DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
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C.I.F. A29507456

ISED CABid: ES1909

Test report No:
NIE: 65936RRF.002

Test Report
USA FCC Part 15.249, 15.209
CANADA RSS-210, RSS-Gen

(*) Identification of item tested	Hearing Aid
(*) Trademark	Phonak
(*) Model and /or type reference	Phonak Slim P90-R left
(*) Derived model not tested	Phonak Slim P90-R right, Phonak Slim P70-R left, Phonak Slim P70-R right, Phonak Slim P50-R left, Phonak Slim P50-R right, Phonak Slim P30-R left, Phonak Slim P30-R right, Phonak Slim P-R Trial left, Phonak Slim P-R Trial right
Other identification of the product	HW version: 050-085-xx SW version: Target 7.2 FCC ID: KWC-SLR IC: 2262A-SLR
(*) Features	Bluetooth, Bluetooth LE, DM, Flora
Applicant	SONOVA USA INC. 4520 Weaver Parkway, 60555, Warrenville, IL, USA
Test method requested, standard	USA FCC Part 15.249 (10-1-19 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, 5725 - 5875 MHz, and 24.0 – 24.25 GHz. USA FCC Part 15.209 (10-1-19 Edition): Radiated emission limits; general requirements. CANADA RSS-210 Issue 10 (December 2019). CANADA RSS-Gen Issue 5 Amendment 1 (March 2019). ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael López EMC Consumer & RF Lab. Manager 2021.11.22 13:13:18 +01'00'
Date of issue	2021-11-22
Report template No	FDT08_23 (*) "Data provided by the client"

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Competences and guarantees

DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

General Conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample of the model Slim P-R is a Receiver-in-Canal hearing aid with Li-ion rechargeable battery and Bluetooth.

3. Derived model not tested. These models have been declared by the supplier of the sample as being the same as the model under test.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of result.

Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
65936D/018	Hearing Aid	Phonak Slim P90-R left	--	2021/03/11

Sample S/01 has undergone the following test(s): The Conducted tests indicated in Appendixes A, B, C, D.

- Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
65936D/027	Hearing Aid	Phonak Slim P90-R left	--	2021/03/11

Sample S/02 has undergone the following test(s): The Radiated tests indicated in Appendixes A, B, C, D.

Test sample description

Ports..... :	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)		
	N/A		☐	☐	☐		
Supplementary information to the ports..... :							
Rated power supply .....:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: Vnom: 3.8 V Lithium-Ion Rechargeable.					
	☐	DC:					
Rated Power .....:	-						
Clock frequencies .....:	-						
Other parameters.....:	-						
Software version .....:	Target 7.2						
Hardware version.....:	050-085-xx						
Dimensions in cm (W x H x D)....:	-						
Mounting position.....:	☐	Table top equipment					
	☐	Wall/Ceiling mounted equipment					
	☐	Floor standing equipment					
	☐	Hand-held equipment					

	☒	Other: Hearing Aid		
Modules/parts .....:	Module/parts of test item		Type	Manufacturer
	-			
Accessories (not part of the test item) .....:	Description		Type	Manufacturer
	-			
Documents as provided by the applicant.....:	Description		File name	Issue date
	-			

(3) Only for Medical Equipment

Identification of the client

Sonova AG
Laubisrütistrasse 28, 8712 Stäfa, Switzerland

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-03-15
Date (finish)	2021-04-08

Document history

Report number	Date	Description
65936RRF.002	2021-11-22	First release.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Cristina Calle, Pablo Redondo.

Used instrumentation:

Conducted Measurements:

		Last Calibration	Due Calibration
1.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
2.	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/09	2021/09
3.	DC Power Supply, 30V/5A KEYSIGHT TECHNOLOGIES U8002A	N.A.	N.A.
4.	Digital Multimeter, FLUKE 175	2020/11	2021/11

Radiated Measurements:

		Last Calibration	Due Calibration
1.	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2.	Shielded Room ETS LINDGREN S101	N.A.	N.A.
3.	Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2020/04	2023/04
4.	Preamplifier G>40dB 10MHz-6GHz, BONN ELEKTRONIK, BLNA 0160-01N	2021/03	2022/03
5.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2020/12	2022/12
6.	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
7.	RF Preamplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05
8.	Horn Antenna 18-40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2020/05	2023/05
9.	Preamplifier G>30dB 18-40GHz, BONN ELEKTRONIK, BLMA 1840-3G	2019/11	2021/11
10.	Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2020/07	2022/07

Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M

Summary

1. Bluetooth Low Energy

FCC PART 15 PARAGRAPH / RSS-210			
Requirement – Test case		**Verdict**	**Remark**
15.249 (a) / RSS-210 B.10 (a)	Field strength of fundamental and harmonic emissions	P	
15.249 (d) / RSS-210 B.10 (b)	Emissions radiated outside of the specific frequency bands	P	
Supplementary information and remarks: None.			

2. Bluetooth Basic Rate

FCC PART 15 PARAGRAPH / RSS-210			
Requirement – Test case		**Verdict**	**Remark**
15.249 (a) / RSS-210 B.10 (a)	Field strength of fundamental and harmonic emissions	P	
15.249 (d) / RSS-210 B.10 (b)	Emissions radiated outside of the specific frequency bands	P	
Supplementary information and remarks: None.			

3. Proprietary protocol DM 2.4 GHz

FCC PART 15 PARAGRAPH / RSS-210			
Requirement – Test case		**Verdict**	**Remark**
15.249 (a) / RSS-210 B.10 (a)	Field strength of fundamental and harmonic emissions	P	
15.249 (d) / RSS-210 B.10 (b)	Emissions radiated outside of the specific frequency bands	P	
Supplementary information and remarks: None.			

4. Proprietary protocol Flora 2.4 GHz

FCC PART 15 PARAGRAPH / RSS-210			
Requirement – Test case		**Verdict**	**Remark**
15.249 (a) / RSS-210 B.10 (a)	Field strength of fundamental and harmonic emissions	P	
15.249 (d) / RSS-210 B.10 (b)	Emissions radiated outside of the specific frequency bands	P	
Supplementary information and remarks: None.			

Appendix A: Test results. Bluetooth Low Energy

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TEST CONDITIONS

POWER SUPPLY:

V nominal:	3.8 Vdc
Type of Power Supply:	Lithium-Ion rechargeable battery.

ANTENNA:

Type of Antenna:	Internal.
Maximum Declared Antenna Gain:	-0.5 dBi

TEST FREQUENCIES:

Low Channel:	2402 MHz
Middle Channel:	2440 MHz
High Channel:	2480 MHz

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

The DC supply voltage is applied using an external power supply.

RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

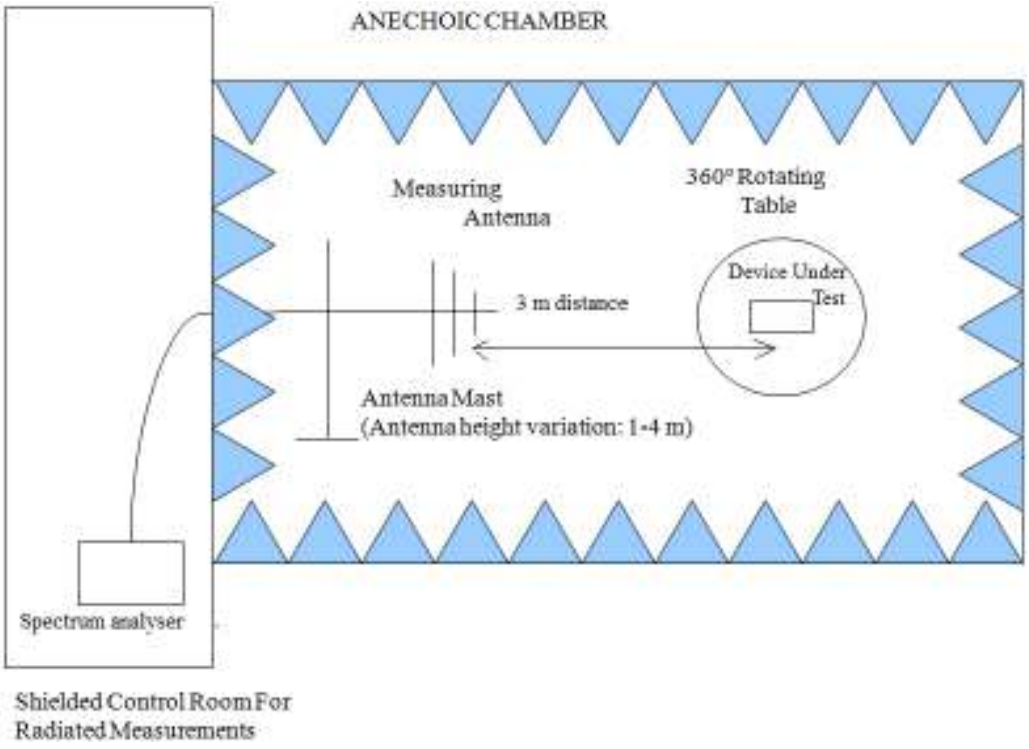
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

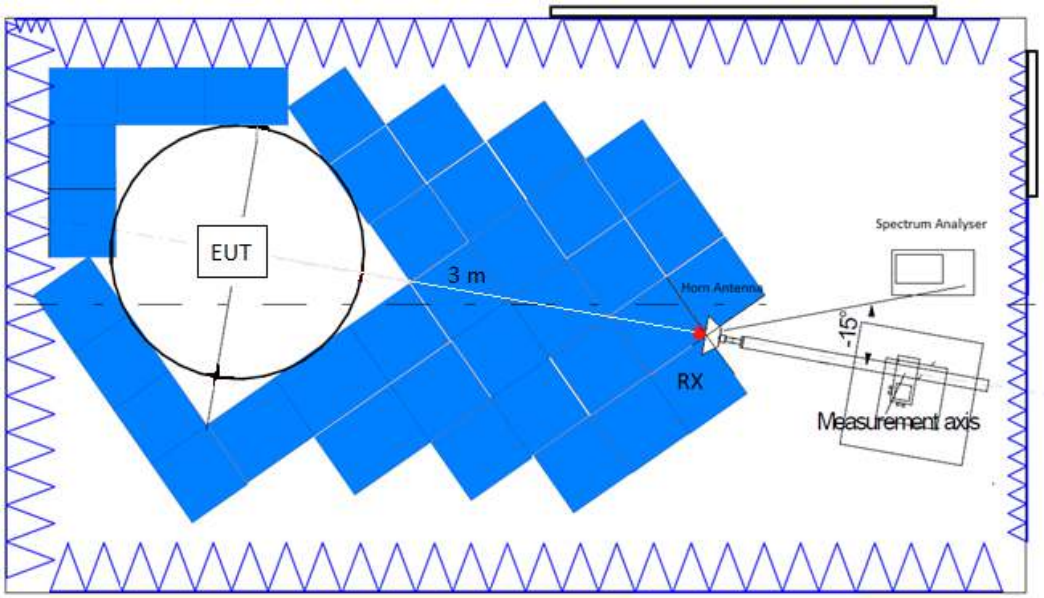
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

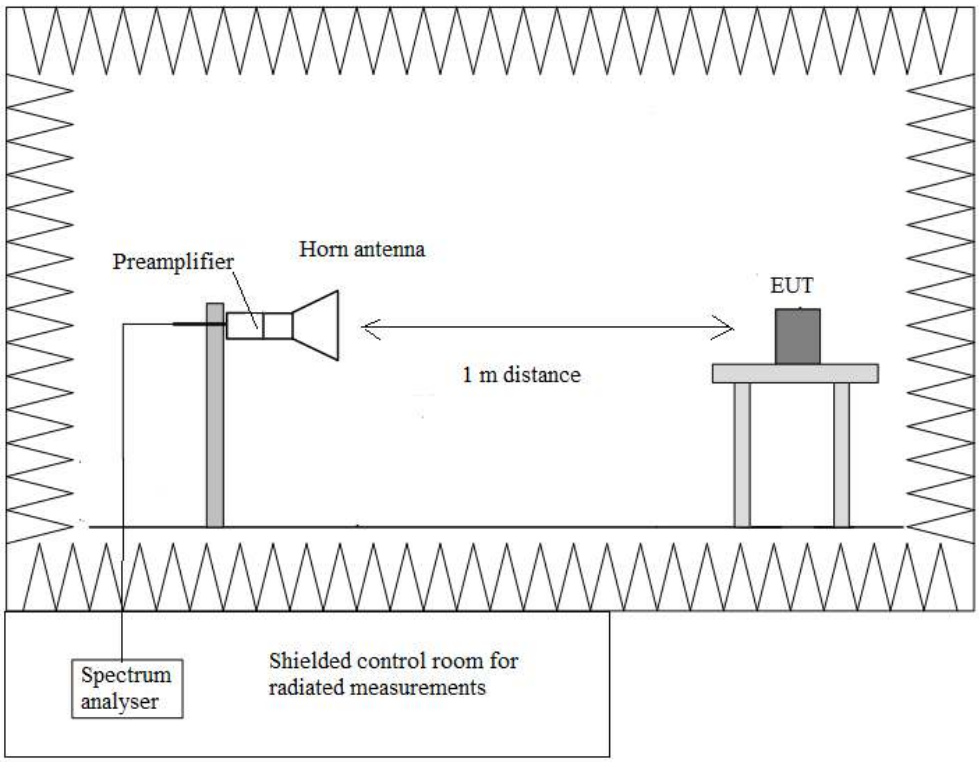
Radiated measurements setup f < 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



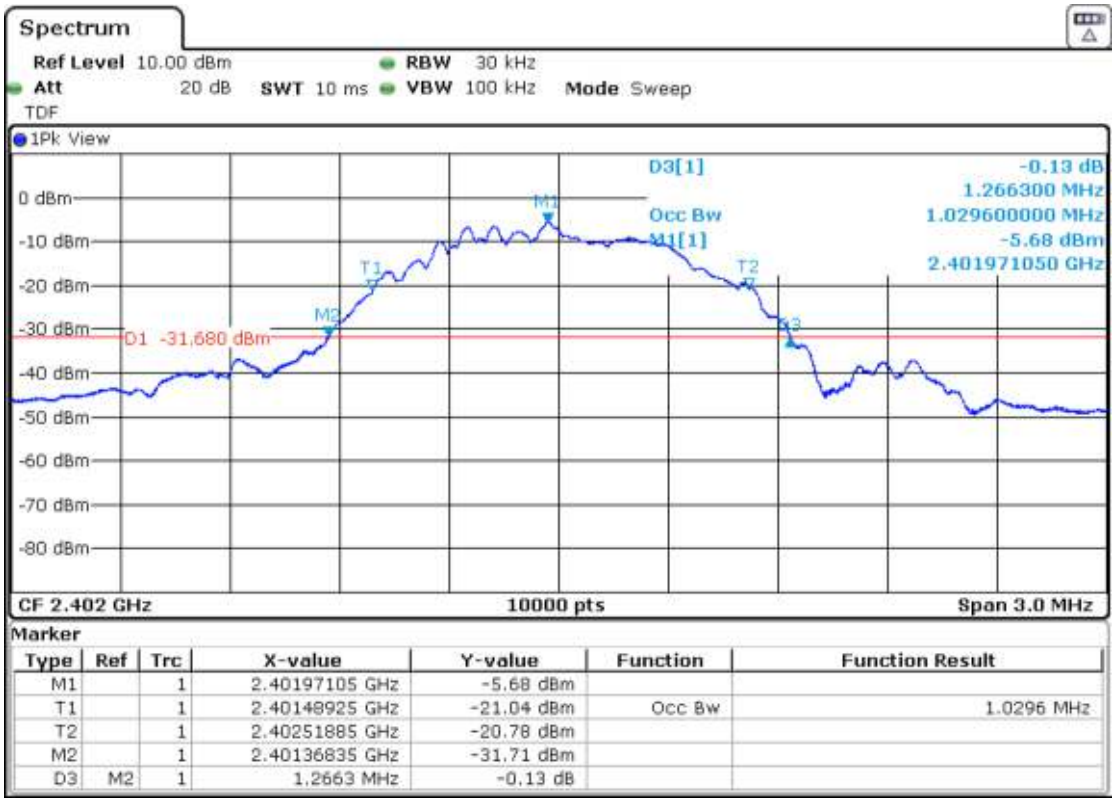
Occupied Bandwidth

RESULTS:

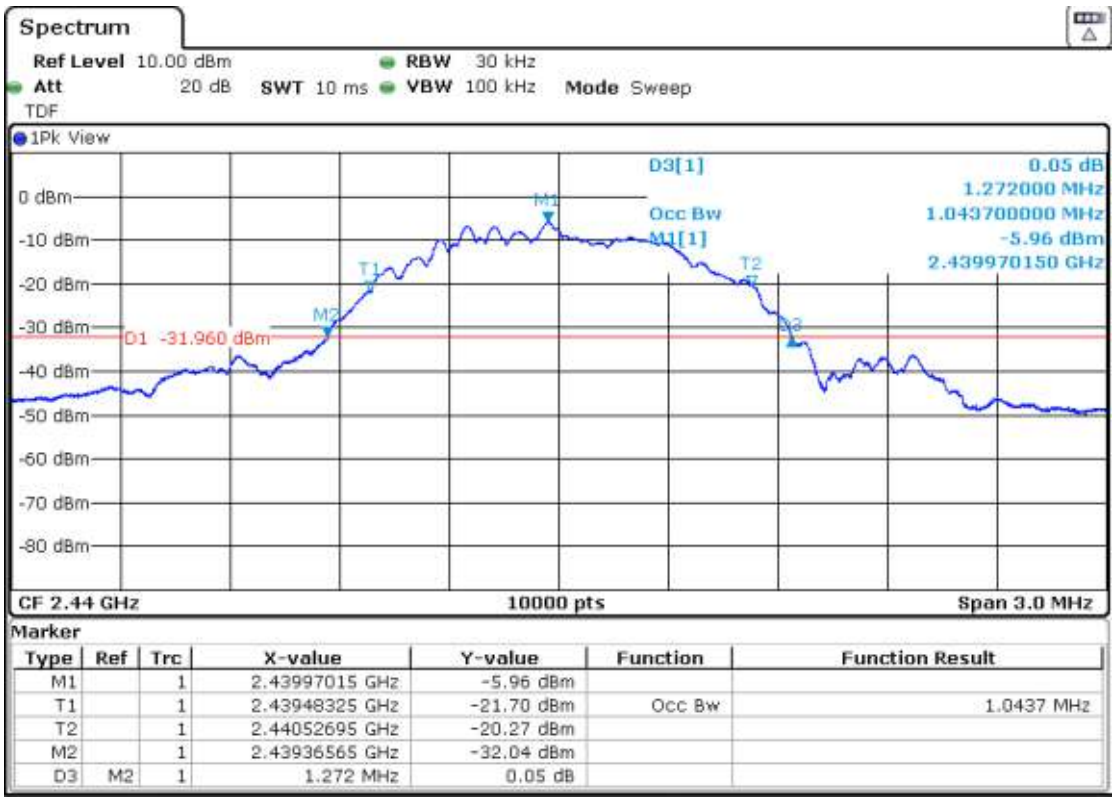
	Low Channel	Middle Channel	High Channel
99% Bandwidth (MHz)	1.0296	1.0437	1.0635
Measurement Uncertainty (kHz)	<±3.64		

Verdict: PASS

- Low Channel:



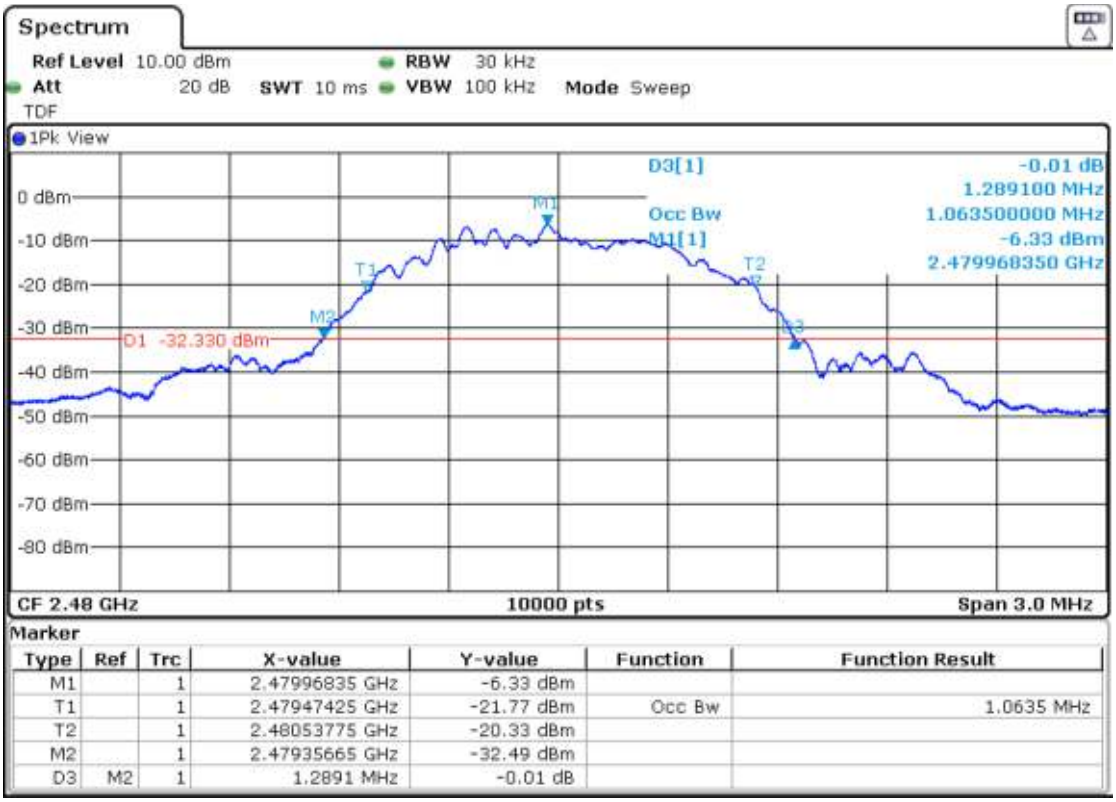
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.43997015 GHz	-5.96 dBm		
T1		1	2.43948325 GHz	-21.70 dBm	Occ Bw	1.0437 MHz
T2		1	2.44052695 GHz	-20.27 dBm		
M2		1	2.43936565 GHz	-32.04 dBm		
D3	M2	1	1.272 MHz	0.05 dB		

- High Channel:



Marker

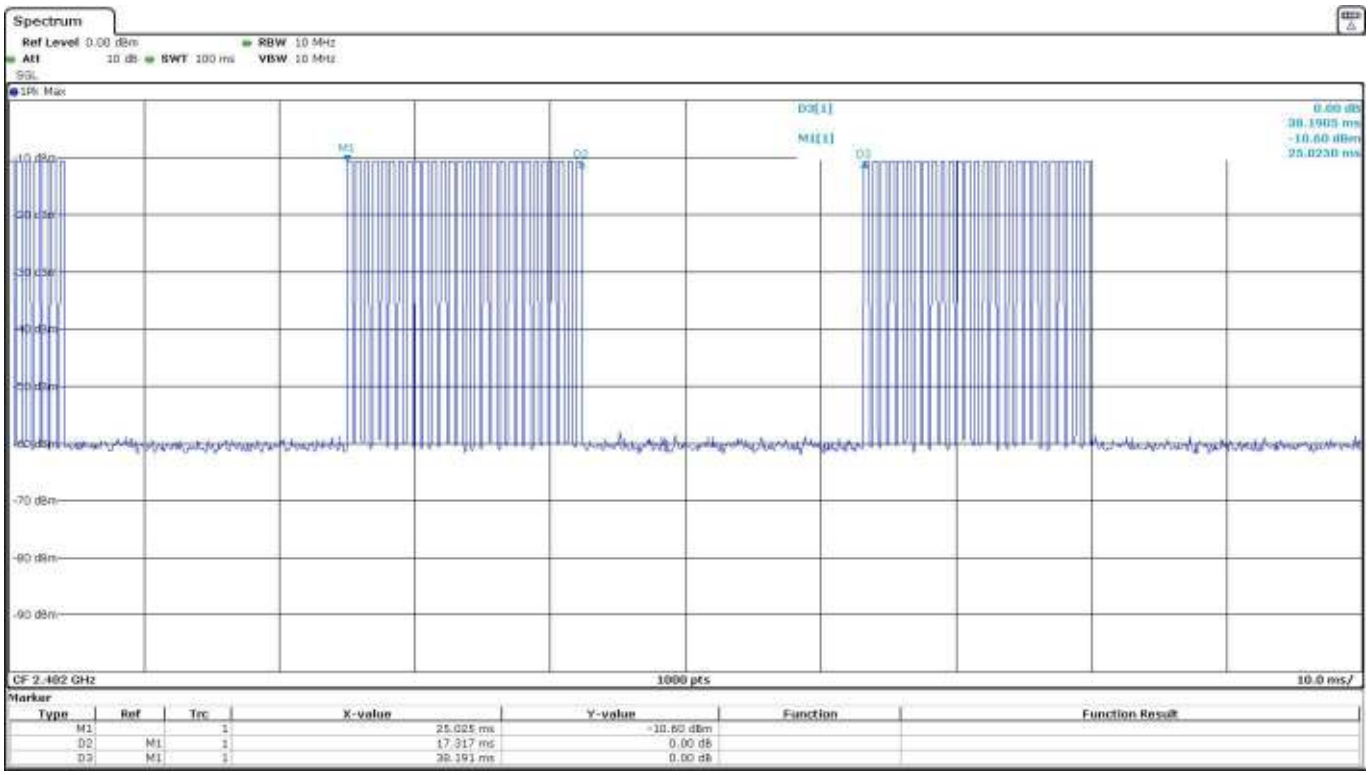
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47996835 GHz	-6.33 dBm		
T1		1	2.47947425 GHz	-21.77 dBm	Occ Bw	1.0635 MHz
T2		1	2.48053775 GHz	-20.33 dBm		
M2		1	2.47935665 GHz	-32.49 dBm		
D3	M2	1	1.2891 MHz	-0.01 dB		

Duty cycle

Computation of duty-cycle correction factor

Number of pulses within 100 ms: 2.5

Pulse duration: 17.317 ms.



Duty-cycle correction factor calculation.

Duration (ms)	Number of pulses	“On Time” (ms)
17.317	2.5	43.29

Duty cycle in 100ms = “On Time” / 100 ms = 0.4329
Duty cycle correction factor δ = 20 log (0.4329) = -7.27 dB

15.249 (a) / RSS-210 B.10 (a) Field strength of fundamental and harmonics emissions

SPECIFICATION:

The field strength of emissions from intentional radiators shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (mV/m)	Field strength (dBµV/m)	Measurement distance (m)
902 - 928	50	93.98	3
2400 – 2483.5	50	93.98	3
5725 - 5875	50	93.98	3
24000-24250	250	107.96	3

For frequencies above 1000 MHz, the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

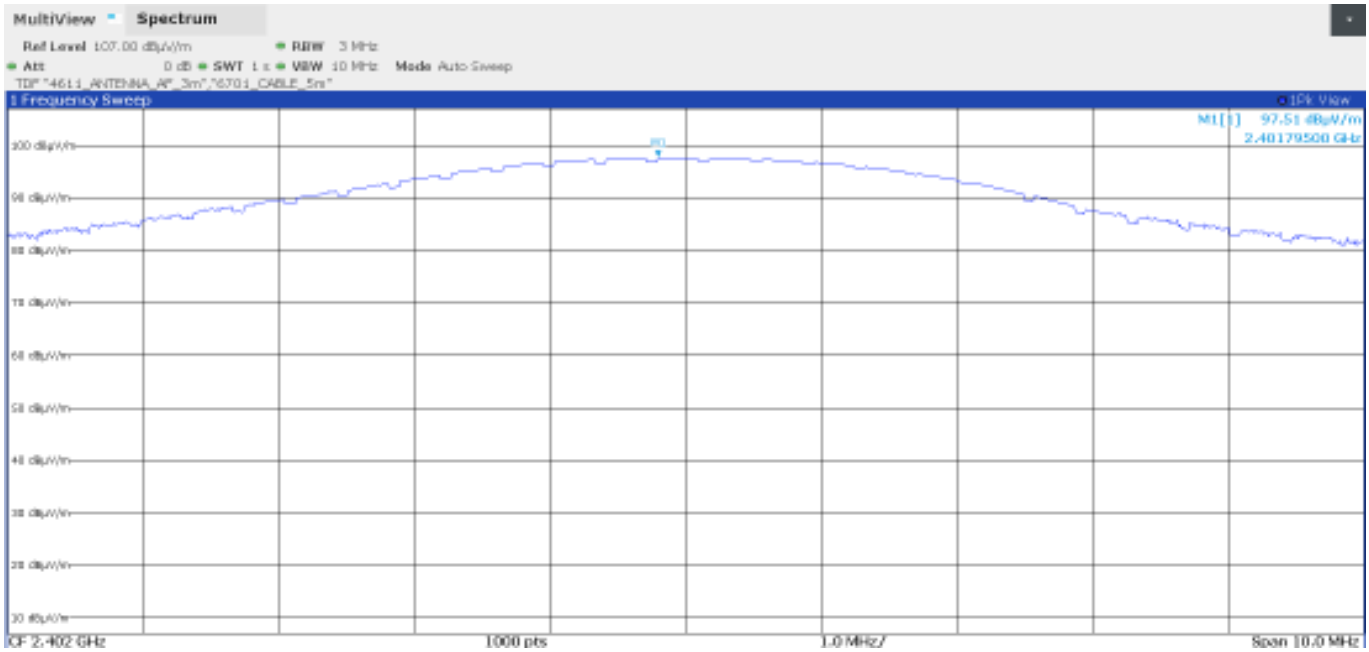
RESULTS:

	Low Channel	Middle Channel	High Channel
Field Strength (dBµV/m) Peak	97.51	98.55	97.69
Duty cycle correction factor δ (dB)	-7.27	-7.27	-7.27
Field Strength (dBµV/m) Average	90.24	91.28	90.42
Measurement Uncertainty (dB)	<±4.11		

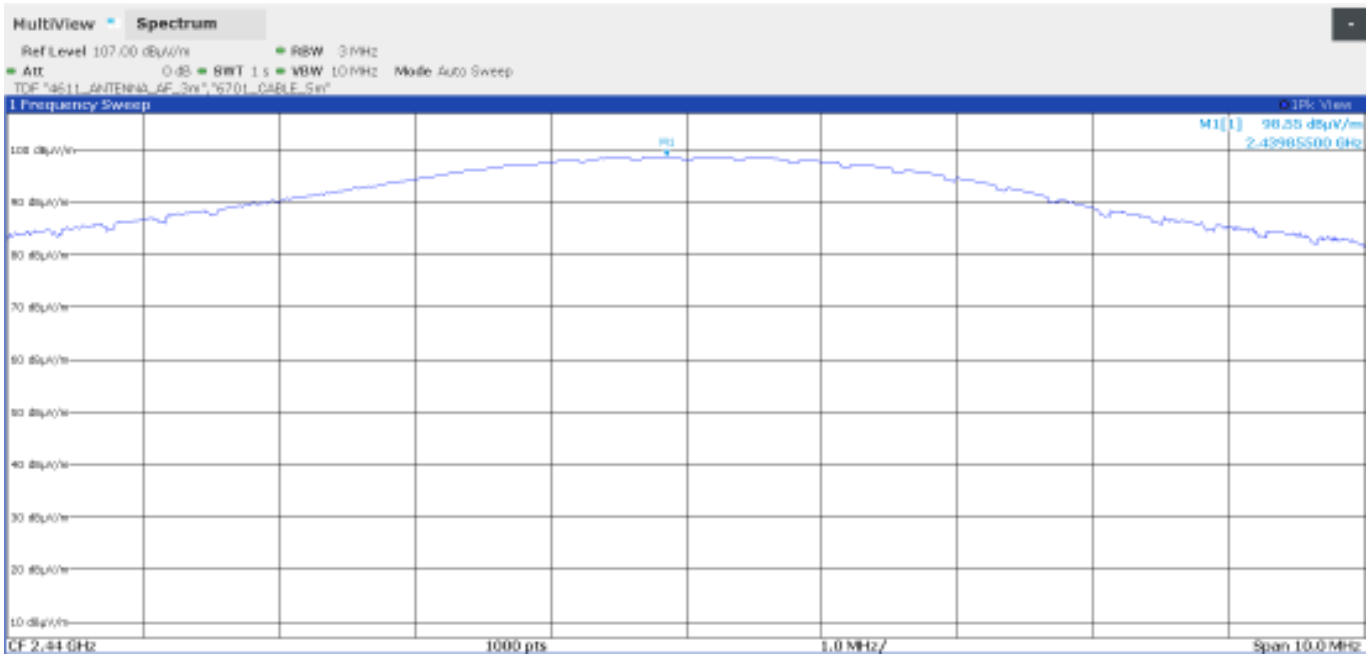
Verdict: PASS

FIELD STRENGTH

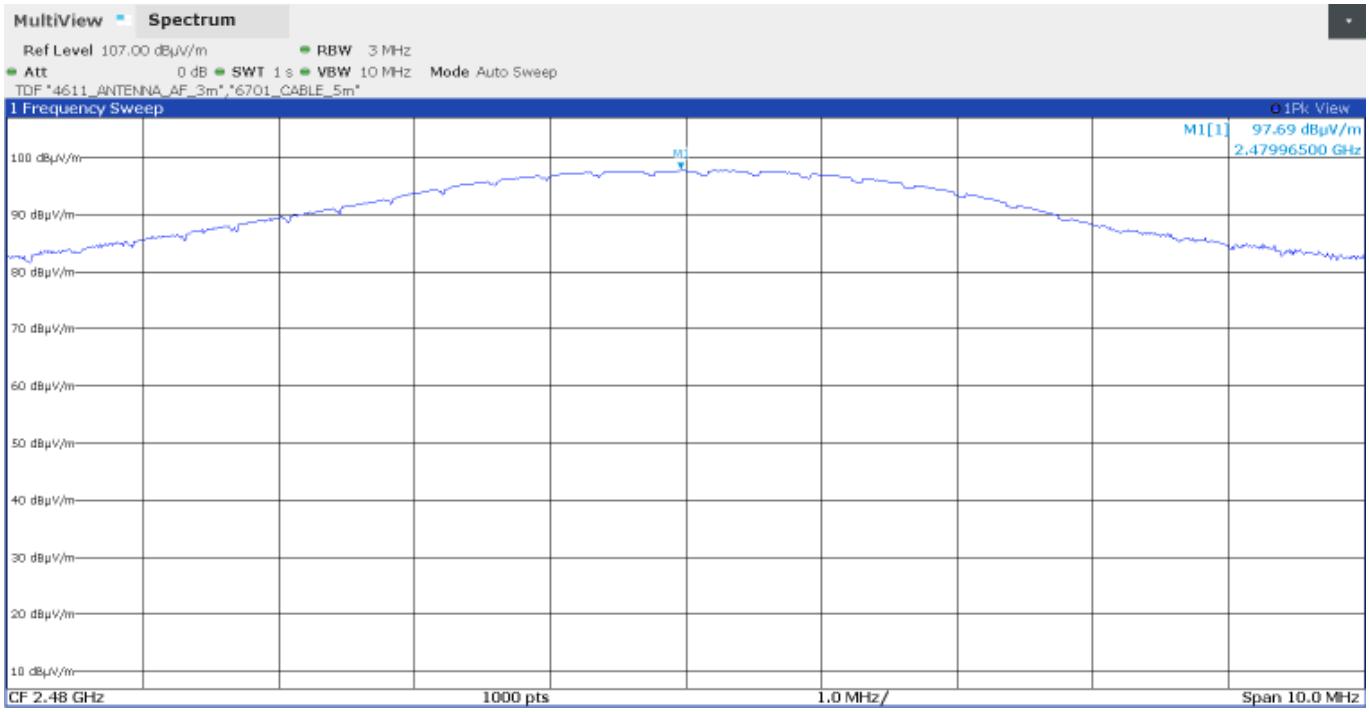
- Low Channel:



- Middle Channel:



- High Channel:



15.249 (d) / RSS-210 B.10 (b) Emissions radiated outside of the specific frequency bands

SPECIFICATION:

The field strength of harmonics from intentional radiators shall comply with the following

Fundamental frequency (MHz)	Field strength of harmonics (µV/m)	Field strength of harmonics (dBµV/m)	Measurement distance (m)
902 - 928	500	54	3
2400 – 2483.5	500	54	3
5725 - 5875	500	54	3
24000-24250	2500	67.96	3

Emissions radiated outside of the specific frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of fundamental or to the general radiated emission limits specified in section 15.209:

Frequency Range (MHz)	Field strength (µV/m)	Field strength (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	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

Whichever is the lesser attenuation.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-17 GHz and at distance of 1 m for the frequency range 17 GHz-26 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected do not depend on the operating channel.

Spurious frequencies detected at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level (dBµV/m)	Detector	Polarization
31.98850	20.63	Quasi peak	V

Measurement Uncertainty (dB) <± 4.99

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.37840	64.16	H	Peak
	41.31		Average
4.80500	48.70	H	Peak
14.41100	52.49	V	Peak

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.48753	56.54	H	Peak
	41.30		Average
4.87950	46.72	H	Peak
12.19900	49.48	H	Peak
14.63850	54.59	V	Peak
	41.81		Average

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

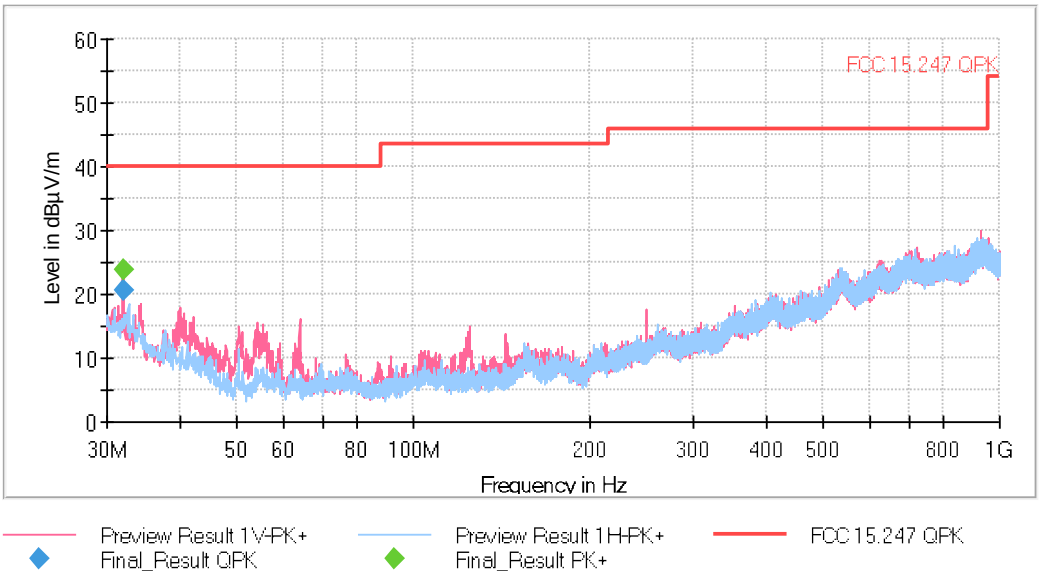
Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.48393	72.77	H	Peak
	41.83		Average
4.96000	46.80	H	Peak
14.87800	52.62	V	Peak

Measurement Uncertainty (dB): $< \pm$ 4.98 for $1 \leq f \leq 17$ GHz
$< \pm$ 5.08 for $17 < f \leq 26$ GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):

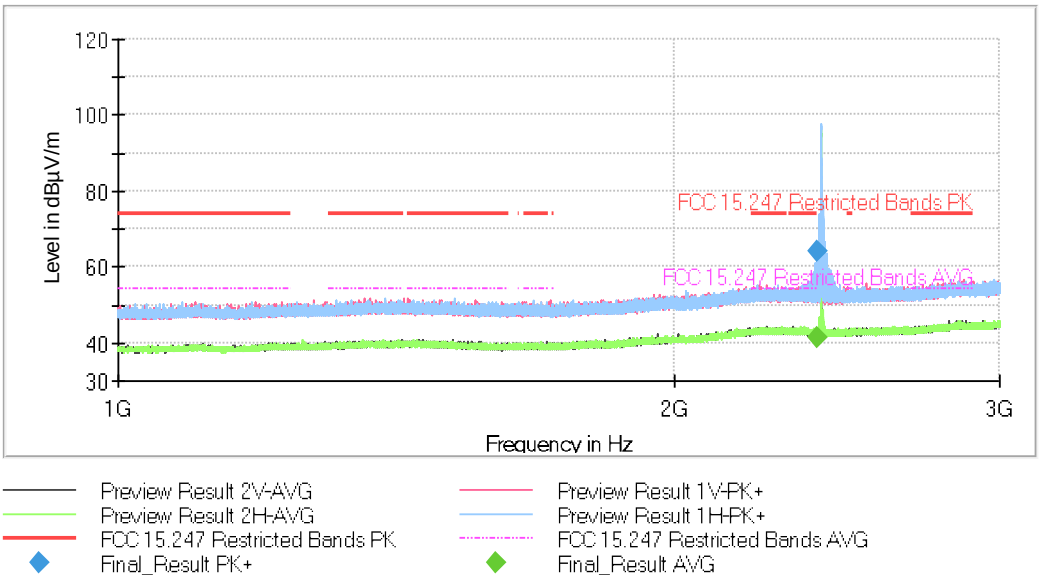
The spurious frequencies detected do not depend on the operating channel.



This plot is valid for the Low, Middle and High Channels.

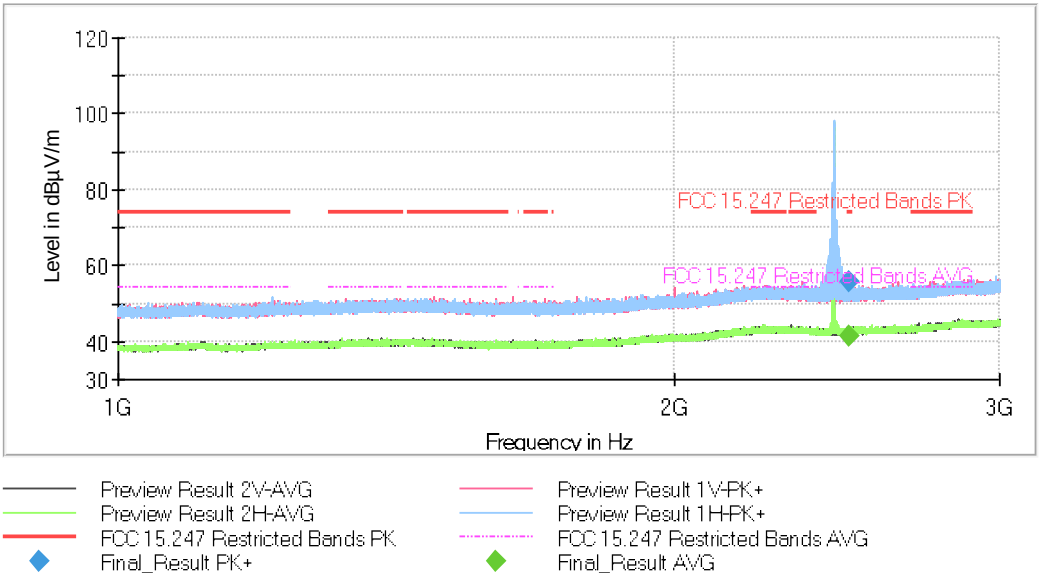
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



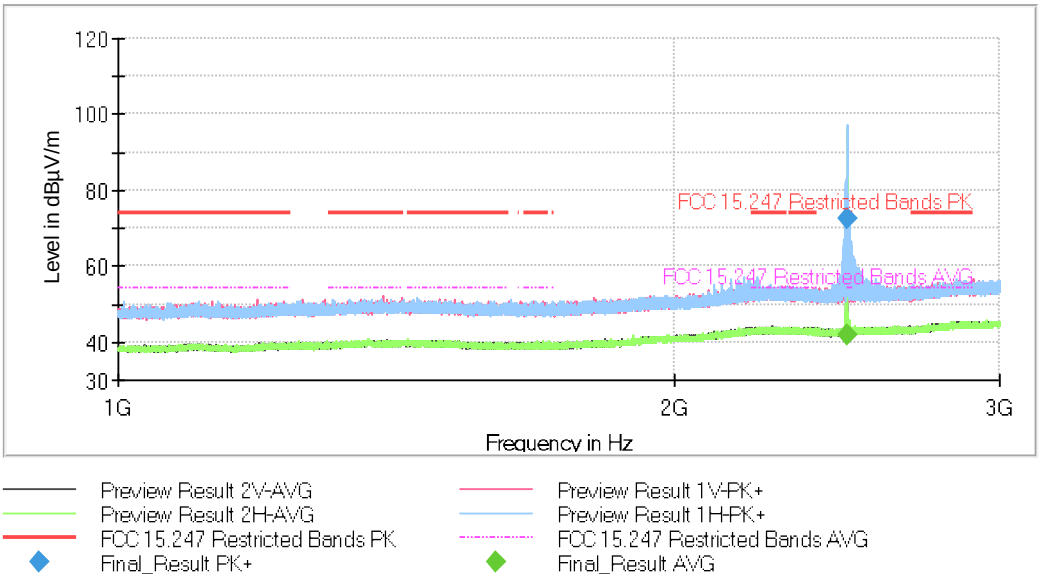
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

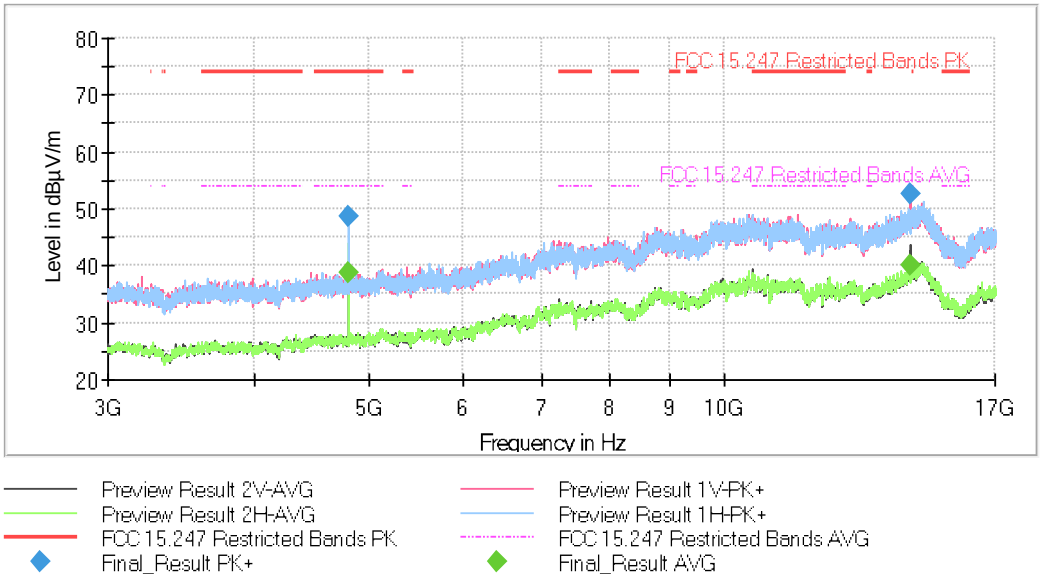
- High Channel:



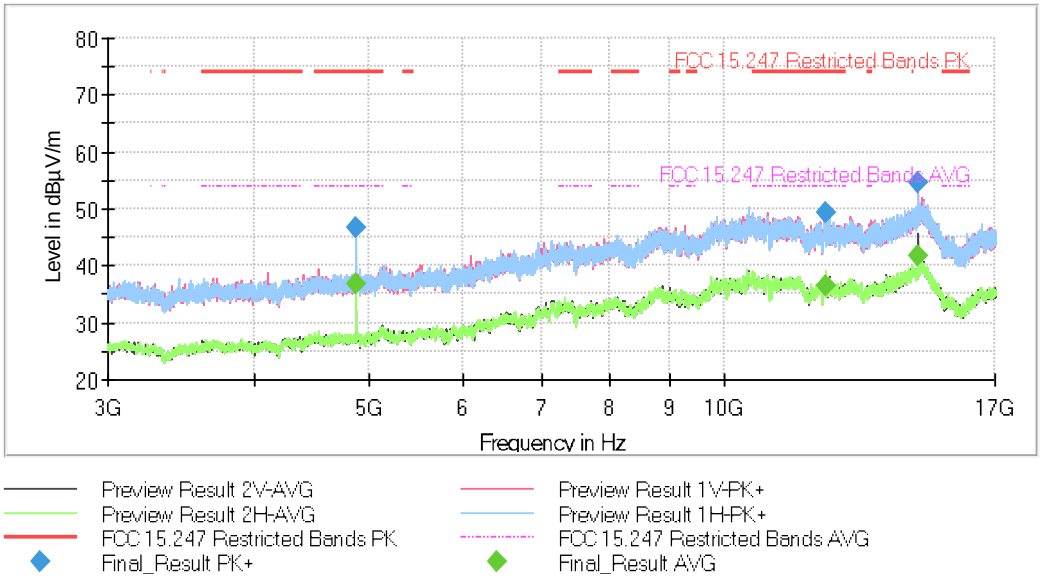
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

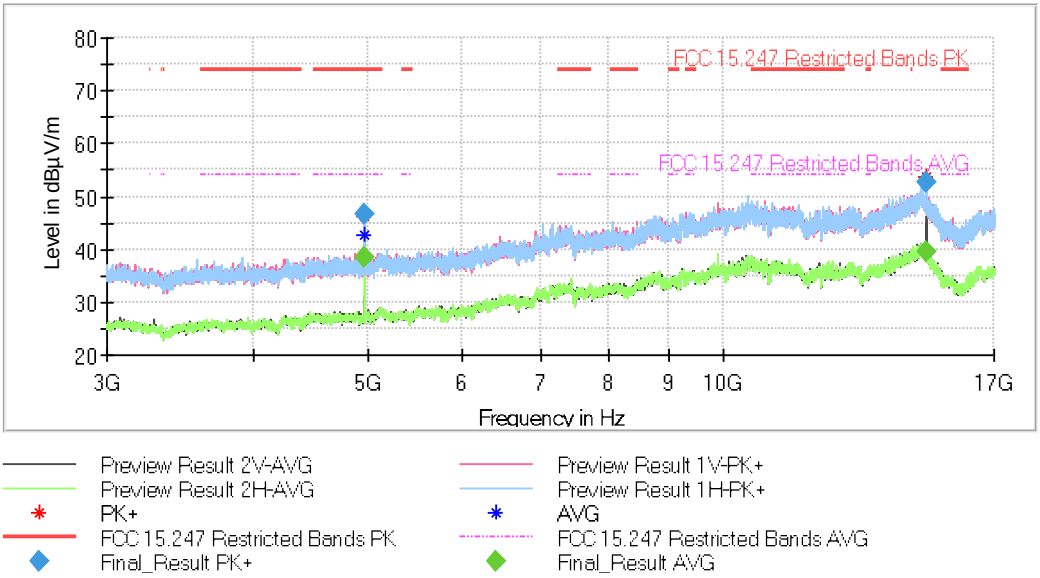
- Low Channel:



- Middle Channel:

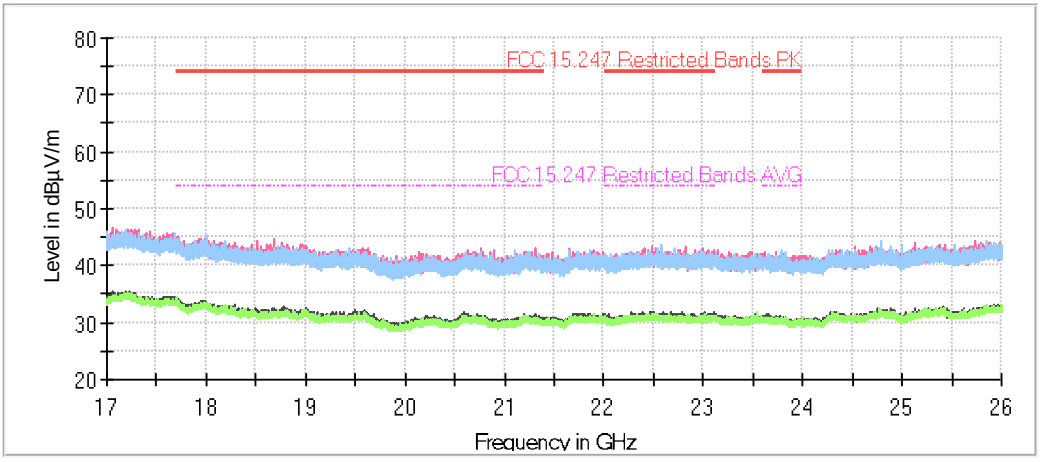


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

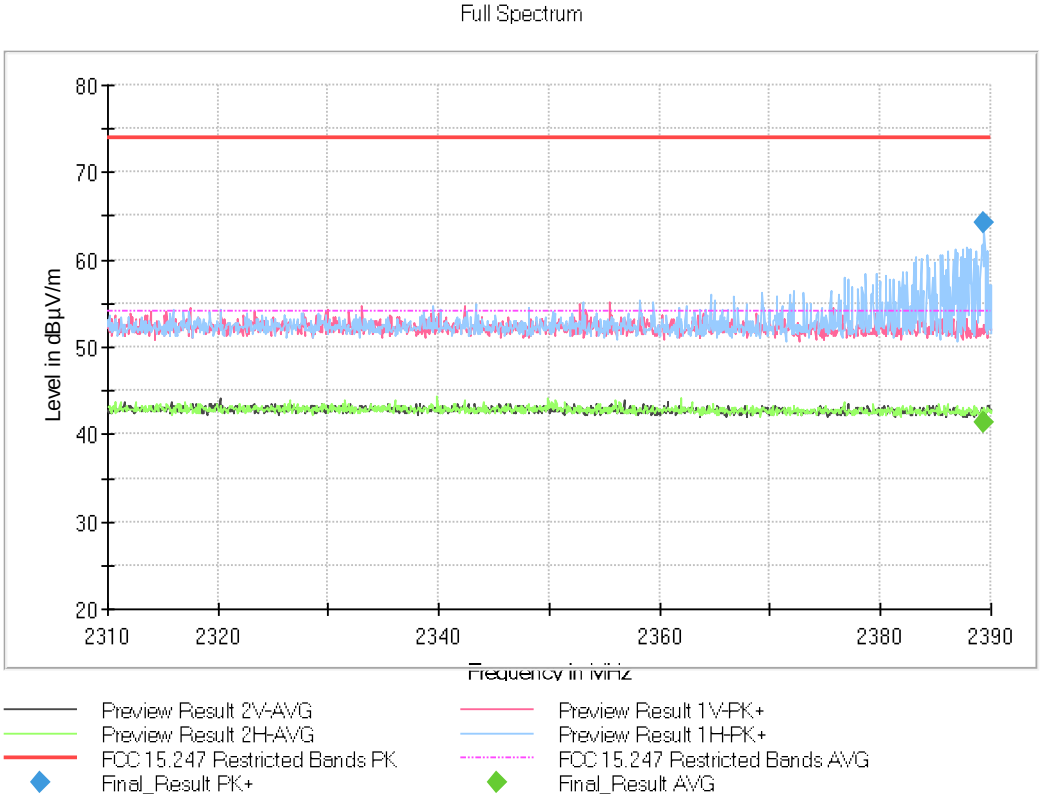
The spurious frequencies detected do not depend on the operating channel.



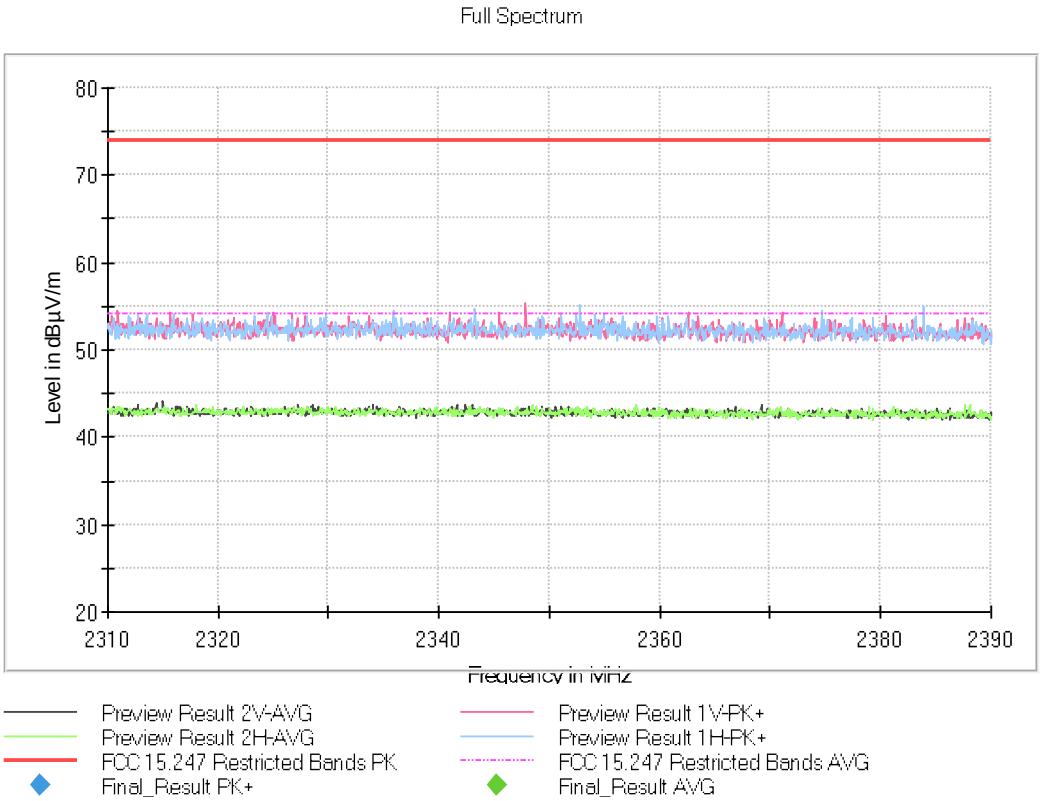
This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

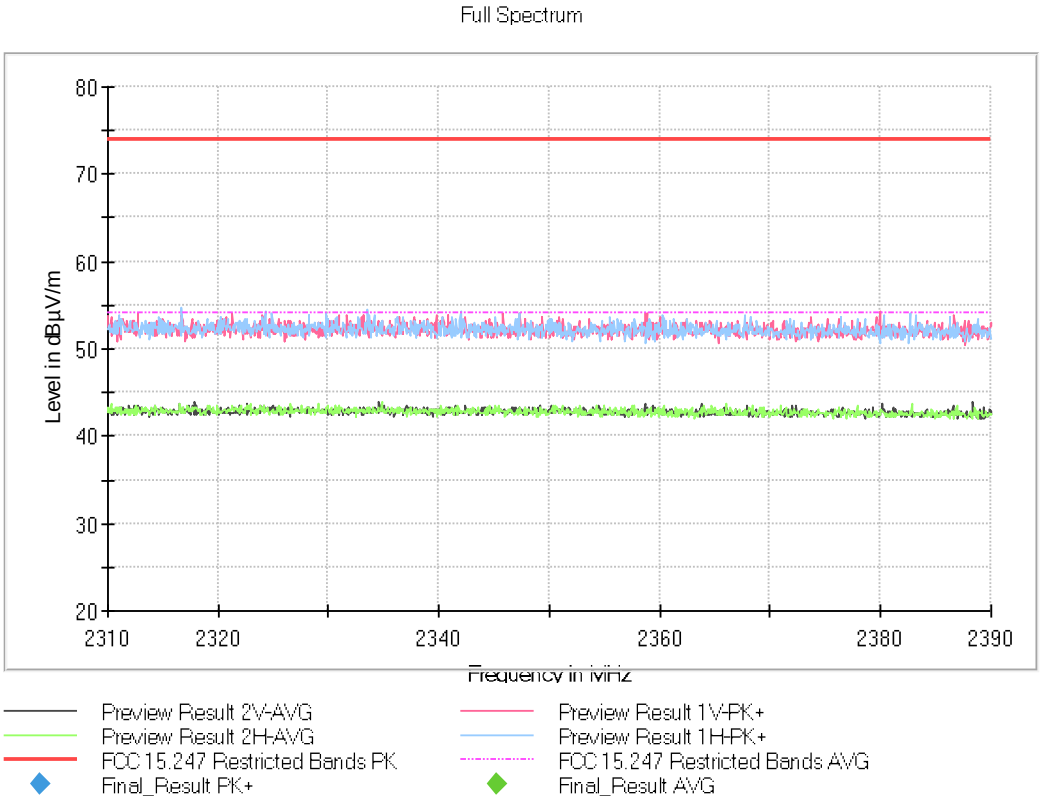
- Low Channel:



- Middle Channel:

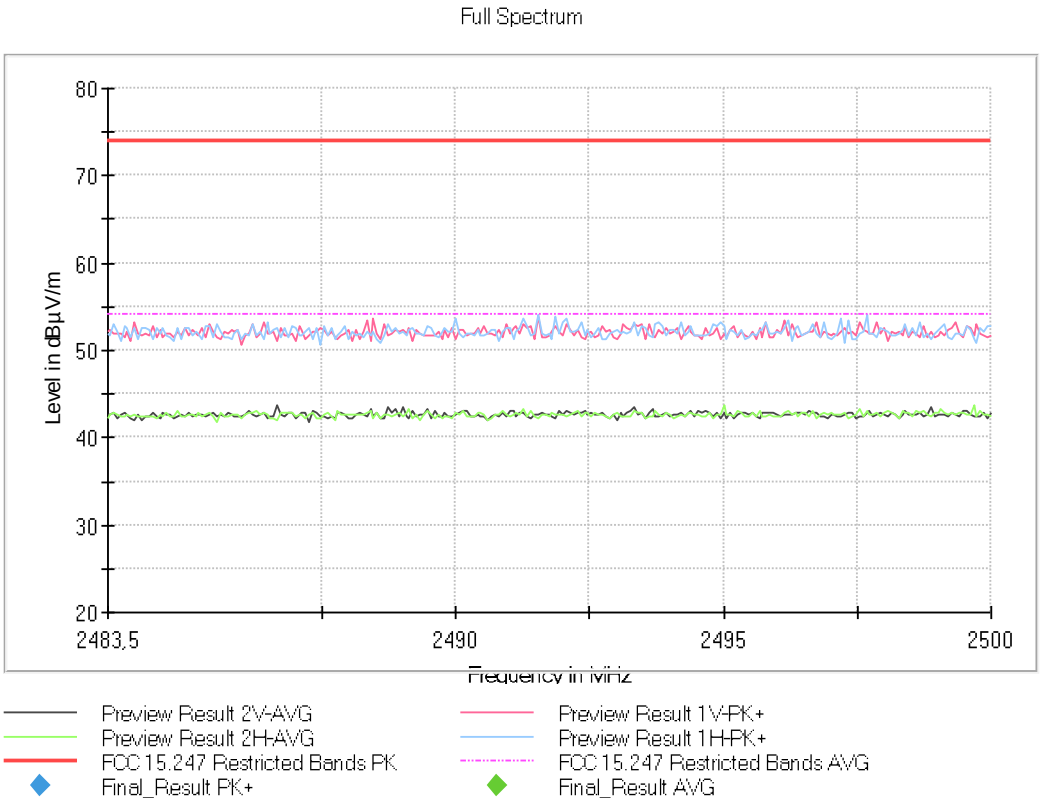


- High Channel:

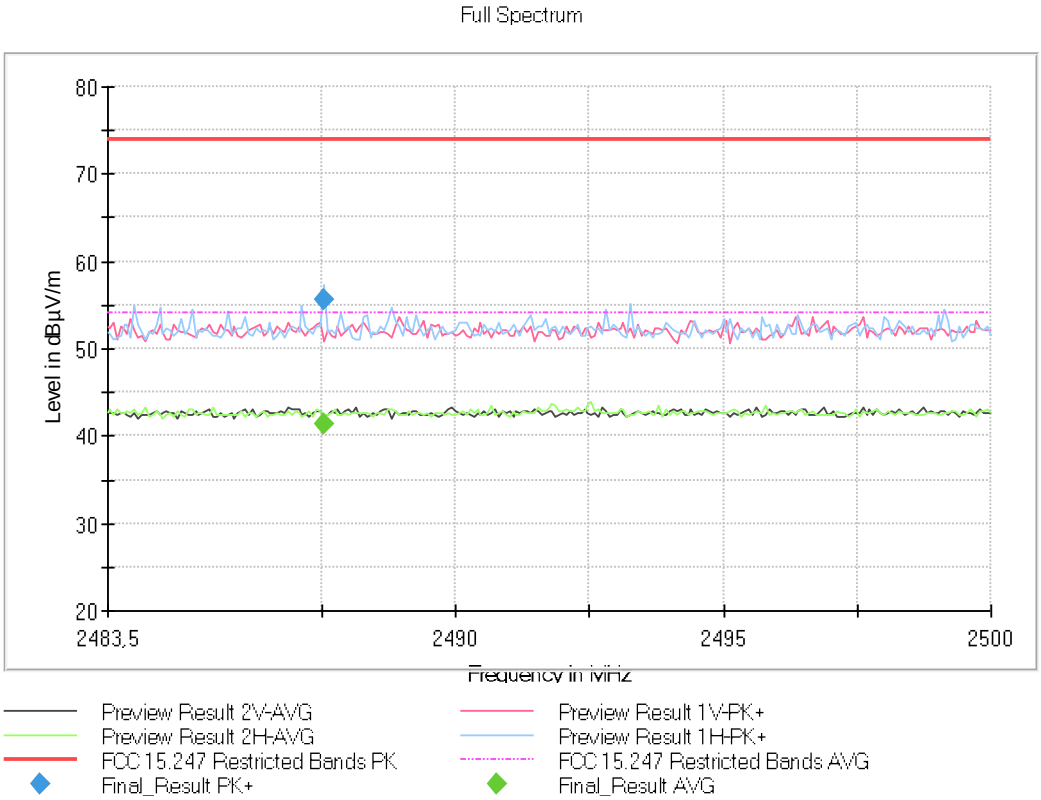


FREQUENCY RANGE 2.4835-2.5 GHz:

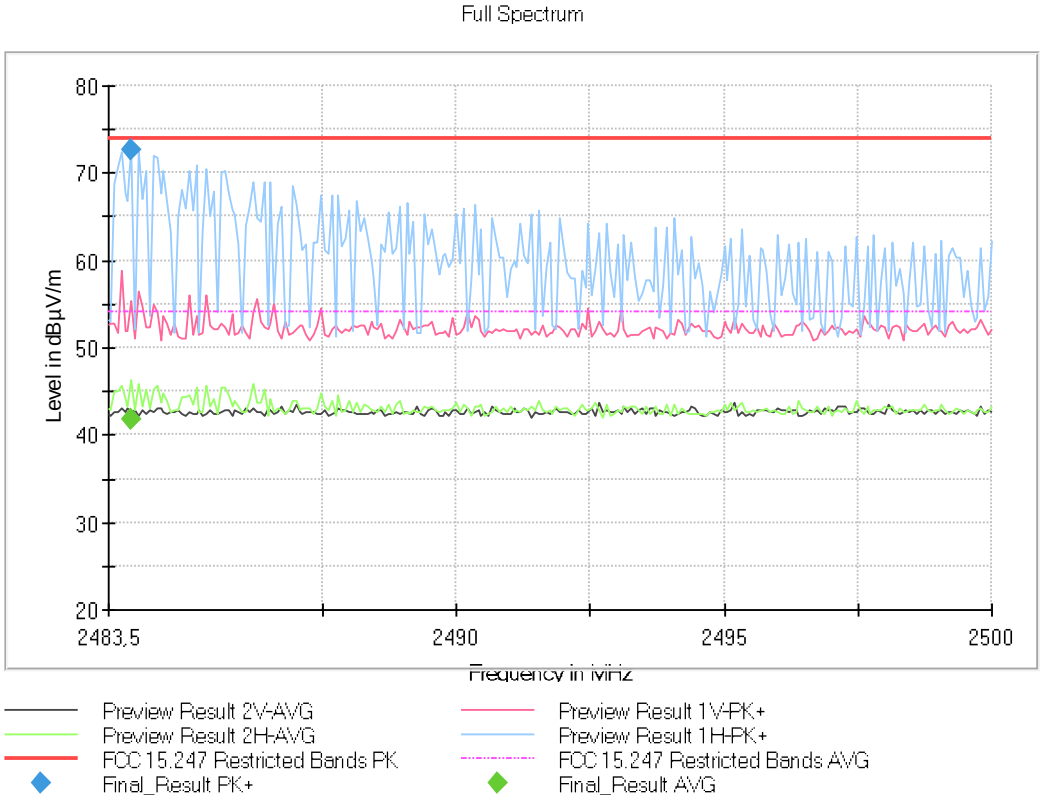
- Low Channel:



- Middle Channel:



- High Channel:



Appendix B: Test results. Bluetooth Basic Rate

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TEST CONDITIONS

POWER SUPPLY:

V nominal:	3.8 Vdc
Type of Power Supply:	Lithium-Ion rechargeable battery.

ANTENNA:

Type of Antenna:	Internal.
Maximum Declared Antenna Gain:	-0.5 dBi

TEST FREQUENCIES:

Low Channel:	2402 MHz
Middle Channel:	2440 MHz
High Channel:	2480 MHz

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

The DC supply voltage is applied using an external power supply.

RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

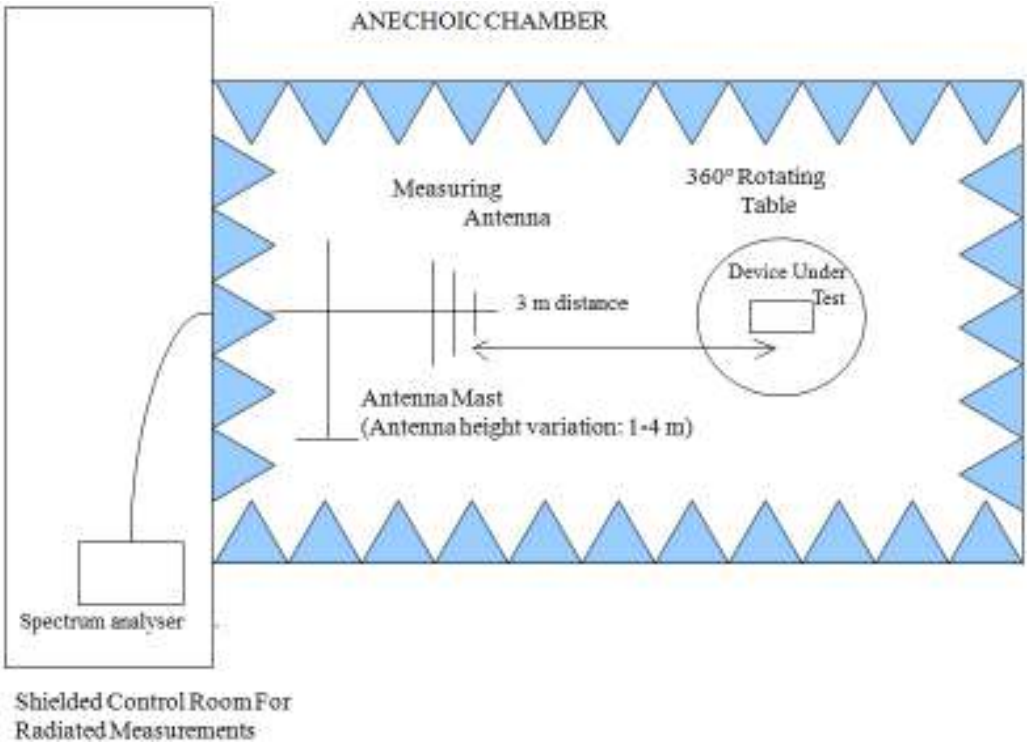
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

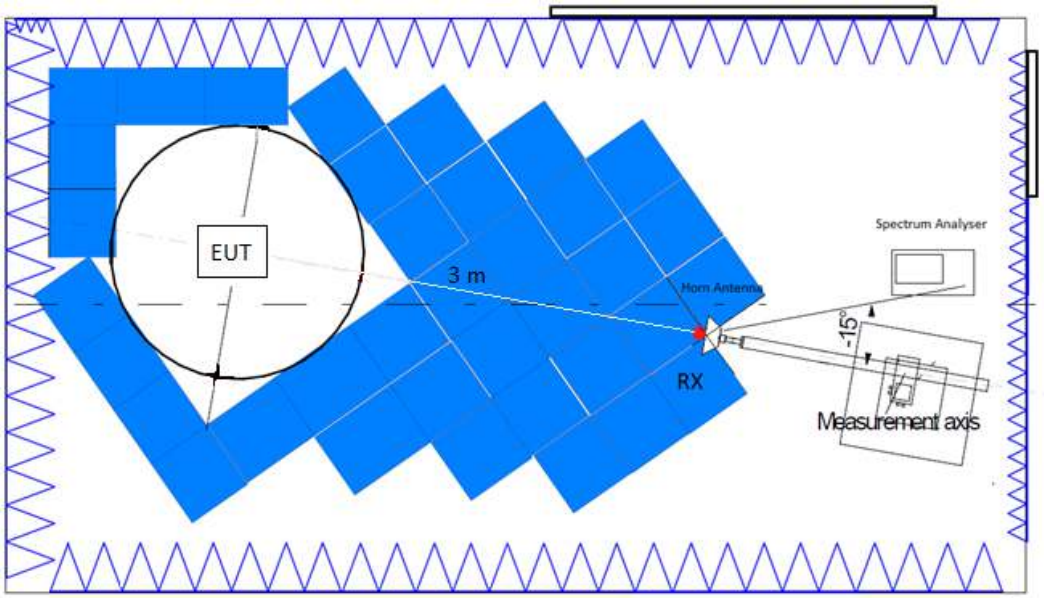
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

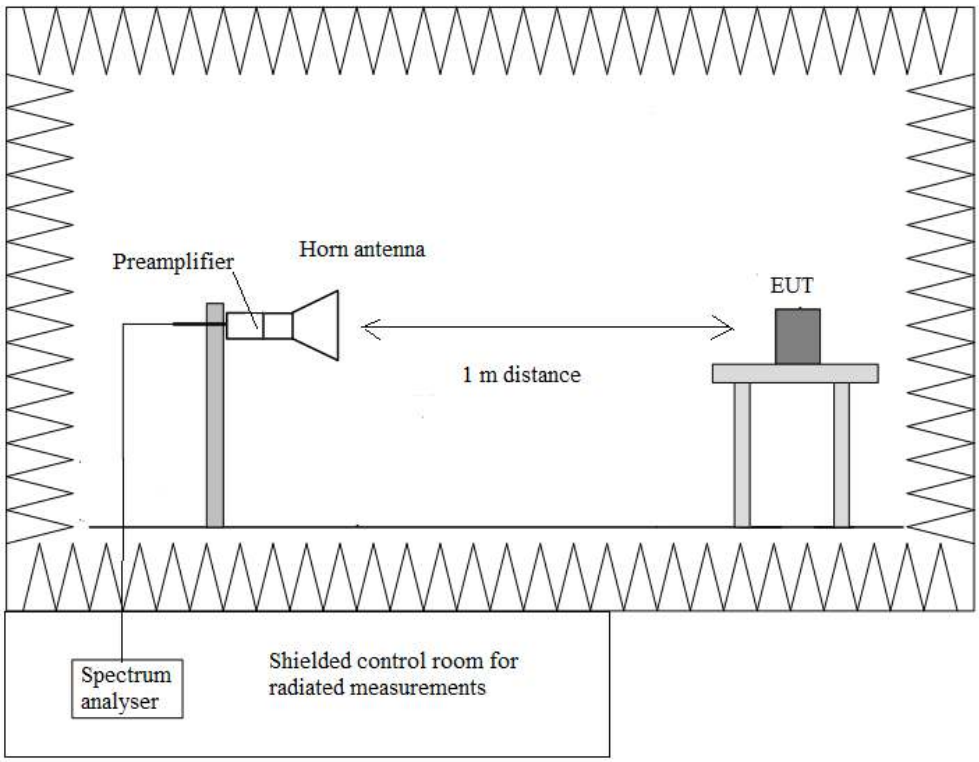
Radiated measurements setup f < 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



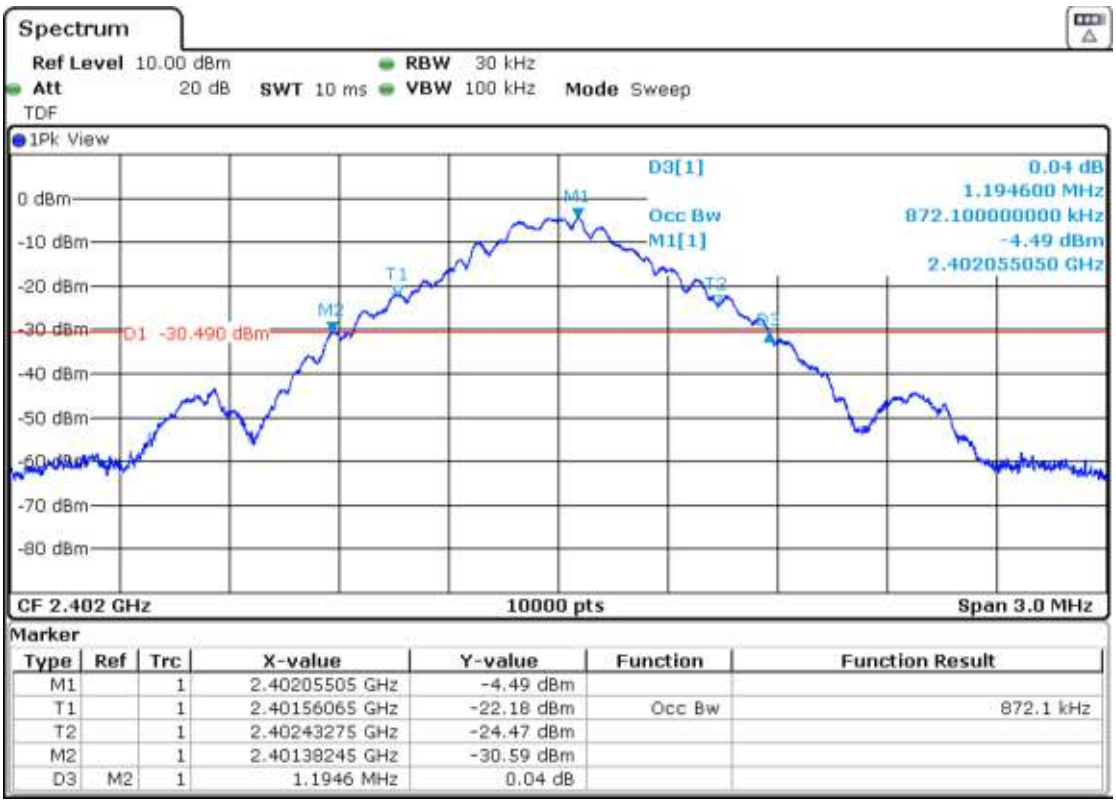
Occupied Bandwidth

RESULTS:

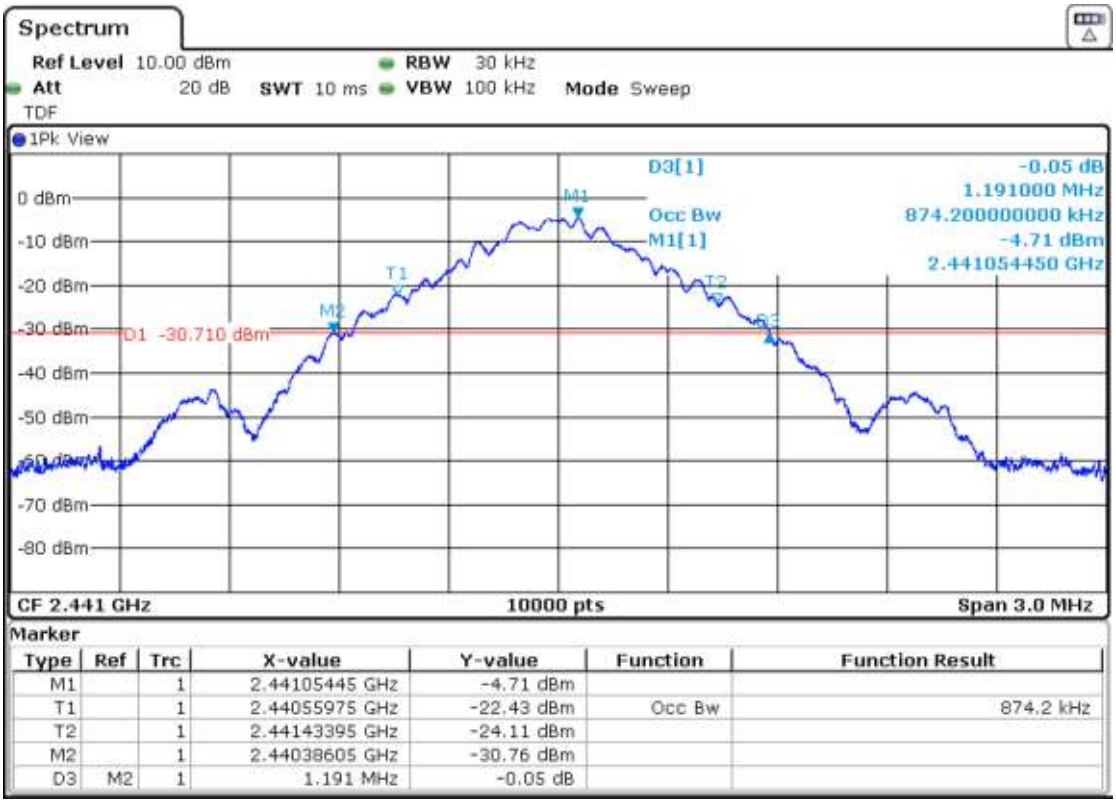
	Low Channel	Middle Channel	High Channel
99% Bandwidth (MHz)	0.8721	0.8742	0.8766
Measurement Uncertainty (kHz)	<±3.64		

Verdict: PASS

- Low Channel:



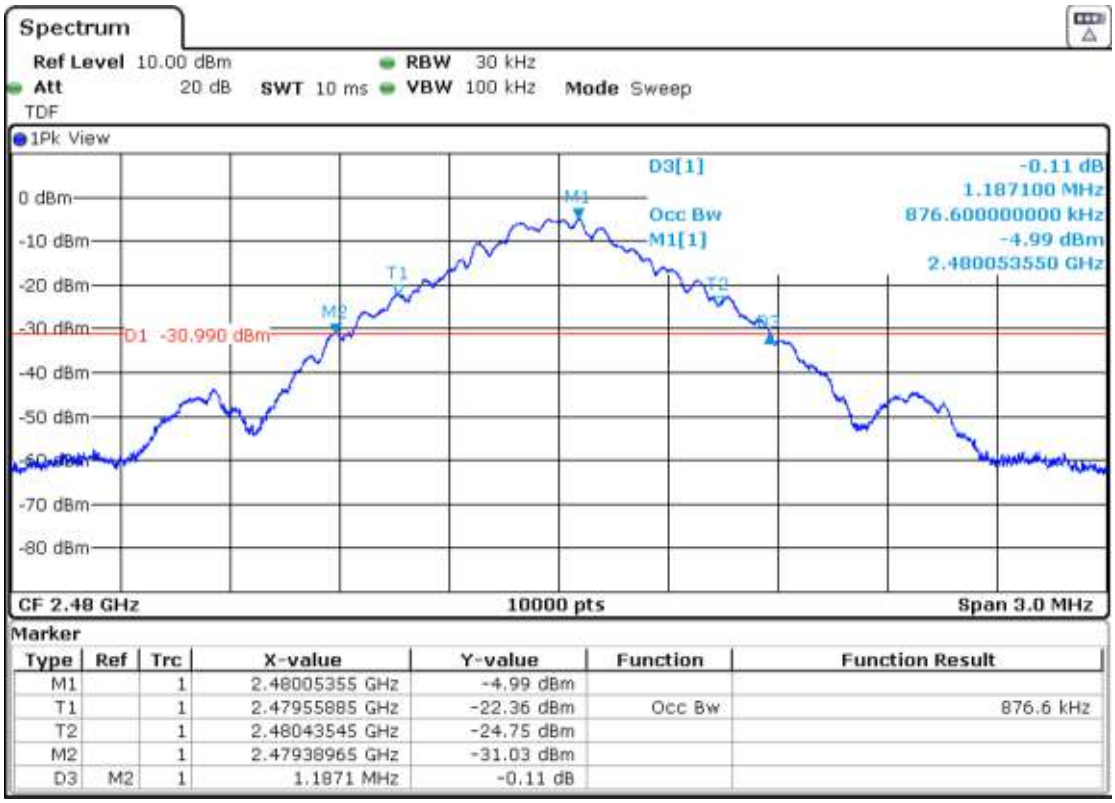
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44105445 GHz	-4.71 dBm		
T1		1	2.44055975 GHz	-22.43 dBm	Occ Bw	874.2 kHz
T2		1	2.44143395 GHz	-24.11 dBm		
M2		1	2.44038605 GHz	-30.76 dBm		
D3	M2	1	1.191 MHz	-0.05 dB		

- High Channel:



Marker

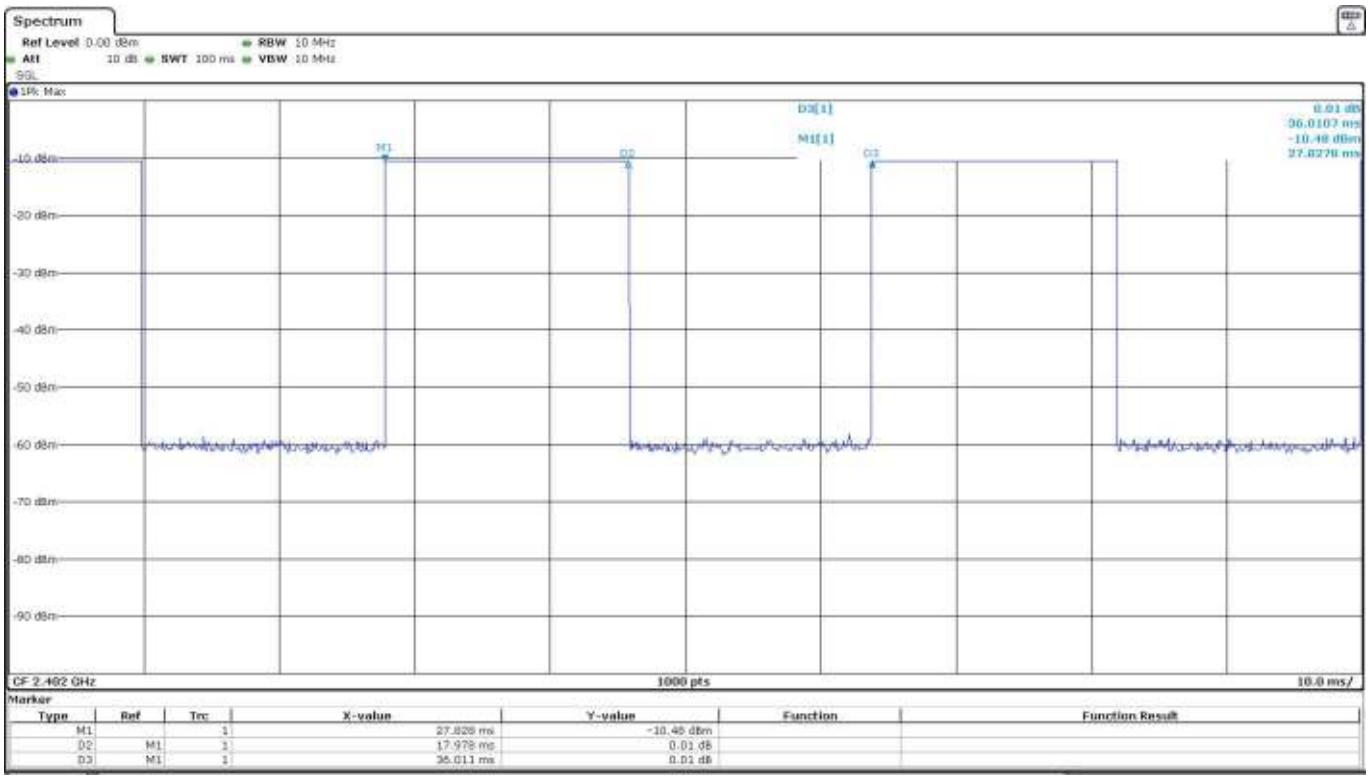
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48005355 GHz	-4.99 dBm		
T1		1	2.47955885 GHz	-22.36 dBm	Occ Bw	876.6 kHz
T2		1	2.48043545 GHz	-24.75 dBm		
M2		1	2.47938965 GHz	-31.03 dBm		
D3	M2	1	1.1871 MHz	-0.11 dB		

Duty Cycle

Computation of duty-cycle correction factor

Number of pulses within 100 ms: 2.5

Pulse duration: 17.978 ms.



Duty-cycle correction factor calculation.

Duration (ms)	Number of pulses	“On Time” (ms)
17.978	2.5	44.94

Duty cycle in 100ms = “On Time” / 100 ms = 0.4494
Duty cycle correction factor δ = 20 log (0.4329) = -6.95 dB

15.249 (a) / RSS-210 B.10 (a) Field strength of fundamental and harmonics emissions

SPECIFICATION:

The field strength of emissions from intentional radiators shall comply with the following

Fundamental frequency (MHz)	Field strength of fundamental (mV/m)	Field strength (dBµV/m)	Measurement distance (m)
902 - 928	50	93.98	3
2400 – 2483.5	50	93.98	3
5725 - 5875	50	93.98	3
24000-24250	250	107.96	3

For frequencies above 1000 MHz, the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

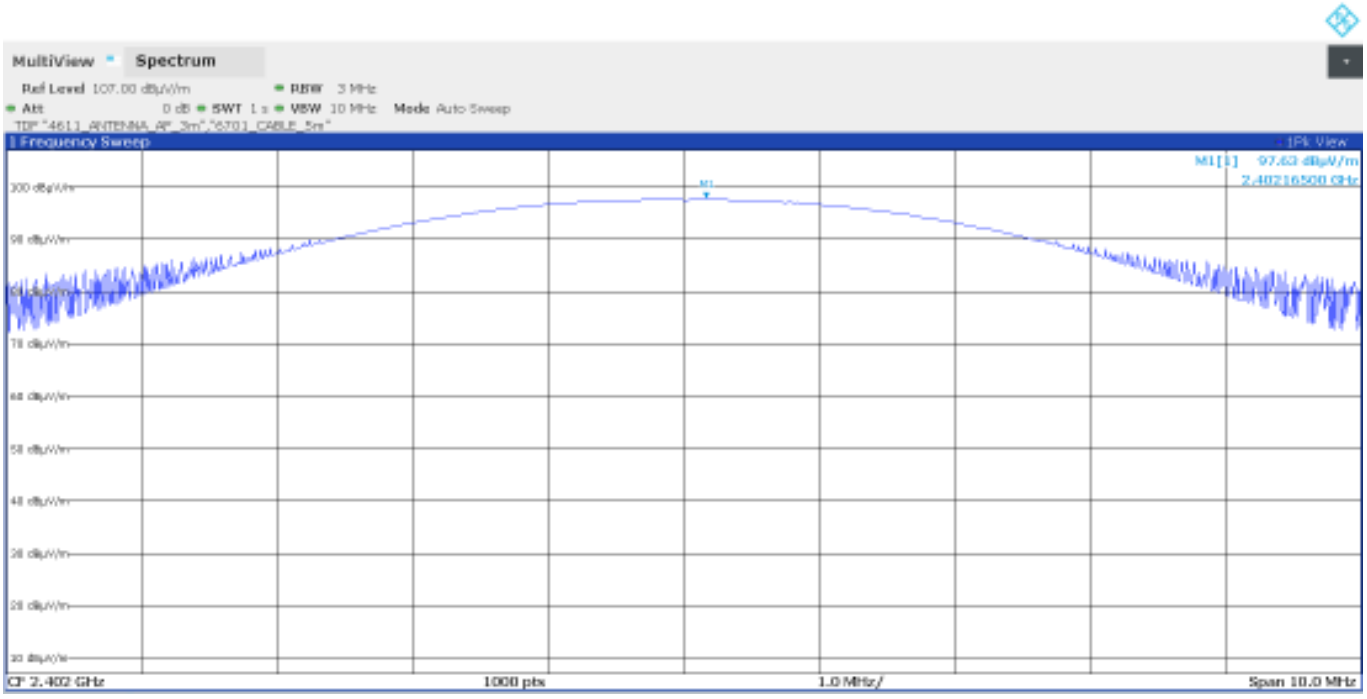
RESULTS:

	Low Channel	Middle Channel	High Channel
Field Strength (dBµV/m) Peak	97.63	98.21	98.21
Duty cycle correction factor δ (dB)	-6.95	-6.95	-6.95
Field Strength (dBµV/m) Average	90.68	91.26	91.26
Measurement Uncertainty (dB)	<±4.11		

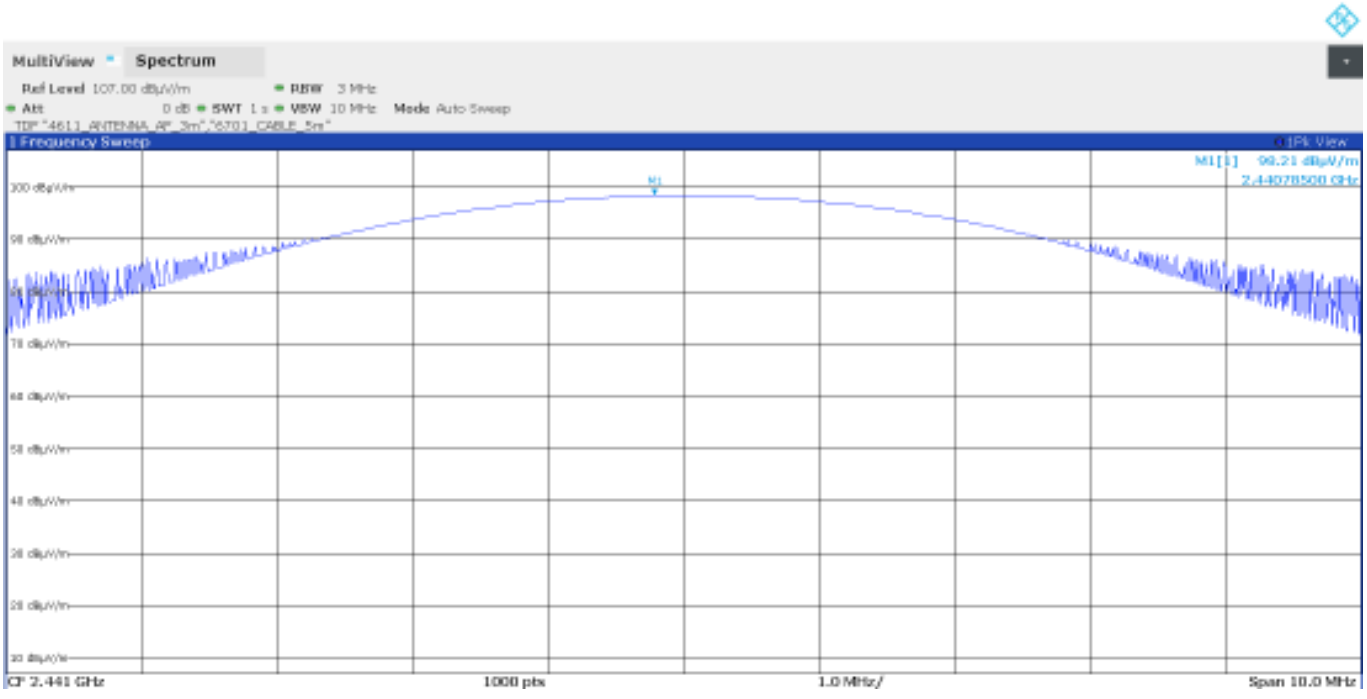
Verdict: PASS

FIELD STRENGTH

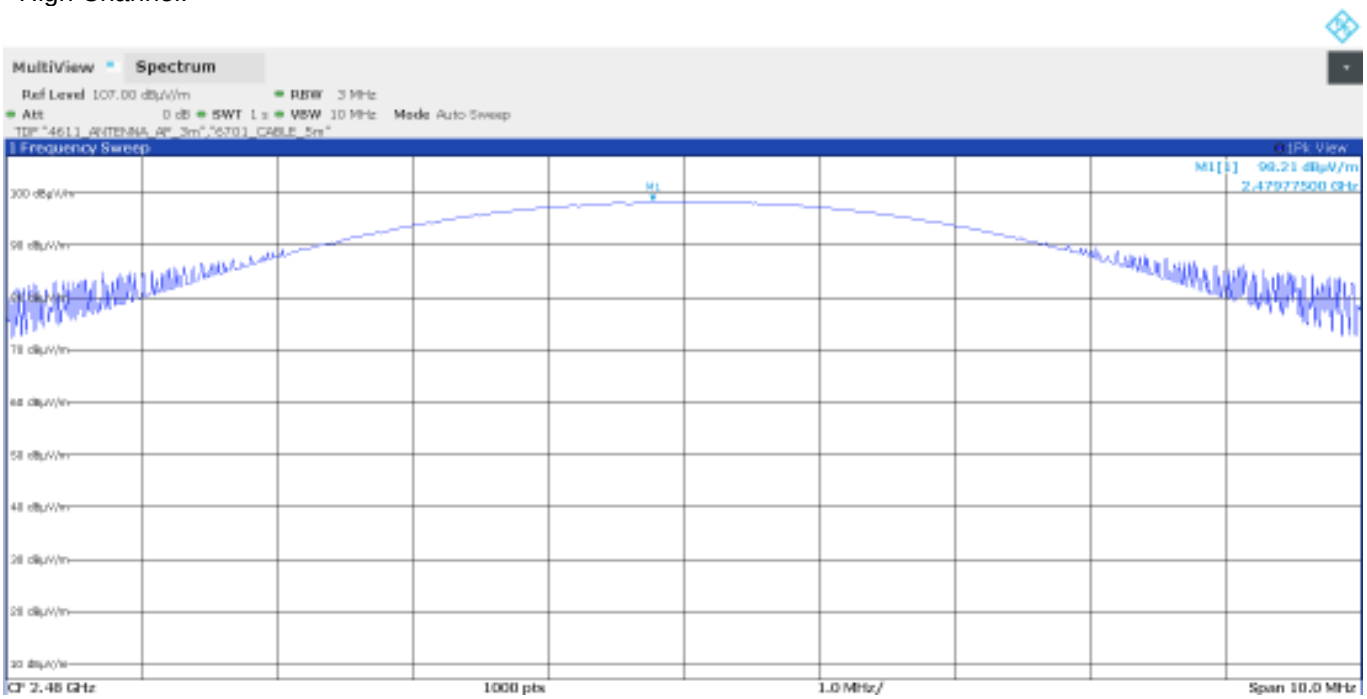
- Low Channel:



- Middle Channel:



- High Channel:



15.249 (d) / RSS-210 B.10 (b) Emissions radiated outside of the specific frequency bands

SPECIFICATION:

The field strength of harmonics from intentional radiators shall comply with the following:

Fundamental frequency (MHz)	Field strength of harmonics (µV/m)	Field strength of harmonics (dBµV/m)	Measurement distance (m)
902 - 928	500	54	3
2400 – 2483.5	500	54	3
5725 - 5875	500	54	3
24000-24250	2500	67.96	3

Emissions radiated outside of the specific frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of fundamental or to the general radiated emission limits specified in section 15.209:

Frequency Range (MHz)	Field strength (µV/m)	Field strength (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	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

Whichever is the lesser attenuation.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-17 GHz and at distance of 1 m for the frequency range 17 GHz-26 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected do not depend on the operating channel.

No spurious frequencies detected at less than 20 dB below the limit.

Measurement Uncertainty (dB) <± 4.99

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.38220	56.70	H	Peak
	41.29		Average
2.38873	62.20	H	Peak
	41.25		Average
4.80400	50.57	H	Peak
14.41150	51.87	V	Peak

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
4.88150	49.27	H	Peak
14.64700	54.12	V	Peak
	41.78		Average

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

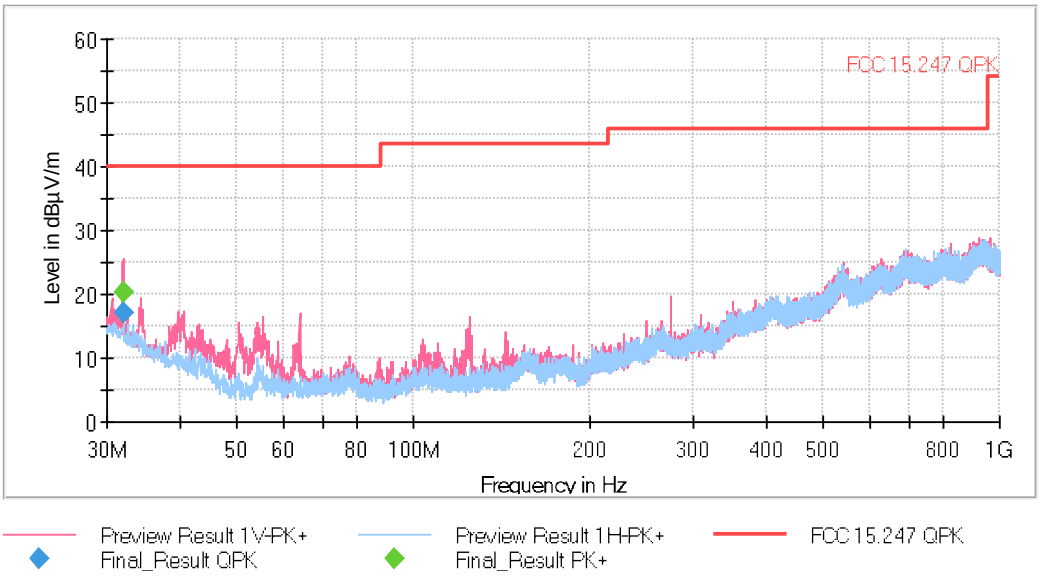
Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.33100	54.37	H	Peak
	41.61		Average
2.48700	68.23	H	Peak
	41.40		Average
2.49120	65.78	H	Peak
	41.39		Average
4.95950	47.31	H	Peak
7.43950	45.40	H	Peak

Measurement Uncertainty (dB): $<\pm$ 4.98 for $1 \leq f \leq 17$ GHz
$<\pm$ 5.08 for $17 < f \leq 26$ GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):

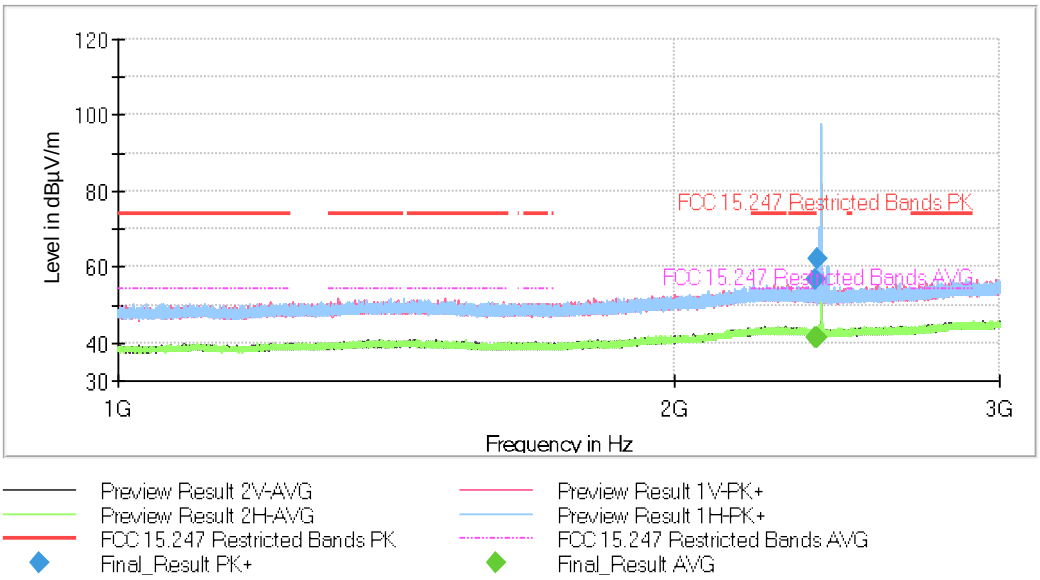
The spurious frequencies detected do not depend on the operating channel.



This plot is valid for the Low, Middle and High Channels.

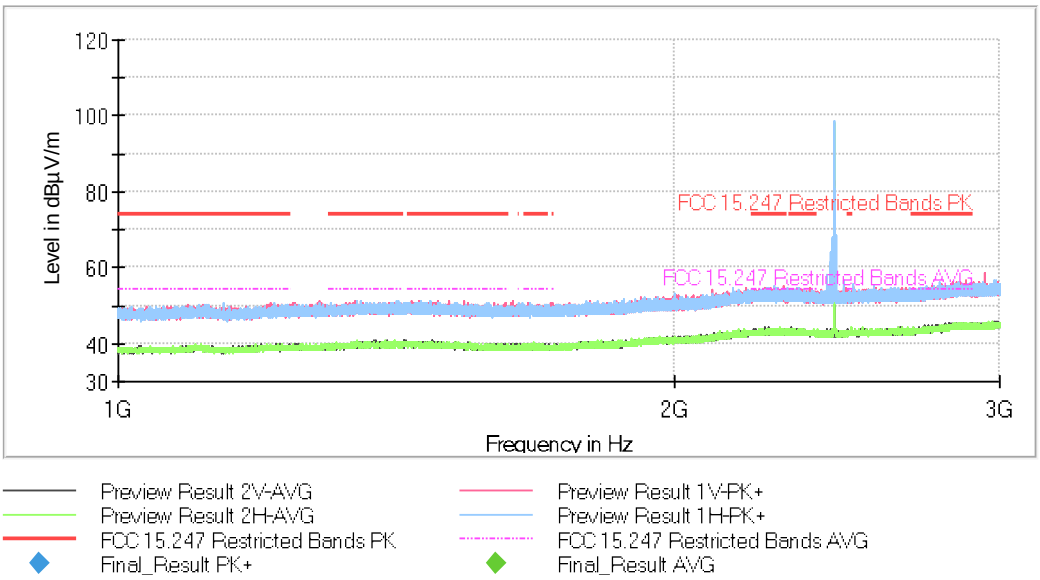
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



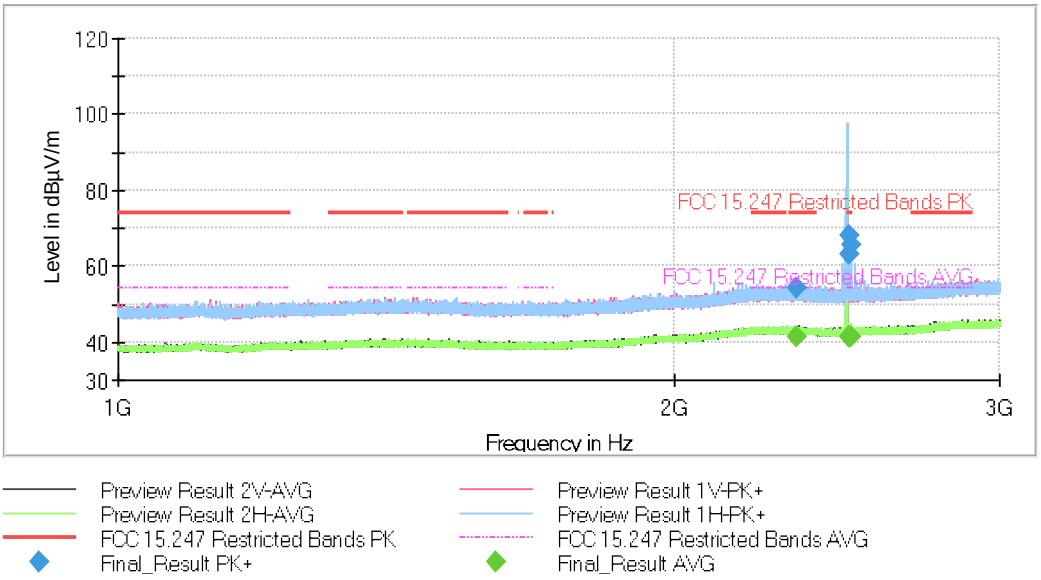
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

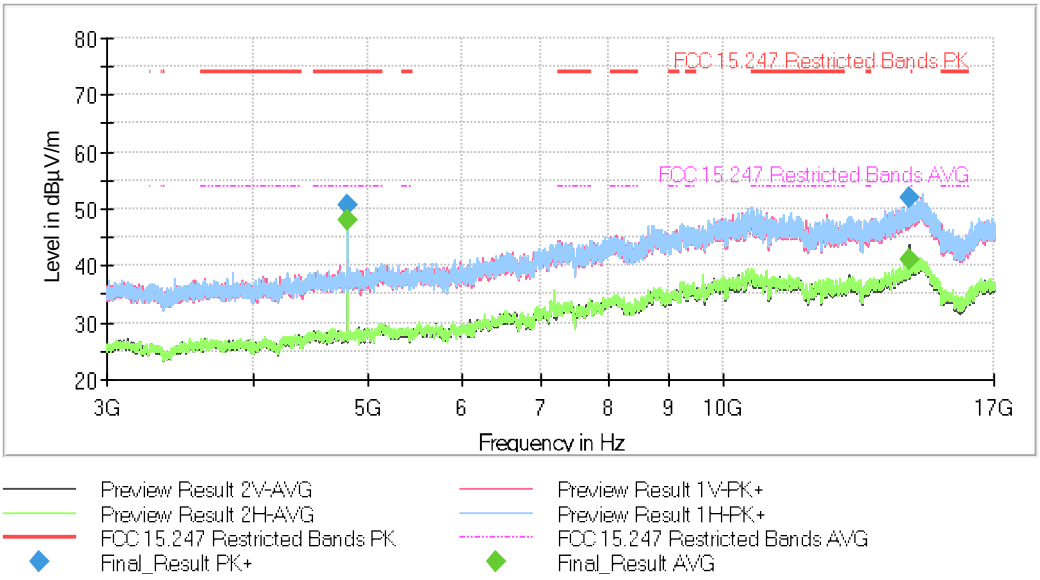
- High Channel:



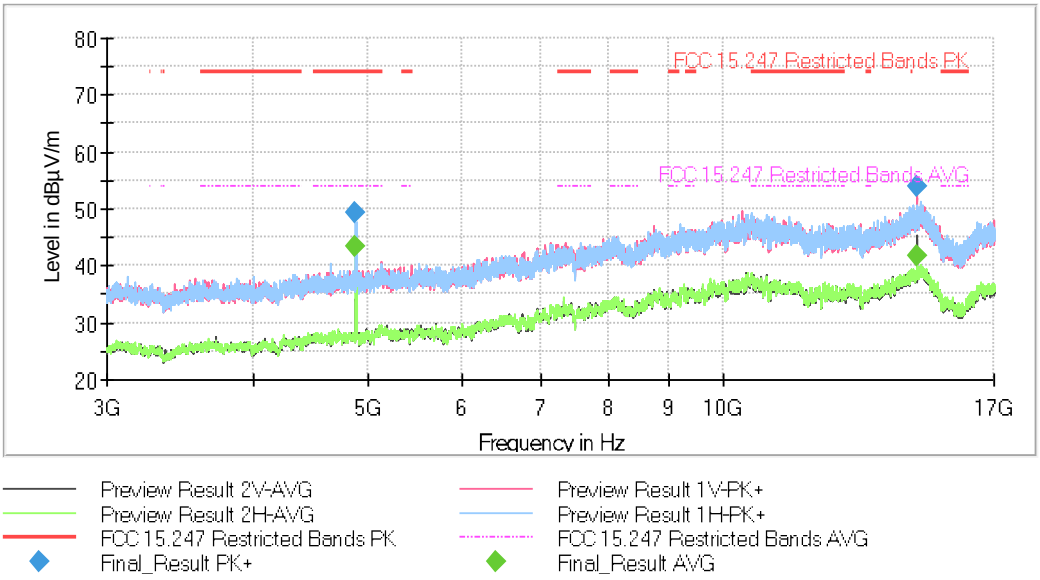
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

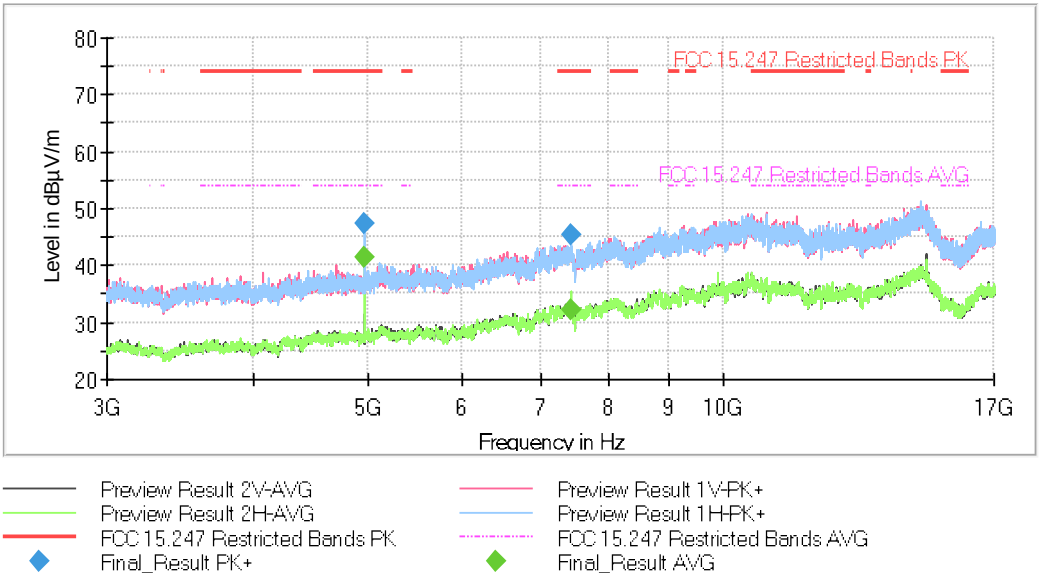
- Low Channel:



- Middle Channel:

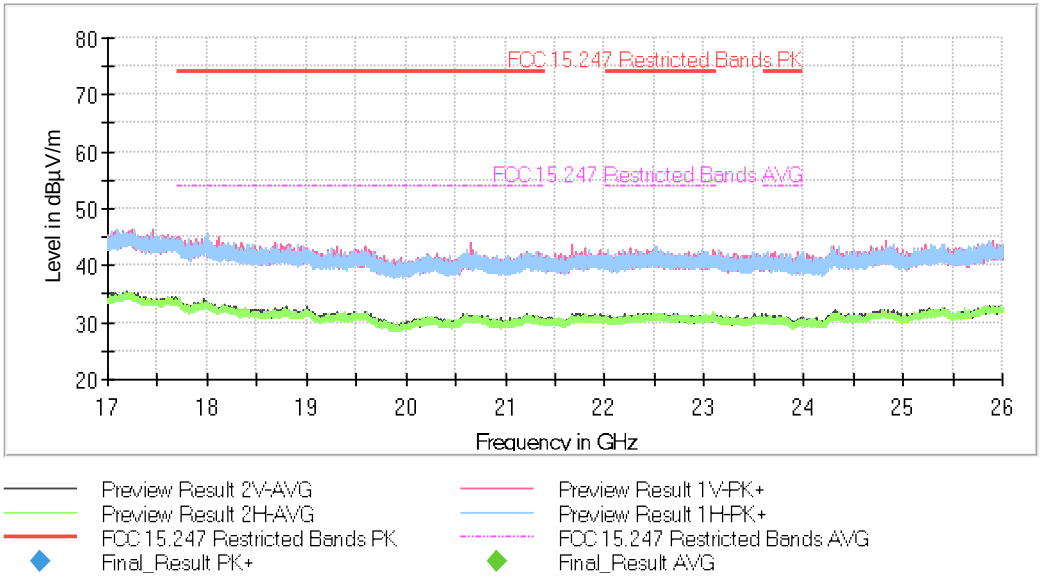


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

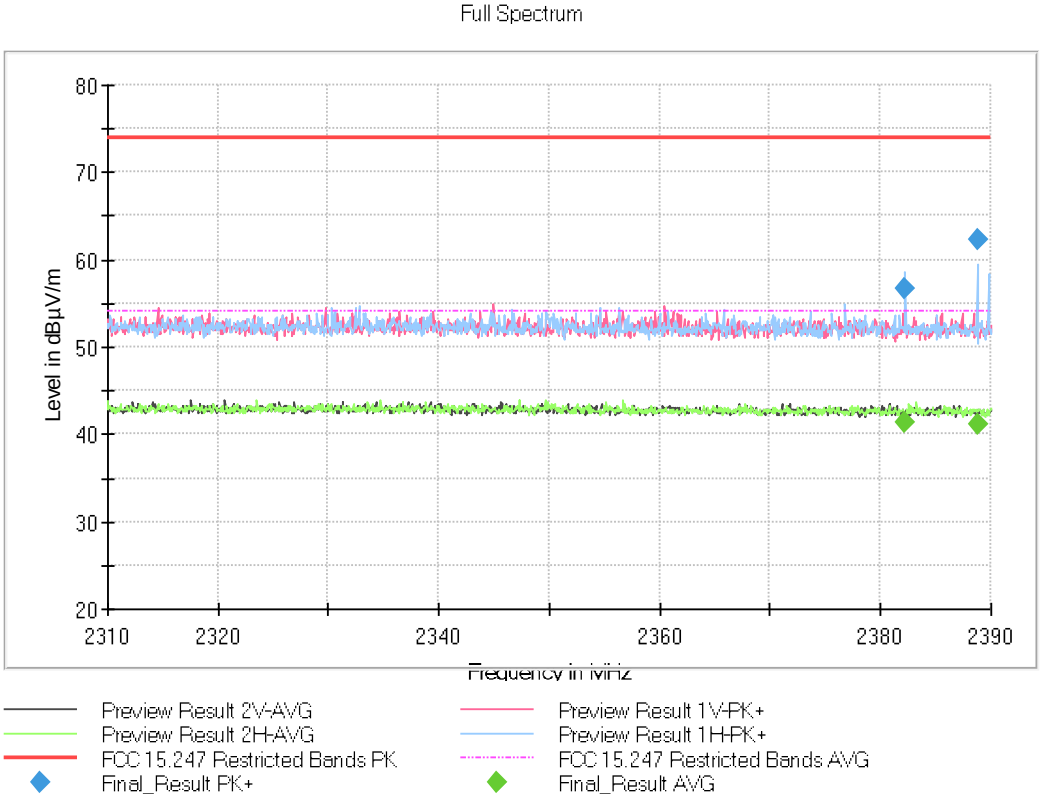
The spurious frequencies detected do not depend on the operating channel.



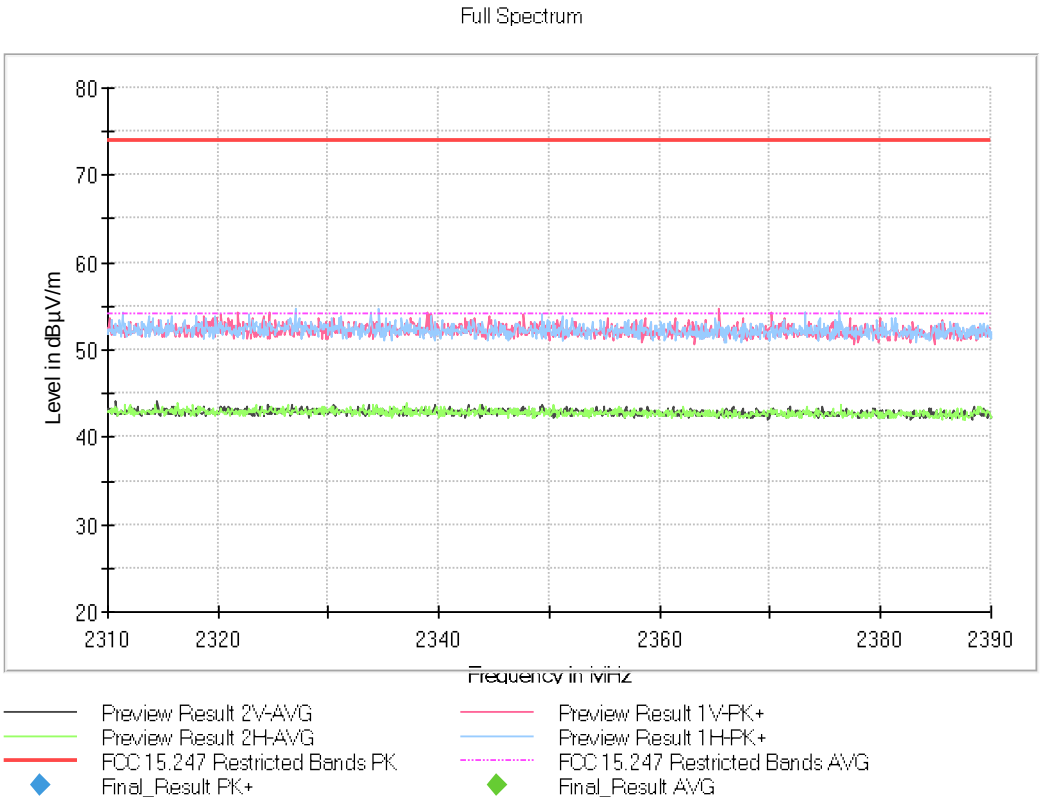
This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

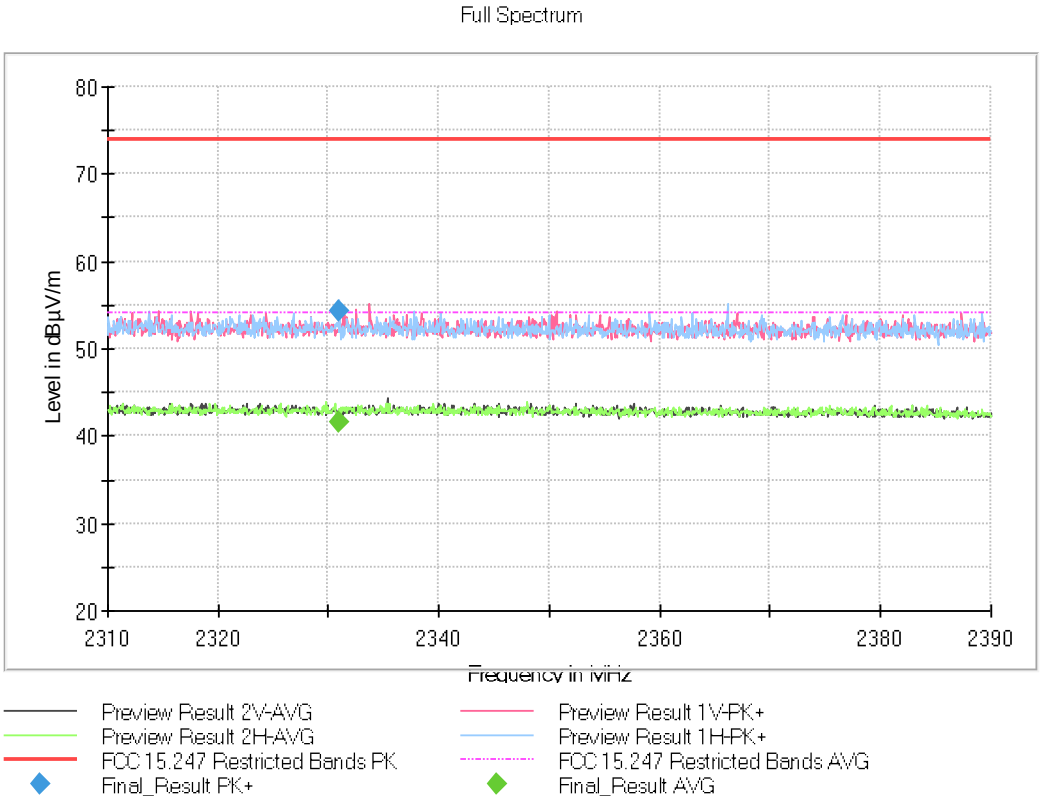
- Low Channel:



- Middle Channel:

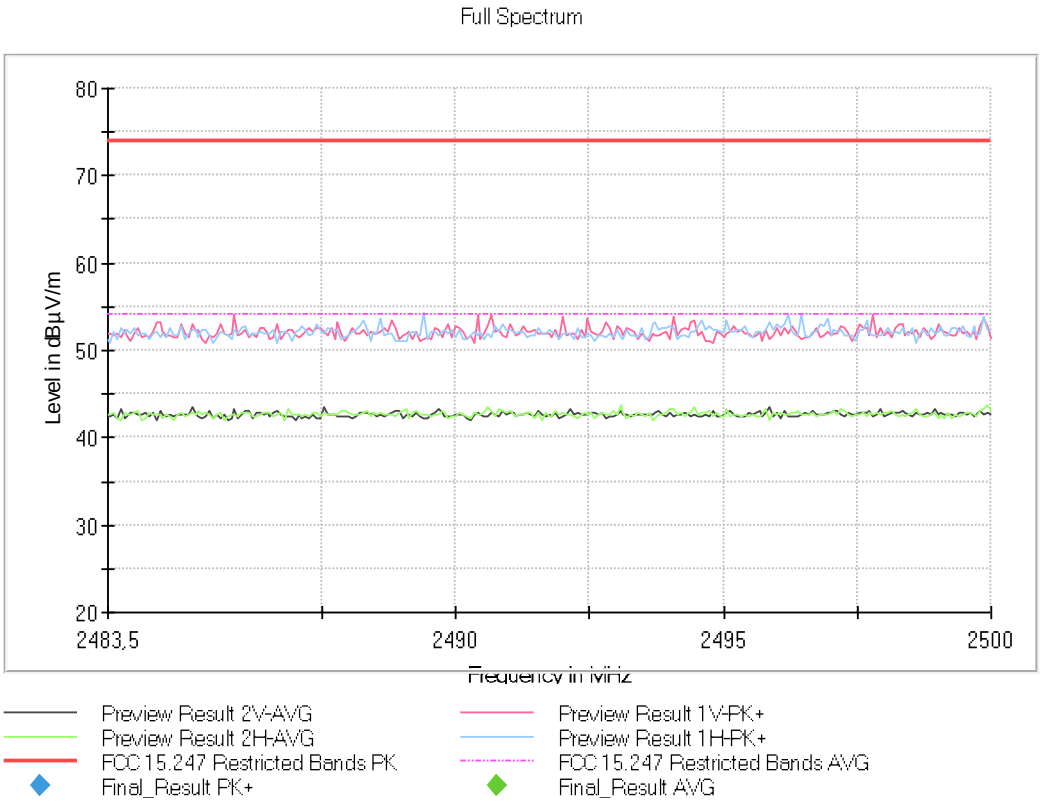


- High Channel:

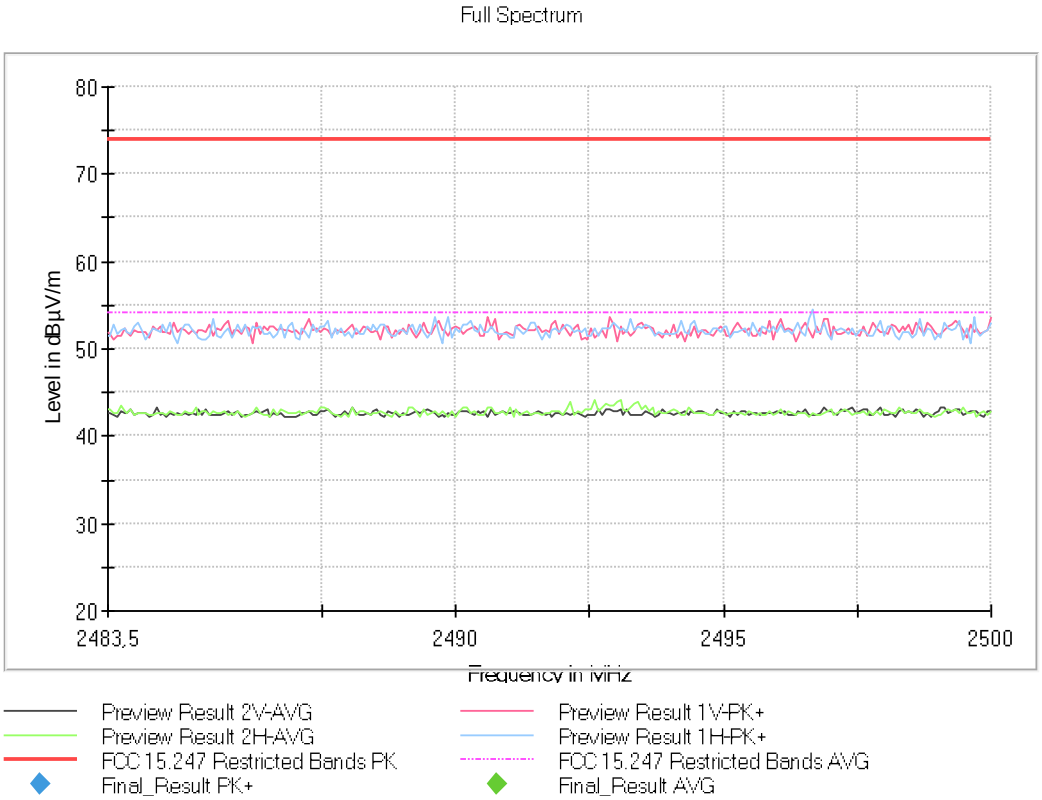


FREQUENCY RANGE 2.4835-2.5 GHz:

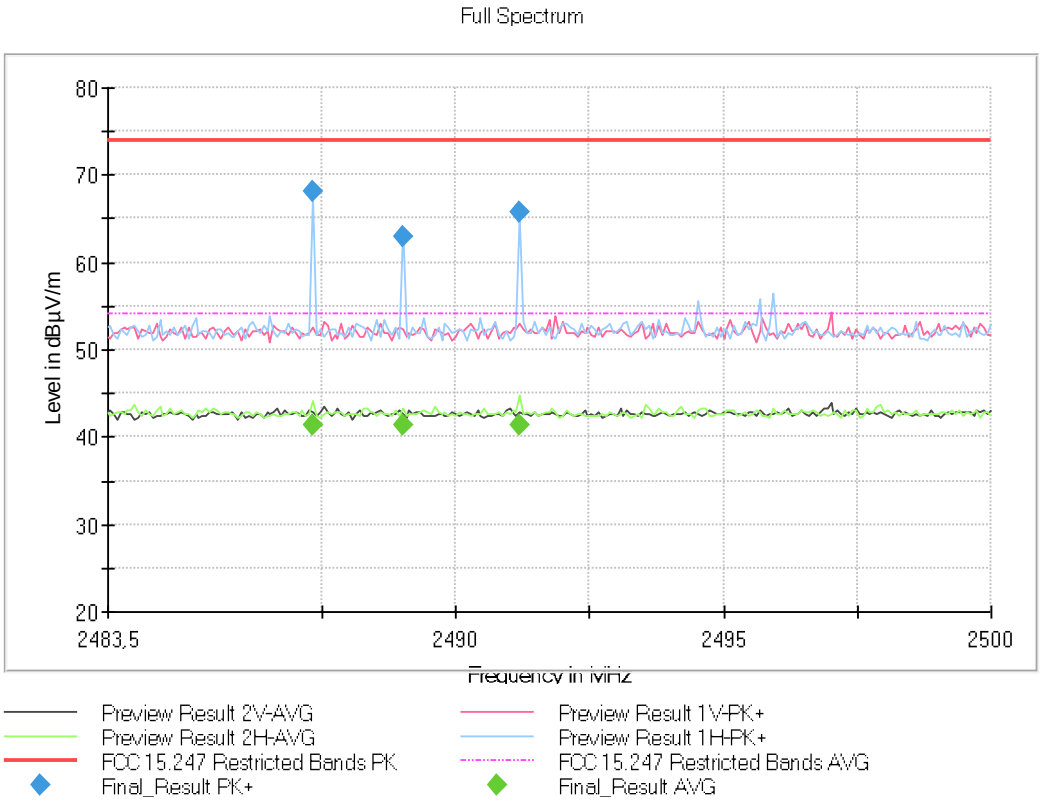
- Low Channel:



- Middle Channel:



- High Channel:



Appendix C: Test results. Proprietary protocol DM 2.4 GHz

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TEST CONDITIONS

POWER SUPPLY:

V nominal:	3.8 Vdc
Type of Power Supply:	Lithium-Ion rechargeable battery.

ANTENNA:

Type of Antenna:	Internal.
Maximum Declared Antenna Gain:	-0.5 dBi

TEST FREQUENCIES:

Low Channel:	2402 MHz
Middle Channel:	2440 MHz
High Channel:	2480 MHz

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

The DC supply voltage is applied using an external power supply.

RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

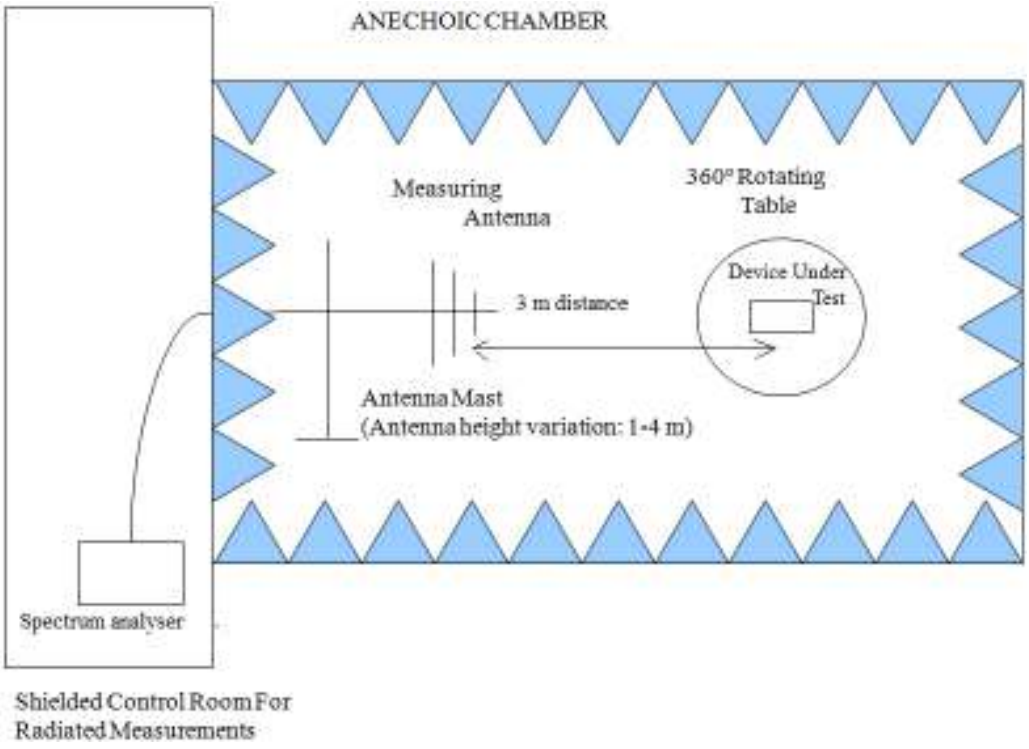
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

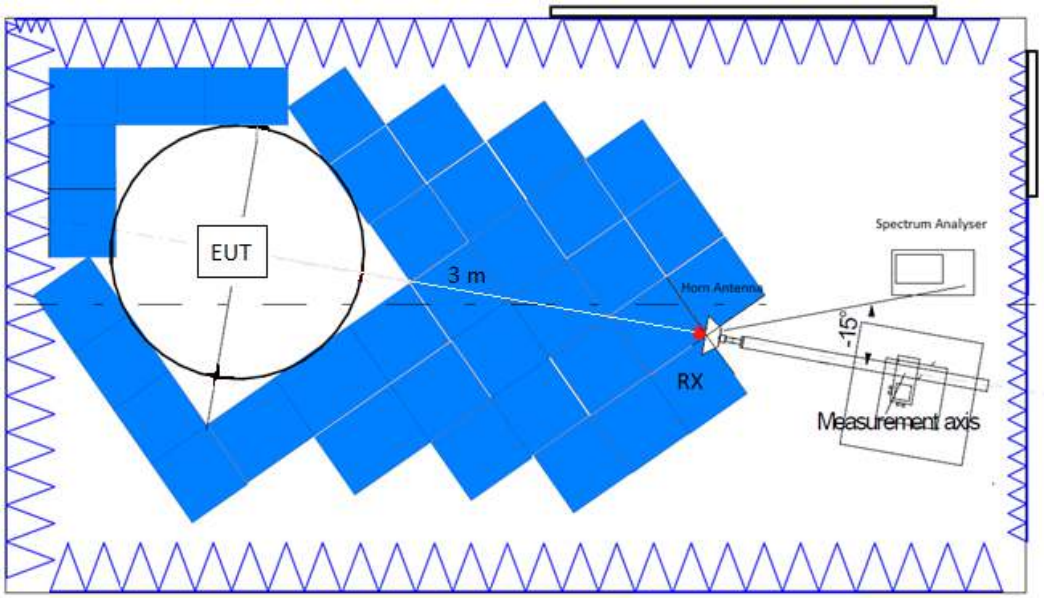
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

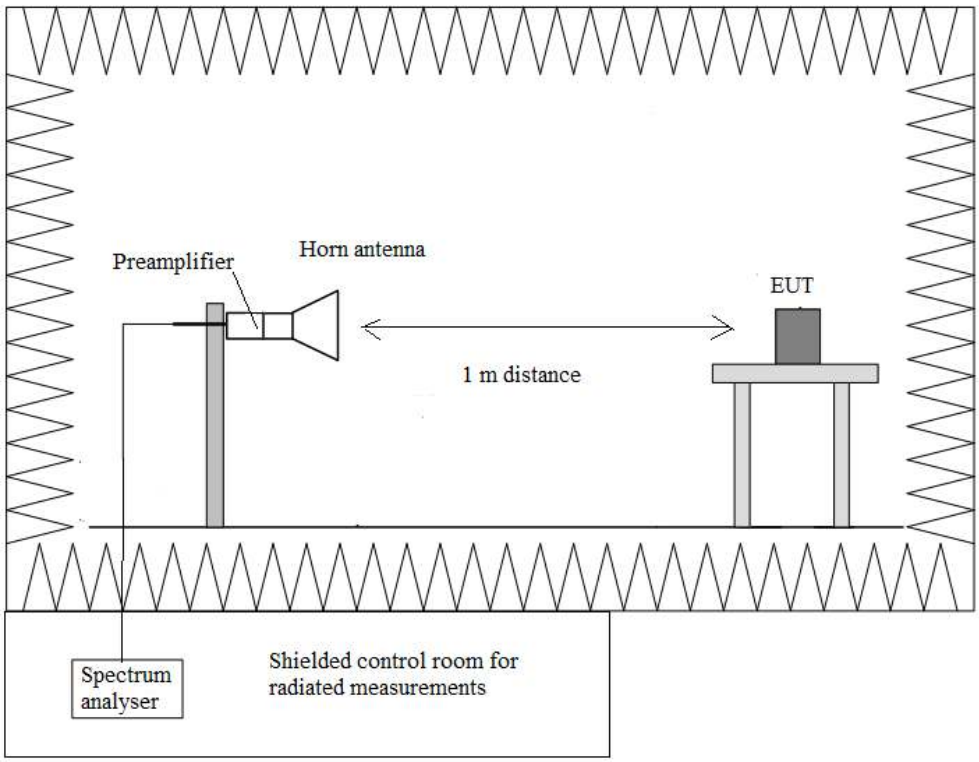
Radiated measurements setup f < 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



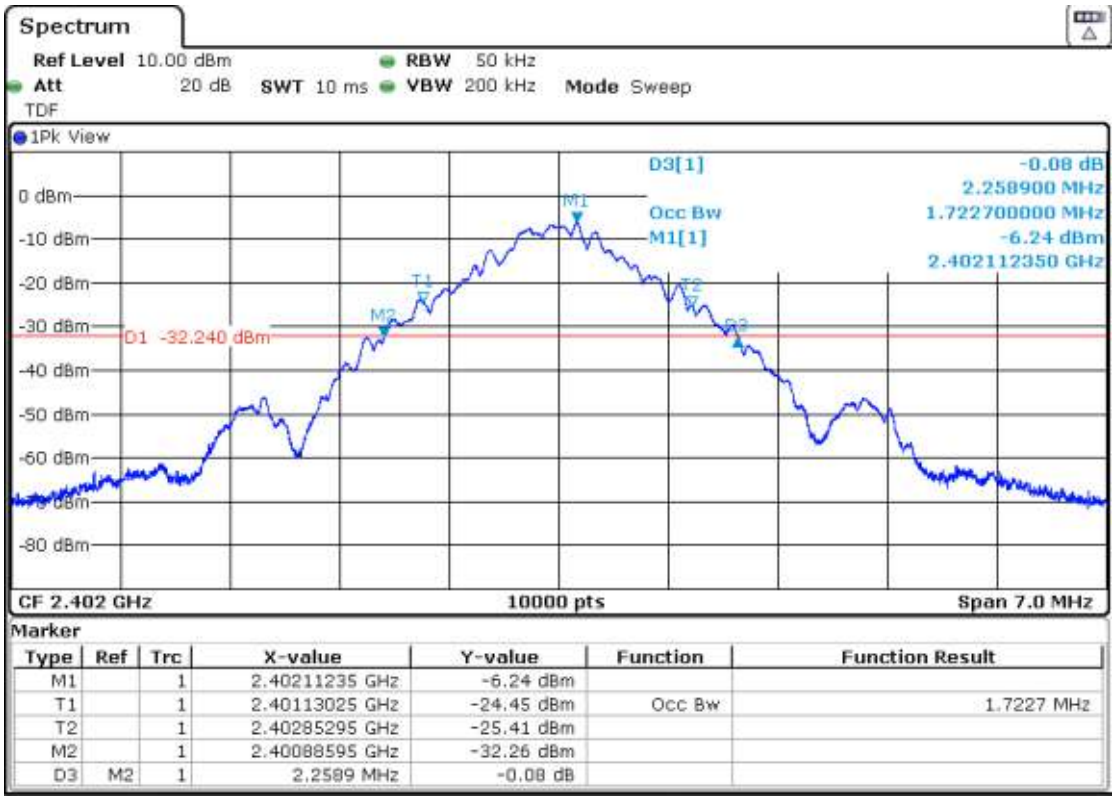
Occupied Bandwidth

RESULTS:

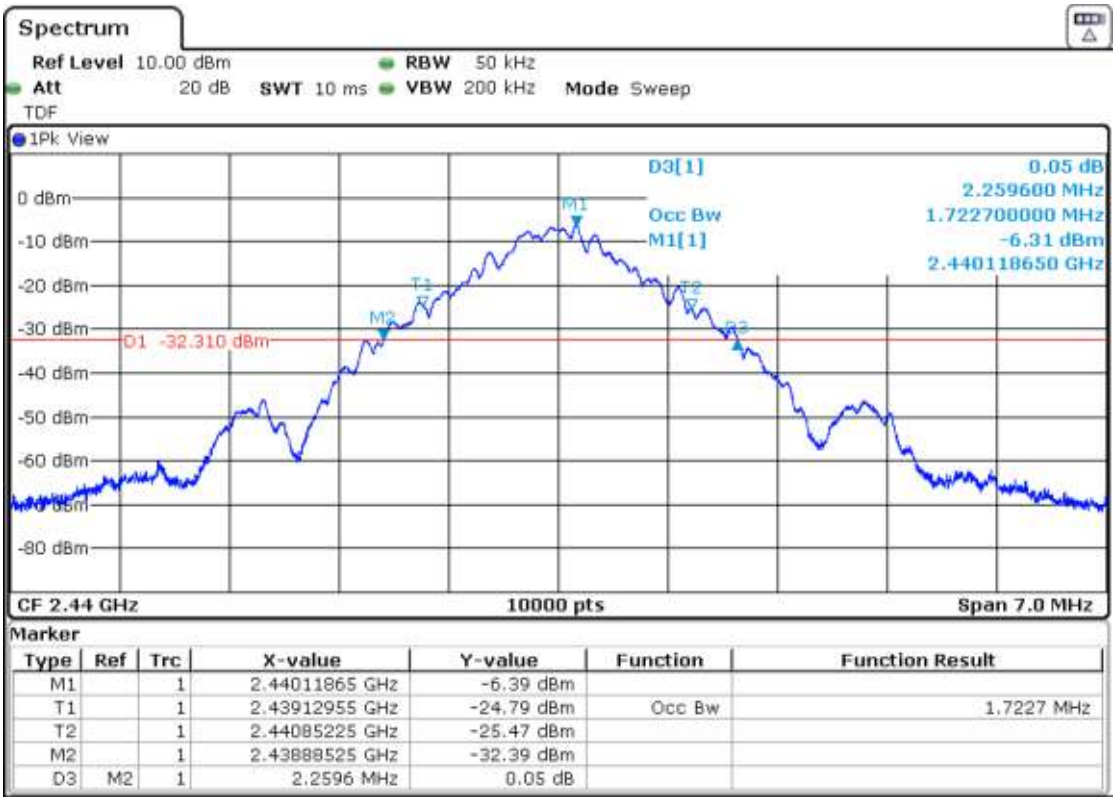
	Low Channel	Middle Channel	High Channel
99% Bandwidth (MHz)	1.7227	1.7227	1.722
Measurement Uncertainty (kHz)	<±3.64		

Verdict: PASS

- Low Channel:



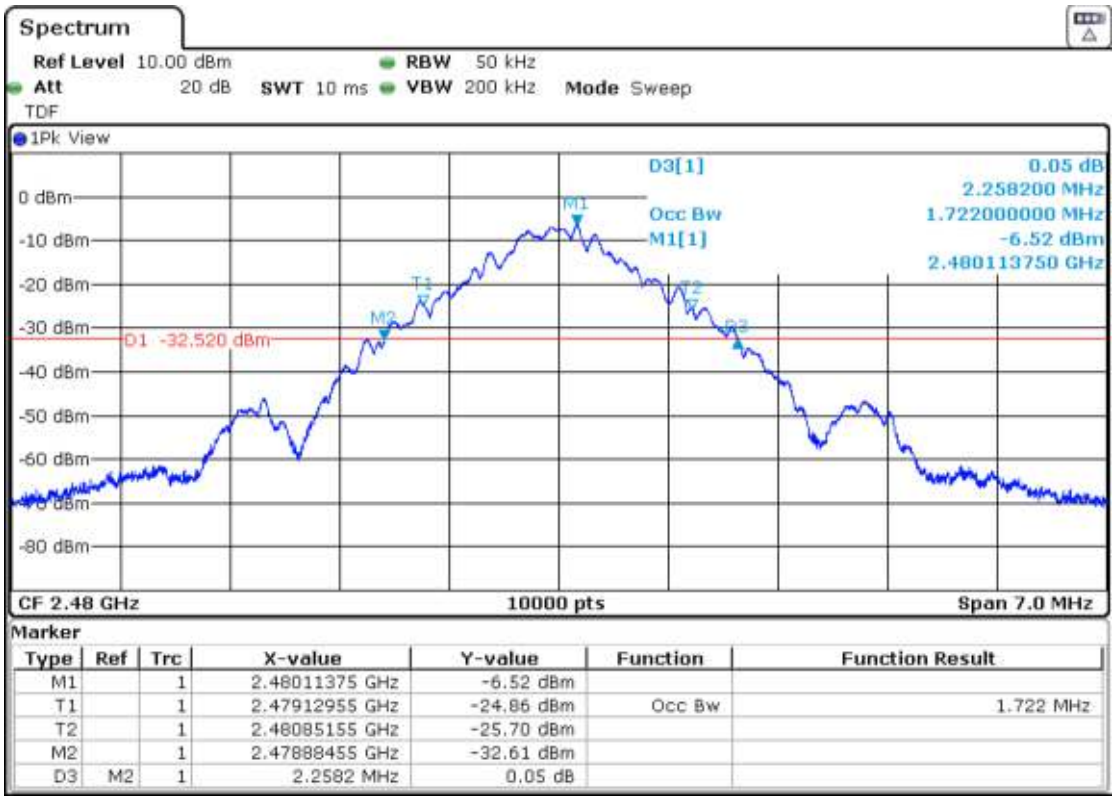
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44011865 GHz	-6.39 dBm		
T1		1	2.43912955 GHz	-24.79 dBm	Occ Bw	1.7227 MHz
T2		1	2.44085225 GHz	-25.47 dBm		
M2		1	2.43888525 GHz	-32.39 dBm		
D3	M2	1	2.2596 MHz	0.05 dB		

- High Channel:



Marker

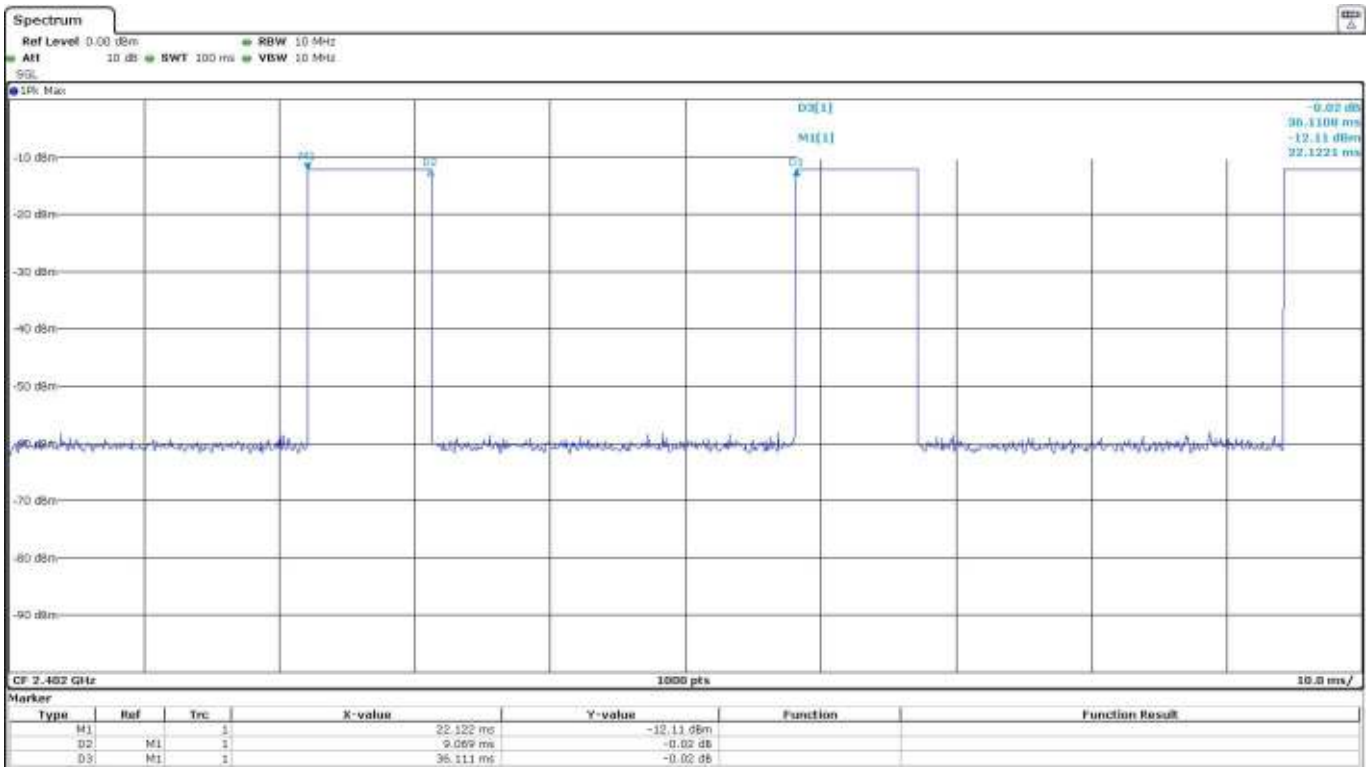
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48011375 GHz	-6.52 dBm		
T1		1	2.47912955 GHz	-24.86 dBm	Occ Bw	1.722 MHz
T2		1	2.48085155 GHz	-25.70 dBm		
M2		1	2.47888455 GHz	-32.61 dBm		
D3	M2	1	2.2582 MHz	0.05 dB		

Duty cycle

Computation of duty-cycle correction factor

Number of pulses within 100 ms: 2.6

Pulse duration: 9.069 ms.



Duty-cycle correction factor calculation.

Duration (ms)	Number of pulses	“On Time” (ms)
9.069	2.6	23.579

Duty cycle in 100ms = “On Time” / 100 ms = 0.2358
Duty cycle correction factor δ = 20 log (0.4329) = -12.55 dB

15.249 (a) / RSS-210 B.10 (a) Field strength of fundamental and harmonics emissions

SPECIFICATION:

The field strength of emissions from intentional radiators shall comply with the following

Fundamental frequency (MHz)	Field strength of fundamental (mV/m)	Field strength (dBµV/m)	Measurement distance (m)
902 - 928	50	93.98	3
2400 – 2483.5	50	93.98	3
5725 - 5875	50	93.98	3
24000-24250	250	107.96	3

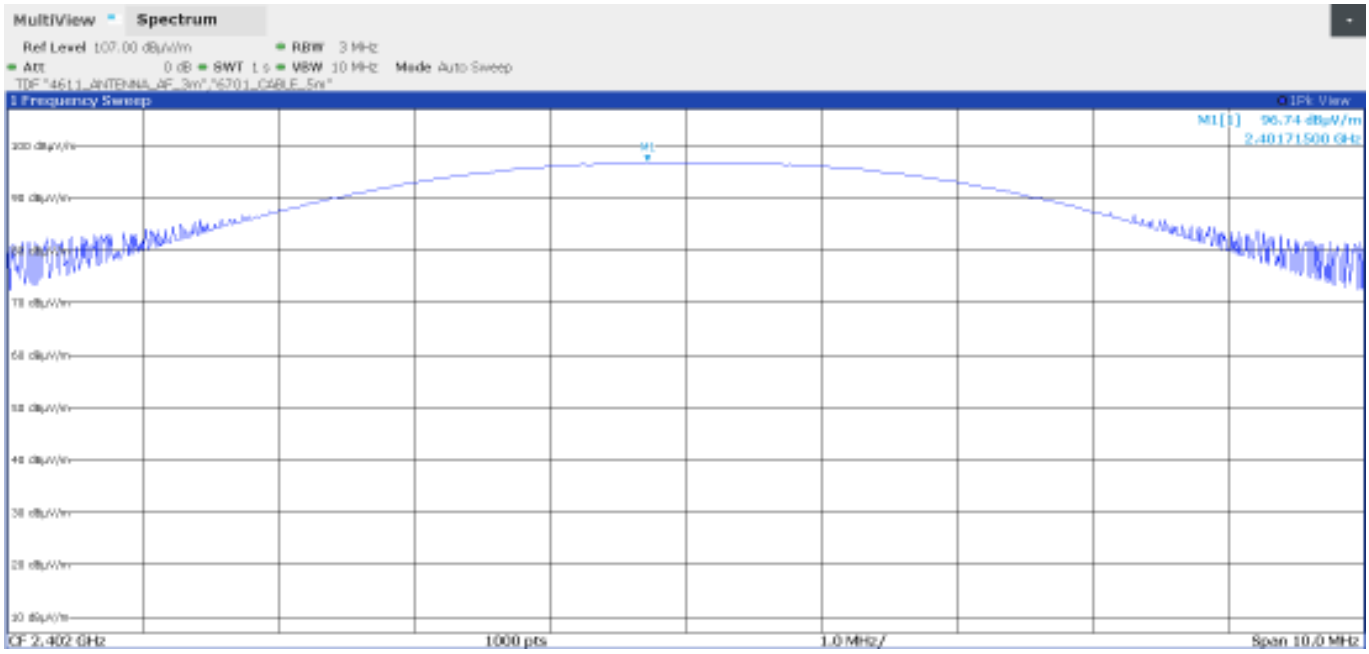
For frequencies above 1000 MHz, the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

RESULTS:

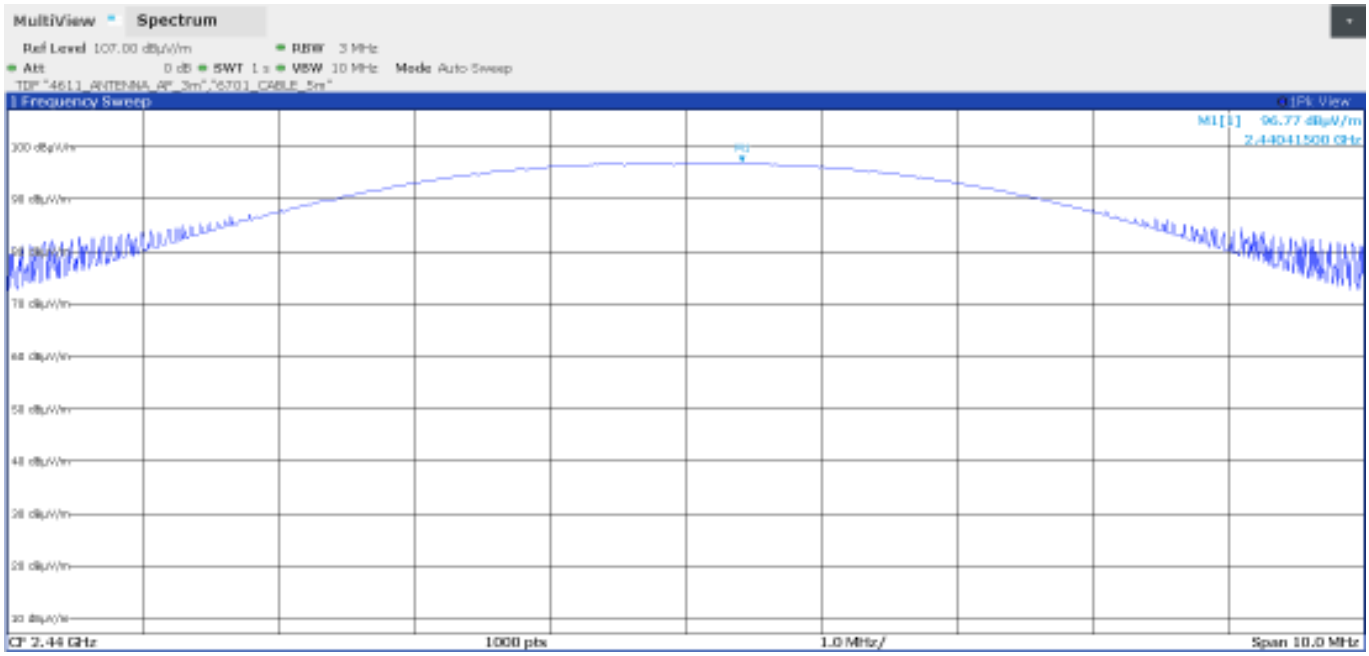
	Low Channel	Middle Channel	High Channel
Field Strength (dBµV/m) Peak	96.74	96.77	95.85
Duty cycle correction factor δ (dB)	-12.55	-12.55	-12.55
Field Strength (dBµV/m) Average	84.19	84.22	83.30
Measurement Uncertainty (dB)	<±4.11		

Verdict: PASS

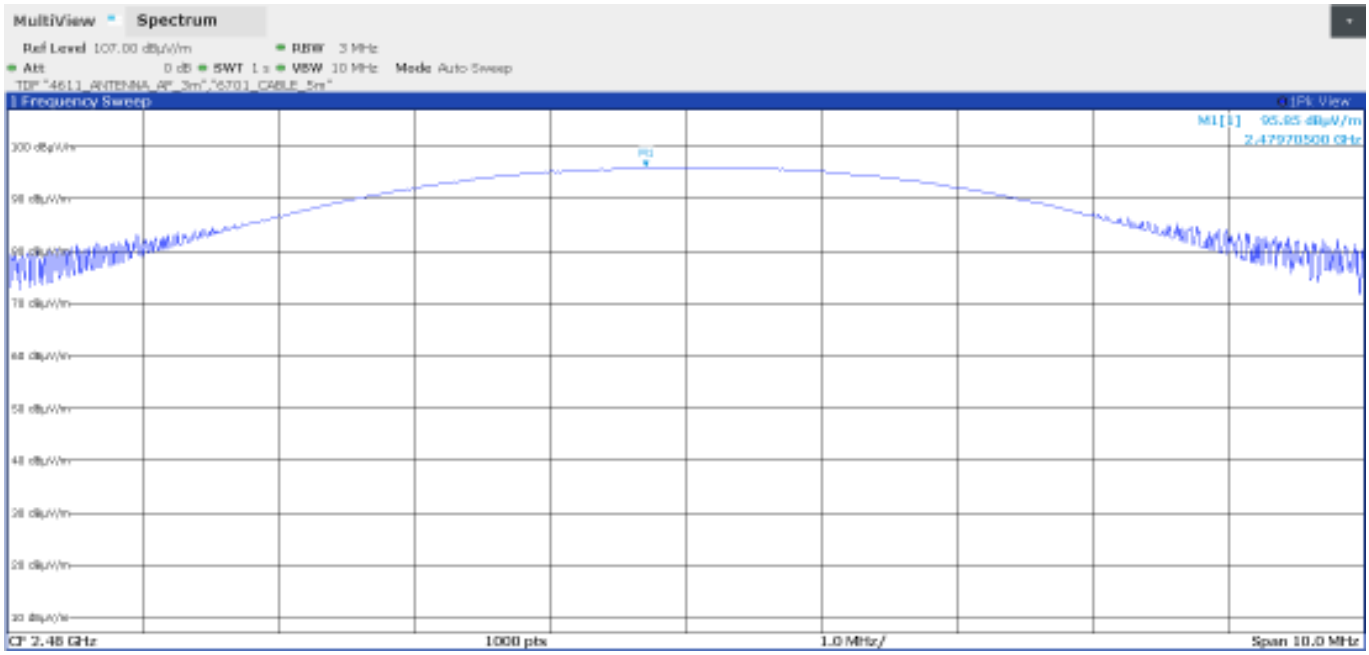
- Low Channel:



- Middle Channel:



- High Channel:



15.249 (d) / RSS-210 B.10 (b) Emissions radiated outside of the specific frequency bands

SPECIFICATION:

The field strength of harmonics from intentional radiators shall comply with the following:

Fundamental frequency (MHz)	Field strength of harmonics (µV/m)	Field strength of harmonics (dBµV/m)	Measurement distance (m)
902 - 928	500	54	3
2400 – 2483.5	500	54	3
5725 - 5875	500	54	3
24000-24250	2500	67.96	3

Emissions radiated outside of the specific frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of fundamental or to the general radiated emission limits specified in section 15.209:

Frequency Range (MHz)	Field strength (µV/m)	Field strength (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	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

Whichever is the lesser attenuation.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-17 GHz and at distance of 1 m for the frequency range 17 GHz-26 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected do not depend on the operating channel.

No spurious frequencies detected at less than 20 dB below the limit.

Measurement Uncertainty (dB) <± 4.99

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.38620	61.07	H	Peak
	41.26		Average
4.80300	47.11	H	Peak

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
4.88000	47.17	H	Peak
14.63850	52.59	V	Peak

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

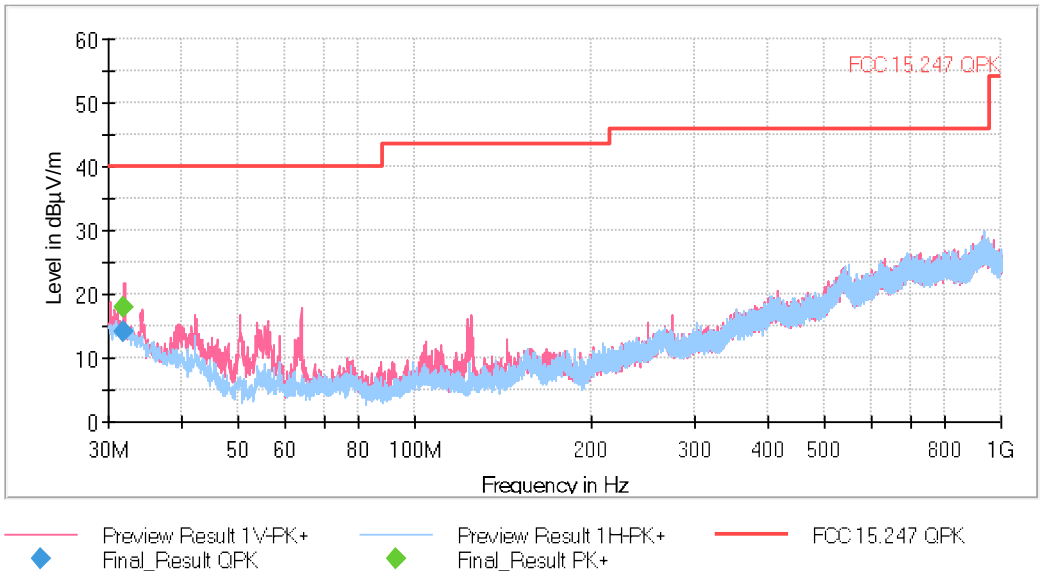
Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.48860	66.98	H	Peak
	41.41		Average
2.49320	54.42	H	Peak
	41.37		Average
4.96050	45.94	H	Peak
8.11500	46.34	V	Peak
12.40150	48.96	H	Peak

Measurement Uncertainty (dB): $<\pm$ 4.98 for $1 \leq f \leq 17$ GHz
$<\pm$ 5.08 for $17 < f \leq 26$ GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):

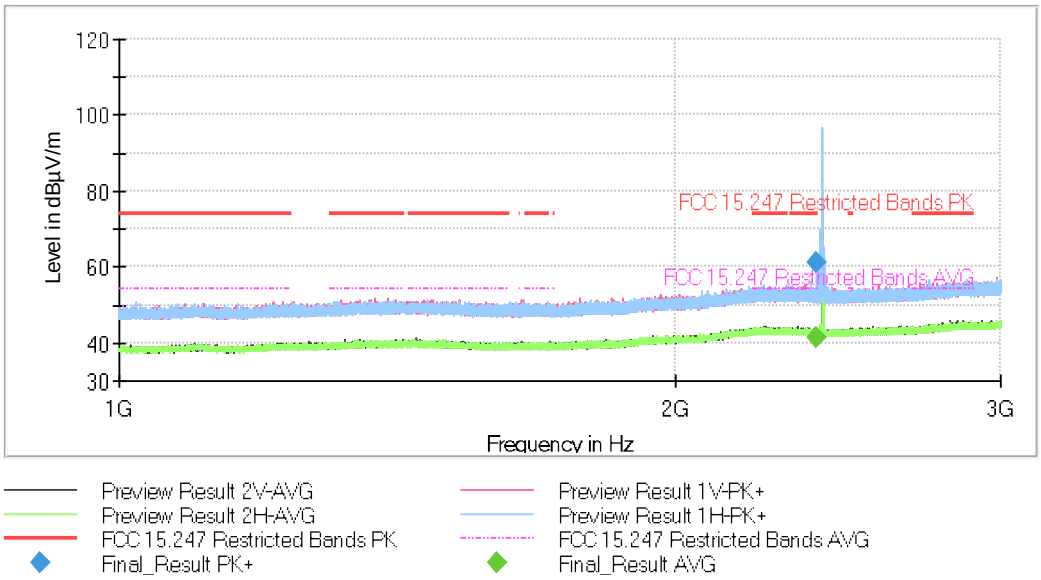
The spurious frequencies detected do not depend on the operating channel.



This plot is valid for the Low, Middle and High Channels.

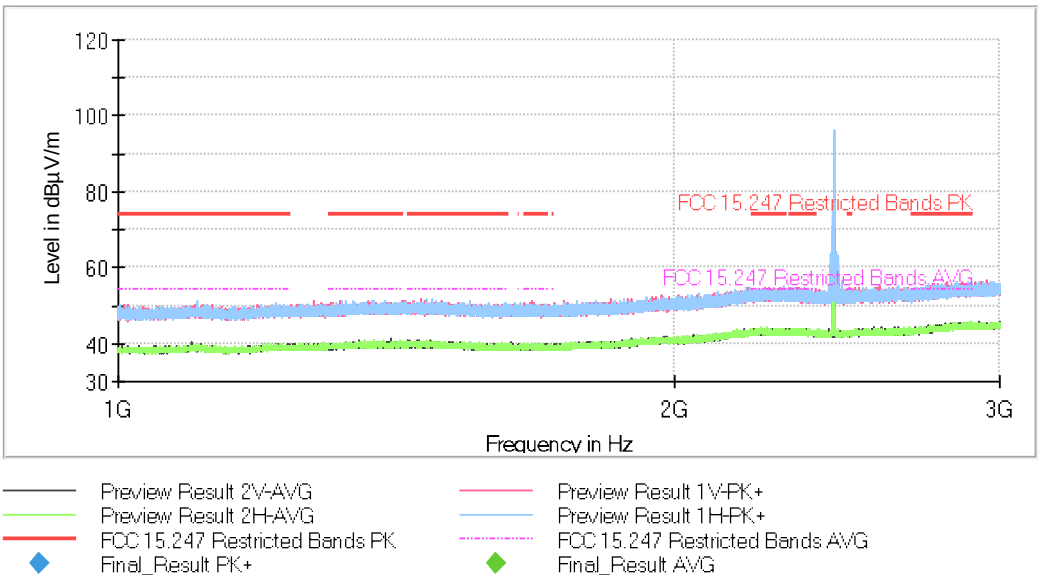
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



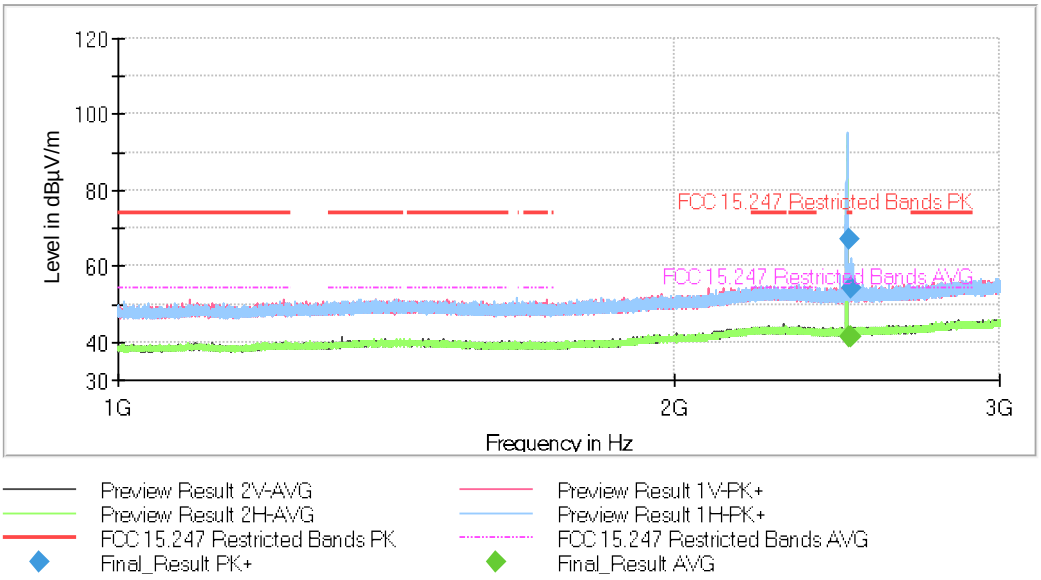
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

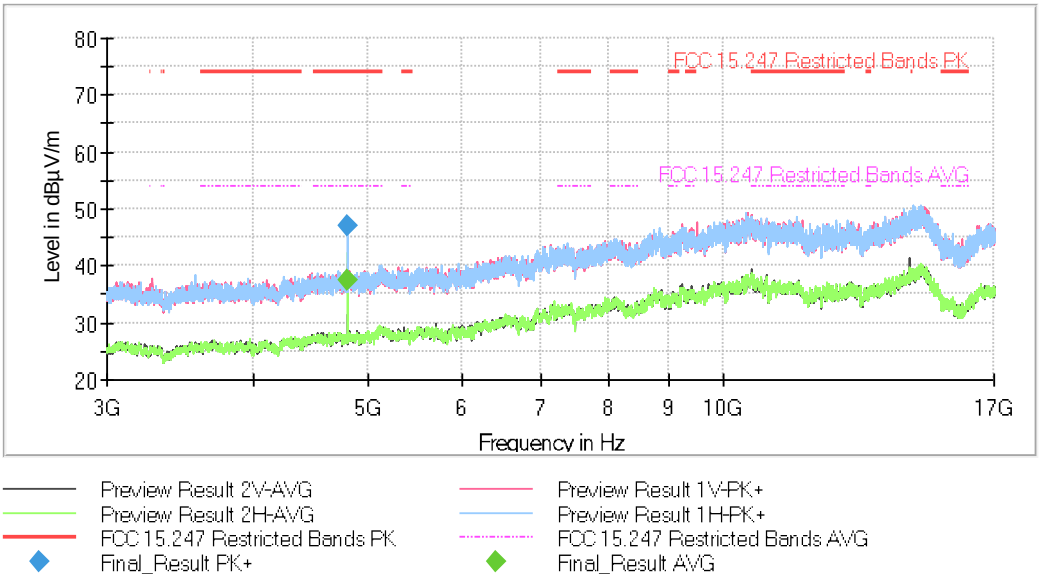
- High Channel:



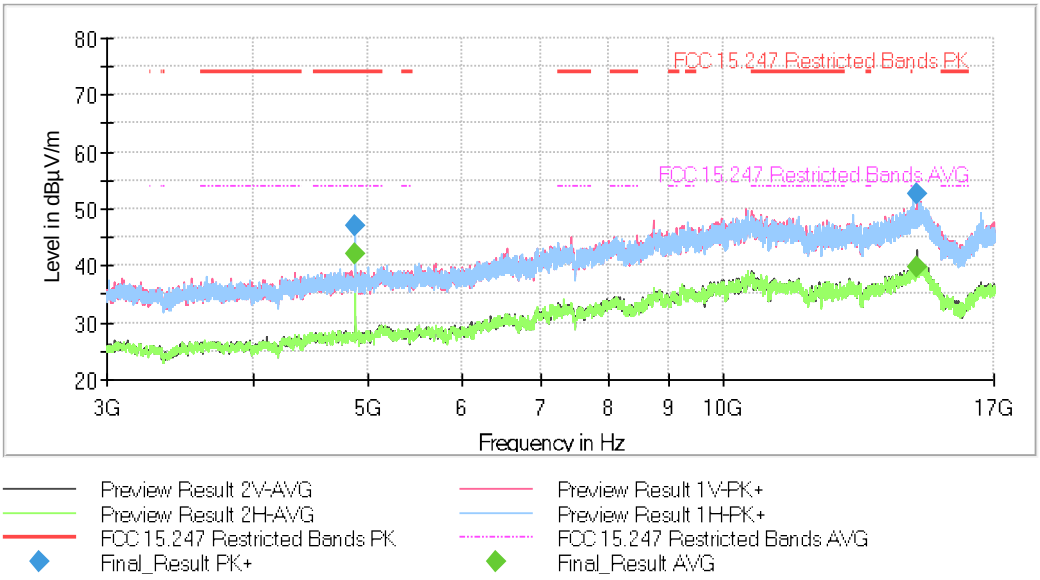
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

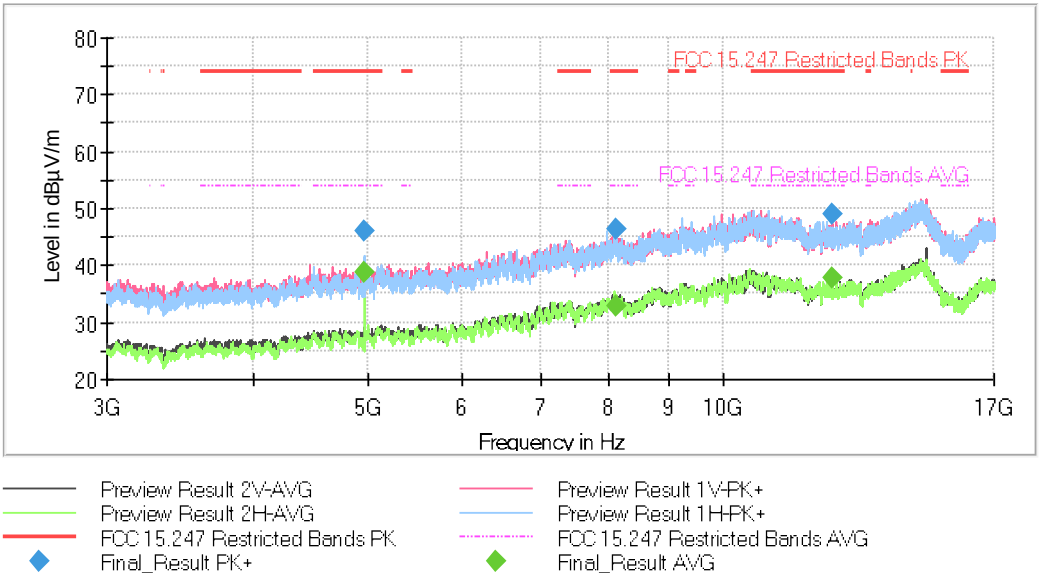
- Low Channel:



- Middle Channel:

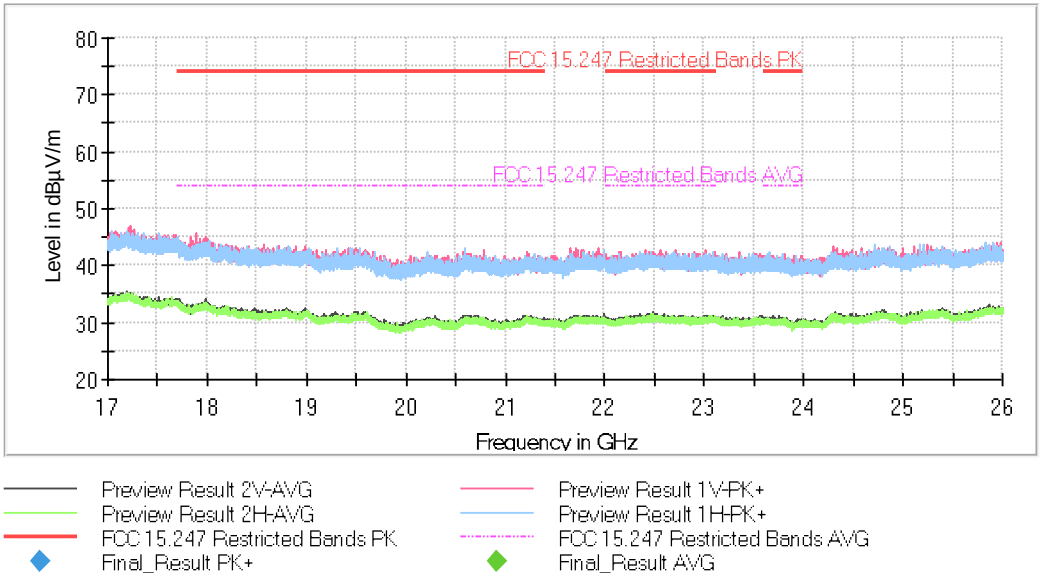


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

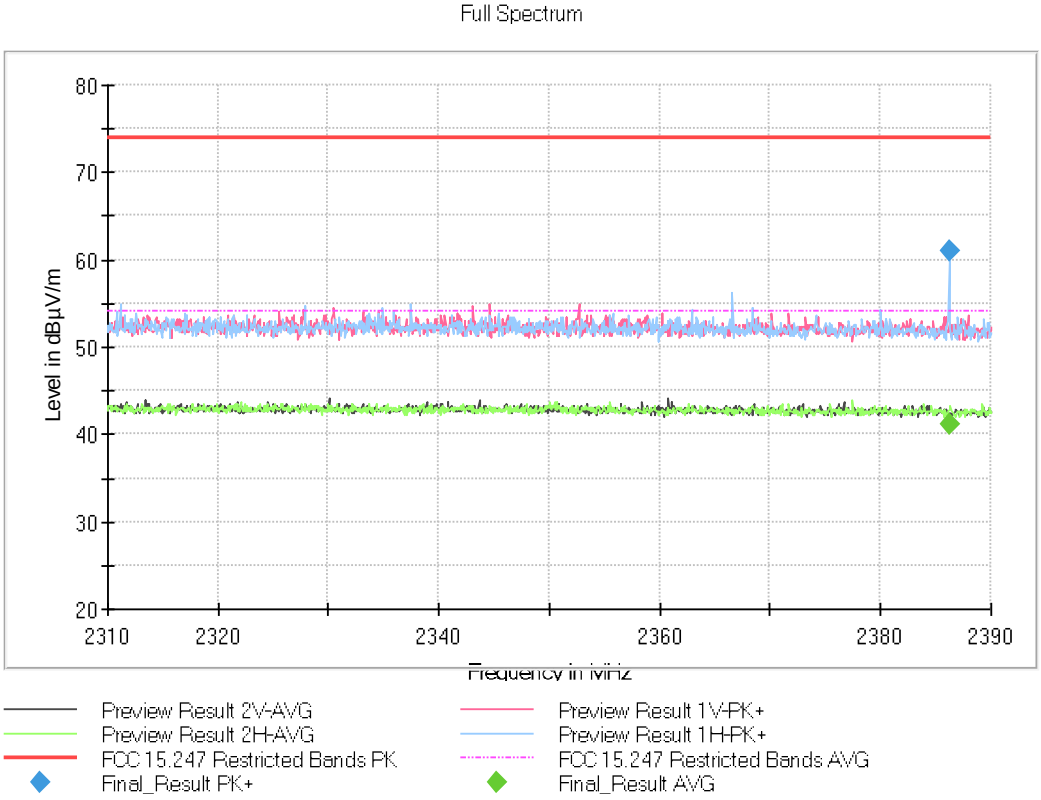
The spurious frequencies detected do not depend on the operating channel.



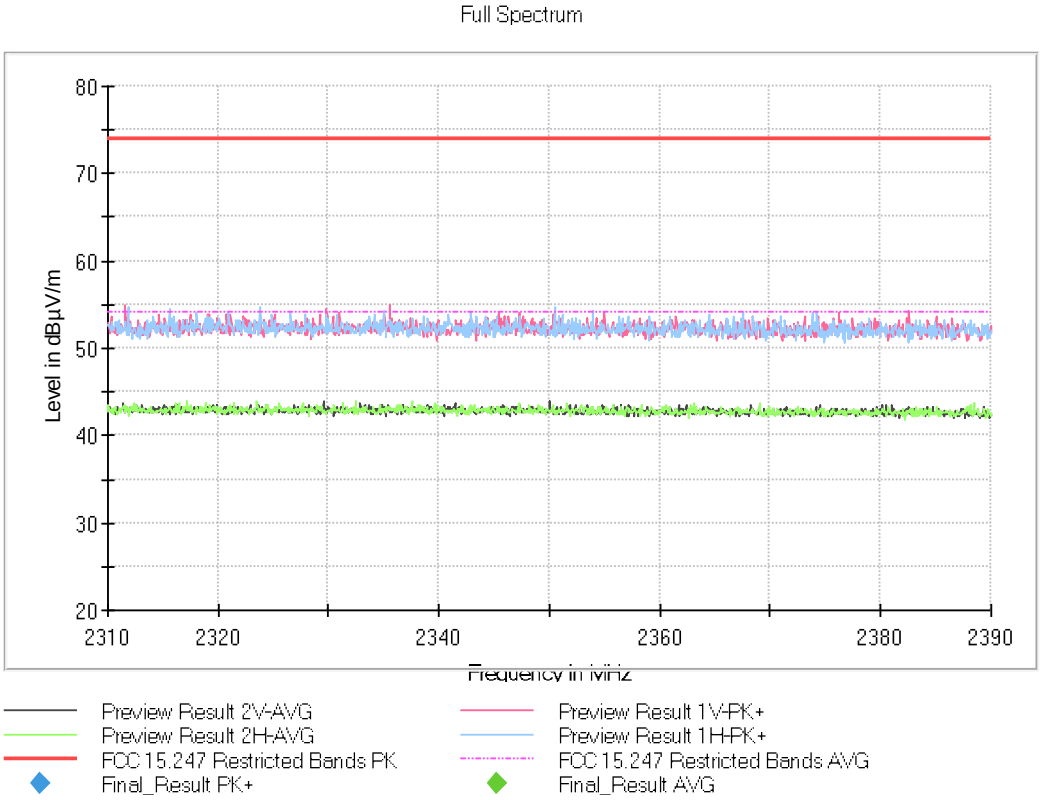
This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

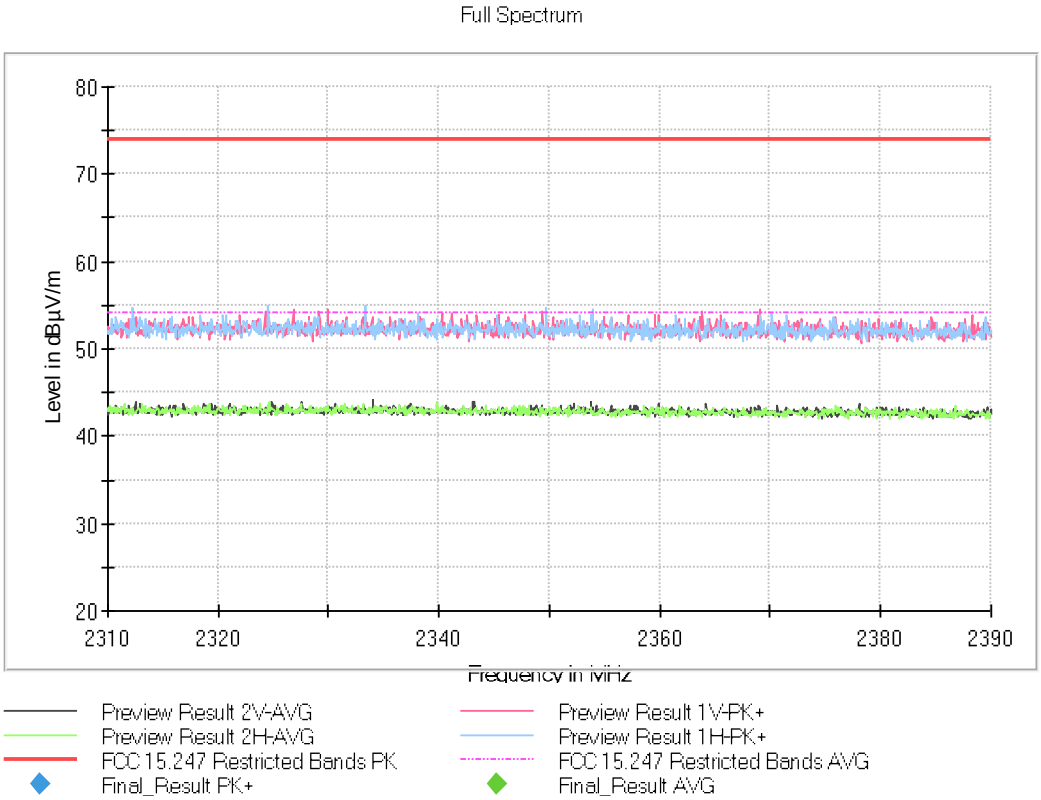
- Low Channel:



- Middle Channel:

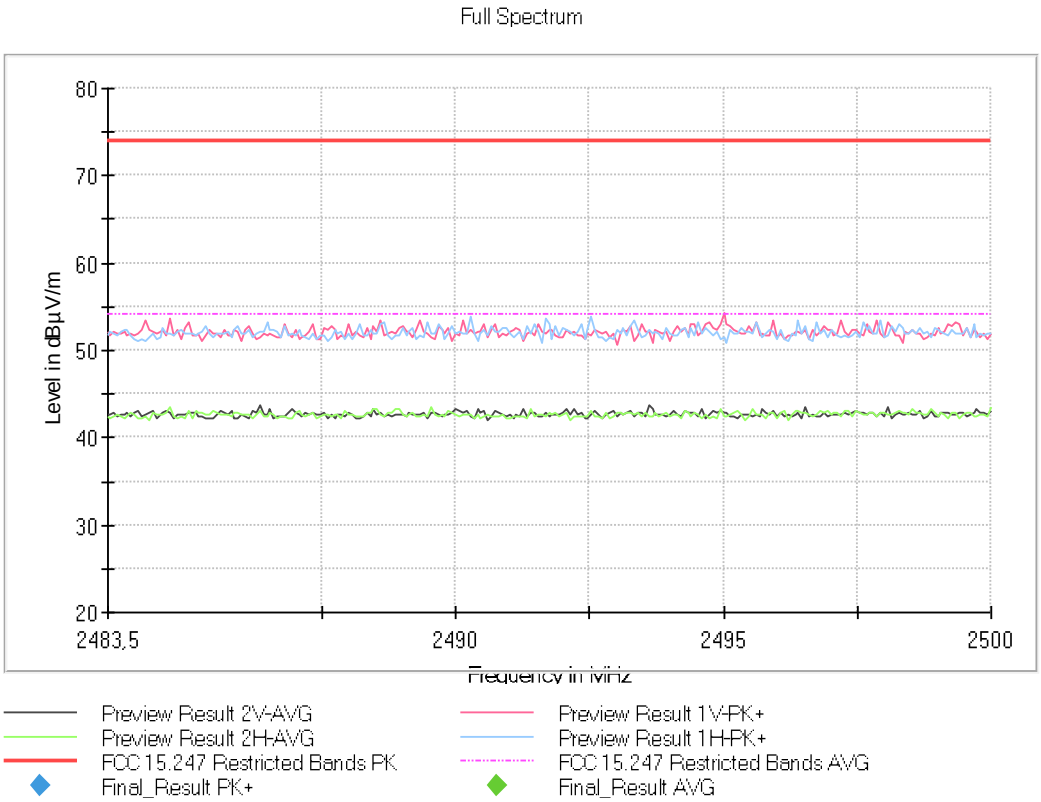


- High Channel:

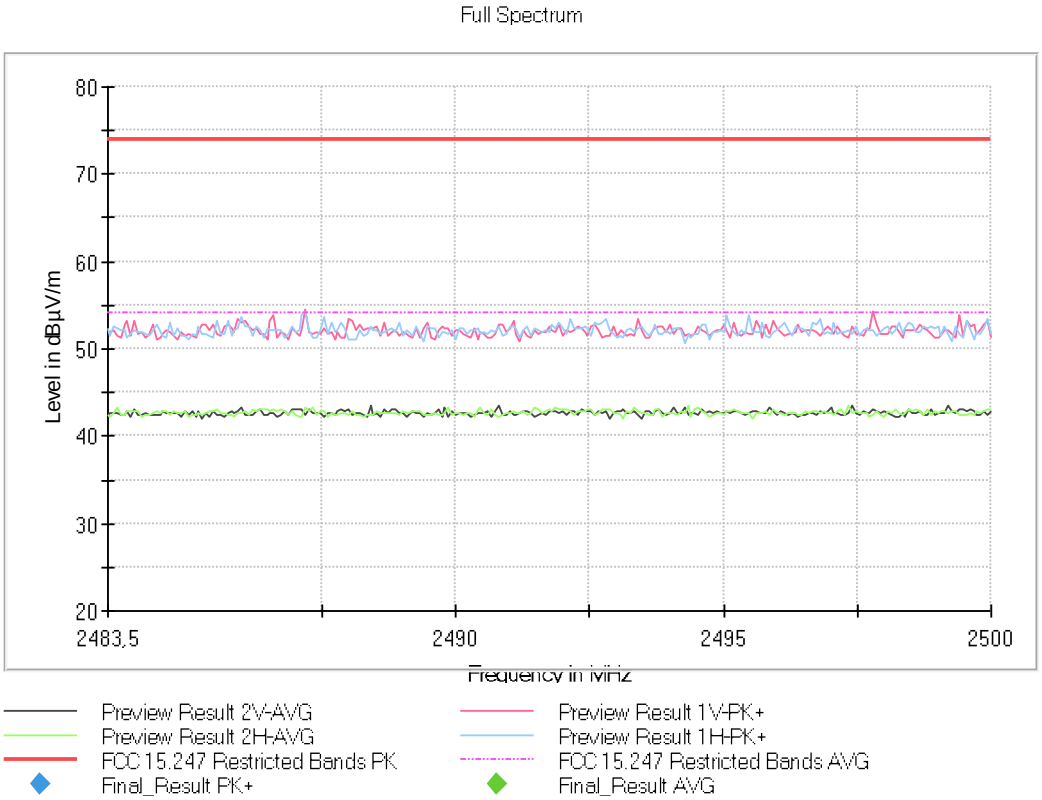


FREQUENCY RANGE 2.4835-2.5 GHz:

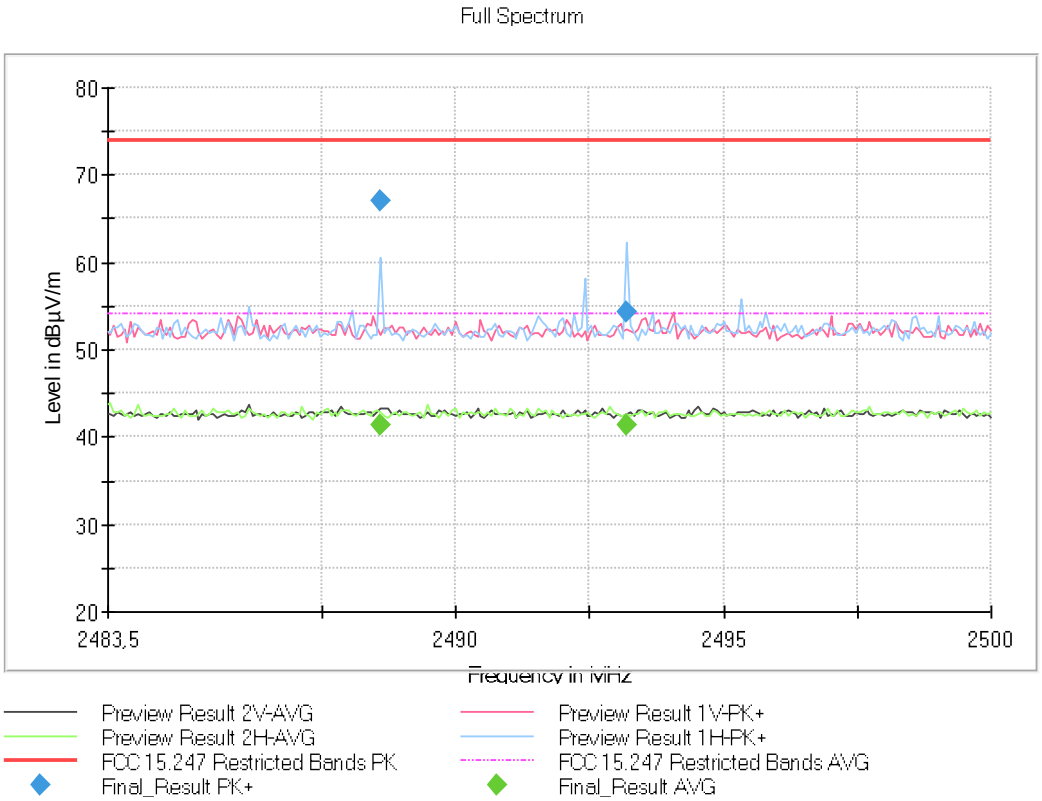
- Low Channel:



- Middle Channel:



- High Channel:



Appendix D: Test results. Proprietary protocol Flora 2.4 GHz

INDEX

TEST CONDITIONS

POWER SUPPLY:

V nominal:	3.8 Vdc
Type of Power Supply:	Lithium-Ion rechargeable battery.

ANTENNA:

Type of Antenna:	Internal.
Maximum Declared Antenna Gain:	-0.5 dBi

TEST FREQUENCIES:

Low Channel:	2402 MHz
Middle Channel:	2440 MHz
High Channel:	2480 MHz

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

The DC supply voltage is applied using an external power supply.

RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

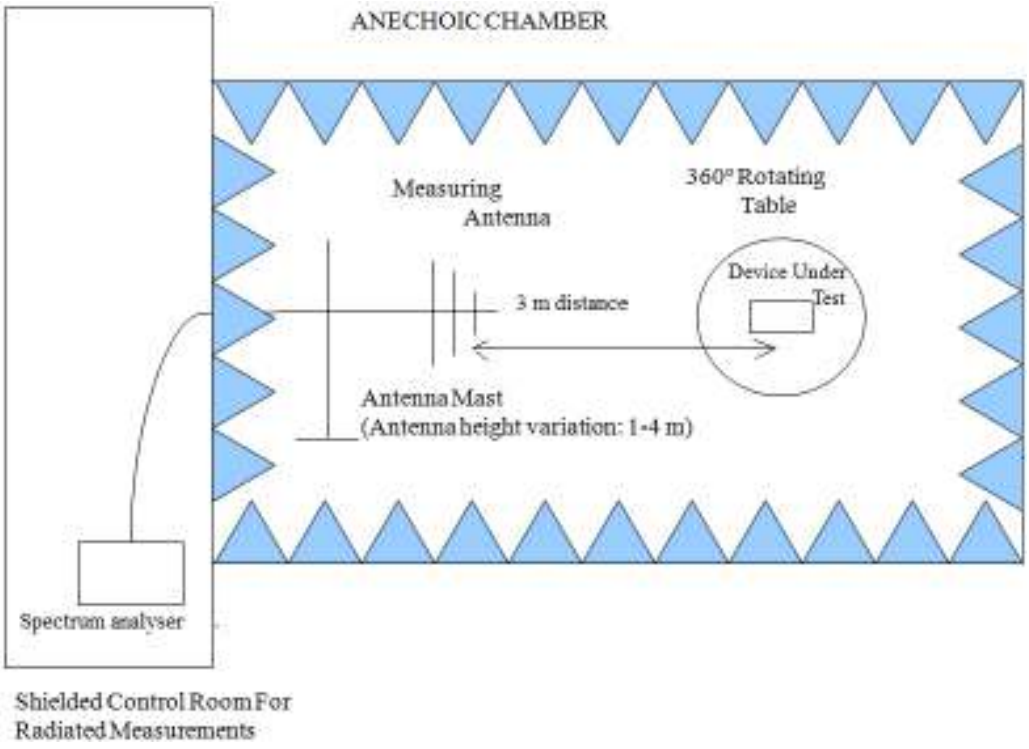
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

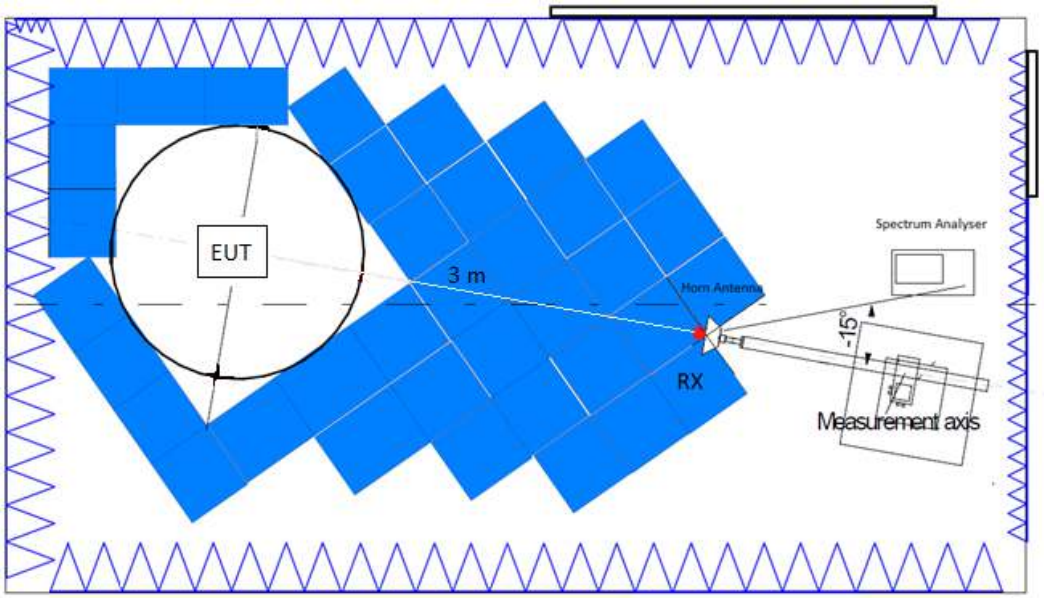
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

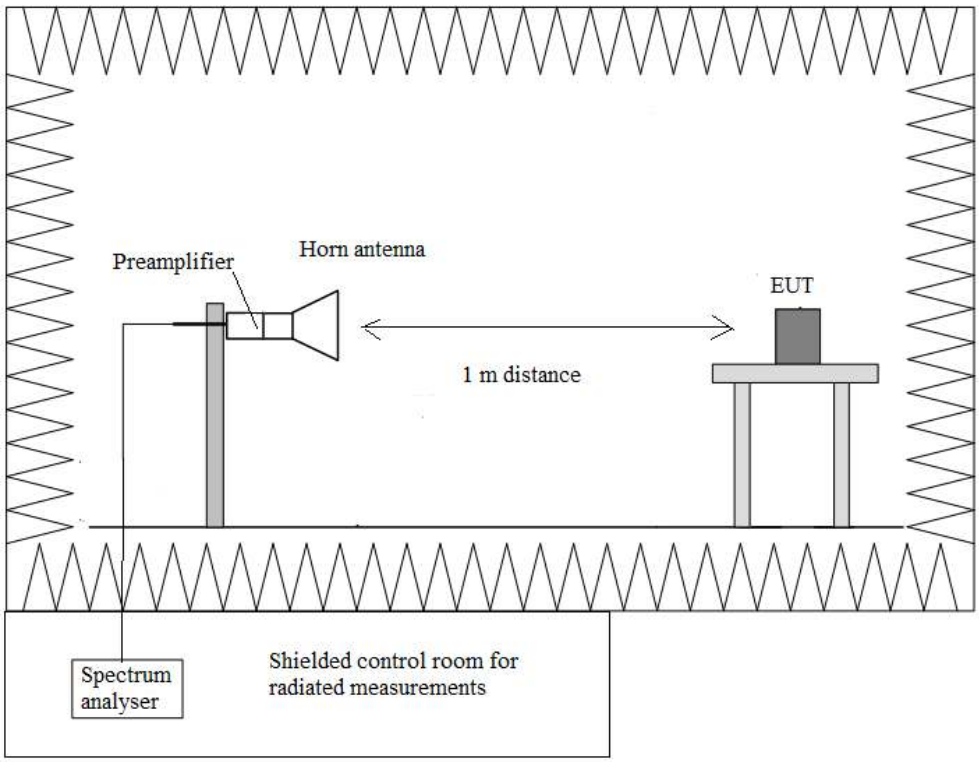
Radiated measurements setup f < 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



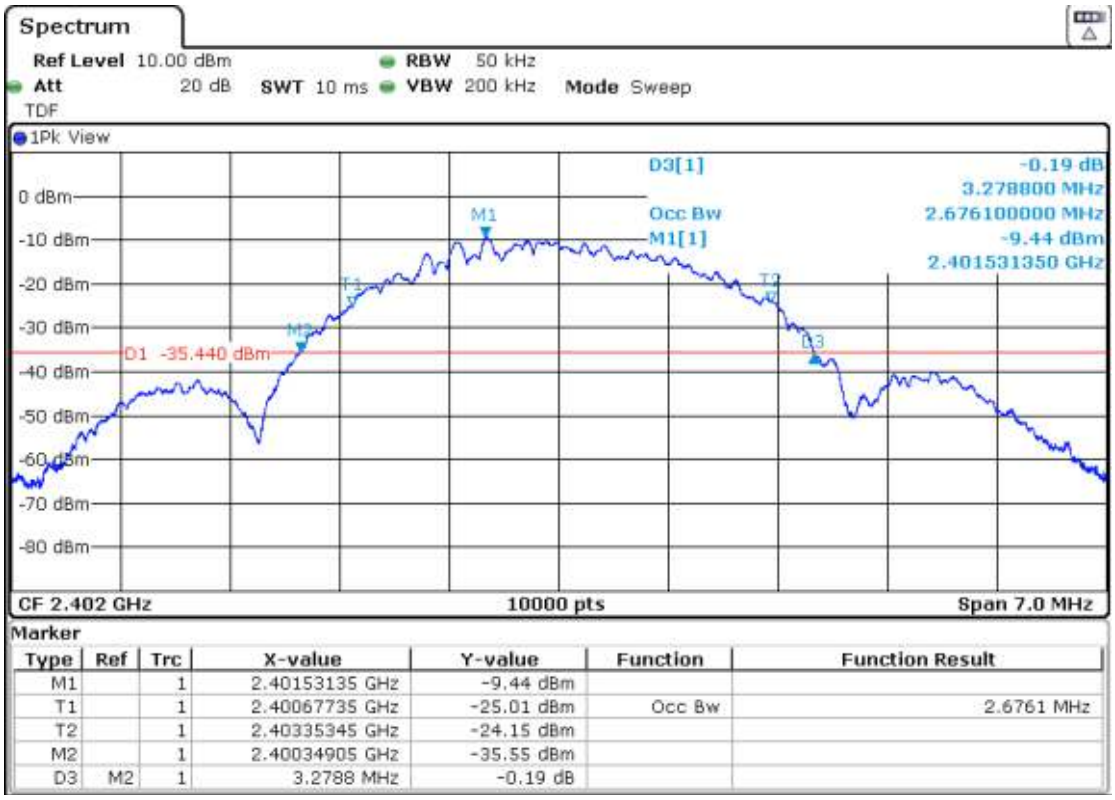
Occupied Bandwidth

RESULTS:

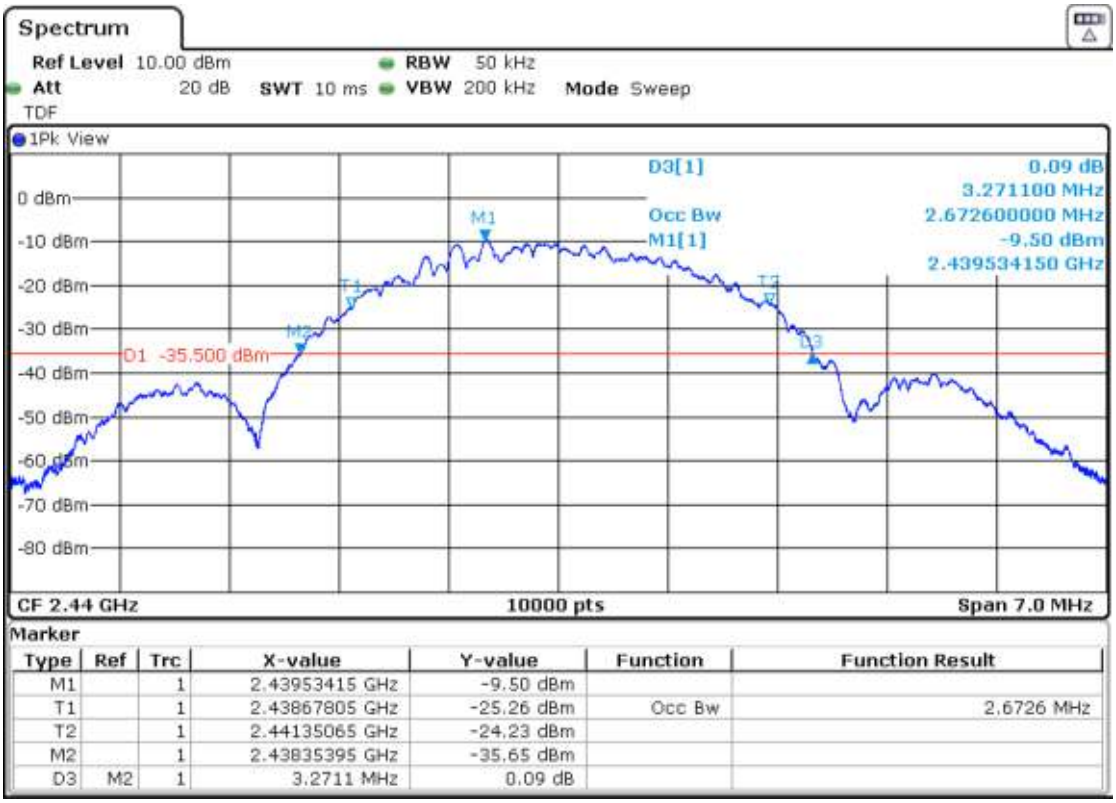
	Low Channel	Middle Channel	High Channel
99% Bandwidth (MHz)	2.6761	2.6726	2.6712
Measurement Uncertainty (kHz)	<±3.64		

Verdict: PASS

- Low Channel:



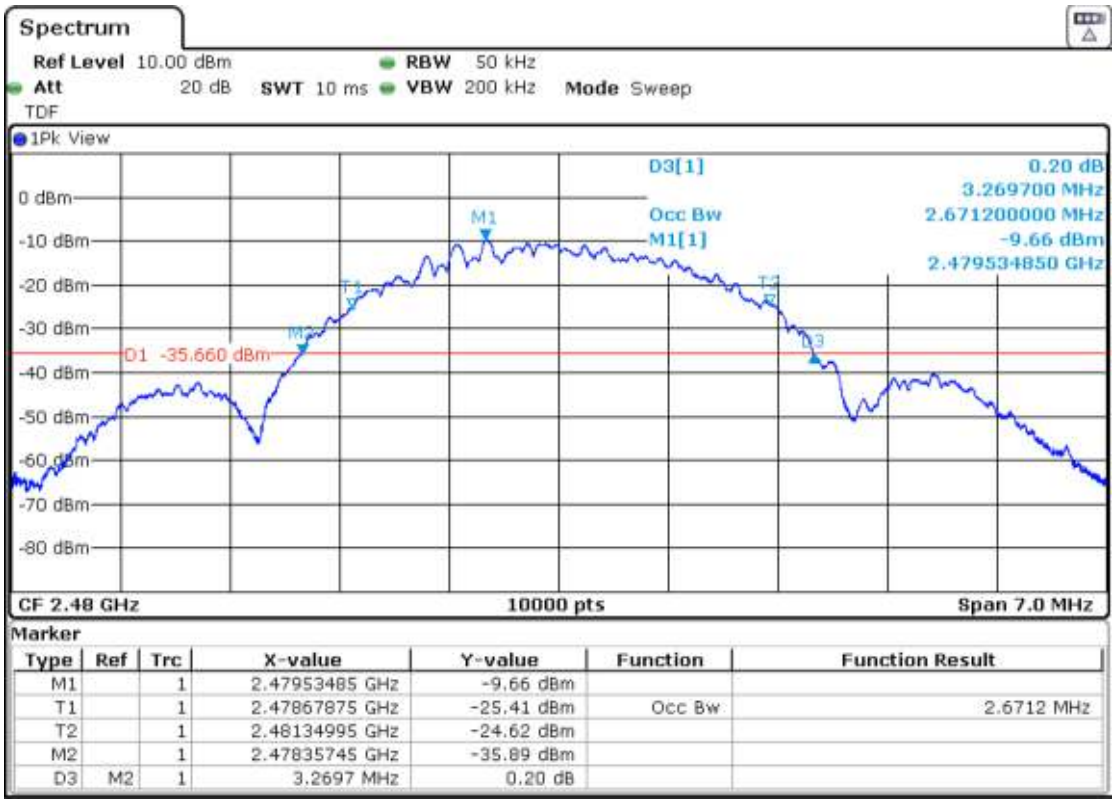
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.43953415 GHz	-9.50 dBm		
T1		1	2.43867805 GHz	-25.26 dBm	Occ Bw	2.6726 MHz
T2		1	2.44135065 GHz	-24.23 dBm		
M2		1	2.43835395 GHz	-35.65 dBm		
D3	M2	1	3.2711 MHz	0.09 dB		

- High Channel:



Marker

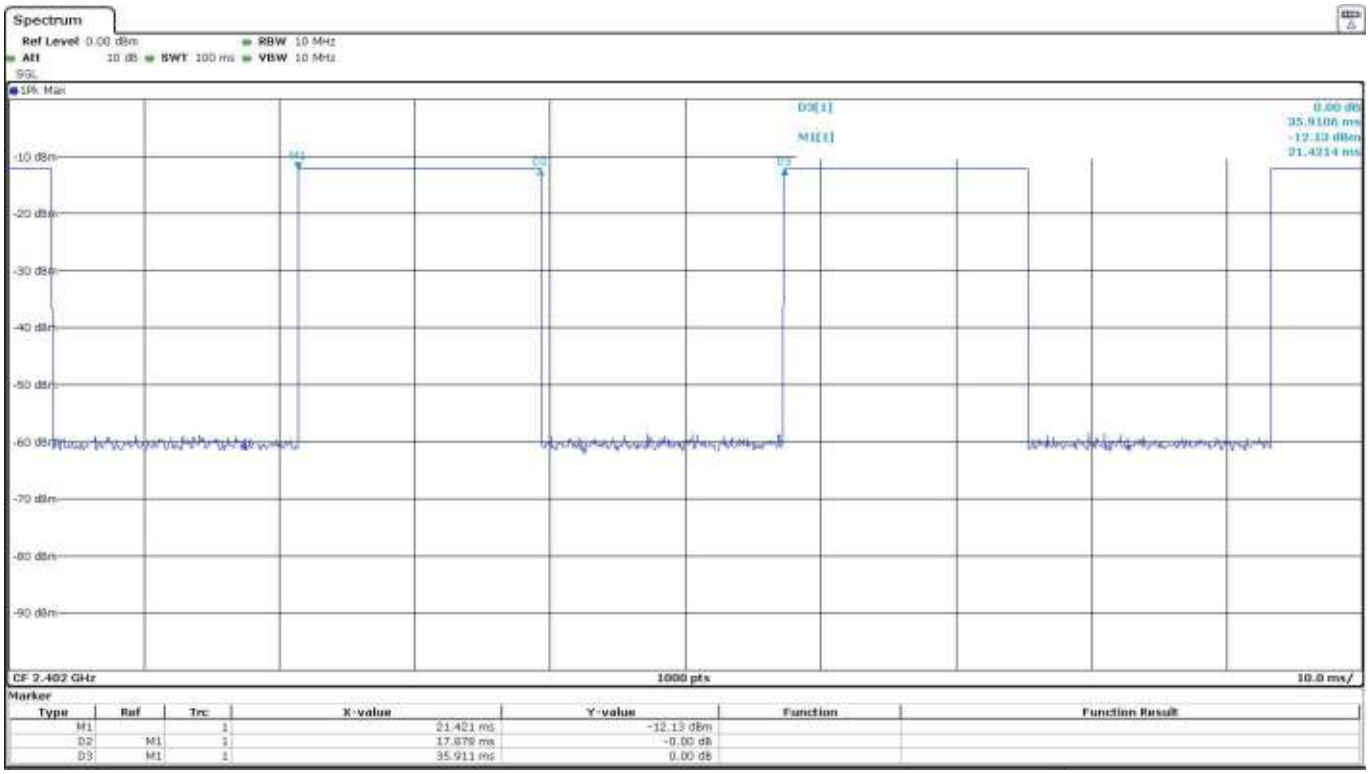
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47953485 GHz	-9.66 dBm		
T1		1	2.47867875 GHz	-25.41 dBm	Occ Bw	2.6712 MHz
T2		1	2.48134995 GHz	-24.62 dBm		
M2		1	2.47835745 GHz	-35.89 dBm		
D3	M2	1	3.2697 MHz	0.20 dB		

Duty cycle

Computation of duty-cycle correction factor

Number of pulses within 100 ms: 2.6

Pulse duration: 17.878 ms.



Duty-cycle correction factor calculation.

Duration (ms)	Number of pulses	“On Time” (ms)
17.878	2.6	46.48

Duty cycle in 100ms = “On Time” / 100 ms = 0.4648
Duty cycle correction factor δ = 20 log (0.4329) = -6.65 dB

15.249 (a) / RSS-210 B.10 (a) Field strength of fundamental and harmonics emissions

SPECIFICATION:

The field strength of emissions from intentional radiators shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (mV/m)	Field strength (dBµV/m)	Measurement distance (m)
902 - 928	50	93.98	3
2400 – 2483.5	50	93.98	3
5725 - 5875	50	93.98	3
24000-24250	250	107.96	3

For frequencies above 1000 MHz, the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

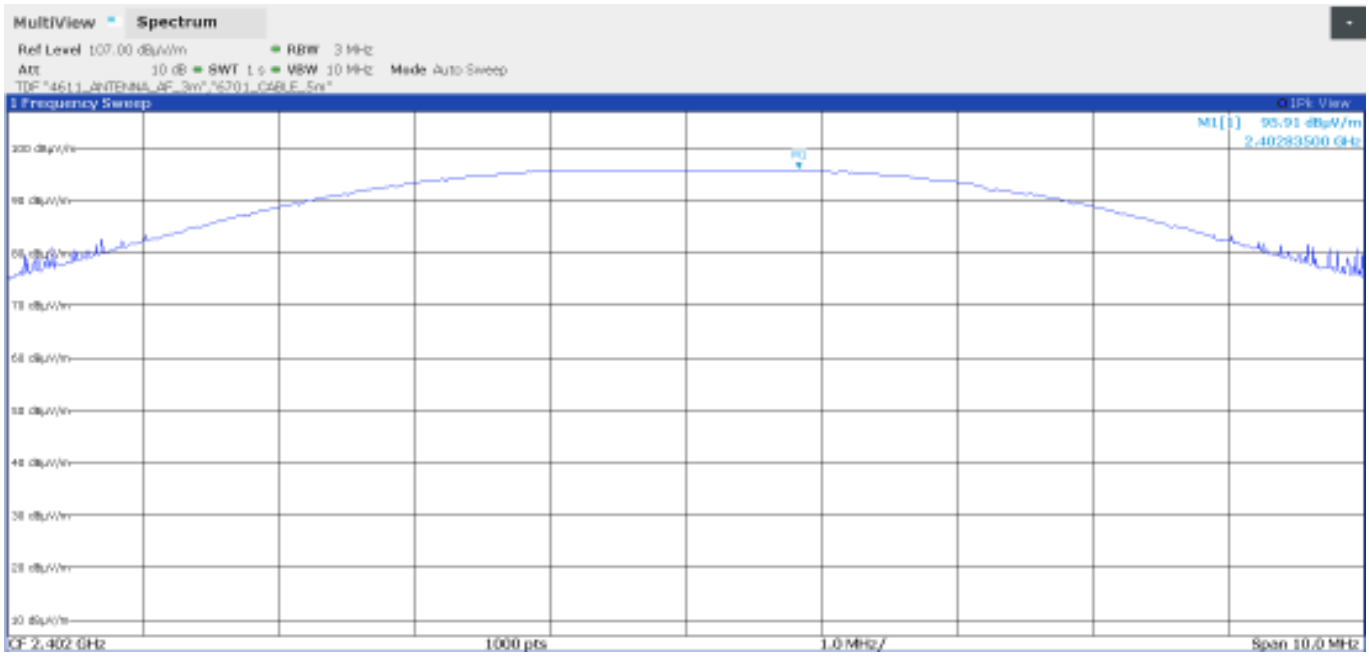
RESULTS:

	Low Channel	Middle Channel	High Channel
Field Strength (dBµV/m) Peak	95.91	96.56	95.61
Duty cycle correction factor δ (dB)	-6.65	-6.65	-6.65
Field Strength (dBµV/m) Average	89.26	89.91	88.96
Measurement Uncertainty (dB)	<±4.11		

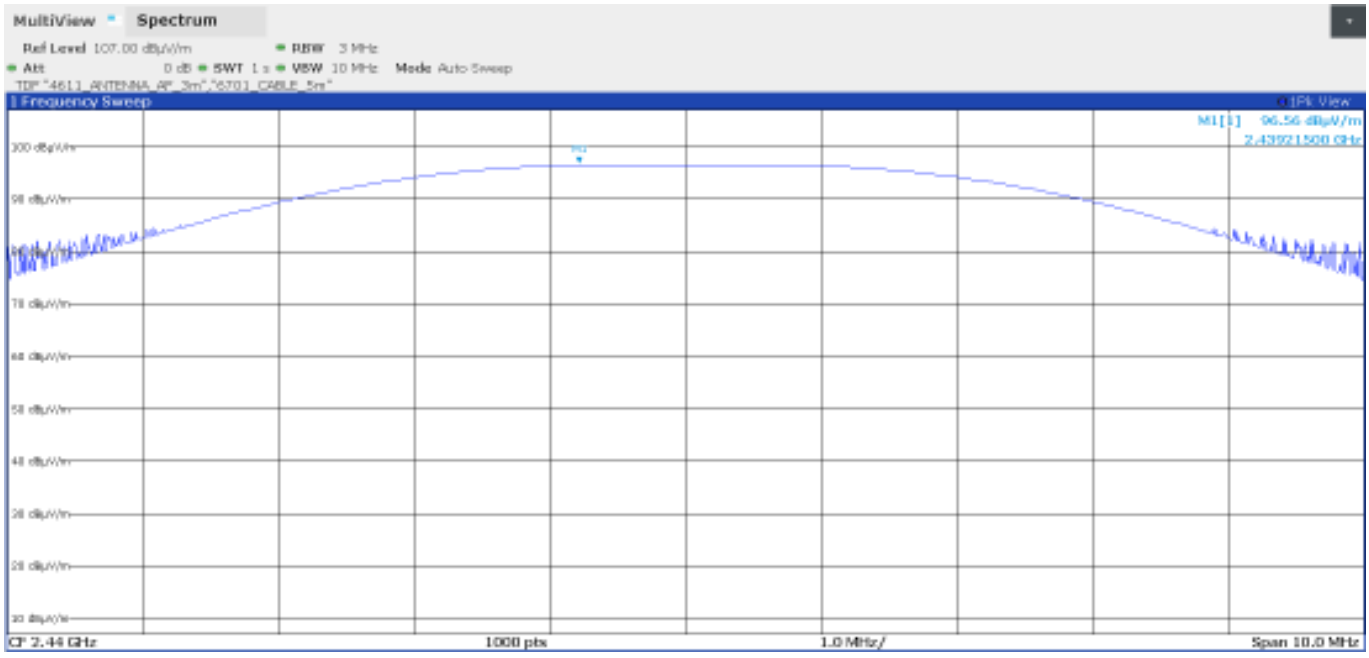
Verdict: PASS

FIELD STRENGTH

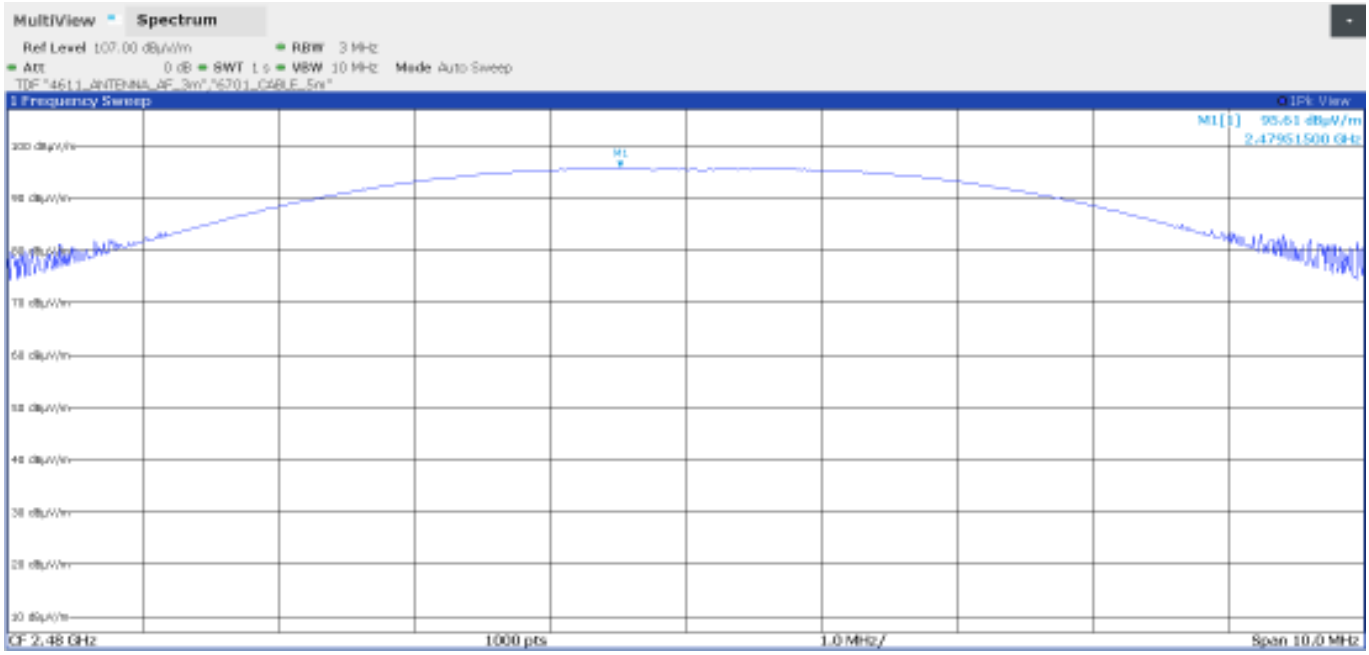
- Low Channel:



- Middle Channel:



- High Channel:



15.249 (d) / RSS-210 B.10 (b) Emissions radiated outside of the specific frequency bands

SPECIFICATION:

The field strength of harmonics from intentional radiators shall comply with the following:

Fundamental frequency (MHz)	Field strength of harmonics (µV/m)	Field strength of harmonics (dBµV/m)	Measurement distance (m)
902 - 928	500	54	3
2400 – 2483.5	500	54	3
5725 - 5875	500	54	3
24000-24250	2500	67.96	3

Emissions radiated outside of the specific frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of fundamental or to the general radiated emission limits specified in section 15.209:

Frequency Range (MHz)	Field strength (µV/m)	Field strength (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	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

Whichever is the lesser attenuation.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-17 GHz and at distance of 1 m for the frequency range 17 GHz-26 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies detected do not depend on the operating channel.

No spurious frequencies detected at less than 20 dB below the limit.

Measurement Uncertainty (dB) <± 4.99

Frequency range 1 - 26 GHz:

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

- LOW CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.38060	53.83	H	Peak
4.80550	47.00	H	Peak
14.41600	50.99	V	Peak

- MIDDLE CHANNEL. Spurious frequencies detected closest to the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
4.88150	46.15	H	Peak
14.64450	52.43	V	Peak

- HIGH CHANNEL. Spurious frequencies detected closest to the limit:

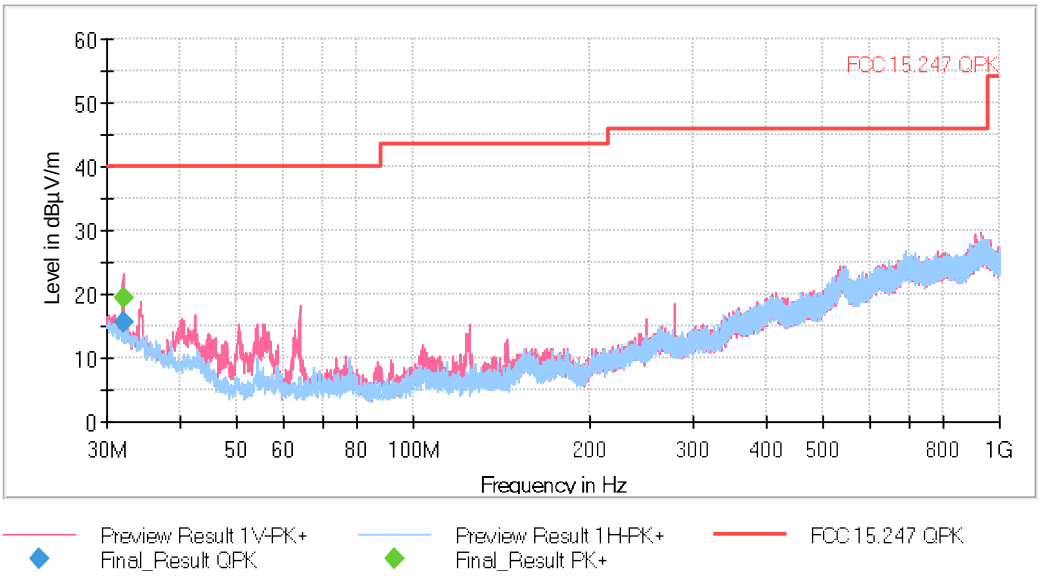
Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
2.48366	72.22	H	Peak
	46.88		Average
2.48506	65.95	H	Peak
	41.39		Average
2.49326	63.04	H	Peak
	41.38		Average
4.95850	45.75	H	Peak

Measurement Uncertainty (dB): $<\pm$ 4.98 for $1 \leq f \leq 17$ GHz
$<\pm$ 5.08 for $17 < f \leq 26$ GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):

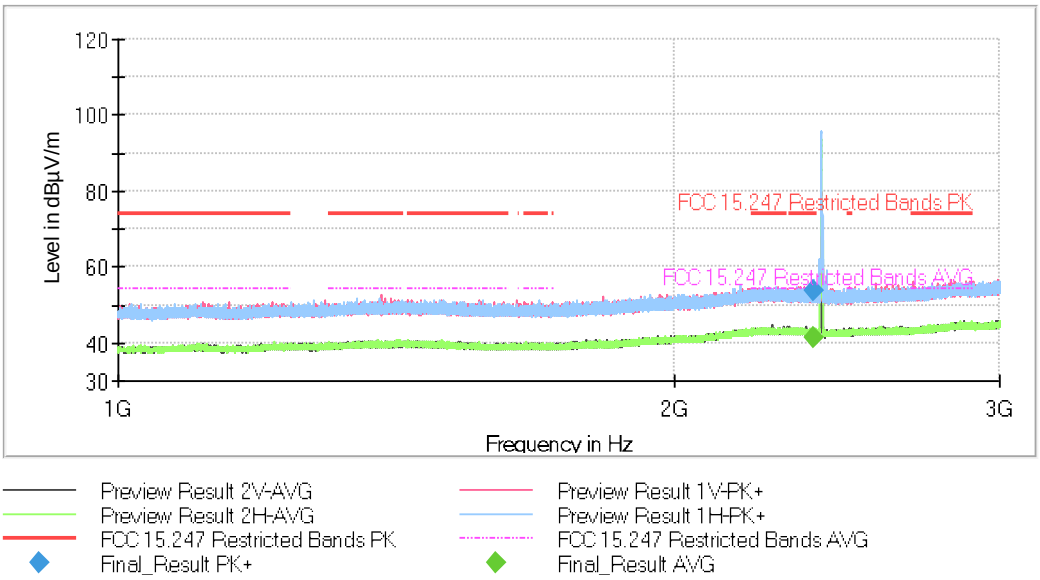
The spurious frequencies detected do not depend on the operating channel.



This plot is valid for the Low, Middle and High Channels.

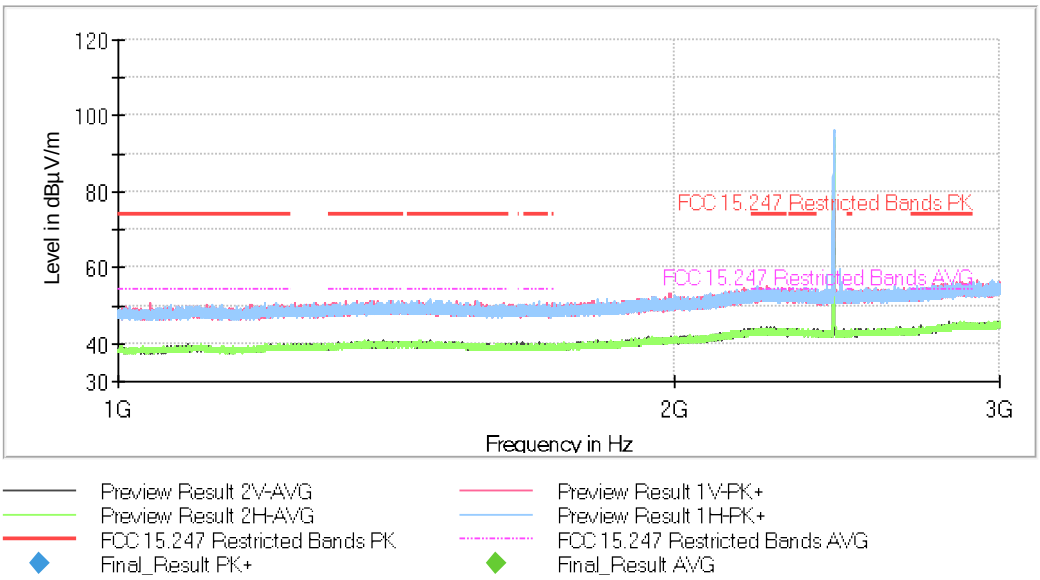
FREQUENCY RANGE 1 - 3 GHz:

- Low Channel:



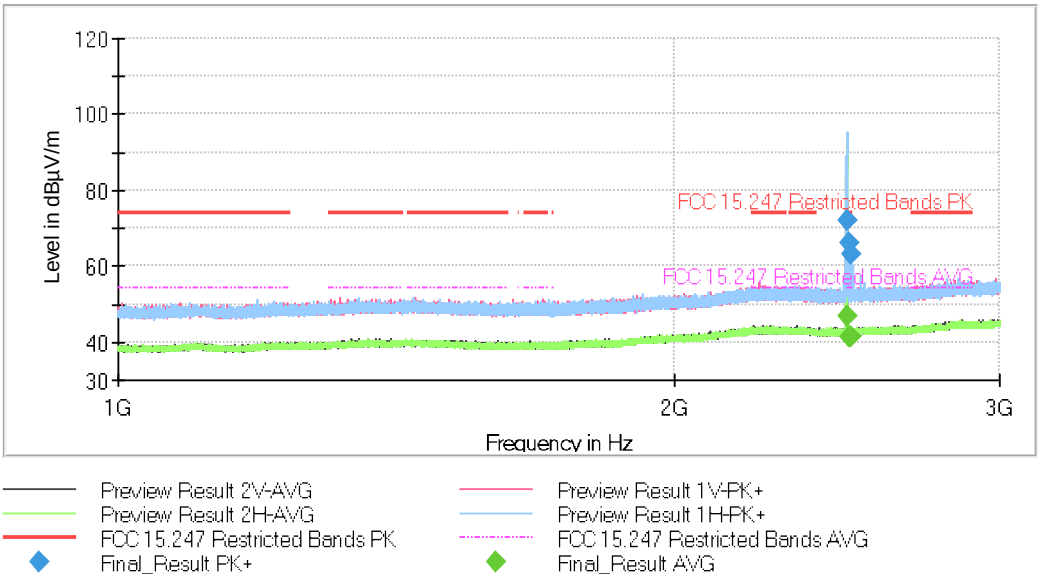
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

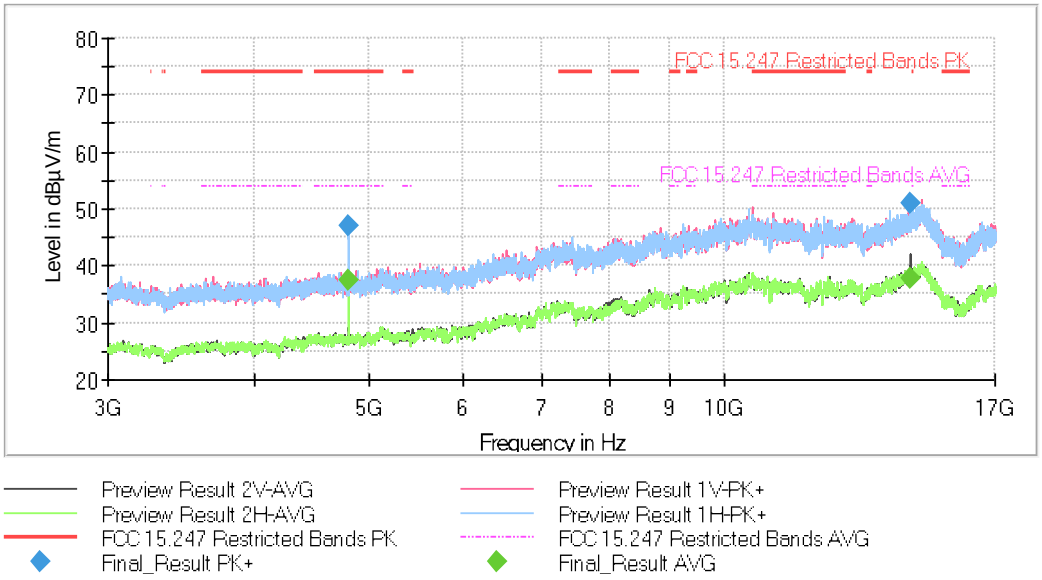
- High Channel:



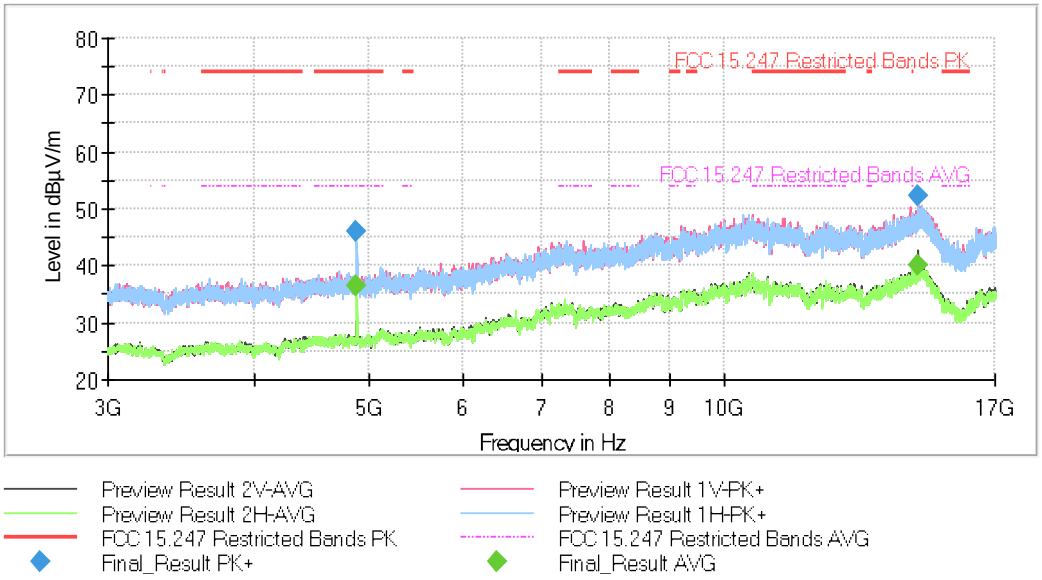
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 - 17 GHz:

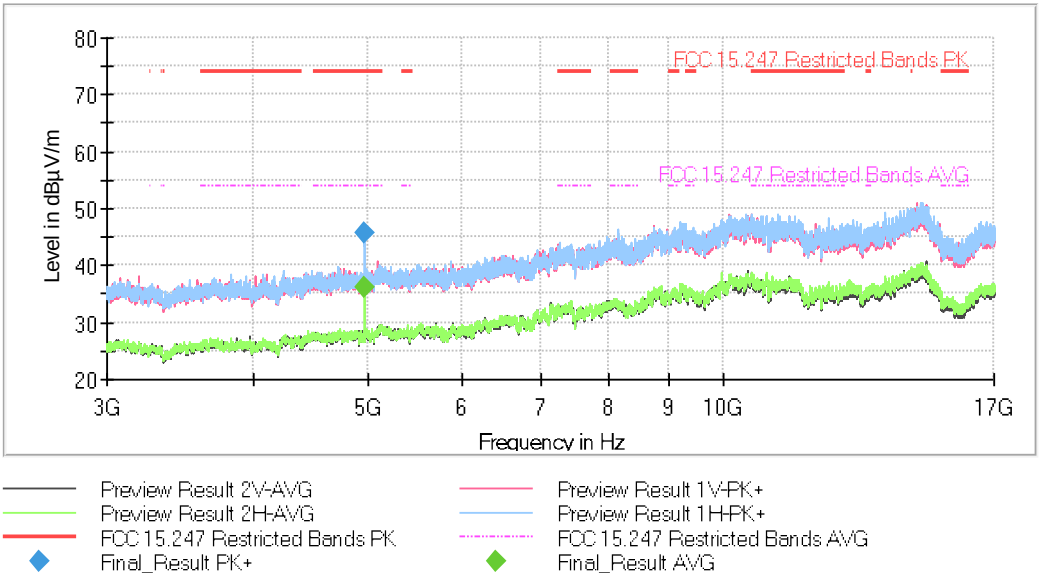
- Low Channel:



- Middle Channel:

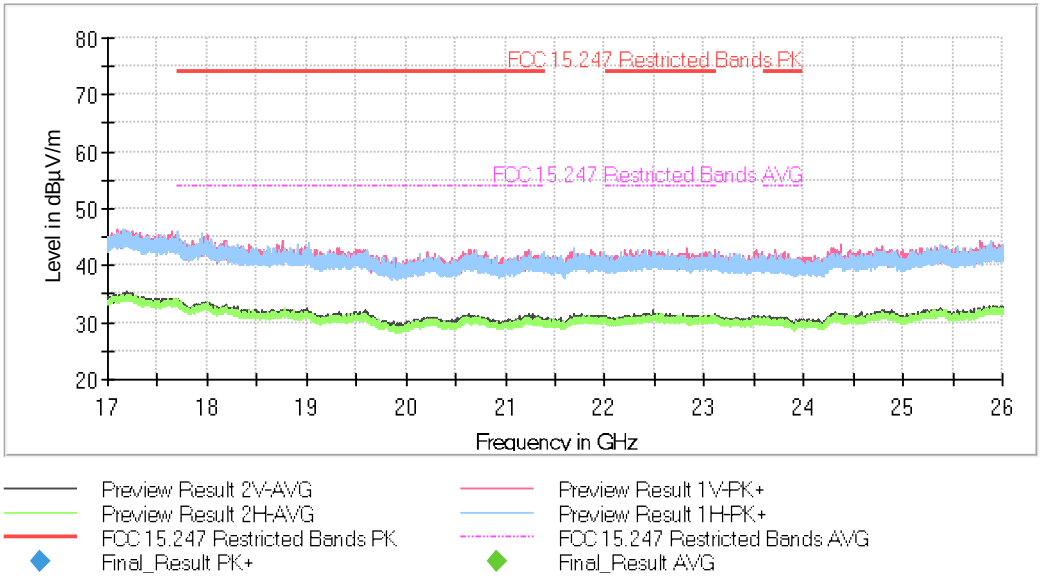


- High Channel:



FREQUENCY RANGE 17 - 26 GHz:

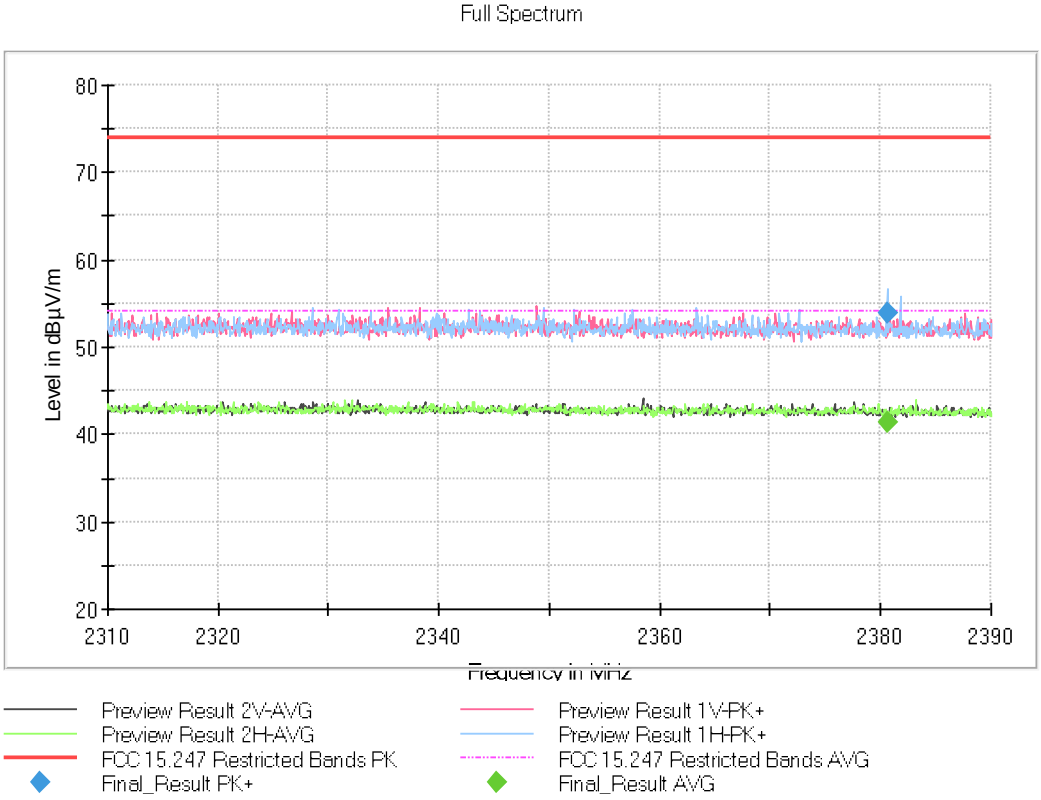
The spurious frequencies detected do not depend on the operating channel.



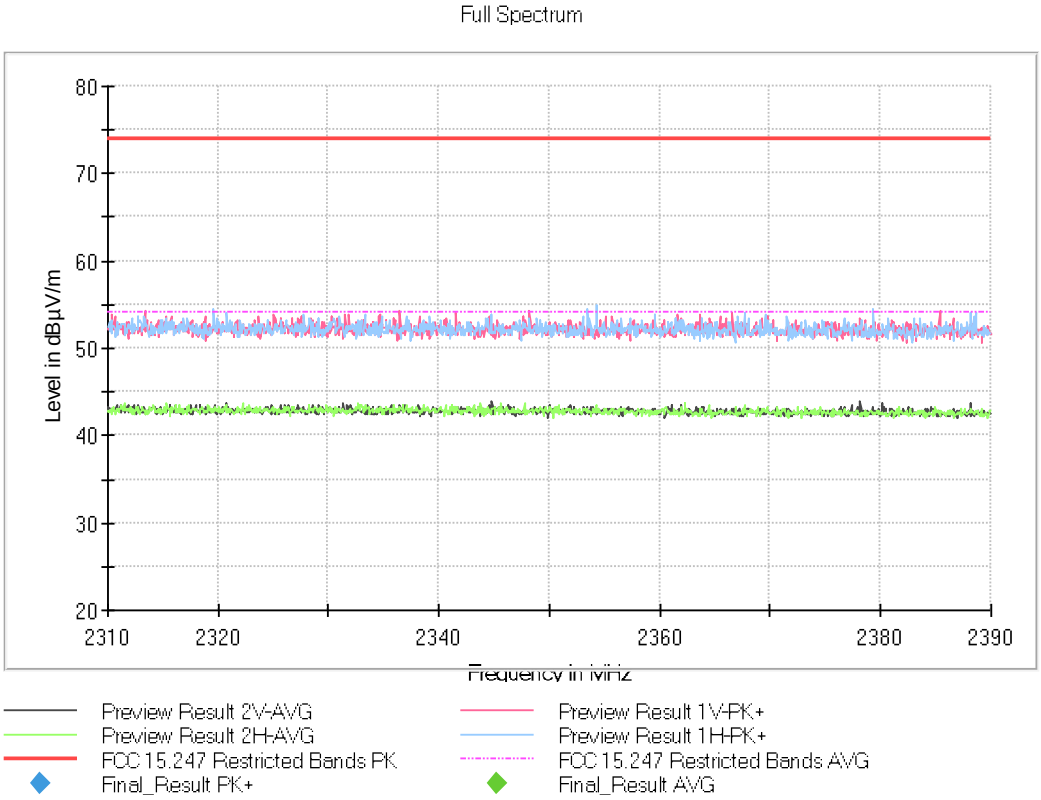
This plot is valid for the Low, Middle and High Channels.

FREQUENCY RANGE 2.31-2.39 GHz:

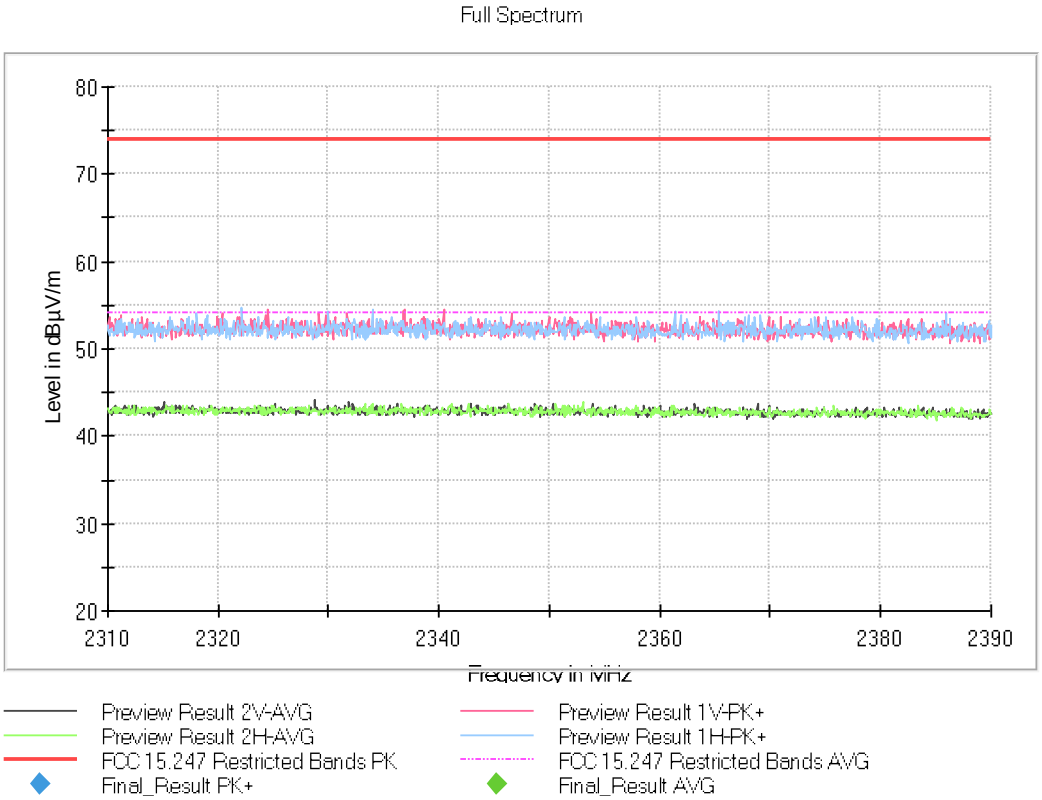
- Low Channel:



- Middle Channel:

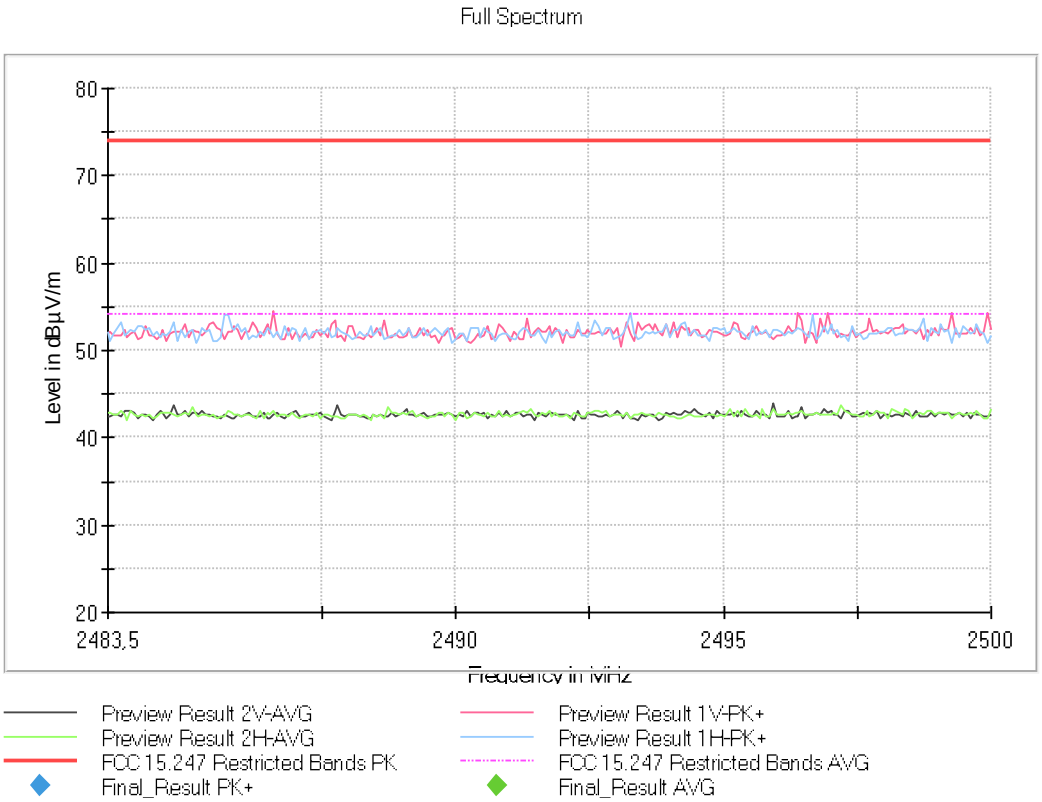


- High Channel:

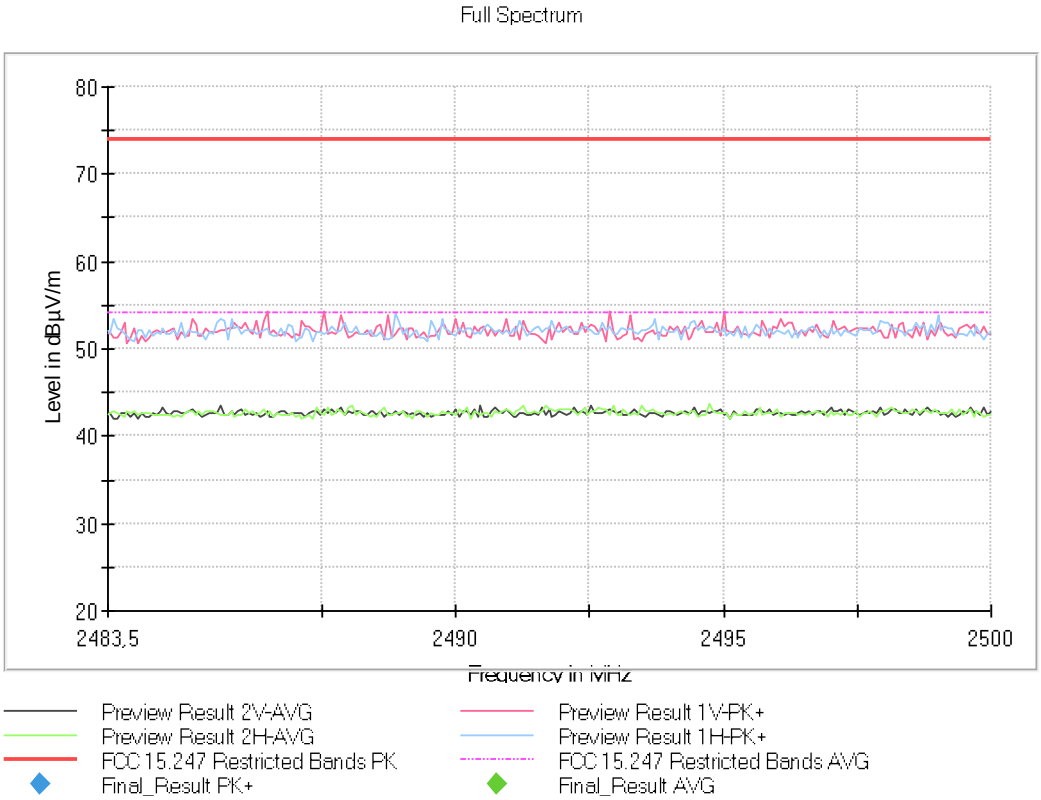


FREQUENCY RANGE 2.4835-2.5 GHz:

- Low Channel:



- Middle Channel:



- High Channel: