



**FCC PART 15 SUBPART C
ISED RSS-247 ISSUE 2**

TEST REPORT

For

Dragon Staff

MODEL NUMBER: RH18, CCD18

REPORT NUMBER: UL20211019-000517-WFC

FCC ID: RFD-RH18

IC: 3177A-RH18

ISSUE DATE: 7/22/2022

Prepared for

Leica Geosystems AG

Prepared by

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Revision History

Rev.	Issue Date	Revisions	Revised By
0	7/22/2022	Initial Issue	



Summary of Test Results			
Clause	Test Items	FCC Requirements	Test Results
1	20dB Bandwidth	FCC 15.247 (a) (1) RSS-247 Clause 5.1	Pass
2	Frequency Separation	FCC 15.247 (a)(1) RSS-247 Clause 5.1	Pass
3	Number of Hopping Frequencies	FCC 15.247 (a)(1)(iii) RSS-247 Clause 5.1	Pass
4	Dwell Time	FCC 15.247 (a)(1)(iii) RSS-247 Clause 5.1	Pass
5	Peak and Average Conducted Power	FCC 15.247 (b) (3) RSS-247 Clause 5.4	Pass
6	Conducted Band edge And Spurious emission	FCC 15.247 (d) RSS-247 Clause 5.5	Pass
7	Radiated Band edge And Radiated Spurious Emission	FCC 15.247 (d) FCC 15.209 FCC 15.205 RSS-247 Clause 5.5 RSS-GEN Clause 8.9	Pass
8	Conducted Emission Test for AC Power Port *	FCC 15.207 RSS-GEN Clause 8.8	Not Applicable
9	Antenna Requirement *	FCC 15.203 RSS-GEN Clause 8.3	Pass

* Conducted Emission Test is not applicable due to battery operated product

* The EUT uses a permanently attached antenna, with gain 1dBi and 2.3dBi, in accordance with 47 CFR § 15.203, it shall be considered sufficient to comply with the provisions of this section.

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1. ATTESTATION OF TEST RESULTS

Applicant Information

Company Name: Leica Geosystems - Part of Hexagon
Address: Heinrich Wild Strasse, 9435 Heerbrugg, Switzerland

Manufacturer Information

Company Name: Graf Elektronik GmbH
Address: In Steinen 5, 6850 Dornbirn, Austria

EUT Description

EUT Name: RH18, CCD18
Wireless Module #1: Bluetooth BR/EDR only
Model: OBS421
Brand Name: u-blox
Software Ver: V5.2.0
Hardware Ver: 1.11
Sample ID: RF Test Sample 01
Sample Received Date: 4/14/2022
Date of Tested: 4/14/2022 - 4/14/2022

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 FCC PART 15 SUBPART C ISED RSS-GEN ISSUE 5 ISED RSS-247 ISSUE 2	Pass

Prepared By:

Approved By:

Yu Bin
RF Project Engineer

Lim Kian Meng
Program Manager



2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with 558074 D01 DTS Meas Guidance v05, 414788 D01 Radiated Test Site v01, FCC CFR 47 Part 2, FCC CFR 47 Part 15 and ANSI C63.10-2013.

3. FACILITIES AND ACCREDITATION

Accreditation Certificate	SINGLAS REGISTRATION LA-2009-0450-E
	FCC REGISTRATION 600804
	VCCI REGISTRATION R-14163 (RE ≤1GHz) G-10846 (RE ≥1GHz) C-14564 (CE-MAINS) T-12147 (CE-TELECOM)
	ISED CAB Identifier SGAP07

Note: All tests measurement facilities use to collect the measurement data are located at UL INTERNATIONAL-SINGAPORE PTE LTD, 20 KIAN TECK LANE, SINGAPORE 627854. Otherwise, indicated.

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The results reported herein have been performed in accordance with the laboratory's terms of accreditation under the Singapore Accreditation Council.





4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations and is traceable to recognize national standards.

4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Test Item	Uncertainty
Conduction emission	± 3.83
Radiation Emission test (include Fundamental emission) (30MHz-1GHz)	± 5.22
Radiation Emission test (include Fundamental emission) (1GHz to 26GHz)	± 5.48
Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.	



5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

Equipment	Dragon Staff		
EUT Description	Radio handle for wireless remote control of TPS instruments		
Model	RH18, CCD18		
Series Model	N. A		
Model Difference	No difference for all samples		
Radio Technology	☒ BT BR/EDR (DSS)		
Operation Frequency and Channel	☒ BT BR/EDR (2402 – 2480 MHz)		
Modulation	☒ BT BR/EDR: GFSK, $\pi/4$ DQPSK and 8DPSK		
Power Supply	Power Adapter	Input	N. A
		Output	N. A
	Battery	N. A	
	DC Powered	5V – 17.5V / 3W Max	

**5.2. MAXIMUM OUTPUT POWER**

Frequency Range (MHz)	Number of Transmit Chains (NTX)	Radio Technology	Frequency (MHz)	Channel Number	Max PK Conducted Power (dBm)	EIRP (dBm)
2400-2483.5	1	BT BR/EDR	2402-2480	0-78[79]	10.2	11.2

5.3. CHANNEL LIST

BT BR/EDR					
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	27	2429	54	2456
1	2403	28	2430	55	2457
2	2404	29	2431	56	2458
3	2405	30	2432	57	2459
4	2406	31	2433	58	2460
5	2407	32	2434	59	2461
6	2408	33	2435	60	2462
7	2409	34	2436	61	2463
8	2410	35	2437	62	2464
9	2411	36	2438	63	2465
10	2412	37	2439	64	2466
11	2413	38	2440	65	2467
12	2414	39	2441	66	2468
13	2415	40	2442	67	2469
14	2416	41	2443	68	2470
15	2417	42	2444	69	2471
16	2418	43	2445	70	2472
17	2419	44	2446	71	2473
18	2420	45	2447	72	2474
19	2421	46	2448	73	2475
20	2422	47	2449	74	2476
21	2423	48	2450	75	2477
22	2424	49	2451	76	2478
23	2425	50	2452	77	2479
24	2426	51	2453	78	2480
25	2427	52	2454	-/-	-/-
26	2428	53	2455	-/-	-/-

**5.4. TEST CHANNEL CONFIGURATION**

BT BR/EDR			
Channel	0	39	78
Frequency (MHz)	2402	2441	2480

5.5. THE WORSE CASE POWER SETTING PARAMETER

The Worse Case Power Setting Parameter under 2400 ~ 2483.5MHz Band		
Test Software	R&S TS8997 WMS32	
Test Mode	Test Channel	Output Power Setting (dBm)
BT BR/EDR	0, 39, 78	9

5.6. DESCRIPTION OF AVAILABLE ANTENNAS

Antenna Specifications	1	Frequency	2400 – 2485 MHz
		Model	877520
		Gain	< 1 dBi
		Type	Dipole
		Transmit & Receive Mode	TRX, Chain 1 can be used as transmitting/receiving antenna.
	2	Frequency	2400 – 2500 MHz
		Model	904755
		Gain	< 2.3 dBi
		Type	Dipole PCB
		Transmit & Receive Mode	TRX, Chain 2 can be used as transmitting/receiving antenna.



5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Item	Equipment	Brand Name	Model Name	P/N
1	PC	HP	EliteBook	NIL
2	-/-	-/-	-/-	-/-

I/O CABLES

Cable No	Port	Connector Type	Cable Type	Cable Length(m)	Remarks
1	USB – RS232	Unshielded	0.3	NIL	1
2	RS232 – Lemo	Shielded	1	NIL	2

ACCESSORY

Item	Accessory	Brand Name	Model Name	Description
1	-/-	-/-	-/-	-/-

TEST MODE

RF continuously transmitting mode

SETUP DIAGRAM FOR TESTS





6. MEASURING INSTRUMENT AND SOFTWARE USED

Test Equipment					
Used	Equipment	Manufacturer	Model No.	Serial No.	Due. Date
☒	EMI Test Receiver 20kHz - 26.5GHz	R&S	ESU26	100405	23-Aug-23
☒	Teseq Loop Antenna - 9kHz - 30 MHz	ETS-LINDGREN	6502	214013	05-Nov-22
☒	Teseq Bilog Antenna 30MHz - 2GHz	ETS-LINDGREN	CBL6112B	2874	09-Sep-23
☒	Hewlett Packard Pre-amp 9KHz -1.3GHz	HP	8447F	172289	03-Dec-22
☒	Horn Antenna 1-6GHz	Schwarzbeck	BBHA 9120 D	1019	27-Aug-23
☒	Pre-Amplifier 1-6GHz	Toyo	TPA0106-40AS	1806-007	12-Jul-23
☒	Horn Antenna + Pre-Amplifier 6.0 - 18.0 GHz	Schwarzbeck	HAP06-18W	B1510452202-100	14-Mar-23
☒	Horn Antenna, 18-40GHz	Schwarzbeck	BBHA 9170	811	30-May-23
☒	Pre-Amplifier (18GHz to 40GHz)	EMC Instruments Corporation	EMC184045SE	980655	01-Feb-23
☒	Signal Analyzer 10Hz - 40GHz	R&S	FSV 40	101517	02-Jun-23
Software					
Used	Description	Manufacturer	Name		Version
☒	RSE Test Software	Toyo	Toyo EMI Software		V 6.0.120
☒	Wireless Measurement System Software	R&S	WMS32		V10.60.10

7. MEASUREMENT METHODS

No.	Test Item	KDB Name
1	6dB Bandwidth and 99% Bandwidth	KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1
2	Peak Output Power	KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.9.2.2
3	Power Spectral Density	KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013
4	Out-of-band emissions in non-restricted bands	KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.11
5	Out-of-band emissions in restricted bands	KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.12
6	Band-edge	KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013
7	Conducted Emission Test for AC Power Port	ANSI C63.10-2013



8. TEST PROCEDURES AND RESULTS

8.1. NORMAL AND EXTREME CONDITIONS

LIMITS

None; for reporting purposes only.

RESULTS

	Normal Test Conditions (T_{nom})	Extreme Test Conditions (T_{ext})
Relative Humidity	66.1 %	-/-
Temperature	20.1 °C	-/-



8.2. 20 dB BANDWIDTH

LIMITS

According to §15.247(a) (1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

TEST PROCEDURE

Connect the UUT to the spectrum analyser and use the following settings:

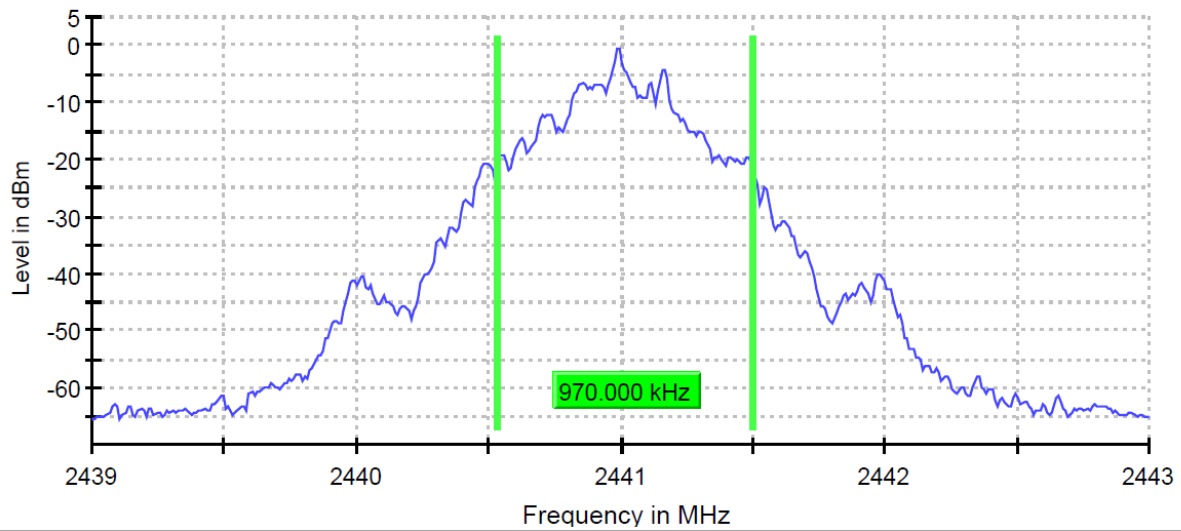
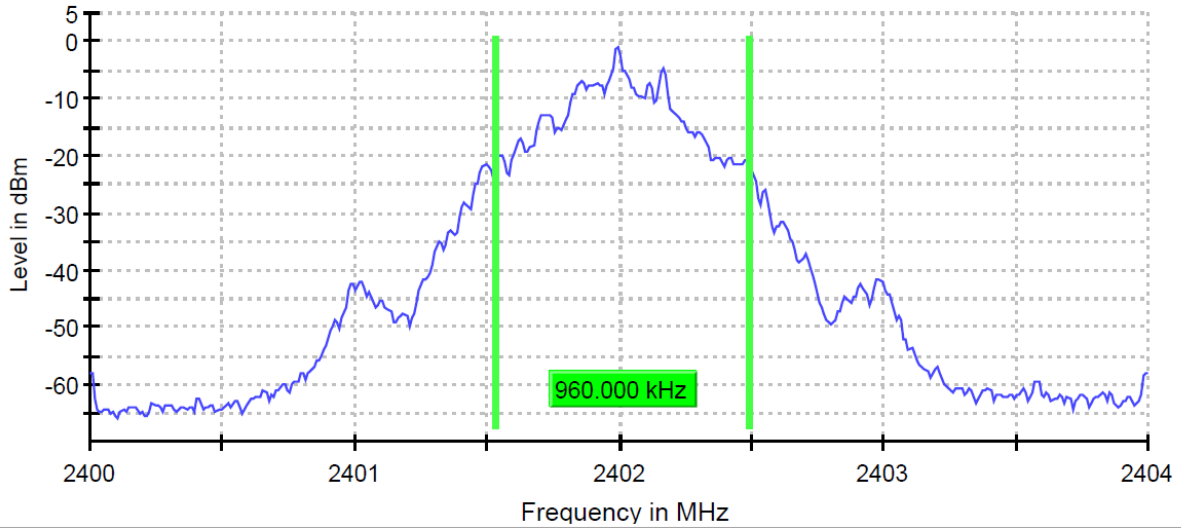
Center Frequency	The centre frequency of the channel under test
Detector	Peak
RBW	RBW $\geq$ 1% of the span
VBW	VBW $\geq$ RBW
Trace	Max hold
Sweep	Auto couple

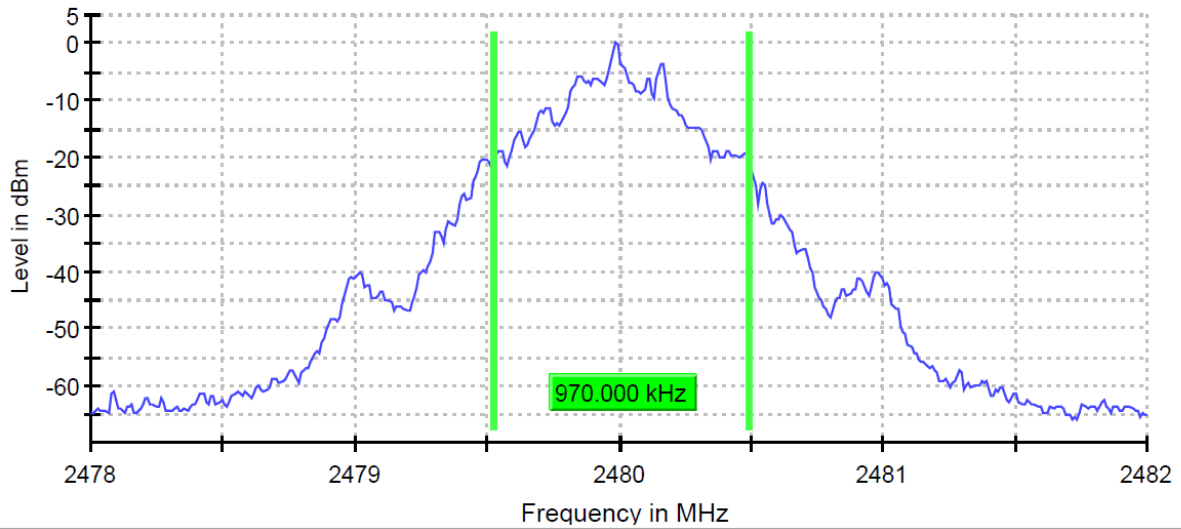
Allow the trace to stabilize and measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

Measurement	
☒ Conducted measurement	☐ Radiated measurement

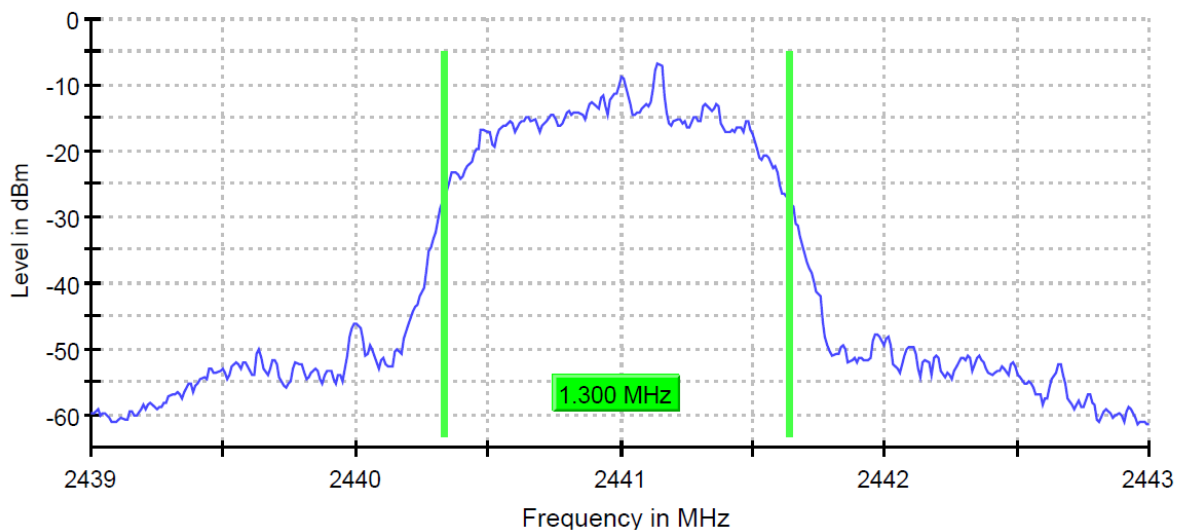
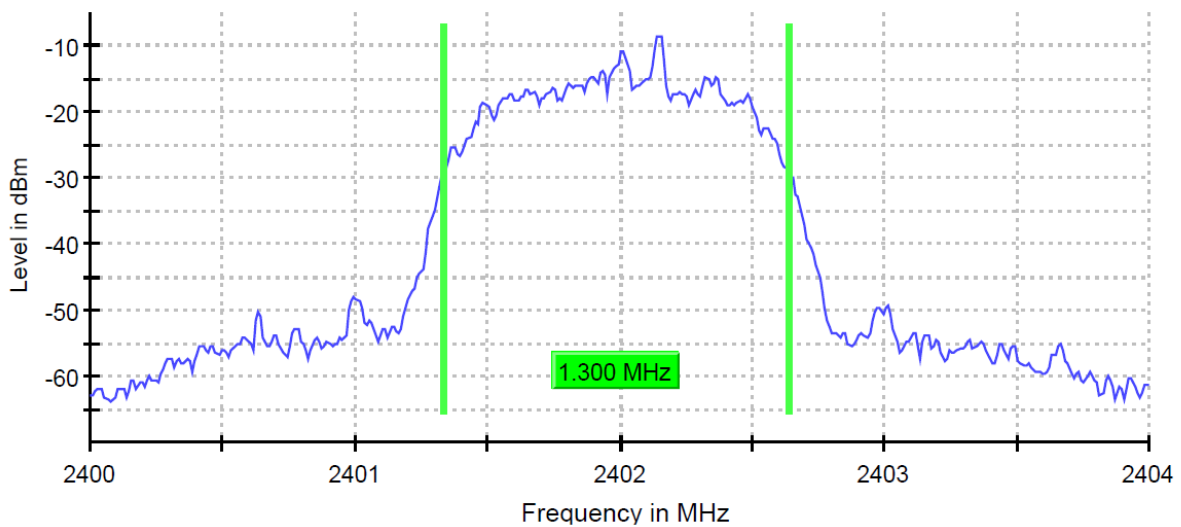
RESULT

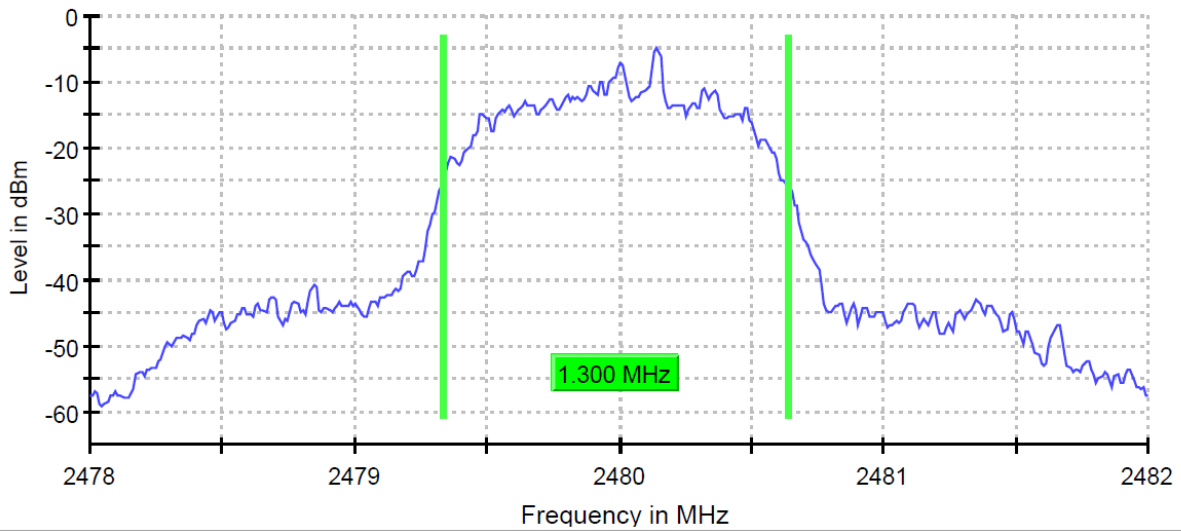
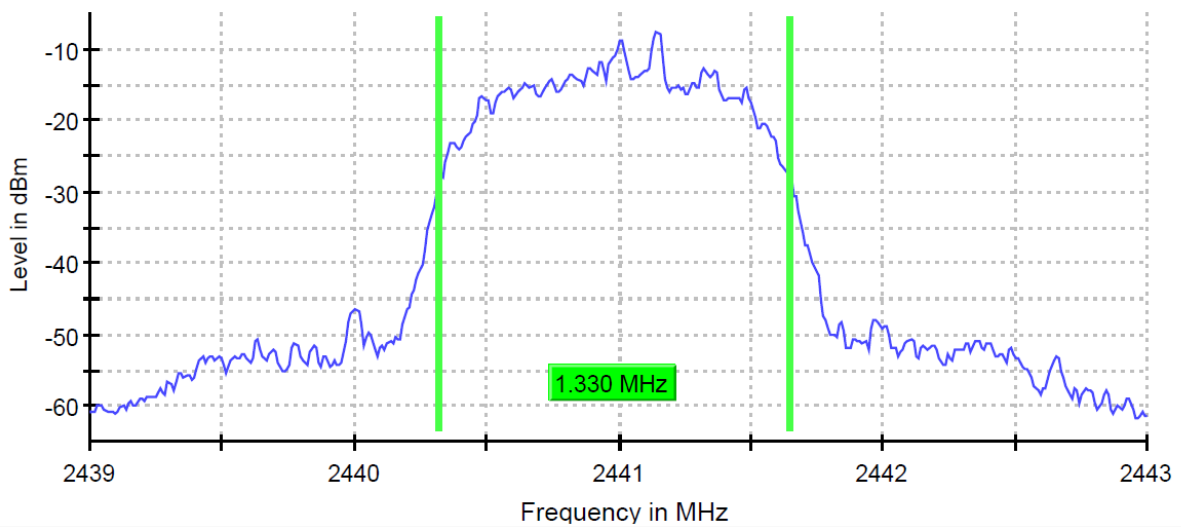
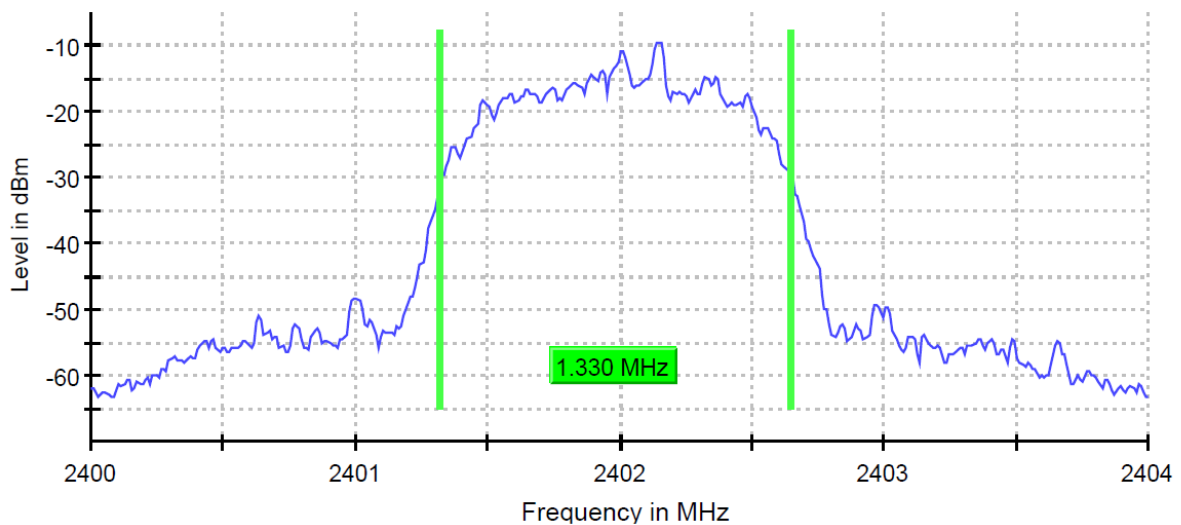
Pass

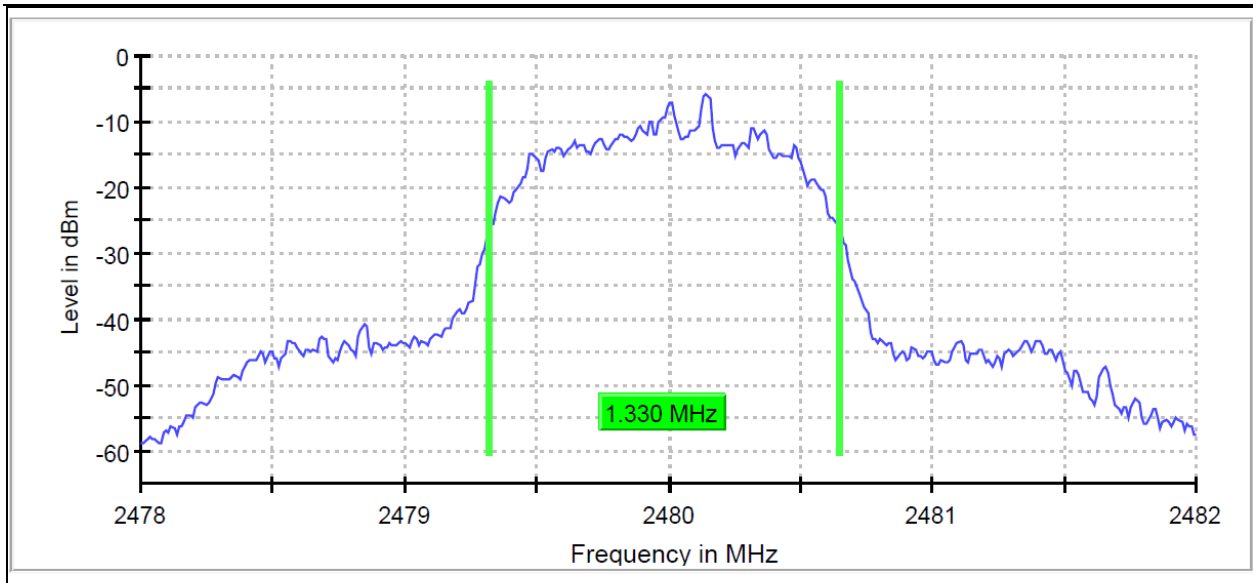
**BT BR/EDR****20 dB Bandwidth (Low/Mid/High)****GFSK**



$\pi/4$ -DQPSK



**8DPSK**





8.3. FREQUENCY SEPARATION

LIMITS

FCC Part15 (15.247) Subpart C & RSS-247 ISSUE 2			
Section	Test Item	Limit	Frequency Range (MHz)
FCC 15.247 (a)(1) RSS-247 Clause 5.1	Frequency Separation	Minimum of 25 kHz or 2/3 of 20 dB Bandwidth, whichever is greater	2400-2483.5

TEST PROCEDURE

Connect the UUT to the spectrum analyser and use the following settings:

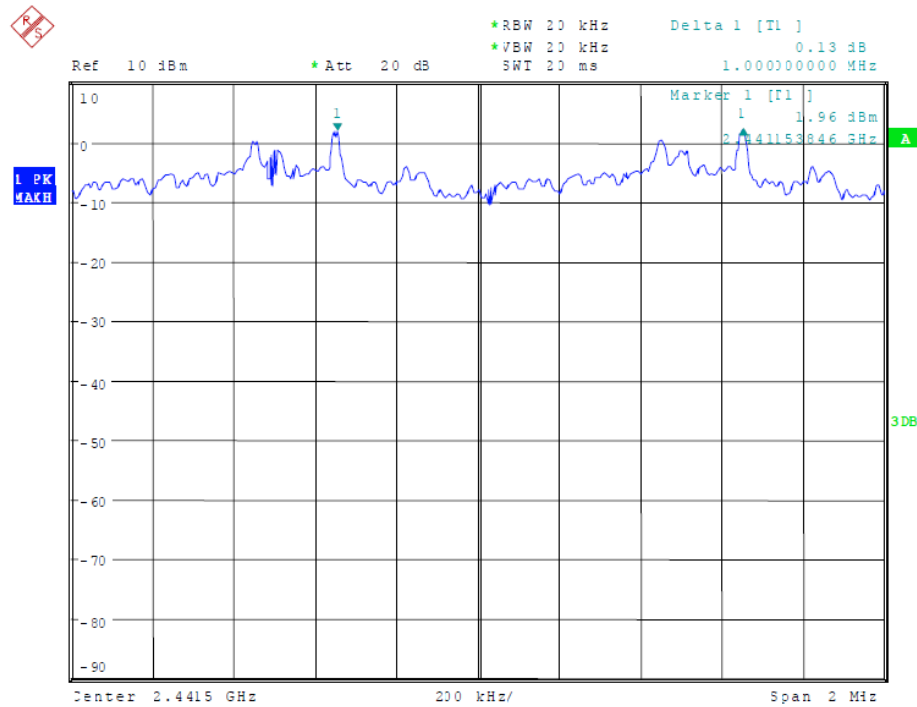
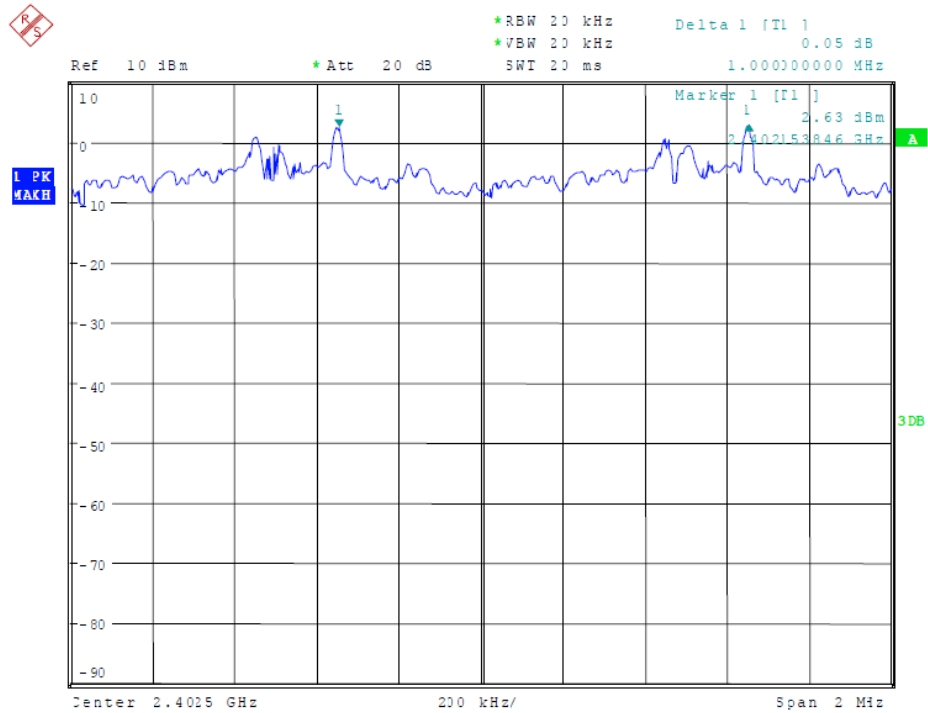
Center Frequency	The centre frequency of the channel under test
Detector	Peak
RBW	RBW $\geq$ 1% of the span
VBW	VBW $\geq$ RBW
Trace	Max hold
Sweep	Auto couple

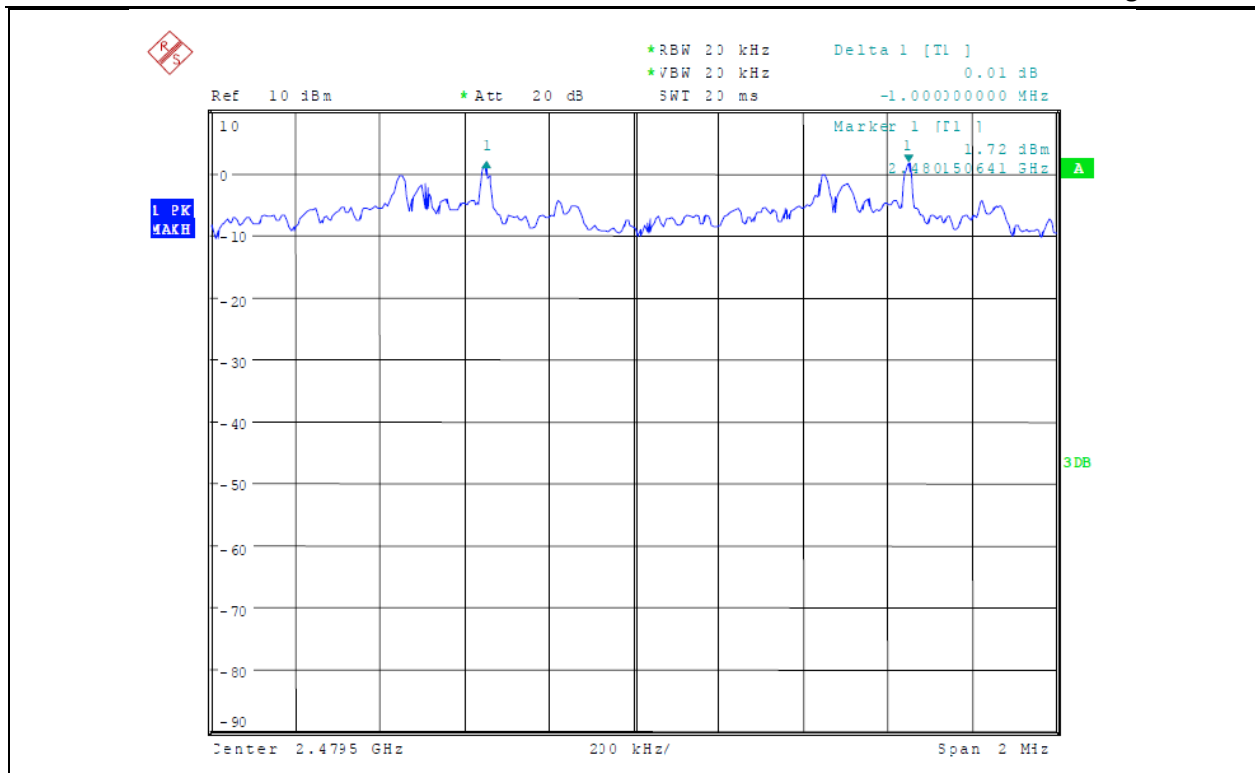
After trace stabilization the marker and the delta marker function will be used to determine the separation between the peaks of two adjacent channel signals.

Measurement	
☒ Conducted measurement	☐ Radiated measurement

RESULT

Mode	Frequency (MHz)	Separation Frequency (kHz)	Limit (kHz)	Result
BT BR/EDR	2402	1000	860	Pass
	2441	1000	860	Pass
	2480	1000	860	Pass







8.4. NUMBER OF HOPPING FREQUENCIES

LIMITS

FCC Part15 (15.247) Subpart C & RSS-247 ISSUE 2			
Section	Test Item	Limit	Frequency Range (MHz)
FCC 15.247 (a)(1)(iii) RSS-247 Clause 5.1	No. of Hopping Frequencies	≥ 15 hopping channels	2400-2483.5

TEST PROCEDURE

Connect the UUT to the spectrum analyser and use the following settings:

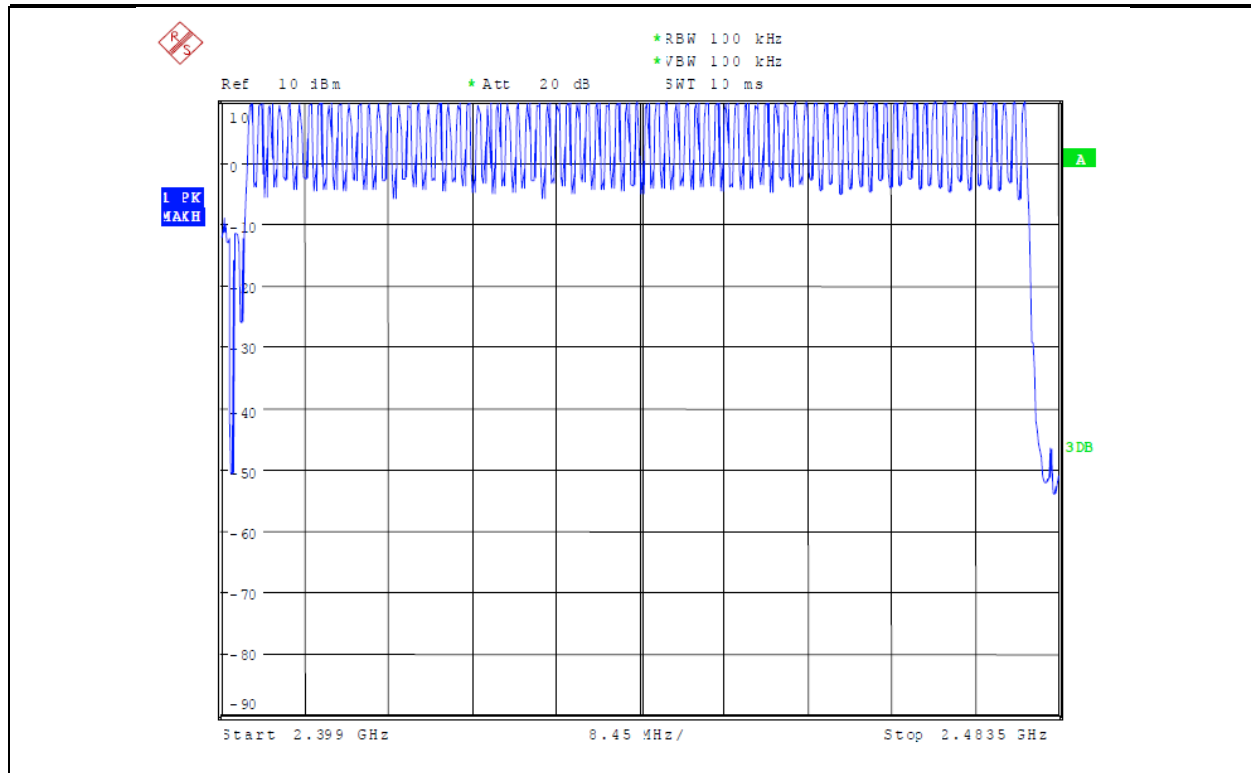
Center Frequency	The centre frequency of the channel under test
Detector	Peak
RBW	$\text{RBW} \geq 1\%$ of the span
VBW	$\text{VBW} \geq \text{RBW}$
Trace	Max hold
Sweep	Auto couple

After trace stabilization the marker and the delta marker function will be used to determine the separation between the peaks of two adjacent channel signals.

Measurement	
☒ Conducted measurement	☐ Radiated measurement

RESULT

Mode	No. of Hopping Channels	Limit	Result
BT BR/EDR	79	15	Pass





8.5. DWELL TIME

LIMITS

FCC Part15 (15.247) Subpart C & RSS-247 ISSUE 2			
Section	Test Item	Limit	Frequency Range (MHz)
FCC 15.247 (a)(1)(iii) RSS-247 Clause 5.1	Dwell Time	400 ms	2400-2483.5

TEST PROCEDURE

Connect the UUT to the spectrum analyser and use the following settings:

Center Frequency	The centre frequency of the channel under test, and zero span
Detector	Peak
RBW	1 MHz
VBW	VBW $\geq$ RBW
Trace	Max hold
Sweep	Auto couple

The dwell time is calculated with the following formula:

Dwell time = $t_{\text{pulse}} \times n_{\text{hops}} / \text{number of hopping channels} \times 31.6$ (equal to 0.4 s x number of hopping channels)

Where:

t_{pulse} is the measured pulse time (pls. refer the plots of the spectrum analyser above) [s], n_{hops} is the number of hops per second in the actual operating mode of the transmitter [1/s].

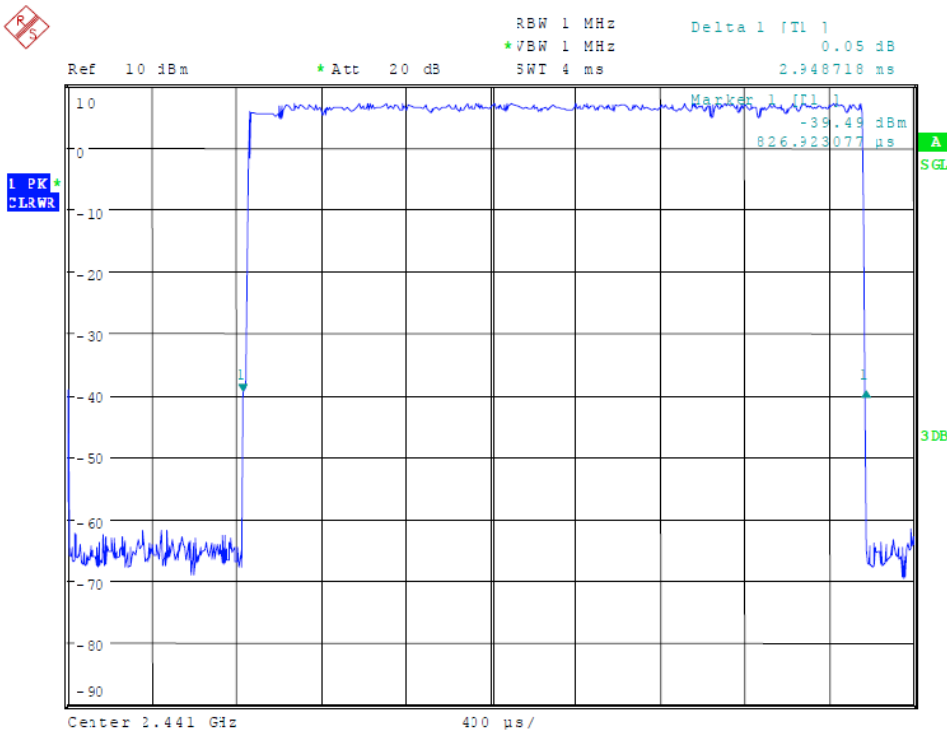
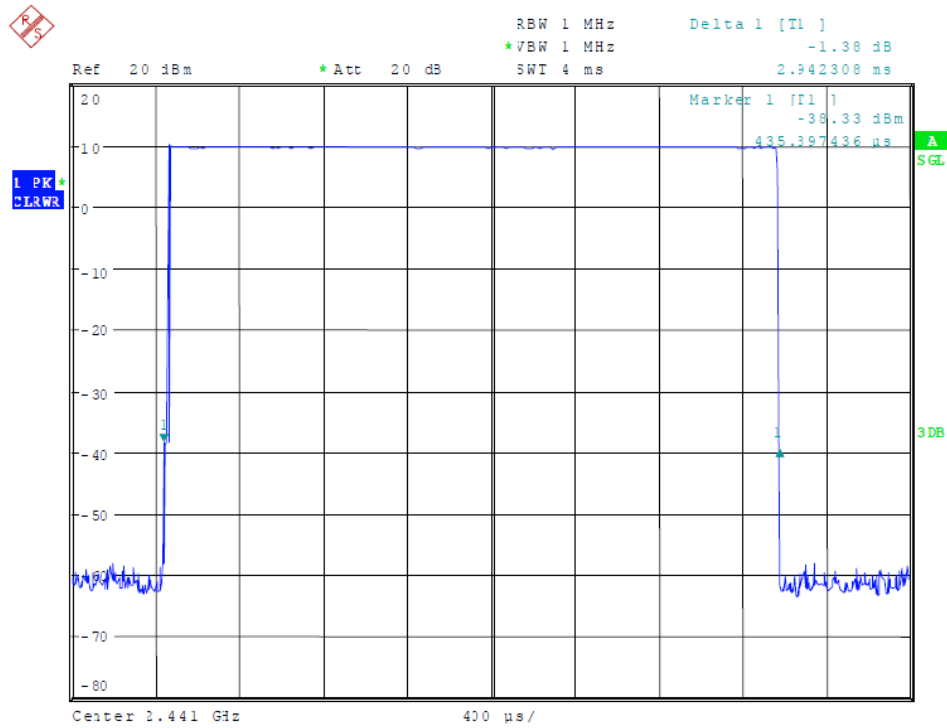
The hopping rate of the system is 1600 hops per second and the system uses 79 channels. For this reason, one time slot has a length of 625 μ s.

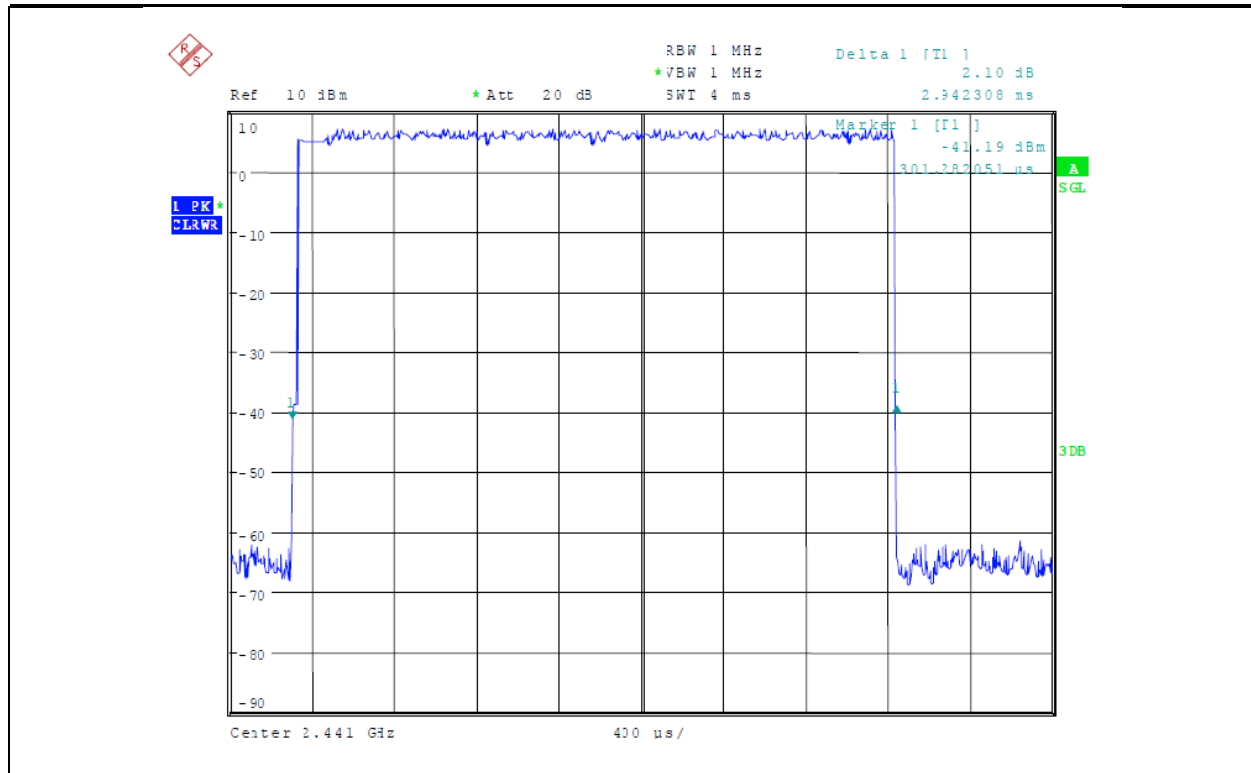
With the used hopping modes DH5, 2DH5 and 3DH5 a packet needs 5 timeslots for transmitting and the next timeslot for receiving. So, the system makes in worst case 267 hops per second in transmit mode ($n_{\text{hops}} = 267$ 1/s).

Measurement	
☒ Conducted measurement	☐ Radiated measurement

RESULT

Mode	Frequency (MHz)	T_{pulse} (μ s)	Dwell Time (μ s)	Limit (ms)	Result
BT GSKF Mode	2441	2492.3	313.8	400	Pass
BT $\pi/4$ -DQPSK Mode	2441	2948.7	314.5	400	Pass
BT 8DPSK Mode	2441	2942.3	313.8	400	Pass







8.6. PEAK AND AVERAGE CONDUCTED OUTPUT POWER

LIMITS

FCC Part15 (15.247) Subpart C & RSS-247 ISSUE 2			
Section	Test Item	Limit	Frequency Range (MHz)
FCC 15.247(b)(3) RSS-247 5.4 (4)	Peak Output Power	1 watt or 30dBm	2400-2483.5
FCC 15.247(b)(3) RSS-247 5.4 (4)	Average Output Power	1 watt or 30dBm	2400-2483.5

TEST PROCEDURE

Place the EUT on the table and set it in the transmitting mode.

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power sensor.

Measure peak power each channel.

Measurement	
☒ Conducted measurement	☐ Radiated measurement

RESULT

Mode	Frequency (MHz)	Peak Output Power (dBm)	EIRP (dBm)	Result
BT GSKF Mode	2402	10.2	11.2	Pass
	2441	10.1	11.1	Pass
	2480	10.0	11.0	Pass
BT $\pi/4$ DQPSK Mode	2402	6.5	7.5	Pass
	2441	6.1	7.1	Pass
	2480	6.0	7.0	Pass
BT 8DPSK Mode	2402	6.0	7.0	Pass
	2441	5.6	6.6	Pass
	2480	5.5	6.5	Pass



Mode	Frequency (MHz)	Average Output Power (dBm)	EIRP (dBm)	Result
BT GSKF Mode	2402	8.2	9.2	Pass
	2441	8.1	9.1	Pass
	2480	8.0	9.0	Pass
BT $\pi/4$ DQPSK Mode	2402	5.3	6.3	Pass
	2441	5.0	6.0	Pass
	2480	4.8	5.8	Pass
BT 8DPSK Mode	2402	4.5	5.5	Pass
	2441	4.0	5.0	Pass
	2480	4.0	5.0	Pass



8.7. CONDUCTED BANDEGE AND SPURIOUS EMISSIONS

LIMITS

FCC Part15 (15.247) Subpart C & RSS-247 ISSUE 2		
Section	Test Item	Limit
FCC §15.247 (d) RSS-247 5.5	Conducted Bandedge and Spurious Emissions	at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

TEST PROCEDURE

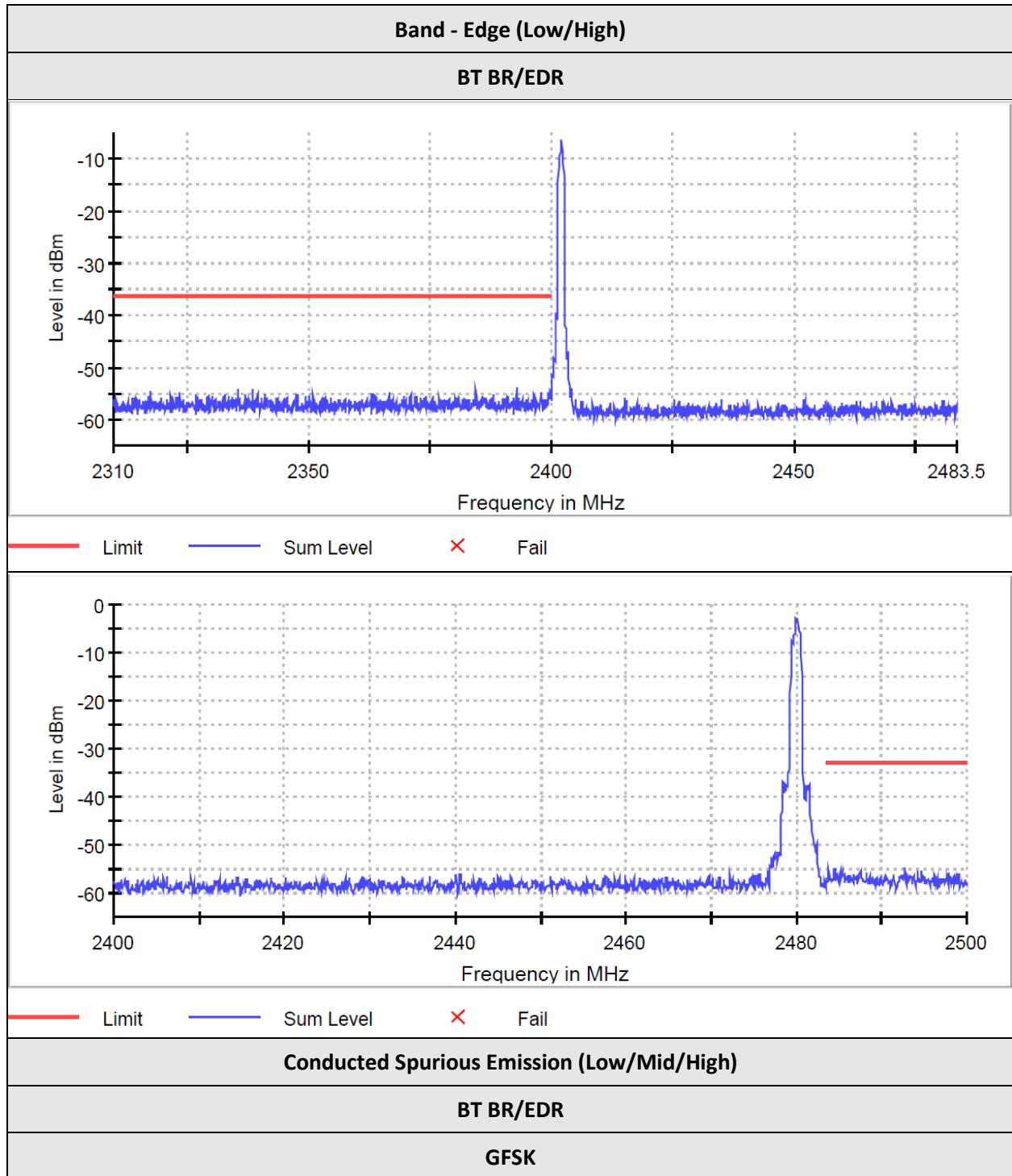
Connect the UUT to the spectrum analyser and use the following settings:

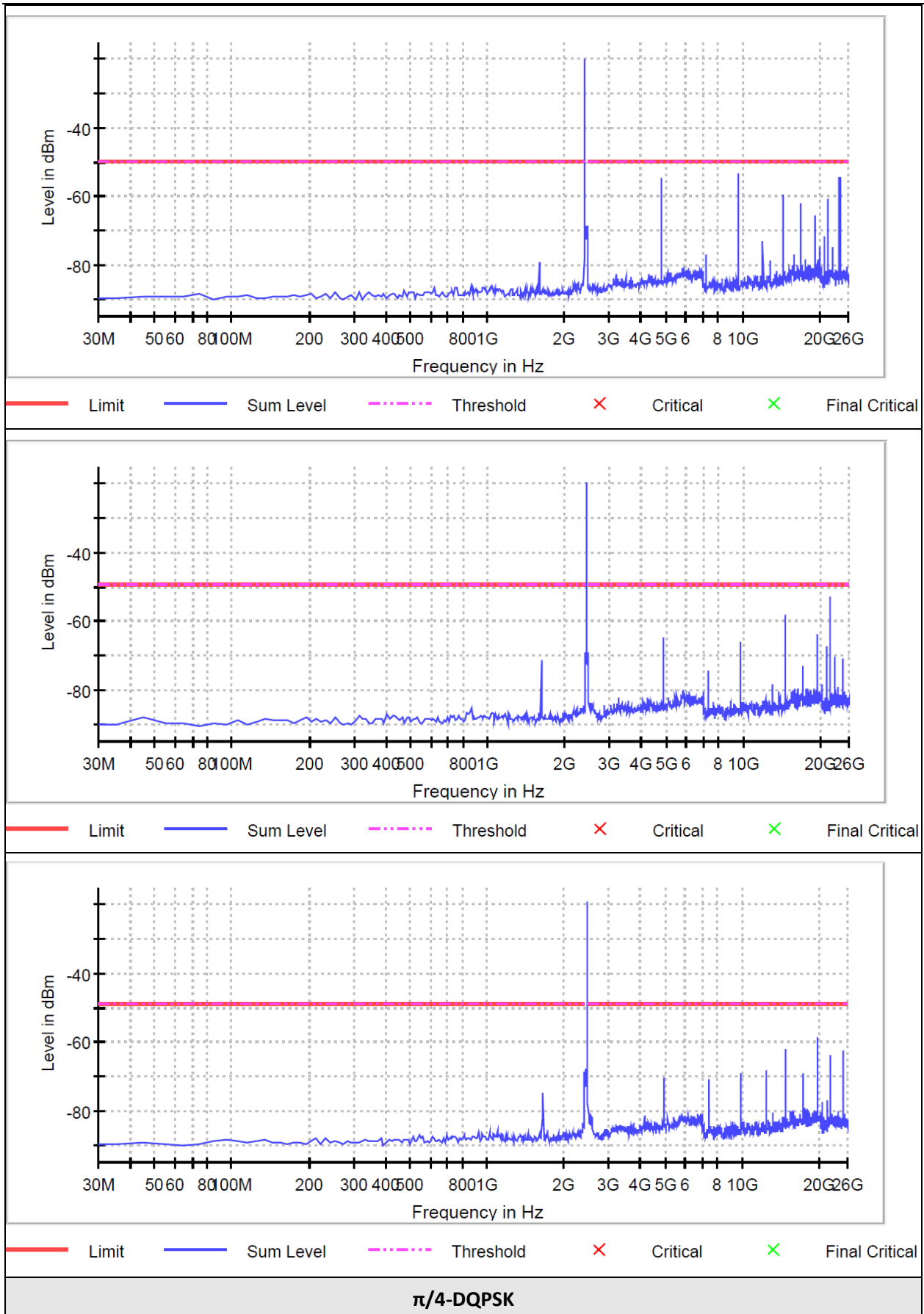
Center Frequency	The centre frequency of the channel under test
Detector	Peak
RBW	100K
VBW	$\geq 3 \times \text{RBW}$
Span	1.5 x DTS bandwidth
Trace	Max hold
Sweep time	Auto couple.

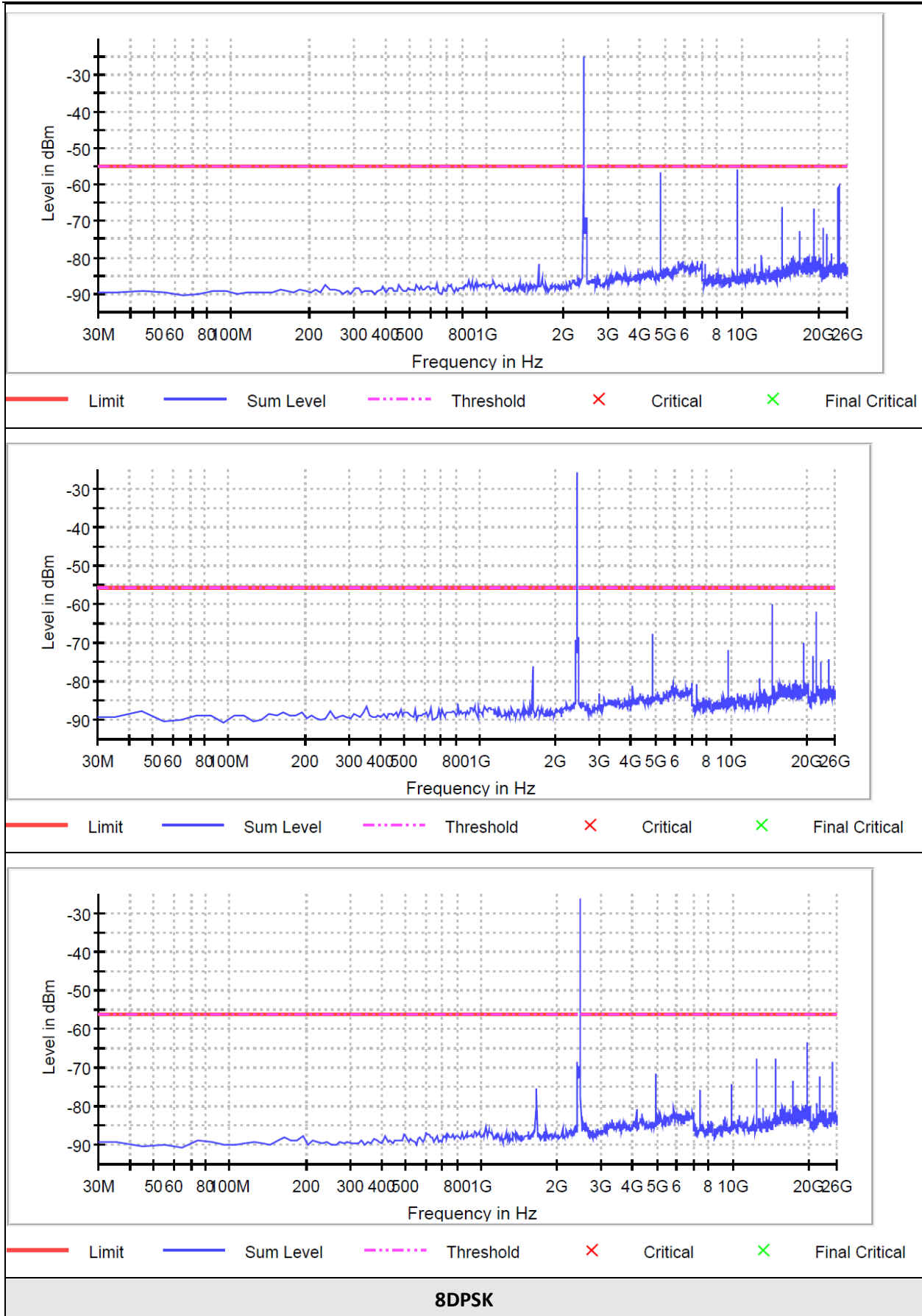
Use the peak marker function to determine the maximum PSD level.

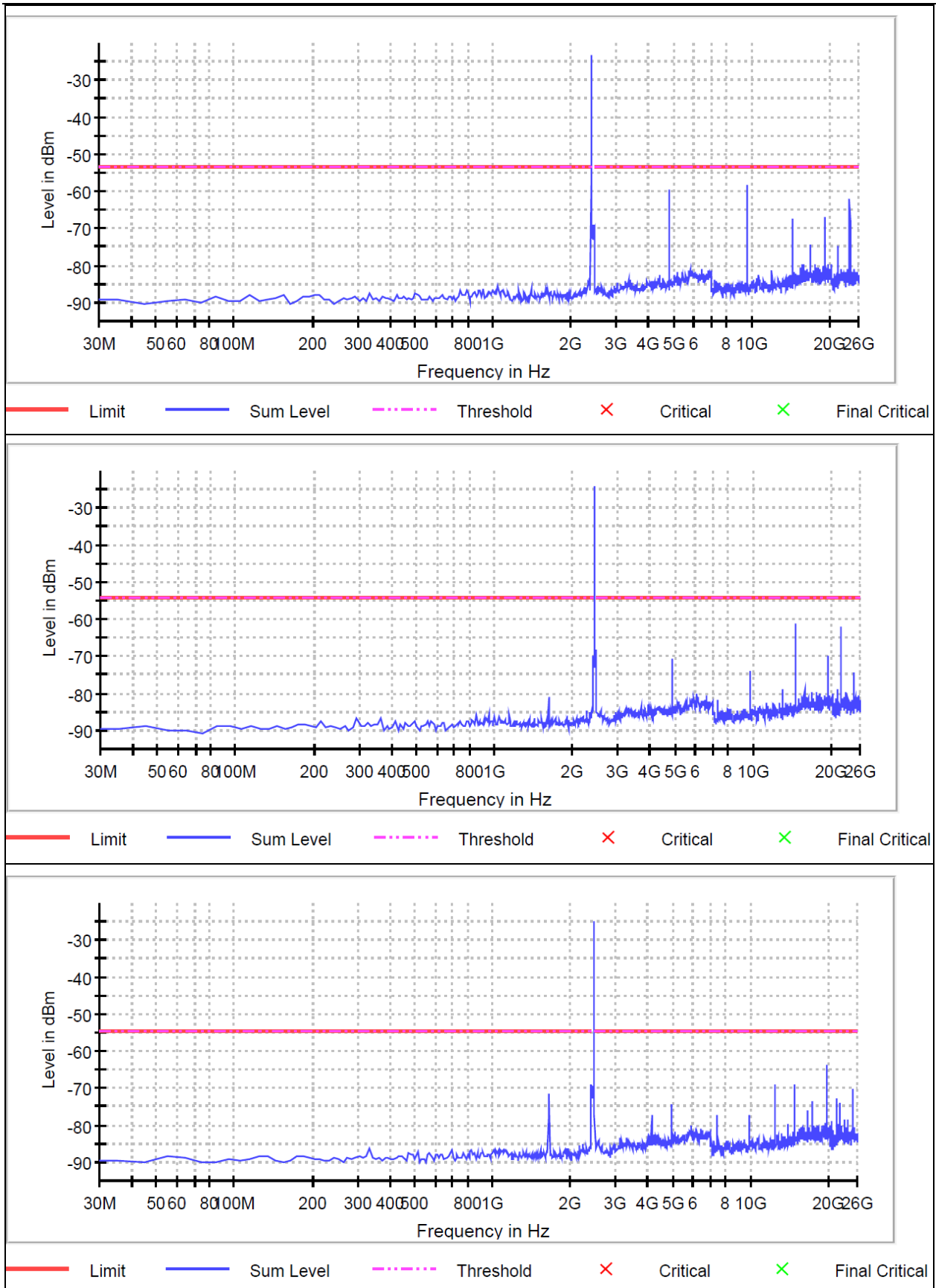
Span	Set the center frequency and span to encompass frequency range to be measured
Detector	Peak
RBW	100K
VBW	$\geq 3 \times \text{RBW}$
Measurement points	$\geq \text{span}/\text{RBW}$
Trace	Max hold
Sweep time	Auto couple.

Use the peak marker function to determine the maximum amplitude level.

**RESULT**









8.8. RADIATED BAND EDGE AND RADIATED SPURIOUS EMISSION

LIMITS

Please refer to CFR 47 FCC §15.205 and §15.209

Please refer to ISSED RSS-GEN Clause 8.9 (Transmitter)

Radiation Disturbance Test Limit for FCC (Class B) (9KHz-1GHz)

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
960~1000	500	3

Note: 1) At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

(2) At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). This paragraph (f) shall not apply to Access BPL devices operating below 30 MHz.

Radiation Disturbance Test Limit for FCC (Above 1G)

Frequency (MHz)	dB(uV/m) (at 3 meters)	
	Peak	Average
Above 1000	74	54

FCC Restricted bands of operation:

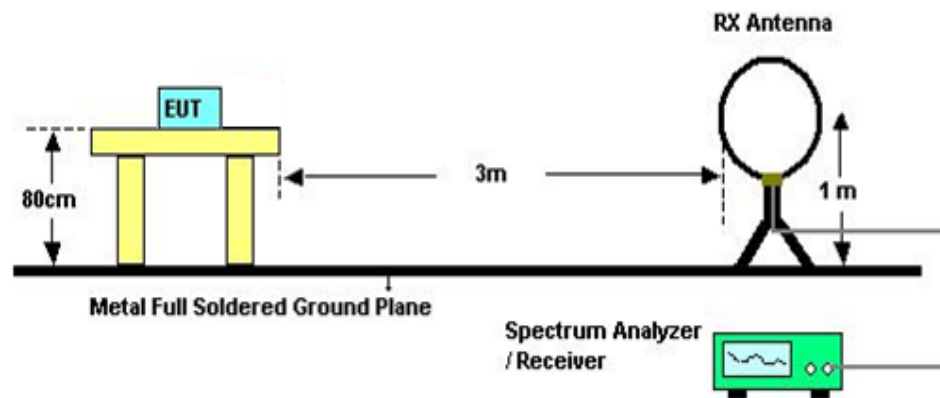
MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(²)
13.36-13.41			

Note: ¹Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

²Above 38.6c

TEST SETUP AND PROCEDURE

Below 30MHz



The setting of the spectrum analyser

RBW	200Hz (From 9kHz to 0.15MHz)/ 9KHz (From 0.15MHz to 30MHz)
VBW	200Hz (From 9kHz to 0.15MHz)/ 9KHz (From 0.15MHz to 30MHz)
Sweep	Auto
Detector	Peak/QP/ Average
Trace	Max hold

1. The testing follows the guidelines in ANSI C63.10-2013
2. The EUT was arranged to its worst case and then turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level. Both Horizontal, Face-on and Face-off polarizations of the antenna are set to make the measurement.
3. The EUT was placed on a turntable with 0.8 meter above ground.

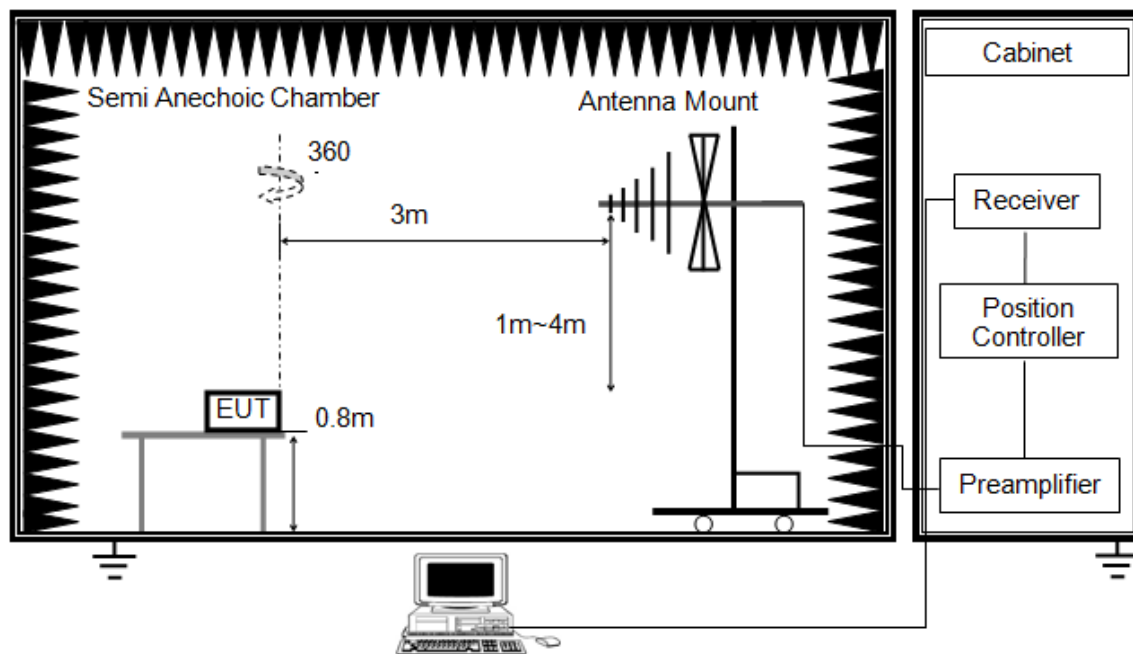
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a 1m height antenna tower.

5. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

6. For the actual test configuration, please refer to the related item in this test report (Photographs of the Test Configuration)

7. Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30m open area test site. Therefore, sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

Below 1G



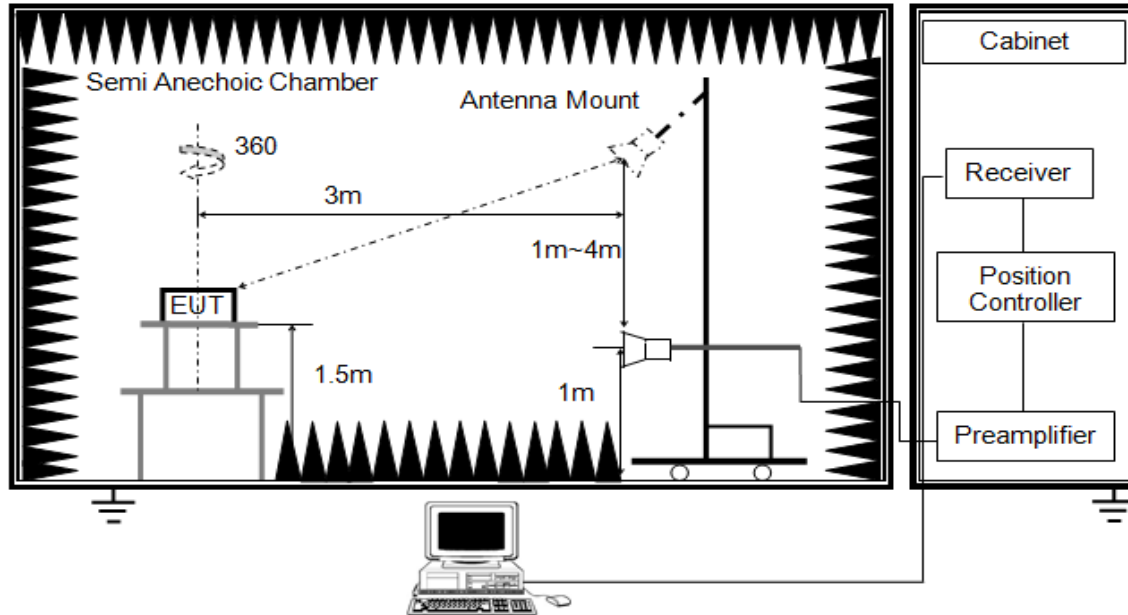
The setting of the spectrum analyser

RBW	120K
VBW	300K
Sweep	Auto
Detector	Peak/QP
Trace	Max hold

1. The testing follows the guidelines in ANSI C63.10-2013.

2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

ABOVE 1G



3. The EUT was placed on a turntable with 0.8 meter above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

The setting of the spectrum analyser

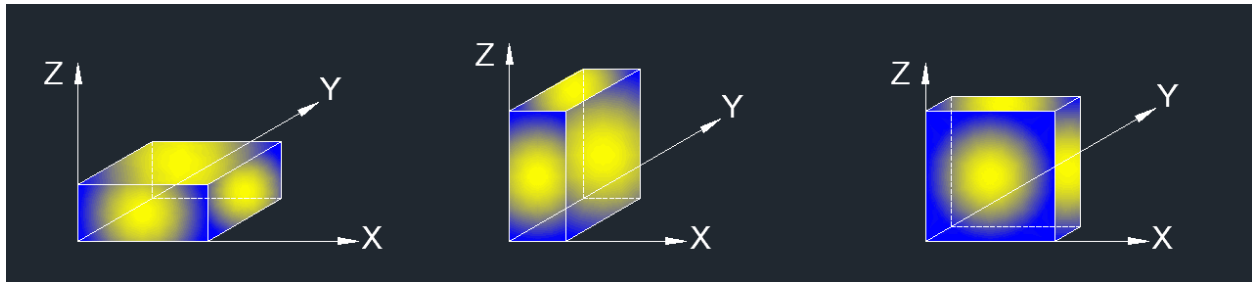
RBW	1M
VBW	PEAK: 3M AVG: see note 6
Sweep	Auto
Detector	Peak
Trace	Max hold

1. The testing follows the guidelines in ANSI C63.10-2013.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
3. The EUT was placed on a turntable with 1.5m above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.

5. For measurement above 1GHz, the emission measurement will be measured by the peak detector. This peak level, once corrected, must comply with the limit specified in Section 15.209.

6. For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 3 MHz for peak measurements and 1 MHz resolution bandwidth with 1/T video bandwidth with peak detector for average measurements. For the Duty Cycle please refer to clause 8.1. ON TIME AND DUTY CYCLE.

X axis, Y axis, Z axis positions :



Note 1: For all radiated test, EUT in each of three orthogonal axis emissions had been tested, but only the worst case (X axis) data recorded in the report.

Note 2: The EUT was fully exercised with external accessories during the test. In the case of multiple accessory external ports, an external accessory shall be connected to one of each type of port.

RESULT

BT BR/EDR

GFSK

Band-edge compliance (lower band edge. hopping enabled)

Result measured with the peak detector:

Frequency GHz	Corr. value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Height cm	Pol.	Restr. Band
2.402	107.9	-	-	75.9	150	Vert.	-
2.3861	57.6	74.0	16.4	25.6	150	Vert.	Yes

Result measured with the average detector:

2.402	95.5	-	-	63.5	150	Vert.	-
2.3861	34.4	54.0	19.6	2.4	150	Vert.	Yes

Band-edge compliance (higher band edge. hopping enabled)

Result measured with the peak detector:

Frequency GHz	Corr. value dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Height cm	Pol.	Restr. Band
2.480	108.5	-	-	76.2	150	Vert.	-
2.4866	52.3	74.0	21.7	20.0	150	Vert.	Yes

Result measured with the average detector:

2.480	94.9	-	-	62.6	150	Vert.	-
2.4866	26.8	54.0	27.2	-5.5	150	Vert.	Yes

 **$\pi/4$ -DQPSK**

Band-edge compliance (lower band edge. hopping enabled)

Result measured with the peak detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Height cm	Pol.	Restr. Band
2.402	98.5	-	-	66.5	150	Vert.	-
2.3865	52.2	74.0	21.8	20.2	150	Vert.	Yes

Result measured with the average detector:

2.402	95.5	-	-	63.5	150	Vert.	-
2.3865	34.4	54.0	19.6	2.4	150	Vert.	Yes

Band-edge compliance (higher band edge. hopping enabled)

Result measured with the peak detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Height cm	Pol.	Restr. Band
2.480	97.8	-	-	65.5	150	Vert.	-
2.4888	42.6	74.0	31.4	10.3	150	Vert.	Yes

Result measured with the average detector:

2.480	94.9	-	-	62.6	150	Vert.	-
2.4888	26.8	54.0	27.2	-5.5	150	Vert.	Yes

8DPSK

Band-edge compliance (lower band edge. hopping enabled)

Result measured with the peak detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Height cm	Pol.	Restr. Band
2.402	97.4	-	-	65.4	150	Vert.	-
2.3836	51.9	74	22.1	19.9	150	Vert.	Yes

Result measured with the average detector:

2.402	95	-	-	63	150	Vert.	-
2.3836	34.3	54	19.7	2.2	150	Vert.	Yes

Band-edge compliance (higher band edge. hopping enabled)

Result measured with the peak detector:

Frequency GHz	Corr. value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Height cm	Pol.	Restr. Band
2.48	94.8	-	-	62.5	150	Vert.	-
2.4886	42.5	74	31.5	10.2	150	Vert.	Yes

Result measured with the average detector:

2.48	94.2	-	-	61.9	150	Vert.	-
2.4886	26.4	54	27.6	-5.9	150	Vert.	Yes

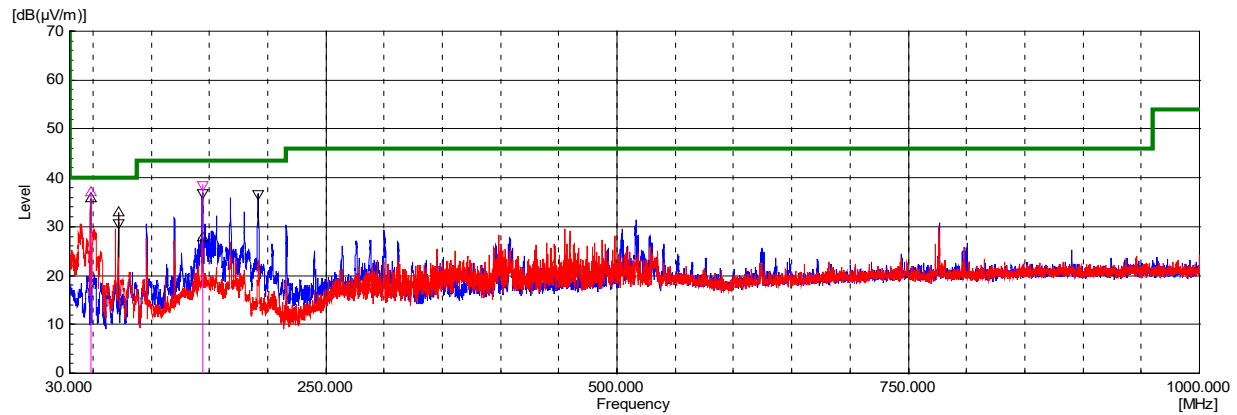


30MHz – 1GHz (Low/Mid/High)

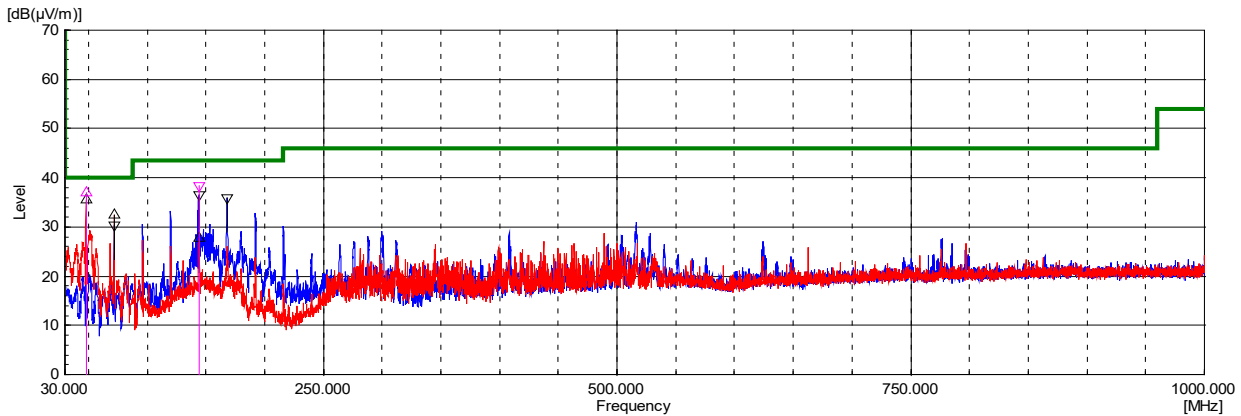
Horizontal



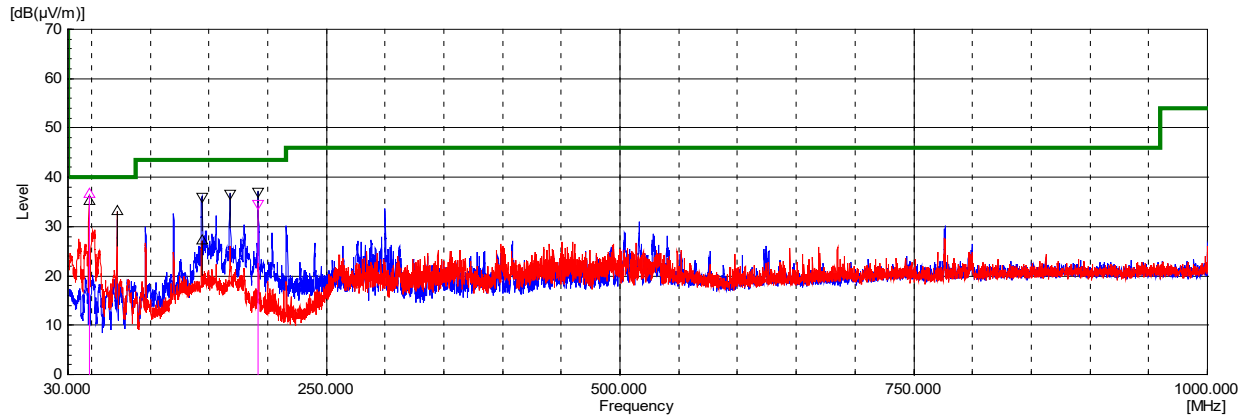
Vertical



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level PK [dB(μV/m)]	Limit QP [dB(μV/m)]	Margin QP [dB]	Height [cm]	Angle [°]
47.88	V	54.7	-18.9	35.8	40	4.2	100	54
71.882	V	54.3	-21.5	32.8	40	7.2	100	35
144.013	V	43.6	-15.9	27.7	43.5	15.8	200	267
144.013	H	52.9	-15.9	37	43.5	6.5	200	0
192.018	H	54.1	-17.3	36.8	43.5	6.7	100	47
72.005	H	52.4	-21.5	30.9	40	9.1	300	191



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level PK [dB(μV/m)]	Limit QP [dB(μV/m)]	Margin QP [dB]	Height [cm]	Angle [°]
47.88	V	54.4	-18.9	35.5	40	4.5	100	73
72.005	V	54	-21.5	32.5	40	7.5	200	96
144.013	V	43.7	-15.9	27.8	43.5	15.7	200	285
143.89	H	52.5	-15.9	36.6	43.5	6.9	200	0
168.015	H	53.1	-17.1	36	43.5	7.5	200	0
71.882	H	51.9	-21.5	30.4	40	9.6	300	39



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level PK [dB(μV/m)]	Limit QP [dB(μV/m)]	Margin QP [dB]	Height [cm]	Angle [°]
48.124	V	54.2	-19	35.2	40	4.8	100	73
72.005	V	54.5	-21.5	33	40	7	100	73
143.89	V	43	-15.9	27.1	43.5	16.4	200	304
191.895	H	54.5	-17.3	37.2	43.5	6.3	100	28
167.893	H	53.8	-17.1	36.7	43.5	6.8	200	0
144.013	H	52.1	-15.9	36.2	43.5	7.3	200	0

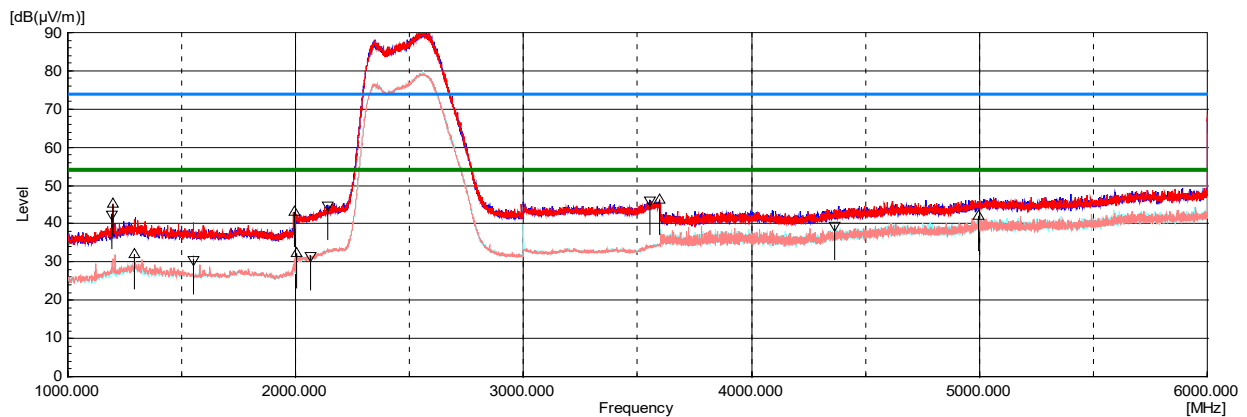
Note:

1. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
2. Only the worst-case emission was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
3. For all the test results have been considered the correct factors.

1GHz – 6GHz (Low/Mid/High)

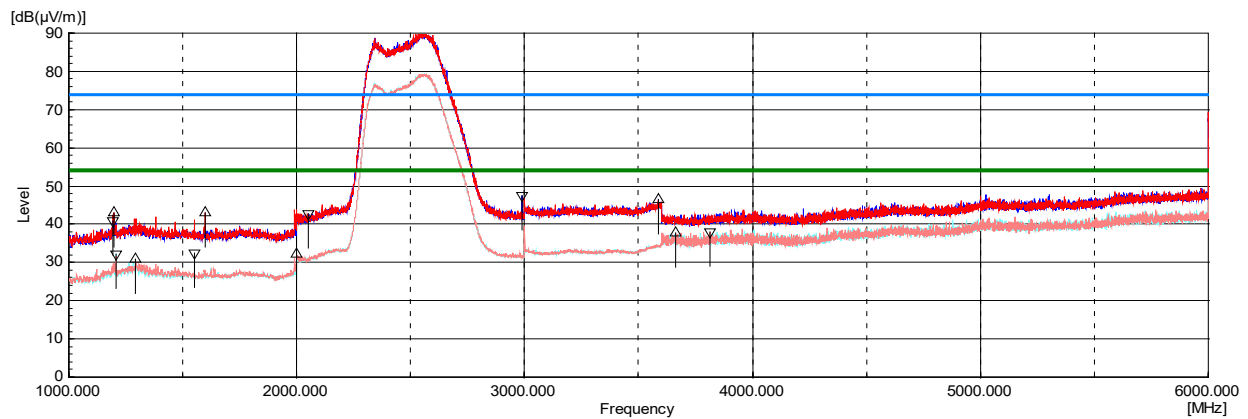
Horizontal

Vertical

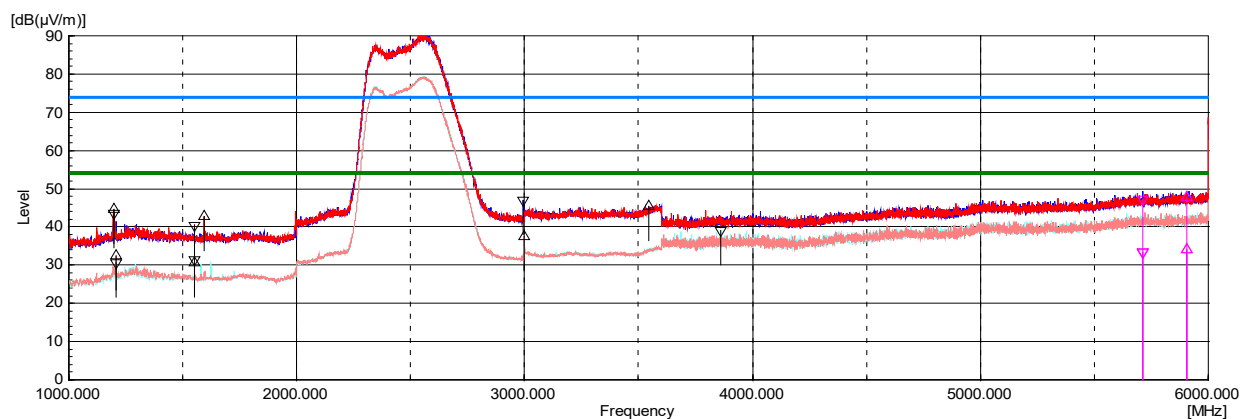




Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
1552.344	H	31.5	-0.8	30.7	54	23.3	200	110
2065.55	H	29	2.7	31.7	54	22.3	400	339
4365.194	H	32.3	7.2	39.5	54	14.5	100	341
1293.531	V	33.1	-1	32.1	54	21.9	100	131
2003.056	V	30.2	1.9	32.1	54	21.9	200	145
4997.075	V	31.9	10	41.9	54	12.1	400	196



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
1207.05	H	34.3	-2.2	32.1	54	21.9	200	276
1552.344	H	33.4	-0.8	32.6	54	21.4	100	112
3813.481	H	31.5	6.5	38	54	16	200	173
1293.531	V	32	-1	31	54	23	200	207
2000.531	V	30.2	1.9	32.1	54	21.9	200	187
3663.244	V	31.8	6.1	37.9	54	16.1	400	154





Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
1207.05	H	32.9	-2.2	30.7	54	23.3	200	256
1552.344	H	32.2	-0.8	31.4	54	22.6	200	110
3862.719	H	32.6	6.5	39.1	54	14.9	100	20
1207.05	V	34.6	-2.2	32.4	54	21.6	100	330
1552.344	V	31.5	-0.8	30.7	54	23.3	200	83
2999.8	V	32.6	5	37.6	54	16.4	300	256

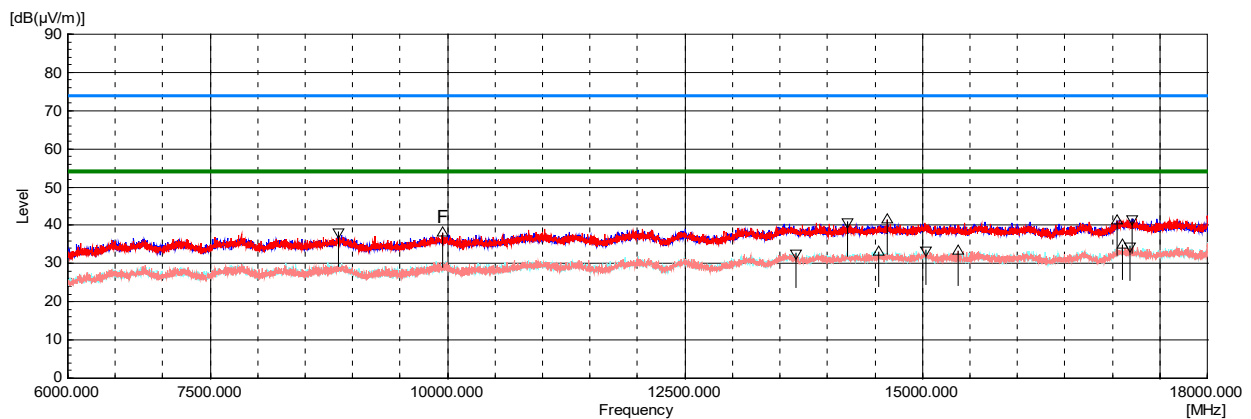
Note:

1. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
2. Only the worst-case emission was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
3. For all the test results have been considered the correct factors.
4. 2.4GHz band-stop filter is applied in the duration of the scan.

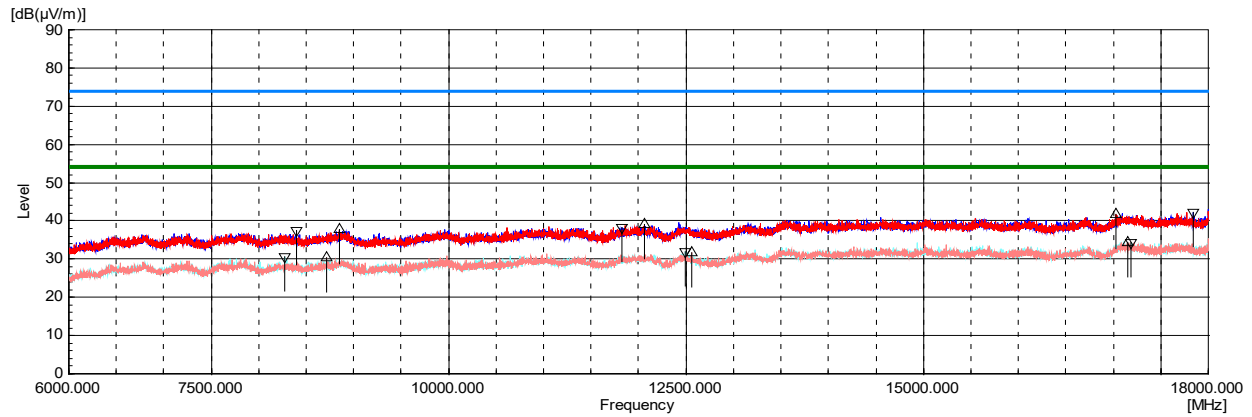
6GHz – 18GHz (Low/Mid/High)

Horizontal

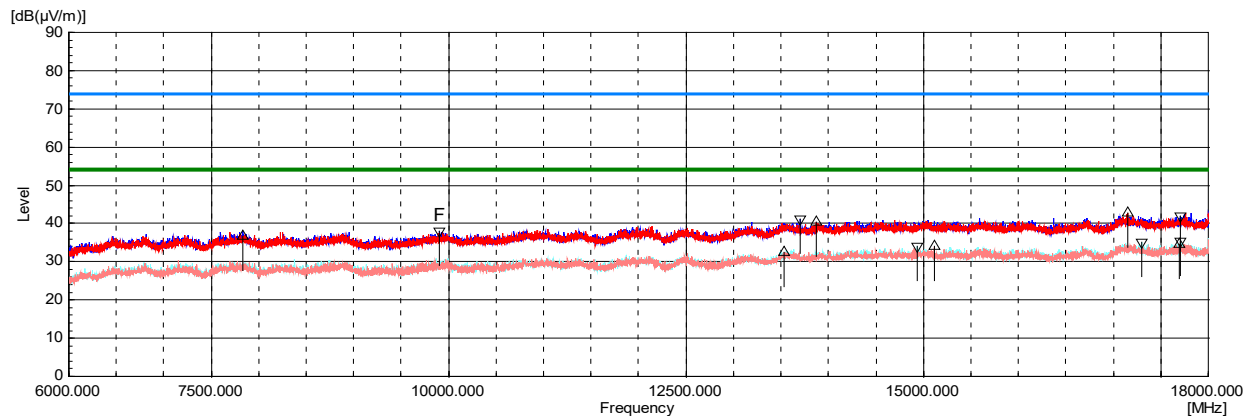
Vertical



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
17101.92	V	35.8	-0.9	34.9	54	19.1	300	276
15373.31	V	37.2	-3.8	33.4	54	20.6	200	145
14543.09	V	36.9	-4	32.9	54	21.1	200	166
17183.73	H	35.3	-0.7	34.6	54	19.4	400	26
15036.98	H	37.3	-3.9	33.4	54	20.6	200	339
13670.45	H	36	-3.3	32.7	54	21.3	200	213



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
8269.47	H	40.4	-9.9	30.5	74	43.5	100	217
12493.29	H	35.7	-3.7	32	74	42	300	312
17183.73	H	35.1	-0.7	34.4	74	39.6	300	20
8710.335	V	38.6	-8.3	30.3	74	43.7	300	47
12555.41	V	35.3	-3.7	31.6	74	42.4	200	333
17151.92	V	35.1	-0.8	34.3	74	39.7	100	172



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
17298.87	H	35.8	-0.7	35.1	54	18.9	300	62
17701.86	H	37.3	-2	35.3	54	18.7	200	151
14930.93	H	38.3	-4.3	34	54	20	400	109
17691.26	V	36.5	-1.9	34.6	54	19.4	300	47
15111.21	V	38.1	-4.1	34	54	20	200	270
13537.13	V	35.7	-3.2	32.5	54	21.5	200	250

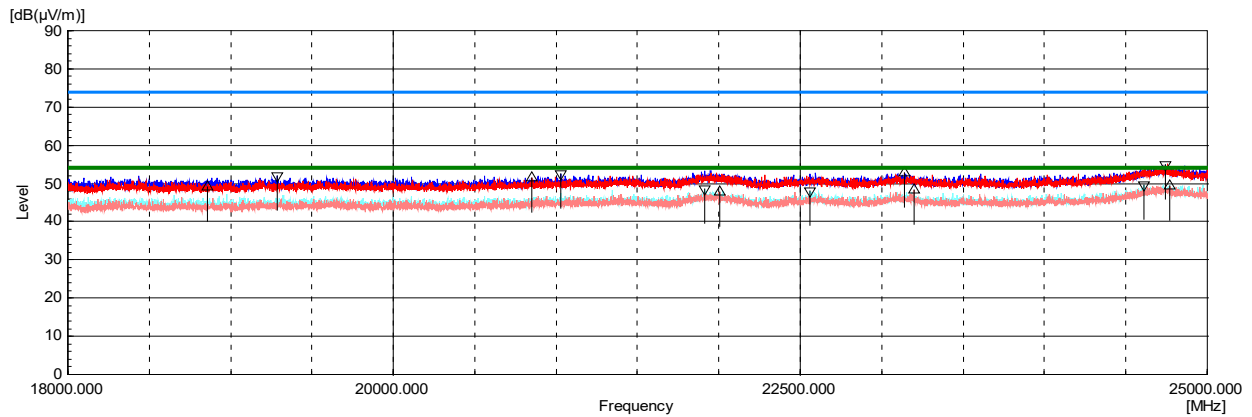
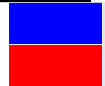
Note:

1. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
2. Only the worst-case emission was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
3. For all the test results have been considered the correct factors.

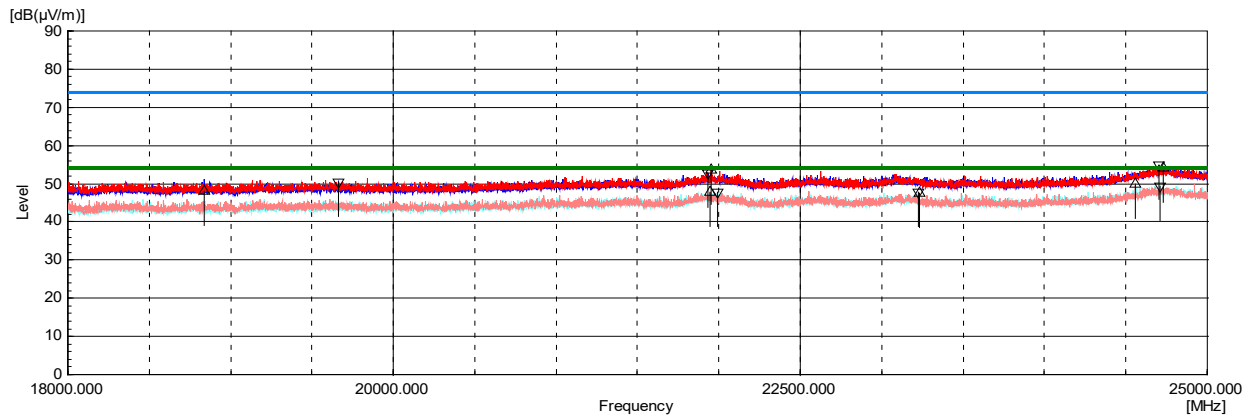
**18GHz – 25GHz (Low/Mid/High)**

Horizontal

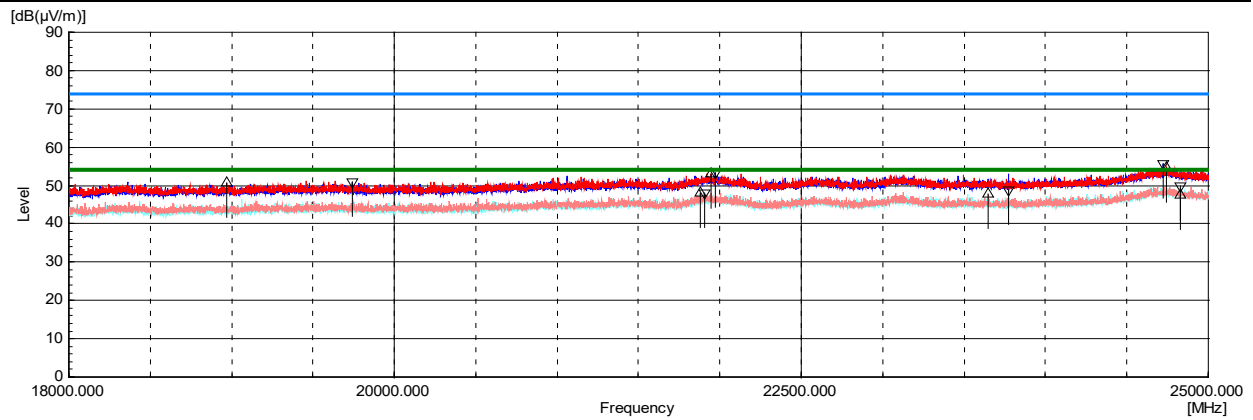
Vertical



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
24613.04	H	39.7	9.8	49.5	54	4.5	300	172
22558.95	H	40	8.1	48.1	54	5.9	300	5
21911.97	H	40.7	7.9	48.6	54	5.4	300	193
24766.84	V	39.4	10.1	49.5	54	4.5	300	230
23198.87	V	39.4	9	48.4	54	5.6	400	58
22003.89	V	40	7.9	47.9	54	6.1	300	167



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
24711.15	H	39.4	10	49.4	54	4.6	300	213
21992.4	H	39.9	7.9	47.8	54	6.2	400	354
23228.03	H	38.8	9	47.8	54	6.2	200	313
24556.48	V	40.2	9.7	49.9	54	4.1	400	59
23232.45	V	38.5	9	47.5	54	6.5	400	267
21945.55	V	39.9	7.9	47.8	54	6.2	300	292



Frequency [MHz]	(P)	Reading [dB(μV)]	Factor [dB(1/m)]	Level Avg [dB(μV/m)]	Limit Avg [dB(μV/m)]	Margin [dB]	Height [cm]	Angle [°]
24825.17	H	39.6	10.2	49.8	54	4.2	300	67
23771.61	H	39.8	8.9	48.7	54	5.3	300	213
21905.78	H	40	7.9	47.9	54	6.1	300	150
24825.17	V	37.4	10.2	47.6	54	6.4	400	205
23650.52	V	38.7	9	47.7	54	6.3	300	145
21877.5	V	40.2	7.9	48.1	54	5.9	400	267

Note:

1. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
2. Only the worst-case emission was recorded, if it complies with the limit, the other emissions deemed to comply with the limit.
3. For all the test results have been considered the correct factors.

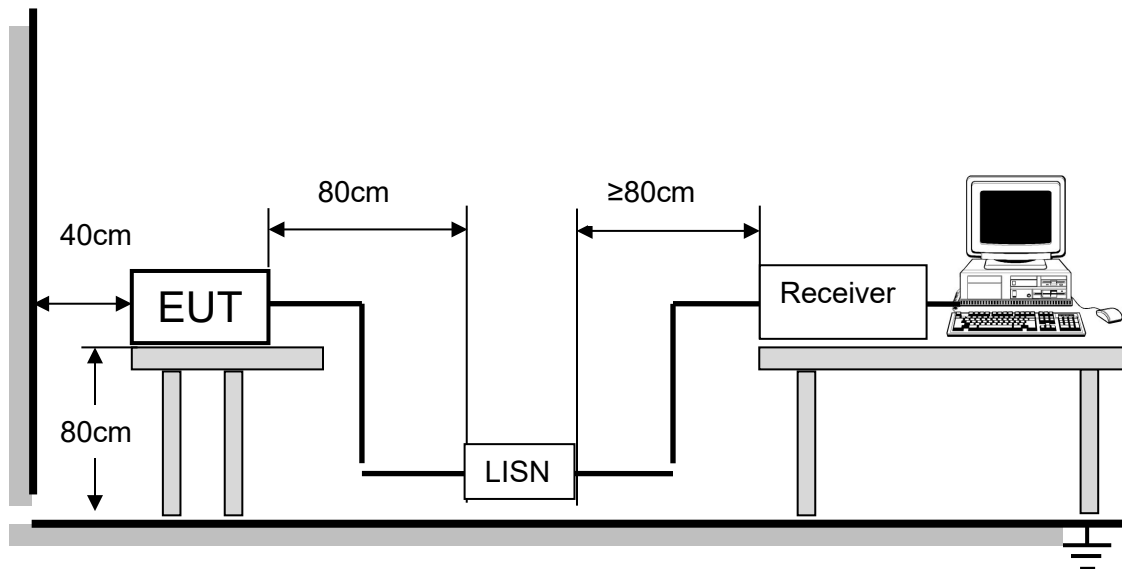
8.9. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

Please refer to CFR 47 FCC §15.207 (a)

FREQUENCY (MHz)	Class B (dBuV)	
	Quasi-peak	Average
0.15 -0.5	66 - 56 *	56 - 46 *
0.50 -5.0	56.00	46.00
5.0 -30.0	60.00	50.00

TEST SETUP AND PROCEDURE



The EUT is put on a table of non-conducting material that is 80cm high. The vertical conducting wall of shielding is located 40cm to the rear of the EUT. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.). A EMI Measurement Receiver (R&S Test Receiver ESR3) used to test the emissions from both sides of AC line. According to the requirements in Section 7 and 13 of ANSI C63.10-2013. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-Peak and average detector mode. The bandwidth of EMI test receiver is set at 9kHz.

The arrangement of the equipment is installed to meet the standards and operating in a manner, which tends to maximize its emission characteristics in a normal application.

TEST RESULTS

Not applicable due to battery operated product



8.10. ANTENNA REQUIREMENT

LIMITS

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Test Result

The EUT uses a permanently attached antenna, with gain 1dBi and 2.3dBi, in accordance with 47 CFR § 15.203, it shall be considered sufficient to comply with the provisions of this section.



END OF REPORT