Test Report

Test report no.: 24080432-41496-0
Date of issue: 2025-02-17

Test result: The test item **- passed - and complies** with below listed standards.

Applicant
AVL DiTEST GmbH

Manufacturer
AVL DiTEST GmbH

Test Item
322001

RF-Spectrum Testing
according to:

FCC 47 CFR Part 15
Radio Frequency Devices – Subpart C
§ 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz

RSS-247, Issue 3 (2023-08)
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen, Issue 5 (2018-04)
General Requirements for Compliance of Radio Apparatus

Tested by (name, function, signature)	Karsten Geraldy Lab Manager RF	signature
Approved by (name, function, signature)	Andreas Bender Deputy Managing Director	signature

Applicant and Test item details	
Applicant	AVL DiTEST GmbH Alte Poststrasse 156 8020, Graz, Austria
Manufacturer	AVL DiTEST GmbH Alte Poststrasse 156 8020, Graz, Austria
Test item description	Vehicle Communication Interface VCI ONE (weLINK)
Model/Type reference	322001
Standard specific information	
FCC ID	2A9TU-322001
IC	29975-322001
HMN	N/A
PMN	VCI
HVIN	322001
FVIN	N/A
Technology	Bluetooth Basic Data Rate (BDR), Enhanced Data Rate (EDR)
Frequency	2.4 GHz ISM band (2400 – 2483.5 MHz)
Antenna	Flexible Polymer Series Antenna (FXP830.24.0100B)
Power supply	6.0 to 36.0 V DC
Temperature range	-30 °C to +60 °C

Disclaimer and Notes

The content of this report relates to the mentioned test sample(s) only.
IBL-Lab GmbH does not take samples. The samples used for testing are provided by the applicant.
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The last valid version is available at TAMSys®.
Signatures are done electronically, if signer does not match stated signer, it is signed per order.
Information supplied by the applicant can affect the validity of results. The data is marked accordingly.

Within this test report, a ☒ point / ☐ comma is used as a decimal separator.
If otherwise, a detailed note is added adjected to its use.

Decision rule:
Decision rule based on simple acceptance without guard bands, binary statement, based on mutually agreed uncertainty tolerances with expansion factor k=2 according to ILAC-G8:09/2019

1 TABLE OF CONTENTS

2 GENERAL INFORMATION

2.1 Administrative details

Testing laboratory	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany Fon: +49 6894 38938-0 Fax: +49 6894 38938-99 URL: https://ib-lenhardt.com/ E-Mail: info@ib-lenhardt.com
Accreditation / Designation	The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025:2018. Scope of testing and registration number: • Attachment to the accreditation certificate D-PL-21375-01-00 ○ Electronics ○ Electromagnetic Compatibility ○ Radio ○ Electromagnetic Compatibility and Telecommunication (FCC requirements) ○ Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards ○ Automotive EMC Website DAkkS: https://www.dakks.de/ The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to the ILAC Mutual Recognition Arrangement. • Designations ○ FCC Testing Laboratory Designation Number DE0024 ○ ISED ISED Company Number 27156 Testing Laboratory CAB Identifier DE0020 ○ Kraftfahrt-Bundesamt KBA-P 00120-23
Testing location	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany
Date of receipt of test samples	2024-09-09
Start – End of tests	2024-09-17 – 2025-01-29

2.2 Possible test case verdicts

Test sample meets the requirements	P (PASS) – the measured value is below the acceptance limit, AL = TL
Test sample does not meet the requirements	F (FAIL) – the measured value is above the acceptance limit, AL = TL
Test case does not apply to the test sample	N/A (Not applicable)
Test case not performed	N/P (Not performed)

2.3 Observations

No additional observations other than the reported observations within this test report have been made.

2.4 Opinions and interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

2.5 Revision history

-0 Initial Version

2.6 Further documents

List of further applicable documents belonging to the present test report:
– no additional documents –

3 ENVIRONMENTAL & TEST CONDITIONS

3.1 Environmental conditions

Temperature	20°C ± 5°C
Relative humidity	25-75 % r.H.
Barometric Pressure	860-1060 mbar
Power supply	230 V AC ± 5% / 50 Hz

3.2 Normal and extreme test conditions

	minimum	nominal	maximum
Temperature	-/- °C	20 °C	-/- °C
Relative humidity	-/-	45 % r.h.	-/-
Power supply	-/- V DC	12 V DC	-/- V DC

4 TEST STANDARDS AND REFERENCES

Test standard (accredited)	Description
FCC 47 CFR Part 15	Radio Frequency Devices – Subpart C § 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz
RSS-247, Issue 3 (2023-08)	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen, Issue 5 (2018-04)	General Requirements for Compliance of Radio Apparatus

Reference	Description
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
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
558074 D01 15.247 Meas Guide v05r02	Guidance for compliance measurements on digital transmission systems, frequency hopping spread spectrum systems and hybrid system devices operating under section 15.247 of the FCC rules

5 EQUIPMENT UNDER TEST (EUT)

5.1 Product Description

Vehicle Communication Interface VCI ONE (weLINK)

*: as declared by applicant

5.2 Test Item Description

Model name*	322001
Serial number*	radiated test sample: 00122 / conducted test sample: 00114
Hardware status*	V4.2
Software status*	V2.4.3

*: as declared by applicant; please see Annex A, B for EUT photographs.

5.3 Technical Data of Equipment

Technology*	Bluetooth Basic Data Rate (BDR), Enhanced Data Rate (EDR)
Operational frequency band*	2.4 GHz ISM band (2400 – 2483.5 MHz)
Operational carrier frequency*	2402 – 2480 MHz
Modulation type*	FHSS (GFSK, π/4-DQPSK, 8DPSK)
Data rate*	1 Mbps, 2 Mbps, 3 Mbps
Number of channels*	79
Channel bandwidth*	1 MHz
Channel spacing*	1 MHz
Antenna*	Flexible Polymer Series Antenna (FXP830.24.0100B)
Antenna gain*	Frequency (MHz) / FXP830.24.0100B Peak gain (dBi): 2400 / 1.95; 2450 / 3.00; 2500 / 3.32
Power supply*	6.0 to 36.0 V DC
Temperature range*	-30 °C to +60 °C

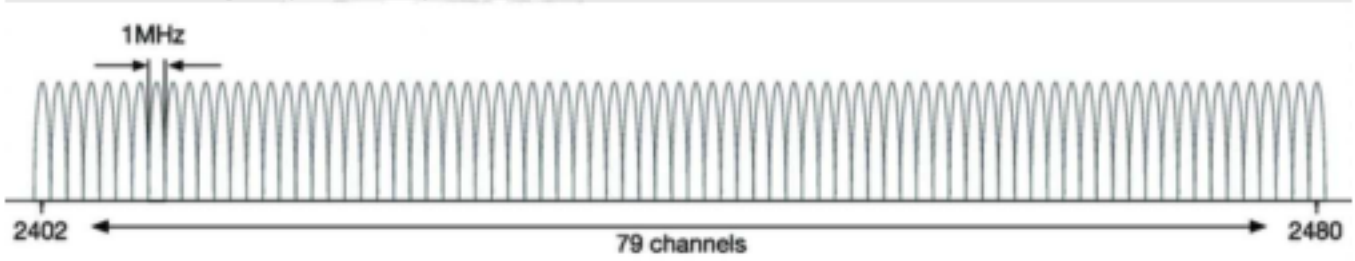
*: as declared by applicant

5.4 Additional Information

Model differences	– none –
Ancillaries tested with	– none –
Additional equipment used for testing	Notebook with test tool (terminal programm with set of commands to configure necessary test modes)

5.5 Test modes	
Mode 1	DH1: GFSK, PRBS9, max. power
Mode 2	DH3: GFSK, PRBS9, max. power
Mode 3	DH5: GFSK, PRBS9, max. power
Mode 4	2-DH1: π/4-DQPSK, PRBS9, max. power
Mode 5	2-DH3: π/4-DQPSK, PRBS9, max. power
Mode 6	2-DH5: π/4-DQPSK, PRBS9, max. power
Mode 7	3-DH1: 8DPSK, PRBS9, max. power
Mode 8	3-DH3: 8DPSK, PRBS9, max. power
Mode 9	3-DH5: 8DPSK, PRBS9, max. power
Low Channel	CH00: 2402 MHz
Mid Channel	CH39: 2441 MHz
High Channel	CH78: 2480 MHz

Bluetooth channel plan (informative):



6 SUMMARY OF TEST RESULTS

Test specification
FCC 47 CFR Part 15 RSS-247, Issue 3 (2023-08) / RSS-Gen, Issue 5 (2018-04)

Clause	Requirement / Test Case	Result - Remark	Result	Verdict
15.247(a)(1) RSS-247, 5.1 (b)	Carrier frequency separation	KDB 558074, clause: 9	980 kHz	**- PASS -**
15.247(a)(1)(iii), (g) RSS-247, 5.1 (d)	Number of frequency hopping channels	KDB 558074, clause: 9	79	**- PASS -**
15.247(a)(1)(iii) RSS-247, 5.1 (d)	Time of channel occupancy	KDB 558074, clause: 9	333 ms	**- PASS -**
§15.247(a)(1) RSS-247,5.1 (a)	Minimum emission bw 6dB, emission bandwidth 20 dB	KDB 558074, clause: 2.2	1089 kHz 1350 kHz	**- PASS -**
RSS Gen, 6.7	Occupied bandwidth (99%)	-/-	1200 kHz	**- PASS -**
§15.247(b)(1) RSS-247, 5.4 (b)	RF output power (conducted power)	KDB 558074, clause: 9	6.7 dBm	**- PASS -**
§15.247(b)(4) RSS-247, 5.4 (b)	Antenna gain Peak EIRP	-/-	3.3 dBi 10.0 dBm	**- PASS -**
§15.247(d) RSS-247, 5.5	Band edge compliance (BEC), conducted	KDB 558074, clause: 9	< limit	**- PASS -**
§15.247(d) RSS-247, 5.5	Band edge compliance (BEC), radiated	KDB 558074, clause: 9	< limit	**- PASS -**
§15.247(d) RSS-247, 5.5	Conducted spurious emissions (CSE)	KDB 558074, clause: 9	< limit	**- PASS -**
15.247(d) / §15.209 RSS-247, 5.5 / RSS-Gen, 8.9	Radiated spurious emissions (RSE)	-/-	< limit	**- PASS -**
§15.207 RSS-Gen, 8.8	AC conducted emissions	EUT is battery powered via vehicle battery		**- N/A -**

Comments and observations
Following pages show requirements and references of FCC Part 15.247, ANSI C63.10 and KDB 558074 only. Same tests are also applicable and valid for RSS-247, with clauses given in table above.

7 TEST RESULTS

7.1 Carrier frequency separation

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum frequency value.

Limit
§15.247 (a)(1)
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test procedure
ANSI C63.10, 7.8.2
The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: No faster than coupled (auto) time.
e) Detector function: Peak.
f) Trace: Max-hold.
g) Allow the trace to stabilize.
Use the marker-delta function to determine the separation between the peaks of the adjacent channels.
Compliance of an EUT with the appropriate regulatory limit shall be determined. A spectral plot of the data shall be included in the test report.
Where the device shares the same channel plan (carrier frequencies and number of channels) across multiple data rates or modulation schemes then the carrier separation need only be measured for one of those modulation schemes or data rates.

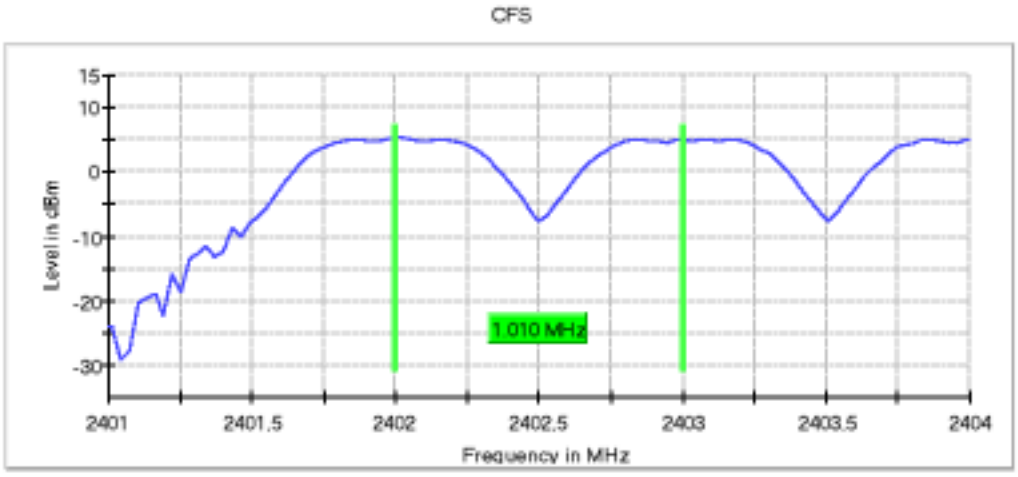
Test setup: 8.4 with conducted test sample (see section 5.2)

Test Results				
EUT Mode	Carrier frequency separation			Limit
	low channel [kHz]	mid channel [kHz]	high channel [kHz]	
Mode 1	1010	1010	**980**	≥ 2/3 of 20 dB BW
Mode 2	1010	1010	**980**	≥ 2/3 of 20 dB BW
Mode 3	1010	1010	**980**	≥ 2/3 of 20 dB BW
Mode 4	**980**	1040	1010	≥ 2/3 of 20 dB BW
Mode 5	1010	1010	1010	≥ 2/3 of 20 dB BW
Mode 6	1010	1010	1010	≥ 2/3 of 20 dB BW
Mode 7	1010	1040	1010	≥ 2/3 of 20 dB BW
Mode 8	1010	**980**	1040	≥ 2/3 of 20 dB BW
Mode 9	1010	1010	**980**	≥ 2/3 of 20 dB BW

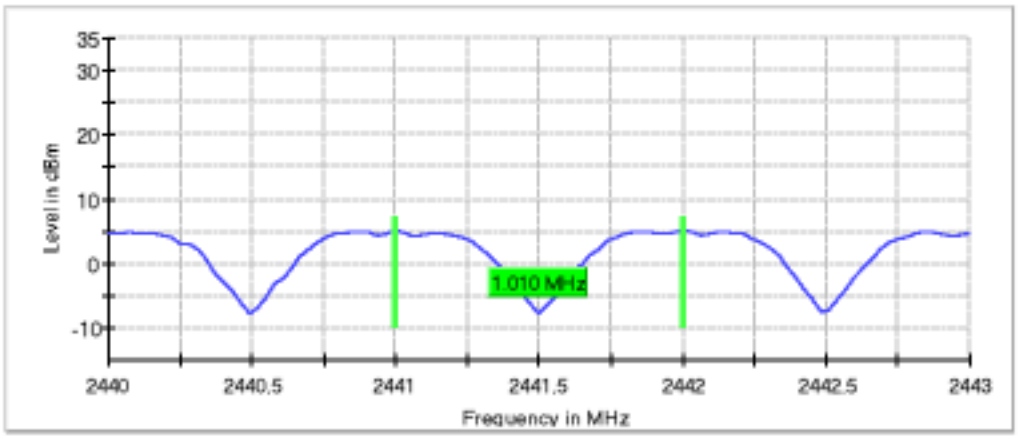
Comment:	---

Verdict	- PASS -	see next plots

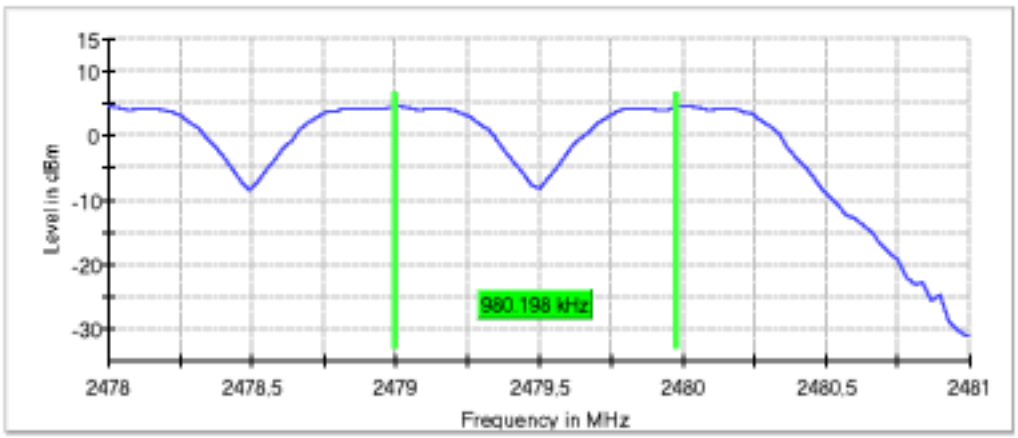
Plot 1: Carrier Frequency Separation, Mode 1, low channel



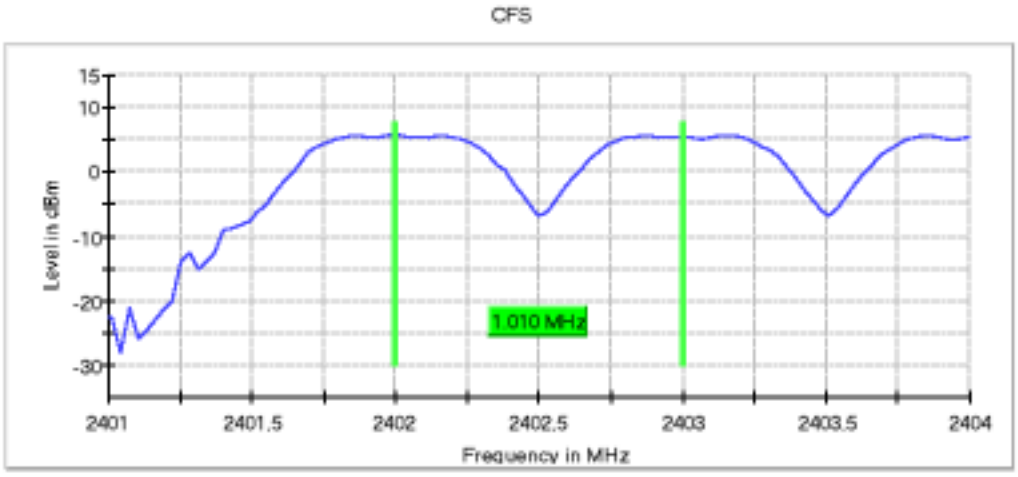
Plot 2: Carrier Frequency Separation, Mode 1, mid channel



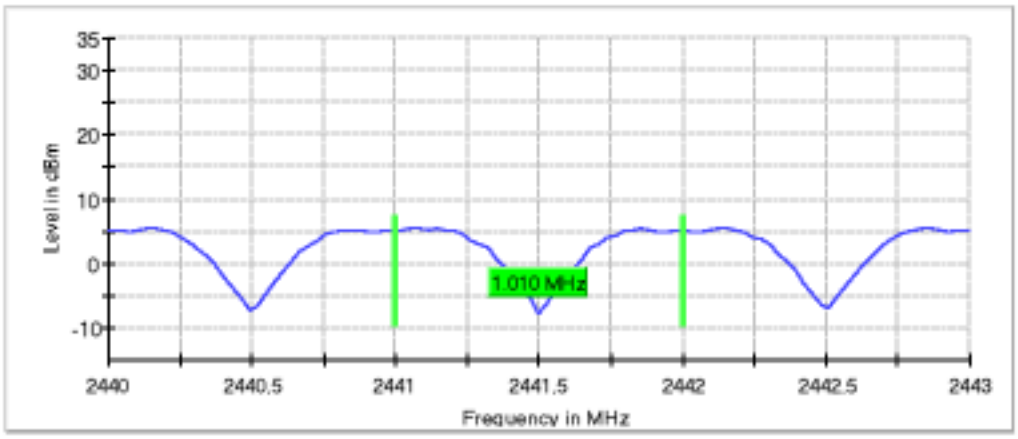
Plot 3: Carrier Frequency Separation, Mode 1, high channel



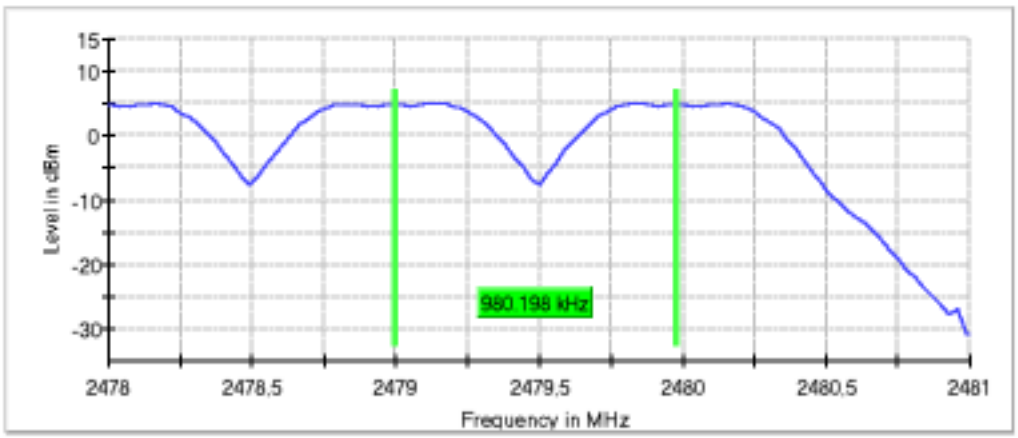
Plot 4: Carrier Frequency Separation, Mode 2, low channel



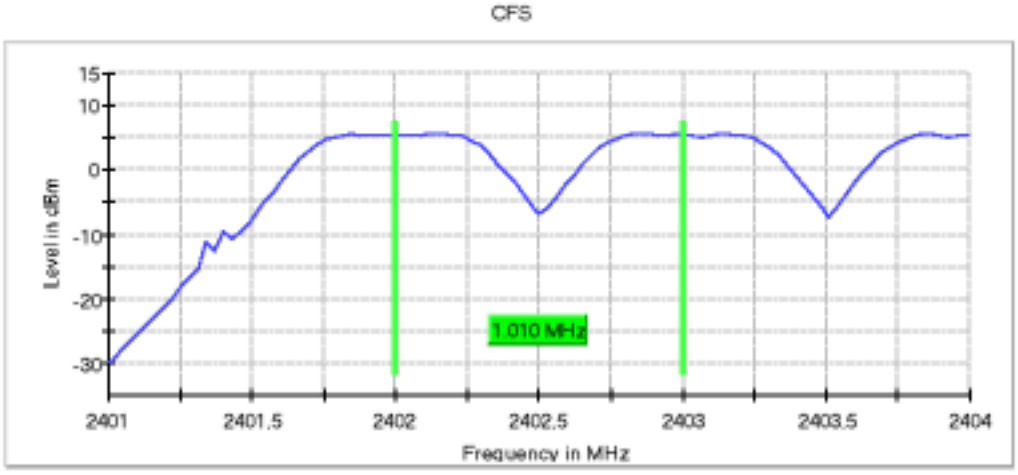
Plot 5: Carrier Frequency Separation, Mode 2, mid channel*



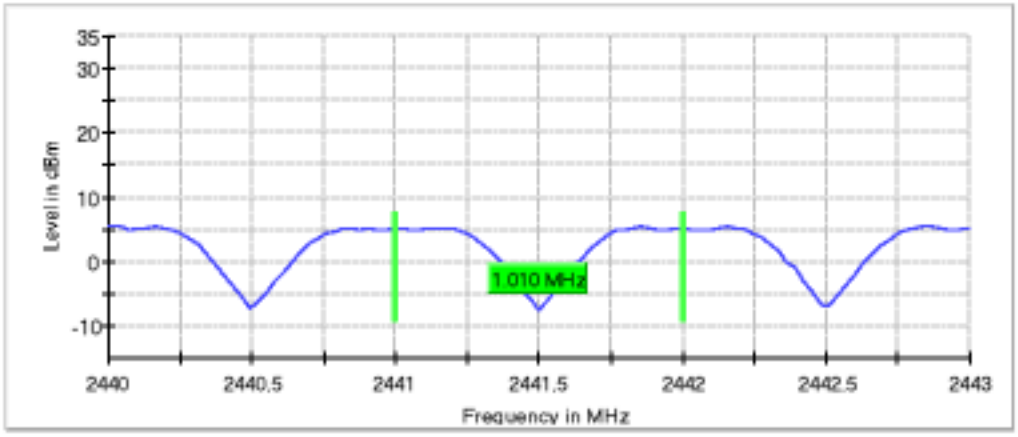
Plot 6: Carrier Frequency Separation, Mode 2, high channel



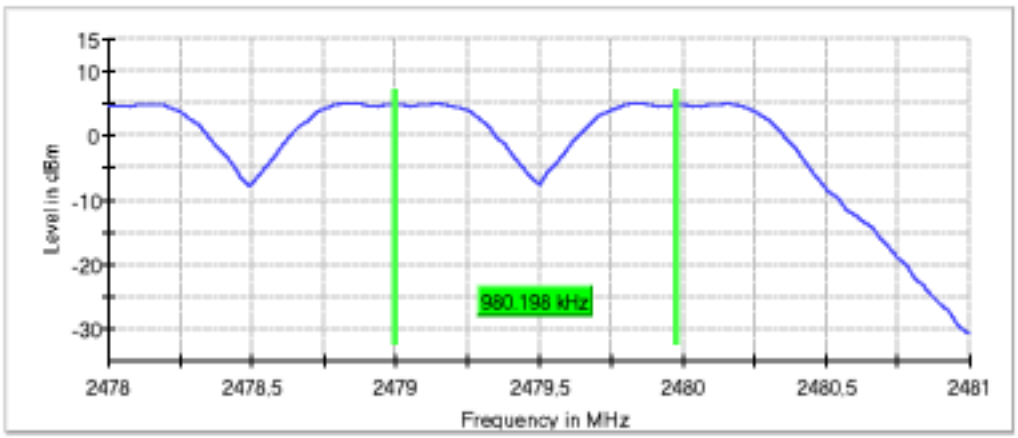
Plot 7: Carrier Frequency Separation, Mode 3, low channel



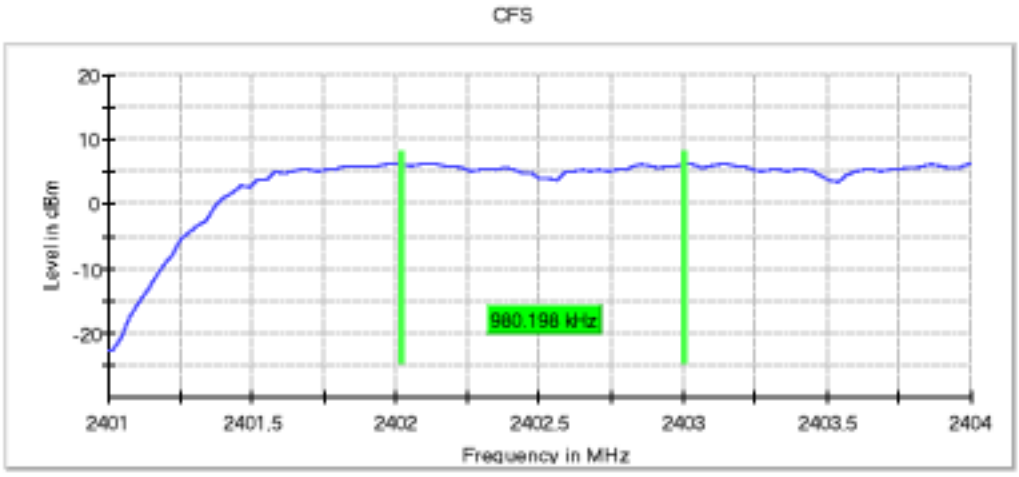
Plot 8: Carrier Frequency Separation, Mode 3, mid channel*



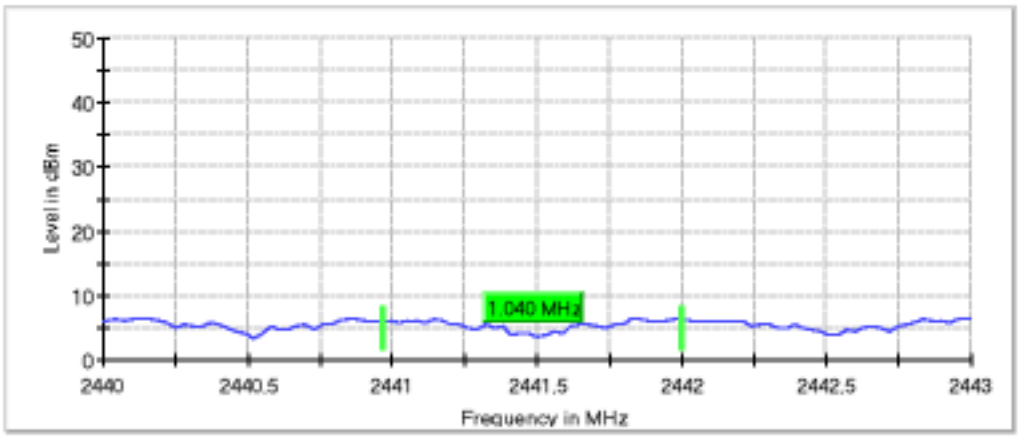
Plot 9: Carrier Frequency Separation, Mode 3, high channel



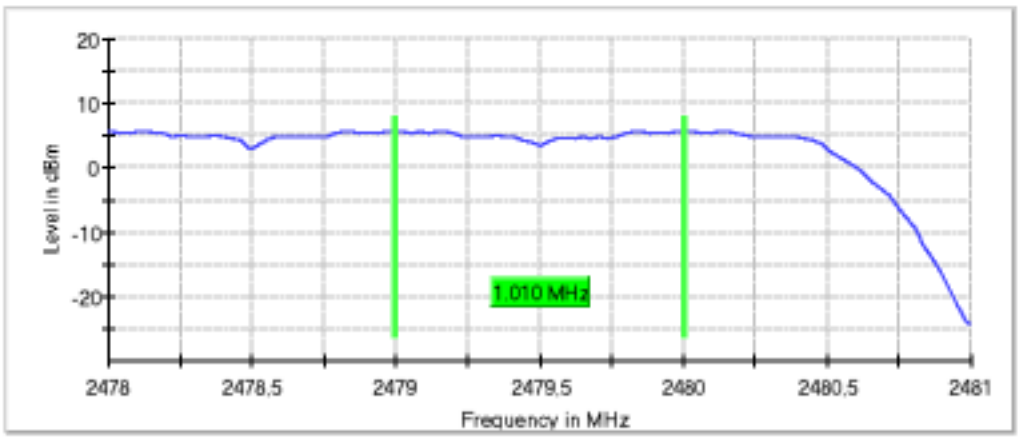
Plot 10: Carrier Frequency Separation, Mode 4, low channel



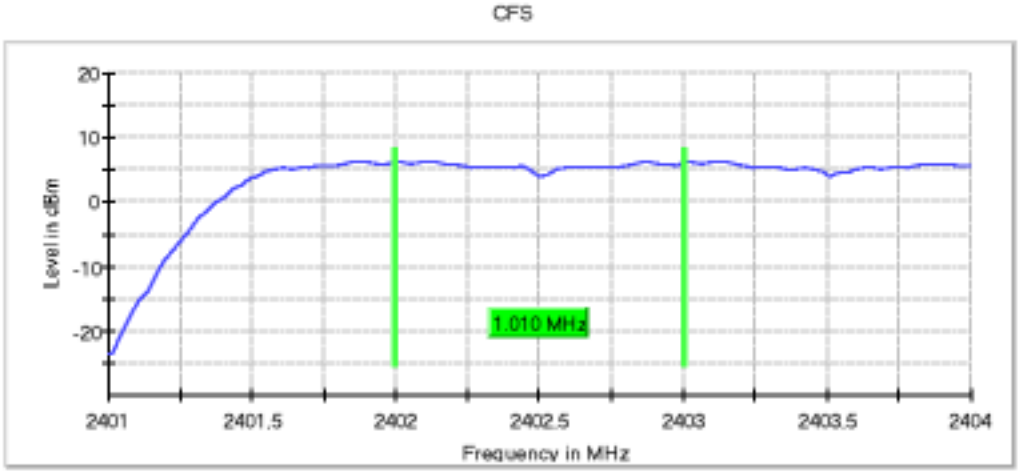
Plot 11: Carrier Frequency Separation, Mode 4, mid channel*



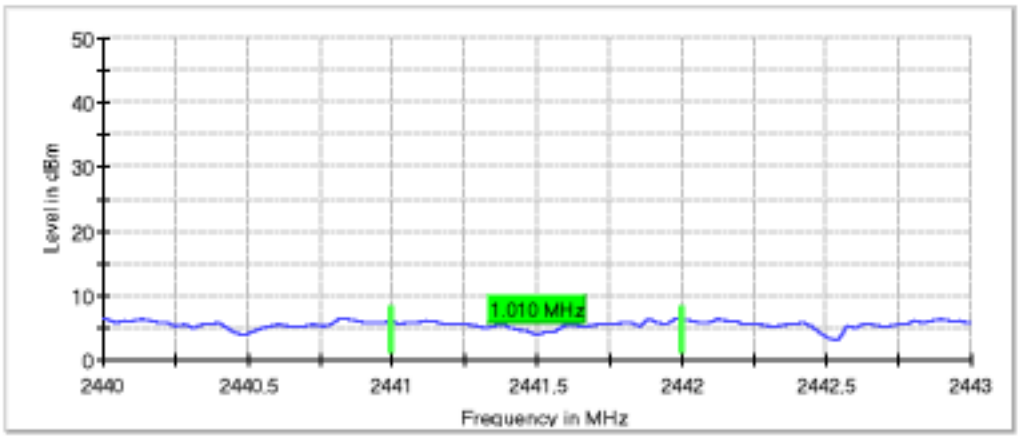
Plot 12: Carrier Frequency Separation, Mode 4, high channel



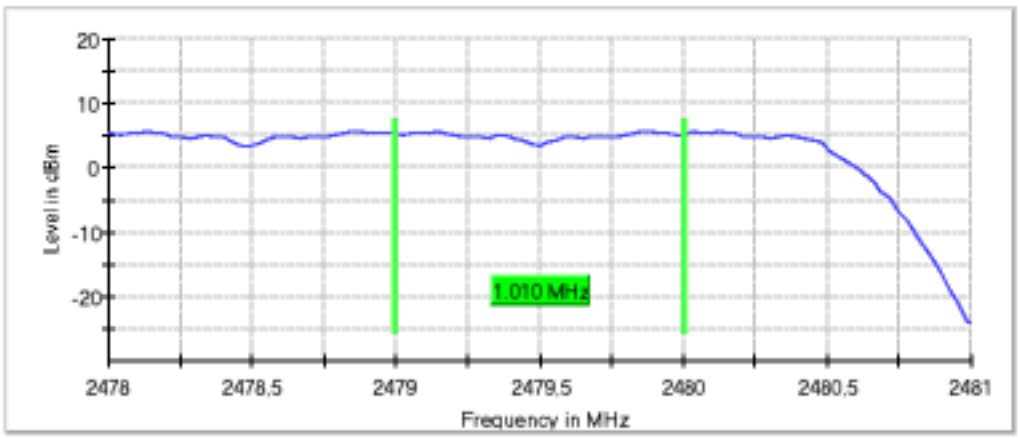
Plot 13: Carrier Frequency Separation, Mode 5, low channel



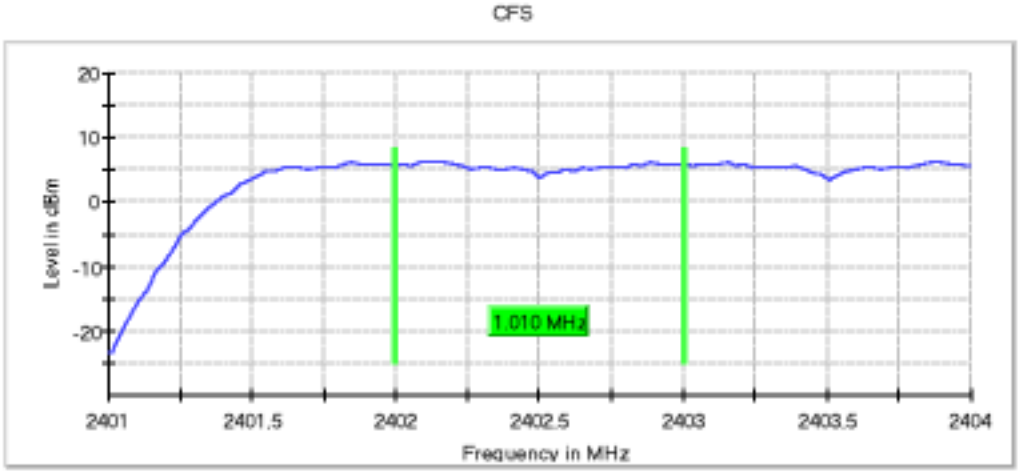
Plot 14: Carrier Frequency Separation, Mode 5, mid channel*



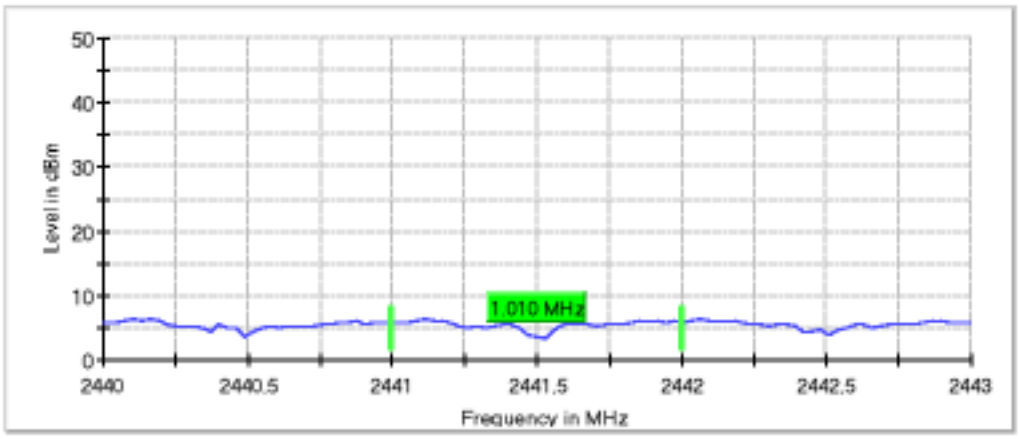
Plot 15: Carrier Frequency Separation, Mode 5, high channel



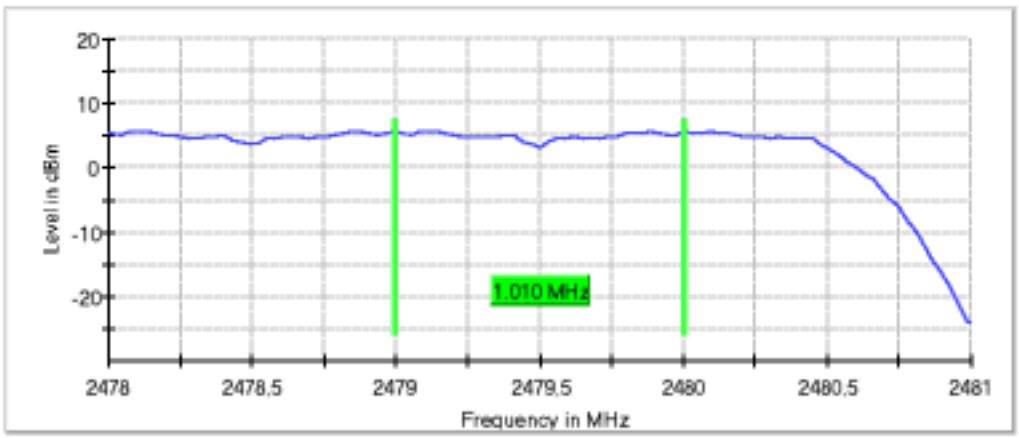
Plot 16: Carrier Frequency Separation, Mode 6, low channel



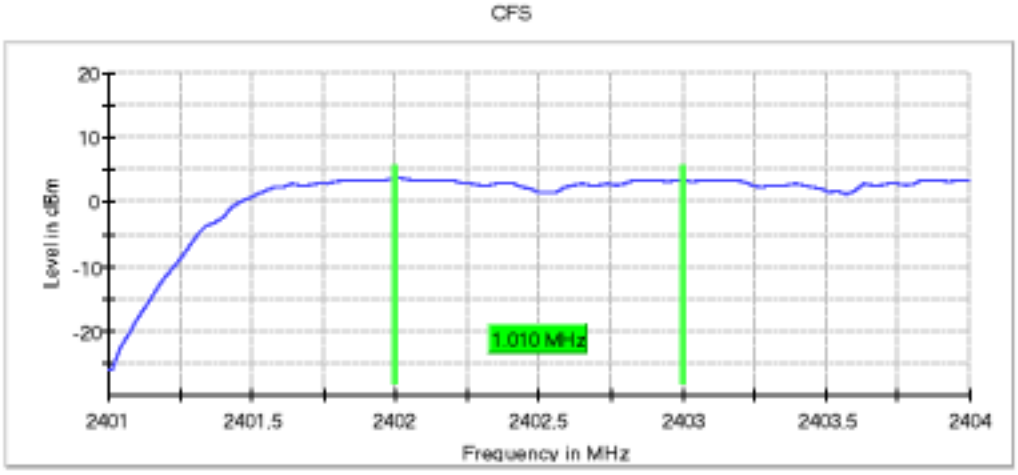
Plot 17: Carrier Frequency Separation, Mode 6, mid channel*



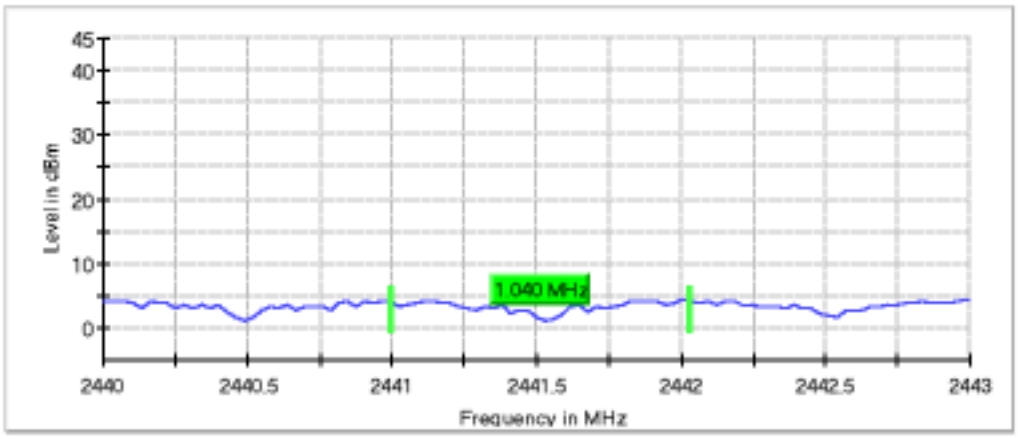
Plot 18: Carrier Frequency Separation, Mode 6, high channel



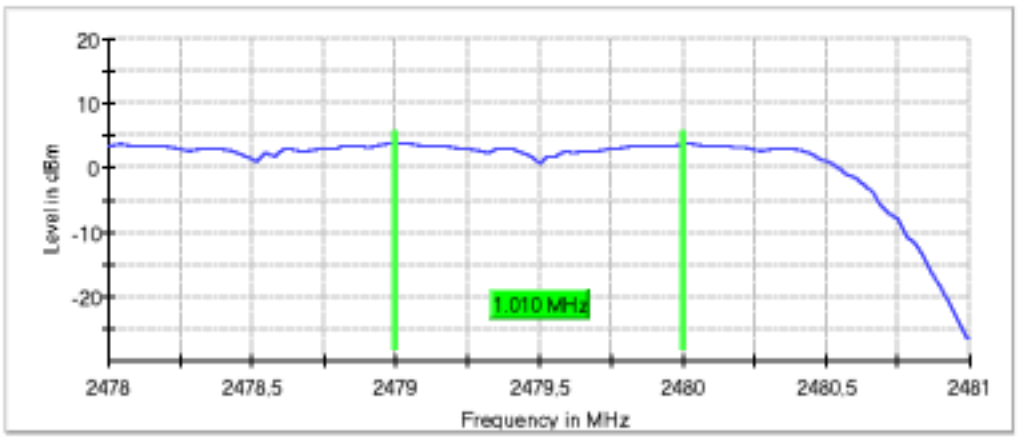
Plot 19: Carrier Frequency Separation, Mode 7, low channel



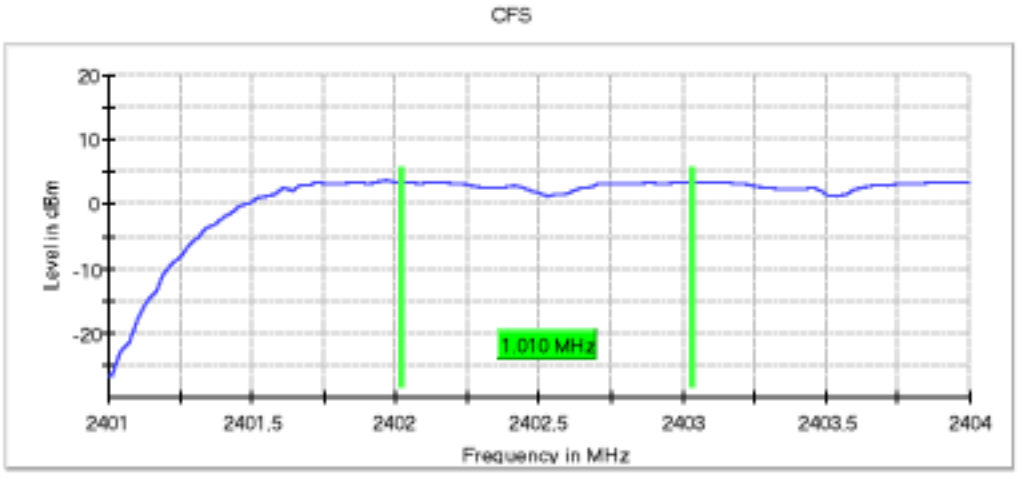
Plot 20: Carrier Frequency Separation, Mode 7, mid channel*



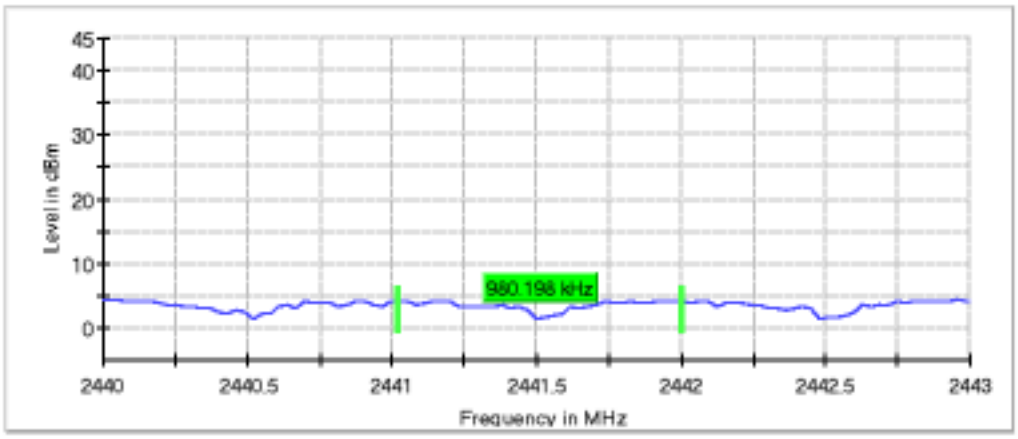
Plot 21: Carrier Frequency Separation, Mode 7, high channel



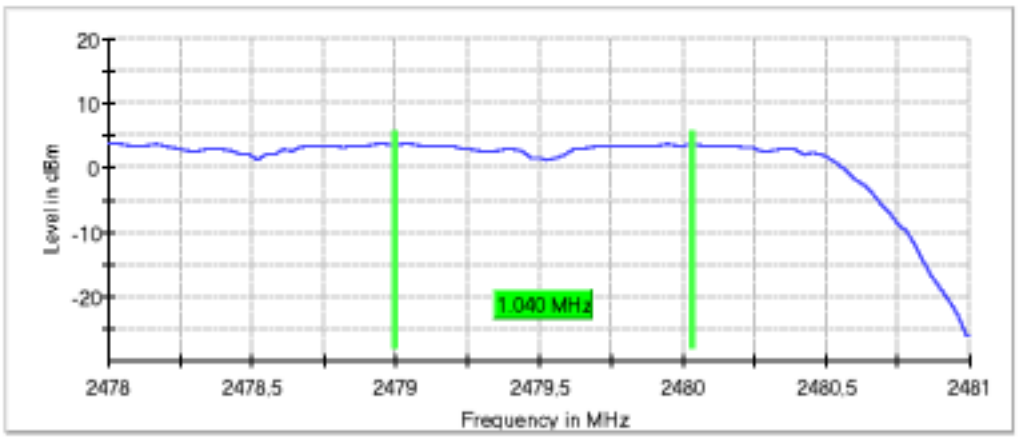
Plot 22: Carrier Frequency Separation, Mode 8, low channel



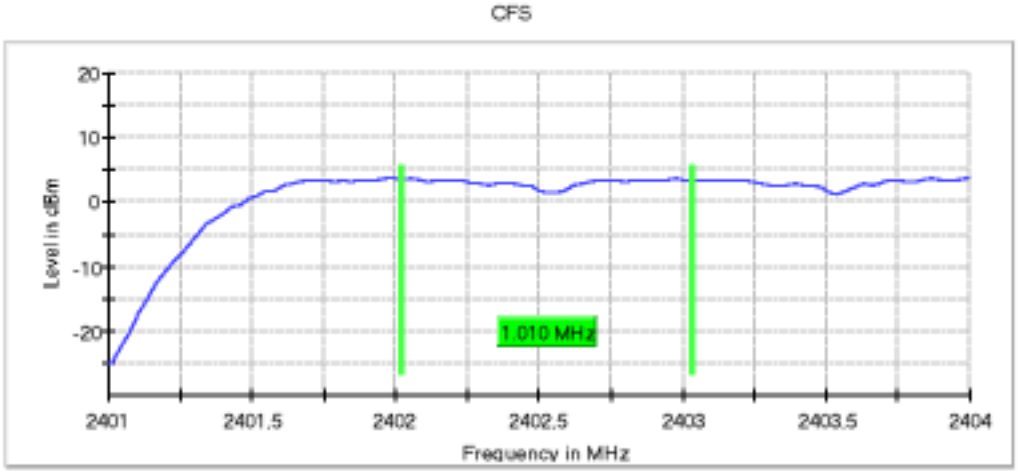
Plot 23: Carrier Frequency Separation, Mode 8, mid channel*



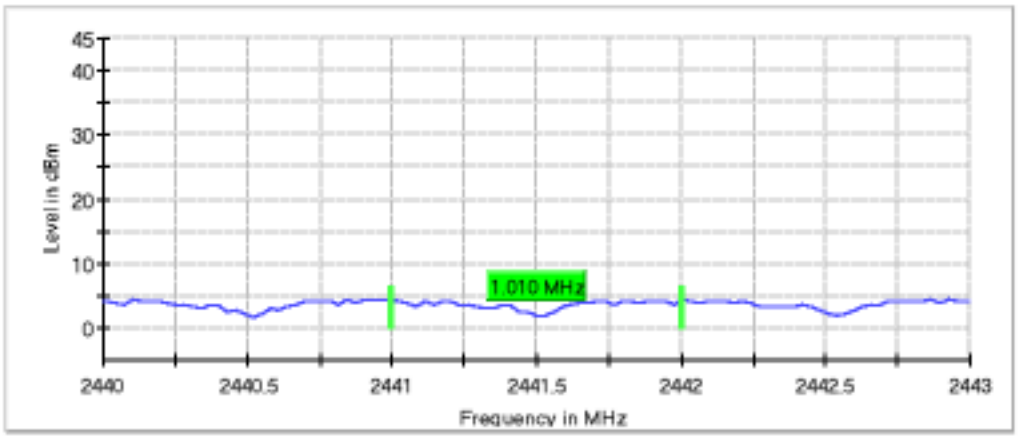
Plot 24: Carrier Frequency Separation, Mode 8, high channel



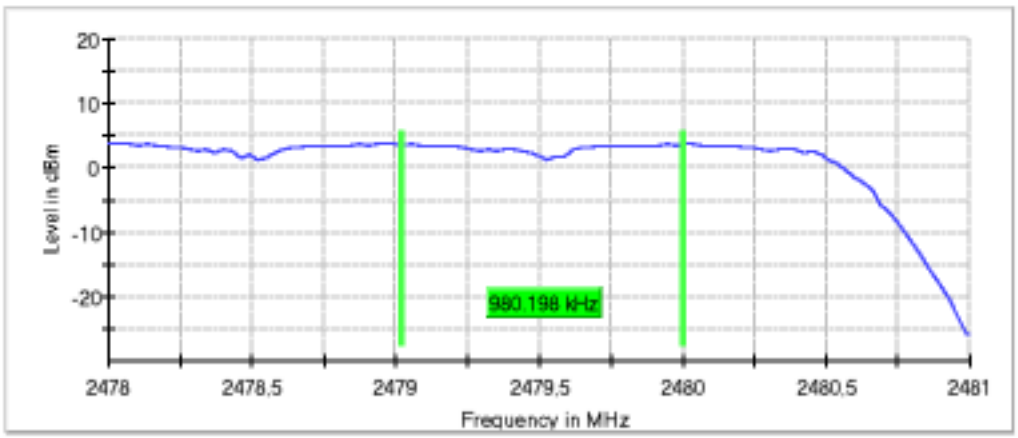
Plot 25: Carrier Frequency Separation, Mode 9, low channel



Plot 26: Carrier Frequency Separation, Mode 9, mid channel*



Plot 27: Carrier Frequency Separation, Mode 9, high channel



7.2 Number of frequency hopping channels

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
Frequency hopping systems shall have a minimum number of hopping channels.

Limit
§15.247 (a)(1)(iii)
Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

Test procedure
ANSI C63.10, 7.8.3
The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: The frequency band of operation. Depending on the number of channels the device supports, it could be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c) VBW ≥ RBW.
d) Sweep: No faster than coupled (auto) time.
e) Detector function: Peak.
f) Trace: Max-hold.
g) Allow the trace to stabilize.
It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A spectral plot of the data shall be included in the test report.
Where the device shares the same channel plan (carrier frequencies and number of channels) across multiple data rates or modulation schemes then the number of channels need only be measured for one of those modulation schemes or data rates.

Test setup: 8.4 with conducted test sample (see section 5.2)

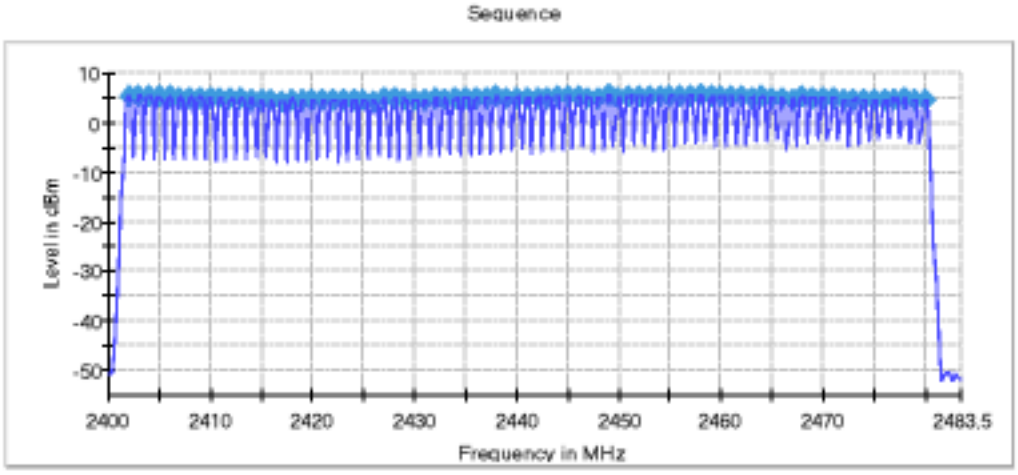
Test Results

EUT Mode	Number of frequency hopping channels			Result
	Channels	Limit min	Limit max	
Mode 3	79	15	-	≥ 15
Mode 6	79	15	-	≥ 15
Mode 9	79	15	-	≥ 15

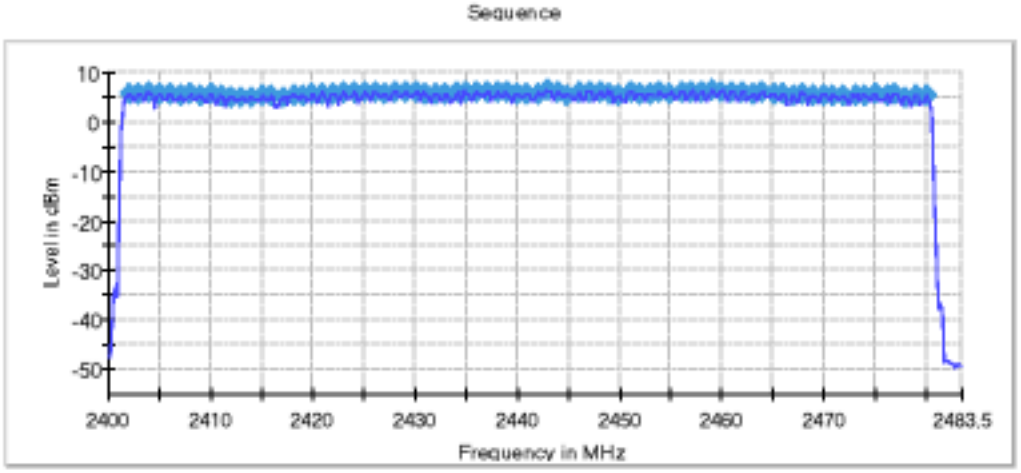
Comment:	---

Verdict	- PASS -	see next plots

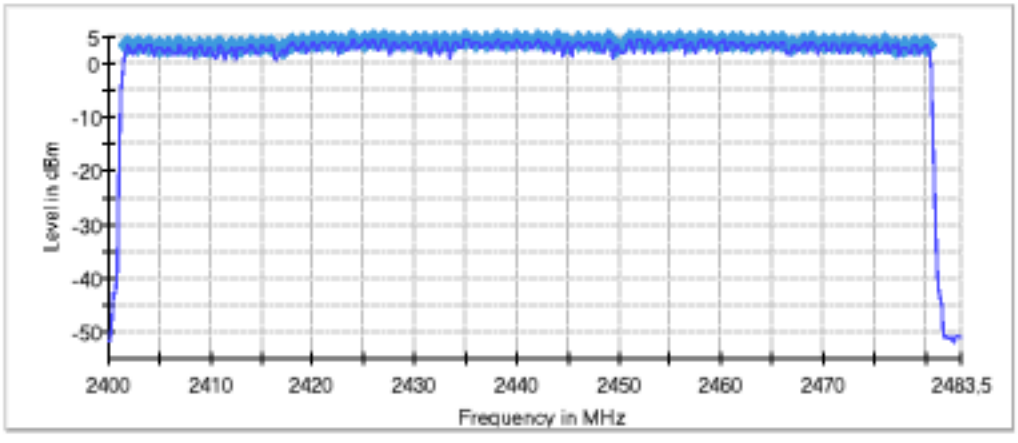
Plot 28: Mode 3, Hopping Frequencies



Plot 29: Mode 6, Hopping Frequencies



Plot 30: Mode 9, Hopping Frequencies



7.3 Time of channel occupancy

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
The dwell time per hop on a channel is the time from the start of the first transmission to the end of the last transmission for that hop. If the device has a single transmission per hop then the dwell time is the duration of that transmission. If the device has a multiple transmissions per hop then the dwell time is measured from the start of the first transmission to the end of the last transmission.
The time of occupancy is the total time that the device dwells on a channel over an observation period specified in the regulatory requirement. To determine the time of occupancy the spectrum analyzer will be configured to measure both the dwell time per hop and the number of times the device transmits on a specific channel in a given period.

Limit
§15.247 (a)(1)(iii), RSS-247, 5.1 (d)
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test procedure
ANSI C63.10, 7.8.4
The EUT shall have its hopping function enabled. Compliance with the requirements shall be made with the minimum and with the maximum number of channels enabled. If the dwell time per channel does not vary with the number of channels than compliance with the requirements may be based on the minimum number of channels. If the device supports different dwell times per channel (example Bluetooth devices can dwell on a channel for 1, 3 or 5 time slots) then measurements can be limited to the longest dwell time with the minimum number of channels.
Use the following spectrum analyzer settings to determine the dwell time per hop:

a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected transmission time per hop.
c) Sweep time: Set so that the start of the first transmission and end of the last transmission for the hop are clearly captured. Setting the sweep time to be slightly longer than the hopping period per channel (hopping period = 1/hopping rate) should achieve this.
d) Use a video trigger, where possible with a trigger delay, so that the start of the transmission is clearly observed. The trigger level might need adjustment to reduce the chance of triggering when the system hops on an adjacent channel.
e) Detector function: Peak.
f) Trace: Clear-write, single sweep.
g) Place markers at the start of the first transmission on the channel and at the end of the last transmission. The dwell time per hop is the time between these two markers.

To determine the number of hops on a channel in the regulatory observation period repeat the measurement using a longer sweep time. When the device uses a single hopping sequence the period of measurement should be sufficient to capture at least 2 hops. When the device uses a dynamic hopping sequence, or the sequence varies, the period of measurement may need to capture multiple hops to better determine the average time of occupancy. Count the number of hops on the channel across the sweep time.
The average number of hops on the same channel within the regulatory observation period is calculated from the number of hops on the channel divided by the spectrum analyzer sweep time multiplied by the regulatory observation period. For example, if three hops are counted with an analyzer sweep time of 500 ms and the regulatory observation period is 10 s, then the number of hops in that ten seconds is 3 / 0.5 × 10, or 60 hops.
The average time of occupancy is calculated by multiplying the dwell time per hop by the number of hops in the observation period.
Where the device shares the same hopping algorithms (dwell time, channel selection) across multiple data rates or modulation schemes then the time of occupancy need only be measured for one of those modulation

schemes or data rates. If the dwell time value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in dwell time.

Test setup: 8.4 with conducted test sample (see section 5.2)

Test Results

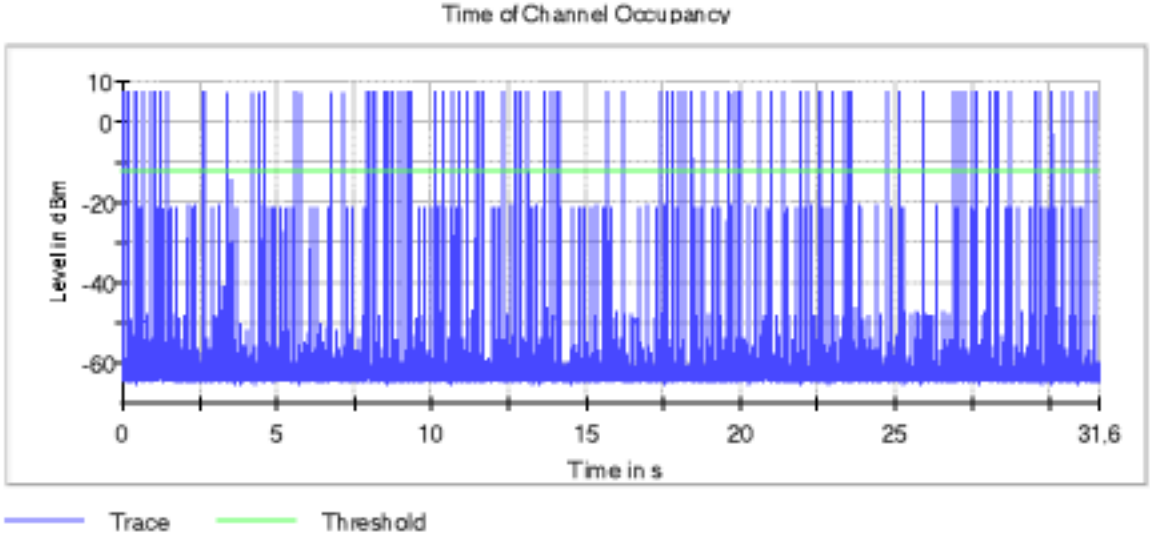
EUT Mode	Average time of occupancy			Limit [ms]
	low channel [ms]	mid channel [ms]	high channel [ms]	
Mode 3	281.0	278.1	304.2	≤ 400
Mode 6	289.7	**333.2**	310.0	≤ 400
Mode 9	289.7	287.3	281.4	≤ 400

Comment:	---

Verdict	**- PASS -**	see next plots

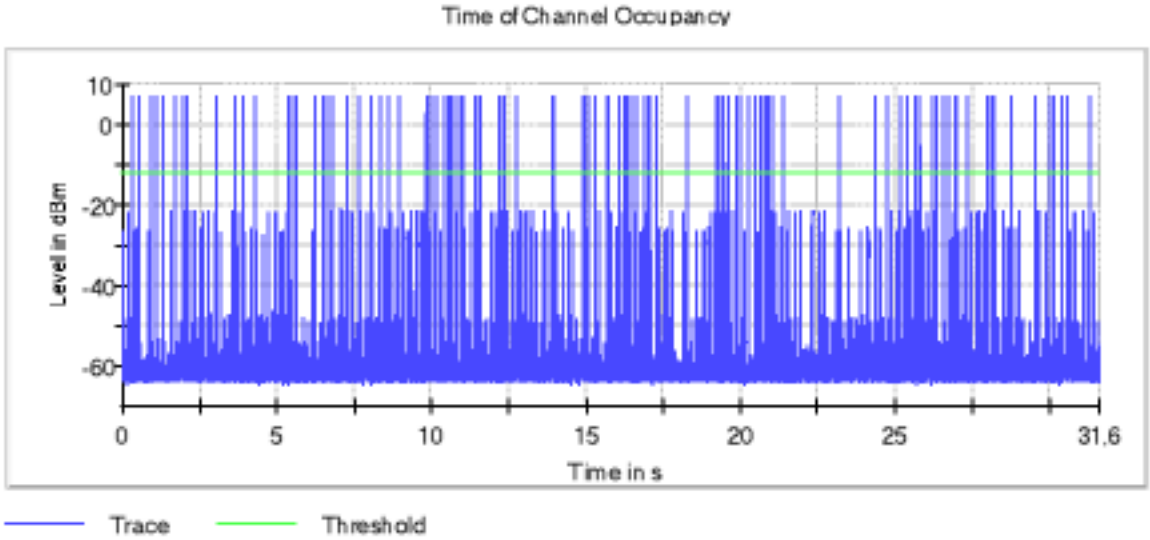
Plot 31: Mode 3, Time of Channel Occupancy, low channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2402.000000	PASS	3	281.030	400.000	0.000	-12.0



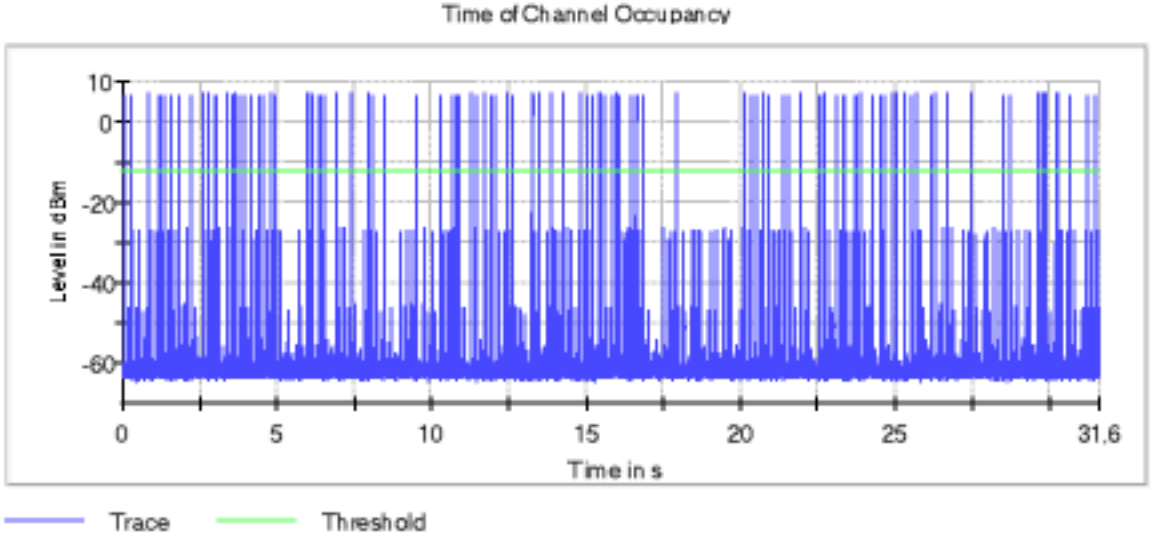
Plot 32: Mode 3, Time of Channel Occupancy, mid channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2441.000000	PASS	96	278.090	400.000	0.000	-12.0



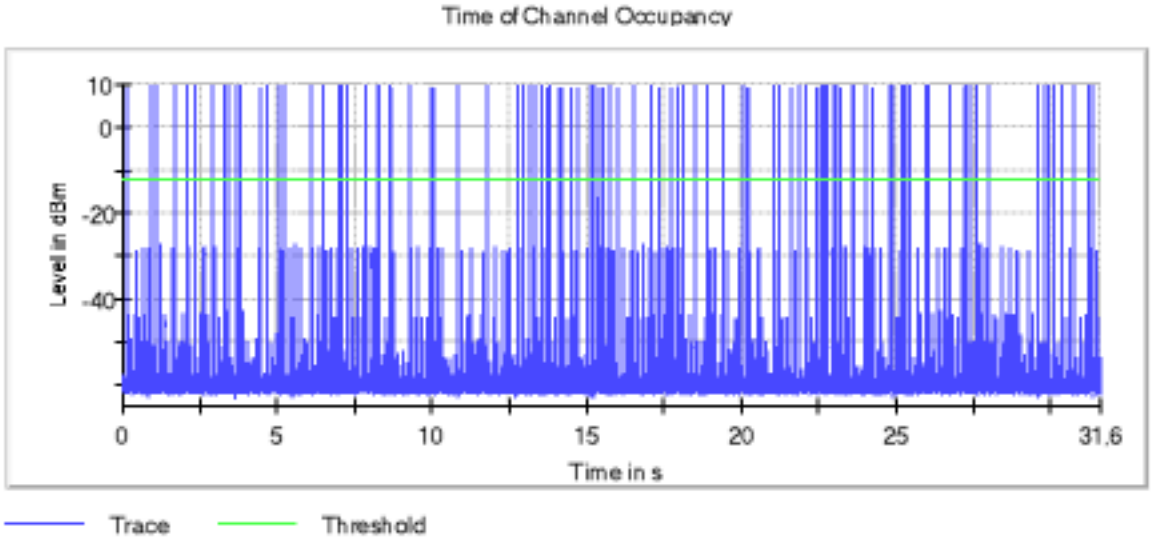
Plot 33: Mode 3, Time of Channel Occupancy, high channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2480.000000	PASS	105	304.230	400.000	0.000	-12.0



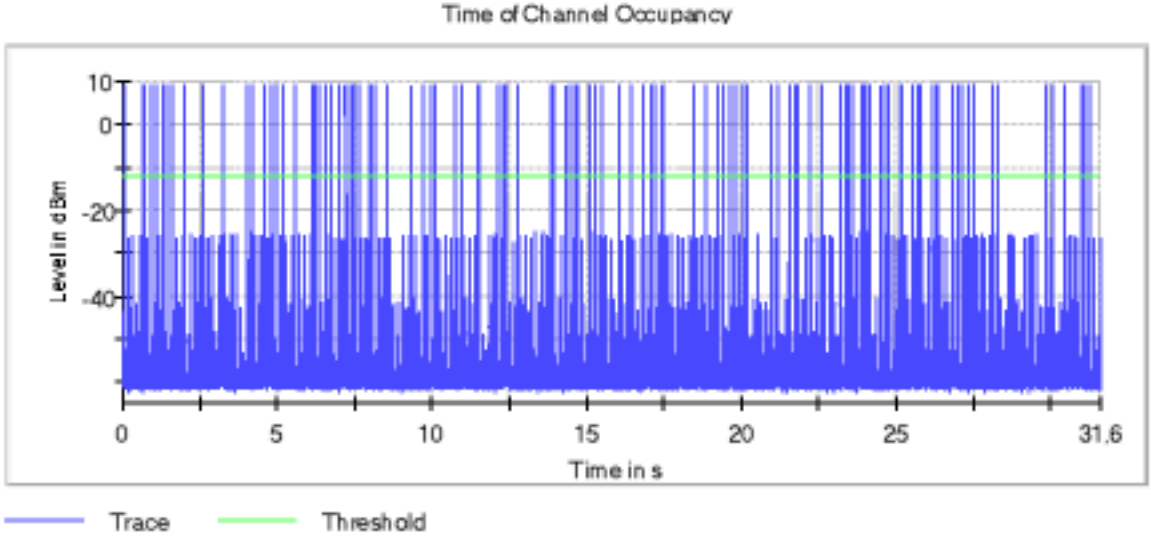
Plot 34: Mode 6, Time of Channel Occupancy, low channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2402.000000	PASS	100	289.720	400.000	0.000	-12.0



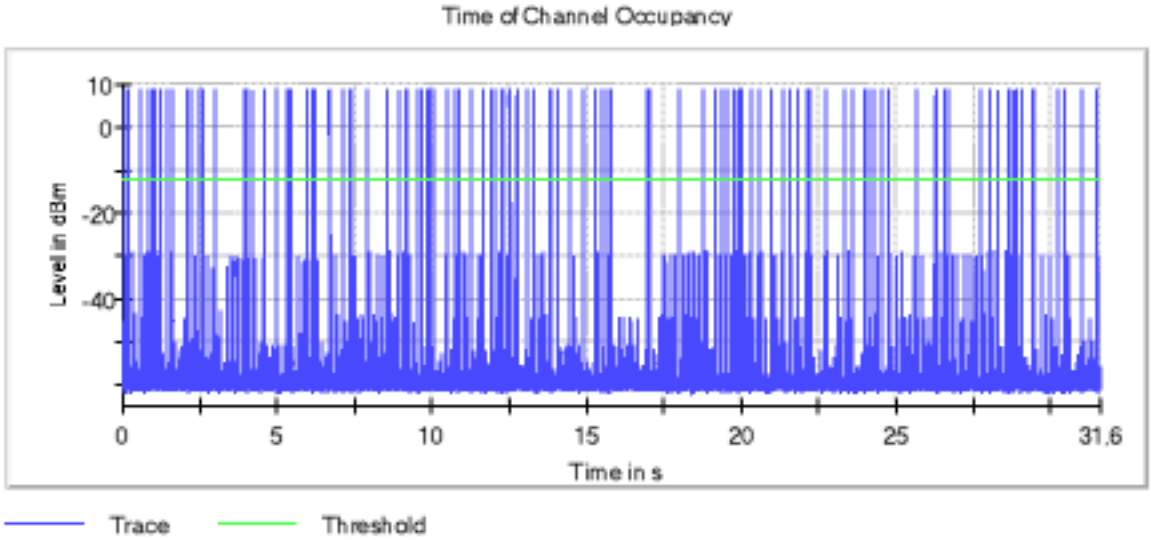
Plot 35: Mode 6, Time of Channel Occupancy, mid channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2441.000000	PASS	115	333.180	400.000	0.000	-12.0



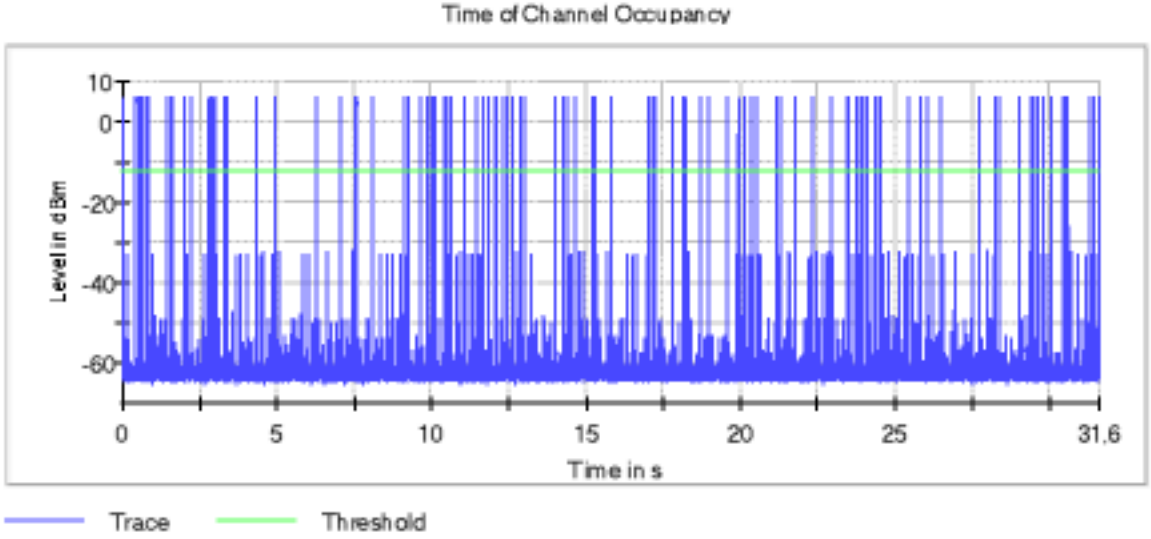
Plot 36: Mode 6, Time of Channel Occupancy, high channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2480.000000	PASS	4	309.980	400.000	0.000	-12.0



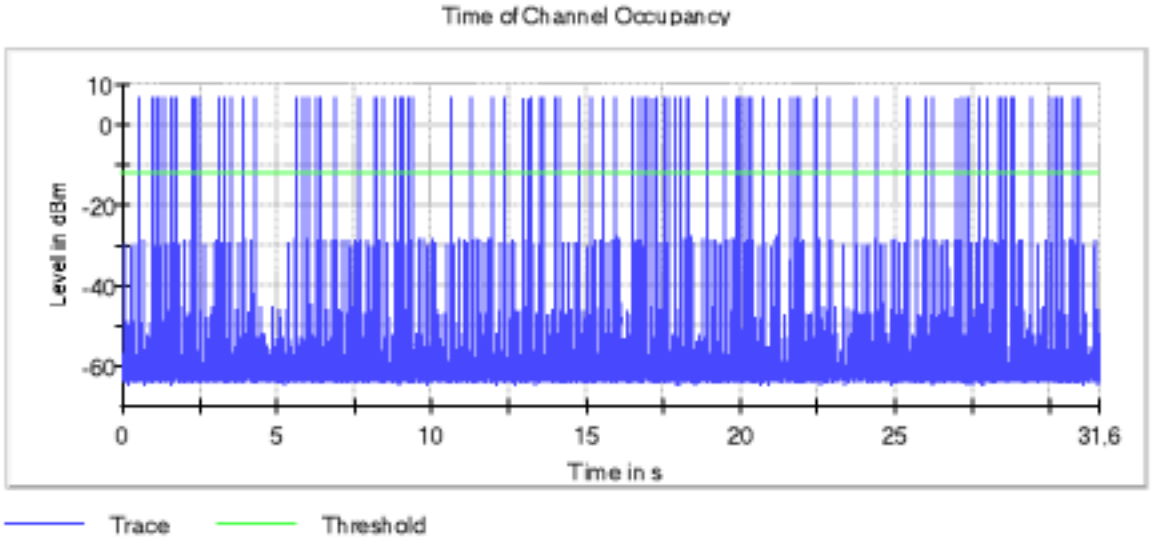
Plot 37: Mode 9, Time of Channel Occupancy, low channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2402.000000	PASS	100	289.680	400.000	0.000	-12.0



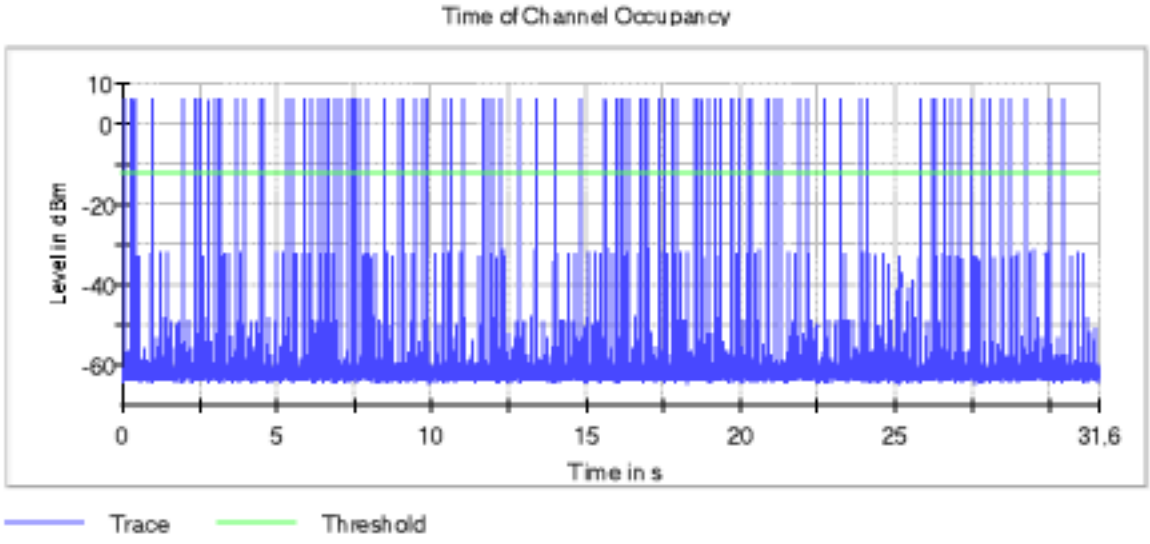
Plot 38: Mode 9, Time of Channel Occupancy, mid channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2441.000000	PASS	99	287.270	400.000	0.000	-12.0



Plot 39: Mode 9, Time of Channel Occupancy, high channel

DUT Frequency (MHz)	Result	Number of Hops	Average time of occupancy (ms)	Limit Max (ms)	Limit Min (ms)	Threshold (dBm)
2480.000000	PASS	2	281.430	400.000	0.000	-12.0



7.4 Minimum emission bandwidth 6 dB, emission bandwidth 20 dB

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
The 6 dB / 20 dB Emission Bandwidth is defined as the frequency width of the emission that is constrained by the frequencies associated with the tow outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB / 20 dB relative to the maximum level measured in the fundamental emission.

Limit
No limit defined

Test procedure
ANSI C63.10, 7.8
The steps are as follows:
a) Set RBW = 100 kHz (6 dB bandwidth measurement) or 10 kHz (20 dB bandwidth measurement)
b) Set the VBW ≥ [3 × RBW].
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB/ 20 dB relative to the maximum level measured in the fundamental emission.
The automatic bandwidth measurement capability of an instrument may be employed using the 6 dB / 20 dB bandwidth mode.

Test setup: 8.4 with conducted test sample (see section 5.2)

Test Results

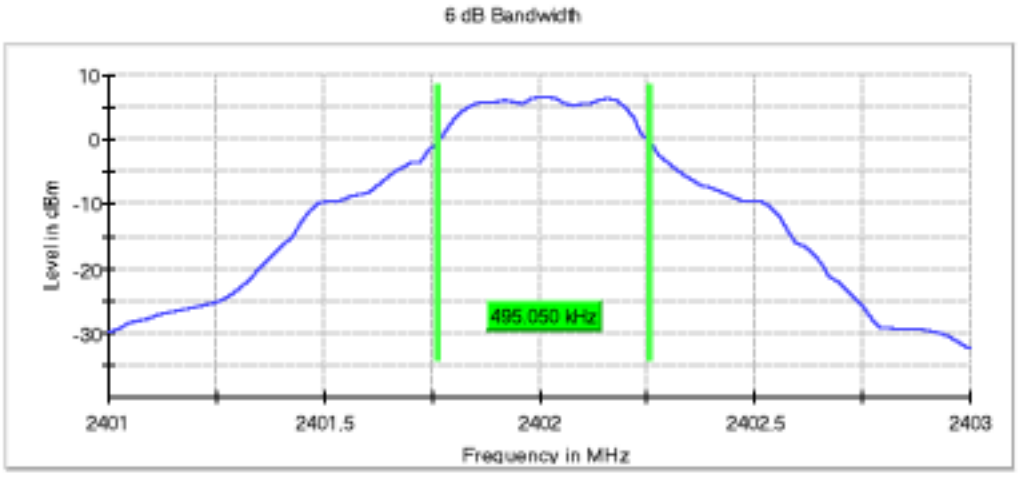
EUT Mode	Minimum emission bandwidth 6 dB			Limit [kHz]
	low channel [kHz]	mid channel [kHz]	high channel [kHz]	
Mode 1	495	475	475	--
Mode 2	495	475	495	--
Mode 3	495	475	495	--
Mode 4	1089	1069	1089	--
Mode 5	1089	1069	1089	--
Mode 6	1089	1069	1089	--
Mode 7	1089	1089	1089	--
Mode 8	1089	1089	1089	--
Mode 9	**1089**	1069	**1089**	--

EUT Mode	Emission bandwidth 20 dB			Limit [kHz]
	low channel [kHz]	mid channel [kHz]	high channel [kHz]	
Mode 1	1015	1015	1015	--
Mode 2	930	925	930	--
Mode 3	930	925	930	--
Mode 4	1325	1290	1330	--
Mode 5	1330	1335	1330	--
Mode 6	1320	1325	1320	--
Mode 7	1325	1285	1330	--
Mode 8	**1350**	**1350**	1345	--
Mode 9	1310	1315	1315	--

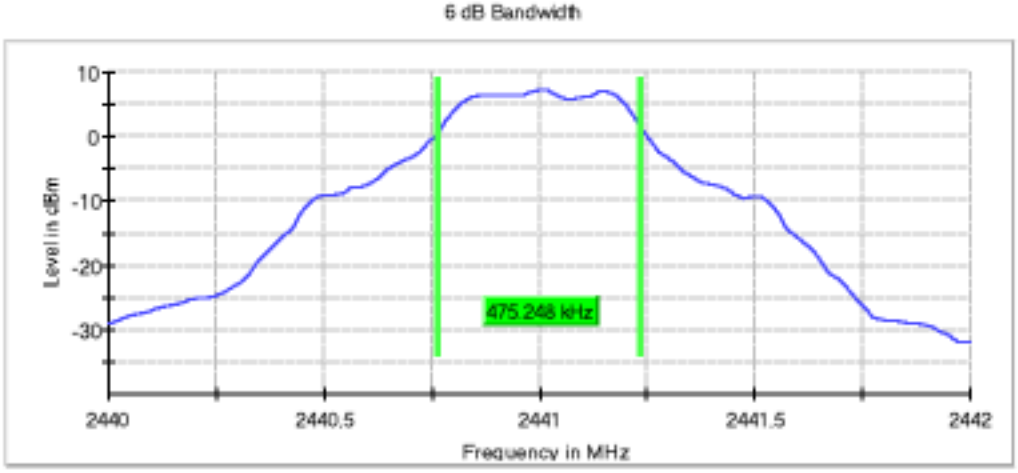
Comment:	---

Verdict	- PASS -	see next plots

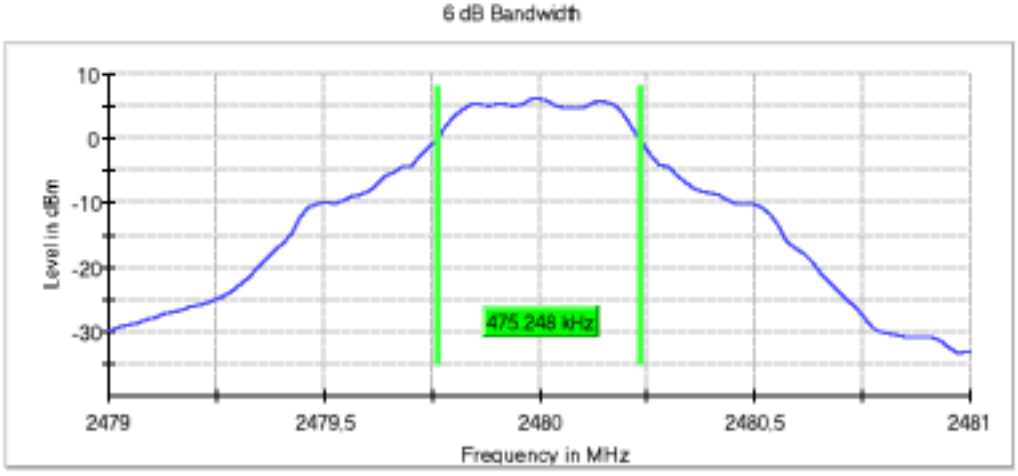
Plot 40: Mode 1, Minimum Emission Bandwidth 6 dB, low channel



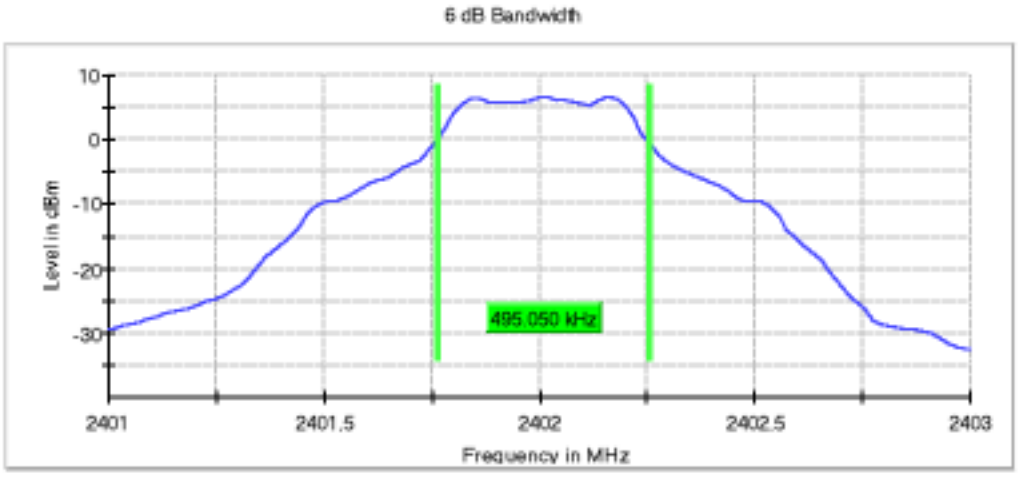
Plot 41: Mode 1, Minimum Emission Bandwidth 6 dB, mid channel



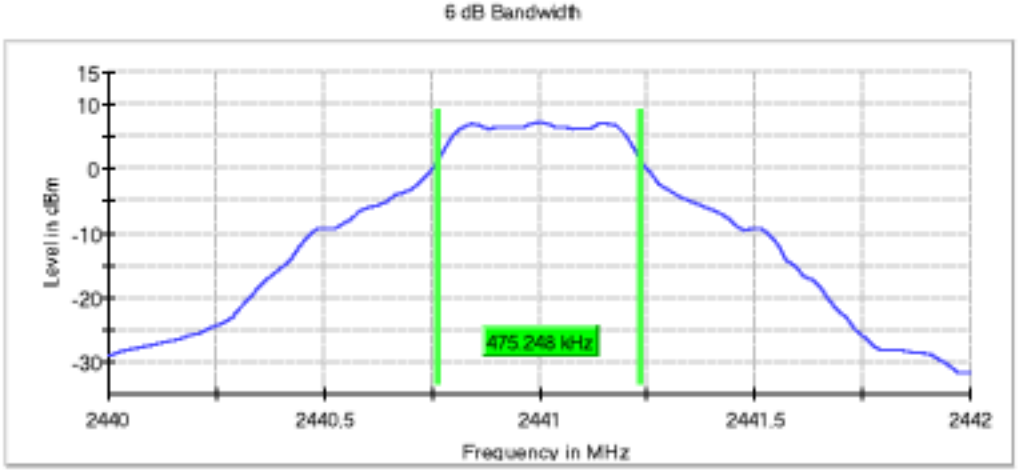
Plot 42: Mode 1, Minimum Emission Bandwidth 6 dB, high channel



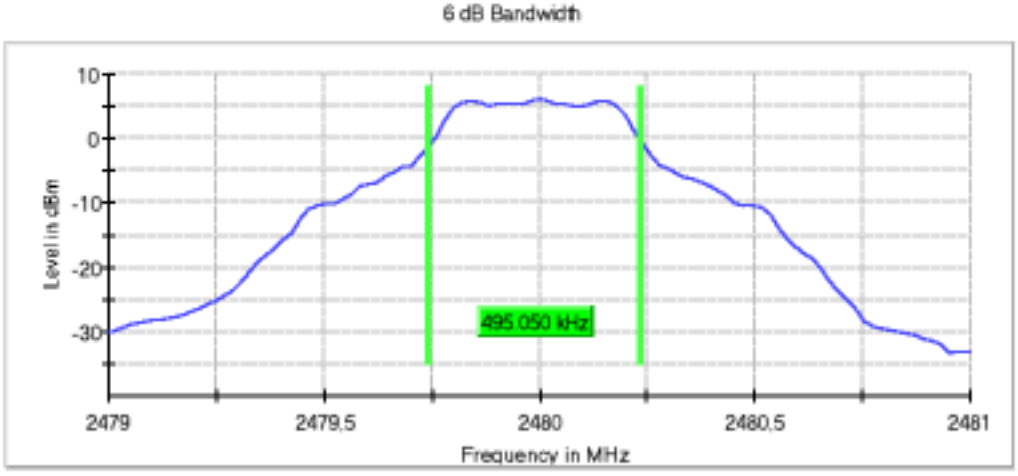
Plot 43: Mode 2, Minimum Emission Bandwidth 6 dB, low channel



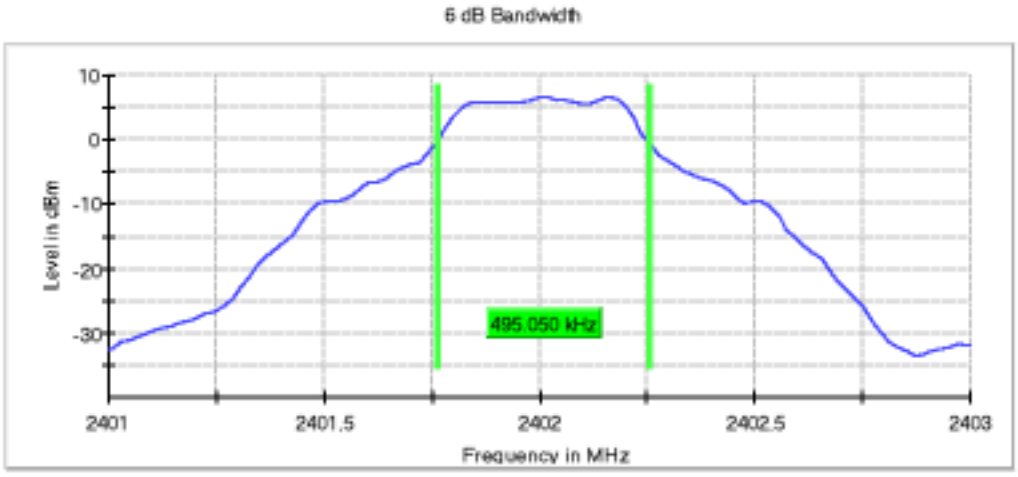
Plot 44: Mode 2, Minimum Emission Bandwidth 6 dB, mid channel



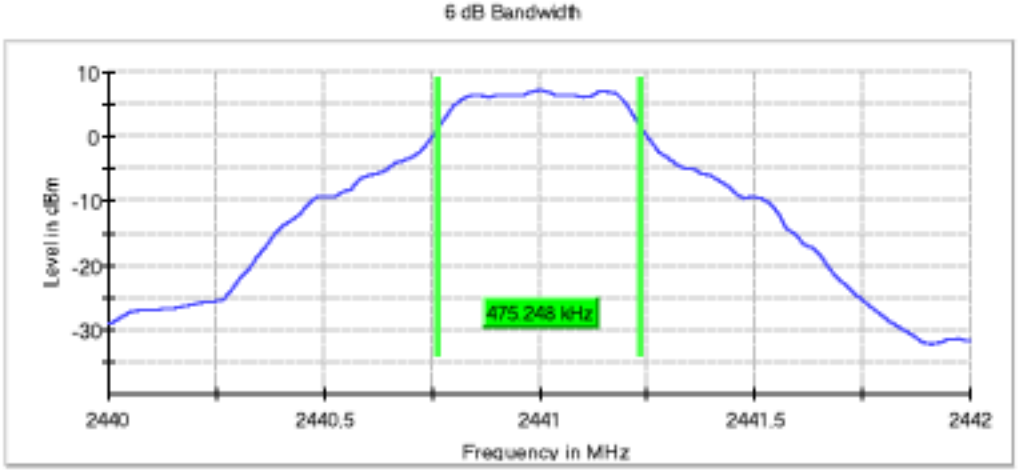
Plot 45: Mode 2, Minimum Emission Bandwidth 6 dB, high channel



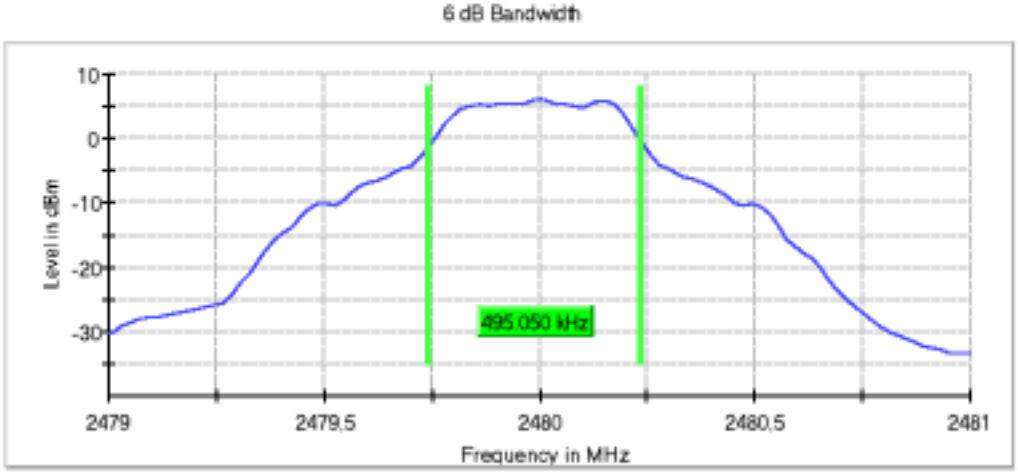
Plot 46: Mode 3, Minimum Emission Bandwidth 6 dB, low channel



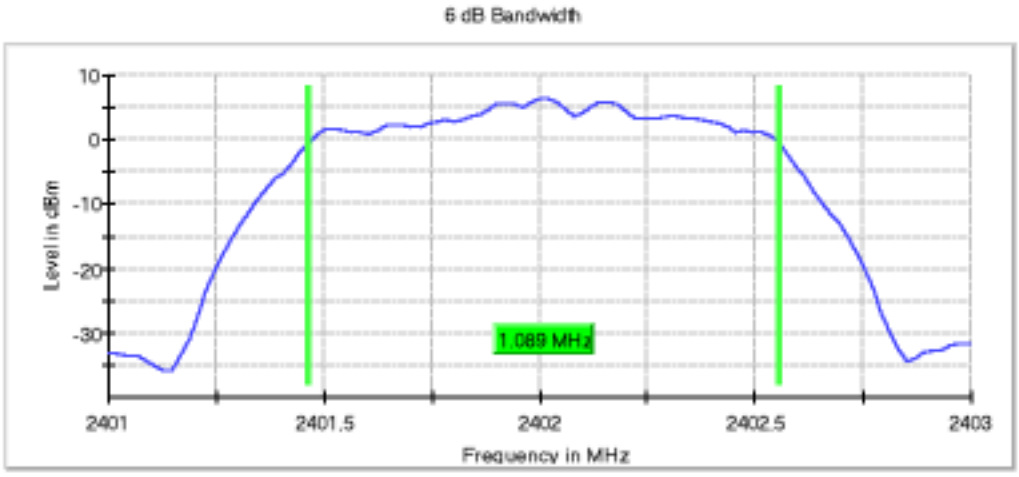
Plot 47: Mode 3, Minimum Emission Bandwidth 6 dB, mid channel



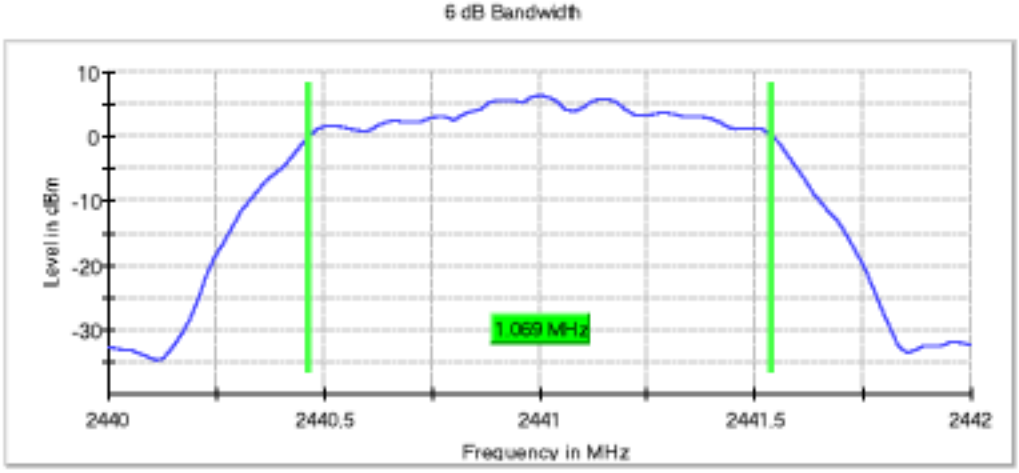
Plot 48: Mode 3, Minimum Emission Bandwidth 6 dB, high channel



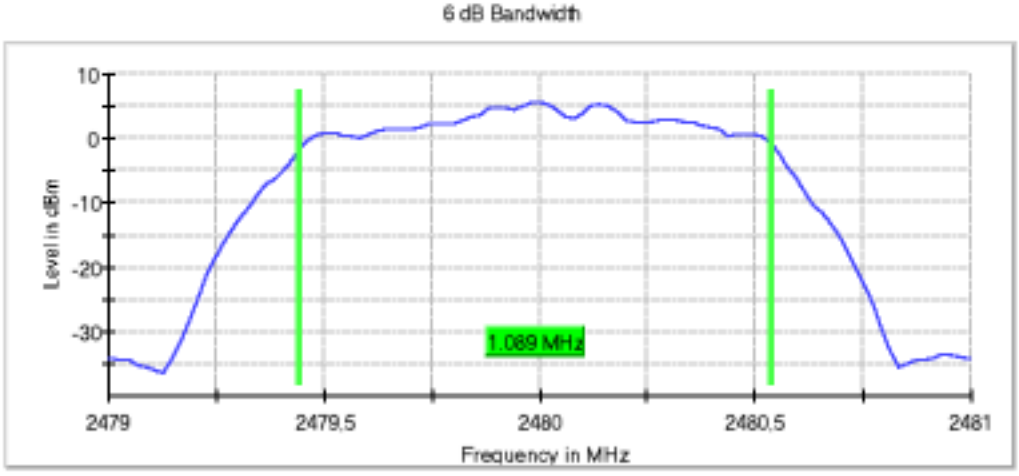
Plot 49: Mode 4, Minimum Emission Bandwidth 6 dB, low channel



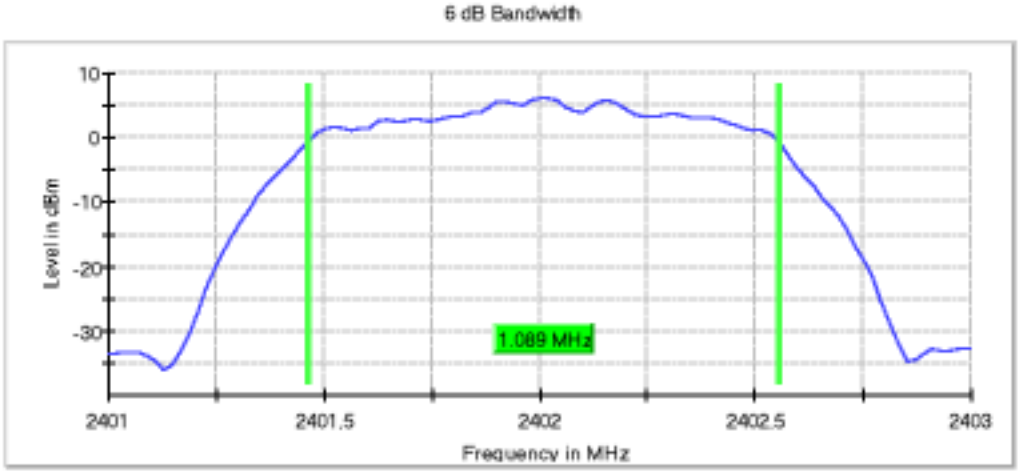
Plot 50: Mode 4, Minimum Emission Bandwidth 6 dB, mid channel



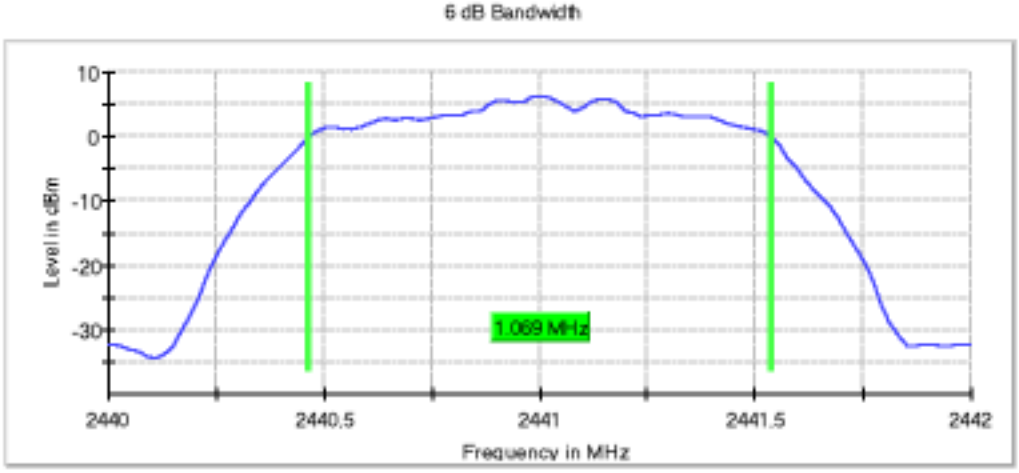
Plot 51: Mode 4, Minimum Emission Bandwidth 6 dB, high channel



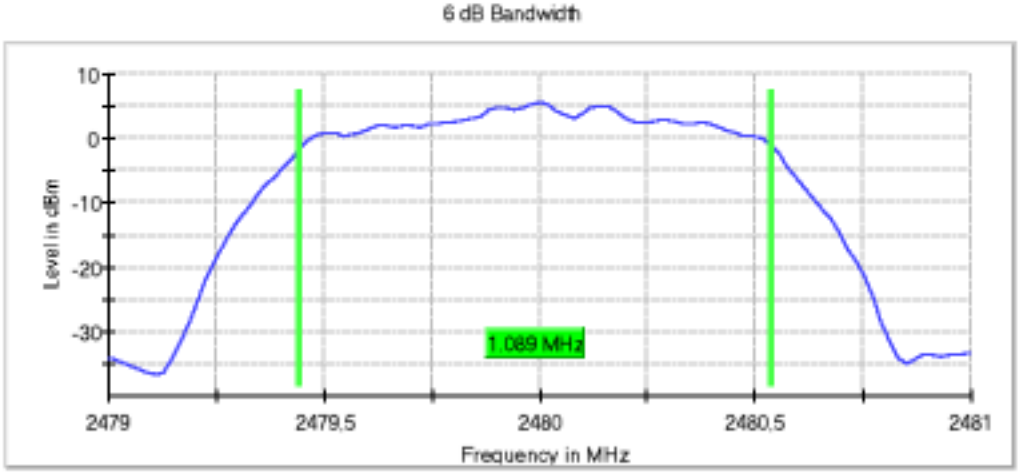
Plot 52: Mode 5, Minimum Emission Bandwidth 6 dB, low channel



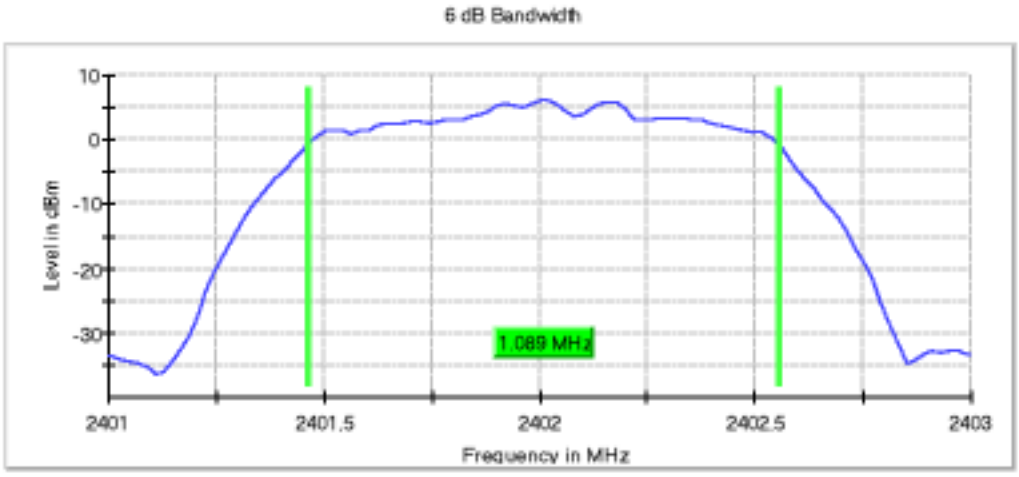
Plot 53: Mode 5, Minimum Emission Bandwidth 6 dB, mid channel



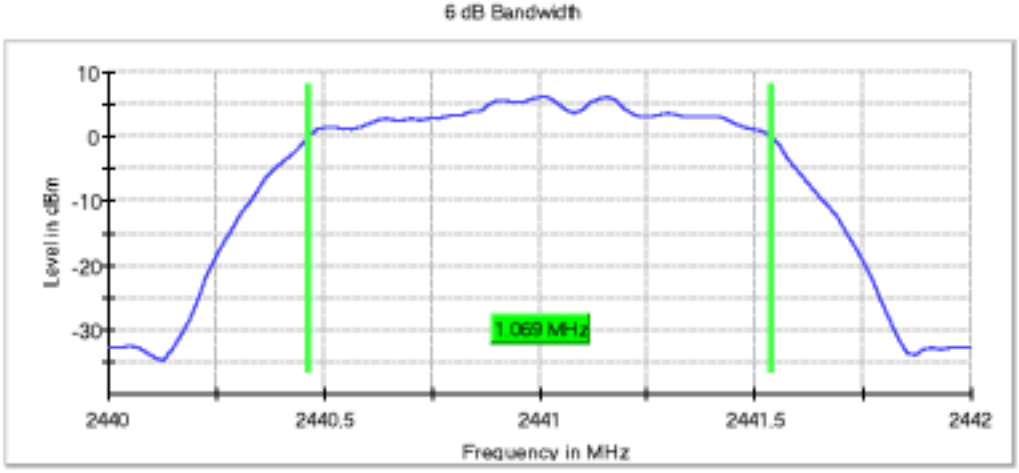
Plot 54: Mode 5, Minimum Emission Bandwidth 6 dB, high channel



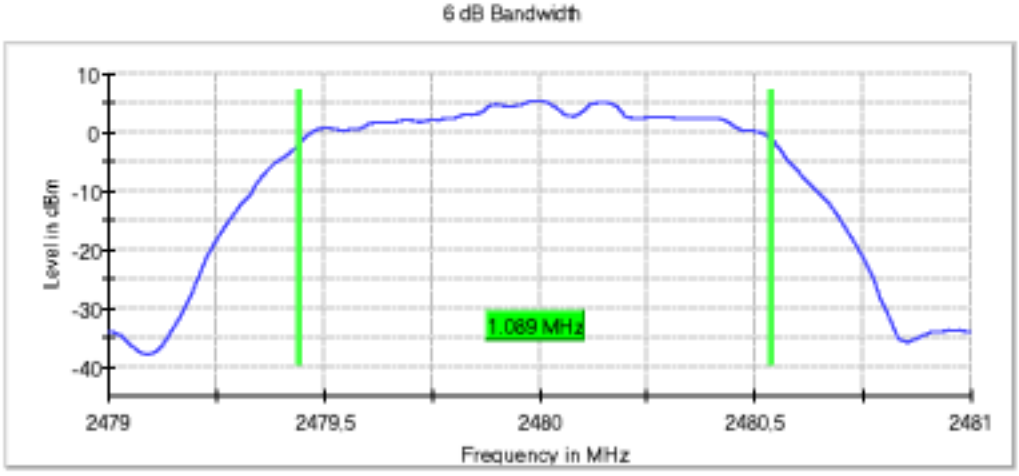
Plot 55: Mode 6, Minimum Emission Bandwidth 6 dB, low channel



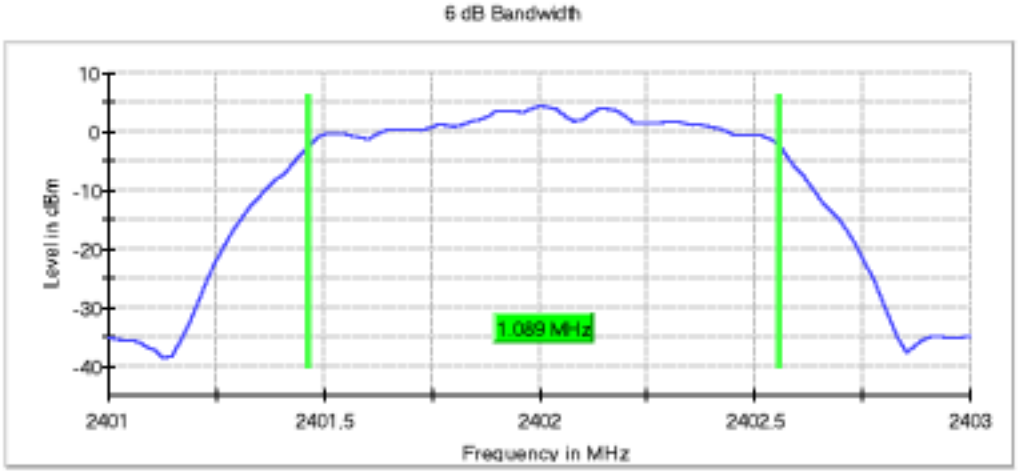
Plot 56: Mode 6, Minimum Emission Bandwidth 6 dB, mid channel



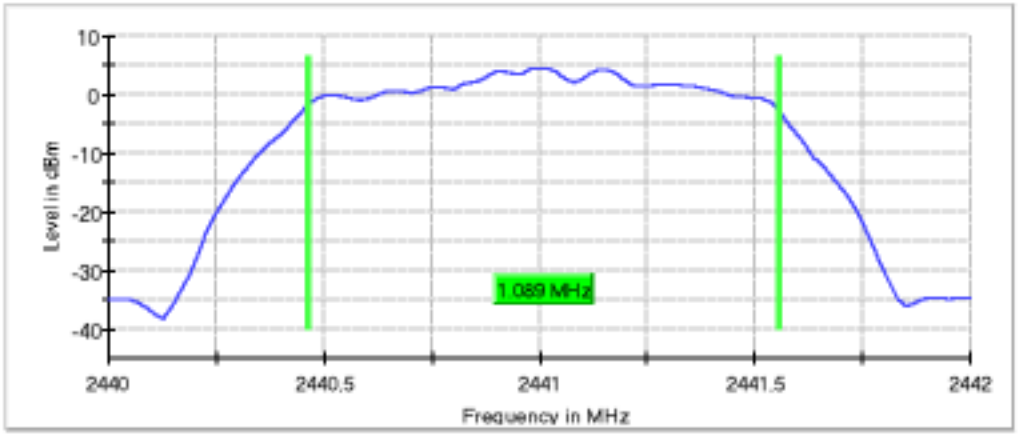
Plot 57: Mode 6, Minimum Emission Bandwidth 6 dB, high channel



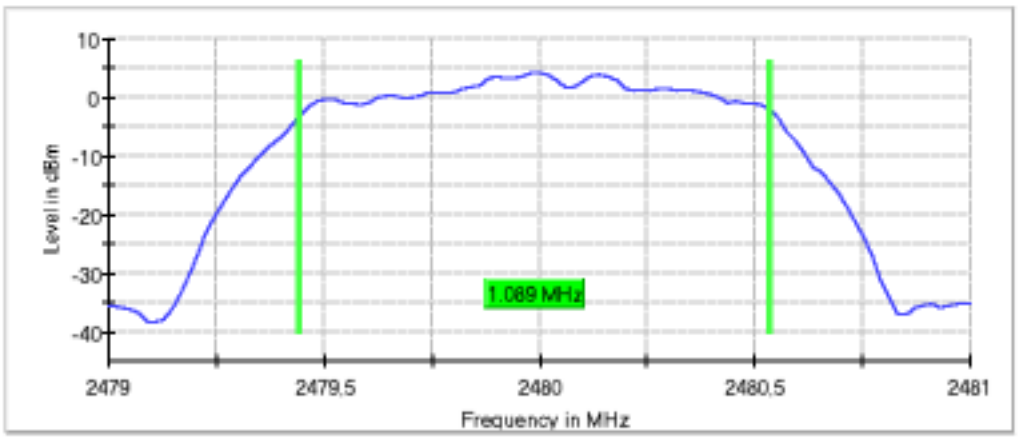
Plot 58: Mode 7, Minimum Emission Bandwidth 6 dB, low channel



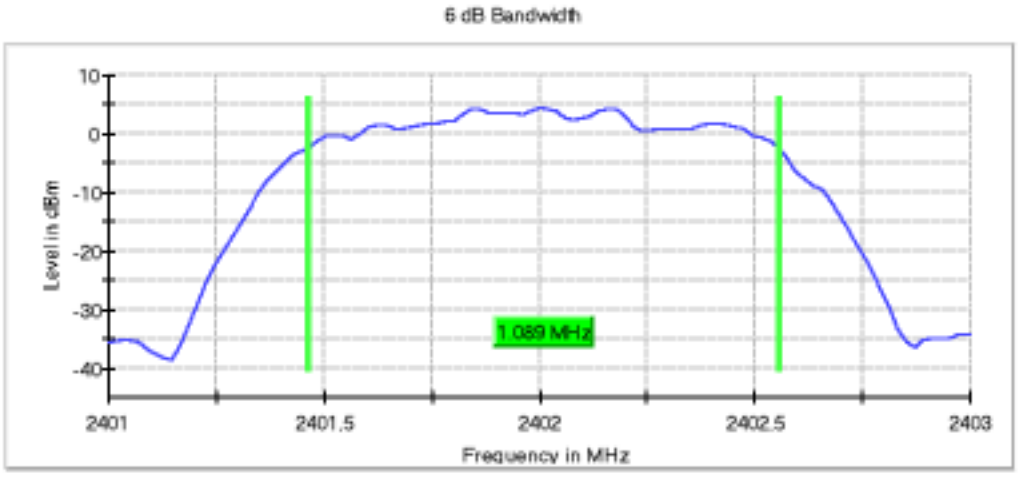
Plot 59: Mode 7, Minimum Emission Bandwidth 6 dB, mid channel



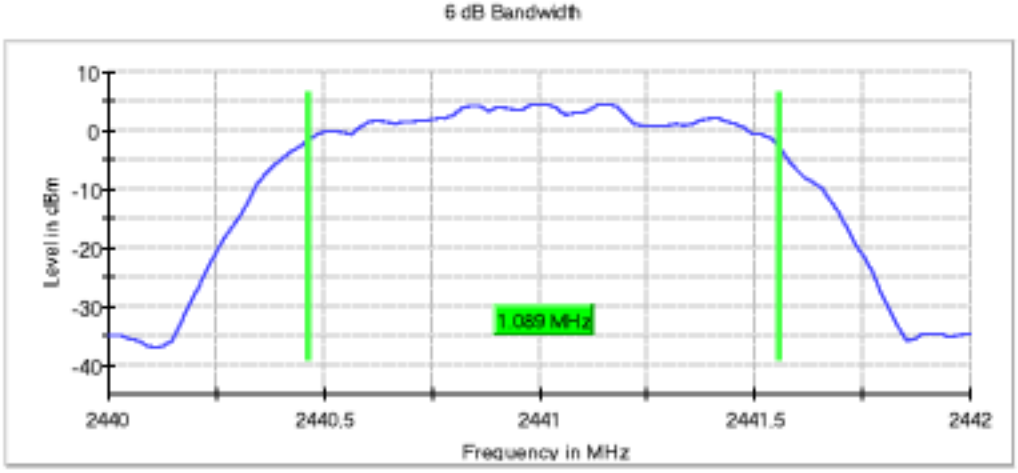
Plot 60: Mode 7, Minimum Emission Bandwidth 6 dB, high channel



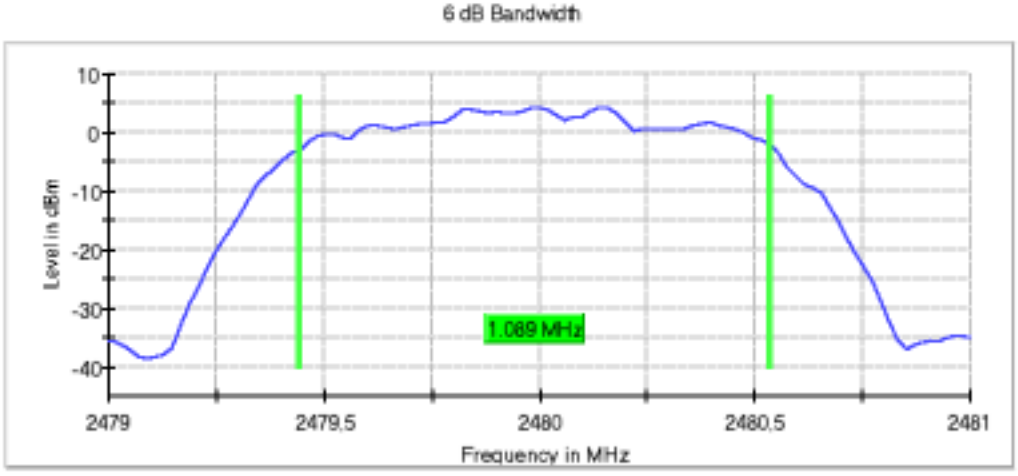
Plot 61: Mode 8, Minimum Emission Bandwidth 6 dB, low channel



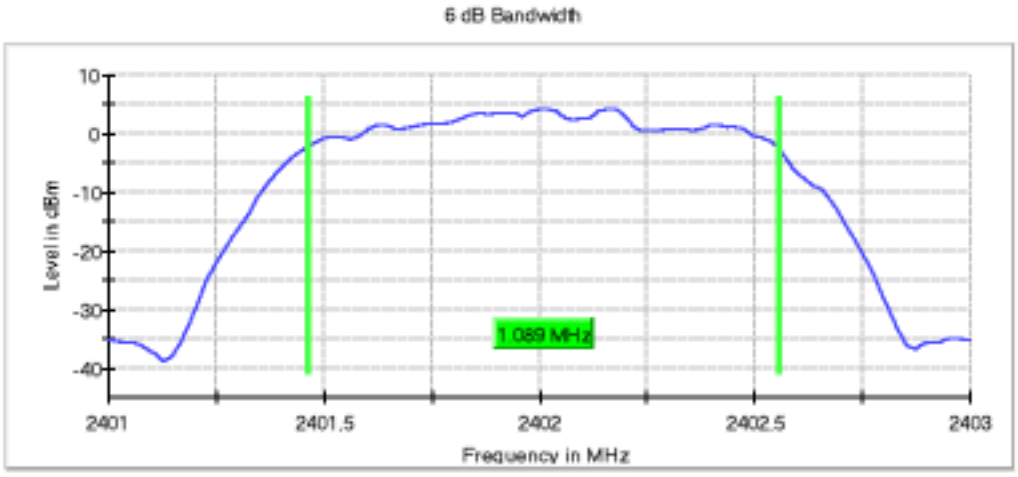
Plot 62: Mode 8, Minimum Emission Bandwidth 6 dB, mid channel



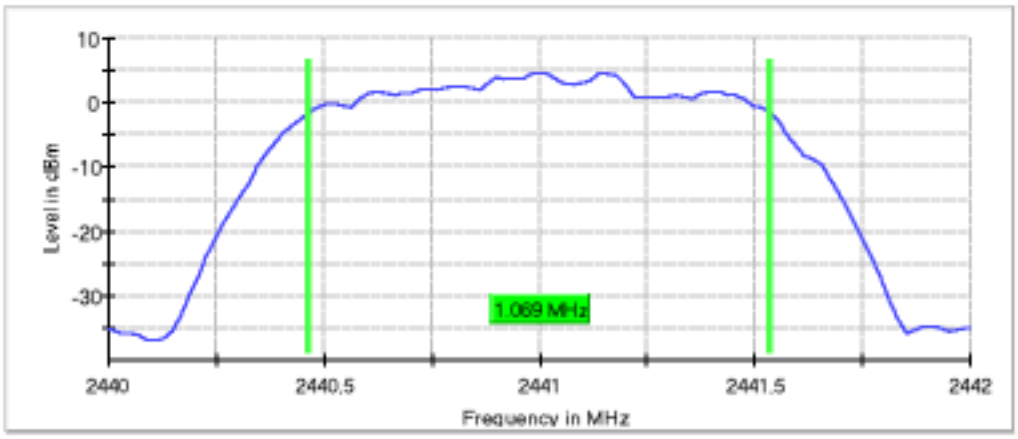
Plot 63: Mode 8, Minimum Emission Bandwidth 6 dB, high channel



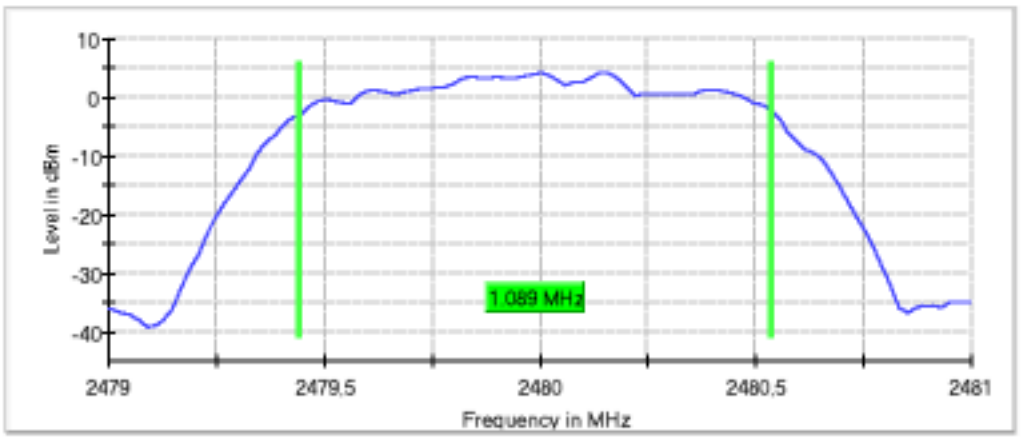
Plot 64: Mode 9, Minimum Emission Bandwidth 6 dB, low channel



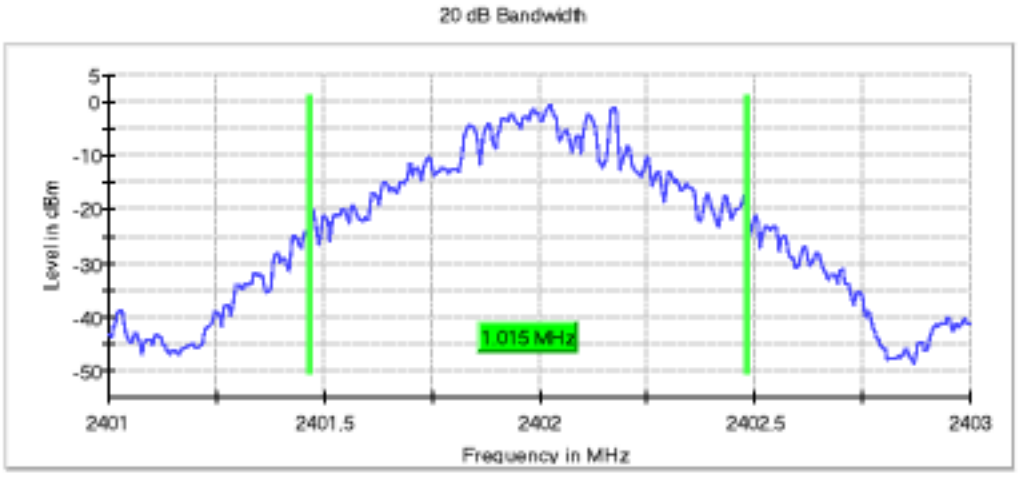
Plot 65: Mode 9, Minimum Emission Bandwidth 6 dB, mid channel



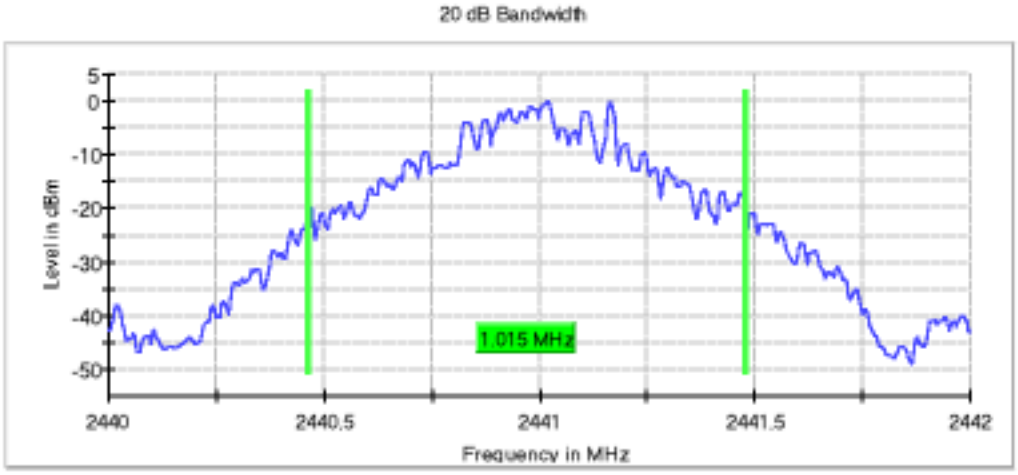
Plot 66: Mode 9, Minimum Emission Bandwidth 6 dB, high channel



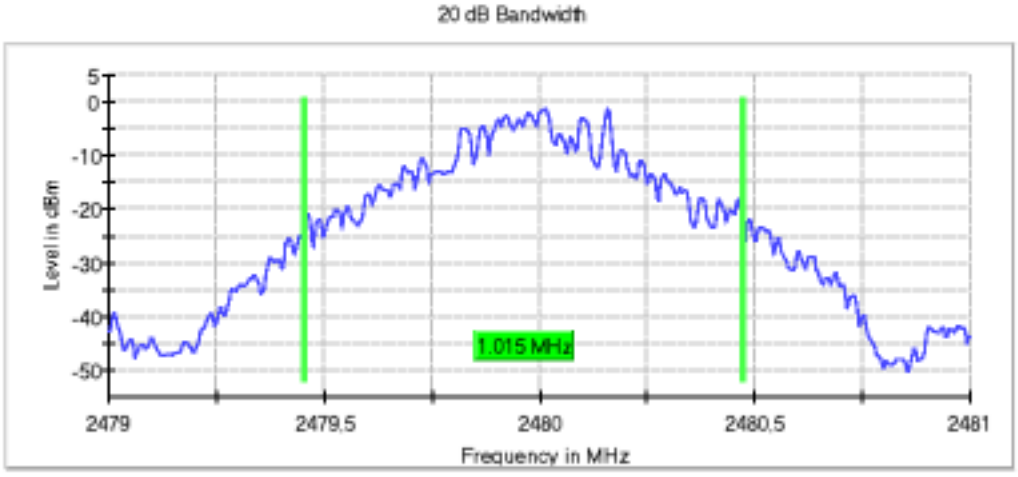
Plot 67: Mode 1, Emission Bandwidth 20 dB, low channel



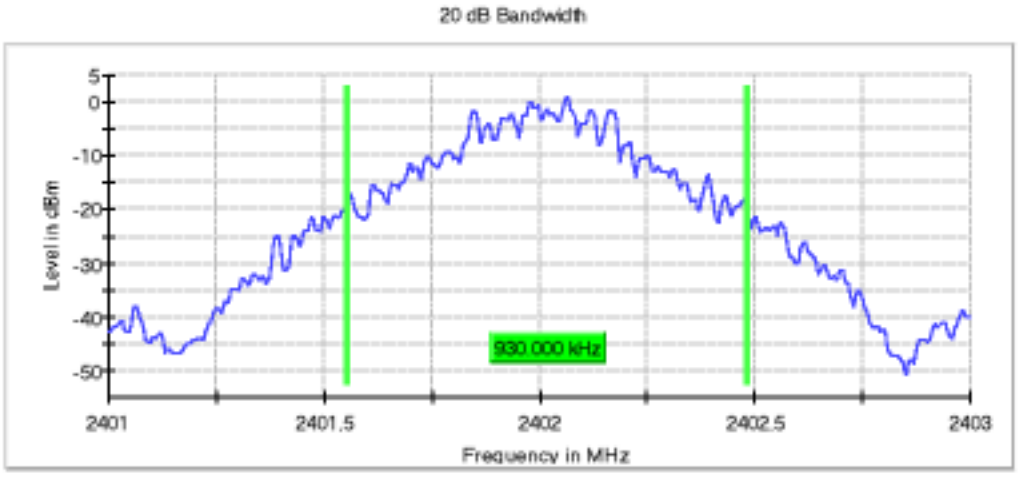
Plot 68: Mode 1, Emission Bandwidth 20 dB, mid channel



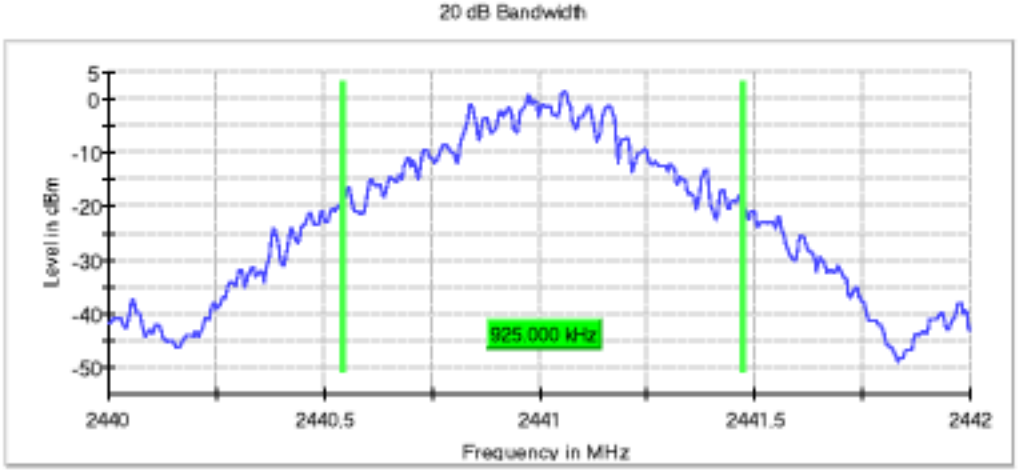
Plot 69: Mode 1, Emission Bandwidth 20 dB, high channel



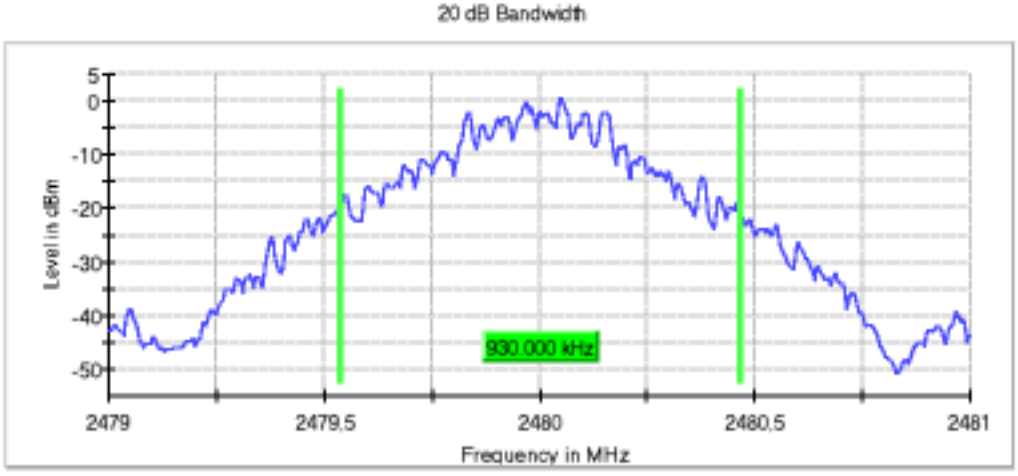
Plot 70: Mode 2, Emission Bandwidth 20 dB, low channel



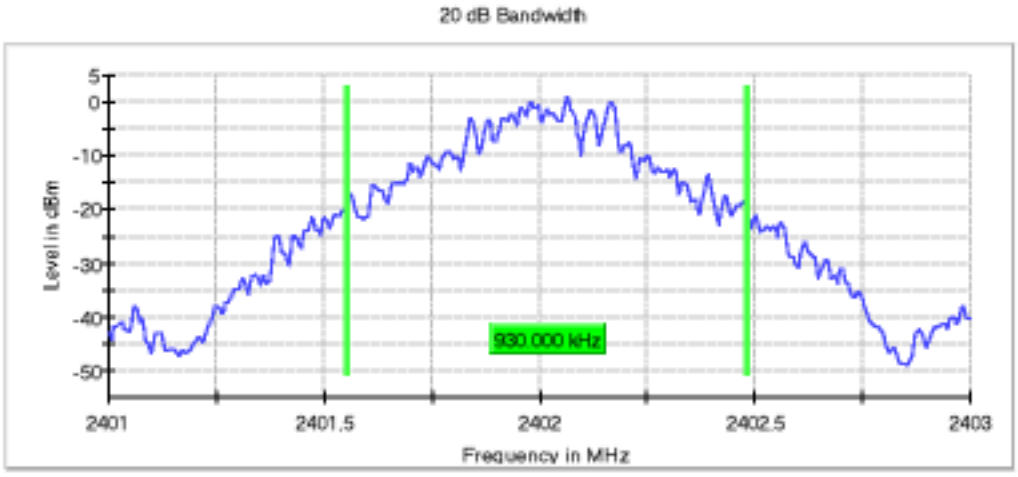
Plot 71: Mode 2, Emission Bandwidth 20 dB, mid channel



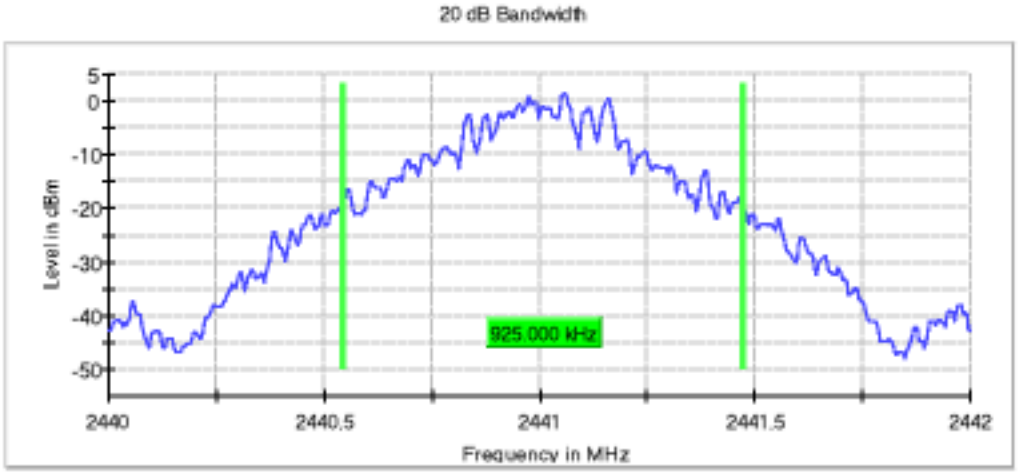
Plot 72: Mode 2, Emission Bandwidth 20 dB, high channel



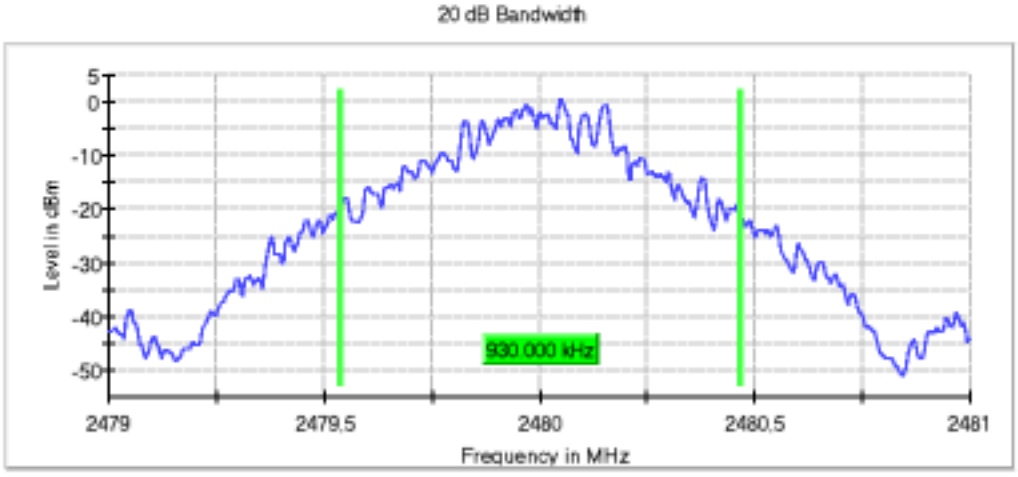
Plot 73: Mode 3, Emission Bandwidth 20 dB, low channel



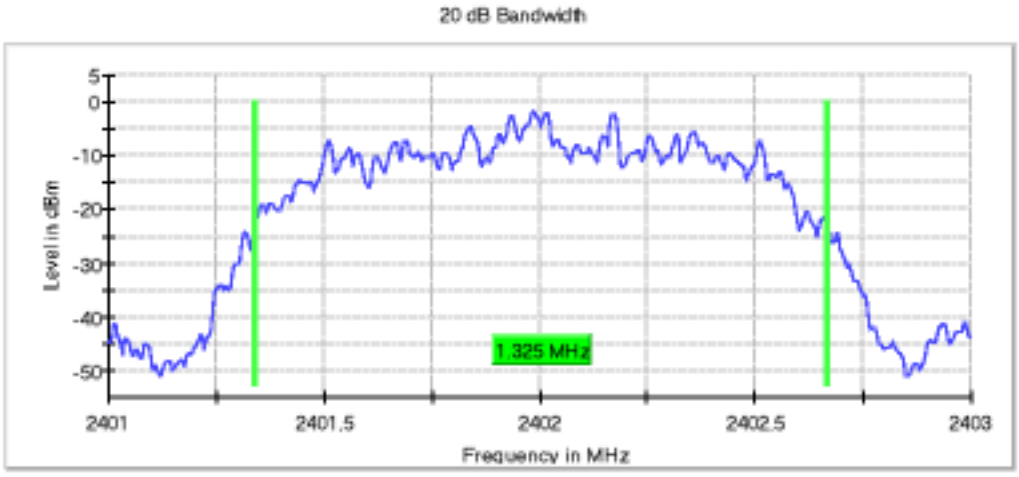
Plot 74: Mode 3, Emission Bandwidth 20 dB, mid channel



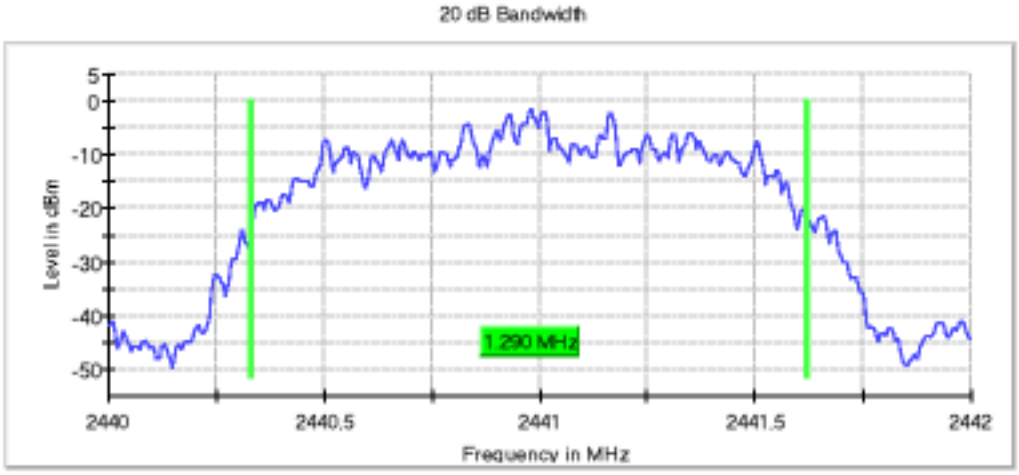
Plot 75: Mode 3, Emission Bandwidth 20 dB, high channel



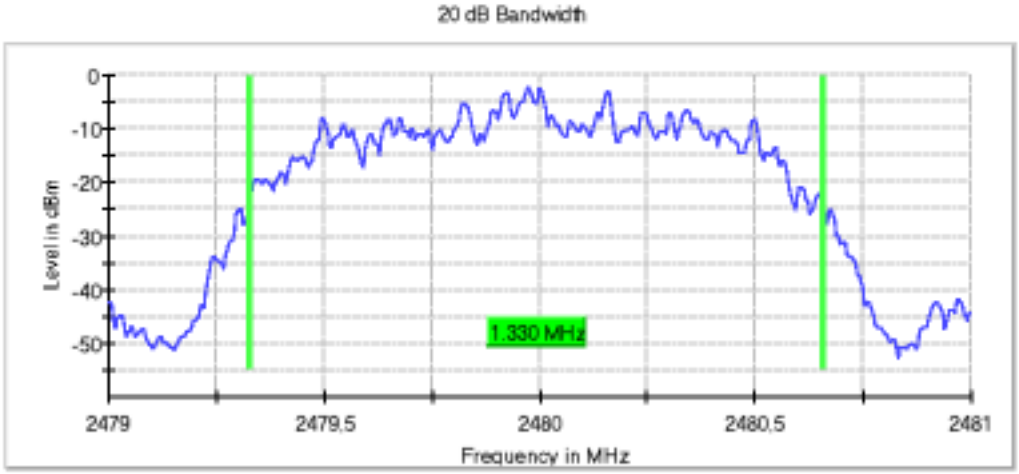
Plot 76: Mode 4, Emission Bandwidth 20 dB, low channel



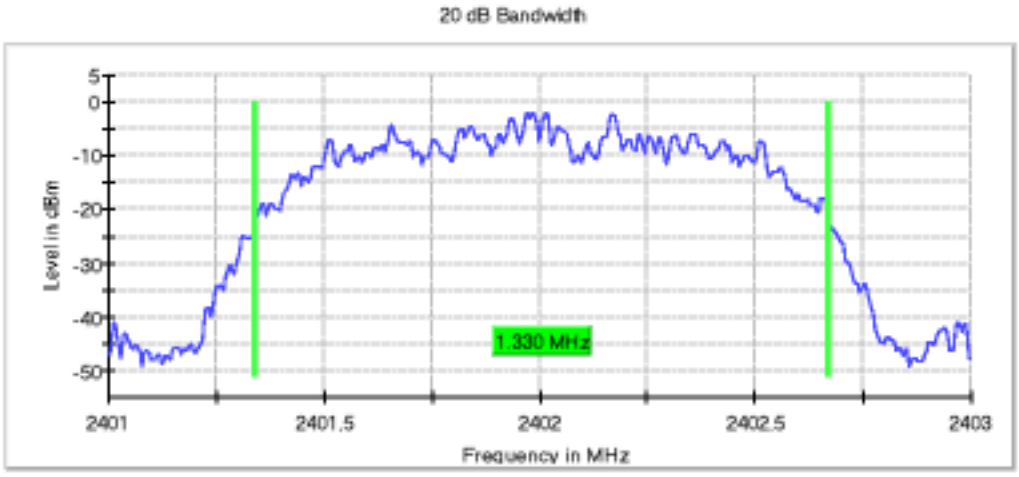
Plot 77: Mode 4, Emission Bandwidth 20 dB, mid channel



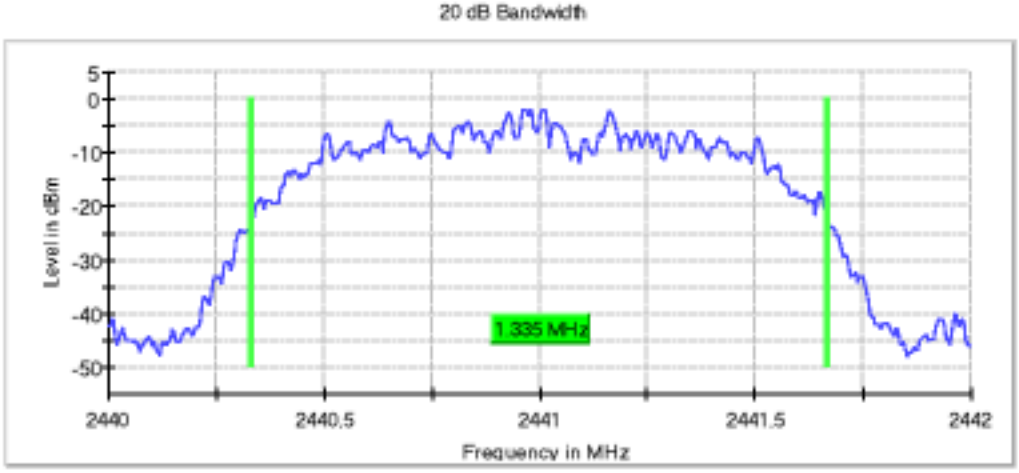
Plot 78: Mode 4, Emission Bandwidth 20 dB, high channel



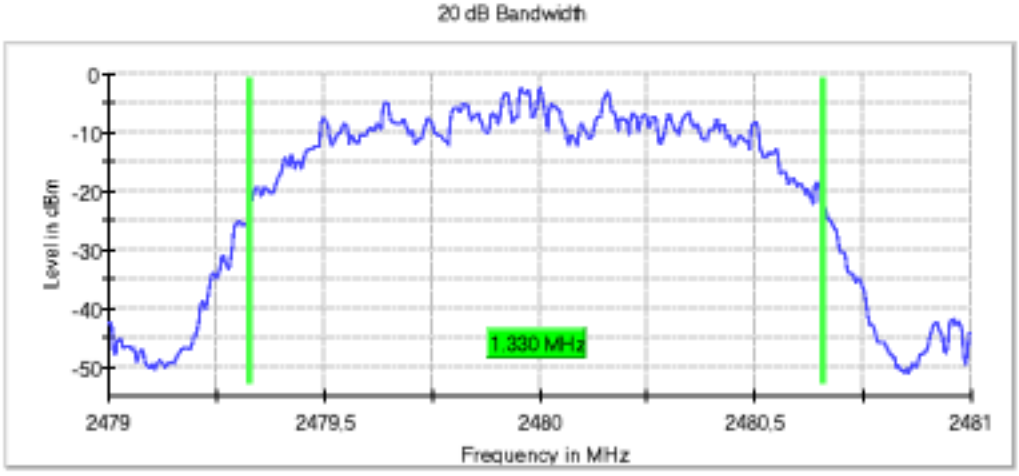
Plot 79: Mode 5, Emission Bandwidth 20 dB, low channel



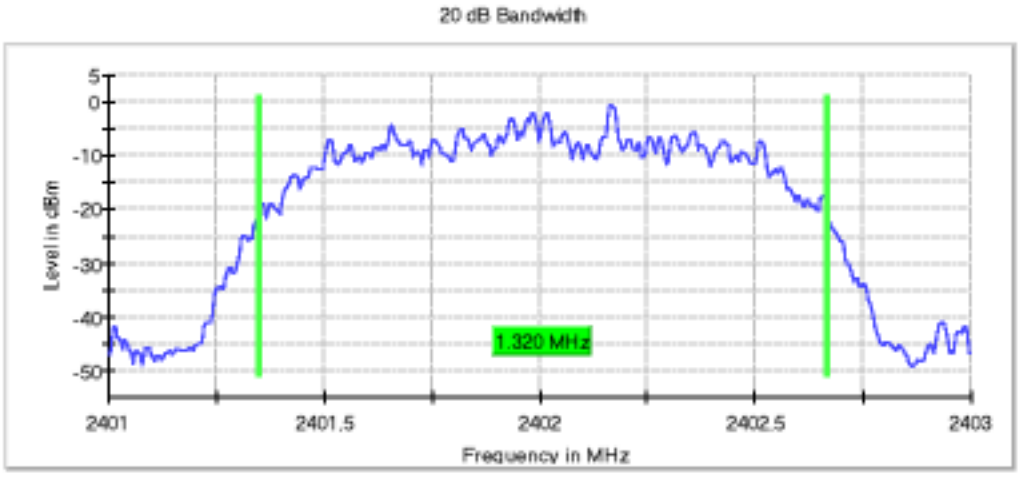
Plot 80: Mode 5, Emission Bandwidth 20 dB, mid channel



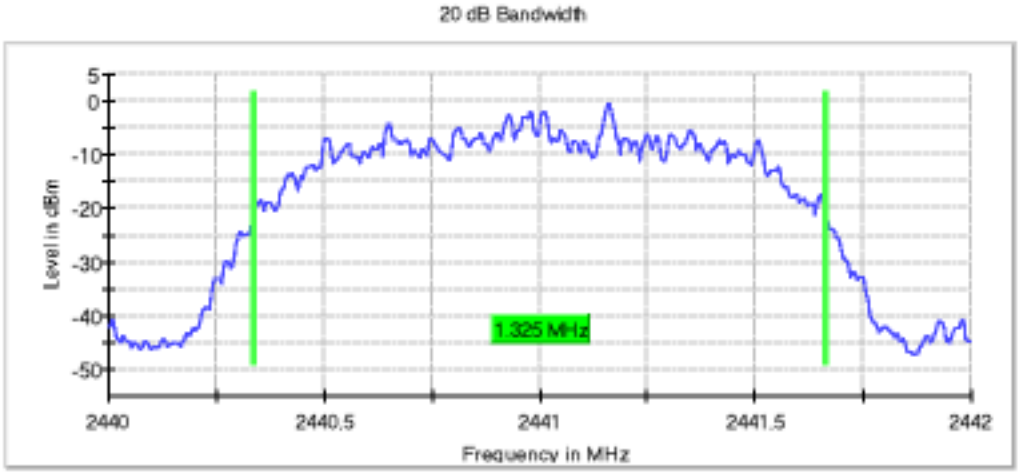
Plot 81: Mode 5, Emission Bandwidth 20 dB, high channel



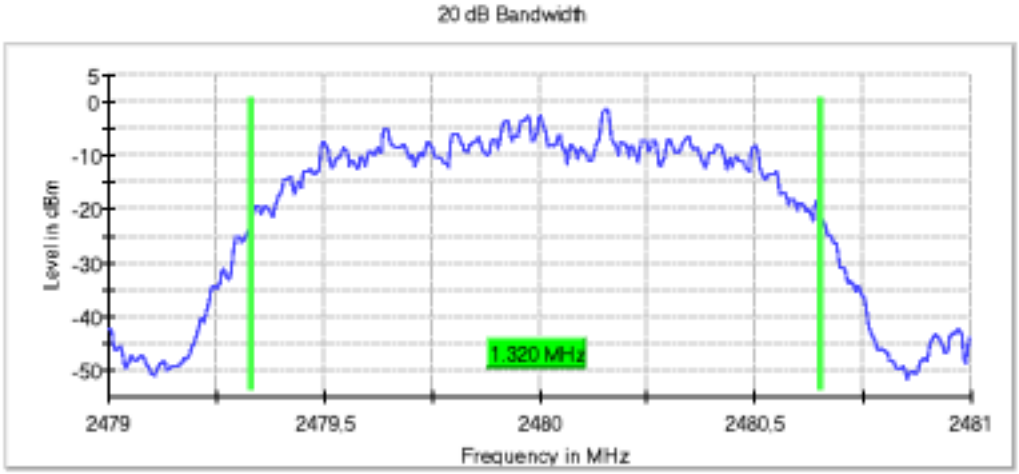
Plot 82: Mode 6, Emission Bandwidth 20 dB, low channel



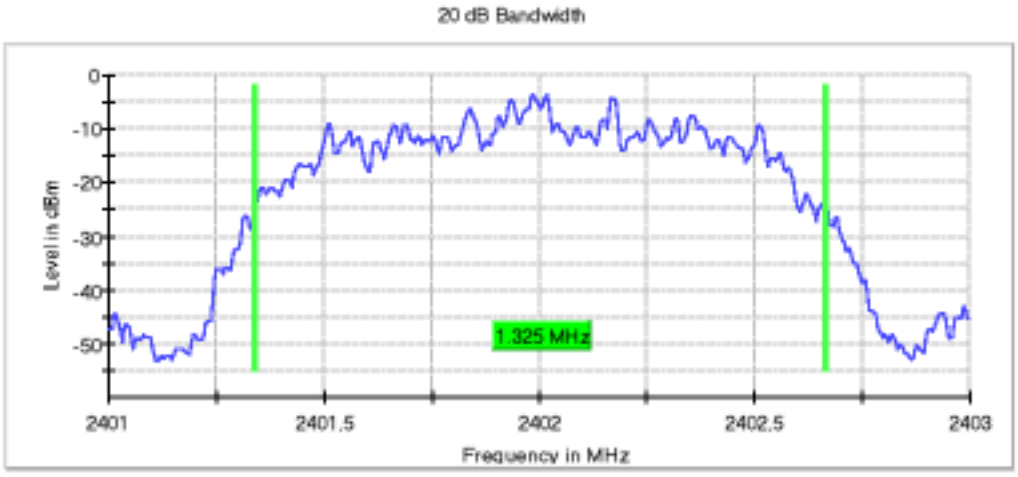
Plot 83: Mode 6, Emission Bandwidth 20 dB, mid channel



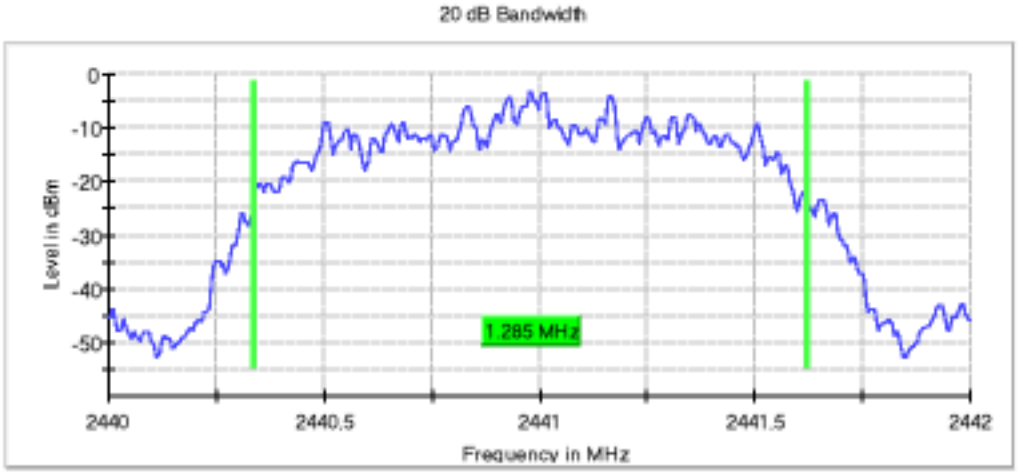
Plot 84: Mode 6, Emission Bandwidth 20 dB, high channel



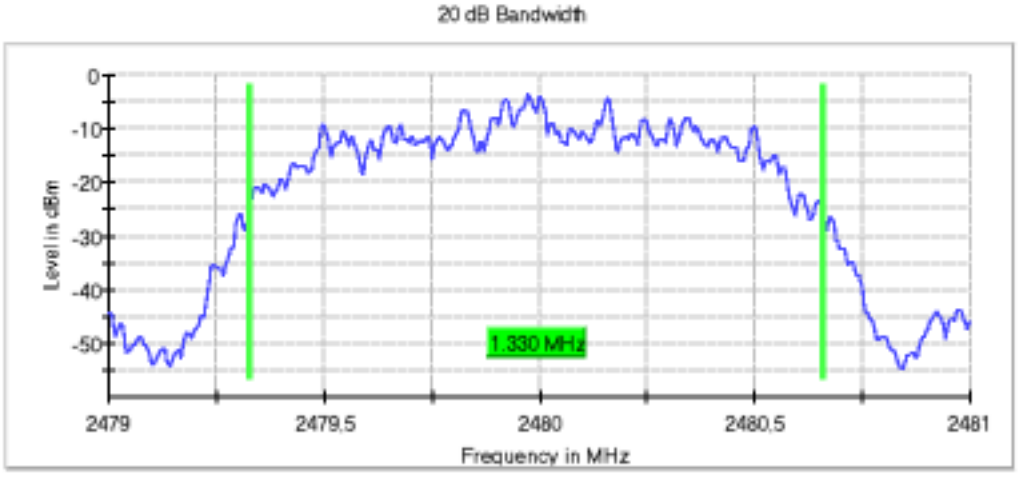
Plot 85: Mode 7, Emission Bandwidth 20 dB, low channel



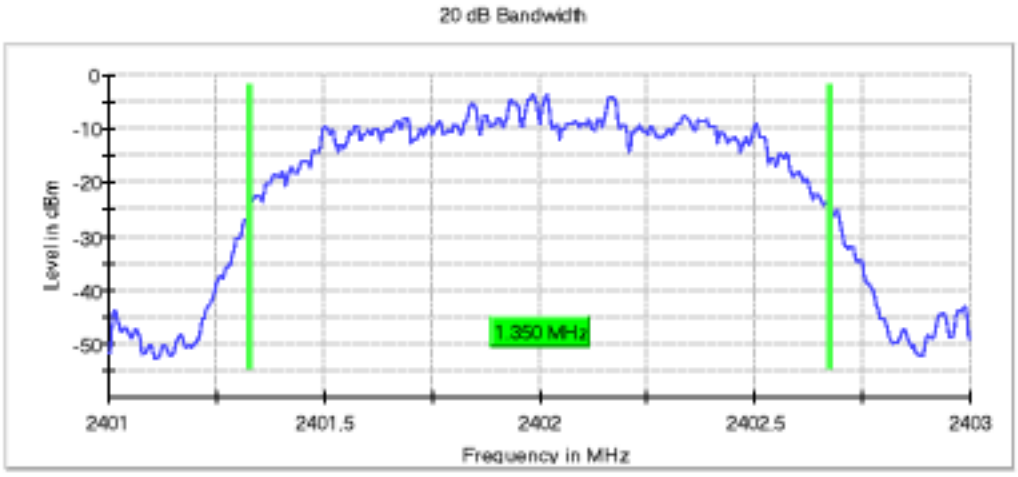
Plot 86: Mode 7, Emission Bandwidth 20 dB, mid channel



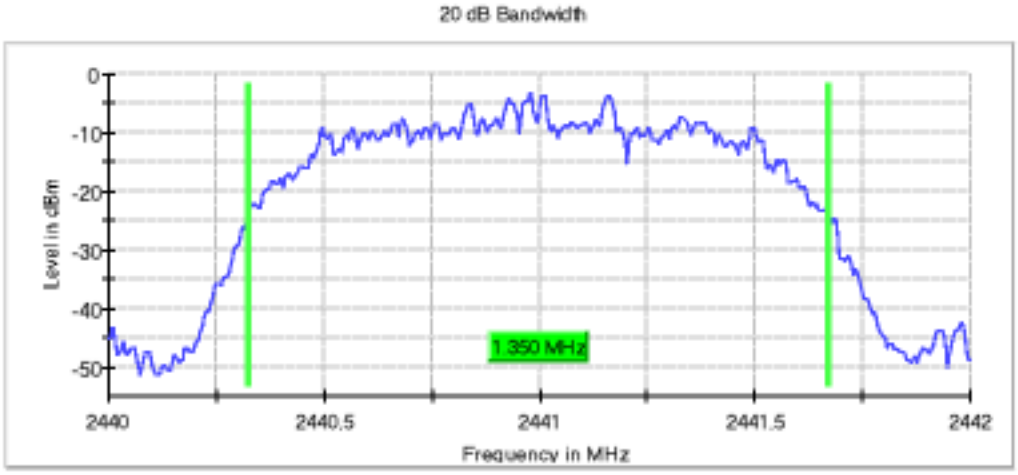
Plot 87: Mode 7, Emission Bandwidth 20 dB, high channel



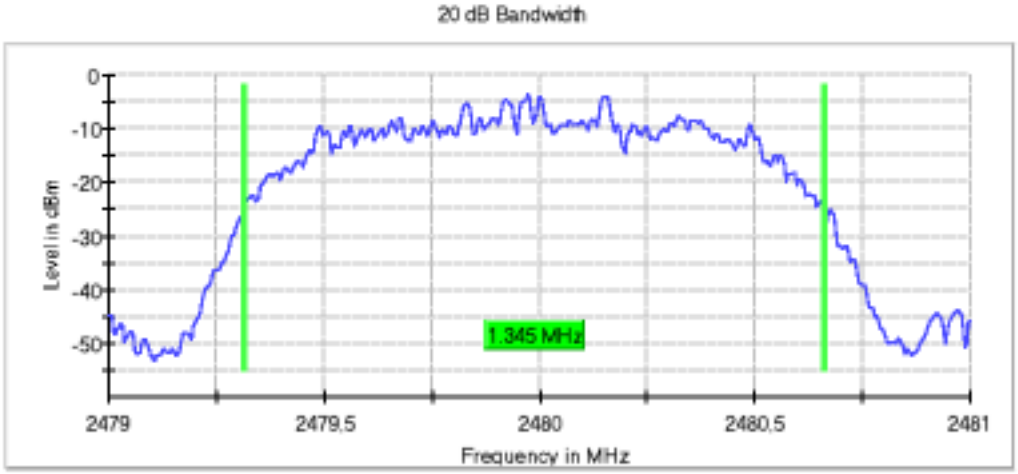
Plot 88: Mode 8, Emission Bandwidth 20 dB, low channel



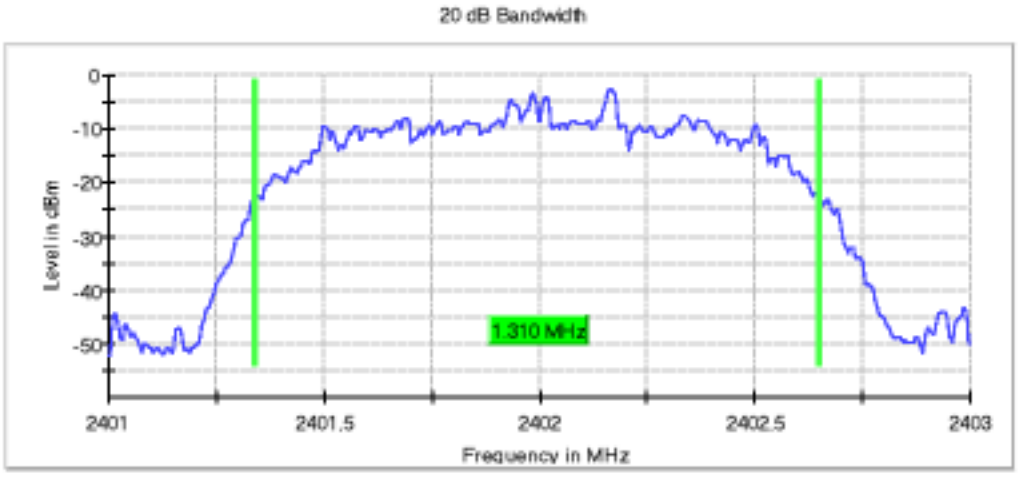
Plot 89: Mode 8, Emission Bandwidth 20 dB, mid channel



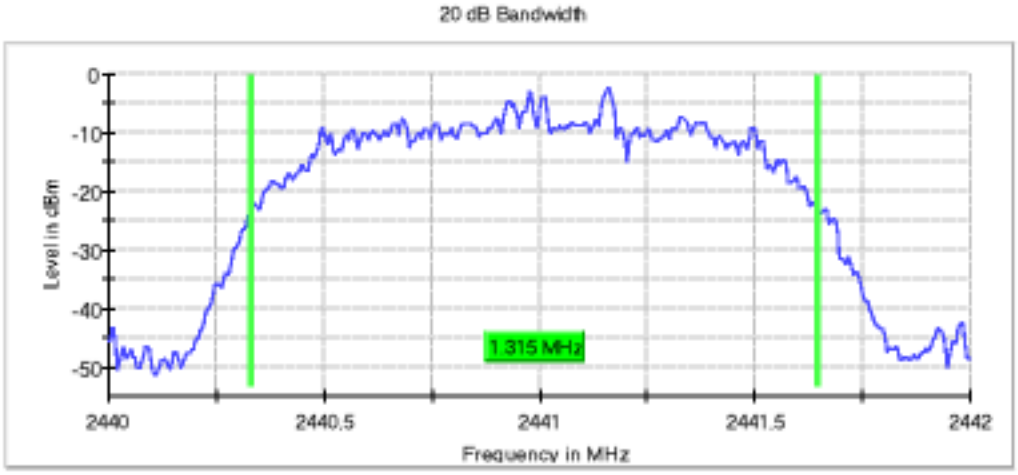
Plot 90: Mode 8, Emission Bandwidth 20 dB, high channel



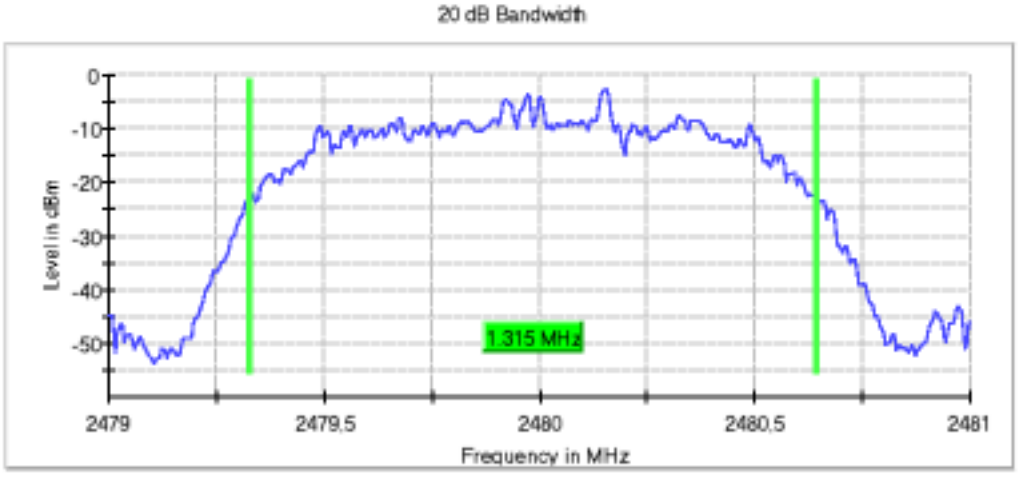
Plot 91: Mode 9, Emission Bandwidth 20 dB, low channel



Plot 92: Mode 9, Emission Bandwidth 20 dB, mid channel



Plot 93: Mode 9, Emission Bandwidth 20 dB, high channel



7.5 Occupied Bandwidth (99% OBW)

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal (RSS-Gen).

Limit
No limit defined.

Test procedure
ANSI C63.10, 7.8
The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.
The following procedure shall be used for measuring 99% power bandwidth:
a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
d) Step a) through step c) might require iteration to adjust within the specified range.
e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

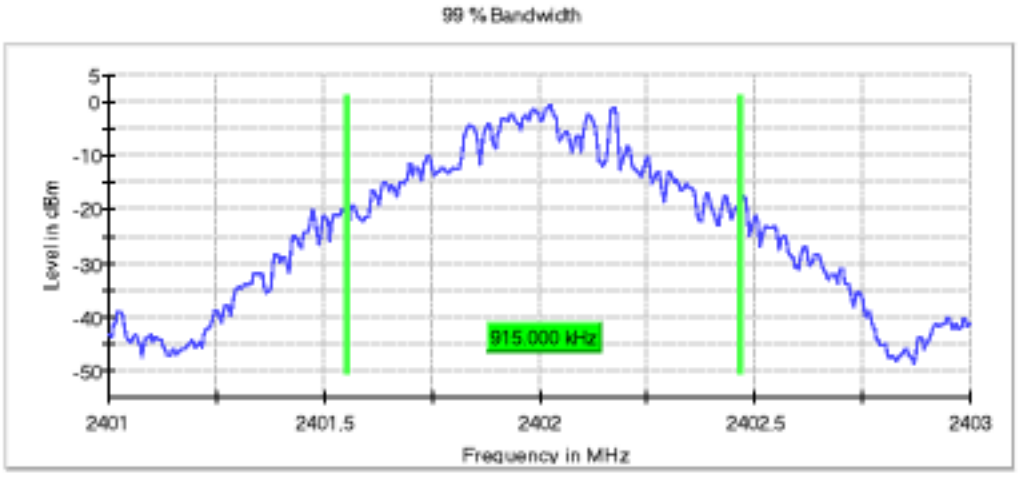
Test setup: 8.4 with conducted test sample (see section 5.2)

Test Results			
EUT Mode	Occupied Bandwidth (99%)		
	low channel [kHz]	mid channel [kHz]	high channel [kHz]
Mode 1	915	915	915
Mode 2	885	885	885
Mode 3	875	880	875
Mode 4	1175	1175	1175
Mode 5	1190	1195	1190
Mode 6	1190	1195	1190
Mode 7	1175	1175	1175
Mode 8	1195	1200	1200
Mode 9	**1200**	**1200**	**1200**

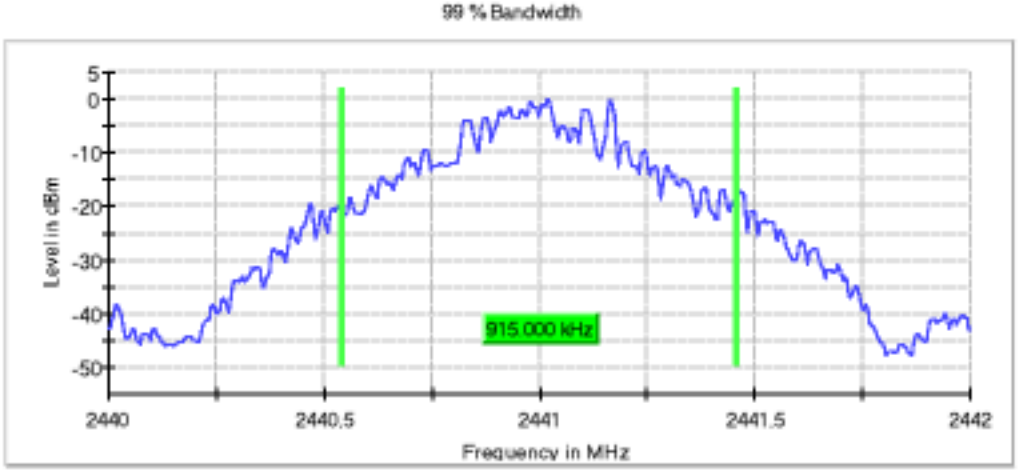
Comment:	---

Verdict	- PASS -	see next plots

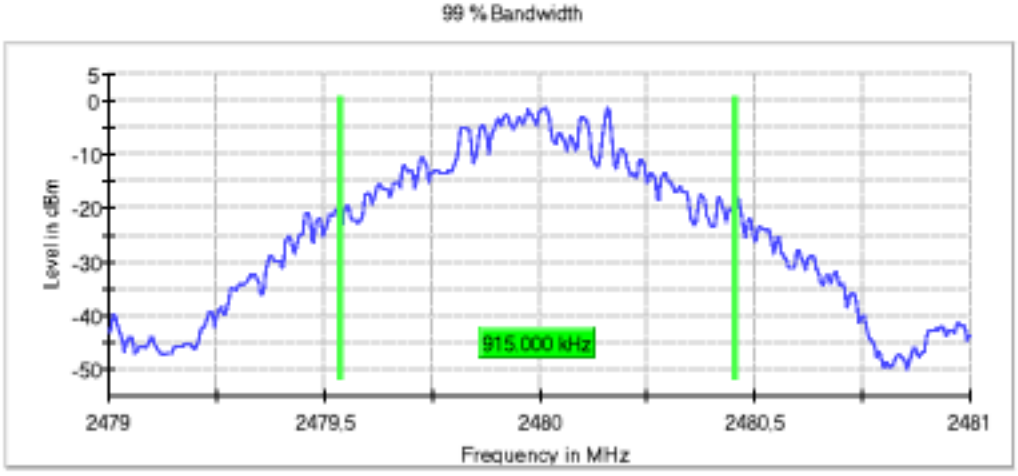
Plot 94: Mode 1, 99% Occupied Bandwidth, low channel



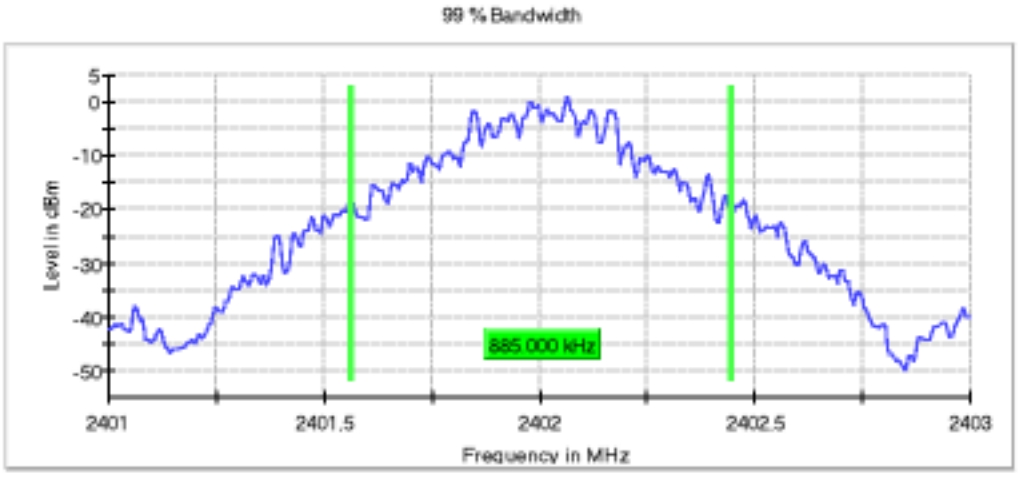
Plot 95: Mode 1, 99% Occupied Bandwidth, mid channel



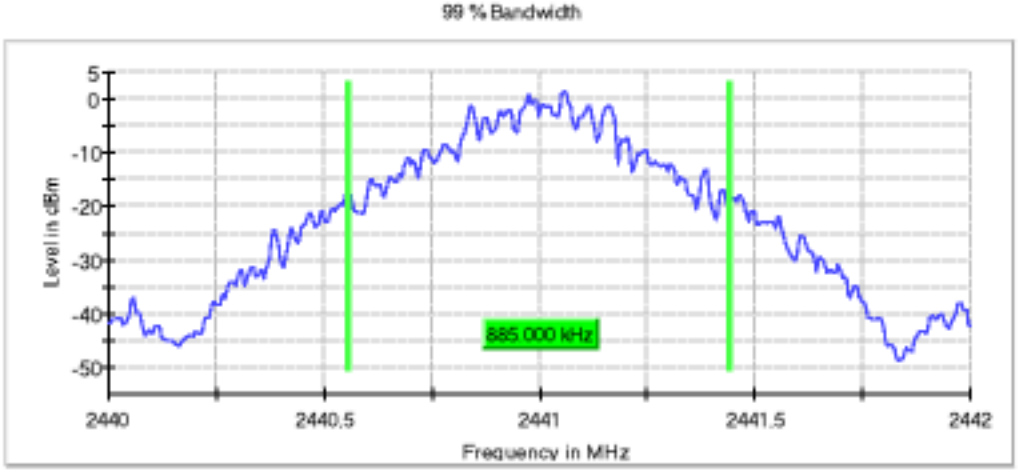
Plot 96: Mode 1, 99% Occupied Bandwidth, high channel



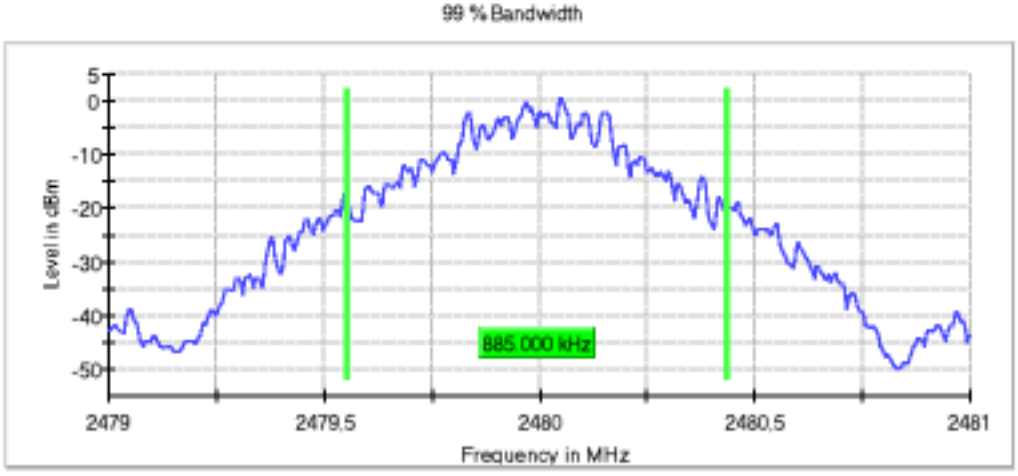
Plot 97: Mode 2, 99% Occupied Bandwidth, low channel



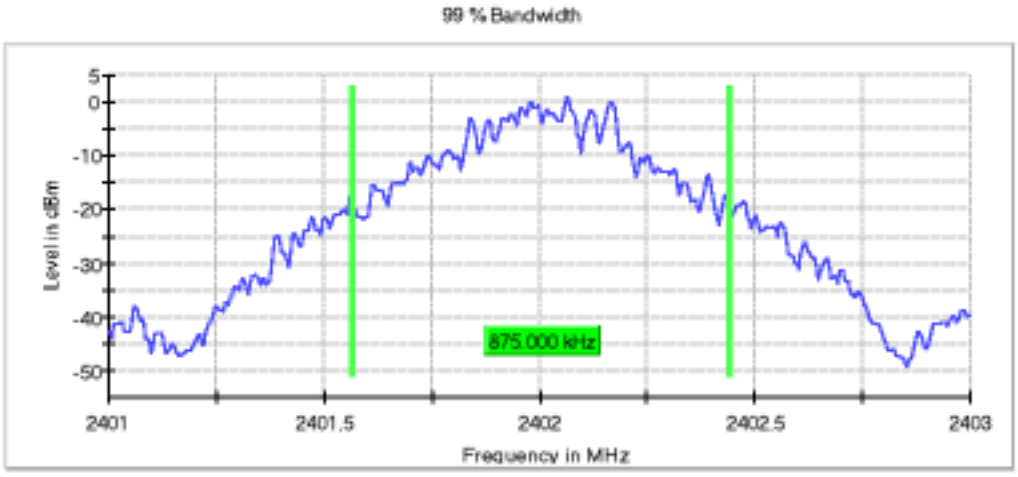
Plot 98: Mode 2, 99% Occupied Bandwidth, mid channel



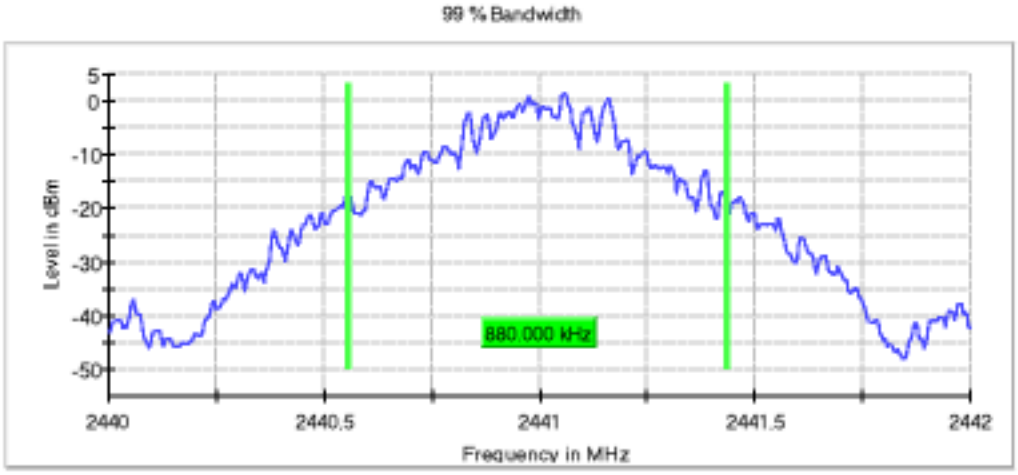
Plot 99: Mode 2, 99% Occupied Bandwidth, high channel



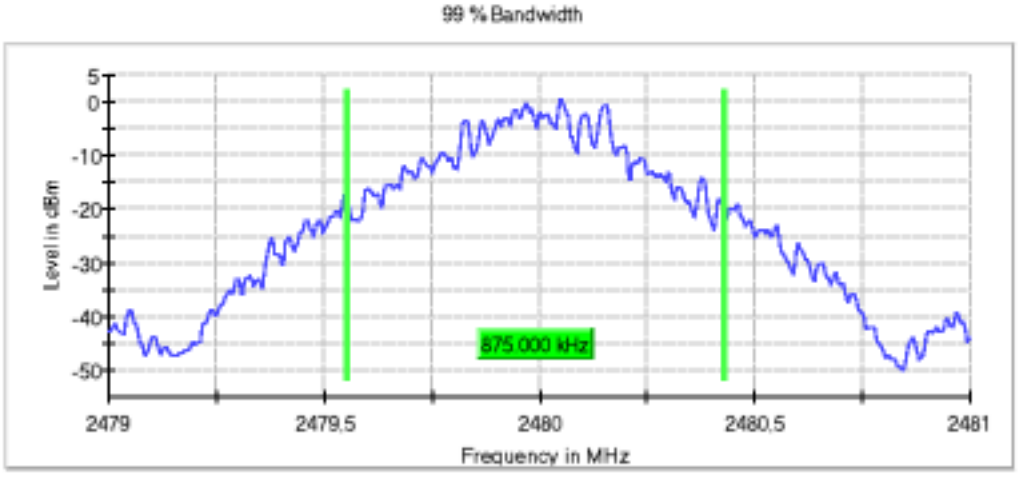
Plot 100: Mode 3, 99% Occupied Bandwidth, low channel



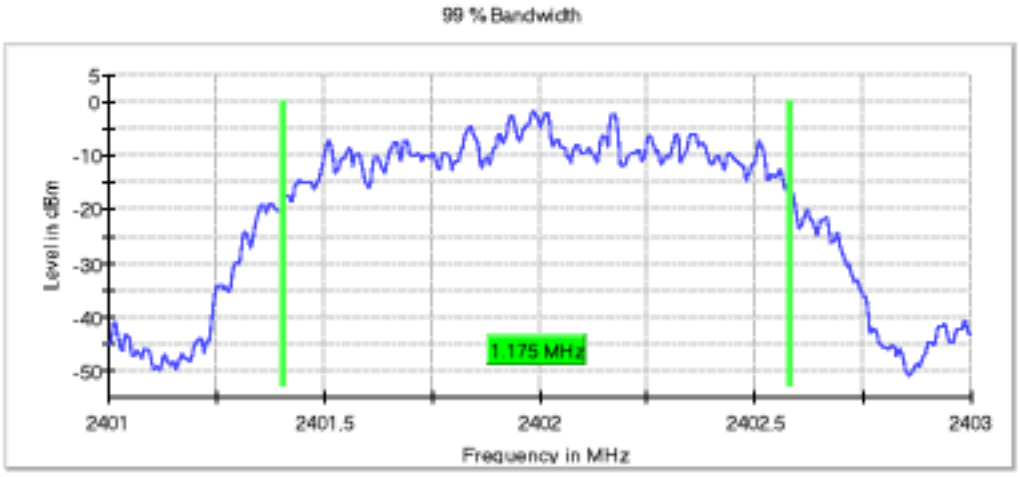
Plot 101: Mode 3, 99% Occupied Bandwidth, mid channel



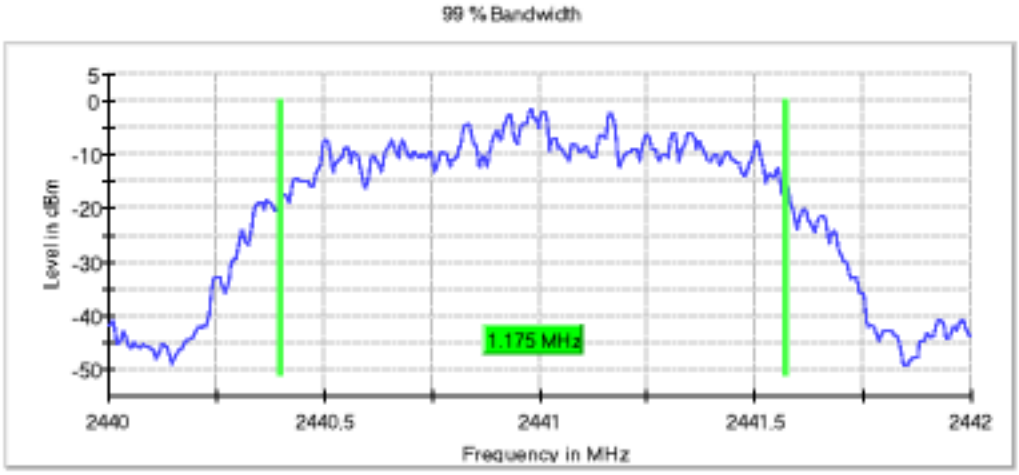
Plot 102: Mode 3, 99% Occupied Bandwidth, high channel



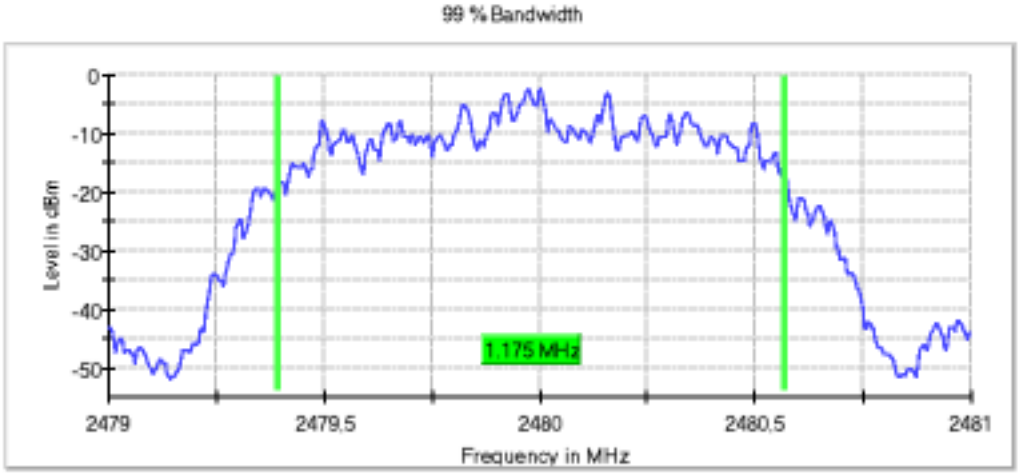
Plot 103: Mode 4, 99% Occupied Bandwidth, low channel



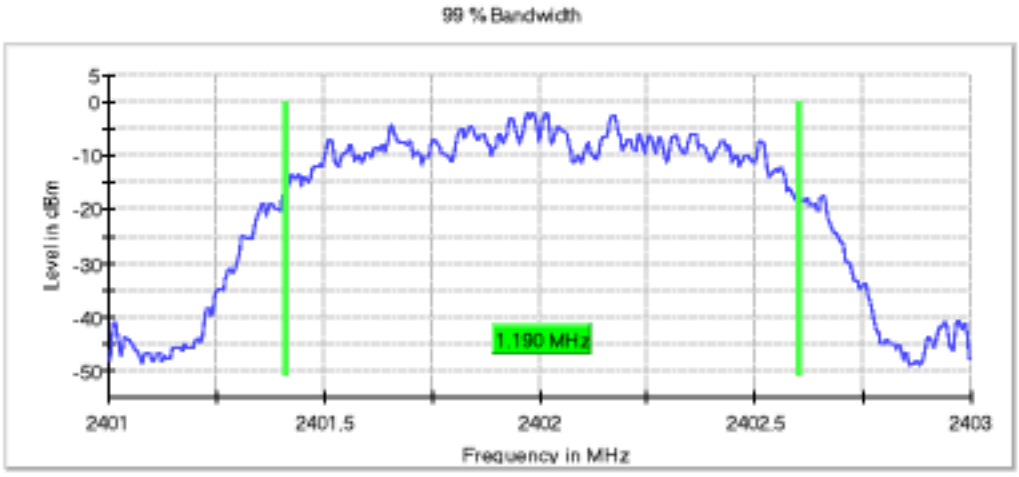
Plot 104: Mode 4, 99% Occupied Bandwidth, mid channel



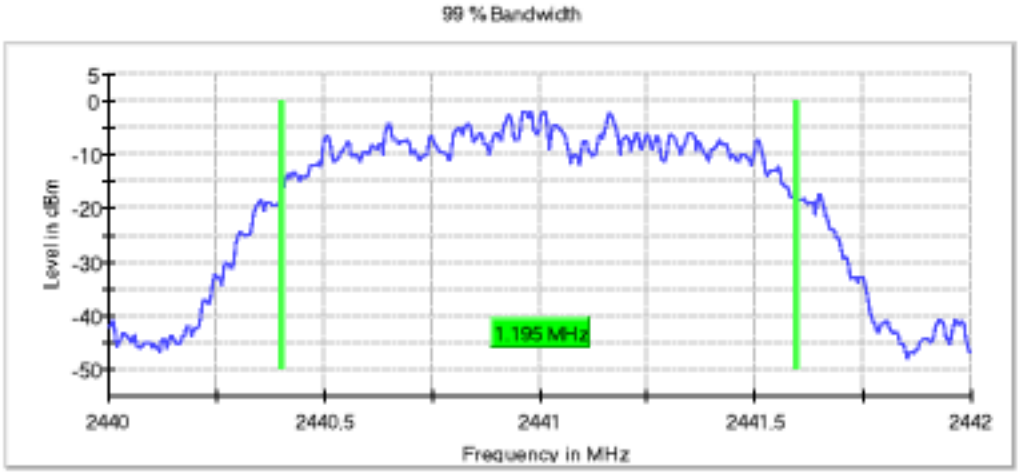
Plot 105: Mode 4, 99% Occupied Bandwidth, high channel



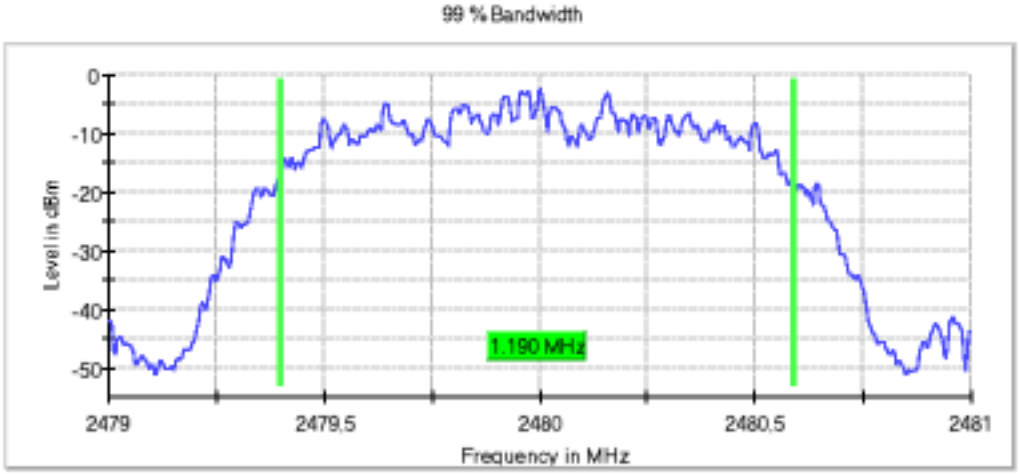
Plot 106: Mode 5, 99% Occupied Bandwidth, low channel



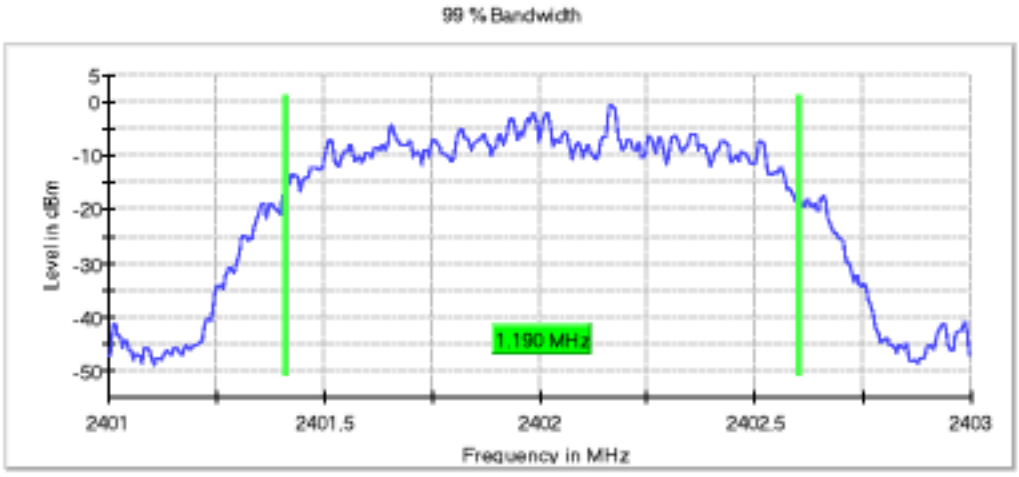
Plot 107: Mode 5, 99% Occupied Bandwidth, mid channel



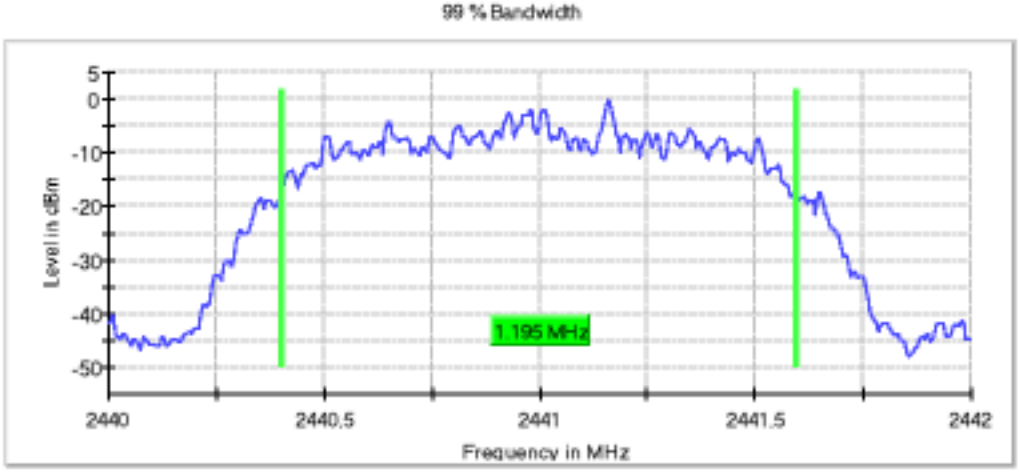
Plot 108: Mode 5, 99% Occupied Bandwidth, high channel



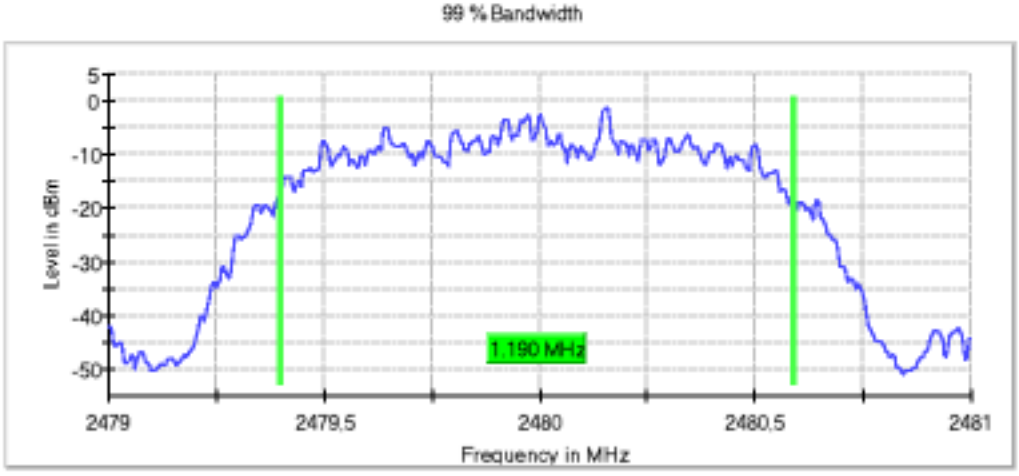
Plot 109: Mode 6, 99% Occupied Bandwidth, low channel



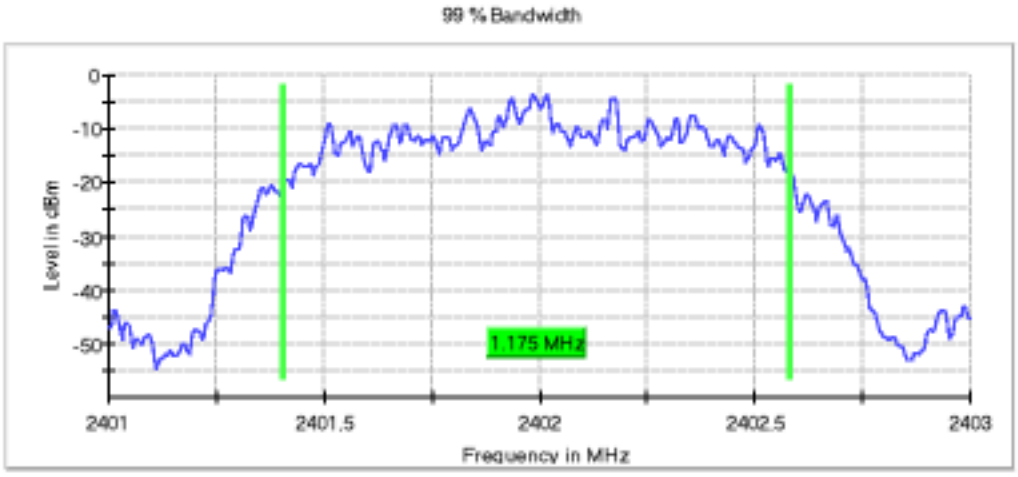
Plot 110: Mode 6, 99% Occupied Bandwidth, mid channel



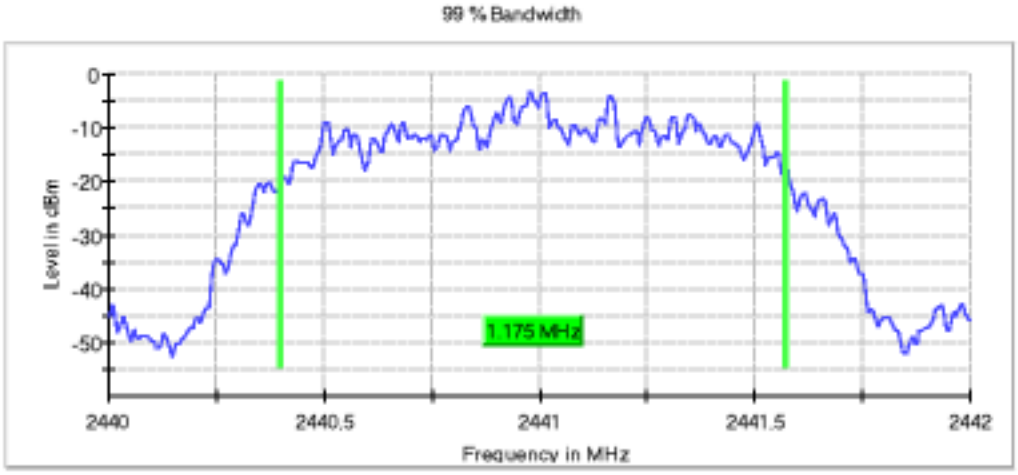
Plot 111: Mode 6, 99% Occupied Bandwidth, high channel



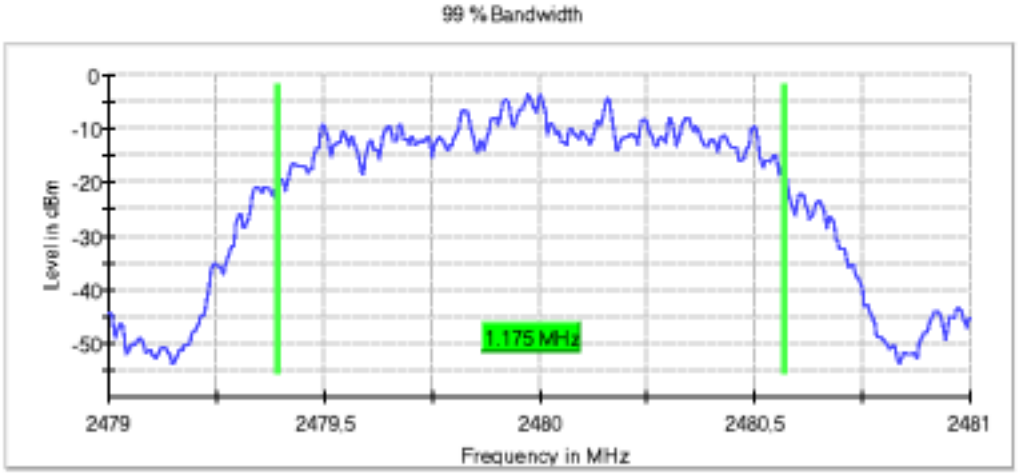
Plot 112: Mode 7, 99% Occupied Bandwidth, low channel



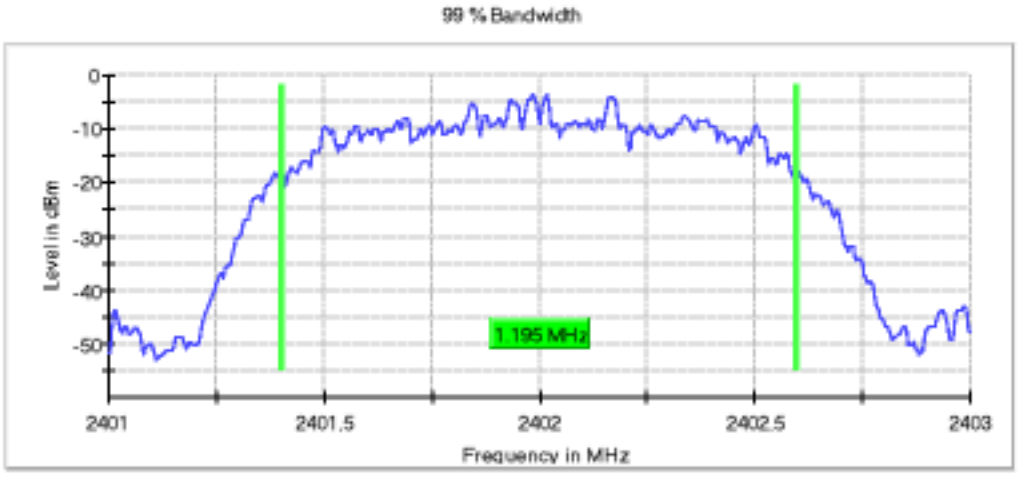
Plot 113: Mode 7, 99% Occupied Bandwidth, mid channel



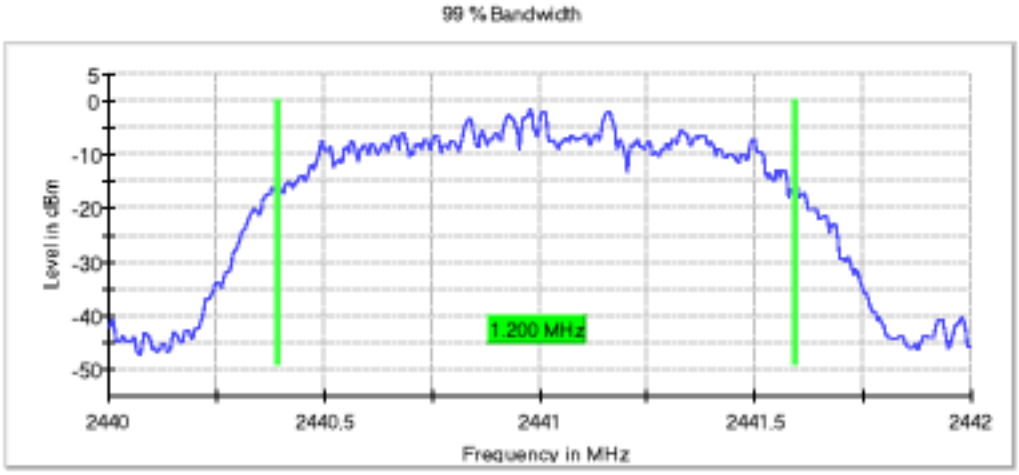
Plot 114: Mode 7, 99% Occupied Bandwidth, high channel



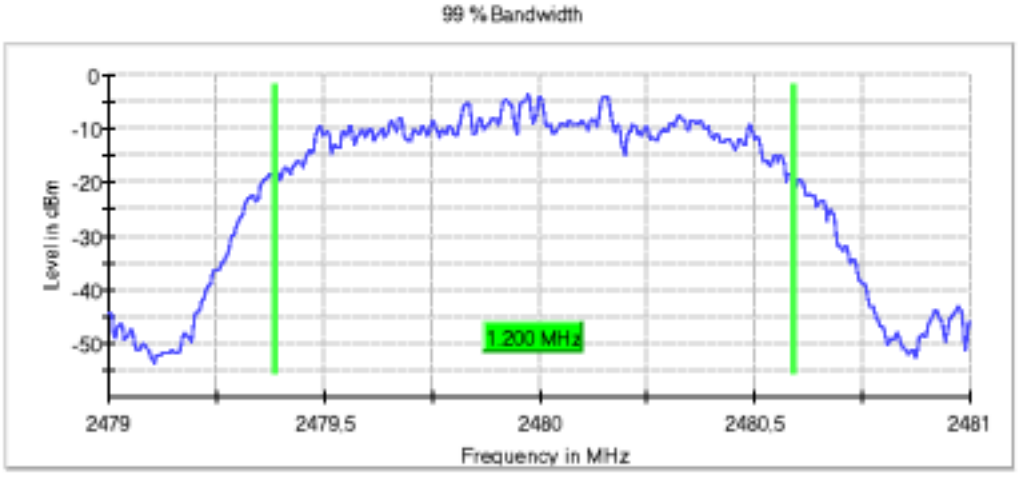
Plot 115: Mode 8, 99% Occupied Bandwidth, low channel



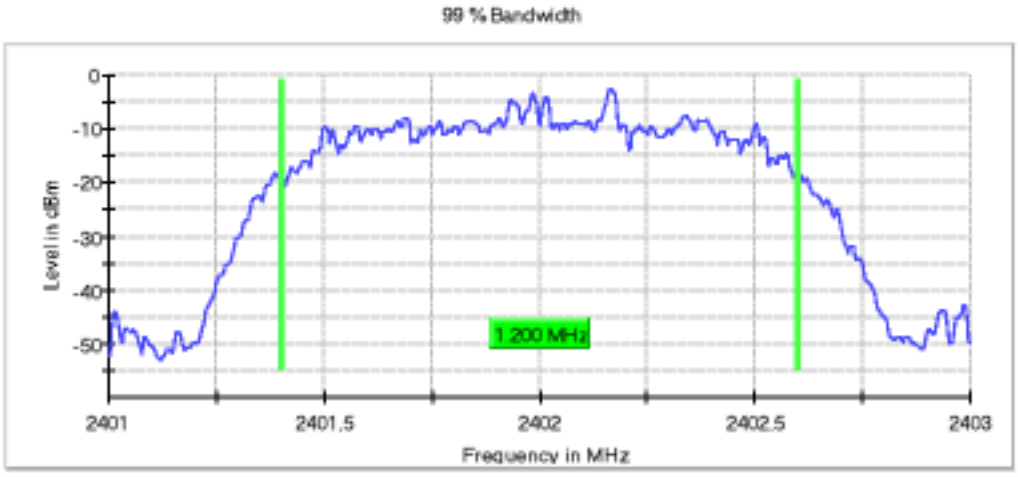
Plot 116: Mode 8, 99% Occupied Bandwidth, mid channel



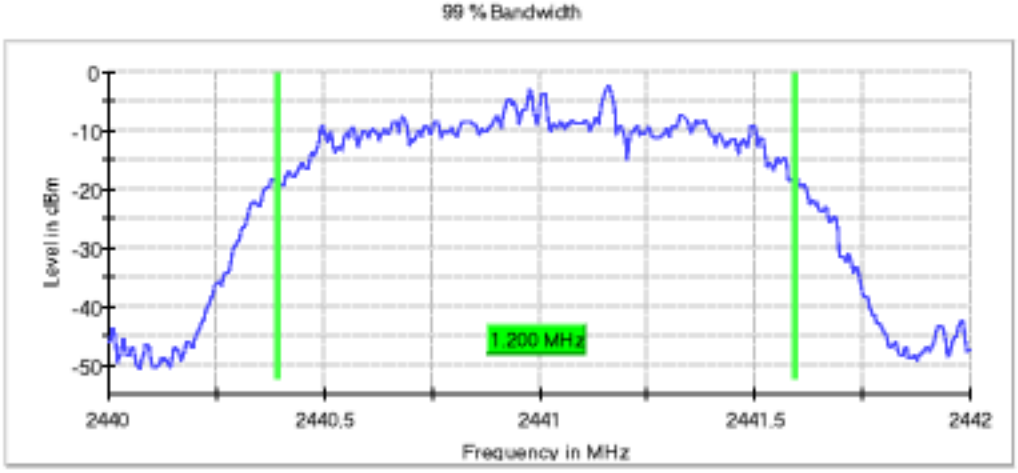
Plot 117: Mode 8, 99% Occupied Bandwidth, high channel



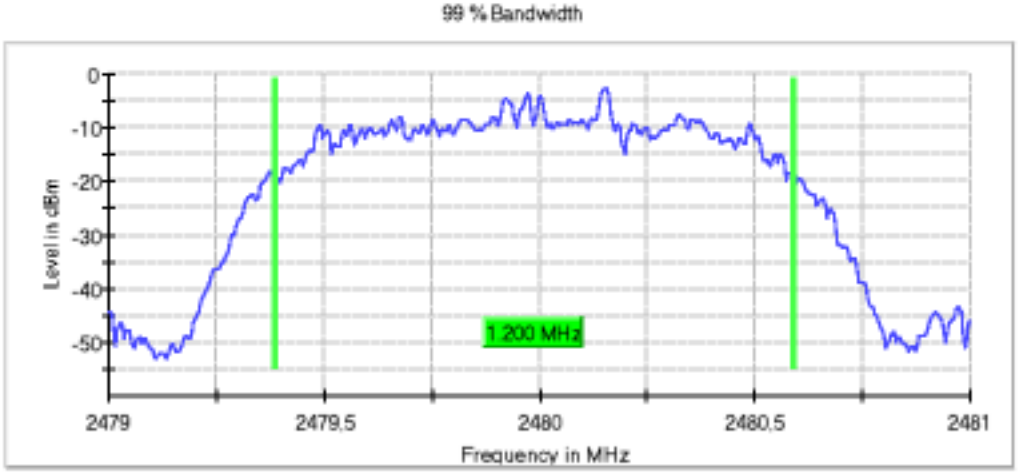
Plot 118: Mode 9, 99% Occupied Bandwidth, low channel



Plot 119: Mode 9, 99% Occupied Bandwidth, mid channel



Plot 120: Mode 9, 99% Occupied Bandwidth, high channel



7.6 RF Output Power (Conducted Power)

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
The RF Output Power is defined as the conducted peak output power.

Limit
§15.247
(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

RSS-247, 5.4 (b)
For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

Test procedure
ANSI C63.10, 7.8.5
This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
   1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
   2) RBW > 20 dB bandwidth of the emission being measured.
   3) VBW >= RBW.
   4) Sweep: Auto.
   5) Detector function: Peak.
   6) Trace: Max hold.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.

ANSI C63.10, 11.9.2.3.2
Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.
Gate triggering can be implemented in such a way that the sweep of the instrument is only active during the burst period of the device. Any Gate triggering shall be performed on the full power portion of the pulses and care must be taken to ensure that static portions of the pulse are not included in the measurement (ensuring that the trace is averaged over the entire symbol range). All Gate triggered measurements shall be accompanied by a Gate setup plot in the test report.

Test setup: 8.4 with conducted test sample (see section 5.2)

Test Results – Peak Power acc. to ANSI C63-10, 7.8.5				
EUT Mode	RF Output Power (Conducted Peak Power)			Limit [dBm]
	low channel [dBm]	mid channel [dBm]	high channel [dBm]	
Mode 1	6.2	5.8	5.2	≤ 30
Mode 2	6.3	5.6	5.1	≤ 30
Mode 3	6.1	5.8	5.2	≤ 30
Mode 4	6.0	5.9	5.5	≤ 30
Mode 5	6.0	5.6	5.6	≤ 30
Mode 6	5.9	6.0	5.5	≤ 30
Mode 7	6.1	6.2	5.9	≤ 30
Mode 8	6.6	6.2	5.8	≤ 30
Mode 9	**6.7**	6.3	5.9	≤ 30

Comment:	---

Verdict	- PASS -	---

7.7 Antenna Gain, Peak EIRP

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
The antenna gain is defined as the difference between radiated peak power (Peak EIRP) subtracted by the conducted peak power of the module, given in dBi.

Limit
§15.247
(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

RSS-247, 5.4 (b)
For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

Test Results

Antenna type	low channel [dBi]	mid channel [dBi]	high channel [dBi]	Limit [dBi]
Flexible Polymer Series Antenna (FXP830.24.0100B)	1.95	3.00	3.32	6

Antenna type	Peak EIRP [dBm]	Limit [dBm]
Flexible Polymer Series Antenna (FXP830.24.0100B)	10.0	36

Note: - for antenna details see section 5.3
- peak EIRP is calcualated based on MAX(conducted peak power) and MAX(antenna gain) as worst case

Comment:	Antenna gain as declared by applicant.

Verdict	- PASS -	---

7.8 Band Edge Compliance (BEC), conducted

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
Emissions within a restricted band and within 2 MHz of an authorized band edge may be measured using either the marker-delta method (ANSI C63.10, 6.10.6) or the integration method (ANSI C63.20, 11.13.3), provided that the DTS bandwidth (or EBW) edge falls within 2 MHz of the band edge. Otherwise, all unwanted emissions measurements shall be performed using the standard methods.

Limits
§15.247
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247, 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test procedure
ANSI C63.10, 11.11
Reference level measurement:
Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.
Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

Emission level measurement:
Establish an emission level by using the following procedure:
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.

e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements as specified (≥ 20 dBc).

The marker-delta method, as described in ANSI C63.10, 6.10.6 can be used to perform measurements of the radiated unwanted emissions level at the band-edges provided that the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Test setup: 8.4 with conducted test sample (see section 5.2)

Test results

BEC	low channel [dBc]	high channel [dBc]	Limit [dBc]
Mode 3	> 55	> 55	≥ 20
Mode 3	> 55	> 55	≥ 20
Mode 9	> 55	> 55	≥ 20

Comment:	---

Verdict	- PASS -	see next plots

Plot 121: Mode 3, BEC, low channel

Result

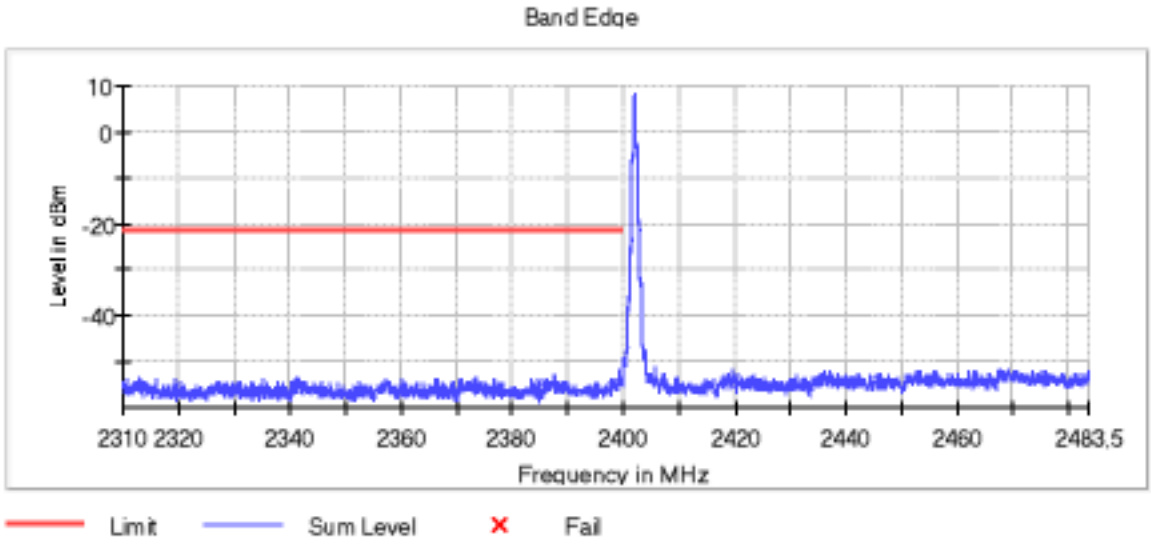
DUT Frequency (MHz)	Result
2402.000000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2402.175000	8.4

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.325000	-51.6	30.0	-21.6	PASS
2399.375000	-51.8	30.2	-21.6	PASS
2399.975000	-52.0	30.4	-21.6	PASS
2399.925000	-52.6	31.0	-21.6	PASS
2399.275000	-52.7	31.1	-21.6	PASS
2399.875000	-53.0	31.4	-21.6	PASS
2387.525000	-53.1	31.5	-21.6	PASS
2387.575000	-53.2	31.6	-21.6	PASS
2399.425000	-53.3	31.7	-21.6	PASS
2313.025000	-53.5	31.9	-21.6	PASS
2373.525000	-53.6	32.0	-21.6	PASS
2341.175000	-53.6	32.0	-21.6	PASS
2399.675000	-53.7	32.1	-21.6	PASS
2341.125000	-53.7	32.1	-21.6	PASS
2341.625000	-53.7	32.1	-21.6	PASS



Plot 122: Mode 3, BEC, high channel

Result

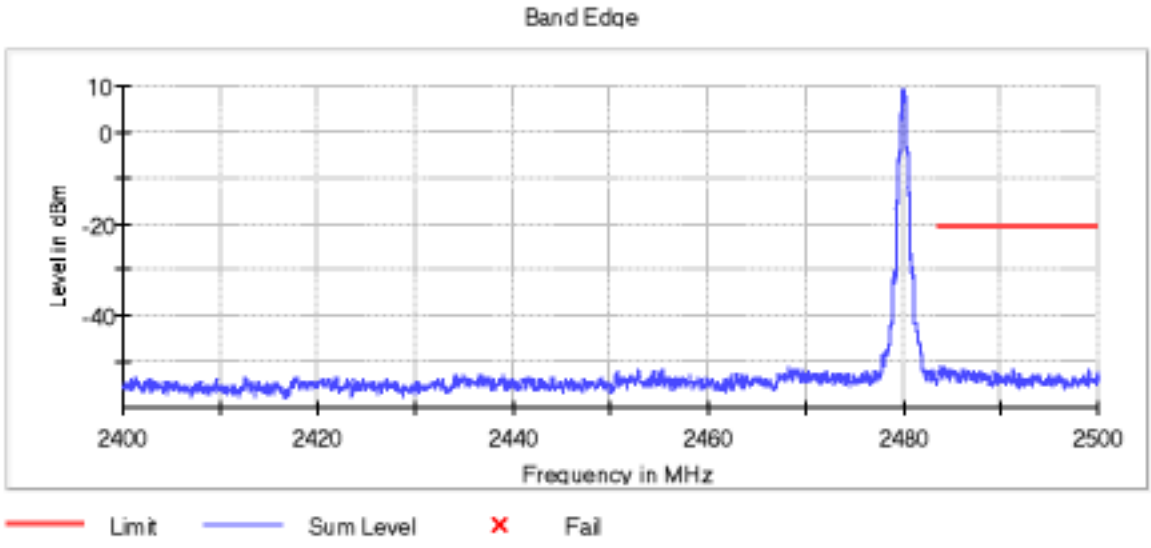
DUT Frequency (MHz)	Result
2480.000000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2479.975000	9.3

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.825000	-51.0	30.3	-20.7	PASS
2483.775000	-51.4	30.6	-20.7	PASS
2484.125000	-51.4	30.7	-20.7	PASS
2486.125000	-51.6	30.9	-20.7	PASS
2483.875000	-51.7	31.0	-20.7	PASS
2499.025000	-51.7	31.0	-20.7	PASS
2491.325000	-51.8	31.0	-20.7	PASS
2486.175000	-51.8	31.0	-20.7	PASS
2484.575000	-51.8	31.0	-20.7	PASS
2484.525000	-51.8	31.1	-20.7	PASS
2491.175000	-51.9	31.1	-20.7	PASS
2484.175000	-51.9	31.1	-20.7	PASS
2484.875000	-51.9	31.2	-20.7	PASS
2484.225000	-51.9	31.2	-20.7	PASS
2484.075000	-52.0	31.2	-20.7	PASS



Plot 123: Mode 6, BEC, low channel

Result

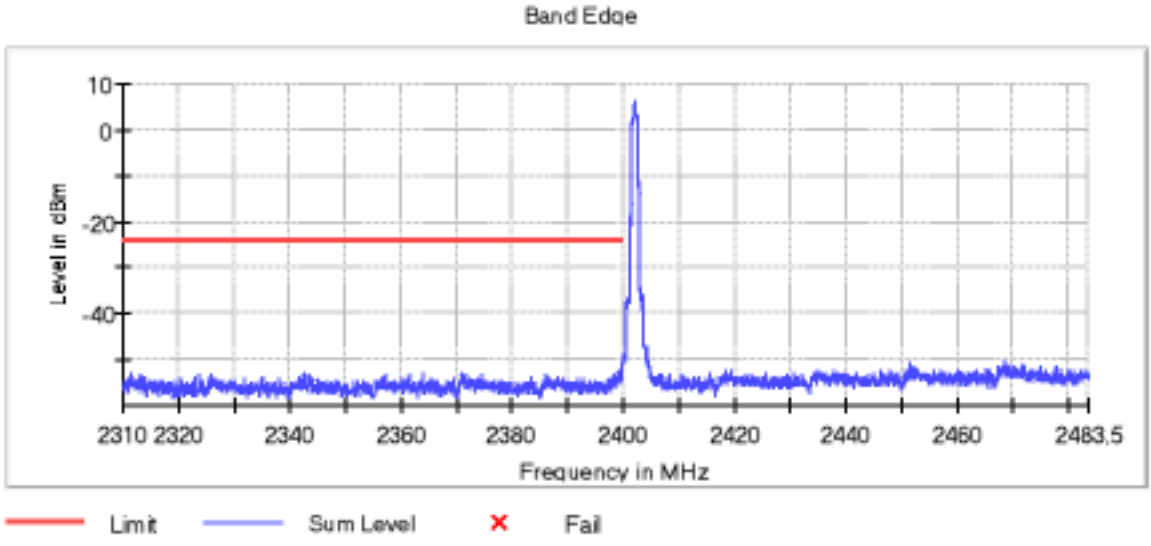
DUT Frequency (MHz)	Result
2402.000000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2402.025000	6.1

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.825000	-50.1	26.1	-23.9	PASS
2399.925000	-50.1	26.1	-23.9	PASS
2399.975000	-50.1	26.2	-23.9	PASS
2399.875000	-50.7	26.7	-23.9	PASS
2399.675000	-50.8	26.9	-23.9	PASS
2399.725000	-51.0	27.0	-23.9	PASS
2399.775000	-51.2	27.2	-23.9	PASS
2399.625000	-51.3	27.4	-23.9	PASS
2399.125000	-52.4	28.4	-23.9	PASS
2399.225000	-52.4	28.5	-23.9	PASS
2399.275000	-52.5	28.6	-23.9	PASS
2399.575000	-52.5	28.6	-23.9	PASS
2399.075000	-52.8	28.9	-23.9	PASS
2370.975000	-52.9	29.0	-23.9	PASS
2363.925000	-53.0	29.0	-23.9	PASS



Plot 124: Mode 6, BEC, high channel

Result

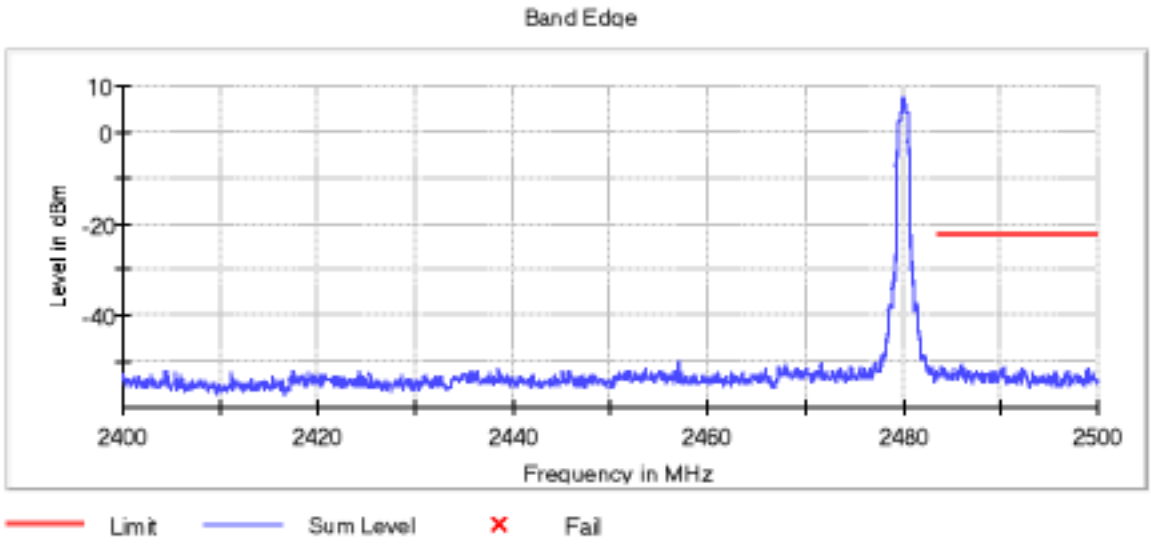
DUT Frequency (MHz)	Result
2480.000000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2480.025000	7.4

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2485.975000	-51.0	28.4	-22.6	PASS
2485.925000	-51.0	28.5	-22.6	PASS
2483.775000	-51.1	28.5	-22.6	PASS
2483.825000	-51.2	28.6	-22.6	PASS
2483.925000	-51.2	28.6	-22.6	PASS
2483.975000	-51.2	28.7	-22.6	PASS
2490.325000	-51.4	28.8	-22.6	PASS
2483.875000	-51.4	28.9	-22.6	PASS
2485.825000	-51.4	28.9	-22.6	PASS
2485.775000	-51.5	28.9	-22.6	PASS
2490.375000	-51.5	28.9	-22.6	PASS
2490.175000	-51.6	29.0	-22.6	PASS
2485.225000	-51.6	29.1	-22.6	PASS
2498.875000	-51.6	29.1	-22.6	PASS
2492.225000	-51.7	29.1	-22.6	PASS



Plot 125: Mode 9, BEC, low channel

Result

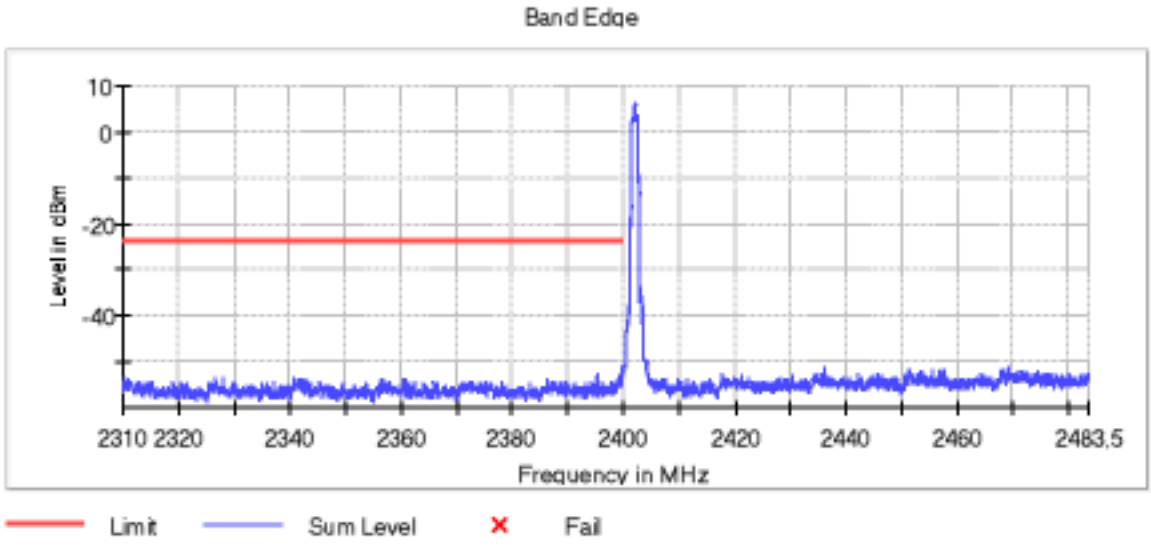
DUT Frequency (MHz)	Result
2402.000000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2402.025000	6.2

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.775000	-51.2	27.4	-23.8	PASS
2399.725000	-51.2	27.4	-23.8	PASS
2399.975000	-51.5	27.6	-23.8	PASS
2399.925000	-51.5	27.7	-23.8	PASS
2399.825000	-52.0	28.2	-23.8	PASS
2399.625000	-52.6	28.8	-23.8	PASS
2395.225000	-52.7	28.8	-23.8	PASS
2399.675000	-52.8	28.9	-23.8	PASS
2399.175000	-52.8	29.0	-23.8	PASS
2399.275000	-52.9	29.0	-23.8	PASS
2395.175000	-52.9	29.1	-23.8	PASS
2399.875000	-53.1	29.2	-23.8	PASS
2399.225000	-53.3	29.4	-23.8	PASS
2328.075000	-53.5	29.7	-23.8	PASS
2340.725000	-53.5	29.7	-23.8	PASS



Plot 126: Mode 9, BEC, high channel

Result

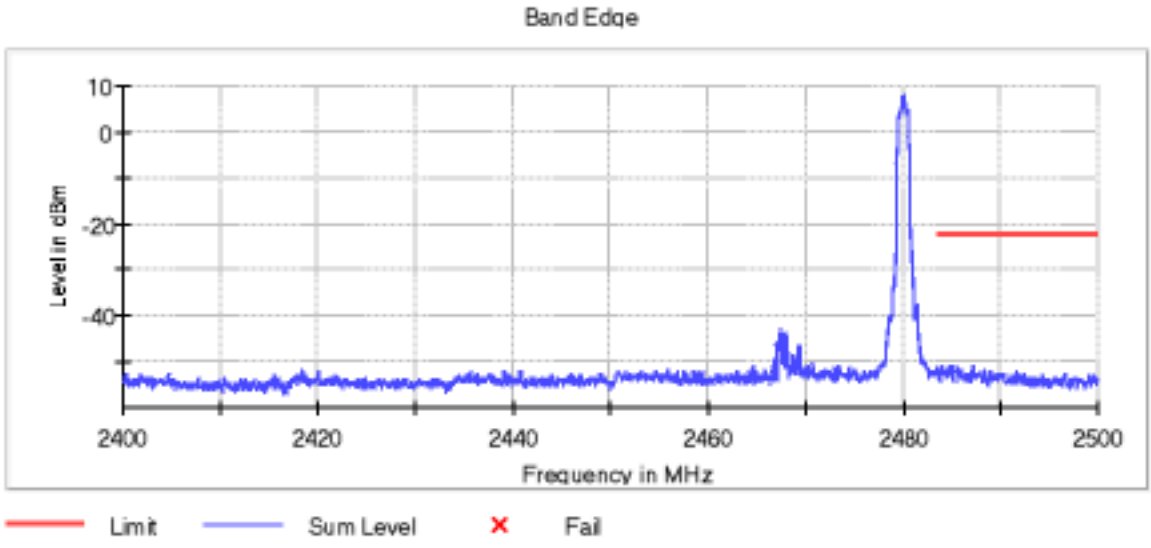
DUT Frequency (MHz)	Result
2480.000000	PASS

Inband Peak

Frequency (MHz)	Level (dBm)
2479.975000	7.7

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2487.125000	-50.8	28.5	-22.3	PASS
2484.875000	-50.8	28.6	-22.3	PASS
2487.175000	-50.9	28.6	-22.3	PASS
2485.175000	-50.9	28.7	-22.3	PASS
2485.125000	-51.0	28.7	-22.3	PASS
2483.975000	-51.0	28.7	-22.3	PASS
2485.675000	-51.2	28.9	-22.3	PASS
2485.625000	-51.2	28.9	-22.3	PASS
2484.375000	-51.3	29.0	-22.3	PASS
2487.025000	-51.3	29.0	-22.3	PASS
2485.225000	-51.4	29.1	-22.3	PASS
2483.825000	-51.5	29.2	-22.3	PASS
2483.875000	-51.5	29.2	-22.3	PASS
2484.825000	-51.6	29.3	-22.3	PASS
2488.325000	-51.6	29.3	-22.3	PASS



7.9 Band Edge Compliance (BEC), radiated

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
Emissions within a restricted band and within 2 MHz of an authorized band edge may be measured using either the marker-delta method (ANSI C63.10, 6.10.6) or the integration method (ANSI C63.20, 11.13.3), provided that the DTS bandwidth (or EBW) edge falls within 2 MHz of the band edge. Otherwise, all unwanted emissions measurements shall be performed using the standard methods.

Limits
§15.247, RSS-247, 5.5
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test procedure
The marker-delta method as described in ANSI C63.10, 6.10.6 or the integration methode as described in ANSI C63.10, 11.13.3 can be used to perform measurements of the unwanted emissions level at the band edges.

Test setup: 8.2 with radiated sample (see 5.2)

Test results

BEC	low channel AVG / Peak [dµV/m @ 3m]	high channel AVG / Peak [dµV/m @ 3m]	Limit AVG / Peak [dµV/m @ 3m]
Mode 3	≤ 40 AVG / ≤ 55 PK	≤ 40 AVG / ≤ 55 PK	≤ 54 AVG / ≤ 74 PK
Mode 9	≤ 40 AVG / ≤ 55 PK	≤ 40 AVG / ≤ 55 PK	≤ 54 AVG / ≤ 74 PK

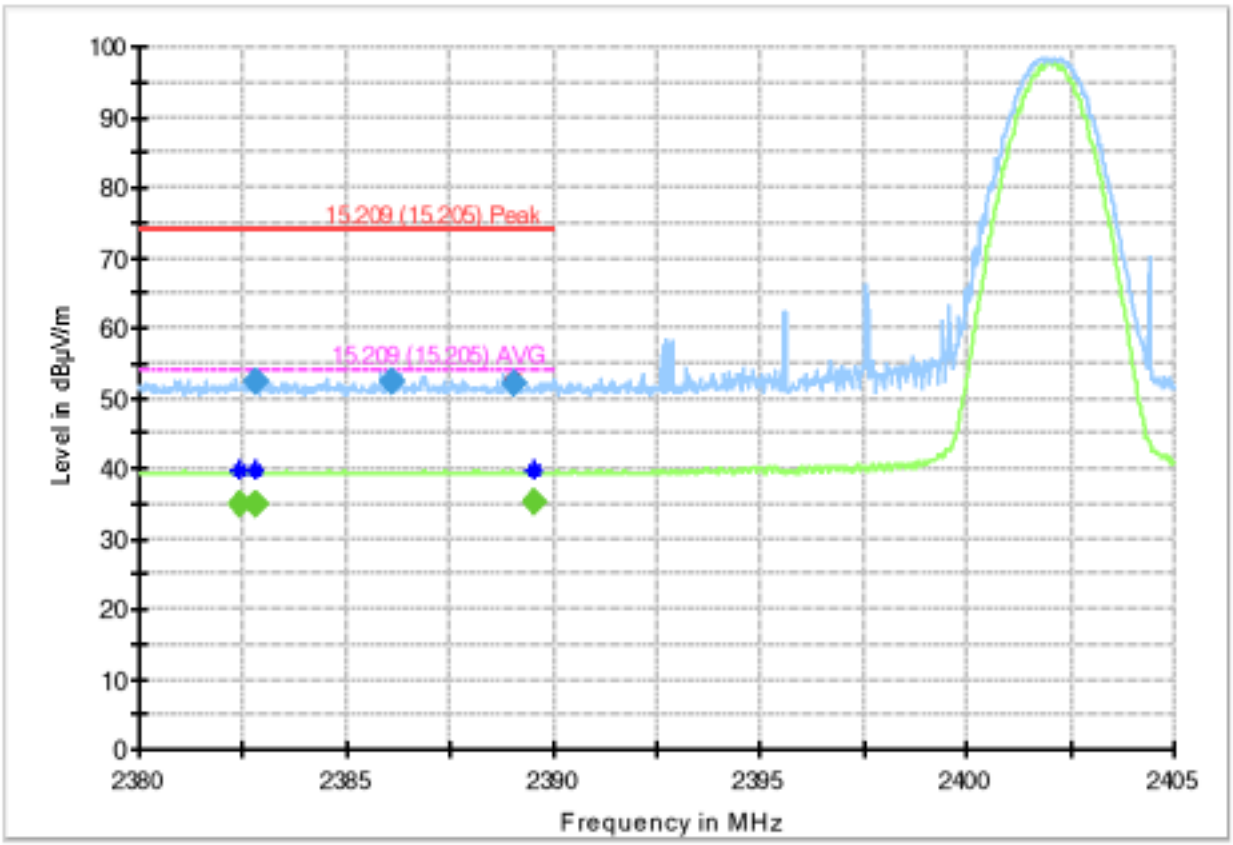
Comment:	---

Verdict	- PASS -	see next plots*

* description of traces for radiated Bend Edge Compliance (BEC) measurements:

Pos-Peak (Max Hold) trace
Average (Max Hold) trace

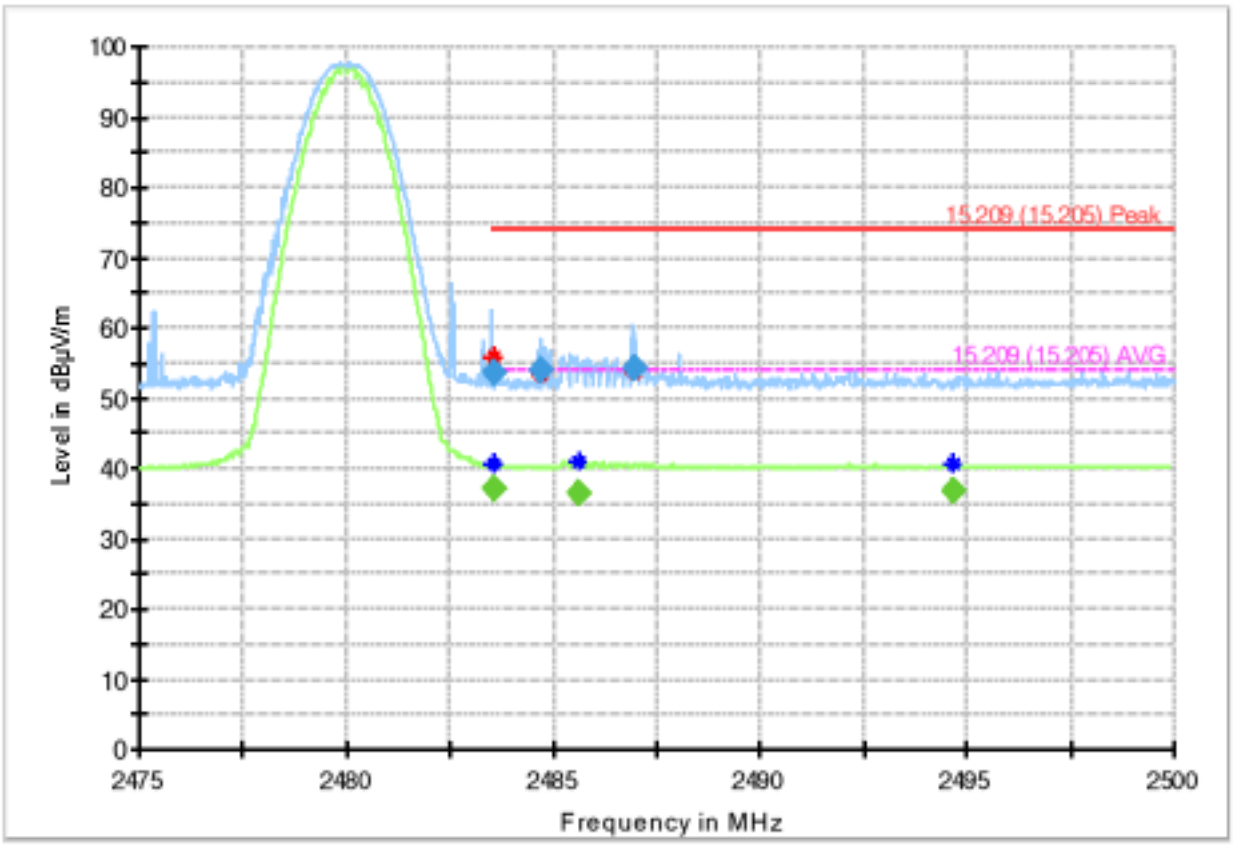
Plot 127: Mode 3, BEC, low channel



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
2382.450000	---	35.06	54.00	18.94	10000.0	1000.000	150.0	H
2382.825000	---	35.04	54.00	18.96	10000.0	1000.000	150.0	V
2382.825000	52.39	---	74.00	21.61	10000.0	1000.000	150.0	H
2386.075000	52.28	---	74.00	21.72	10000.0	1000.000	150.0	V
2389.050000	52.03	---	74.00	21.97	10000.0	1000.000	150.0	H
2389.525000	---	35.10	54.00	18.90	10000.0	1000.000	150.0	V

Plot 128: Mode 3, BEC, high channel

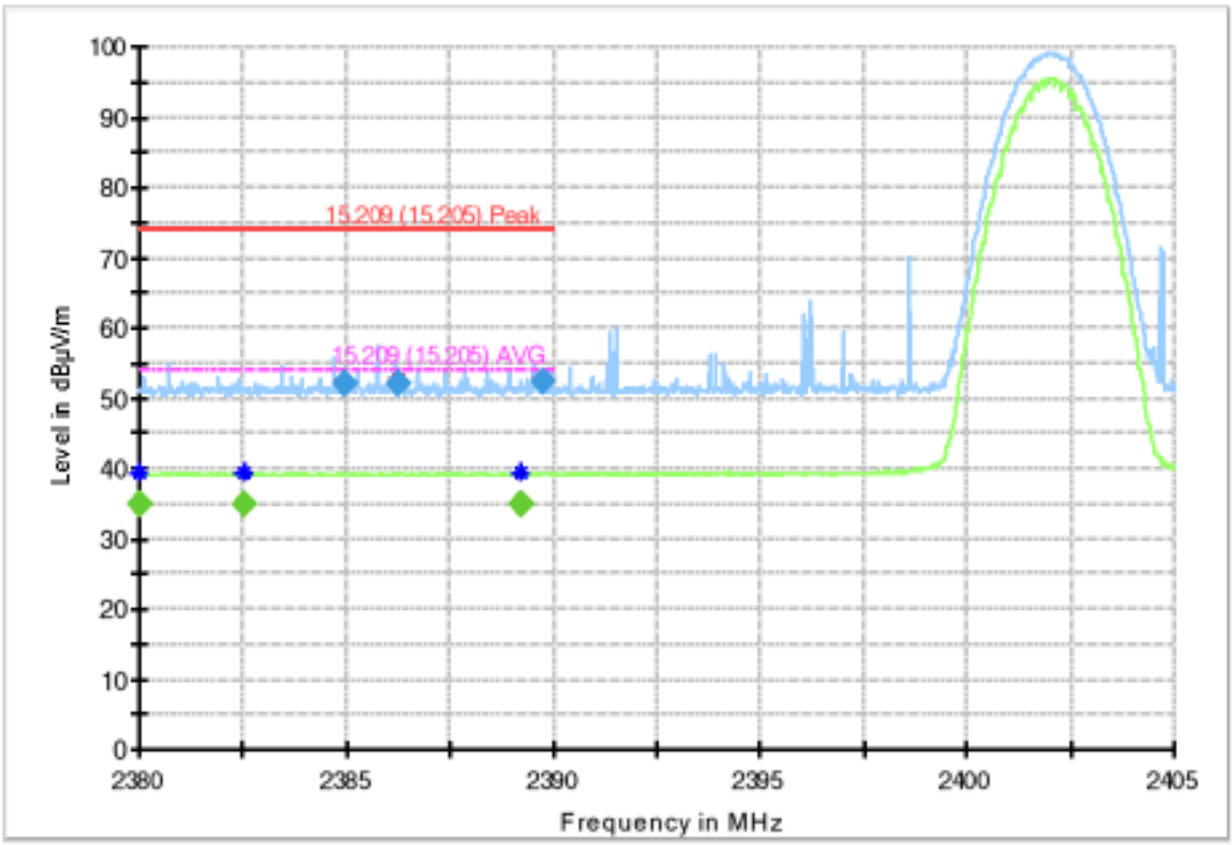


Preview Result 2-AVG
Critical_Freqs PK+
Final_Result PK+
Preview Result 1-PK+
15.209 (15.205) Peak
Final_Result AVG
Critical_Freqs AVG
15.209 (15.205) AVG

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
2483.550000	---	37.30	54.00	16.70	10000.0	1000.000	150.0	V
2483.550000	53.73	---	74.00	20.27	10000.0	1000.000	150.0	V
2484.675000	53.87	---	74.00	20.13	10000.0	1000.000	150.0	V
2485.625000	---	36.58	54.00	17.42	10000.0	1000.000	150.0	V
2486.950000	54.13	---	74.00	19.87	10000.0	1000.000	150.0	V
2494.650000	---	36.71	54.00	17.29	10000.0	1000.000	150.0	V

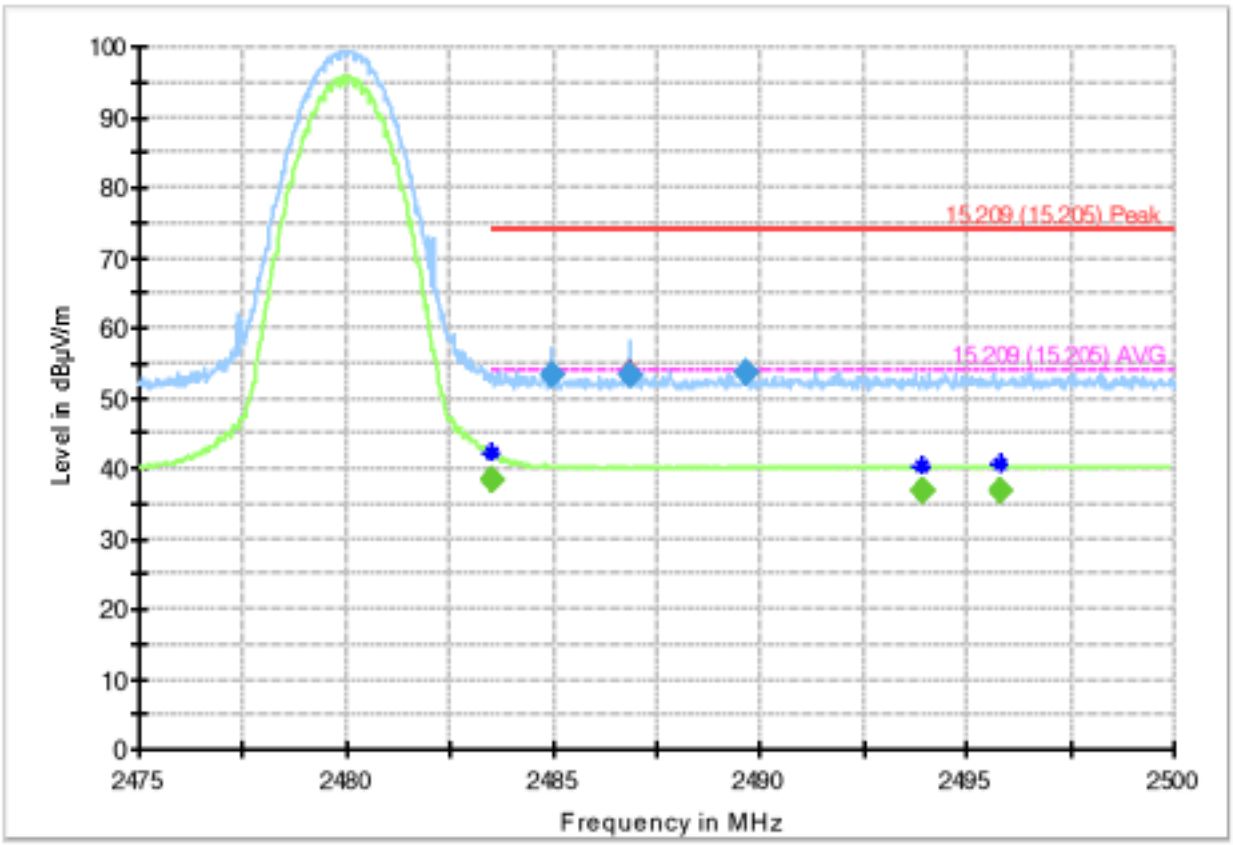
Plot 129: Mode 9, BEC, low channel



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
2380.000000	---	34.89	54.00	19.11	10000.0	1000.000	150.0	V
2382.550000	---	34.91	54.00	19.09	10000.0	1000.000	150.0	V
2384.950000	52.16	---	74.00	21.84	10000.0	1000.000	150.0	V
2386.250000	51.98	---	74.00	22.02	10000.0	1000.000	150.0	V
2389.225000	---	34.98	54.00	19.02	10000.0	1000.000	150.0	H
2389.775000	52.26	---	74.00	21.74	10000.0	1000.000	150.0	V

Plot 130: Mode 9, BEC, high channel



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
2483.500000	---	38.48	54.00	15.52	10000.0	1000.000	150.0	V
2484.975000	53.37	---	74.00	20.63	10000.0	1000.000	150.0	V
2486.875000	53.43	---	74.00	20.57	10000.0	1000.000	150.0	V
2489.675000	53.61	---	74.00	20.39	10000.0	1000.000	150.0	V
2493.900000	---	36.67	54.00	17.33	10000.0	1000.000	150.0	V
2495.800000	---	36.70	54.00	17.30	10000.0	1000.000	150.0	V

7.10 Conducted Spurious Emissions (CSE)

Applicability
This requirement applies to all types of FHS equipment operating in the 2400 – 2483.5 MHz band.

Description
Spurious emission / unwanted emissions are emission on a frequency or frequencies which are outside the authorized band 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.

Limits
§15.247
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247, 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test procedure
ANSI C63.10, 11.11
Reference level measurement:
Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.
Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

Emission level measurement:
Establish an emission level by using the following procedure:
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.

e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements as specified (≥ 20 dBc).

The marker-delta method, as described in ANSI C63.10, 6.10.6 can be used to perform measurements of the radiated unwanted emissions level at the band-edges provided that the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Test setup: 8.4 with conducted sample (see 5.2)

Test results

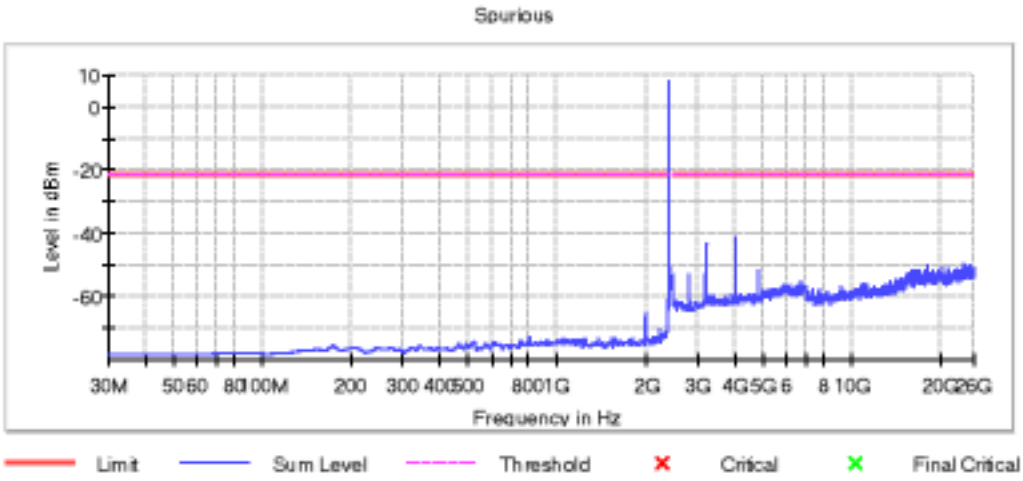
EUT Mode / Channel	Frequency [MHz]	Peak/RMS Detector	Level [dBm]	Limit [dBm]	Verdict
Mode 3	(see plots)	MaxPeak	(see plots)*	(see plots)	- passed -
Mode 6	(see plots)	MaxPeak	(see plots)*	(see plots)	- passed -
Mode 9	(see plots)	MaxPeak	(see plots)*	(see plots)	- passed -

* all detected peaks are more thean 6 dB below the limit

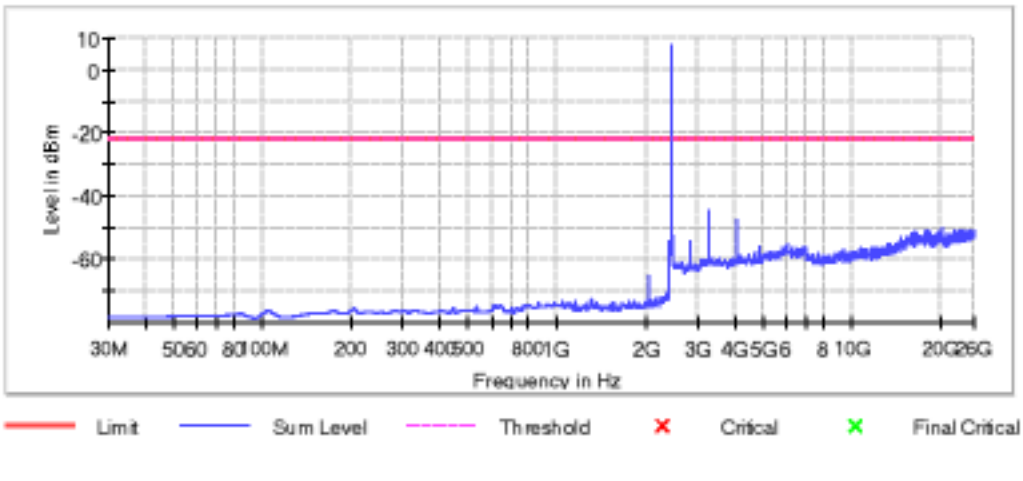
Comment:	---

Verdict	- PASS -	see next plots

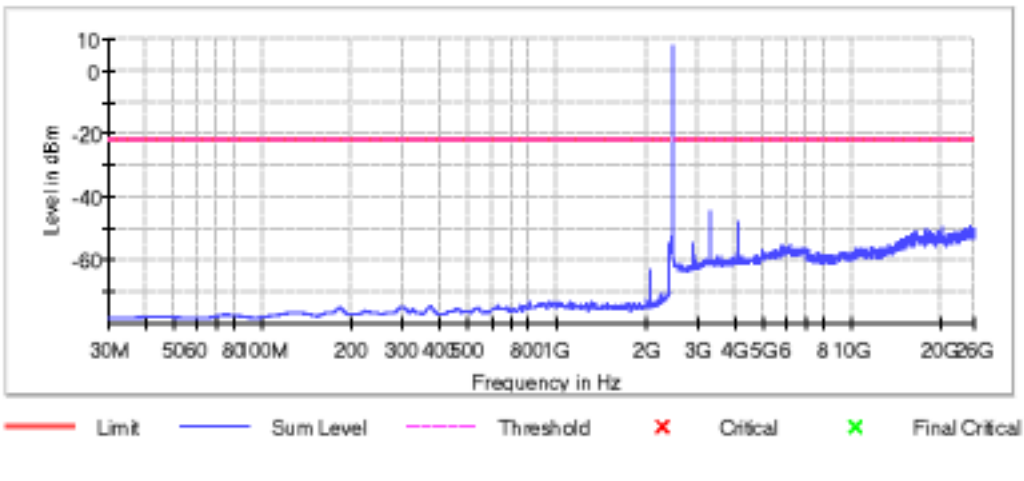
Plot 131: Mode 3, CSE, low channel



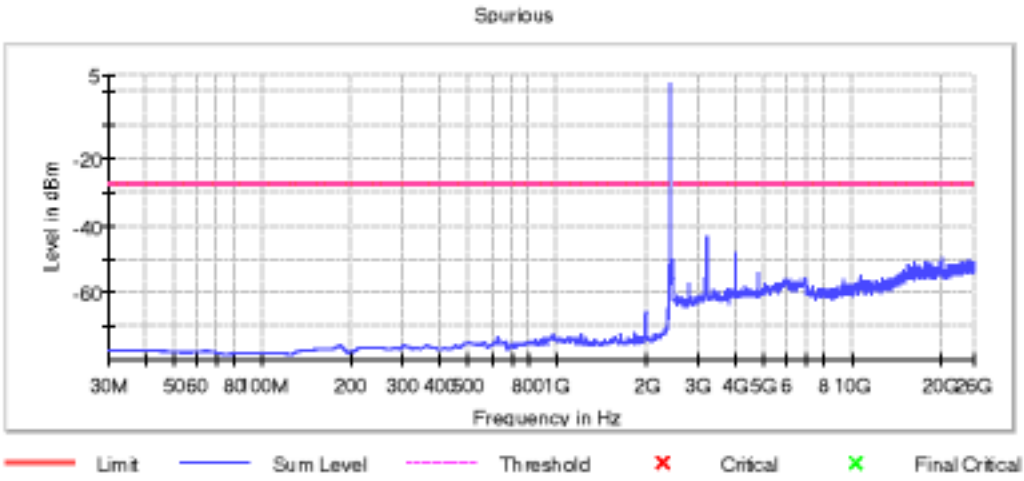
Plot 132: Mode 3, CSE, mid channel



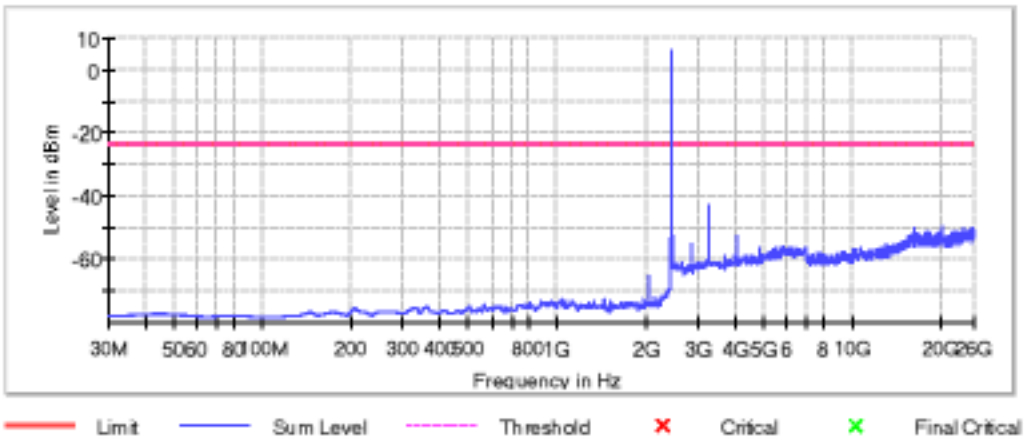
Plot 133: Mode 3, CSE, high channel



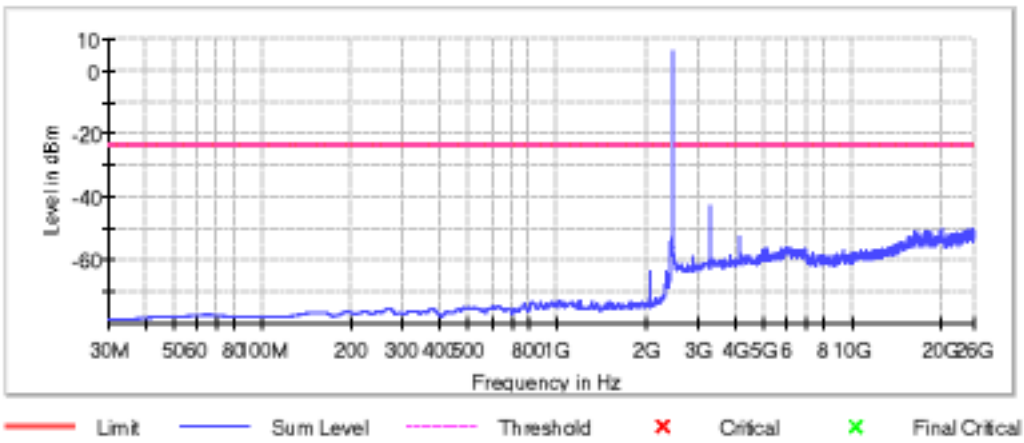
Plot 134: Mode 6, CSE, low channel



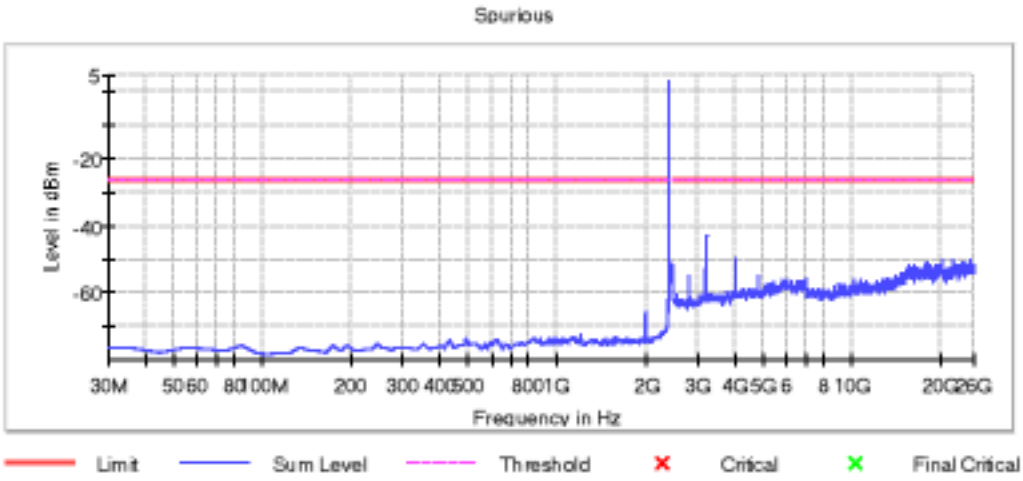
Plot 135: Mode 6, CSE, mid channel



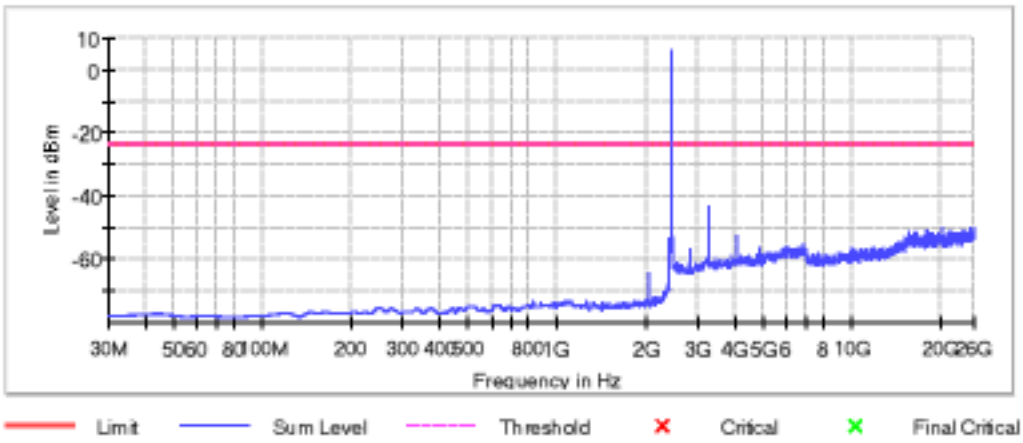
Plot 136: Mode 6, CSE, high channel



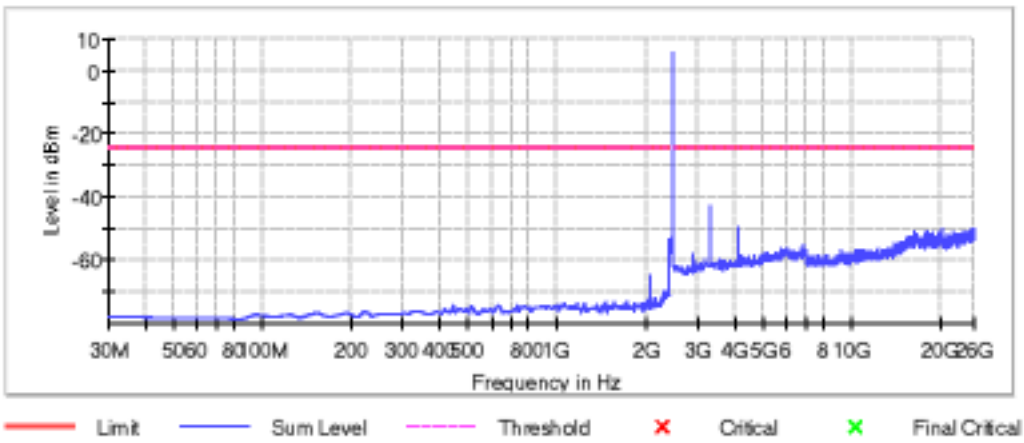
Plot 137: Mode 9, CSE, low channel



Plot 138: Mode 9, CSE, mid channel



Plot 139: Mode 9, CSE, high channel



7.11 Radiated Spurious Emissions (RSE)

Applicability
This requirement applies to all types of DTS and FHS equipment.

Description
Spurious emission / unwanted emissions are emission on a frequency or frequencies which are outside the authorized band 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. Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation.

Limits
§15.247, §15.209
RSS-247, 5.5, RSS-Gen, 8.9
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Frequency [MHz]	Field Strength [µV/m] / [dBµV/m]	Measurement distance [m]
0.009 – 0.490	2400/F[kHz]	300
0.490 – 1.705	24000/F[kHz]	30
1.705 – 30.0	30.0 / 29.5	30
30 – 88	100 / 40.0	3
88 – 216	150 / 43.5	3
216 – 960	200 / 46.0	3
960 – 40 000	500 / 54.0	3

Note: Radiated Spurious Emissions (RSE) are performed for mode 2 low / mid / high channel.

Test setup: 8.1, 8.2, 8.3 with radiated sample (see 5.2)

Test results					
EUT Mode / Channel	**Frequency [MHz]**	**Detector**	**Level [dBµV/m @LD]**	**Limit [dBµV/m @LD]**	**Verdict**
Mode 3 / low channel	see plots	MaxPeak	see plots	see plots	- passed -
Mode 3 / mid channel	see plots	MaxPeak	see plots	see plots	- passed -
Mode 3 / high channel	see plots	MaxPeak	see plots	see plots	- passed -
Mode 9 / low channel	see plots	MaxPeak	see plots	see plots	- passed -
Mode 9 / mid channel	see plots	MaxPeak	see plots	see plots	- passed -
Mode 9 / high channel	see plots	MaxPeak	see plots	see plots	- passed -

Note:
LD = Limit Distance of 300m / 30m / 3m depending on frequency range, see limit table

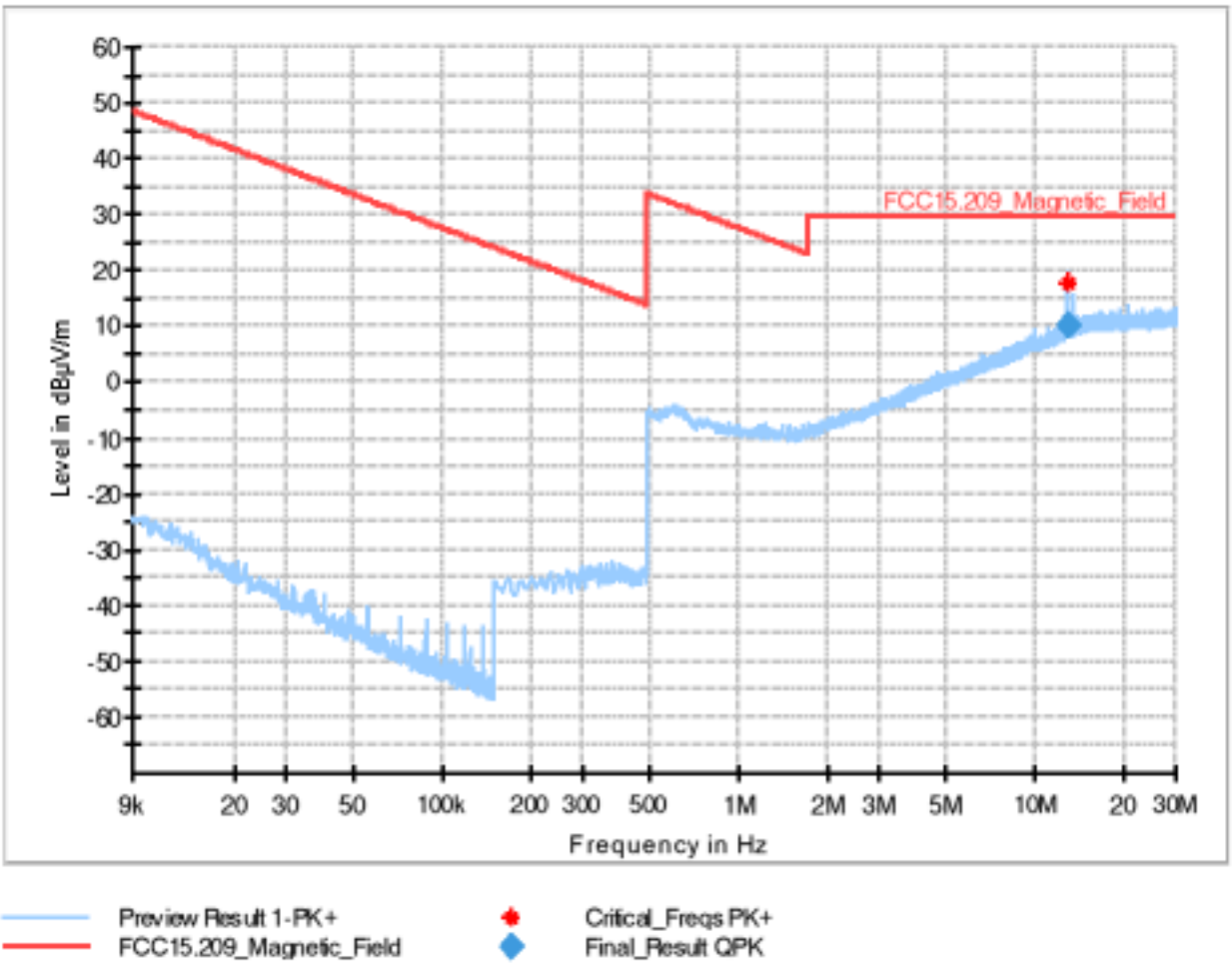
Comment:	---

Verdict	**- PASS -**	see next plots**

** description of line and marker for all radiated spurious emission (RSE) measurements:

Pos-Peak (Max Hold) trace during pre-scan
Max Peak value
final Quasi Peak / AVG value

Plot 140: Mode 3, RSE 9 kHz – 30 MHz, low channel, loop antenna

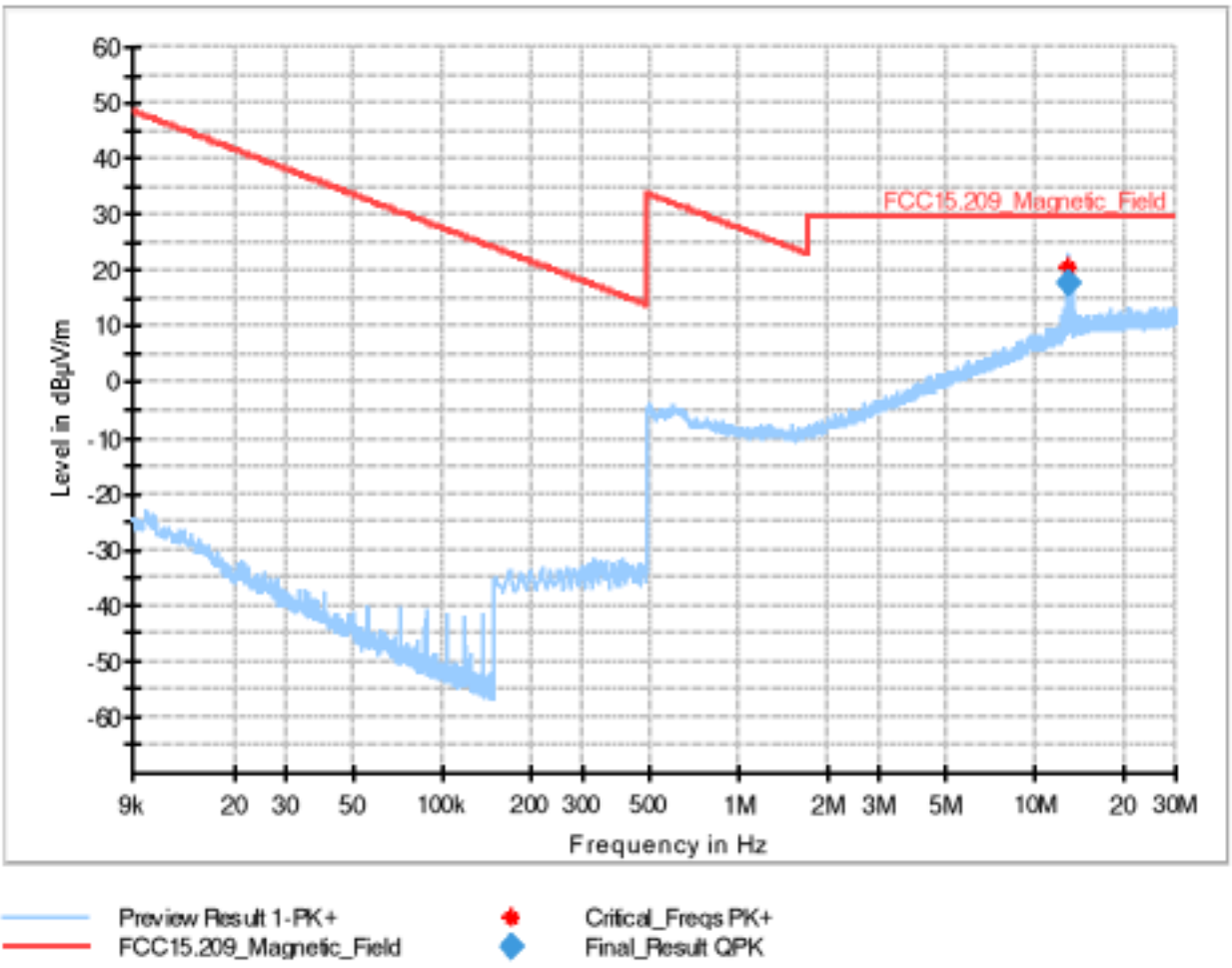


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
13.085250	10.23	29.54	19.31	100.0	9.000	V	206.0	-1.2

Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X kHz resulted in a level of Y dBµV/m, which is equivalent to Y - 51.5 = Z dBµA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.
(Certification & Engineering Bureau, Q&A on Certification Procedures and Requirements, TCB Workshop April 2020, Nicolas DesMarais, 2020-04-09 - ISED Q&A - DesMarais.pdf)

Plot 141: Mode 3, RSE 9 kHz – 30 MHz, mid channel, loop antenna

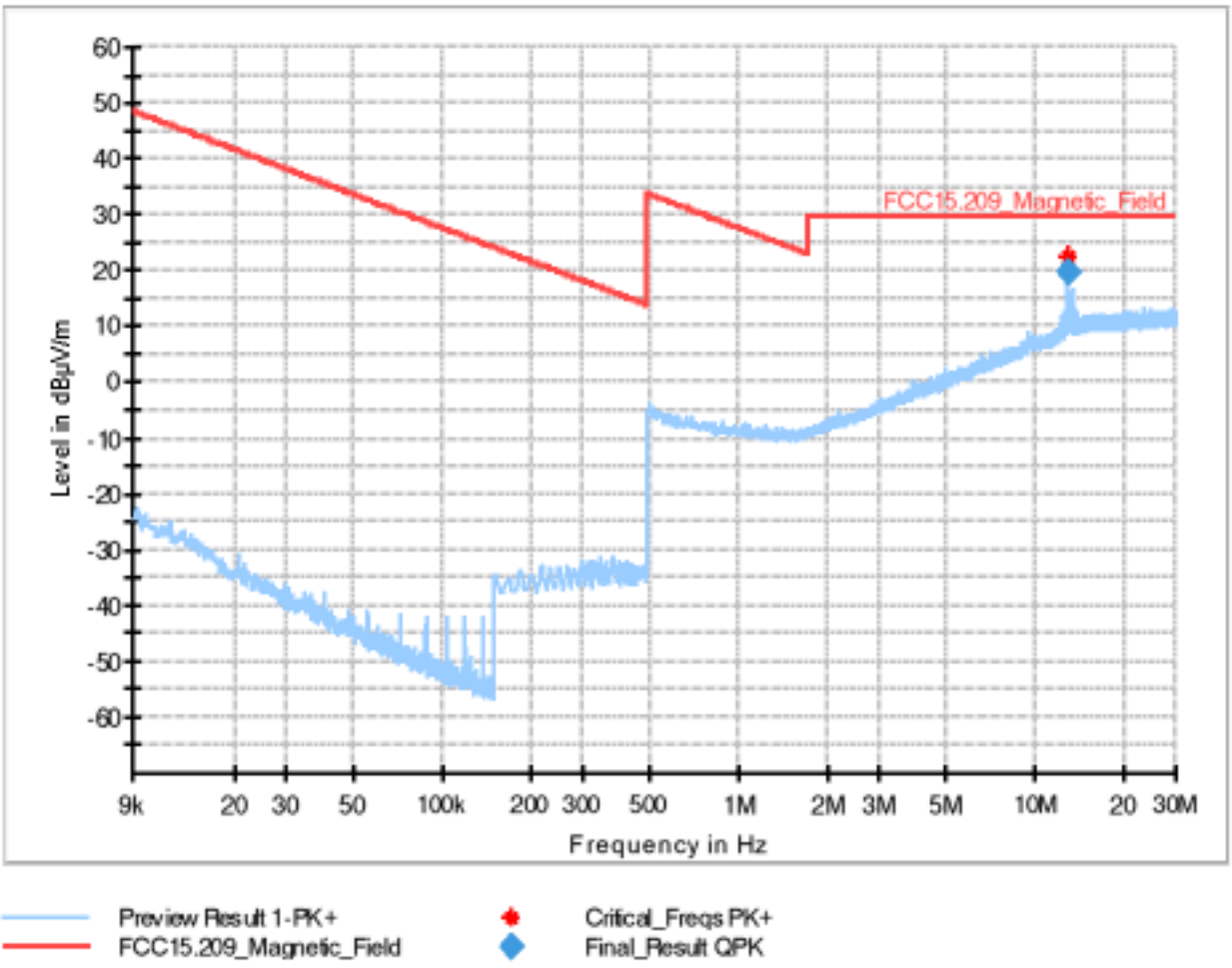


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)
13.080750	17.68	29.54	11.86	100.0	9.000	V	240.0	-1.2

Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X kHz resulted in a level of Y dBµV/m, which is equivalent to Y - 51.5 = Z dBµA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.
(Certification & Engineering Bureau, Q&A on Certification Procedures and Requirements, TCB Workshop April 2020, Nicolas DesMarais, 2020-04-09 - ISED Q&A - DesMarais.pdf)

Plot 142: Mode 3, RSE 9 kHz – 30 MHz, high channel, loop antenna

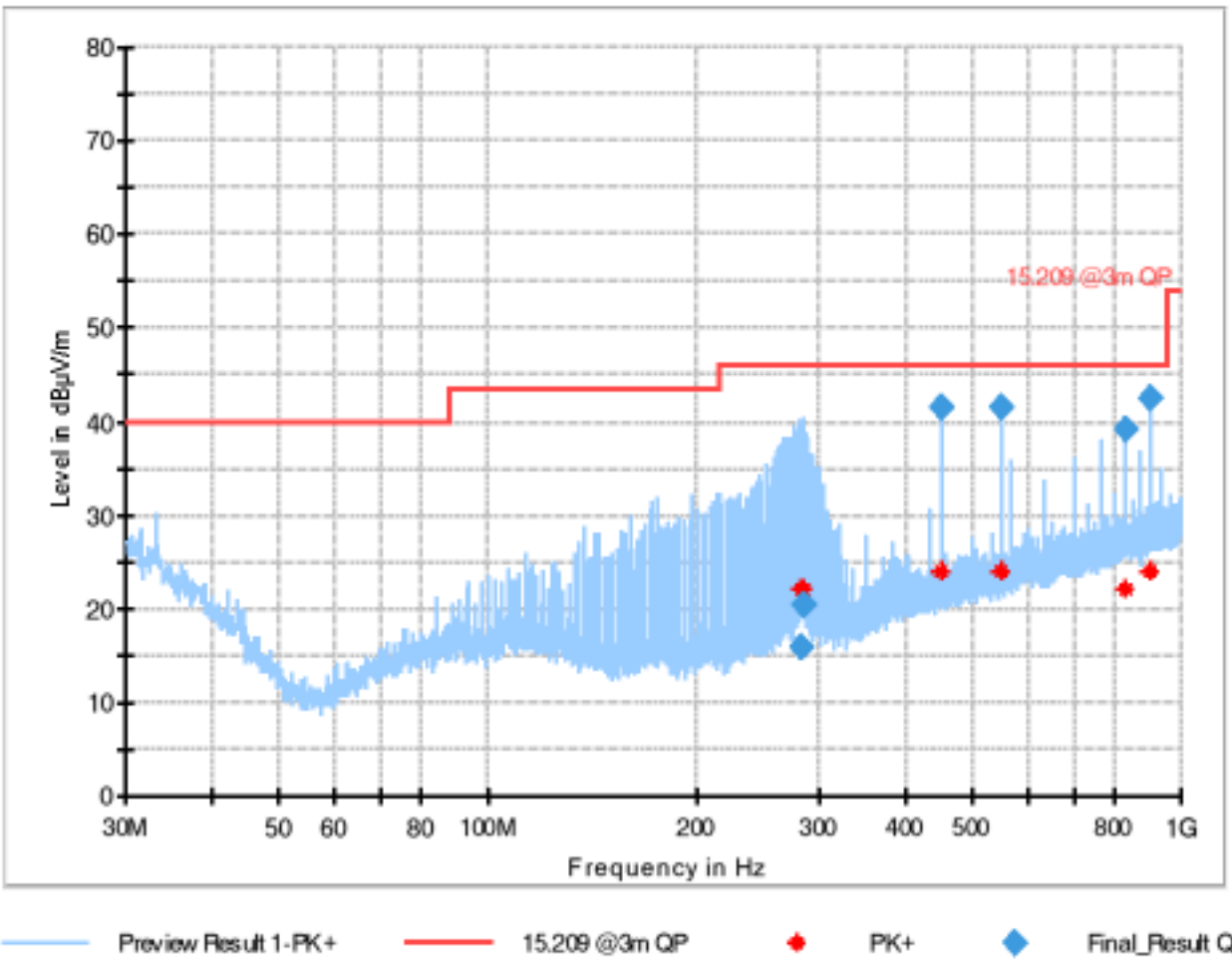


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
13.083000	19.69	29.54	9.85	100.0	9.000	V	226.0	-1.2

Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X kHz resulted in a level of Y dBµV/m, which is equivalent to Y - 51.5 = Z dBµA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.
(Certification & Engineering Bureau, Q&A on Certification Procedures and Requirements, TCB Workshop April 2020, Nicolas DesMarais, 2020-04-09 - ISED Q&A - DesMarais.pdf)

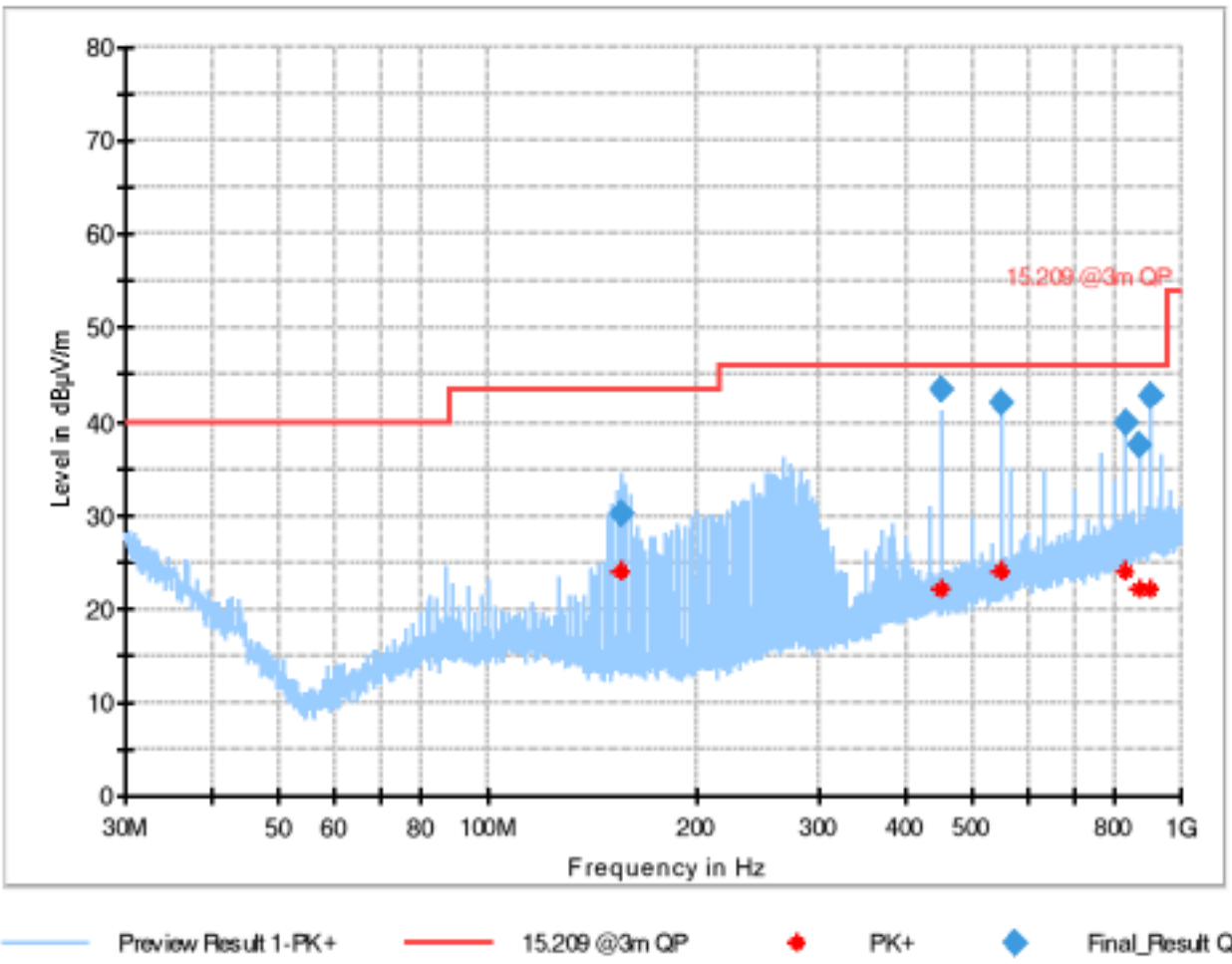
Plot 143: Mode 3, RSE 30 MHz – 1 GHz, low channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
282.119000	15.94	46.00	30.06	100.0	120.000	150.0	H	238.0
284.200000	20.47	46.00	25.53	100.0	120.000	100.0	H	98.0
450.010000	41.61	46.00	4.39	100.0	120.000	116.0	V	81.0
550.017000	41.66	46.00	4.34	100.0	120.000	100.0	V	91.0
833.324000	39.16	46.00	6.84	100.0	120.000	100.0	H	113.0
900.011500	42.43	46.00	3.57	100.0	120.000	100.0	H	120.0

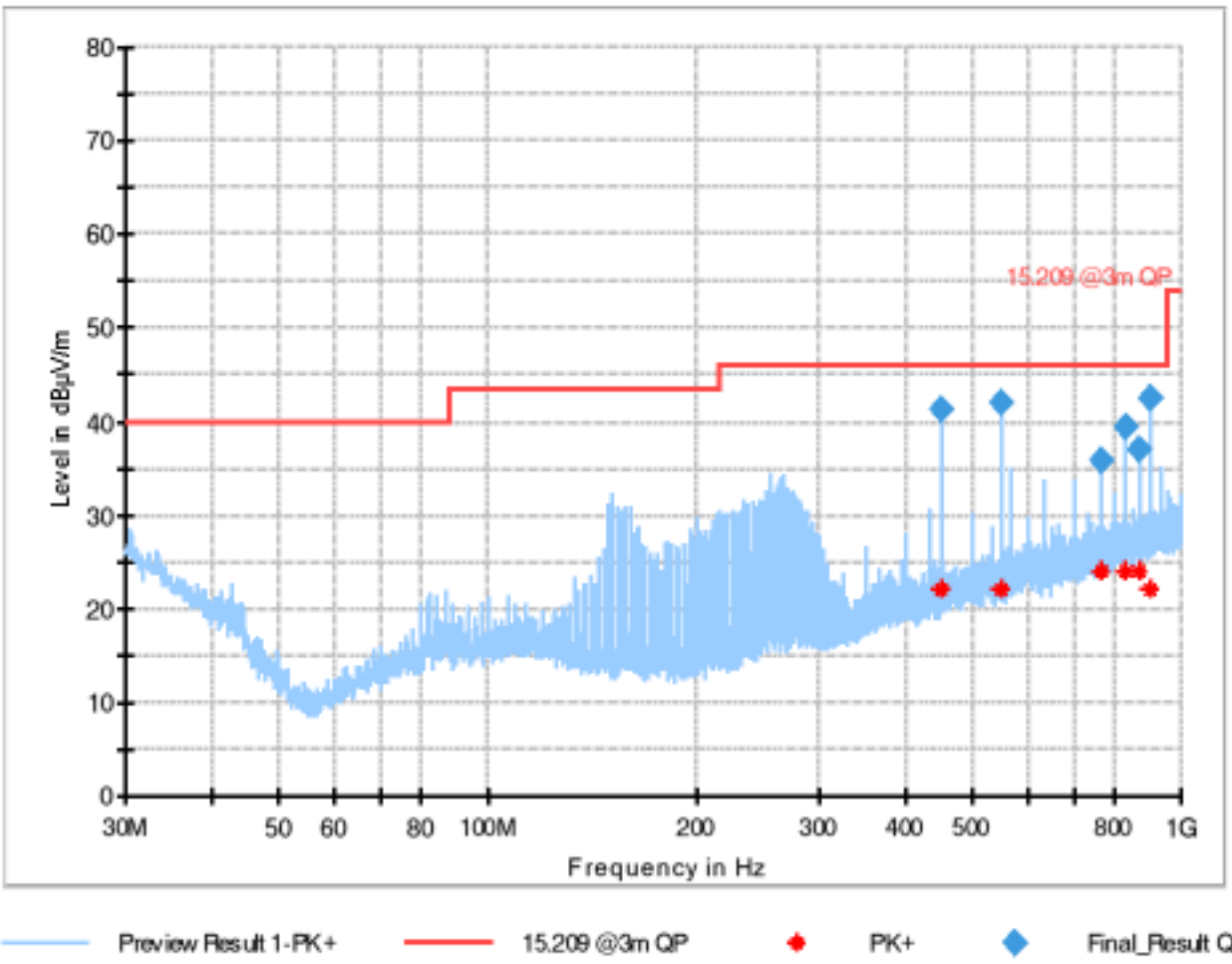
Plot 144: Mode 3, RSE 30 MHz – 1 GHz, mid channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
155.548000	30.13	43.50	13.37	100.0	120.000	253.0	H	99.0
450.010000	43.44	46.00	2.56	100.0	120.000	119.0	V	73.0
550.017000	42.09	46.00	3.91	100.0	120.000	100.0	V	89.0
833.354000	39.82	46.00	6.18	100.0	120.000	100.0	H	112.0
866.673500	37.55	46.00	8.45	100.0	120.000	100.0	H	116.0
900.011500	42.75	46.00	3.25	100.0	120.000	100.0	H	116.0

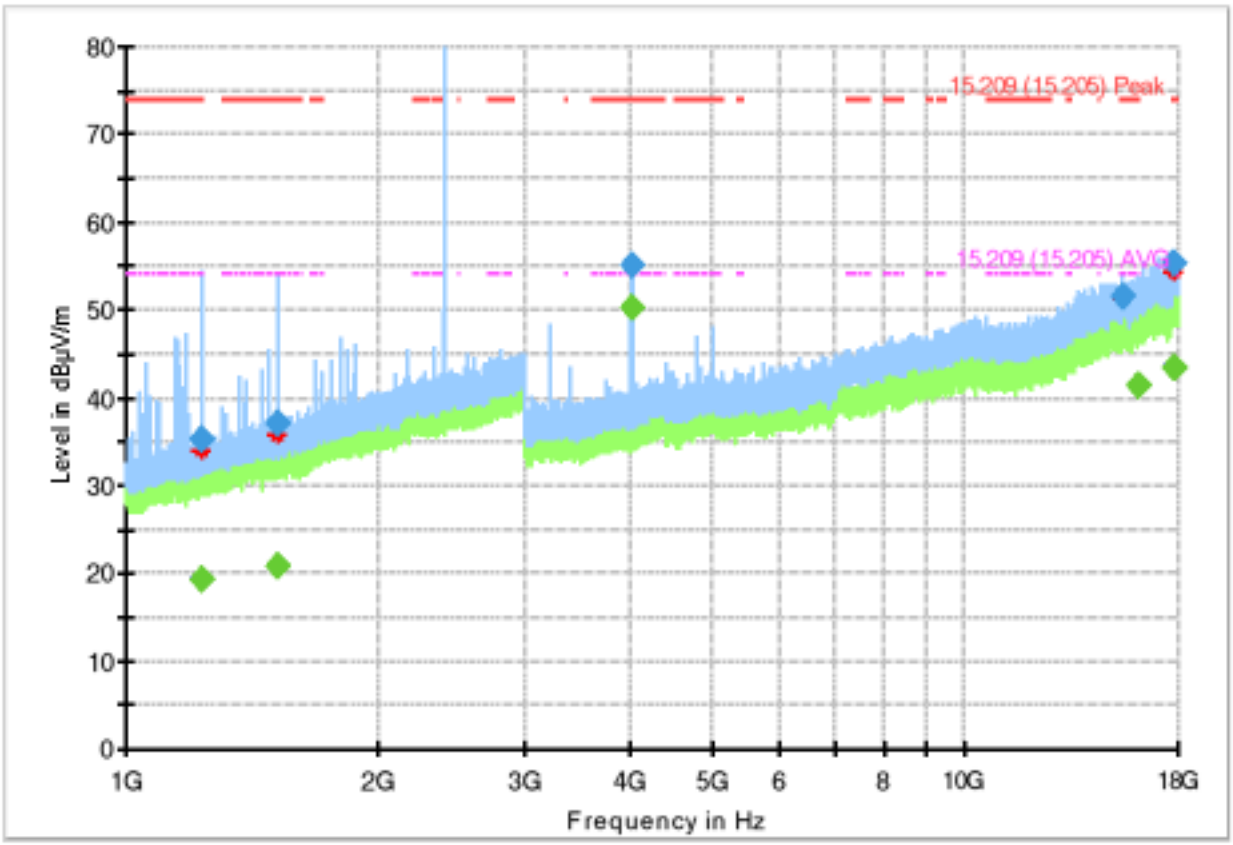
Plot 145: Mode 3, RSE 30 MHz – 1 GHz, high channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
450.010000	41.34	46.00	4.66	100.0	120.000	116.0	V	75.0
550.017000	42.05	46.00	3.95	100.0	120.000	100.0	V	93.0
766.655000	35.81	46.00	10.19	100.0	120.000	100.0	H	122.0
833.324000	39.29	46.00	6.71	100.0	120.000	100.0	H	107.0
866.673500	37.01	46.00	8.99	100.0	120.000	100.0	H	111.0
900.011500	42.38	46.00	3.62	100.0	120.000	100.0	H	118.0

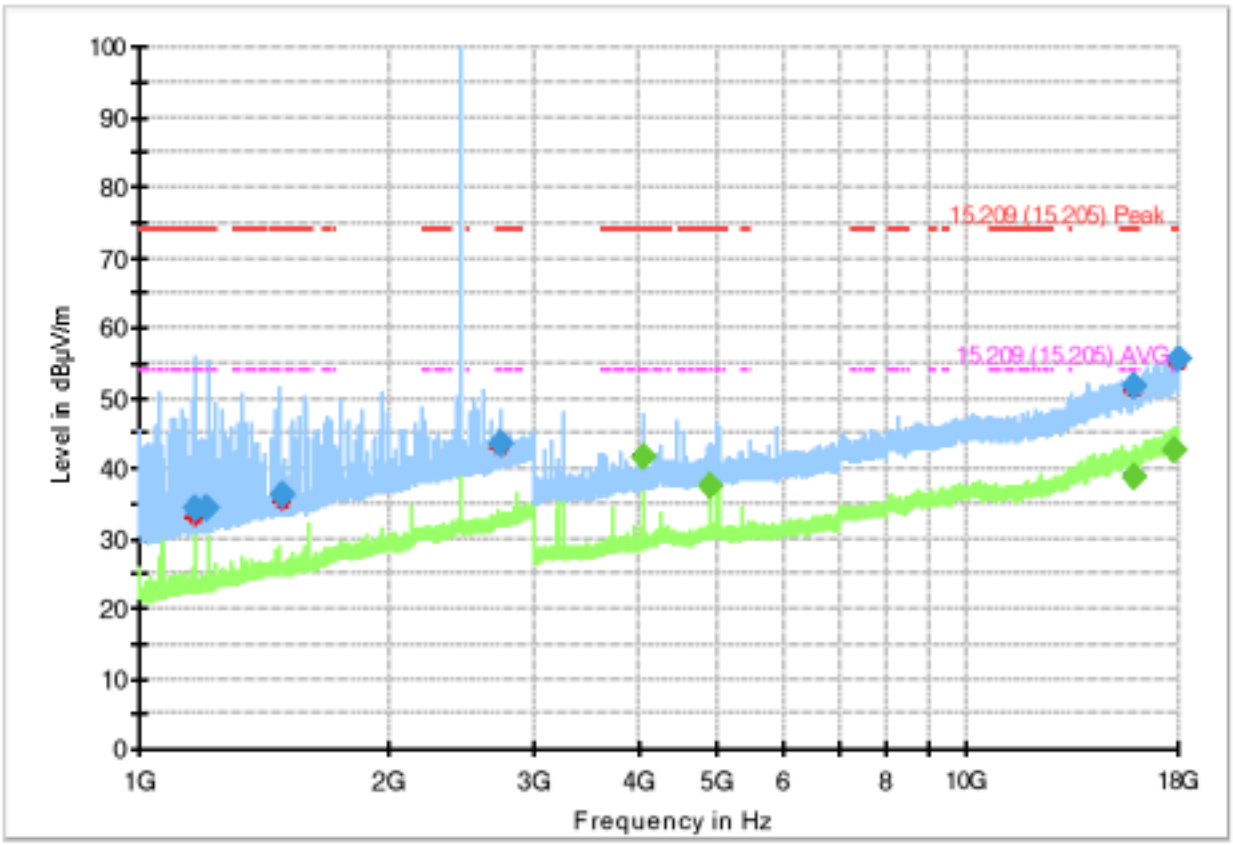
Plot 146: Mode 3, RSE 1 GHz – 18 GHz, low channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1233.200000	---	19.43	54.00	34.57	1000.0	1000.000	150.0	V
1233.450000	35.18	---	74.00	38.82	1000.0	1000.000	150.0	V
1513.150000	37.02	---	74.00	36.98	1000.0	1000.000	150.0	H
1520.150000	---	20.80	54.00	33.20	1000.0	1000.000	150.0	H
4003.250000	55.22	---	74.00	18.78	1000.0	1000.000	150.0	V
4003.250000	---	50.17	54.00	3.83	1000.0	1000.000	150.0	V
15426.650000	51.67	---	74.00	22.33	1000.0	1000.000	150.0	H
16124.600000	---	41.34	54.00	12.66	1000.0	1000.000	150.0	H
17735.300000	---	43.50	54.00	10.50	1000.0	1000.000	150.0	V
17825.850000	55.28	---	74.00	18.72	1000.0	1000.000	150.0	H

Plot 147: Mode 3, RSE 1 GHz – 18 GHz, mid channel, horizontal / vertical polarisation

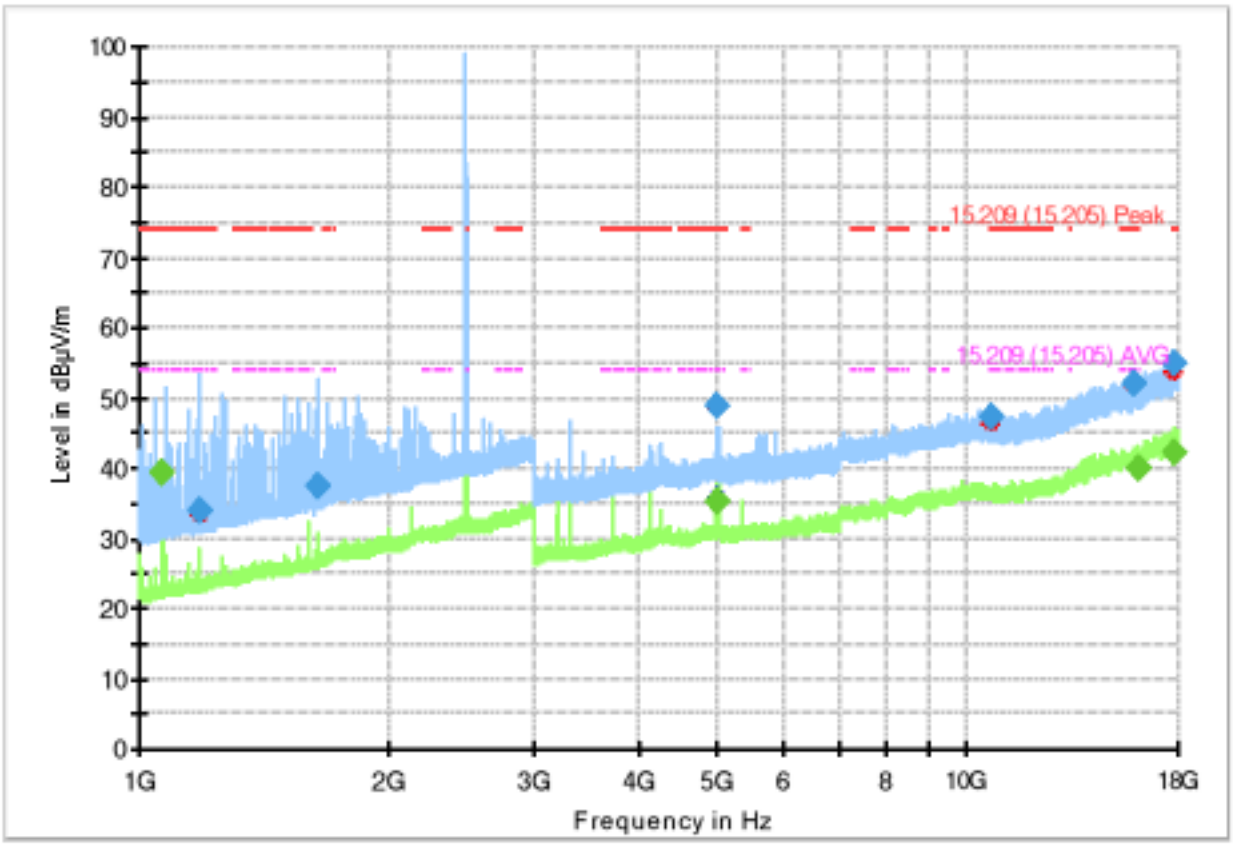


Preview Result 2-AVG
Critical_Freqs PK+
Final_Result PK+
Preview Result 1-PK+
15.209 (15.205) Peak
Final_Result AVG
Critical_Freqs AVG
15.209 (15.205) AVG

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1165.800000	34.26	---	74.00	39.74	1000.0	1000.000	150.0	V
1206.500000	34.42	---	74.00	39.58	1000.0	1000.000	150.0	V
1483.150000	36.18	---	74.00	37.82	1000.0	1000.000	150.0	V
2724.500000	43.48	---	74.00	30.52	1000.0	1000.000	150.0	H
4068.400000	---	41.48	54.00	12.52	1000.0	1000.000	150.0	V
4882.000000	---	37.34	54.00	16.66	1000.0	1000.000	150.0	V
15891.750000	---	38.87	54.00	15.13	1000.0	1000.000	150.0	V
15892.200000	51.68	---	74.00	22.32	1000.0	1000.000	150.0	H
17762.650000	---	42.39	54.00	11.61	1000.0	1000.000	150.0	V
17979.650000	55.51	---	74.00	18.49	1000.0	1000.000	150.0	H

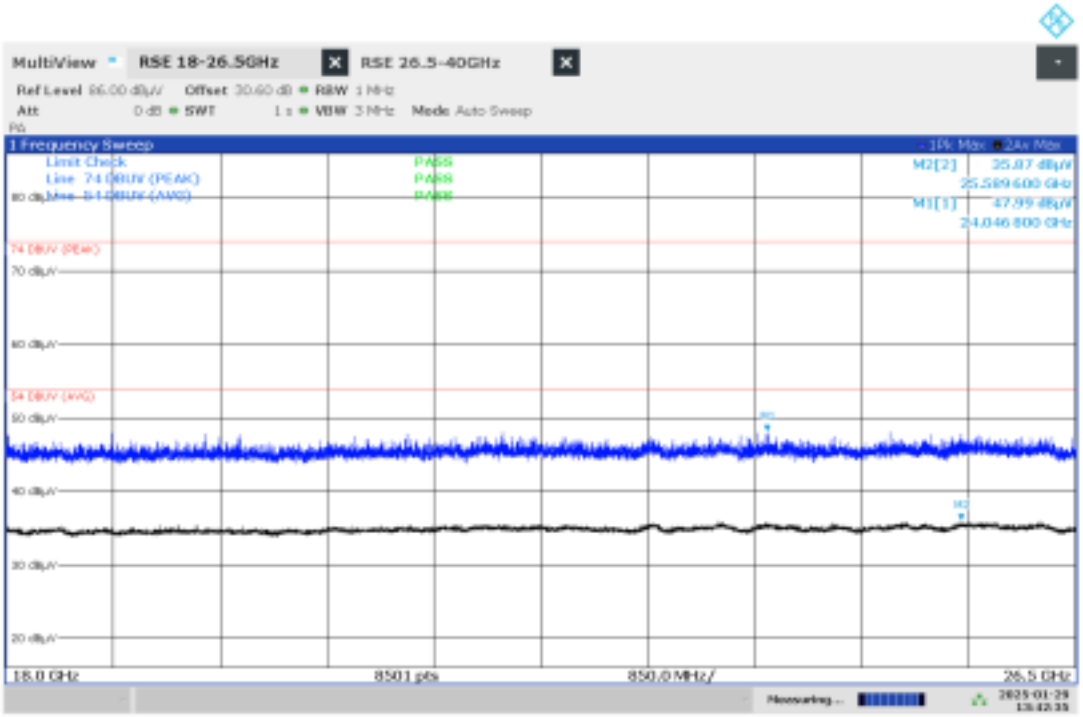
Plot 148: Mode 3, RSE 1 GHz – 18 GHz, high channel, horizontal / vertical polarisation



Final_Result

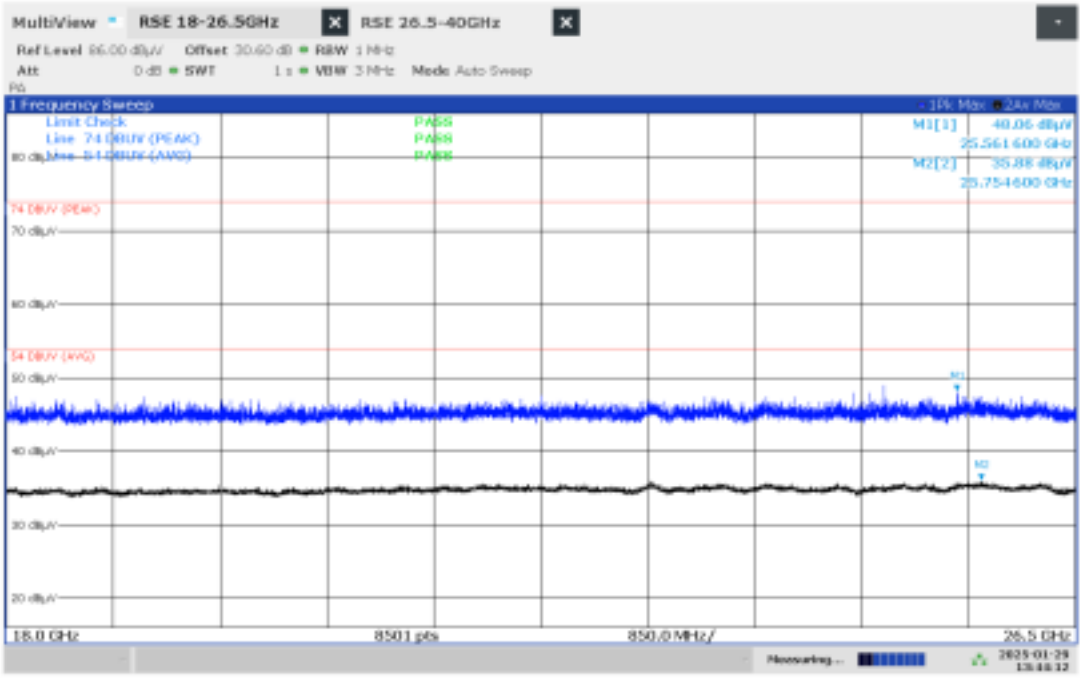
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1066.600000	---	39.34	54.00	14.66	1000.0	1000.000	150.0	H
1179.300000	34.12	---	74.00	39.88	1000.0	1000.000	150.0	H
1646.450000	37.33	---	74.00	36.67	1000.0	1000.000	150.0	V
4998.250000	---	35.30	54.00	18.70	1000.0	1000.000	150.0	V
4998.550000	48.96	---	74.00	25.04	1000.0	1000.000	150.0	V
10670.200000	47.17	---	74.00	26.83	1000.0	1000.000	150.0	V
15945.850000	51.97	---	74.00	22.03	1000.0	1000.000	150.0	H
16100.850000	---	39.94	54.00	14.06	1000.0	1000.000	150.0	V
17736.900000	---	42.35	54.00	11.65	1000.0	1000.000	150.0	H
17816.800000	54.80	---	74.00	19.20	1000.0	1000.000	150.0	V

Plot 149: Mode 3, RSE 18 GHz – 26.5 GHz, low channel, horizontal / vertical polarisation



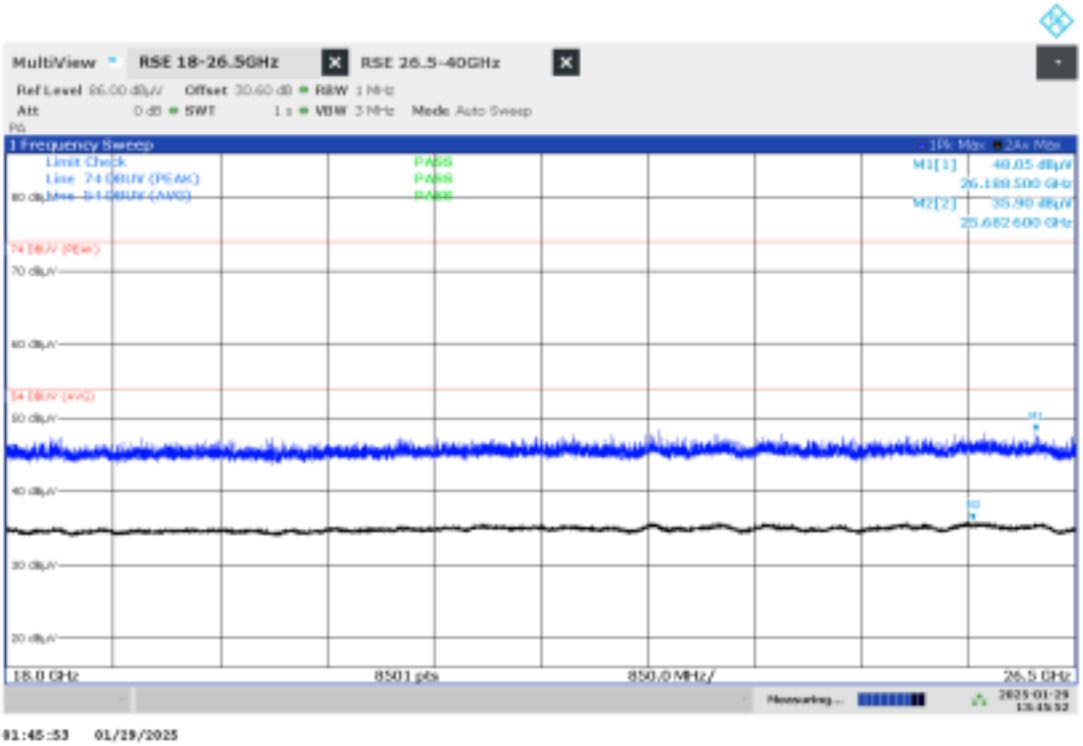
01:42:36 01/29/2025

Plot 150: Mode 3, RSE 18 GHz – 26.5 GHz, mid channel, horizontal / vertical polarisation

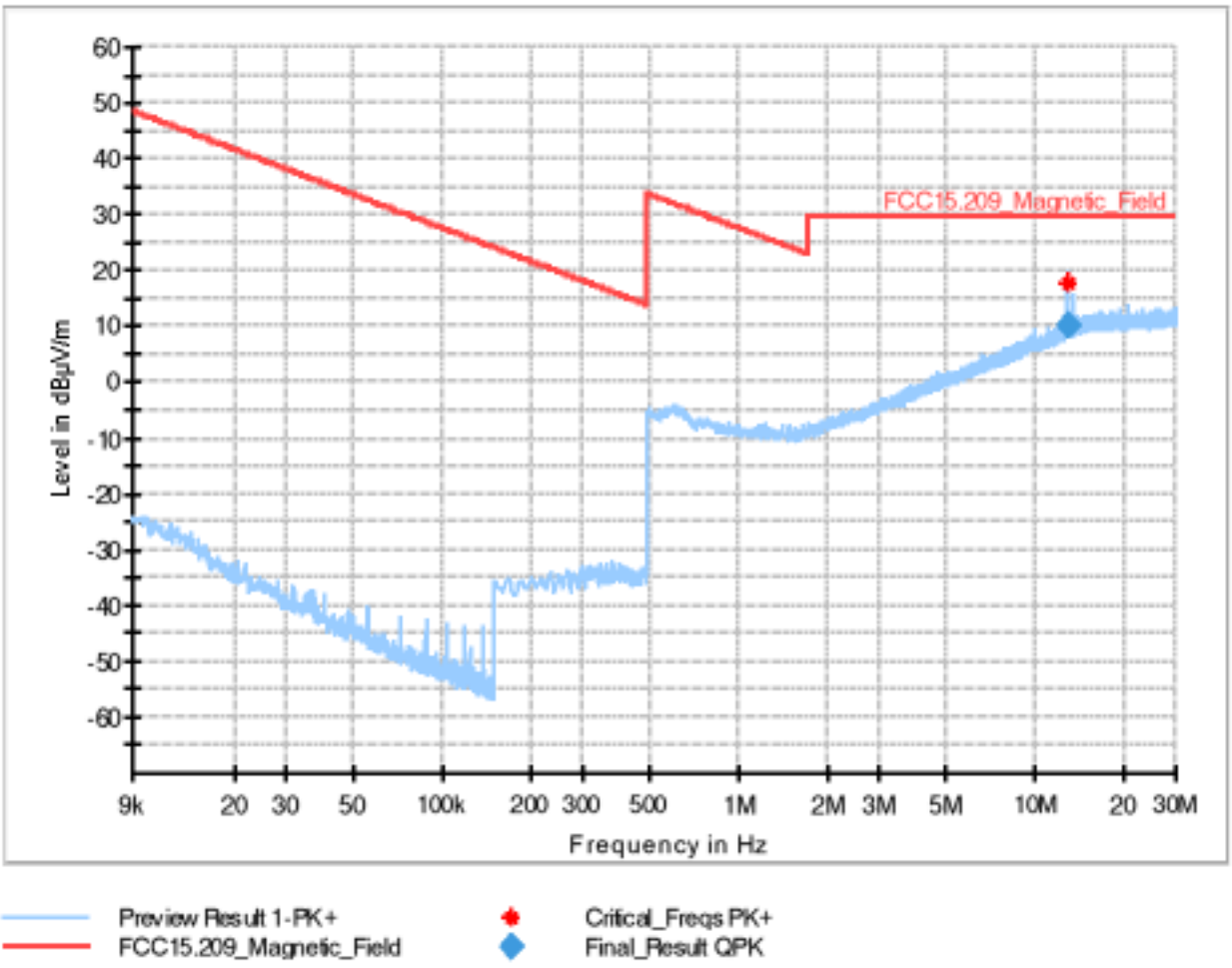


01:44:13 01/29/2025

Plot 151: Mode 3, RSE 18 GHz – 26.5 GHz, high channel, horizontal / vertical polarisation



Plot 152: Mode 3, RSE 9 kHz – 30 MHz, low channel, loop antenna

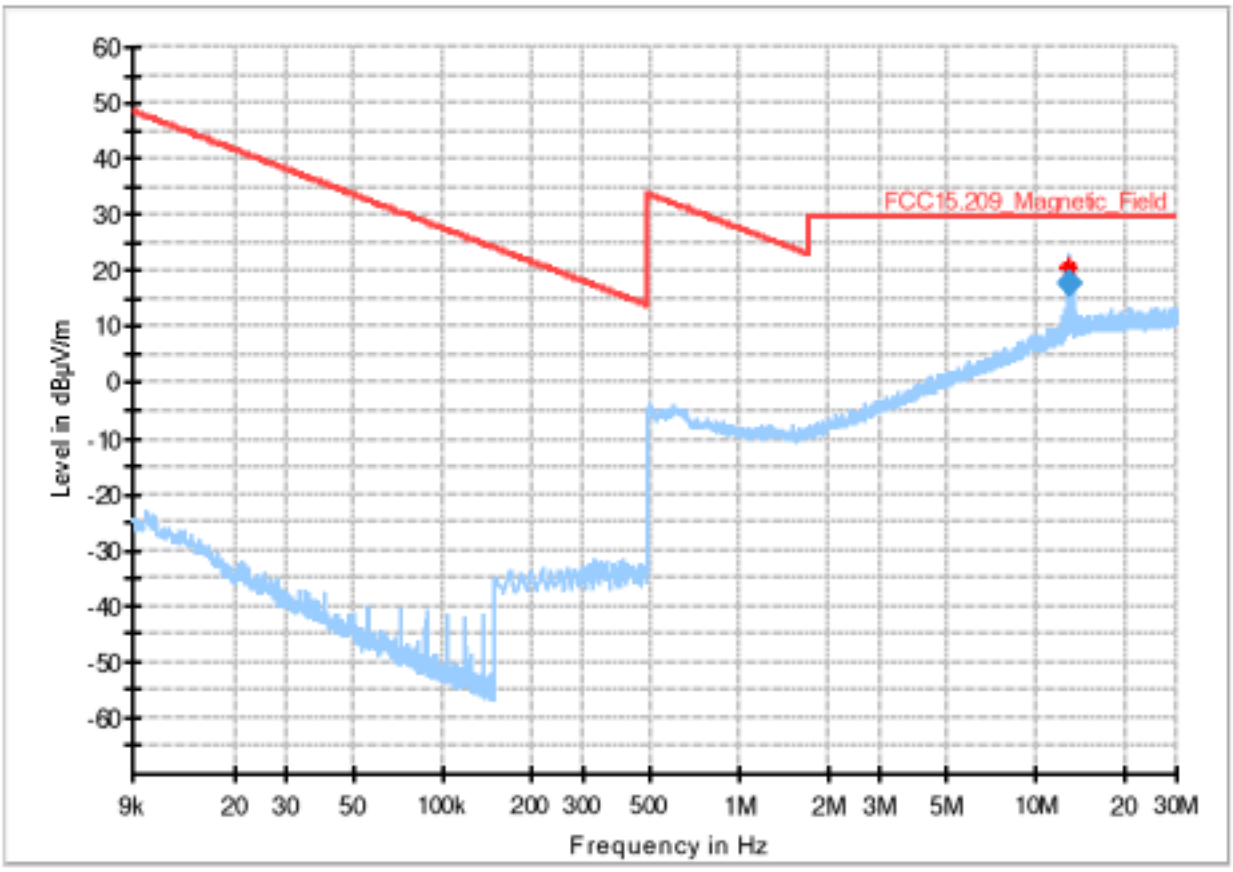


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
13.085250	10.23	29.54	19.31	100.0	9.000	V	206.0	-1.2

Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X kHz resulted in a level of Y dBµV/m, which is equivalent to Y - 51.5 = Z dBµA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.
(Certification & Engineering Bureau, Q&A on Certification Procedures and Requirements, TCB Workshop April 2020, Nicolas DesMarais, 2020-04-09 - ISED Q&A - DesMarais.pdf)

Plot 153: Mode 3, RSE 9 kHz – 30 MHz, mid channel, loop antenna

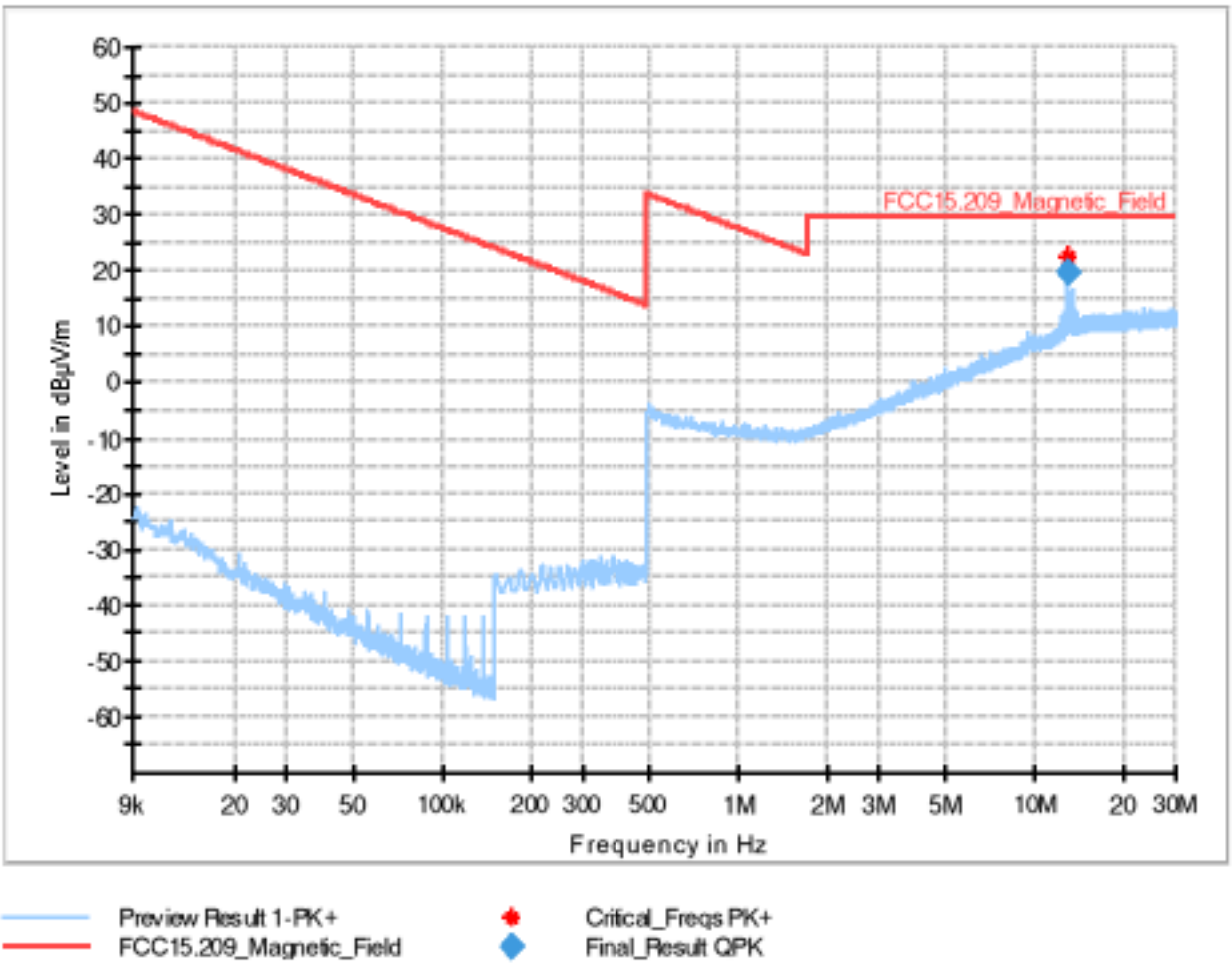


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)
13.080750	17.68	29.54	11.86	100.0	9.000	V	240.0	-1.2

Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X kHz resulted in a level of Y dBµV/m, which is equivalent to Y - 51.5 = Z dBµA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.
(Certification & Engineering Bureau, Q&A on Certification Procedures and Requirements, TCB Workshop April 2020, Nicolas DesMarais, 2020-04-09 - ISED Q&A - DesMarais.pdf)

Plot 154: Mode 3, RSE 9 kHz – 30 MHz, high channel, loop antenna

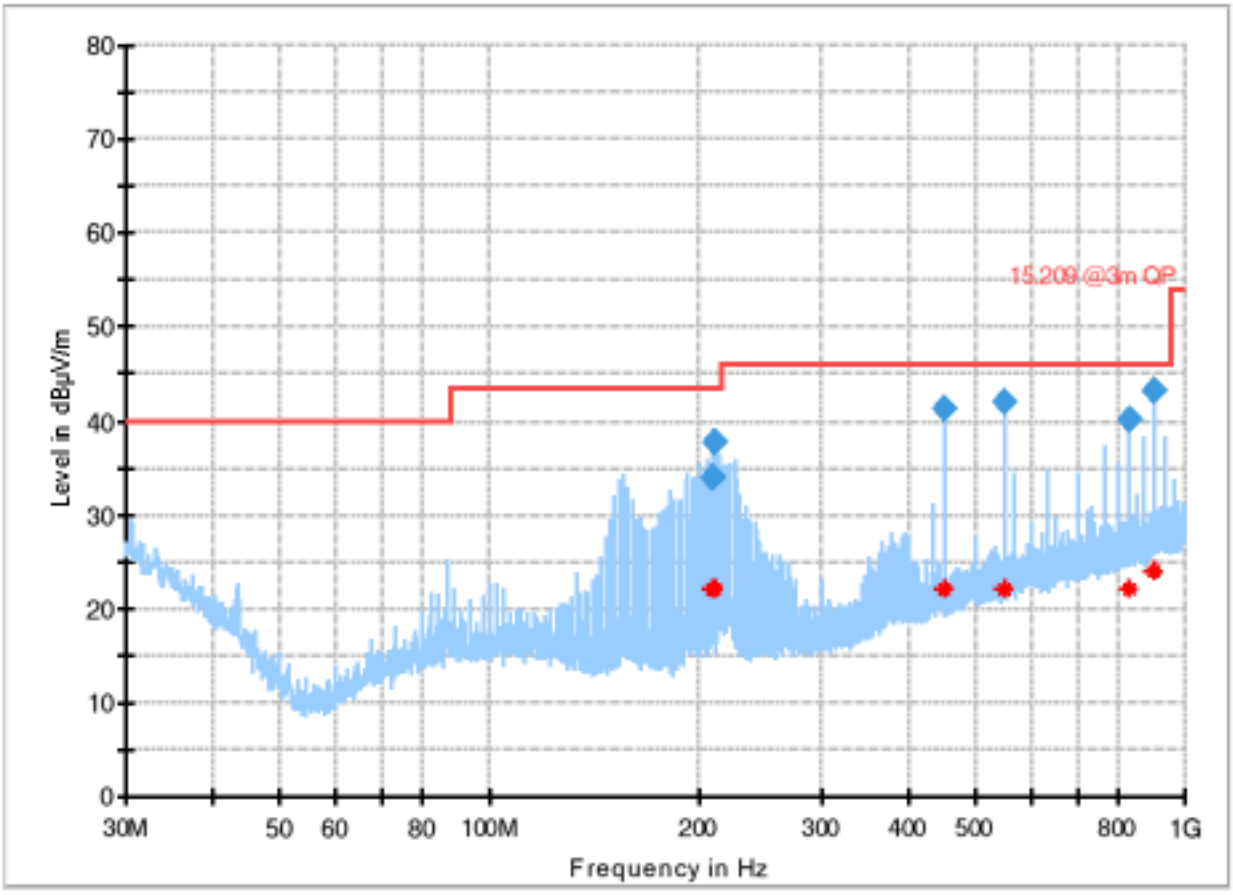


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
13.083000	19.69	29.54	9.85	100.0	9.000	V	226.0	-1.2

Note:
The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω. For example, the measurement frequency X kHz resulted in a level of Y dBµV/m, which is equivalent to Y - 51.5 = Z dBµA/m, which has the same margin, W dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.
(Certification & Engineering Bureau, Q&A on Certification Procedures and Requirements, TCB Workshop April 2020, Nicolas DesMarais, 2020-04-09 - ISED Q&A - DesMarais.pdf)

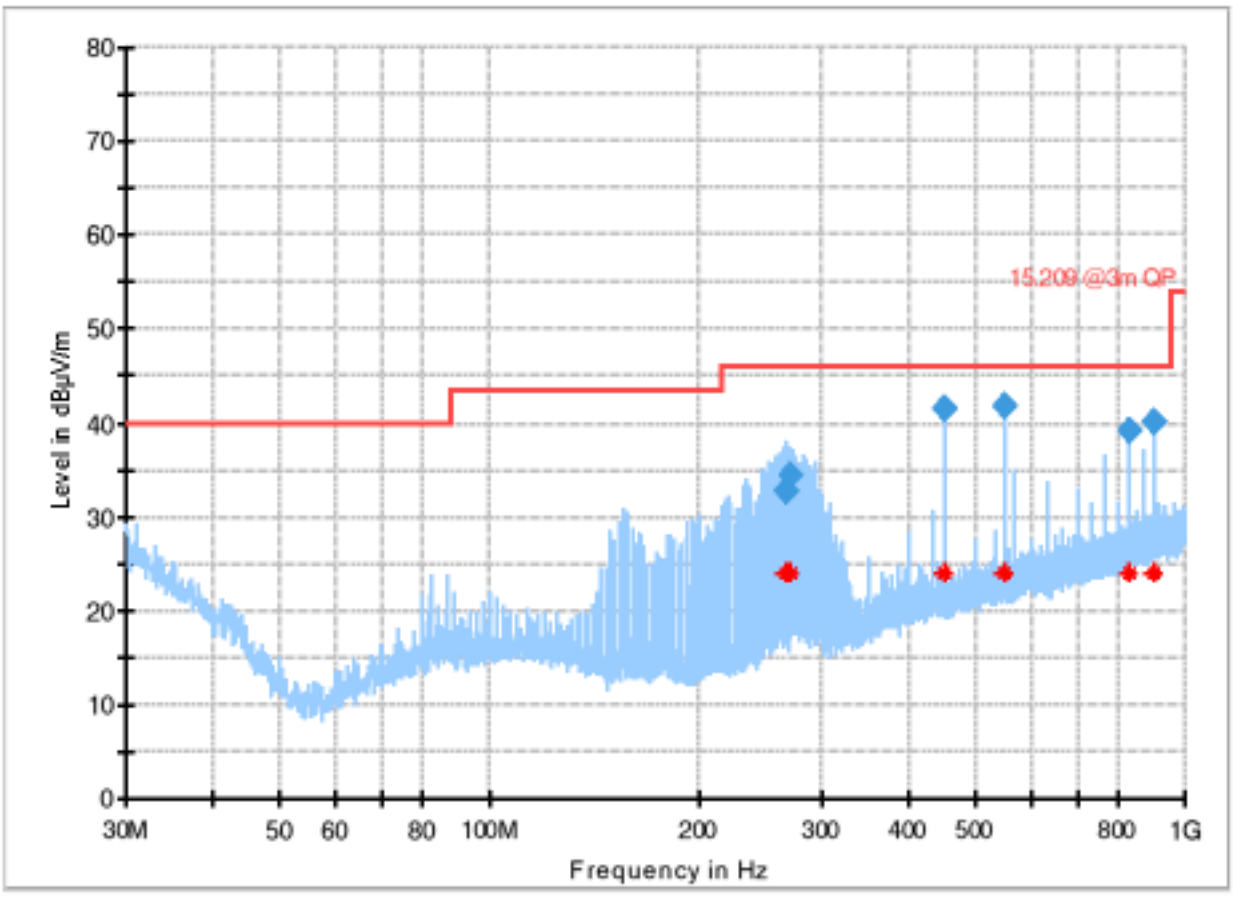
Plot 155: Mode 3, RSE 30 MHz – 1 GHz, low channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
208.928000	34.06	43.50	9.44	100.0	120.000	100.0	V	-23.0
211.147500	37.67	43.50	5.83	100.0	120.000	100.0	V	9.0
450.010000	41.35	46.00	4.65	100.0	120.000	144.0	V	73.0
550.017000	42.00	46.00	4.00	100.0	120.000	103.0	V	91.0
833.354000	40.06	46.00	5.94	100.0	120.000	104.0	H	117.0
900.011500	43.20	46.00	2.80	100.0	120.000	100.0	H	125.0

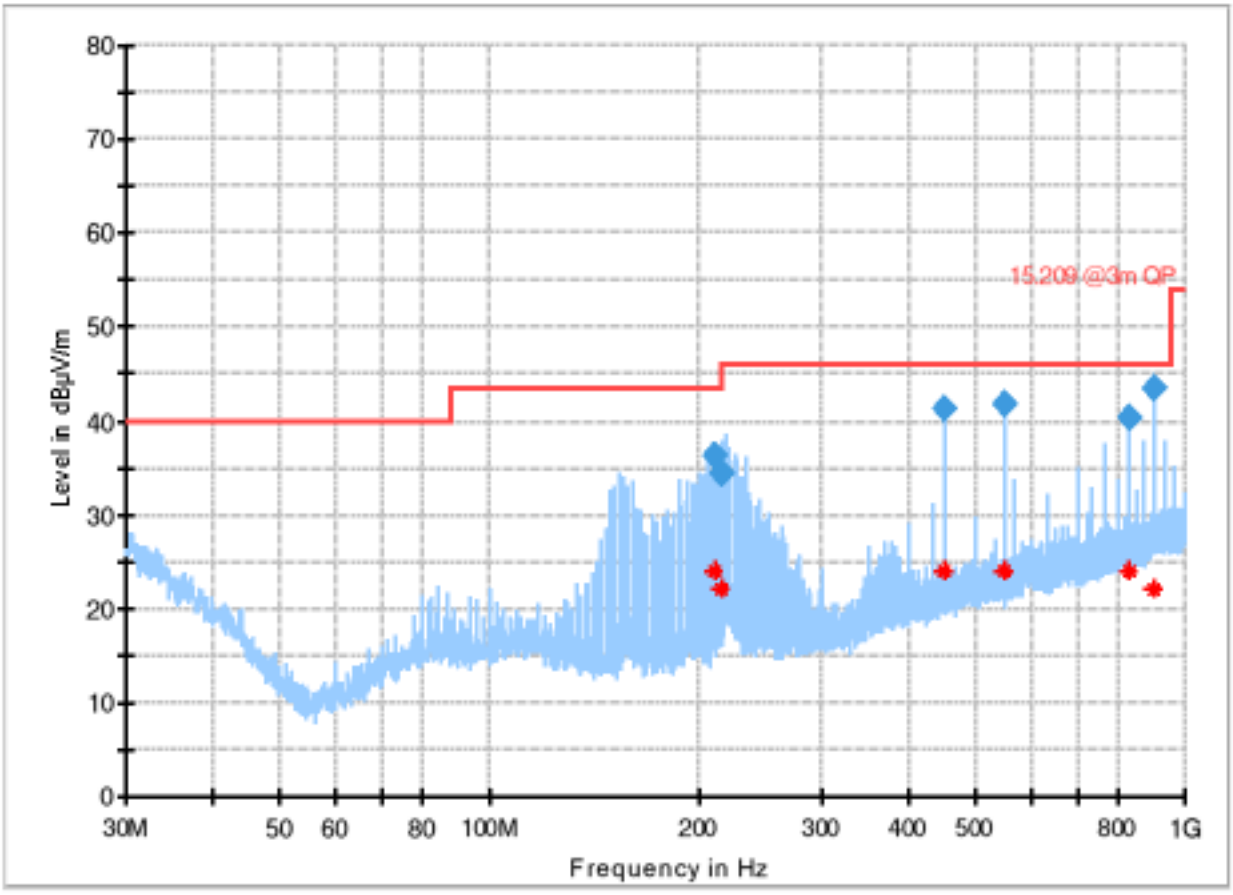
Plot 156: Mode 3, RSE 30 MHz – 1 GHz, mid channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
266.698500	32.72	46.00	13.28	100.0	120.000	136.0	V	16.0
271.172000	34.31	46.00	11.69	100.0	120.000	146.0	H	227.0
450.010000	41.51	46.00	4.49	100.0	120.000	131.0	V	71.0
550.017000	41.76	46.00	4.24	100.0	120.000	103.0	V	87.0
833.324000	39.19	46.00	6.81	100.0	120.000	100.0	H	117.0
900.011500	40.19	46.00	5.81	100.0	120.000	103.0	H	124.0

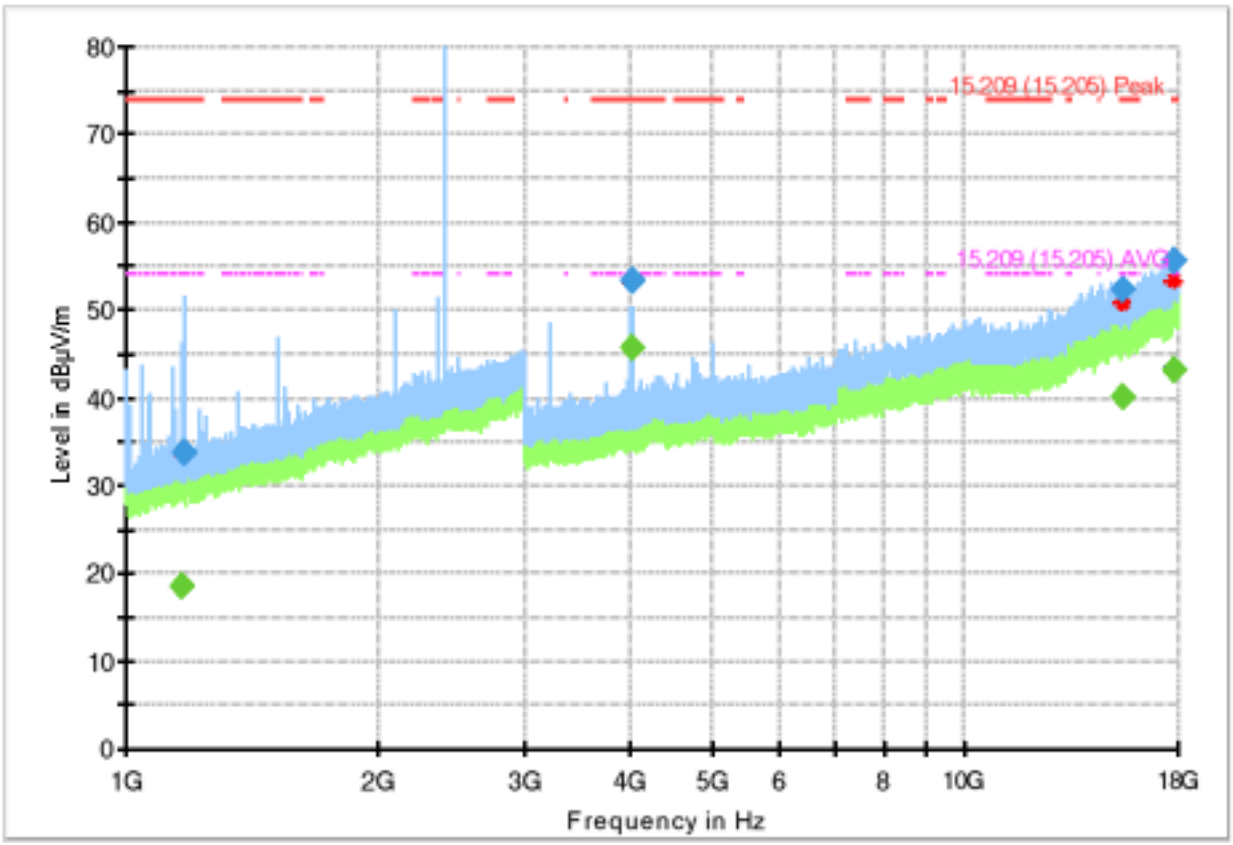
Plot 157: Mode 3, RSE 30 MHz – 1 GHz, high channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
211.147500	36.35	43.50	7.15	100.0	120.000	100.0	V	3.0
215.621000	34.51	43.50	8.99	100.0	120.000	100.0	V	349.0
450.010000	41.40	46.00	4.60	100.0	120.000	119.0	V	71.0
549.987000	41.83	46.00	4.17	100.0	120.000	100.0	V	93.0
833.354000	40.38	46.00	5.62	100.0	120.000	100.0	H	113.0
900.011500	43.43	46.00	2.57	100.0	120.000	100.0	H	120.0

Plot 158: Mode 3, RSE 1 GHz – 18 GHz, low channel, horizontal / vertical polarisation

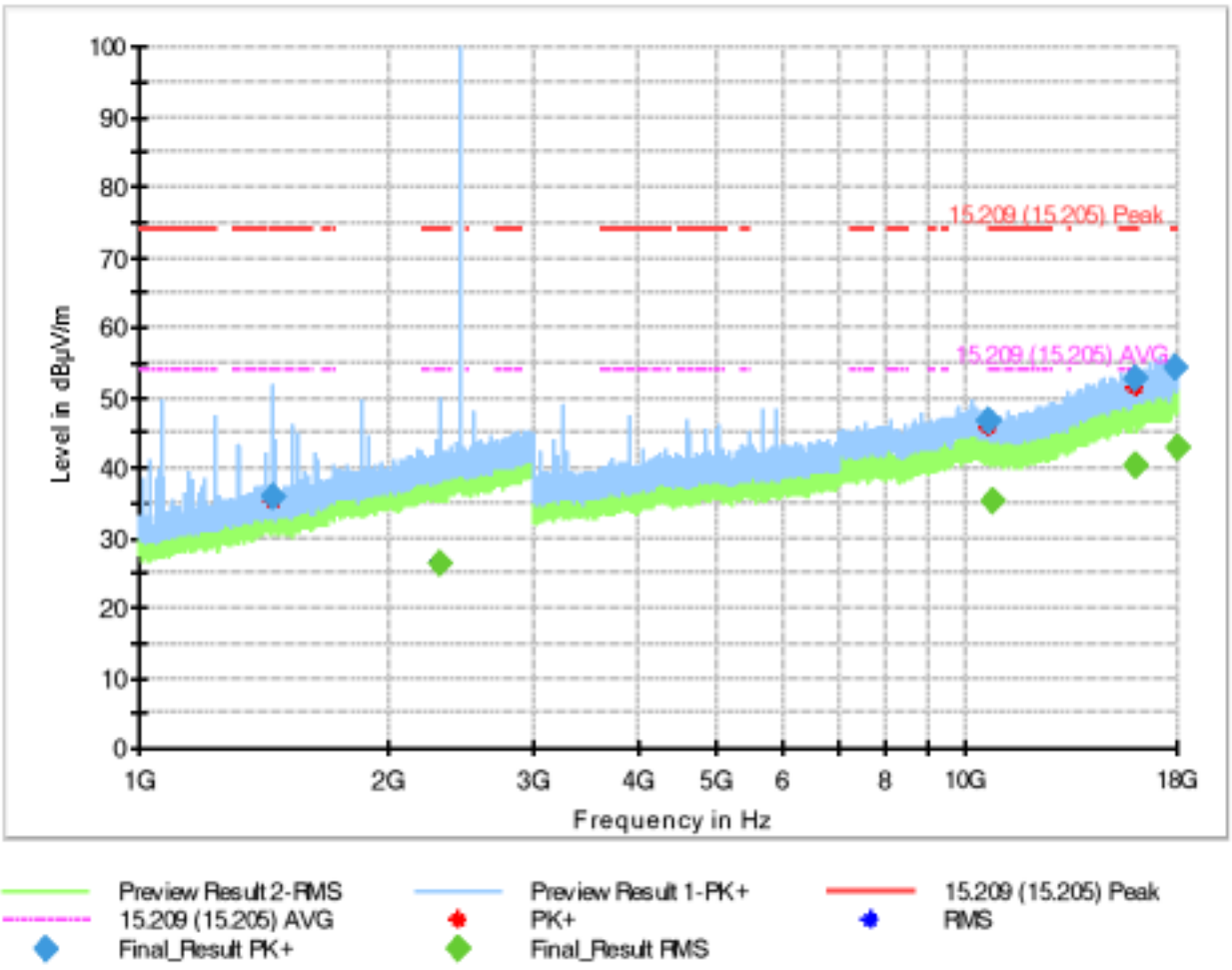


Preview Result 2-RMS
Critical_Freqs PK+
Final_Result PK+
Preview Result 1-PK+
15.209 (15.205) Peak
Final_Result RMS
Critical_Freqs RMS
15.209 (15.205) AVG

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1166.700000	---	18.47	54.00	35.53	1000.0	1000.000	150.0	V
1171.700000	33.79	---	74.00	40.21	1000.0	1000.000	150.0	V
4003.450000	---	45.64	54.00	8.36	1000.0	1000.000	150.0	V
4003.450000	53.36	---	74.00	20.64	1000.0	1000.000	150.0	V
15407.700000	---	40.17	54.00	13.83	1000.0	1000.000	150.0	V
15412.200000	52.25	---	74.00	21.75	1000.0	1000.000	150.0	V
17738.150000	---	43.28	54.00	10.72	1000.0	1000.000	150.0	V
17829.800000	55.58	---	74.00	18.42	1000.0	1000.000	150.0	H

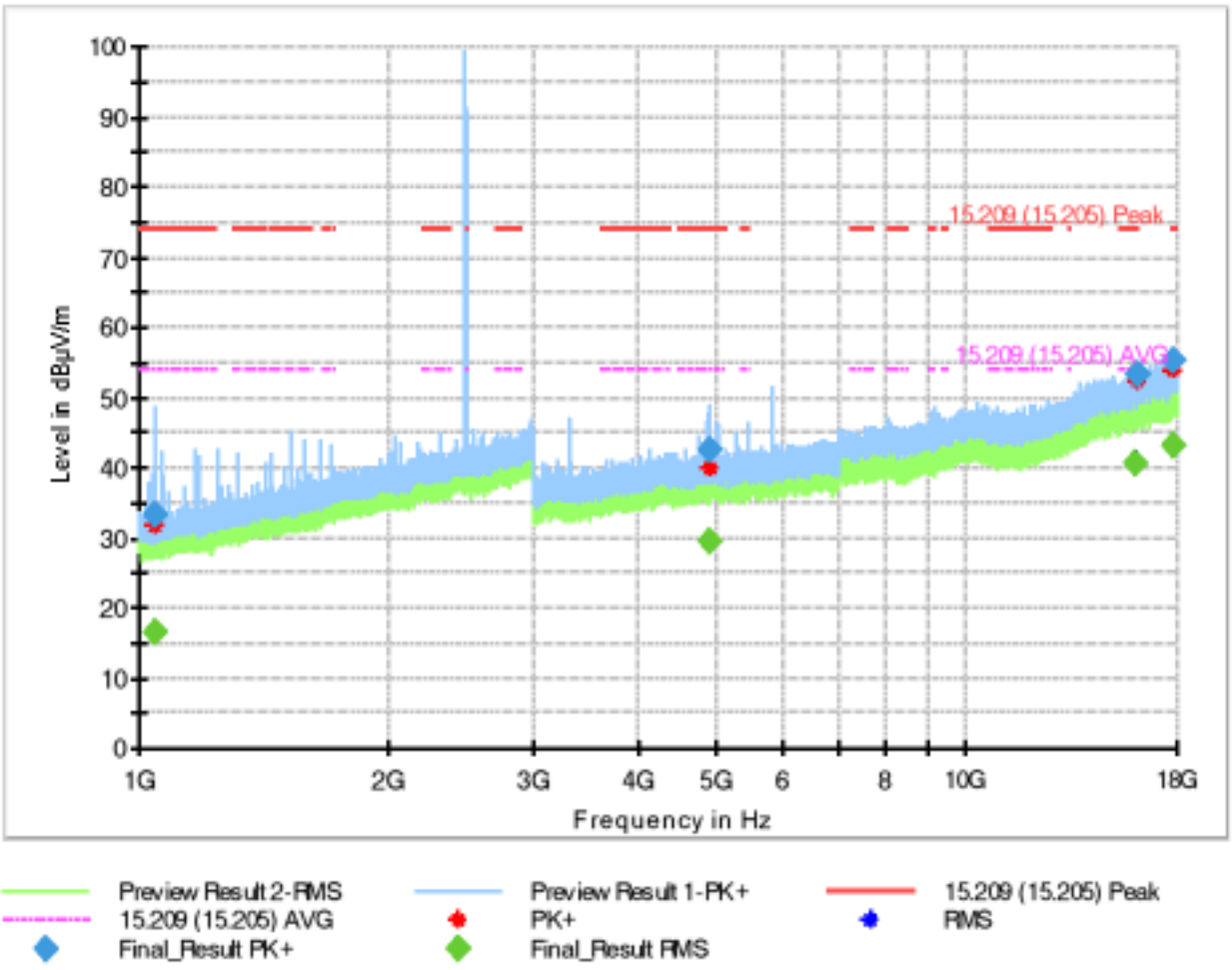
Plot 159: Mode 3, RSE 1 GHz – 18 GHz, mid channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1455.000000	35.90	---	74.00	38.10	1000.0	1000.000	150.0	H
2313.850000	---	26.43	54.00	27.57	1000.0	1000.000	150.0	V
10633.200000	46.80	---	74.00	27.20	1000.0	1000.000	150.0	H
10730.150000	---	35.10	54.00	18.90	1000.0	1000.000	150.0	H
15950.000000	52.69	---	74.00	21.31	1000.0	1000.000	150.0	H
15957.000000	---	40.43	54.00	13.57	1000.0	1000.000	150.0	H
17852.200000	54.14	---	74.00	19.86	1000.0	1000.000	150.0	V
17999.600000	---	42.81	54.00	11.19	1000.0	1000.000	150.0	H

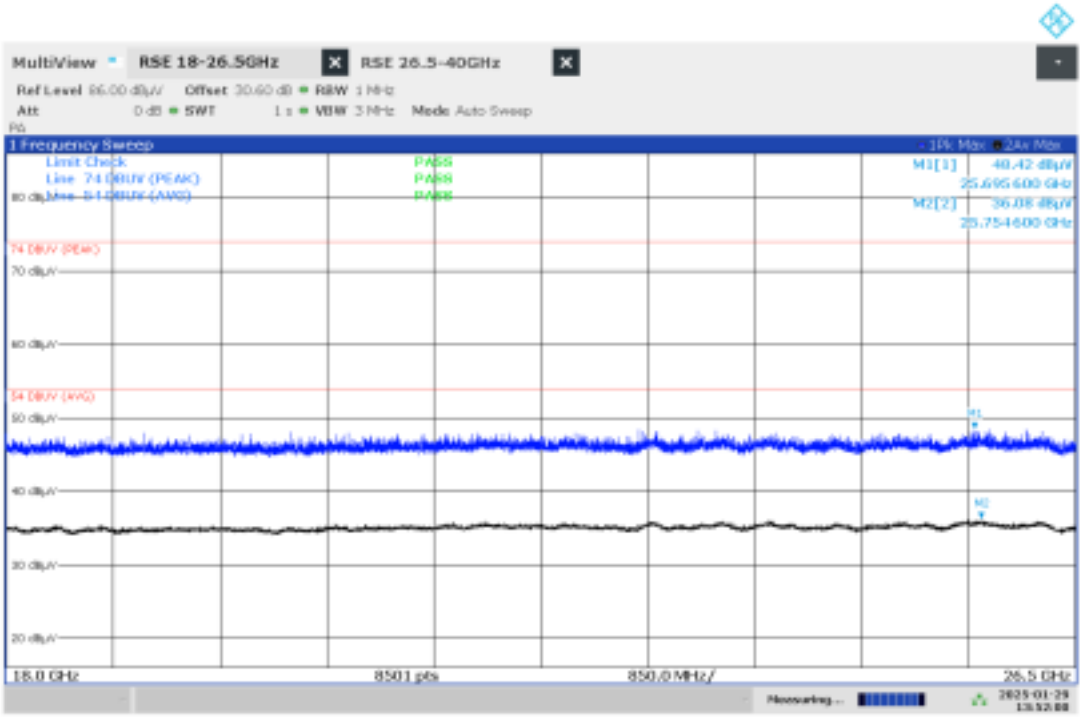
Plot 160: Mode 3, RSE 1 GHz – 18 GHz, high channel, horizontal / vertical polarisation



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1043.700000	33.33	---	74.00	40.67	1000.0	1000.000	150.0	V
1044.450000	---	16.56	54.00	37.44	1000.0	1000.000	150.0	V
4880.450000	---	29.41	54.00	24.59	1000.0	1000.000	150.0	H
4883.200000	42.54	---	74.00	31.46	1000.0	1000.000	150.0	H
15951.900000	---	40.72	54.00	13.28	1000.0	1000.000	150.0	V
16126.500000	53.36	---	74.00	20.64	1000.0	1000.000	150.0	V
17764.050000	---	43.24	54.00	10.76	1000.0	1000.000	150.0	V
17765.550000	55.37	---	74.00	18.63	1000.0	1000.000	150.0	V

Plot 161: Mode 2, RSE 18 GHz – 26.5 GHz, low channel, horizontal / vertical polarisation



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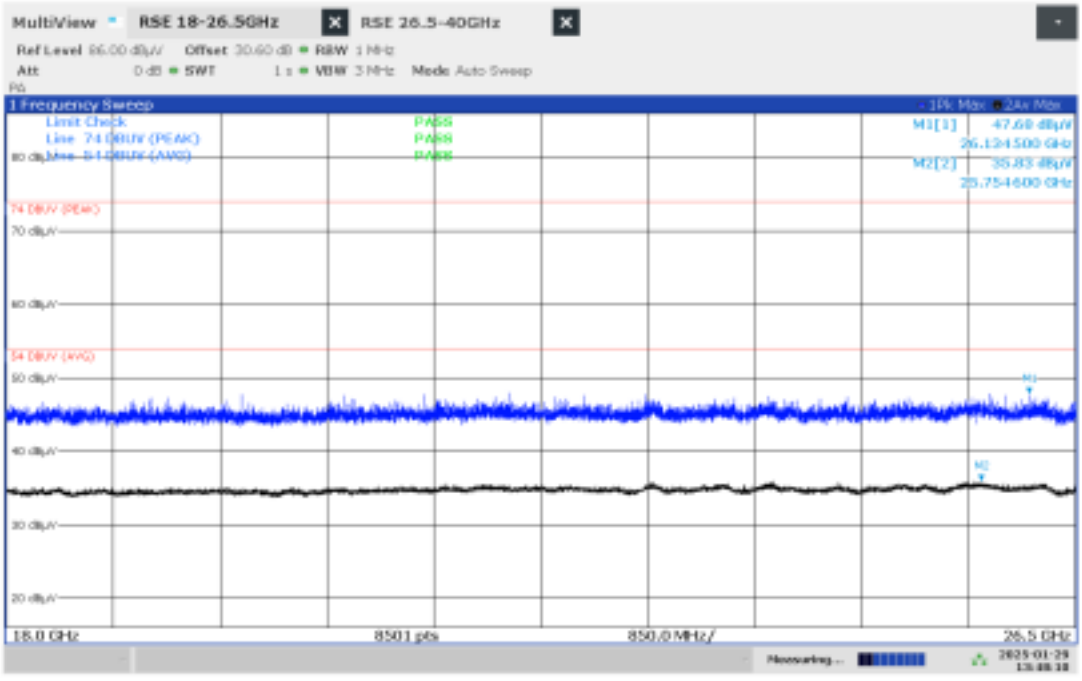
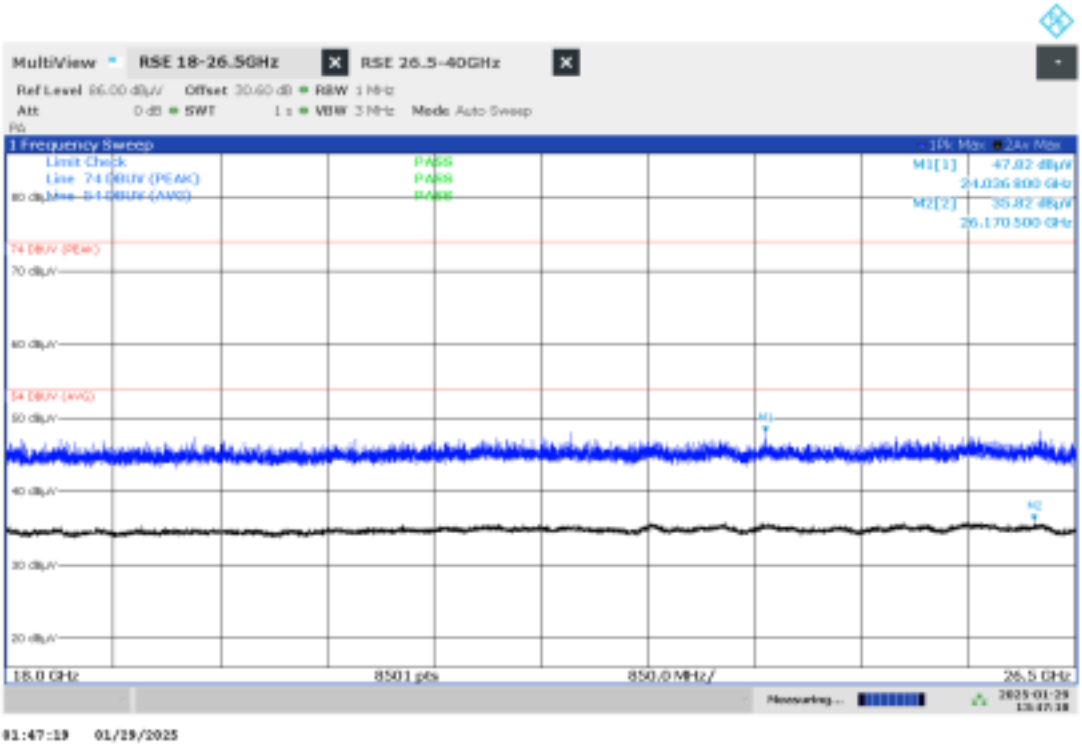
Plot 162: Mode 2, RSE 18 GHz – 26.5 GHz, mid channel, horizontal / vertical polarisation



01:48:11 01/29/2025

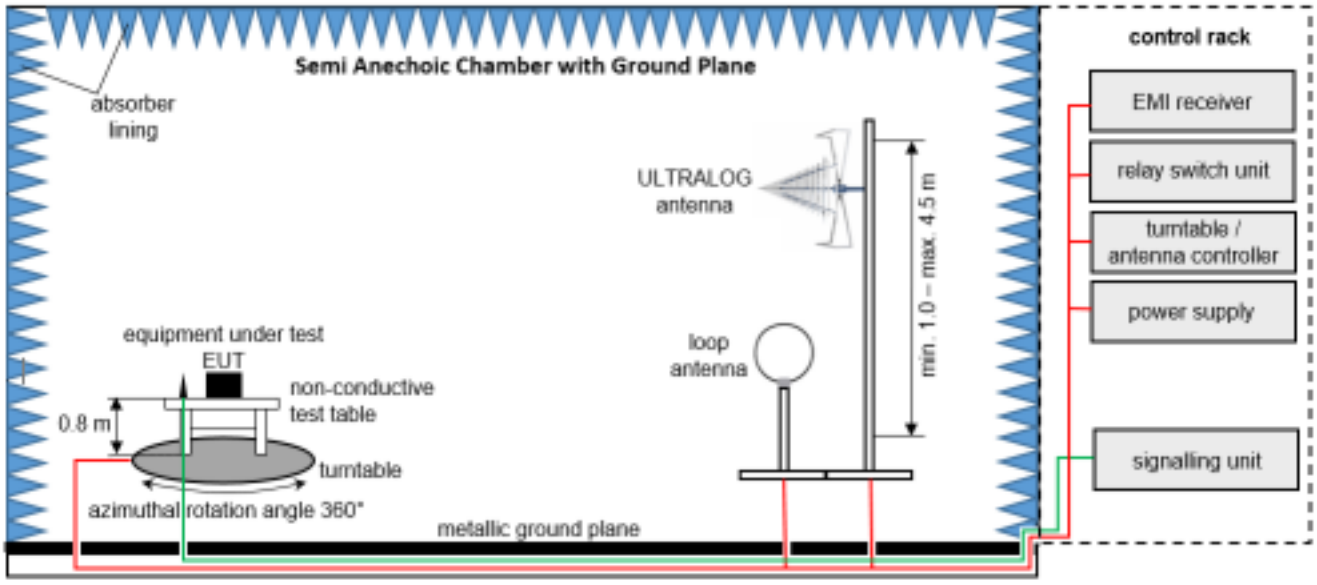
Plot 163: Mode 2, RSE 18 GHz – 26.5 GHz, high channel, horizontal / vertical polarisation



8 TEST SETUP DESCRIPTION

8.1 Semi Anechoic Chamber with Ground Plane

Radiated measurements are performed in vertical and horizontal plane in the frequency range 30 MHz to 1 GHz in a Semi Anechoic Chamber with a metallic ground plane. The EUT is positioned on a non-conductive test table with a height of 0.80 m above the metallic ground plane that covers the whole chamber. The receiving antennas conform to specification ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices. These antennas can be moved over the height range between 1.0 m and 4.5 m in order to search for maximum field strength emitted from the EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by a spectrum analyzer where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: loop antenna 3 m, ULTRALOG antenna 3 m
EMC32 software version: 11.10.00

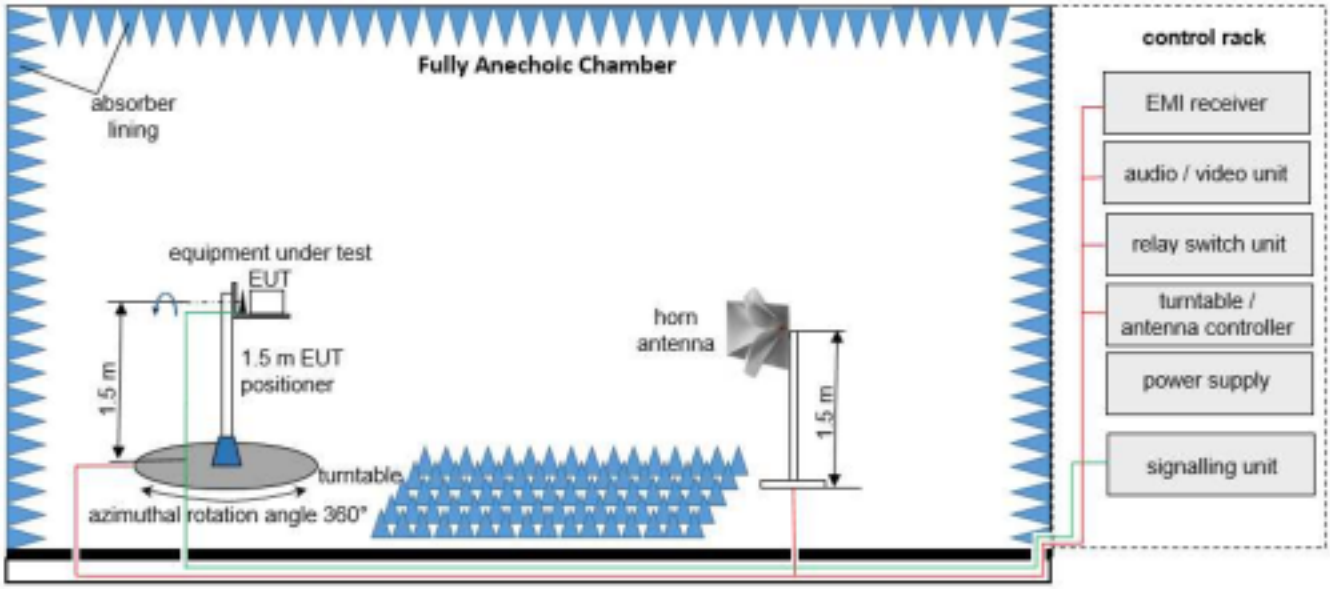
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Power Supply	Rohde & Schwarz	IN 600	101554	LAB000824	NR	–
2	Antenna	Rohde & Schwarz	HL562E	102173	LAB000673	C	2022-10-17 → 36M → 2025-10-17
3	Power Supply	Chroma	61602		LAB000507	NR	–
4	EMI Test Receiver	Rohde & Schwarz	ESW26	101517	LAB000363	C	2025-01-10 → 12M → 2026-01-10
5	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	NR	–
6	Test table	inno systems GmbH	PT1208-080-RH	-	LAB000306	NR	–
7	Antenna Mast	Berlebach	Tripod HFH2-Z8 & -Z9	101752	LAB000292	NR	–
8	Positioner	maturo GmbH	TD 1.5-10KG		LAB000258	NR	–
9	Compressed Air	Implotex	1-850-30	-	LAB000256	NR	–
10	Semi/Fully Anechoic Chamber	Albatross Projects GmbH	Babylon 5 (SAC 5)	20168.PRB	LAB000235	CM	2022-01-31 → 36M → 2025-01-31
11	Measurement Software	Rohde & Schwarz	EMC32 V11.20		LAB000226	NR	–
12	Turntable	maturo GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	NR	–
13	Antenna Mast	maturo GmbH	CAM4.0-P	CAM4.0-P/316	LAB000224	NR	–
14	Antenna Mast	maturo GmbH	BAM4.5-P	BAM4.5-P/272	LAB000223	NR	–
15	Controller	maturo GmbH	FCU 3.0	10082	LAB000222	NR	–
16	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350292	LAB000191	NR	–
17	Pre-Amplifier	Schwarzbeck Mess-Elektronik OHG	BBV 9718 C	84	LAB000169	CM	2022-09-31 → 36M → 2025-09-31
18	Antenna	Rohde & Schwarz	HF907	102899	LAB000151	C	2023-05-15 → 36M → 2026-05-15
19	Antenna	Rohde & Schwarz	HL562E	102005	LAB000150	C	2022-12-22 → 36M → 2025-12-22
20	Open Switch and Control Platform	Rohde & Schwarz	OSP220 Base Unit 2HU	101748	LAB000149	NR	–
21	Antenna	Rohde & Schwarz	HFH2-Z2E	100954	LAB000108	C	2023-05-05 → 36M → 2026-05-05

8.2 Fully Anechoic Chamber



Measurement distance: horn antenna 3 meter
EMC32 software version: 11.10.00

FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

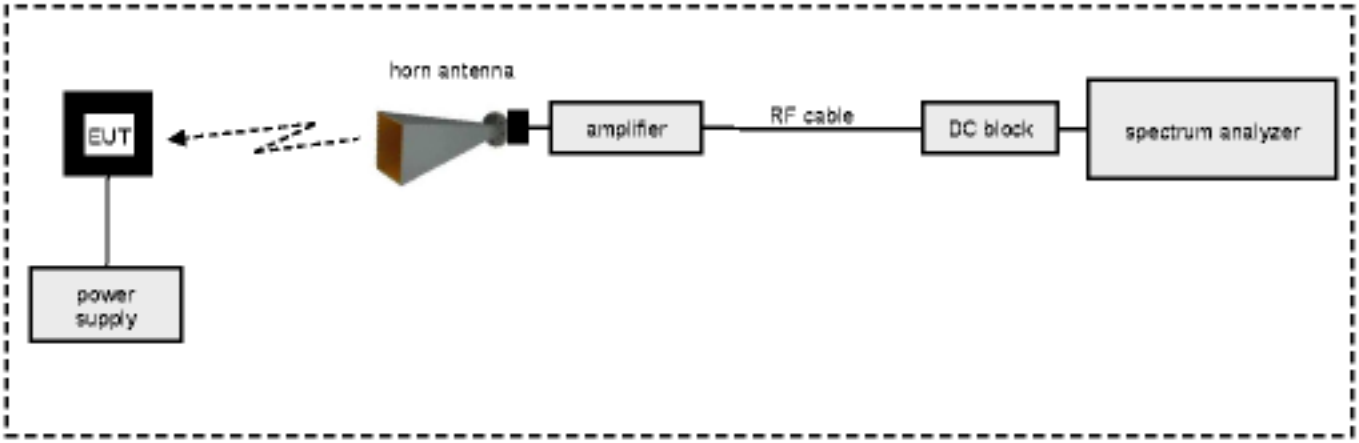
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 µW)

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Power Supply	Rohde & Schwarz	IN 600	101554	LAB000824	NR	–
2	Antenna	Rohde & Schwarz	HL562E	102173	LAB000673	C	2022-10-17 → 36M → 2025-10-17
3	Power Supply	Chroma	61602		LAB000507	NR	–
4	EMI Test Receiver	Rohde & Schwarz	ESW26	101517	LAB000363	C	2025-01-10 → 12M → 2026-01-10
5	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PSI 9080-40 T	2000230001	LAB000313	NR	–
6	Test table	innco systems GmbH	PT1208-080-RH	-	LAB000306	NR	–
7	Antenna Mast	Berlebach	Tripod HFH2-Z8 & -Z9	101752	LAB000292	NR	–
8	Positioner	maturo GmbH	TD 1.5-10KG		LAB000258	NR	–
9	Compressed Air	Implotex	1-850-30	-	LAB000256	NR	–
10	Semi/Fully Anechoic Chamber	Albatross Projects GmbH	Babylon 5 (SAC 5)	20168.PRB	LAB000235	CM	2022-01-31 → 36M → 2025-01-31
11	Measurement Software	Rohde & Schwarz	EMC32 V11.20		LAB000226	NR	–
12	Turntable	maturo GmbH	TT2.0-2t	TT2.0-2t/921	LAB000225	NR	–
13	Antenna Mast	maturo GmbH	CAM4.0-P	CAM4.0-P/316	LAB000224	NR	–
14	Antenna Mast	maturo GmbH	BAM4.5-P	BAM4.5-P/272	LAB000223	NR	–
15	Controller	maturo GmbH	FCU 3.0	10082	LAB000222	NR	–
16	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350292	LAB000191	NR	–
17	Pre-Amplifier	Schwarzbeck Mess-Elektronik OHG	BBV 9718 C	84	LAB000169	CM	2022-09-31 → 36M → 2025-09-31
18	Antenna	Rohde & Schwarz	HF907	102899	LAB000151	C	2023-05-15 → 36M → 2026-05-15
19	Antenna	Rohde & Schwarz	HL562E	102005	LAB000150	C	2022-12-22 → 36M → 2025-12-22
20	Open Switch and Control Platform	Rohde & Schwarz	OSP220 Base Unit 2HU	101748	LAB000149	NR	–
21	Antenna	Rohde & Schwarz	HFH2-Z2E	100954	LAB000108	C	2023-05-05 → 36M → 2026-05-05

8.3 Radiated measurements > 18 GHz

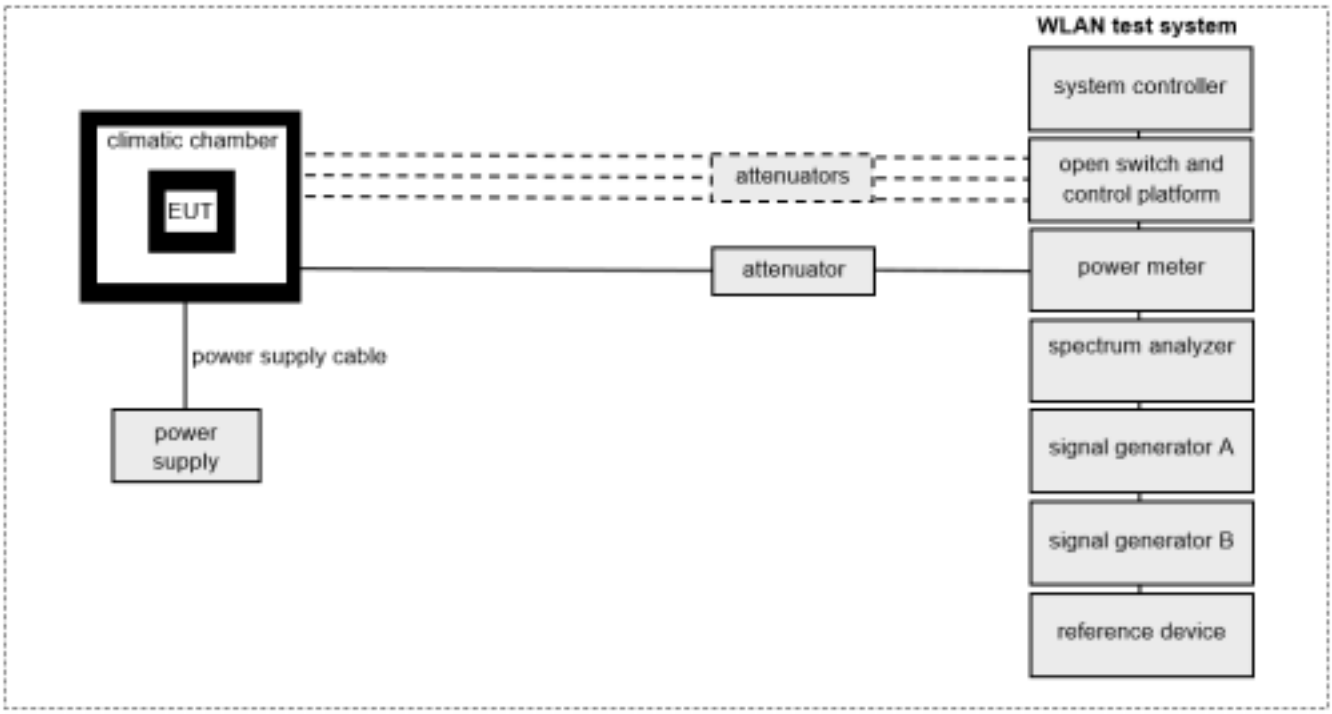


List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Absorber	Telemeter Electronic	EPP 12	-	LAB000327	NR	--
2	Test table	inno systems GmbH	PT0707-RH light	-	LAB000303	NR	--
3	Spectrum Analyser	Rohde & Schwarz	FSW43	101391	LAB000289	C	2024-06-04 → 12M → 2025-06-04
4	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350263	LAB000190	NR	--
5	WG-Coax-Adapter	Flann Microwave Ltd	22093-TF30 UG599/U	273283	LAB000183	CM	2024-07-16 → 12M → 2025-07-16
6	WG-Coax-Adapter	Flann Microwave Ltd	20093-TF30 UBR220	273374	LAB000181	CM	2024-07-16 → 12M → 2025-07-16
7	Coaxial Cable	Huber & Suhner	SF101/1.5m	503987/1	LAB000165	CM	2024-07-17 → 12M → 2025-07-17
8	Antenna	Flann Microwave Ltd	22240-20 (26.5-40.0 GHz)	270448	LAB000130	CM	2024-07-16 → 12M → 2025-07-16
9	Antenna	Flann Microwave Ltd	20240-20 (18.0-26.5 GHz)	266403	LAB000128	CM	2024-07-16 → 12M → 2025-07-16
10	Antenna Mast	Schwarzbeck Mess-Elektronik OHG	AM 9104	99	LAB000109	NR	--
11	Multimeter	Keysight	U1242B	MY59110034	LAB000009	C	2024-08-06 → 12M → 2025-08-06

8.4 Conducted measurements WLAN test system R&S TS 8997

The EUT's RF signal is coupled out by the antenna connector which is supplied by the manufacturer. The losses for all signal paths are first checked within a calibration. The measurement readings on the signalling unit/spectrum analyzer are corrected by the specific test set-up loss. The attenuator, power divider, signalling unit and the spectrum analyzer are impedance matched on 50 Ohm.



EMC32/WMS32 software version: 12.00.00

List of test equipment used:

No.	Equipment	Manufacturer	Type	Serial No.	IBL No.	Kind of Calibration	Last / Next Calibration
1	Attenuator	Hewlett Packard	11713A	3439A01548	LAB000962	NR	–
2	RF Shield Box	Rohde & Schwarz	CMW-Z10	101612	LAB000993	NR	–
3	Open Switch and Control Platform	Rohde & Schwarz	OSP-B157WBPlus	100830	LAB000358	C	2024-03-26 → 12M → 2025-03-26
4	TS8997	Rohde & Schwarz	TS8997-Rack	100829	LAB000322	NR	–
5	Open Switch and Control Platform	Rohde & Schwarz	OSP-B157WX	101247	LAB000280	NR	–
6	Spectrum Analyser	Rohde & Schwarz	FSV40	101403	LAB000278	C	2024-04-10 → 12M → 2025-04-10
7	Vector Signal Generator	Rohde & Schwarz	SMBV100A-08	258240	LAB000277	C	2024-12-10 → 36M → 2027-12-10
8	Signal Generator	Rohde & Schwarz	SMB100A-20	178175	LAB000276	C	2024-04-03 → 12M → 2025-04-03
9	Radio Communication Tester	Rohde & Schwarz	CMW270	101479	LAB000275	NR	–
10	Controller	Hewlett Packard	ATS-Z230	101379	LAB000274	NR	–
11	Attenuator	Hewlett Packard	84906K	3049A00482	LAB000250	NR	–
12	Attenuator	Hewlett Packard	84904K	3047A00772	LAB000249	NR	–
13	Power Supply	Elektro-Automatik GmbH & Co. KG	EA-PS 2042-10 B	2878350263	LAB000190	NR	–
14	Climatic Chamber	CTS GmbH	T-65/50	204002	LAB000110	CM	2024-06-07 → 12M → 2025-06-07
15	Multimeter	Keysight	U1242B	MY59110034	LAB000009	C	2024-08-06 → 12M → 2025-08-06

9 MEASUREMENT PROCEDURES

9.1 Radiated spurious emissions from 9 kHz to 30 MHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 360° continuously.
- For each turntable position the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated with special 3D adapter set to find maximum level of emissions.
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade of distance in the region closer than λ in m divided by 2π (i.e., $\lambda/2\pi$), and at 20 dB/decade of distance beyond that, using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the limit line of corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.2 Radiated spurious emissions from 30 MHz to 1 GHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 360° continuously.
- Antenna polarisation is changed (H-V / V-H) and antenna height is changed from 1 meter to 4 meters.
- For each turntable position / antenna polarisation / antenna height the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan by rotating the turntable and changing antenna height and polarisation.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C6.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position, antenna polarisation and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region λ in m divided by 2π (i.e., $\lambda/2\pi$), using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.3 Radiated spurious emissions from 1 GHz to 18 GHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- In case of floor standing equipment, it is placed in the middle of the turn table.
  In case of tabletop equipment it is placed on a non-conductive table with a height of 80 cm.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- Interface cables, e.g. power supply, network, … are connected to the connection box in the turn table.
- EUT is powered on and set into operation.

Pre-scan

- Turntable performs an azimuthal rotation from 0° to 360° continuously.
- Antenna polarisation is changed (H-V / V-H) and antenna height is changed from 1 meter to 4 meters.
- For each turntable position / antenna polarisation / antenna height the EMI-receiver/spectrum analyser performs a positive-peak/max-hold sweep (=worst-case). Data is transferred to EMI-software and recorded. EMI-software will show the maximum level of all single sweeps as the final result for the pre-scan.

Final measurement

- Significant emissions found during the pre-scan will be maximized by the EMI-software based on evaluated data during the pre-scan by rotating the turntable and changing antenna height and polarisation.
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C6.4).
- Plot of the pre-scan with frequencies of identified emissions including levels, correction factors, turn table position, antenna polarisation and settings of measuring equipment is recorded.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region λ in m divided by 2π (i.e., $\lambda/2\pi$), using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

9.4 Radiated spurious emissions above 18 GHz

Test setup

- The EUT is set up according to its intended use, as described in the user manual or as defined by the manufacturer.
- Additional equipment, cables, … necessary for testing, are positioned like under normal operation.
- EUT is powered on and set into operation.
- Test distance depends on EUT size and test antenna size (farfield conditions shall be met).

Pre-scan

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and for different polarizations of the antenna.

Final measurement

- Significant emissions found during the pre-scan will be maximized, i.e. position and antenna orientation causing the highest emissions with Peak and RMS detector
- Final measurement will be performed with measuring equipment settings as defined in the applicable test standards (e.g. ANSI C63.4 / C63.10).
- Final plot showing measurement data, levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit is recorded.

Note

- In case of measurements with external harmonic mixers (e.g. above 50 GHz) special care is taken to avoid possible overloading of the external mixer's input.
- As external harmonic mixers may generate false images, care is taken to ensure that any emission measured by the spectrum analyzer is indeed radiated from the EUT and not internally generated by the external harmonic mixer. Signal identification feature of spectrum analyzer is used to eliminate/reduce images of the external harmonic mixer.

Distance correction (extrapolation)

- When performing measurements on test distances other than defined in the rules, the results shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 20 dB/decade of distance beyond the region λ in m divided by 2π (i.e., $\lambda/2\pi$), using the measurement of a single point at the radial angle that produces the maximum emission.
  This correction is already included in the corresponding measurement plots.

Detailed requirements can be found in e.g. ANSI C63.4 / C63.10

10 MEASUREMENT UNCERTAINTIES

Radio frequency	≤ ± 1 x 10^{-7}
RF power, conducted	≤ ± 0.75 dB
Power spectral density	≤ ± 3 dB
Maximum frequency deviation	≤ ± 5 %
Deviation limitation Duty Cycle, Tx-sequence, Tx-gap	≤ ± 5 %
Occupied channel bandwidth	≤ ± 5 %
Conducted spurious emission of transmitter	≤ ± 4 dB
Conducted emission of receivers	≤ ± 4 dB
Radiated emission of transmitter	≤ ± 6 dB
Radiated emission of receiver	≤ ± 6 dB
Temperature	≤ ± 2.5 °C
Humidity	≤ ± 10 %

The indicated expanded measurement uncertainty corresponds to the standard measurement uncertainty for the measurement results multiplied by the coverage factor k = 2. It was determined in accordance with EA-4/02 M:2013. The true value is located in the corresponding interval with a probability of 95 %.