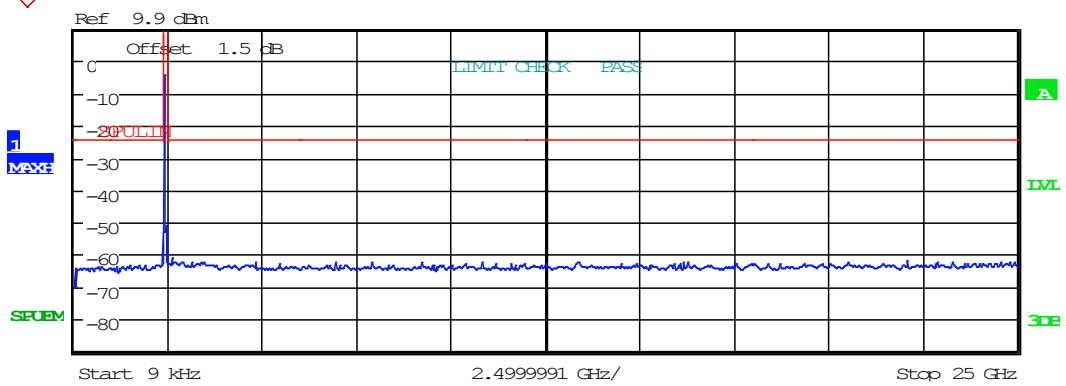
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU50	U544	2021-06-17

15.6 Test Results

Reference Level; Data Rate: 1 Mbps

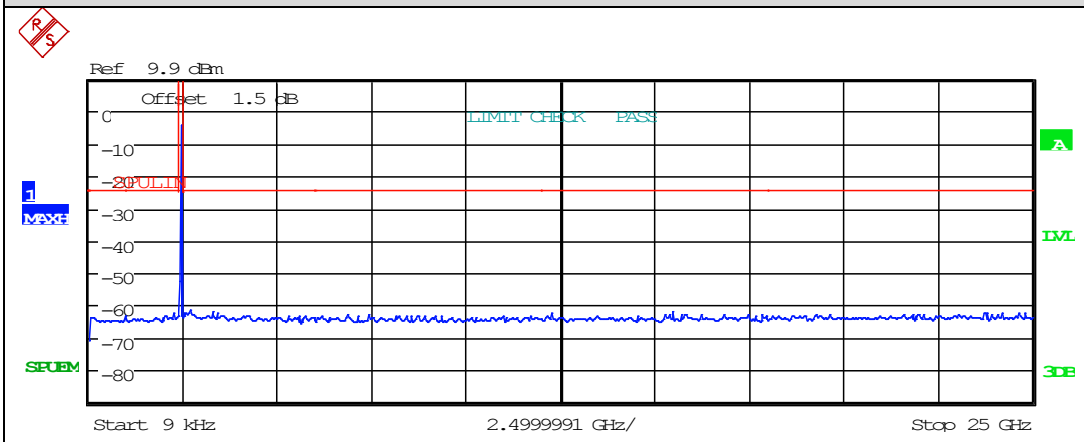


2402 MHz Out of Band Emissions; Data Rate: 1 Mbps



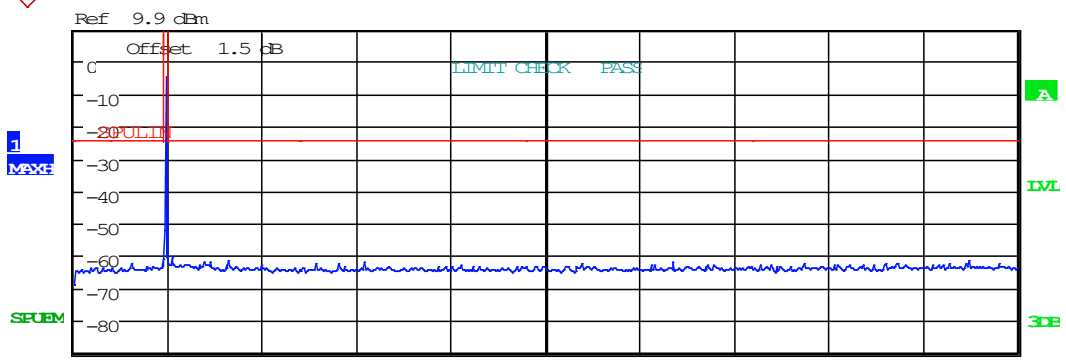
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	17.812500 k	-78.06	-53.63
150.000 k	30.000 M	10.00 k	167.910000 k	-69.98	-45.55
30.000 M	1.000 G	100.00 k	710.843000 M	-64.23	-39.80
1.000 G	2.400 G	100.00 k	2.399627 G	-53.40	-28.97
2.400 G	2.483 G	3.00 M	2.402171 G	-4.40	-34.40
2.483 G	6.000 G	100.00 k	2.593918 G	-61.31	-36.88
6.000 G	12.000 G	100.00 k	10.824600 G	-62.44	-38.01
12.000 G	18.000 G	100.00 k	13.375200 G	-62.49	-38.06
18.000 G	25.000 G	100.00 k	22.086600 G	-62.40	-37.97

2442 MHz Out of Band Emissions; Data Rate: 1 Mbps



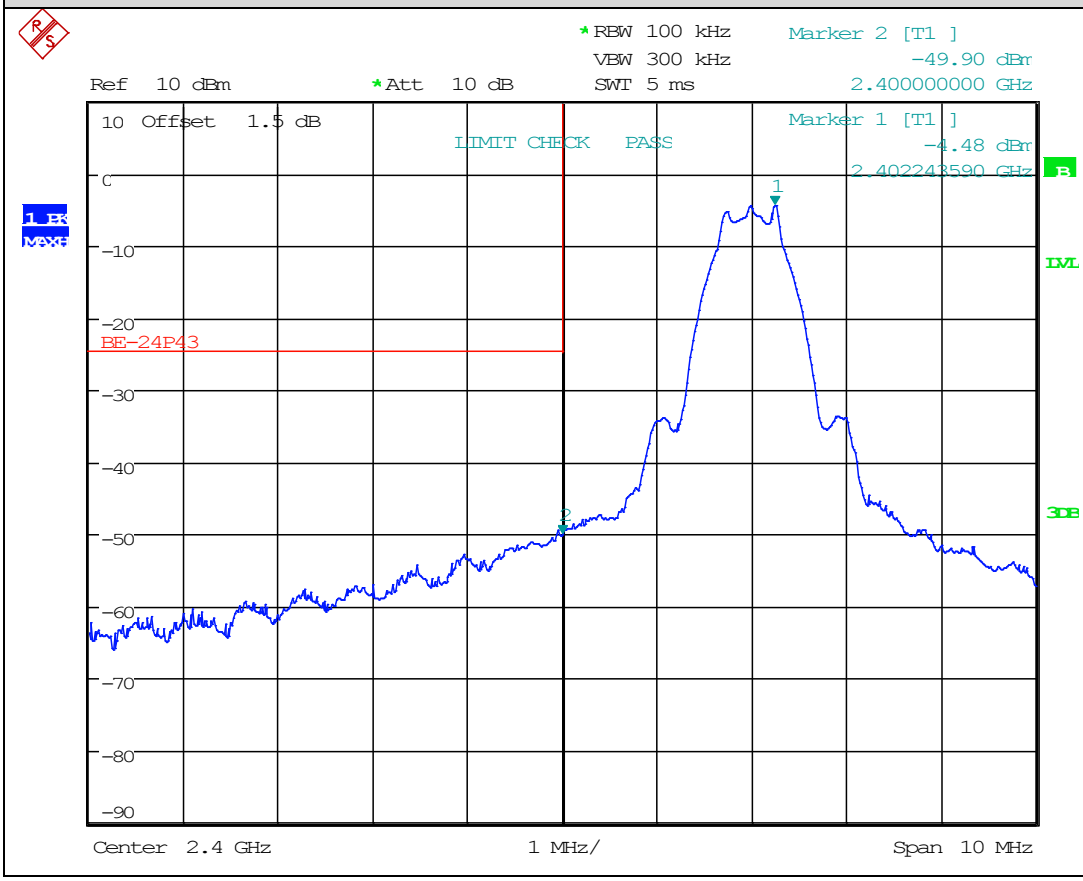
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	9.903846 k	-79.68	-55.25
150.000 k	30.000 M	10.00 k	161.940000 k	-71.28	-46.85
30.000 M	1.000 G	100.00 k	999.935333 M	-63.65	-39.22
1.000 G	2.400 G	100.00 k	2.249967 G	-62.81	-38.38
2.400 G	2.483 G	3.00 M	2.442084 G	-4.50	-34.50
2.483 G	6.000 G	100.00 k	2.697655 G	-61.60	-37.17
6.000 G	12.000 G	100.00 k	7.425000 G	-63.16	-38.73
12.000 G	18.000 G	100.00 k	15.470400 G	-62.36	-37.93
18.000 G	25.000 G	100.00 k	24.185900 G	-62.52	-38.09

2480 MHz Out of Band Emissions; Data Rate: 1 Mbps

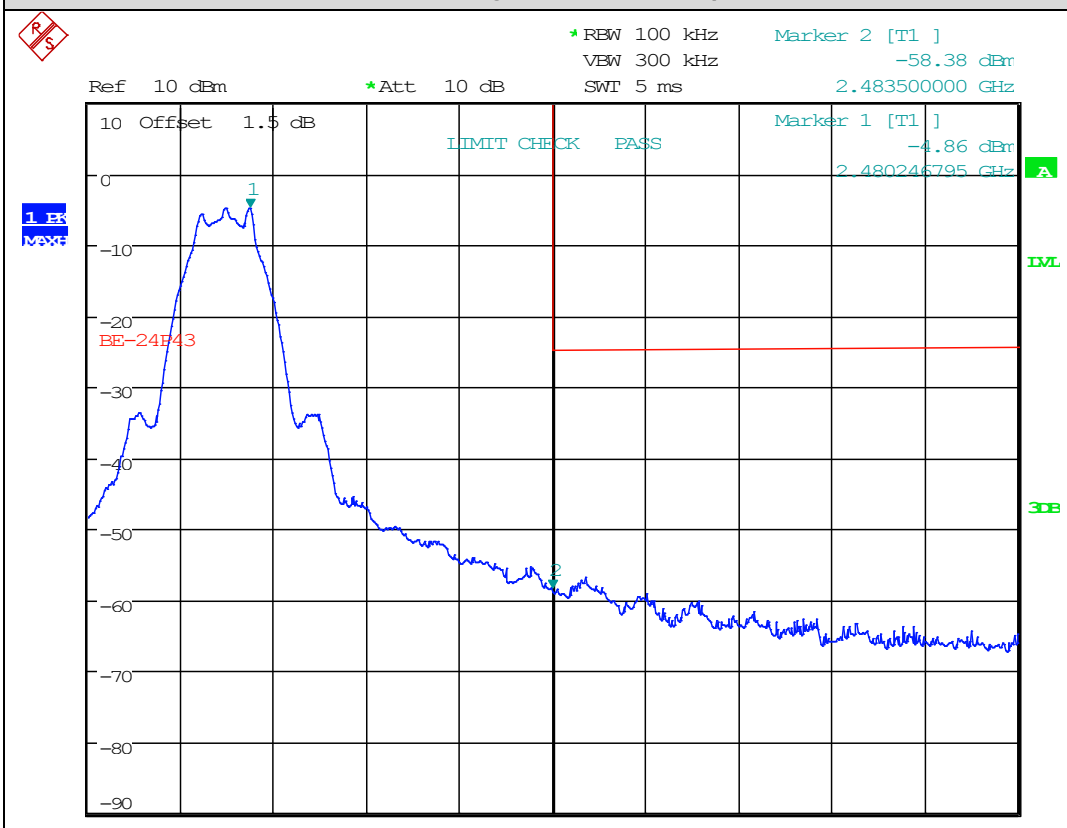


Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	9.000000 k	-78.36	-53.93
150.000 k	30.000 M	10.00 k	188.805000 k	-69.41	-44.98
30.000 M	1.000 G	100.00 k	593.149667 M	-63.81	-39.38
1.000 G	2.400 G	100.00 k	2.351793 G	-61.19	-36.76
2.400 G	2.483 G	3.00 M	2.479659 G	-4.85	-34.85
2.483 G	6.000 G	100.00 k	2.607632 G	-60.78	-36.35
6.000 G	12.000 G	100.00 k	7.690800 G	-62.30	-37.87
12.000 G	18.000 G	100.00 k	15.852600 G	-62.36	-37.93
18.000 G	25.000 G	100.00 k	23.720400 G	-61.85	-37.42

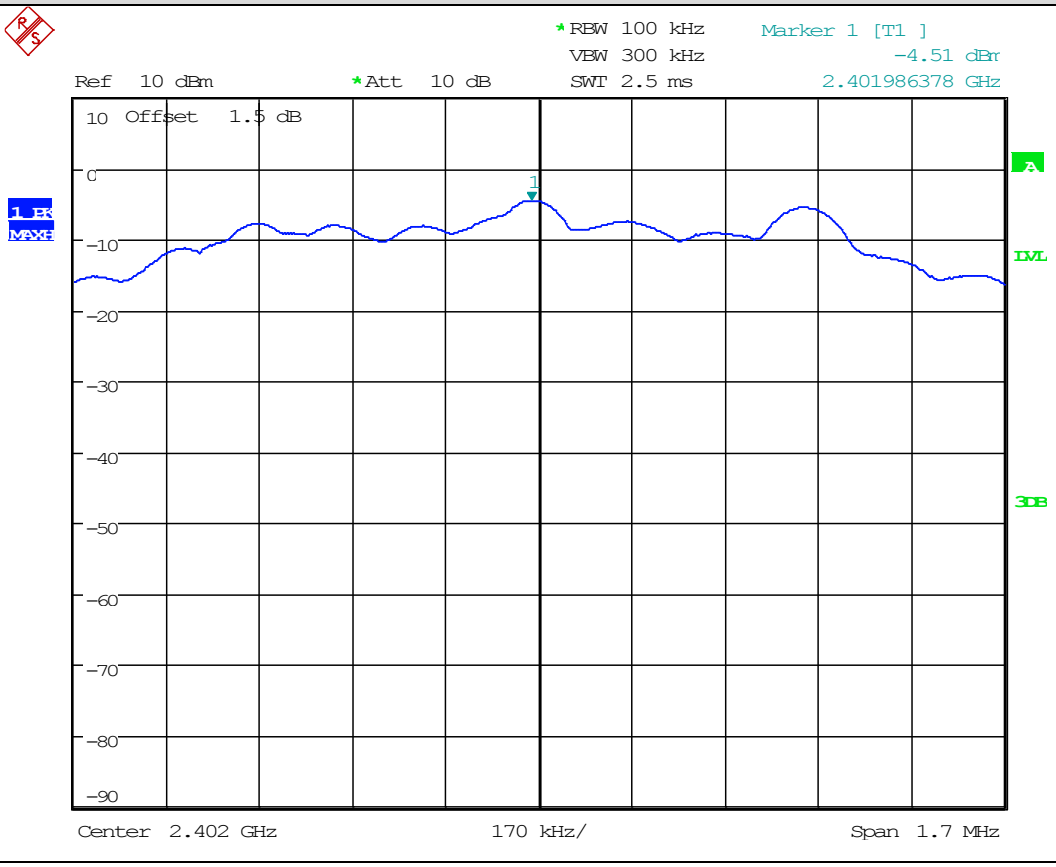
2402 Bandedge; Data Rate: 1 Mbps



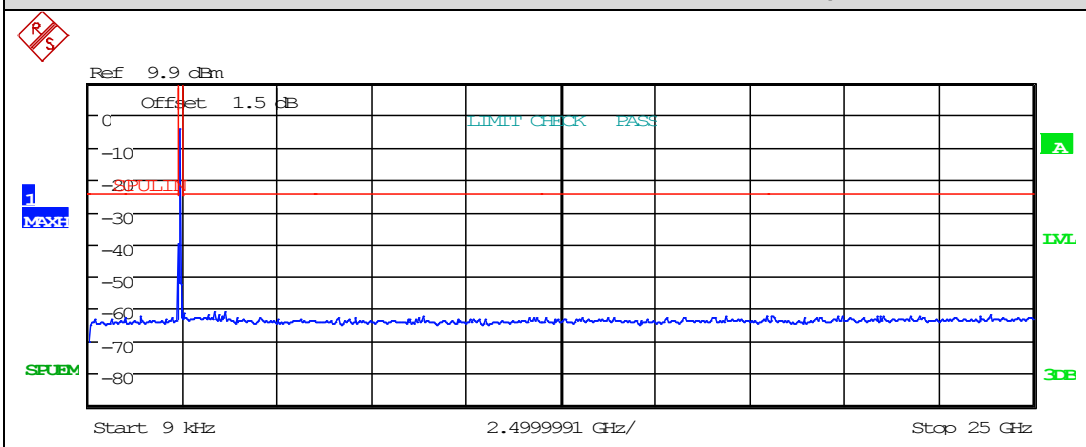
2480 Bandedge; Data Rate: 1 Mbps



Reference Level; Data Rate: 2 Mbps

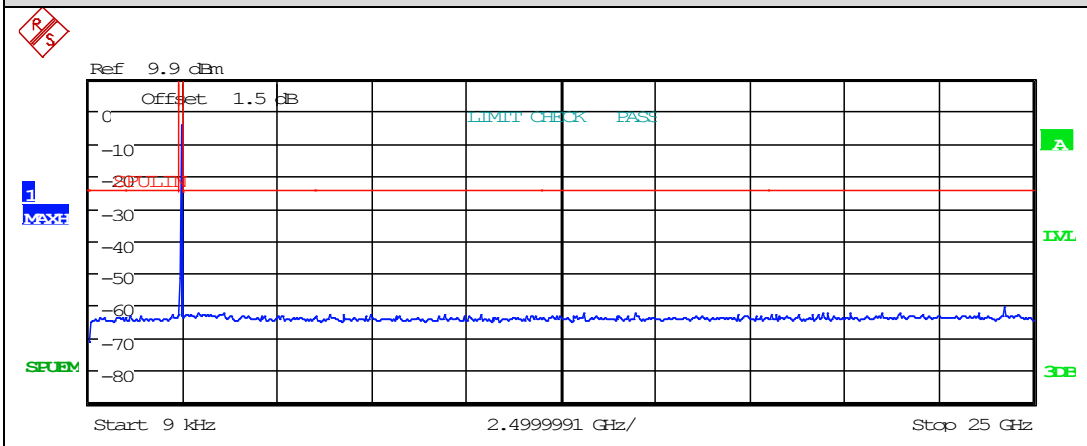


2402 MHz Out of Band Emissions; Data Rate: 2 Mbps



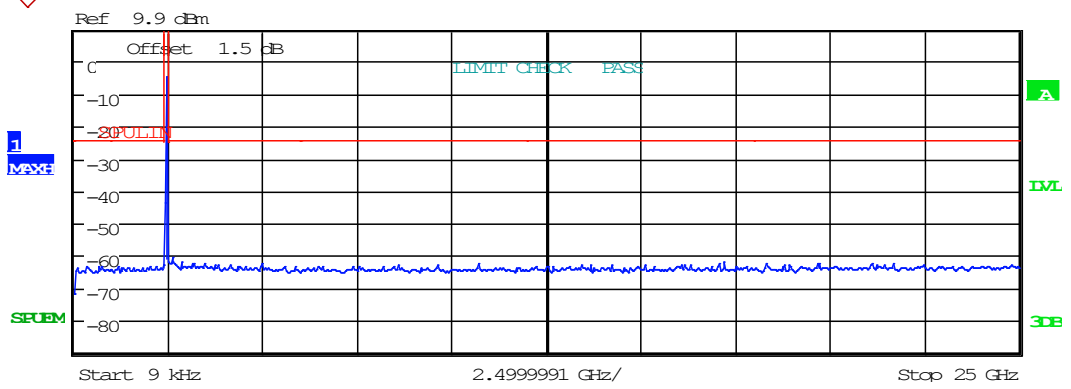
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	10.129808 k	-77.77	-53.26
150.000 k	30.000 M	10.00 k	173.880000 k	-70.63	-46.12
30.000 M	1.000 G	100.00 k	951.338333 M	-63.26	-38.75
1.000 G	2.400 G	100.00 k	2.399907 G	-40.32	-15.81
2.400 G	2.483 G	3.00 M	2.401503 G	-4.30	-34.30
2.483 G	6.000 G	100.00 k	3.589439 G	-61.03	-36.52
6.000 G	12.000 G	100.00 k	8.833800 G	-62.72	-38.21
12.000 G	18.000 G	100.00 k	17.963400 G	-62.63	-38.12
18.000 G	25.000 G	100.00 k	23.896100 G	-62.04	-37.53

2442 MHz Out of Band Emissions; Data Rate: 2 Mbps



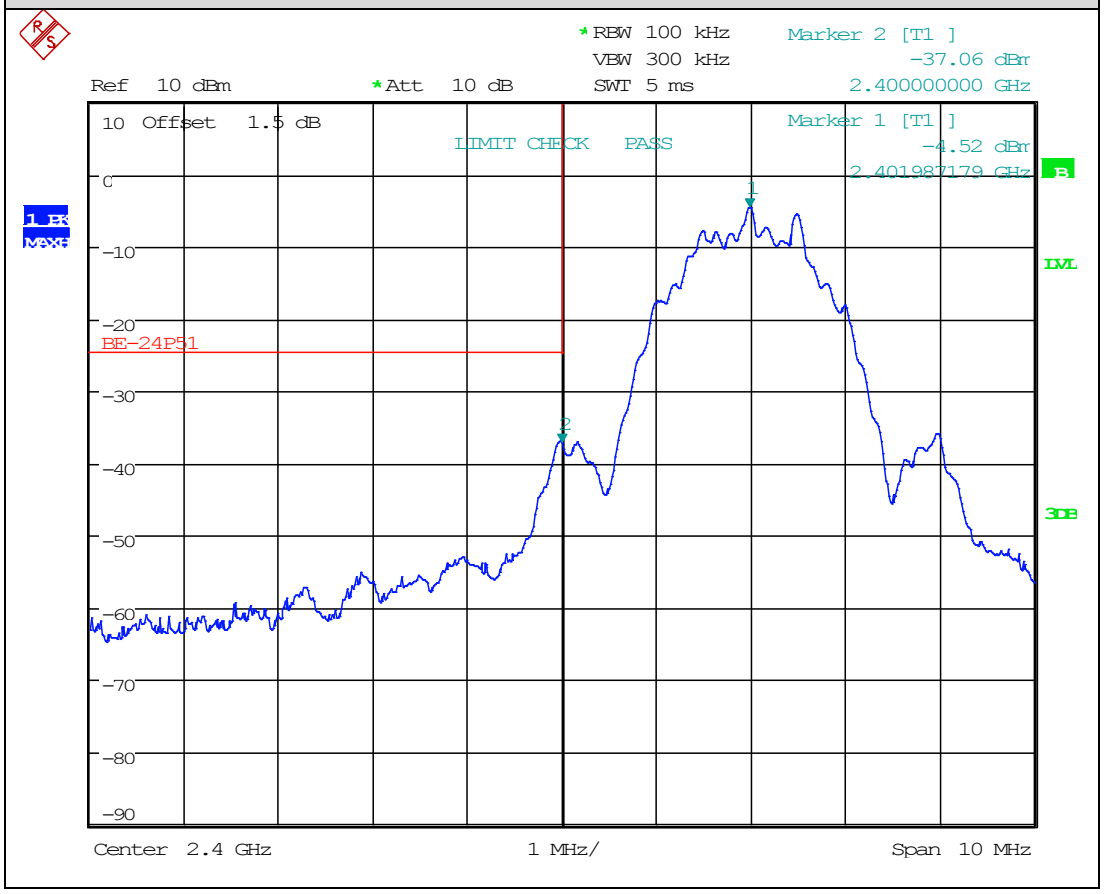
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	9.903846 k	-78.99	-54.48
150.000 k	30.000 M	10.00 k	191.790000 k	-71.56	-47.05
30.000 M	1.000 G	100.00 k	758.146667 M	-63.94	-39.43
1.000 G	2.400 G	100.00 k	2.393467 G	-62.90	-38.39
2.400 G	2.483 G	3.00 M	2.442084 G	-4.52	-34.52
2.483 G	6.000 G	100.00 k	3.582406 G	-62.31	-37.80
6.000 G	12.000 G	100.00 k	9.420000 G	-62.91	-38.40
12.000 G	18.000 G	100.00 k	14.466600 G	-62.60	-38.09
18.000 G	25.000 G	100.00 k	24.246800 G	-60.88	-36.37

2480 MHz Out of Band Emissions; Data Rate: 2 Mbps

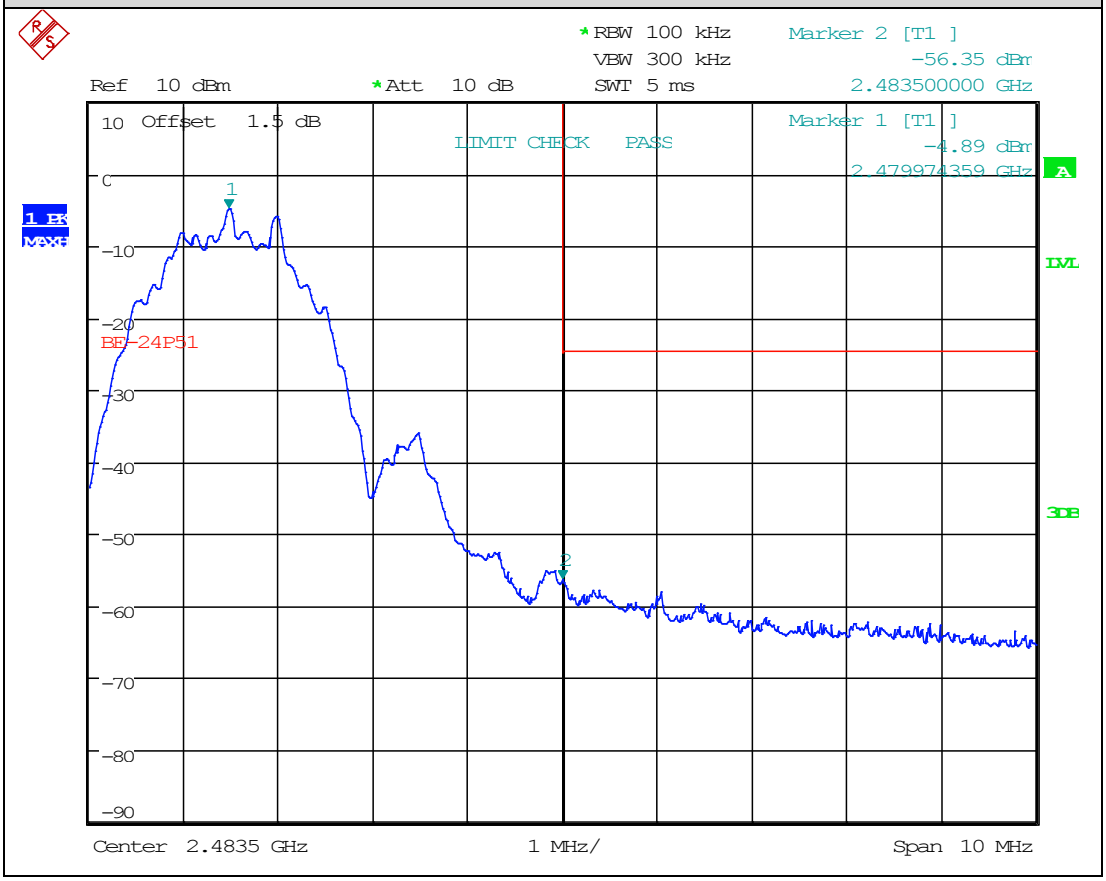


Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	9.000000 k	-78.06	-53.55
150.000 k	30.000 M	10.00 k	197.760000 k	-71.79	-47.28
30.000 M	1.000 G	100.00 k	704.635000 M	-63.67	-39.16
1.000 G	2.400 G	100.00 k	2.372980 G	-63.22	-38.71
2.400 G	2.483 G	3.00 M	2.480243 G	-4.65	-34.65
2.483 G	6.000 G	100.00 k	2.607984 G	-60.63	-36.12
6.000 G	12.000 G	100.00 k	10.680600 G	-62.68	-38.17
12.000 G	18.000 G	100.00 k	17.167200 G	-62.33	-37.82
18.000 G	25.000 G	100.00 k	21.124800 G	-62.41	-37.90

2402 Bandedge; Data Rate: 2 Mbps



2480 Bandedge; Data Rate: 2 Mbps



16 Power spectral density

16.1 Definition

The power per unit bandwidth.

16.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
Deviations From Standard:	None
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 30 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

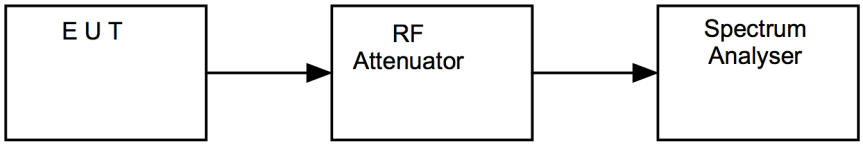
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

16.4 Test Method

With the EUT connected as per Figure vi, the peak emission of the EUT was measured on a spectrum analyser, with path losses taken into account.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

Figure vi Test Setup

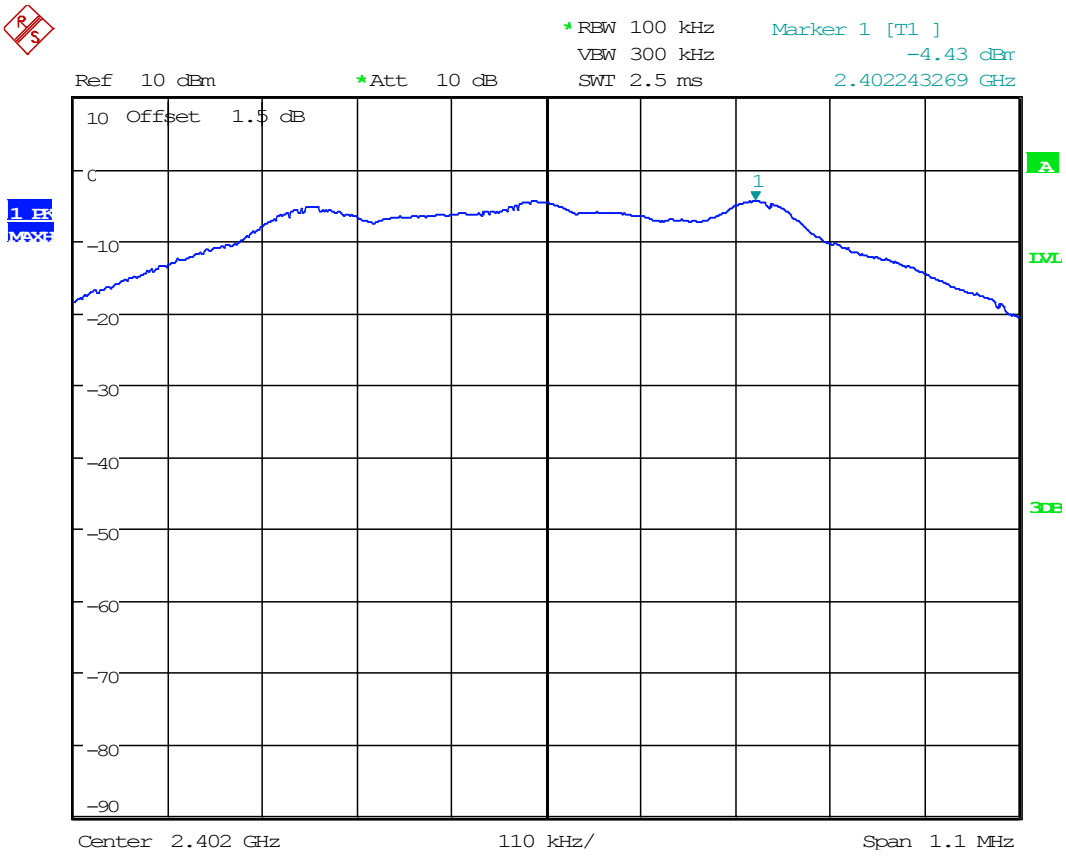


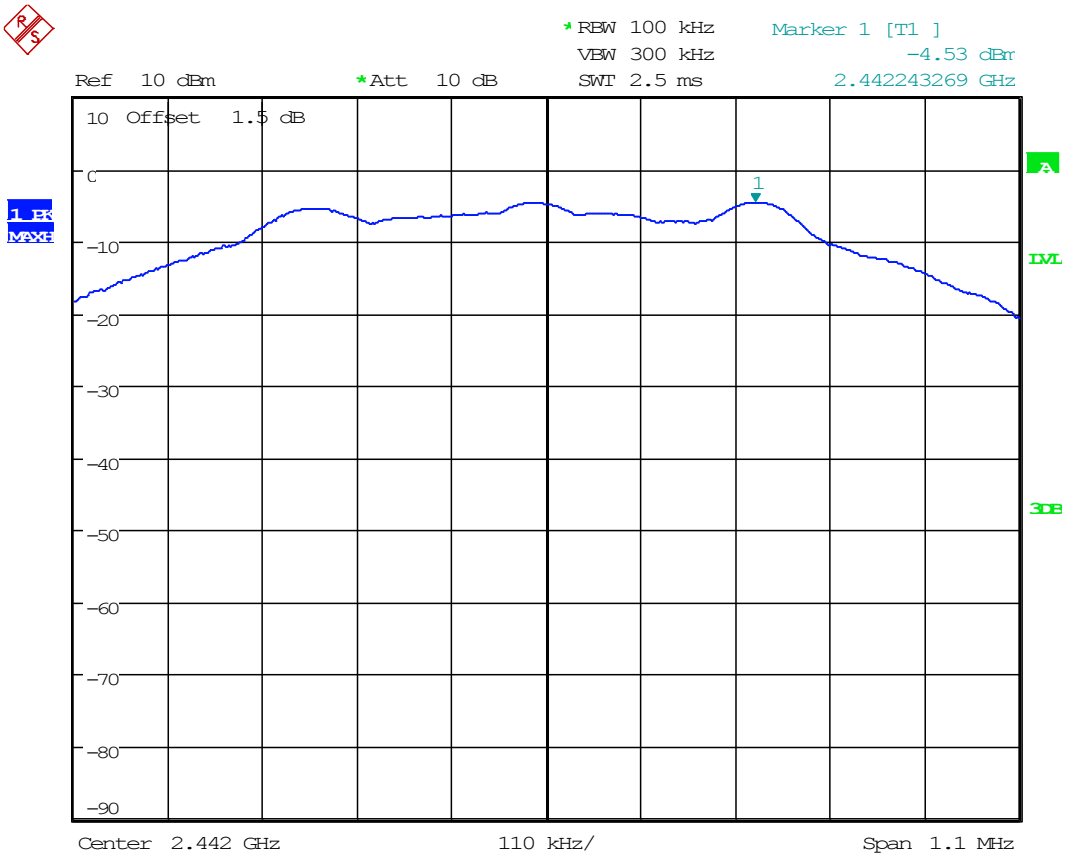
16.5 Test Equipment

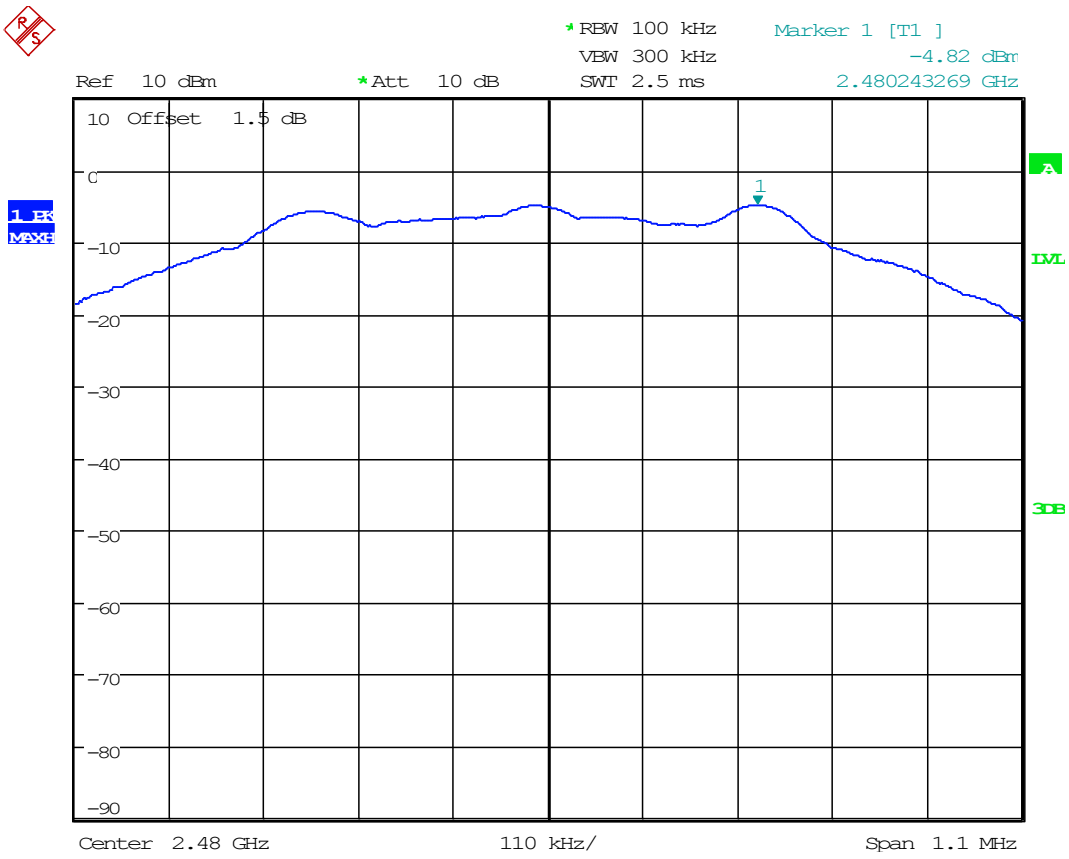
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Due For Calibration*
Spectrum Analyser	R&S	FSU50	U544	2021-06-17

16.6 Test Results

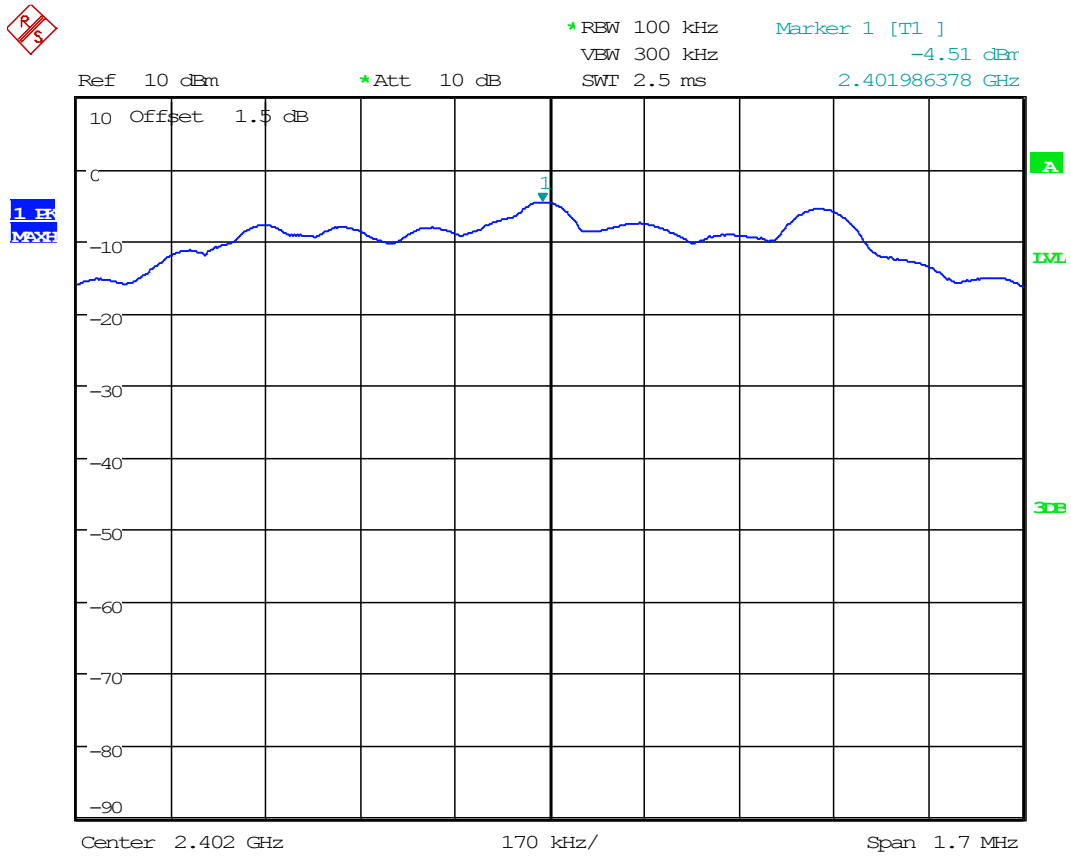
Data Rate: 1 Mbps		
Frequency (MHz)	***Power Spectral Density (dBm)***	***Result***
2402	-4.43	PASS
2442	-4.53	PASS
2480	-4.82	PASS

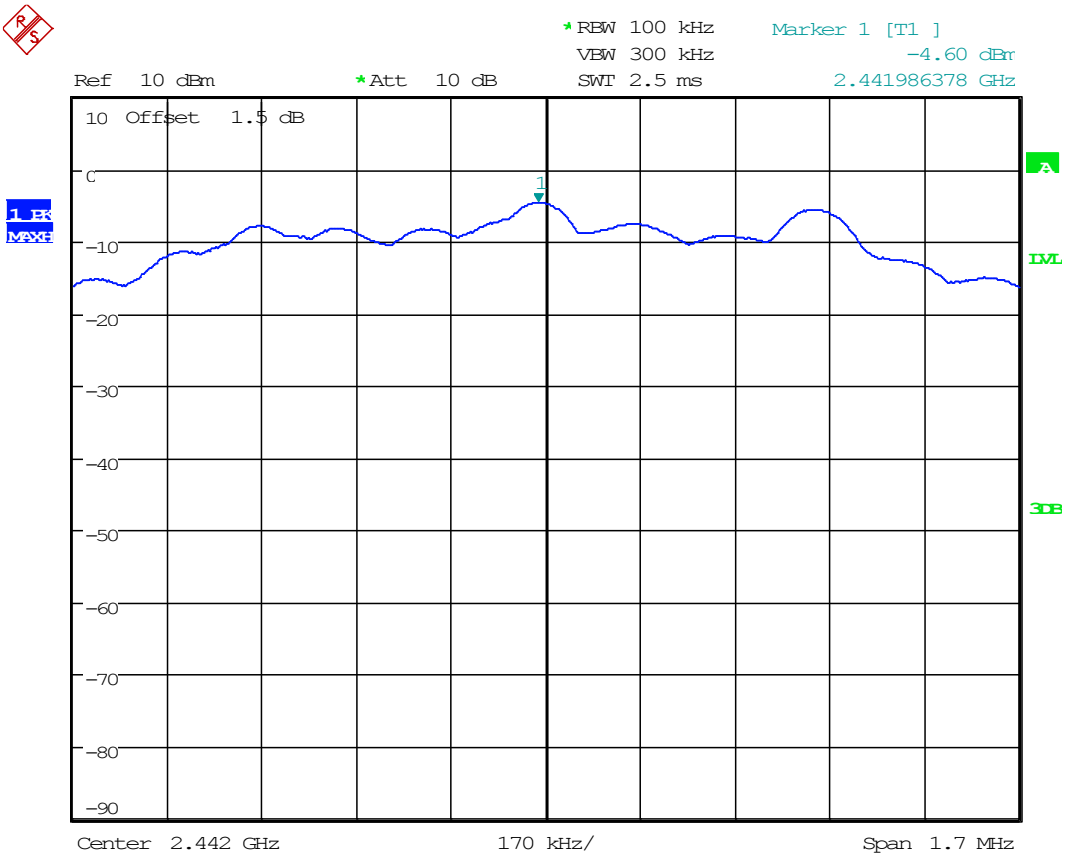


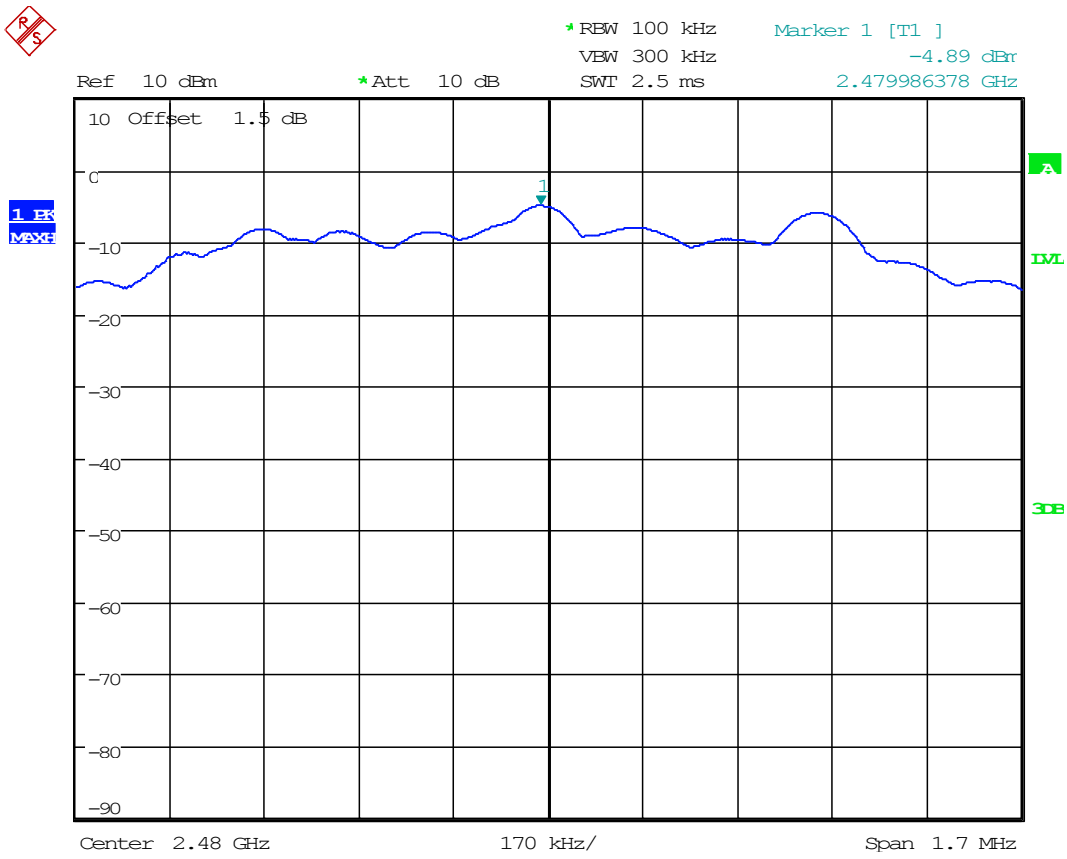

RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.53 dBm
2.442243269 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
A
VIEW
3DB
Center 2.442 GHz
110 kHz/
Span 1.1 MHz


RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.82 dBm
2.480243269 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
A
VIEW
3DB
Center 2.48 GHz
110 kHz/
Span 1.1 MHz

Data Rate: 2 Mbps		
Frequency (MHz)	***Power Spectral Density (dBm)***	***Result***
2402	-4.51	PASS
2442	-4.60	PASS
2480	-4.89	PASS




RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.60 dBm
2.441986378 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
A
VIEW
3DB
Center 2.442 GHz
170 kHz/
Span 1.7 MHz


RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
-4.89 dBm
2.479986378 GHz
Ref 10 dBm
Att 10 dB
10 Offset 1.5 dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
A
VIEW
3DB
Center 2.48 GHz
170 kHz/
Span 1.7 MHz

17 Measurement Uncertainty

Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence where no required test level exists.

Reference No.	Parameter	Description	Value	Unit
1	Adjacent Channel Power	Uncertainty in test result	***1.86***	dB
2	Carrier Power	Uncertainty in test result (Power Meter) Uncertainty in test result (Spectrum Analyser)	**0.070** ***3.11***	dB
3	Effective Radiated Power	Uncertainty in test result	***4.71***	dB
4	Radiated Spurious Emissions	Uncertainty in test result 30 MHz to 1 GHz 1 GHz to 18 GHz	***4.75*** ***4.46***	dB
5	Maximum Frequency Error	Uncertainty in test result (CMTA)	**113.441**	Hz
6	Radiated Emissions, Field Strength OATS 9 kHz – 110 GHz Electric Field	Uncertainty in test result (9 kHz – 30 MHz) Uncertainty in test result (30 MHz – 1 GHz) Uncertainty in test result (1 GHz – 18 GHz) Uncertainty in test result (18 GHz – 26 GHz) Uncertainty in test result (26 GHz – 40 GHz) Uncertainty in test result (40 GHz – 50 GHz) Uncertainty in test result (50 GHz – 75 GHz) Uncertainty in test result (75 GHz – 110 GHz)	**2.3** ***4.75*** ***4.46*** **3.2** **3.3** **3.5** **3.6** **3.6**	dB
7	Frequency Deviation	Uncertainty in test result	**3.7**	%
8	Magnetic Field Emissions	Uncertainty in test result	**2.3**	dB
9	Conducted Spurious	Uncertainty in test result Up to 26 GHz	**0.921**	dB

Reference No.	Parameter	Description	Value	Unit
10	Channel Bandwidth	Uncertainty in test result	***15.71***	%
11	Spectrum Mask Measurements	Uncertainty in test result (frequency) Uncertainty in test result (amplitude)	***2.59*** ***1.32***	% dB
12	Adjacent Sub Band Selectivity	Uncertainty in test result	***1.24***	dB
13	Receiver Blocking – Listen Mode, Radiated	Uncertainty in test result	***3.23***	dB
14	Receiver Blocking – Talk Mode, Radiated	Uncertainty in test result	***3.36***	dB
15	Receiver Blocking – Talk Mode, Conducted	Uncertainty in test result	***1.24***	dB
16	Receiver Threshold	Uncertainty in test result	***3.42***	dB
17	Transmission Time Measurement	Uncertainty in test result	***4.40***	%