

Radio Test Report

According to

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

DUT Name: TempCast FMP100
Model No. : FMP103
Customer: Vaisala
Address: Vanha Nurmijärventie 21, 01670 Vantaa, Finland
Summary IN COMPLIANCE
Date of Reception: 8.5.2023, 22.5.2023
Date(s) of Test(s): 23.05.2023 – 30.05.2023

Tested by Test Engineer



Pekka Pulkkinen

Approved by Technical Manager



Jukka Rauma

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

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Document Version History	Date of issue	Comments	Approved by
v0.1	21.6.2023	Initial version	
v1.0	27.6.2023	Approved version	Jukka Rauma
v2.0	25.7.2023	FCC and IC ID's corrected (switched around)	Jukka Rauma
v3.0	15.9.2023	Internal and external pictures removed. Nominal bandwidth corrected to 1 MHz. EIRP results added to table in page 17.	Jukka Rauma
v4.0	26.9.2023	EUT configuration software name added to page 6.	Jukka Ruma

1. General Information

Test Engineer(s): Arto Kuosmanen, Pekka Pulkkinen

Location:

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

Customer:

Vaisala Oyj

Vanha Nurmijärventie 21, 01670 Vantaa, Finland

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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:

Wireless, pole-mounted sensor to measure air temperature, relative humidity and surface temperature.

Test sample (Conducted):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3772ER004	V1820108	Vaisala Oyj	TempCast FMP100	FMP103	F	1.0.9

Test sample (Radiated):

Sample number	Serial number	Manufacturer	DUT Type	Model	HW version	SW version
3772ER001	V1820102	Vaisala Oyj	TempCast FMP100	FMP103	F	1.0.9 (Emission FW)

Auxiliary equipment:

Sample number	Serial number	Manufacturer	DUT Type	Model	
3772ER003	606D3C4EE4F2	Lenovo	Docking station	NA	

Description	Information	
Additional model	FMP102	
Brand Names(s)	Vaisala	
PMN	Tempcast FMP100	
HVIN	FMP103, FMP102	
FVIN	1.0.9	
HMN	N/A	
FCC ID	2A039-FMP100	
IC ID	23830-FMP100	
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	Quarter wave PCB antenna
	Model	-
	Manufacturer	Vaisala
	Gain	2.5 dBi
Supply voltage	V _{Nom} = 7.2 VDC	
Type of Power source	Battery	
Operating Temperature	TNom = 20°C TMin = -40°C TMax = 70°C	
Manufacturer	Vaisala Oyj Vanha Nyurmijärventie 21 01670 Vantaa 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 0 dBm

Conducted and radiated emission test:

Test modes / description
EUT battery powered, continuous modulated carrier at 2402 MHz, 2440 MHz and 2480 MHz, power level setting 0 dBm, data rate 1 Mbps
EUT battery powered, continuous reception at 2440 MHz

Test/configuration software

Manufacturer	Name	Version
Nordic Semiconductor	nRFConnect for Desktop	v4.1.2
Nordic Semiconductor	Direct Test Mode application	v2.1.0

4. Test equipment

Conducted RF tests

R&S TS8997 Test System equipment list:

Equipment	Certification-No.	Calibration Date	Next calibration
SMW200A	1035089-D-K-15195-01-00-2022-03	31.03.2022	30.06.2023
SMB100A	1041326-D-K-15195-01-00-2022-03	31.03.2022	30.06.2023
OSP-B157WX+OSP220	300642762-D-K-15195-01-00-2022-03	31.03.2022	30.06.2023
OSP-B157W8plus+OSP150	300639878-D-K-15195-01-00-2022-03	31.03.2022	30.06.2023
ESW	1039208-D-K-15195-01-00-2022-03	31.03.2022	30.06.2023
CMW500	300693633-D-K-15195-01-00-2023-04	25.04.2023	25.04.2024
CMW-Z800A	20-1040958-C	31.03.2022	30.06.2023

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
G4C264	Rohde & Schwarz	CMW500	Wideband radio communication tester	126426	18.11.2022	18.11.2023
G4C265	Rohde & Schwarz	ESW26	EMI test receiver	101324	25.8.2022	25.8.2023
G4C273	Frankonia	ALX-4000E	Broadband Antenna, 25MHz-4GHz with 6dB (50-A-MFN-06) att.	00816+1531	11.11.2020	11.11.2023
G4C503	Rohde & Schwarz	ESIB26	EMI Test Receiver 20Hz...26.5GHz	100263	9.7.2021	9.7.2023
G4C560	Bruel & Kjaer	Nexus 2690	Conditioning Amplifier	2340586	24.5.2018	N/A
G4C292	Rohde & Schwarz	TS-LNA 1840	RF Preamplifier 18 to 40 GHz	100841	9.6.2022	9.6.2024
G4C469	Rohde & Schwarz	TS_PRE2	RF Preamplifier	101541	9.6.2022	9.6.2024
G4C294	Rohde & Schwarz	TC-HORN40	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 \leq 1 GHz	4,62
Radiated emission $>$ 1 GHz	5,72

6. Sample emission level calculation

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

Reading:

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

A.F.:

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

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

Net:

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

Limit:

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

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

Margin :

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

Example only:

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

7. Test conditions

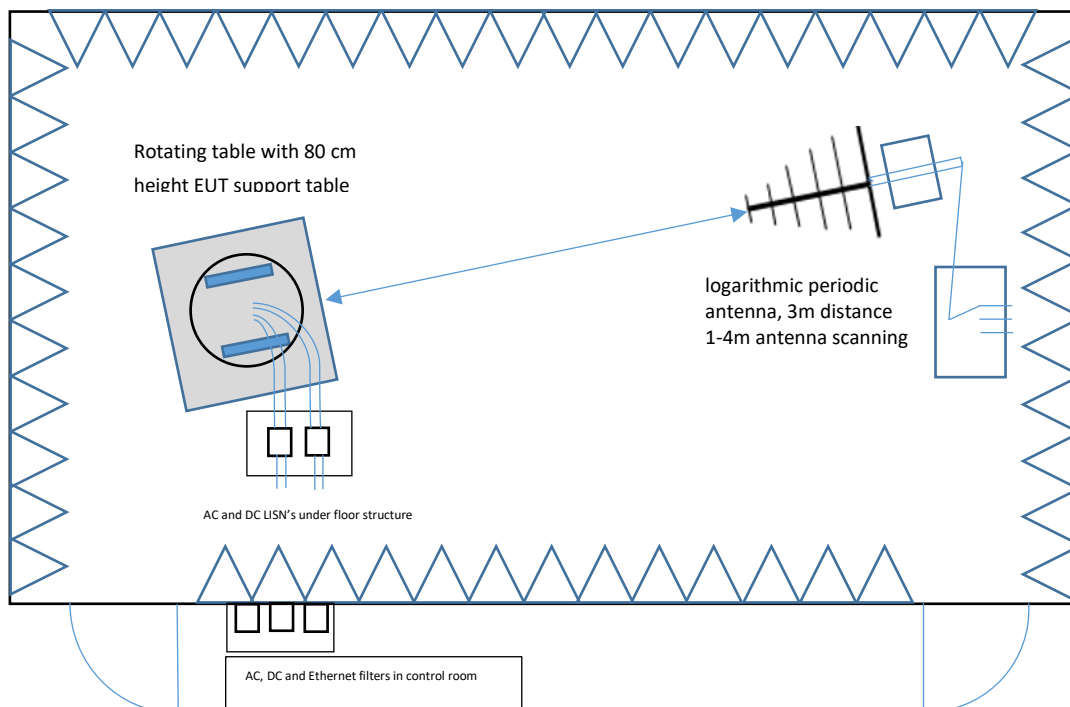
All radiated tests were performed in a semi-anechoic chamber, where the measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz, 1 GHz-18 GHz Double-ridged horn antenna and 18 GHz-40 GHz horn antenna) is located at a distance of 3 m.

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

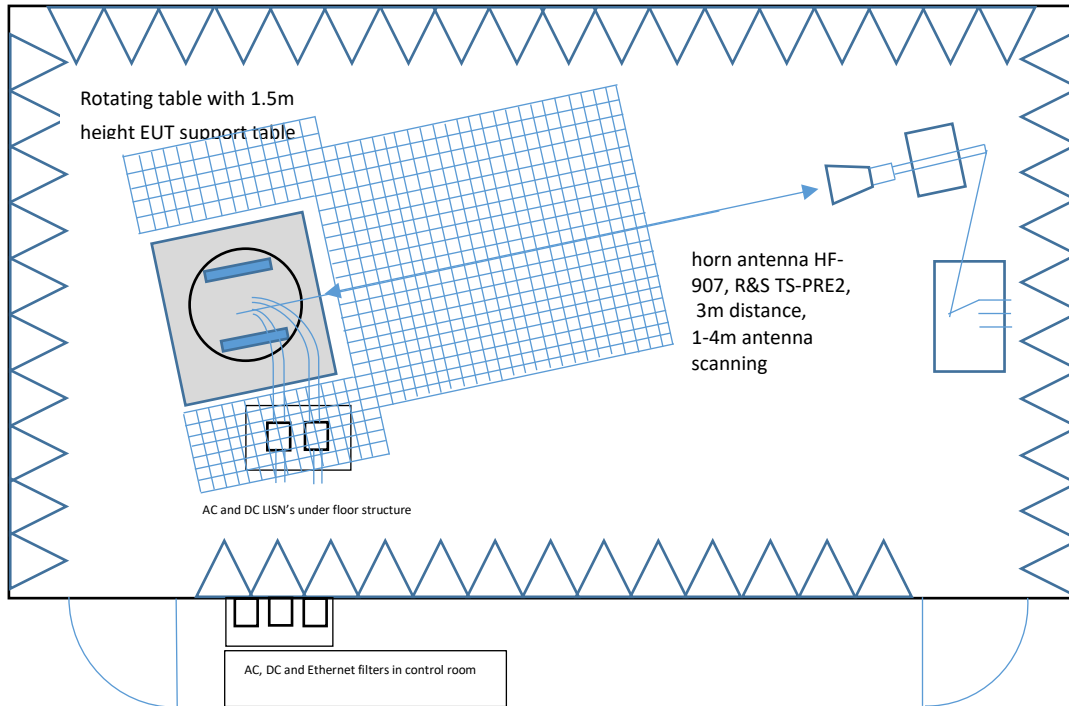
Measurements were made in both horizontal and vertical planes of polarization.

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

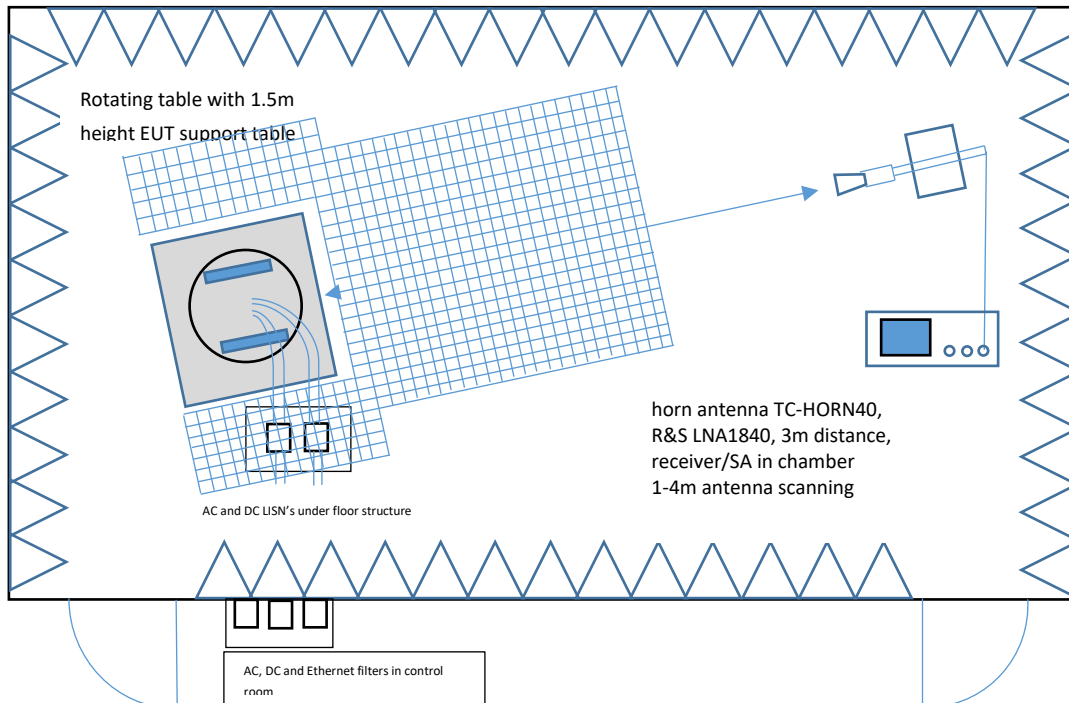
Radiated measurements setup from 30 MHz to 1 GHz:



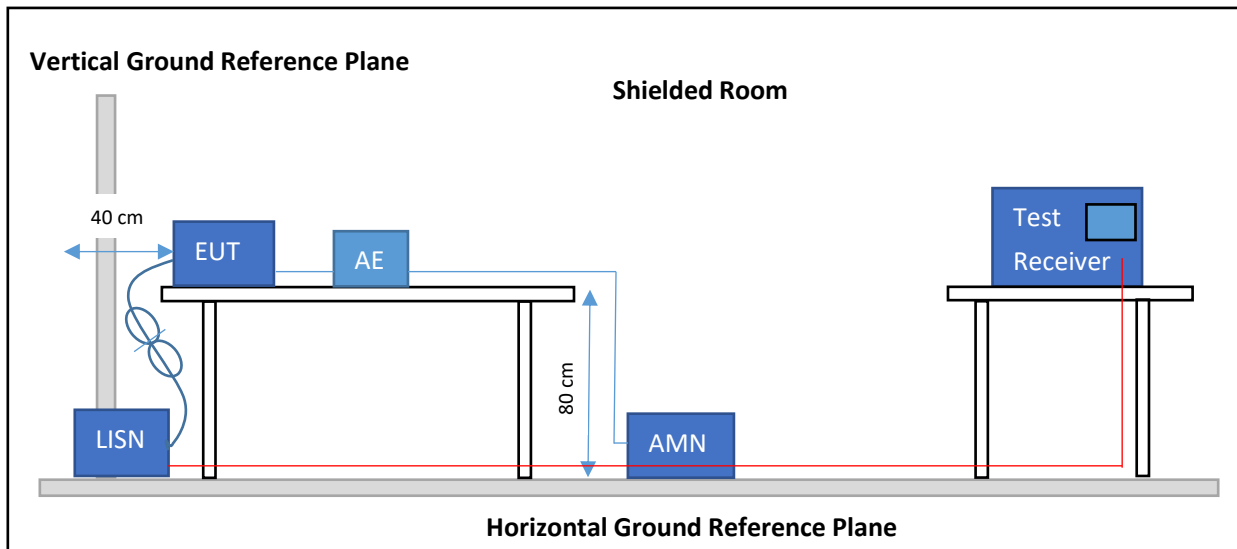
Radiated measurements setup from 1 GHz to 18 GHz:



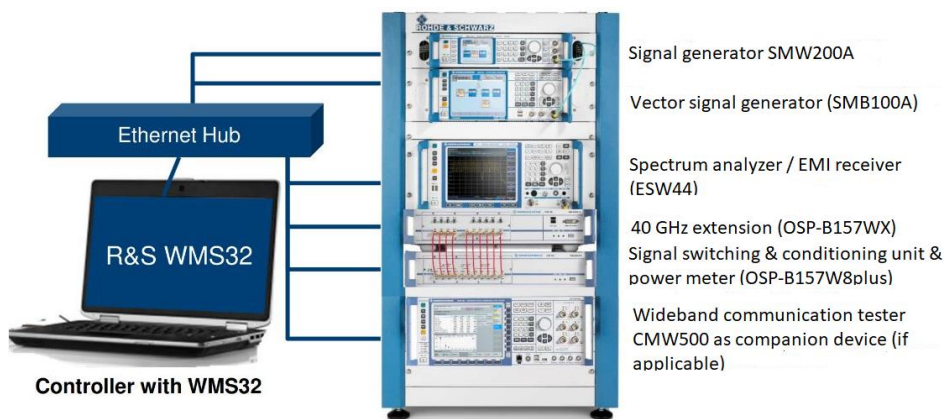
Radiated measurements setup from 18 GHz to 26 / 40 GHz:



Conducted emission setup



Conducted RF measurement system:



8. Summary

FCC/ISED Requirement (15.247 / RSS-247)		Reference method	Result	Remark
Occupied Bandwidth	ISED RSS-Gen, Issue 5 A2 (section 6.7)	ANSI C63.10-2013	N/R	Informational only
6 dB Bandwidth	FCC § 15.247(a)(2) / RSS-247, Issue 2 (section 5.4)	ANSI C63.10-2013	PASS	
Maximum peak conducted power	FCC § 15.247(b) / RSS-247, Issue 2 (section 5.4 (d))	ANSI C63.10-2013	PASS	
Power spectral density	FCC § 15.247(e) / RSS-247, Issue 2 (section 5.2)	ANSI C63.10-2013	PASS	
AC power line conducted emissions	FCC § 15.207 / RSS-247, Issue 2 (section 3.1)	ANSI C63.10-2013	N/A	
Band edge compliance	FCC § 15.247(d) / RSS-247, Issue 2 (section 5.5)	ANSI C63.10-2013	PASS	
Conducted spurious emissions	FCC § 15.247(d) / RSS-247, Issue 2 (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 2 (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)

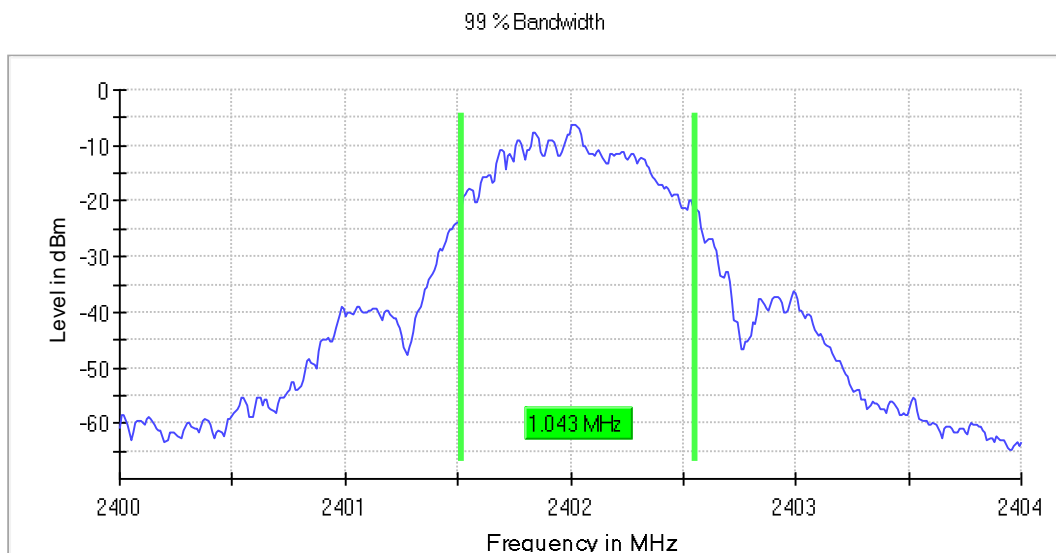
Limits
None (Informational only)

Procedure
<ol style="list-style-type: none"> 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

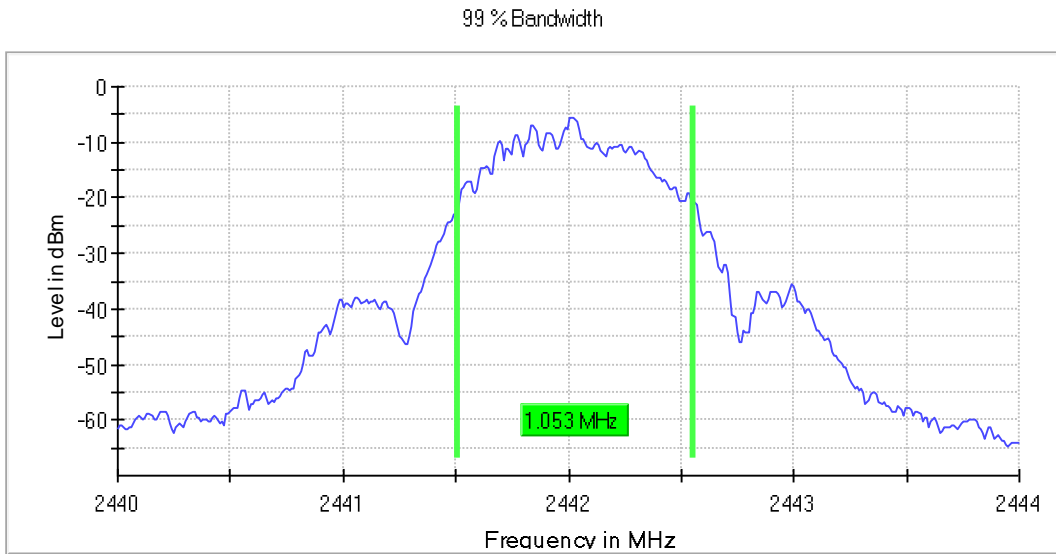
Summary:

Summary		
Mode / modulation	Frequency (MHz)	Bandwidth (MHz)
Bluetooth LE, 1 Mbps	2402	1.042607
Bluetooth LE, 1 Mbps	2442	1.052632
Bluetooth LE, 1 Mbps	2480	1.042607

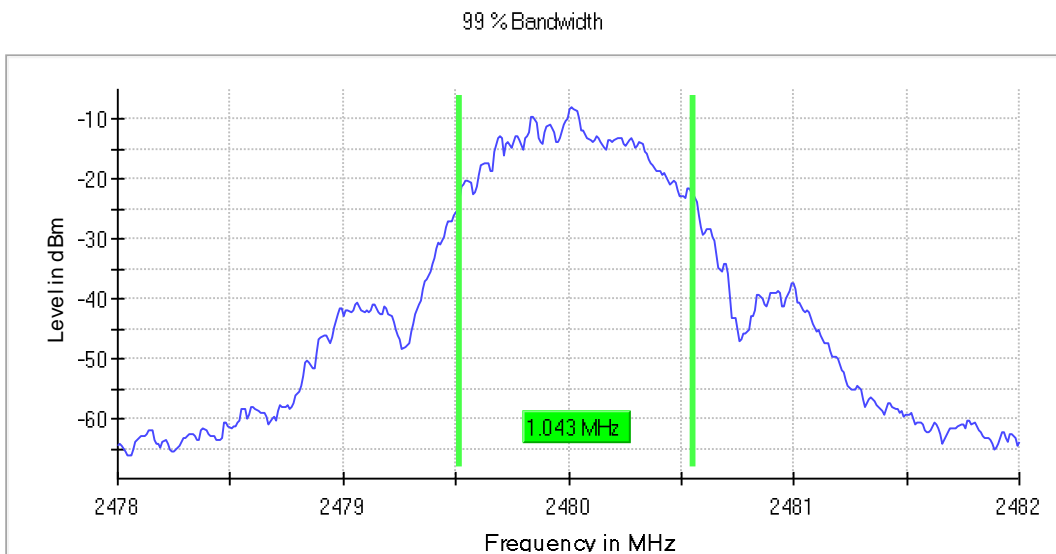
Occupied bandwidth, low channel



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 2 (section 5.2)

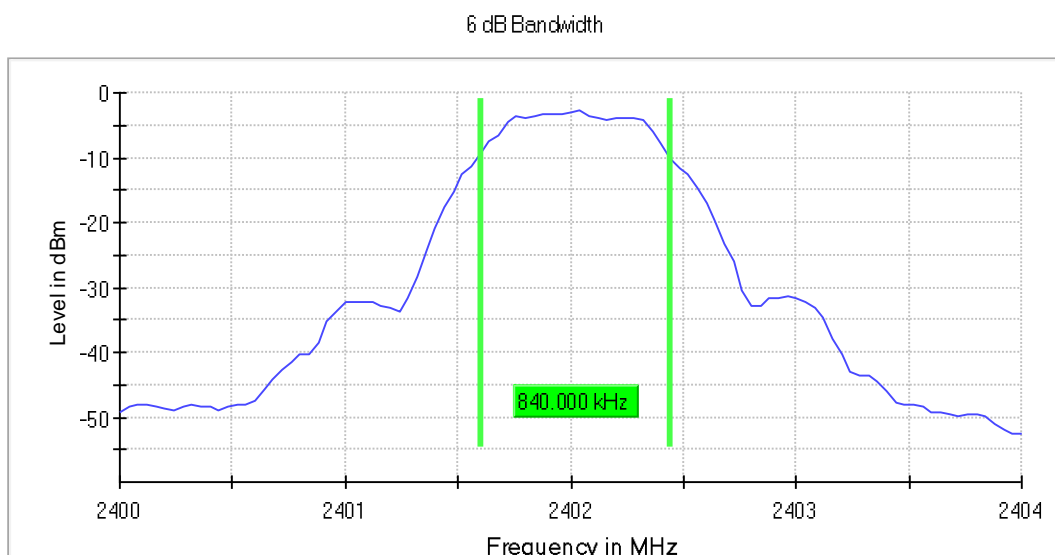
Test method: KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 (11.8.1)

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

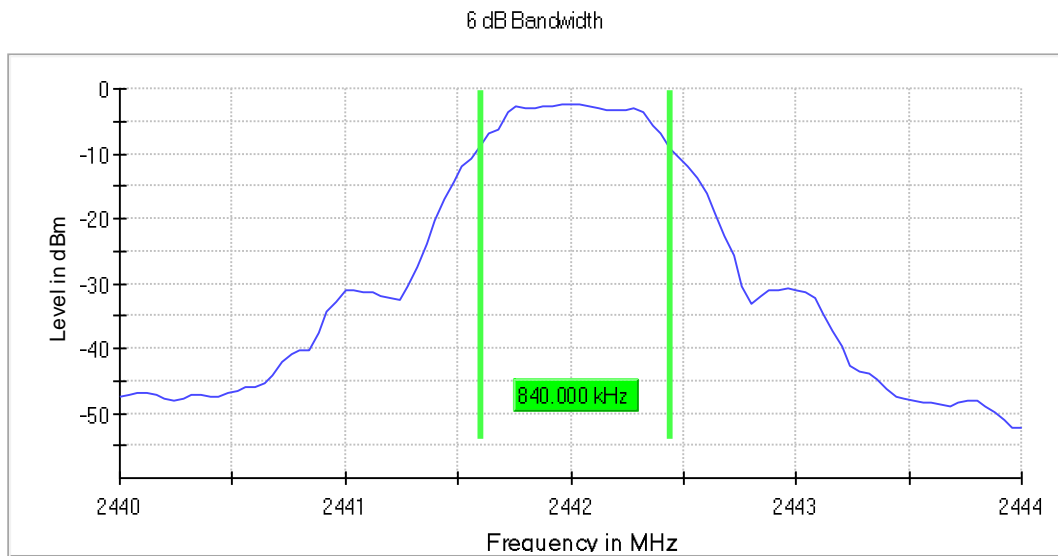
Test procedure
<ol style="list-style-type: none"> 1. EUT set to test mode 2. Span set to at least twice the emission spectrum 3. Detector set to peak and max hold and BW is set to 100 kHz 4. Envelope peak value of emission spectrum is selected 5. Marker on envelope of spectrum is set to level of -6 dB 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	0.840000	0.500000	---	2401.600000	2402.440000	-2.8	PASS
Bluetooth LE, 1 Mbps	2442.000000	0.840000	0.500000	---	2441.600000	2442.440000	-2.3	PASS
Bluetooth LE, 1 Mbps	2480.000000	0.840000	0.500000	---	2479.600000	2480.440000	-3.8	PASS

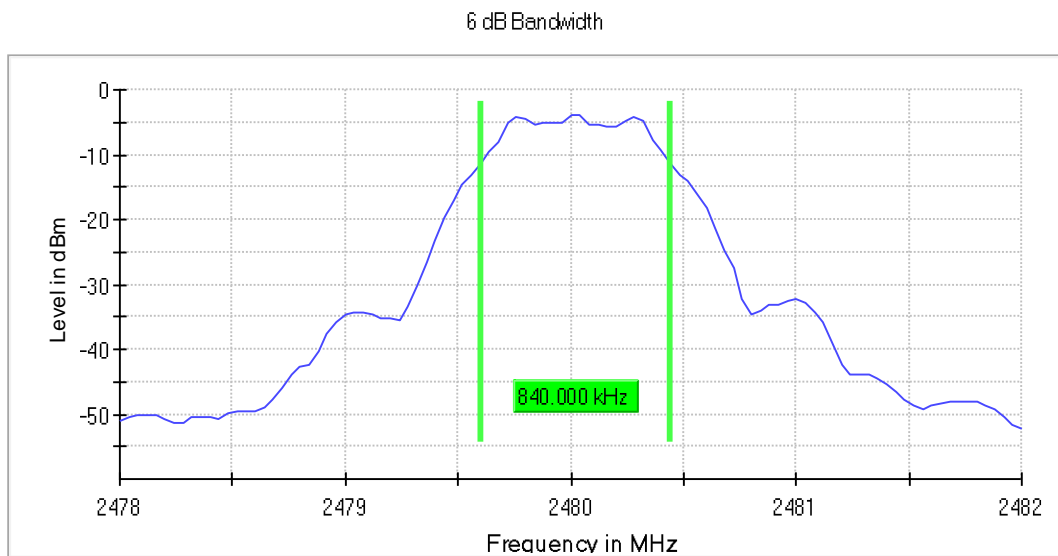
6 dB Bandwidth, low channel:



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 2 (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.

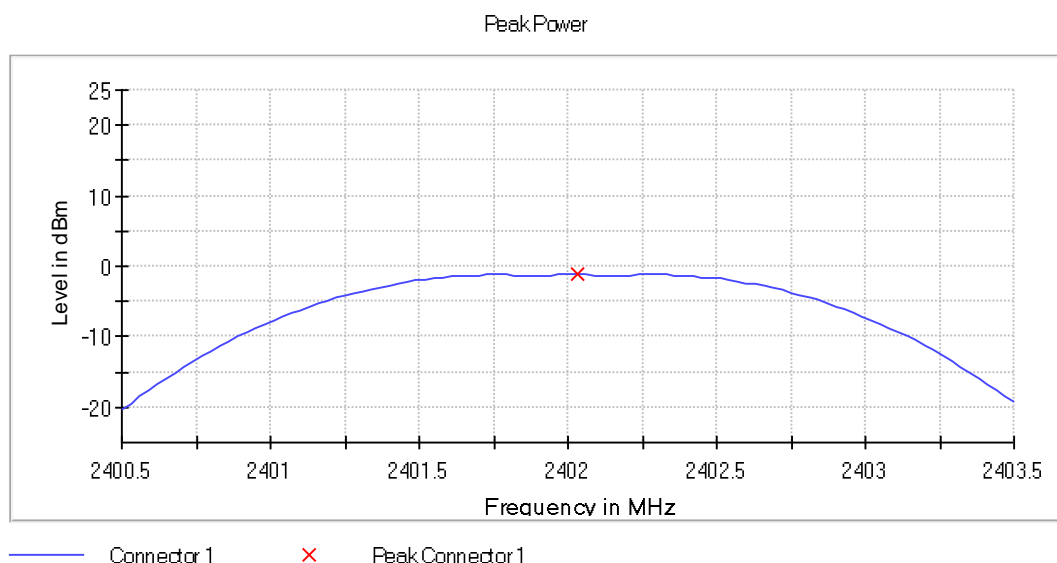
Test procedure
<ol style="list-style-type: none"> 1. EUT set to test mode (communication tested is used if needed) 2. Analyzer resolution bandwidth is set \geq DTS bandwidth 3. Detector set to peak and max hold 4. Sweep time is set to auto 5. After trace has stabilized a marker is set to peak envelope

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

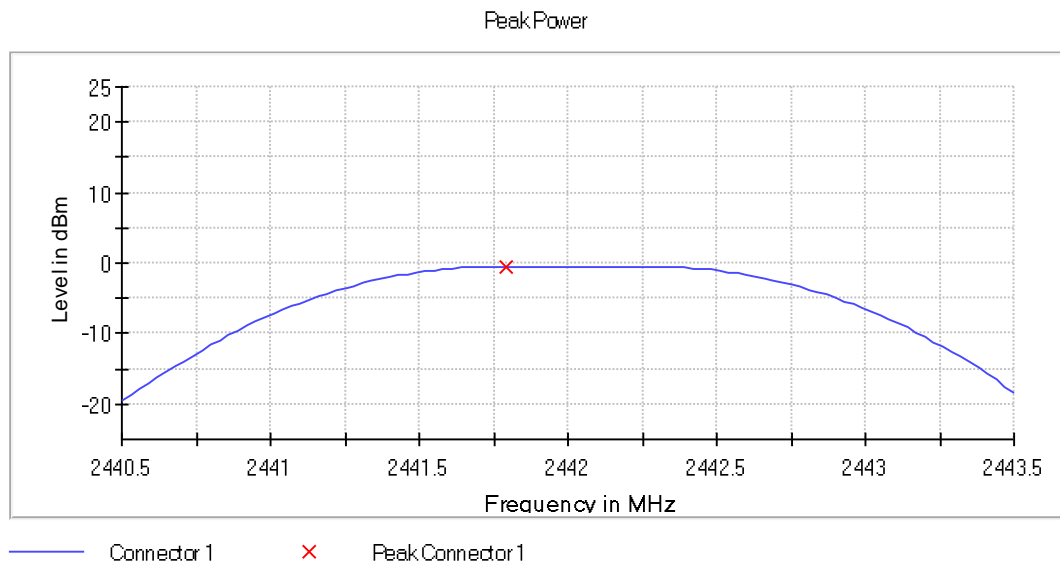
Maximum Declared Antenna Gain: 2.5 dBi

Mode / modulation	DUT Frequency (MHz)	Conducted Peak Power	EIRP Power (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	-1.2	1.3	PASS
Bluetooth LE, 1 Mbps	2442.000000	-0.5	2.0	PASS
Bluetooth LE, 1 Mbps	2480.000000	-2.8	-0.3	PASS

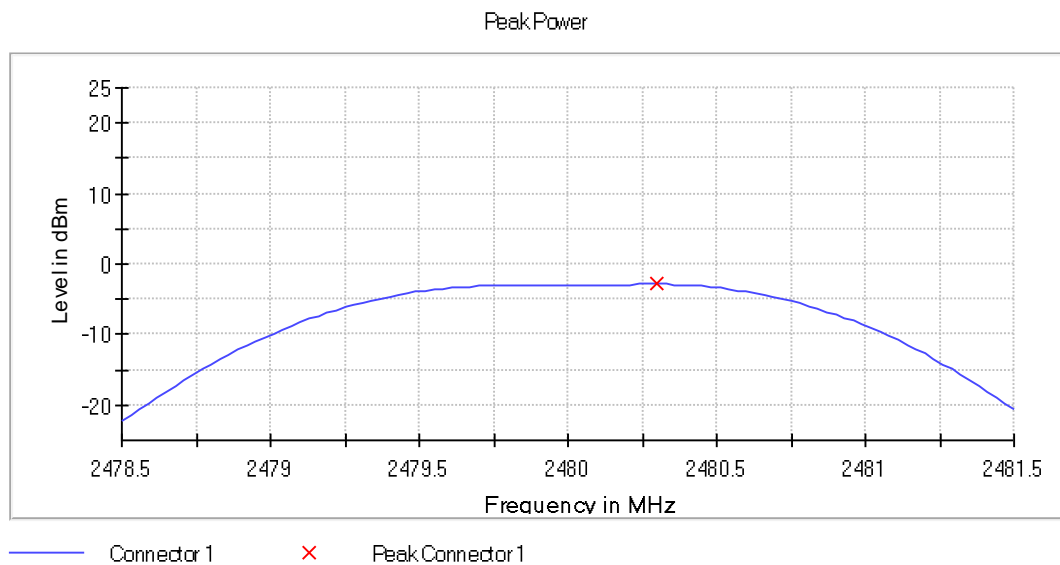
Peak power, low channel



Peak power, middle channel



Peak power, high channel



12. Peak Power Spectral Density

Reference: FCC §15.247(a),(e), ISED RSS-247, Issue 2 (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.

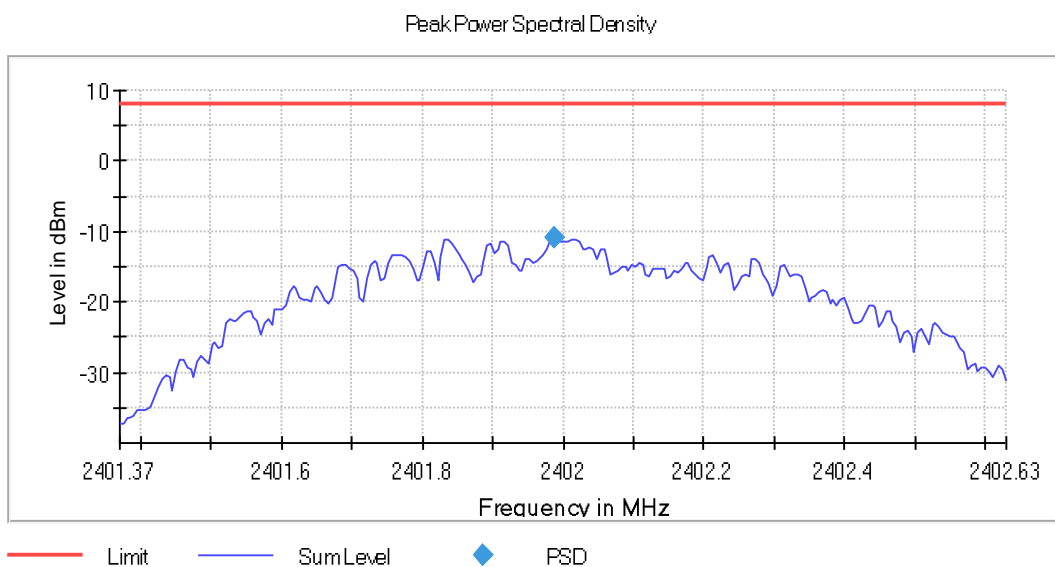
Limits
≤ 8 dBm / 3 kHz

Test procedure
<ol style="list-style-type: none"> 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

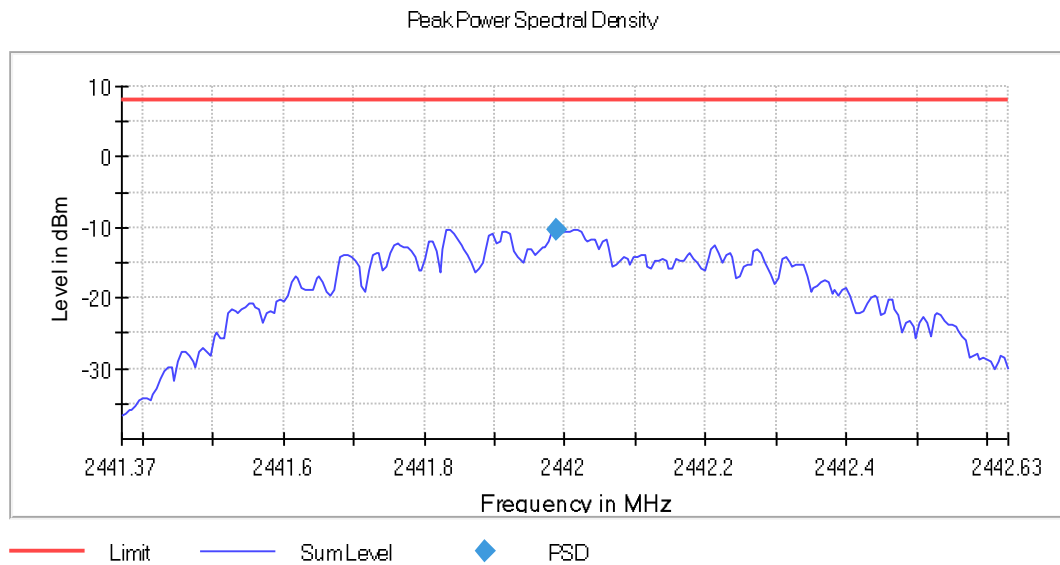
Summary

Mode / modulation	DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
Bluetooth LE, 1 Mbps	2402.000000	2401.987450	-10.874	8.0	PASS
Bluetooth LE, 1 Mbps	2442.000000	2441.987450	-10.229	8.0	PASS
Bluetooth LE, 1 Mbps	2480.000000	2479.987450	-12.734	8.0	PASS

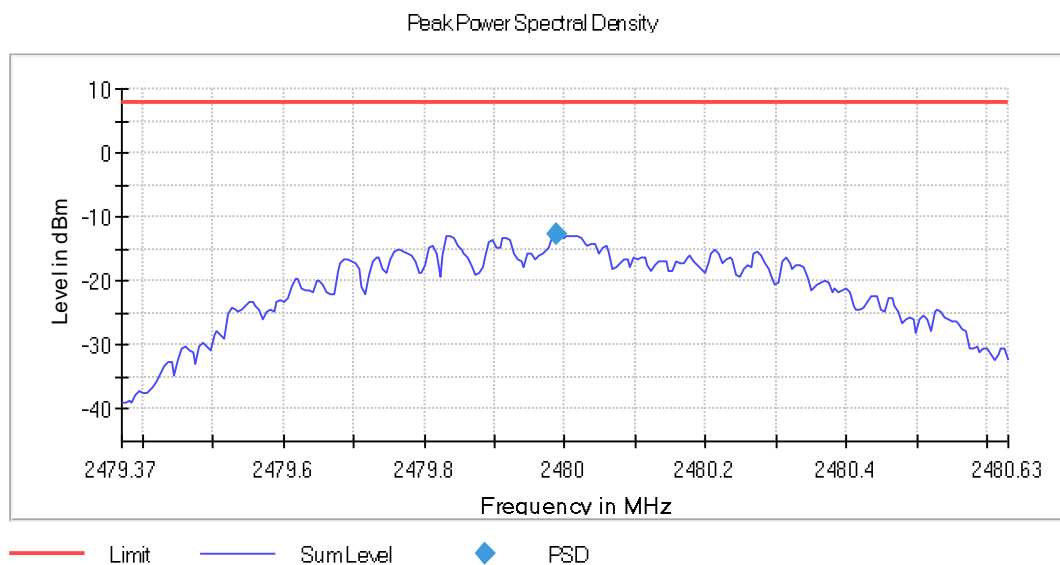
Peak power spectral density, low channel



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 2 (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

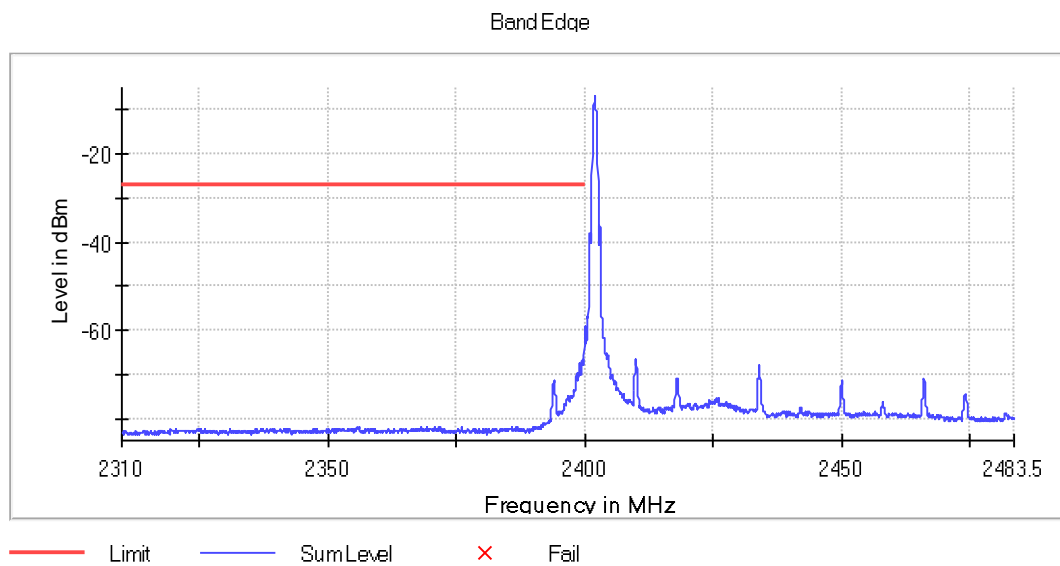
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.949972	-50	31,3	-18,7	PASS
2399.599778	-50,6	31,9	-18,7	PASS
2399.649805	-50,7	32	-18,7	PASS
2399.499722	-50,9	32,2	-18,7	PASS
2399.549750	-50,9	32,2	-18,7	PASS
2399.449694	-51,4	32,7	-18,7	PASS
2399.899944	-51,4	32,7	-18,7	PASS
2399.699833	-51,8	33,1	-18,7	PASS
2399.849917	-52,1	33,4	-18,7	PASS
2399.399666	-52,5	33,8	-18,7	PASS
2398.999444	-53	34,3	-18,7	PASS
2399.749861	-53	34,3	-18,7	PASS
2399.049472	-53	34,3	-18,7	PASS
2398.949416	-53,3	34,6	-18,7	PASS
2399.799889	-53,4	34,7	-18,7	PASS

Measurements, band edge high

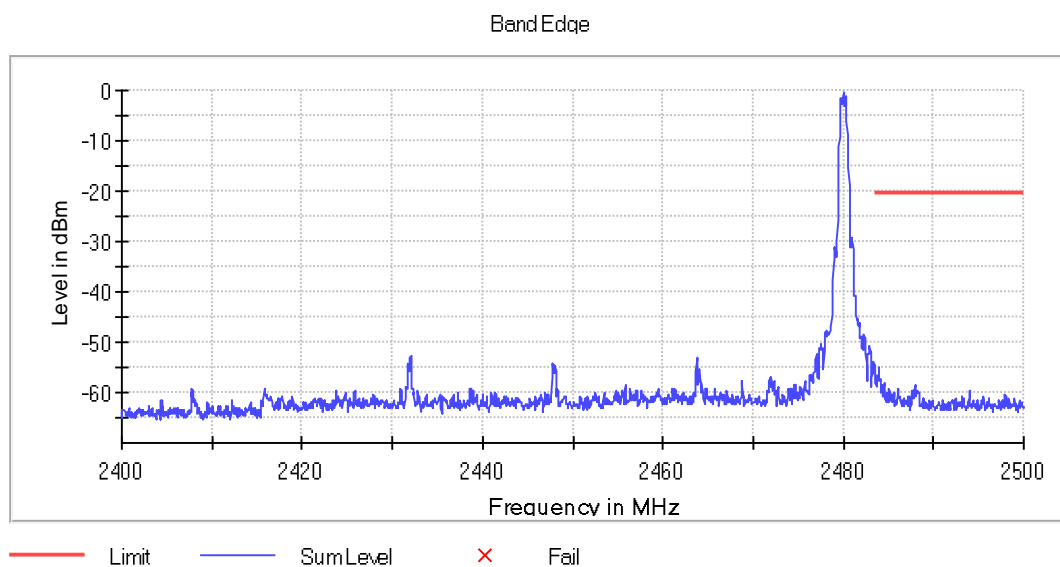
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.901216	-56,1	35,6	-20,5	PASS

2483.951368	-56,6	36,1	-20,5	PASS
2483.800912	-57,7	37,2	-20,5	PASS
2484.051672	-58,4	37,9	-20,5	PASS
2484.101824	-58,5	38	-20,5	PASS
2483.851064	-58,6	38,1	-20,5	PASS
2483.550152	-58,8	38,3	-20,5	PASS
2484.001520	-58,8	38,3	-20,5	PASS
2483.700608	-59,2	38,7	-20,5	PASS
2483.750760	-59,2	38,7	-20,5	PASS
2483.600304	-59,3	38,8	-20,5	PASS
2484.151976	-59,3	38,8	-20,5	PASS
2484.503040	-59,4	38,9	-20,5	PASS
2488.013678	-59,6	39,1	-20,5	PASS
2484.302432	-59,6	39,1	-20,5	PASS

Band edge, low channel



Band edge, high channel



14. Tx spurious emissions, conducted

Reference: FCC §15.247(d), ISED RSS-247, Issue 2 (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)
25910.013393	-65,2	-46,1	-19,1
25790.031250	-65,3	-46,2	-19,1
25770.034226	-65,4	-46,3	-19,1
25450.081845	-65,4	-46,3	-19,1
25880.017857	-65,5	-46,4	-19,1
25810.028274	-65,5	-46,4	-19,1
25830.025298	-65,6	-46,5	-19,1
25370.093750	-65,6	-46,5	-19,1
24960.154762	-65,6	-46,5	-19,1
25890.016369	-65,7	-46,6	-19,1
25990.001488	-65,7	-46,6	-19,1
25780.032738	-65,7	-46,6	-19,1
25850.022321	-65,7	-46,6	-19,1
25390.090774	-65,8	-46,7	-19,1
25970.004464	-65,8	-46,7	-19,1

Pre Measurements Middle channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25830.025298	-65,1	-45,1	-20
25770.034226	-65,3	-45,3	-20
25930.010417	-65,5	-45,5	-20
25760.035714	-65,5	-45,5	-20
25900.014881	-65,6	-45,6	-20
25810.028274	-65,6	-45,6	-20
25950.007440	-65,6	-45,6	-20
25910.013393	-65,6	-45,6	-20
25840.023810	-65,7	-45,7	-20
25870.019345	-65,7	-45,7	-20
25820.026786	-65,8	-45,8	-20
25850.022321	-65,8	-45,8	-20
25790.031250	-65,9	-45,9	-20

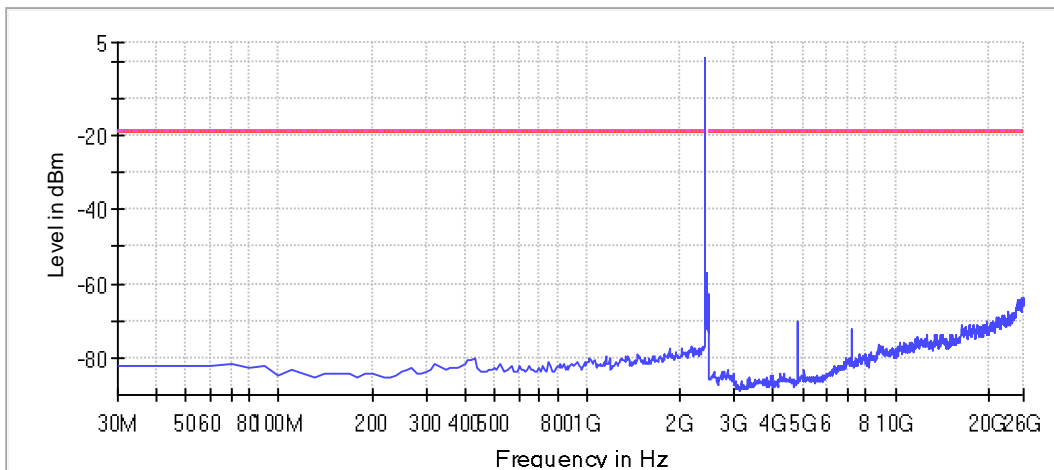
25310.102679	-65,9	-45,9	-20
25460.080357	-65,9	-45,9	-20

Pre Measurements Top channel

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
25400.089286	-54,5	-32	-22,5
25870.019345	-55,1	-32,6	-22,5
25820.026786	-55,3	-32,8	-22,5
25850.022321	-55,5	-33	-22,5
25890.016369	-55,6	-33,1	-22,5
25810.028274	-55,6	-33,1	-22,5
25830.025298	-55,7	-33,2	-22,5
25320.101190	-55,8	-33,3	-22,5
25860.020833	-55,9	-33,4	-22,5
25900.014881	-56	-33,5	-22,5
25880.017857	-56	-33,5	-22,5
25740.038690	-56	-33,5	-22,5
25390.090774	-56	-33,5	-22,5
25380.092262	-56	-33,5	-22,5
25840.023810	-56,1	-33,6	-22,5

Low channel

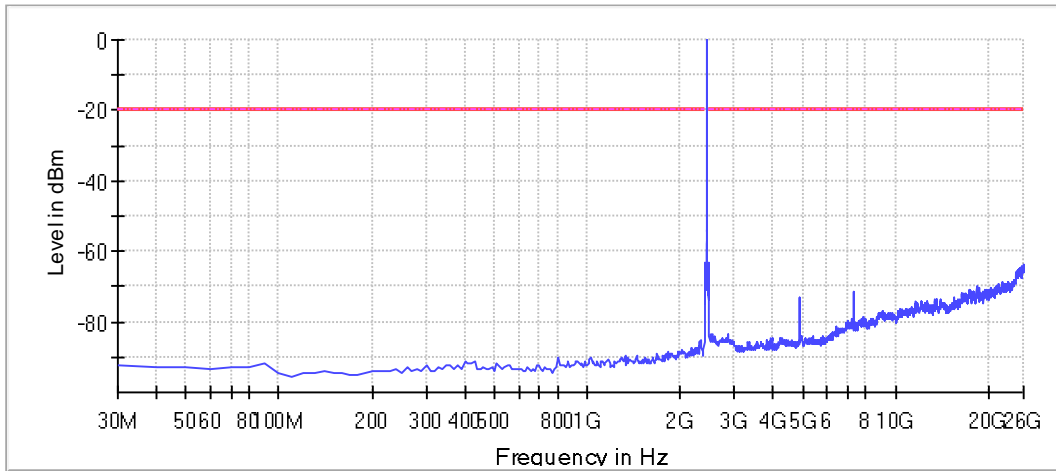
Spurious



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

Middle channel

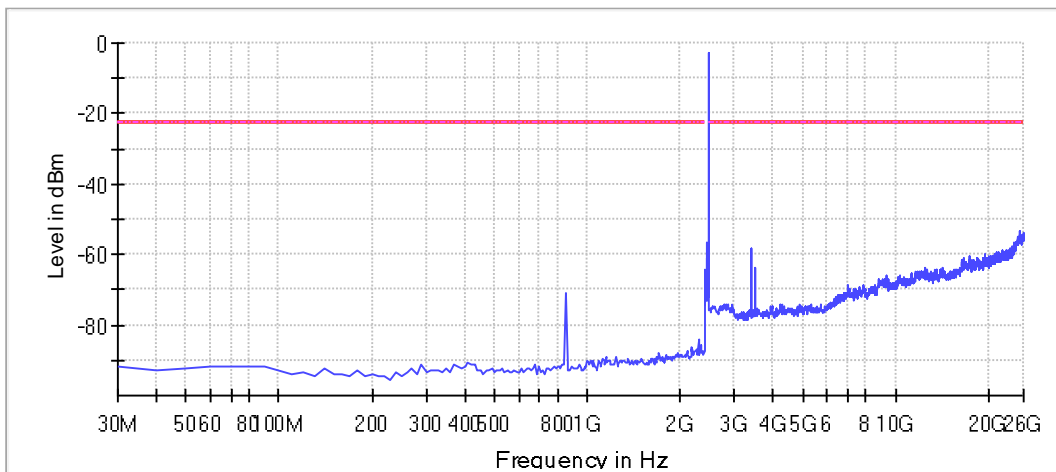
Spurious



— Limit — SumLevel - - - Threshold × Critical × FinalCritical

High channel

Spurious



— Limit — SumLevel - - - Threshold × Critical × FinalCritical

15. Tx spurious emissions, radiated

Reference: FCC §15.247(d), FCC §15.209, ISED 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

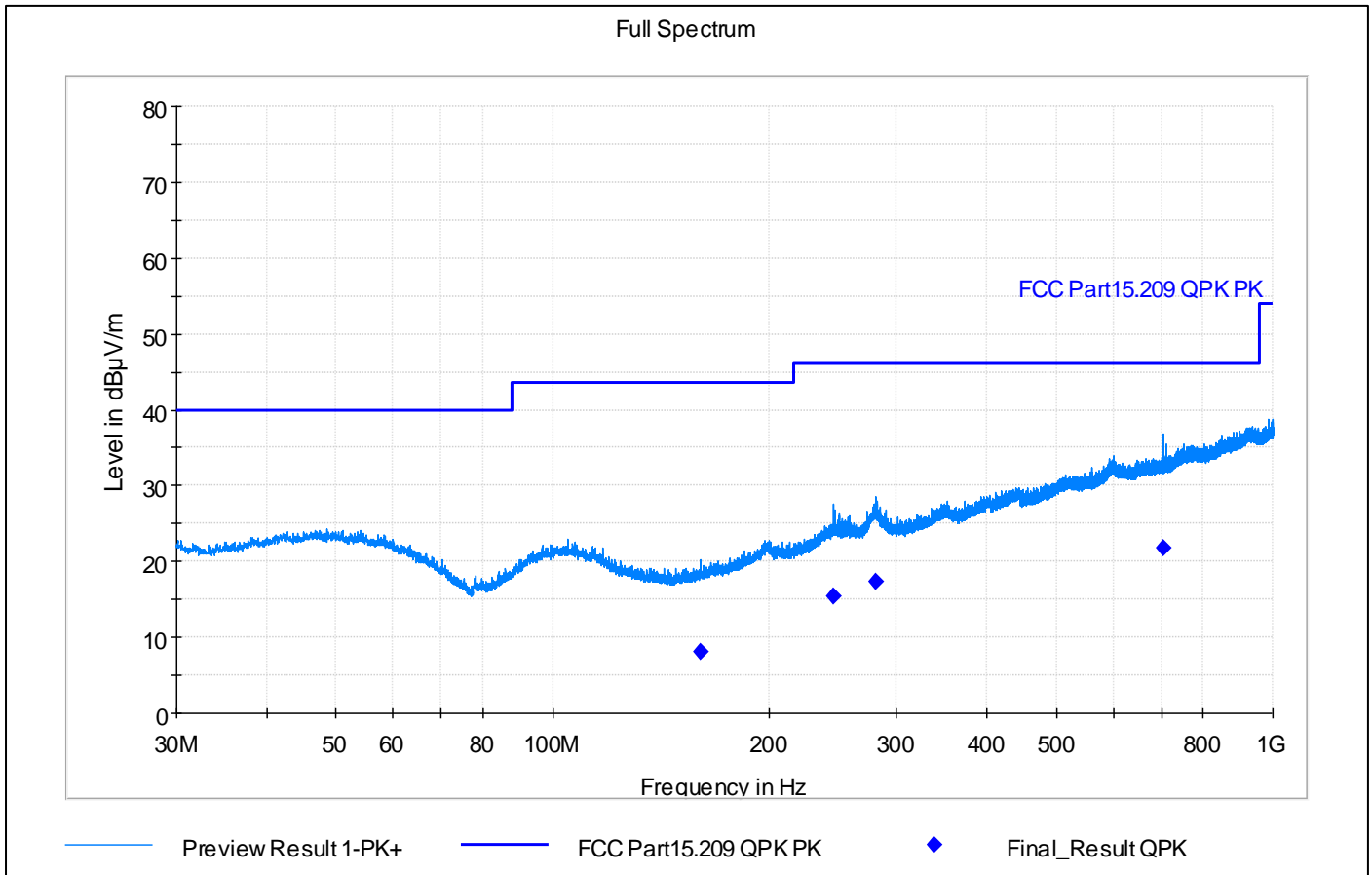
1. EUT is placed on a non conducting support at the center of a turn table 1.5m above the ground
2. EUT set to test mode
3. The receiver is set to peak detection with max hold
4. The EUT is rotated through 360 degrees (orientation varied), measurements were made in both horizontal and vertical planes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

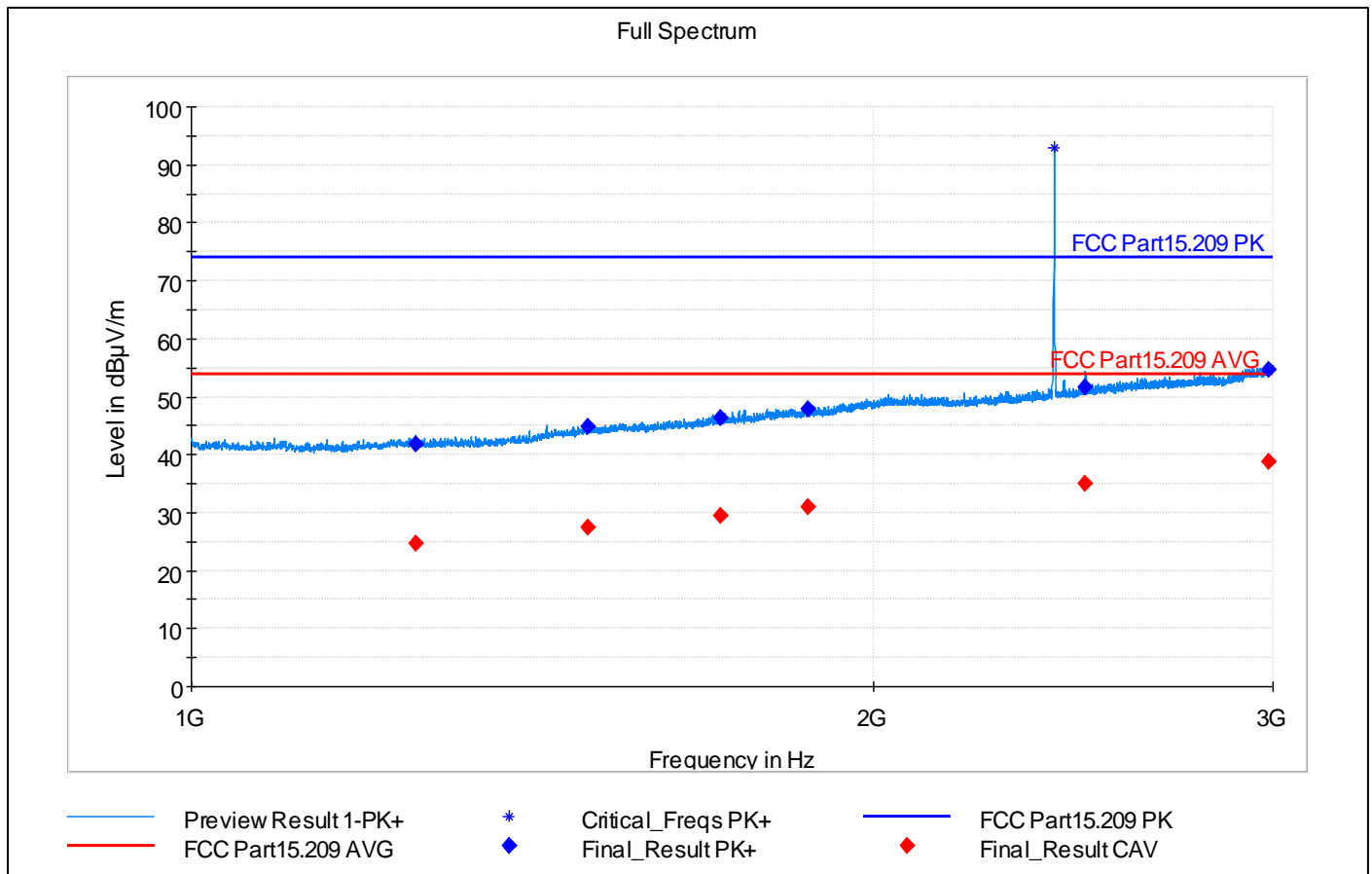
Low channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
160.29000	8.07	---	43.50	35.43	15000.	120.000	277.0	V	247.0	180.0	16.6	PASS
245.25000	15.40	---	46.00	30.60	15000.	120.000	105.0	H	200.0	0.0	21.3	PASS
280.77000	17.44	---	46.00	28.56	15000.	120.000	102.0	H	192.0	0.0	21.9	PASS
705.39000	21.85	---	46.00	24.15	15000.	120.000	127.0	H	282.0	90.0	30.5	PASS

Low channel, 1 – 3 GHz



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

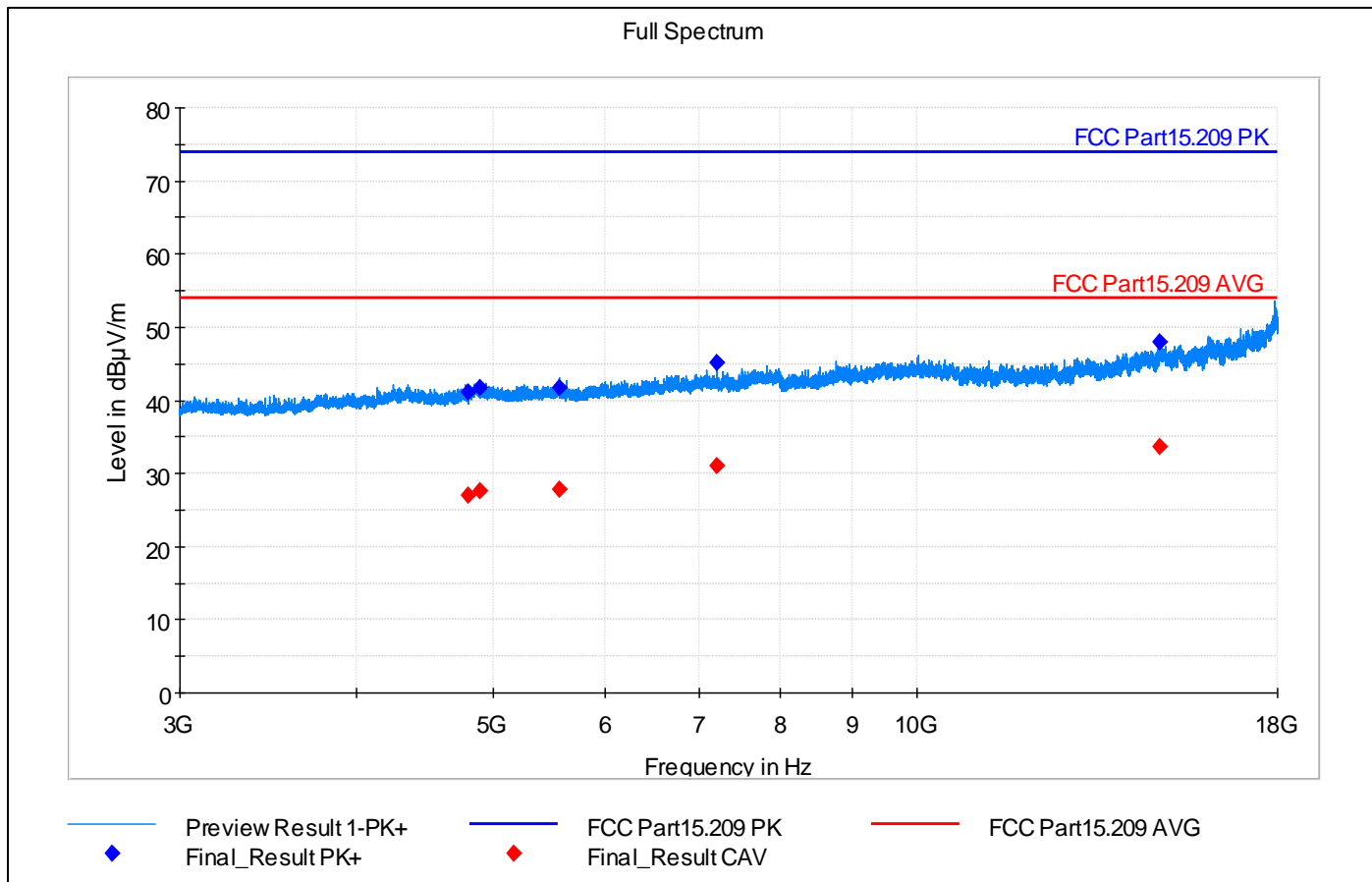
Critical Freqs

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)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1255.50000	41.89	---	74.00	32.11	15000.	1000.000	244.0	V	157.0	0.0	31.2	PASS
1255.50000	---	24.66	54.00	29.34	15000.	1000.000	244.0	V	157.0	0.0	31.2	PASS
1497.00000	44.81	---	74.00	29.19	15000.	1000.000	288.0	H	314.0	90.0	33.2	PASS
1497.00000	---	27.51	54.00	26.49	15000.	1000.000	288.0	H	314.0	90.0	33.2	PASS
1711.50000	---	29.52	54.00	24.48	15000.	1000.000	410.0	V	179.0	90.0	34.4	PASS
1711.50000	46.47	---	74.00	27.53	15000.	1000.000	410.0	V	179.0	90.0	34.4	PASS
1870.00000	47.87	---	74.00	26.13	15000.	1000.000	278.0	V	-15.0	90.0	35.3	PASS
1870.00000	---	30.99	54.00	23.01	15000.	1000.000	278.0	V	-15.0	90.0	35.3	PASS
2480.00000	---	34.89	54.00	19.11	15000.	1000.000	400.0	H	310.0	90.0	38.6	PASS
2480.00000	51.64	---	74.00	22.36	15000.	1000.000	400.0	H	310.0	90.0	38.6	PASS
2987.00000	54.70	---	74.00	19.30	15000.	1000.000	370.0	V	311.0	90.0	40.8	PASS
2987.00000	---	38.91	54.00	15.09	15000.	1000.000	370.0	V	311.0	90.0	40.8	PASS

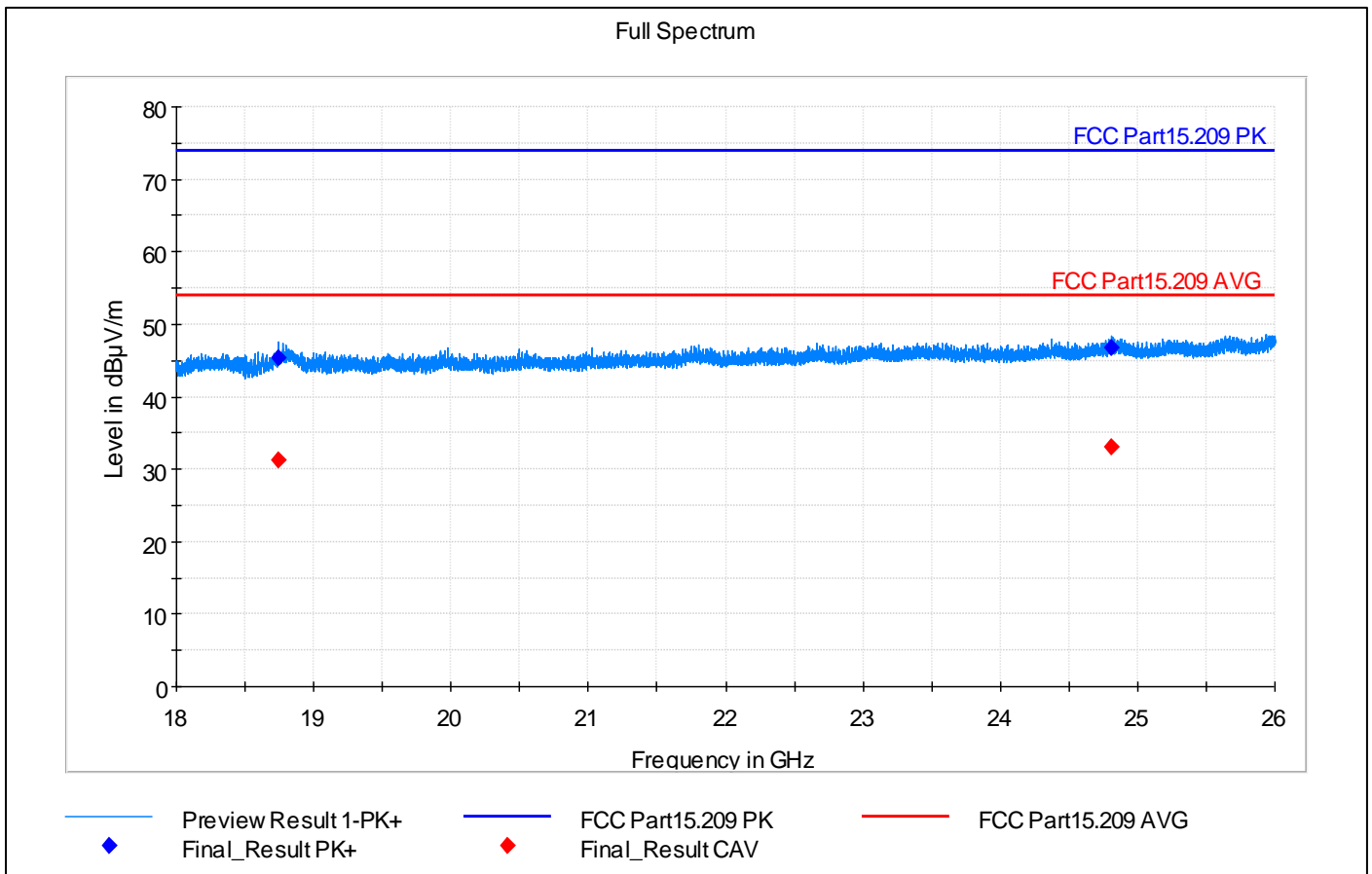
Low channel, 3 – 18 GHz



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
4803.750000	---	27.10	54.00	26.90	15000.	1000.000	301.0	V	-9.0	180.0	9.0	PASS
4803.750000	41.15	---	74.00	32.85	15000.	1000.000	301.0	V	-9.0	180.0	9.0	PASS
4901.000000	---	27.64	54.00	26.36	15000.	1000.000	228.0	V	-11.0	180.0	9.3	PASS
4901.000000	41.79	---	74.00	32.21	15000.	1000.000	228.0	V	-11.0	180.0	9.3	PASS
5568.500000	---	27.75	54.00	26.25	15000.	1000.000	307.0	H	8.0	180.0	10.1	PASS
5568.500000	41.69	---	74.00	32.31	15000.	1000.000	307.0	H	8.0	180.0	10.1	PASS
7205.250000	45.20	---	74.00	28.80	15000.	1000.000	106.0	H	65.0	180.0	13.5	PASS
7205.250000	---	30.94	54.00	23.06	15000.	1000.000	106.0	H	65.0	180.0	13.5	PASS
14844.000000	47.88	---	74.00	26.12	15000.	1000.000	106.0	H	117.0	180.0	27.0	PASS
14844.000000	---	33.62	54.00	20.38	15000.	1000.000	106.0	H	117.0	180.0	27.0	PASS

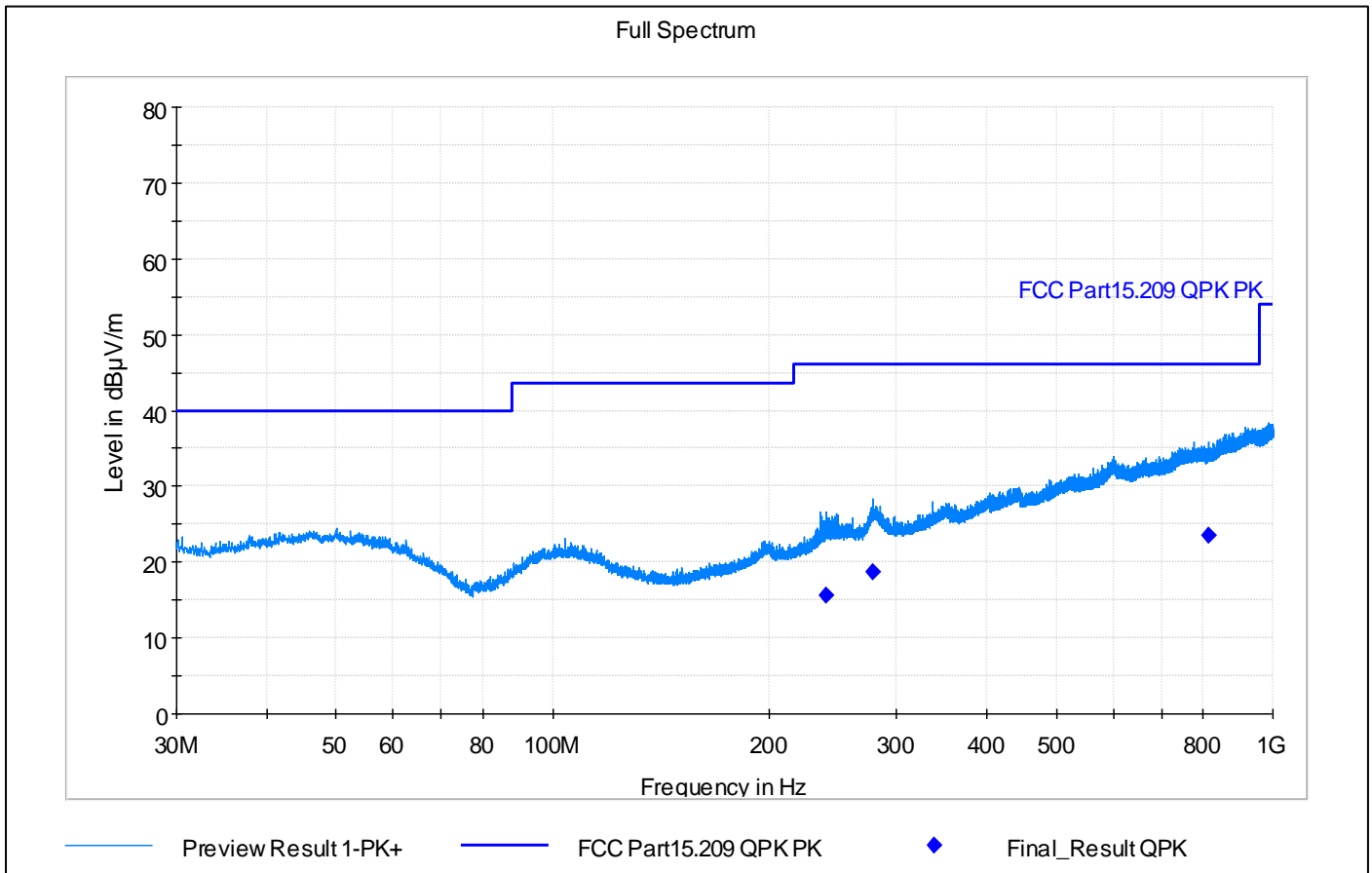
Low channel, 18 – 26 GHz



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
18744.00000	---	31.33	54.00	22.67	3000.	1000.000	112.0	V	265.0	0.0	23.5	PASS
18744.00000	45.39	---	74.00	28.61	3000.	1000.000	112.0	V	265.0	0.0	23.5	PASS
24807.00000	---	33.02	54.00	20.98	3000.	1000.000	212.0	H	22.0	0.0	26.5	PASS
24807.00000	46.85	---	74.00	27.15	3000.	1000.000	212.0	H	22.0	0.0	26.5	PASS

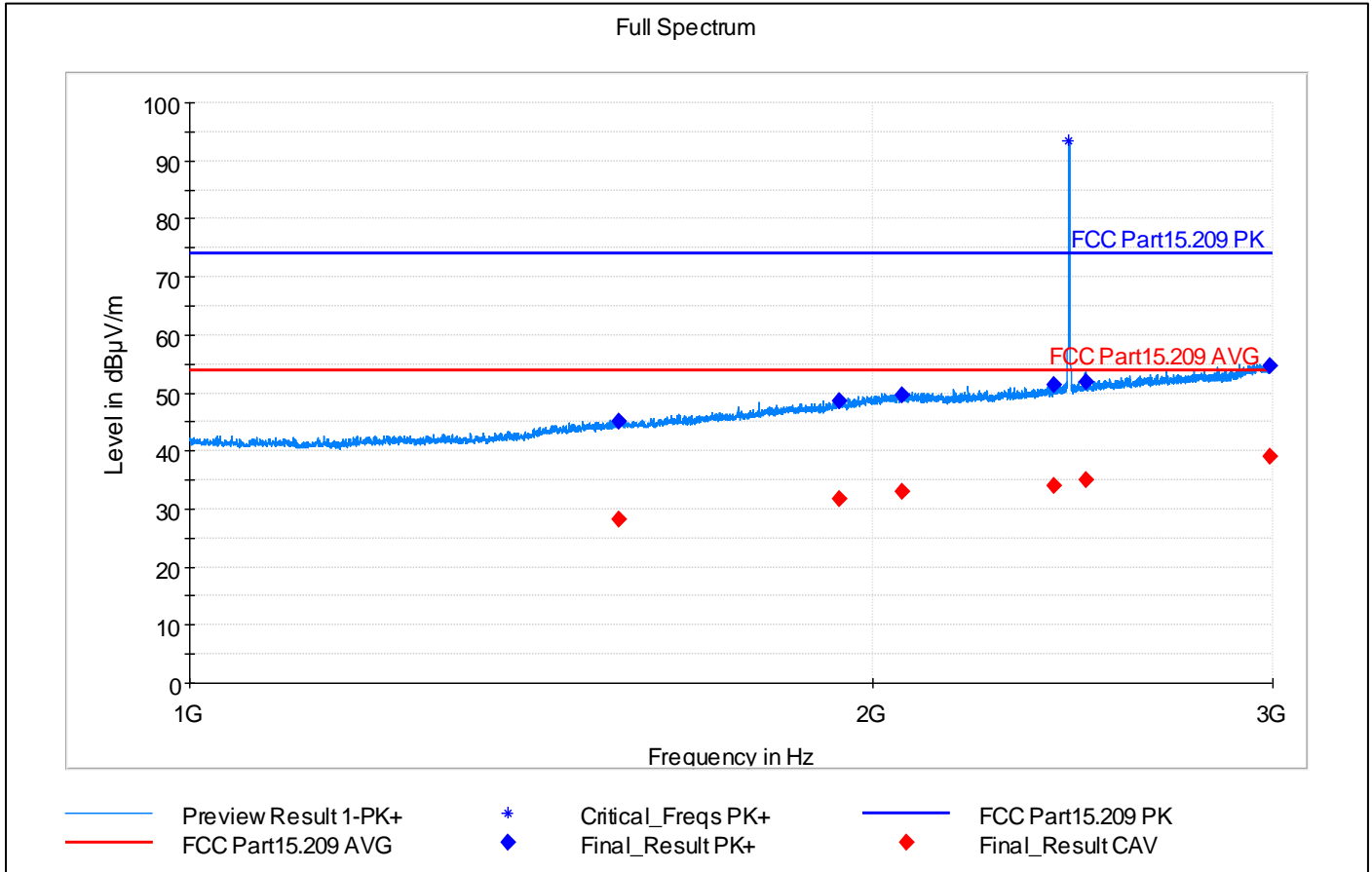
Mid channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
239.82000	15.58	---	46.00	30.42	15000.	120.000	112.0	H	158.0	90.0	21.1	PASS
278.28000	18.74	---	46.00	27.26	15000.	120.000	106.0	H	-21.0	90.0	21.8	PASS
812.67000	23.45	---	46.00	22.55	15000.	120.000	168.0	H	73.0	90.0	32.2	PASS

Mid channel, 1-3 GHz



Note: Frequency 2440,000 MHz is excluded from spurious domain measurements and ignored. See table below.

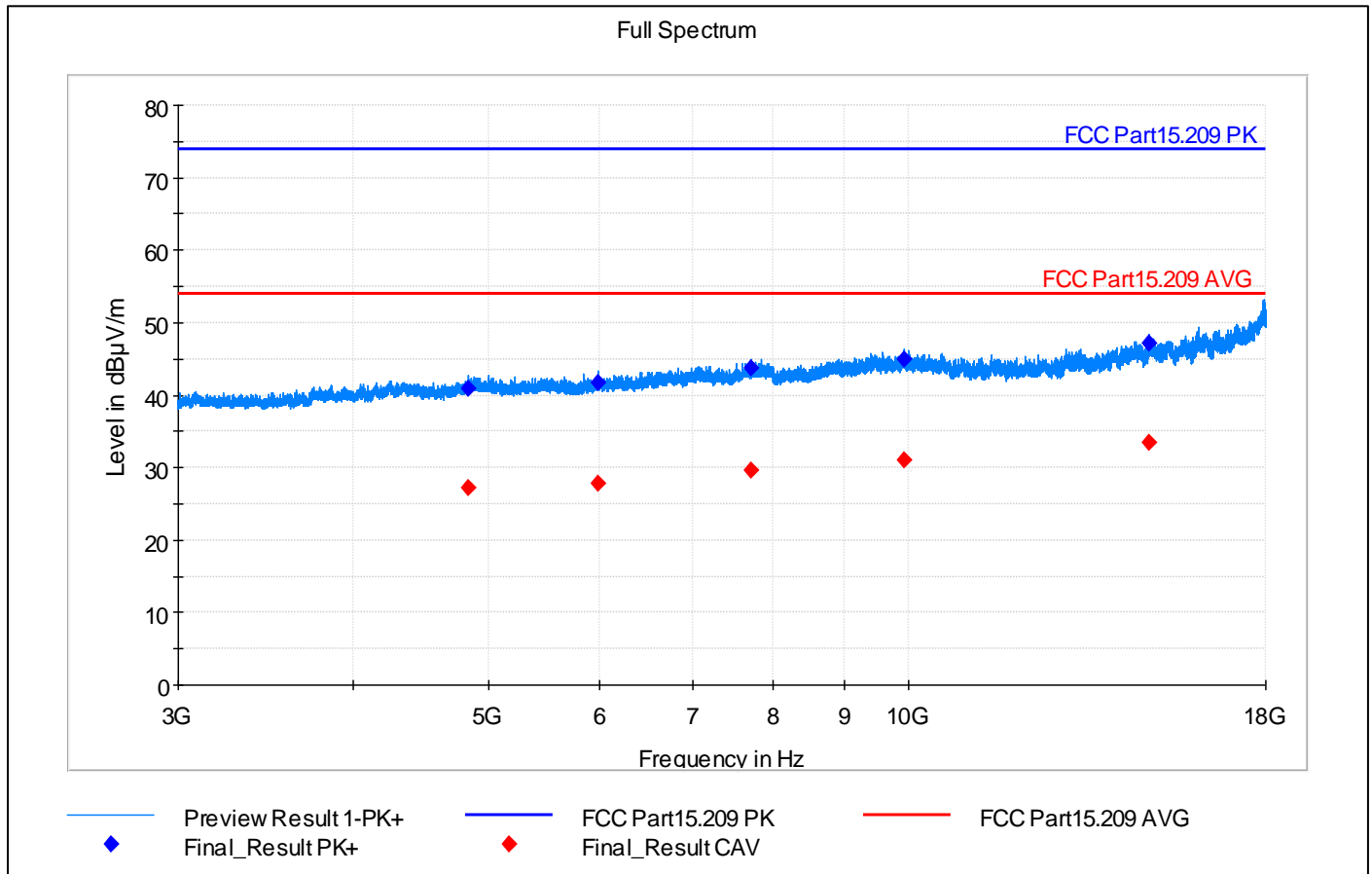
Critical Freqs

Frequency (MHz)	Comment
2440.00000	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)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1544.50000	---	28.18	54.00	25.82	15000.	1000.000	186.0	V	273.0	180.0	33.7	PASS
1544.50000	44.97	---	74.00	29.03	15000.	1000.000	186.0	V	273.0	180.0	33.7	PASS
1931.75000	---	31.62	54.00	22.38	15000.	1000.000	410.0	H	70.0	0.0	36.0	PASS
1931.75000	48.52	---	74.00	25.48	15000.	1000.000	410.0	H	70.0	0.0	36.0	PASS
2060.75000	---	32.91	54.00	21.09	15000.	1000.000	201.0	H	113.0	180.0	37.1	PASS
2060.75000	49.60	---	74.00	24.40	15000.	1000.000	201.0	H	113.0	180.0	37.1	PASS
2402.00000	---	34.08	54.00	19.92	15000.	1000.000	289.0	V	62.0	0.0	38.0	PASS
2402.00000	51.41	---	74.00	22.59	15000.	1000.000	289.0	V	62.0	0.0	38.0	PASS
2480.25000	51.95	---	74.00	22.05	15000.	1000.000	350.0	V	4.0	90.0	38.6	PASS
2480.25000	---	34.97	54.00	19.03	15000.	1000.000	350.0	V	4.0	90.0	38.6	PASS
2992.75000	54.66	---	74.00	19.34	15000.	1000.000	213.0	H	152.0	90.0	40.9	PASS
2992.75000	---	39.02	54.00	14.98	15000.	1000.000	213.0	H	152.0	90.0	40.9	PASS

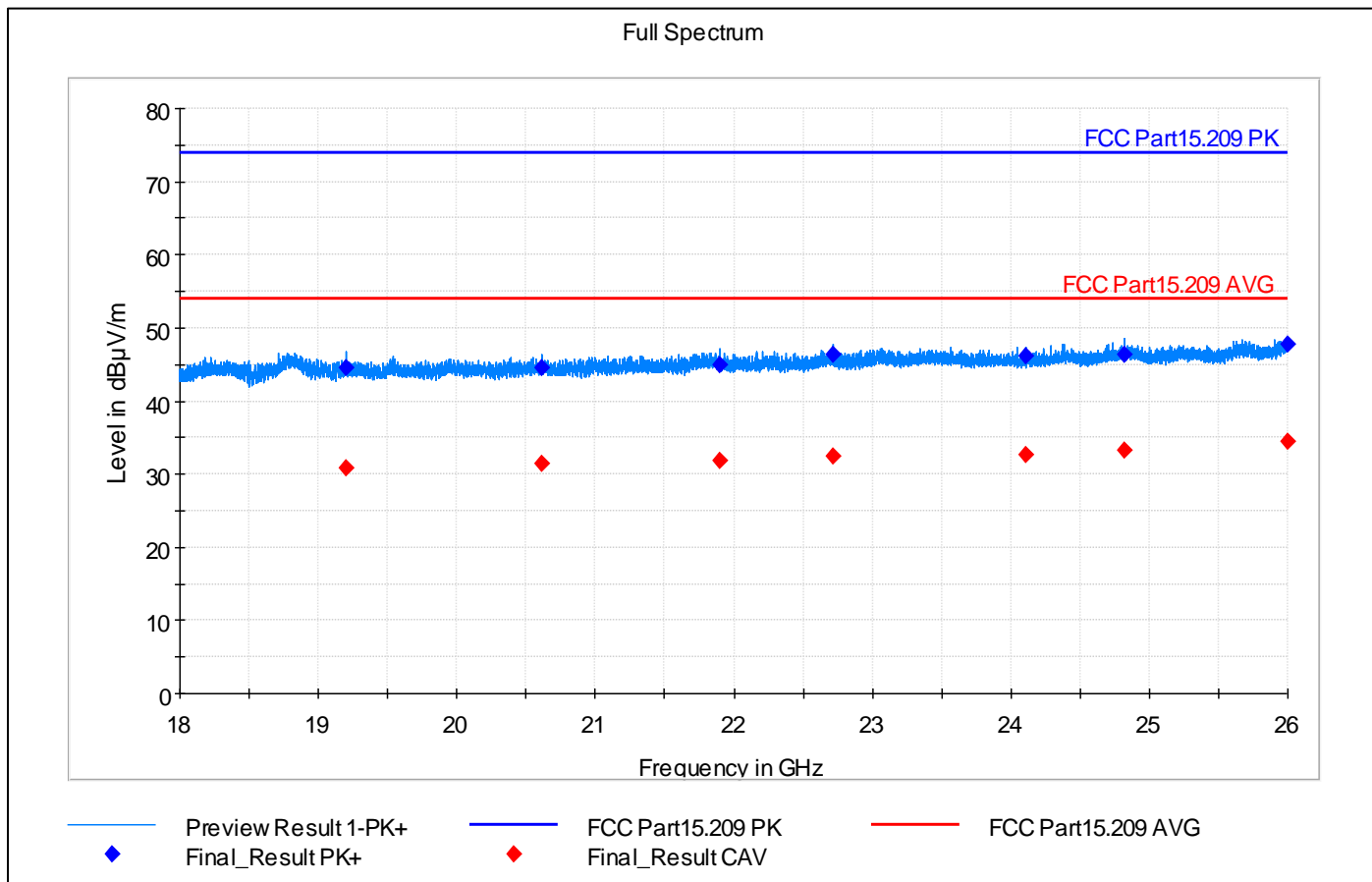
Mid channel, 3–18 GHz



Final Result

Frequency (MHz)	MaxPeak	CAverage	Limit (dBµV/)	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Elevation	Corr. (dB/m)	Comment
4834.000000	---	27.17	54.00	26.83	15000.	1000.000	301.0	V	64.0	180.0	9.3	PASS
4834.000000	40.90	---	74.00	33.10	15000.	1000.000	301.0	V	64.0	180.0	9.3	PASS
5996.000000	---	27.81	54.00	26.19	15000.	1000.000	146.0	V	223.0	180.0	10.8	PASS
5996.000000	41.66	---	74.00	32.34	15000.	1000.000	146.0	V	223.0	180.0	10.8	PASS
7716.750000	---	29.57	54.00	24.43	15000.	1000.000	410.0	V	-7.0	180.0	14.7	PASS
7716.750000	43.73	---	74.00	30.27	15000.	1000.000	410.0	V	-7.0	180.0	14.7	PASS
9917.250000	44.88	---	74.00	29.12	15000.	1000.000	406.0	V	100.0	90.0	18.1	PASS
9917.250000	---	30.98	54.00	23.02	15000.	1000.000	406.0	V	100.0	90.0	18.1	PASS
14845.750000	47.12	---	74.00	26.88	15000.	1000.000	105.0	H	199.0	90.0	27.0	PASS
14845.750000	---	33.52	54.00	20.48	15000.	1000.000	105.0	H	199.0	90.0	27.0	PASS

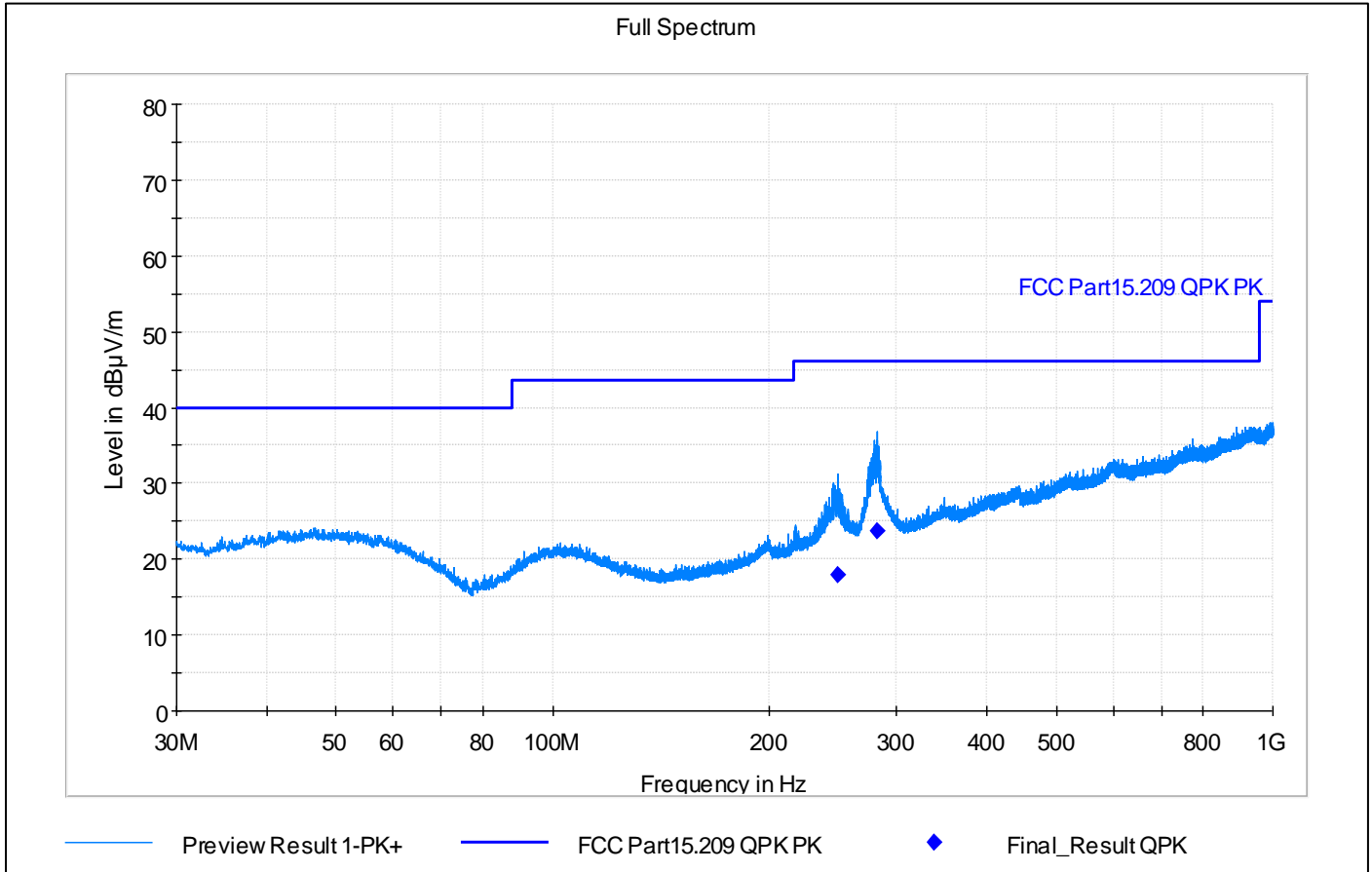
Mid channel, 18–26 GHz



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
19197.25000	44.56	---	74.00	29.44	3000.	1000.000	407.0	V	141.0	0.0	23.7	PASS
19197.25000	---	30.92	54.00	23.08	3000.	1000.000	407.0	V	141.0	0.0	23.7	PASS
20608.75000	---	31.42	54.00	22.58	3000.	1000.000	128.0	V	27.0	90.0	24.2	PASS
20608.75000	44.55	---	74.00	29.45	3000.	1000.000	128.0	V	27.0	90.0	24.2	PASS
21894.75000	---	31.77	54.00	22.23	3000.	1000.000	134.0	H	220.0	0.0	24.8	PASS
21894.75000	44.92	---	74.00	29.08	3000.	1000.000	134.0	H	220.0	0.0	24.8	PASS
22720.25000	---	32.44	54.00	21.56	3000.	1000.000	170.0	H	119.0	90.0	25.4	PASS
22720.25000	46.26	---	74.00	27.74	3000.	1000.000	170.0	H	119.0	90.0	25.4	PASS
24112.75000	46.05	---	74.00	27.95	3000.	1000.000	410.0	V	282.0	0.0	26.1	PASS
24112.75000	---	32.58	54.00	21.42	3000.	1000.000	410.0	V	282.0	0.0	26.1	PASS
24818.75000	46.37	---	74.00	27.63	3000.	1000.000	248.0	V	214.0	90.0	26.5	PASS
24818.75000	---	33.35	54.00	20.65	3000.	1000.000	248.0	V	214.0	90.0	26.5	PASS
25996.00000	47.72	---	74.00	26.28	3000.	1000.000	176.0	V	100.0	90.0	27.0	PASS
25996.00000	---	34.55	54.00	19.45	3000.	1000.000	176.0	V	100.0	90.0	27.0	PASS

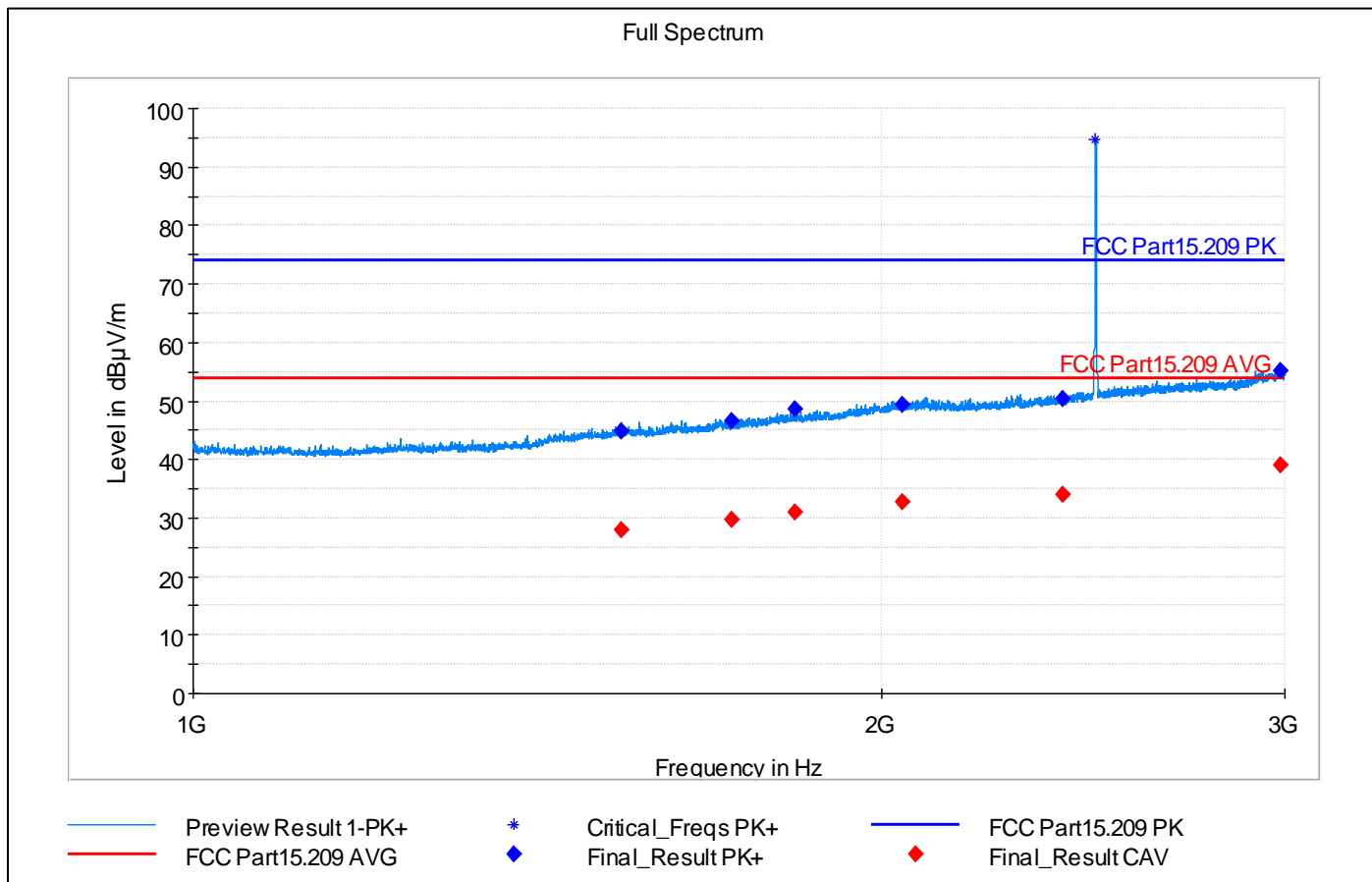
High channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
249.03000	18.01	---	46.00	27.99	15000.	120.000	117.0	H	186.0	90.0	21.4	PASS
281.88000	23.68	---	46.00	22.32	15000.	120.000	134.0	H	202.0	90.0	21.9	PASS

High channel, 1 – 3 GHz



Note: Frequency 2479,750 MHz is excluded from spurious domain measurements and ignored. See table below.

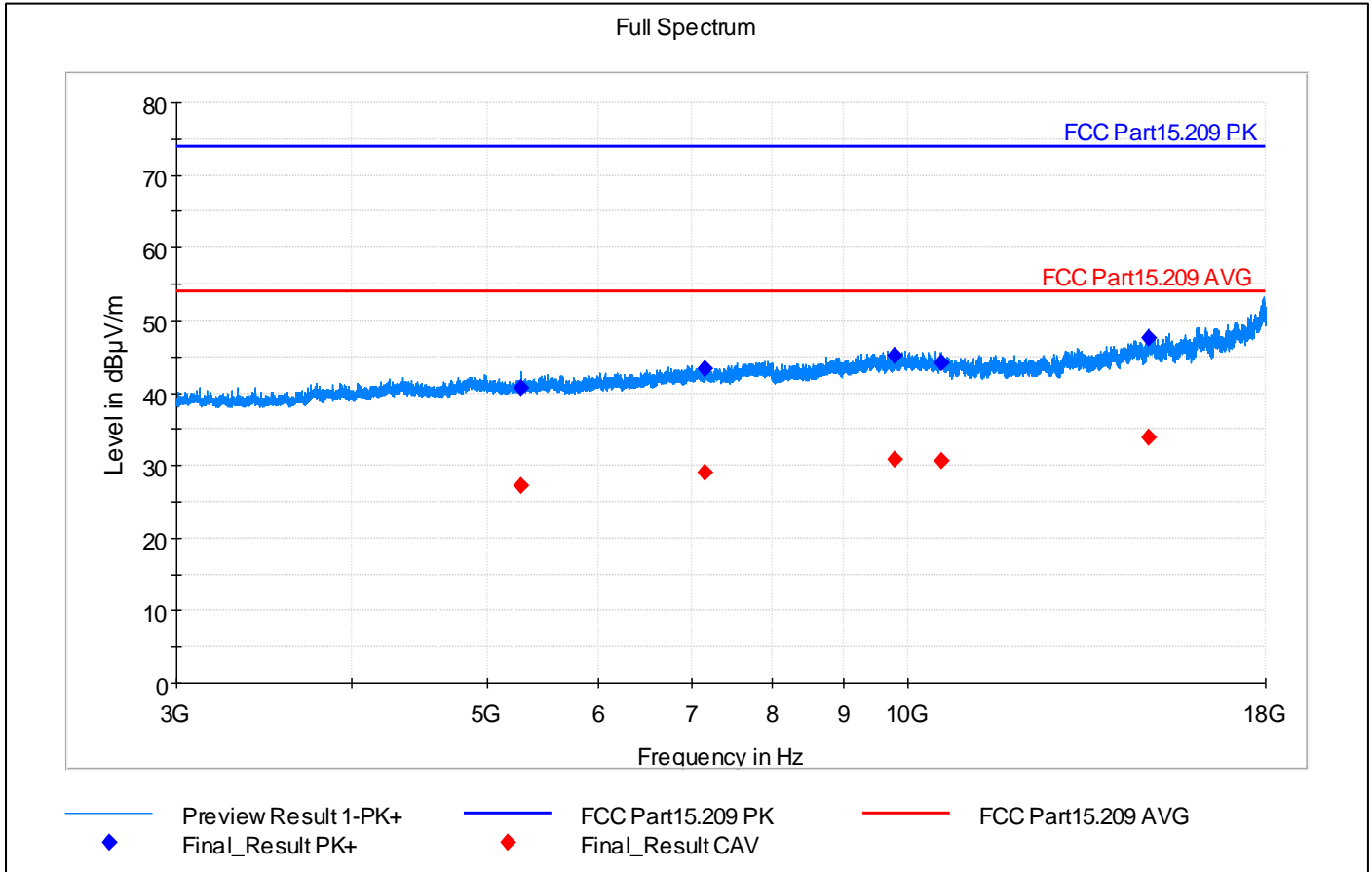
Critical_Freqs

Frequency (MHz)	Comment
2479.750000	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)	Po l	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
1537.50000	44.96	---	74.00	29.04	15000.	1000.000	268.0	V	205.0	0.0	33.6	PASS
1537.50000	---	28.07	54.00	25.93	15000.	1000.000	268.0	V	205.0	0.0	33.6	PASS
1720.00000	46.55	---	74.00	27.45	15000.	1000.000	199.0	H	22.0	0.0	34.4	PASS
1720.00000	---	29.62	54.00	24.38	15000.	1000.000	199.0	H	22.0	0.0	34.4	PASS
1832.75000	---	30.91	54.00	23.09	15000.	1000.000	211.0	H	105.0	180.0	35.0	PASS
1832.75000	48.57	---	74.00	25.43	15000.	1000.000	211.0	H	105.0	180.0	35.0	PASS
2042.50000	---	32.80	54.00	21.20	15000.	1000.000	155.0	V	168.0	180.0	37.1	PASS
2042.50000	49.39	---	74.00	24.61	15000.	1000.000	155.0	V	168.0	180.0	37.1	PASS
2399.75000	50.37	---	74.00	23.63	15000.	1000.000	343.0	H	31.0	0.0	38.0	PASS
2399.75000	---	34.01	54.00	19.99	15000.	1000.000	343.0	H	31.0	0.0	38.0	PASS
2986.25000	55.17	---	74.00	18.83	15000.	1000.000	140.0	V	-1.0	0.0	40.8	PASS
2986.25000	---	38.96	54.00	15.04	15000.	1000.000	140.0	V	-1.0	0.0	40.8	PASS

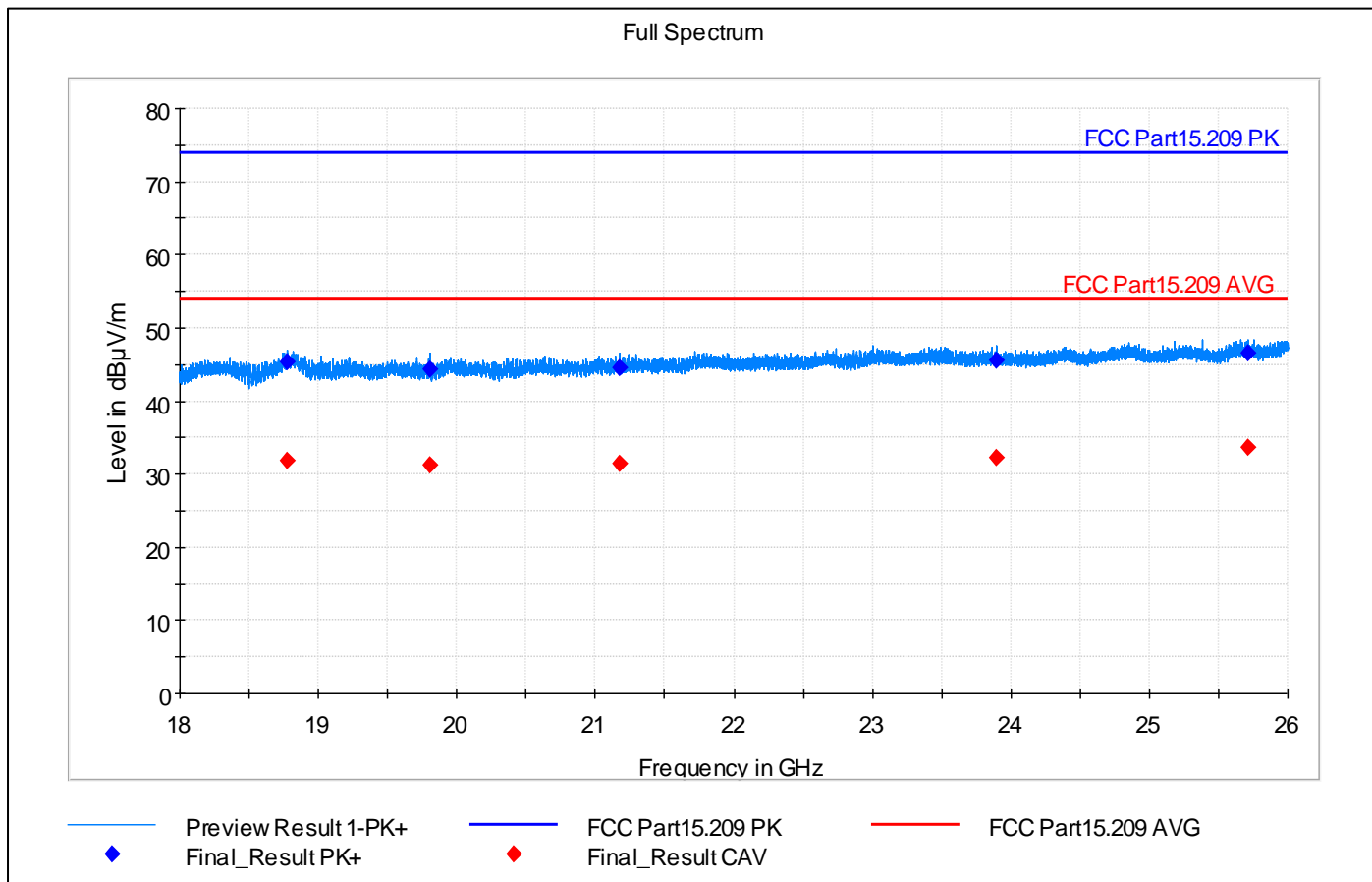
High channel, 3 – 18 GHz



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
5282.750000	40.75	---	74.00	33.25	15000.	1000.000	410.0	H	-6.0	180.0	9.5	PASS
5282.750000	---	27.26	54.00	26.74	15000.	1000.000	410.0	H	-6.0	180.0	9.5	PASS
7163.250000	---	28.98	54.00	25.02	15000.	1000.000	324.0	V	314.0	180.0	13.4	PASS
7163.250000	43.28	---	74.00	30.72	15000.	1000.000	324.0	V	314.0	180.0	13.4	PASS
9788.500000	---	30.75	54.00	23.25	15000.	1000.000	357.0	V	63.0	90.0	17.5	PASS
9788.500000	45.12	---	74.00	28.88	15000.	1000.000	357.0	V	63.0	90.0	17.5	PASS
10550.500000	---	30.72	54.00	23.28	15000.	1000.000	170.0	H	81.0	180.0	18.5	PASS
10550.500000	44.14	---	74.00	29.86	15000.	1000.000	170.0	H	81.0	180.0	18.5	PASS
14844.250000	47.55	---	74.00	26.45	15000.	1000.000	173.0	V	63.0	180.0	27.0	PASS
14844.250000	---	33.81	54.00	20.19	15000.	1000.000	173.0	V	63.0	180.0	27.0	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)	Comment
18777.75000	45.30	---	74.00	28.70	3000.	1000.000	113.0	V	205.0	180.0	23.5	PASS
18777.75000	---	31.89	54.00	22.11	3000.	1000.000	113.0	V	205.0	180.0	23.5	PASS
19801.75000	---	31.29	54.00	22.71	3000.	1000.000	149.0	H	227.0	90.0	24.0	PASS
19801.75000	44.25	---	74.00	29.75	3000.	1000.000	149.0	H	227.0	90.0	24.0	PASS
21178.25000	---	31.50	54.00	22.50	3000.	1000.000	374.0	H	254.0	90.0	24.5	PASS
21178.25000	44.44	---	74.00	29.56	3000.	1000.000	374.0	H	254.0	90.0	24.5	PASS
23894.00000	---	32.31	54.00	21.69	3000.	1000.000	315.0	V	109.0	0.0	25.8	PASS
23894.00000	45.64	---	74.00	28.36	3000.	1000.000	315.0	V	109.0	0.0	25.8	PASS
25717.00000	46.60	---	74.00	27.40	3000.	1000.000	214.0	V	287.0	90.0	26.8	PASS
25717.00000	---	33.74	54.00	20.26	3000.	1000.000	214.0	V	287.0	90.0	26.8	PASS

16. Receiver spurious emissions, radiated

Reference: ISED RSS-247, Issue 2 (section 3.1)

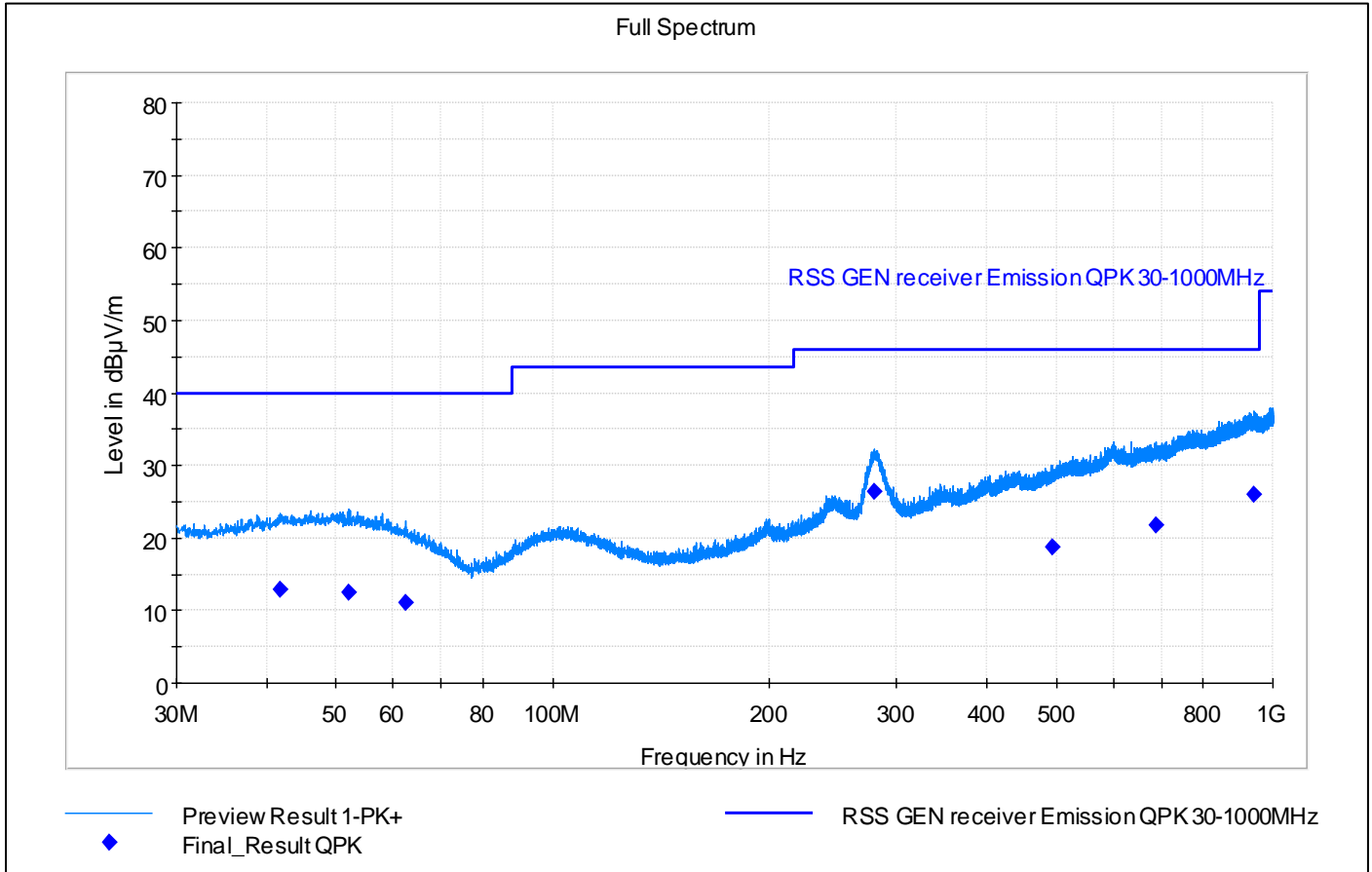
Test method: ANSI C63.4-2014 (8.1 – 8.3)

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
<ol style="list-style-type: none"> 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

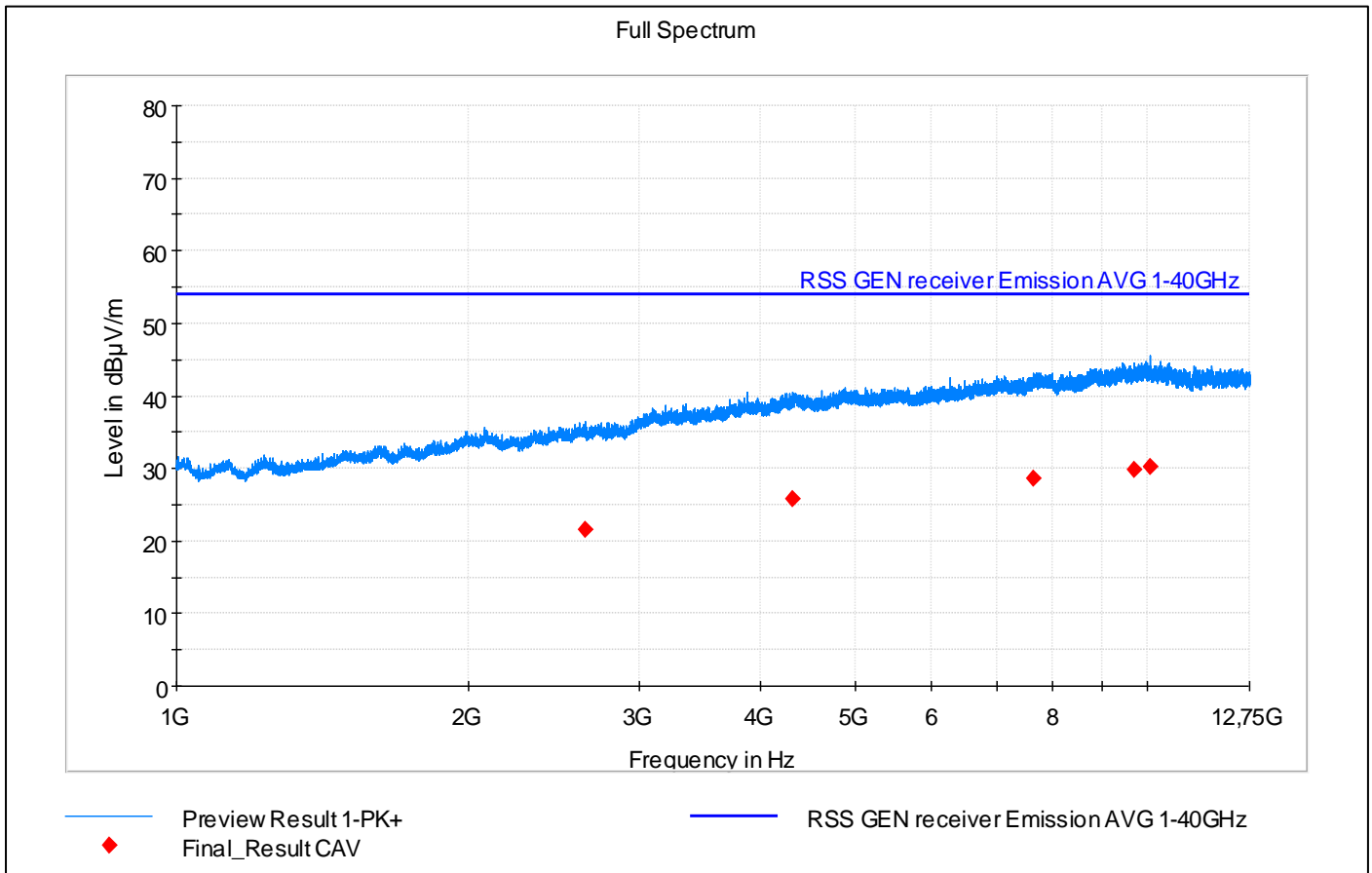
Mid channel, 30 MHz – 1 GHz



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB/m)	Comment
41.760000	12.81	40.00	27.19	15000.0	120.000	235.0	H	248.0	0.0	20.0	PASS
51.960000	12.40	40.00	27.60	15000.0	120.000	134.0	H	46.0	0.0	21.0	PASS
62.520000	11.18	40.00	28.82	15000.0	120.000	269.0	V	136.0	0.0	19.4	PASS
280.140000	26.45	46.00	19.55	15000.0	120.000	102.0	H	-12.0	0.0	21.9	PASS
495.180000	18.75	46.00	27.25	15000.0	120.000	298.0	V	301.0	0.0	27.1	PASS
689.640000	21.82	46.00	24.18	15000.0	120.000	303.0	H	180.0	0.0	30.4	PASS
940.920000	26.07	46.00	19.93	15000.0	120.000	296.0	H	292.0	0.0	34.1	PASS

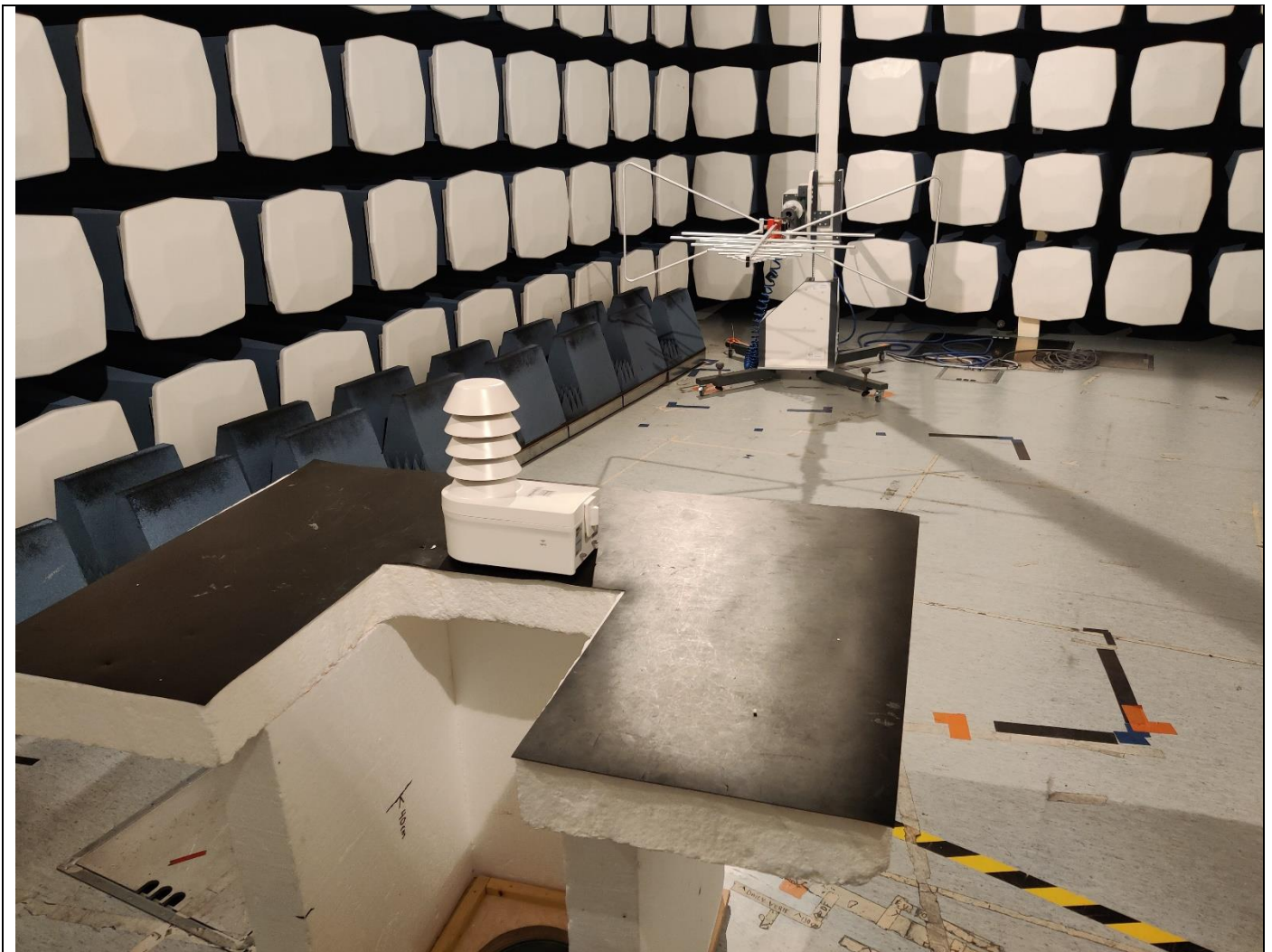
Mid channel, 1 GHz – 12,75 GHz



Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
2634.250000	---	21.64	54.00	32.36	500.0	1000.000	337.0	H	87.0	0.8	PASS
4315.500000	---	25.88	54.00	28.12	500.0	1000.000	344.0	V	39.0	7.6	PASS
7638.000000	---	28.60	54.00	25.40	500.0	1000.000	251.0	H	7.0	14.0	PASS
9710.750000	---	29.86	54.00	24.14	500.0	1000.000	189.0	H	157.0	16.9	PASS
10065.500000	---	30.14	54.00	23.86	500.0	1000.000	132.0	H	293.0	17.5	PASS

17. Photographs – Test Setups



Picture 1, 30 – 1000 MHz, common setup



Picture 2, 30 – 1000 MHz, EUT setup



Picture 3, 1 – 12,75 GHz, common setup



Picture 4, 1 – 12,75 GHz, EUT setup