

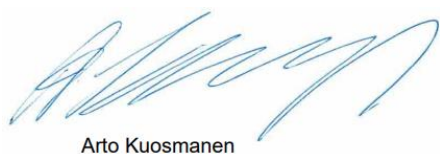
Radio Test Report

According to

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

DUT Name: Mobilaris Companion WiFi
Model No. : Mobilaris Companion WiFi
Customer: Epiroc Rock Drills AB
Address: Sundsbacken 6, 97242, Luleå, Sweden
Summary IN COMPLIANCE
Date of Reception: 19.4.2023
Date(s) of Test(s): 16.05.2023 – 14.08.2023

Tested by Test Engineer


Arto Kuosmanen

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	22.9.2023	Initial version	
v1.0	30.11.2023	Approved version	Jukka Rauma
v2.0	5.2.2024	Amendment1. Antenna gain changed to 3.3 dBi. EIRP result corrected accordingly. RSS-247 Issue 2 updated to Issue 3. No retesting required.	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: Epiroc Rock Drills AB
Andreas Karvonen
tel: +46 703332717, e-mail: andreas.karvonen@epiroc.com
Sundsbacken 6, 97242 Luleå, Sweden

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: Personal WiFi tag with rechargeable battery, capable of scanning BLE beacons.

Test sample (Conducted):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3121ER013	000101	ElectroTech Kalix AB	Personal WiFi tag	Mobilaris Companion WiFi	466F0200_230929	WiFi=3.1.0.26, BLE =5.50.00

Test sample (Radiated):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3121ER015	000104	ElectroTech Kalix AB	Personal WiFi tag	Mobilaris Companion WiFi	466F0200_230929	WiFi=3.1.0.26, BLE =5.50.00

Auxiliary equipment:

Sample number	Serial number	Manufacturer	DUT Type	Model	Comments
NA	NA	NA	USB-A to USB-C cable	NA	Conducted RF-tests

Description	Information	
Additional model	Mobilaris Companion WiFi	
Brand Names(s)	Mobilaris Companion WiFi	
PMN	Companion WiFi	
HVIN	466F0200_230929	
FVIN	WiFi=3.1.0.26, BLE =5.50.00	
HMN	Companion Wifi	
FCC ID	2A93V-466F	
IC ID	29959-466F	
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	
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	Integrated antenna
	Model	Inverted F
	Manufacturer	Mobilaris
	Gain	3.3 dBi
Supply voltage	120V/60 Hz, (battery operated, V _{Nom} = 5 VDC)	
Type of Power source	AC/DC adaptor, battery operated	
Operating Temperature	TNom = 25°C TMin = -20°C TMax = 60°C	
Manufacturer	Epiroc Rock Drills AB Sundsbacken 6, 97242 Luleå, Sweden	

3. Configuration and Operation Modes

Conducted RF test:

Test modes / description
GFSK modulation, power level setting 5 dBm, data rate 1 Mbps
Continuous modulated carrier at 2402 MHz, 2440 MHz and 2480 MHz

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 5 dBm, data rate 1 Mbps
EUT battery powered, continuous reception at 2440 MHz

Test/configuration software

Manufacturer	Name	Version
Texas Instruments	BTool, Bluetooth Low Energy Application	v1.42.20

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
G4C217	Rohde & Schwarz	HF907	Double-Ridged Waveguide Horn Antenna 800MHz-18GHz	100164	4.11.2020	4.11.2023
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	11.11.2020	11.11.2023
G4C292	Rohde & Schwarz	TS-LNA 1840	RF Preamplifier 18 to 40 GHz	100841	9.6.2022	9.6.2024
G4C298	Rohde & Schwarz	CMW500	Wideband radio communication tester	170980	29.6.2023	29.6.2024
G4C469	Rohde & Schwarz	TS_PRE2	RF Preamplifier	101541	9.6.2022	9.6.2024
G4C294	Rohde & Schwarz	Antenna	Horn Antenna -> 40GHz	101057	4.11.2022	4.11.2025

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

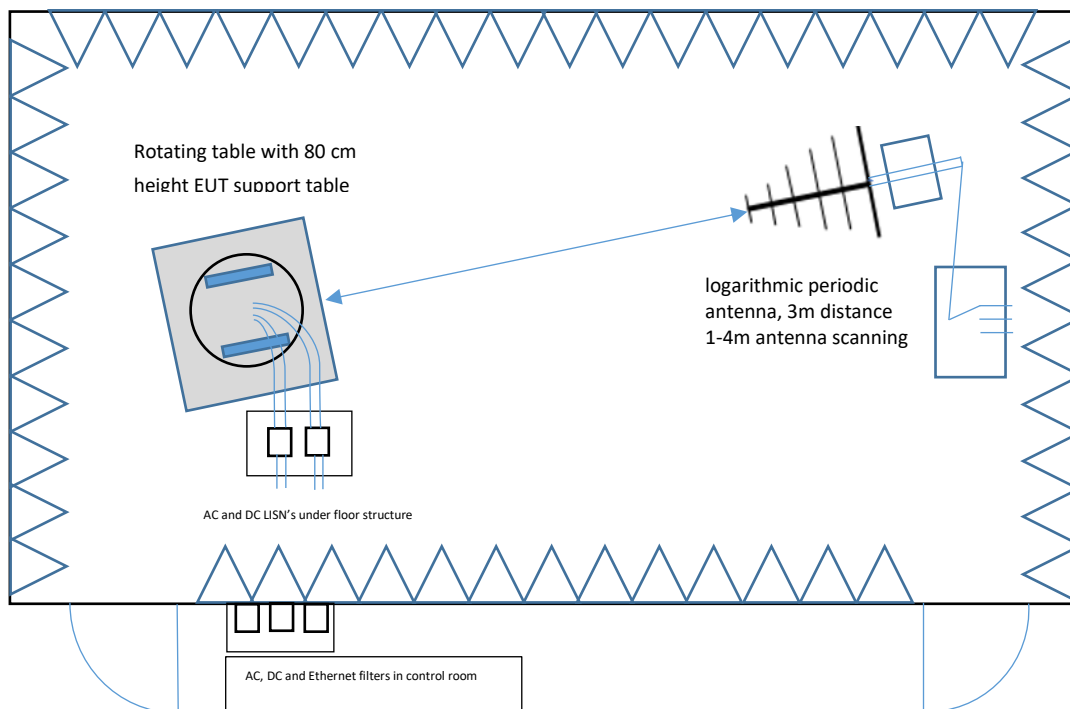
All radiated tests were performed in a semi-anechoic chamber, where the measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz, 1 GHz-18 GHz Double-ridged horn antenna and 18 GHz-40 GHz horn antenna) is located at a distance of 3 m.

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.

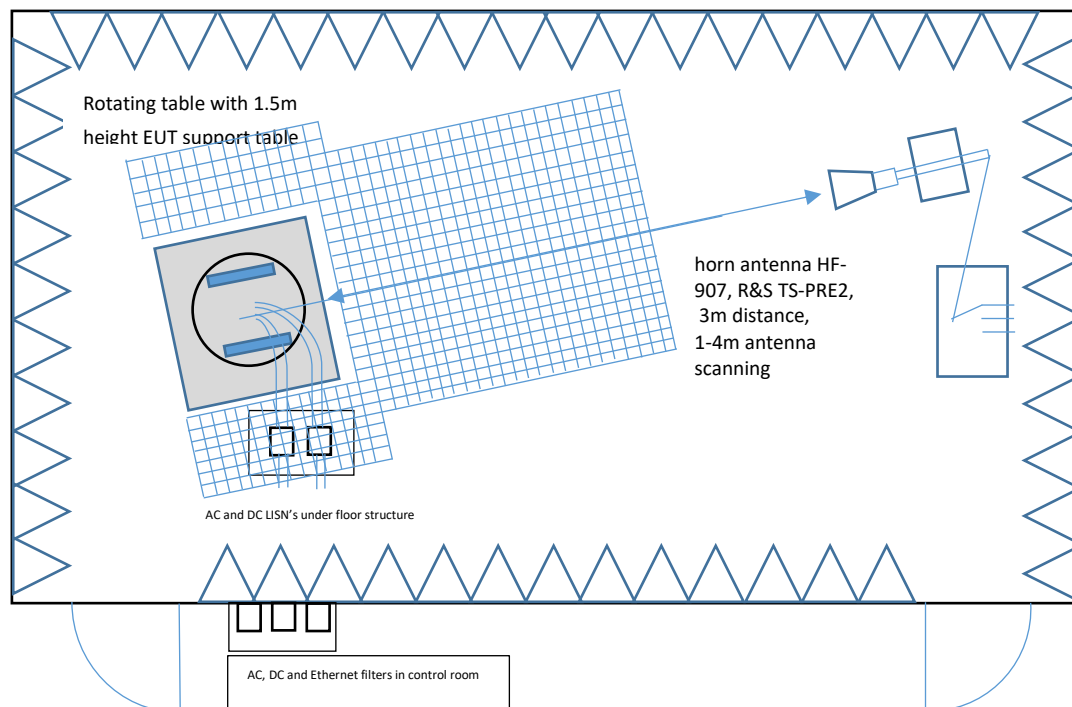
Measurements were made in both horizontal and vertical planes of polarization.

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.

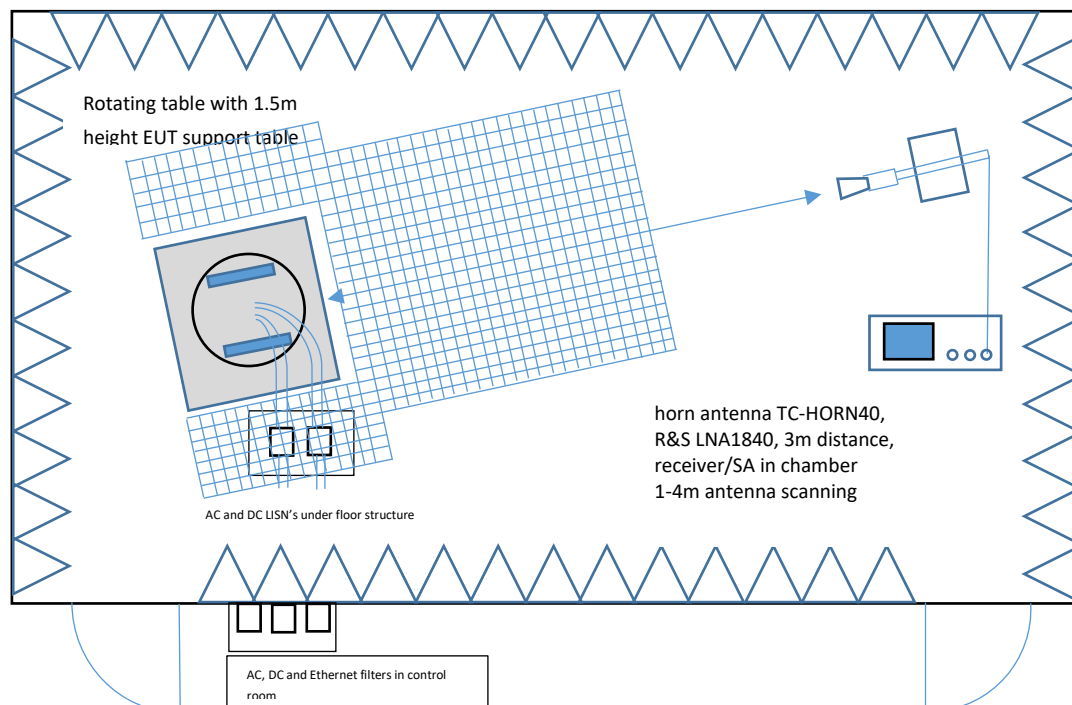
Radiated measurements setup from 30 MHz to 1 GHz:



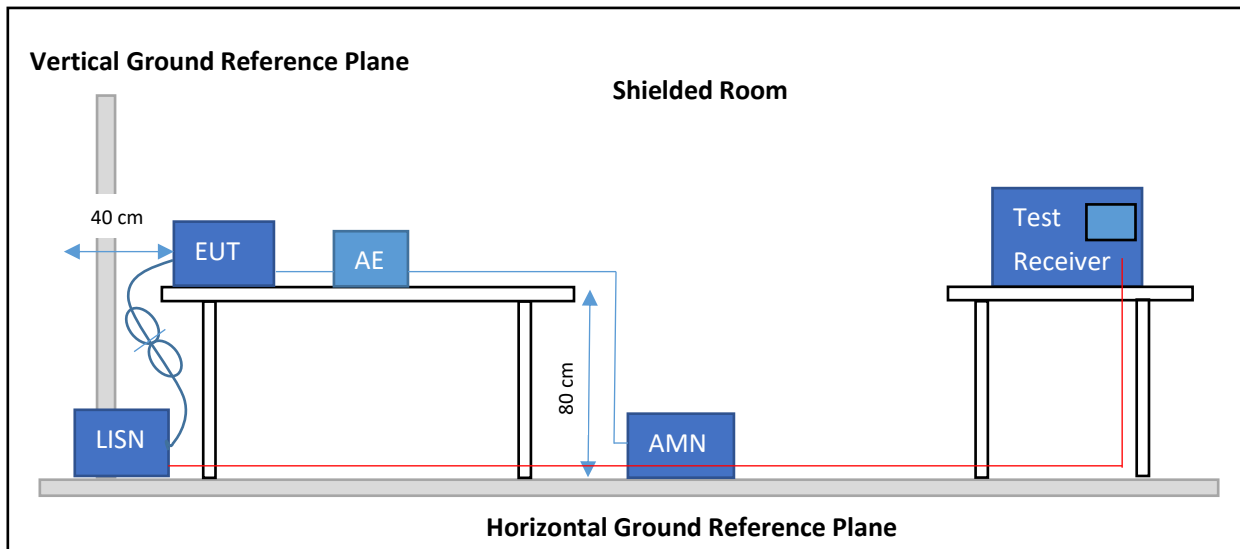
Radiated measurements setup from 1 GHz to 18 GHz:



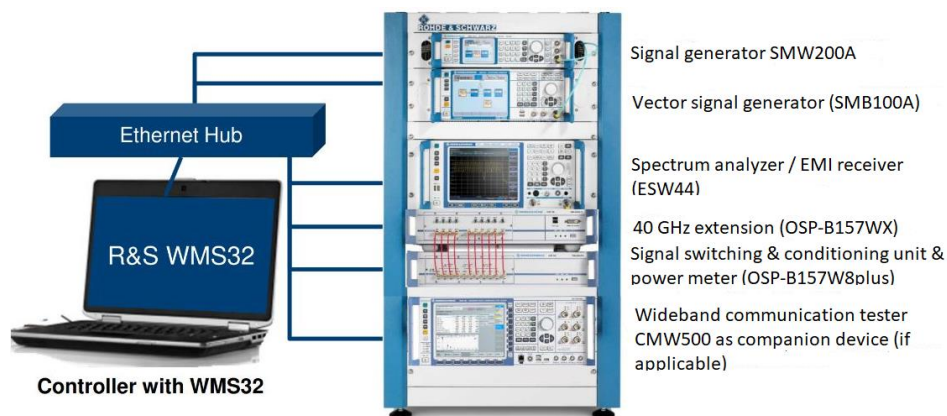
Radiated measurements setup from 18 GHz to 26 / 40 GHz:



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	PASS	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	
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)

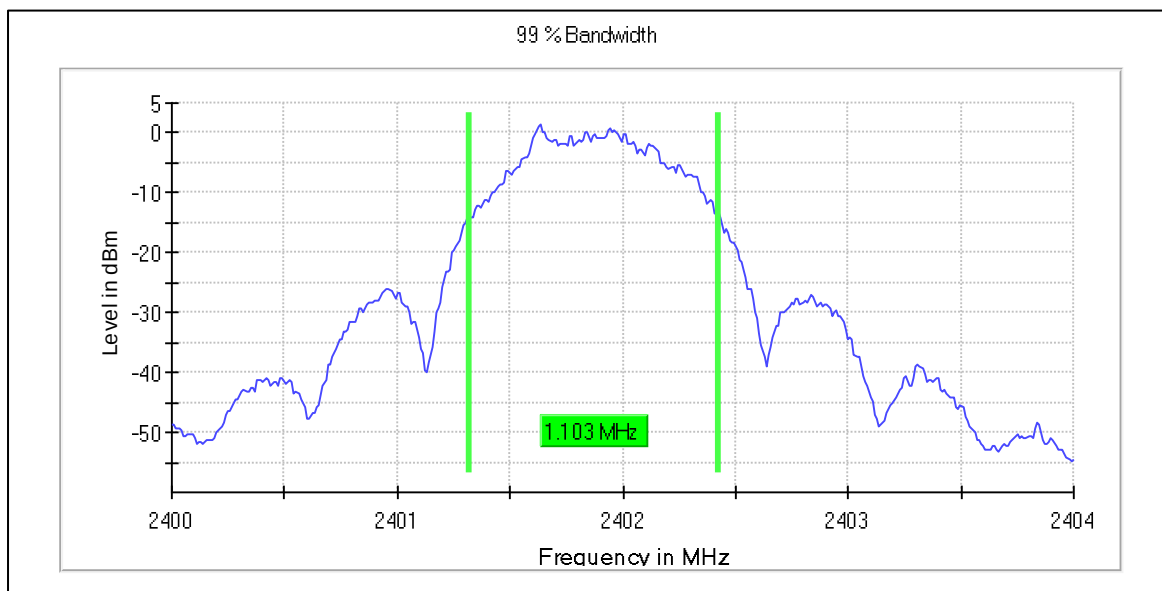
Limits
None (Informational only)

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

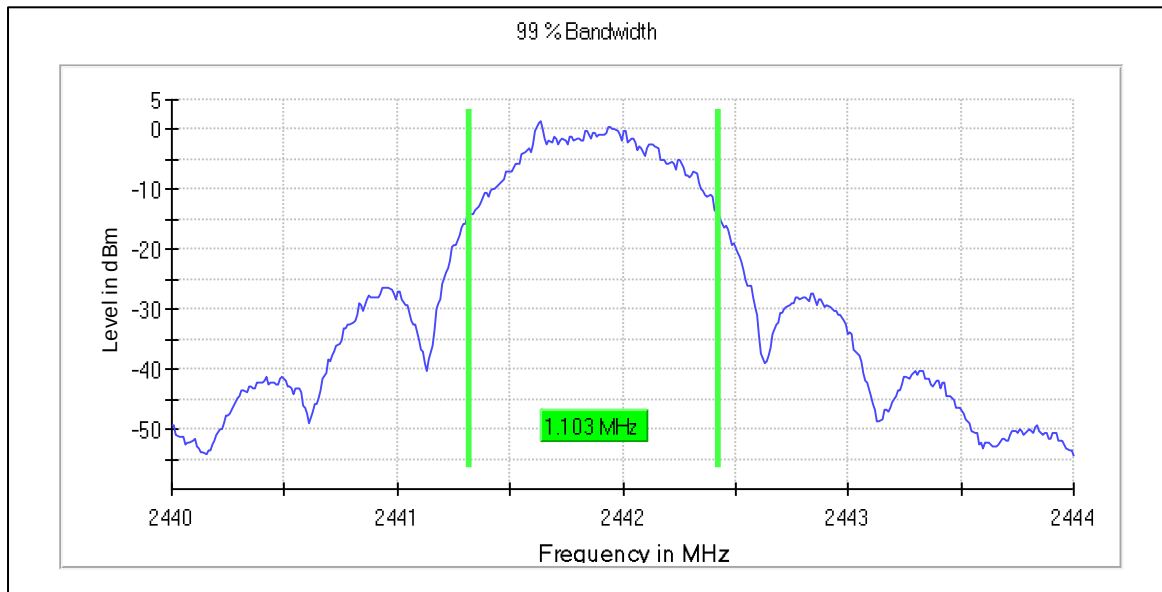
Summary:

Summary		
Mode / modulation	Frequency (MHz)	Bandwidth (MHz)
Bluetooth LE, 1 Mbps	2402	1.102757
Bluetooth LE, 1 Mbps	2442	1.102757
Bluetooth LE, 1 Mbps	2480	1.092732

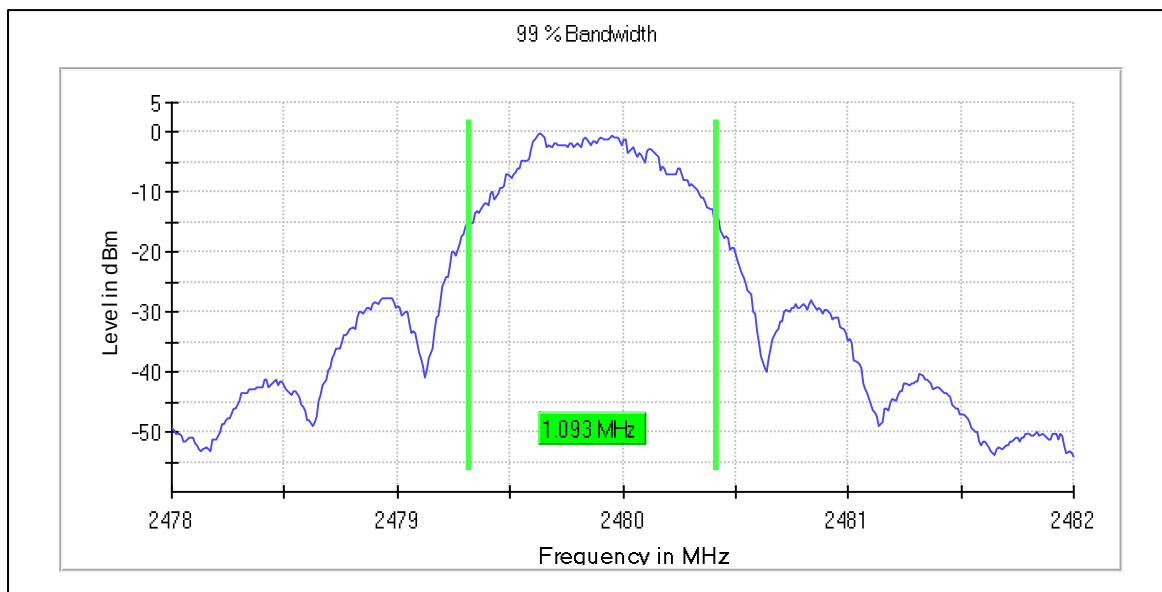
Occupied bandwidth, low channel



Occupied bandwidth, middle channel



Occupied bandwidth, high channel



10. 6 dB bandwidth

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

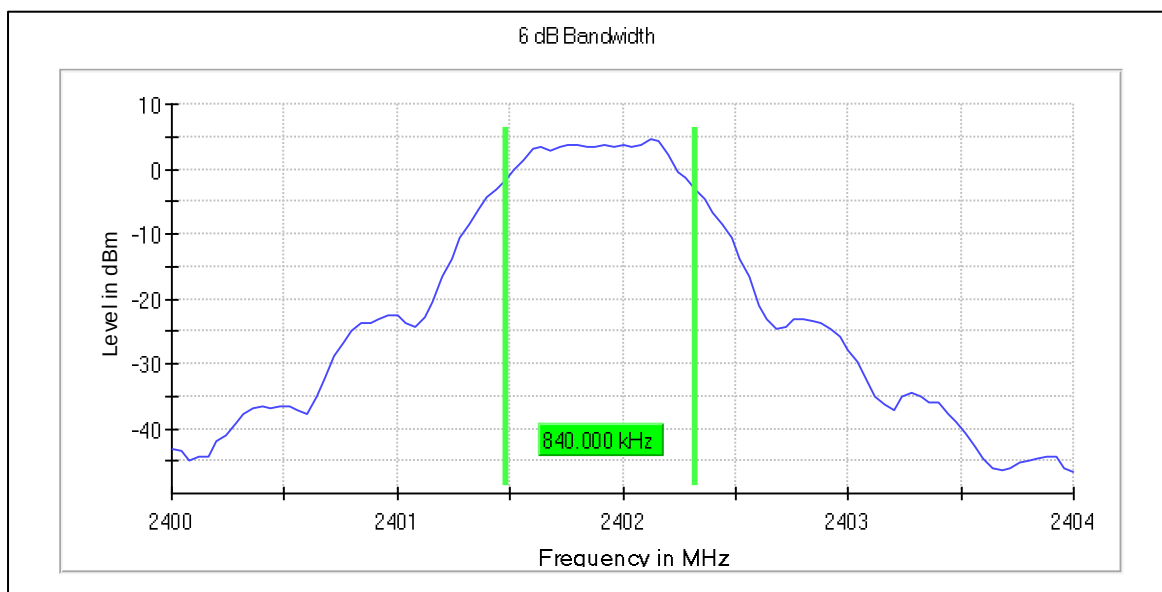
Test method: KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 (11.8.1)

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

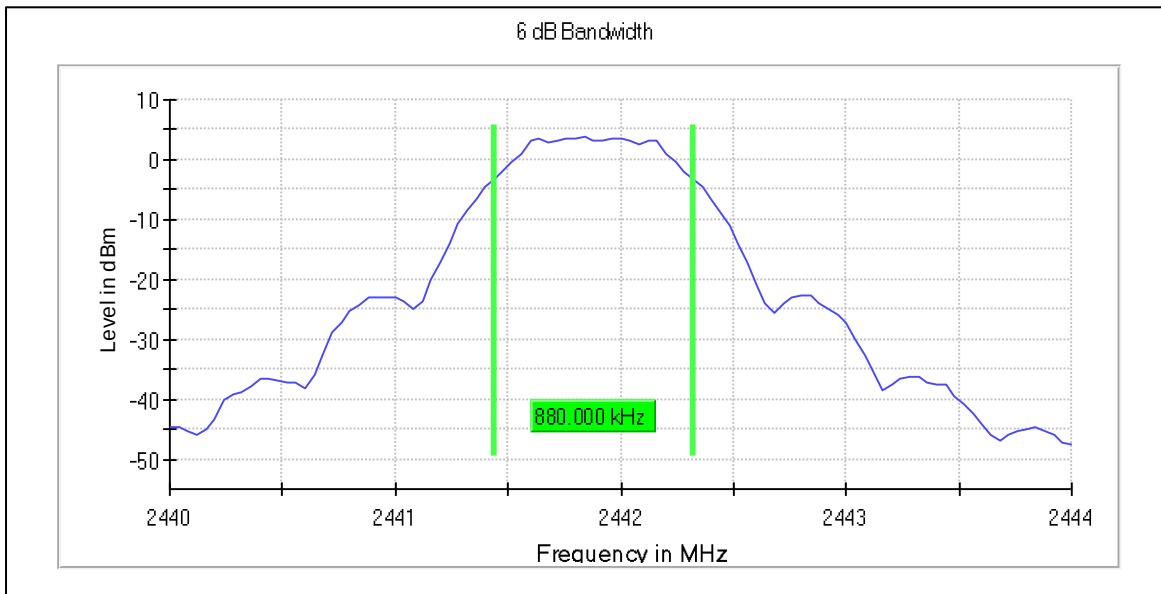
Test procedure
1. EUT set to test mode 2. Span set to at least twice the emission spectrum 3. Detector set to peak and max hold and BW is set to 100 kHz 4. Envelope peak value of emission spectrum is selected 5. Marker on envelope of spectrum is set to level of -6 dB to the left of the peak 6. Marker 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)	Band Edge Left (MHz)	Band Edge Right (MHz)	Max Level (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	0.840000	0.500000	2401.480000	2402.320000	4.5	PASS
Bluetooth LE, 1 Mbps	2442.000000	0.880000	0.500000	2441.440000	2442.320000	3.8	PASS
Bluetooth LE, 1 Mbps	2480.000000	0.880000	0.500000	2479.440000	2480.320000	3.1	PASS

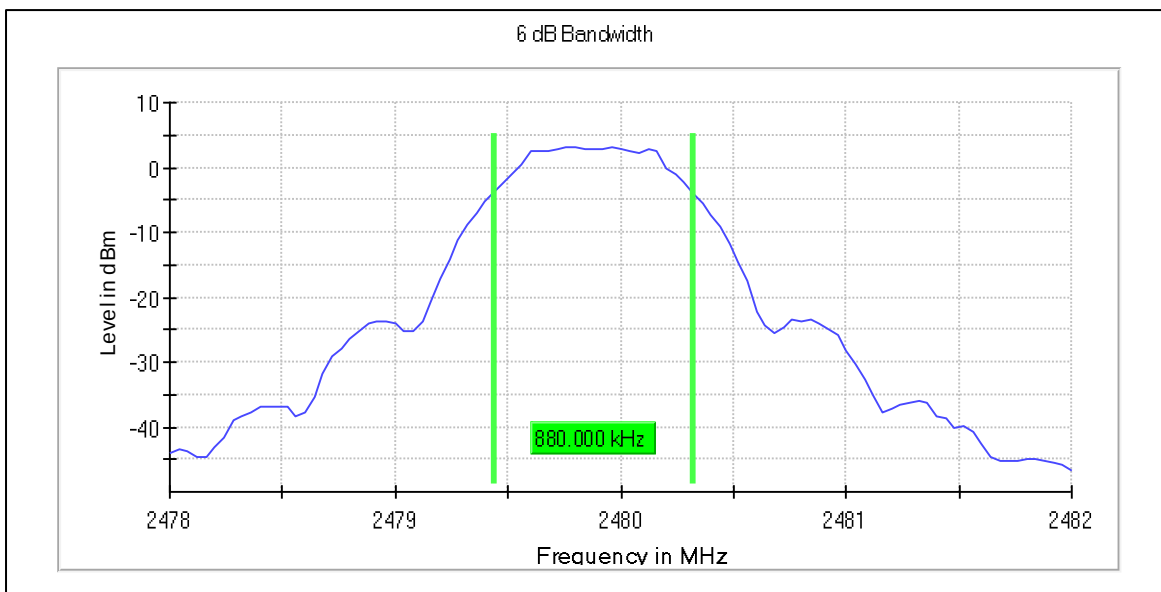
6 dB Bandwidth, low channel:



6 dB Bandwidth, middle channel:



6 dB Bandwidth, high channel:



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.

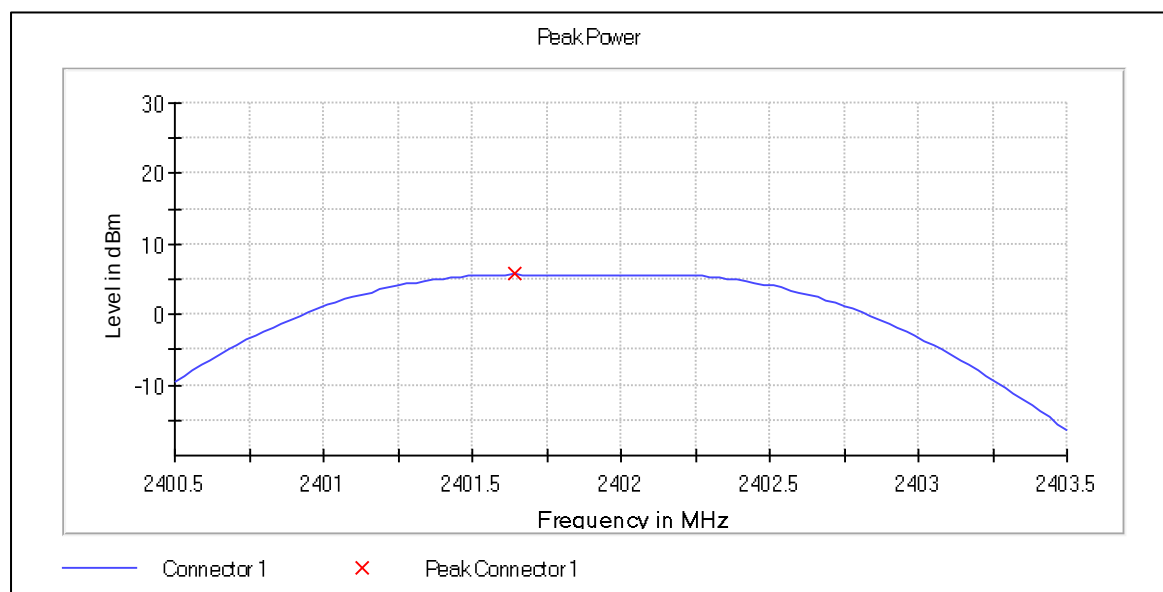
Test procedure
1. EUT set to test mode (communication tested is used if needed)
2. Analyzer resolution bandwidth is set $\geq$ DTS bandwidth
3. Detector set to peak and max hold
4. Sweep time is set to auto
5. After trace has stabilized a marker is set to peak envelope

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

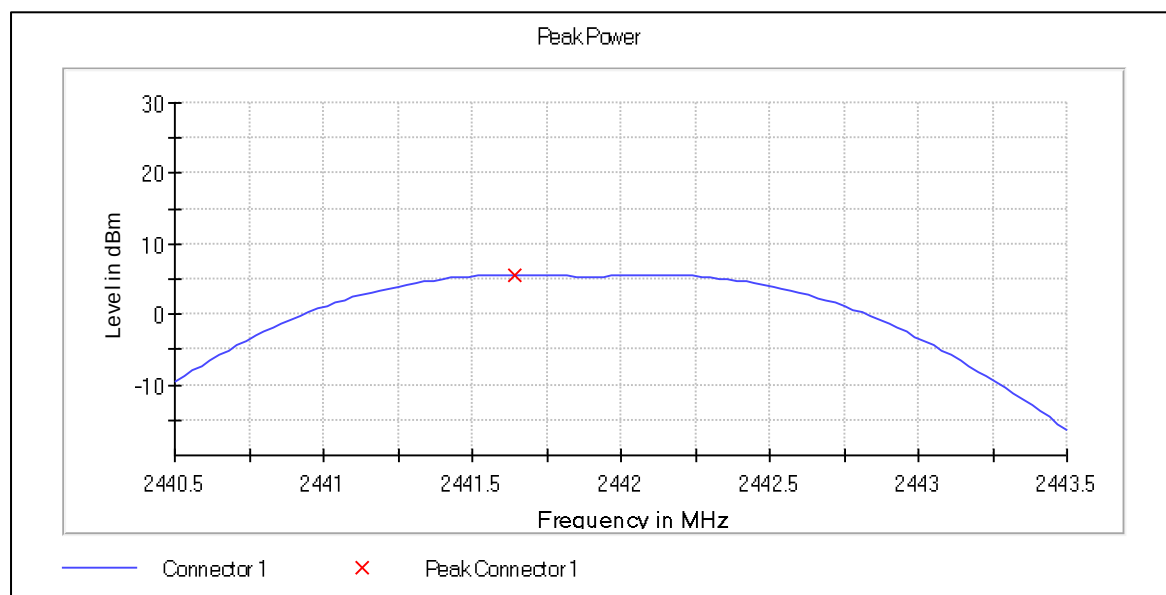
Maximum Declared Antenna Gain: 3.3 dBi

Mode / modulation	DUT Frequency (MHz)	Peak Power (dBm)	EIRP Power (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	5.7	9.0	PASS
Bluetooth LE, 1 Mbps	2442.000000	5.6	8.9	PASS
Bluetooth LE, 1 Mbps	2480.000000	4.9	8.2	PASS

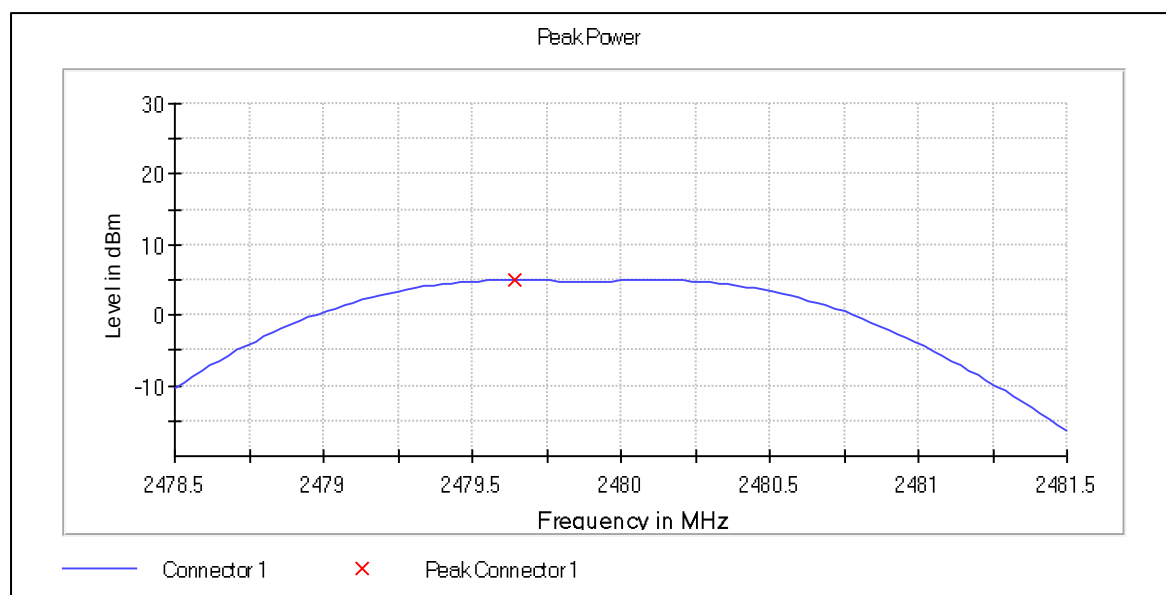
Peak power, low channel



Peak power, middle channel



Peak power, high channel



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.

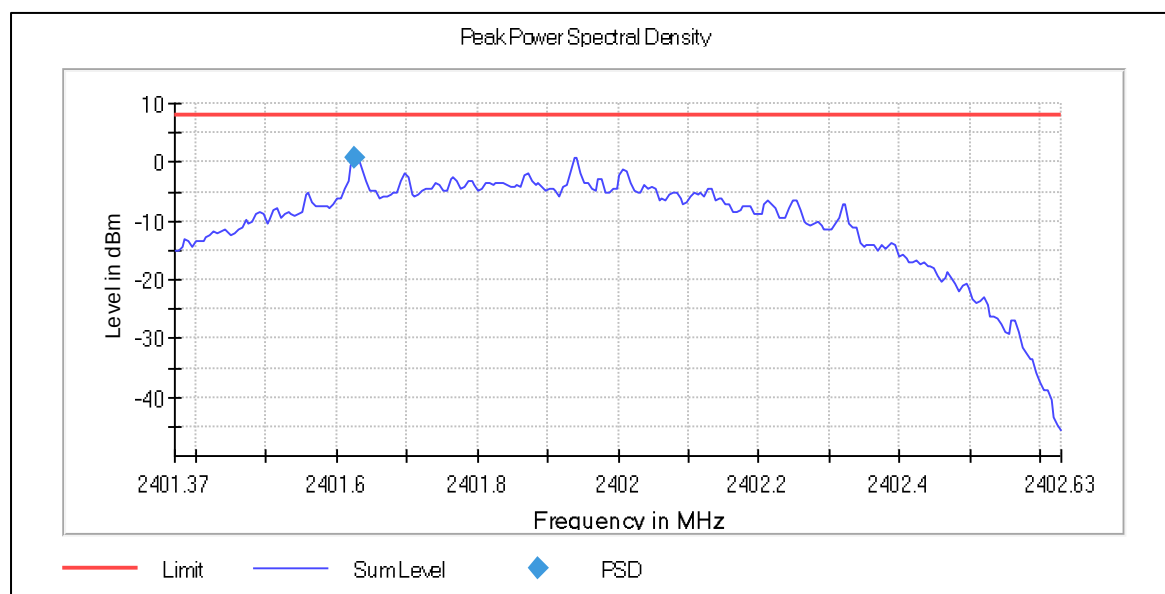
Limits
≤ 8 dBm / 3 kHz

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

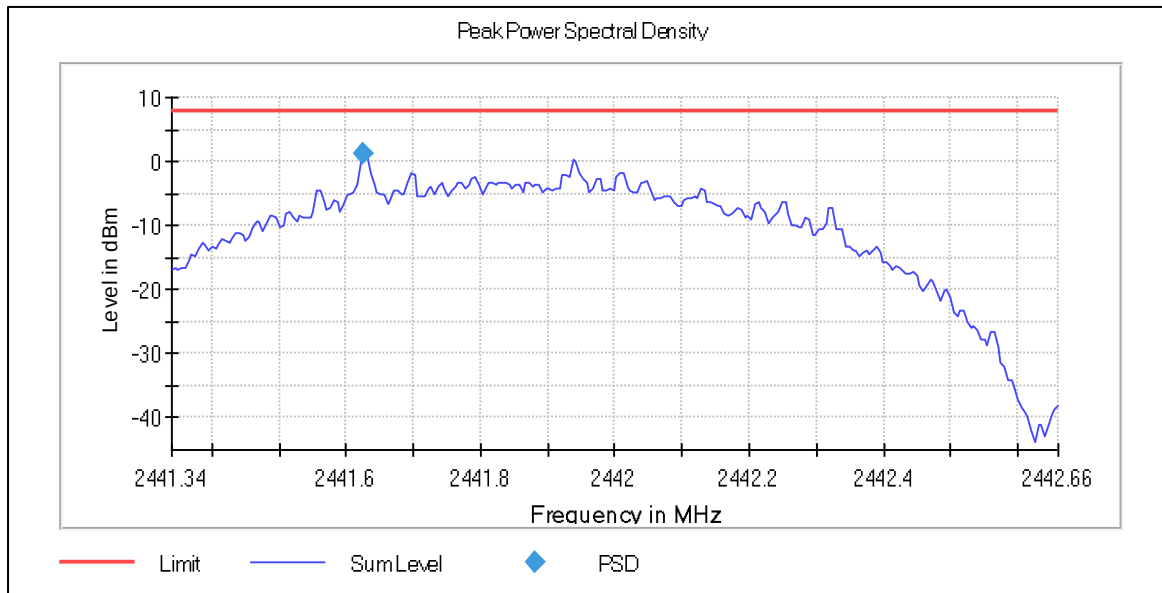
Summary

Mode / modulation	DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	2401.626016	0.895	8.0	PASS
Bluetooth LE, 1 Mbps	2442.000000	2441.626084	1.194	8.0	PASS
Bluetooth LE, 1 Mbps	2480.000000	2479.626084	0.425	8.0	PASS

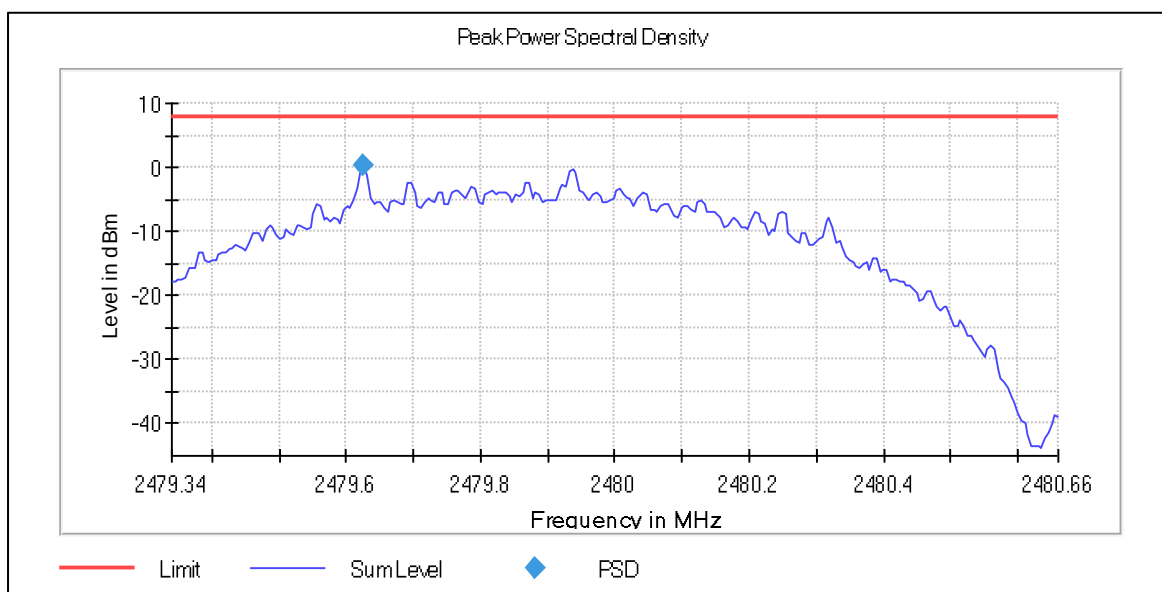
Peak power spectral density, low channel



Peak power spectral density, middle channel



Peak power spectral density, high channel:



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

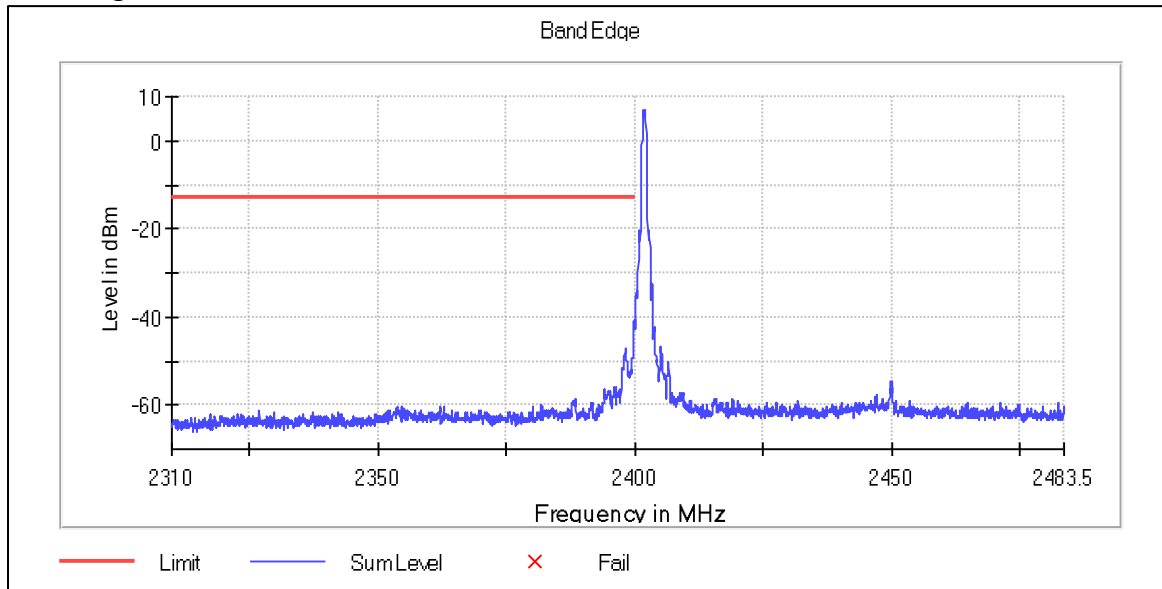
Measurements, band edge low

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.949972	-40.5	27.6	-12.9	PASS
2399.899944	-41.2	28.3	-12.9	PASS
2399.849917	-41.9	29.0	-12.9	PASS
2399.799889	-44.2	31.3	-12.9	PASS
2399.749861	-46.3	33.4	-12.9	PASS
2398.148972	-47.1	34.2	-12.9	PASS
2399.699833	-47.1	34.2	-12.9	PASS
2398.198999	-47.4	34.5	-12.9	PASS
2398.098944	-48.0	35.1	-12.9	PASS
2398.249027	-48.7	35.8	-12.9	PASS
2398.048916	-48.8	35.9	-12.9	PASS
2399.649805	-49.0	36.1	-12.9	PASS
2399.549750	-49.3	36.4	-12.9	PASS
2399.599778	-49.5	36.6	-12.9	PASS
2398.399111	-49.6	36.7	-12.9	PASS

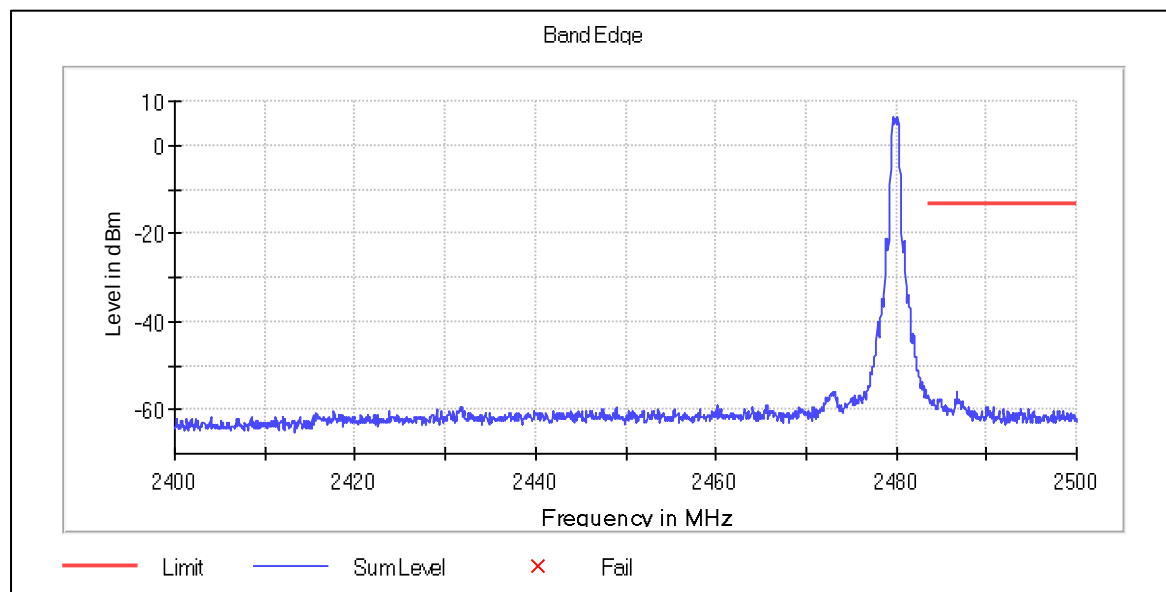
Measurements, band edge high

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2486.759878	-55.9	42.6	-13.3	PASS
2486.709726	-56.6	43.2	-13.3	PASS
2483.600304	-56.8	43.5	-13.3	PASS
2483.550152	-57.2	43.9	-13.3	PASS
2484.904255	-57.5	44.1	-13.3	PASS
2484.854103	-57.5	44.2	-13.3	PASS
2484.703647	-57.7	44.4	-13.3	PASS
2484.753799	-57.7	44.4	-13.3	PASS
2486.910334	-57.8	44.4	-13.3	PASS
2484.603343	-57.8	44.5	-13.3	PASS
2484.051672	-57.8	44.5	-13.3	PASS
2483.800912	-57.8	44.5	-13.3	PASS
2486.509119	-57.9	44.6	-13.3	PASS
2486.559271	-57.9	44.6	-13.3	PASS
2486.860182	-57.9	44.6	-13.3	PASS

Band edge, low channel



Band edge, high channel



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)
2351.982851	-54.4	33.2	-21.2
2483.500000	-54.7	33.5	-21.2
2378.492319	-54.8	33.6	-21.2
2377.992140	-54.9	33.7	-21.2
2343.479814	-54.9	33.7	-21.2
2388.996070	-55.0	33.8	-21.2
2383.494105	-55.0	33.8	-21.2
2382.993926	-55.1	33.9	-21.2
2389.496249	-55.3	34.1	-21.2
2387.995713	-55.5	34.3	-21.2
2384.994641	-55.5	34.3	-21.2
2372.990354	-55.6	34.4	-21.2
2365.487674	-55.7	34.5	-21.2
2376.491604	-55.7	34.5	-21.2
2381.493390	-55.8	34.6	-21.2

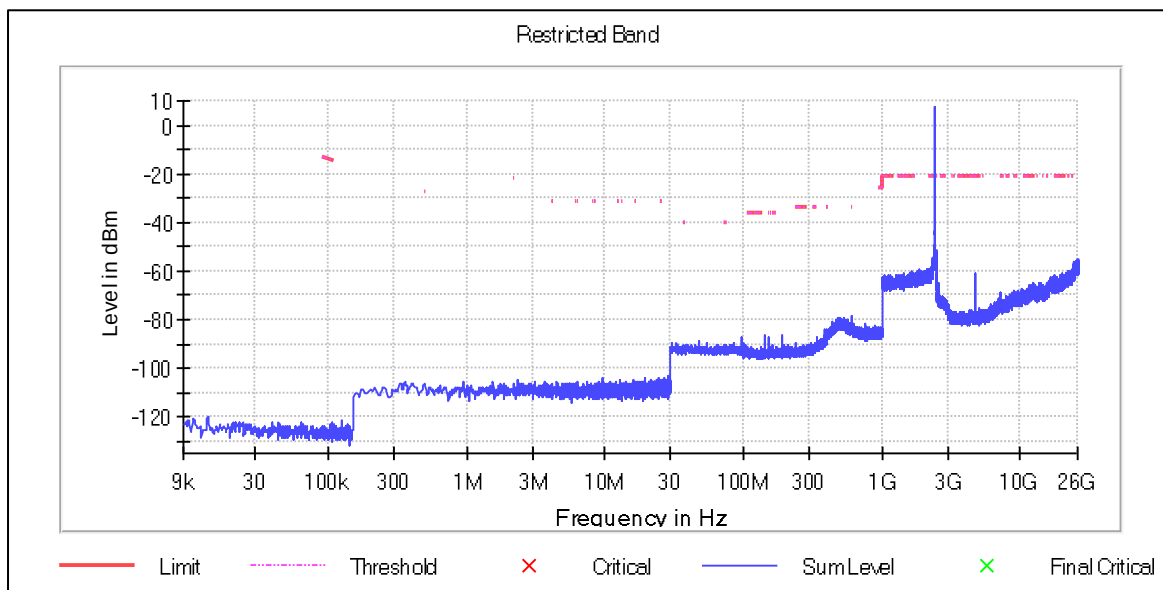
Pre Measurements, middle channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2483.500000	-51.5	30.3	-21.2
2489.500222	-53.3	32.1	-21.2
2485.000055	-53.3	32.1	-21.2
2490.000240	-53.8	32.6	-21.2
2488.500185	-54.1	32.9	-21.2
2489.000203	-54.1	32.9	-21.2
2487.000129	-54.2	33.0	-21.2
2485.500074	-54.2	33.0	-21.2
2486.000092	-54.3	33.1	-21.2
2345.980707	-54.5	33.3	-21.2
2484.000018	-54.6	33.4	-21.2
2488.000166	-54.7	33.5	-21.2
2486.500111	-54.8	33.6	-21.2
2484.500037	-55.1	33.9	-21.2
2490.500259	-55.3	34.1	-21.2

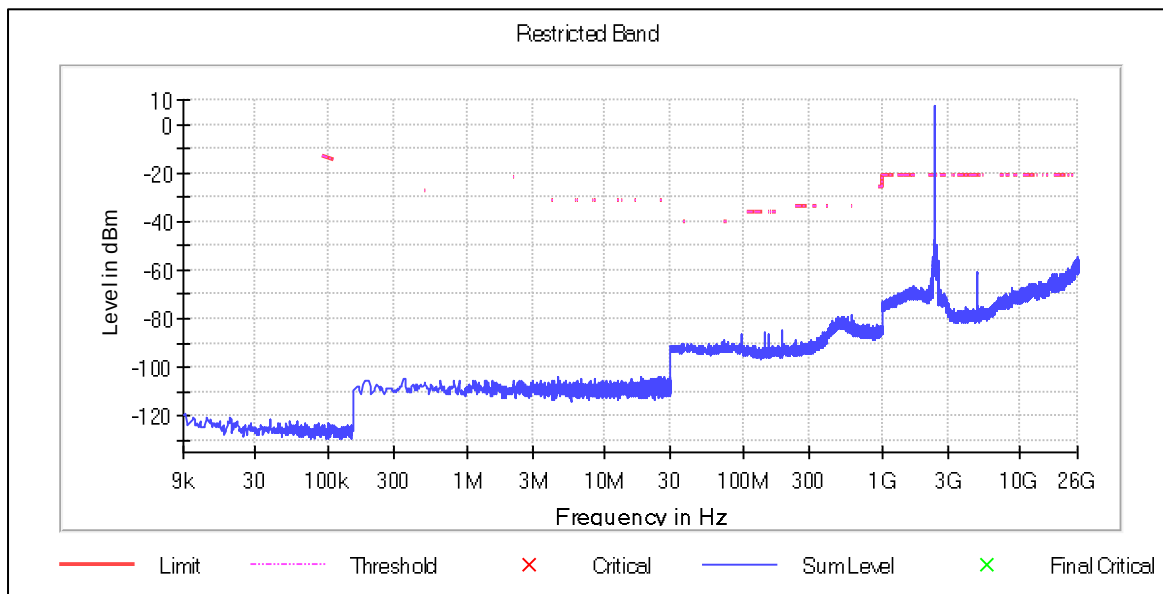
Pre Measurements, top channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2483.500000	-43.8	22.6	-21.2
15613.985721	-44.4	23.2	-21.2
15697.488810	-44.6	23.4	-21.2
12524.371430	-45.0	23.8	-21.2
12153.357706	-45.0	23.8	-21.2
15995.999852	-45.1	23.9	-21.2
15960.498539	-45.2	24.0	-21.2
12096.855616	-45.2	24.0	-21.2
15874.995376	-45.2	24.0	-21.2
15458.479968	-45.2	24.0	-21.2
12572.873224	-45.3	24.1	-21.2
12481.369839	-45.3	24.1	-21.2
15563.983871	-45.3	24.1	-21.2
12569.373095	-45.3	24.1	-21.2
12595.374057	-45.3	24.1	-21.2

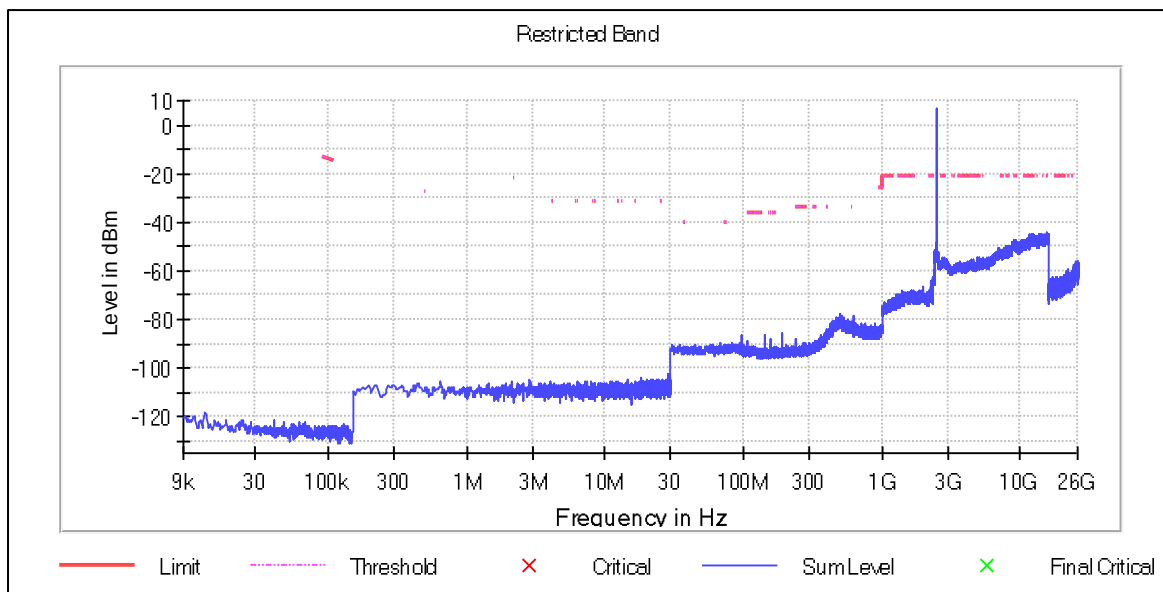
Low channel



Middle channel



High channel



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.

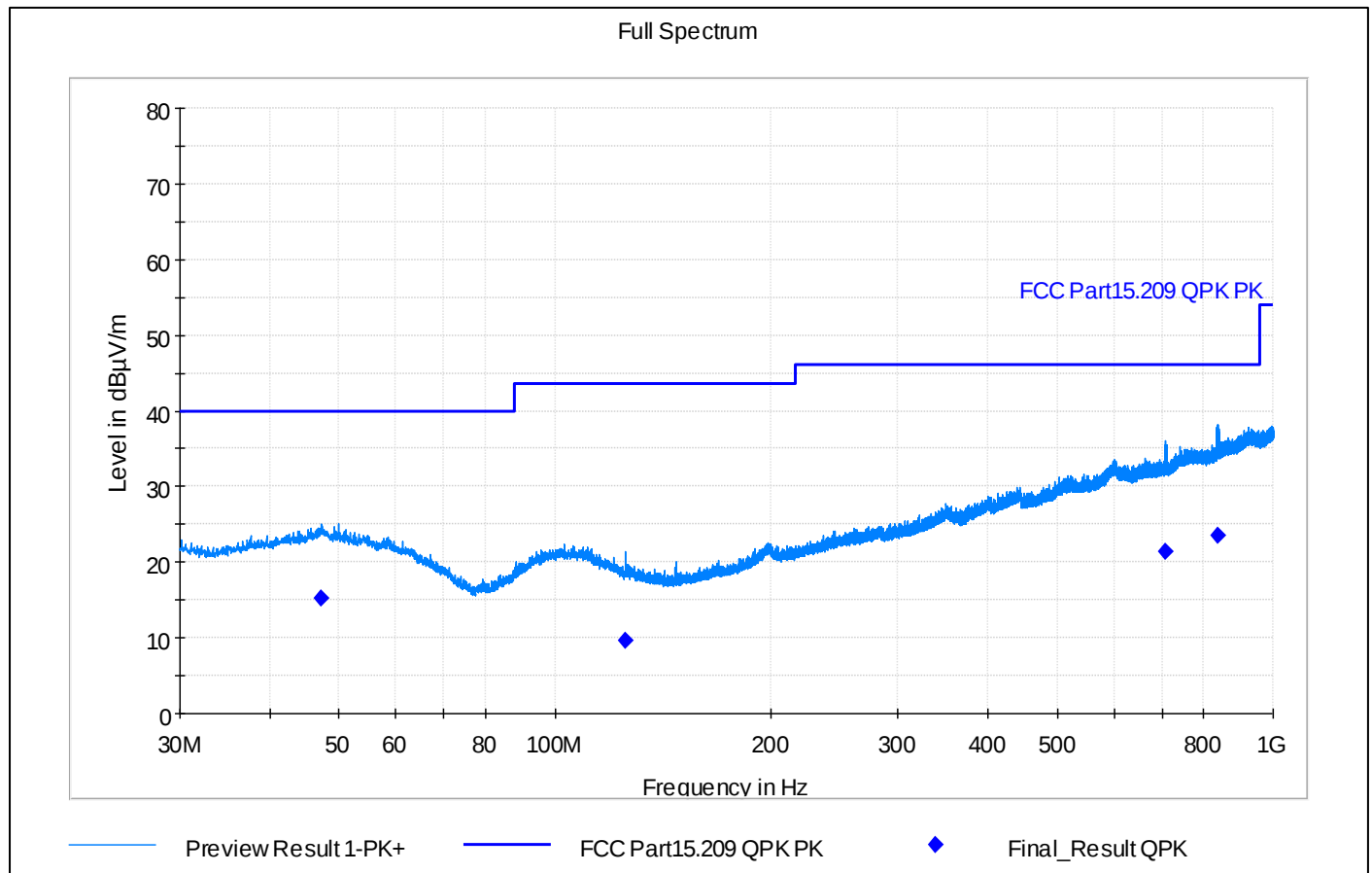
Test procedure > 1 GHz	
1.	EUT is placed on a non conducting support at the center of a turn table 1.5m above the ground
2.	EUT set to test mode
3.	The receiver is set to peak detection with max hold
4.	The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal 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 ch0, 2402 MHz	PASS
Bluetooth LE TX, 1 Mbps	Mid channel ch19, 2440 MHz	PASS
Bluetooth LE TX, 1 Mbps	High channel ch39, 2480 MHz	PASS

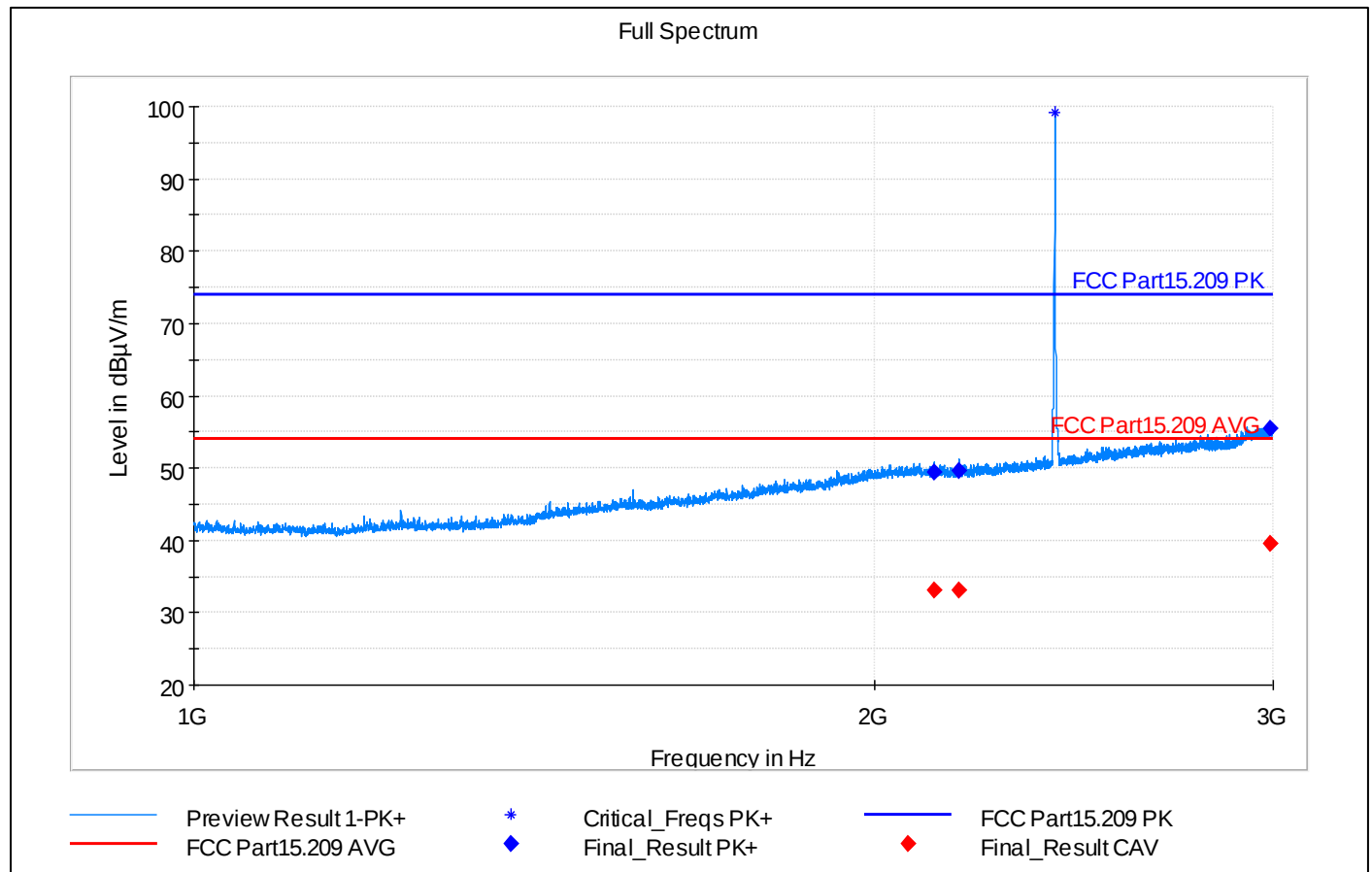
Low channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
47.280000	15.26	---	40.00	24.74	15000.0	120.000	98.0	V	261.0	180.0	21.0	PASS
125.010000	9.73	---	43.50	33.77	15000.0	120.000	274.0	V	140.0	90.0	17.0	PASS
709.020000	21.40	---	46.00	24.60	15000.0	120.000	193.0	V	135.0	180.0	30.6	PASS
836.370000	23.53	---	46.00	22.47	15000.0	120.000	300.0	H	112.0	90.0	32.5	PASS

Low channel, 1 – 3 GHz



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

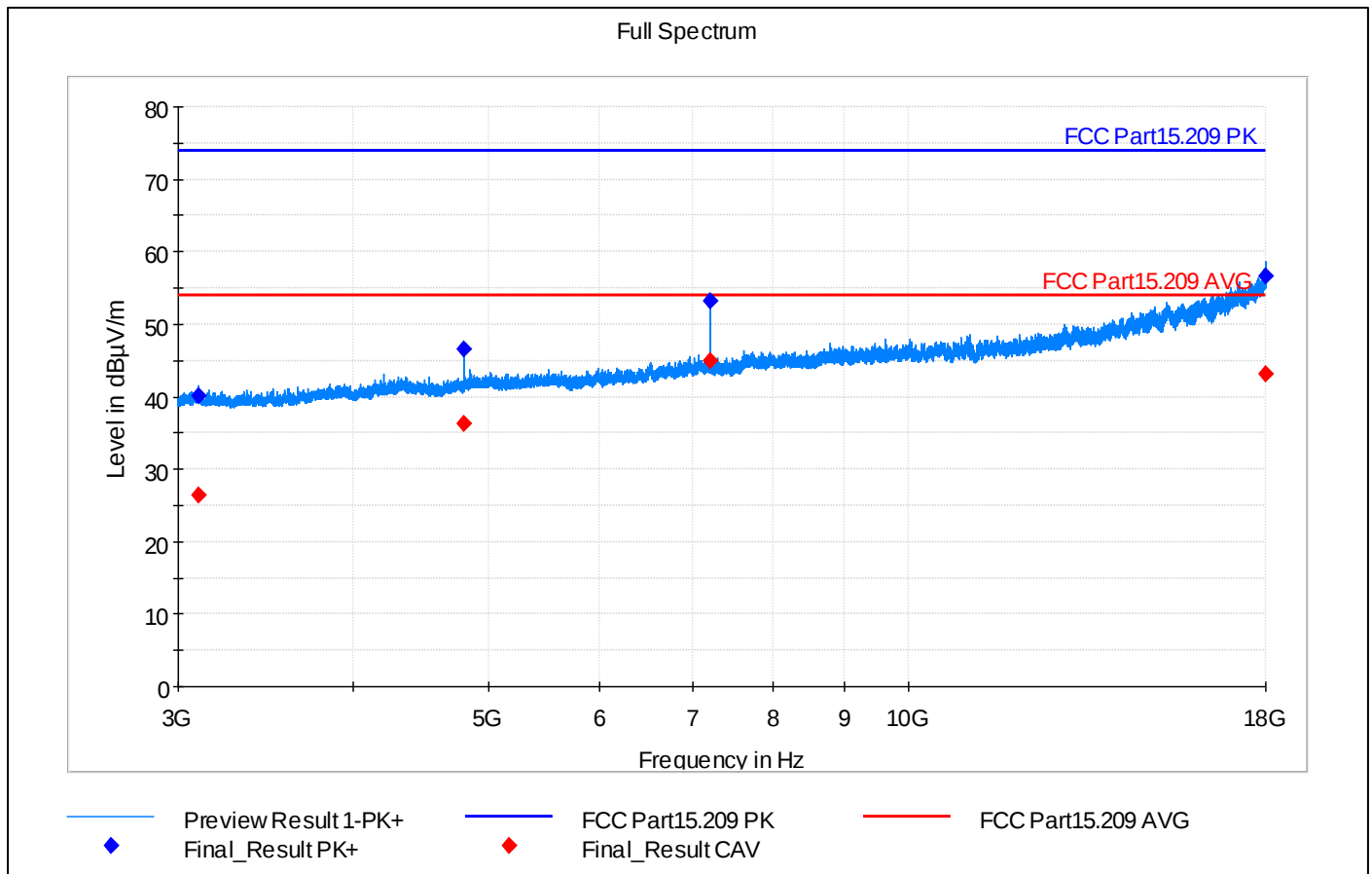
Critical_Freqs

Frequency (MHz)	Comment
2401.750000	Fundamental TX signal ***IGNORED***

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
2124.500000	---	33.19	54.00	20.81	15000.0	1000.000	292.0	H	333.0	180.0	37.5	PASS
2124.500000	49.36	---	74.00	24.64	15000.0	1000.000	292.0	H	333.0	180.0	37.5	PASS
2177.750000	49.62	---	74.00	24.38	15000.0	1000.000	338.0	H	194.0	90.0	37.3	PASS
2177.750000	---	33.10	54.00	20.90	15000.0	1000.000	338.0	H	194.0	90.0	37.3	PASS
2990.500000	---	39.62	54.00	14.38	15000.0	1000.000	138.0	V	112.0	0.0	41.5	PASS
2990.500000	55.55	---	74.00	18.45	15000.0	1000.000	138.0	V	112.0	0.0	41.5	PASS

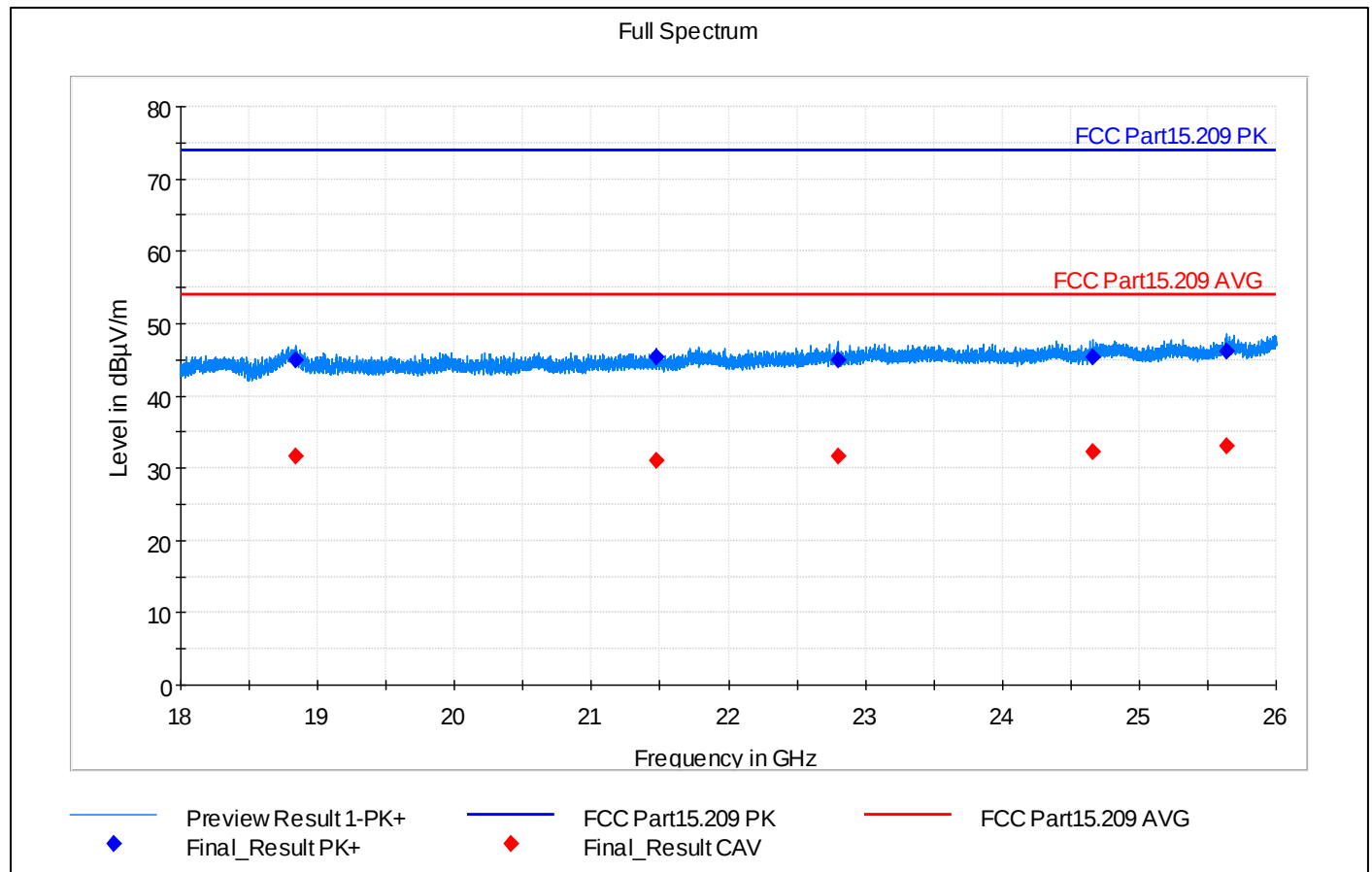
Low channel, 3 – 18 GHz



Final_Result

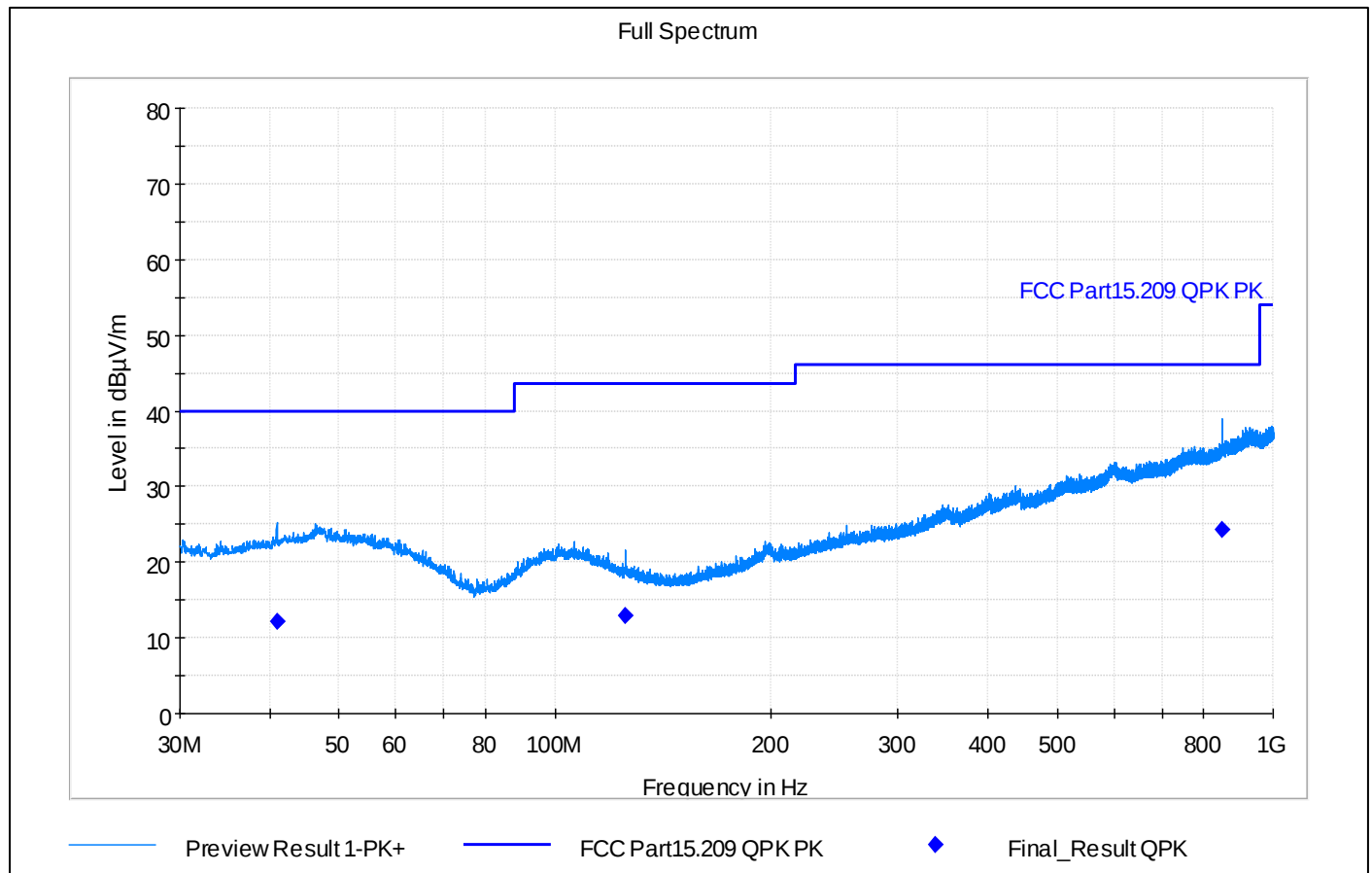
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
3104.250000	---	26.45	54.00	27.55	15000.0	1000.000	210.0	H	126.0	90.0	5.7	PASS
3104.250000	40.04	---	74.00	33.96	15000.0	1000.000	210.0	H	126.0	90.0	5.7	PASS
4803.250000	46.56	---	74.00	27.44	15000.0	1000.000	98.0	H	50.0	180.0	10.0	PASS
4803.250000	---	36.23	54.00	17.77	15000.0	1000.000	98.0	H	50.0	180.0	10.0	PASS
7205.000000	53.20	---	74.00	20.80	15000.0	1000.000	199.0	H	322.0	90.0	14.9	PASS
7205.000000	---	44.90	54.00	9.10	15000.0	1000.000	199.0	H	322.0	90.0	14.9	PASS
17984.750000	---	43.18	54.00	10.82	15000.0	1000.000	232.0	H	329.0	180.0	38.7	PASS
17984.750000	56.67	---	74.00	17.33	15000.0	1000.000	232.0	H	329.0	180.0	38.7	PASS

Low channel, 18 – 26 GHz

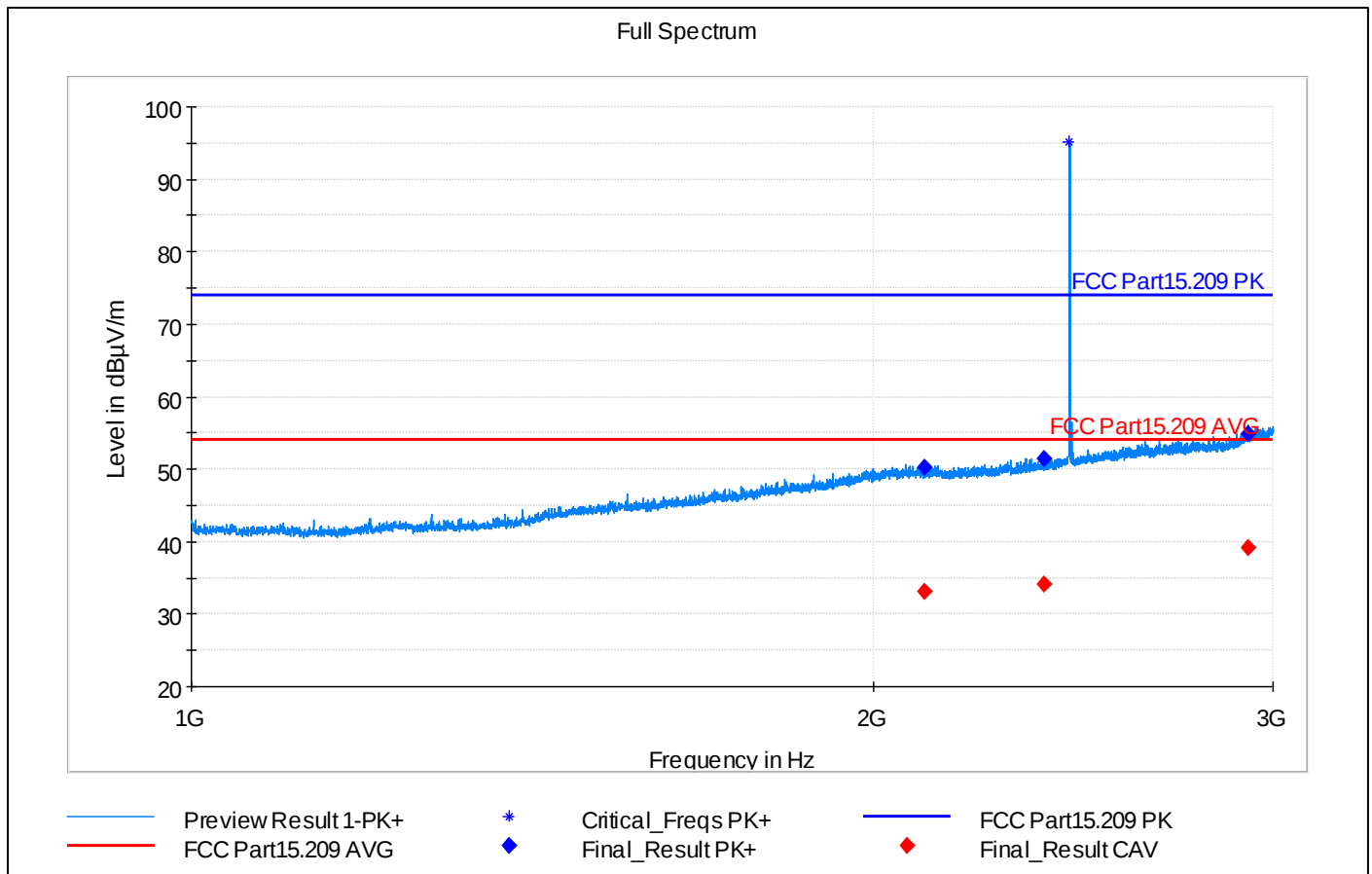


Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18838.750000	44.86	---	74.00	29.14	3000.0	1000.000	240.0	H	49.0	180.0	23.5	PASS
18838.750000	---	31.73	54.00	22.27	3000.0	1000.000	240.0	H	49.0	180.0	23.5	PASS
21477.750000	45.27	---	74.00	28.73	3000.0	1000.000	330.0	V	292.0	90.0	24.7	PASS
21477.750000	---	31.04	54.00	22.96	3000.0	1000.000	330.0	V	292.0	90.0	24.7	PASS
22797.000000	---	31.67	54.00	22.33	3000.0	1000.000	160.0	V	31.0	90.0	25.4	PASS
22797.000000	44.95	---	74.00	29.05	3000.0	1000.000	160.0	V	31.0	90.0	25.4	PASS
24658.250000	---	32.27	54.00	21.73	3000.0	1000.000	191.0	H	259.0	0.0	26.3	PASS
24658.250000	45.34	---	74.00	28.66	3000.0	1000.000	191.0	H	259.0	0.0	26.3	PASS
25633.750000	---	32.96	54.00	21.04	3000.0	1000.000	283.0	V	22.0	0.0	26.6	PASS
25633.750000	46.13	---	74.00	27.87	3000.0	1000.000	283.0	V	22.0	0.0	26.6	PASS

Mid channel, 30 MHz – 1 GHz

Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
40.950000	12.11	---	40.00	27.89	15000.0	120.000	374.0	H	104.0	90.0	19.8	PASS
125.010000	12.84	---	43.50	30.66	15000.0	120.000	154.0	V	317.0	180.0	17.0	PASS
849.810000	24.33	---	46.00	21.67	15000.0	120.000	132.0	H	92.0	180.0	32.8	PASS

Mid channel, 1-3 GHz


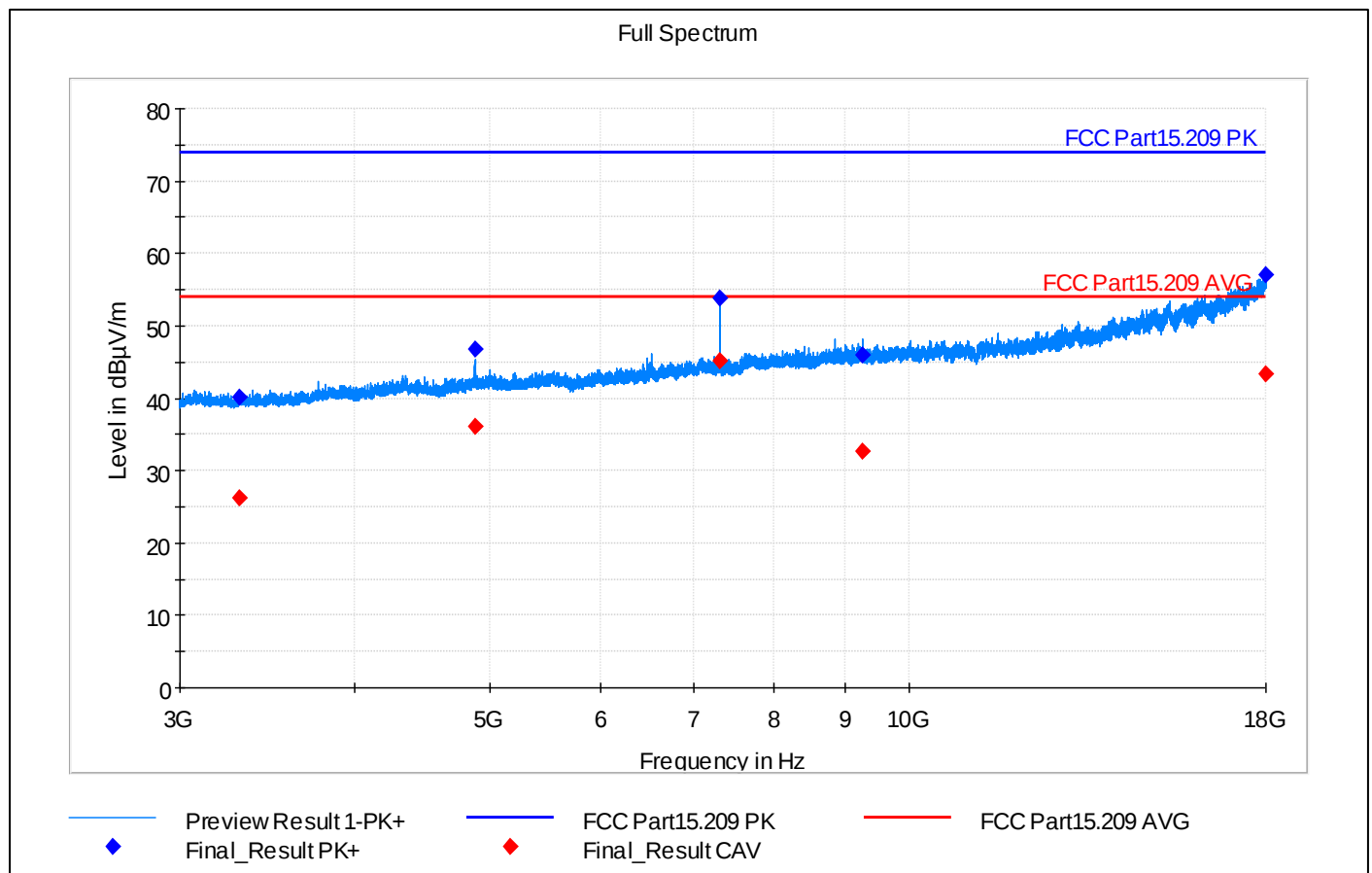
Note: Frequency 2439,750 MHz is excluded from spurious domain measurements and ignored. See table below.

Critical_Freqs

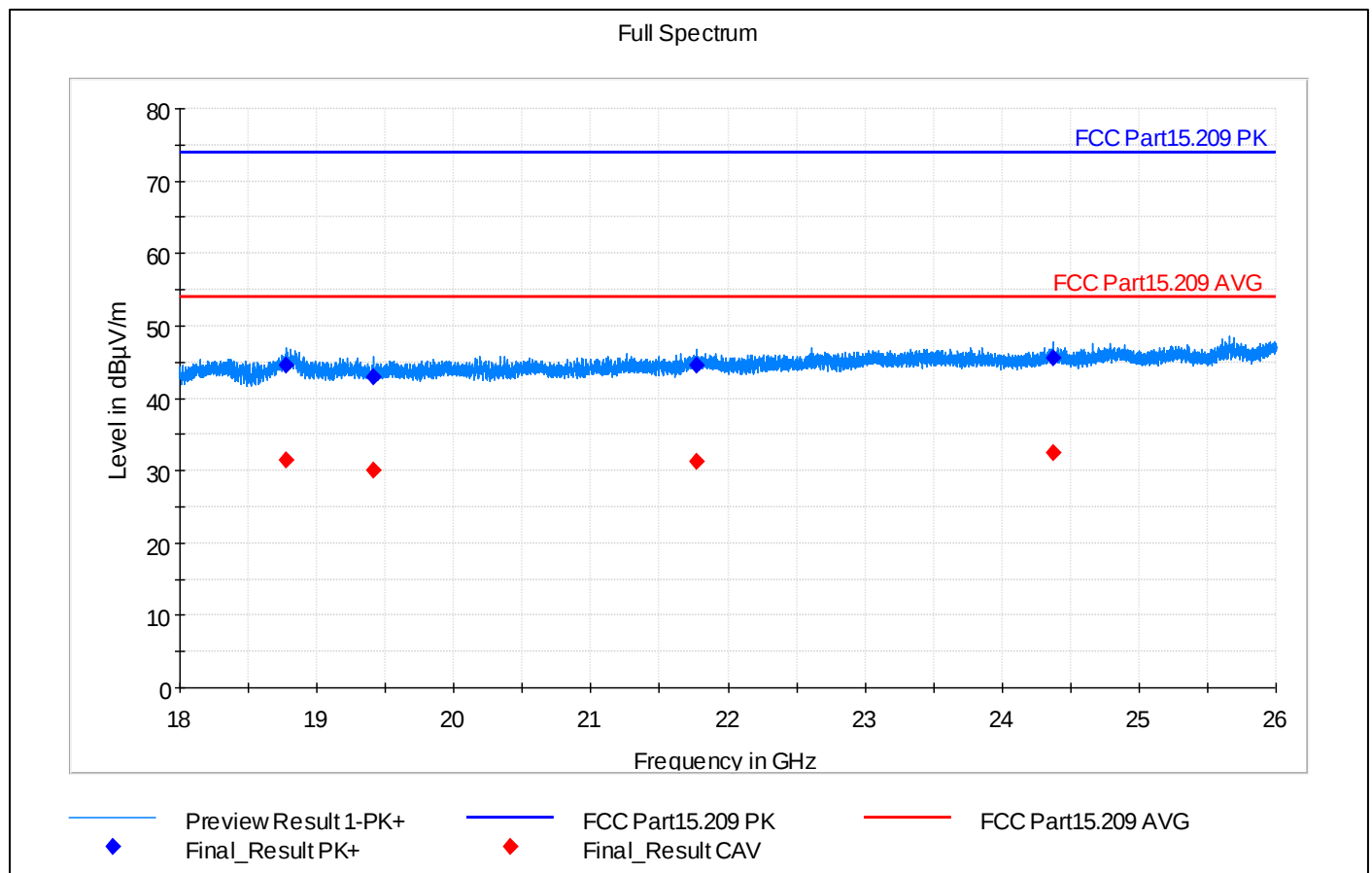
Frequency (MHz)	Comment
2439.750000	Fundamental TX signal ***IGNORED***

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
2106.000000	---	33.18	54.00	20.82	15000.0	1000.000	253.0	H	337.0	180.0	37.5	PASS
2106.000000	50.13	---	74.00	23.87	15000.0	1000.000	253.0	H	337.0	180.0	37.5	PASS
2377.250000	---	34.20	54.00	19.80	15000.0	1000.000	299.0	V	137.0	180.0	38.4	PASS
2377.250000	51.35	---	74.00	22.65	15000.0	1000.000	299.0	V	137.0	180.0	38.4	PASS
2925.750000	54.86	---	74.00	19.14	15000.0	1000.000	187.0	V	305.0	0.0	40.6	PASS
2925.750000	---	39.08	54.00	14.92	15000.0	1000.000	187.0	V	305.0	0.0	40.6	PASS

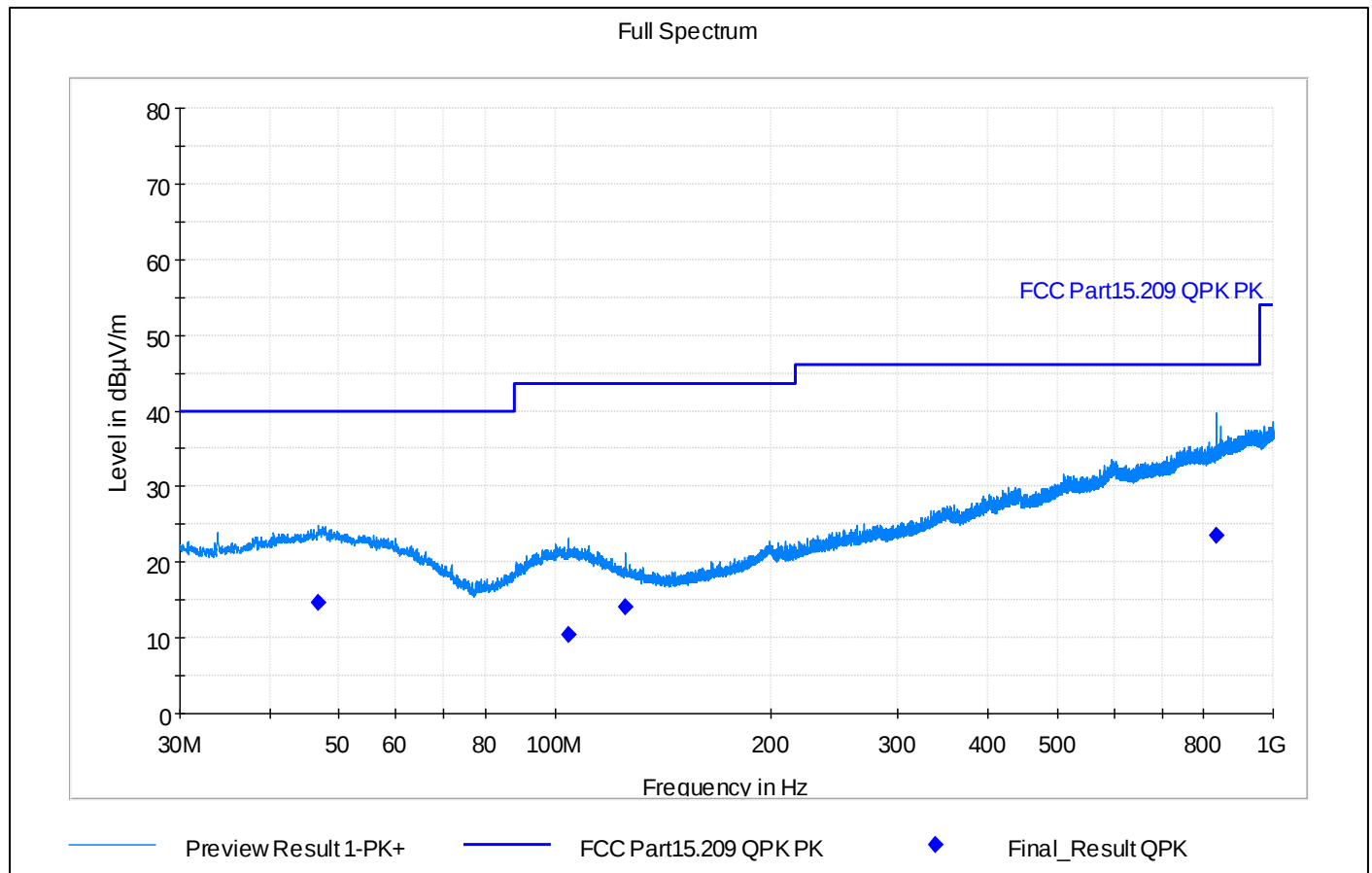
Mid channel, 3–18 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
3307.000000	40.15	---	74.00	33.85	15000.0	1000.000	300.0	V	199.0	180.0	5.7	PASS
3307.000000	---	26.18	54.00	27.82	15000.0	1000.000	300.0	V	199.0	180.0	5.7	PASS
4880.250000	46.81	---	74.00	27.19	15000.0	1000.000	207.0	H	74.0	180.0	10.2	PASS
4880.250000	---	36.14	54.00	17.86	15000.0	1000.000	207.0	H	74.0	180.0	10.2	PASS
7319.000000	53.83	---	74.00	20.17	15000.0	1000.000	177.0	V	267.0	180.0	15.2	PASS
7319.000000	---	45.06	54.00	8.94	15000.0	1000.000	177.0	V	267.0	180.0	15.2	PASS
9256.000000	45.97	---	74.00	28.03	15000.0	1000.000	149.0	H	247.0	90.0	18.5	PASS
9256.000000	---	32.68	54.00	21.32	15000.0	1000.000	149.0	H	247.0	90.0	18.5	PASS
17985.500000	---	43.40	54.00	10.60	15000.0	1000.000	196.0	H	-2.0	180.0	38.7	PASS
17985.500000	57.10	---	74.00	16.90	15000.0	1000.000	196.0	H	-2.0	180.0	38.7	PASS

Mid channel, 18–26 GHz

Final Result

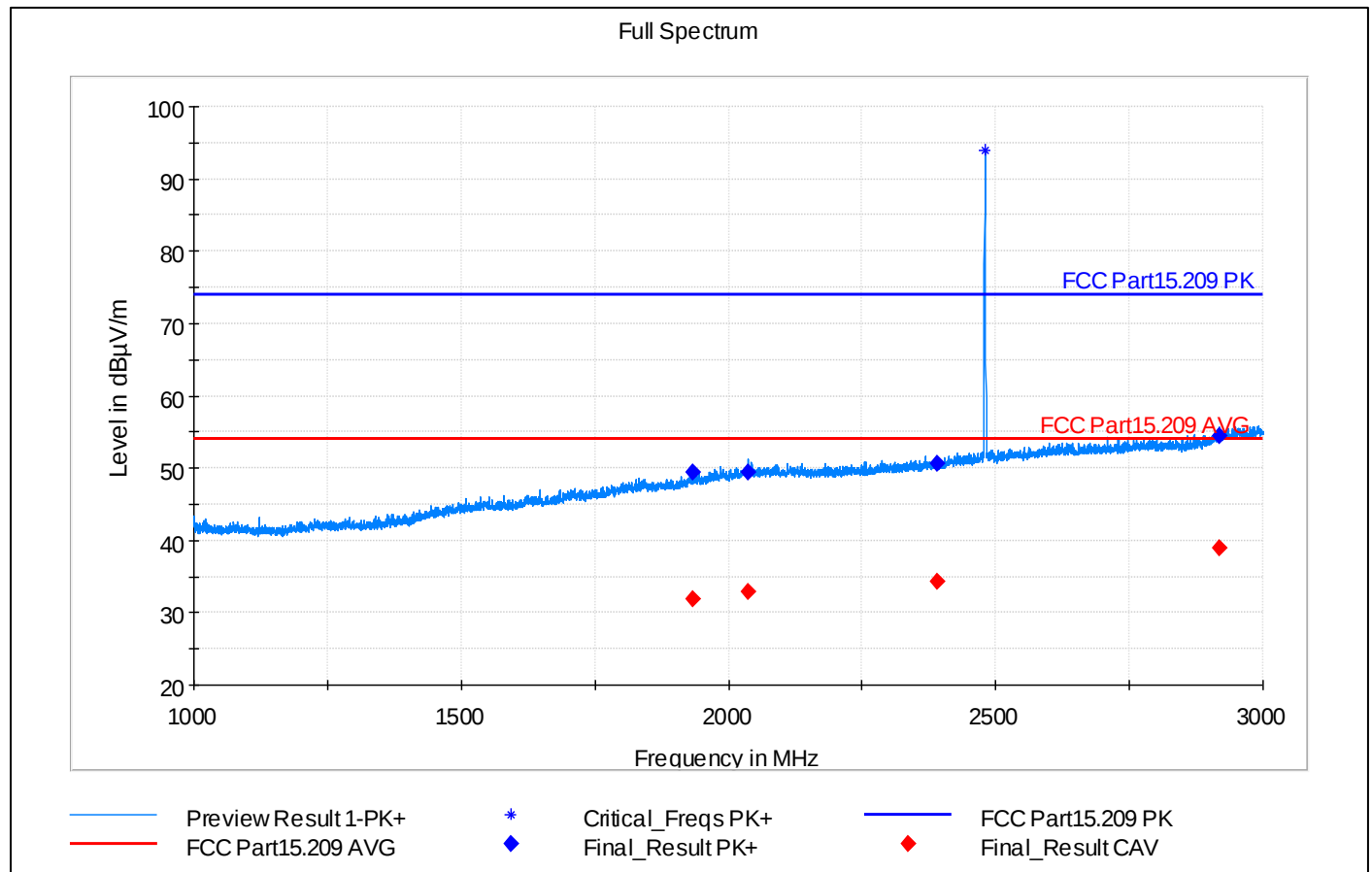
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18777.250000	---	31.41	54.00	22.59	3000.0	1000.000	110.0	V	240.0	0.0	23.5	PASS
18777.250000	44.59	---	74.00	29.41	3000.0	1000.000	110.0	V	240.0	0.0	23.5	PASS
19408.500000	---	29.99	54.00	24.01	3000.0	1000.000	309.0	V	295.0	0.0	23.7	PASS
19408.500000	42.95	---	74.00	31.05	3000.0	1000.000	309.0	V	295.0	0.0	23.7	PASS
21771.250000	---	31.20	54.00	22.80	3000.0	1000.000	146.0	V	304.0	0.0	24.9	PASS
21771.250000	44.52	---	74.00	29.48	3000.0	1000.000	146.0	V	304.0	0.0	24.9	PASS
24375.000000	---	32.37	54.00	21.63	3000.0	1000.000	346.0	V	328.0	0.0	26.1	PASS
24375.000000	45.49	---	74.00	28.51	3000.0	1000.000	346.0	V	328.0	0.0	26.1	PASS

High channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
46.740000	14.71	---	40.00	25.29	15000.0	120.000	98.0	V	202.0	0.0	20.9	PASS
104.460000	10.33	---	43.50	33.17	15000.0	120.000	301.0	H	290.0	90.0	19.5	PASS
125.010000	13.98	---	43.50	29.52	15000.0	120.000	130.0	H	46.0	90.0	17.0	PASS
834.750000	23.44	---	46.00	22.56	15000.0	120.000	314.0	V	63.0	0.0	32.4	PASS

High channel, 1 – 3 GHz


Note: Frequency 2480,000 MHz is excluded from spurious domain measurements and ignored. See table below.

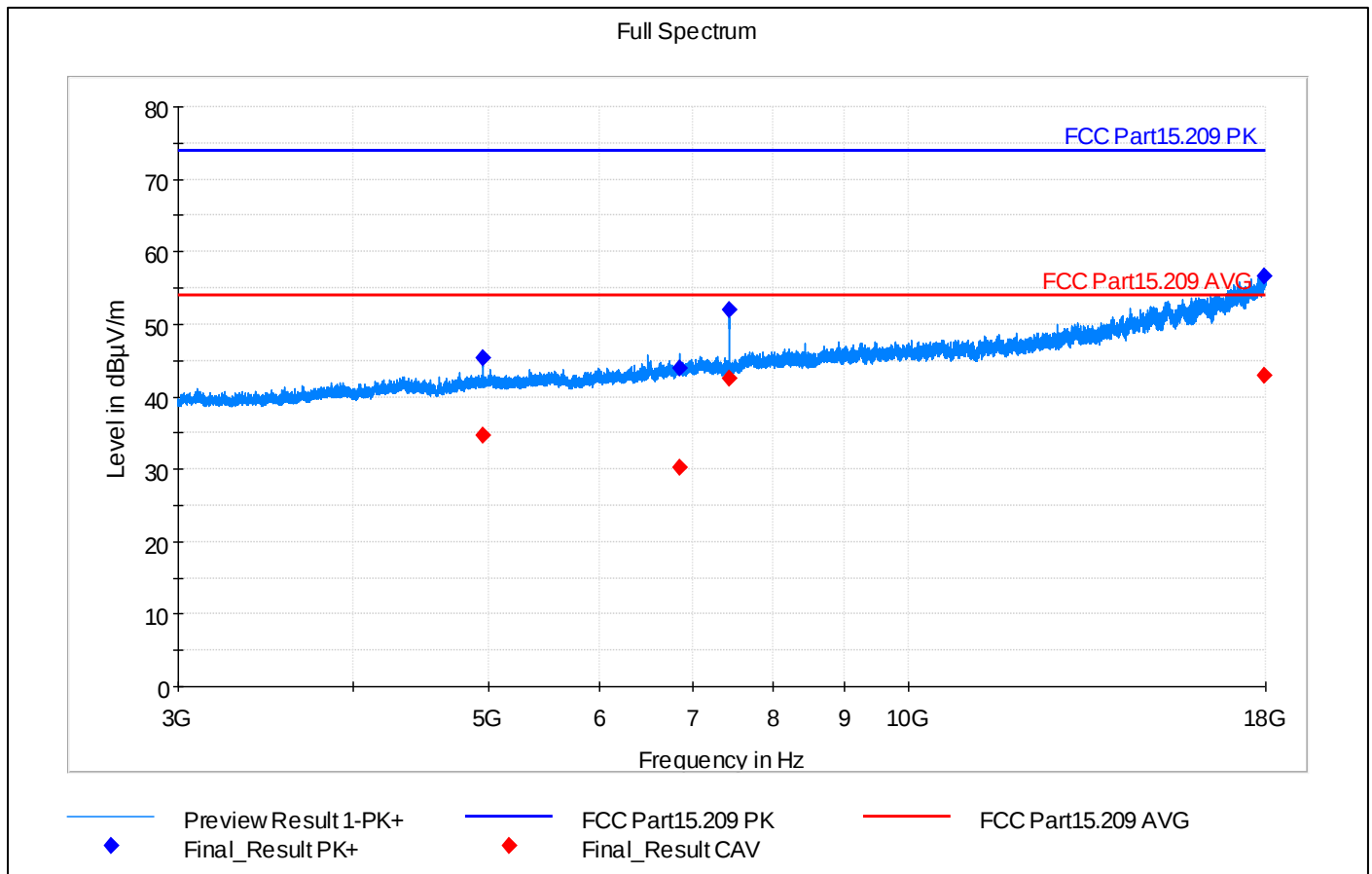
Critical_Freqs

Frequency (MHz)	Comment
2480.000000	Fundamental TX signal ***IGNORED***

Final_Result

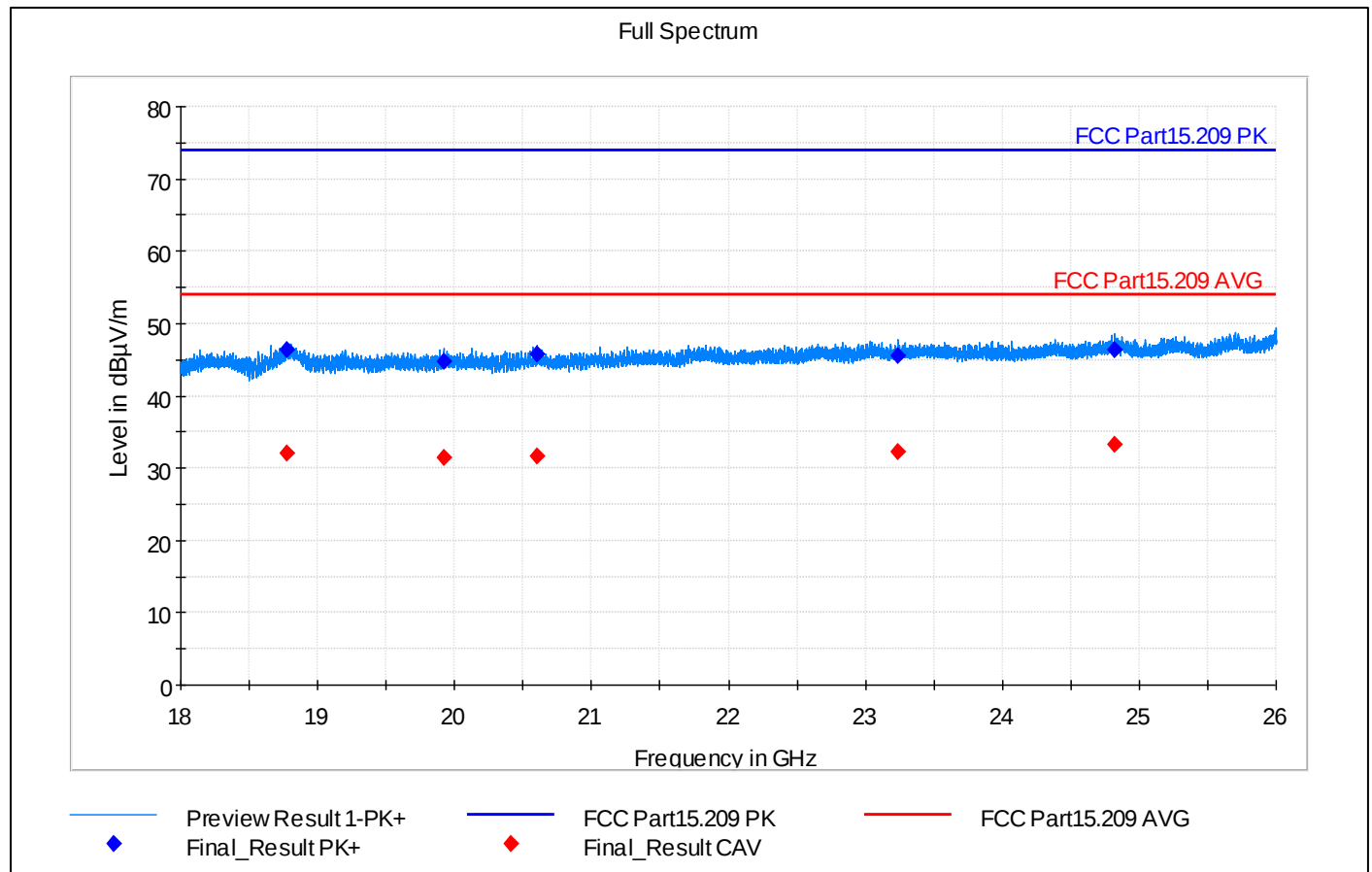
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1932.250000	---	31.89	54.00	22.11	15000.0	1000.000	346.0	V	337.0	90.0	36.4	PASS
1932.250000	49.48	---	74.00	24.52	15000.0	1000.000	346.0	V	337.0	90.0	36.4	PASS
2036.750000	49.43	---	74.00	24.57	15000.0	1000.000	215.0	V	51.0	90.0	37.5	PASS
2036.750000	---	32.95	54.00	21.05	15000.0	1000.000	215.0	V	51.0	90.0	37.5	PASS
2390.250000	---	34.29	54.00	19.71	15000.0	1000.000	167.0	V	51.0	0.0	38.4	PASS
2390.250000	50.66	---	74.00	23.34	15000.0	1000.000	167.0	V	51.0	0.0	38.4	PASS
2918.750000	54.55	---	74.00	19.45	15000.0	1000.000	127.0	V	301.0	90.0	40.6	PASS
2918.750000	---	38.95	54.00	15.05	15000.0	1000.000	127.0	V	301.0	90.0	40.6	PASS

High channel, 3 – 18 GHz



Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
4959.500000	---	34.57	54.00	19.43	15000.0	1000.000	225.0	H	217.0	0.0	10.2	PASS
4959.500000	45.29	---	74.00	28.71	15000.0	1000.000	225.0	H	217.0	0.0	10.2	PASS
6852.750000	43.93	---	74.00	30.07	15000.0	1000.000	320.0	V	268.0	180.0	14.0	PASS
6852.750000	---	30.18	54.00	23.82	15000.0	1000.000	320.0	V	268.0	180.0	14.0	PASS
7440.500000	---	42.46	54.00	11.54	15000.0	1000.000	178.0	H	319.0	0.0	15.1	PASS
7440.500000	52.02	---	74.00	21.98	15000.0	1000.000	178.0	H	319.0	0.0	15.1	PASS
17948.750000	56.62	---	74.00	17.38	15000.0	1000.000	367.0	H	256.0	0.0	38.5	PASS
17948.750000	---	42.97	54.00	11.03	15000.0	1000.000	367.0	H	256.0	0.0	38.5	PASS

High channel, 18 – 26 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18777.000000	46.44	---	74.00	27.56	3000.0	1000.000	155.0	V	251.0	180.0	23.5	PASS
18777.000000	---	32.12	54.00	21.88	3000.0	1000.000	155.0	V	251.0	180.0	23.5	PASS
19918.000000	---	31.44	54.00	22.56	3000.0	1000.000	130.0	V	192.0	180.0	24.1	PASS
19918.000000	44.71	---	74.00	29.29	3000.0	1000.000	130.0	V	192.0	180.0	24.1	PASS
20604.750000	45.77	---	74.00	28.23	3000.0	1000.000	173.0	V	69.0	180.0	24.2	PASS
20604.750000	---	31.65	54.00	22.35	3000.0	1000.000	173.0	V	69.0	180.0	24.2	PASS
23240.250000	45.56	---	74.00	28.44	3000.0	1000.000	165.0	V	137.0	180.0	25.6	PASS
23240.250000	---	32.23	54.00	21.77	3000.0	1000.000	165.0	V	137.0	180.0	25.6	PASS
24822.500000	46.37	---	74.00	27.63	3000.0	1000.000	286.0	H	296.0	180.0	26.5	PASS
24822.500000	---	33.35	54.00	20.65	3000.0	1000.000	286.0	H	296.0	180.0	26.5	PASS

16. Receiver spurious emissions, radiated

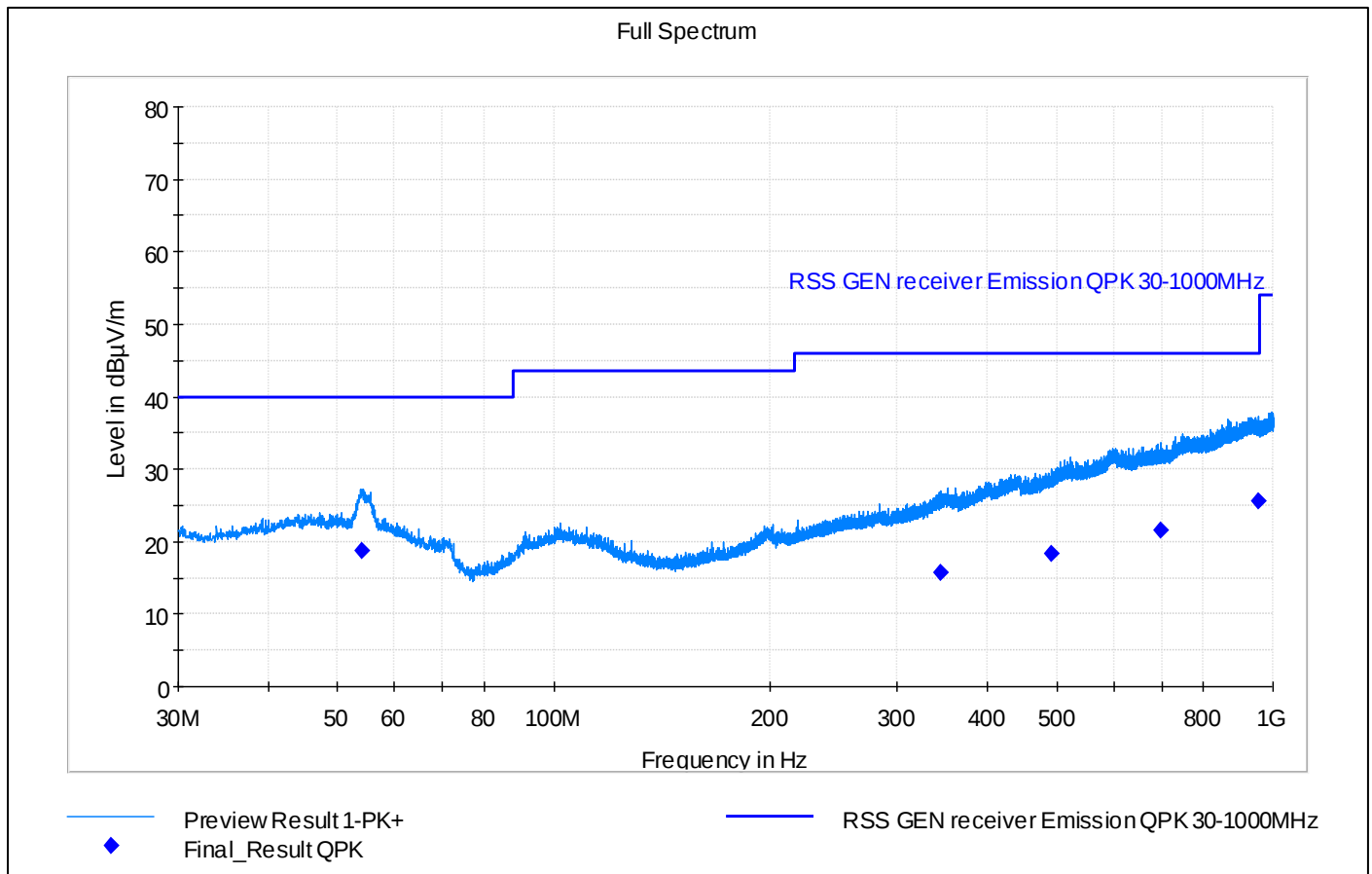
Reference: ISED RSS-247, Issue 3 (section 3.1)

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

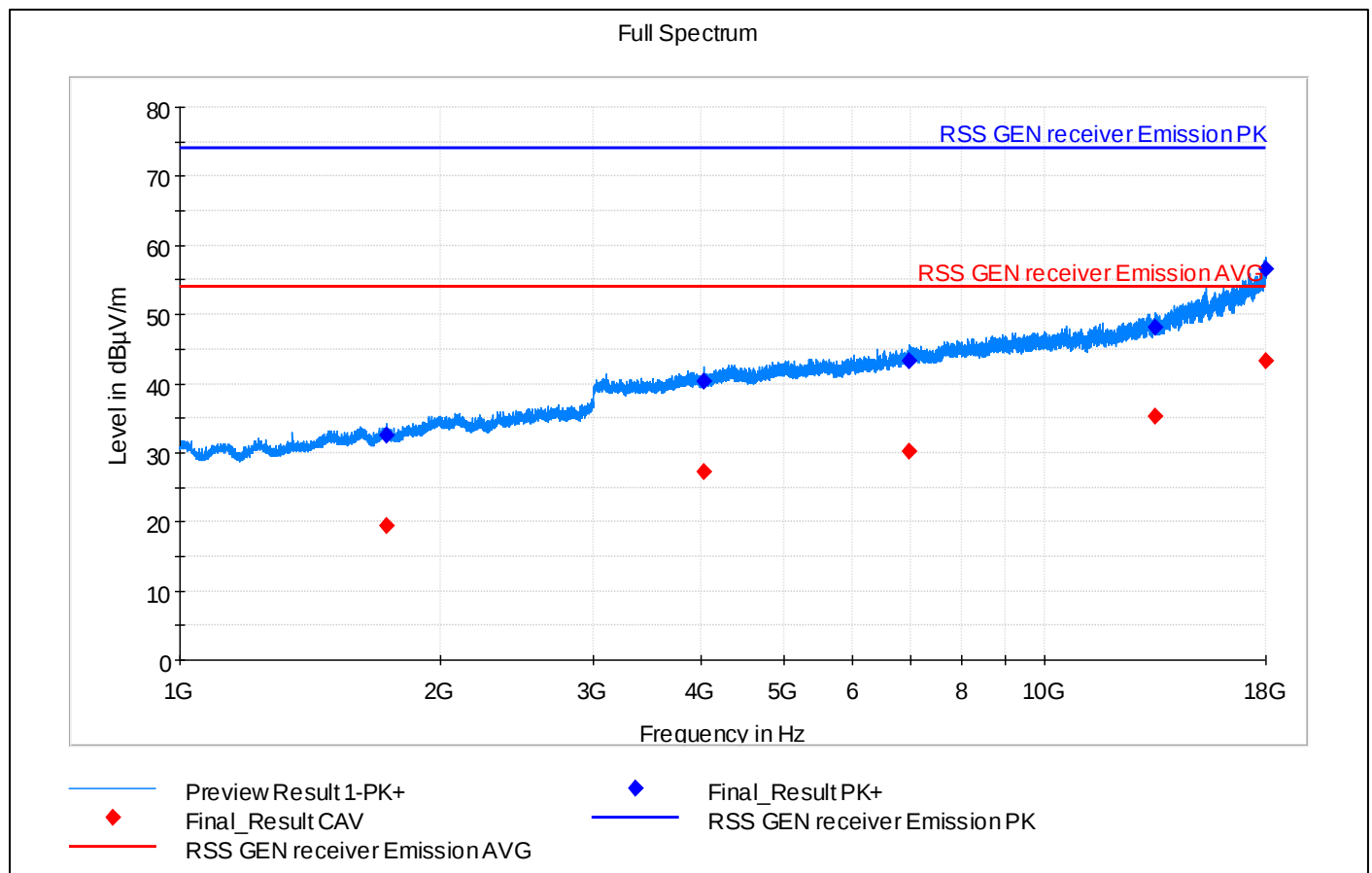
Limits			
Frequency (MHz)	Detector	Field strength (uV/m)	Measurement distance (m)
30 – 88	Quasi-Peak	100	3
88 - 216	Quasi-Peak	150	3
216 - 960	Quasi-Peak	200	3
960 - 1000	Quasi-Peak	500	3
> 1000	Average	500	3

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, 30 MHz – 1 GHz

Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
54.090000	18.66	40.00	21.34	15000.0	120.000	115.0	V	257.0	0.0	20.9	PASS
345.420000	15.64	46.00	30.36	15000.0	120.000	158.0	H	103.0	0.0	24.2	PASS
491.820000	18.36	46.00	27.64	15000.0	120.000	331.0	V	292.0	0.0	27.0	PASS
697.200000	21.63	46.00	24.37	15000.0	120.000	396.0	H	37.0	0.0	30.5	PASS
953.460000	25.69	46.00	20.31	15000.0	120.000	188.0	H	163.0	0.0	34.0	PASS

Mid channel, 1 GHz – 18,00 GHz

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
1735.500000	32.50	---	74.00	41.50	500.0	1000.000	146.0	H	221.0	-4.5	PASS
1735.500000	---	19.38	54.00	34.62	500.0	1000.000	146.0	H	221.0	-4.5	PASS
4040.250000	40.30	---	74.00	33.70	500.0	1000.000	153.0	V	39.0	8.1	PASS
4040.250000	---	27.20	54.00	26.80	500.0	1000.000	153.0	V	39.0	8.1	PASS
6961.750000	43.22	---	74.00	30.78	500.0	1000.000	117.0	V	316.0	14.4	PASS
6961.750000	---	30.27	54.00	23.73	500.0	1000.000	117.0	V	316.0	14.4	PASS
13417.500000	---	35.31	54.00	18.69	500.0	1000.000	180.0	H	112.0	25.5	PASS
13417.500000	48.18	---	74.00	25.82	500.0	1000.000	180.0	H	112.0	25.5	PASS
17986.000000	56.67	---	74.00	17.33	500.0	1000.000	389.0	H	335.0	38.7	PASS
17986.000000	---	43.32	54.00	10.68	500.0	1000.000	389.0	H	335.0	38.7	PASS

17. Photographs – Equipment External



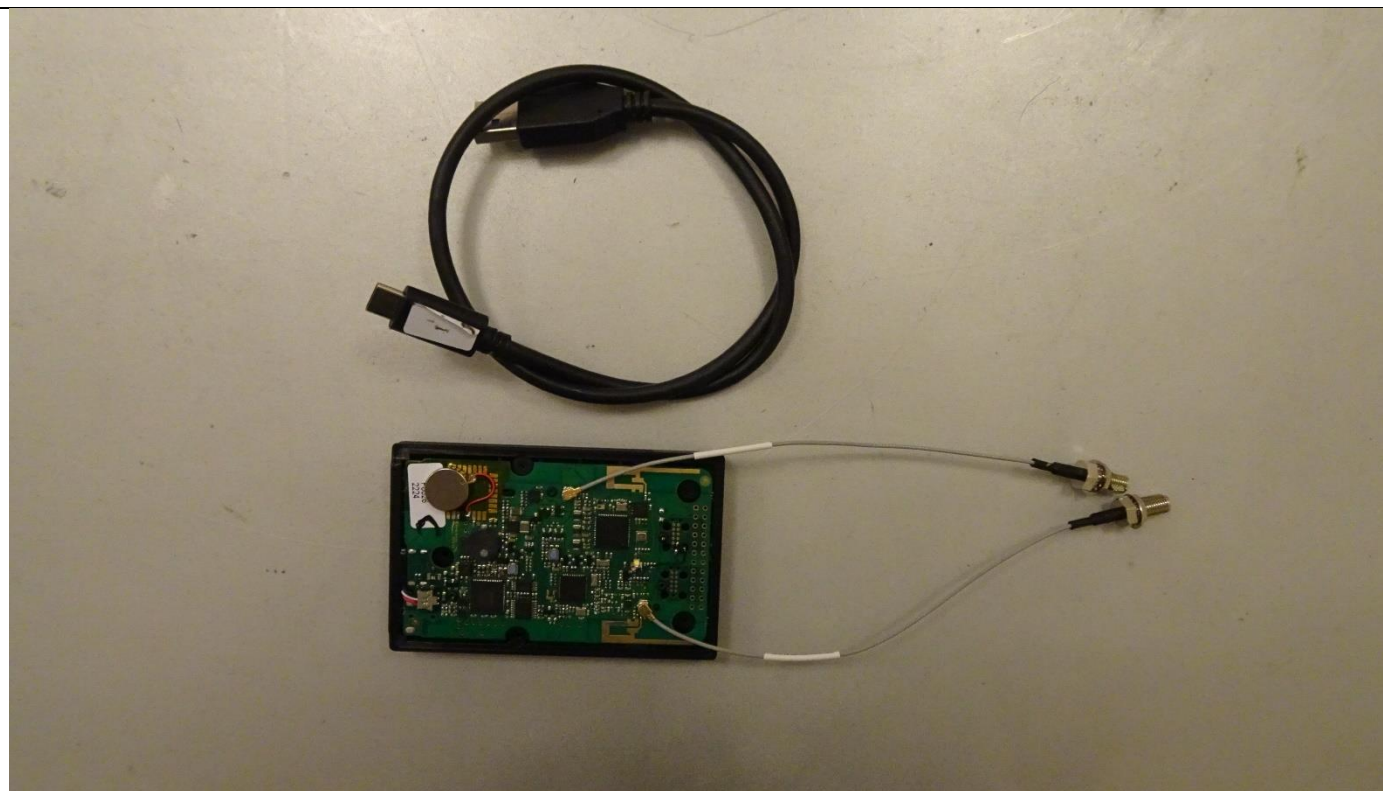
Picture 1, EUT Top view



Picture 2, EUT Bottom view



Picture 3, EUT USB port



Picture 4, Conducted RF EUT with auxiliary equipment

18. Photographs – Equipment Internal



Picture 5, EUT, top cover inside



Picture 6, EUT, bottom cover inside with battery



Picture 7, PCB top

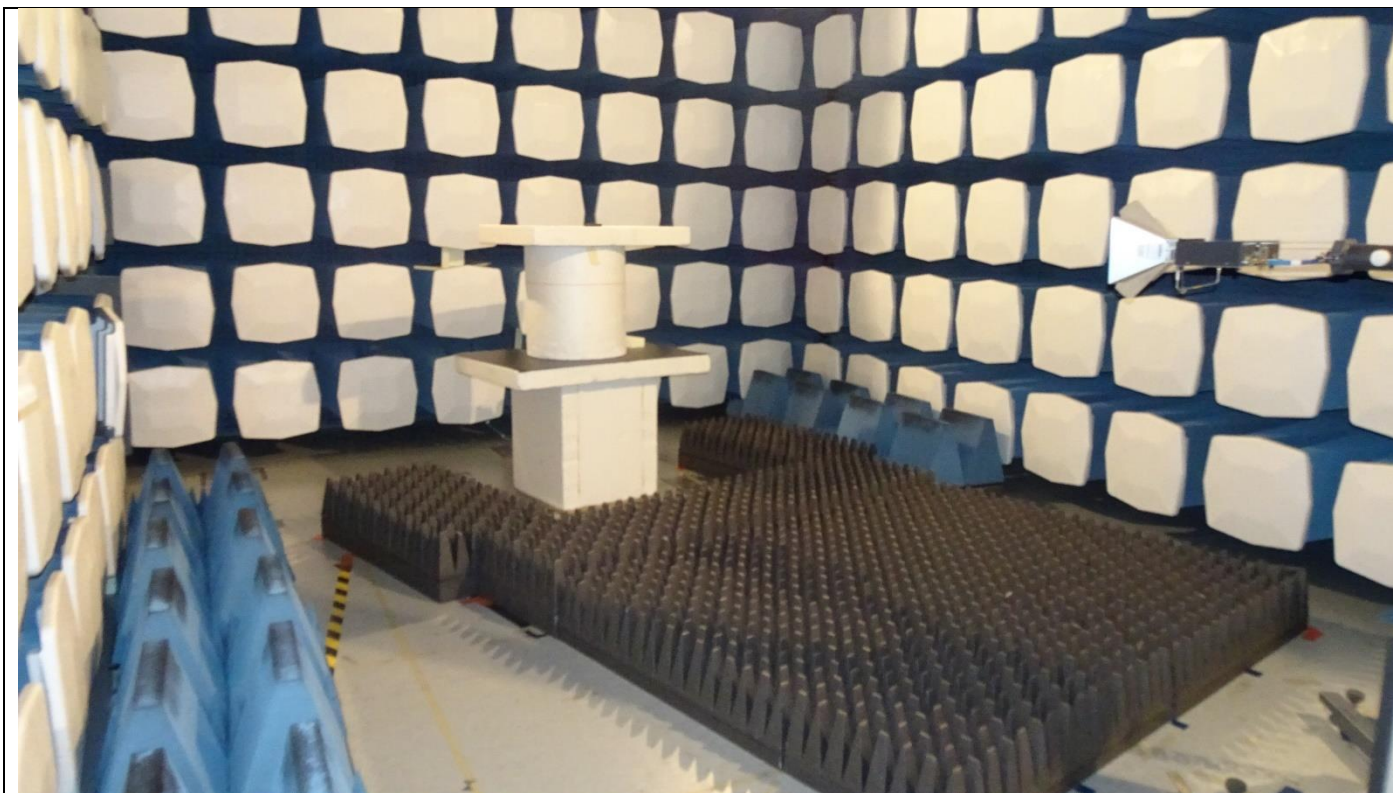


Picture 8, PCB bottom

19. Photographs – Test Setups



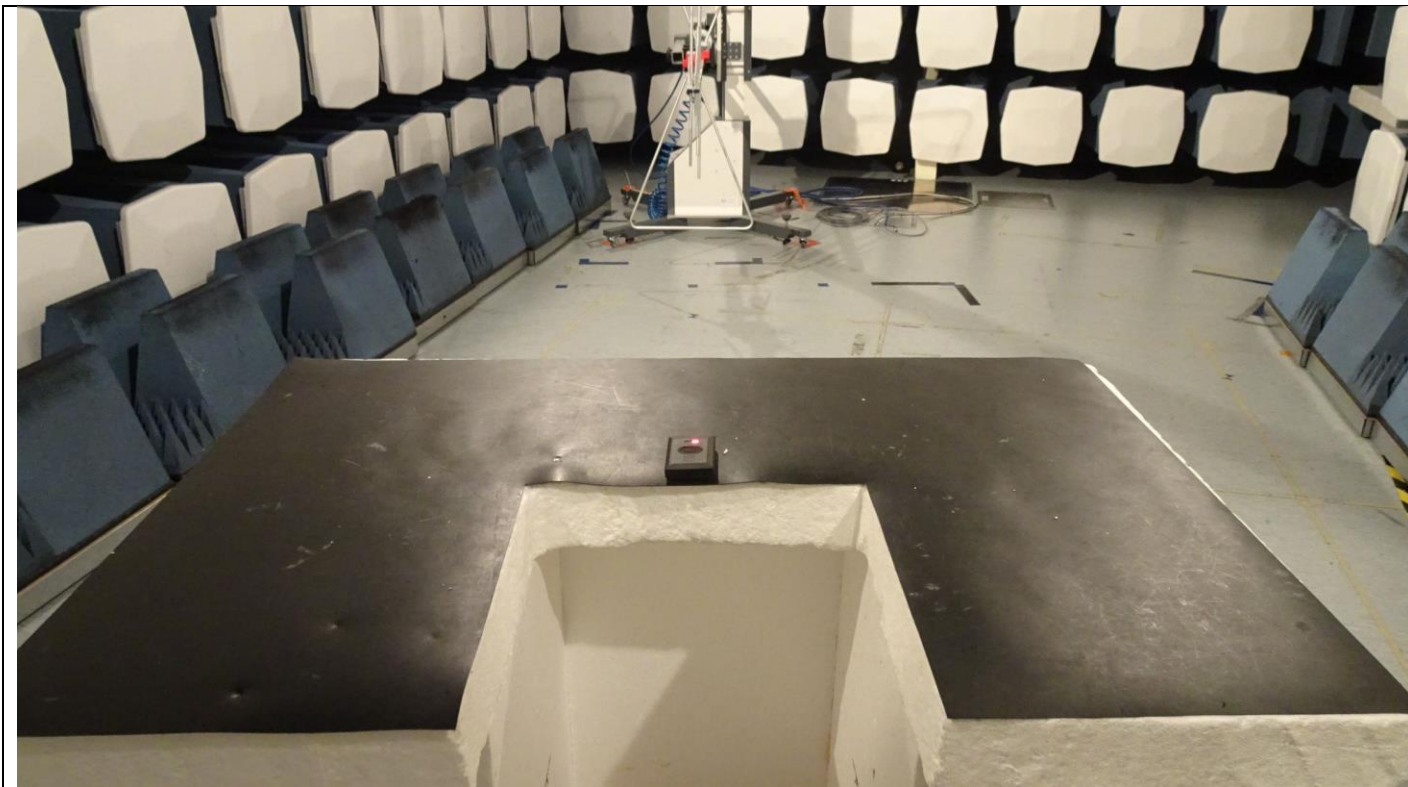
Picture 9, Radiated Spurious Emissions, common setup, TX and RX 30 - 1000 MHz



Picture 10, Radiated Spurious Emissions, common setup, TX, 1 – 26 GHz



Picture 11, Radiated Spurious Emissions, common setup, RX, 1 – 12,75 MHz



Picture 12, Radiated Spurious Emissions, EUT setup, TX and RX 30 – 1000 MHz and RX 1 – 12,75 GHz



Picture 13, Radiated Spurious Emissions, EUT setup, TX 1 – 26 GHz