

Radio Test Report

According to

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

DUT Name: Treon Industrial Node C
Model No. : 2311
Customer: Treon Oy
Address: Visiokatu 3, 33720 Tampere
Summary IN COMPLIANCE
Date of Reception: 16.6.2025
Date(s) of Test(s): 16.6.2025 – 25.6.2025

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	02.07.2025	Initial version	
v1.0	04.07.2025	Approved version	Jukka Rauma
v2.0	20.8.2025	Duty cycle correction added	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: Treon Oy
Visiokatu 3, 33720 Tampere
Joni Arola
e-mail: joni.arola@treon.fi

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:

Treon Industrial Node C (model number 2311) is a wireless battery-operated sensor device for seamless monitoring in everyday operations. Treon Industrial Node C measures vibration and surface temperature of rotating equipment, such as pumps, bearings motors, gearboxes and conveyors with a frequency range up to 1 kHz.

Test sample (Conducted):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
2500231813	25224914 9200032	Treon Oy	Wireless battery operated sensor device	2311	DVT	2.0.0

Test sample (Radiated):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
2500231801	25224914 9200075	Treon Oy	Wireless battery operated sensor device	2311	DVT	2.0.0
2500231805	25224914 9200106	Treon Oy	Wireless battery operated sensor device	2311	DVT	2.0.0 Emission SW (SW1)

Auxiliary equipment:

Sample number	Serial number	Manufacturer	DUT Type	Model	Comments
G4CER063	682601334	Nordic Semiconductor	Bluetooth LE	nRF52DK	Companion device
G4CER061	RR620-010668	Advanced Card System Ltd.	nFC reader	ACR1552	
G4CER049	22-031518	Messtechnik	optoUSB Tranceiver		

Description	Information	
Additional model	-	
Brand Names(s)	-	
PMN	2311	
HVIN	2311	
FVIN	2.1.X	
HMN	N/A	
FCC ID	2AR86-ND23	
IC ID	24716-ND23	
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 5.0	
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	Integrated F-antenna integrated to PCB
	Model	Treon 2311 BT Antenna
	Manufacturer	Treon Oy
	Gain	0.0dBi
Supply voltage	Battery operated, $V_{Nom} = 3\text{ V}$	
Type of Power source	2 x Lithium Cells (Maxell CR2450HR 3V)	
Operating Temperature	TNom = 20°C TMin = -20°C TMax = 80°C	
Manufacturer	Treon Oy Visiokatu 3, 33720 Tampere, Finland	

3. Configuration and Operation Modes

Conducted and radiated emission test:

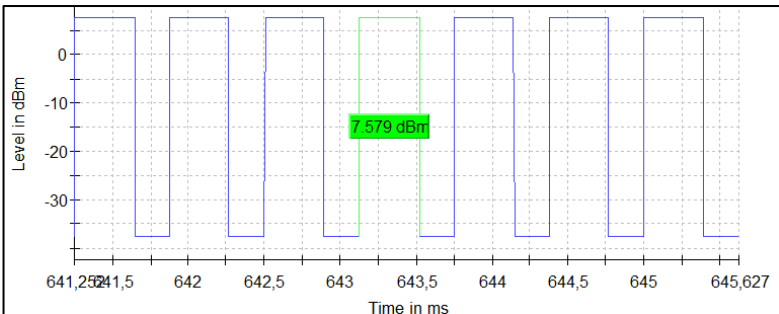
Test modes / description
EUT battery powered, Bluetooth LE continuous modulated carrier at 2402 MHz (ch37), 2442 MHz (ch18) and 2480 MHz (ch39), power level setting 8dBm (Nordic nRF Connect), data rate 1 Mbps PHY. Duty cycle 63%.
EUT battery powered, Bluetooth LE continuous reception at 2442 MHz. nFC continuous reading with nFC reader.

Test/configuration software

Manufacturer	Name	Version
Nordic Semiconductor ASA	nRF connect for desktop	V5.1.0
Nordic Semiconductor ASA	nRF connect for desktop	V2.4.1

4. Test mode duty cycle

Test information	
Measurement method	FCC 558074 D01 15.247 Meas Guidance v05r02, ANSI C63.10 11.6
Test procedure	R&S WMS32 test software was used to measure the duty cycle

Measurement result	
Bluetooth LE, 1 Mbps	
Bluetooth LE 1Mbps Duty cycle = 63.231% Duty cycle correction factor = $20 \cdot \log(1/0.63231) = 3.98 \text{ dB}$	

5. 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	27.06.2023	26.06.2026
OSP-B157WX+OSP220	300642762-D-K-15195-01-00-2022-03	13.08.2024	17.06.2026
OSP-B157W8plus+OSP150	300639878-D-K-15195-01-00-2022-03	12.06.2025	11.06.2026
ESW 44	1039208-D-K-15195-01-00-2022-03	10.06.2025	09.06.2026
CMW500	1041276-D-K-15195-01-00-2022-03	18.06.2025	17.06.2026

Radiated emission

New ID	Manufacturer	Equipment type	Description	Serial	Calibration information	Next calibration
G4C265	Rohde & Schwarz	ESW26	EMI test receiver	101324	26.7.2024	26.7.2025
G4C273	Frankonia	ALX-4000E	Broadband Antenna, 25MHz-4GHz with 6dB (50-A-MFN-06) att.	00816+1531	22.1.2024	22.1.2027
G4C292	Rohde & Schwarz	TS-LNA 1840	RF Preamplifier 18 to 40 GHz	100841	12.8.2024	12.8.2026
G4C294	Rohde & Schwarz	TC-HORN40 + WRD180-2.5	Horn Antenna -> 40GHz	101057 + 100667	4.11.2022	4.11.2025
G4C298	Rohde & Schwarz	CMW500	Wideband radio communication tester	170980	29.6.2023	29.6.2025
G4C469	Rohde & Schwarz	TS_PRE2	RF Preamplifier	101541	12.8.2024	12.8.2026
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	12.10.00

6. 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

7. 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

8. Test conditions

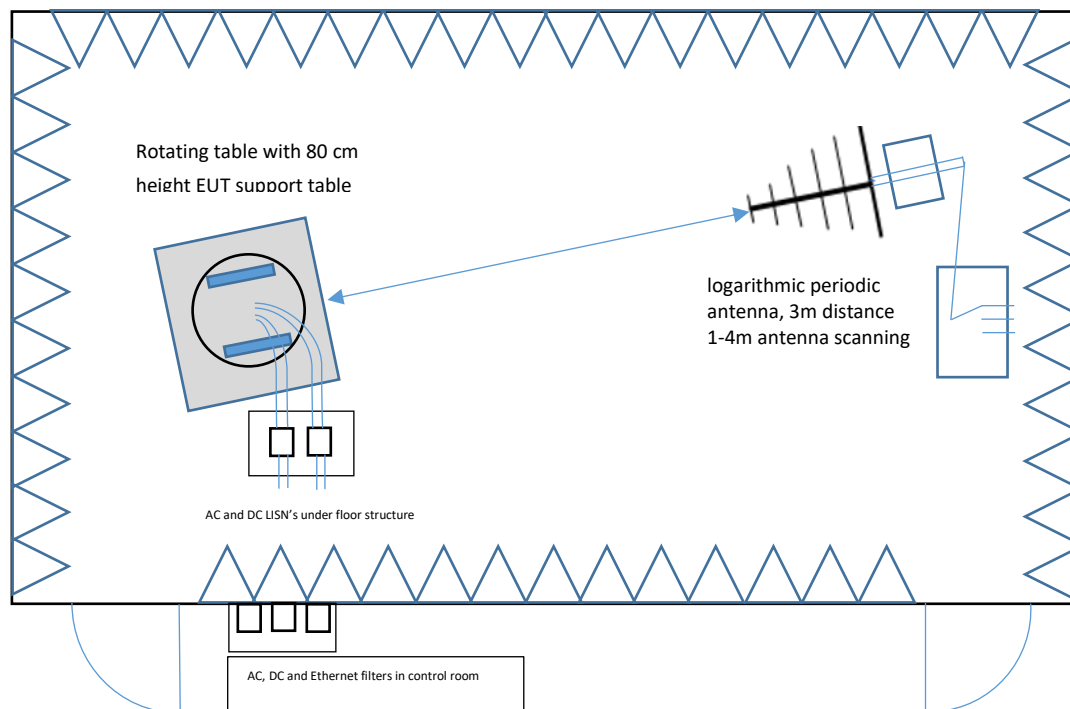
All radiated tests were performed in a semi-anechoic chamber, where the measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz, 1 GHz-18 GHz Double-ridged horn antenna and 18 GHz-40 GHz horn antenna) is located at a distance of 3 m.

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.

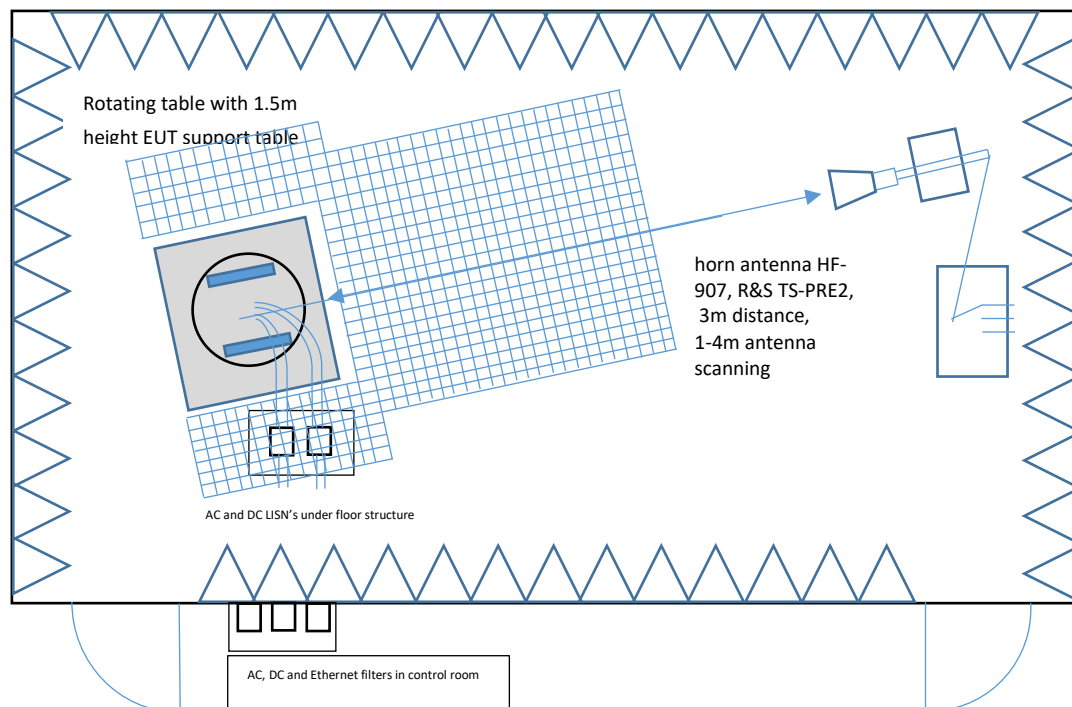
Measurements were made in both horizontal and vertical planes of polarization.

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.

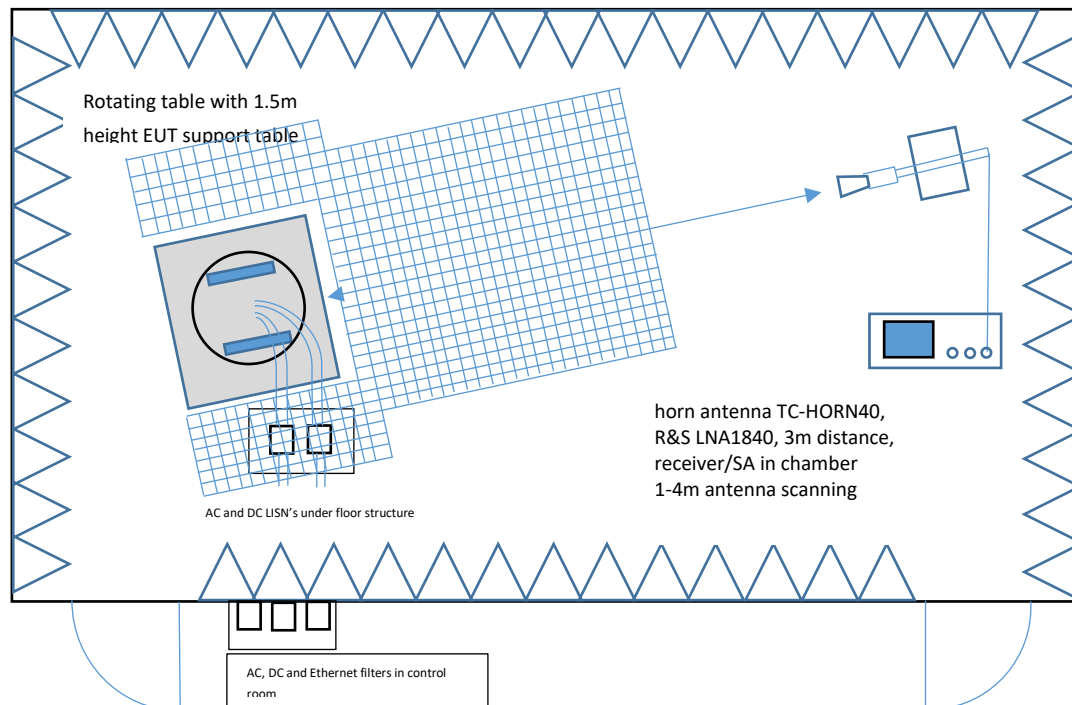
Radiated measurements setup from 30 MHz to 1 GHz:



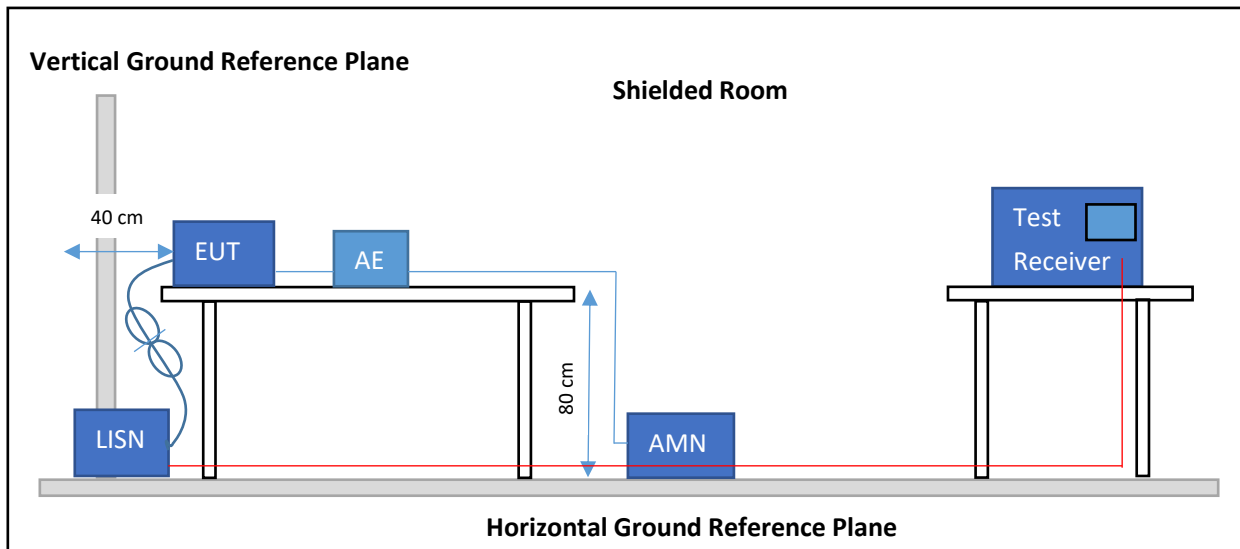
Radiated measurements setup from 1 GHz to 18 GHz:



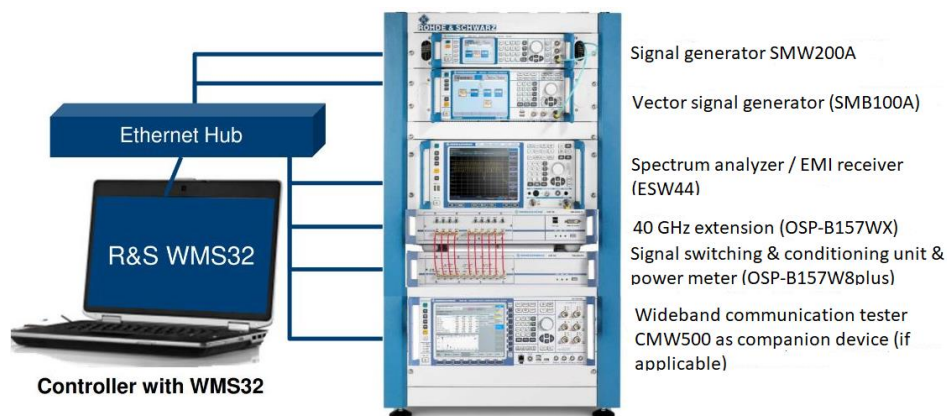
Radiated measurements setup from 18 GHz to 26 / 40 GHz:



Conducted emission setup



Conducted RF measurement system:



9. 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 5.2 (a))	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	PASS	
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)				

10. Occupied bandwidth

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

Test method: ANSI C63.10 (6.9.3)

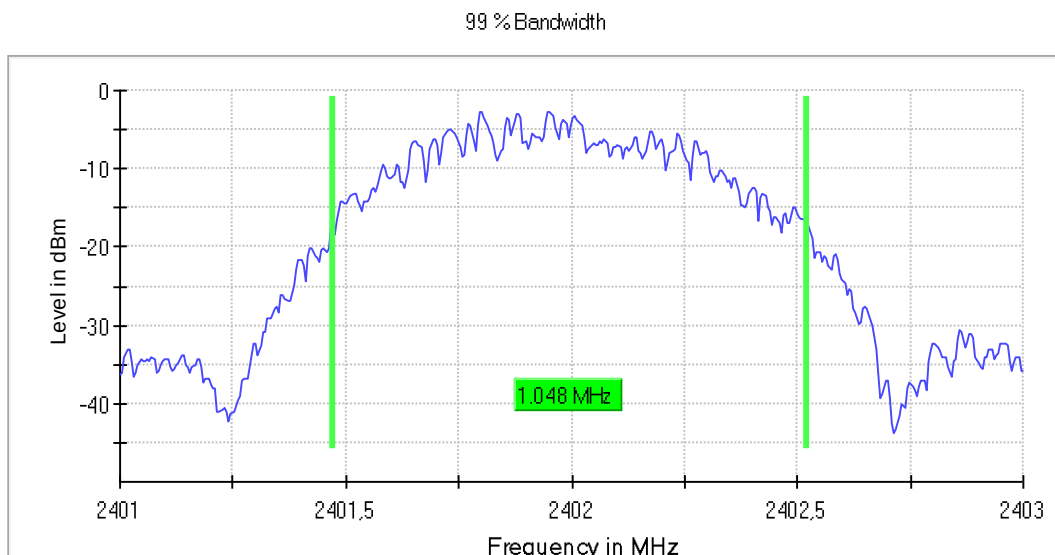
Limits
None (Informational only)

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

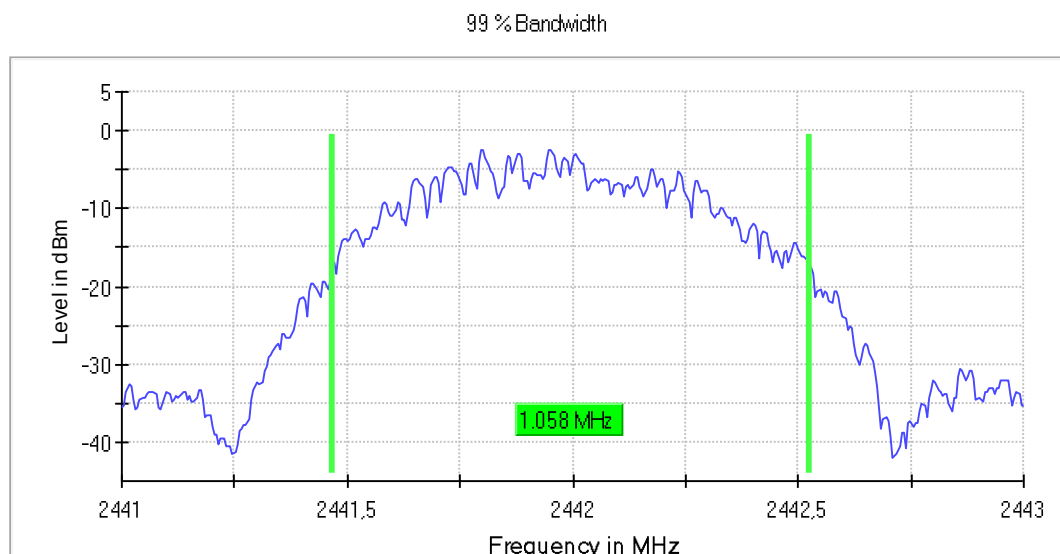
Summary:

Summary		
Mode / modulation	Frequency (MHz)	Bandwidth (MHz)
Bluetooth LE, 1 Mbps	2402	1.047619
Bluetooth LE, 1 Mbps	2442	1.057645
Bluetooth LE, 1 Mbps	2480	1.057645

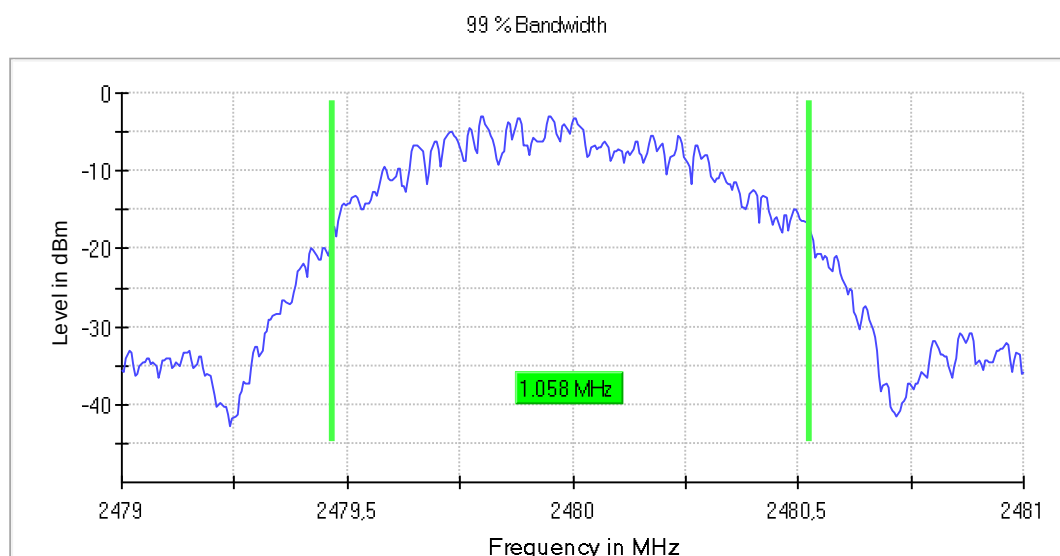
Occupied bandwidth, low channel



Occupied bandwidth, middle channel



Occupied bandwidth, high channel



11. 6 dB bandwidth

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

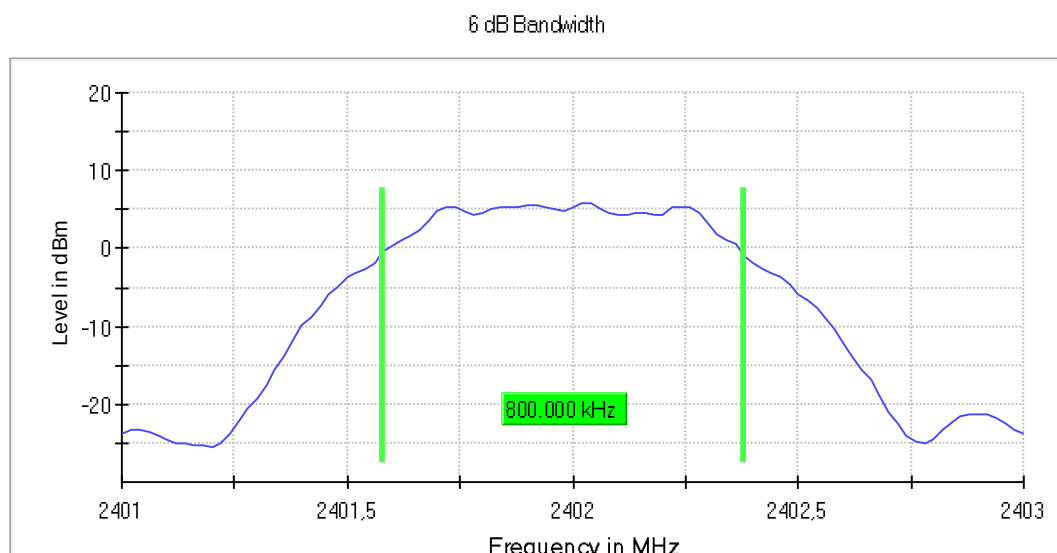
Test method: KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 (11.8.1)

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

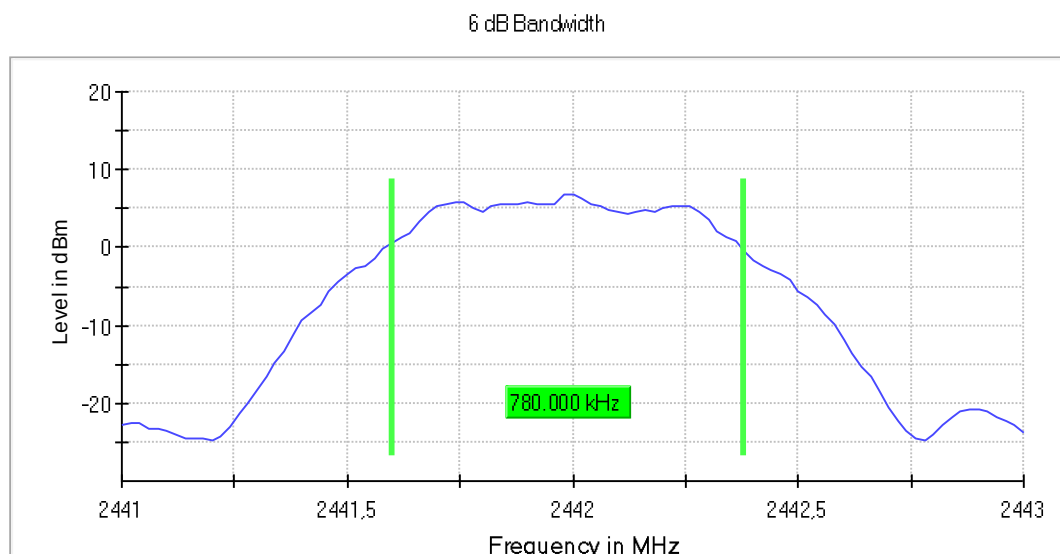
Test procedure
1. EUT set to test mode 2. Span set to at least twice the emission spectrum 3. Detector set to peak and max hold and BW is set to 100 kHz 4. Envelope peak value of emission spectrum is selected 5. Marker on envelope of spectrum is set to level of -6 dB to the left of the peak 6. Marker 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	0.800000	0.500000	---	2401.580000	2402.380000	5.8	PASS
Bluetooth LE, 1 Mbps	2442.000000	0.780000	0.500000	---	2441.600000	2442.380000	6.9	PASS
Bluetooth LE, 1 Mbps	2480.000000	0.780000	0.500000	---	2479.600000	2480.380000	6.2	PASS

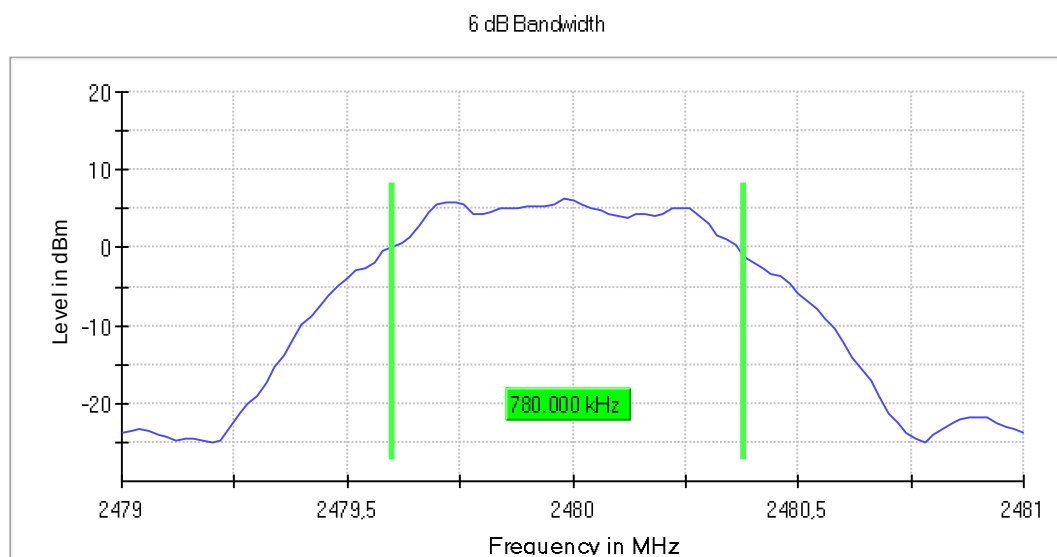
6 dB Bandwidth, low channel:



6 dB Bandwidth, middle channel:



6 dB Bandwidth, high channel:



12. 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.

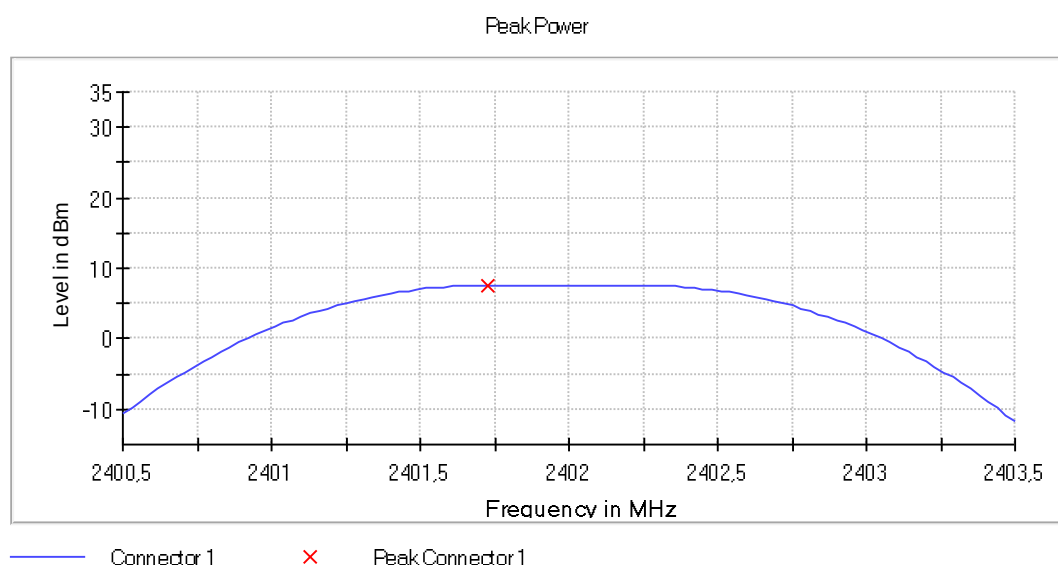
Test procedure
1. EUT set to test mode (communication tested is used if needed)
2. Analyzer resolution bandwidth is set $\geq$ DTS bandwidth
3. Detector set to peak and max hold
4. Sweep time is set to auto
5. After trace has stabilized a marker is set to peak envelope

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

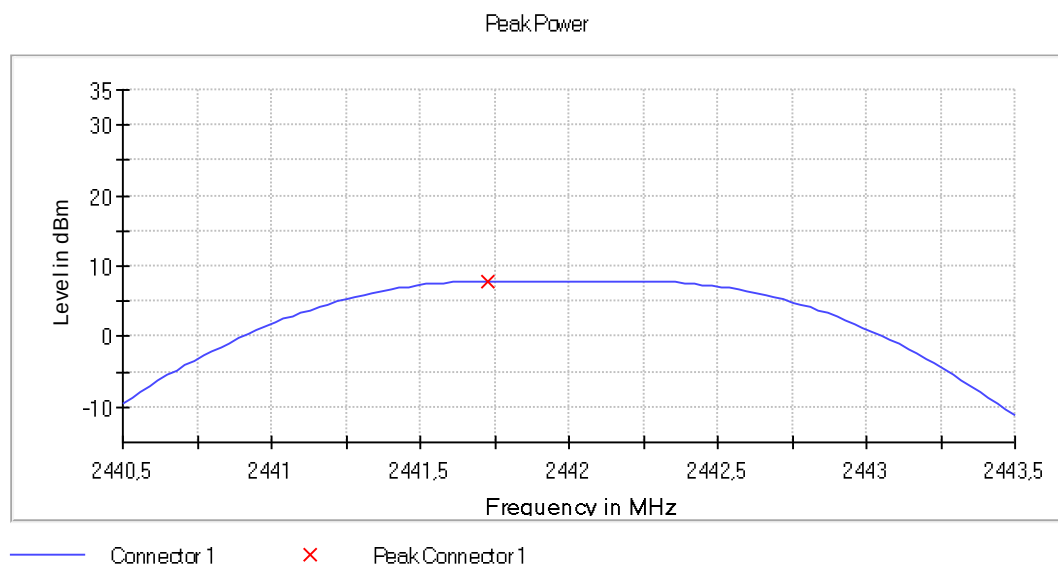
Maximum Declared Antenna Gain: 0.0dBi

Mode / modulation	DUT Frequency (MHz)	Peak Power (dBm)	EIRP Power (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	7.6	7.6	PASS
Bluetooth LE, 1 Mbps	2442.000000	7.9	7.9	PASS
Bluetooth LE, 1 Mbps	2480.000000	7.5	7.5	PASS

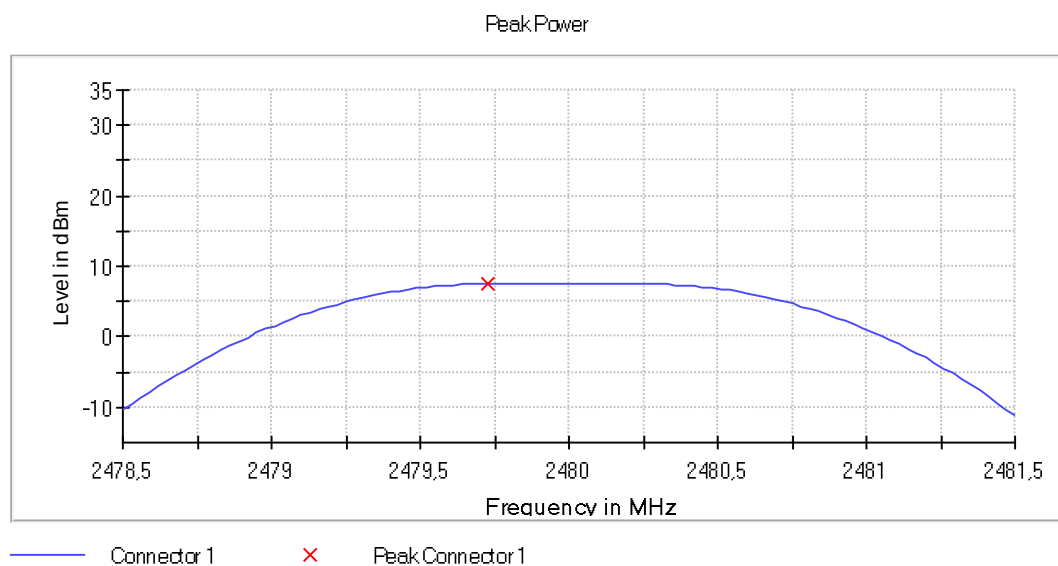
Peak power, low channel



Peak power, middle channel



Peak power, high channel



13. 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

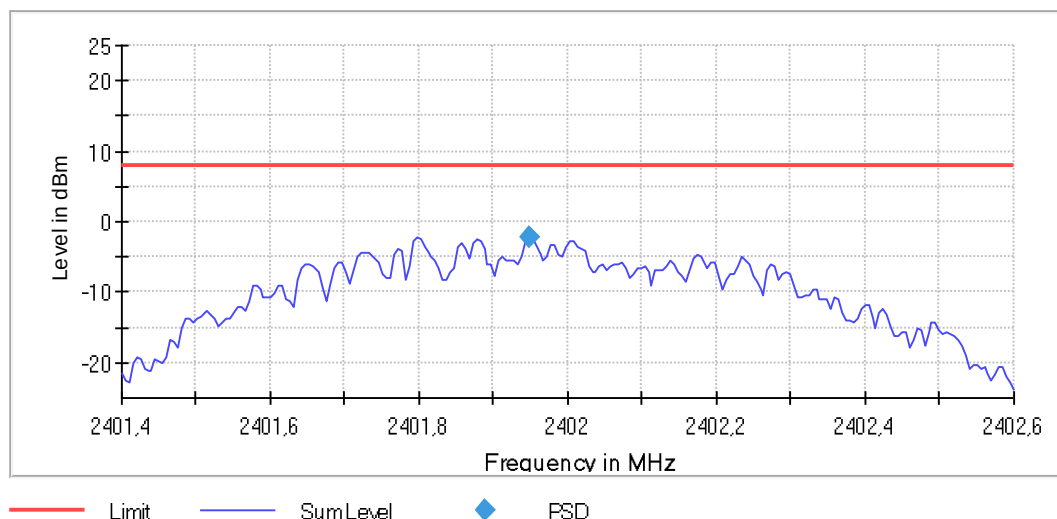
Test procedure
1. EUT set to test mode 2. The analyser is set to DTS channel center frequency with a span of 1.5 times the DTS bandwidth 3. The analyzer is set to 100 kHz with VBW ≥ RBW and the detector is set to peak with max hold 4. After trace has stabilized a marker is set to the envelope maximum 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	2401.947280	-2.176	8.0	PASS
Bluetooth LE, 1 Mbps	2442.000000	2441.947275	-1.693	8.0	PASS
Bluetooth LE, 1 Mbps	2480.000000	2479.947275	-2.246	8.0	PASS

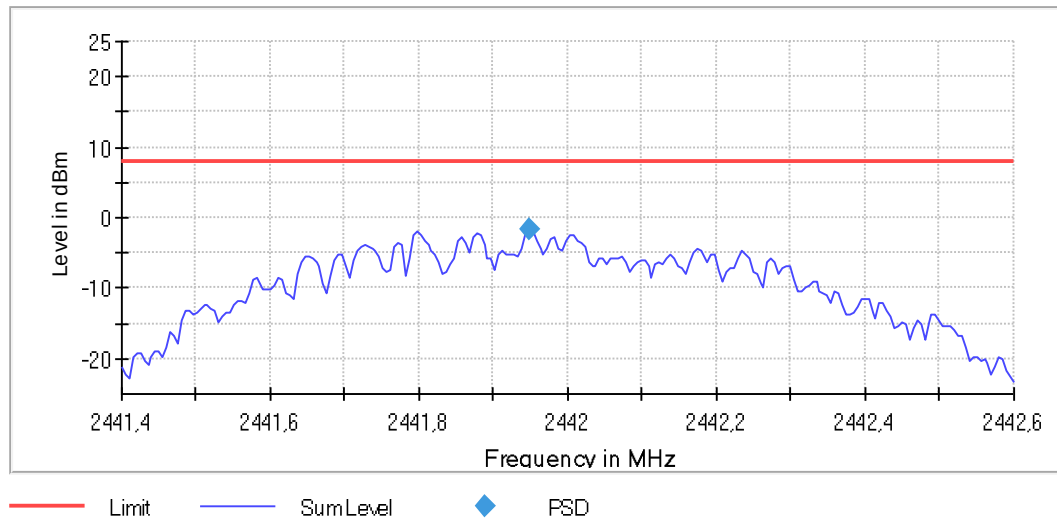
Peak power spectral density, low channel

Peak Power Spectral Density



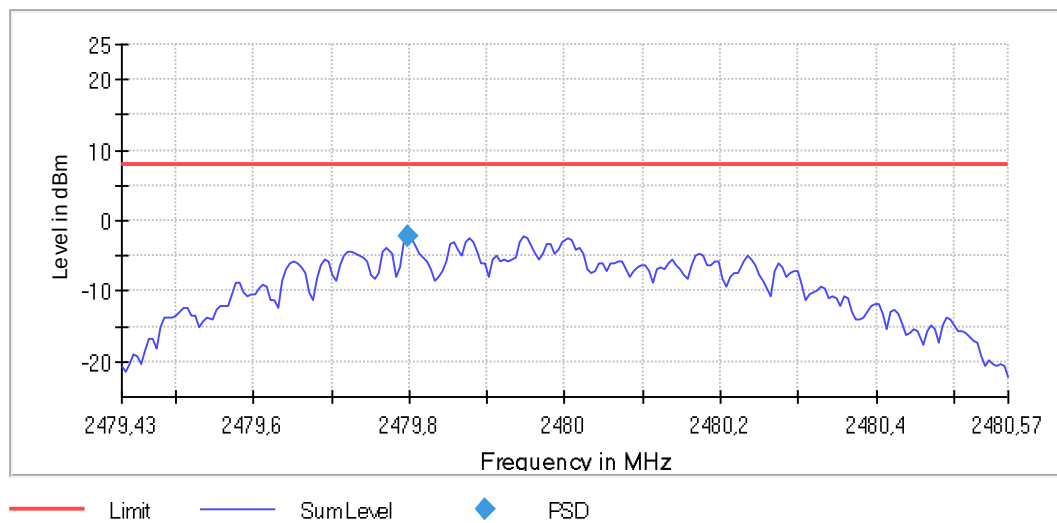
Peak power spectral density, middle channel

Peak Power Spectral Density



Peak power spectral density, high channel:

Peak Power Spectral Density



14. 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

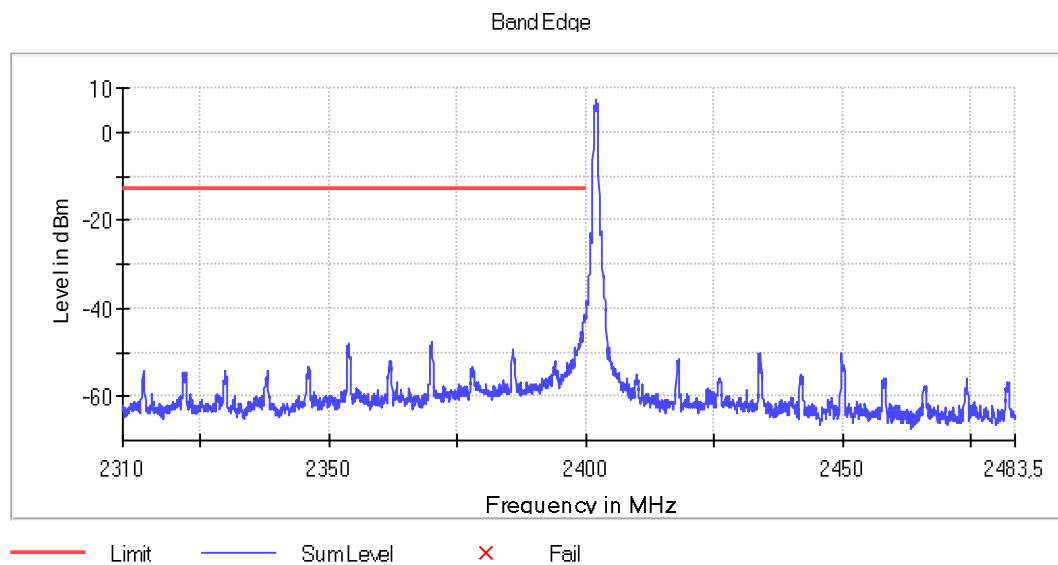
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.749861	-41.4	28.6	-12.8	PASS
2399.699833	-41.7	28.9	-12.8	PASS
2399.949972	-41.9	29.1	-12.8	PASS
2399.799889	-42.1	29.3	-12.8	PASS
2399.899944	-42.3	29.5	-12.8	PASS
2400.000000	-42.5	29.7	-12.8	PASS
2399.649805	-42.7	29.9	-12.8	PASS
2399.849917	-42.8	30.0	-12.8	PASS
2399.499722	-43.1	30.3	-12.8	PASS
2399.599778	-43.3	30.5	-12.8	PASS
2399.549750	-43.3	30.5	-12.8	PASS
2399.449694	-43.9	31.1	-12.8	PASS
2399.399666	-45.0	32.2	-12.8	PASS
2399.149528	-45.3	32.6	-12.8	PASS
2399.199555	-45.5	32.7	-12.8	PASS

Measurements, band edge high

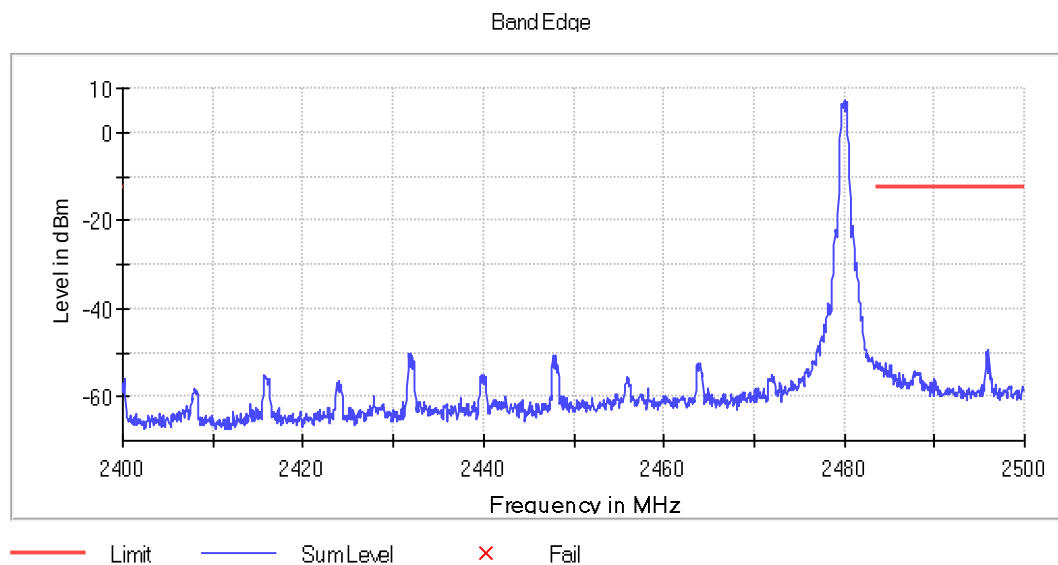
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2495.987842	-49.2	36.8	-12.4	PASS

2496.037994	-49.8	37.3	-12.4	PASS
2495.737082	-49.8	37.4	-12.4	PASS
2495.787234	-49.9	37.5	-12.4	PASS
2495.937690	-50.9	38.4	-12.4	PASS
2495.686930	-51.3	38.9	-12.4	PASS
2483.600304	-51.9	39.4	-12.4	PASS
2483.650456	-52.2	39.8	-12.4	PASS
2484.553191	-52.3	39.8	-12.4	PASS
2495.837386	-52.3	39.9	-12.4	PASS
2483.700608	-52.4	39.9	-12.4	PASS
2483.901216	-52.6	40.2	-12.4	PASS
2483.951368	-52.7	40.3	-12.4	PASS
2483.851064	-52.8	40.4	-12.4	PASS
2483.750760	-53.0	40.5	-12.4	PASS

Band edge, low channel



Band edge, high channel



15. 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	-36.4	21.6	-14.8
7202.797619	-45.3	30.5	-14.8
2370.000000	-48.9	34.1	-14.8
2733.462798	-49.5	34.7	-14.8
2360.000000	-49.5	34.7	-14.8
2070.000000	-50.4	35.6	-14.8
2703.467262	-51.0	36.2	-14.8
2543.491071	-51.3	36.4	-14.8
2843.446429	-51.3	36.5	-14.8
2210.000000	-51.7	36.9	-14.8
2260.000000	-51.9	37.1	-14.8
2390.000000	-53.1	38.3	-14.8
1960.000000	-53.6	38.8	-14.8
2310.000000	-53.7	38.9	-14.8
2513.495536	-54.0	39.2	-14.8

Pre Measurements, middle channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
4883.142857	-38.2	24.6	-13.6
7322.779762	-46.0	32.4	-13.6
2350.000000	-48.5	34.9	-13.6
2533.492560	-49.6	36.0	-13.6
2110.000000	-50.1	36.5	-13.6
2030.000000	-50.7	37.1	-13.6
2853.444940	-50.9	37.3	-13.6
19540.961310	-52.8	39.2	-13.6
2300.000000	-52.9	39.3	-13.6
2330.000000	-53.7	40.1	-13.6
2250.000000	-54.1	40.5	-13.6
2130.000000	-54.3	40.7	-13.6
2290.000000	-54.6	41.0	-13.6

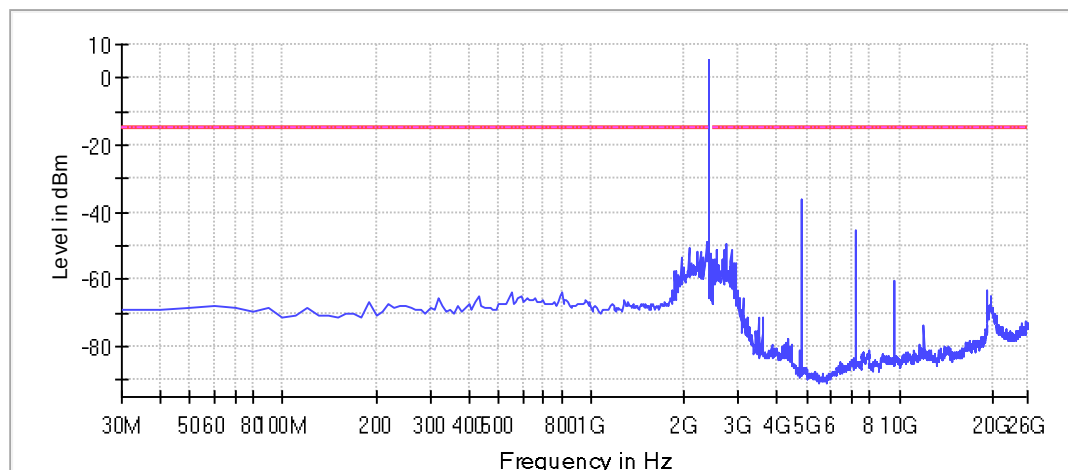
2060.000000	-55.1	41.5	-13.6
2010.000000	-55.1	41.5	-13.6

Pre Measurements, top channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
4953.132440	-42.2	29.1	-13.1
7432.763393	-47.8	34.7	-13.1
2070.000000	-49.4	36.3	-13.1
7442.761905	-49.5	36.4	-13.1
2390.000000	-50.3	37.1	-13.1
2150.000000	-50.4	37.3	-13.1
2493.498512	-50.6	37.4	-13.1
2813.450893	-50.7	37.6	-13.1
2623.479167	-51.0	37.9	-13.1
19840.916667	-51.4	38.3	-13.1
2783.455357	-51.6	38.5	-13.1
2260.000000	-52.0	38.9	-13.1
2893.438988	-52.0	38.9	-13.1
2793.453869	-52.1	39.0	-13.1
2573.486607	-52.7	39.6	-13.1

Low channel

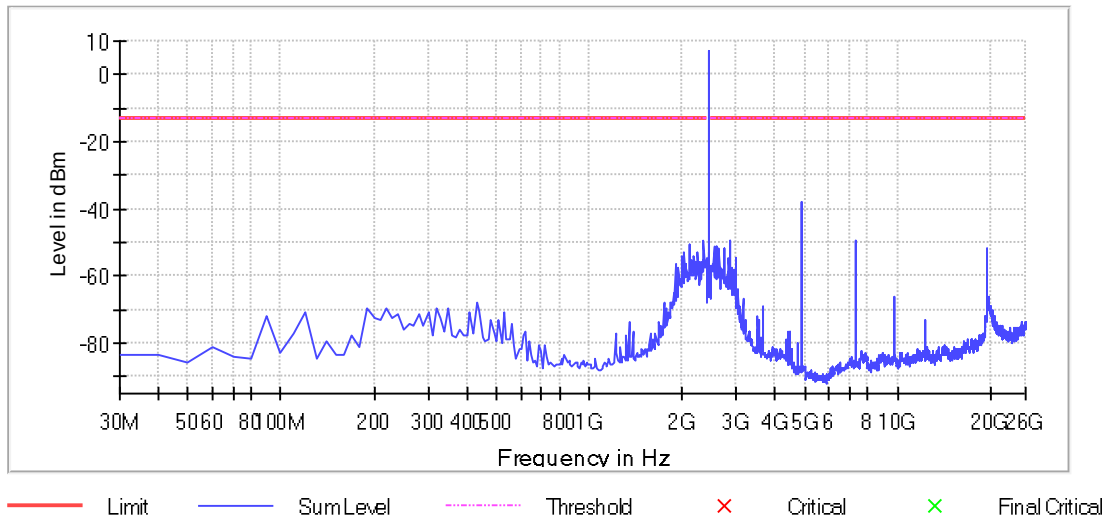
Spurious



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

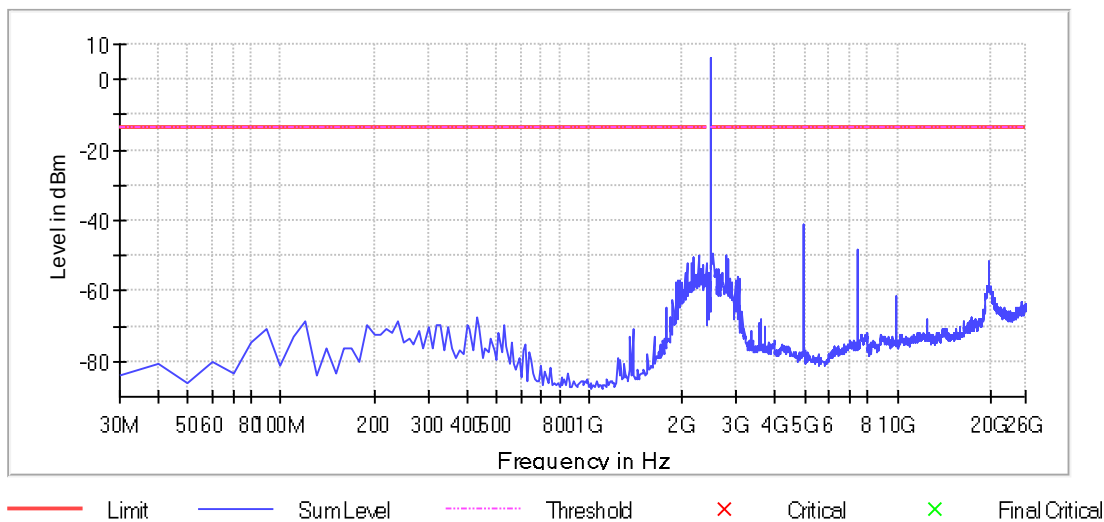
Middle channel

Spurious



High channel

Spurious



16. Emissions in restricted frequency bands

Reference: FCC §15.247(d), ISSED RSS-247, Issue 3 (section 6.2)

Test method: KDB 558074 D01 DTS Meas Guidance v05r02 8.6 and ANSI C63.10-2013 (11.12)

Limits	
Power measurement	Out-of-band attenuation (dB)
Peak	according to FCC §15.209 and FCC §15.205

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 300 Hz
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)
4803.585824	-34.8	13.6	-21.2
4803.085806	-34.8	13.6	-21.2
4804.585861	-34.8	13.6	-21.2
4804.085843	-34.9	13.7	-21.2
4805.085880	-37.4	16.2	-21.2
4802.585787	-37.8	16.6	-21.2
2378.492319	-41.2	20.0	-21.2
2378.992497	-44.5	23.3	-21.2
4805.585898	-45.6	24.4	-21.2
2373.490532	-46.1	24.9	-21.2
2373.990711	-46.3	25.1	-21.2
4802.085769	-46.5	25.3	-21.2
2705.508212	-46.6	25.4	-21.2
2706.008231	-46.8	25.6	-21.2
2498.000536	-47.0	25.8	-21.2

Pre Measurements, middle channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
4884.088802	-36.4	15.2	-21.2
4884.588821	-36.5	15.3	-21.2
4883.588784	-36.5	15.3	-21.2
4883.088765	-36.5	15.3	-21.2
4885.088839	-38.7	17.5	-21.2
4882.588747	-39.8	18.6	-21.2
7325.179103	-44.8	23.6	-21.2
7326.179140	-44.8	23.6	-21.2
7325.679121	-45.1	23.9	-21.2
7326.679158	-45.1	23.9	-21.2
7327.179177	-45.6	24.4	-21.2
7324.679084	-45.8	24.6	-21.2

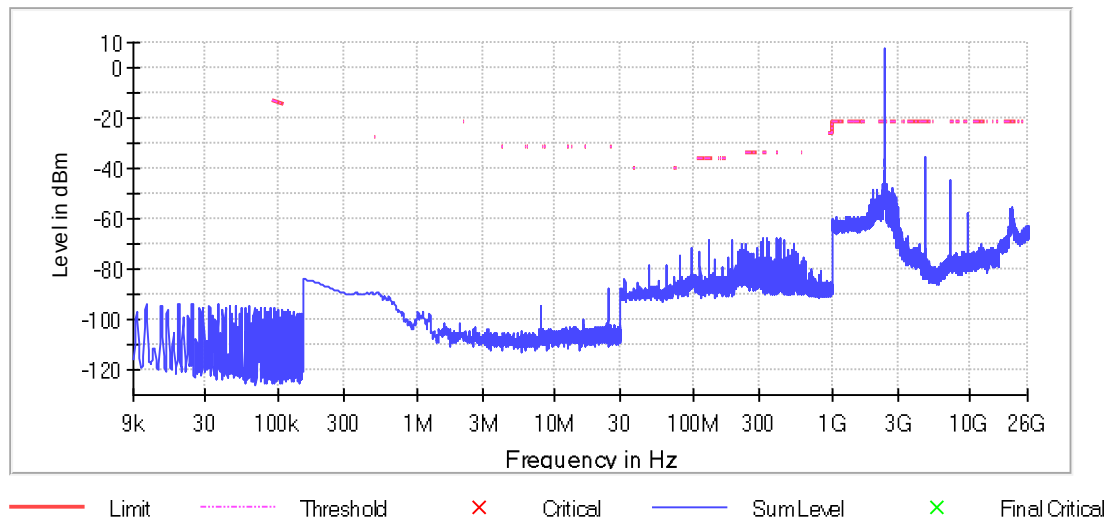
2345.980707	-46.1	24.9	-21.2
2346.480886	-46.3	25.1	-21.2
4885.588858	-46.8	25.6	-21.2

Pre Measurements, top channel

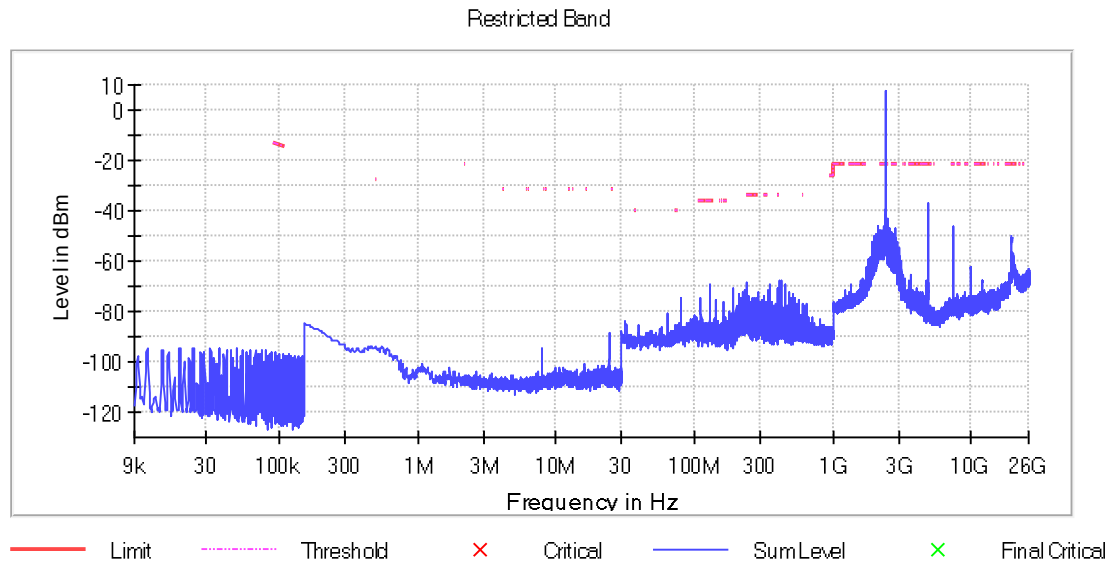
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2484.500037	-38.7	17.5	-21.2
2484.000018	-38.9	17.7	-21.2
4960.591632	-39.7	18.5	-21.2
4960.091614	-39.9	18.7	-21.2
4959.591595	-40.0	18.8	-21.2
4959.091577	-40.0	18.8	-21.2
2487.000129	-40.2	19.0	-21.2
2483.500000	-40.5	19.3	-21.2
2485.000055	-41.5	20.3	-21.2
2487.500148	-41.5	20.3	-21.2
2485.500074	-41.8	20.6	-21.2
2490.000240	-41.9	20.7	-21.2
2489.000203	-41.9	20.7	-21.2
2488.500185	-42.0	20.8	-21.2
2486.000092	-42.0	20.8	-21.2

Low channel

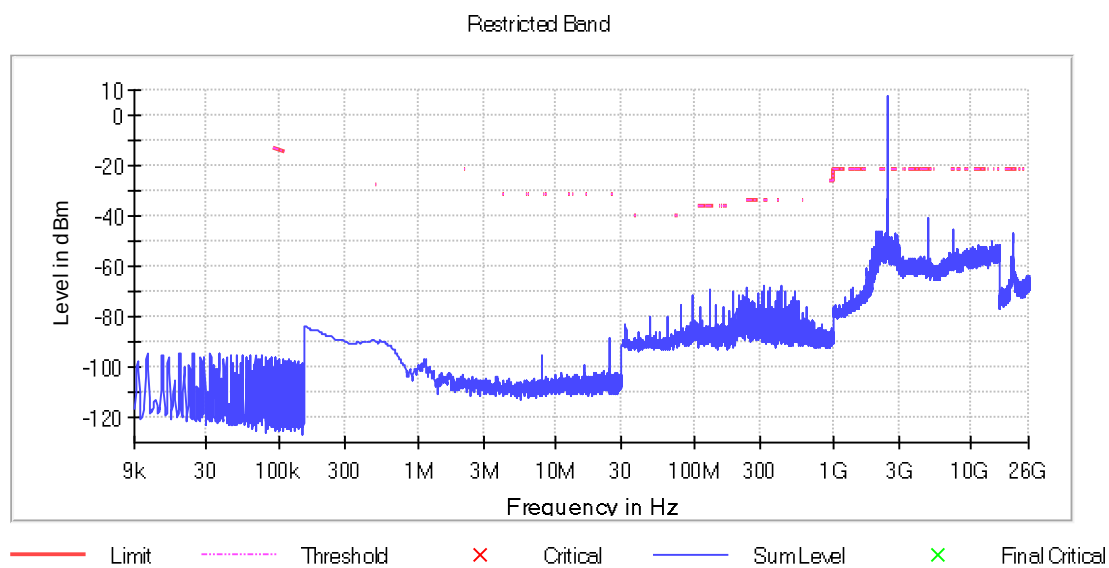
Restricted Band



Middle channel



High channel



17. 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.

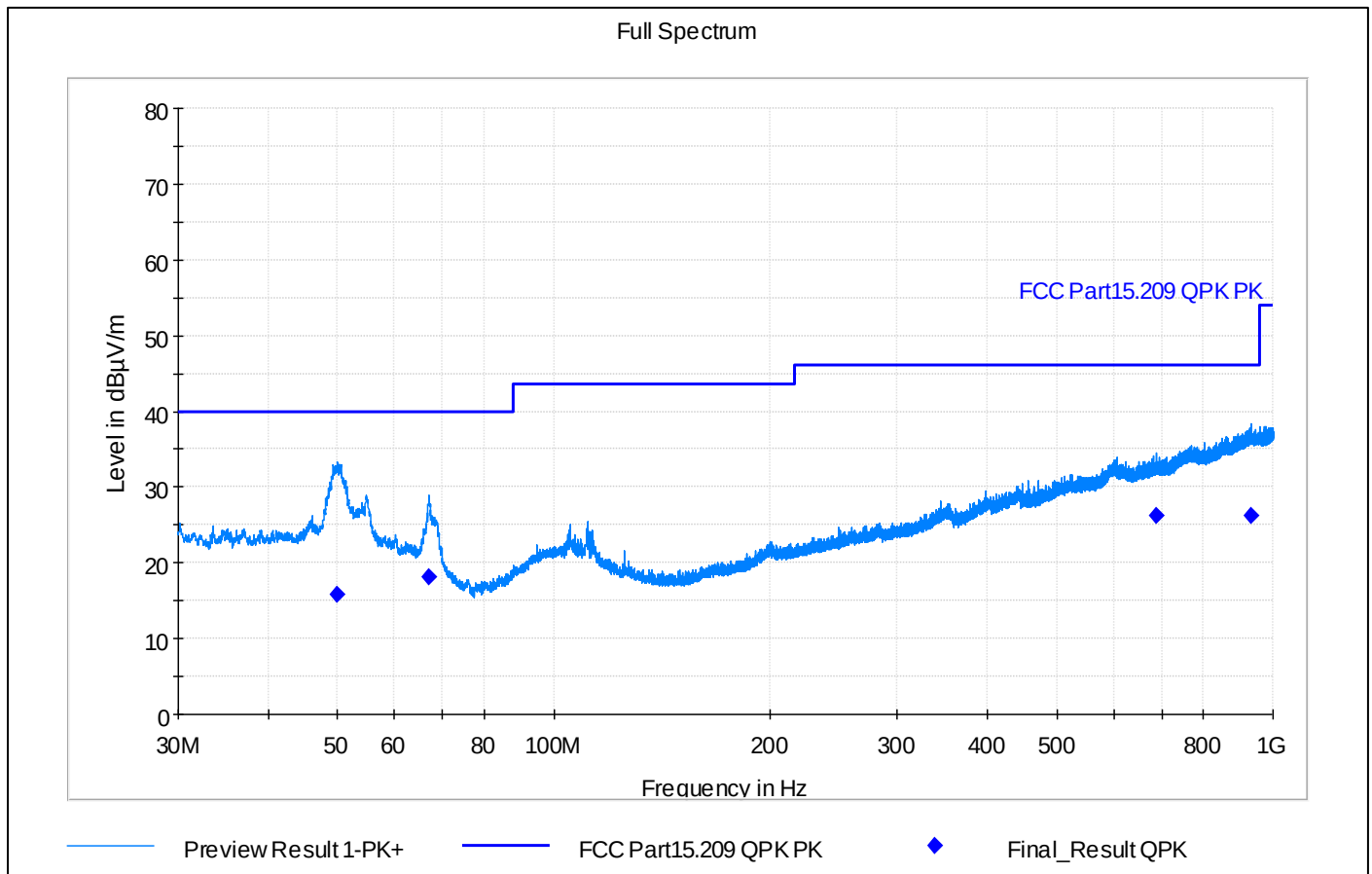
Test procedure > 1 GHz	
1.	EUT is placed on a non conducting support at the center of a turn table 1.5m above the ground
2.	EUT set to test mode
3.	The receiver is set to peak detection with max hold
4.	The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal 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.

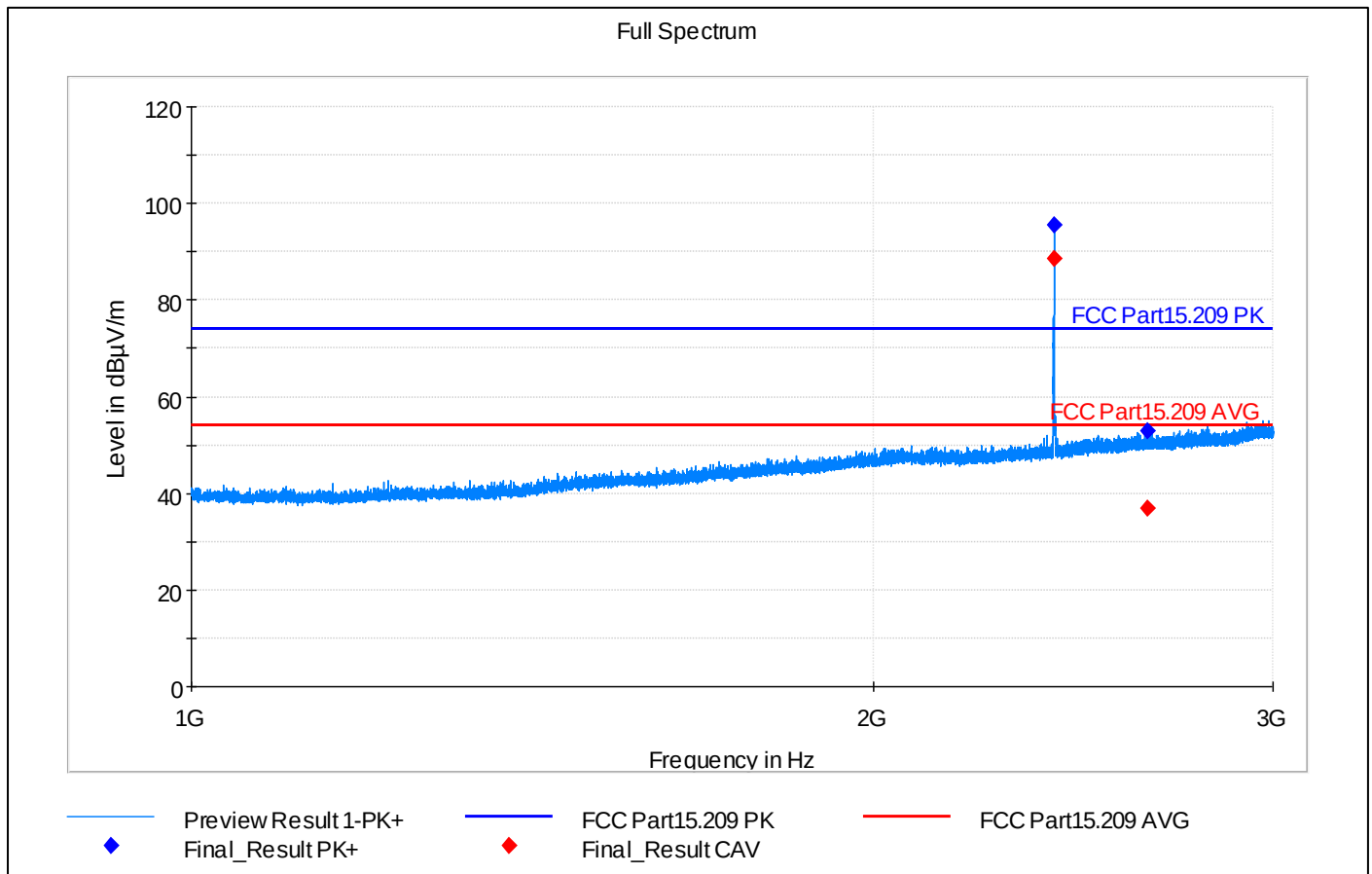
Operation mode(s)	Configuration	Test Verdict
Bluetooth LE TX, 1 Mbps	Low channel, 2402 MHz	PASS
Bluetooth LE TX, 1 Mbps	Mid channel, 2440 MHz	PASS
Bluetooth LE TX, 1 Mbps	High channel, 2480 MHz	PASS

Low channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
50.010	15.87	40.0	24.13	15000	120	100.0	V	247	90	21.1	PASS
66.990	18.11	40.0	21.89	15000	120	100.0	V	202	90	18.1	PASS
687.600	26.25	46.0	19.75	15000	120	144.0	V	158	0	30.5	PASS
933.300	26.20	46.0	19.80	15000	120	154.0	V	67	0	34.1	PASS

Low channel, 1 – 3 GHz


Note: Frequency 2402,300 MHz is excluded from spurious domain measurements and ignored. See table below.

All CAverage values contain correction factor of 3.98 dB, according ANSI C63.10 section 11.12.2.5.2.

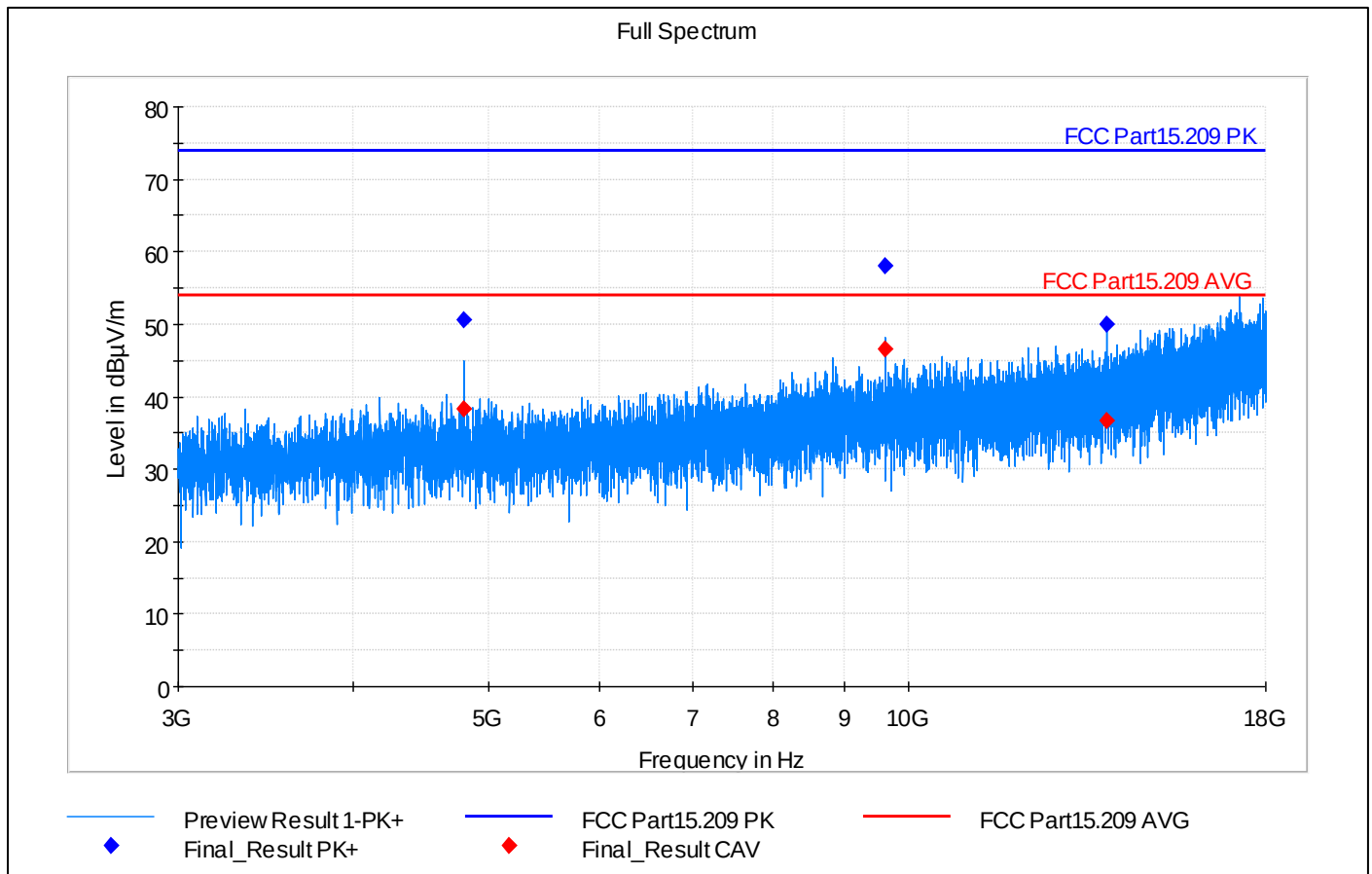
Final Result

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)
2639.500	---	40.93	54.0	13.07	15000	1000	117.0	V	92	90	40.0
2639.500	53.02	---	74.0	20.98	15000	1000	117.0	V	92	90	40.0

(continuation of the "Final_Result" table from column 17 ...)

Frequency (MHz)	Comment
2402.300	Fundamental TX signal ***IGNORED***
2402.300	Fundamental TX signal ***IGNORED***
2639.500	PASS
2639.500	PASS

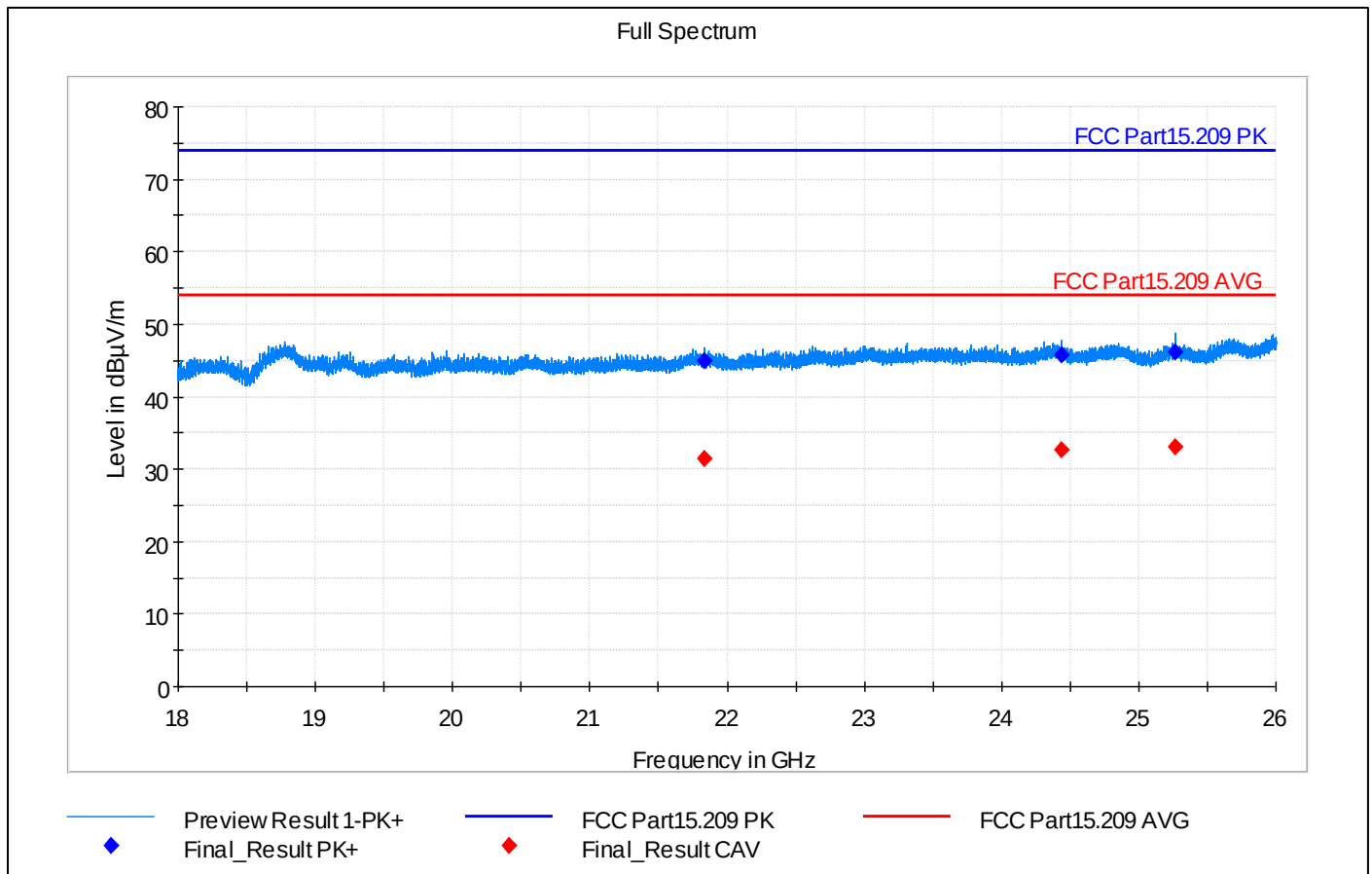
Low channel, 3 – 18 GHz



Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwith (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)	Comment
4804.500	50.57	---	74.0	23.43	15000	1000	252.0	V	322	0	10.4	PASS
4804.500	---	42.23	54.0	11.77	15000	1000	252.0	V	322	0	10.4	PASS
9607.000	58.00	---	74.0	16.00	15000	1000	228.0	H	43	90	19.6	PASS
9607.000	---	50.52	54.0	3.48	15000	1000	228.0	H	43	90	19.6	PASS
13862.750	---	40.60	54.0	13.40	15000	1000	283.0	H	-3	0	27.2	PASS
13862.750	50.01	---	74.0	23.99	15000	1000	283.0	H	-3	0	27.2	PASS

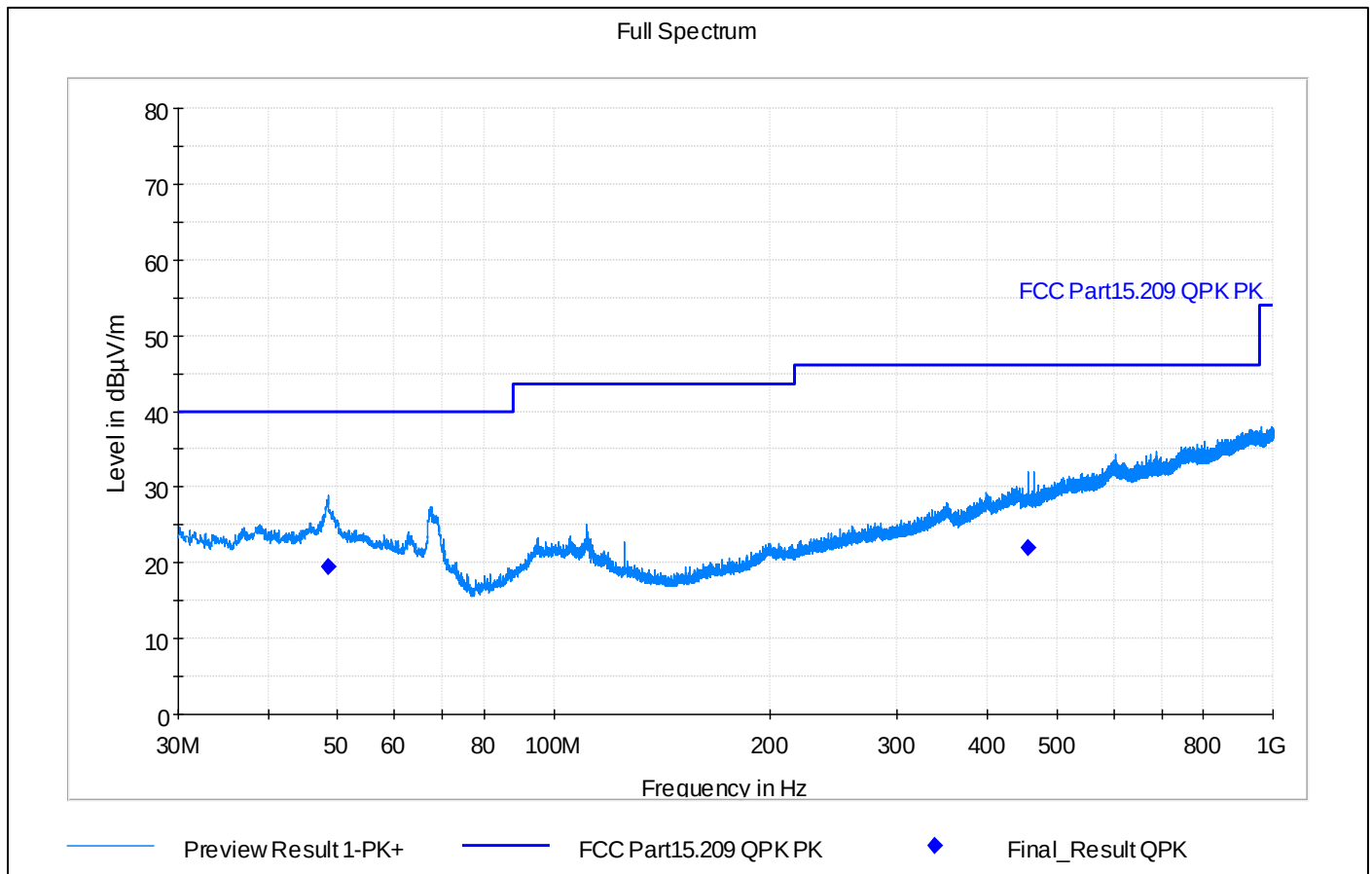
Low channel, 18 – 26 GHz



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
21831.250	---	35.50	54.0	18.50	3000	1000	359.0	H	311	0	24.9	PASS
21831.250	44.99	---	74.0	29.01	3000	1000	359.0	H	311	0	24.9	PASS
24442.500	45.80	---	74.0	28.20	3000	1000	203.0	H	71	0	26.1	PASS
24442.500	---	36.59	54.0	17.41	3000	1000	203.0	H	71	0	26.1	PASS
25266.000	46.20	---	74.0	27.80	3000	1000	139.0	H	112	0	26.7	PASS
25266.000	---	37.11	54.0	16.89	3000	1000	139.0	H	112	0	26.7	PASS

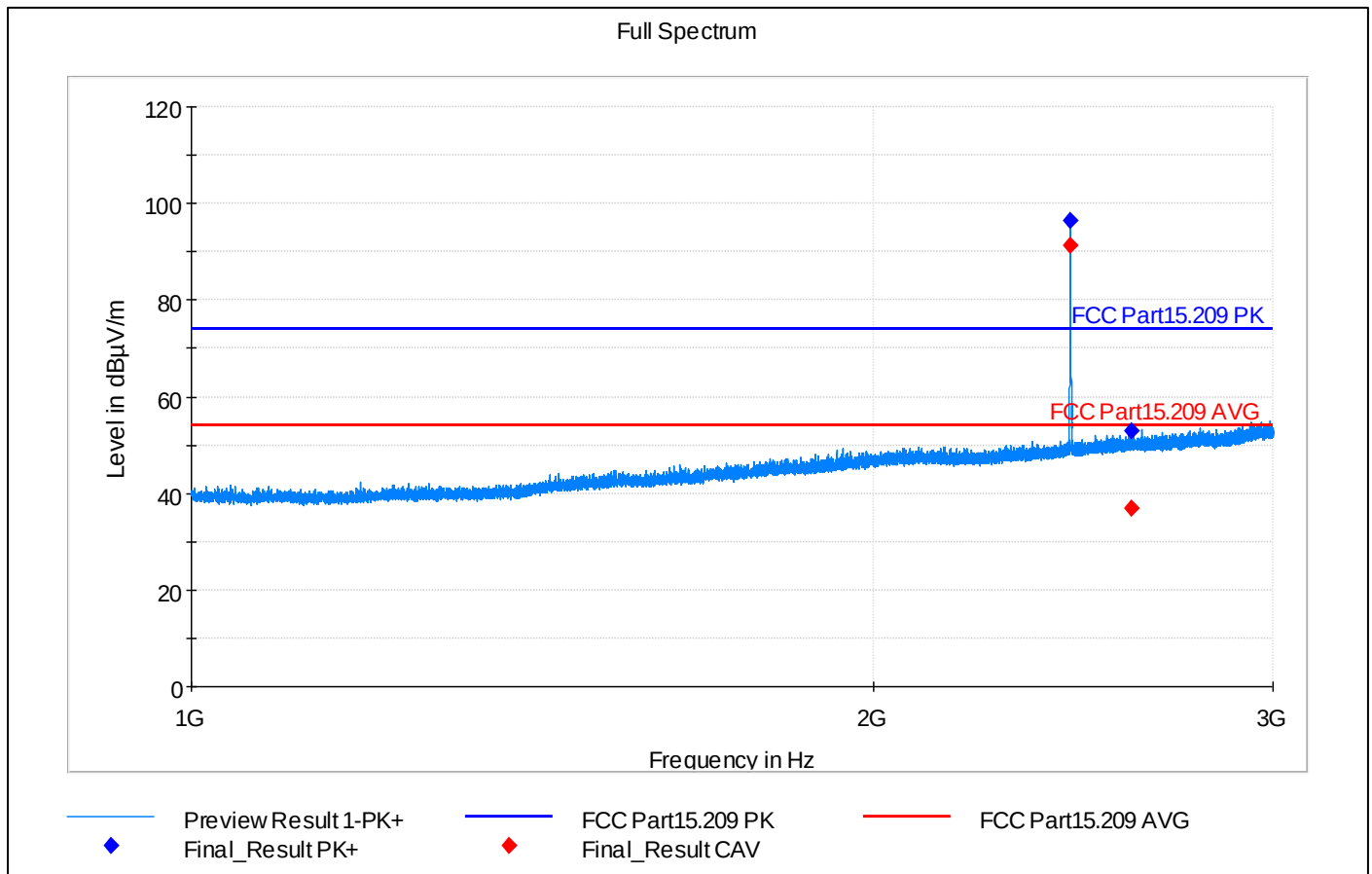
Mid channel, 30 MHz – 1 GHz



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
48.480	19.50	40.0	20.50	15000	120	100.0	V	229	0	21.1	PASS
456.000	21.95	46.0	24.05	15000	120	118.0	V	315	90	26.2	PASS

Mid channel, 1-3 GHz



Note: Frequency 2441,950 MHz is excluded from spurious domain measurements and ignored. See table below.

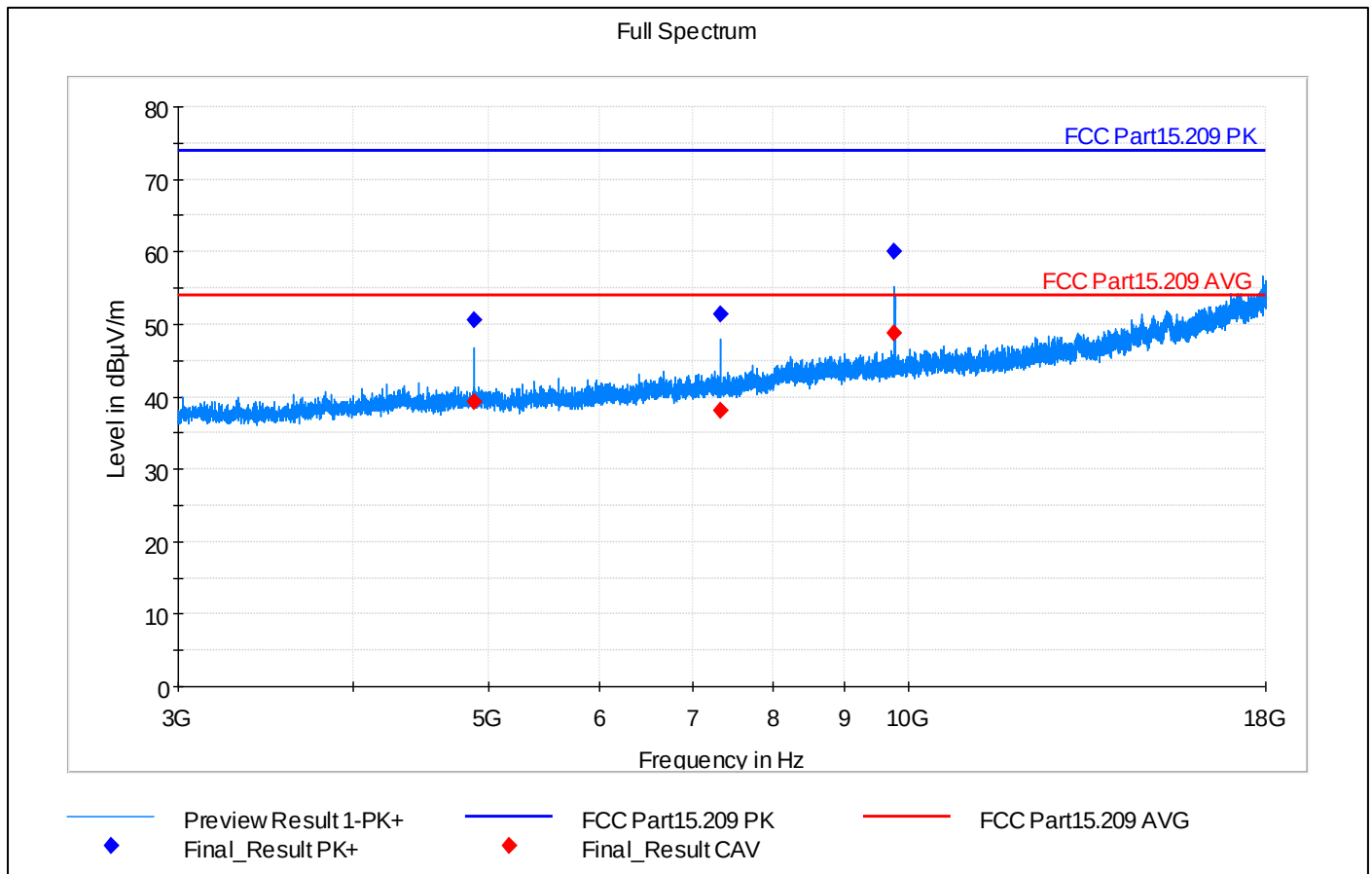
Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
2600.500	52.77	---	74.0	21.23	15000	1000	211.0	H	196	0	39.7
2600.500	---	40.78	54.0	13.22	15000	1000	211.0	H	196	0	39.7

(continuation of the "Final_Result" table from column 17 ...)

Frequency (MHz)	Comment
2441.950	Fundamental TX signal ***IGNORED***
2441.950	Fundamental TX signal ***IGNORED***
2600.500	PASS
2600.500	PASS

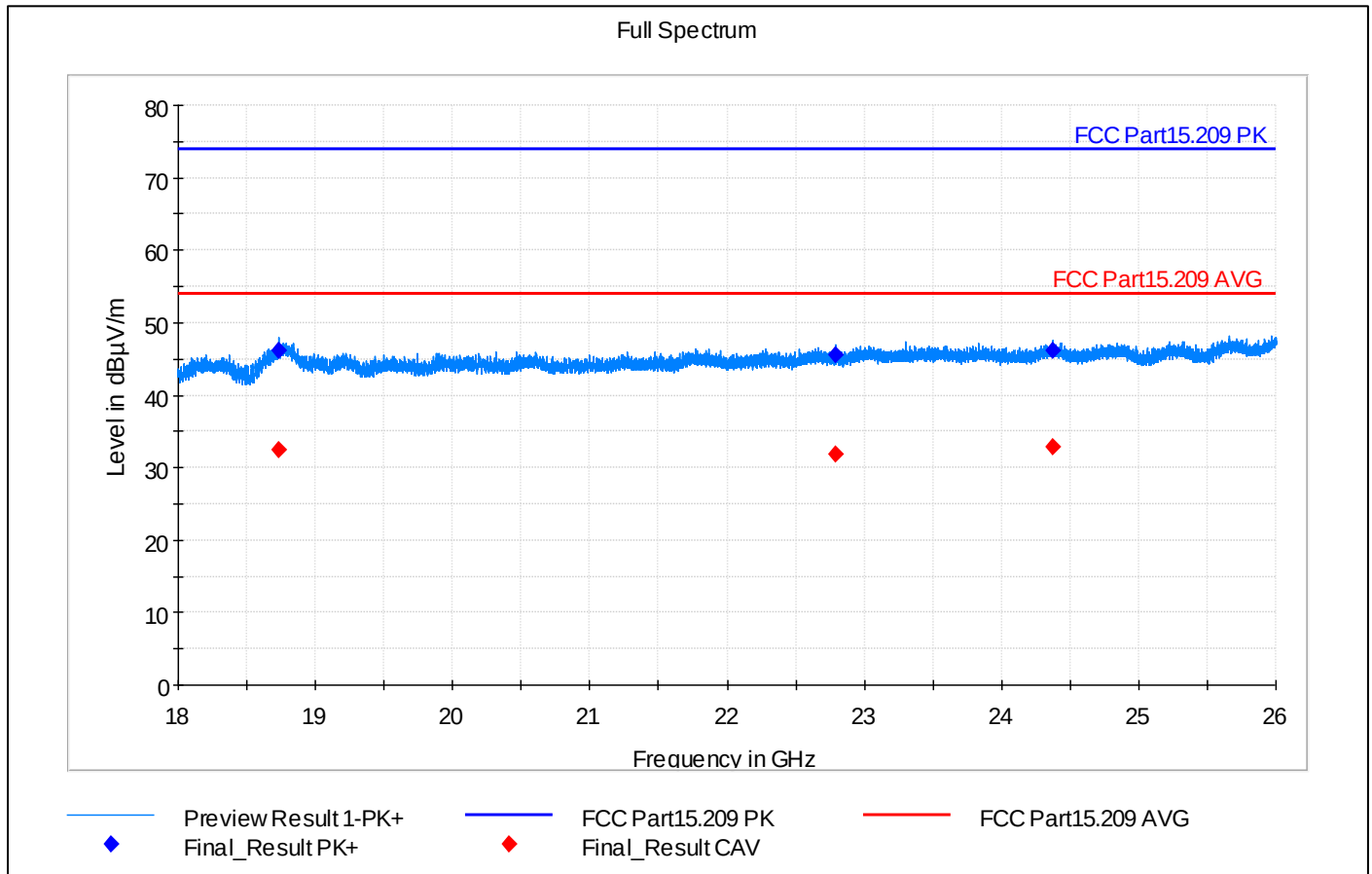
Mid channel, 3–18 GHz



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)	Comment
4883.500	---	43.19	54.0	10.81	15000	1000	228.0	V	337	0	10.6	PASS
4883.500	50.59	---	74.0	23.41	15000	1000	228.0	V	337	0	10.6	PASS
7325.000	51.35	---	74.0	22.65	15000	1000	249.0	H	136	90	15.8	PASS
7325.000	---	42.12	54.0	11.88	15000	1000	249.0	H	136	90	15.8	PASS
9767.000	59.96	---	74.0	14.04	15000	1000	223.0	H	48	90	19.9	PASS
9767.000	---	52.67	54.0	1.34	15000	1000	223.0	H	48	90	19.9	PASS

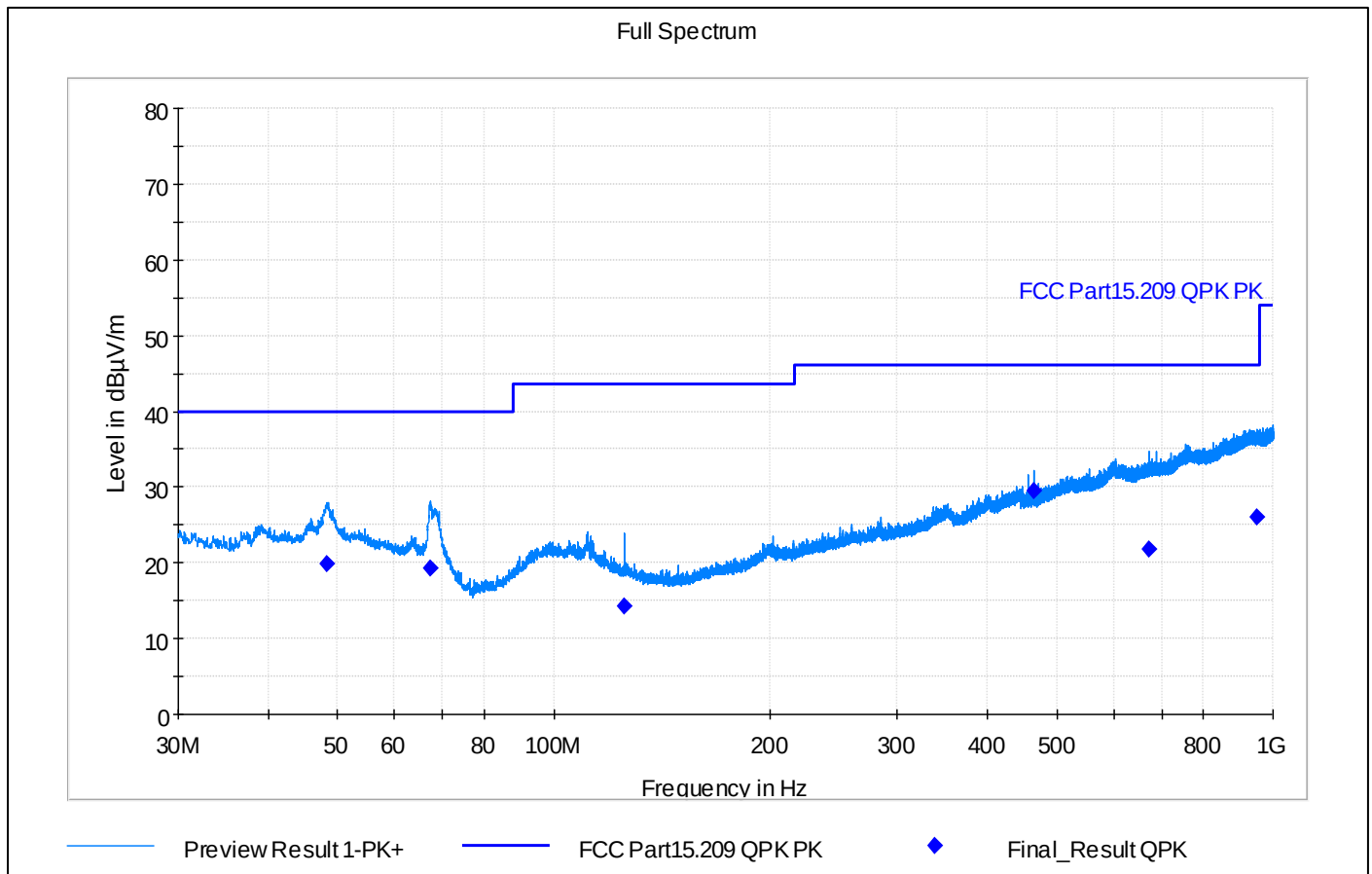
Mid channel, 18–26 GHz



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
18734.500	46.08	---	74.0	27.92	3000	1000	282.0	H	84	90	23.5	PASS
18734.500	---	36.50	54.0	17.50	3000	1000	282.0	H	84	90	23.5	PASS
22794.000	---	35.88	54.0	18.12	3000	1000	363.0	H	325	0	25.3	PASS
22794.000	45.60	---	74.0	28.40	3000	1000	363.0	H	325	0	25.3	PASS
24375.000	46.19	---	74.0	27.81	3000	1000	179.0	H	113	0	26.1	PASS
24375.000	---	36.76	54.0	17.24	3000	1000	179.0	H	113	0	26.1	PASS

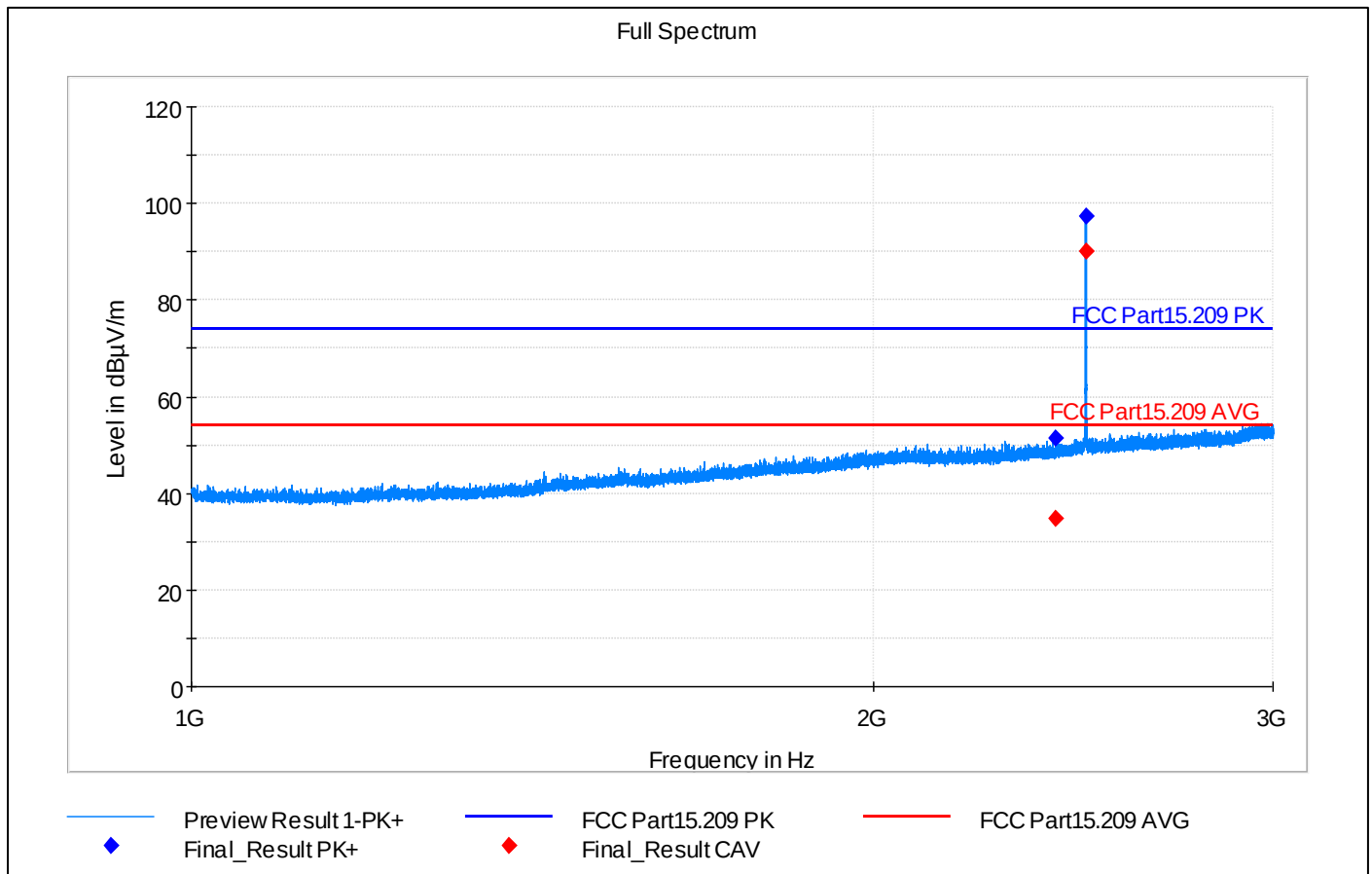
High channel, 30 MHz – 1 GHz



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
48.270	19.81	40.0	20.19	15000	120	98.0	V	157	0	21.1	PASS
67.380	19.24	40.0	20.76	15000	120	98.0	V	337	90	18.0	PASS
125.010	14.20	43.5	29.30	15000	120	100.0	V	266	0	17.1	PASS
464.010	29.48	46.0	16.52	15000	120	188.0	H	188	0	26.2	PASS
672.660	21.79	46.0	24.21	15000	120	398.0	H	289	0	30.4	PASS
951.150	26.06	46.0	19.94	15000	120	145.0	H	68	90	34.1	PASS

High channel, 1 – 3 GHz



Note: Frequency 2480,300 MHz is excluded from spurious domain measurements and ignored. See table below.

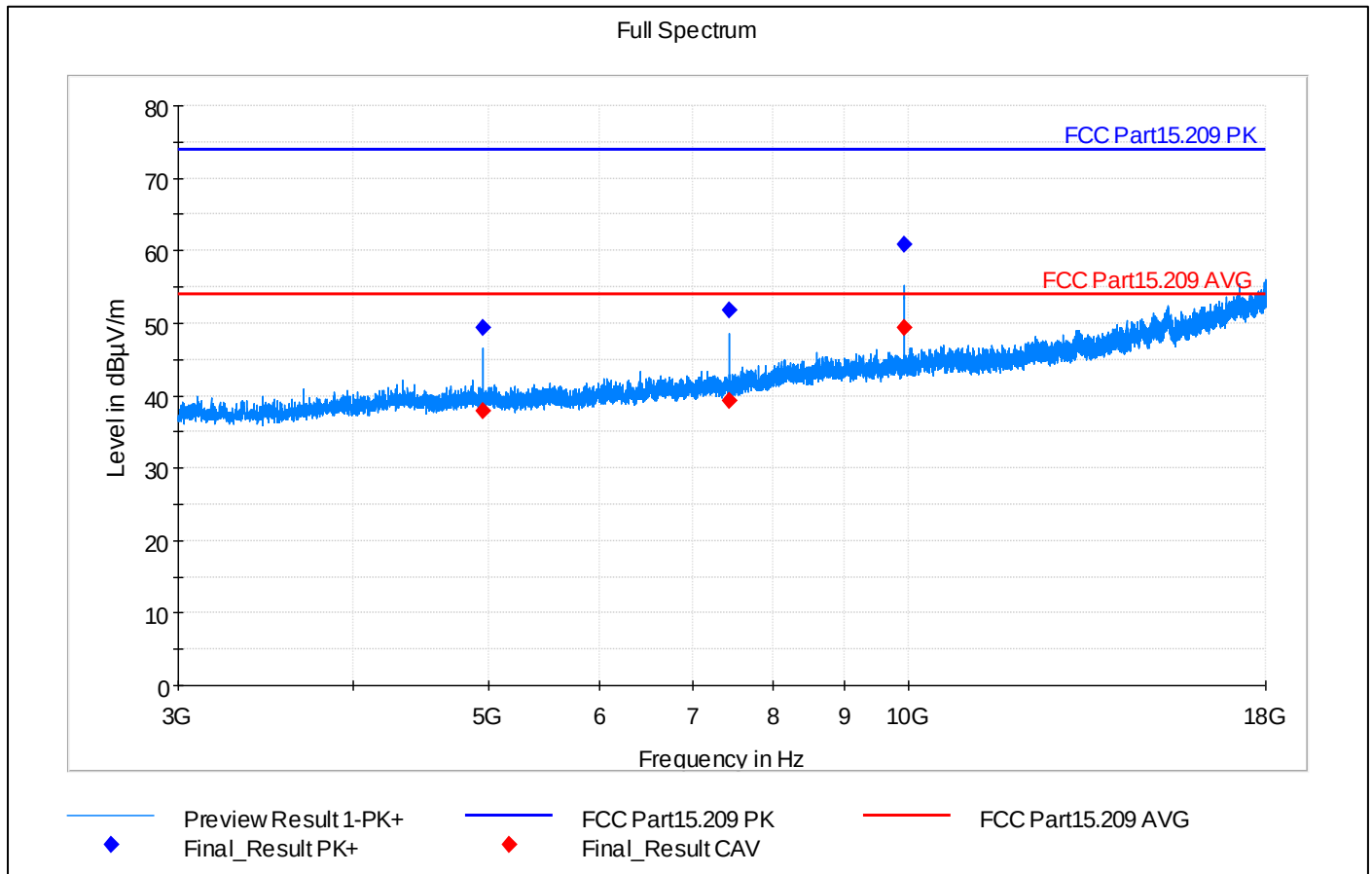
Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)
2406.650	51.24	---	74.0	22.76	15000	1000	272.0	H	169	90	38.7
2406.650	---	38.85	54.0	15.15	15000	1000	272.0	H	169	90	38.7

(continuation of the "Final_Result" table from column 17 ...)

Frequency (MHz)	Comment
2406.650	PASS
2406.650	PASS
2480.300	Fundamental TX signal ***IGNORED***
2480.300	Fundamental TX signal ***IGNORED***

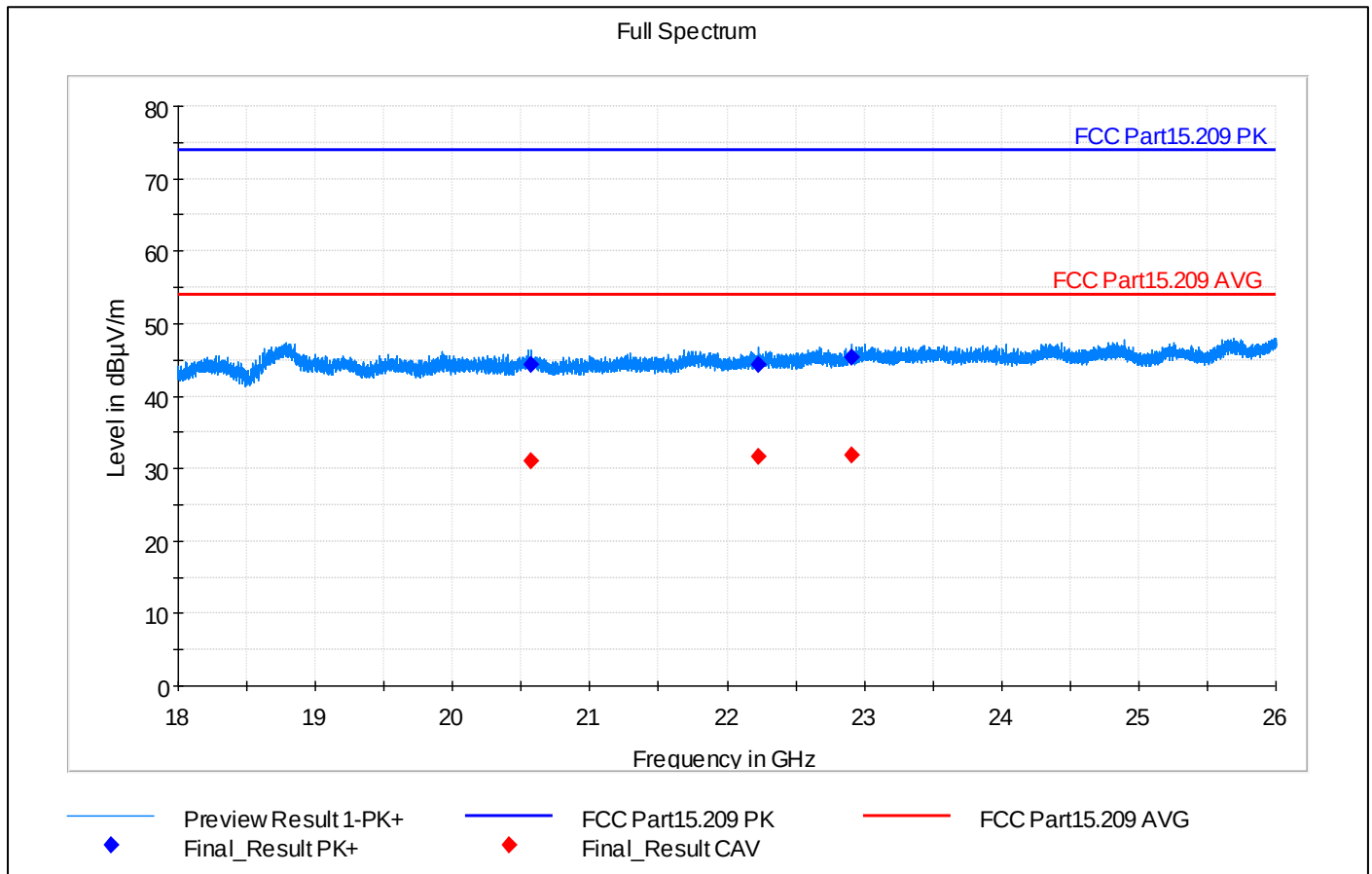
High channel, 3 – 18 GHz



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)	Comment
4959.500	---	41.78	54.0	12.22	15000	1000	264.0	V	50	90	10.6	PASS
4959.500	49.47	---	74.0	24.53	15000	1000	264.0	V	50	90	10.6	PASS
7439.750	51.80	---	74.0	22.20	15000	1000	219.0	H	39	0	15.7	PASS
7439.750	---	43.23	54.0	10.77	15000	1000	219.0	H	39	0	15.7	PASS
9919.000	60.91	---	74.0	13.09	15000	1000	224.0	H	52	90	20.1	PASS
9919.000	---	53.42	54.0	0.58	15000	1000	224.0	H	52	90	20.1	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
20572.750	---	35.09	54.0	18.91	3000	1000	188.0	H	33	90	24.2	PASS
20572.750	44.39	---	74.0	29.61	3000	1000	188.0	H	33	90	24.2	PASS
22231.750	---	35.64	54.0	18.36	3000	1000	174.0	H	194	90	25.0	PASS
22231.750	44.29	---	74.0	29.71	3000	1000	174.0	H	194	90	25.0	PASS
22912.750	---	35.77	54.0	18.23	3000	1000	216.0	V	315	90	25.4	PASS
22912.750	45.27	---	74.0	28.73	3000	1000	216.0	V	315	90	25.4	PASS

18. Receiver spurious emissions, radiated

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

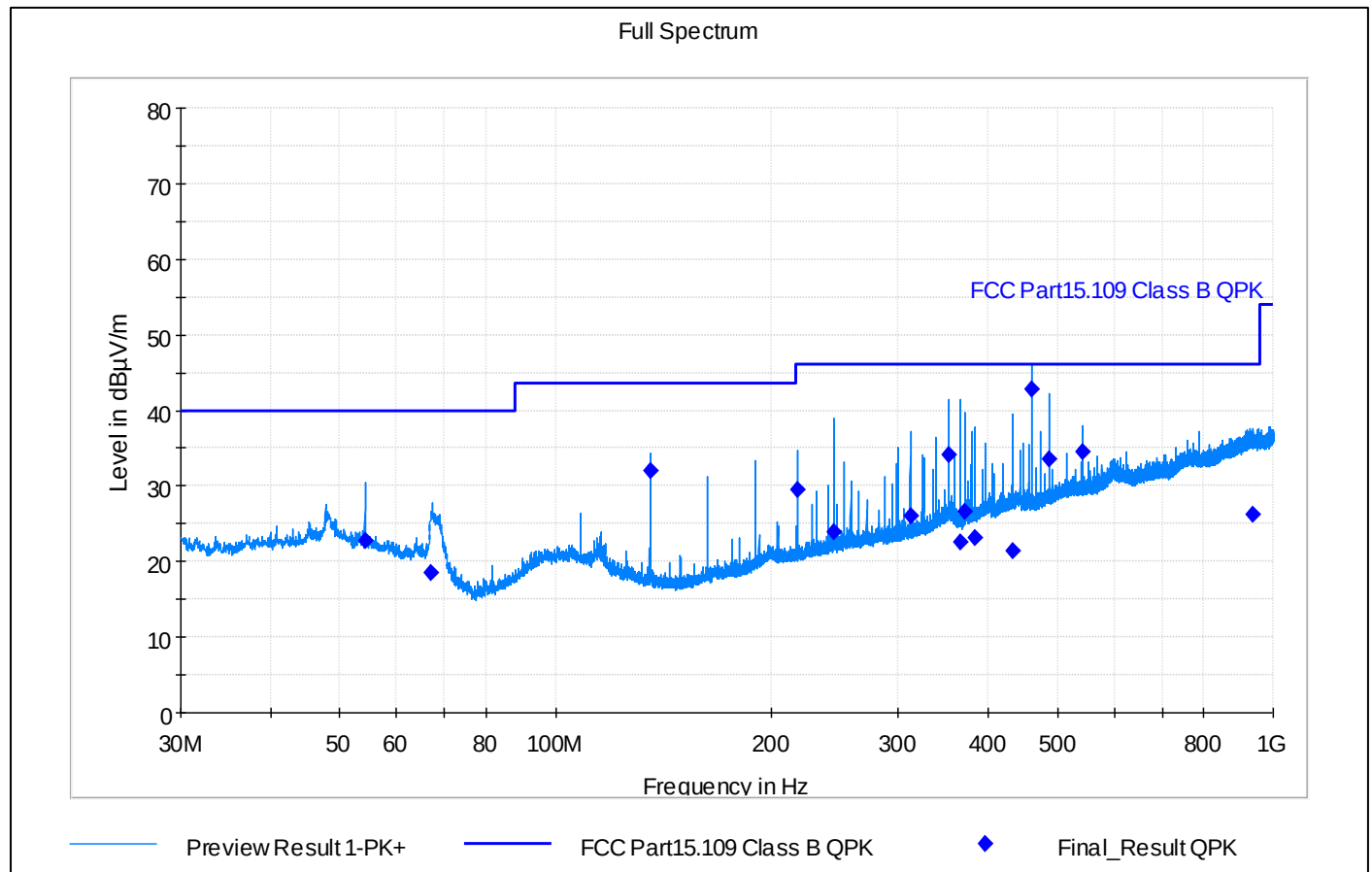
Test method: ANSI C63.4-2014 (8.1 – 8.3)

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, 2442 MHz	PASS

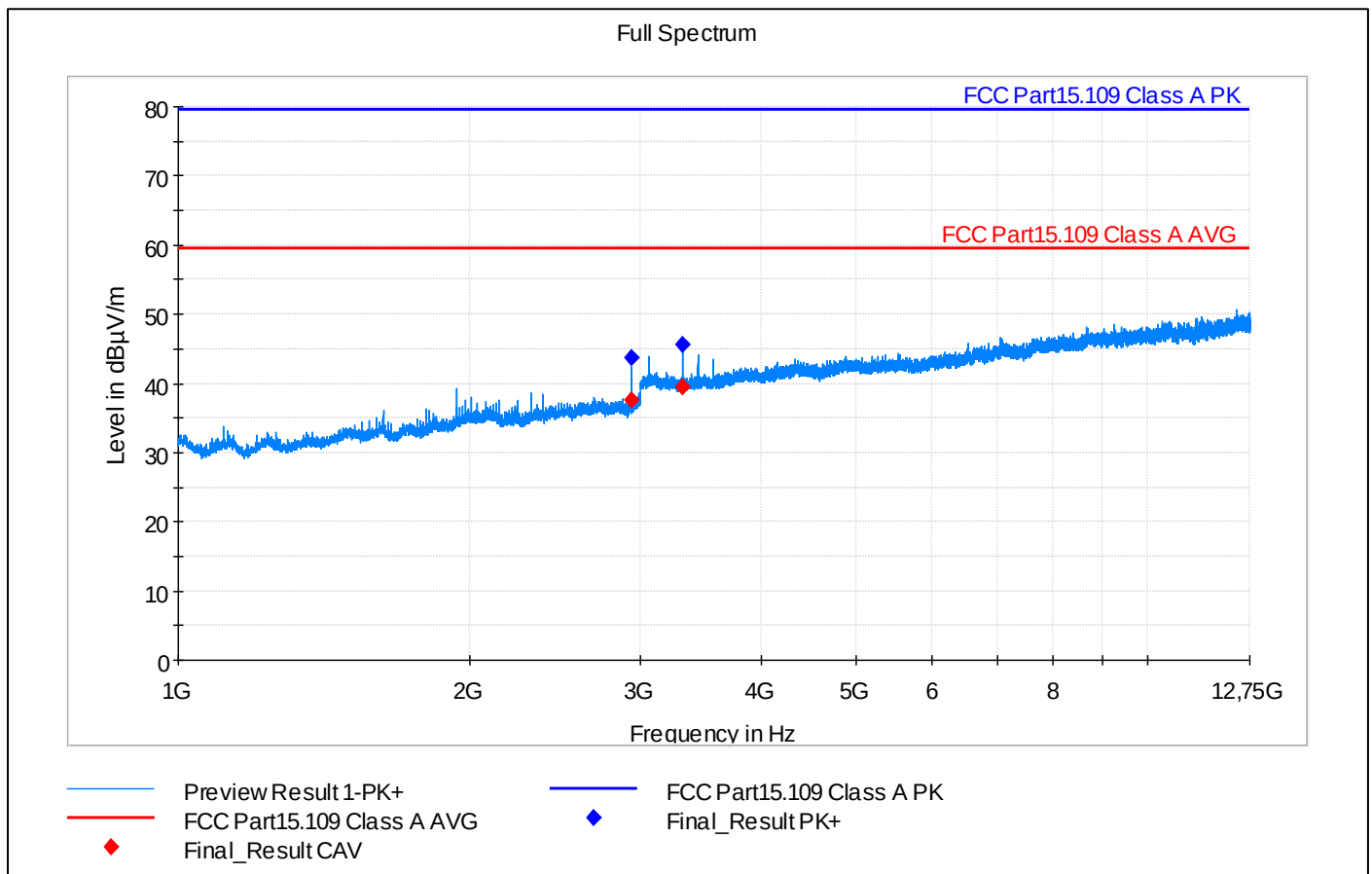
Mid channel, 30 MHz – 1 GHz



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
54.270	22.80	40.0	17.20	15000	120	105.0	V	-15	0	20.8	PASS
67.110	18.60	40.0	21.40	15000	120	163.0	V	337	0	18.0	PASS
135.600	31.99	43.5	11.51	15000	120	106.0	V	247	0	16.3	PASS
216.930	29.57	46.0	16.43	15000	120	100.0	V	202	0	19.8	PASS
243.990	23.85	46.0	22.15	15000	120	160.0	H	269	0	21.1	PASS
312.000	25.99	46.0	20.01	15000	120	178.0	H	-21	0	22.6	PASS
352.560	34.07	46.0	11.93	15000	120	100.0	H	126	0	24.7	PASS
366.240	22.60	46.0	23.40	15000	120	108.0	H	323	0	24.0	PASS
371.970	26.51	46.0	19.49	15000	120	106.0	H	302	0	24.3	PASS
384.000	23.14	46.0	22.86	15000	120	124.0	H	318	0	24.7	PASS
433.830	21.31	46.0	24.69	15000	120	131.0	V	247	0	26.0	PASS
461.040	42.80	46.0	3.20	15000	120	107.0	H	118	0	26.2	PASS
488.220	33.54	46.0	12.46	15000	120	147.0	V	131	0	27.0	PASS
542.400	34.42	46.0	11.58	15000	120	121.0	V	155	0	28.1	PASS
938.670	26.21	46.0	19.79	15000	120	116.0	V	147	0	34.1	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
2937.500	---	37.66	59.5	21.84	500	1000	100.0	H	323	2.2	PASS
2937.500	43.80	---	79.5	35.70	500	1000	100.0	H	323	2.2	PASS
3312.500	---	39.40	59.5	20.10	500	1000	300.0	H	327	6.1	PASS
3312.500	45.62	---	79.5	33.88	500	1000	300.0	H	327	6.1	PASS