NCC Test Report

Equipment	:	**Bluetooth speakerphone**
Model No.	:	**SP 30** **(Refer to item 1.1.1 for more details)**
Brand Name	:	**SENNHEISER**
Applicant	:	**Sennheiser Communications A/S**
Address	:	**Industriparken 27, Ballerup 2750 , Denmark**
Standard	:	**LP0002 Section 3.10.1 (2018-01-10)**
Received Date	:	**Oct. 29, 2018**
Tested Date	:	**Oct. 31 ~ Nov. 20, 2018**

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:

Along Chen / Assistant Manager

Approved by:

Gary Chang / Manager

Testing Laboratory 2732

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Release Record

Report No.	Version	Description	Issued Date
TR8O2901AE	Rev. 01	Initial issue	Dec. 14, 2018

Summary of Test Results

NCC Rules	Test Items	Measured	Result
2.3	AC Power Line Conducted Emissions	[dBuV]: 0.369MHz 39.59 (Margin -18.93dB) - QP	Pass
3.10.1.5 2.8	Radiated Emissions	[dBuV/m at 3m]: 7440.00MHz 50.49 (Margin -3.51dB) - AV	Pass
3.10.1.2(1)(C)	Maximum Output Power	Power [dBm]: 5.11	Pass
3.10.1.6(2)(A)	6dB Bandwidth	Meet the requirement of limit	Pass
3.10.1.6(2)(B)	Power Spectral Density	Meet the requirement of limit	Pass
3.10.1.4	Antenna Requirement	Meet the requirement of limit	Pass

Declaration of Conformity:
The judgement of conformity in the report is based on the measurement results excluding the measurement uncertainty.
Comments and Explanations:
None

1 General Description

1.1 Information

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description
SENNHEISER	SP 30	Bluetooth speakerphone	2 microphones
	SP 40		1. 3 microphones 2. Extra button for BT connecting to another SP 40

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	**Bluetooth Mode**	**Ch. Freq. (MHz)**	**Channel Number**	**Data Rate**
2400-2483.5	V5.0 LE	2402-2480	0-39 [40]	1 Mbps
Note 1: Bluetooth LE (Low energy) uses GFSK modulation.				

1.1.3 Antenna Details

Ant. No.	Type	Connector	Gain (dBi)	Remarks
1	IFA	N/A	4.8	---

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	5Vdc, 1.3A from host 3.7Vdc from battery

1.1.5 Accessories

Accessories		
No.	**Equipment**	**Description**
1	Battery	Brand: SYNERGY Model: AHB723938PCT-01 Power Rating: 3.7Vdc, 1110mAh
2	USB cable (Undetachable)	0.75m shielded without core
3	USB-C to -A adapter	---

1.1.6 Channel List

Frequency band (MHz)				2400~2483.5			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	9	2422	18	2442	28	2462
0	2404	10	2424	19	2444	29	2464
1	2406	38	2426	20	2446	30	2466
2	2408	11	2428	21	2448	31	2468
3	2410	12	2430	22	2450	32	2470
4	2412	13	2432	23	2452	33	2472
5	2414	14	2434	24	2454	34	2474
6	2416	15	2436	25	2456	35	2476
7	2418	16	2438	26	2458	36	2478
8	2420	17	2440	27	2460	39	2480

1.1.7 Test Tool and Duty Cycle

Test tool	Blue Tool 3, ver. 2.5
Duty cycle of test signal (%)	69.77%
Duty Factor (dB)	1.56

1.1.8 Power Setting

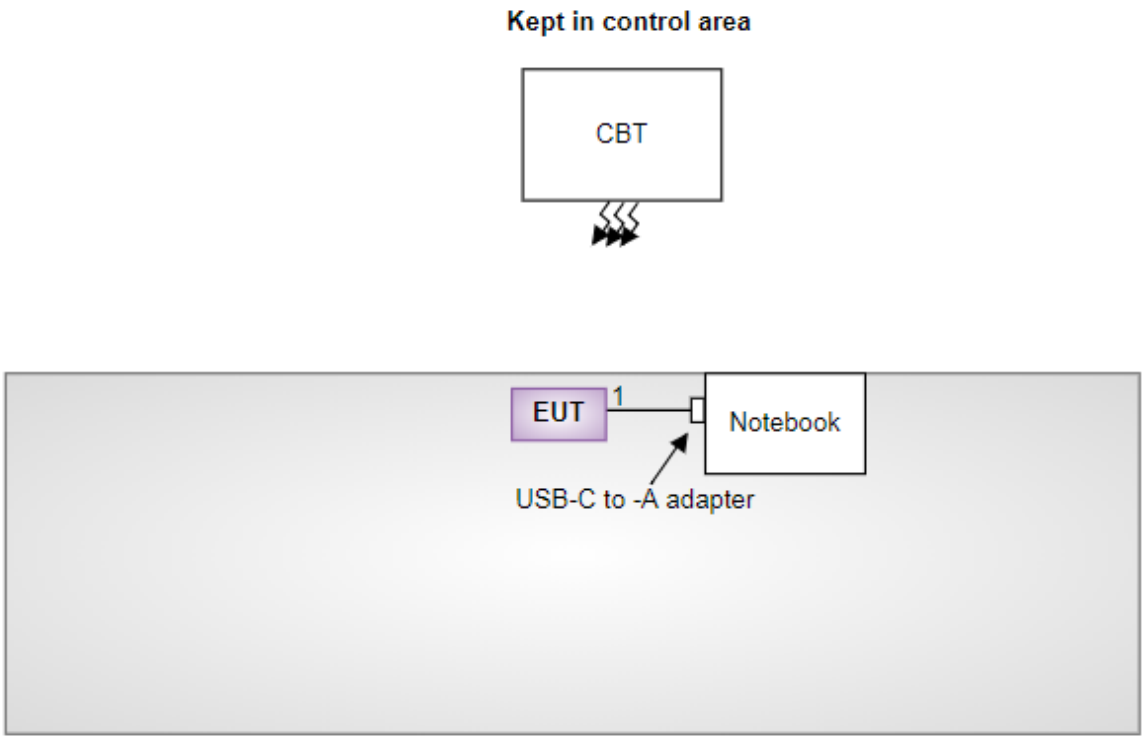
Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/1Mbps	Default	Default	Default

1.2 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**FCC ID**	**Remarks**
1	Notebook	DELL	Latitude E5470	DoC	---

1.3 Test Setup Chart

Test Setup Diagram



No.	Signal cable / Length (m)
1	USB, 0.75m shielded without core (Undetachable).

1.4 Test Equipment List and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Nov. 08, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	R&S	ESR3	101657	Jan. 05, 2018	Jan. 04, 2019
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 05, 2018	Nov. 04, 2019
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 18, 2017	Dec. 17, 2018
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	Oct. 31 ~ Nov. 01, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101498	Dec. 04, 2017	Dec. 03, 2018
Receiver	R&S	ESR3	101658	Nov. 20, 2017	Nov. 19, 2018
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 18, 2018	Jul. 17, 2019
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 20, 2017	Dec. 19, 2018
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 23, 2017	Nov. 22, 2018
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2017	Nov. 12, 2018
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 07, 2017	Dec. 06, 2018
Preamplifier	EMC	EMC02325	980225	Jul. 20, 2018	Jul. 19, 2019
Preamplifier	Agilent	83017A	MY39501308	Oct. 04, 2018	Oct. 03, 2019
Preamplifier	EMC	EMC184045B	980192	Aug. 09, 2018	Aug. 08, 2019
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16140/4	May 09, 2018	May 08, 2019
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 07, 2017	Dec. 06, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 07, 2017	Dec. 06, 2018
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	16052	Dec. 07, 2017	Dec. 06, 2018
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 07, 2017	Dec. 06, 2018
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 07, 2017	Dec. 06, 2018
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Nov. 20, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101063	Apr. 16, 2018	Apr. 15, 2019
Power Meter	Anritsu	ML2495A	1241002	Oct. 09, 2018	Oct. 08, 2019
Power Sensor	Anritsu	MA2411B	1207366	Oct. 09, 2018	Oct. 08, 2019
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 25, 2018	Oct. 24, 2019
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

According to the specification of EUT, the EUT must comply with following standards and KDB documents.

LP0002 Section 3.10.1 (2018-01-10)
ANSI C63.10-2013
ANSI C63.4-2014
FCC KDB 558074 D01 15.247 Meas Guidance v05

1.6 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty	
Parameters	**Uncertainty**
Bandwidth	±34.134 Hz
Conducted power	±0.808 dB
Power density	±0.463 dB
Conducted emission	±2.670 dB
AC conducted emission	±2.90 dB
Radiated emission ≤ 1GHz	±3.66 dB
Radiated emission > 1GHz	±5.63 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	20°C / 60%	Alex Tsai
Radiated Emissions	03CH01-WS	24-25°C / 62-65%	Akun Chung Roger Lu
RF Conducted	TH01-WS	23°C / 66%	Felix Sung

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- IC site registration No.: 10807A-1

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Data Rate	Mode
AC Power Line Conducted Emissions Radiated Emissions ≤ 1GHz	BT LE	2480	1Mbps	TX
Maximum Output Power 6dB bandwidth Power spectral density Radiated Emissions > 1GHz	BT LE	2402, 2440, 2480	1Mbps	TX

NOTE:
1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Y-plane** result was found as the worst case and was shown in this report.
2. Model SP 30 and SP 40 had been pretested and found that **SP 40** was the worst case and was selected for final testing.

Test item	Mode	Test Frequency (MHz)	Data Rate	Mode
AC Power Line Conducted Emissions	BT LE	2480	1Mbps	RX
Radiated Emissions	BT LE	2480	1Mbps	RX

NOTE:
1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Y-plane** result was found as the worst case and was shown in this report.
2. Model SP 30 and SP 40 had been pretested and found that **SP 40** was the worst case and was selected for final testing.

3 Transmitter Test Results

3.1 Conducted Emissions

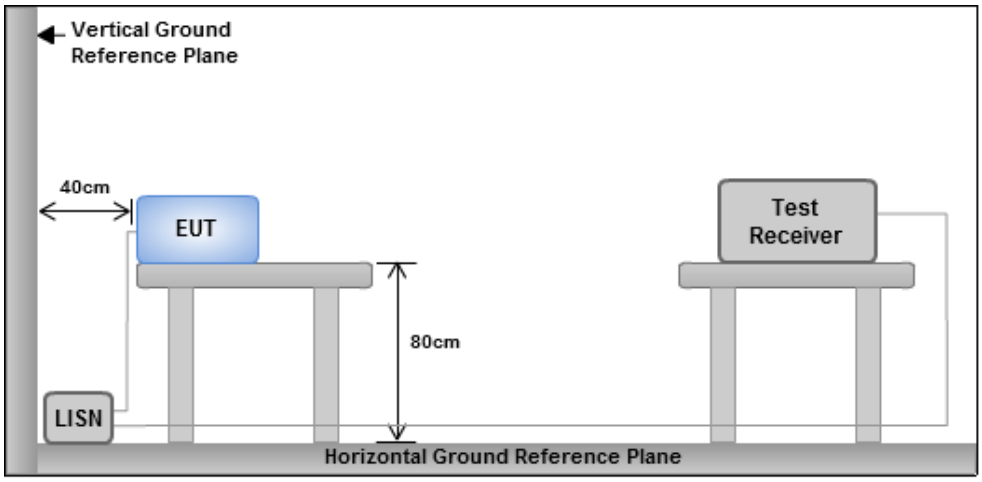
3.1.1 Limit of Conducted Emissions

Conducted Emissions Limit		
Frequency Emission (MHz)	**Quasi-Peak**	**Average**
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50
Note 1: * Decreases with the logarithm of the frequency.		

3.1.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V/60Hz

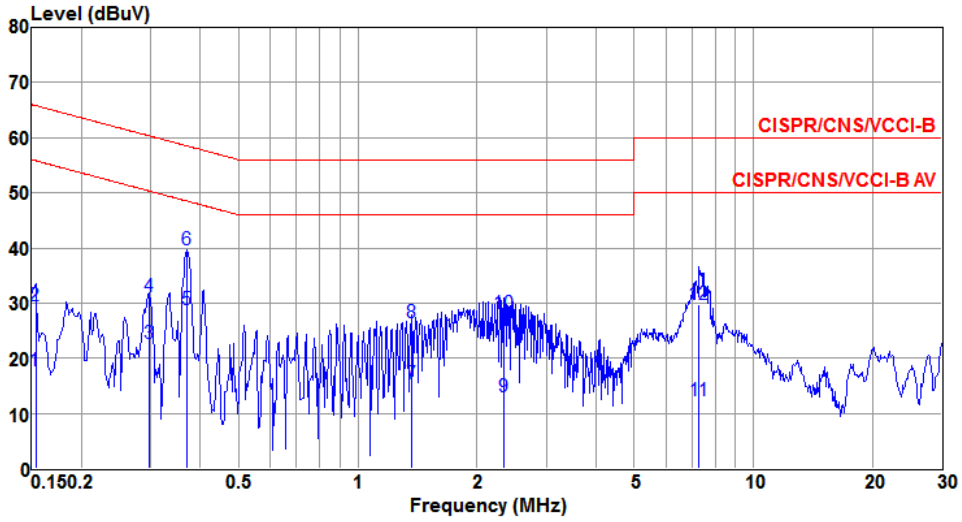
3.1.3 Test Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions

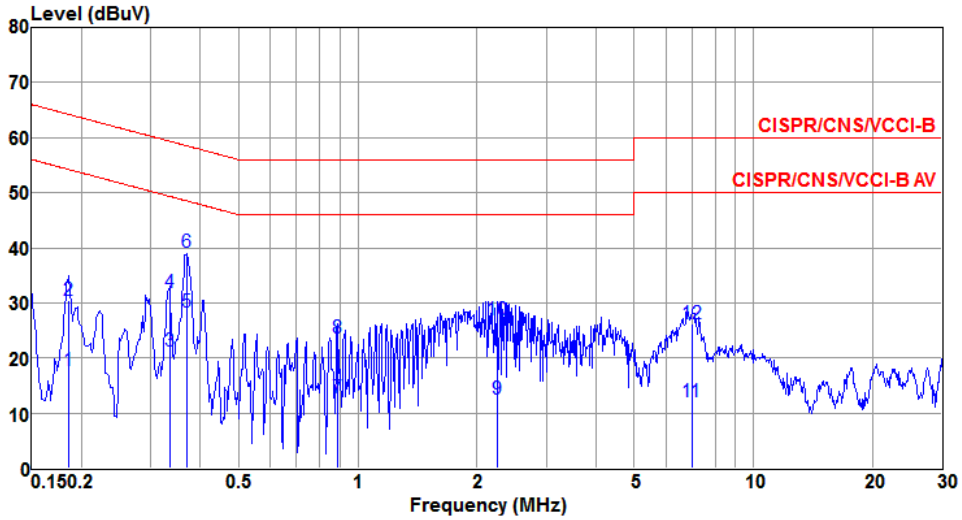
Modulation Mode	GFSK	Test Freq. (MHz)	2480
Power Phase	Line		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.153	17.76	55.82	-38.06	17.72	0.03	0.01	Average
2	0.153	29.60	65.82	-36.22	29.56	0.03	0.01	QP
3	0.297	22.55	50.32	-27.77	22.50	0.03	0.02	Average
4	0.297	31.06	60.32	-29.26	31.01	0.03	0.02	QP
5	0.369	28.91	48.52	-19.61	28.86	0.03	0.02	Average
6*	0.369	39.54	58.52	-18.98	39.49	0.03	0.02	QP
7	1.367	15.23	46.00	-30.77	15.13	0.04	0.06	Average
8	1.367	26.34	56.00	-29.66	26.24	0.04	0.06	QP
9	2.334	12.99	46.00	-33.01	12.80	0.06	0.13	Average
10	2.334	28.08	56.00	-27.92	27.89	0.06	0.13	QP
11	7.290	12.36	50.00	-37.64	11.93	0.14	0.29	Average
12	7.290	29.72	60.00	-30.28	29.29	0.14	0.29	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Modulation Mode	GFSK	Test Freq. (MHz)	2480
Power Phase	Neutral		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.186	17.60	54.20	-36.60	17.54	0.03	0.03	Average
2	0.186	30.43	64.20	-33.77	30.37	0.03	0.03	QP
3	0.334	21.23	49.35	-28.12	21.18	0.03	0.02	Average
4	0.334	31.89	59.35	-27.46	31.84	0.03	0.02	QP
5	0.369	28.38	48.52	-20.14	28.33	0.03	0.02	Average
6*	0.369	39.13	58.52	-19.39	39.08	0.03	0.02	QP
7	0.890	12.85	46.00	-33.15	12.78	0.04	0.03	Average
8	0.890	23.69	56.00	-32.31	23.62	0.04	0.03	QP
9	2.249	12.41	46.00	-33.59	12.23	0.06	0.12	Average
10	2.249	26.87	56.00	-29.13	26.69	0.06	0.12	QP
11	6.988	11.98	50.00	-38.02	11.57	0.13	0.28	Average
12	6.988	26.20	60.00	-33.80	25.79	0.13	0.28	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 6dB and Occupied Bandwidth

3.2.1 Limit of 6dB Bandwidth

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

3.2.2 Test Procedures

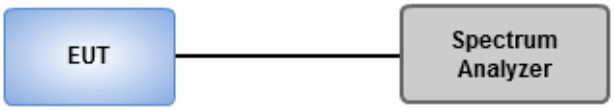
6dB Bandwidth

1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Peak, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth

1. Set resolution bandwidth (RBW) = 1% ~ 5 % of OBW, Video bandwidth = 3 x RBW
2. Detector = Sample, Trace mode = max hold.
3 Sweep = auto couple, Allow the trace to stabilize.
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

3.2.3 Test Setup



3.2.4 Test Result of 6dB and Occupied Bandwidth

Summary

Mode	Max-N dB (Hz)	Max-OBW (Hz)	ITU-Code	Min-N dB (Hz)	Min-OBW (Hz)
2.4-2.4835GHz	-	-	-	-	-
BT-LE(1Mbps)	702.899k	1.027M	1M03F1D	684.783k	1.024M

Max-N dB = Maximum 6dB down bandwidth; **Max-OBW** = Maximum 99% occupied bandwidth;
Min-N dB = Minimum 6dB down bandwidth; **Min-OBW** = Minimum 99% occupied bandwidth;

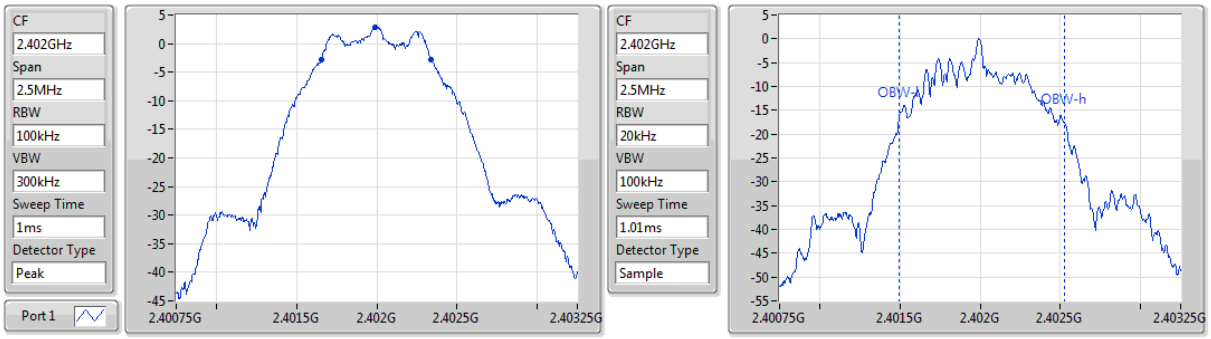
Result

Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	500k	684.783k	1.027M
2440MHz	Pass	500k	702.899k	1.024M
2480MHz	Pass	500k	688.406k	1.024M

Port X-N dB = Port **X** 6dB down bandwidth; **Port X-OBW** = Port **X** 99% occupied bandwidth;

BT-LE(1Mbps) **EBW**

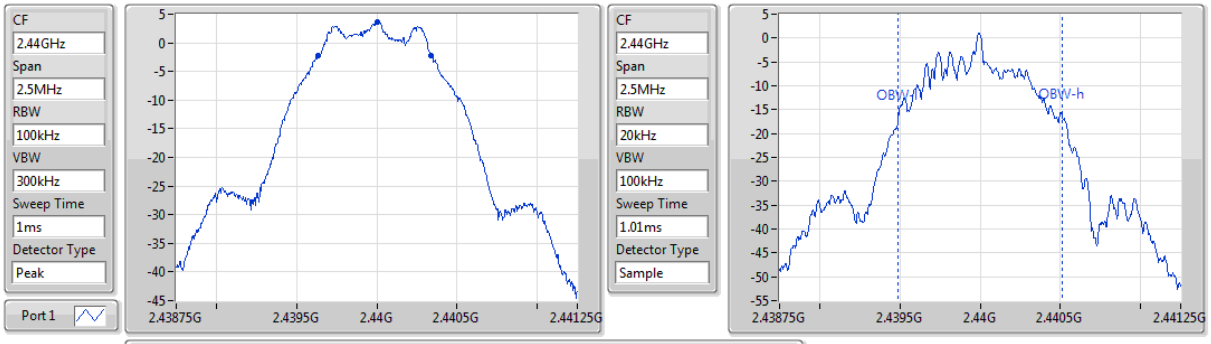
2402MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
684.783k	2.401656G	2.402341G	1.027M	2.401497G	2.402525G	500k	1

BT-LE(1Mbps) **EBW**

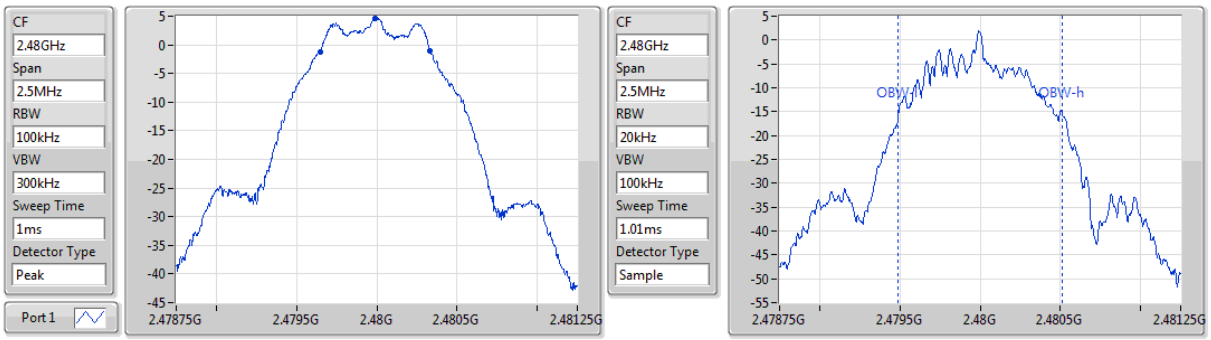
2440MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
702.899k	2.439638G	2.440341G	1.024M	2.43949G	2.440514G	500k	1

BT-LE(1Mbps) **EBW**

2480MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
688.406k	2.479645G	2.480333G	1.024M	2.47949G	2.480514G	500k	1

3.3 RF Output Power

3.3.1 Limit of RF Output Power

Conducted power shall not exceed 1Watt.

Antenna gain <= 6dBi, no any corresponding reduction is in output power limit.

3.3.2 Test Procedures

A broadband RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power.

3.3.3 Test Setup

3.3.4 Test Result of Maximum Output Power

Peak Power Summary

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-LE(1Mbps)	**5.11**	0.00324

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	4.80	3.25	30.00
2440MHz	Pass	4.80	4.02	30.00
2480MHz	Pass	4.80	**5.11**	30.00

Average Power Summary

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-LE(1Mbps)	4.67	0.00293

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	4.80	2.82	-
2440MHz	Pass	4.80	3.59	-
2480MHz	Pass	4.80	4.67	-

Note: Average power is for reference only.

3.4 Power Spectral Density

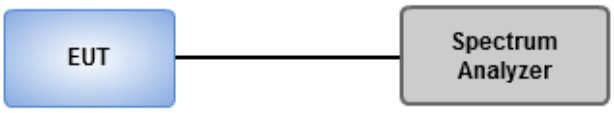
3.4.1 Limit of Power Spectral Density

Power spectral density shall not be greater than 8 dBm in any 3 kHz band.

3.4.2 Test Procedures

1. Set the RBW = 3 kHz, VBW = 10 kHz.
2. Detector = Peak, Sweep time = auto couple.
3. Trace mode = max hold, allow trace to fully stabilize.
4. Use the peak marker function to determine the maximum amplitude level.

3.4.3 Test Setup



3.4.4 Test Result of Power Spectral Density

Summary

Mode	PD (dBm/RBW)
2.4-2.4835GHz	-
BT-LE(1Mbps)	-10.59

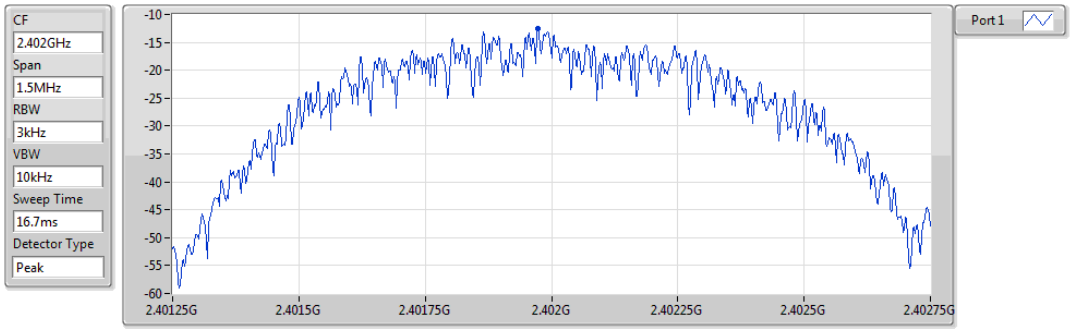
RBW=3kHz.

Result

Mode	Result	Gain (dBi)	PD (dBm/RBW)	PD Limit (dBm/RBW)
BT-LE(1Mbps)	-	-	-	-
2402MHz	Pass	4.80	-12.52	8.00
2440MHz	Pass	4.80	-11.53	8.00
2480MHz	Pass	4.80	-10.59	8.00

BT-LE(1Mbps) **PSD**

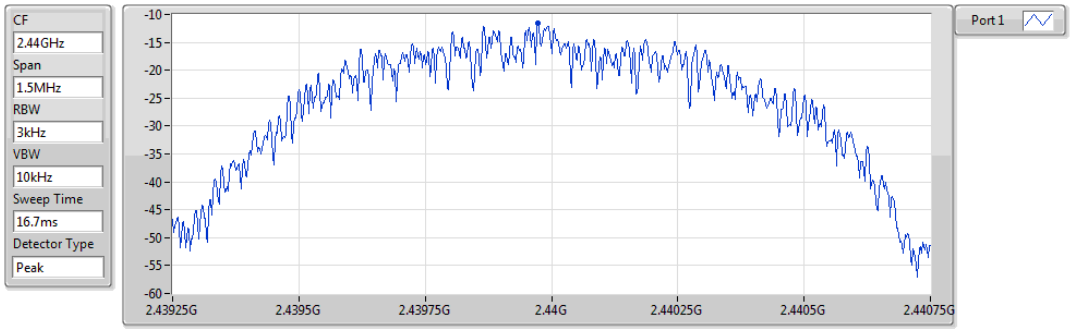
2402MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-12.52	-12.52	-12.52

BT-LE(1Mbps) **PSD**

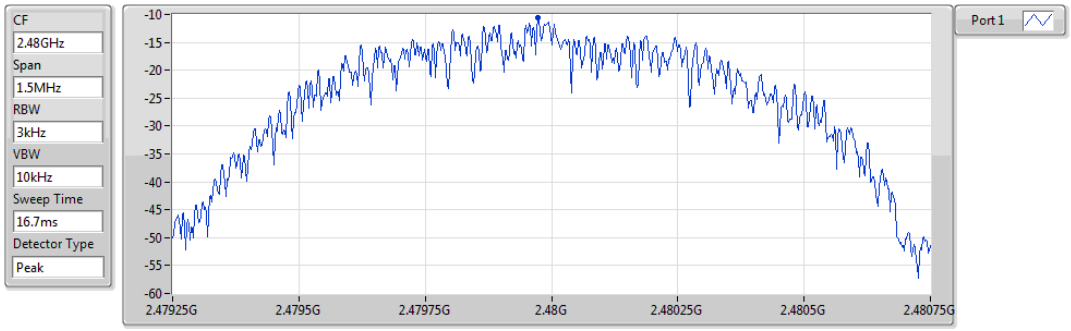
2440MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-11.53	-11.53	-11.53

BT-LE(1Mbps) **PSD**

2480MHz



Sum	PD	Port 1
(dBm/RBW)	(dBm/RBW)	(dBm/RBW)
-10.59	-10.59	-10.59

3.5 Emissions in Restricted Frequency Bands

3.5.1 Limit of Emissions in Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	**Field Strength (uV/m)**	**Field Strength (dBuV/m)**	**Measure Distance (m)**
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Qusai-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit
Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.5.2 Test Procedures

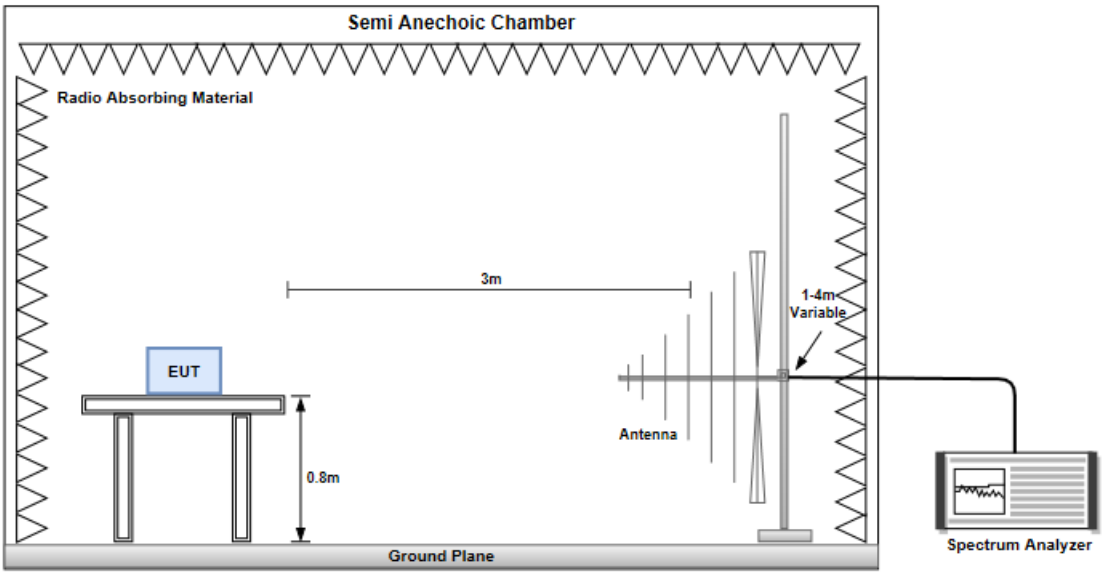
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

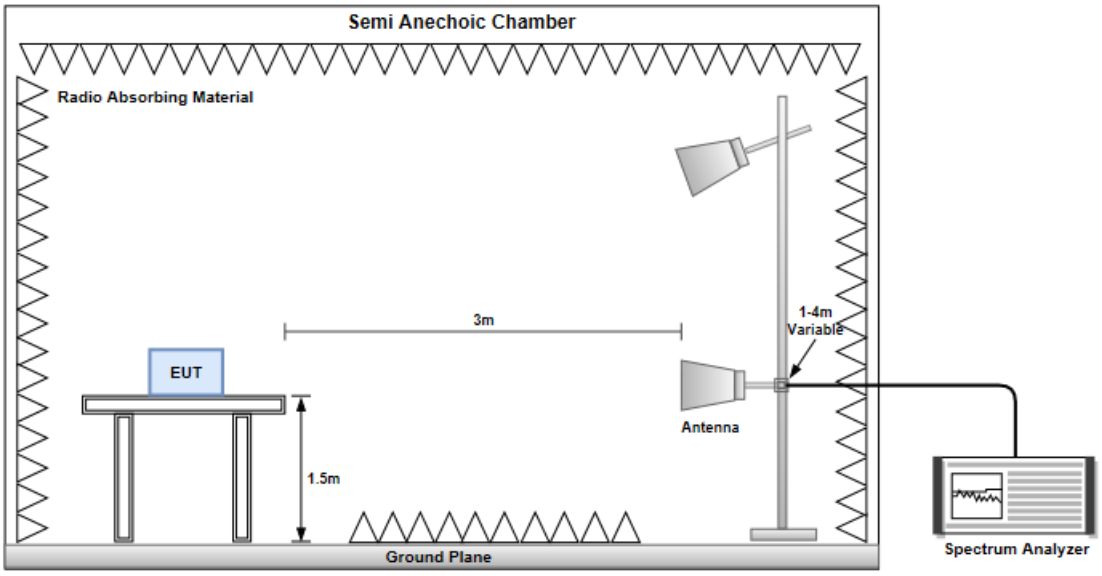
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above 1GHz.

3.5.3 Test Setup

Radiated Emissions below 1 GHz

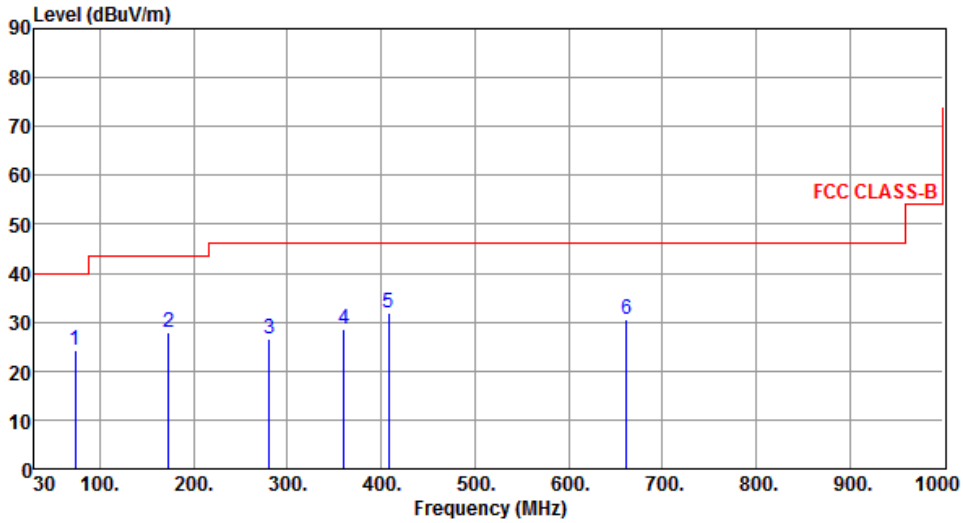


Radiated Emissions above 1 GHz



3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

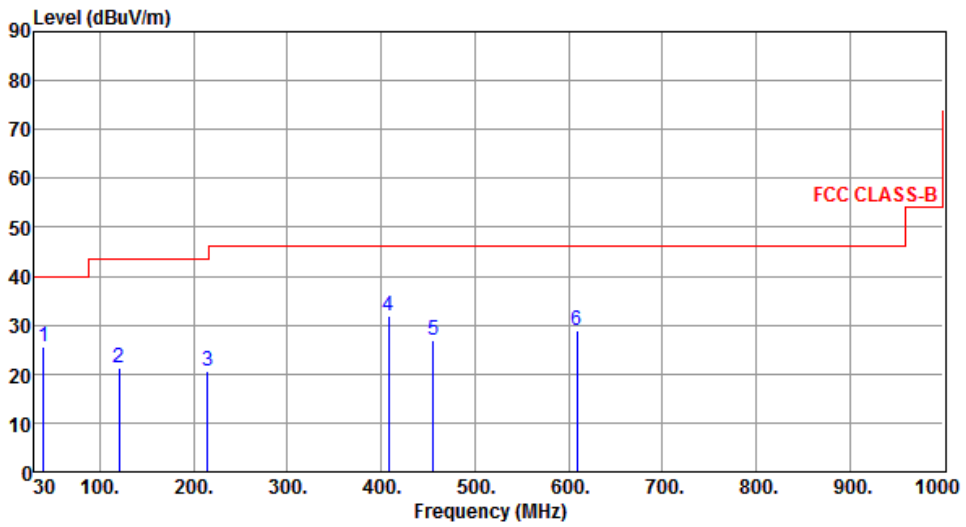
Modulation	GFSK	**Test Freq. (MHz)**	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	73.65	24.11	40.00	-15.89	35.87	-11.76	Peak	---	---
2	173.56	27.95	43.50	-15.55	37.03	-9.08	Peak	---	---
3	280.26	26.58	46.00	-19.42	34.87	-8.29	Peak	---	---
4	360.77	28.41	46.00	-17.59	34.71	-6.30	Peak	---	---
5	408.30	31.83	46.00	-14.17	36.96	-5.13	Peak	---	---
6	661.47	30.47	46.00	-15.53	30.64	-0.17	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		

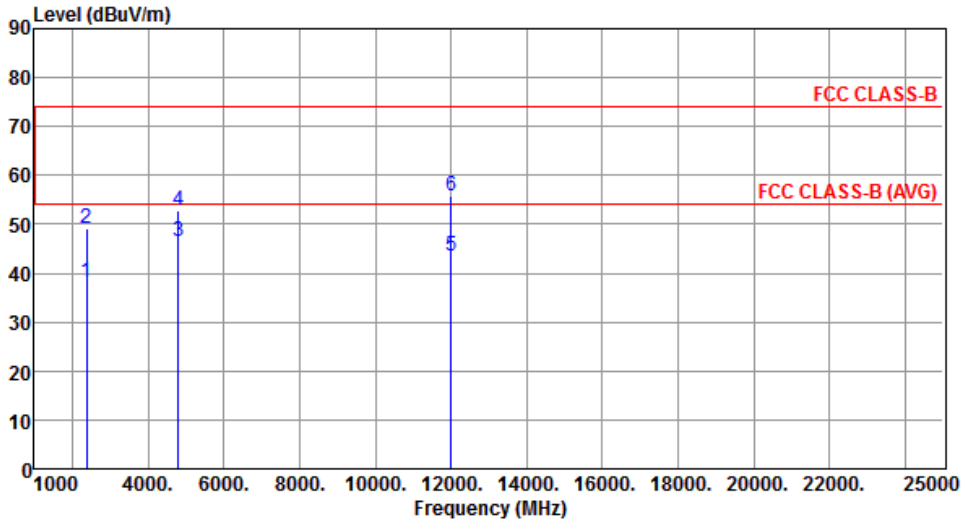


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	39.70	25.46	40.00	-14.54	33.77	-8.31	Peak	---	---
2	120.21	21.40	43.50	-22.10	32.13	-10.73	Peak	---	---
3	215.27	20.52	43.50	-22.98	31.46	-10.94	Peak	---	---
4	408.30	31.84	46.00	-14.16	36.97	-5.13	Peak	---	---
5	455.83	26.83	46.00	-19.17	30.87	-4.04	Peak	---	---
6	609.09	28.89	46.00	-17.11	29.63	-0.74	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

3.5.5 Transmitter Radiated Unwanted Emissions (Above 1GHz) for GFSK

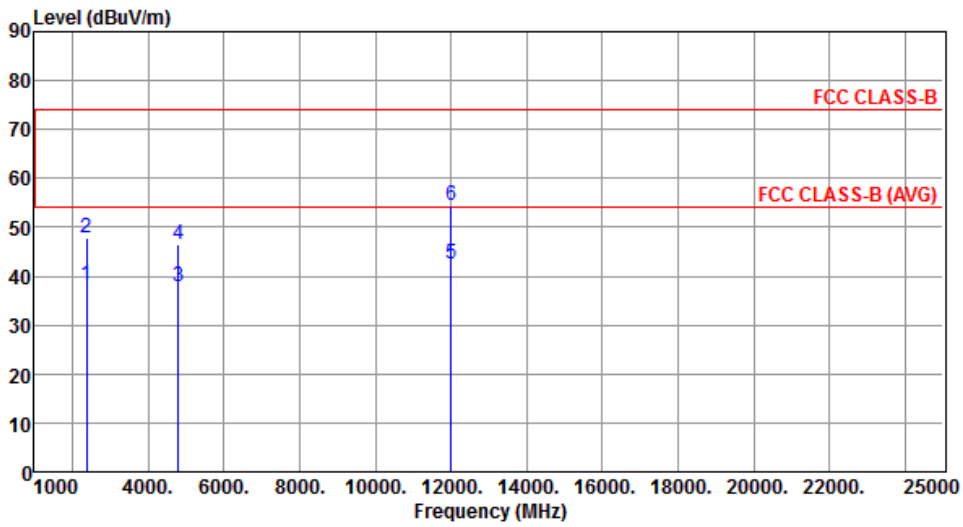
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.04	54.00	-15.96	41.41	-3.37	Average	100	111
2	2390.00	49.21	74.00	-24.79	52.58	-3.37	Peak	100	111
3	4804.00	46.34	54.00	-7.66	42.45	3.89	Average	114	218
4	4804.00	52.70	74.00	-21.30	48.81	3.89	Peak	114	218
5	12010.00	43.38	54.00	-10.62	30.00	13.38	Average	100	125
6	12010.00	55.84	74.00	-18.16	42.46	13.38	Peak	100	125

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

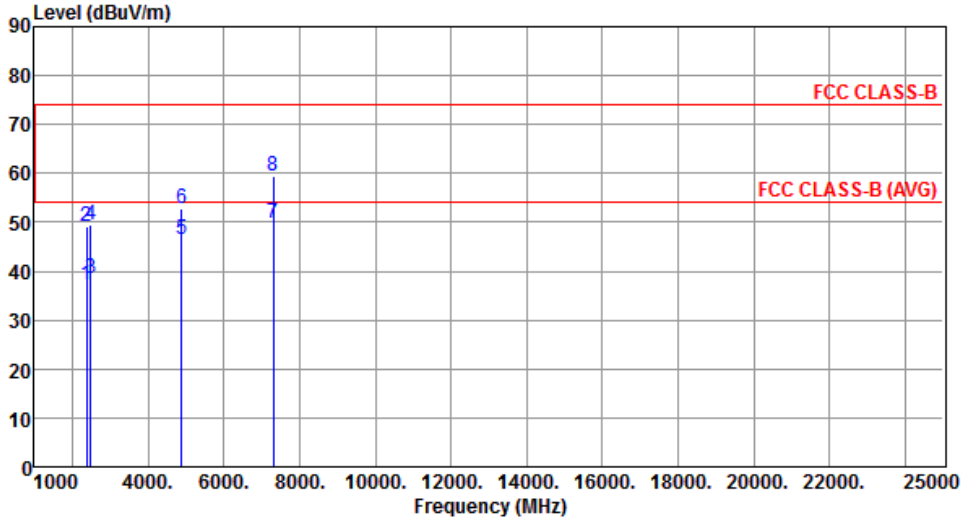
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	38.32	54.00	-15.68	41.69	-3.37	Average	100	155
2	2390.00	47.88	74.00	-26.12	51.25	-3.37	Peak	100	155
3	4804.00	37.72	54.00	-16.28	33.83	3.89	Average	103	117
4	4804.00	46.65	74.00	-27.35	42.76	3.89	Peak	103	117
5	12010.00	42.60	54.00	-11.40	29.22	13.38	Average	100	60
6	12010.00	54.43	74.00	-19.57	41.05	13.38	Peak	100	60

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

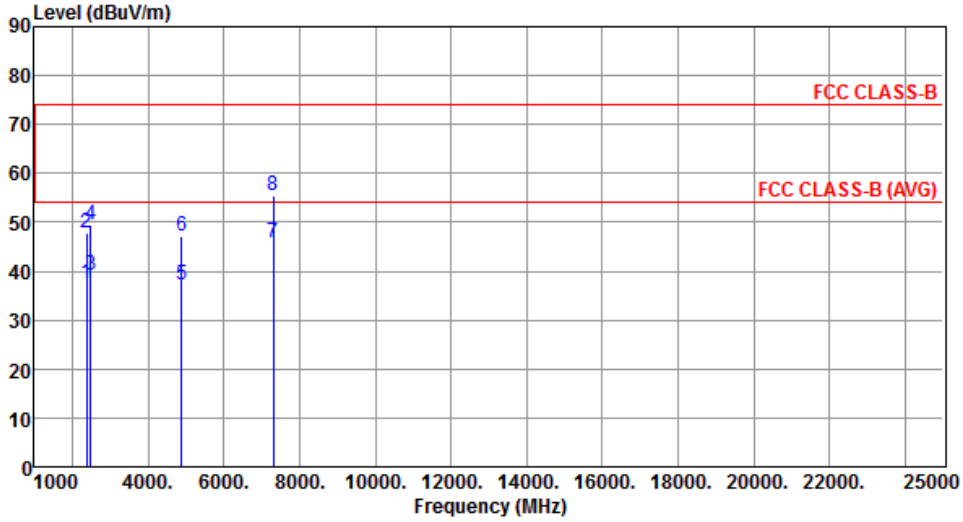
Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	37.22	54.00	-16.78	40.59	-3.37	Average	100	100
2	2390.00	48.99	74.00	-25.01	52.36	-3.37	Peak	100	100
3	2483.50	38.40	54.00	-15.60	41.36	-2.96	Average	100	100
4	2483.50	49.51	74.00	-24.49	52.47	-2.96	Peak	100	100
5	4880.00	46.63	54.00	-7.37	42.51	4.12	Average	108	213
6	4880.00	52.64	74.00	-21.36	48.52	4.12	Peak	108	213
7	7320.00	49.87	54.00	-4.13	41.22	8.65	Average	186	132
8	7320.00	59.55	74.00	-14.45	50.90	8.65	Peak	186	132

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

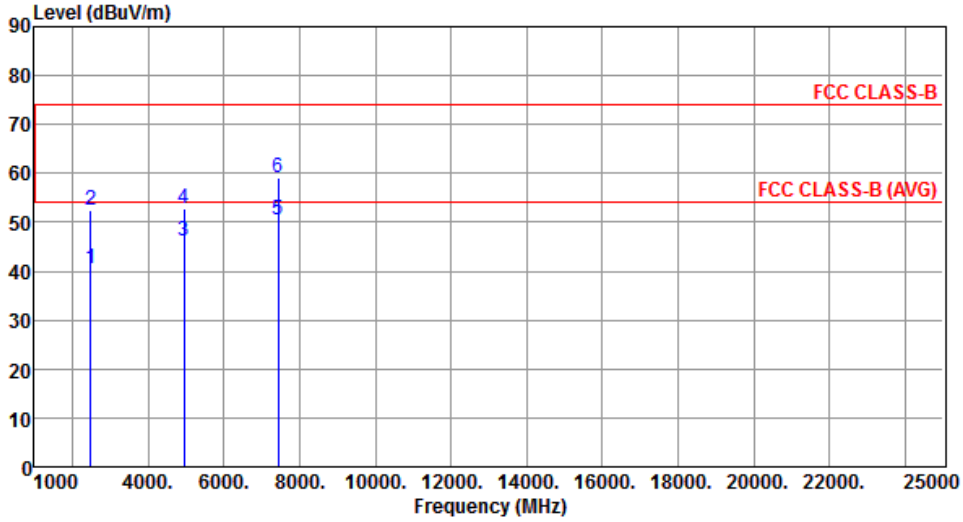
Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	37.37	54.00	-16.63	40.74	-3.37	Average	100	149
2	2390.00	47.94	74.00	-26.06	51.31	-3.37	Peak	100	149
3	2483.50	39.29	54.00	-14.71	42.25	-2.96	Average	100	149
4	2483.50	49.64	74.00	-24.36	52.60	-2.96	Peak	100	149
5	4880.00	37.17	54.00	-16.83	33.05	4.12	Average	100	108
6	4880.00	47.10	74.00	-26.90	42.98	4.12	Peak	100	108
7	7320.00	45.86	54.00	-8.14	37.21	8.65	Average	110	211
8	7320.00	55.50	74.00	-18.50	46.85	8.65	Peak	110	211

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

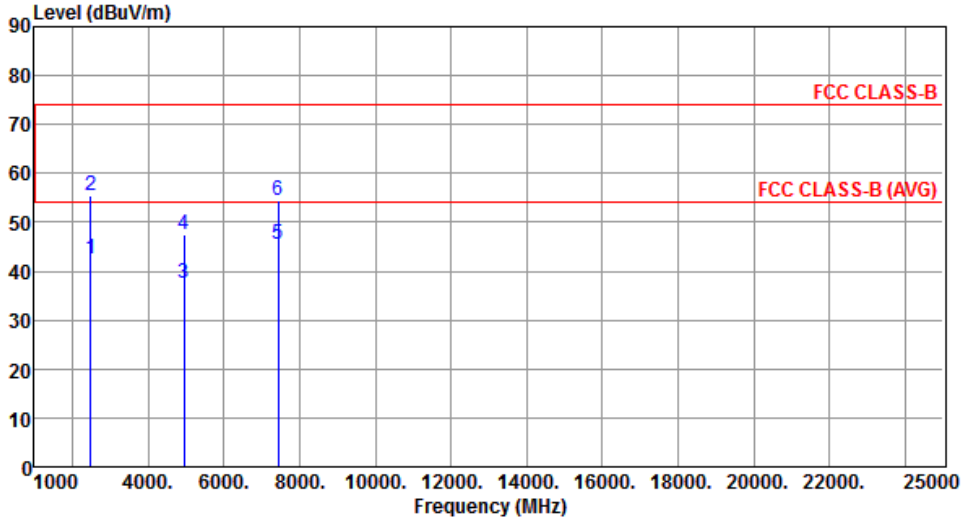
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	40.51	54.00	-13.49	43.47	-2.96	Average	104	98
2	2483.50	52.44	74.00	-21.56	55.40	-2.96	Peak	104	98
3	4960.00	46.30	54.00	-7.70	41.93	4.37	Average	108	215
4	4960.00	52.70	74.00	-21.30	48.33	4.37	Peak	108	215
5	7440.00	50.49	54.00	-3.51	41.67	8.82	Average	190	140
6	7440.00	59.05	74.00	-14.95	50.23	8.82	Peak	190	140

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	42.58	54.00	-11.42	45.54	-2.96	Average	100	157
2	2483.50	55.30	74.00	-18.70	58.26	-2.96	Peak	100	157
3	4960.00	37.56	54.00	-16.44	33.19	4.37	Average	101	114
4	4960.00	47.58	74.00	-26.42	43.21	4.37	Peak	101	114
5	7440.00	45.40	54.00	-8.60	36.58	8.82	Average	103	210
6	7440.00	54.37	74.00	-19.63	45.55	8.82	Peak	103	210

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.6 Emissions in non-restricted Frequency Bands

3.6.1 Emissions in non-restricted frequency bands limit

Peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

3.6.2 Test Procedures

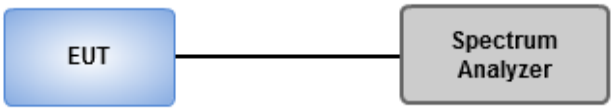
Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

Emission level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 25GHz
4. Use the peak marker function to determine the maximum amplitude level

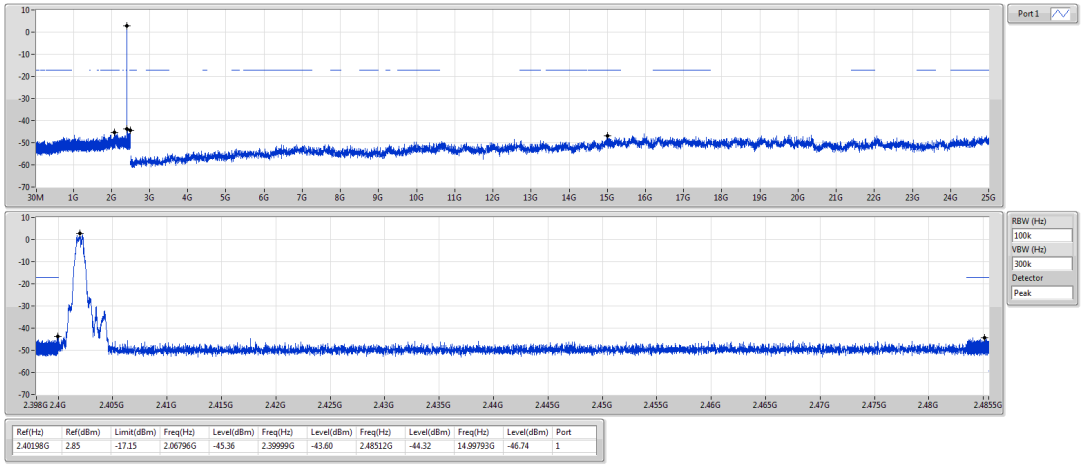
3.6.3 Test Setup



3.6.4 Test Result of Emissions in non-restricted Frequency Bands

BT-LE(1Mbps) **CSE NdB**

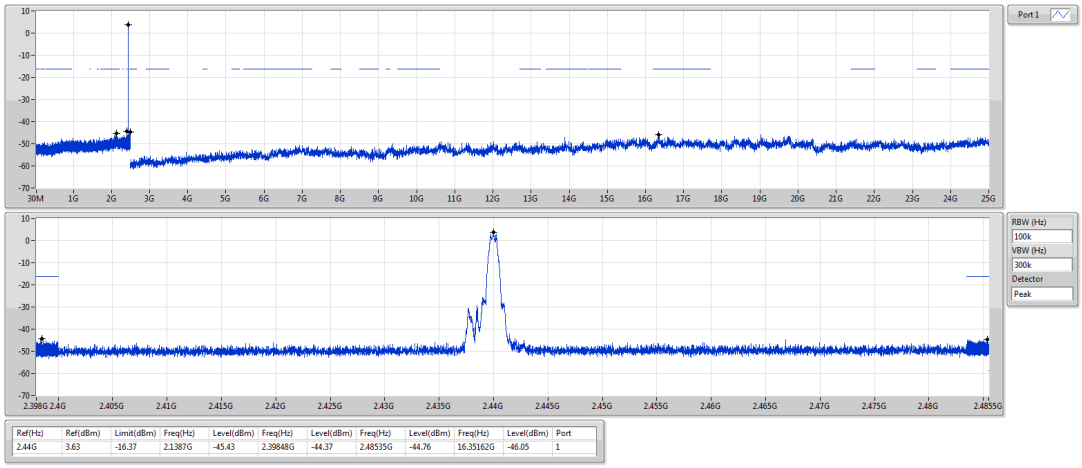
2402MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.40198G	2.85	-17.15	2.06796G	-45.36	2.39999G	-43.60	2.48512G	-44.32	14.99793G	-46.74	1

BT-LE(1Mbps) **CSE NdB**

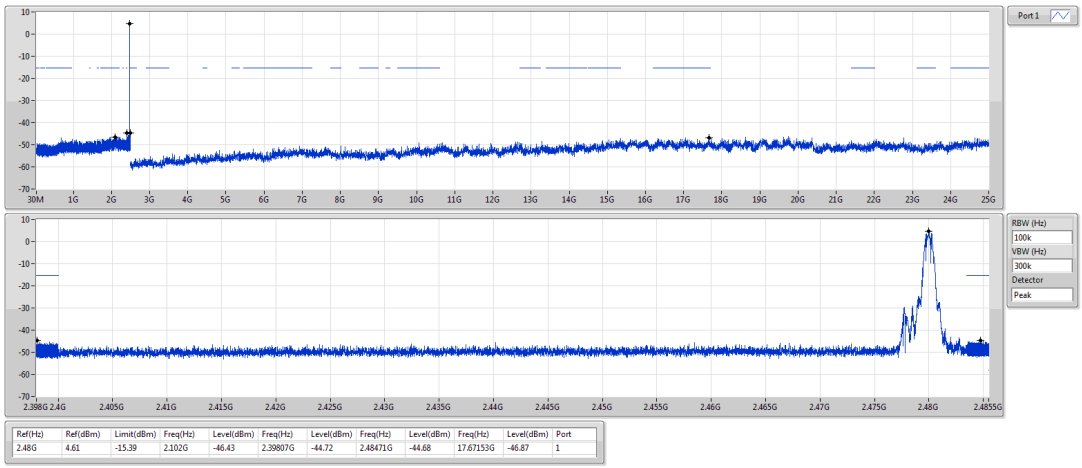
2440MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.44G	3.63	-16.37	2.1387G	-45.43	2.39848G	-44.37	2.48535G	-44.76	16.35162G	-46.05	1

BT-LE(1Mbps) **CSE NdB**

2480MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.48G	4.61	-15.39	2.102G	-46.43	2.39807G	-44.72	2.48471G	-44.68	17.67153G	-46.87	1

4 Receiver Test Results

4.1 Conducted Emissions

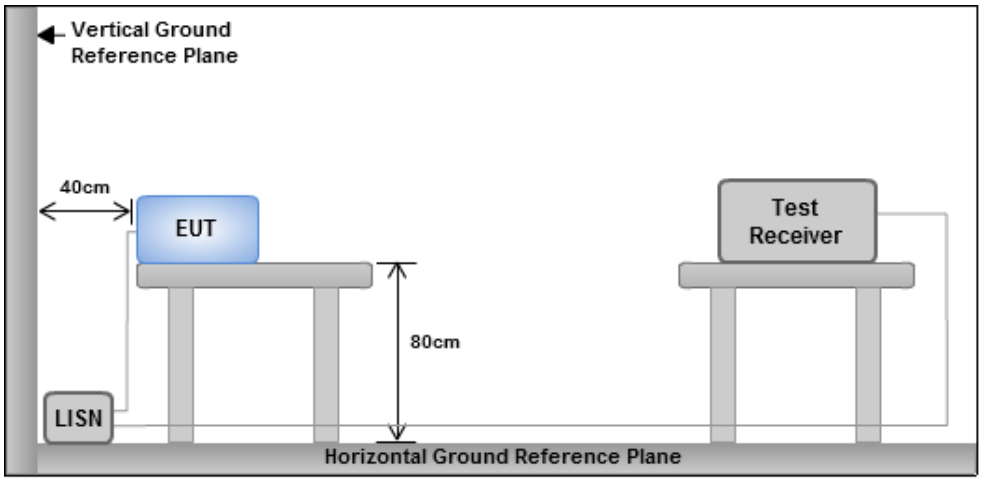
4.1.1 Limit of Conducted Emissions

Conducted Emissions Limit		
Frequency Emission (MHz)	**Quasi-Peak**	**Average**
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50
Note 1: * Decreases with the logarithm of the frequency.		

4.1.2 Test Procedures

5. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
6. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
7. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
8. This measurement was performed with AC 120V/60Hz

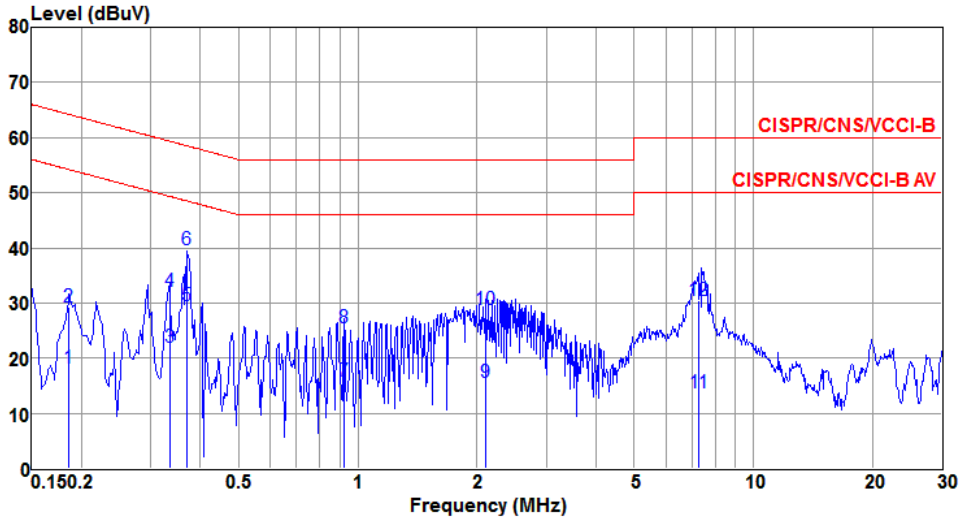
4.1.3 Test Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

4.1.4 Test Result of Conducted Emissions

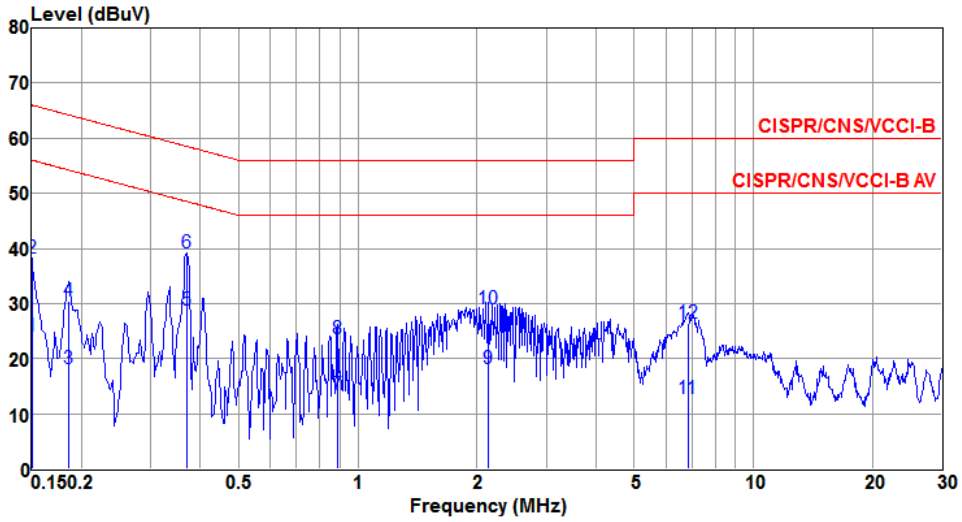
Modulation Mode	GFSK	Test Freq. (MHz)	2480
Power Phase	Line		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.186	18.29	54.20	-35.91	18.23	0.03	0.03	Average
2	0.186	29.33	64.20	-34.87	29.27	0.03	0.03	QP
3	0.334	21.89	49.35	-27.46	21.84	0.03	0.02	Average
4	0.334	32.14	59.35	-27.21	32.09	0.03	0.02	QP
5	0.369	29.44	48.52	-19.08	29.39	0.03	0.02	Average
6*	0.369	39.59	58.52	-18.93	39.54	0.03	0.02	QP
7	0.923	15.75	46.00	-30.25	15.68	0.04	0.03	Average
8	0.923	25.56	56.00	-30.44	25.49	0.04	0.03	QP
9	2.110	15.48	46.00	-30.52	15.32	0.05	0.11	Average
10	2.110	28.87	56.00	-27.13	28.71	0.05	0.11	QP
11	7.281	13.75	50.00	-36.25	13.33	0.14	0.28	Average
12	7.281	30.39	60.00	-29.61	29.97	0.14	0.28	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Modulation Mode	GFSK	Test Freq. (MHz)	2480
Power Phase	Neutral		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.150	24.10	56.00	-31.90	24.06	0.03	0.01	Average
2	0.150	38.24	66.00	-27.76	38.20	0.03	0.01	QP
3	0.186	18.21	54.20	-35.99	18.15	0.03	0.03	Average
4	0.186	30.53	64.20	-33.67	30.47	0.03	0.03	QP
5	0.369	28.88	48.52	-19.64	28.83	0.03	0.02	Average
6*	0.369	39.20	58.52	-19.32	39.15	0.03	0.02	QP
7	0.890	13.51	46.00	-32.49	13.44	0.04	0.03	Average
8	0.890	23.70	56.00	-32.30	23.63	0.04	0.03	QP
9	2.144	18.25	46.00	-27.75	18.08	0.06	0.11	Average
10	2.144	29.10	56.00	-26.90	28.93	0.06	0.11	QP
11	6.841	12.83	50.00	-37.17	12.42	0.13	0.28	Average
12	6.841	26.43	60.00	-33.57	26.02	0.13	0.28	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

4.2 Radiated Emissions

4.2.1 Limit of Radiated Emissions

Restricted Band Emissions Limit			
Frequency Range (MHz)	**Field Strength (uV/m)**	**Field Strength (dBuV/m)**	**Measure Distance (m)**
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Qusai-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit
Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

4.2.2 Test Procedures

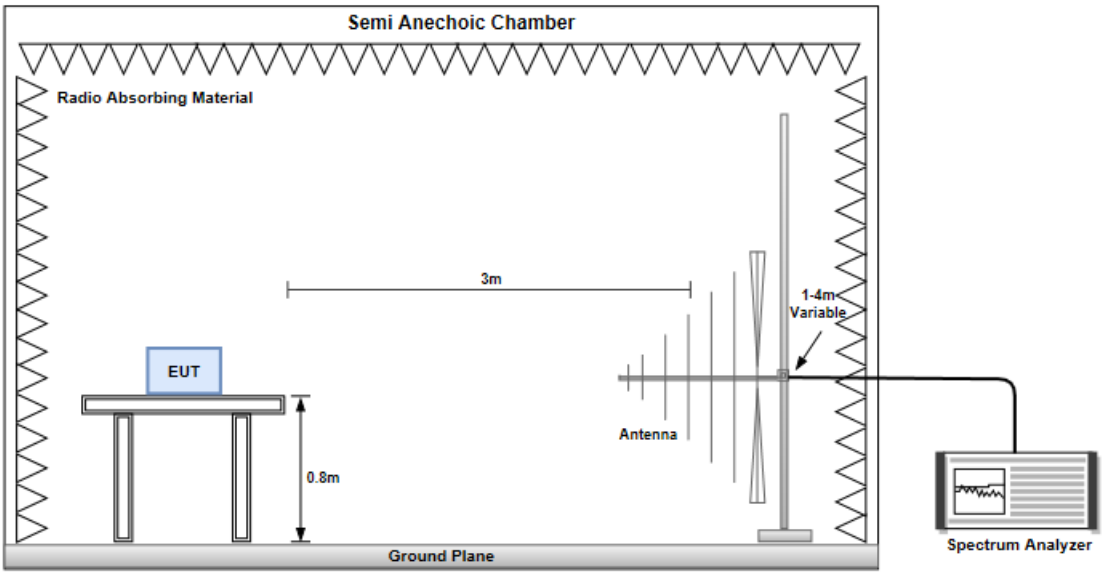
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

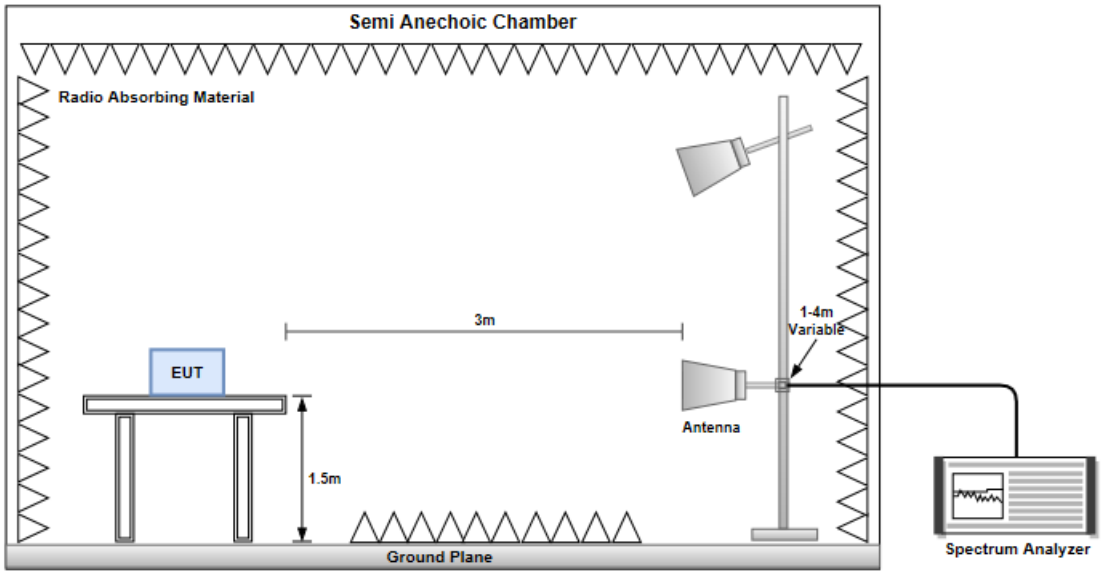
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=3MHz and RMS detector is for average measured value of radiated emission above 1GHz.

4.2.3 Test Setup

Radiated Emissions below 1 GHz

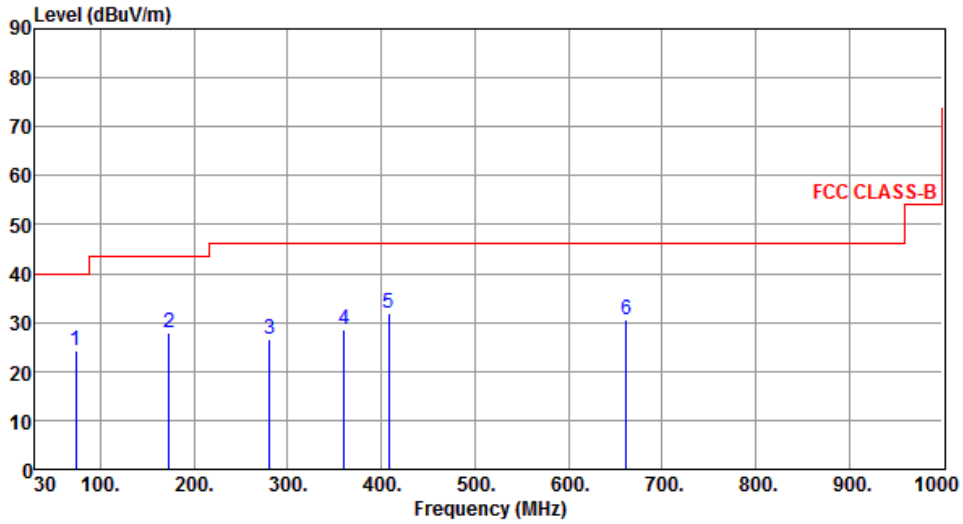


Radiated Emissions above 1 GHz



4.2.4 Receiver Emissions (Below 1GHz)

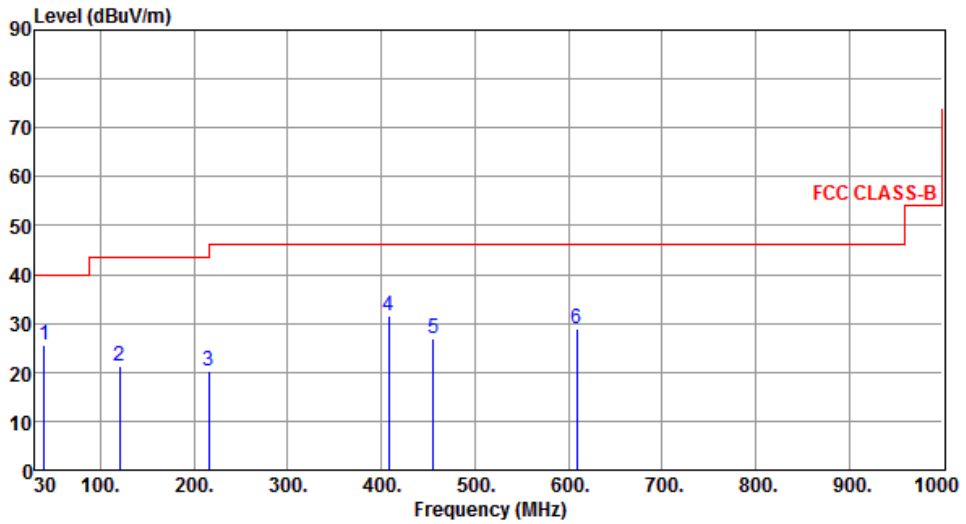
Modulation	GFSK	**Test Freq. (MHz)**	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	73.65	24.21	40.00	-15.79	35.97	-11.76	Peak	---	---
2	173.44	27.88	43.50	-15.62	36.94	-9.06	Peak	---	---
3	280.33	26.41	46.00	-19.59	34.70	-8.29	Peak	---	---
4	360.77	28.56	46.00	-17.44	34.86	-6.30	Peak	---	---
5	408.23	31.79	46.00	-14.21	36.93	-5.14	Peak	---	---
6	661.58	30.51	46.00	-15.49	30.68	-0.17	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		

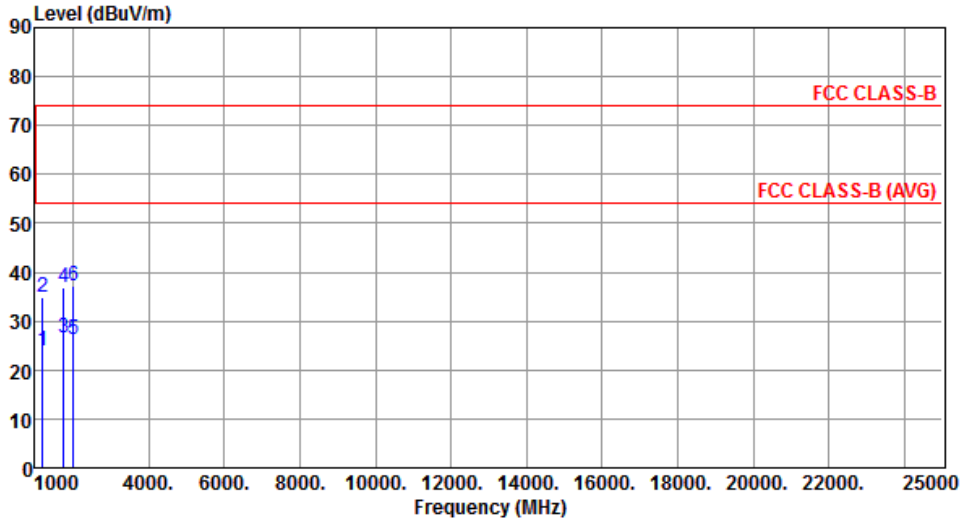


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	39.65	25.57	40.00	-14.43	33.89	-8.32	Peak	---	---
2	120.21	21.39	43.50	-22.11	32.12	-10.73	Peak	---	---
3	215.33	20.42	43.50	-23.08	31.36	-10.94	Peak	---	---
4	408.28	31.67	46.00	-14.33	36.80	-5.13	Peak	---	---
5	455.77	26.74	46.00	-19.26	30.78	-4.04	Peak	---	---
6	609.12	28.74	46.00	-17.26	29.48	-0.74	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

4.2.5 Receiver Emissions (Above 1GHz)

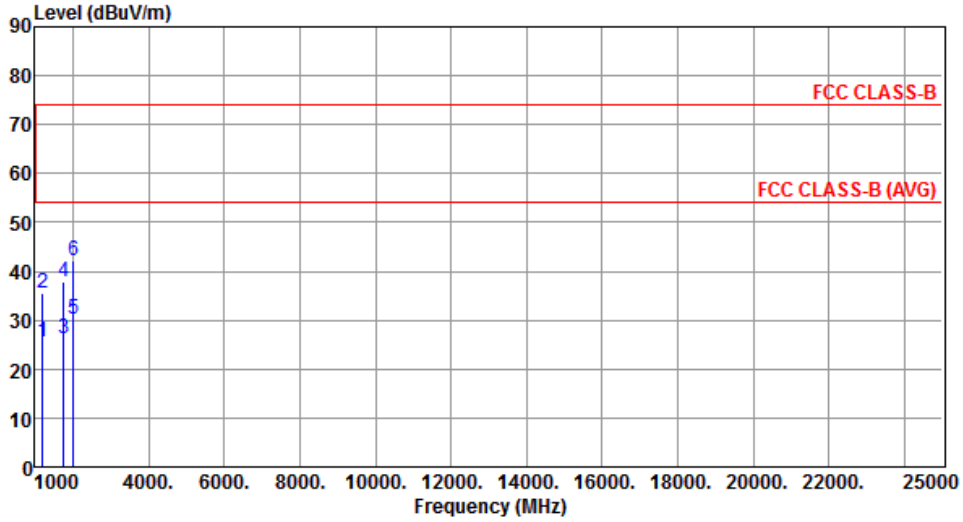
Modulation	GFSK	**Test Freq. (MHz)**	2480
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1194.00	23.95	54.00	-30.05	33.17	-9.22	Average	100	354
2	1194.00	34.95	74.00	-39.05	44.17	-9.22	Peak	100	354
3	1760.00	26.41	54.00	-27.59	32.37	-5.96	Average	100	195
4	1760.00	36.76	74.00	-37.24	42.72	-5.96	Peak	100	195
5	2023.00	26.09	54.00	-27.91	31.12	-5.03	Average	100	67
6	2023.00	37.17	74.00	-36.83	42.20	-5.03	Peak	100	67

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1194.00	25.53	54.00	-28.47	34.75	-9.22	Average	100	58
2	1194.00	35.58	74.00	-38.42	44.80	-9.22	Peak	100	58
3	1760.00	26.33	54.00	-27.67	32.29	-5.96	Average	100	321
4	1760.00	37.80	74.00	-36.20	43.76	-5.96	Peak	100	321
5	2023.00	30.28	54.00	-23.72	35.31	-5.03	Average	100	125
6	2023.00	42.08	74.00	-31.92	47.11	-5.03	Peak	100	125

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
*Factor includes antenna factor , cable loss and amplifier gain
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

5 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information.

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