

Radio Test Report

According to

**FCC part 15C,
RSS-247, RSS-Gen**

DUT Name: Haltian RADAR
Model No. : DRA
Customer: Haltian Oy
Address: Yrttipellontie 1 D, FIN-90230 OULU
Summary: IN COMPLIANCE
Date of Reception: 08.12.2023
Date(s) of Test(s): 12.12.2023 – 18.1.2024

Tested by Test Engineer


Pekka Pulkkinen

Approved by Technical Manager


Jukka Rauma

The test report shall not be reproduced except in full, without the written approval of the laboratory. This report is only for the equipment which is described in page 4.

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Document Version History	Date of issue	Comments	Approved by
v0.1	28.2.2024	Initial version	
v1.0	18.3.2024	Approved version	Jukka Rauma
v2.0	18.10.2024	Second approved version. EUT and test setup pictures moved to 3897RER004_Annex1	Jukka Rauma

1. General Information

Test Engineer(s): Arto Kuosmanen, Pekka Pulkkinen

Location:

Test Firm Name	Eurofins Electric & Electronics Finland Oy (EEEF)
Test Site	Yrttipellontie, Peltola
Address of Test Site	Yrttipellontie 6, 90230 Oulu, Finland
FCC Designation number	FI0008
FCC site registration number	771880
ISED number	29576
CAB Identifier	T290

Customer: Haltian Oy
Juha Pikkarainen
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Climate Conditions: Temperature: 15 - 35 °C
Air pressure: 860 - 1060 hPa
Humidity: 30-60 rH%
These limits were not exceeded during testing.

2. Test Samples

General description:

Haltian RADAR senses warehouse loading dock or parking slot occupancy status and sends this information via Wirepas mesh network to Thingsee Gateway and from there to Cloud. The device is also capable of performing at least up to 1 cm accurate distance measurements. Haltian RADAR is built for tough environments and fulfills the MIL-STD-810H Military Standard.

Test sample (Conducted):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3897ER001	TG123098707	Haltian Oy	Radar	DRA	DRA_03	2023_11_17

Test sample (Radiated):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3897ER002	TG123098701	Haltian Oy	Radar	DRA	DRA_03	2023_11_17

Auxiliary equipment:

Sample number	Serial number	Manufacturer	DUT Type	Model
3897ER004	PC-OYR95B	Lenovo	Laptop PC	T480S

Description	Information	
Model	DRA	
Additional model	-	
Brand Names(s)	Haltian	
PMN	Haltian RADAR	
HVIN	DRA	
FVIN	2023_11_17	
HMN	N/A	
FCC ID	2AEU3HARADAR	
IC ID	20236-HARADAR	
Equipment type	End product	
Radio type	Transceiver	
- operating frequency range:	2400.0 MHz – 2483.5 MHz	
- Nominal Channel Bandwidth:	1 MHz	
Radio technology / type of equipment	Bluetooth 5.2	
Modulation:	GFSK	
Number of antennas	1	
Bluetooth Specification	LE 1Mbps PHY	Yes
	LE 2Mbps PHY	No
	LE Coded PHY S=2 (500 kbit)	No
	LE Coded PHY S=8 (125 kbit)	No
	Stable Modulation Index - Transmitter	No
	Stable Modulation Index - Reer	No
Antenna	Type	Integral antenna as a strip line on PCB
	Model	Custom
	Manufacturer	Haltian Oy
	Gain	1.75 dBi
Supply voltage	Battery operated, $V_{Nom} = 3.6VDC$	
Type of Power source	Battery operated	
Operating Temperature	T _{Nom} = 25°C T _{Min} = -30°C T _{Max} = 85°C	
Manufacturer	Haltian Oy Yrttipellontie 1 D, FIN-9230 OULU	

3. Configuration and Operation Modes

Conducted RF test:

Test modes / description
GFSK modulation, data rate 1 Mbps, duty cycle 63%
Continuous modulated carrier at 2402 MHz, 2442 MHz and 2480 MHz, power level setting 4 dBm

Conducted and radiated emission test:

Test modes / description
EUT battery powered, continuous modulated carrier at 2402 MHz, 2440 MHz and 2480 MHz, power level setting 4 dBm, data rate 1 Mbps
EUT battery powered, continuous reception at 2440 MHz

Test/configuration software

Manufacturer	Name	Version
Haltian Oy	Python script	1.0

4. Test equipment

Conducted RF tests

R&S TS8997 Test System equipment list:

Equipment	Certification-No.	Calibration Date	Next calibration
SMW200A	1035089-D-K-15195-01-00-2022-03	26.06.2023	25.06.2026
SMB100A	1041326-D-K-15195-01-00-2022-03	26.06.2023	25.06.2026
OSP-B157WX+OSP220	300642762-D-K-15195-01-00-2022-03	26.06.2023	25.06.2024
OSP-B157W8plus+OSP150	300639878-D-K-15195-01-00-2022-03	26.06.2023	25.06.2024
ESW	1039208-D-K-15195-01-00-2022-03	05.07.2023	04.07.2024
CMW500	300693633-D-K-15195-01-00-2023-04	25.04.2023	24.04.2024

Radiated emission

New ID	Manufacturer	Equipment type	Description	Serial	Calibration information	Next calibration
G4C265	Rohde & Schwarz	ESW26	EMI test receiver	101324	29.6.2023	29.6.2024
G4C273	Frankonia	ALX-4000E	Broadband Antenna, 25MHz-4GHz with 6dB (50-A-MFN-06) att.	00816+1531	22.1.2023	22.1.2027
G4C469	Rohde & Schwarz	TS_PRE2	RF Preamplifier	101541	9.6.2022	9.6.2024
G4C576	Rohde & Schwarz	HF907	Double-Ridged Waveguide Horn Antenna 800MHz-18GHz	100163	9.8.2022	9.8.2025

Test software

Description	Manufacturer	Name	Version
EMC Software	Rohde & Schwarz	EMC32	10.60.20
RF Software	Rohde & Schwarz	WMS32	11.60.00

5. Uncertainties

Description	Expanded Uncertainty (k=2)
RF Output Power	0,99
Peak Power	0,80
Power Spectral Density	0,99
Accumulated Transmit Time	0,01%
Minimum Frequency Occupation Time	0,01%
Hopping Frequency Separation	0,60%
Occupied Channel Bandwidth	2,08 %
Out-of-band emissions	0,89
Transmitter unwanted emissions in the spurious domain	1,76
AC conducted emission	2,24
Radiated emission ≤ 1 GHz	4,62
Radiated emission > 1 GHz	5,72

6. Sample emission level calculation

The following is a description of term and a sample calculation, as appears in the radiated emissions data table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading:

This is the reading obtained on the spectrum analyzer in dBuV.

A.F.:

This is the antenna factor for the receiving antenna. It is a conversion factor, which converts electric fields strength to voltages, which can be measured directly on the spectrum analyzer. It is treated as a loss in dB. RF path losses, including RF cables and preamplifiers, have been included with the A.F to simplify the calculations. The antenna factor is used in calculations as follows:

$$\text{Reading on Analyzer (dBuV)} + \text{A.F. (dB/m)} = \text{Net field strength (dBuV/m)}$$

Net:

This is the net field strength measurement (as shown above).

Limit:

This is the FCC Class B radiated emission limit (in units of dBuV/m). The FCC limits are given in units of uV/m. The following formula is used to convert the units of uV/m to dbuV/m:

$$\text{Limit (dBuV/m)} = 20 * \log(\text{uV/m})$$

Margin :

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Example only:

Reading + AF	= Net Reading :	Net reading – FCC limit	= Margin
+ 21.5 dBuV + 26 dB/m	= 47.5 dBuV/m :	47.5 dBuV/m – 57.0 dBuV/m	= -9.5 dB

7. Test conditions

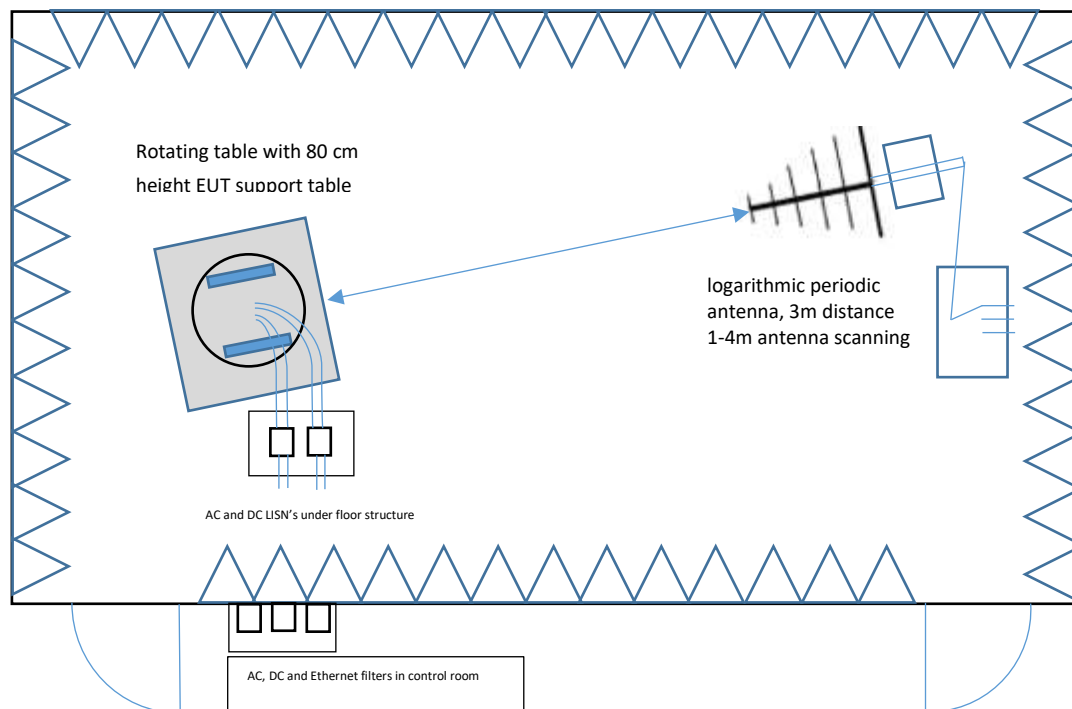
All radiated tests were performed in a semi-anechoic chamber, where the measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz, 1 GHz-18 GHz Double-ridged horn antenna and 18 GHz-40 GHz horn antenna) is located at a distance of 3 m.

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 360° and the antenna height (all antennas) was varied from 1 to 4 meters to find the maximum radiated emission.

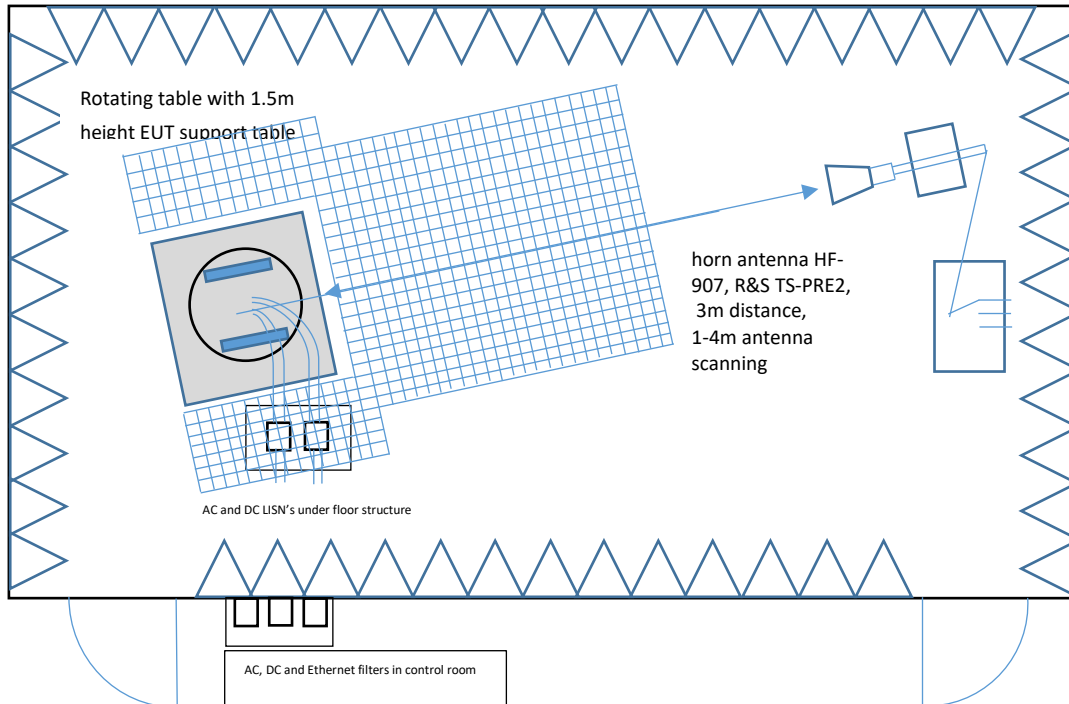
Measurements were made in both horizontal and vertical planes of polarization.

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.

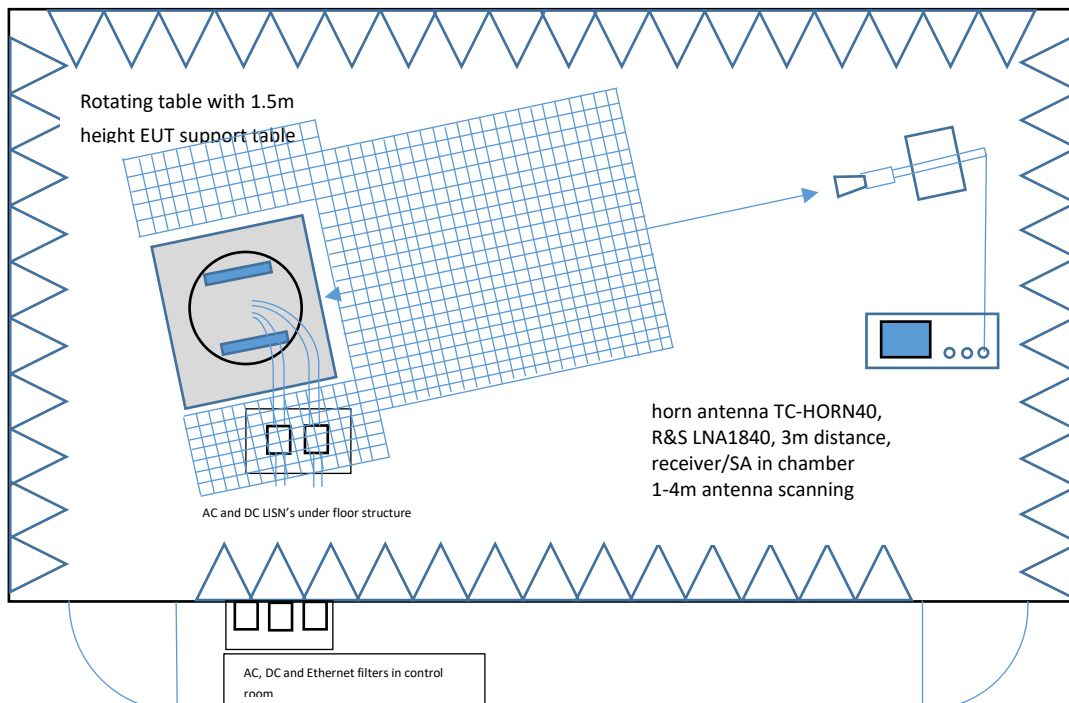
Radiated measurements setup from 30 MHz to 1 GHz:



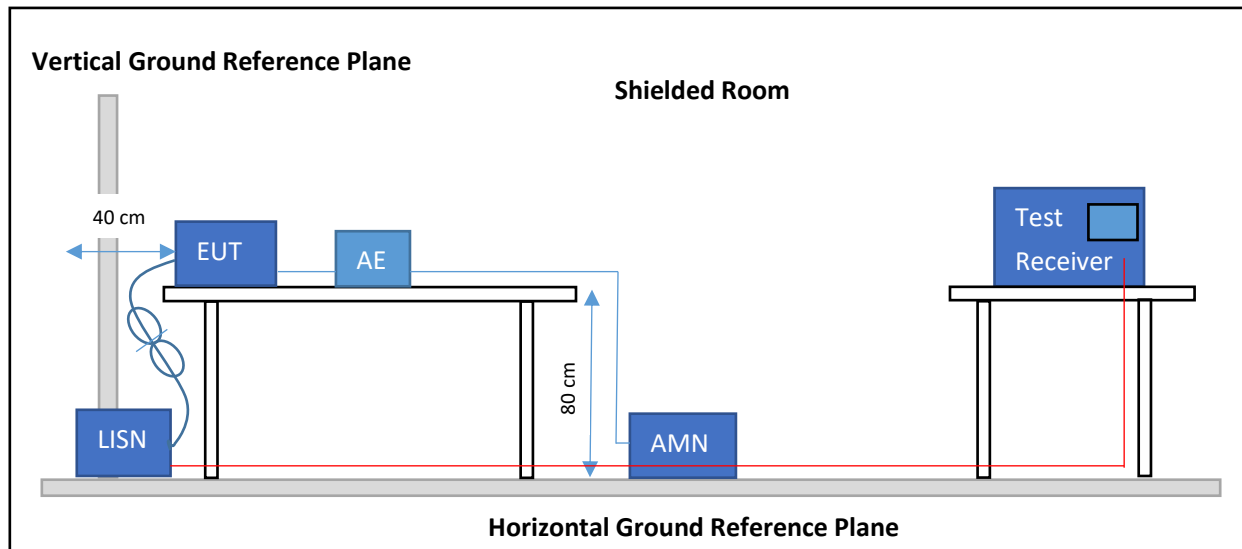
Radiated measurements setup from 1 GHz to 18 GHz:



Radiated measurements setup from 18 GHz to 26 / 40 GHz:



Conducted emission setup



Conducted RF measurement system:



8. Summary

FCC/ISED Requirement (15.247 / RSS-247)		Reference method	Result	Remark
Occupied Bandwidth	ISED RSS-Gen, Issue 5 A2 (section 6.7)	ANSI C63.10-2013	N/R	Informational only
6 dB Bandwidth	FCC § 15.247(a)(2) / RSS-247, Issue 3 (section 5.4)	ANSI C63.10-2013	PASS	
Maximum peak conducted power	FCC § 15.247(b) / RSS-247, Issue 3 (section 5.4 (d))	ANSI C63.10-2013	PASS	
Power spectral density	FCC § 15.247(e) / RSS-247, Issue 3 (section 5.2)	ANSI C63.10-2013	PASS	
AC power line conducted emissions	FCC § 15.207 / RSS-247, Issue 3 (section 3.1)	ANSI C63.10-2013	N/A	Battery operated
Band edge compliance	FCC § 15.247(d) / RSS-247, Issue 3 (section 5.5)	ANSI C63.10-2013	PASS	
Conducted spurious emissions	FCC § 15.247(d) / RSS-247, Issue 3 (section 5.5)	ANSI C63.10-2013	PASS	
Transmitter radiated spurious emissions	FCC § 15.247(d), FCC § 15.209 / RSS-Gen, Issue 5 A2 (section 6.13)	ANSI C63.10-2013	PASS	
Receiver radiated spurious emissions	ISED RSS-247, Issue 3 (section 3.1)	ANSI C63.4-2014	PASS	
Possible test case verdicts: PASS = Tested device meets the requirements FAIL = Tested device does not meet the requirements N/A = Test requirement not applicable for tested device N/T = Test requirement applicable for tested device, but not tested				
Applicable FCC KDB(s): KDB 558074 DO1: DTS measurement guidance v 0502 (Apr 2, 2019)				

9. Occupied bandwidth

Reference: ISED RSS-Gen, Issue 5 A2 (section 6.7)

Test method: ANSI C63.10 (6.9.3)

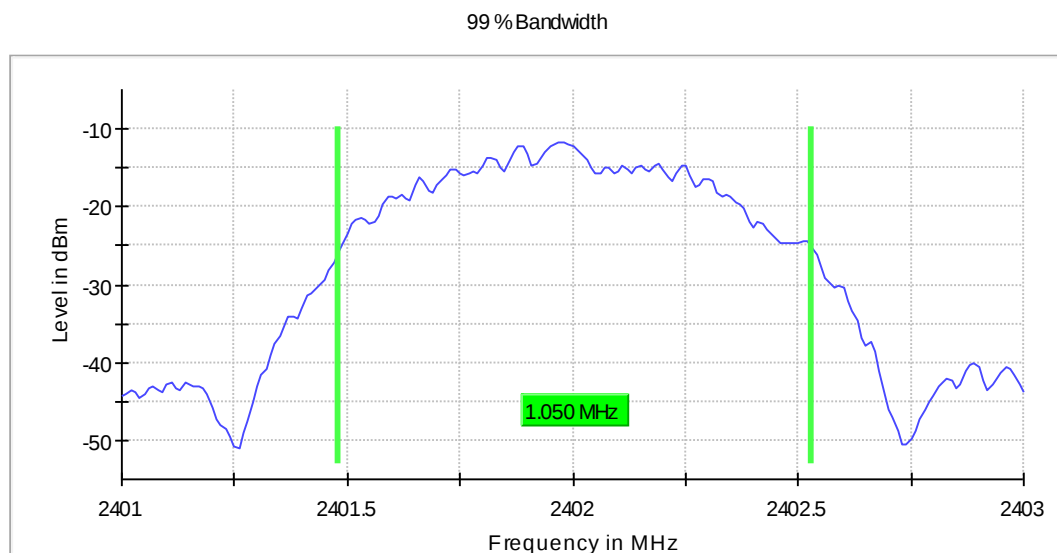
Limits
None (Informational only)

Procedure
1. EUT transmitter is activated in test mode under normal conditions 2. Spectrum analyzer is set to peak detection and maximum hold with a span twice the emission spectrum 3. The resolution bandwidth is set to the range of 1% to 5% of the occupied bandwidth 4. The occupied bandwidth is measured with the build-in analyzer function

Summary:

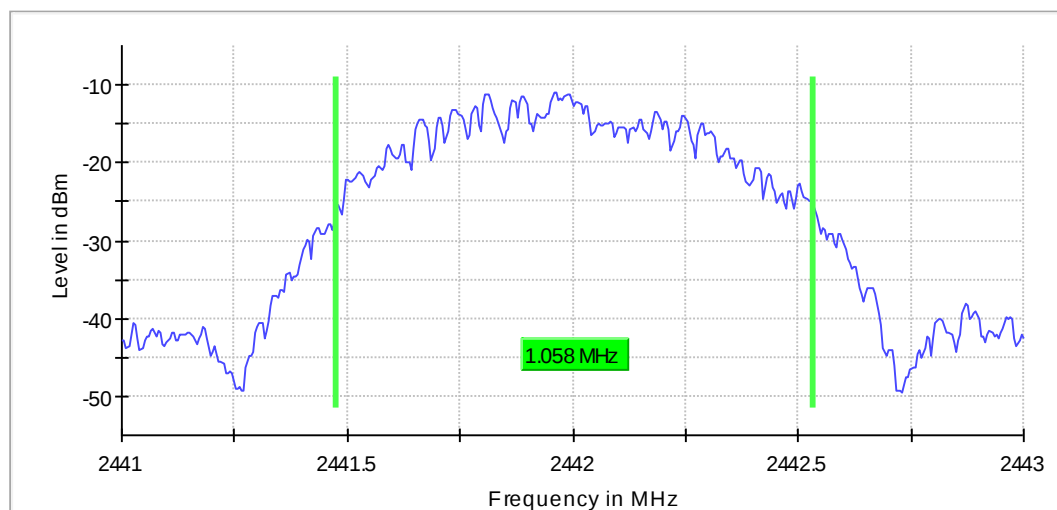
Summary		
Mode / modulation	Frequency (MHz)	Bandwidth (MHz)
Bluetooth LE, 1 Mbps	2402	1.050000
Bluetooth LE, 1 Mbps	2442	1.057645
Bluetooth LE, 1 Mbps	2480	1.060000

Occupied bandwidth, low channel



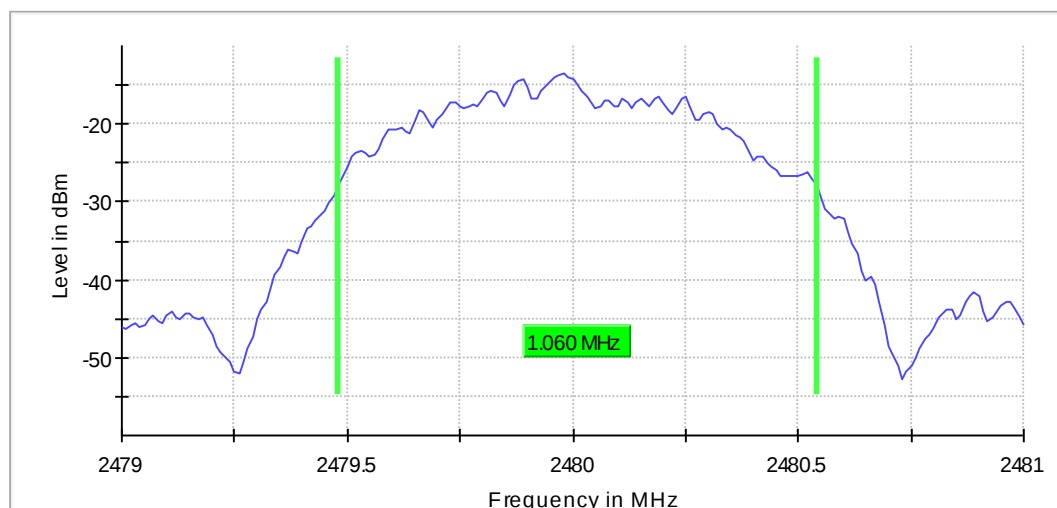
Occupied bandwidth, middle channel

99 % Bandwidth



Occupied bandwidth, high channel

99 % Bandwidth



10. 6 dB bandwidth

Reference: FCC title 47 part 15 §15.247(a), ISSED RSS-247, Issue 3 (section 5.2)

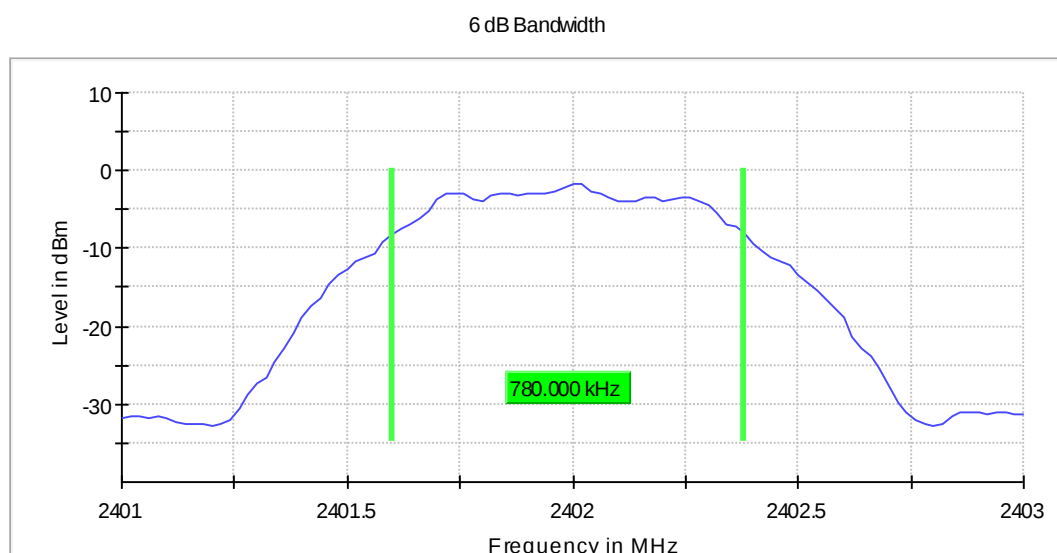
Test method: KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 (11.8.1)

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

Test procedure
1. EUT set to test mode 2. Span set to at least twice the emission spectrum 3. Detector set to peak and max hold and BW is set to 100 kHz 4. Envelope peak value of emission spectrum is selected 5. Marker on envelope of spectrum is set to level of -6 dB to the left of the peak 6. Marker on envelope of spectrum is set to level of -6 dB to the right of the peak 7. 6 dB bandwidth is determined by marker frequency separation

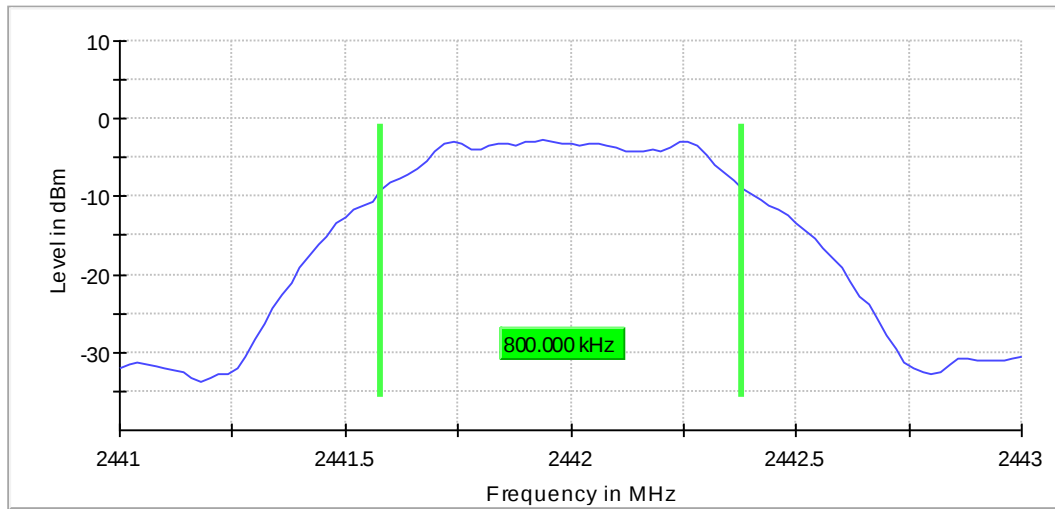
Mode / modulation	DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Max Level (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	0.780000	0.500000	-	2401.600000	2402.380000	-1.6	PASS
Bluetooth LE, 1 Mbps	2442.000000	0.800000	0.500000	-	2441.580000	2442.380000	-2.6	PASS
Bluetooth LE, 1 Mbps	2480.000000	0.780000	0.500000	-	2479.600000	2480.380000	-2.0	PASS

6 dB Bandwidth, low channel:



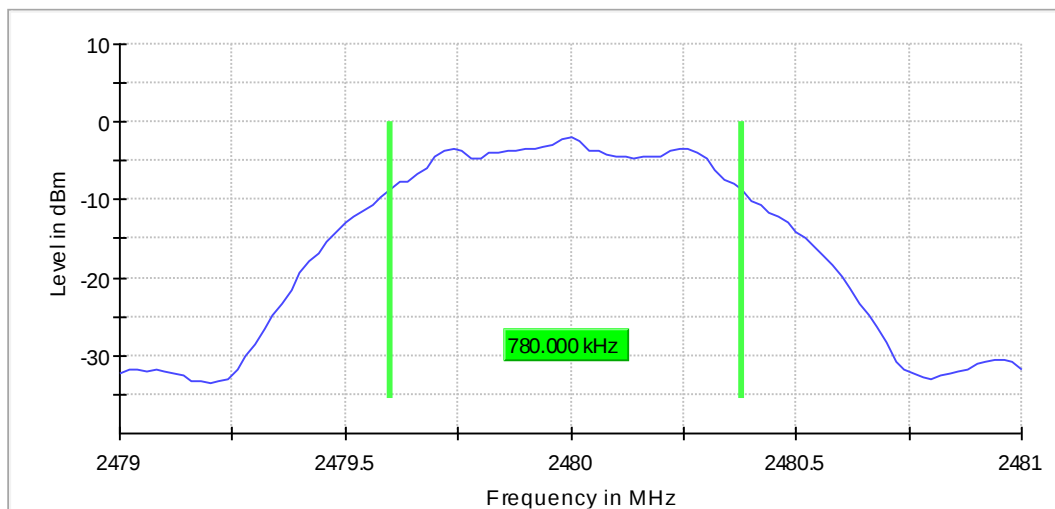
6 dB Bandwidth, middle channel:

6 dB Bandwidth



6 dB Bandwidth, high channel:

6 dB Bandwidth



11. Peak conducted output power

Reference: FCC part 15 §15.247(b), ISSED RSS-247, Issue 3 (section 5.4)

Test method: KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 (11.9.1.1)

Limits
For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm). The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).
The conducted output power limit specified above is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in the table, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

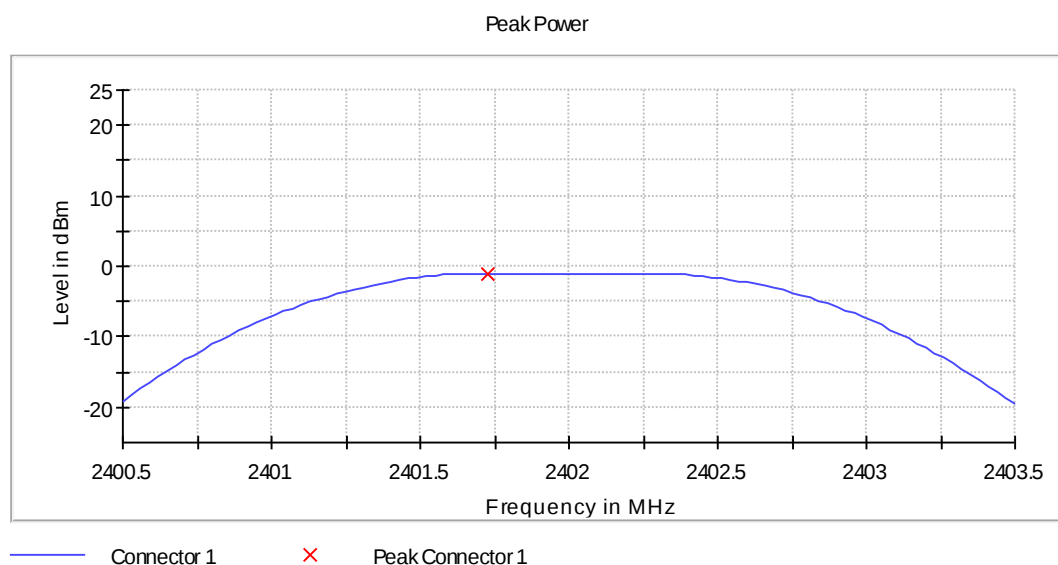
Test procedure
1. EUT set to test mode (communication tested is used if needed)
2. Analyzer resolution bandwidth is set $\geq$ DTS bandwidth
3. Detector set to peak and max hold
4. Sweep time is set to auto
5. After trace has stabilized a marker is set to peak envelope

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Maximum Declared Antenna Gain: 1.75 dBi

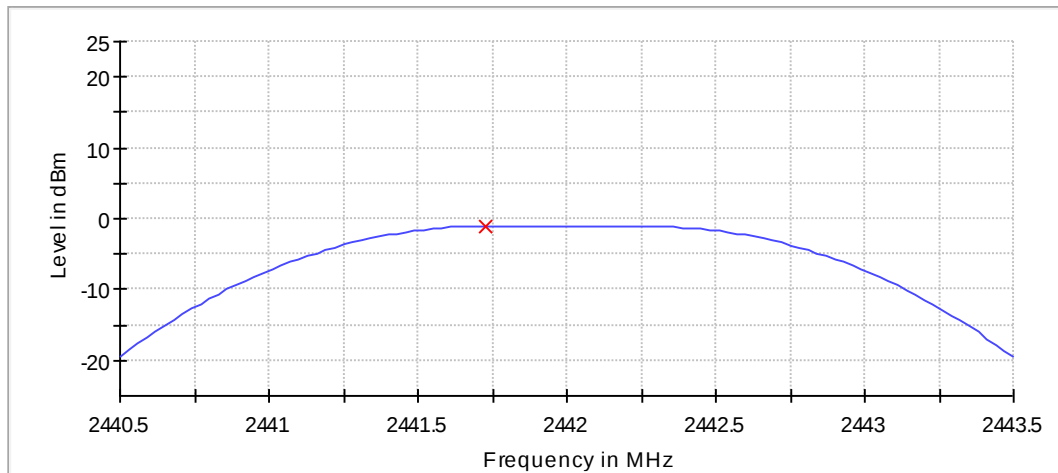
Mode / modulation	DUT Frequency (MHz)	Peak Power (dBm)	EIRP Power (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	-1.0	0.75	PASS
Bluetooth LE, 1 Mbps	2442.000000	-1.1	0.65	PASS
Bluetooth LE, 1 Mbps	2480.000000	-1.6	0.15	PASS

Peak power, low channel



Peak power, middle channel

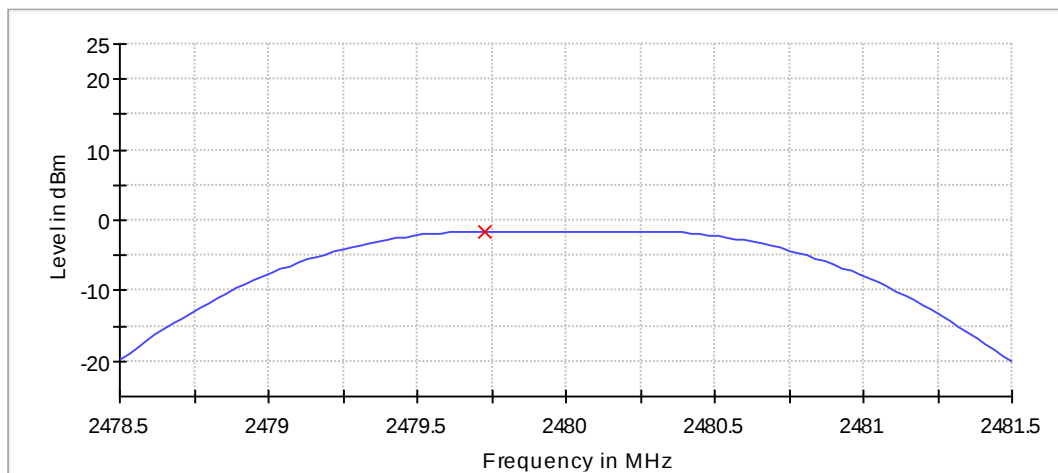
Peak Power



— Connector 1 × Peak Connector 1

Peak power, high channel

Peak Power



— Connector 1 × Peak Connector 1

12. Peak Power Spectral Density

Reference: FCC §15.247(a),(e), ISED RSS-247, Issue 3 (section 5.2)

Test method: KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 (11.10.2, 14.3.2)

Specification: For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Limits
≤ 8 dBm / 3 kHz

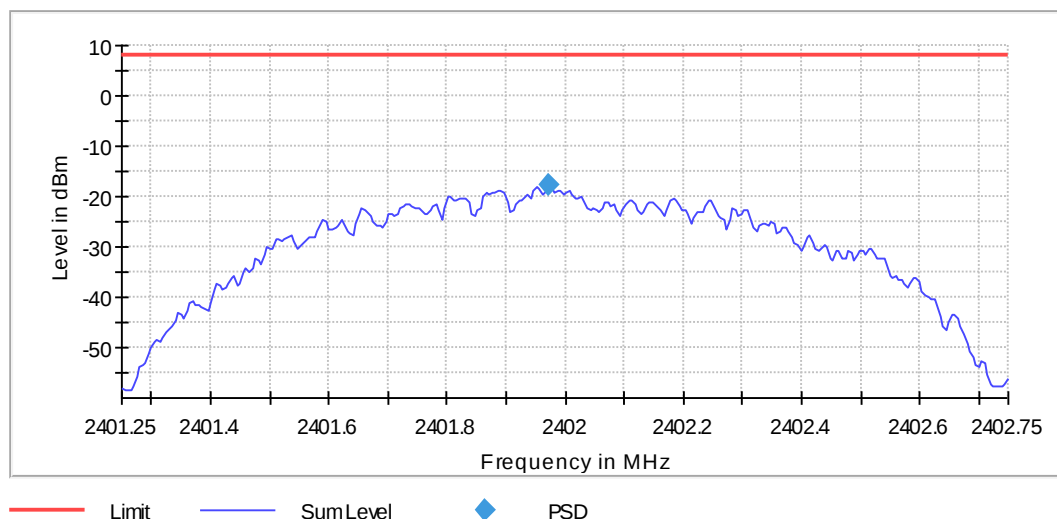
Test procedure
1. EUT set to test mode 2. The analyser is set to DTS channel center frequency with a span of 1.5 times the DTS bandwidth 3. The analyzer is set to 100 kHz with VBW ≥ RBW and the detector is set to peak with max hold 4. After trace has stabilized a marker is set to the envelope maximum 5. If the power spectral density is above the limit the RBW is reduces (not lower than 3 kHz) and the measurement is repeated 6. If the EUT has more than one transmit chain the procedure is repeated for each chain

Summary

Mode / modulation	DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	2401.972408	-17.855	8.0	PASS
Bluetooth LE, 1 Mbps	2442.000000	2441.957322	-10.822	8.0	PASS
Bluetooth LE, 1 Mbps	2480.000000	2479.957318	-11.422	8.0	PASS

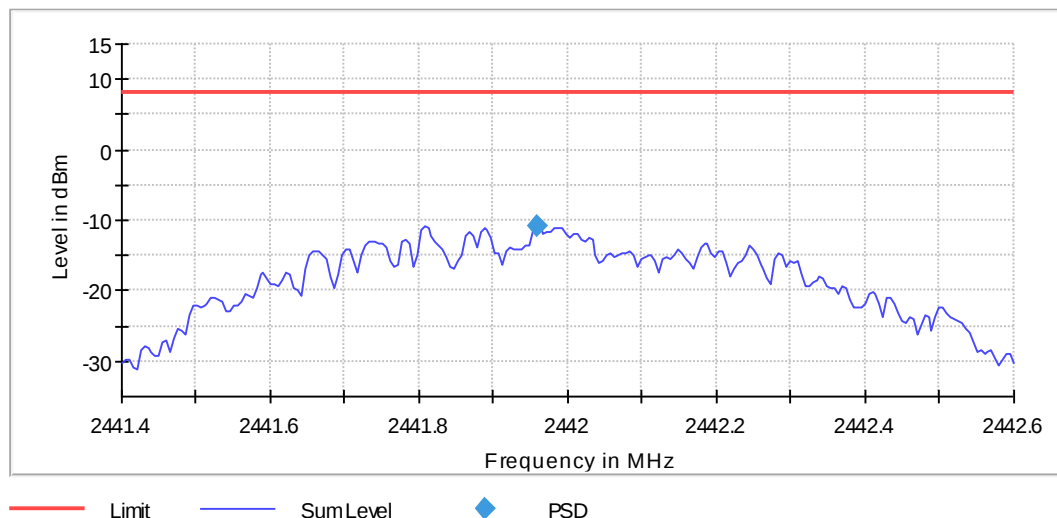
Peak power spectral density, low channel

Power Spectral Density (AVGPSD-1)



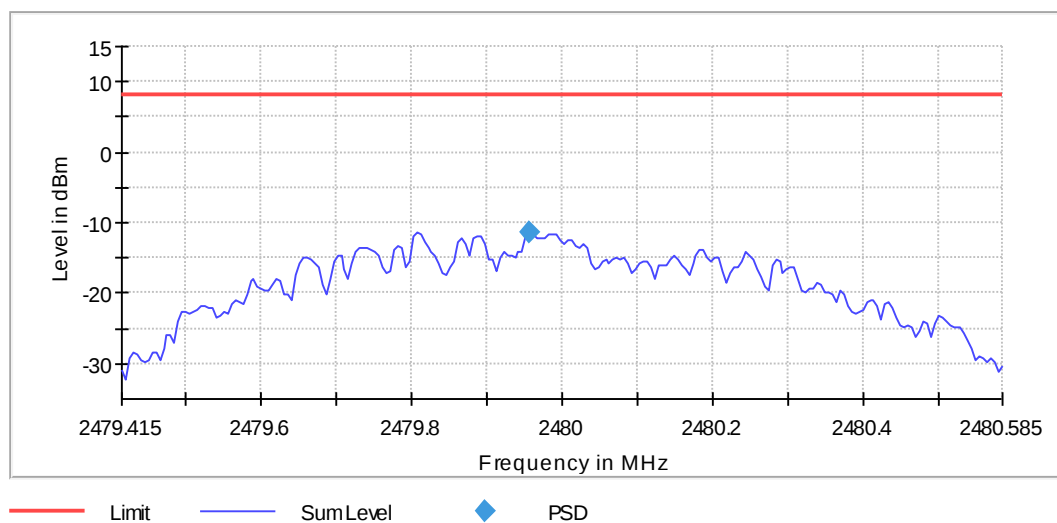
Peak power spectral density, middle channel

Peak Power Spectral Density



Peak power spectral density, high channel:

Peak Power Spectral Density



13. Band edge emissions compliance (transmitter)

Reference: FCC §15.247(d), ISSED RSS-247, Issue 3 (section 5.5)

Test method: KDB 558074 D01 DTS Meas Guidance v05r02 8.7 and ANSI C63.10-2013 (11.13)

Specification: In any 100 kHz bandwidths outside the frequency band in which the 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Limits	
Power measurement	Out-of-band attenuation (dB)
Peak	20
RMS	30

Limits
1. EUT set to test mode (communication tester is used if needed)
2. Span set around lower band edge and detector is set to peak and max hold
3. Resolution bandwidth is set to 100 kHz
4. Peak emission level(s) within frequency band and outside frequency band is measured
5. Band edge attenuation is determined from level difference

Summary

Mode / modulation	DUT Frequency (MHz)	Result
Bluetooth LE, 1 Mbps	2402.000000	PASS
Bluetooth LE, 1 Mbps	2480.000000	PASS

Measurements, band edge low

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.599778	-44.9	28.0	-16.9	PASS
2399.749861	-45.0	28.1	-16.9	PASS
2399.549750	-45.0	28.1	-16.9	PASS
2399.699833	-45.2	28.2	-16.9	PASS
2399.799889	-45.2	28.2	-16.9	PASS
2399.649805	-45.2	28.3	-16.9	PASS
2399.849917	-45.5	28.6	-16.9	PASS
2399.499722	-45.9	28.9	-16.9	PASS
2399.899944	-46.2	29.3	-16.9	PASS
2399.949972	-46.2	29.3	-16.9	PASS
2399.449694	-47.0	30.1	-16.9	PASS
2399.049472	-47.7	30.8	-16.9	PASS
2398.999444	-47.7	30.8	-16.9	PASS
2399.099500	-47.9	30.9	-16.9	PASS
2399.149528	-48.0	31.1	-16.9	PASS

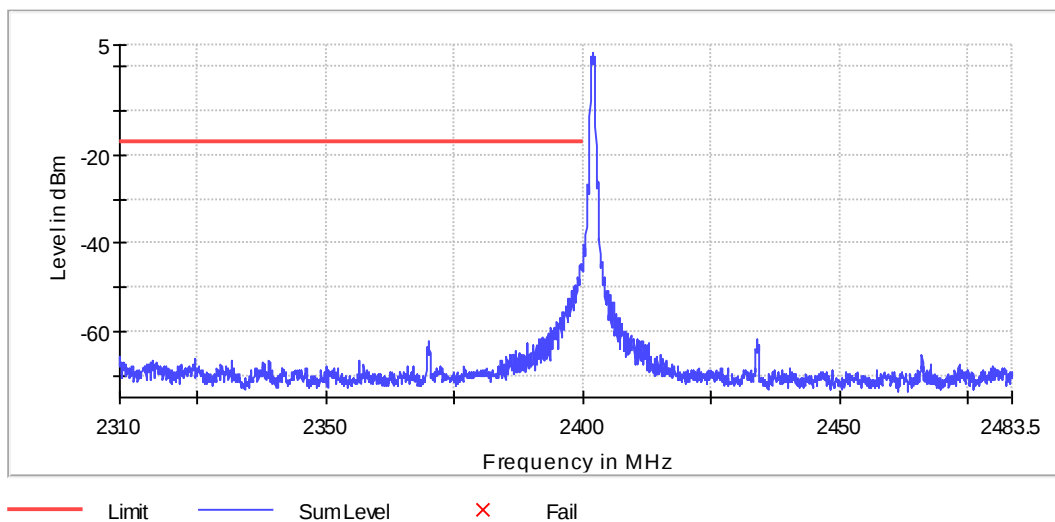
Measurements, band edge high

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.951368	-53.4	36.0	-17.4	PASS

2483.901216	-53.5	36.1	-17.4	PASS
2484.051672	-54.5	37.0	-17.4	PASS
2483.550152	-54.5	37.1	-17.4	PASS
2484.001520	-54.6	37.2	-17.4	PASS
2483.851064	-54.6	37.2	-17.4	PASS
2484.503040	-55.3	37.9	-17.4	PASS
2484.553191	-55.5	38.1	-17.4	PASS
2484.101824	-55.6	38.1	-17.4	PASS
2483.800912	-55.6	38.2	-17.4	PASS
2485.054711	-56.0	38.6	-17.4	PASS
2485.104863	-56.0	38.6	-17.4	PASS
2484.603343	-56.1	38.7	-17.4	PASS
2485.155015	-56.3	38.9	-17.4	PASS
2484.151976	-56.5	39.0	-17.4	PASS

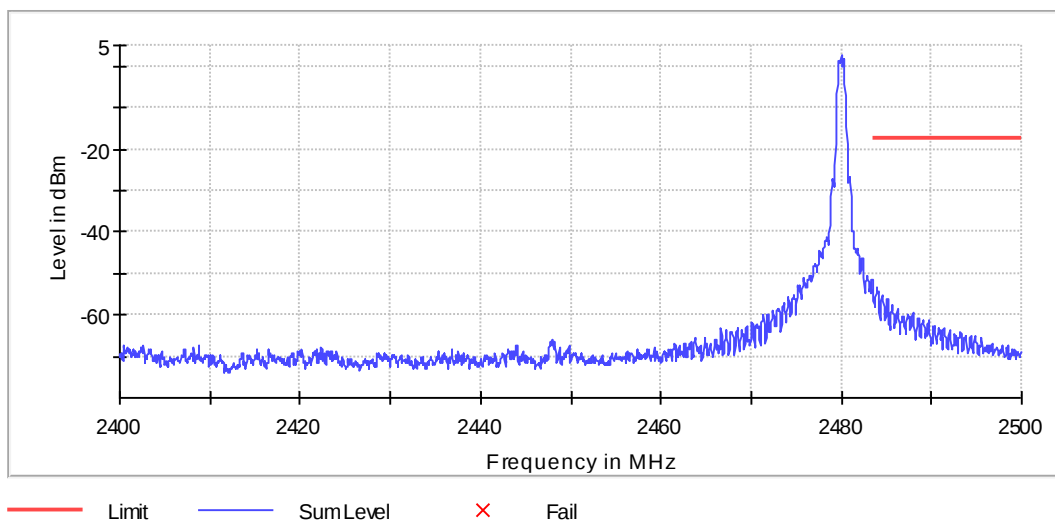
Band edge, low channel

Band Edge



Band edge, high channel

Band Edge



14. Tx spurious emissions, conducted

Reference: FCC §15.247(d), ISSED RSS-247, Issue 3 (section 5.5)

Test method: KDB 558074 D01 DTS Meas Guidance v05r02 8.5 and ANSI C63.10-2013 (11.11.2 & 11.11.3)

Limits	
Power measurement	Out-of-band attenuation (dB)
Peak	20
RMS	30

Test procedure
1. EUT set to test mode (communication tester is used if needed)
2. Span set around lower band edge and detector is set to peak and max hold
3. Resolution bandwidth is set to 100 kHz
4. Markers are set to peak emission levels outside frequency band

Mode / modulation	DUT Frequency (MHz)	Result
Bluetooth LE, 1 Mbps	2402.000000	PASS
Bluetooth LE, 1 Mbps	2440.000000	PASS
Bluetooth LE, 1 Mbps	2480.000000	PASS

Pre Measurements, low channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
4803.154762	-55.8	38.2	-17.6
2390.000000	-62.3	44.7	-17.6
2370.000000	-64.8	47.2	-17.6
2210.000000	-65.1	47.5	-17.6
2593.483631	-65.2	47.7	-17.6
7202.797619	-66.0	48.4	-17.6
1860.000000	-66.1	48.6	-17.6
2280.000000	-66.2	48.7	-17.6
1830.000000	-66.6	49.1	-17.6
2523.494048	-66.7	49.1	-17.6
2380.000000	-66.8	49.2	-17.6
2300.000000	-66.8	49.2	-17.6
1890.000000	-67.3	49.7	-17.6
2320.000000	-67.4	49.8	-17.6
2290.000000	-67.4	49.9	-17.6

Pre Measurements, middle channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
4883.142857	-56.1	35.9	-20.1
2250.000000	-61.2	41.1	-20.1
1900.000000	-64.5	44.3	-20.1
2633.477679	-64.9	44.8	-20.1
1870.000000	-65.0	44.8	-20.1
2220.000000	-65.7	45.5	-20.1
2983.425595	-66.3	46.2	-20.1
2663.473214	-67.0	46.8	-20.1
2330.000000	-67.3	47.2	-20.1
2320.000000	-67.4	47.2	-20.1
2350.000000	-67.6	47.5	-20.1
1930.000000	-67.6	47.5	-20.1
2340.000000	-67.8	47.7	-20.1

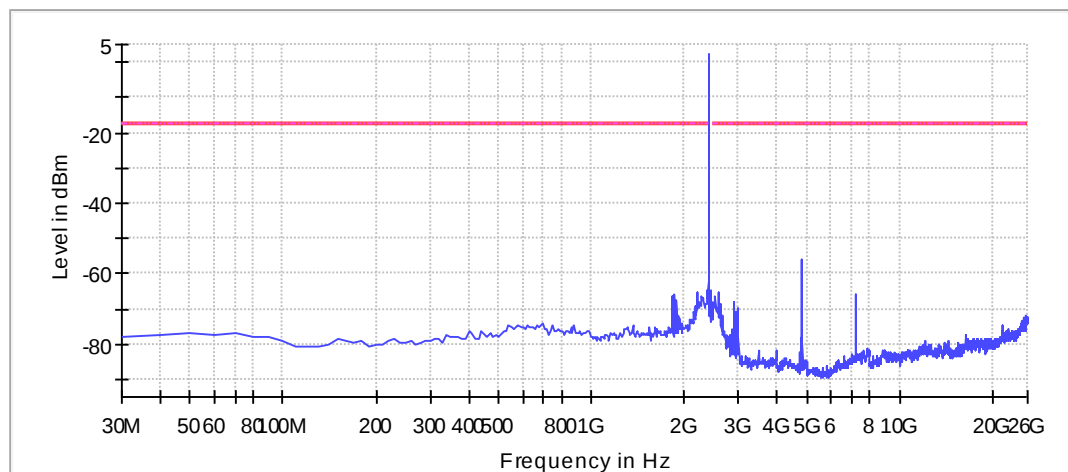
7322.779762	-68.4	48.2	-20.1
2190.000000	-68.4	48.3	-20.1

Pre Measurements, top channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2360.000000	-60.5	42.7	-17.9
4953.132440	-61.9	44.1	-17.9
25400.089286	-62.1	44.2	-17.9
25390.090774	-62.2	44.3	-17.9
25990.001488	-62.5	44.7	-17.9
25370.093750	-62.7	44.8	-17.9
25380.092262	-62.7	44.9	-17.9
25910.013393	-62.9	45.0	-17.9
25880.017857	-62.9	45.1	-17.9
25330.099702	-63.1	45.2	-17.9
1940.000000	-63.1	45.2	-17.9
25810.028274	-63.2	45.3	-17.9
25510.072917	-63.2	45.4	-17.9
25890.016369	-63.3	45.4	-17.9
26000.000000	-63.3	45.5	-17.9

Low channel

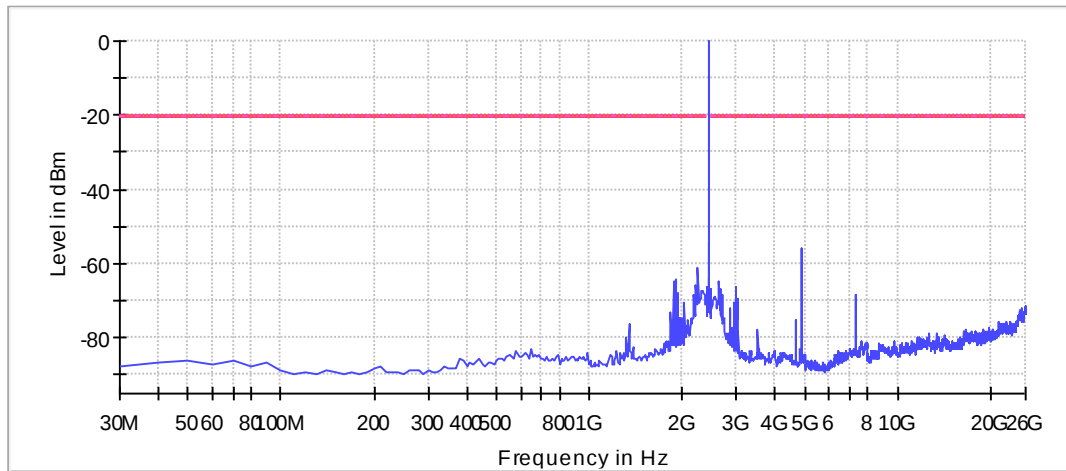
Spurious



— Limit — SumLevel — Threshold × Critical × Final Critical

Middle channel

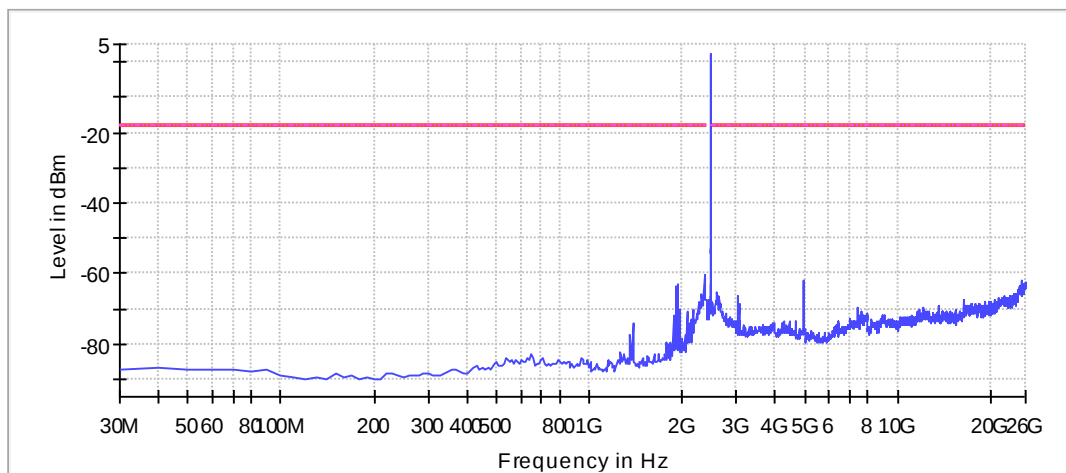
Spurious



— Limit — SumLevel - - - Threshold × Critical × Final Critical

High channel

Spurious



— Limit — SumLevel - - - Threshold × Critical × Final Critical

15. Tx spurious emissions, radiated

Reference: FCC §15.247(d), FCC §15.209, ISSED RSS-Gen Issue 5 A2 (section 6.13)

Test method: KDB 558074 D01 DTS Meas Guidance v05r02 8.5 and ANSI C63.10-2013 (6.4, 6.5, 6.6 & 11.12)

Specification: Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)/RSS-Gen):

Limits				
Frequency range (MHz)	Detector	Field strength (uV/m)	Field strength (dBuV/m)	Measurement distance (m)
0.009 – 0.09	Average	2400/F(kHz)	-	300
0.09 – 0.110	Quasi-Peak	2400/F(kHz)	-	300
0.110 – 0.490	Average	2400/F(kHz)	-	300
0.490 – 1.705	Quasi-Peak	24000/F(kHz)	-	30
1.705 – 30.0	Quasi-Peak	30	-	30
30 - 88	Quasi-Peak	100	40	3
88 – 216	Quasi-Peak	150	43.5	3
216 – 960	Quasi-Peak	200	46	3
960 - 1000	Quasi-Peak	500	54	3
>1000	Average	500	54	3

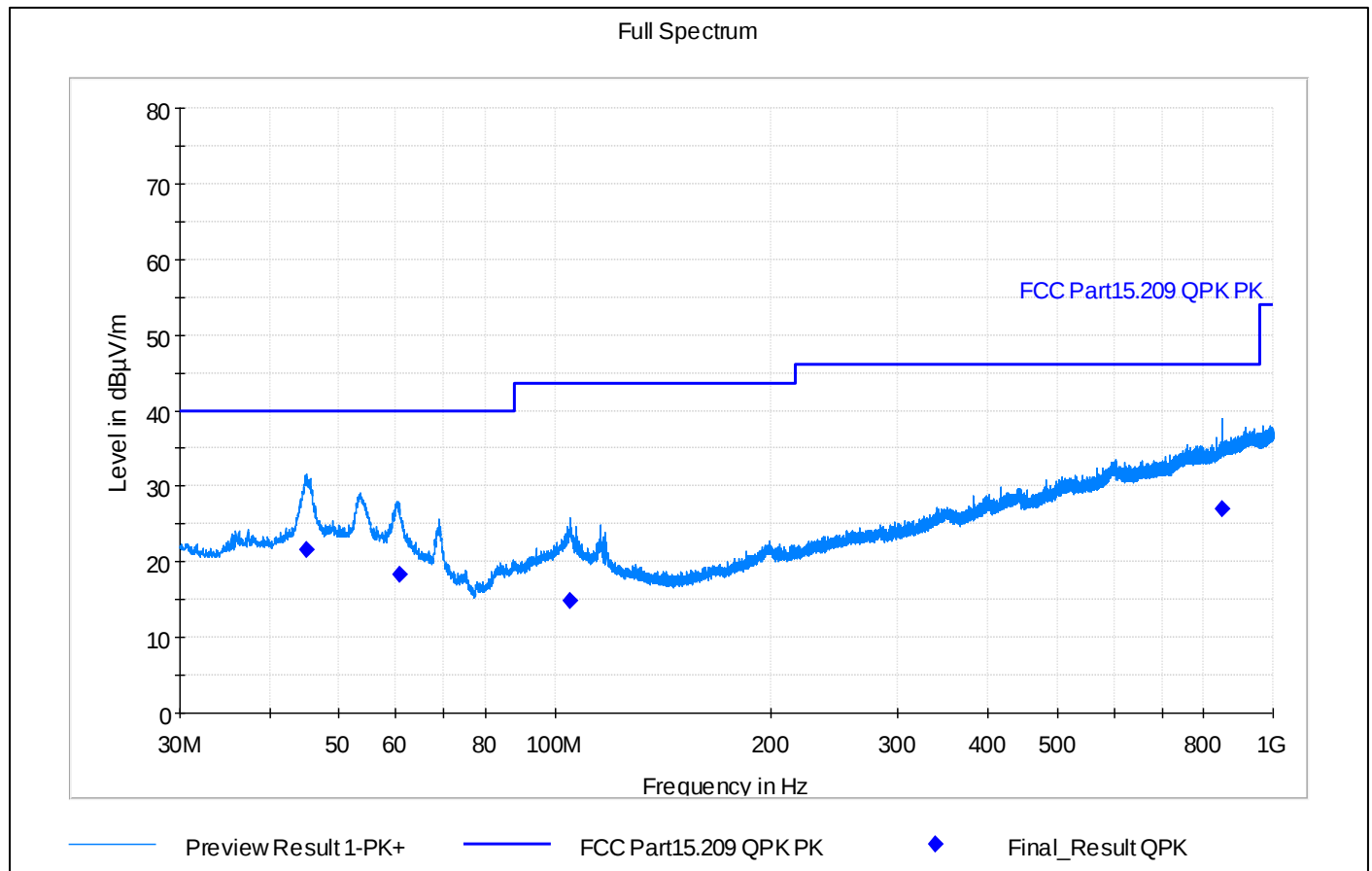
Test procedure 30 MHz -1 GHz	
1.	EUT is placed on a non conducting support at the center of a turn table 0.8m above the ground
2.	EUT set to test mode
3.	The receiver is set to peak detection with max hold
4.	The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal and vertical planes of polarization
5.	Found peak values were further maximized by adjusting turntable position $\pm 22,5$ degrees around detected value and scanning the antenna height 1 to 4m
6.	For maximized values, final measurement was done with the corresponding final detector.

Test procedure > 1 GHz	
1.	EUT is placed on a non conducting support at the center of a turn table 1.5m above the ground
2.	EUT set to test mode
3.	The receiver is set to peak detection with max hold
4.	The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal and vertical planes of polarization.
5.	Found peak values were further maximized by adjusting turntable position $\pm 22,5$ degrees around detected value and scanning the antenna height 1 to 4m
6.	For maximized values, final measurement was done with the corresponding final detector.

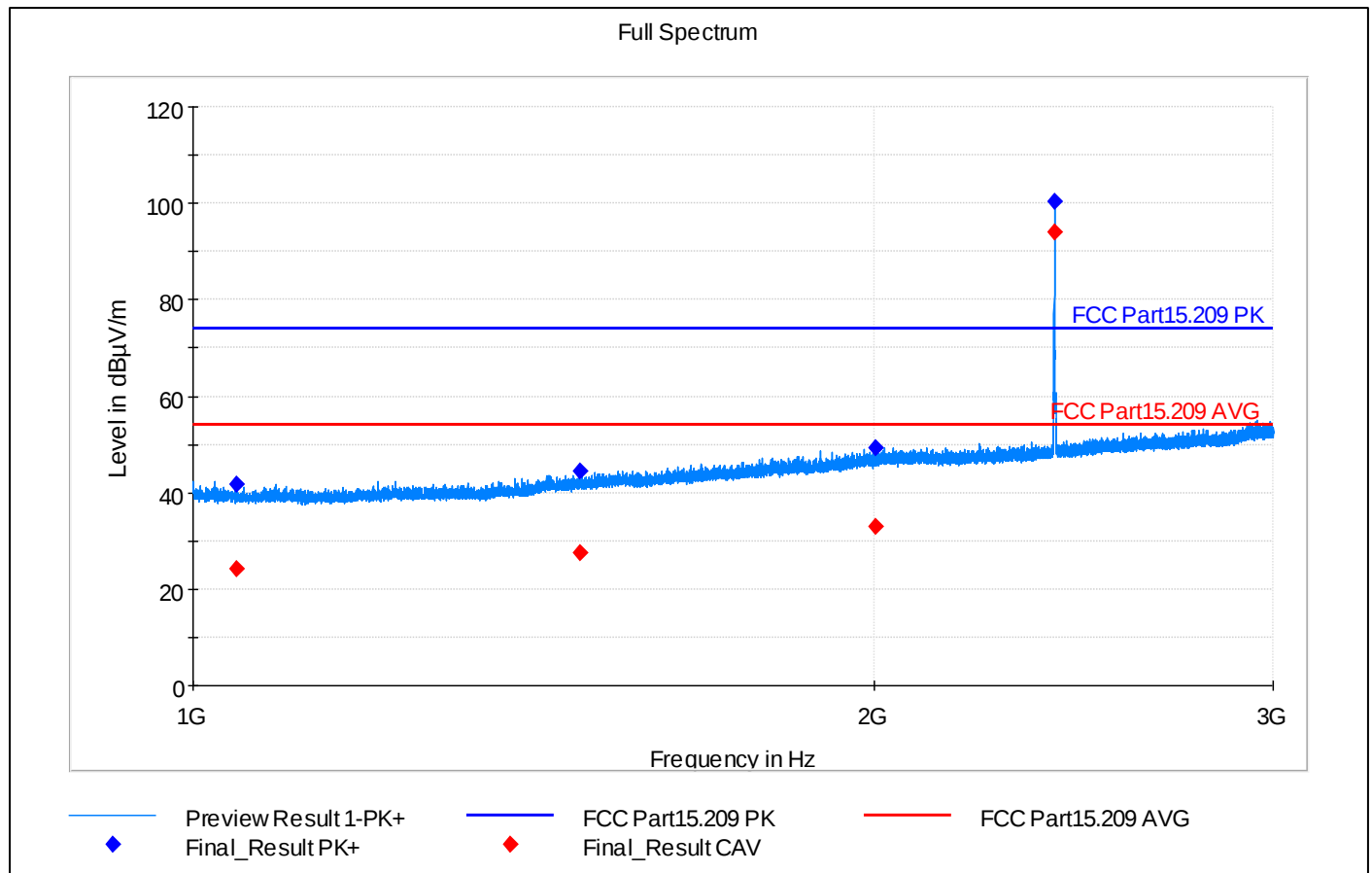
For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function. RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

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.

Operation mode(s)	Configuration	Test Verdict
Bluetooth LE TX, 1 Mbps	Low channel, 2402 MHz	PASS
Bluetooth LE TX, 1 Mbps	Mid channel, 2440 MHz	PASS
Bluetooth LE TX, 1 Mbps	High channel, 2480 MHz	PASS

Low channel, 30 MHz – 1 GHz

Final_Result

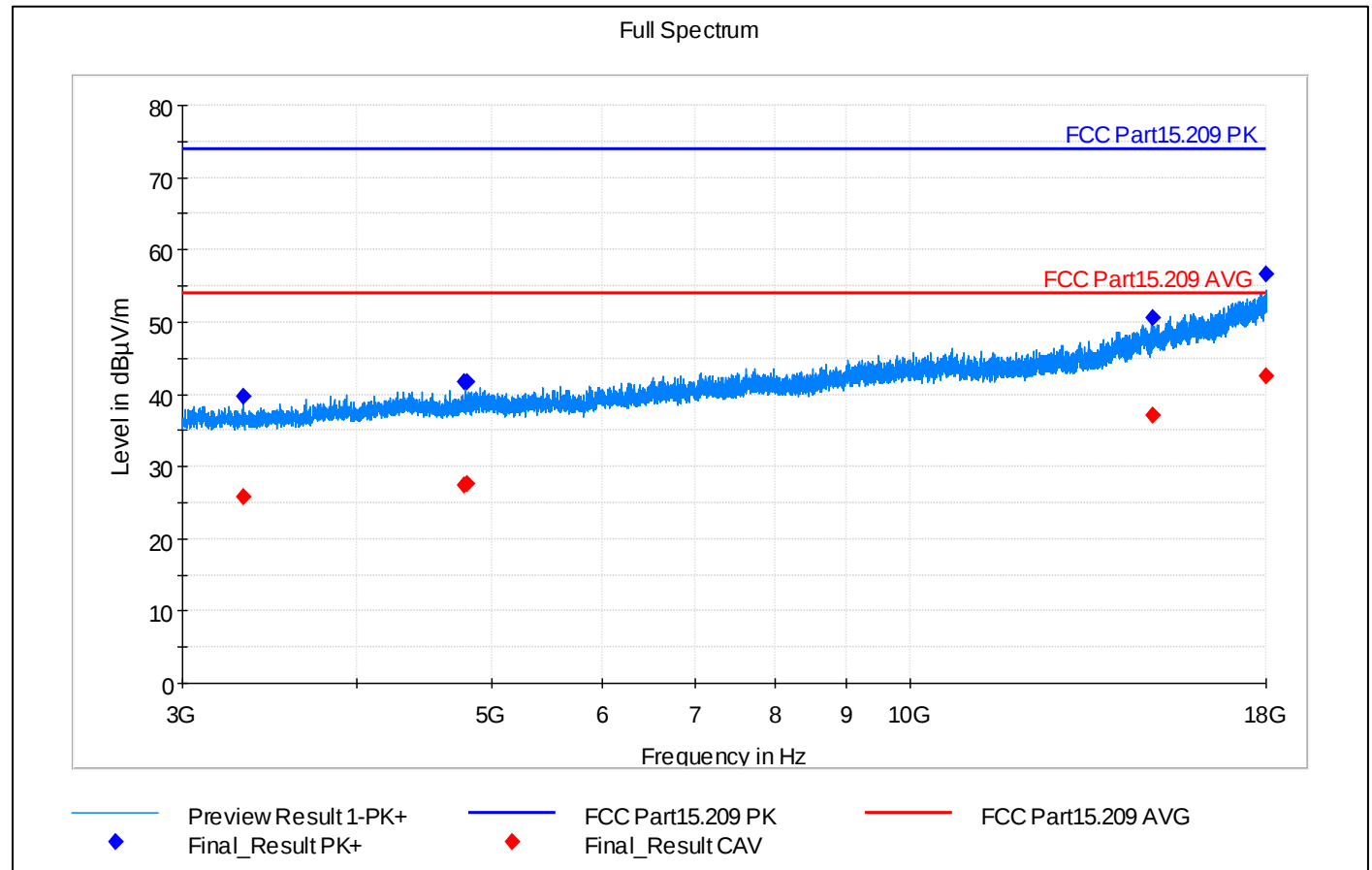
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
45.030000	21.54	40.00	18.46	15000.0	120.000	98.0	V	-6.0	90.0	20.7	PASS
60.600000	18.39	40.00	21.61	15000.0	120.000	258.0	V	186.0	0.0	19.8	PASS
104.760000	14.85	43.50	28.65	15000.0	120.000	328.0	V	-15.0	90.0	19.6	PASS
849.120000	27.08	46.00	18.92	15000.0	120.000	102.0	H	331.0	90.0	32.7	PASS

Low channel, 1 – 3 GHz


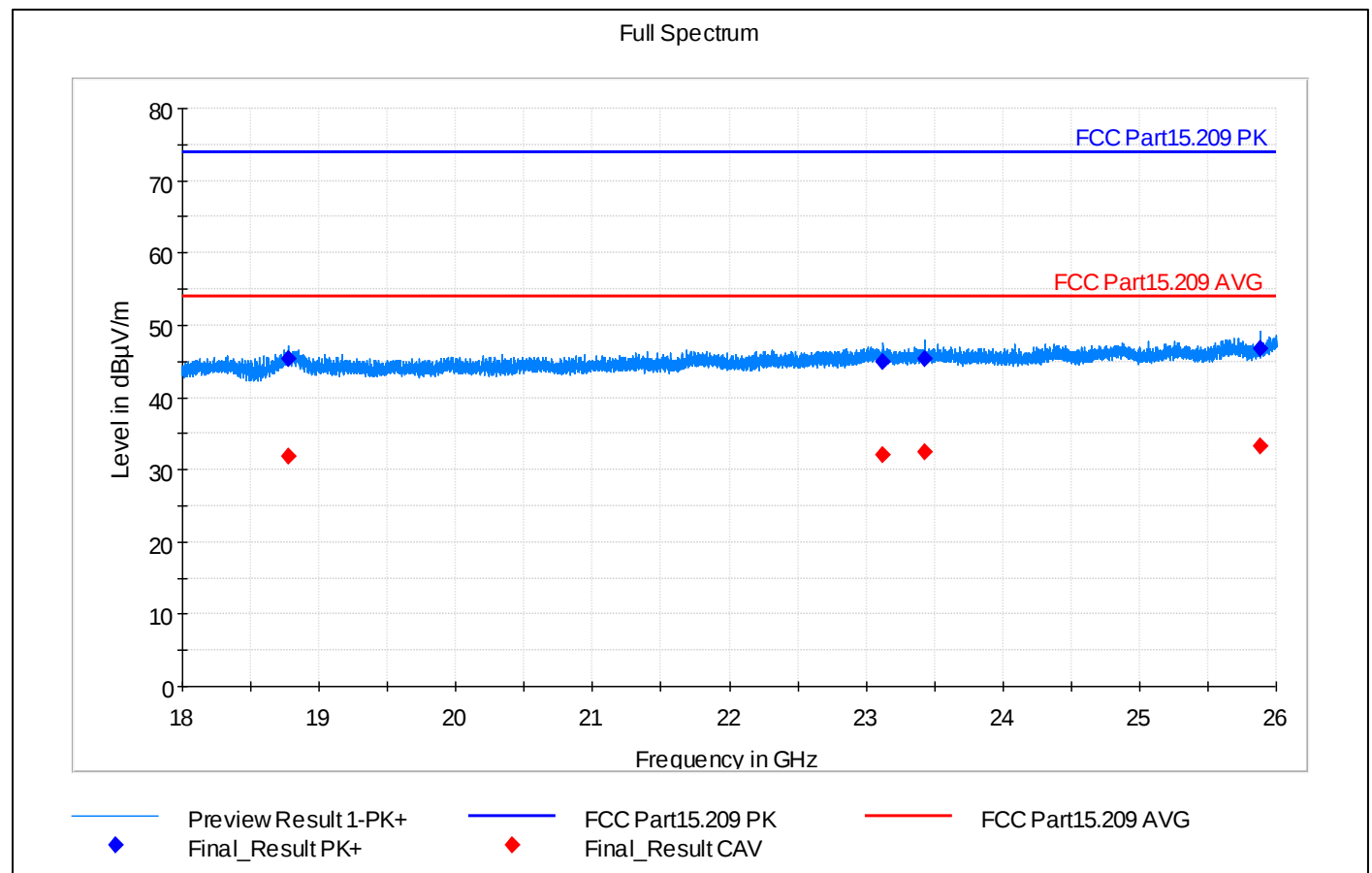
Note: Frequency 2401,750 MHz is excluded from spurious domain measurements and ignored. See table below.

Final_Result

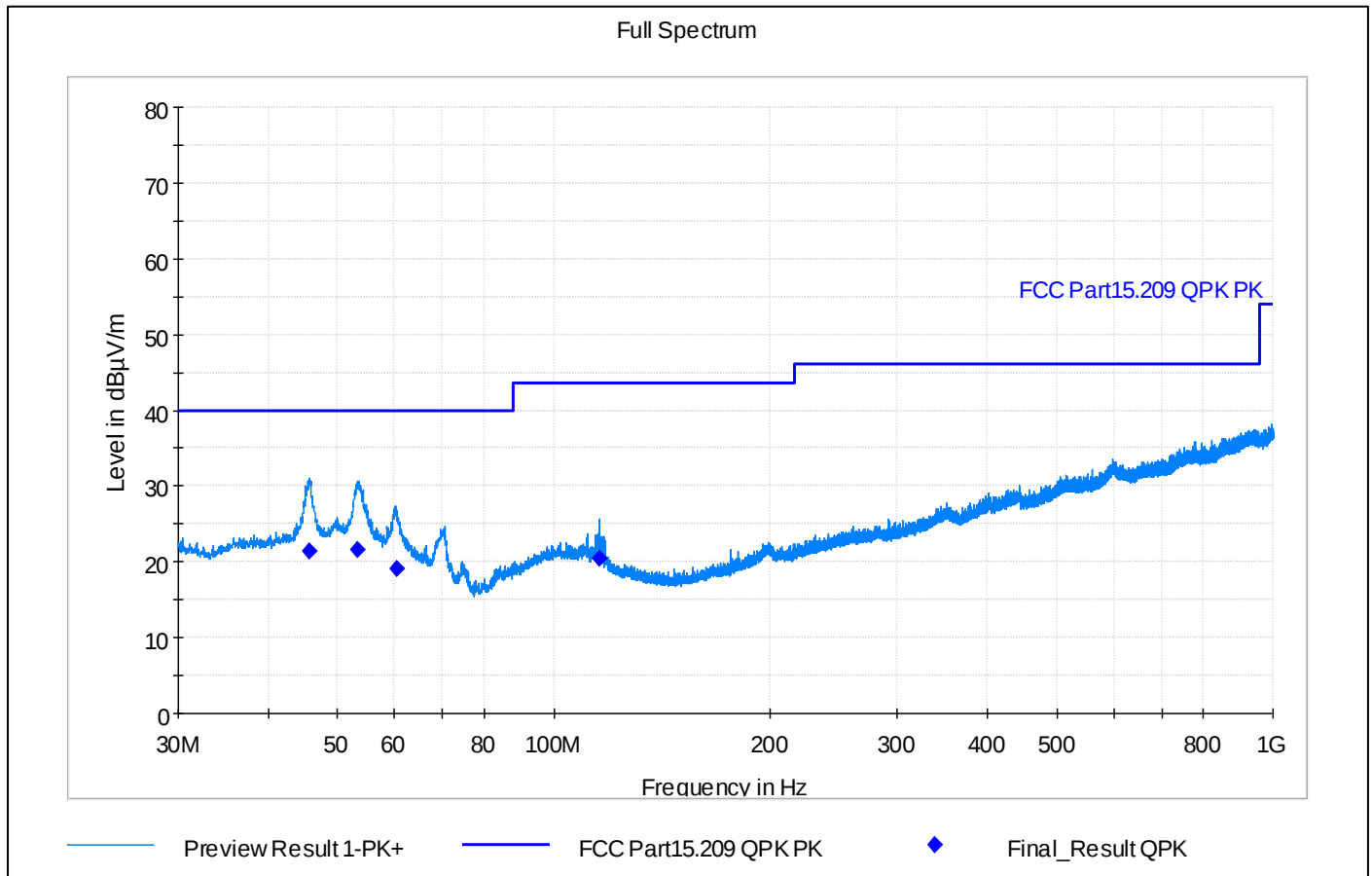
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1045.600000	---	24.18	54.00	29.82	15000.0	1000.000	188.0	H	88.0	0.0	30.8	PASS
1045.600000	41.84	---	74.00	32.16	15000.0	1000.000	188.0	H	88.0	0.0	30.8	PASS
1481.700000	44.54	---	74.00	29.46	15000.0	1000.000	216.0	H	269.0	90.0	33.4	PASS
1481.700000	---	27.61	54.00	26.39	15000.0	1000.000	216.0	H	269.0	90.0	33.4	PASS
2002.900000	---	32.85	54.00	21.15	15000.0	1000.000	233.0	V	289.0	90.0	37.4	PASS
2002.900000	49.18	---	74.00	24.82	15000.0	1000.000	233.0	V	289.0	90.0	37.4	PASS
2401.750000	100.29	---	74.00	-26.29	15000.0	1000.000	137.0	H	124.0	90.0	38.6	Fundamental TX signal
2401.750000	---	94.10	54.00	-40.10	15000.0	1000.000	137.0	H	124.0	90.0	38.6	Fundamental TX signal

Low channel, 3 – 18 GHz

Final_Result

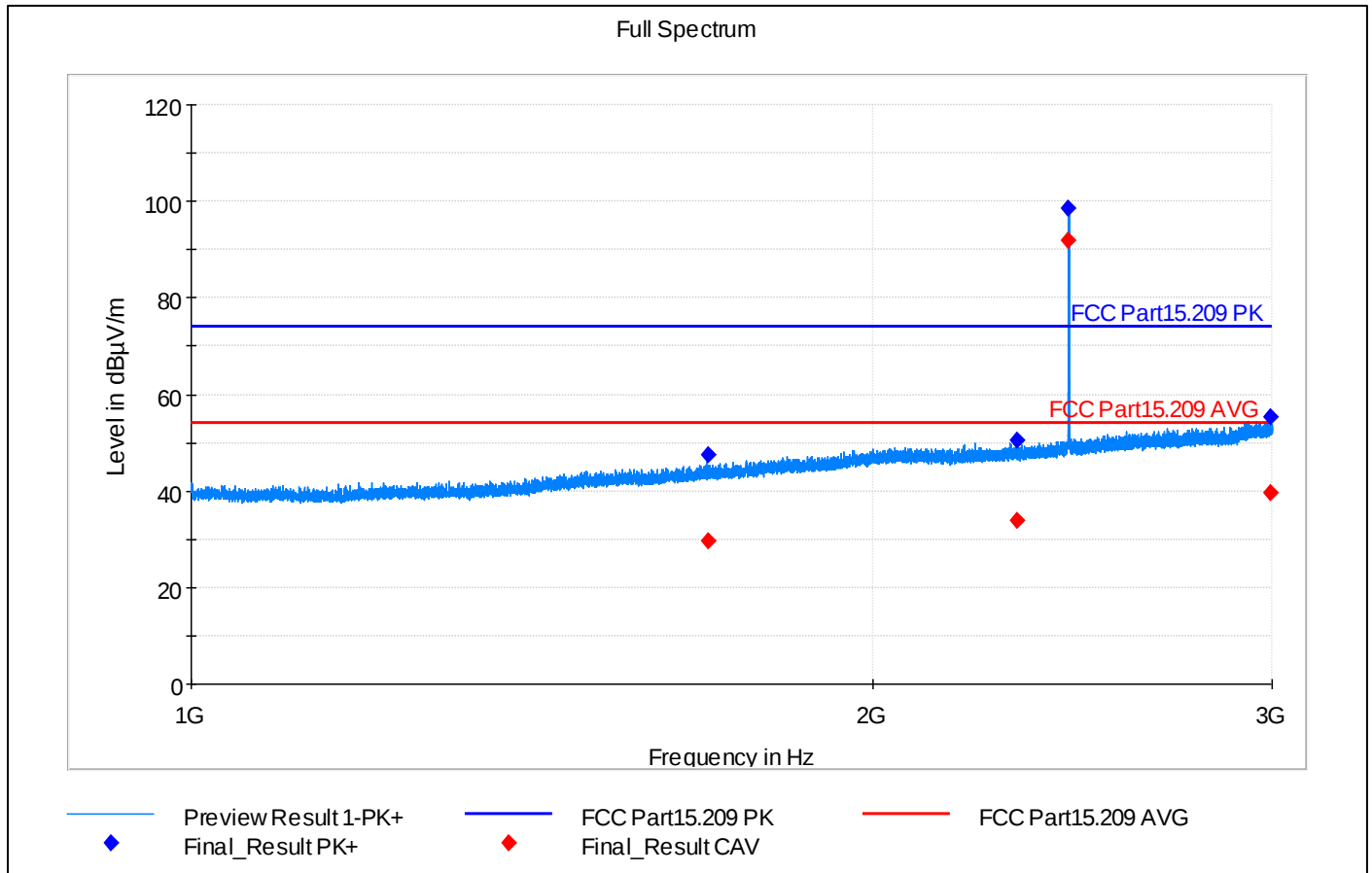
Frequency (MHz)	MaxPeak	CAverage	Limit (dBμV)	Margin	Meas. Time	Bandwidth	Height	Po l	Azimuth	Elevation	Corr. (dB/m)	Comment
3319.750000	---	25.87	54.00	28.13	15000.	1000.000	382.0	V	37.0	90.0	5.7	PASS
3319.750000	39.75	---	74.00	34.25	15000.	1000.000	382.0	V	37.0	90.0	5.7	PASS
4786.000000	41.65	---	74.00	32.35	15000.	1000.000	150.0	H	239.0	0.0	9.8	PASS
4786.000000	---	27.49	54.00	26.51	15000.	1000.000	150.0	H	239.0	0.0	9.8	PASS
4804.750000	---	27.68	54.00	26.32	15000.	1000.000	148.0	H	17.0	90.0	10.0	PASS
4804.750000	41.70	---	74.00	32.30	15000.	1000.000	148.0	H	17.0	90.0	10.0	PASS
14907.000000	50.50	---	74.00	23.50	15000.	1000.000	307.0	V	86.0	0.0	30.3	PASS
14907.000000	---	37.06	54.00	16.94	15000.	1000.000	307.0	V	86.0	0.0	30.3	PASS
17995.250000	---	42.60	54.00	11.40	15000.	1000.000	180.0	V	37.0	90.0	39.2	PASS
17995.250000	56.66	---	74.00	17.34	15000.	1000.000	180.0	V	37.0	90.0	39.2	PASS

Low channel, 18 – 26 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18774.500000	45.27	---	74.00	28.73	3000.0	1000.000	176.0	H	250.0	90.0	23.5	PASS
18774.500000	---	31.88	54.00	22.12	3000.0	1000.000	176.0	H	250.0	90.0	23.5	PASS
23126.000000	---	32.00	54.00	22.00	3000.0	1000.000	306.0	V	40.0	0.0	25.6	PASS
23126.000000	45.00	---	74.00	29.00	3000.0	1000.000	306.0	V	40.0	0.0	25.6	PASS
23429.000000	45.33	---	74.00	28.67	3000.0	1000.000	316.0	H	-11.0	0.0	25.7	PASS
23429.000000	---	32.43	54.00	21.57	3000.0	1000.000	316.0	H	-11.0	0.0	25.7	PASS
25885.250000	---	33.26	54.00	20.74	3000.0	1000.000	186.0	V	77.0	90.0	26.9	PASS
25885.250000	46.70	---	74.00	27.30	3000.0	1000.000	186.0	V	77.0	90.0	26.9	PASS

Mid channel, 30 MHz – 1 GHz

Final_Result

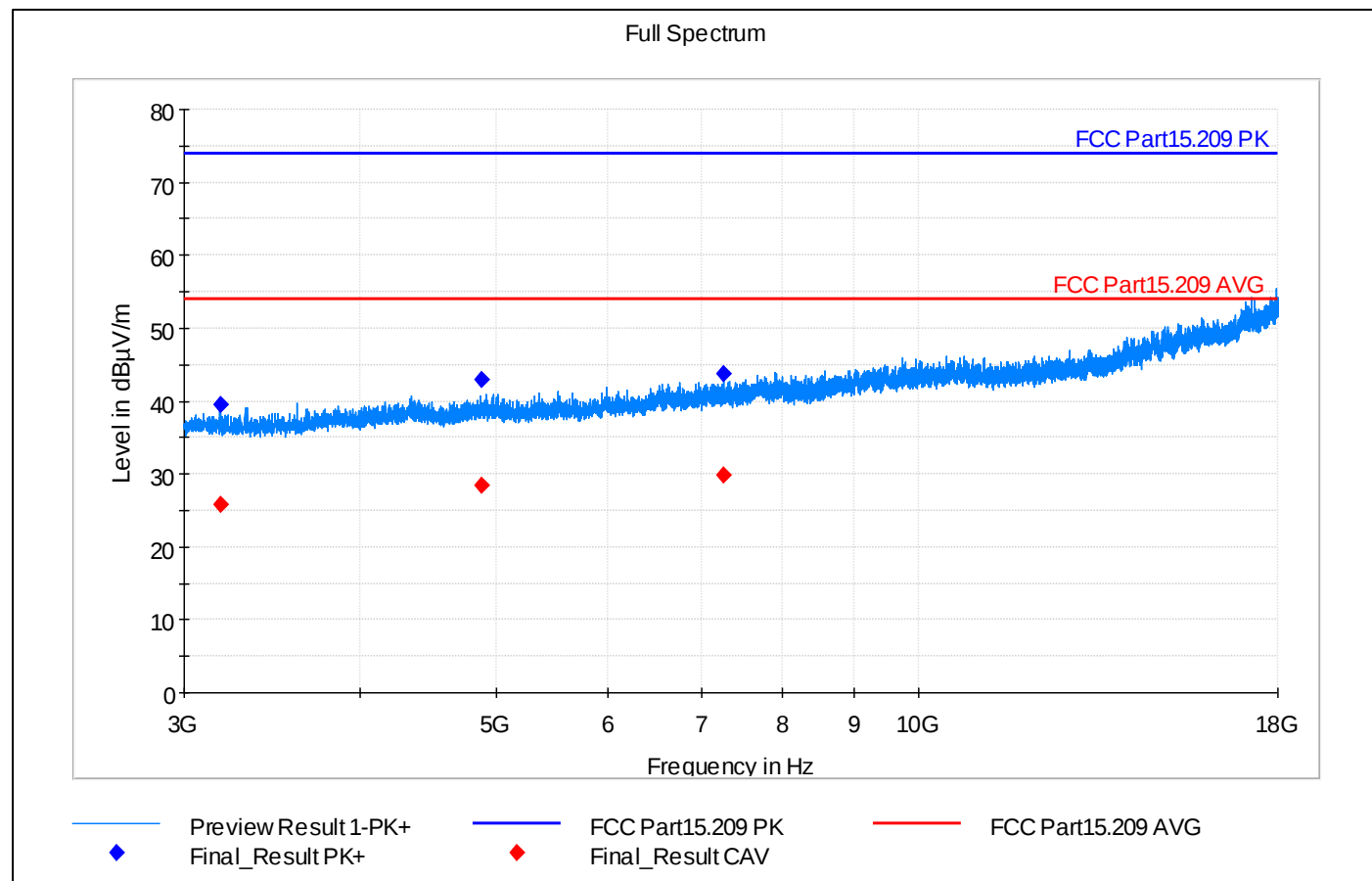
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
45.630000	21.46	40.00	18.54	15000.0	120.000	100.0	V	127.0	0.0	20.8	PASS
53.250000	21.54	40.00	18.46	15000.0	120.000	100.0	V	157.0	0.0	20.9	PASS
60.510000	19.11	40.00	20.89	15000.0	120.000	261.0	V	337.0	0.0	19.9	PASS
115.620000	20.47	43.50	23.03	15000.0	120.000	324.0	V	73.0	90.0	18.5	PASS

Mid channel, 1-3 GHz


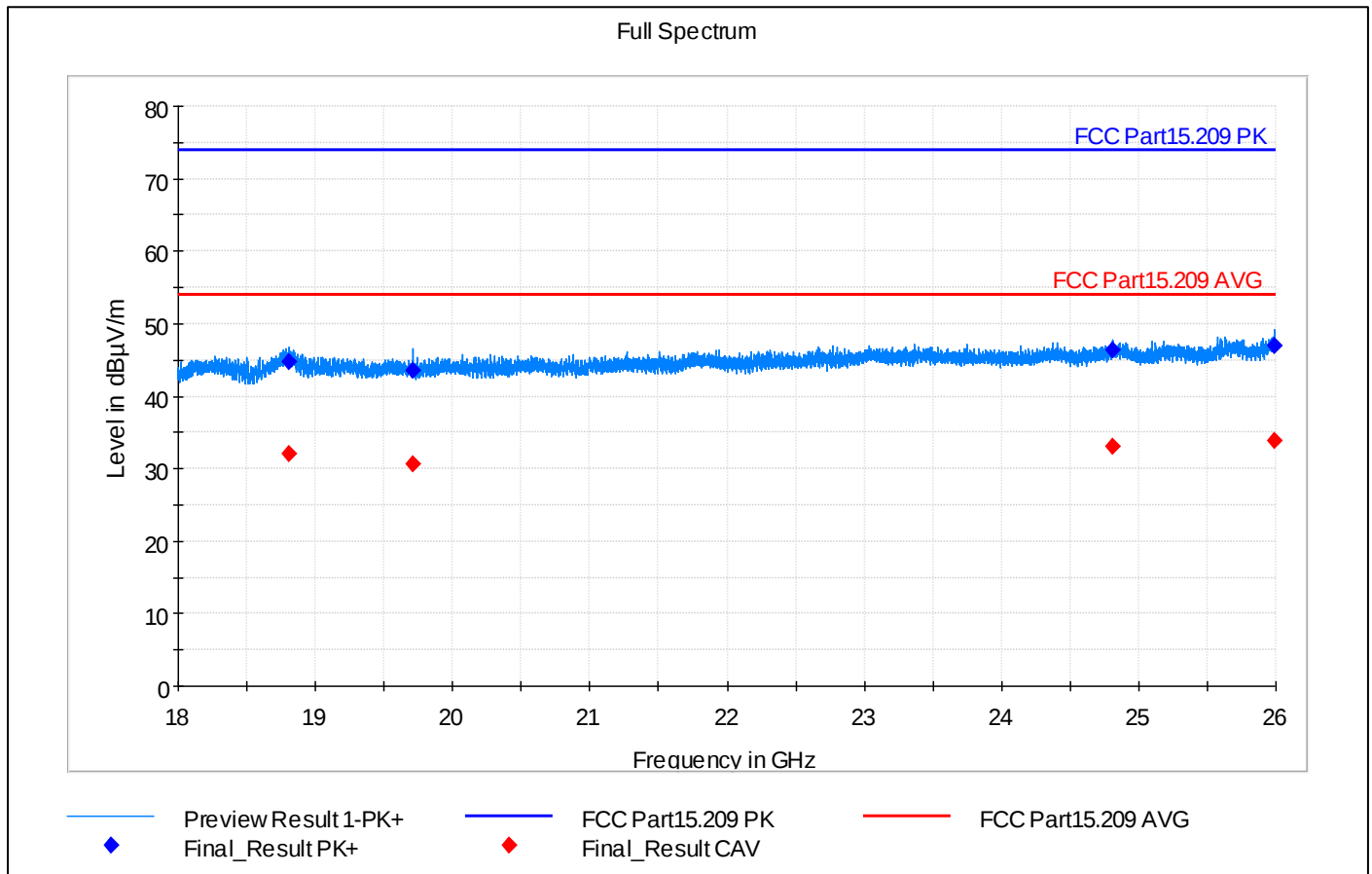
Note: Frequency 2439,700 MHz is excluded from spurious domain measurements and ignored. See table below.

Final_Result

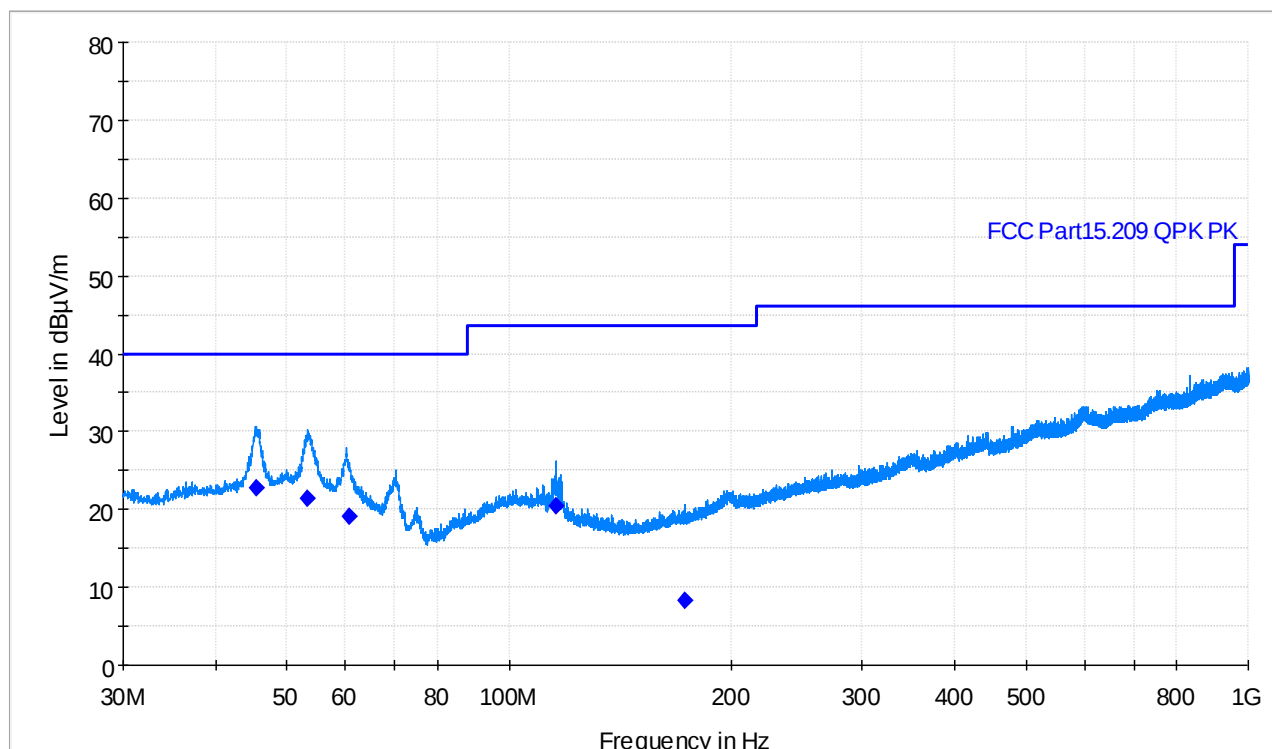
Frequency (MHz)	MaxPeak (dB μ V/m)	CAverage (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1690.400000	---	29.58	54.00	24.42	15000.0	1000.000	202.0	H	272.0	90.0	34.9	PASS
1690.400000	47.37	---	74.00	26.63	15000.0	1000.000	202.0	H	272.0	90.0	34.9	PASS
2313.900000	50.57	---	74.00	23.43	15000.0	1000.000	230.0	H	243.0	90.0	38.0	PASS
2313.900000	---	33.84	54.00	20.16	15000.0	1000.000	230.0	H	243.0	90.0	38.0	PASS
2439.700000	---	91.79	54.00	-37.79	15000.0	1000.000	130.0	H	115.0	90.0	38.9	Fundamental TX signal
2439.700000	98.47	---	74.00	-24.47	15000.0	1000.000	130.0	H	115.0	90.0	38.9	Fundamental TX signal
2997.450000	55.23	---	74.00	18.77	15000.0	1000.000	294.0	H	236.0	90.0	41.7	PASS
2997.450000	---	39.61	54.00	14.39	15000.0	1000.000	294.0	H	236.0	90.0	41.7	PASS

Mid channel, 3–18 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
3182.000000	39.57	---	74.00	34.43	15000.0	1000.000	255.0	V	102.0	90.0	5.4	PASS
3182.000000	---	25.79	54.00	28.21	15000.0	1000.000	255.0	V	102.0	90.0	5.4	PASS
4880.500000	42.85	---	74.00	31.15	15000.0	1000.000	182.0	V	181.0	90.0	10.1	PASS
4880.500000	---	28.41	54.00	25.59	15000.0	1000.000	182.0	V	181.0	90.0	10.1	PASS
7261.250000	---	29.90	54.00	24.10	15000.0	1000.000	334.0	V	0.0	90.0	15.1	PASS
7261.250000	43.81	---	74.00	30.19	15000.0	1000.000	334.0	V	0.0	90.0	15.1	PASS

Mid channel, 18–26 GHz

Final_Result

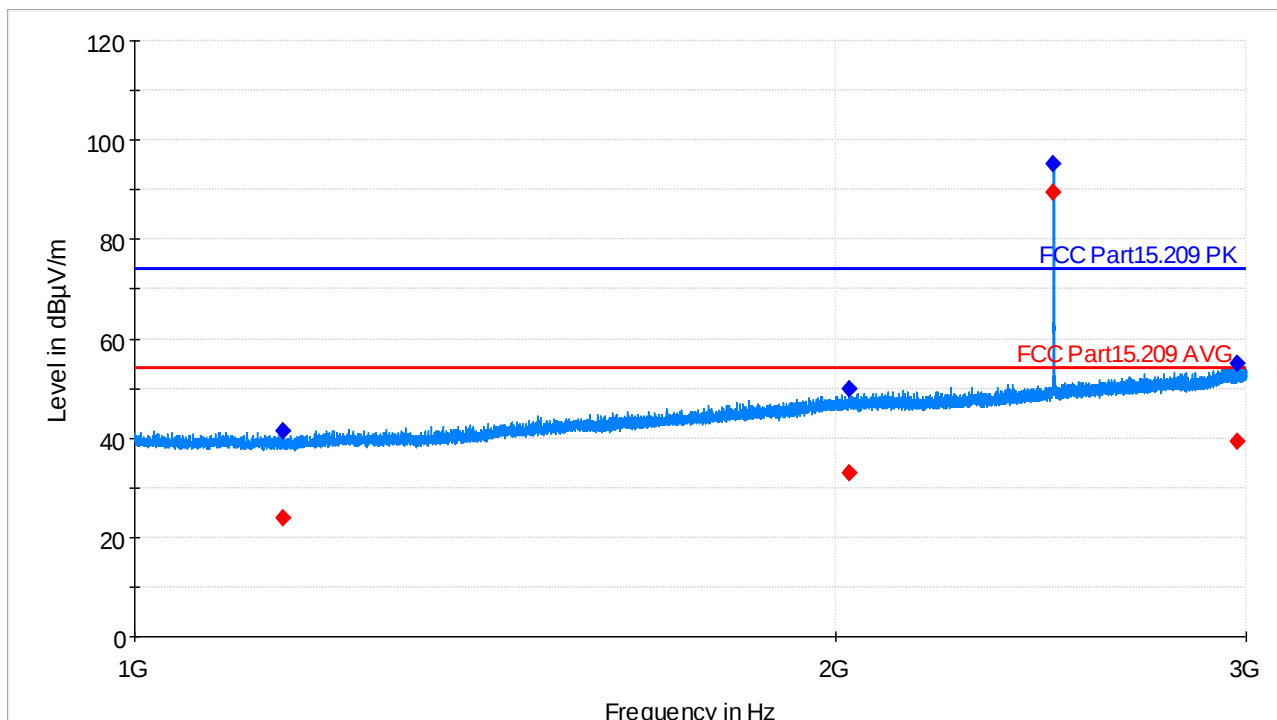
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18806.750000	44.81	---	74.00	29.19	3000.0	1000.000	117.0	V	76.0	90.0	23.5	PASS
18806.750000	---	31.99	54.00	22.01	3000.0	1000.000	117.0	V	76.0	90.0	23.5	PASS
19706.500000	---	30.61	54.00	23.39	3000.0	1000.000	364.0	V	309.0	0.0	23.9	PASS
19706.500000	43.55	---	74.00	30.45	3000.0	1000.000	364.0	V	309.0	0.0	23.9	PASS
24813.500000	---	33.02	54.00	20.98	3000.0	1000.000	123.0	V	186.0	0.0	26.6	PASS
24813.500000	46.27	---	74.00	27.73	3000.0	1000.000	123.0	V	186.0	0.0	26.6	PASS
25992.500000	46.89	---	74.00	27.11	3000.0	1000.000	168.0	H	155.0	90.0	27.0	PASS
25992.500000	---	33.85	54.00	20.15	3000.0	1000.000	168.0	H	155.0	90.0	27.0	PASS

High channel, 30 MHz – 1 GHz
Full Spectrum


— Preview Result 1-PK+
 — FCC Part15.209 QPK PK
 ◆ Final_Result QPK

Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
45.360000	22.75	40.00	17.26	15000.0	120.000	98.0	V	254.0	90.0	20.7	PASS
53.400000	21.30	40.00	18.70	15000.0	120.000	100.0	V	67.0	90.0	20.9	PASS
60.660000	19.10	40.00	20.90	15000.0	120.000	259.0	V	302.0	90.0	19.8	PASS
115.620000	20.37	43.50	23.13	15000.0	120.000	323.0	V	221.0	90.0	18.5	PASS
172.620000	8.24	43.50	35.26	15000.0	120.000	223.0	V	151.0	90.0	17.2	PASS

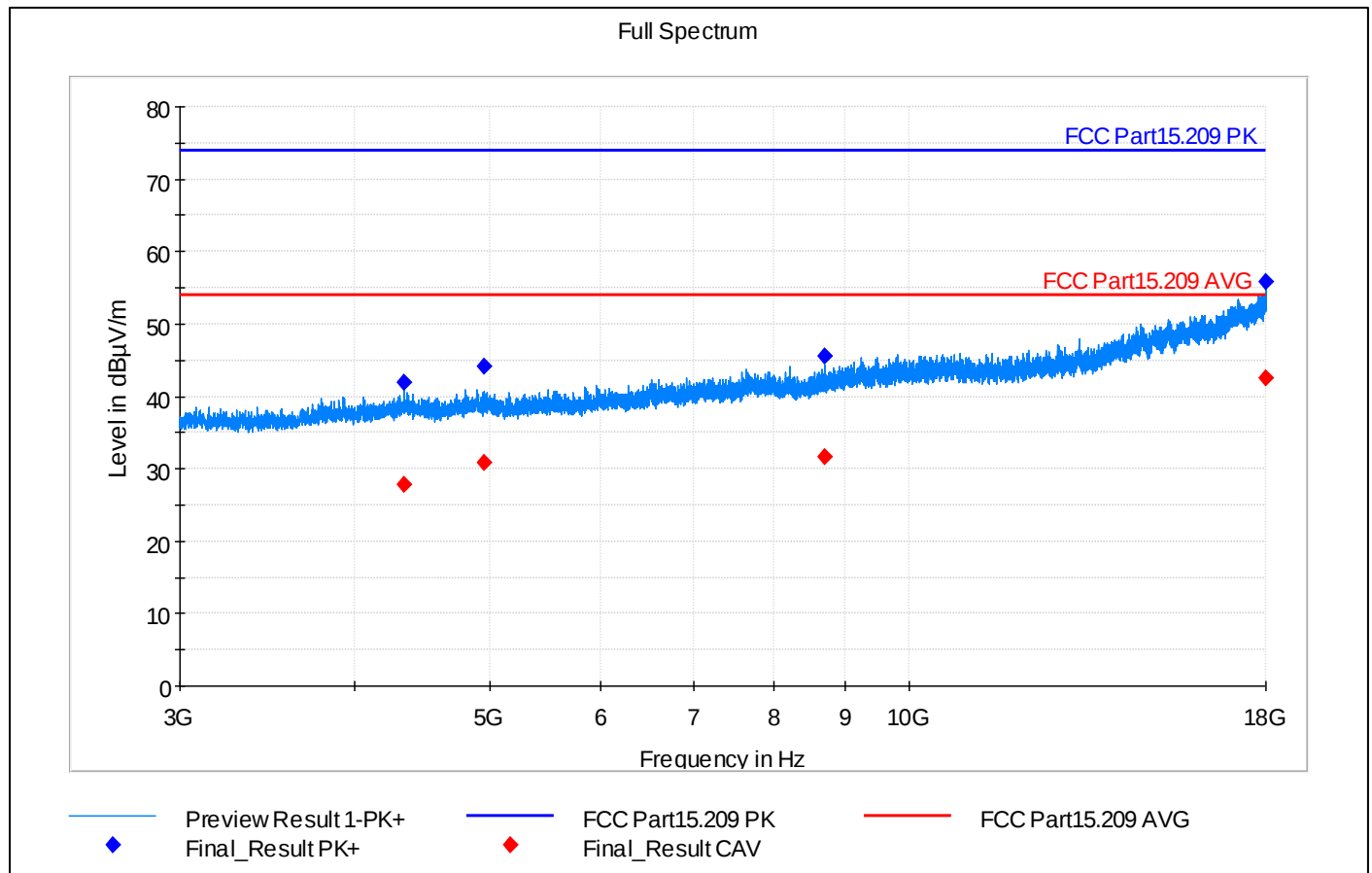
High channel, 1 – 3 GHz
Full Spectrum


◆ Preview Result 1-PK+ Final_Result PK+
 — FCC Part15.209 PK
 — FCC Part15.209 AVG
 ◆ Final_Result CAV

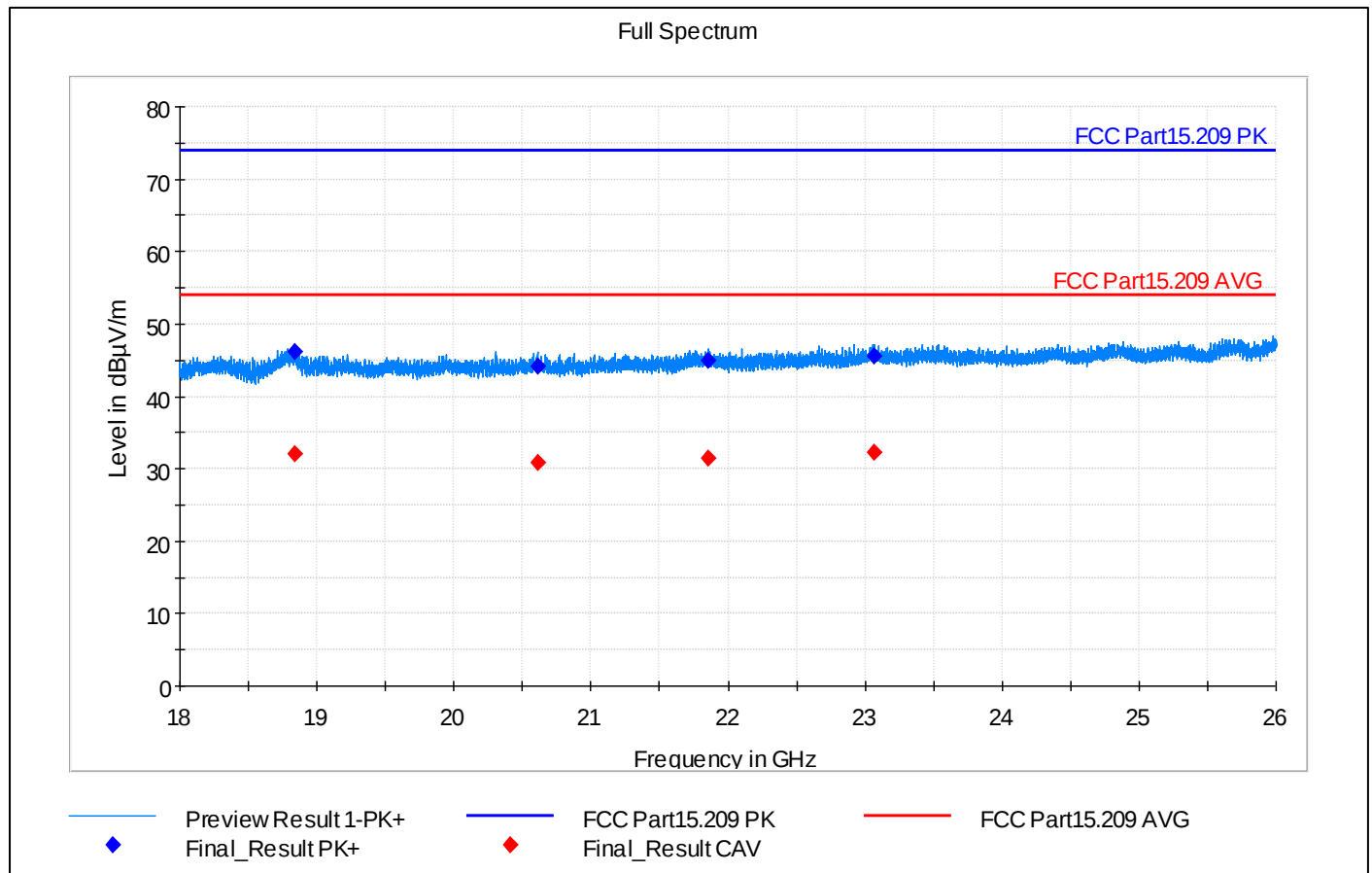
Note: Frequency 2479,800 MHz is excluded from spurious domain measurements and ignored. See table below.

Final Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1158.450000	---	23.87	54.00	30.13	15000.0	1000.000	359.0	H	342.0	90.0	31.0	PASS
1158.450000	41.44	---	74.00	32.56	15000.0	1000.000	359.0	H	342.0	90.0	31.0	PASS
2025.650000	49.93	---	74.00	24.07	15000.0	1000.000	178.0	H	226.0	0.0	37.6	PASS
2025.650000	---	33.01	54.00	20.99	15000.0	1000.000	178.0	H	226.0	0.0	37.6	PASS
2479.800000	---	89.33	54.00	-35.33	15000.0	1000.000	169.0	H	109.0	90.0	39.2	Fundamental TX signal
2479.800000	95.12	---	74.00	-21.12	15000.0	1000.000	169.0	H	109.0	90.0	39.2	Fundamental TX signal
2972.100000	55.15	---	74.00	18.85	15000.0	1000.000	407.0	H	327.0	90.0	41.3	PASS
2972.100000	---	39.40	54.00	14.60	15000.0	1000.000	407.0	H	327.0	90.0	41.3	PASS

High channel, 3 – 18 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
4339.750000	---	27.72	54.00	26.28	15000.0	1000.000	268.0	V	130.0	0.0	9.1	PASS
4339.750000	41.89	---	74.00	32.11	15000.0	1000.000	268.0	V	130.0	0.0	9.1	PASS
4959.500000	44.09	---	74.00	29.91	15000.0	1000.000	397.0	H	198.0	90.0	10.1	PASS
4959.500000	---	30.87	54.00	23.13	15000.0	1000.000	397.0	H	198.0	90.0	10.1	PASS
8697.750000	---	31.58	54.00	22.42	15000.0	1000.000	349.0	V	333.0	90.0	17.7	PASS
8697.750000	45.49	---	74.00	28.51	15000.0	1000.000	349.0	V	333.0	90.0	17.7	PASS
17990.750000	55.82	---	74.00	18.18	15000.0	1000.000	383.0	H	142.0	90.0	39.2	PASS
17990.750000	---	42.57	54.00	11.43	15000.0	1000.000	383.0	H	142.0	90.0	39.2	PASS

High channel, 18 – 26 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18836.250000	46.10	---	74.00	27.90	3000.0	1000.000	407.0	H	328.0	0.0	23.5	PASS
18836.250000	---	31.95	54.00	22.05	3000.0	1000.000	407.0	H	328.0	0.0	23.5	PASS
20608.250000	44.23	---	74.00	29.77	3000.0	1000.000	336.0	H	169.0	90.0	24.1	PASS
20608.250000	---	30.84	54.00	23.16	3000.0	1000.000	336.0	H	169.0	90.0	24.1	PASS
21853.250000	---	31.36	54.00	22.64	3000.0	1000.000	288.0	H	19.0	0.0	24.9	PASS
21853.250000	44.95	---	74.00	29.05	3000.0	1000.000	288.0	H	19.0	0.0	24.9	PASS
23064.250000	---	32.34	54.00	21.66	3000.0	1000.000	295.0	V	131.0	90.0	25.6	PASS
23064.250000	45.61	---	74.00	28.39	3000.0	1000.000	295.0	V	131.0	90.0	25.6	PASS

16. Receiver spurious emissions, radiated

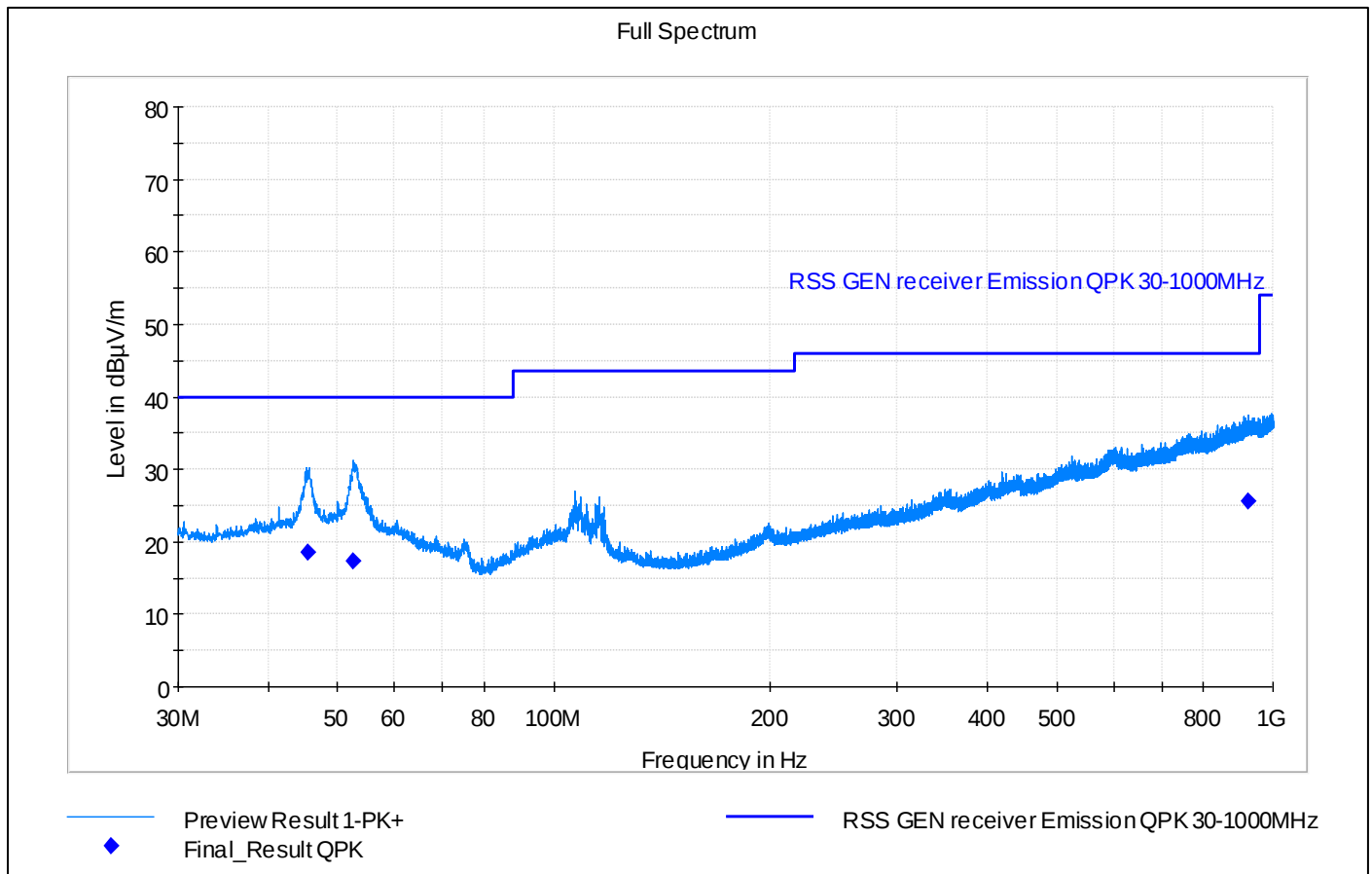
Reference: ISED RSS-247, Issue 3 (section 3.1)

Test method: ANSI C63.4-2014 (8.1 – 8.3)

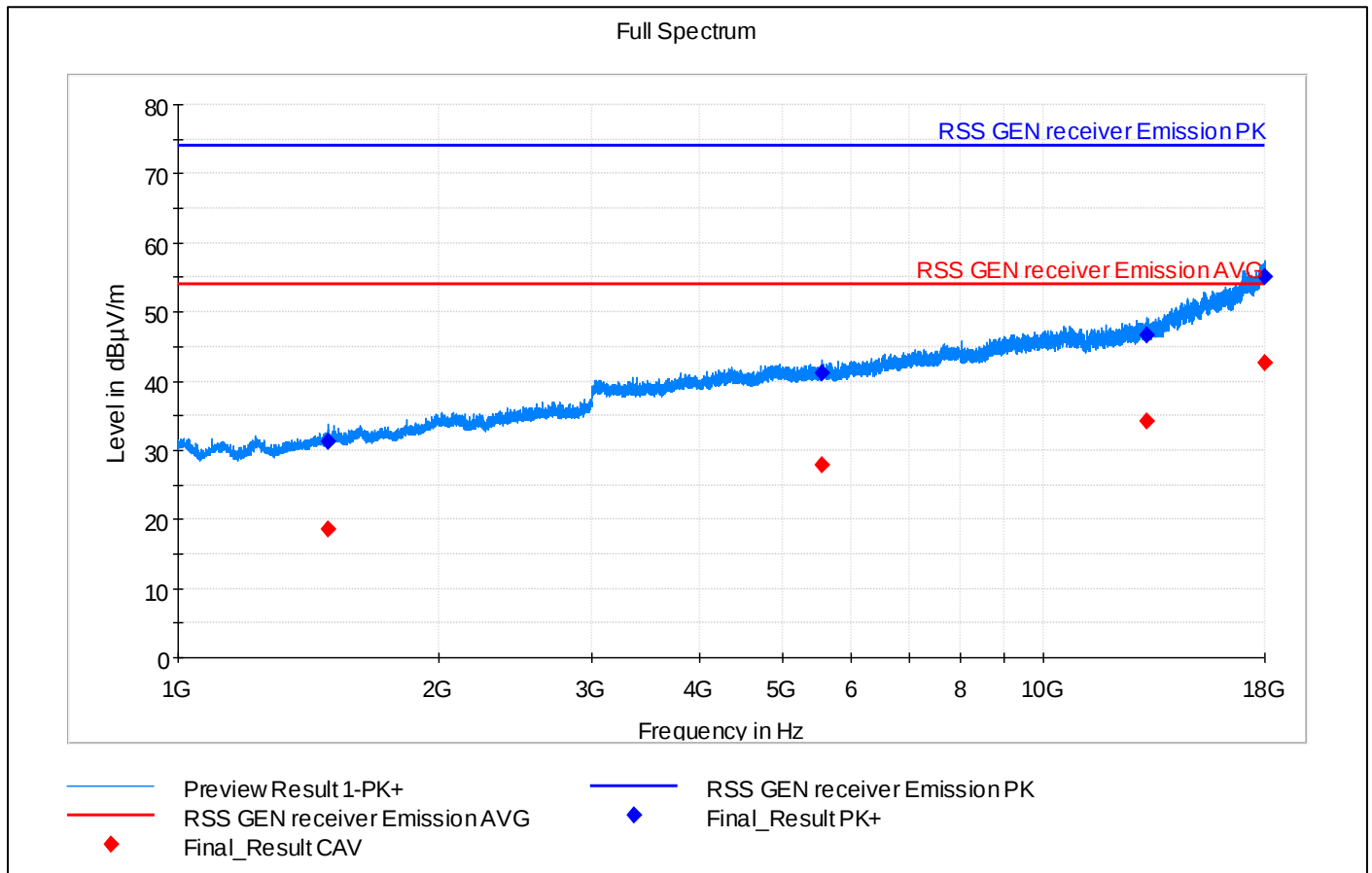
Limits			
Frequency (MHz)	Detector	Field strength (uV/m)	Measurement distance (m)
30 – 88	Quasi-Peak	100	3
88 - 216	Quasi-Peak	150	3
216 - 960	Quasi-Peak	200	3
960 - 1000	Quasi-Peak	500	3
> 1000	Average	500	3

Test procedure
1. EUT is placed on a non conducting support at the center of a turn table 0.8m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal and vertical planes of polarization 5. Found peak values were further maximized by adjusting turntable position $\pm 22,5$ degrees around detected value and scanning the antenna height 1 to 4m 6. For maximized values, final measurement was done with the corresponding final detector.

Operation mode(s)	Configuration	Test Verdict
Bluetooth LE RX	Mid channel, 2440 MHz	PASS

Mid channel RX, 30 MHz – 1 GHz

Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
45.450000	18.51	40.00	21.49	15000.0	120.000	100.0	V	214.0	0.0	20.7	PASS
52.650000	17.38	40.00	22.62	15000.0	120.000	104.0	V	227.0	0.0	20.9	PASS
922.980000	25.60	46.00	20.40	15000.0	120.000	113.0	V	166.0	0.0	34.0	PASS

Mid channel RX, 1 GHz – 18 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
1491.000000	---	18.63	54.00	35.37	500.0	1000.000	182.0	V	129.0	-5.3	PASS
1491.000000	31.22	---	74.00	42.78	500.0	1000.000	182.0	V	129.0	-5.3	PASS
5545.250000	---	27.80	54.00	26.20	500.0	1000.000	132.0	V	315.0	10.9	PASS
5545.250000	41.08	---	74.00	32.92	500.0	1000.000	132.0	V	315.0	10.9	PASS
13145.250000	46.60	---	74.00	27.40	500.0	1000.000	291.0	V	90.0	25.2	PASS
13145.250000	---	34.17	54.00	19.83	500.0	1000.000	291.0	V	90.0	25.2	PASS
17984.750000	55.04	---	74.00	18.96	500.0	1000.000	128.0	H	170.0	39.1	PASS
17984.750000	---	42.61	54.00	11.39	500.0	1000.000	128.0	H	170.0	39.1	PASS