

Radio Test Report

According to

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

DUT Name: RDY
Model No. : ADY1
Customer: Sandvik Mining and Construction Oy
Address: Taivalkatu 8, P.O. Box 165, FI-15101 Lahti, Finland
Summary IN COMPLIANCE
Date of Reception: 14.11.2023
Date(s) of Test(s): 18.11.2023 – 10.1.2024

Tested by Test Engineer


Pekka Pulkkinen

Approved by Technical Manager


Jukka Rauma

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Document Version History	Date of issue	Comments	Approved by
v0.1	19.2.2024	Initial version	
v1.0	5.3.2024	Approved version	Jukka Rauma
v2.0	24.9.2024	Second approved version. Antenna gain corrected according to customer declaration. EUT and test setup pictures moved to different 3848RER005_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: Sandvik Mining and Construction Oy
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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:

Machine mounted device that enables remote monitoring of the machine. During machine operation, device collects and transmits operation and location information.

Test sample (Conducted):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3848ER001	ÄRDY DTM DUT	Haltian	Remote monitoring unit	ADY1	ADY_04, APP_02	2023.11.02.1_ardy_v2

Test sample (Radiated):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3848ER004	SVTG223000028	Haltian Oy	Remote monitoring unit	ADY1	ADY_04, APP_02	2023.11.02.1_ardy_v2

Description	Information	
Additional model	-	
Brand Names(s)	-	
PMN	RDY	
HVIN	ADY1	
FVIN	2023.11.02.1_ardy_v2	
HMN	-	
FCC ID	2BD5URDY	
IC ID	31800-RDY	
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 LE 5.1	
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	Quad band, Dual feed Chip Antenna
	Model	2450AD47A1590
	Manufacturer	Johanson Technology
	Gain	1.8 dBi
Supply voltage	V _{Nom} = 3.6 VDC	
Type of Power source	Internal primary lion battery	
Operating Temperature	T _{Nom} = 20°C T _{Min} = -25°C T _{Max} = 80°C	
Manufacturer	Sandvik Mining and Construction Oy Taivalkatu 8, P.O. Box 165, FI-15101 Lahti, Finland	

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

Radiated emission test:

Test modes / description
EUT battery powered, continuous modulated carrier at ch0 2402 MHz, ch19 2440 MHz and ch39 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	HEAT Tokyo	2019.10.22.1

4. Test equipment

Conducted RF tests

R&S TS8997 Test System equipment list:

G4C462	Rohde & Schwarz	SMW200A	Vector signal generator	110578	29.6.2023	29.6.2024
G4C463	Rohde & Schwarz	SMB100A	Signal Generator	183205	29.6.2023	29.6.2024
G4C464	Rohde & Schwarz	OSP150	Open switch and control unit	101135	29.6.2023	29.6.2024
G4C465	Rohde & Schwarz	OSP220	Open switch and control unit	102440	29.6.2023	29.6.2024
G4C466	Rohde & Schwarz	ESW44	EMI test receiver	103103	29.6.2023	29.6.2024
G4C467	Rohde & Schwarz	CMW500	Wideband radio communication tester	171062	29.6.2023	29.6.2024

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
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	101067	4.11.2022	4.11.2025
G4C572	Schaffner	CBL 6143	Bilog Antenna 30MHz-3GHz	5071	7.9.2022	7.9.2025
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

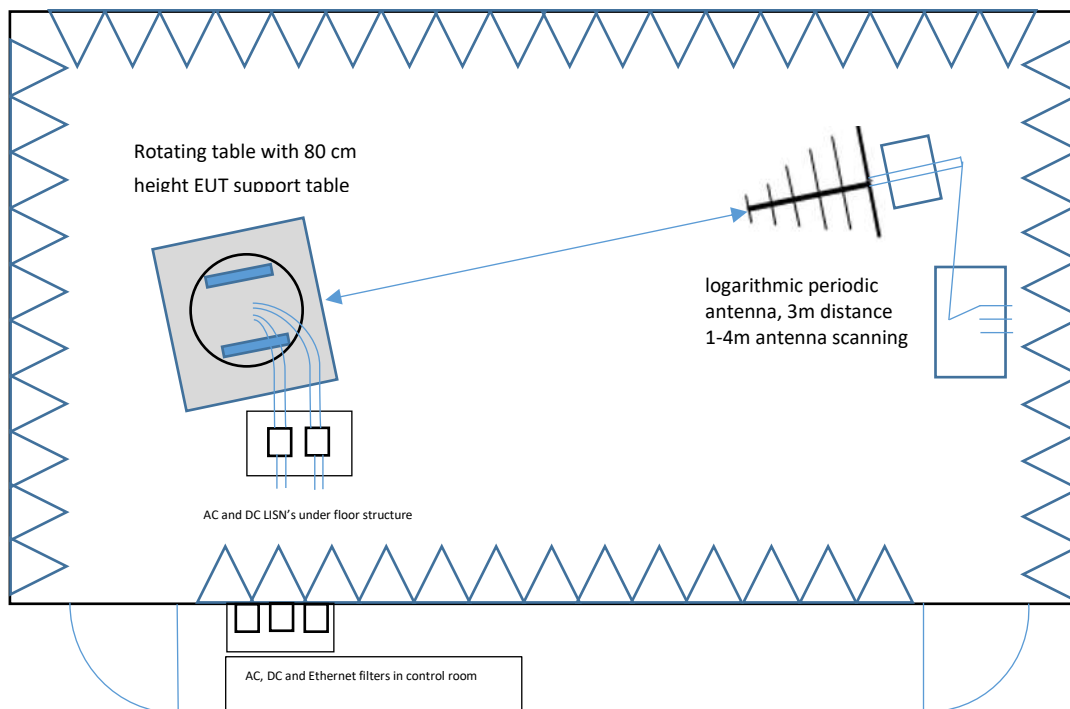
All radiated tests were performed in a semi-anechoic chamber, where the measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz, 1 GHz-18 GHz Double-ridged horn antenna and 18 GHz-40 GHz horn antenna) is located at a distance of 3 m.

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.

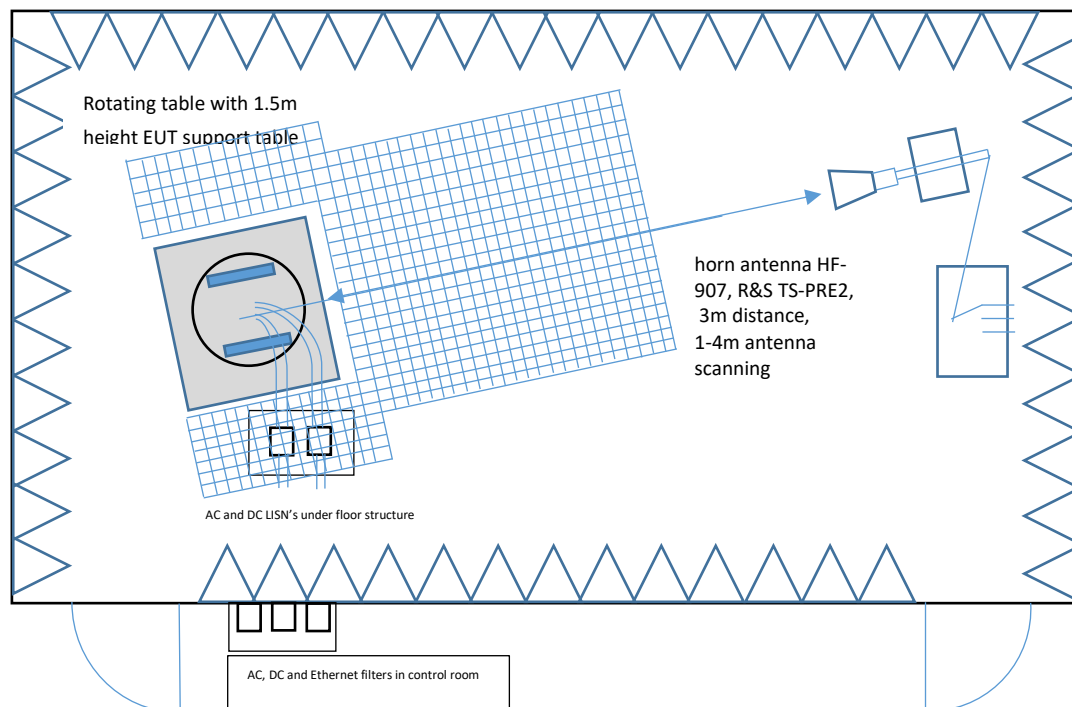
Measurements were made in both horizontal and vertical planes of polarization.

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.

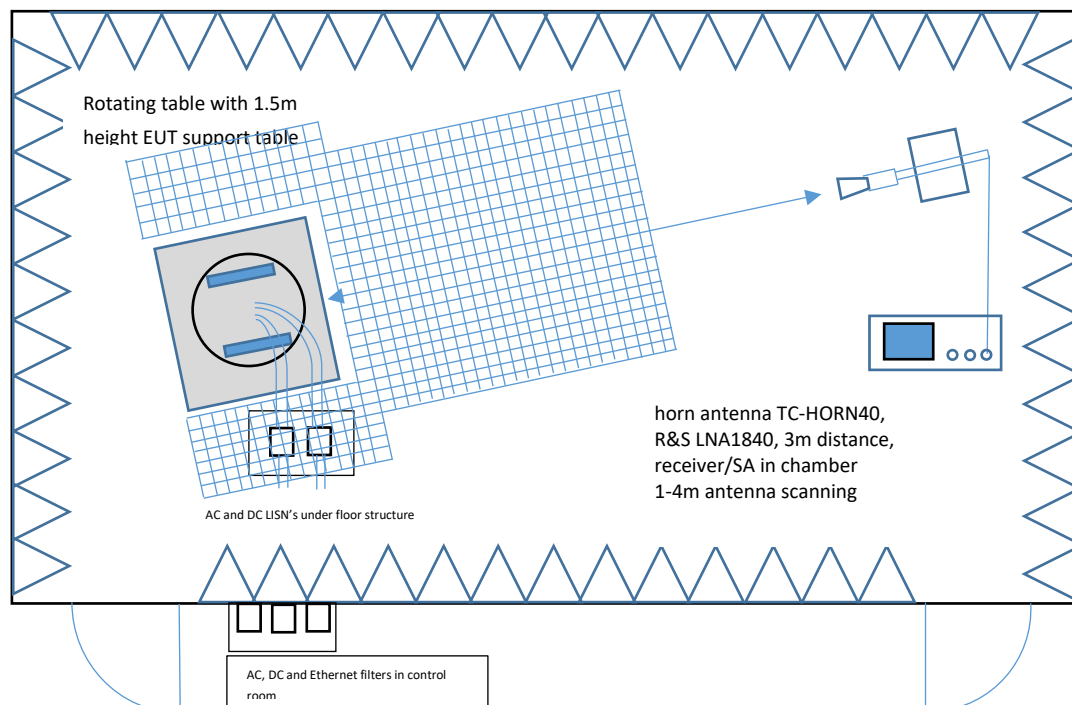
Radiated measurements setup from 30 MHz to 1 GHz:



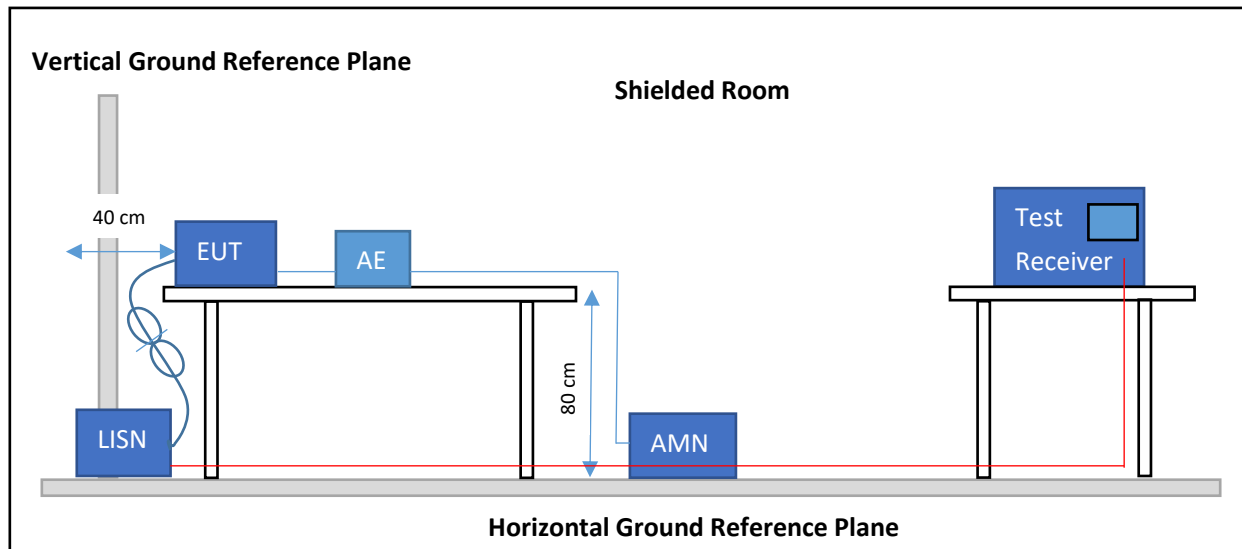
Radiated measurements setup from 1 GHz to 18 GHz:



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



Conducted emission setup



Conducted RF measurement system:



8. Summary

Bluetooth LE

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 powered
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 N/R = Not required by standard for the test object				
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)

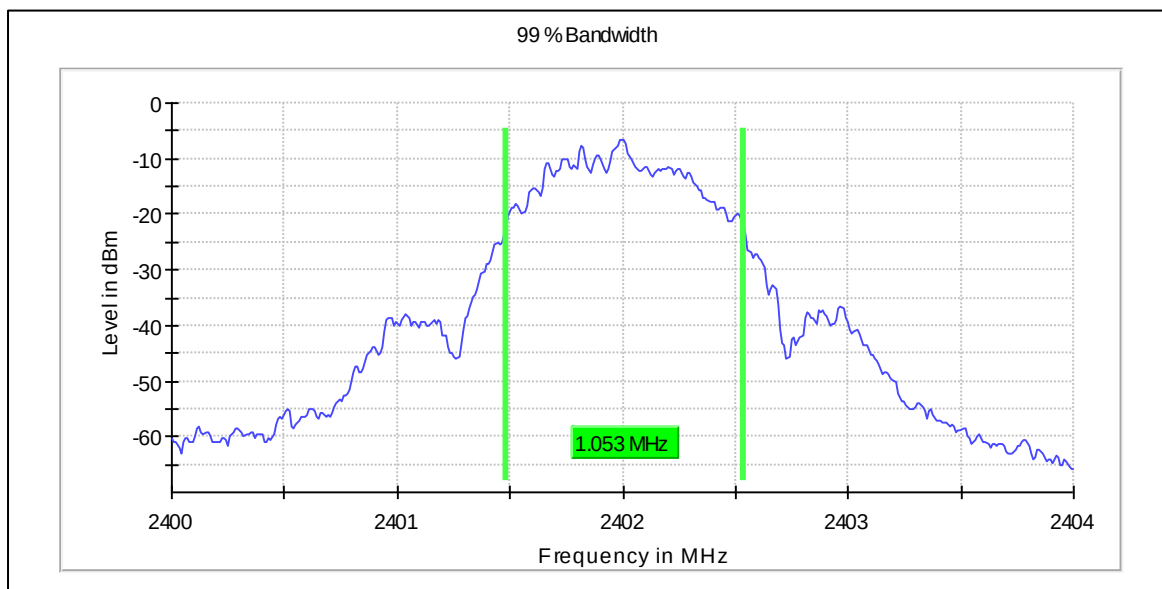
Limits
None (Informational only)

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

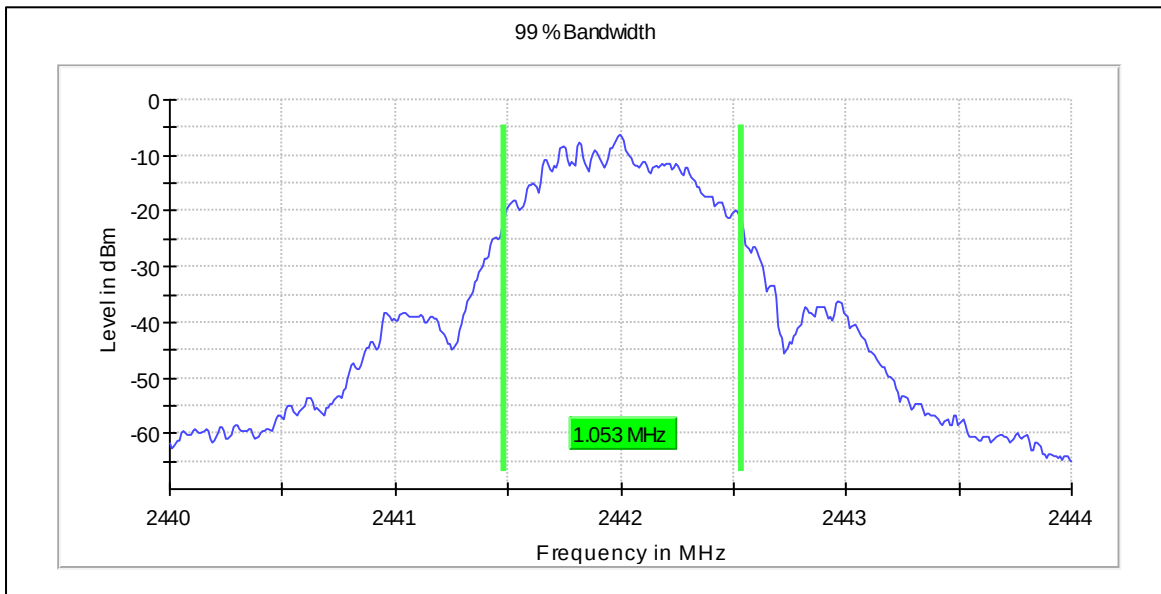
Summary:

Summary		
Mode / modulation	Frequency (MHz)	Bandwidth (MHz)
Bluetooth LE, 1 Mbps	2402	1.053 MHz
Bluetooth LE, 1 Mbps	2442	1.053 MHz
Bluetooth LE, 1 Mbps	2480	1.063 MHz

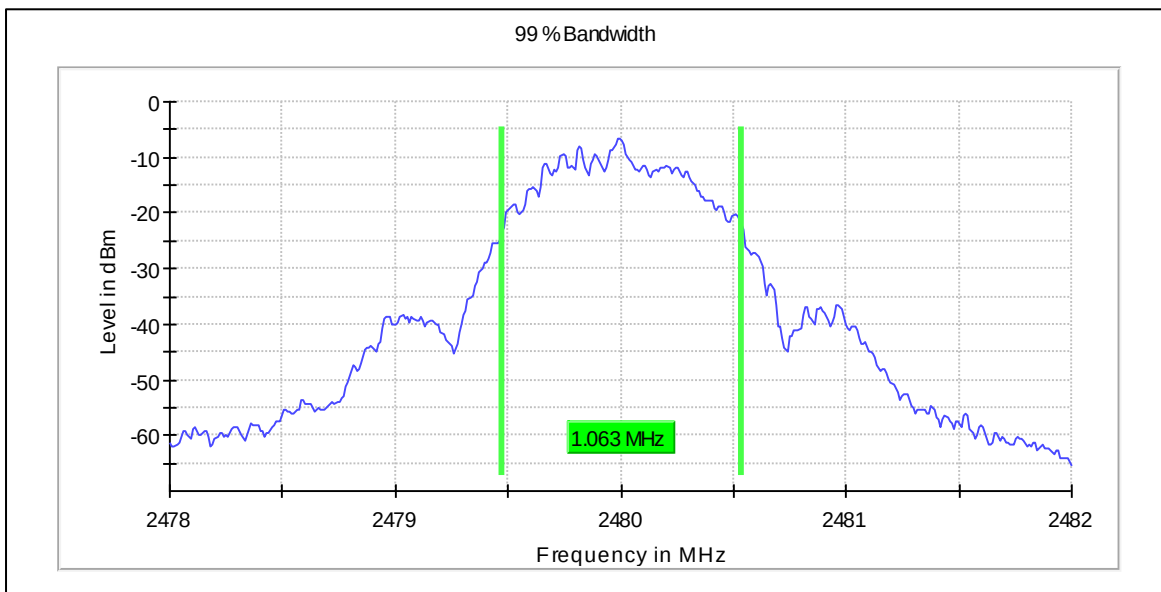
Occupied bandwidth, low channel



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)

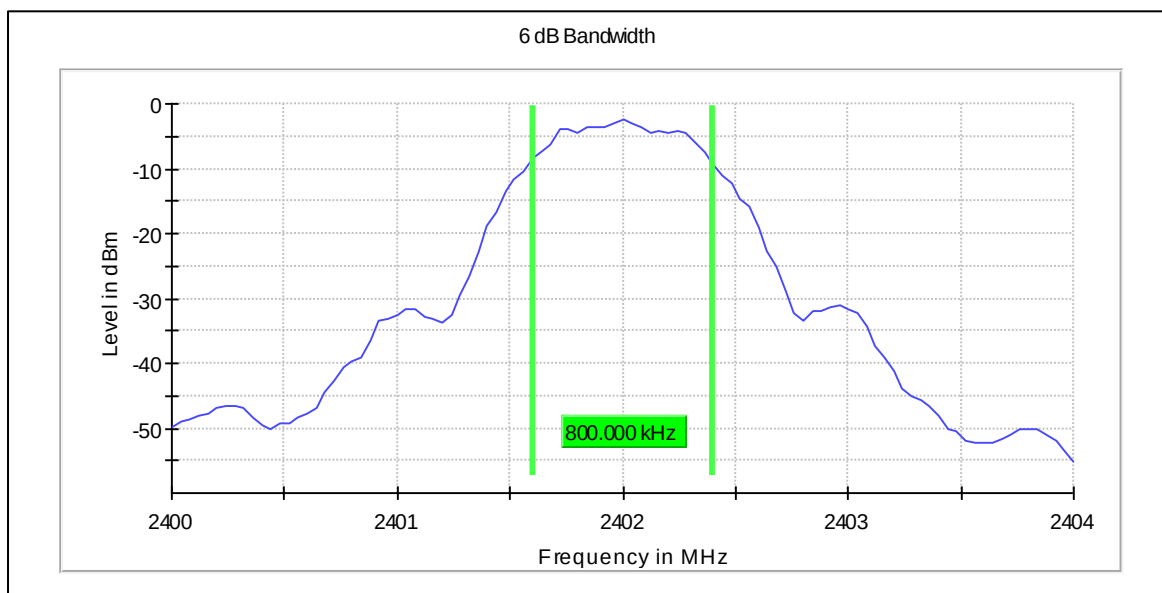
Test method: KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 (11.8.1)

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

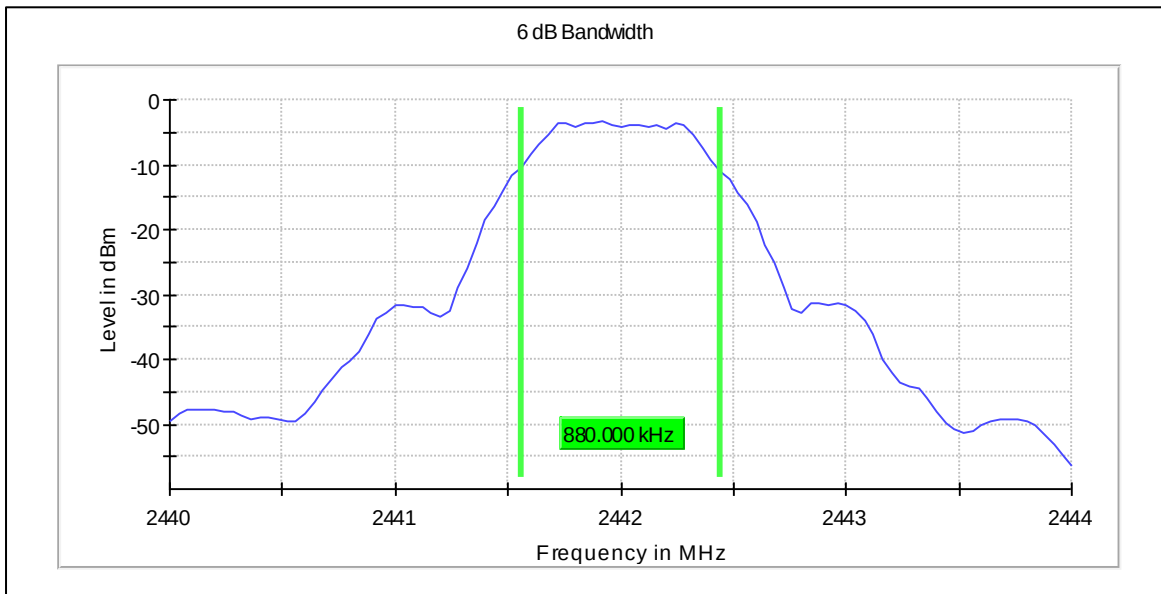
Test procedure
1. EUT set to test mode 2. Span set to at least twice the emission spectrum 3. Detector set to peak and max hold and BW is set to 100 kHz 4. Envelope peak value of emission spectrum is selected 5. Marker on envelope of spectrum is set to level of -6 dB to the left of the peak 6. Marker 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)	Limit Max (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Max Level (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	0.800000	0.500000	---	2401.600000	2402.400000	-2.2	PASS
Bluetooth LE, 1 Mbps	2442.000000	0.880000	0.500000	---	2441.560000	2442.440000	-3.2	PASS
Bluetooth LE, 1 Mbps	2480.000000	0.880000	0.500000	---	2479.560000	2480.440000	-3.6	PASS

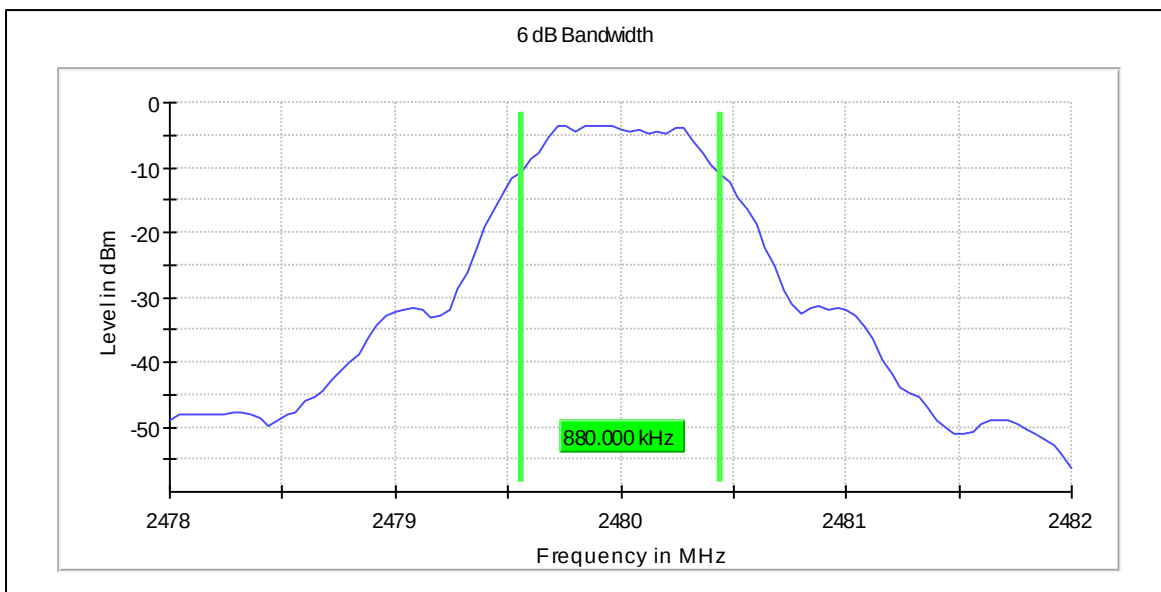
6 dB Bandwidth, low channel:



6 dB Bandwidth, middle channel:



6 dB Bandwidth, high channel:



11. Peak conducted output power

Reference: FCC part 15 §15.247(b), ISED 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.

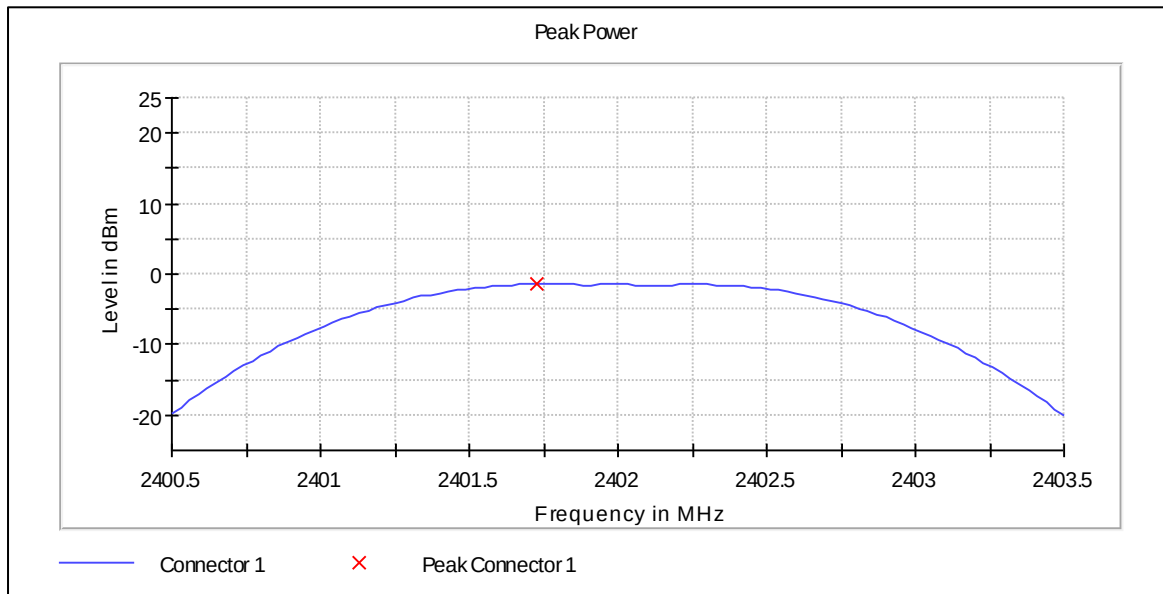
Test procedure
1. EUT set to test mode (communication tested is used if needed) 2. Analyzer resolution bandwidth is set $\geq$ DTS bandwidth 3. Detector set to peak and max hold 4. Sweep time is set to auto 5. After trace has stabilized a marker is set to peak envelope

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

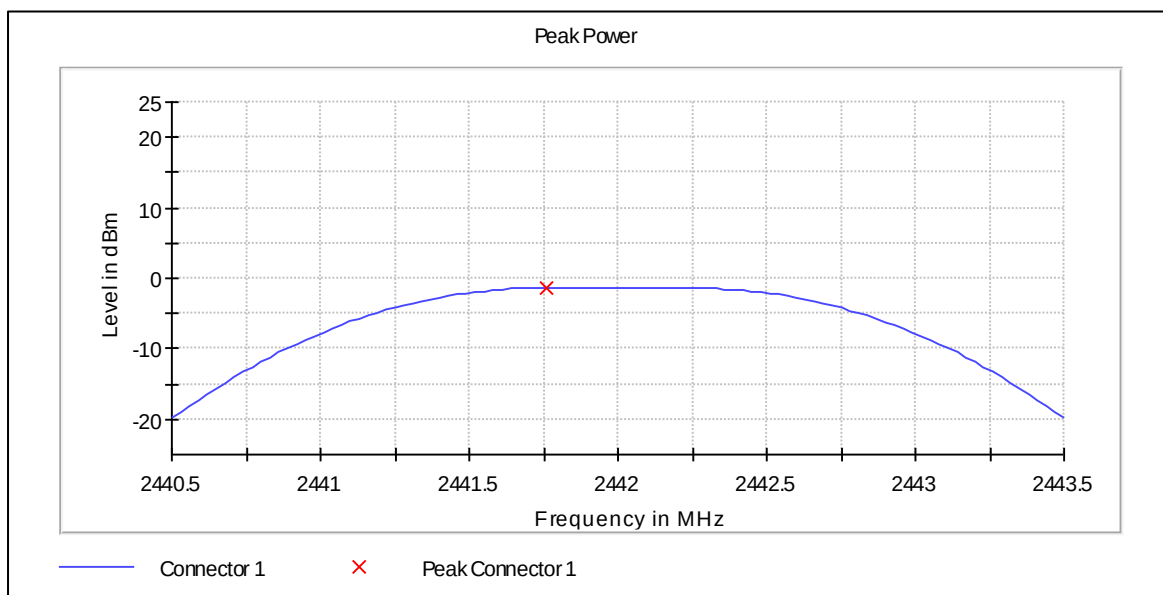
Maximum Declared Antenna Gain: 1.8 dBi

Mode / modulation	DUT Frequency (MHz)	Peak Power (dBm)	EIRP Power (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	-1.5	0.3	PASS
Bluetooth LE, 1 Mbps	2442.000000	-1.4	0.4	PASS
Bluetooth LE, 1 Mbps	2480.000000	-1.6	0.2	PASS

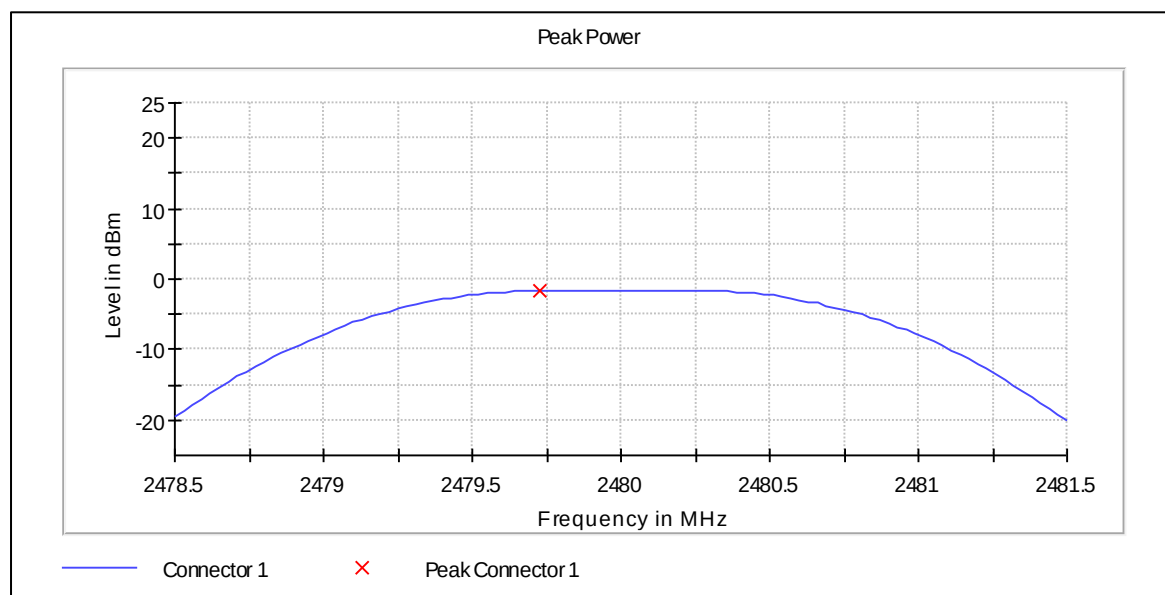
Peak power, low channel



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.

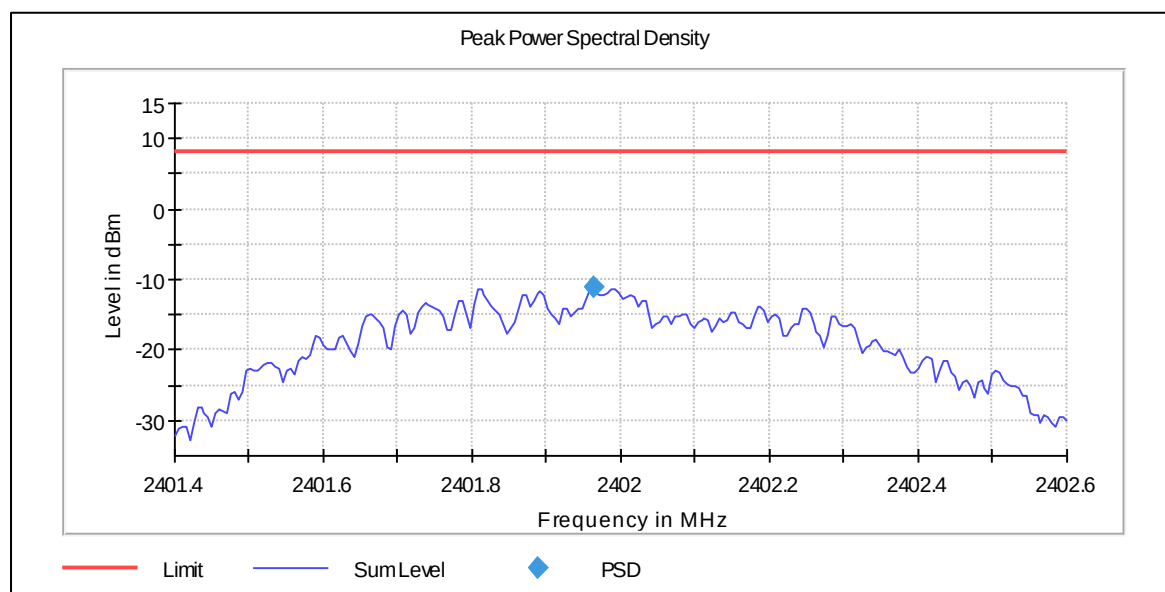
Limits
≤ 8 dBm / 3 kHz

Test procedure
1. EUT set to test mode 2. The analyzer 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

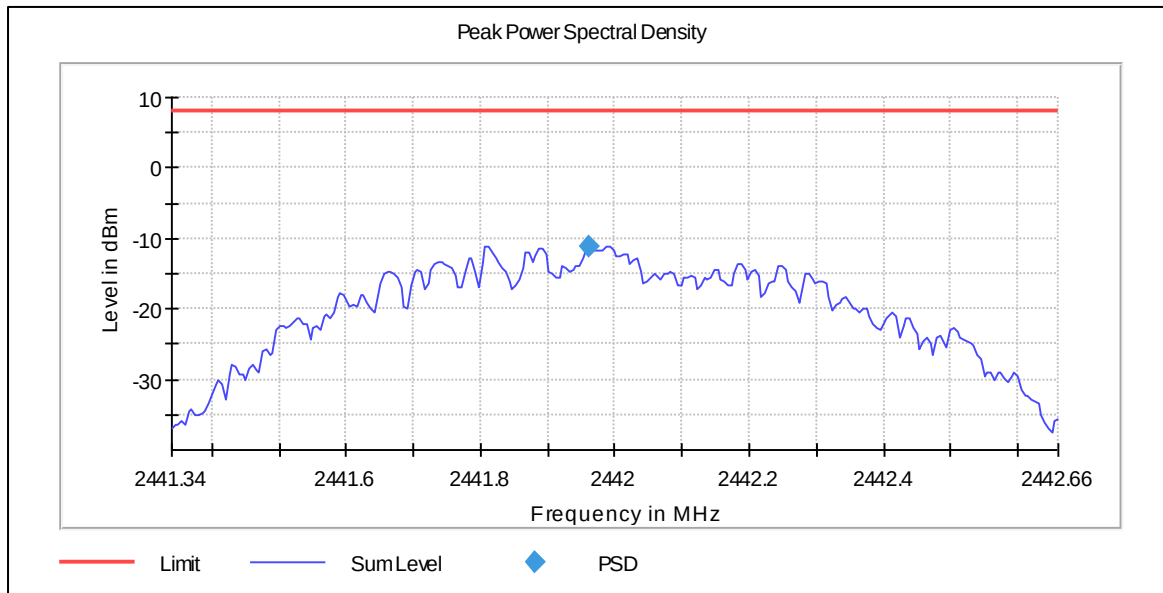
Summary

Mode / modulation	DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	2401.962343	-11.214	8.0	PASS
Bluetooth LE, 1 Mbps	2442.000000	2441.962357	-11.059	8.0	PASS
Bluetooth LE, 1 Mbps	2480.000000	2479.962357	-11.426	8.0	PASS

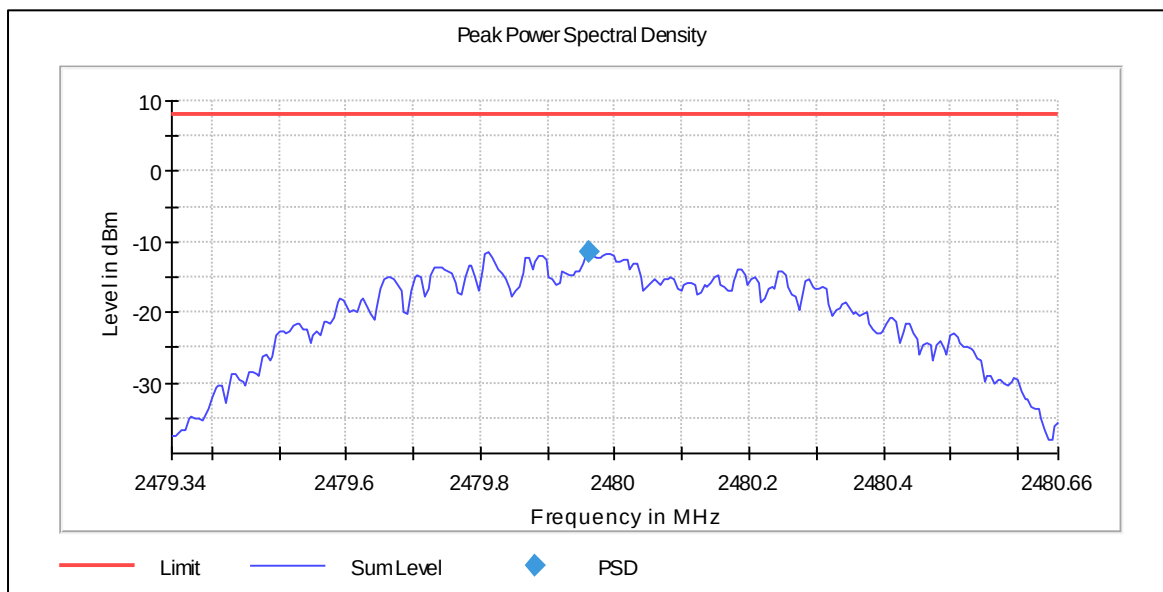
Peak power spectral density, low channel



Peak power spectral density, middle channel



Peak power spectral density, high channel:



13. Band edge emissions compliance (transmitter)

Reference: FCC §15.247(d), ISED 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

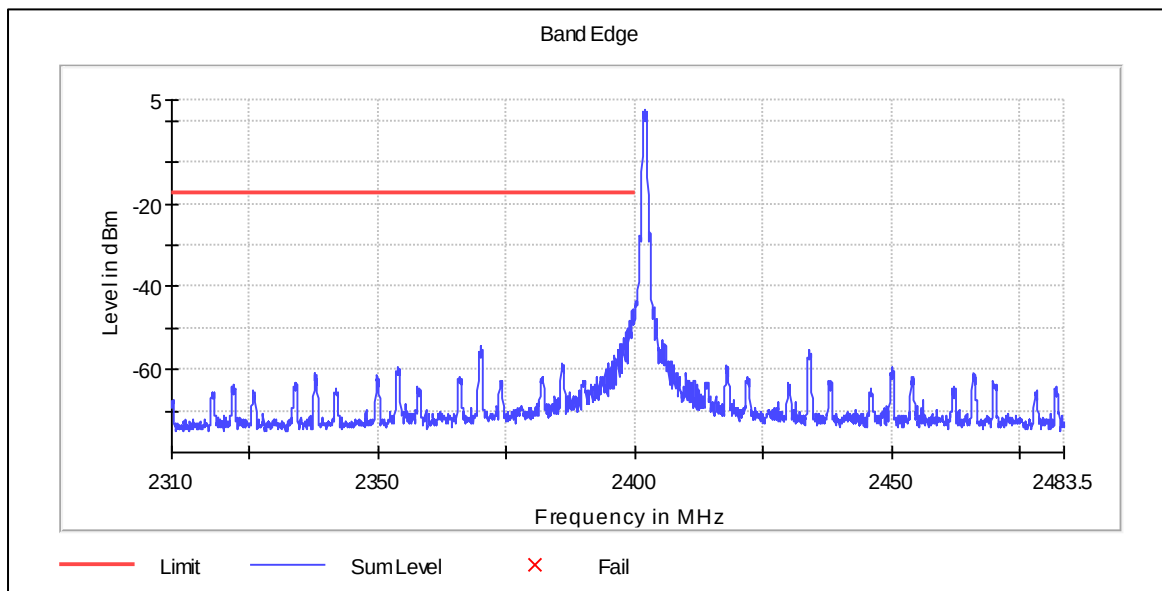
Measurements, band edge low

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.599778	-45.6	28.4	-17.2	PASS
2399.649805	-45.7	28.5	-17.2	PASS
2399.549750	-46.0	28.8	-17.2	PASS
2399.699833	-46.1	28.9	-17.2	PASS
2399.499722	-46.6	29.4	-17.2	PASS
2399.749861	-47.2	30.0	-17.2	PASS
2399.949972	-47.7	30.5	-17.2	PASS
2398.999444	-48.2	31.0	-17.2	PASS
2399.449694	-48.3	31.1	-17.2	PASS
2399.049472	-48.6	31.4	-17.2	PASS
2399.849917	-48.9	31.7	-17.2	PASS
2399.099500	-49.0	31.7	-17.2	PASS
2399.799889	-49.0	31.8	-17.2	PASS
2398.949416	-49.0	31.8	-17.2	PASS
2399.899944	-49.0	31.8	-17.2	PASS

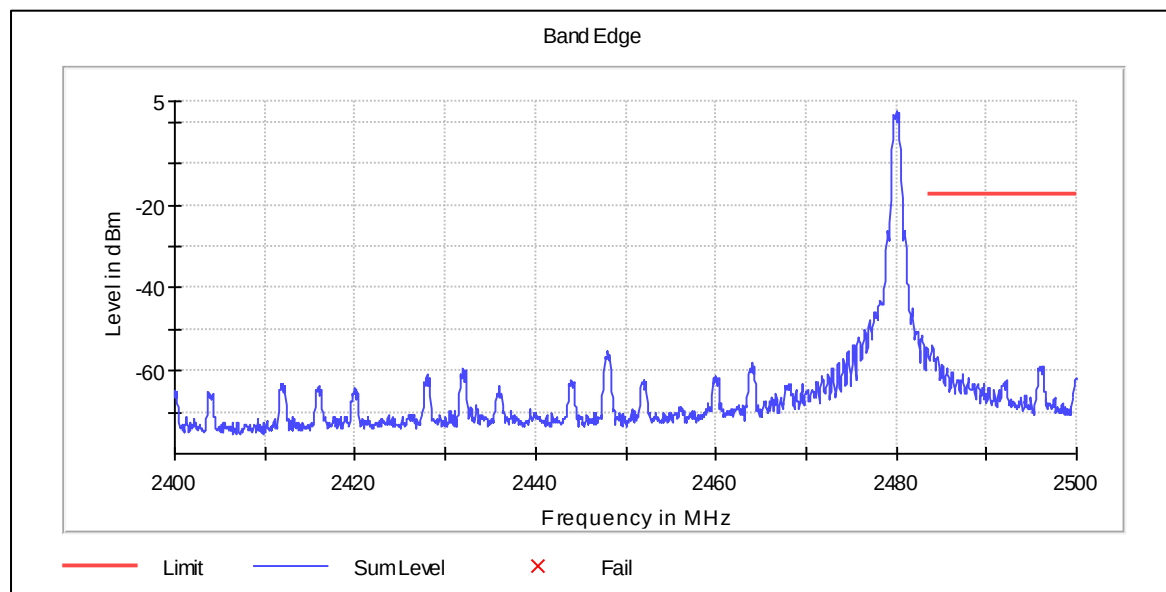
Measurements, band edge high

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2484.001520	-54.1	36.8	-17.3	PASS
2483.951368	-54.2	36.9	-17.3	PASS
2484.051672	-54.6	37.3	-17.3	PASS
2483.901216	-54.7	37.4	-17.3	PASS
2483.550152	-55.2	37.9	-17.3	PASS
2483.851064	-55.3	38.0	-17.3	PASS
2483.600304	-56.4	39.1	-17.3	PASS
2484.503040	-56.6	39.3	-17.3	PASS
2484.653495	-56.6	39.3	-17.3	PASS
2484.101824	-56.6	39.3	-17.3	PASS
2484.553191	-56.6	39.3	-17.3	PASS
2484.603343	-56.6	39.4	-17.3	PASS
2483.800912	-56.7	39.4	-17.3	PASS
2484.202128	-56.9	39.6	-17.3	PASS
2483.700608	-57.1	39.8	-17.3	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)
2370.000000	-56.8	39.2	-17.6
2390.000000	-60.0	42.4	-17.6
2360.000000	-60.3	42.7	-17.6
2380.000000	-60.4	42.9	-17.6
2340.000000	-62.8	45.2	-17.6
2523.494048	-63.2	45.6	-17.6
2350.000000	-63.6	46.0	-17.6
2280.000000	-63.7	46.2	-17.6
2310.000000	-64.9	47.3	-17.6
2693.468750	-65.1	47.5	-17.6
2330.000000	-65.1	47.6	-17.6
2493.498512	-65.2	47.6	-17.6
2683.470238	-65.3	47.8	-17.6
2713.465774	-65.6	48.1	-17.6
2603.482143	-66.2	48.6	-17.6

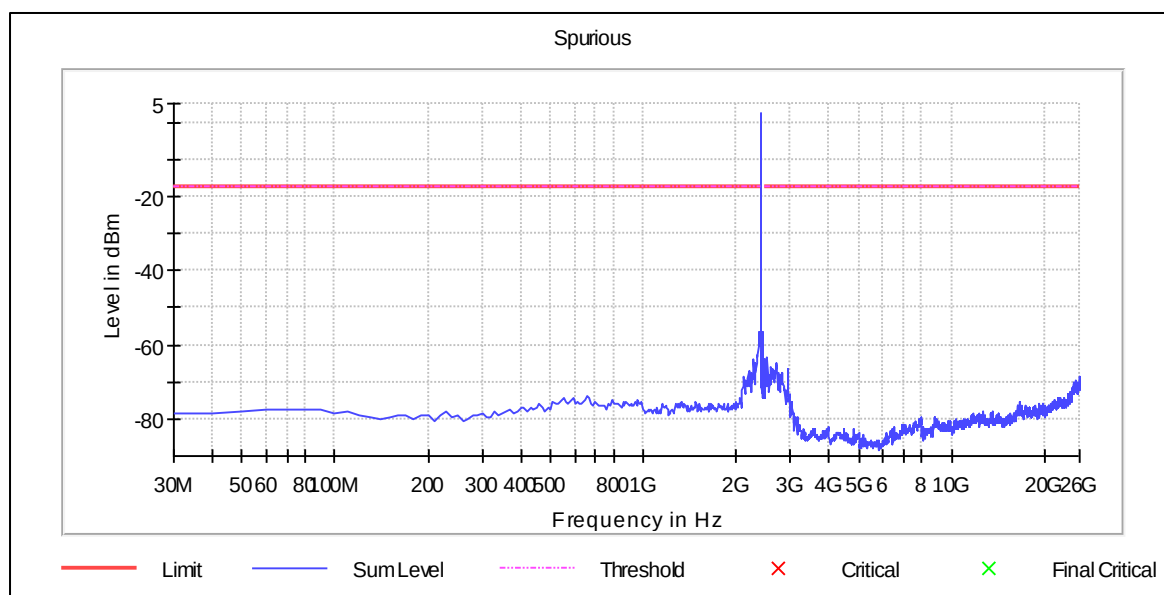
Pre Measurements, middle channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2493.498512	-62.2	44.1	-18.1
2390.000000	-62.6	44.5	-18.1
2350.000000	-63.4	45.3	-18.1
2380.000000	-63.7	45.6	-18.1
2503.497024	-64.1	46.0	-18.1
2533.492560	-64.1	46.0	-18.1
2320.000000	-64.5	46.4	-18.1
2983.425595	-64.6	46.5	-18.1
2370.000000	-65.2	47.1	-18.1
2240.000000	-65.3	47.2	-18.1
2643.476190	-65.7	47.6	-18.1
2513.495536	-66.2	48.1	-18.1
2563.488095	-66.3	48.2	-18.1
2270.000000	-66.4	48.3	-18.1
2733.462798	-66.4	48.3	-18.1

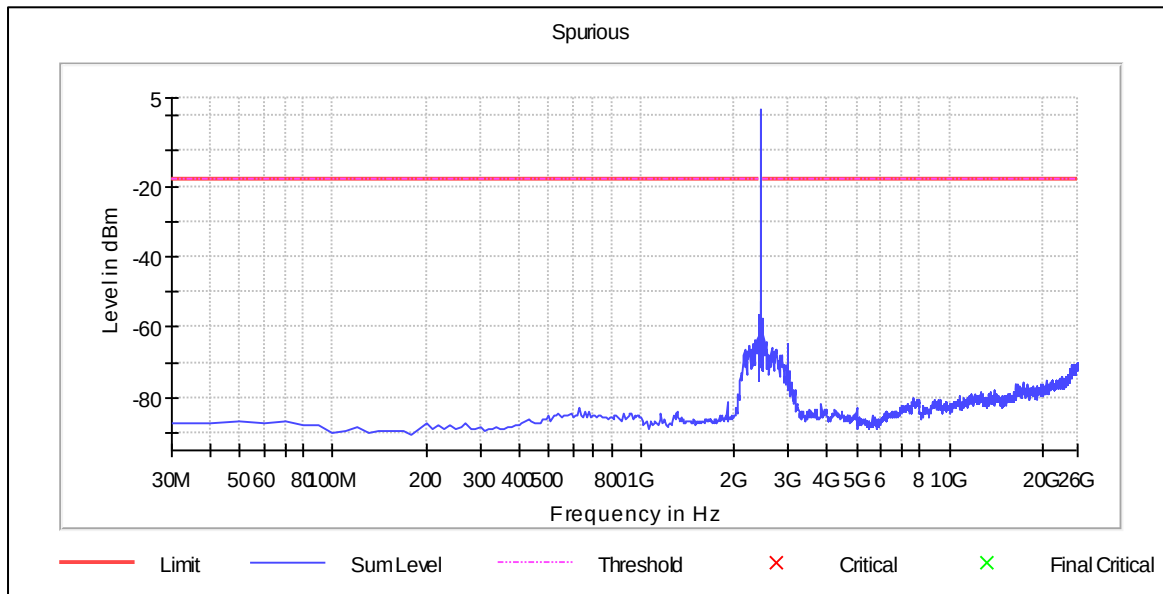
Pre Measurements, high channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2503.497024	-56.0	37.2	-18.8
25830.025298	-59.3	40.5	-18.8
25400.089286	-59.5	40.7	-18.8
25900.014881	-59.5	40.7	-18.8
2493.498512	-59.7	41.0	-18.8
25980.002976	-59.8	41.0	-18.8
25850.022321	-59.9	41.1	-18.8
25920.011905	-60.1	41.3	-18.8
25420.086310	-60.2	41.4	-18.8
25350.096726	-60.4	41.6	-18.8
25480.077381	-60.4	41.7	-18.8
25910.013393	-60.5	41.7	-18.8
25890.016369	-60.5	41.8	-18.8
25380.092262	-60.6	41.8	-18.8
25390.090774	-60.7	41.9	-18.8

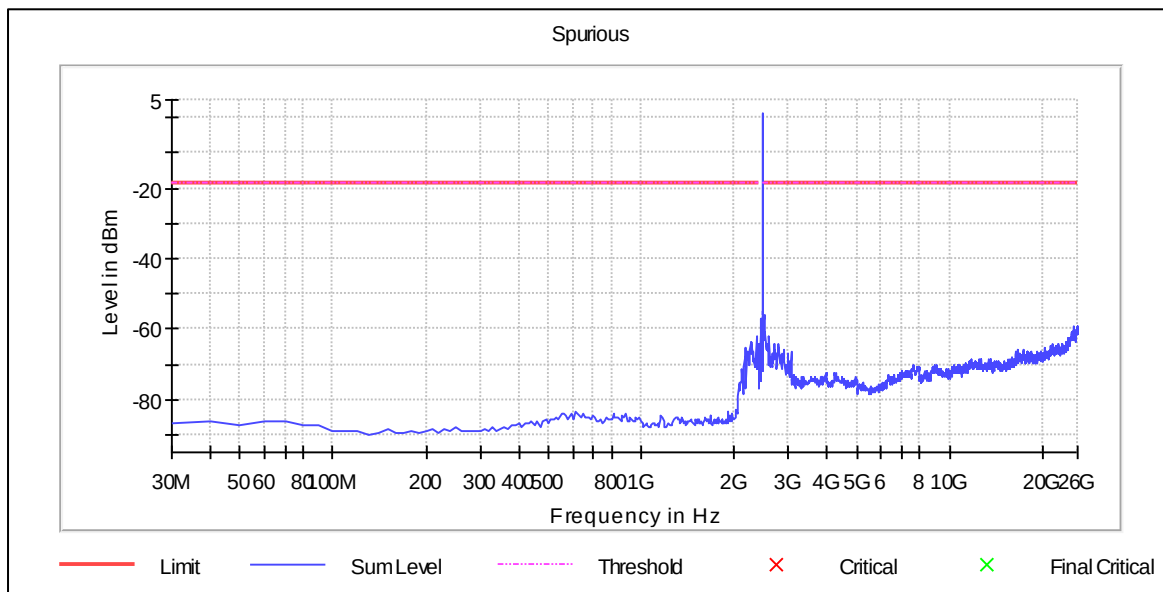
Low channel



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

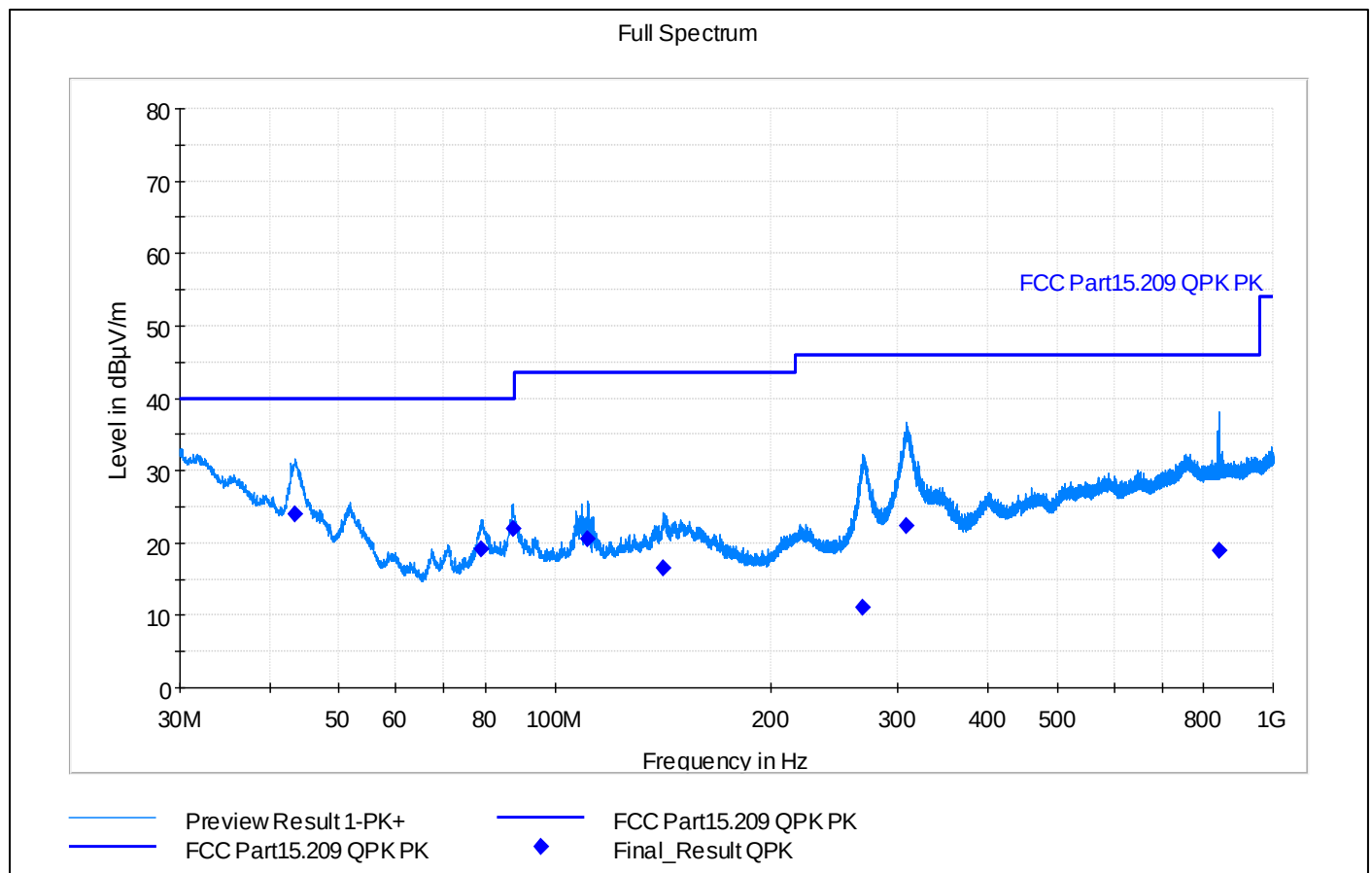
Test procedure 30 MHz -1 GHz	
1.	EUT is placed on a non conducting support at the center of a turn table 0.8m above the ground
2.	EUT set to test mode
3.	The receiver is set to peak detection with max hold
4.	The EUT is rotated through 360 degrees (orientation varied), measurements were made in both 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.

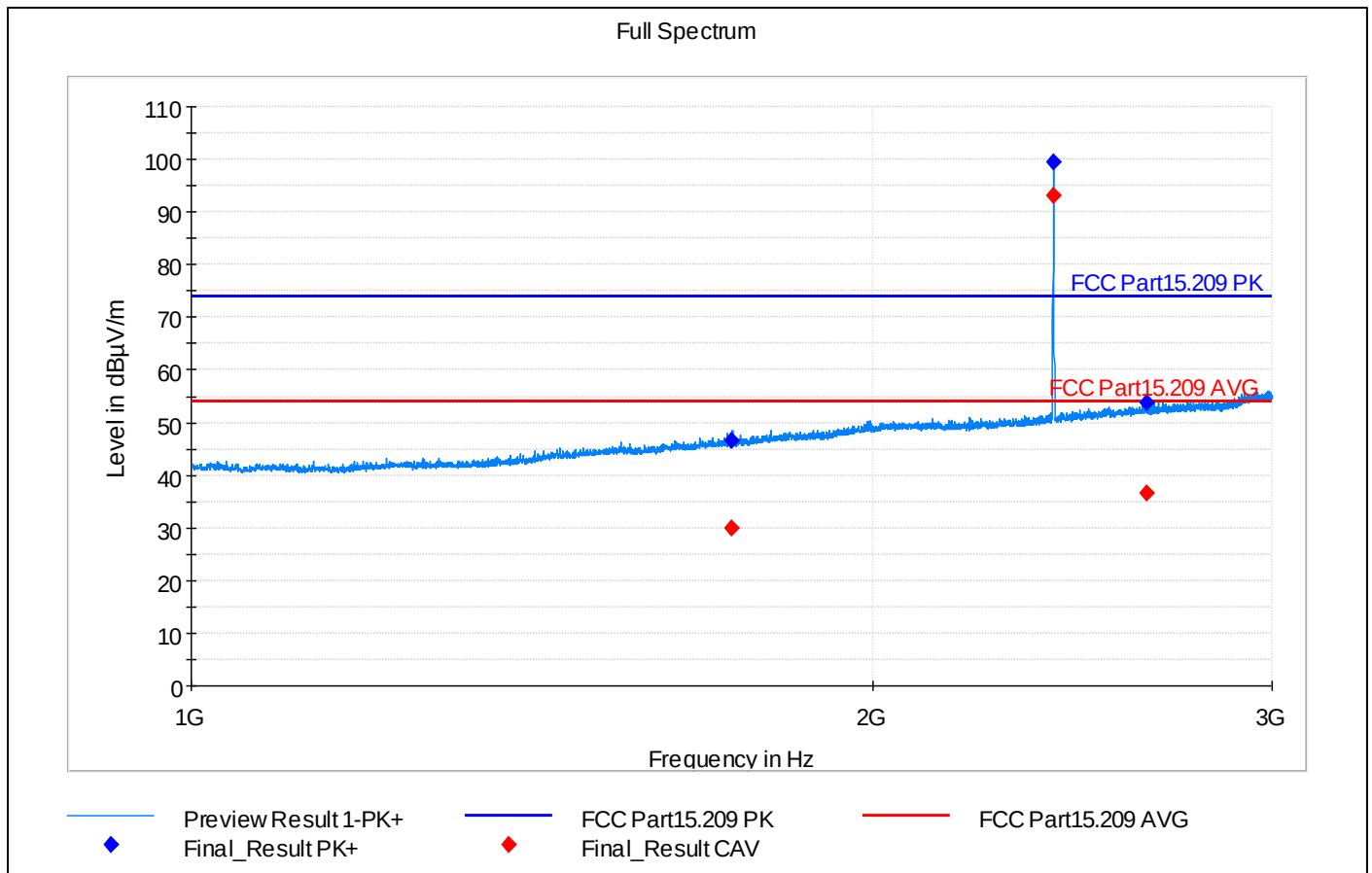
For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function. RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

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.

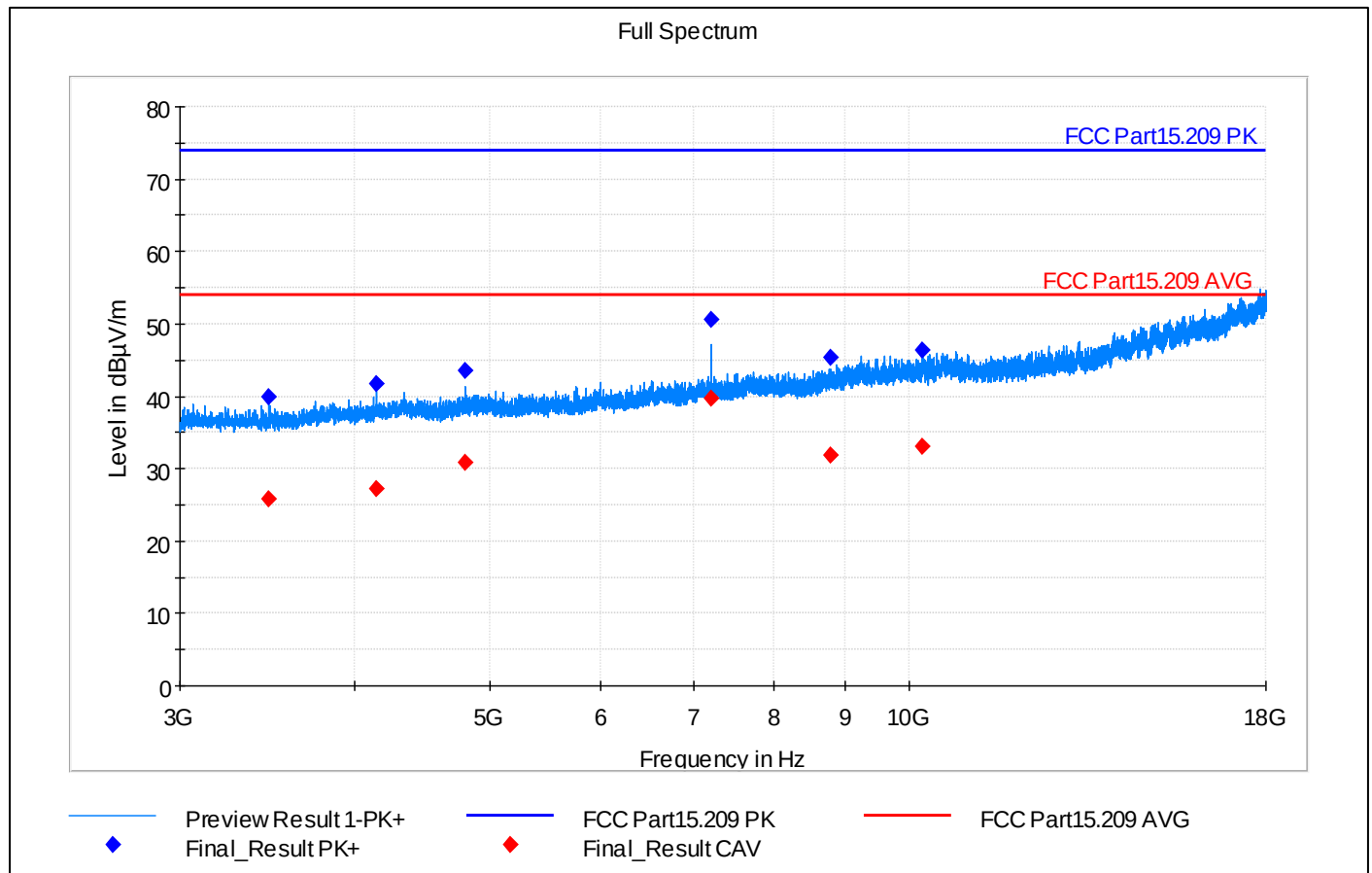
Operation mode(s)	Configuration	Test Verdict
Bluetooth LE TX, 1 Mbps, PCL 7	Low channel ch0, 2402 MHz	PASS
Bluetooth LE TX, 1 Mbps, PCL 7	Mid channel ch19, 2440 MHz	PASS
Bluetooth LE TX, 1 Mbps, PCL 7	High channel ch39, 2480 MHz	PASS

Low channel, 30 MHz – 1 GHz

Final_Result

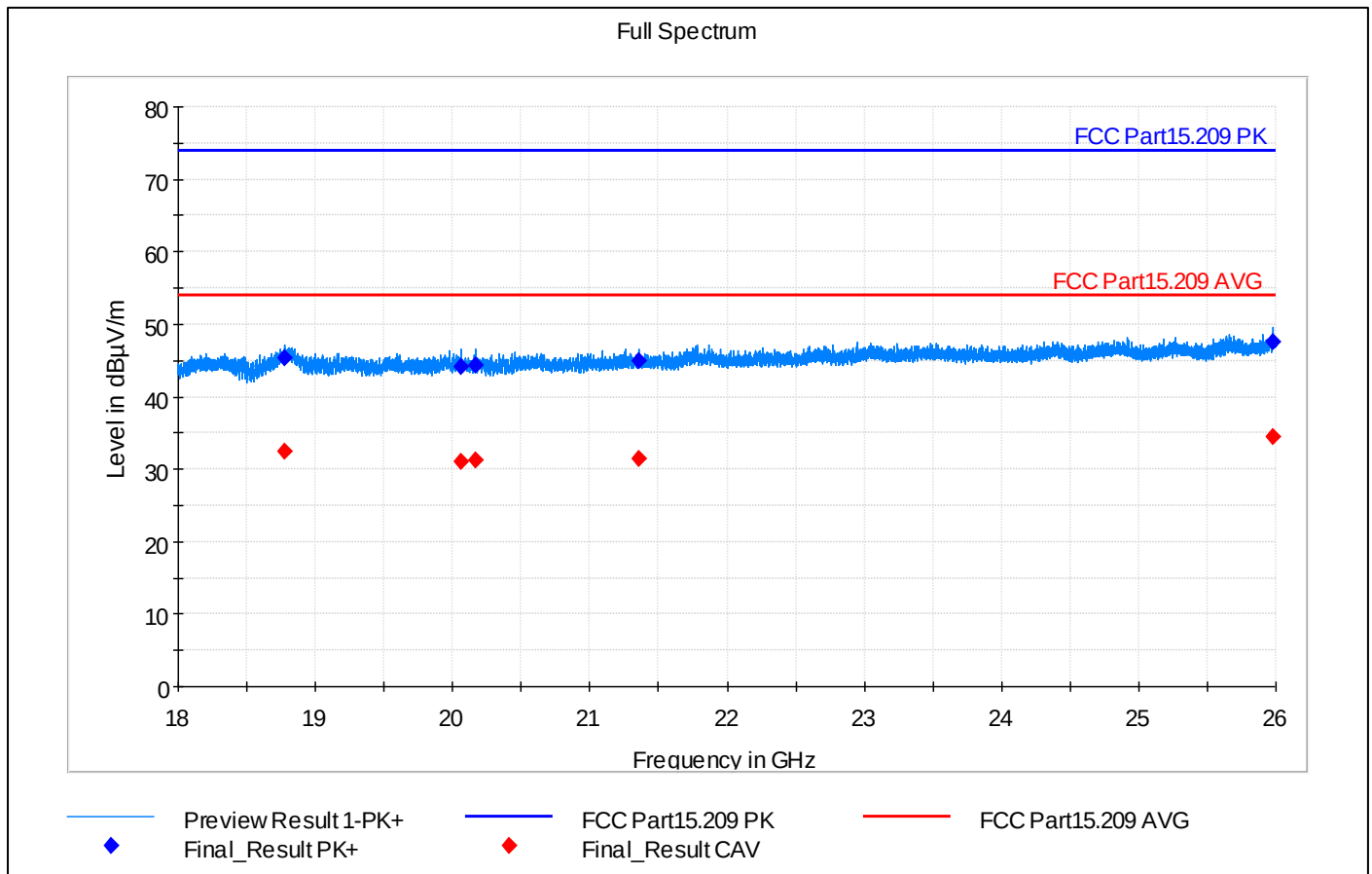
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
43.470000	24.01	40.00	15.99	15000.0	120.000	116.0	V	49.0	0.0	20.3	PASS
78.870000	19.15	40.00	20.85	15000.0	120.000	164.0	V	-11.0	0.0	16.2	PASS
87.480000	22.01	40.00	17.99	15000.0	120.000	142.0	V	202.0	0.0	16.7	PASS
110.790000	20.65	43.50	22.85	15000.0	120.000	98.0	V	212.0	0.0	17.0	PASS
141.210000	16.48	43.50	27.02	15000.0	120.000	116.0	V	146.0	90.0	18.5	PASS
268.200000	11.01	46.00	34.99	15000.0	120.000	377.0	H	272.0	0.0	20.0	PASS
308.760000	22.38	46.00	23.62	15000.0	120.000	98.0	H	69.0	90.0	20.0	PASS
840.090000	18.97	46.00	27.03	15000.0	120.000	309.0	H	22.0	0.0	27.8	PASS

Low channel, 1 – 3 GHz

Final Result

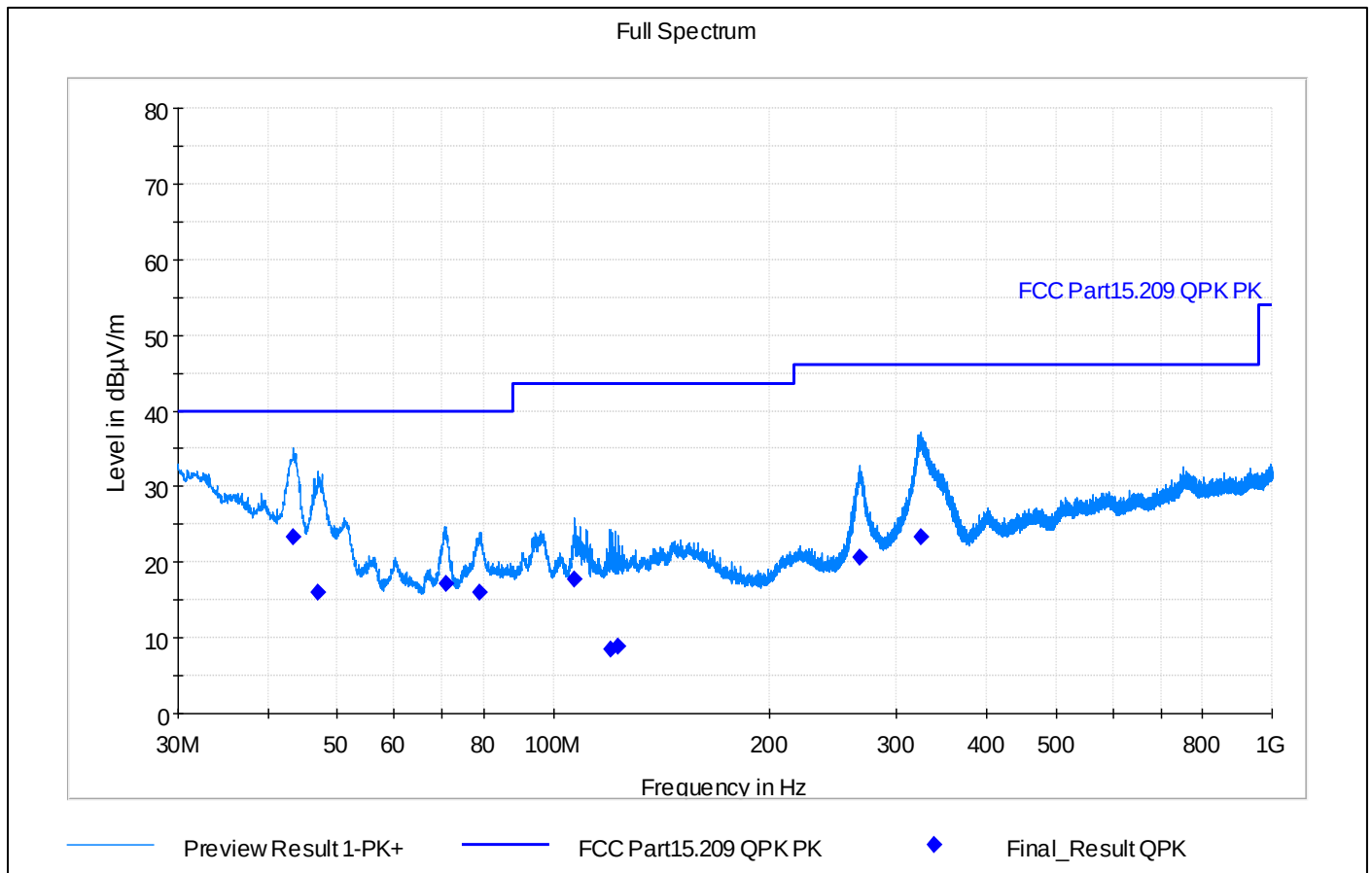
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1733.250000	---	29.80	54.00	24.20	15000.0	1000.000	237.0	H	112.0	90.0	34.8	PASS
1733.250000	46.63	---	74.00	27.37	15000.0	1000.000	237.0	H	112.0	90.0	34.8	PASS
2402.250000	---	93.03	54.00	-39.03	15000.0	1000.000	145.0	H	322.0	90.0	38.6	Fundamental TX signal
2402.250000	99.36	---	74.00	-25.36	15000.0	1000.000	145.0	H	322.0	90.0	38.6	Fundamental TX signal
2643.000000	---	36.62	54.00	17.38	15000.0	1000.000	299.0	V	279.0	90.0	40.0	PASS
2643.000000	53.77	---	74.00	20.23	15000.0	1000.000	299.0	V	279.0	90.0	40.0	PASS

Low channel, 3 – 18 GHz

Final_Result

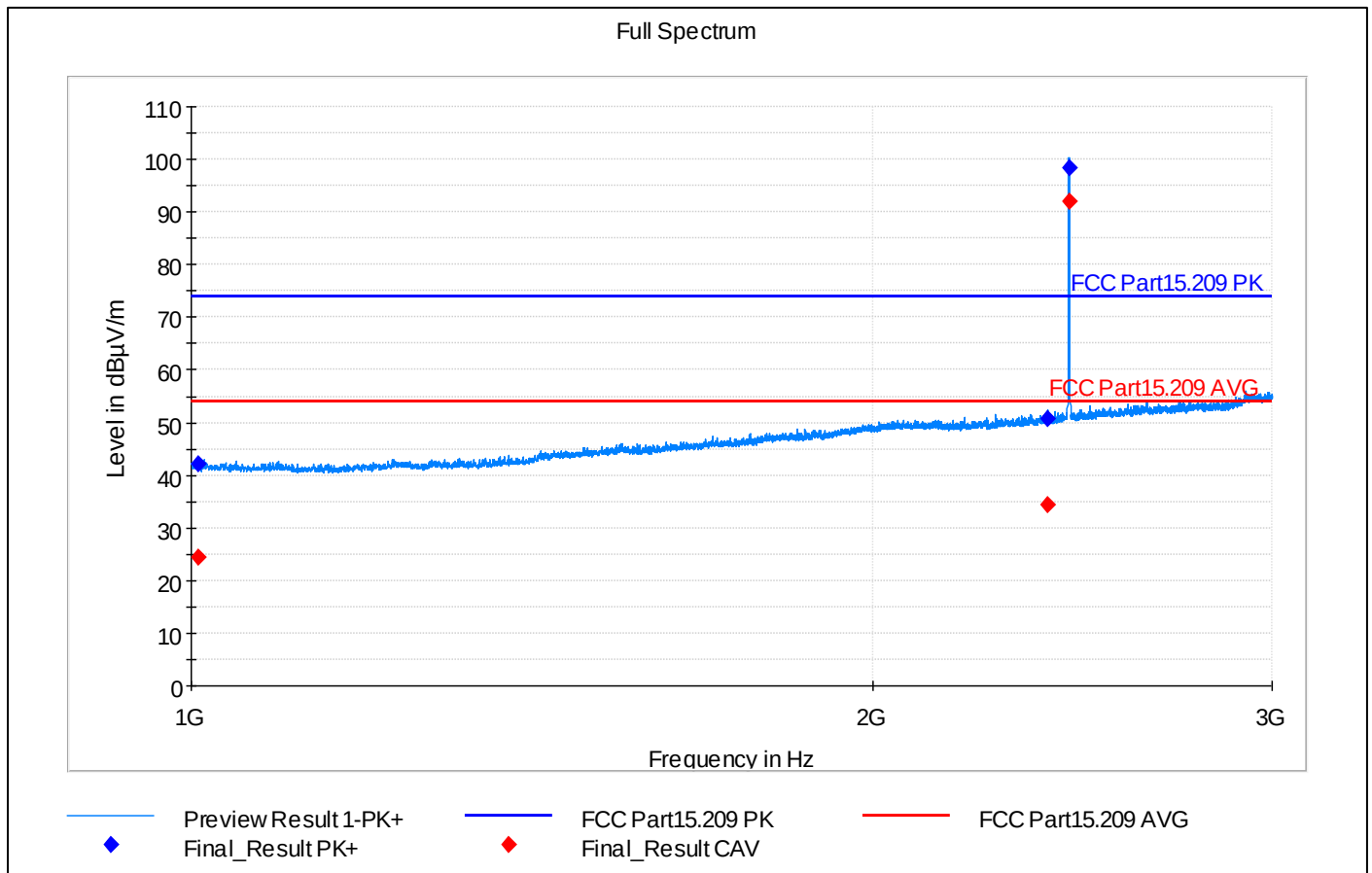
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
3473.500000	39.86	---	74.00	34.14	15000.0	1000.000	278.0	H	301.0	90.0	6.0	PASS
3473.500000	---	25.79	54.00	28.21	15000.0	1000.000	278.0	H	301.0	90.0	6.0	PASS
4152.500000	---	27.15	54.00	26.85	15000.0	1000.000	407.0	H	83.0	90.0	8.2	PASS
4152.500000	41.65	---	74.00	32.35	15000.0	1000.000	407.0	H	83.0	90.0	8.2	PASS
4804.250000	---	30.93	54.00	23.07	15000.0	1000.000	368.0	V	254.0	90.0	10.0	PASS
4804.250000	43.45	---	74.00	30.55	15000.0	1000.000	368.0	V	254.0	90.0	10.0	PASS
7206.000000	50.52	---	74.00	23.48	15000.0	1000.000	127.0	H	99.0	90.0	14.9	PASS
7206.000000	---	39.73	54.00	14.27	15000.0	1000.000	127.0	H	99.0	90.0	14.9	PASS
8776.000000	45.34	---	74.00	28.66	15000.0	1000.000	333.0	V	334.0	90.0	18.0	PASS
8776.000000	---	31.78	54.00	22.22	15000.0	1000.000	333.0	V	334.0	90.0	18.0	PASS
10223.500000	46.25	---	74.00	27.75	15000.0	1000.000	140.0	V	338.0	90.0	20.3	PASS
10223.500000	---	32.98	54.00	21.02	15000.0	1000.000	140.0	V	338.0	90.0	20.3	PASS

Low channel, 18 – 26 GHz

Final_Result

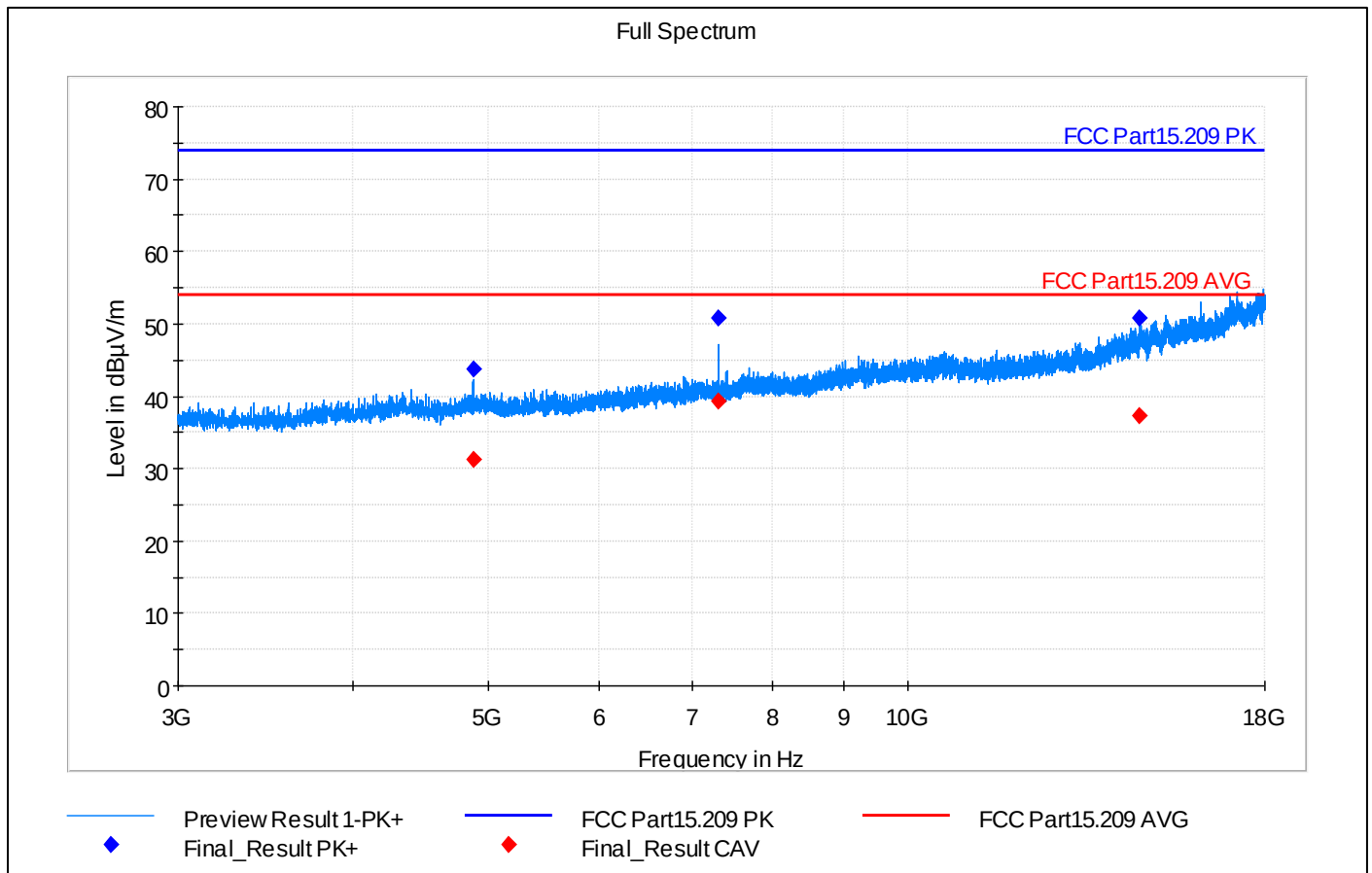
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18776.250000	---	32.35	54.00	21.65	3000.0	1000.000	194.0	H	112.0	0.0	23.5	PASS
18776.250000	45.27	---	74.00	28.73	3000.0	1000.000	194.0	H	112.0	0.0	23.5	PASS
20064.250000	---	30.96	54.00	23.04	3000.0	1000.000	277.0	V	175.0	0.0	24.0	PASS
20064.250000	44.16	---	74.00	29.84	3000.0	1000.000	277.0	V	175.0	0.0	24.0	PASS
20169.000000	44.43	---	74.00	29.57	3000.0	1000.000	199.0	H	102.0	0.0	24.0	PASS
20169.000000	---	31.21	54.00	22.79	3000.0	1000.000	199.0	H	102.0	0.0	24.0	PASS
21359.750000	---	31.41	54.00	22.59	3000.0	1000.000	350.0	H	303.0	0.0	24.5	PASS
21359.750000	44.94	---	74.00	29.06	3000.0	1000.000	350.0	H	303.0	0.0	24.5	PASS
25982.250000	47.58	---	74.00	26.42	3000.0	1000.000	306.0	V	-21.0	0.0	27.0	PASS
25982.250000	---	34.45	54.00	19.55	3000.0	1000.000	306.0	V	-21.0	0.0	27.0	PASS

Mid channel, 30 MHz – 1 GHz

Final_Result

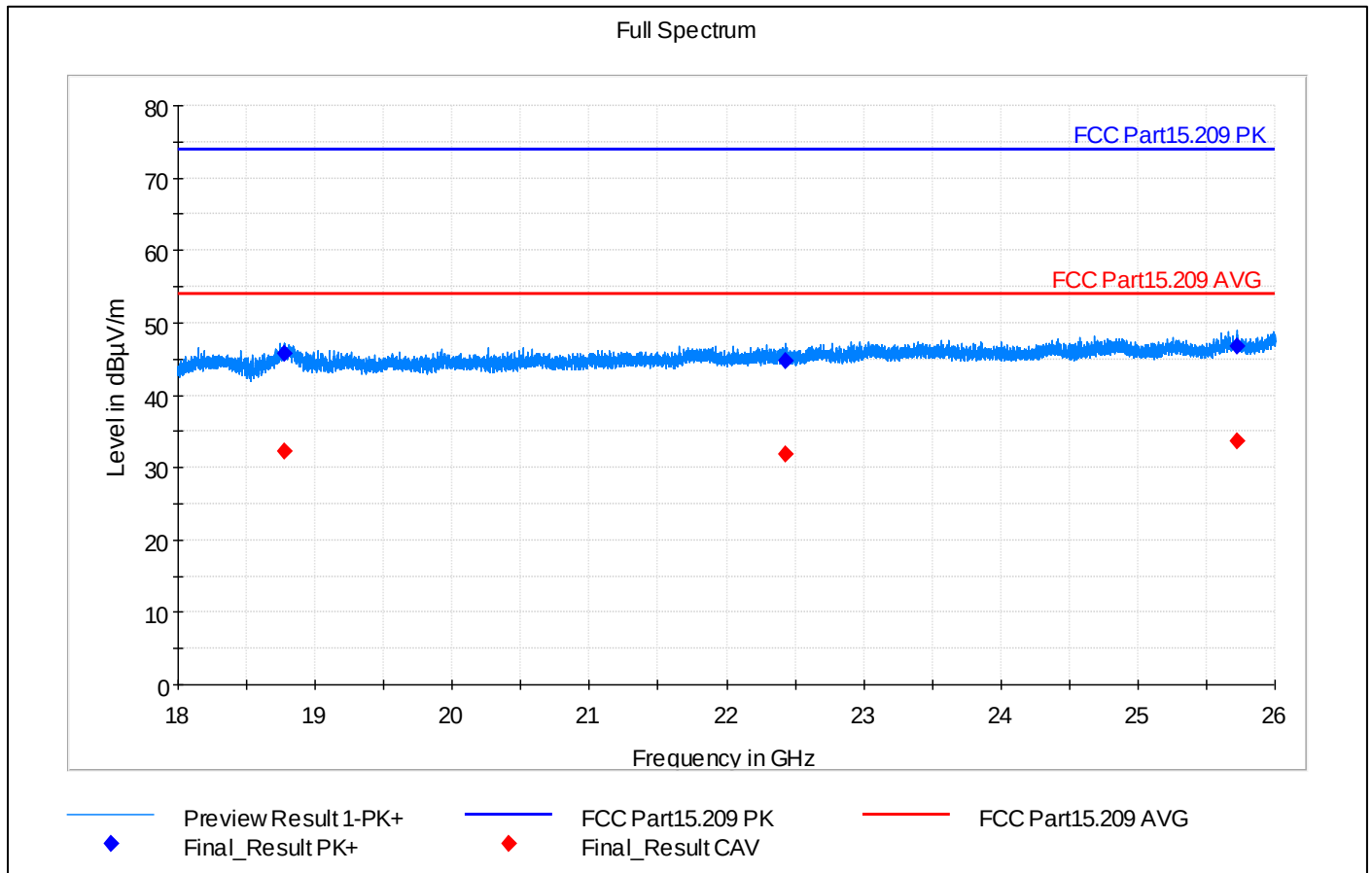
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
43.350000	23.35	40.00	16.65	15000.0	120.000	258.0	V	337.0	0.0	20.4	PASS
47.010000	16.03	40.00	23.97	15000.0	120.000	284.0	V	202.0	0.0	19.0	PASS
70.680000	17.09	40.00	22.91	15000.0	120.000	181.0	V	311.0	0.0	14.4	PASS
78.810000	15.98	40.00	24.02	15000.0	120.000	260.0	V	157.0	0.0	16.2	PASS
106.680000	17.79	43.50	25.71	15000.0	120.000	101.0	V	101.0	90.0	16.7	PASS
120.240000	8.44	43.50	35.06	15000.0	120.000	143.0	H	78.0	90.0	17.6	PASS
122.850000	8.83	43.50	34.67	15000.0	120.000	219.0	H	97.0	90.0	17.7	PASS
266.430000	20.70	46.00	25.30	15000.0	120.000	98.0	H	297.0	0.0	19.8	PASS
324.180000	23.24	46.00	22.76	15000.0	120.000	98.0	H	277.0	90.0	20.3	PASS

Mid channel, 1-3 GHz

Final_Result

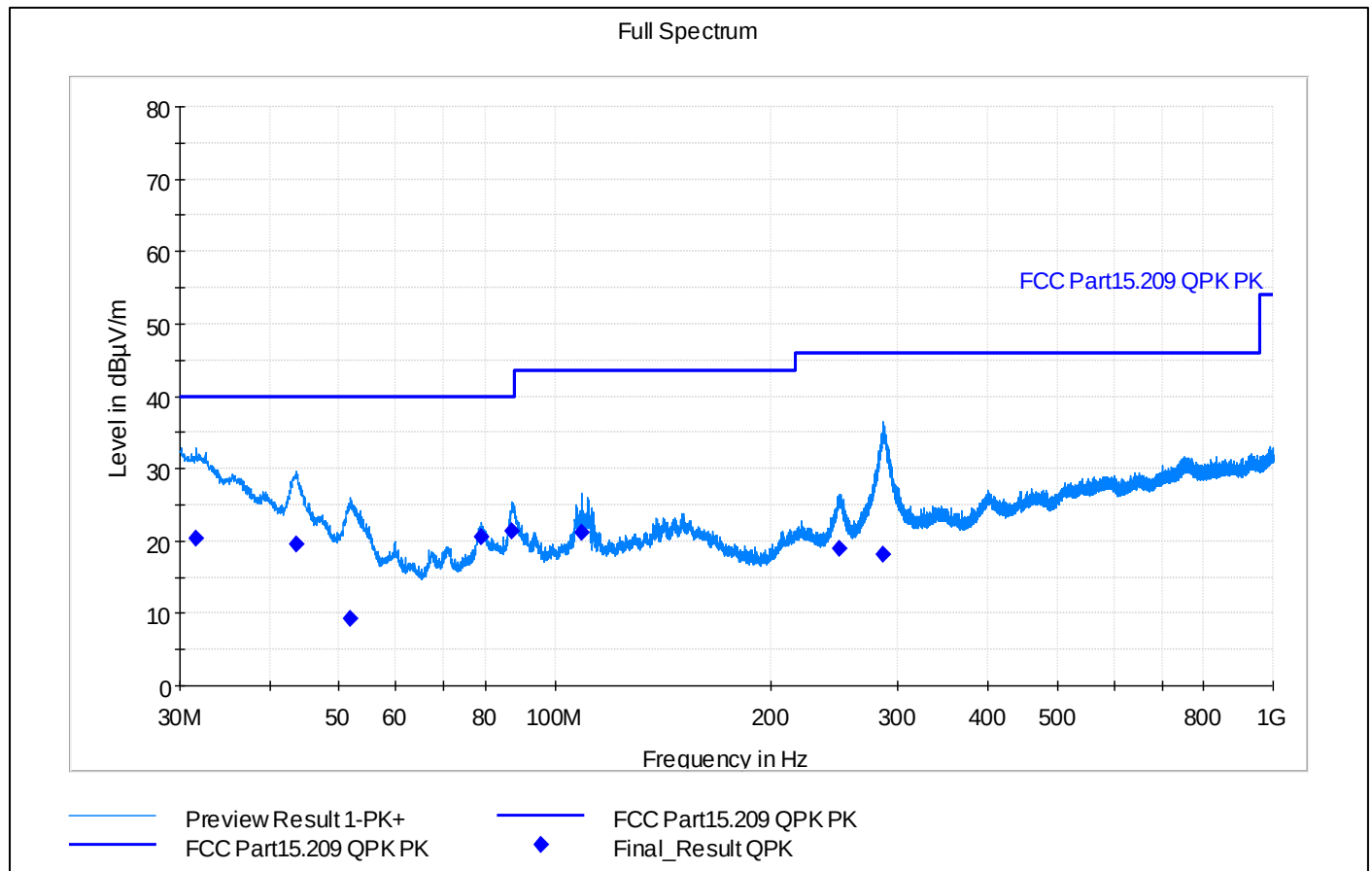
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1007.250000	---	24.41	54.00	29.59	15000.0	1000.000	367.0	H	67.0	0.0	30.7	PASS
1007.250000	42.01	---	74.00	31.99	15000.0	1000.000	367.0	H	67.0	0.0	30.7	PASS
2389.250000	---	34.26	54.00	19.74	15000.0	1000.000	306.0	H	315.0	0.0	38.5	PASS
2389.250000	50.72	---	74.00	23.28	15000.0	1000.000	306.0	H	315.0	0.0	38.5	PASS
2440.250000	---	91.89	54.00	-37.89	15000.0	1000.000	98.0	H	323.0	0.0	38.9	Fundamental TX signal
2440.250000	98.23	---	74.00	-24.23	15000.0	1000.000	98.0	H	323.0	0.0	38.9	Fundamental TX signal

Mid channel, 3–18 GHz

Final_Result

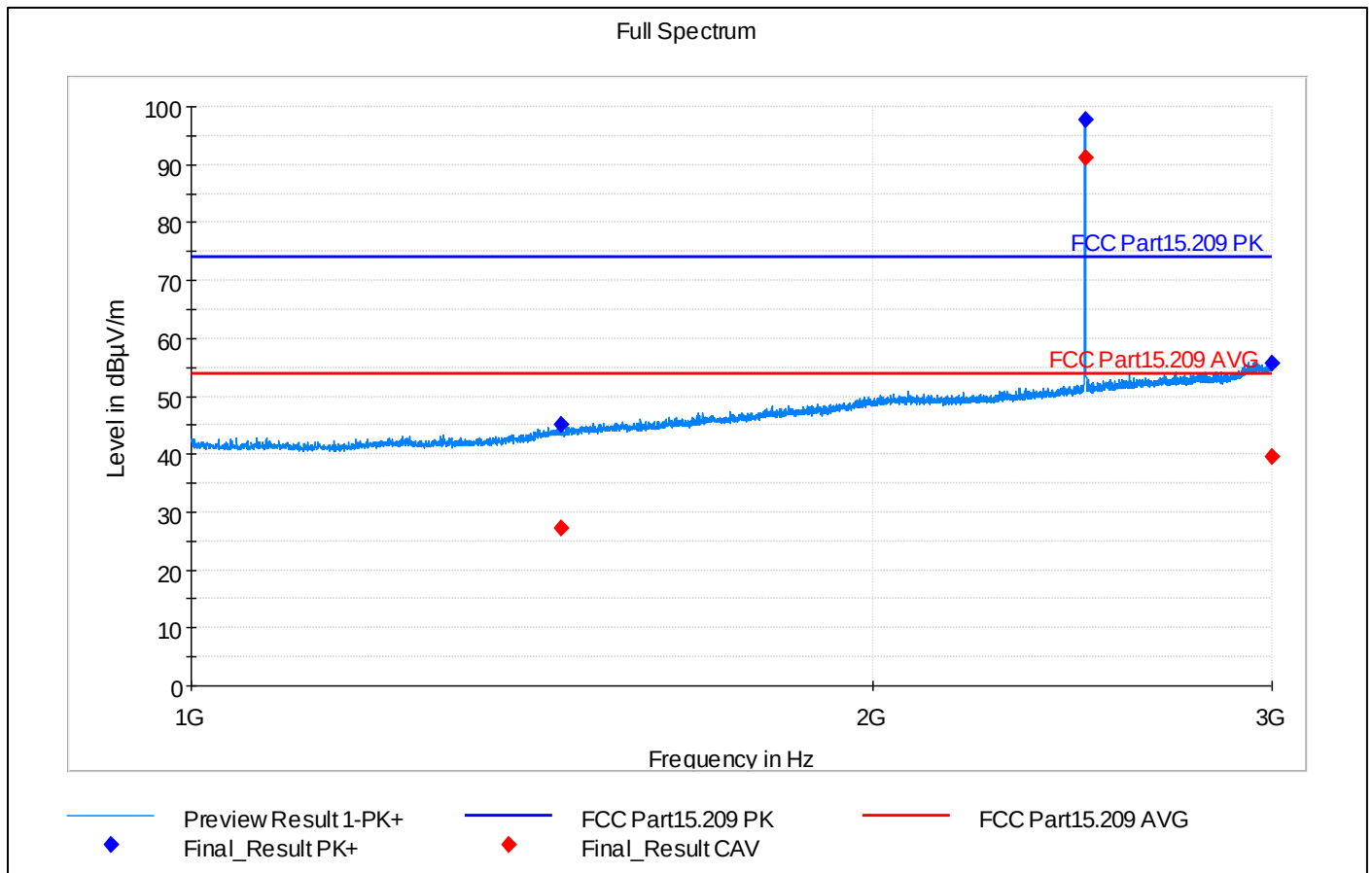
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
4880.000000	43.74	---	74.00	30.26	15000.0	1000.000	402.0	V	182.0	90.0	10.1	PASS
4880.000000	---	31.21	54.00	22.79	15000.0	1000.000	402.0	V	182.0	90.0	10.1	PASS
7320.000000	---	39.30	54.00	14.70	15000.0	1000.000	155.0	V	161.0	0.0	15.2	PASS
7320.000000	50.79	---	74.00	23.21	15000.0	1000.000	155.0	V	161.0	0.0	15.2	PASS
14636.000000	50.74	---	74.00	23.26	15000.0	1000.000	253.0	V	14.0	0.0	29.7	PASS
14636.000000	---	37.30	54.00	16.70	15000.0	1000.000	253.0	V	14.0	0.0	29.7	PASS

Mid channel, 18–26 GHz

Final_Result

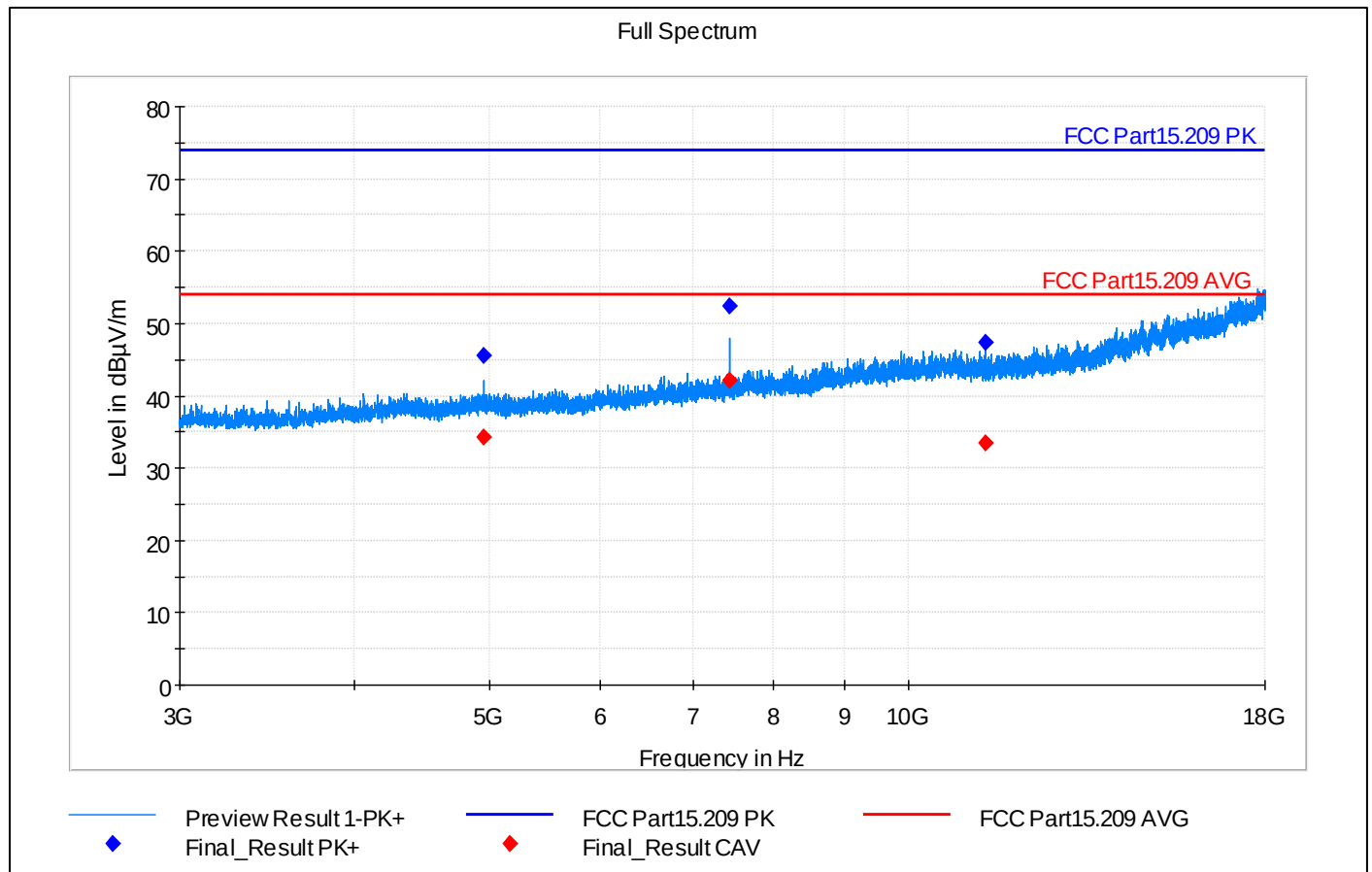
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18776.750000	45.68	---	74.00	28.32	3000.0	1000.000	216.0	H	274.0	90.0	23.5	PASS
18776.750000	---	32.33	54.00	21.67	3000.0	1000.000	216.0	H	274.0	90.0	23.5	PASS
22433.750000	44.76	---	74.00	29.24	3000.0	1000.000	145.0	H	-20.0	90.0	24.9	PASS
22433.750000	---	31.80	54.00	22.20	3000.0	1000.000	145.0	H	-20.0	90.0	24.9	PASS
25728.000000	---	33.73	54.00	20.27	3000.0	1000.000	232.0	V	30.0	90.0	26.7	PASS
25728.000000	46.79	---	74.00	27.21	3000.0	1000.000	232.0	V	30.0	90.0	26.7	PASS

High channel, 30 MHz – 1 GHz

Final_Result

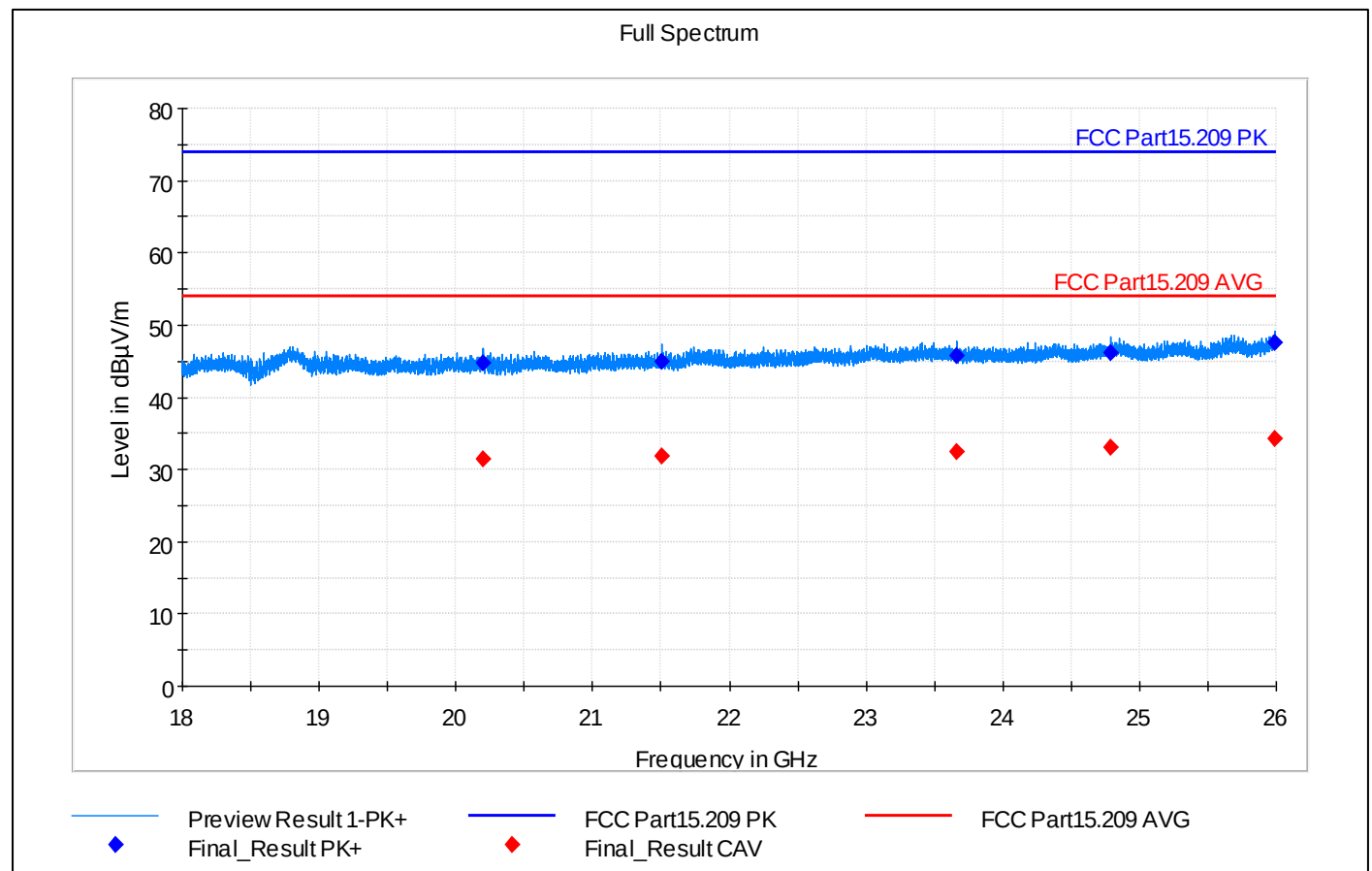
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
31.620000	20.33	40.00	19.67	15000.0	120.000	245.0	H	68.0	0.0	26.6	PASS
43.530000	19.56	40.00	20.44	15000.0	120.000	257.0	V	285.0	0.0	20.3	PASS
51.840000	9.30	40.00	30.70	15000.0	120.000	179.0	V	56.0	0.0	17.0	PASS
78.990000	20.63	40.00	19.37	15000.0	120.000	181.0	V	307.0	0.0	16.2	PASS
87.030000	21.37	40.00	18.63	15000.0	120.000	127.0	V	155.0	90.0	16.8	PASS
108.810000	21.22	43.50	22.28	15000.0	120.000	98.0	V	112.0	90.0	16.8	PASS
249.210000	18.97	46.00	27.03	15000.0	120.000	115.0	H	281.0	0.0	17.9	PASS
285.900000	18.21	46.00	27.79	15000.0	120.000	98.0	H	281.0	90.0	20.1	PASS

High channel, 1 – 3 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
1456.500000	---	27.19	54.00	26.81	15000.0	1000.000	327.0	V	-5.0	0.0	33.2	PASS
1456.500000	44.97	---	74.00	29.03	15000.0	1000.000	327.0	V	-5.0	0.0	33.2	PASS
2480.250000	97.74	---	74.00	-23.74	15000.0	1000.000	107.0	H	76.0	0.0	39.2	Fundamental TX signal
2480.250000	---	91.18	54.00	-37.18	15000.0	1000.000	107.0	H	76.0	0.0	39.2	Fundamental TX signal
2998.000000	55.72	---	74.00	18.28	15000.0	1000.000	269.0	H	305.0	0.0	41.7	PASS
2998.000000	---	39.58	54.00	14.42	15000.0	1000.000	269.0	H	305.0	0.0	41.7	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
4959.750000	---	34.32	54.00	19.68	15000.0	1000.000	153.0	H	1.0	0.0	10.1	PASS
4959.750000	45.62	---	74.00	28.38	15000.0	1000.000	153.0	H	1.0	0.0	10.1	PASS
7440.000000	52.32	---	74.00	21.68	15000.0	1000.000	104.0	V	357.0	0.0	15.1	PASS
7440.000000	---	42.02	54.00	11.98	15000.0	1000.000	104.0	V	357.0	0.0	15.1	PASS
11345.000000	47.25	---	74.00	26.75	15000.0	1000.000	255.0	V	116.0	0.0	21.7	PASS
11345.000000	---	33.43	54.00	20.57	15000.0	1000.000	255.0	V	116.0	0.0	21.7	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
20194.750000	44.76	---	74.00	29.24	3000.0	1000.000	174.0	H	303.0	90.0	24.0	PASS
20194.750000	---	31.36	54.00	22.64	3000.0	1000.000	174.0	H	303.0	90.0	24.0	PASS
21508.000000	44.87	---	74.00	29.13	3000.0	1000.000	194.0	H	39.0	0.0	24.7	PASS
21508.000000	---	31.77	54.00	22.23	3000.0	1000.000	194.0	H	39.0	0.0	24.7	PASS
23661.500000	---	32.39	54.00	21.61	3000.0	1000.000	373.0	V	166.0	90.0	25.9	PASS
23661.500000	45.75	---	74.00	28.25	3000.0	1000.000	373.0	V	166.0	90.0	25.9	PASS
24793.250000	46.21	---	74.00	27.79	3000.0	1000.000	178.0	V	203.0	0.0	26.5	PASS
24793.250000	---	33.10	54.00	20.90	3000.0	1000.000	178.0	V	203.0	0.0	26.5	PASS
25984.500000	47.56	---	74.00	26.44	3000.0	1000.000	241.0	H	30.0	0.0	26.9	PASS
25984.500000	---	34.35	54.00	19.65	3000.0	1000.000	241.0	H	30.0	0.0	26.9	PASS

16. Receiver spurious emissions, radiated

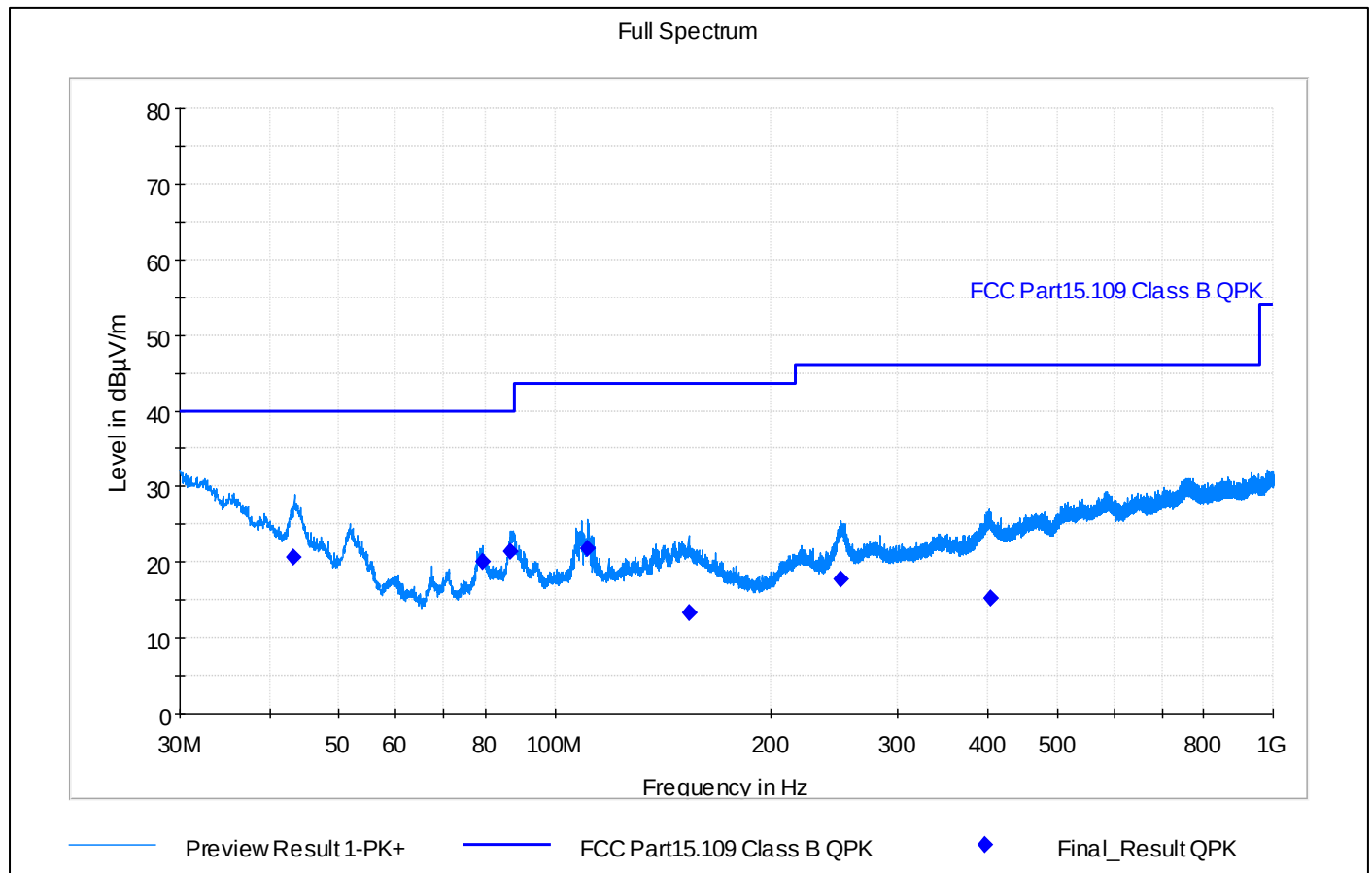
Reference: ISED RSS-247, Issue 3 (section 3.1)

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

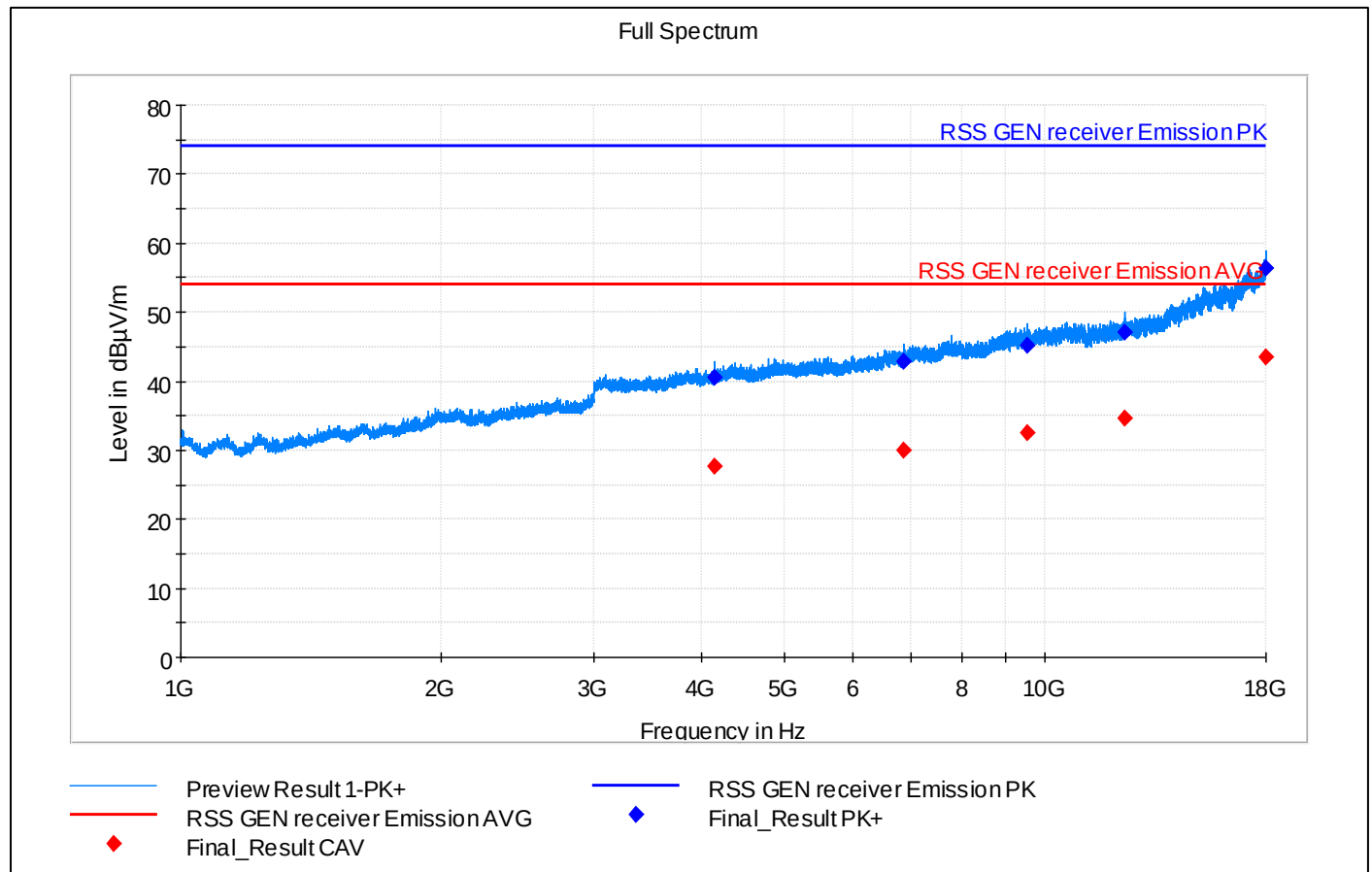
Limits			
Frequency (MHz)	Detector	Field strength (uV/m)	Measurement distance (m)
30 – 88	Quasi-Peak	100	3
88 - 216	Quasi-Peak	150	3
216 - 960	Quasi-Peak	200	3
960 - 1000	Quasi-Peak	500	3
> 1000	Average	500	3

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
43.200000	20.55	40.00	19.45	15000.0	120.000	116.0	V	293.0	0.0	20.4	PASS
79.260000	20.10	40.00	19.90	15000.0	120.000	192.0	V	186.0	0.0	16.3	PASS
86.700000	21.36	40.00	18.64	15000.0	120.000	282.0	V	110.0	0.0	16.8	PASS
110.790000	21.75	43.50	21.75	15000.0	120.000	100.0	V	12.0	0.0	17.0	PASS
153.420000	13.38	43.50	30.12	15000.0	120.000	123.0	V	118.0	0.0	19.4	PASS
249.660000	17.75	46.00	28.25	15000.0	120.000	137.0	H	297.0	0.0	17.9	PASS
403.290000	15.27	46.00	30.73	15000.0	120.000	235.0	V	212.0	0.0	23.6	PASS

Mid channel, 1 GHz – 12,75 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
4149.250000	---	27.57	54.00	26.43	500.0	1000.000	260.0	V	324.0	8.2	PASS
4149.250000	40.56	---	74.00	33.44	500.0	1000.000	260.0	V	324.0	8.2	PASS
6853.500000	42.83	---	74.00	31.17	500.0	1000.000	320.0	H	98.0	13.9	PASS
6853.500000	---	29.93	54.00	24.07	500.0	1000.000	320.0	H	98.0	13.9	PASS
9539.500000	---	32.55	54.00	21.45	500.0	1000.000	359.0	V	142.0	19.4	PASS
9539.500000	45.27	---	74.00	28.73	500.0	1000.000	359.0	V	142.0	19.4	PASS
12373.500000	---	34.52	54.00	19.48	500.0	1000.000	365.0	V	31.0	23.5	PASS
12373.500000	47.13	---	74.00	26.87	500.0	1000.000	365.0	V	31.0	23.5	PASS
17986.750000	56.35	---	74.00	17.65	500.0	1000.000	108.0	V	195.0	39.1	PASS
17986.750000	---	43.52	54.00	10.48	500.0	1000.000	108.0	V	195.0	39.1	PASS