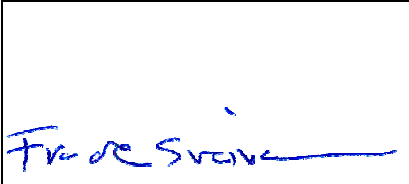
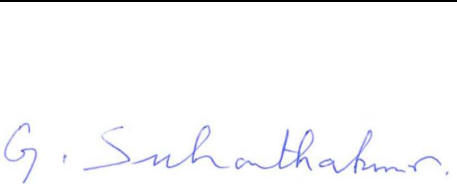


Test Report

Product	WLAN Handset with Bluetooth
Name and address of the applicant	Ascom (Sweden) AB Grimbodalen 2 SE-417 49 Gothenburg, Sweden
Name and address of the manufacturer	Ascom (Sweden) AB Grimbodalen 2 SE-417 49 Gothenburg, Sweden
Model	WH2
Rating	3.7V _{DC} (Li-Ion battery)
Trademark	ASCOM
Serial number	/
Additional information	WiFi, 802.11a/b/g/n, Bluetooth, Bluetooth Low Energy
Tested according to	FCC Part 15.247 Frequency Hopping Transmitters / Digital Transmission Systems Industry Canada RSS-247, Issue 2 Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	362353
Tested in period	2019-02-13 to 2019-04-02
Issue date	2019-04-26
Name and address of the testing laboratory	 Instituttveien 6 Kjeller, Norway CAB Number: FCC: NO0001 ISED: NO0470   An accredited technical test executed under the Norwegian accreditation scheme
 Prepared by [Frode Sveinsen]  Approved by [G.Suhanthakumar]	
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1 INFORMATION

1.1 Test Item

Name	Ascom
FCC ID	BXZWH2
ISED ID	3724B-WH2
Model/version	WH2
Serial number	/
Hardware identity and/or version	PB
Software identity and/or version	1.0.4_Nemko
Frequency Range	2402–2480 MHz
Number of Channels	40
Operating Modes	Bluetooth Low Energy
Type of Modulation	Digital (Gaussian Frequency Shift Keying)
Conducted Output Power	3.4 mW (Peak)
Antenna Connector	None
Number of Antennas	1
Antenna Diversity Supported	No
Power Supply	Secondary Battery (3.7V Li-Ion)

Description of Test Item

The tested device is a WiFi Handset with 2.4GHz and 5GHz WLAN, and Bluetooth Basic Rate and Bluetooth Low Energy.

All radio transmitters in the handset, including Bluetooth Low Energy are supplied by an already certified radio module.

Description	Brand	Model	Regulatory Information
WiFi and BT Radio Module	Murata	SP-HY1MW	FCC ID: VPYLBEE5HY1MW IC: 772C-LBEE5HY1MW

1.2 Normal test condition

Temperature:	20–25 °C
Relative humidity	20–50 %
Air pressure	860–1060 mbar
Normal test voltage	3.7 V _{DC} (Nominal Voltage)

All tests were performed with the EUT powered from a fully charged battery.

Values above are the limit registered during the test period.

1.3 Test Engineer

Frode Sveinsen

1.4 Antenna Requirement

Does the EUT have detachable antenna(s)?	☐ YES	☒ NO
If detachable, is the antenna connector(s) non-standard?	☐ YES	☐ NO
The tested equipment has only integral antennas. Conducted tests with a temporary antenna connector.		

Requirement: FCC 15.203, 15.204

1.5 Comments

All tested parameters are passed.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable to national standards.

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and Industry Canada RSS-247 Issue 2 and RSS-GEN Issue 5.

Tests were performed in accordance with ANSI C63.4-2014 and ANSI C63.10-2013.

Radiated tests were made in a semi-anechoic chamber at measuring distance of 3m.

A description of the test facility is on file with FCC and ISSED.

☒ New Submission

☒ Production Unit

☐ Class II Permissive Change

☐ Pre-production Unit

DTS Equipment Code

☐ Family Listing



THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".

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2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 2, RSS-GEN Issue 5 reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	Complies
Antenna Requirement	15.203	6.8 (RSS-GEN)	Complies
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	N/A ¹
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	Complies
Minimum 6 dB Bandwidth (DTS BW)	15.247(a)(2)	5.2 (1) (RSS-247)	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	Complies
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	Complies
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	5.5 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	Complies

¹ The EUT is battery powered and the battery is charged in an external charger

Revision history

Version	Date	Comment	Sign
1.0	2019-04-26	First edition	FS

3 TEST RESULTS

3.1 Occupied Bandwidth (99% BW)

RSS-GEN Issue 5, Clause 6.7

Test Results: Complies

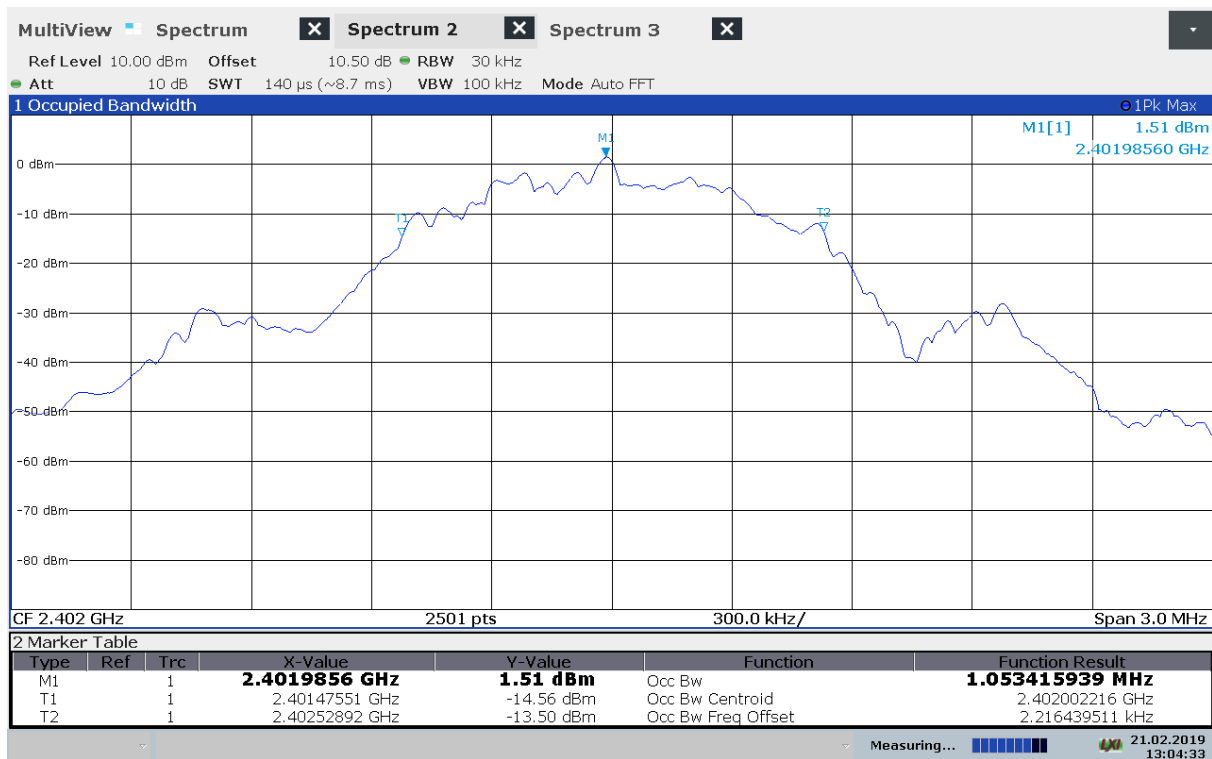
Measurement Data:

Carrier Frequency	Occupied Bandwidth (99% BW)
2402 MHz	1.05 MHz
2440 MHz	1.05 MHz
2480 MHz	1.05 MHz

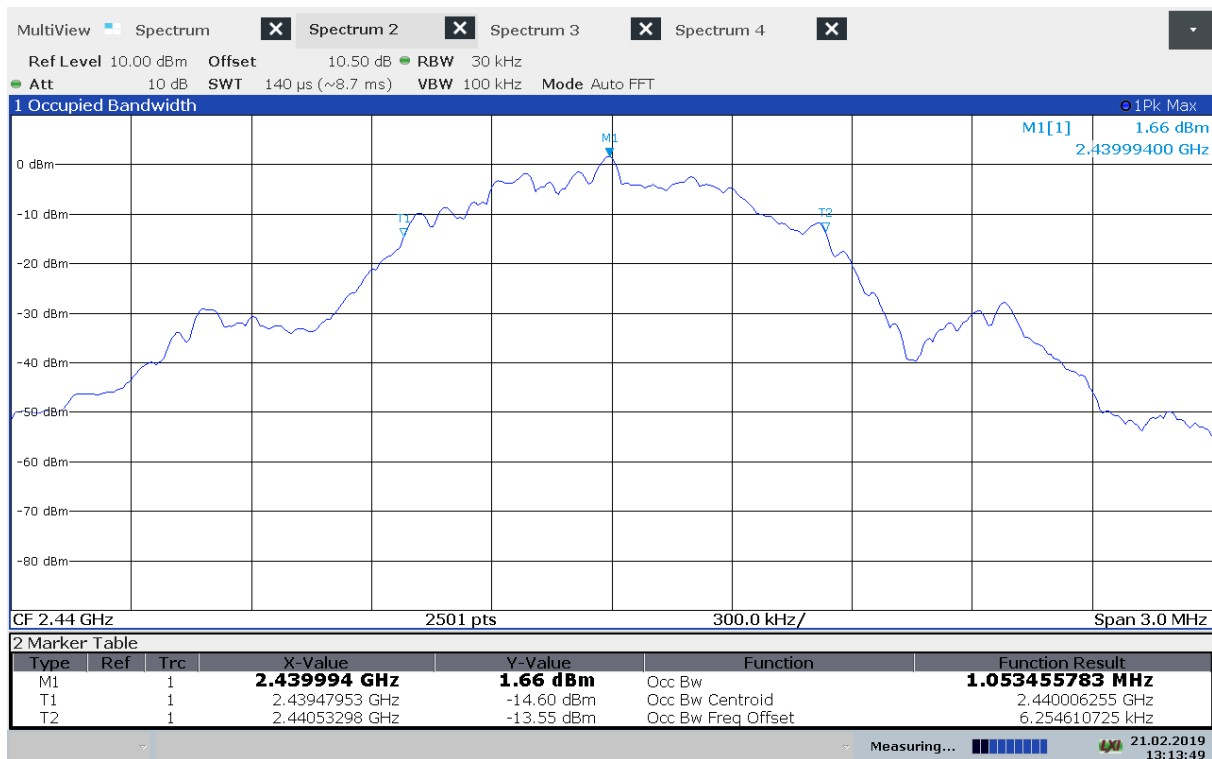
See attached plots.

Requirements:

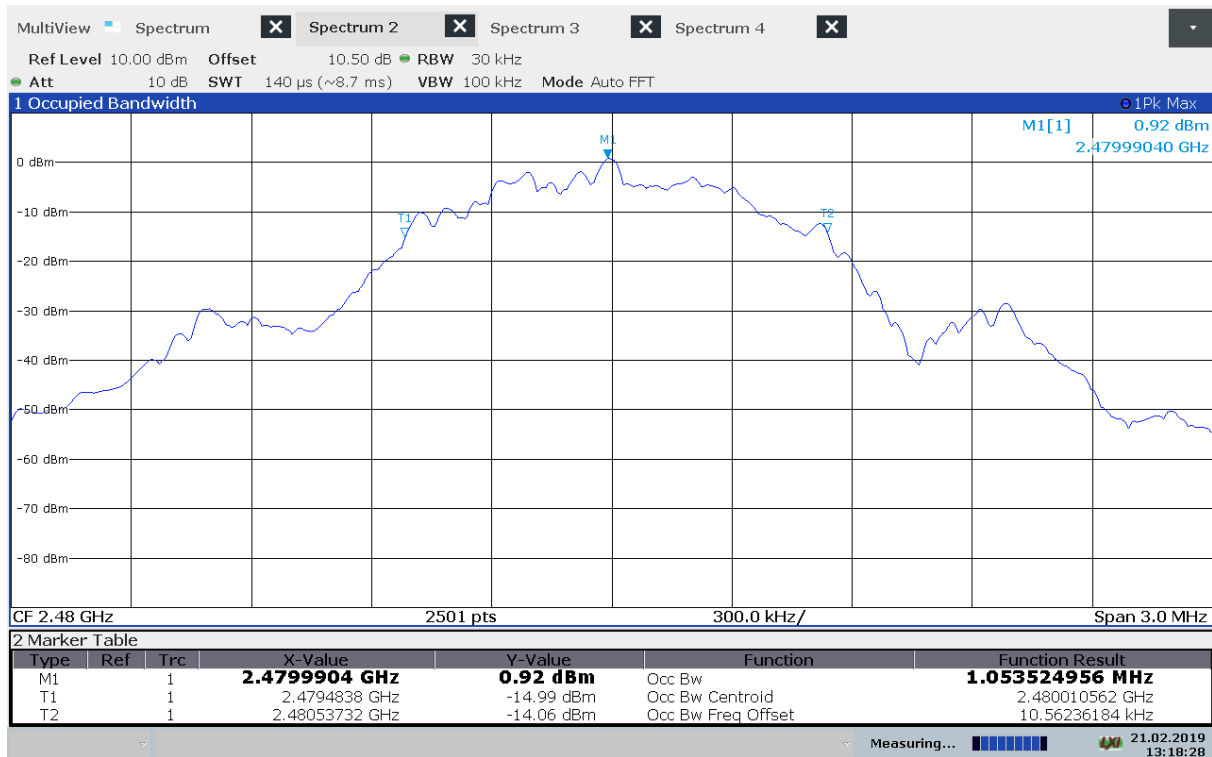
No limit specified.



Occupied Bandwidth, 99%, 2402 MHz



Occupied Bandwidth, 99%, 2440 MHz



Occupied Bandwidth, 99%, 2480 MHz

3.2 Minimum 6 dB Bandwidth (DTS BW)

FCC Part 15.247 (a)(2)

RSS-247 Issue 2, Clause 5.2 (a)

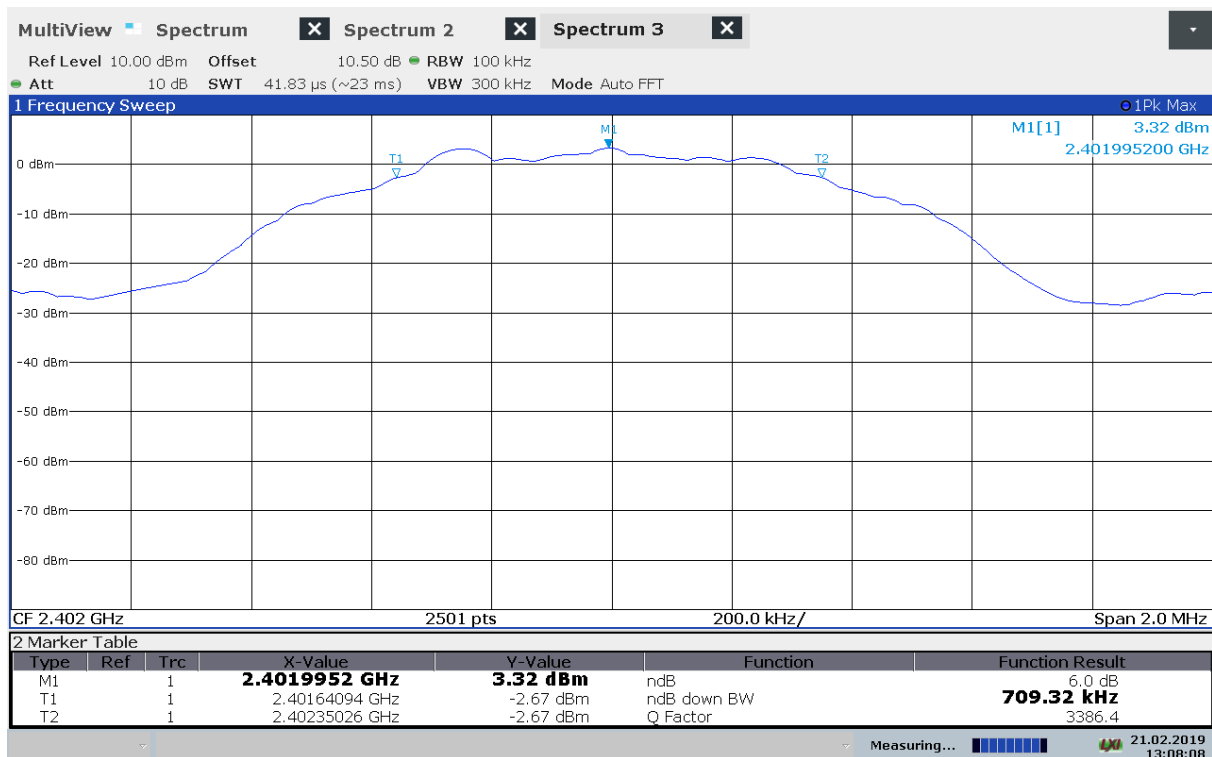
Test Results: Complies

Measurement Data:

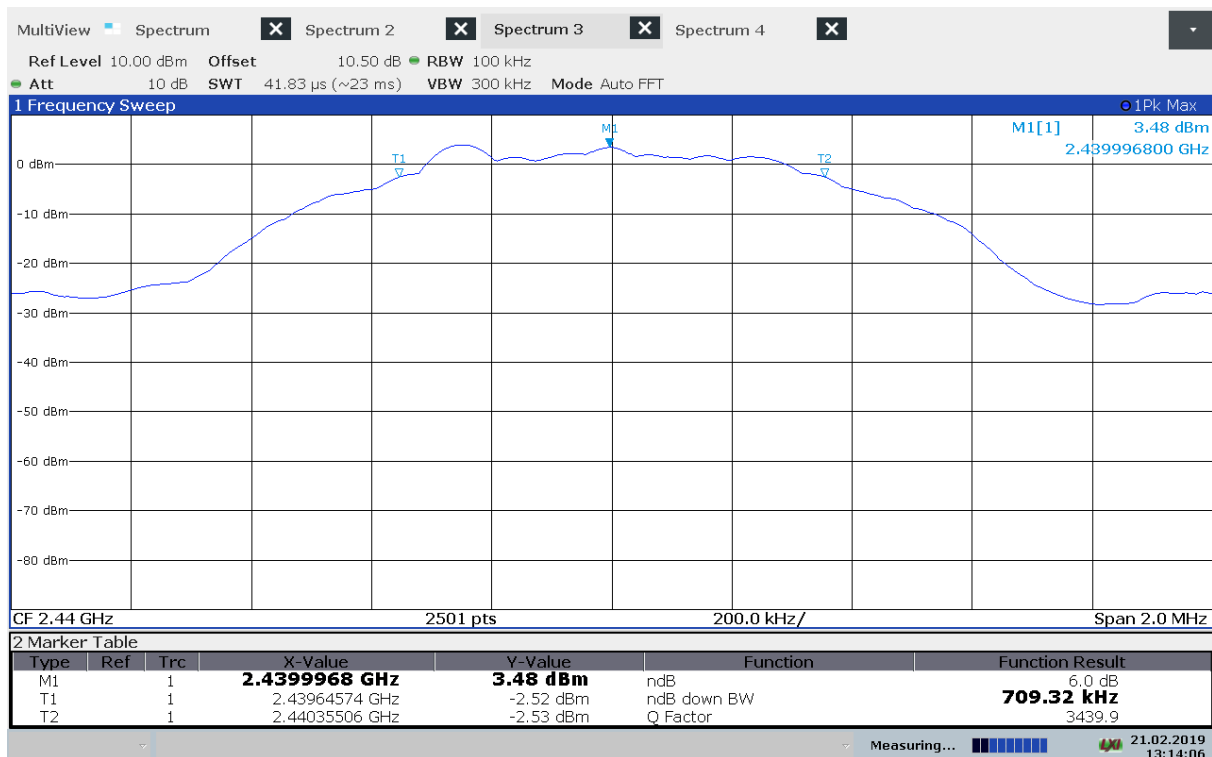
Modulation type and bitrate	Measured 6 dB Bandwidth (kHz)
2402 MHz	709
2440 MHz	709
2480 MHz	711

Requirements:

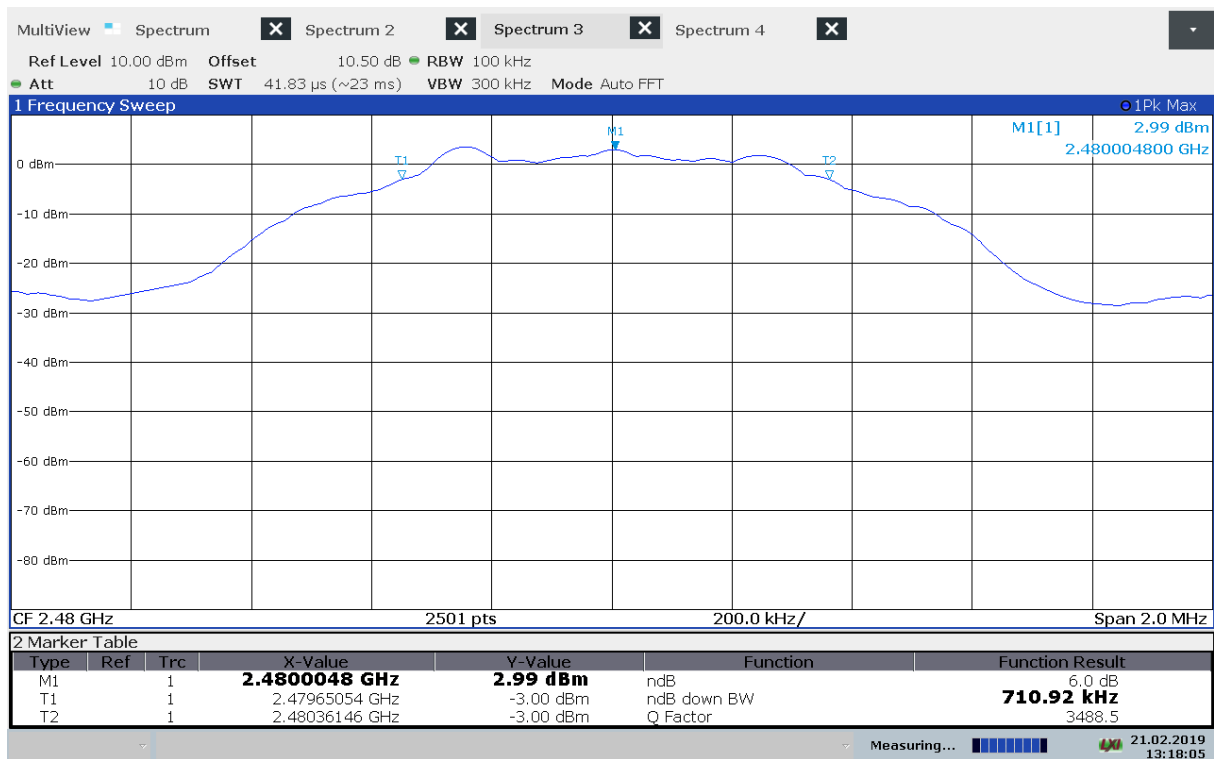
For Digital Transmission Systems in the 2400–2483.5 MHz band the minimum 6 dB bandwidth (DTS BW) shall be at least 500 kHz.



DTS Bandwidth, 2402 MHz



DTS Bandwidth, 2440 MHz



DTS Bandwidth, 2480 MHz

3.3 Peak Power Output

FCC 15.247 (b)

RSS-247 Issue 2, Clause 5.4 (d)

Test Results: Complies

Measurement Data:

Maximum Peak Power, Max Power			
	2402 MHz	2440 MHz	2480 MHz
Peak Conducted Power (dBm)	5.1	5.3	4.8
Peak Conducted Power (mW)	3.2	3.4	3.0
Peak Field Strength (dBμV/m @3m)	103.16	101.23	101.53
Peak Radiated power (calculated e.i.r.p.) (dBm)	7.9	6.0	6.3
Calculated Antenna Gain (dBi)	2.8	0.7	1.5

Output Power reported is Maximum Peak Power.

Conducted values have been corrected with 0.9 dB for cable loss.

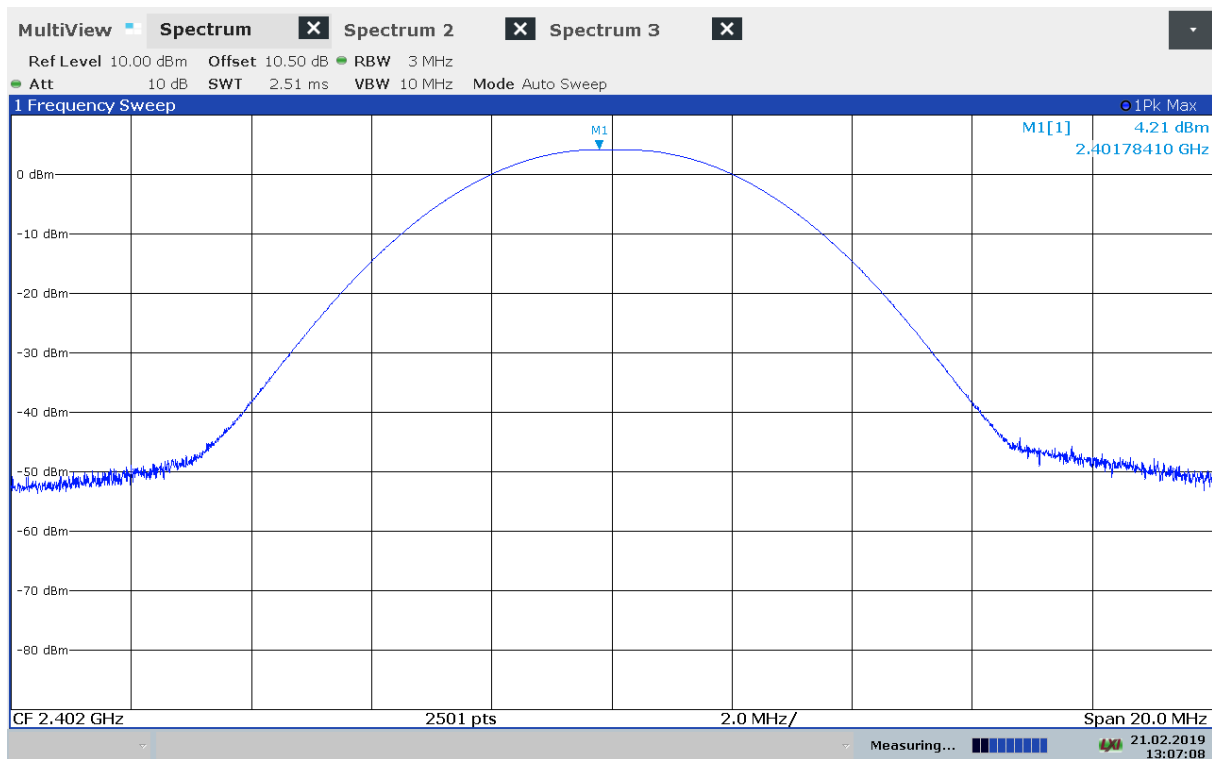
See attached plots.

Requirements:

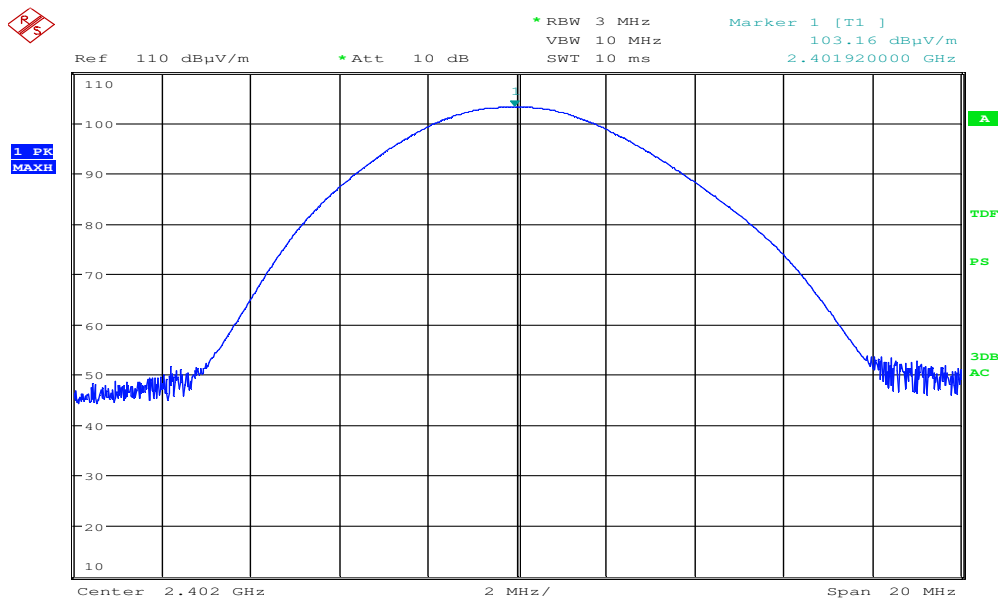
The maximum peak output power shall not exceed the following limits:

For Digital Transmission Systems in the 2400–2483.5 MHz band: 1 Watt

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

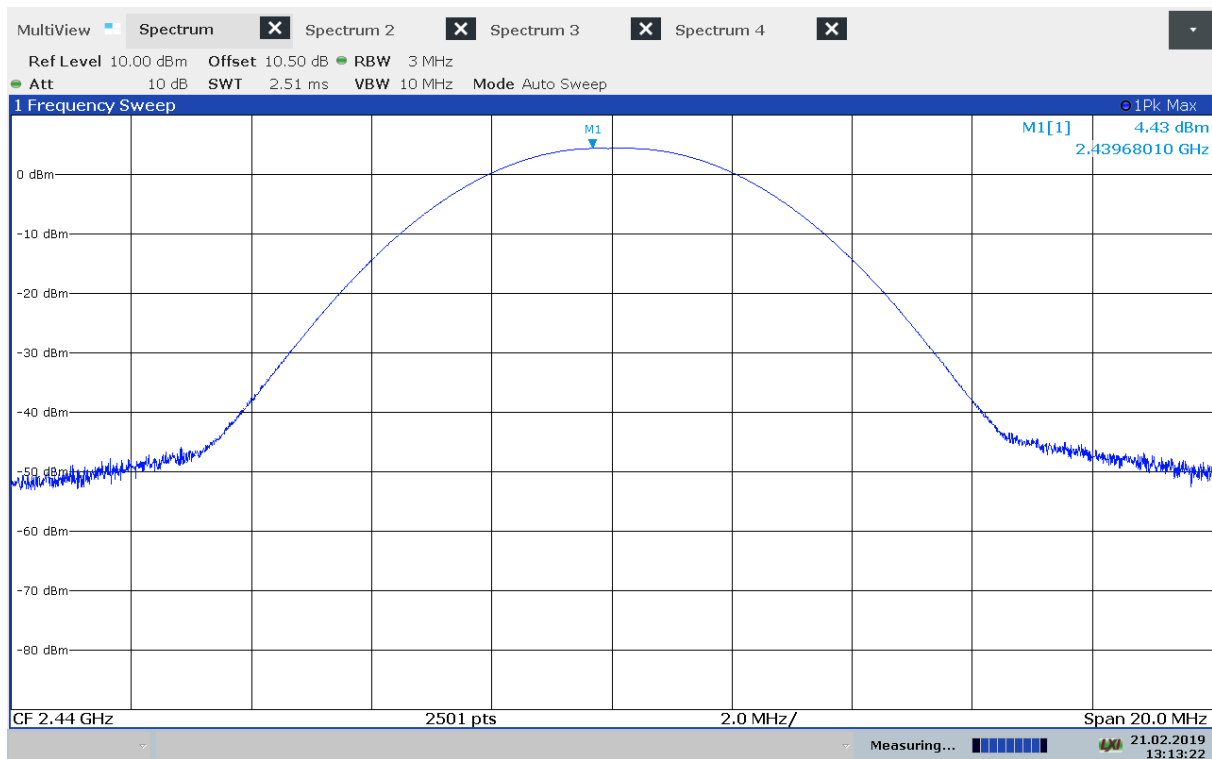


Conducted Power, 2402 MHz

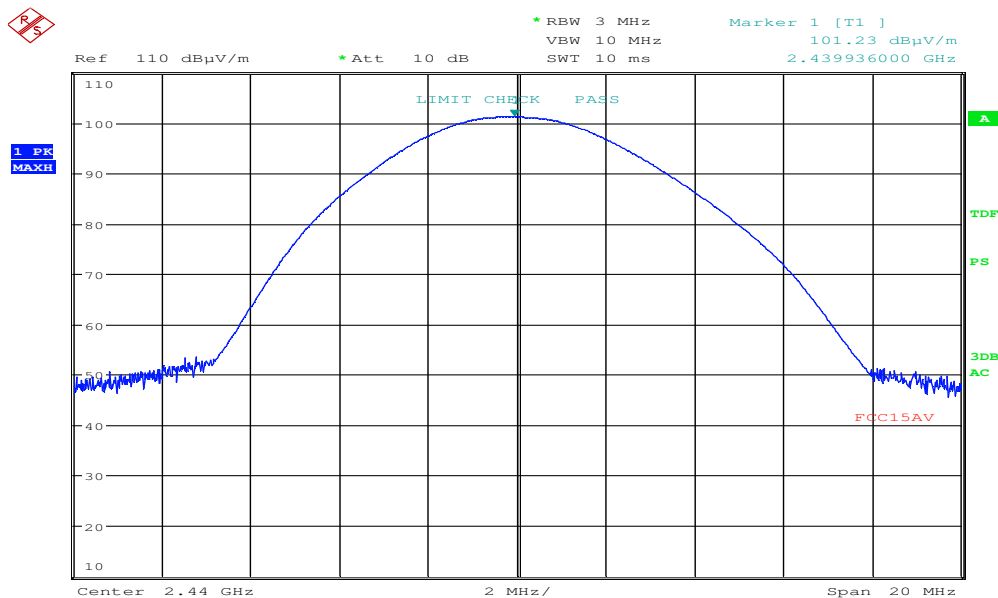


Date: 4.MAR.2019 14:32:15

Maximum Field Strength, 2402 MHz

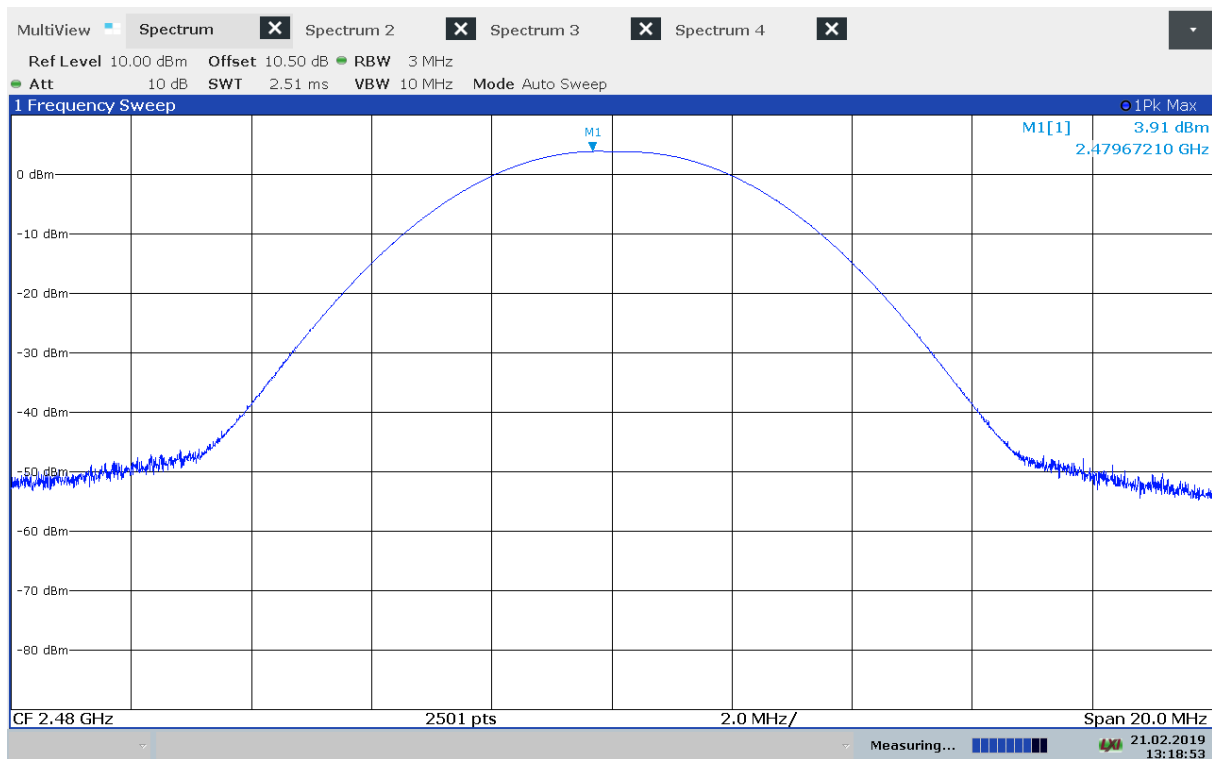


Conducted Power, 2440 MHz

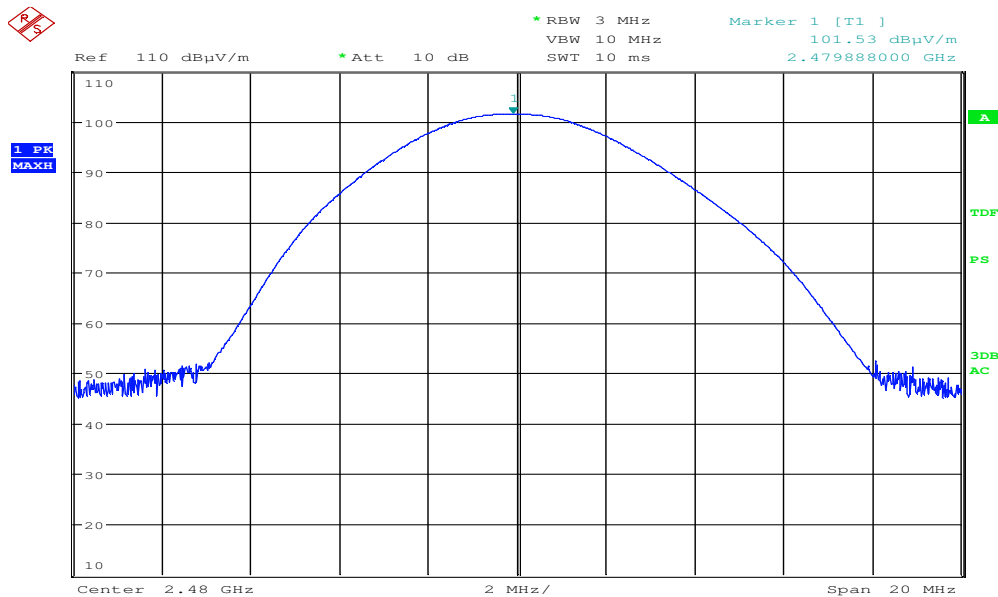


Date: 4.MAR.2019 15:13:28

Maximum Field Strength, 2440 MHz



Conducted Power, 2480 MHz



Date: 4.MAR.2019 15:17:45

Maximum Field Strength, 2480 MHz

3.4 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Results: Passed

Measured and Calculated Data:

The measurement procedures PKPSD described in ANSI C63.10-2013 was used.

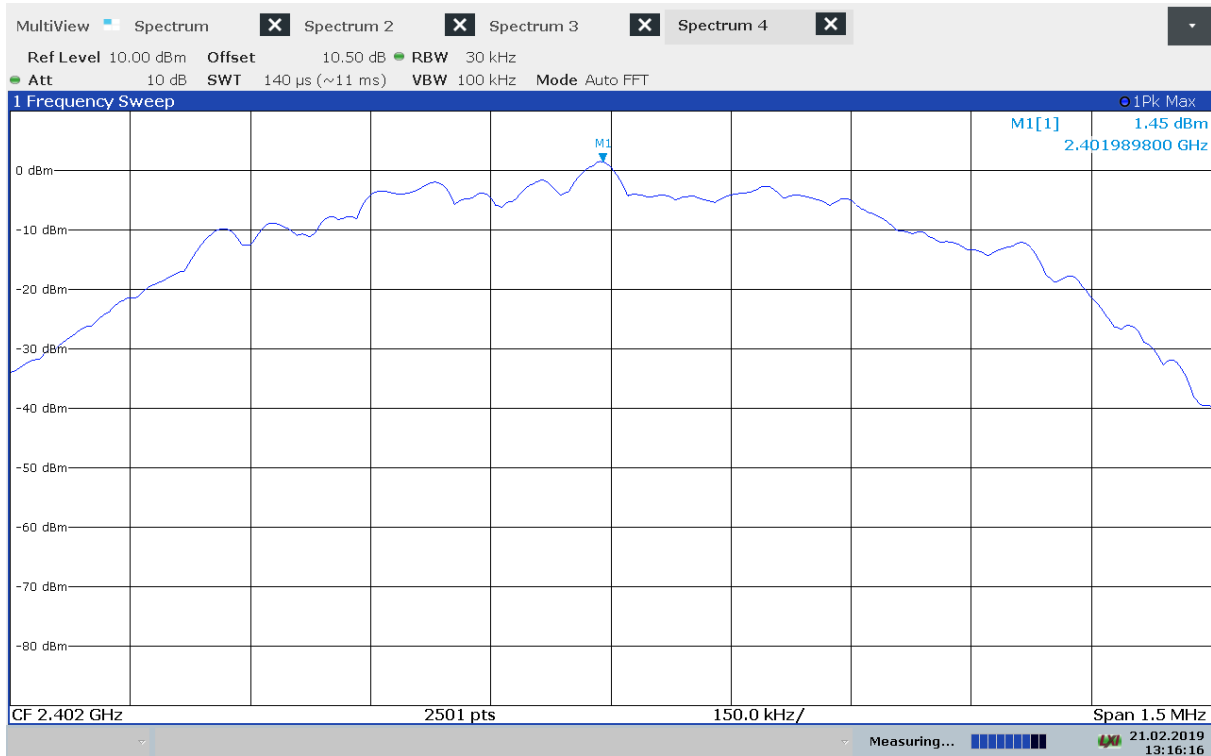
Carrier Frequency (MHz)	Power Spectral Density (dBm/3 kHz)
2402	-7.6
2440	-7.6
2480	-7.9

The measured values with 30 kHz RBW are corrected by a Bandwidth Correction Factor of -10 dB.

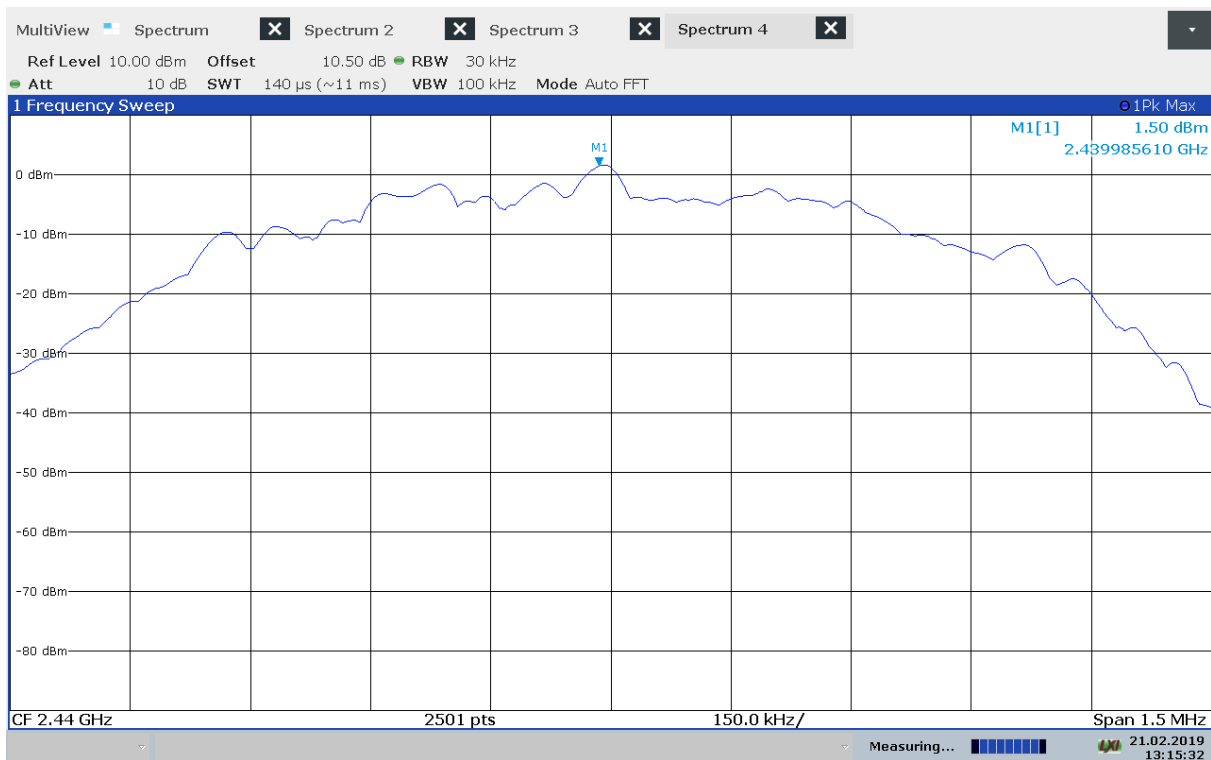
Values above have been corrected with 0.9 dB for cable loss.

Requirements:

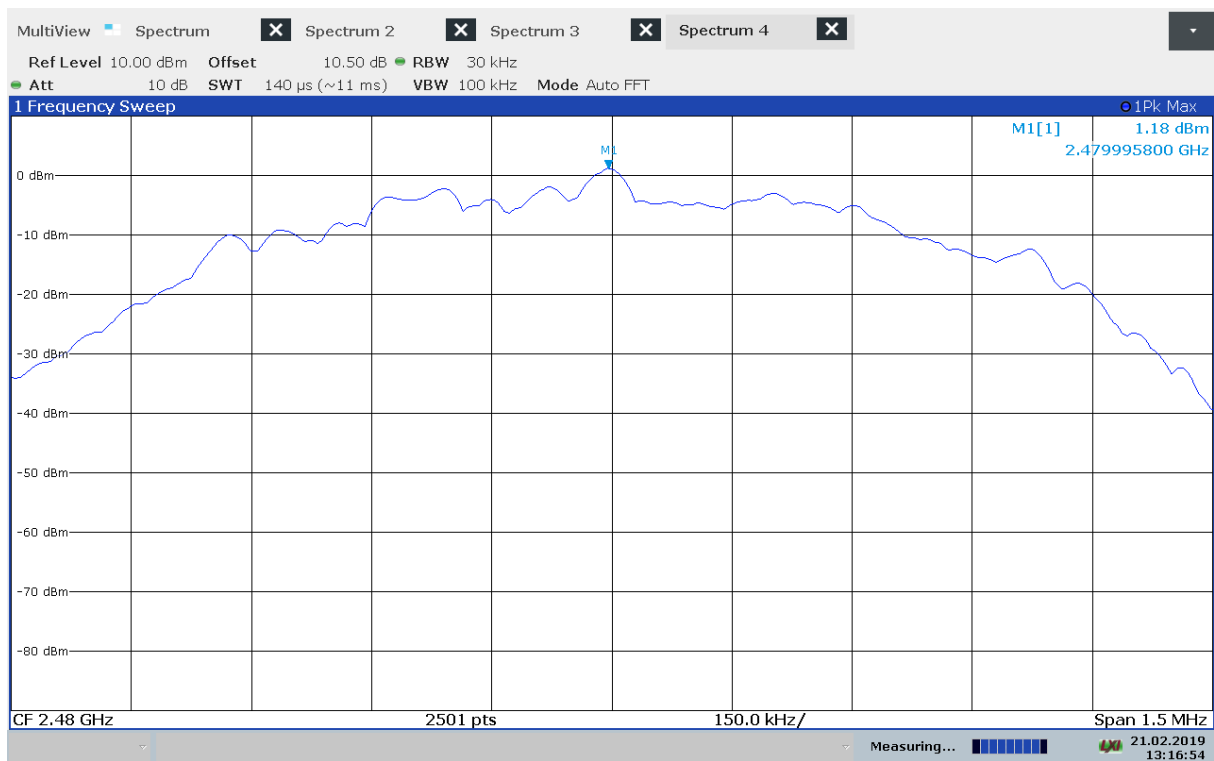
The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3 kHz band.



Power Spectral Density, 2402 MHz



Power Spectral Density, 2440 MHz



Power Spectral Density, 2480 MHz

3.5 Conducted Emissions at Antenna Connector

Para. No.: 15.247 (d)

Carrier Frequency	Highest Value (dBc)	Margin (dB)	Verdict
2402 MHz	> 60	> 40	Pass
2440 MHz	> 60	> 40	Pass
2480 MHz	> 60	> 40	Pass

Measured with Peak Detector

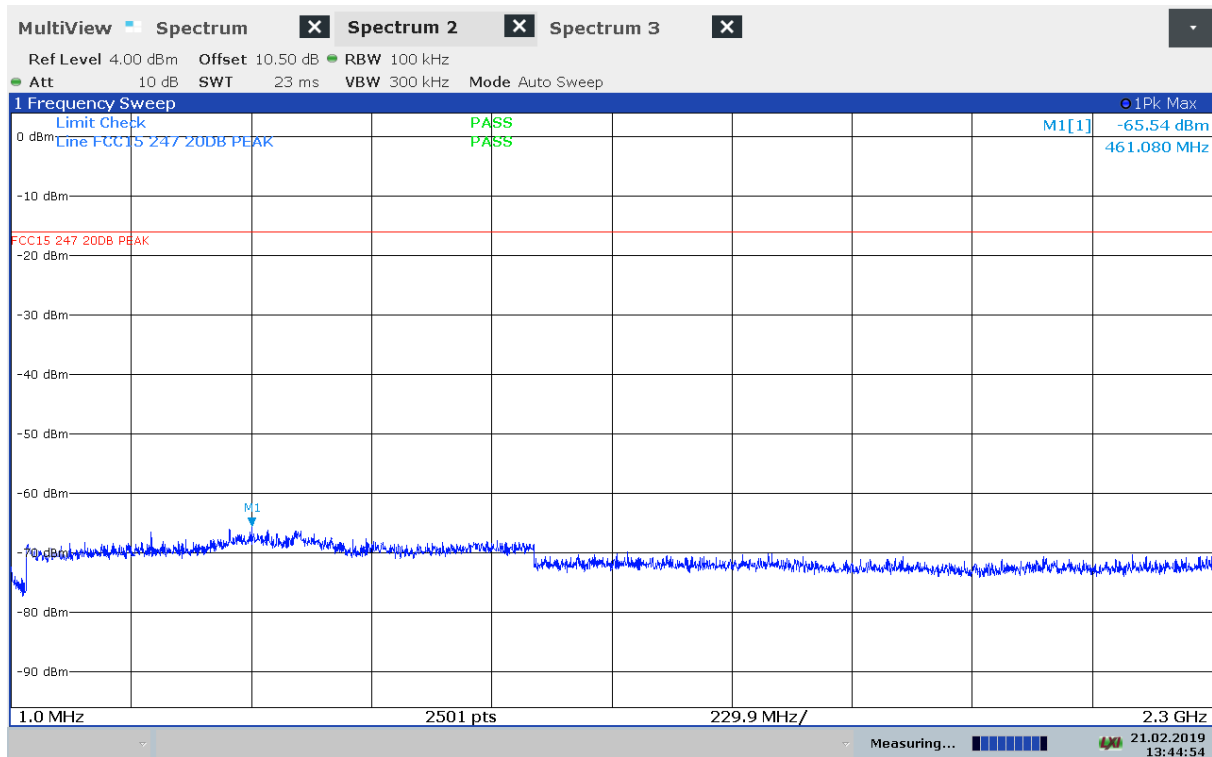
RF conducted power to 25 GHz: see attached plots.

Limit

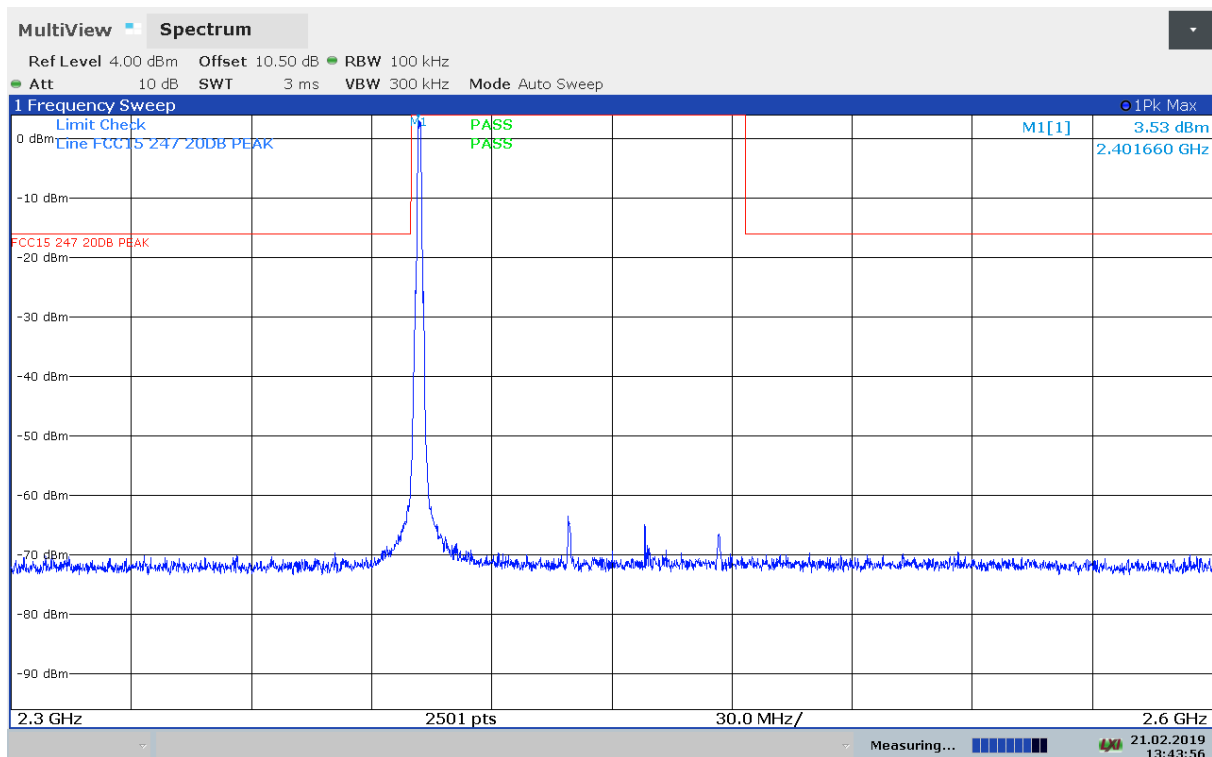
Peak measurement	RMS averaging
20 dBc or more in 100 kHz bandwidth	30 dBc or more in 100 kHz bandwidth

Detector type shall be the same as used for measuring Output Power.

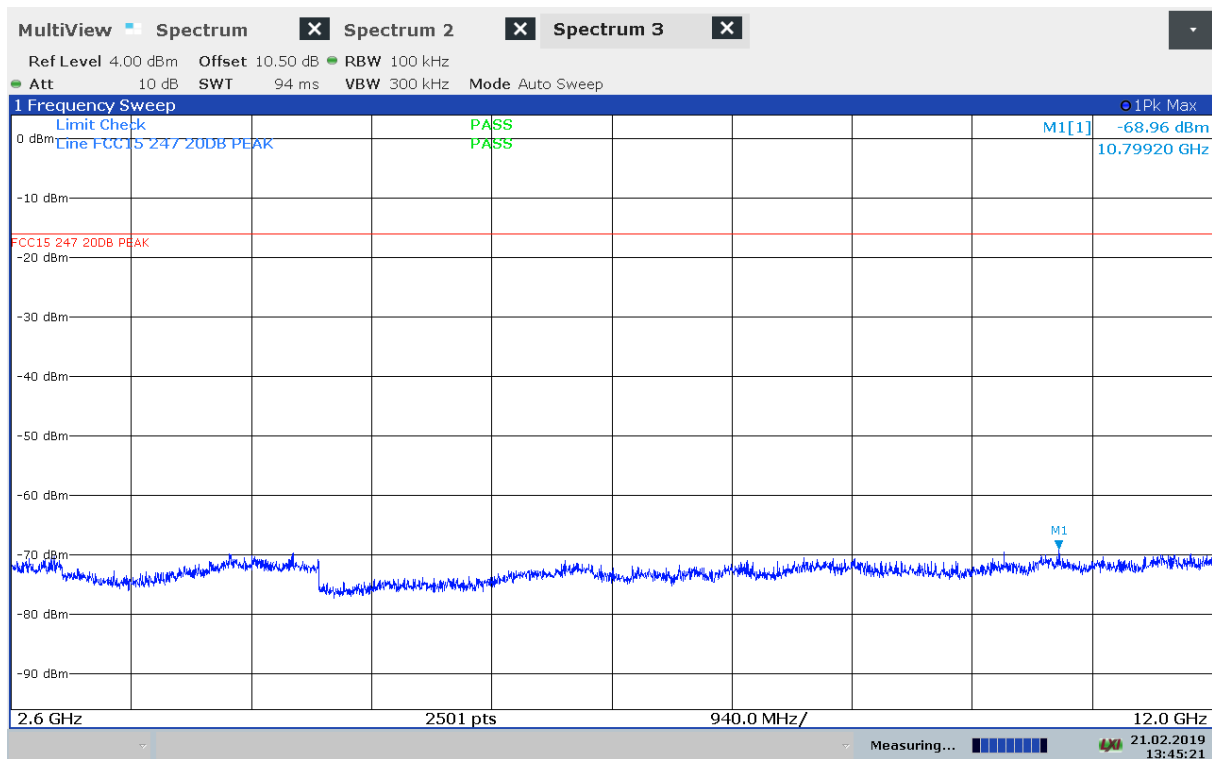
Attenuation below the general limits specified in part 15.209(a) is not required.



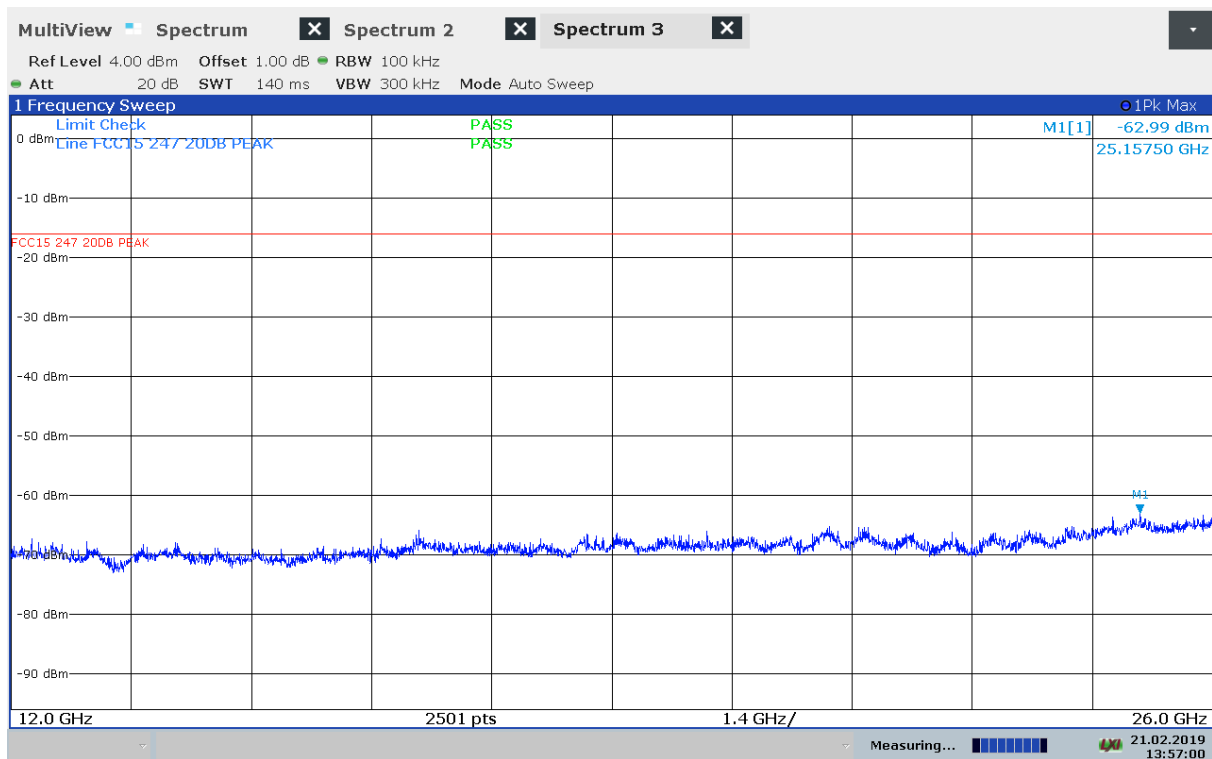
Conducted Emissions, 1–2300 MHz, 2402MHz



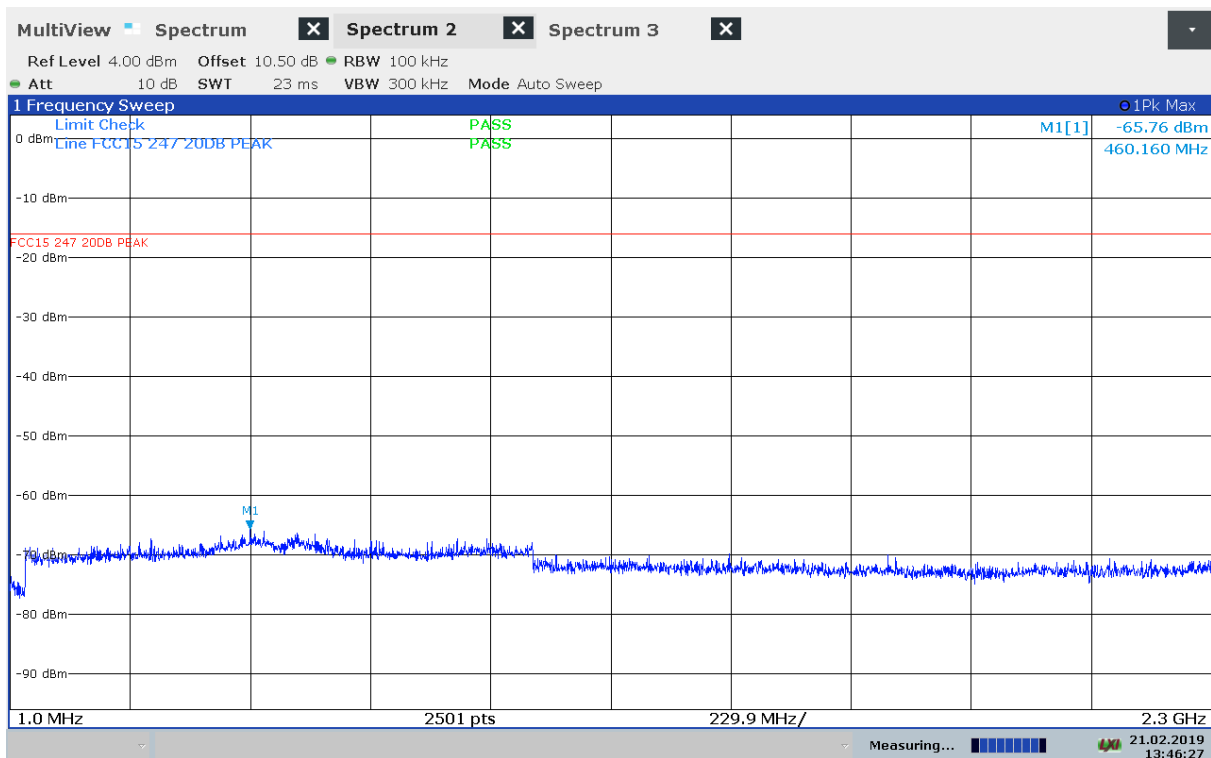
Conducted Emissions, 2300–2600 MHz, 2402MHz



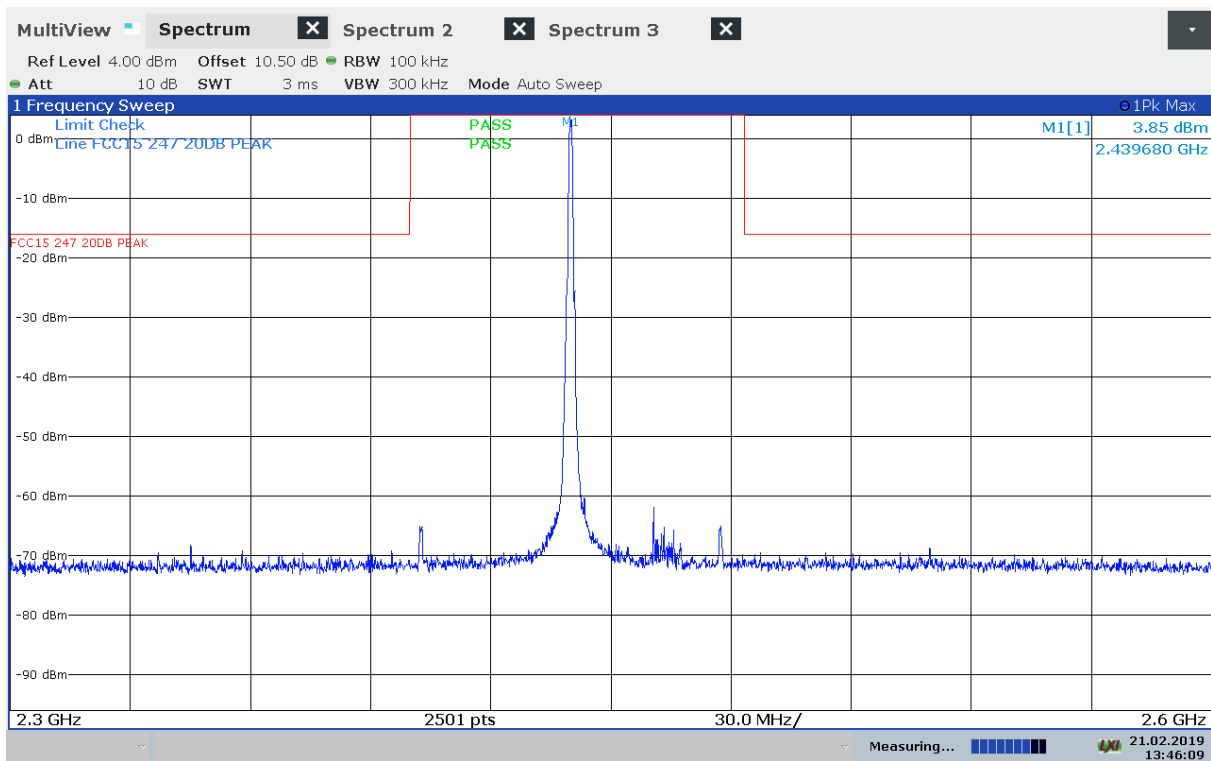
Conducted Emissions, 2600–12000 MHz, 2402MHz



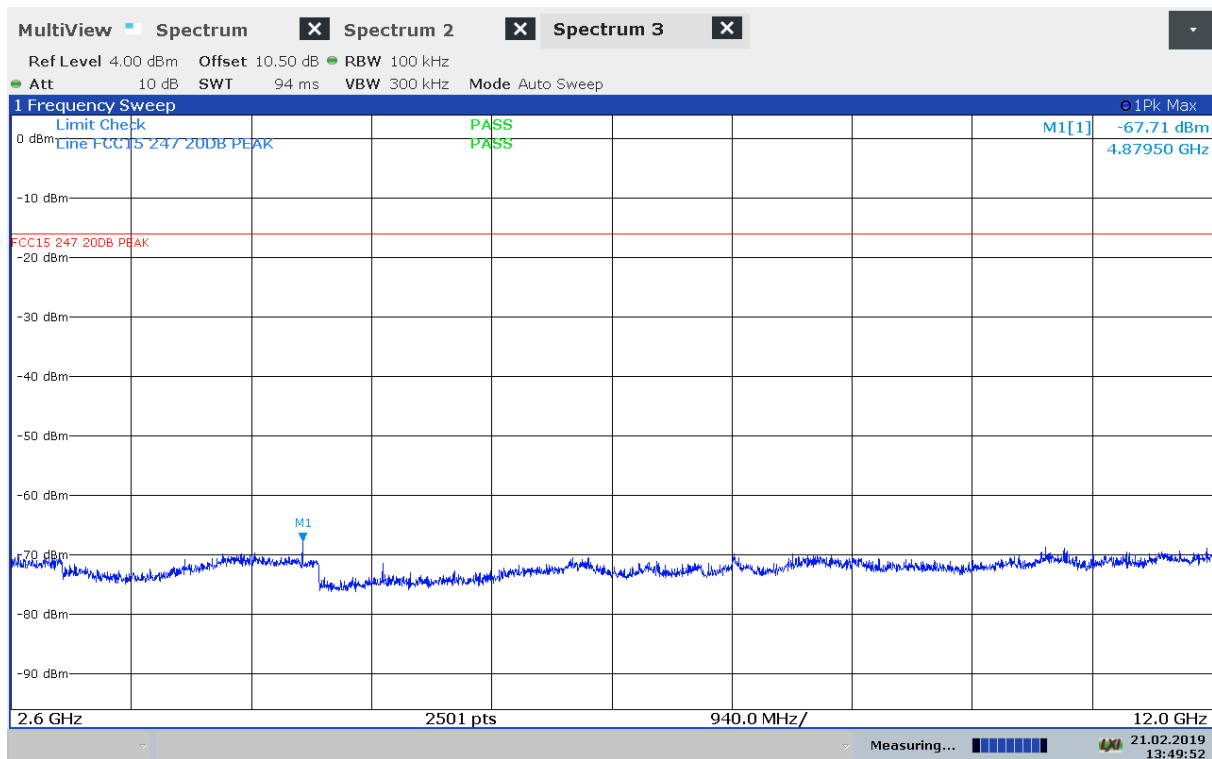
Conducted Emissions, 12000–26000 MHz, 2402MHz



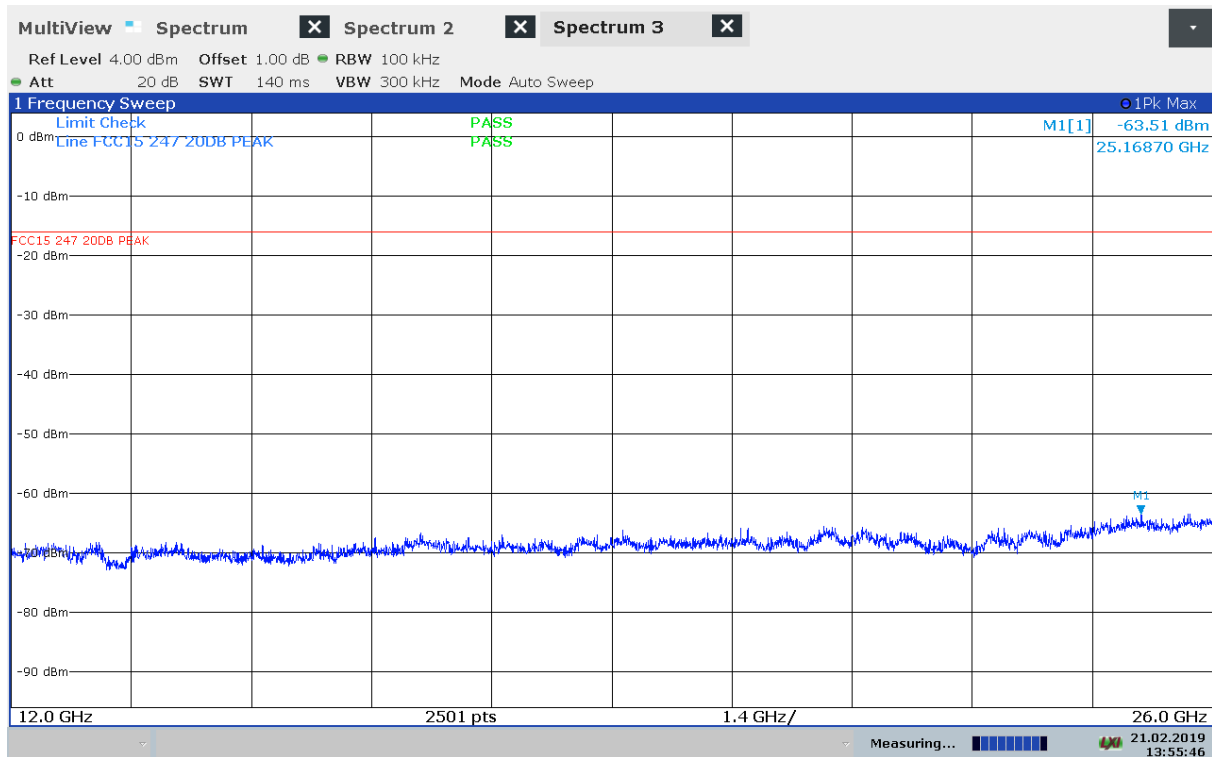
Conducted Emissions, 1–2300 MHz, 2440MHz



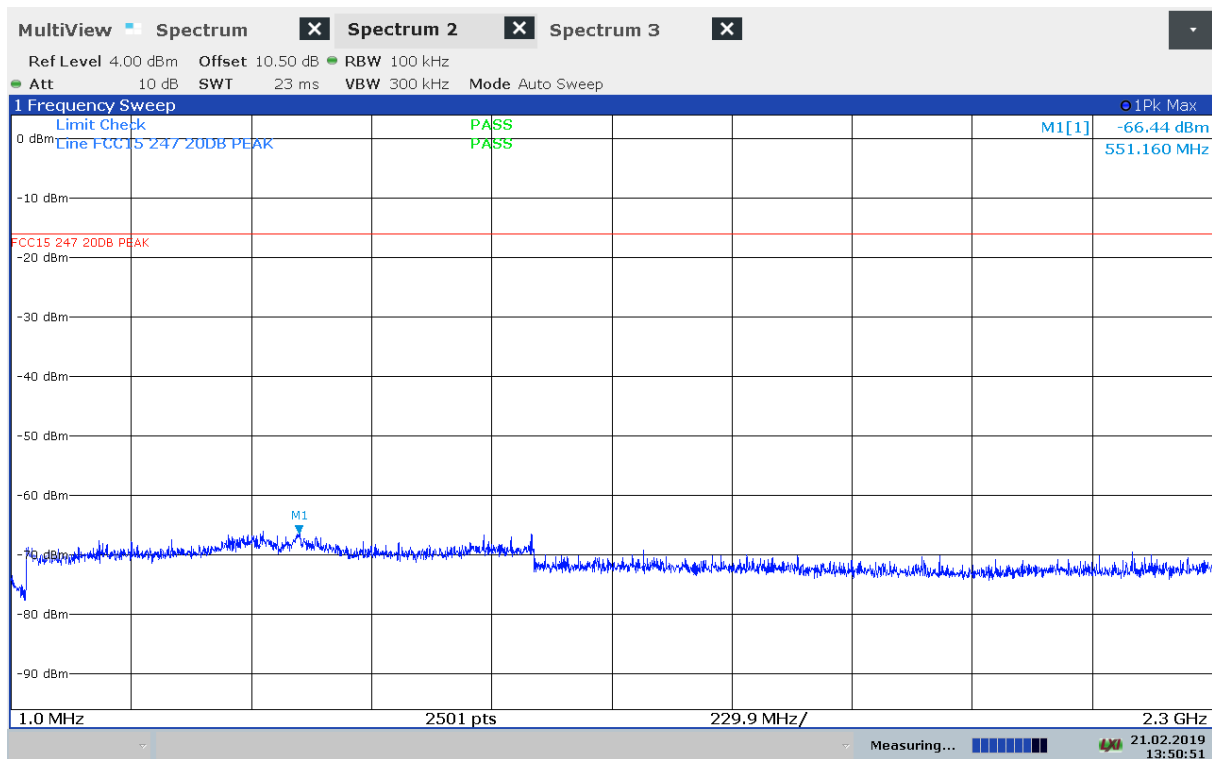
Conducted Emissions, 2300–2600 MHz, 2440MHz



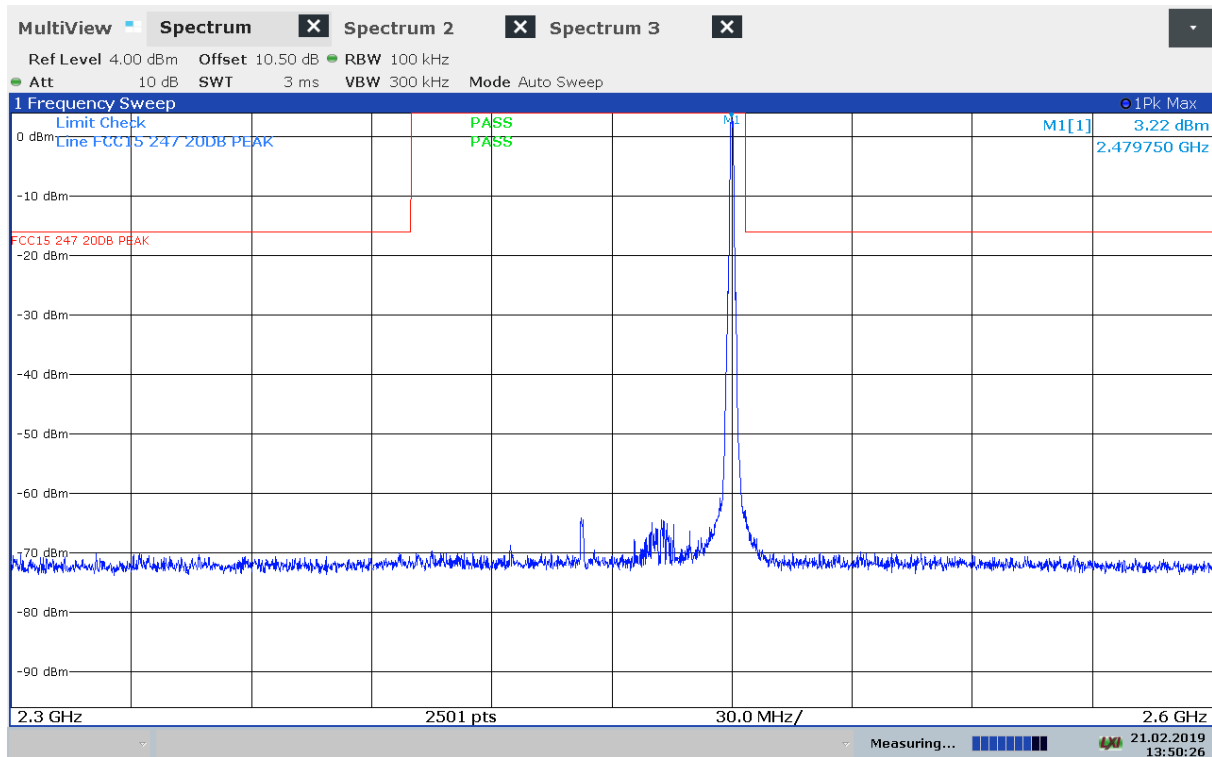
Conducted Emissions, 2600–12000 MHz, 2440MHz



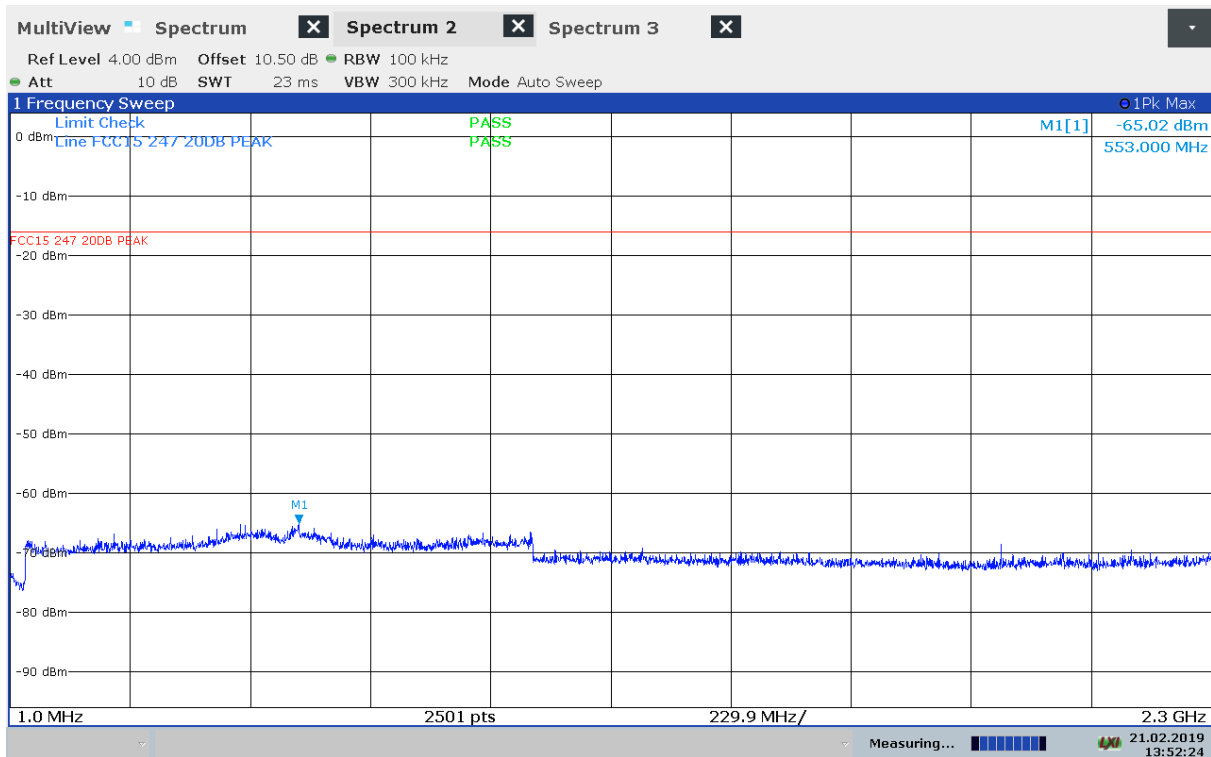
Conducted Emissions, 12000–26000 MHz, 2440MHz



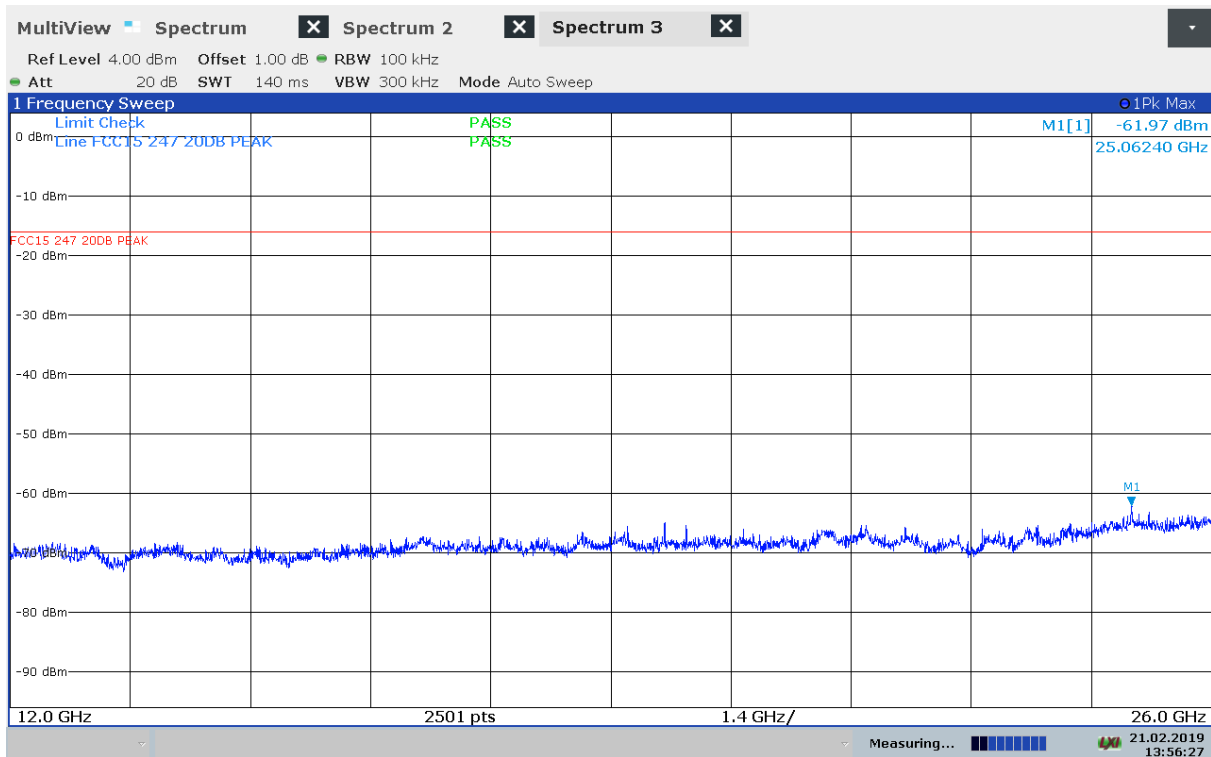
Conducted Emissions, 1–2300 MHz, 2480MHz



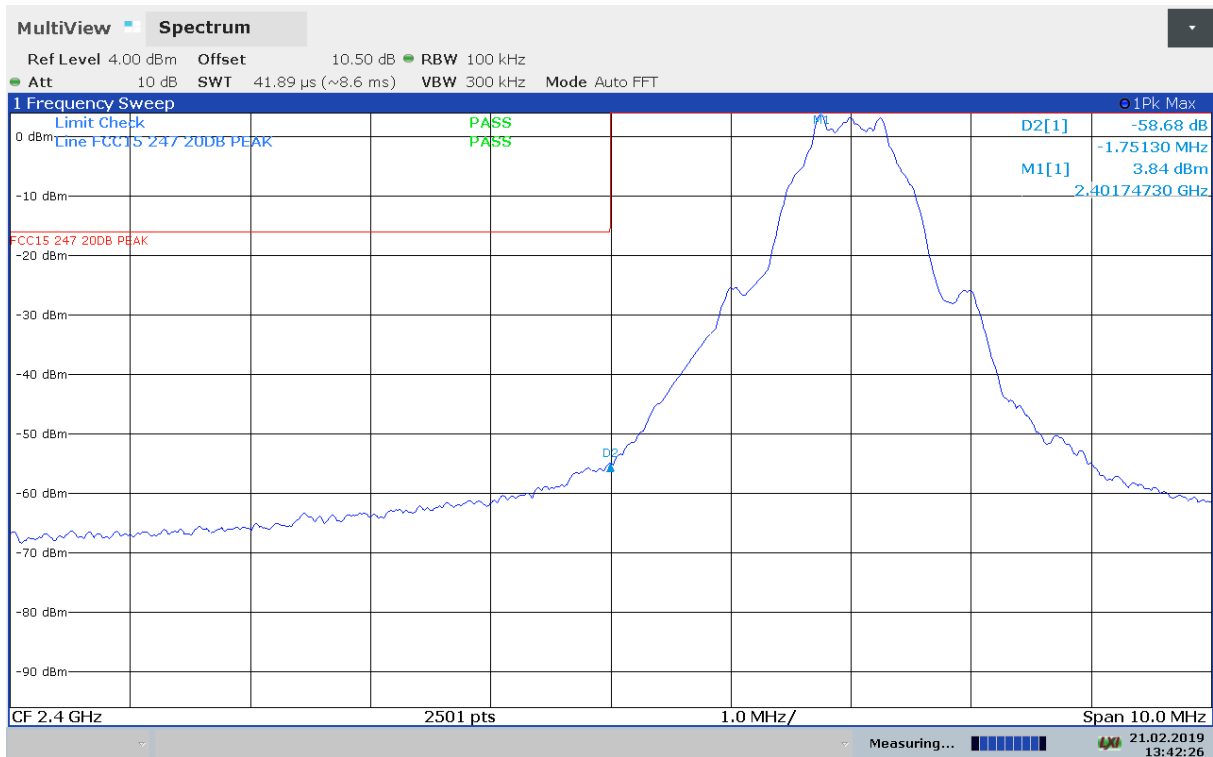
Conducted Emissions, 2300–2600 MHz, 2480MHz



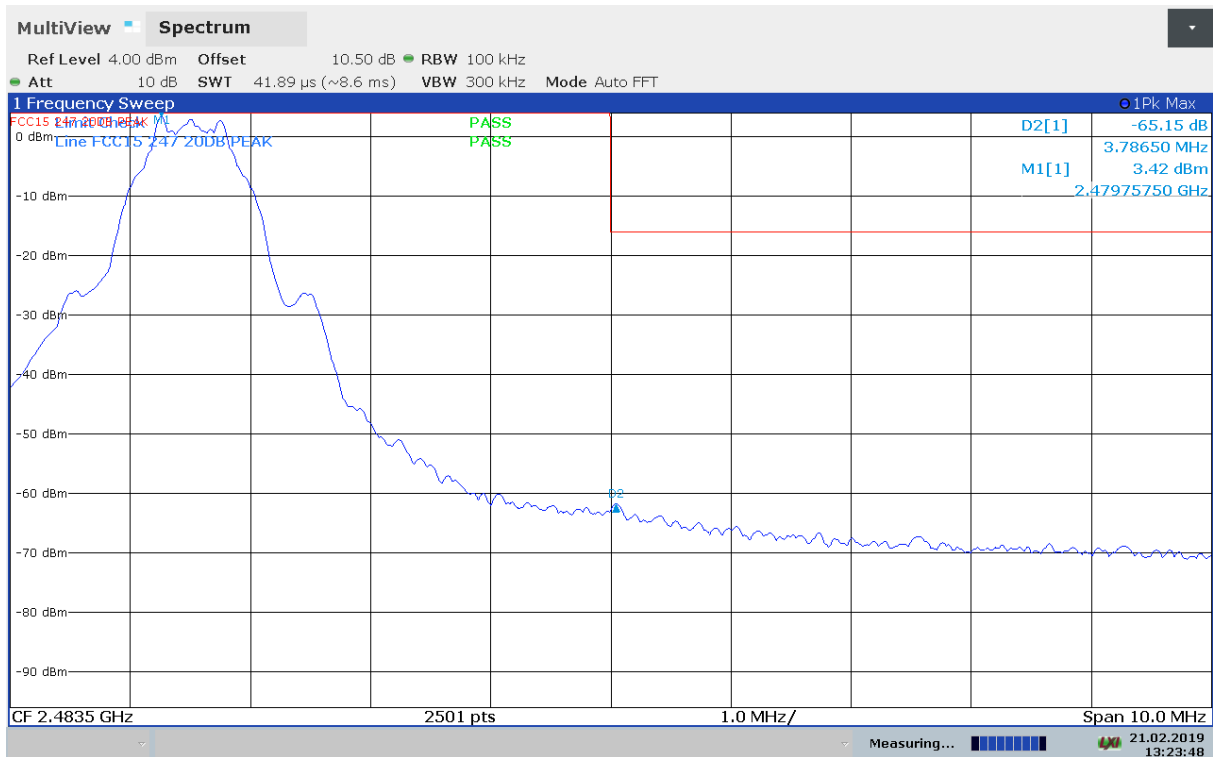
Conducted Emissions, 2600–12000 MHz, 2480MHz



Conducted Emissions, 12000–26000 MHz, 2480MHz



Conducted Emissions, 2402 MHz, Lower Band Edge



Conducted Emissions, 2480 MHz, Upper Band Edge

3.6 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 4 clause 8.10.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 5, clause 8.9.

FCC (MHz)	ISSED (MHz)	FCC (GHz)	ISSED (GHz)
0.090-0.110		0.96-1.24 1.3-1.427	0.96-1.427
0.495-0.505		1.435-1.6265	
2.1735-2.1905		1.6455-1.6465	
	3.020-3.026	1.660-1.710	
4.125-4.128		1.7188-1.7222	
4.17725-4.17775		2.2-2.3	
4.20725-4.20775		2.31-2.39	
	5.677-5.683	2.4835-2.5	
6.215-6.218		2.69-2.9	2.655-2.9
6.26775-6.26825		3.26-3.267	
6.31175-6.31225		3.332-3.339	
8.291-8.294		3.3458-3.358	
8.362-8.366		3.6-4.4	3.5-4.4
8.37625-8.38675		4.5-5.15	
8.41425-8.41475		5.35-5.46	
12.29-12.293		7.25-7.75	
12.51975-12.52025		8.025-8.5	
12.57675-12.57725		9.0-9.2	
13.36-13.41		9.3-9.5	
16.42-16.423		10.6-12.7	
16.69475-16.69525		13.25-13.4	
16.80425-16.80475		14.47-14.5	
25.5-25.67		15.35-16.2	
37.5-38.25		17.7-21.4	
73-74.6		22.01-23.12	
74.8-75.2		23.6-24.0	
108-121.94 123-138	108-138	31.2-31.8	
149.9-150.05		36.43-36.5	
156.52475-156.52525		Above 38.6	
156.7-156.9			
162.0125-167.17			
167.72-173.2			
240-285			
322-335.4			
399.9-410			
608-614			

Frequencies in **Bold** text are specific for FCC or ISSED, all other frequencies are common.

3.7 Spurious Emissions (Radiated)

FCC Part 15.209

Test Results: Complies

Measurement Data:

	Measured field strength (dBμV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	(dBμV/m)	(dB)	
Peak Detector	43.3	59.6	74	30.7	14.4
Average Detector	23.3	39.6	54	30.7	14.4

Band Edge is measured with the EUT transmitting on 2402 and 2480 MHz

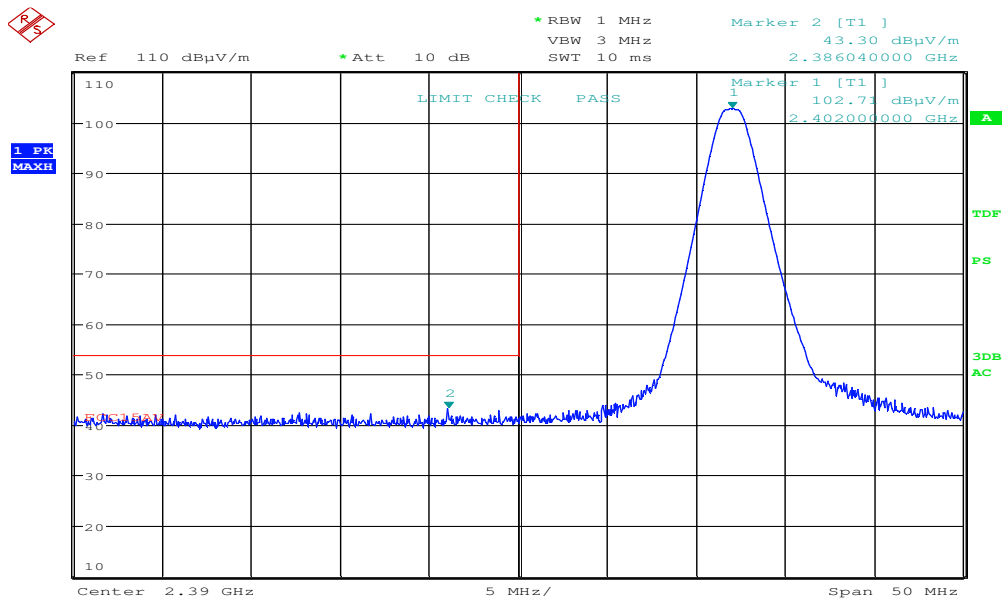
Average values are calculated from Peak Values using the Duty Cycle correction factor.

See attached plots.

Duty Cycle Correction Factors

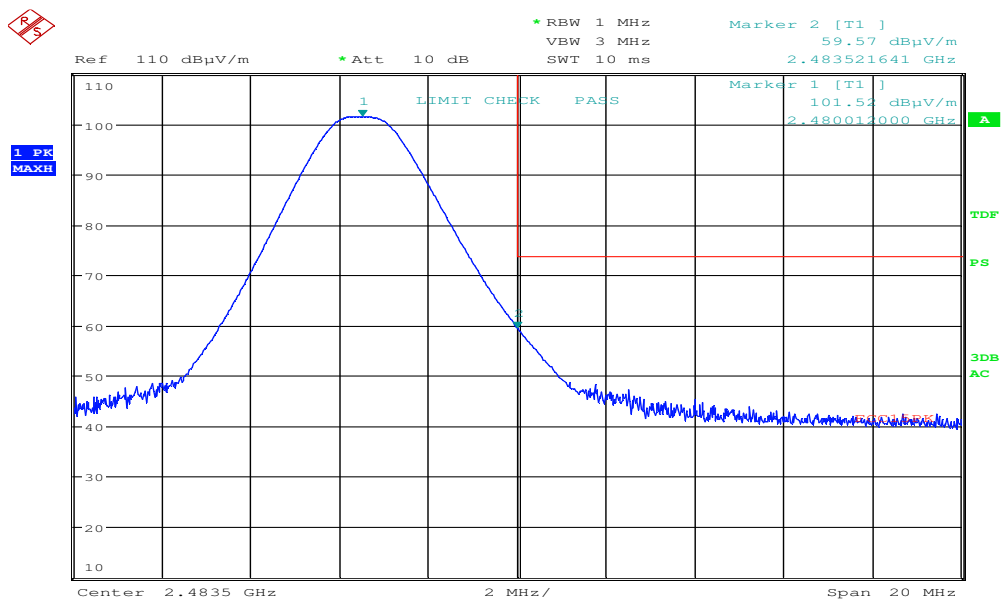
Correction Factor = $-20 \times \log(\text{Sum of Bursts} / (\text{Frame Length} \times (\text{Min \# Hopping Channels} / \text{Bursts per frame})))$
 $= -20 \times \log((0.140 + 3 \times 0.164) / (4.000 \times (20 / 4))) \text{ dB} = -20 \times \log(0.632 / 20) = 30.0 \text{ dB}$

Maximum Allowed Correction Factor = 20 dB



Date: 4.MAR.2019 15:08:42

Band Edge, Lower, Peak, 2402 MHz, Max Power



Date: 4.MAR.2019 15:20:34

Band Edge, Upper, Peak, 2480 MHz, Max Power

3.8 Radiated Emissions, below 1GHz

FCC 15.205, 15.209

ISED RSS-GEN, Issue 5, Clause 8.9

Test Results: Complies

Radiated emission 30–1000 MHz

Measuring distance 3m.

Tested in test mode with EUT transmitting on channel 19.

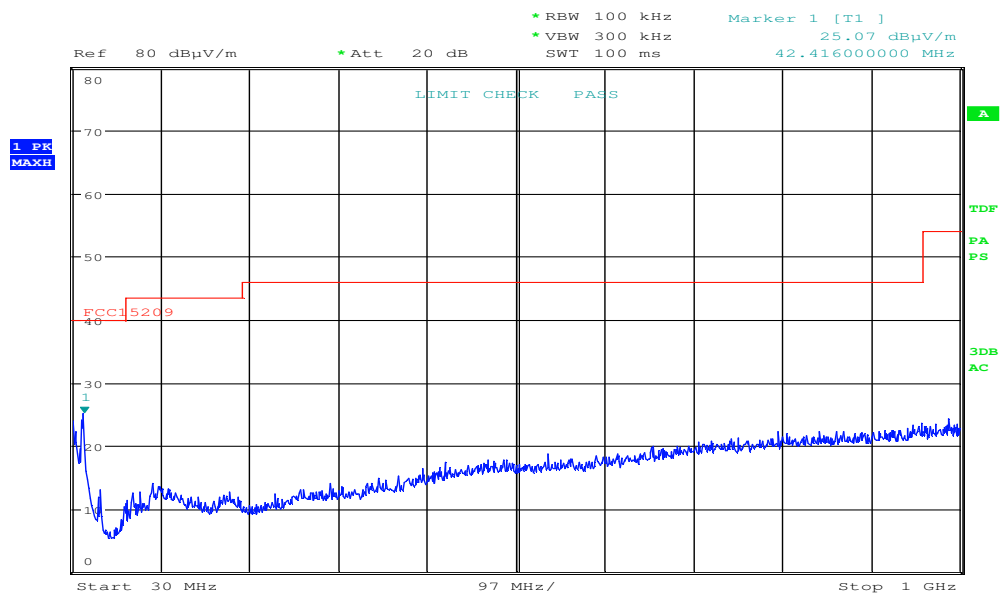
Measured values:

Measured Frequency (MHz)	Carrier Frequency (MHz)	Measured Emission (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
30 – 88	2440	< 27	40.0	> 13
88 – 216	2440	< 20	43.5	> 23.5
216 – 960	2440	< 26	46.0	> 20
960 – 1000	2440	< 30	54.0	> 24

See attached plots.

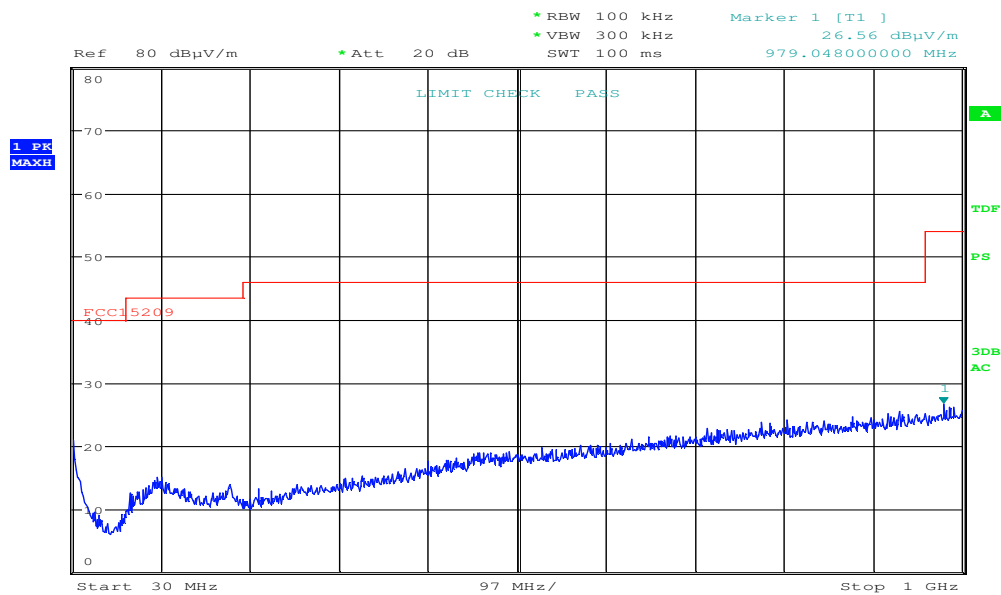
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency (MHz)	Quasi Peak (µV/m)	Quasi Peak (dBµV/m)
30 – 88	100	40.0
88 – 216	150	43.5
216 – 960	200	46.0
960 - 1000	500	54.0



Date: 29.MAR.2019 15:35:45

Radiated Emissions, 30 – 1000 MHz, 2440 MHz, EUT V, VP



Date: 29.MAR.2019 15:31:02

Radiated Emissions, 30 – 1000 MHz, 2440 MHz, EUT V, HP

3.9 Radiated Emissions, above 1GHz

FCC 15.205, 15.209

ISED RSS-GEN, Issue 5, Clause 8.9

Test Results: Complies

Measurement Data:

Radiated Emissions, 1–26 GHz

Measuring distance: 3 m (1–18 GHz)
Pre-scan (18-26 GHz)

Bandwidths: RBW=1MHz / VBW=3MHz

Measured values:

Frequency (MHz)	Channel	Polarization	Peak (dBμV/m)	Average (dBμV/m)	Peak Margin (dB)	Av Margin (dB)
Any	00/19/39	V/H	< 54	< 44	> 20	> 10

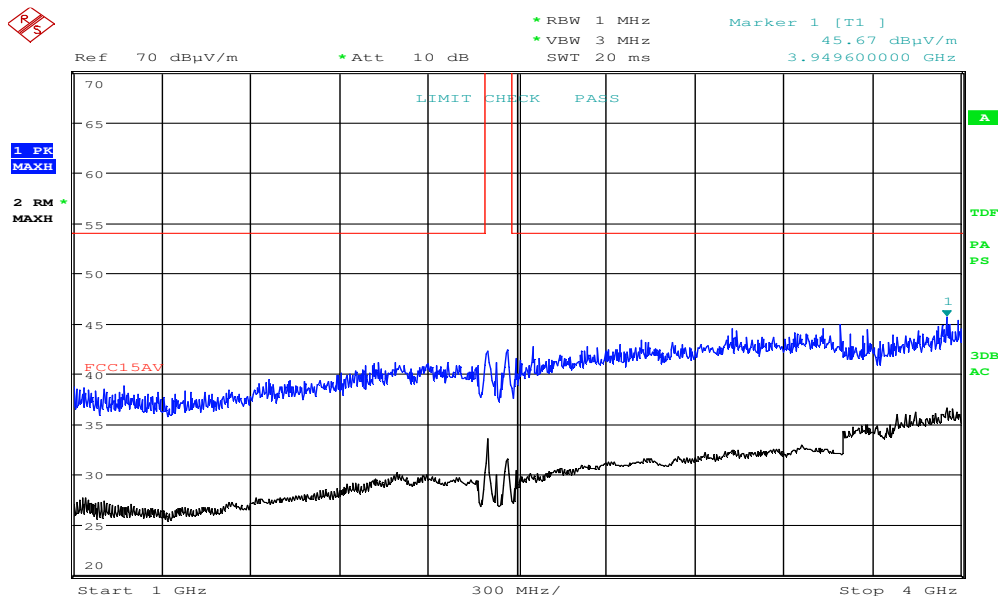
All measurements were performed with the EUT transmitting on a fixed channel.

Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

See plots.

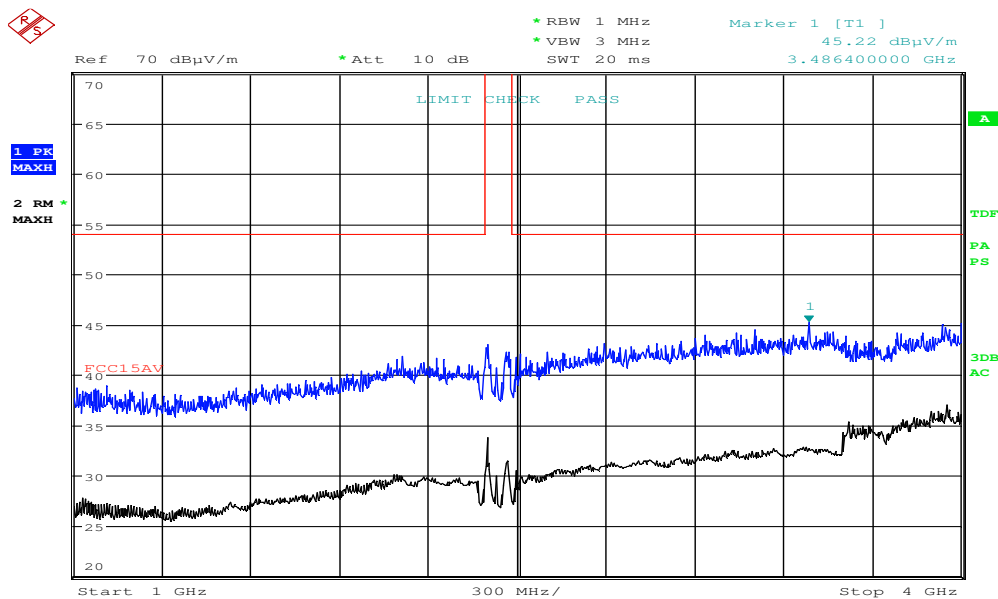
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency (MHz)	Average Detector (dBμV/m)	Peak Detector (dBμV/m)
1 – 26 GHz	54.0	74.0



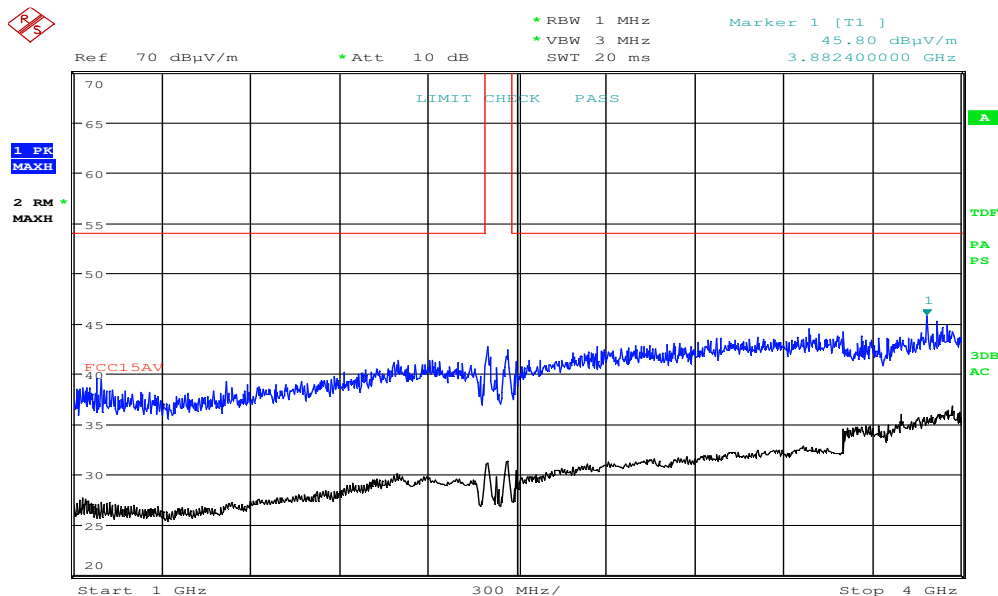
Date: 4.MAR.2019 15:46:18

Radiated Emissions, 1000 – 4000 MHz, 2402 MHz, EUT V, VP



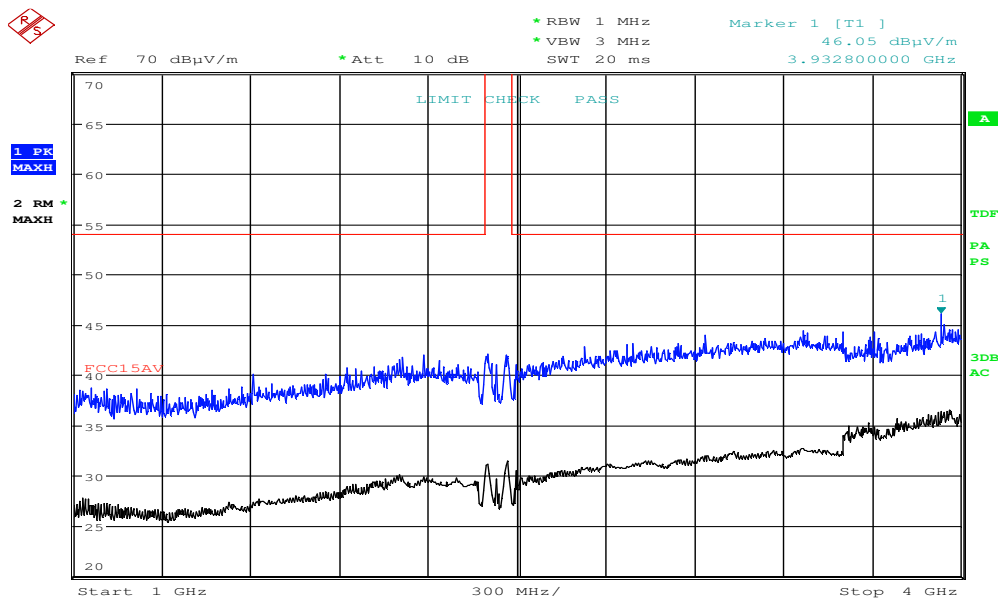
Date: 4.MAR.2019 15:48:13

Radiated Emissions, 1000 – 4000 MHz, 2402 MHz, EUT V, HP



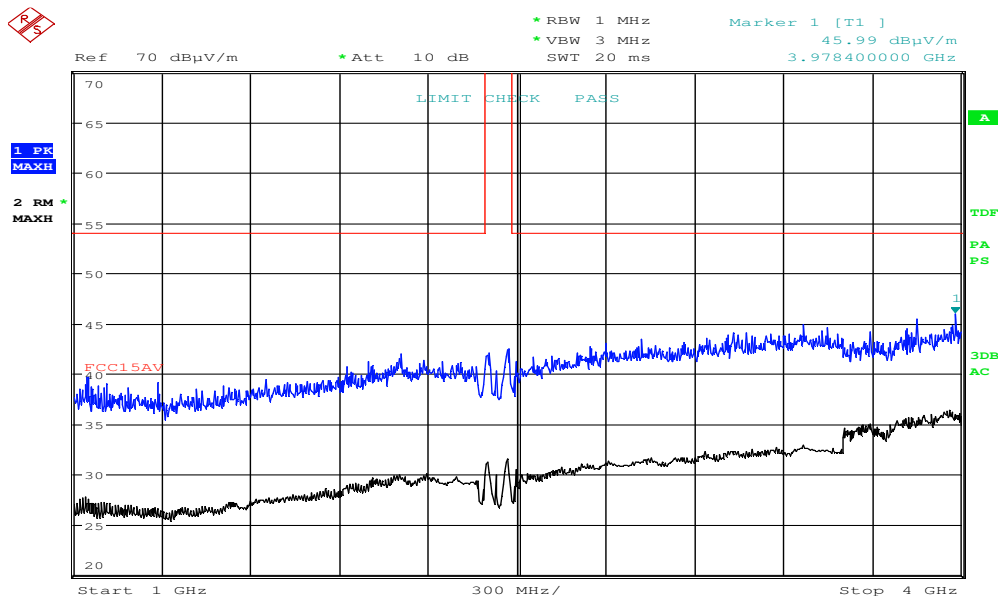
Date: 4.MAR.2019 15:40:26

Radiated Emissions, 1000 – 4000 MHz, 2440 MHz, EUT V, VP



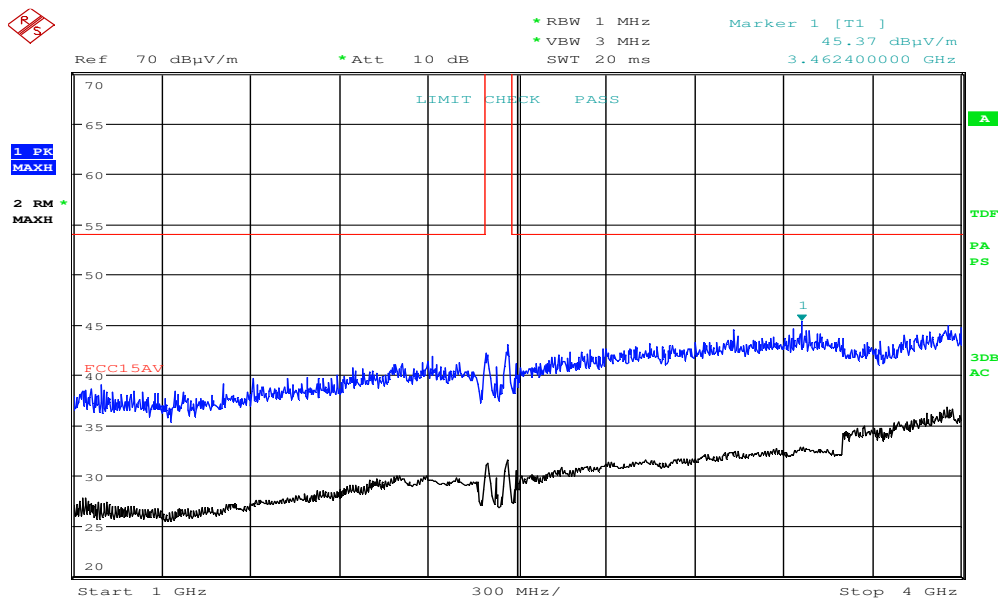
Date: 4.MAR.2019 15:42:22

Radiated Emissions, 1000 – 4000 MHz, 2440 MHz, EUT V, HP



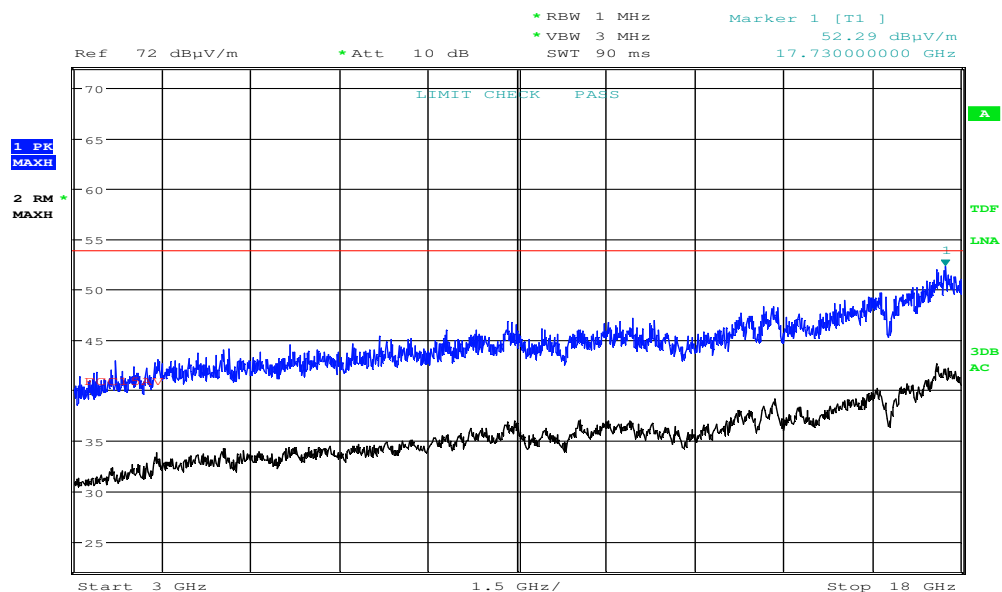
Date: 4.MAR.2019 15:28:50

Radiated Emissions, 1000 – 4000 MHz, 2480 MHz, EUT V, VP



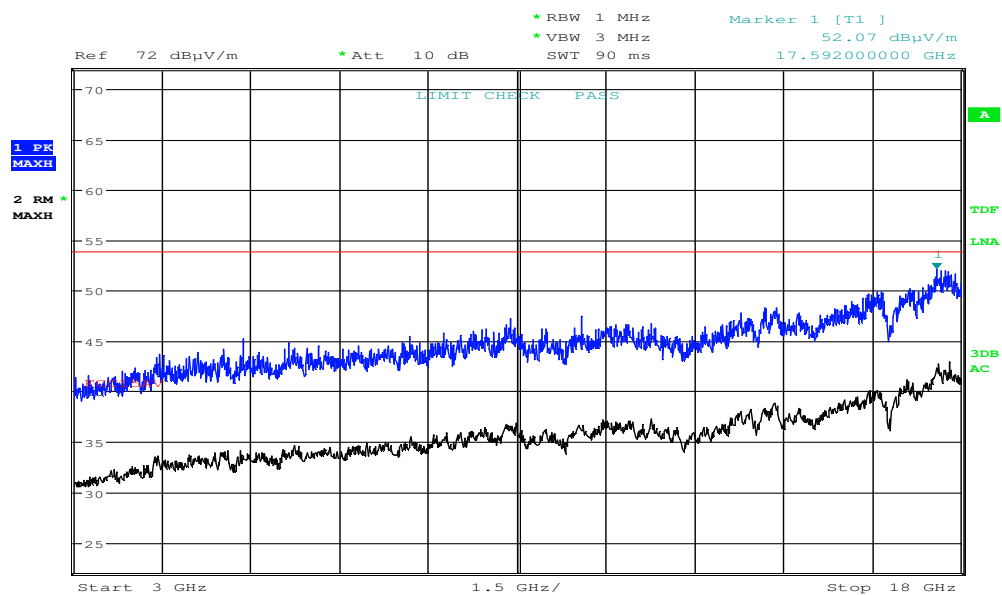
Date: 4.MAR.2019 15:30:45

Radiated Emissions, 1000 – 4000 MHz, 2480 MHz, EUT V, HP



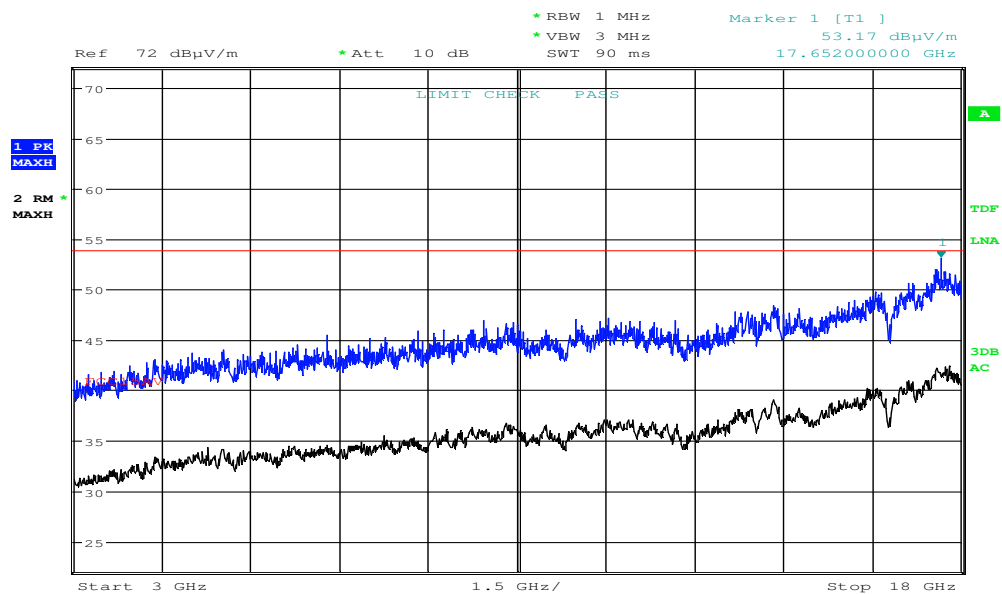
Date: 29.MAR.2019 12:59:09

Radiated Emissions, 3000 – 18000 MHz, 2402 MHz, EUT V, VP



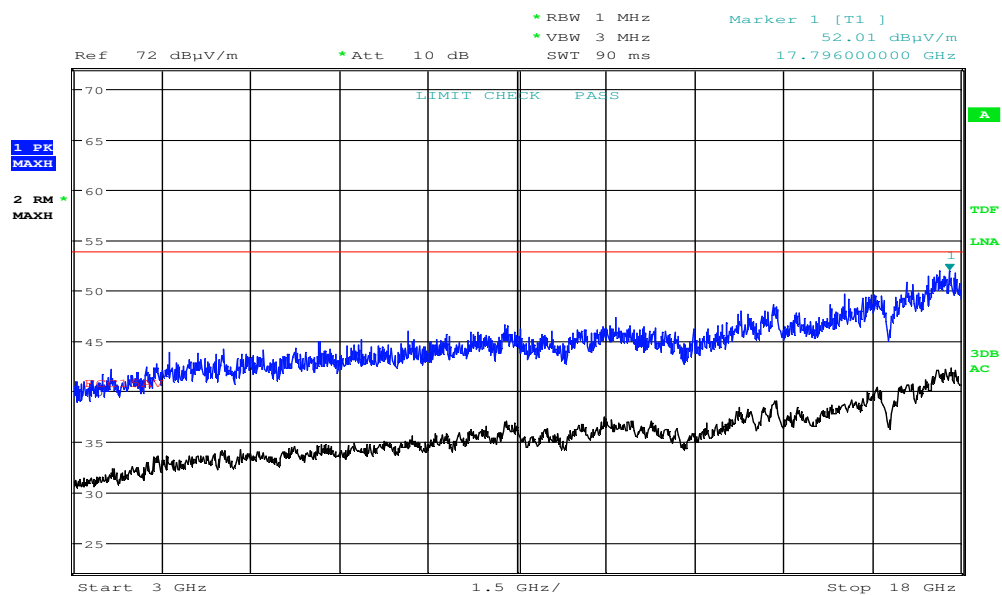
Date: 29.MAR.2019 13:01:05

Radiated Emissions, 3000 – 18000 MHz, 2402 MHz, EUT V, HP



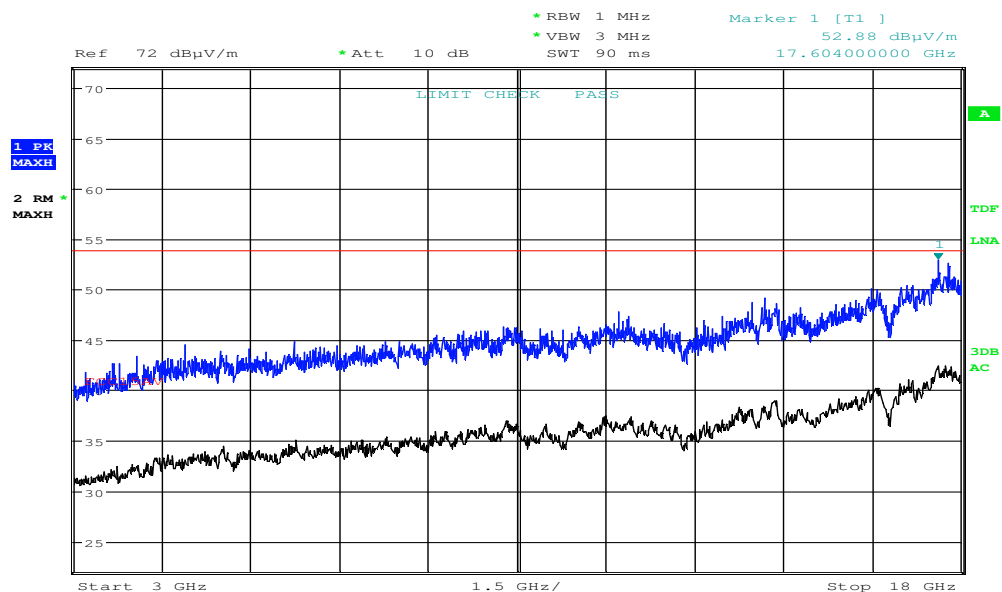
Date: 29.MAR.2019 13:31:34

Radiated Emissions, 3000 – 18000 MHz, 2440 MHz, EUT V, VP



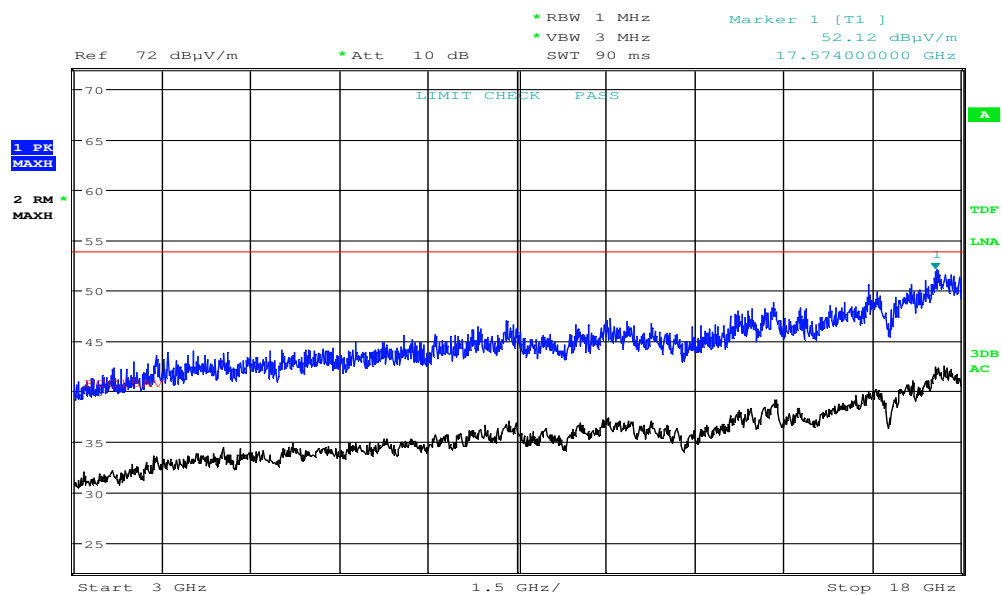
Date: 29.MAR.2019 13:33:29

Radiated Emissions, 3000 – 18000 MHz, 2440 MHz, EUT V, HP



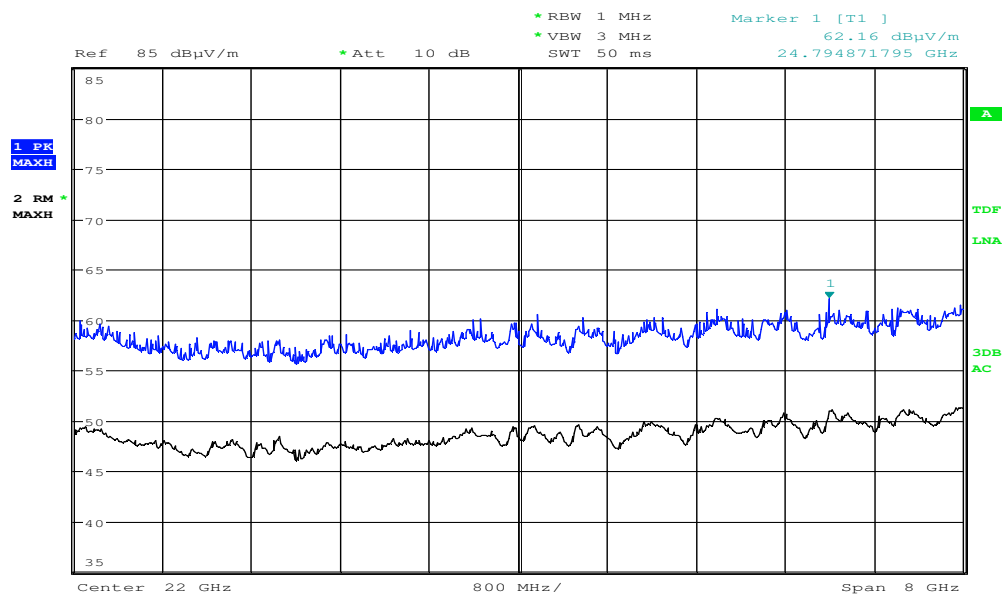
Date: 29.MAR.2019 13:38:13

Radiated Emissions, 3000 – 18000 MHz, 2480 MHz, EUT V, VP



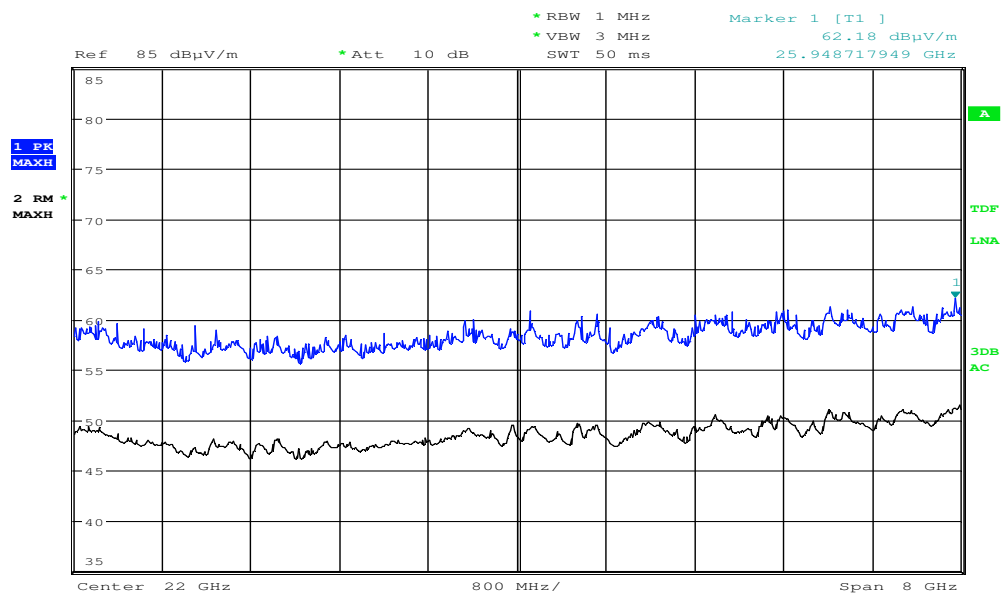
Date: 29.MAR.2019 13:40:08

Radiated Emissions, 3000 – 18000 MHz, 2480 MHz, EUT V, HP



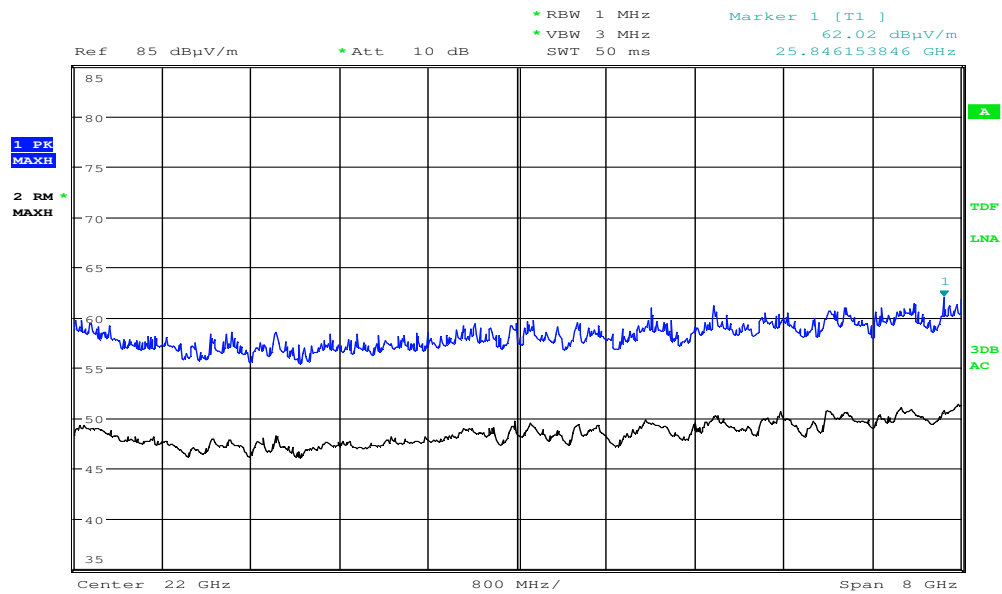
Date: 29.MAR.2019 14:51:16

Radiated Emissions, 18 – 26 GHz, 2402 MHz, ~10cm



Date: 29.MAR.2019 14:55:00

Radiated Emissions, 18 – 26 MHz, 2440 MHz, ~10cm



Date: 29.MAR.2019 14:56:18

Radiated Emissions, 18 – 26 GHz, 2480 MHz, ~10cm

4 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		Uncertainty
Output Power		±0.5 dB
Power Spectral Density		±0.5 dB
Out of Band Emissions, Conducted	< 3.6 GHz	±0.6 dB
	> 3.6 GHz	±0.9 dB
Spurious Emissions, Radiated	< 1 GHz	±2.5 dB
	> 1 GHz	±2.2 dB
Emission Bandwidth		±4 %
Power Line Conducted Emissions		+2.9 / -4.1 dB
Spectrum Mask Measurements	Frequency	±5 %
	Amplitude	±1.0 dB
Frequency Error		±0.6 ppm
Temperature Uncertainty		±1 °C

All uncertainty values are expanded standard uncertainty to give a confidence level of 95%, based on coverage factor k=2

5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

No.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	FSW43	Spectrum Analyzer	Rohde & Schwarz	LR 1690	2019-01	2020-01
2	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2019-01	2020-01
3	6810.17B	Attenuator	Suhner	LR 1669	COU	
4	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	COU	
5	JB3	BiLog Antenna	Sunol Sciences	N-4525	2016-05	2019-05
6	317	Preamplifier	Sonoma Inst.	LR 1687	2018-07	2019-07
7	3115	Horn Antenna	EMCO	LR 1330	2016-10	2019-10
8	3117-PA	Horn Antenna with Preamp	EMCO	LR 1717	2017-12	2019-12
9	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2018-07	2019-07
10	638	Horn Antenna	Narda	LR 1480	2010-06	2020-06
11	WRCG2400/2483.5	Band Reject Filter	Wainwright Inst.	LR 1530	COU	
12	Model 87 V	Multimeter	Fluke	LR 1597	2018.02	2020.02
13	6812B	AC Power Source	Agilent	LR 1515	COU	
14	ENV216	Two Line V-Network	Rohde & Schwarz	LR 1665	2017.11	2019.11
15	ESC13	Measuring Receiver	Rohde & Schwarz	N-4259	2017.10	2019.10
16	ST18/SMA/N/36	RF Cable	Suhner	LR 1627	COU	
17	SF102/1000MM	RF Cable	Suhner	SN 50113/2	COU	
18	SF102/2000MM	RF Cable	Suhner	SN 500100/2	COU	

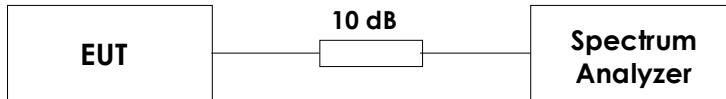
COU - Calibrate ON Use; N/A – Not Applicable

The software listed below has been used for one or more tests.

No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.20.10	Power Line Conducted test software
2	Rohde & Schwarz	EMC32	10.20.10	Radiated Emission test software
3	Rohde & Schwarz	GPBShot	2.7	Screenshots from R&S Spectrum Analyzers

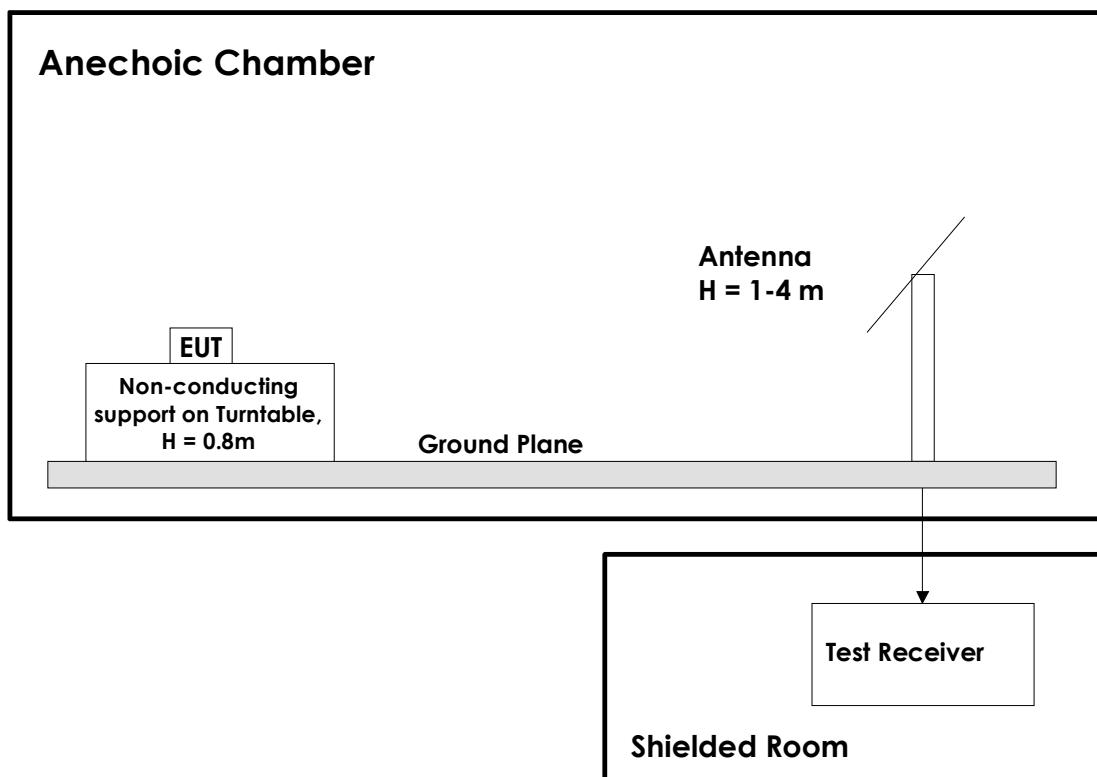
6 BLOCK DIAGRAM

6.1 Conducted Tests



This test set-up is used for all Conducted tests.

6.2 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. Measuring distance is 3m for all frequencies up to 18 GHz. Above 18 GHz measuring distance is 1m.

Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna.

All measurements at 1 GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers.

A pre-amplifier is used for all measurements, and High-Pass filter is used for all harmonics.

Above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss.