AS/NZS Test Report

Equipment	:	**Intelligent LoRa/BLE Module [915MHz LoRa) featuring smartBASIC**
Model No.	:	**RM191-SM**
Brand Name	:	**Laird Connectivity**
Applicant	:	**Laird Connectivity**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**AS/NZS 4268:2017**
Received Date	:	**May 08, 2019**
Tested Date	:	**May 24 ~ Jul. 22, 2019**

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: **Approved by:**

James Fan / Assistant Manager **Gary Chang / Manager**

Testing Laboratory 2732

Table of Contents

1 GENERAL DESCRIPTION 5

1.1 Information 5
1.2 Local Support Equipment List 7
1.3 Test Setup Chart 7
1.4 Test Equipment and Calibration Data 9
1.5 Testing Applied Standards 11
1.6 Deviation from Test Standard and Measurement Procedure 11
1.7 Measurement Uncertainty 11

2 TEST CONFIGURATION 12

2.1 Testing Condition 12
2.2 The Worst Test Modes and Channel Details 13

3 TRANSMITTER TEST RESULTS 14

3.1 Maximum EIRP 14
3.2 Emission Bandwidth 16
3.3 Peak Power Spectral Density 18
3.4 Operating Frequencies 19
3.5 Transmitter Spurious Emissions 21
3.6 Emissions in non-restricted Frequency Bands 34

4 RECEIVER TEST RESULTS 36

4.1 Receiver Spurious Emissions 36

5 PHOTOGRAPHS OF THE TEST CONFIGURATION 45

6 TEST LABORATORY INFORMATION 52

Release Record

Report No.	Version	Description	Issued Date
AR821301-03AE	Rev. 01	Initial issue	Jul. 30, 2019

Summary of Test Results

Ref. Std. Clause	Test Items	Measured	Result
6.3	Maximum EIRP	3.83 dBm	Pass
6.5	Emission Bandwidth	Meet the requirement of limit.	Pass
6.6	Operating Frequencies	Meet the requirement of limit.	Pass
6.4	Transmitter Spurious Emissions	Meet the requirement of limit.	Pass
7.2	Receiver Spurious Emissions	Meet the requirement of limit.	Pass
Row 59	Peak Power Spectral Density	Meet the requirement of limit.	Pass

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information					
Country	**Frequency Range (MHz)**	**Bluetooth Mode**	**Ch. Frequency (MHz)**	**Channel Number**	**Data Rate**
AUSTRALIA and NEW ZEALAND	2400-2483.5	V4.1 LE	2402-2480	0-39 [40]	1 Mbps
Note 1: Bluetooth LE (Low energy) uses GFSK modulation.					

1.1.2 Antenna Details

Ant. No.	Model	Type	Gain (dBi)	Connector
1	ACX AT5020-E3R0HBANT/LF	Chip	0	N/A

1.1.3 EUT Operational Condition

Power Supply Type	3.5Vdc from host		
Operational Voltage	☒ Vnom (3.3 Vdc)	☒ Vmax (3.50 Vdc)	☒ Vmin (1.80 Vdc)
Operational Climatic	☒ Tnom (20°C)	☒ Tmax (85°C)	☒ Tmin (-40°C)

1.1.4 Accessories

N/A

1.1.5 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

1.1.6 Test Tool and Duty Cycle

Test Tool	UwTerminal, Version: v7_94	
Duty Cycle and Duty Factor	Duty Cycle (%)	Duty Factor (dB)
	96.74%	0.14

1.1.7 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
LE-1Mbps	0	0	0

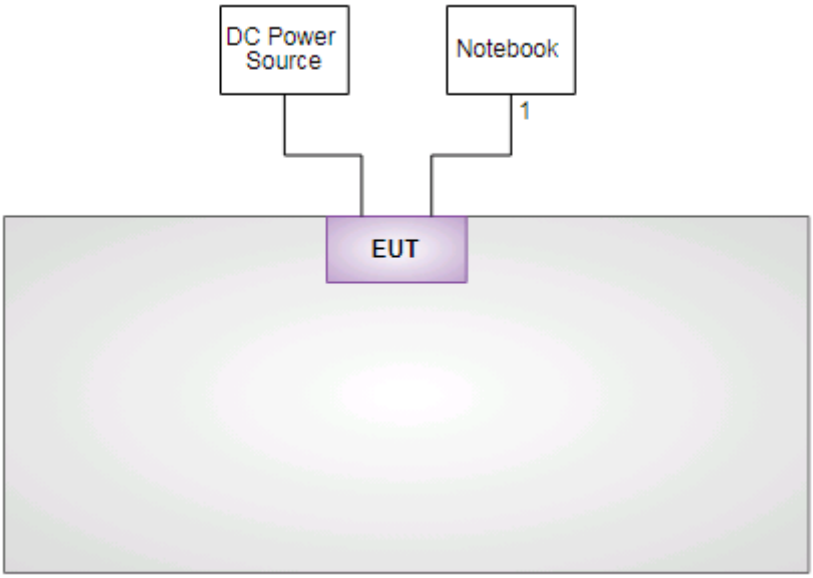
Note: Test Tool setting of 0 is 4dBm setting

1.2 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**S/N**	**Remarks**
1	Notebook	DELL	Latitude E6440	JPXMD12	---

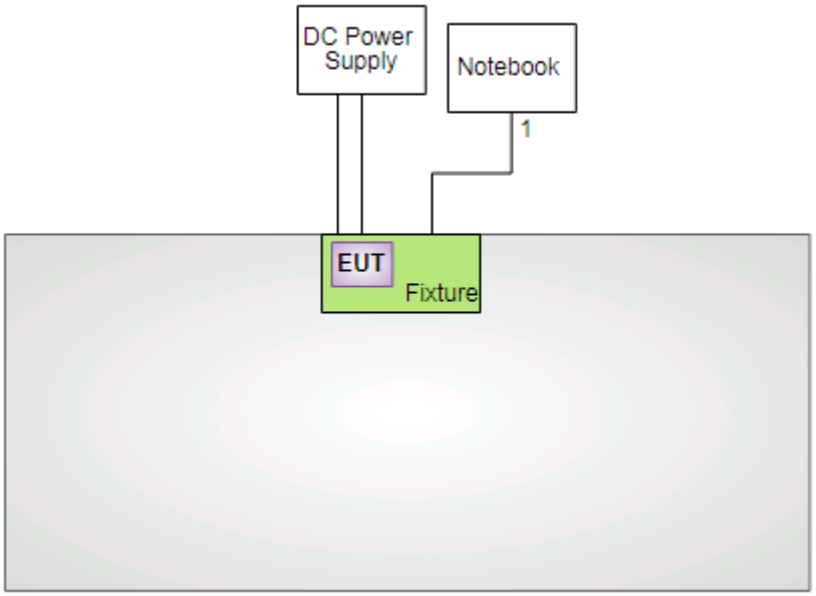
1.3 Test Setup Chart

Test Setup Diagram (below 30 MHz)



No.	Signal cable / Length (m)
1	USB, 0.5m non-shielded.

Test Setup Diagram above 30 MHz



No.	Signal cable / Length (m)
1	RJ45, 1.81m non-shielded.

1.4 Test Equipment and Calibration Data

Test Item	Radiated Emissions				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	May 24 ~ May 28, 2019				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	Agilent	N9010A	MY52221474	Oct. 10, 2018	Oct. 09, 2019
Bilog Antenna 30-1000MHz	SCHWARZBECK	VULB9168	9168-563	Jan. 04, 2019	Jan. 03, 2020
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	9120D-1205	Jan. 18, 2019	Jan. 17, 2020
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170508	Dec. 22, 2018	Dec. 21, 2019
Preamplifier	Agilent	83017A	MY53270013	Dec. 27, 2018	Dec. 26, 2019
Preamplifier	EMC	EMC02325	980188	Dec. 13, 2018	Dec. 12, 2019
Preamplifier	EMC	EMC184045B	980192	Aug. 09, 2018	Aug. 08, 2019
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22622/4	Oct. 16, 2018	Oct. 15, 2019
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22623/4	Oct. 16, 2018	Oct. 15, 2019
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22621/4	Oct. 16, 2018	Oct. 15, 2019
RF cable-4M	HUBER+SUHNER	SUCOFLEX104	MY22579/4	Oct. 16, 2018	Oct. 15, 2019
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-002	Oct. 16, 2018	Oct. 15, 2019
LF cable-3M	EMC	EMC8D-NM-NM-3000	131102	Oct. 16, 2018	Oct. 15, 2019
LF cable-10M	EMC	EMC8D-NM-NM-10000	131101	Oct. 16, 2018	Oct. 15, 2019
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	Jun. 03 ~ Jul. 22, 2019				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101486	Jan. 08, 2019	Jan. 07, 2020
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Dec. 05, 2018	Dec. 04, 2019
Power Sensor	Agilent	U2021XA	MY53480019	Jan. 30, 2019	Jan. 29, 2020
Power Sensor	Agilent	U2021XA	MY53510003	Jan. 30, 2019	Jan. 29, 2020
Power Sensor	Agilent	U2021XA	MY54070003	Feb. 11, 2019	Feb. 10, 2020
Power Sensor	Agilent	U2021XA	MY54060013	Feb. 11, 2019	Feb. 10, 2020
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 25, 2018	Oct. 24, 2019
AC POWER SOURCE	APC	AFC-500W	F312060012	Nov. 29, 2018	Nov. 28, 2019
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Measurement Software	Agilent	EN RF test	1.1501125	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emissions				
Test Site	(10CH01-HY)				
Tested Date	Jun. 13, 2019				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	Keysight	N9038A	MY54130031	Nov. 06, 2018	Nov. 05, 2019
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 09, 2018	Nov. 08, 2019
RF Cable-R10m	Suhner Switzerland + Rosenberger	RG223/U + UAA220A-0	CB022-DOOR	Nov. 11, 2018	Nov. 10, 2019
Turn Table	HD	DT 60 RPS	1513/004/00	NA	NA
Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

AS/NZS 4268:2017

1.6 Deviation from Test Standard and Measurement Procedure

None

1.7 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**
Radio Frequency	$\pm 1.4 \times 10^{-9}$
RF power conducted	±0.808 dB
RF power radiated	±3.401 dB
Spurious emission, conducted	±2.994 dB
Spurious emission, radiated	±3.401 dB
Humidity	±0.6 %
Temperature	±0.29 ^{o}C
Time	±0.1 %

2 Test Configuration

2.1 Testing Condition

Testing Location			
☒	ICC Lab	ADD : No.3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan (R.O.C.) TEL : 886-3-271-8666 FAX : 886-3-318-0155	
☒	Sporton Lab	ADD : No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL : 886-3-327-3456 FAX : 886-3-327-0973	

Test Condition	Test Site No.	Test Engineer	Test Environment
Antenna port conducted measurement	TH01-WS	25°C / 65%	Chris Zeng
Transmitter Radiated Emission > 30 MHz Receiver Radiated Emission > 30 MHz	03CH01-WS	22°C / 63%	Felix Sung
Transmitter Radiated Emission > 1 GHz Receiver Radiated Emission > 1 GHz	03CH01-WS	22°C / 63%	Felix Sung
Transmitter Radiated Emission ≤ 30 MHz Receiver Radiated Emission ≤ 30 MHz	10CH01-HY*	25°C / 65%	Jack Li

Note: * ICC lab subcontracts this test item to Sporton Lab (TAF:1190).

Sporton Lab is a TAF accreditation test firm and also is an approved provider of ICC lab.

2.2 The Worst Test Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate	Voltage	Temperature	TX / RX test	Conducted / Radiated measurement
Maximum EIRP	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V, Vmin=1.8V Vmax=3.5V	Tnom=20°C Tmin=- 40°C Tmax=85°C	TX	Conducted
Emission Bandwidth	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V	Tnom=20°C	TX	Conducted
6dB Bandwidth	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V	Tnom=20°C	TX	Conducted
Peak Power Spectral Density	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V	Tnom=20°C	TX	Conducted
Operating Frequencies	GFSK	2402 / 2480	1 Mbps	Vnom=3.3V, Vmin=1.8V Vmax=3.5V	Tnom=20°C Tmin=- 40°C Tmax=85°C	TX	Conducted
Band Edge	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V	Tnom=20°C	TX	Conducted
Transmitter Spurious Emissions ≤ 30 MHz	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V	Tnom=20°C	TX	Radiated
Transmitter Spurious Emissions > 30 MHz	GFSK	2440	1 Mbps	Vnom=3.3V	Tnom=20°C	TX	Radiated
Transmitter Spurious Emissions > 1 GHz	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V	Tnom=20°C	TX	Radiated
Receiver Spurious Emissions ≤ 30 MHz	GFSK	2402 / 2440 / 2480	1 Mbps	Vnom=3.3V	Tnom=20°C	RX	Radiated
Receiver Spurious Emissions > 30 MHz Receiver Spurious Emissions > 1 GHz	GFSK	2440	1 Mbps	Vnom=3.3V	Tnom=20°C	RX	Radiated

3 Transmitter Test Results

3.1 Maximum EIRP

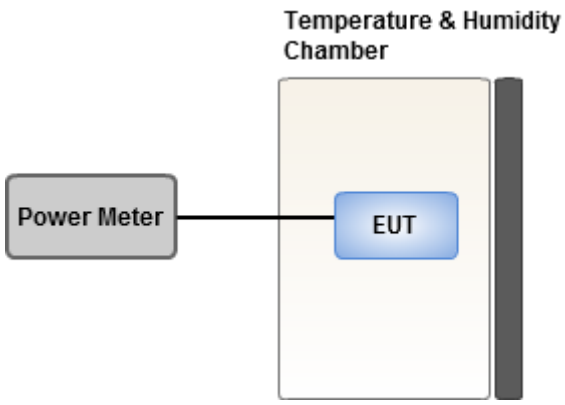
3.1.1 EIRP Limits

The equivalent isotropic radiated power (e.i.r.p.) shall be equal to or less than 4 W (36dBm).
Note: Limit is from AS/NZS 4268:2017

3.1.2 Test Procedures

Reference to clause 6.2.1 of AS/NZS 4268:2017.

3.1.3 Test Setup



3.1.4 Test Result of EIRP

Condition	Freq. (MHz)	EIRP PK Power (dBm)	EIRP AV Power (dBm)	Limit (dBm)	Results
$T_{nom}V_{nom}$	2402	3.36	3.27	36	Pass
$T_{min}V_{max}$	2402	3.77	3.68	36	Pass
$T_{min}V_{min}$	2402	3.64	3.55	36	Pass
$T_{max}V_{max}$	2402	2.91	2.82	36	Pass
$T_{max}V_{min}$	2402	2.14	2.05	36	Pass
$T_{nom}V_{nom}$	2440	3.28	3.19	36	Pass
$T_{min}V_{max}$	2440	3.83	3.74	36	Pass
$T_{min}V_{min}$	2440	3.72	3.63	36	Pass
$T_{max}V_{max}$	2440	2.68	2.59	36	Pass
$T_{max}V_{min}$	2440	1.99	1.90	36	Pass
$T_{nom}V_{nom}$	2480	2.93	2.85	36	Pass
$T_{min}V_{max}$	2480	3.51	3.43	36	Pass
$T_{min}V_{min}$	2480	3.28	3.20	36	Pass
$T_{max}V_{max}$	2480	2.41	2.33	36	Pass
$T_{max}V_{min}$	2480	1.56	1.48	36	Pass

3.2 Emission Bandwidth

3.2.1 Emission Bandwidth Limits

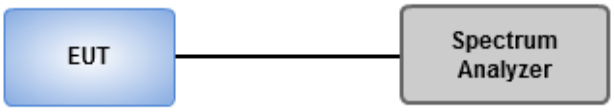
The upper and lower frequency limits of the transmitter 99% emission power bandwidth shall at all times remain within the operating frequency limits (2.4 ~ 2.4835 GHz).

Note: Limit is from AS/NZS 4268:2017

3.2.2 Test Procedures

1. Set RBW=100kHz, VBW=300kHz, Sweep time=Auto, Detector=Peak Trace max hold.
2. Allow trace to stabilize.
3. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth.
4. Record the F_L and F_H

3.2.3 Test Setup



3.2.4 Test Result of Emission 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)	626.812k	998.553k	999KF1D	608.696k	987.699k

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;

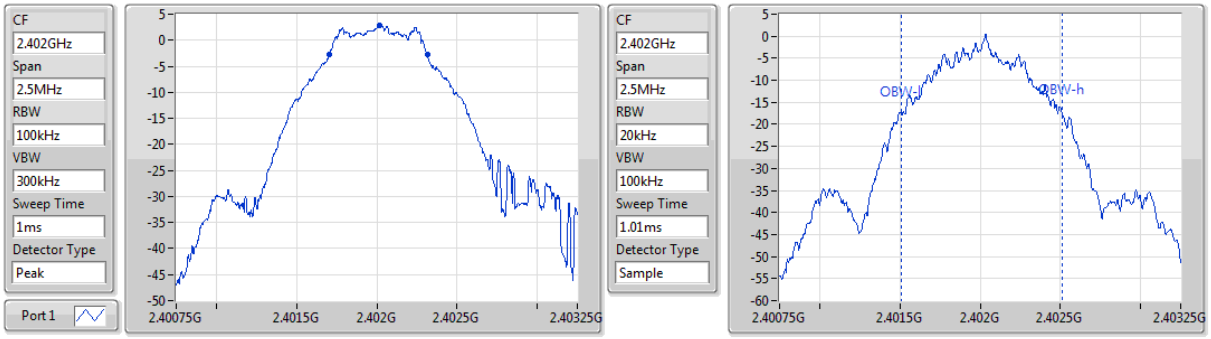
Result

Mode	Result	Limit (Hz)	fl-OBW (Hz)	fh-OBW (Hz)	OBW (Hz)	N dB (Hz)
BT-LE(1Mbps)	-	-	-	-	-	-
2402MHz	Pass	2.4-2.4835G	2.401512G	2.40251G	998.553k	608.696k
2440MHz	Pass	2.4-2.4835G	2.439512G	2.440503G	991.317k	626.812k
2480MHz	Pass	2.4-2.4835G	2.479508G	2.480496G	987.699k	612.319k

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

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

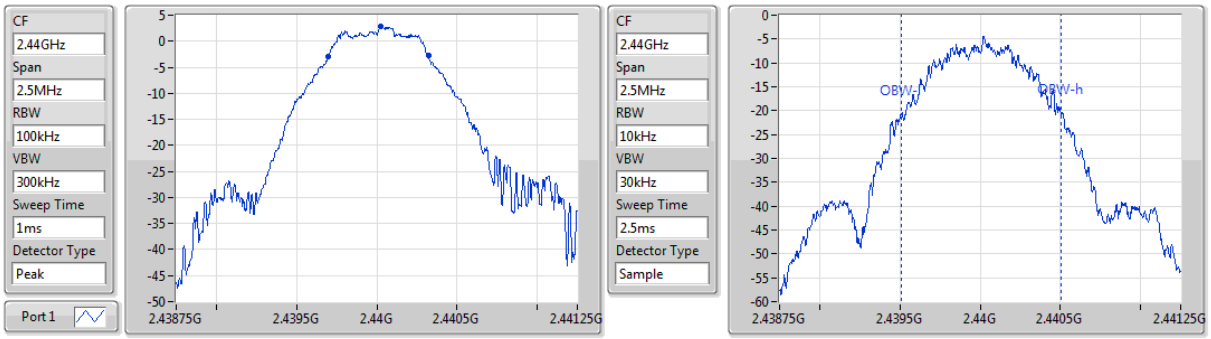
2402MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
608.696k	2.401707G	2.402315G	998.553k	2.401512G	2.40251G	500k	1

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

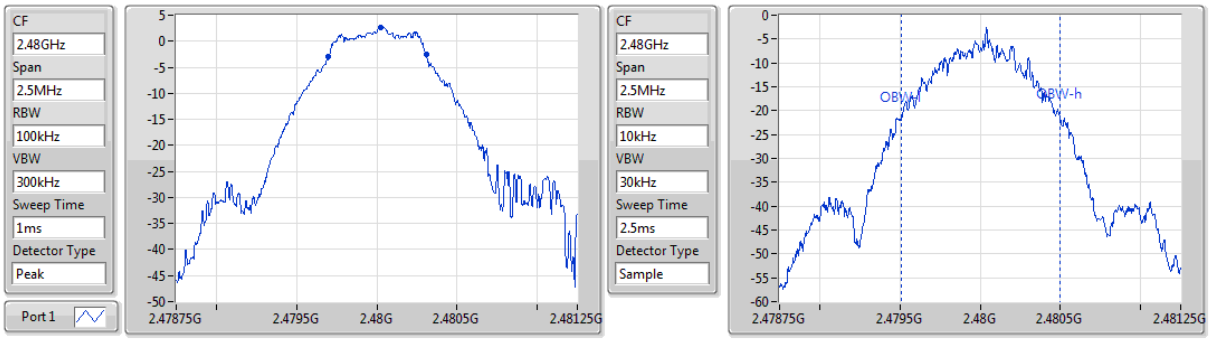
2440MHz



6dB(Hz)	Fl-6dB(Hz)	Fh-6dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
626.812k	2.439696G	2.440322G	991.317k	2.439512G	2.440503G	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
612.319k	2.479699G	2.480312G	987.699k	2.479508G	2.480496G	500k	1

3.3 Peak Power Spectral Density

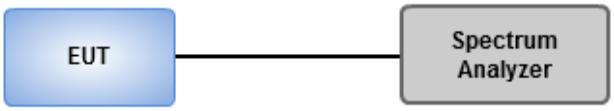
3.3.1 Peak Power Spectral Density Limits

The raidated peak power spectral density in any 3kHz is limited to 25 mW (14dBm) per 3 kHz.
Note: Limit is from AS/NZS 4268:2017

3.3.2 Test Procedures

1. Set the RBW = 3kHz, VBW = 10kHz.
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.

3.3.3 Test Setup



3.3.4 Test Result of Peak Power Spectral Density

Modulation Mode	Freq. (MHz)	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Results
GFSK-1Mbps	2402	-9.12	14	Pass
GFSK-1Mbps	2440	-9.35	14	Pass
GFSK-1Mbps	2480	10.15	14	Pass

3.4 Operating Frequencies

3.4.1 Operating Frequencies Limits

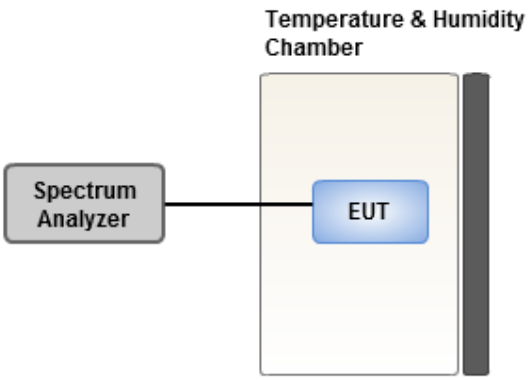
The upper and lower frequency limit of the emission bandwidth shall at all times remain within the operating frequency (F_L > 2,4 GHz and F_H < 2,4835 GHz).

Note: Limit is from AS/NZS 4268:2017

3.4.2 Test Procedures

1. Set RBW=30kHz, VBW=100kHz,Sweep time = Auto, Detector=Peak Trace max hold
2 Allow trace to stabilize
3. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth
4. Record the F_L and F_H

3.4.3 Test Setup



3.4.4 Test Result of Operating Frequencies

Frequency Range (MHz)							
Condition	**Modulation Mode**	**Freq. (MHz)**	**F_L (MHz)**	**F_H (MHz)**	**F_L Limit (MHz)**	**F_H Limit (MHz)**	**Results**
$T_{nom}V_{nom}$	GFSK-1Mbps	2402	2401.51	-	2400.0	2483.5	Pass
$T_{min}V_{max}$	GFSK-1Mbps	2402	2401.49	-	2400.0	2483.5	Pass
$T_{min}V_{min}$	GFSK-1Mbps	2402	2401.49	-	2400.0	2483.5	Pass
$T_{max}V_{max}$	GFSK-1Mbps	2402	2401.52	-	2400.0	2483.5	Pass
$T_{max}V_{min}$	GFSK-1Mbps	2402	2401.52	-	2400.0	2483.5	Pass
$T_{nom}V_{nom}$	GFSK-1Mbps	2480	-	2480.40	2400.0	2483.5	Pass
$T_{min}V_{max}$	GFSK-1Mbps	2480	-	2480.42	2400.0	2483.5	Pass
$T_{min}V_{min}$	GFSK-1Mbps	2480	-	2480.42	2400.0	2483.5	Pass
$T_{max}V_{max}$	GFSK-1Mbps	2480	-	2480.39	2400.0	2483.5	Pass
$T_{max}V_{min}$	GFSK-1Mbps	2480	-	2480.39	2400.0	2483.5	Pass

3.5 Transmitter Spurious Emissions

3.5.1 Transmitter Spurious Emissions Limits

Spurious Emissions Limit (peak power)	Frequency Range	Measurement Bandwidth
-56 dBW (2.5μW) e.i.r.p (59 dBμV/m at 10 metres)	< 150 kHz	1 kHz
	150 kHz – 30 MHz	10 kHz

Note: Limit is from "NEW ZEALAND https://gazette.govt.nz/notice/id/2015-go694 Table 2"

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.			

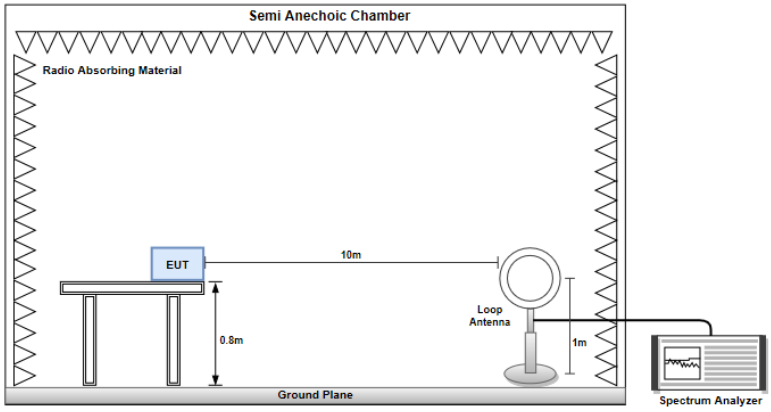
Note: Limit is from FCC Part 15.209

3.5.2 Test Procedures

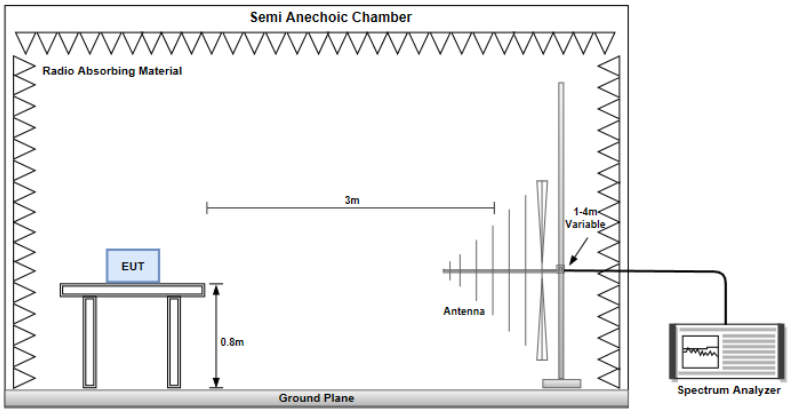
Reference to clause 6.2.1 of AS/NZS 4268:2017.

3.5.3 Test Setup

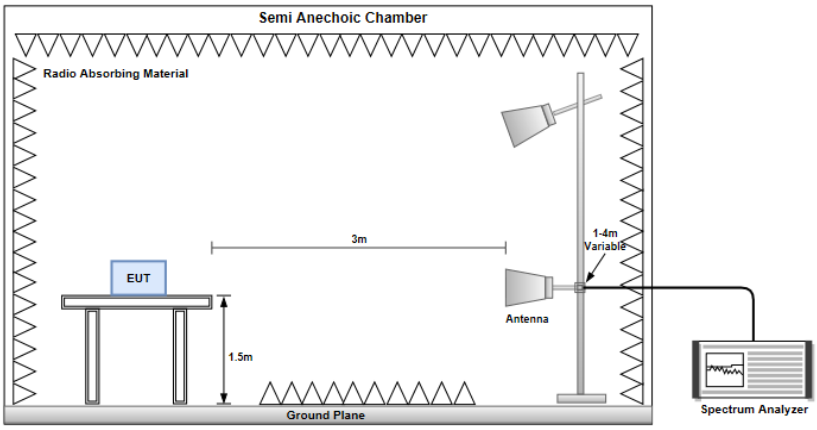
Below 30MHz



Below 1GHz

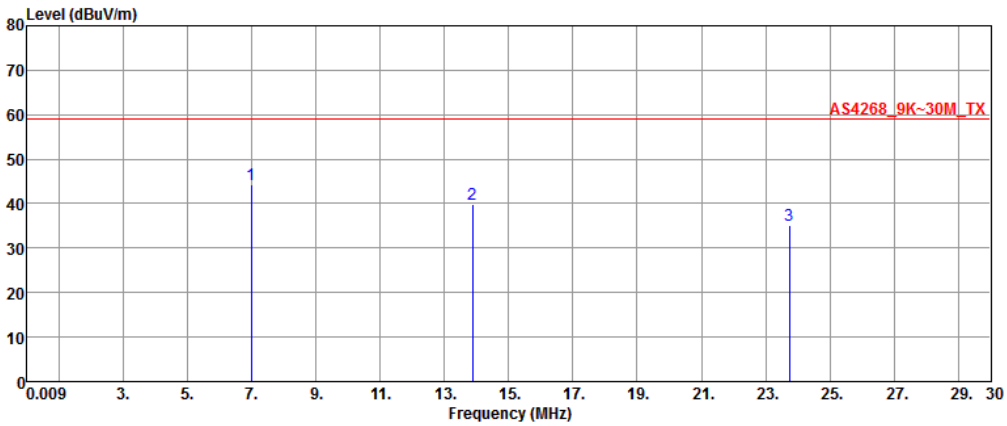


Above 1 GHz



3.5.4 Transmitter Radiated Unwanted Emissions (Below 30MHz)

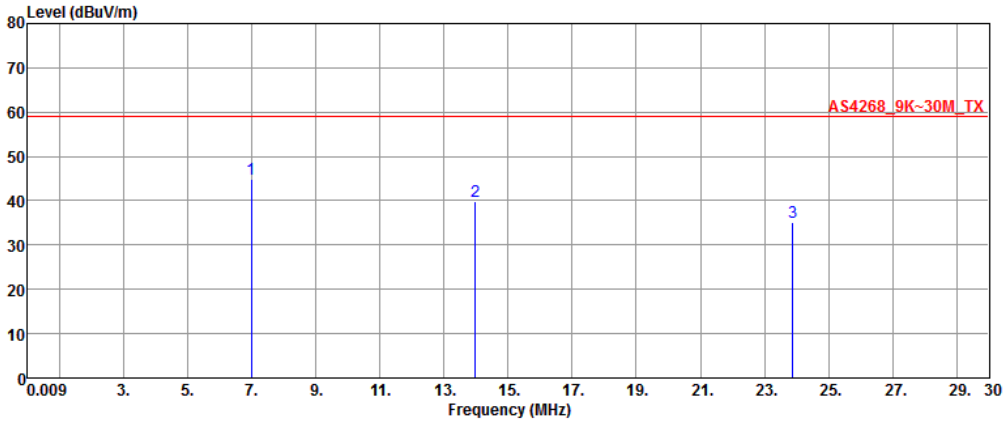
Modulation	GFSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBuV/m	dBuV/m	dB	dB	dBuV
1	6.97	44.24	59.00	-14.76	20.03	24.21
2	13.87	39.74	59.00	-19.26	21.02	18.72
3	23.74	34.99	59.00	-24.01	21.99	13.00

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

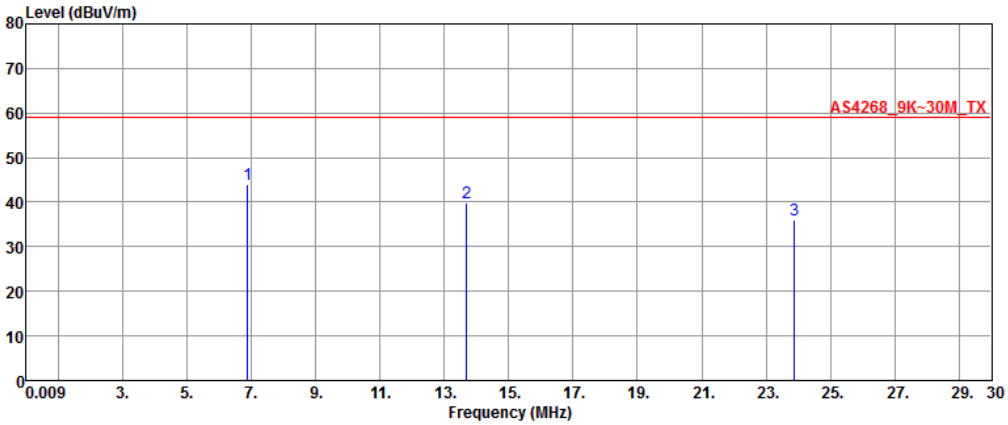
Modulation	GFSK	Test Freq. (MHz)	2440



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBuV/m	dBuV/m	dB	dB	dBuV
1	6.97	44.75	59.00	-14.25	20.03	24.72
2	13.97	39.90	59.00	-19.10	21.04	18.86
3	23.87	34.99	59.00	-24.01	21.99	13.00

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	GFSK	Test Freq. (MHz)	2480

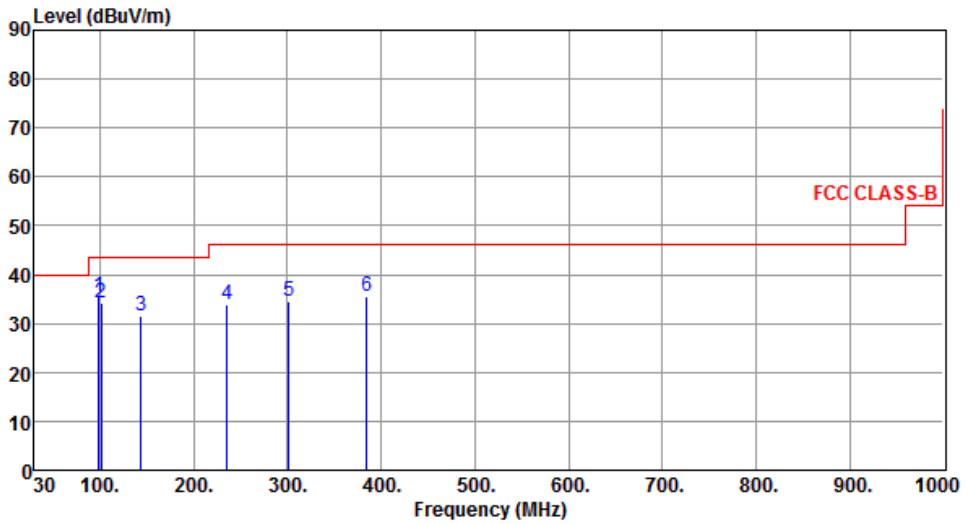


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBuV/m	dBuV/m	dB	dB	dBuV
1	6.88	44.12	59.00	-14.88	20.02	24.10
2	13.69	39.98	59.00	-19.02	20.99	18.99
3	23.87	35.98	59.00	-23.02	21.99	13.99

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

3.5.5 Transmitter Radiated Unwanted Emissions (Below 1GHz)

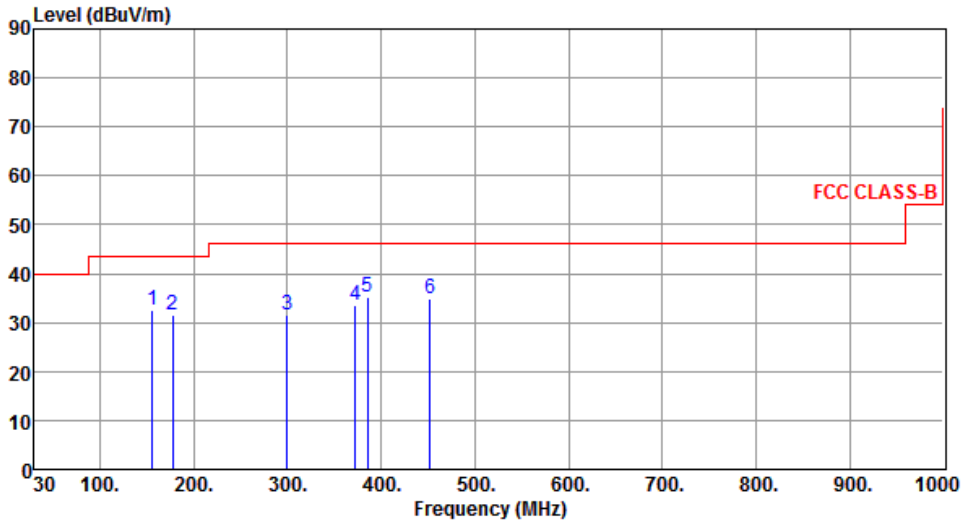
Modulation	GFSK	**Test Freq. (MHz)**	2440
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	98.56	35.65	43.50	-7.85	48.91	-13.26	Peak	---	---
2	101.56	34.21	43.50	-9.29	46.86	-12.65	Peak	---	---
3	143.56	31.65	43.50	-11.85	40.15	-8.50	Peak	---	---
4	235.62	33.89	46.00	-12.11	43.76	-9.87	Peak	---	---
5	301.65	34.47	46.00	-11.53	42.24	-7.77	Peak	---	---
6	384.35	35.65	46.00	-10.35	41.03	-5.38	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).

Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Vertical		

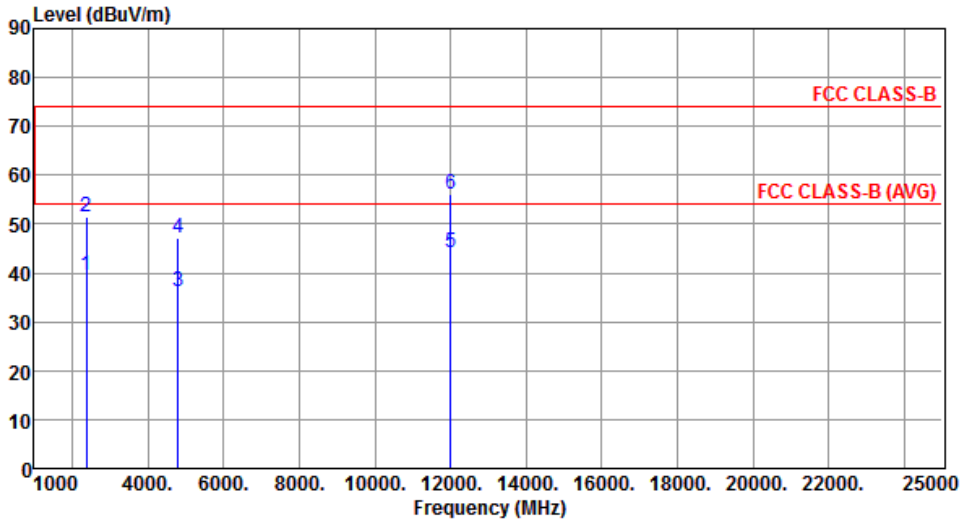


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	155.51	32.68	43.50	-10.82	40.93	-8.25	Peak	---	---
2	177.54	31.56	43.50	-11.94	40.99	-9.43	Peak	---	---
3	299.65	31.56	46.00	-14.44	39.37	-7.81	Peak	---	---
4	372.65	33.45	46.00	-12.55	39.18	-5.73	Peak	---	---
5	385.21	35.17	46.00	-10.83	40.51	-5.34	Peak	---	---
6	452.23	34.86	46.00	-11.14	38.71	-3.85	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).

3.5.1 Transmitter Radiated Unwanted Emissions (Above 1GHz)

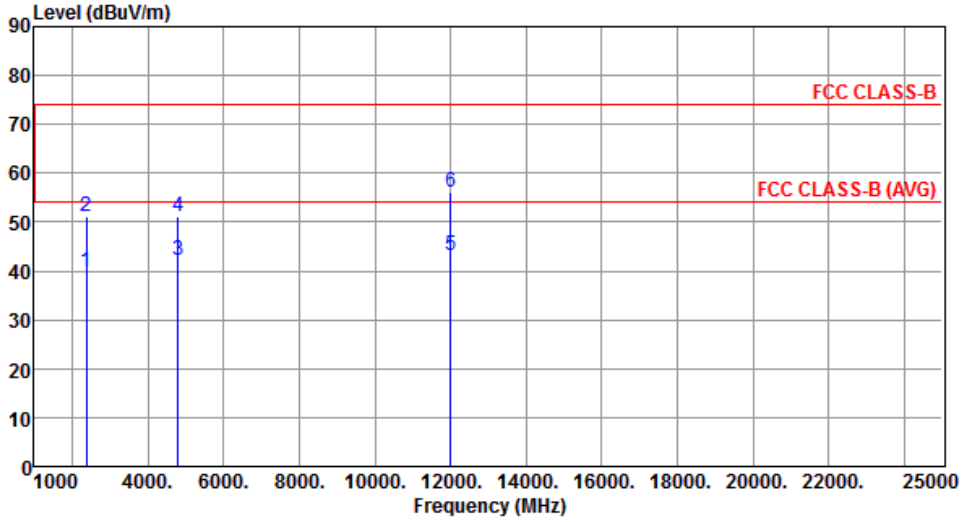
Modulation	GFSK	**Test Freq. (MHz)**	2402
Polarization	Horizontal		



	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	39.51	54.00	-14.49	42.58	-3.07	Average	248	129
2	2390.00	51.45	74.00	-22.55	54.52	-3.07	Peak	248	129
3	4804.00	36.36	54.00	-17.64	32.86	3.50	Average	100	120
4	4804.00	47.09	74.00	-26.91	43.59	3.50	Peak	100	120
5	12010.00	44.11	54.00	-9.89	30.85	13.26	Average	100	115
6	12010.00	56.14	74.00	-17.86	42.88	13.26	Peak	100	115

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).

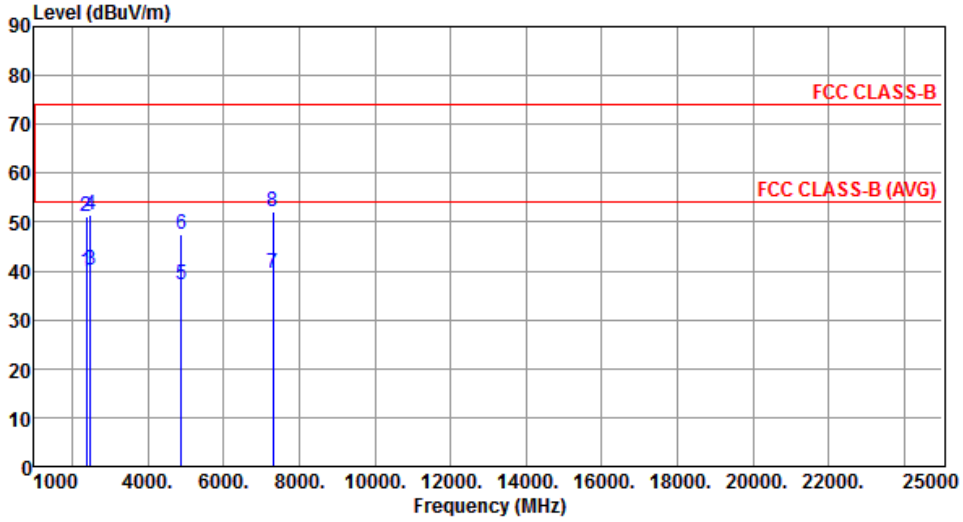
Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		



	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	39.74	54.00	-14.26	42.81	-3.07	Average	100	104
2	2390.00	51.15	74.00	-22.85	54.22	-3.07	Peak	100	104
3	4804.00	42.25	54.00	-11.75	38.75	3.50	Average	100	235
4	4804.00	51.16	74.00	-22.84	47.66	3.50	Peak	100	235
5	12010.00	43.12	54.00	-10.88	29.86	13.26	Average	100	250
6	12010.00	56.22	74.00	-17.78	42.96	13.26	Peak	100	244

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).

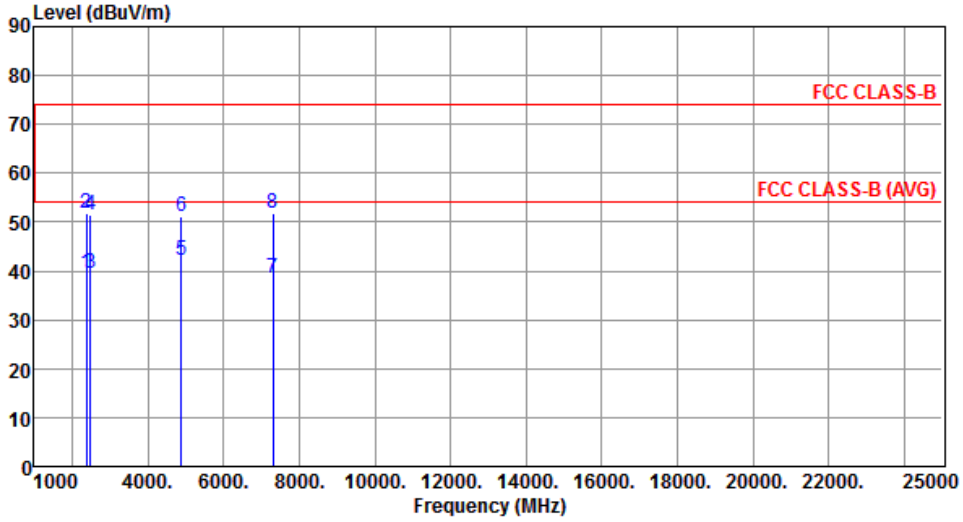
Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Horizontal		



	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	39.78	54.00	-14.22	42.85	-3.07	Average	204	121
2	2390.00	51.21	74.00	-22.79	54.28	-3.07	Peak	204	121
3	2483.50	40.35	54.00	-13.65	43.57	-3.22	Average	204	121
4	2483.50	51.34	74.00	-22.66	54.56	-3.22	Peak	204	121
5	4880.00	37.11	54.00	-16.89	33.50	3.61	Average	100	113
6	4880.00	47.44	74.00	-26.56	43.83	3.61	Peak	100	113
7	7320.00	39.64	54.00	-14.36	30.84	8.80	Average	100	115
8	7320.00	52.04	74.00	-21.96	43.24	8.80	Peak	100	115

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).

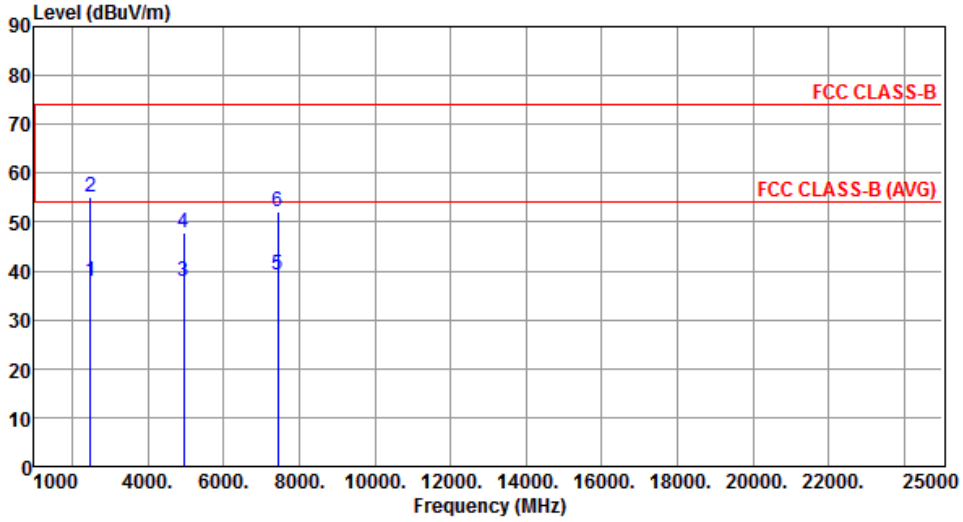
Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Vertical		



	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	39.47	54.00	-14.53	42.54	-3.07	Average	100	108
2	2390.00	51.79	74.00	-22.21	54.86	-3.07	Peak	100	108
3	2483.50	39.63	54.00	-14.37	42.85	-3.22	Average	100	108
4	2483.50	51.52	74.00	-22.48	54.74	-3.22	Peak	100	108
5	4880.00	42.11	74.00	-31.89	38.50	3.61	Average	100	231
6	4880.00	51.11	74.00	-22.89	47.50	3.61	Peak	100	231
7	7320.00	38.65	54.00	-15.35	29.85	8.80	Average	100	250
8	7320.00	51.67	74.00	-22.33	42.87	8.80	Peak	100	250

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).

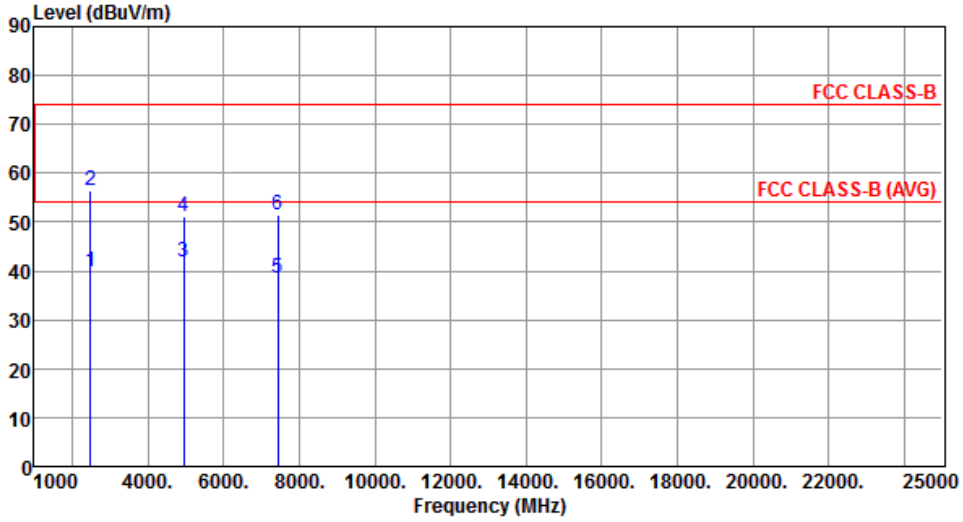
Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		



	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	37.82	54.00	-16.18	41.04	-3.22	Average	243	125
2	2483.50	55.03	74.00	-18.97	58.25	-3.22	Peak	243	125
3	4960.00	37.71	54.00	-16.29	33.85	3.86	Average	100	117
4	4960.00	47.71	74.00	-26.29	43.85	3.86	Peak	100	117
5	7440.00	39.08	54.00	-14.92	30.54	8.54	Average	100	121
6	7440.00	52.17	74.00	-21.83	43.63	8.54	Peak	100	121

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	39.78	54.00	-14.22	43.00	-3.22	Average	100	105
2	2483.50	56.57	74.00	-17.43	59.79	-3.22	Peak	100	105
3	4960.00	42.00	54.00	-12.00	38.14	3.86	Average	100	236
4	4960.00	51.30	74.00	-22.70	47.44	3.86	Peak	100	236
5	7440.00	38.62	54.00	-15.38	30.08	8.54	Average	100	248
6	7440.00	51.50	74.00	-22.50	42.96	8.54	Peak	100	248

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.

Note: Limit is from FCC Part 15.247

3.6.2 Test Procedures

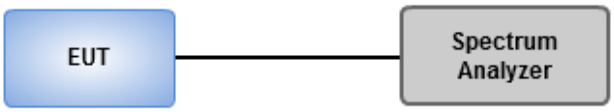
Reference level measurement

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

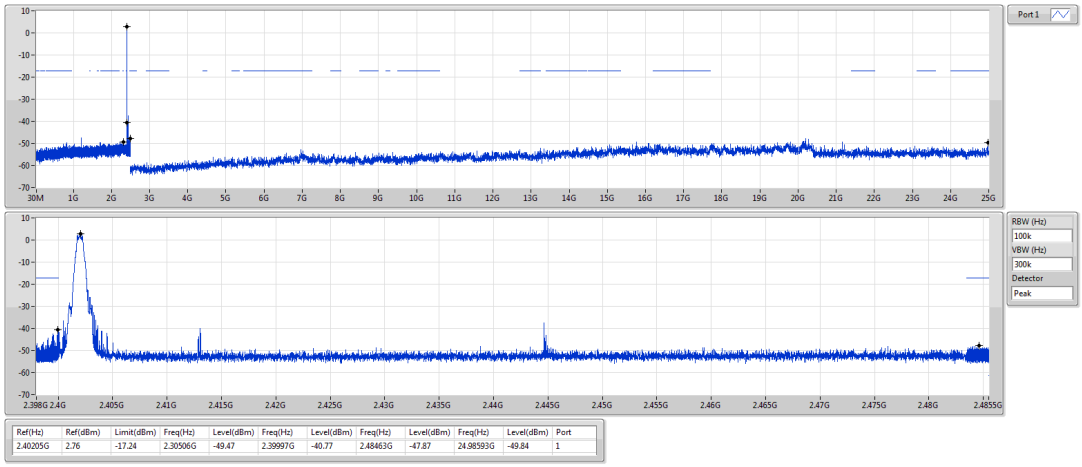
3.6.3 Test Setup



3.6.4 Test Result of Emissions in non-restricted Frequency Bands

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

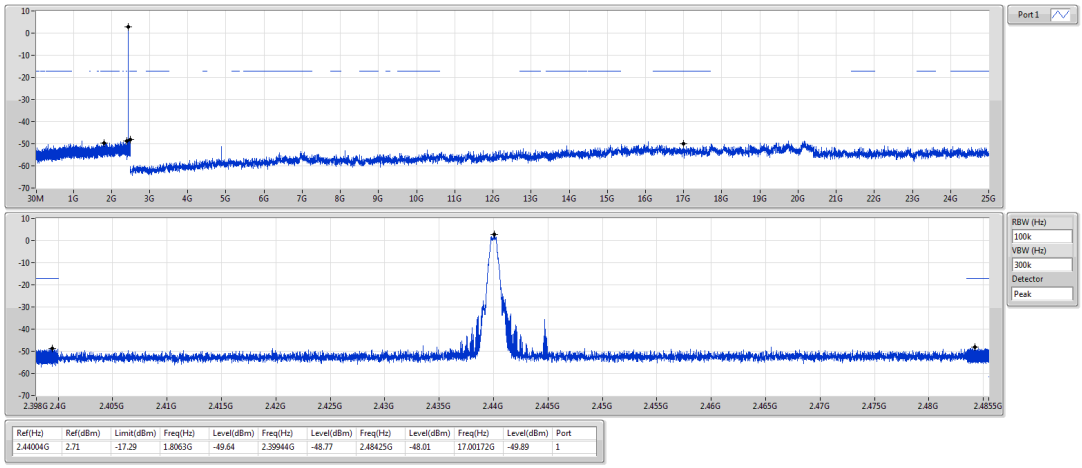
2402MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.40205G	2.76	-17.24	2.30506G	-49.47	2.39997G	-40.77	2.48463G	-47.87	24.98593G	-49.84	1

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

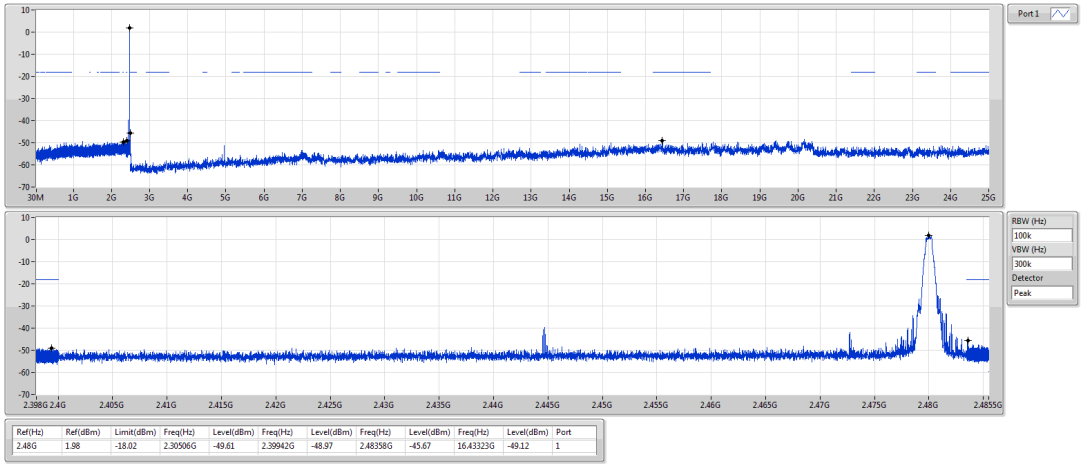
2440MHz



Ref(Hz)	Ref(dBm)	Limit(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Freq(Hz)	Level(dBm)	Port
2.44004G	2.71	-17.29	1.8063G	-49.64	2.39944G	-48.77	2.48425G	-48.01	17.00172G	-49.89	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	1.98	-18.02	2.30506G	-49.61	2.39942G	-48.97	2.48358G	-45.67	16.43323G	-49.12	1

4 Receiver Test Results

4.1 Receiver Spurious Emissions

4.1.1 Receiver Spurious Emissions Limits

Spurious Emissions Limit (peak power)	Frequency Range	Measurement Bandwidth
-56 dBW (2.5μW) e.i.r.p (59 dBμV/m at 10 metres)	< 150 kHz	1 kHz
	150 kHz – 30 MHz	10 kHz

Note: Limit is from "NEW ZEALAND https://gazette.govt.nz/notice/id/2015-go694 Table 2"

Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
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.

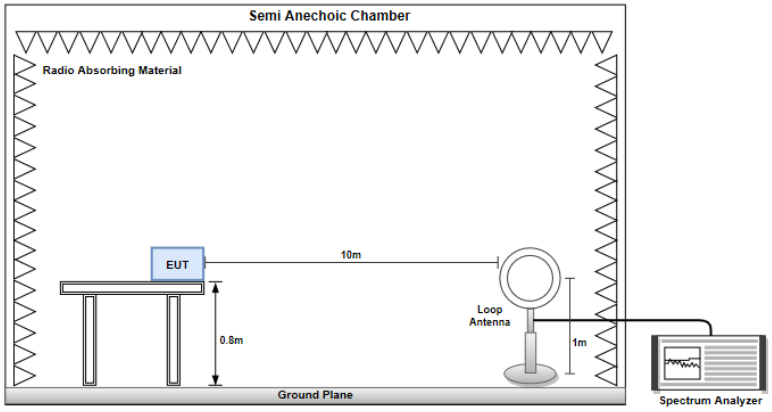
Note: Limit is from FCC Part 15.109

4.1.2 Test Procedures

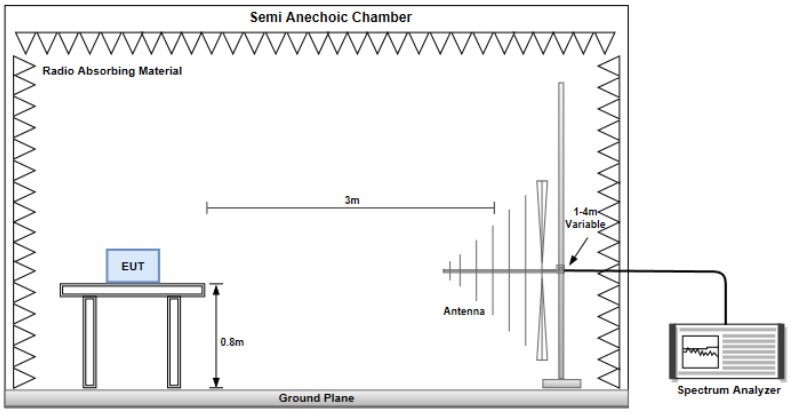
Reference to clause 7.2.1 of AS/NZS 4268:2017.

4.1.3 Test Setup

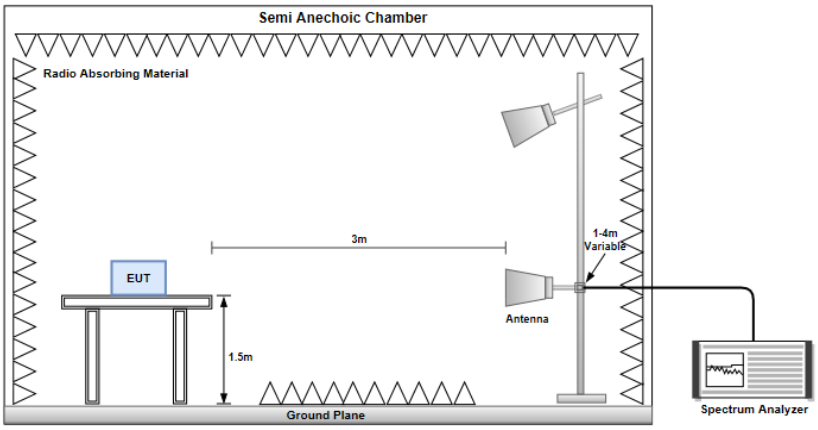
Below 30MHz



Below 1GHz

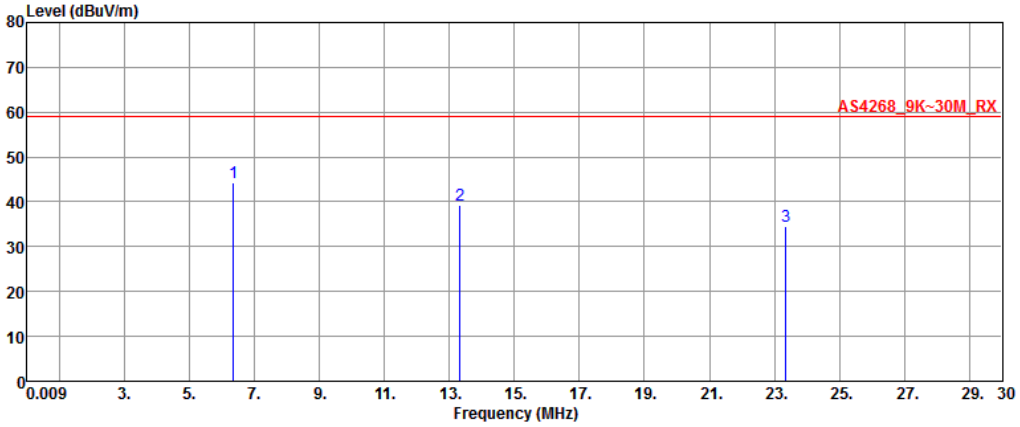


Above 1 GHz



4.1.4 Receiver Radiated Unwanted Emissions (Below 30MHz)

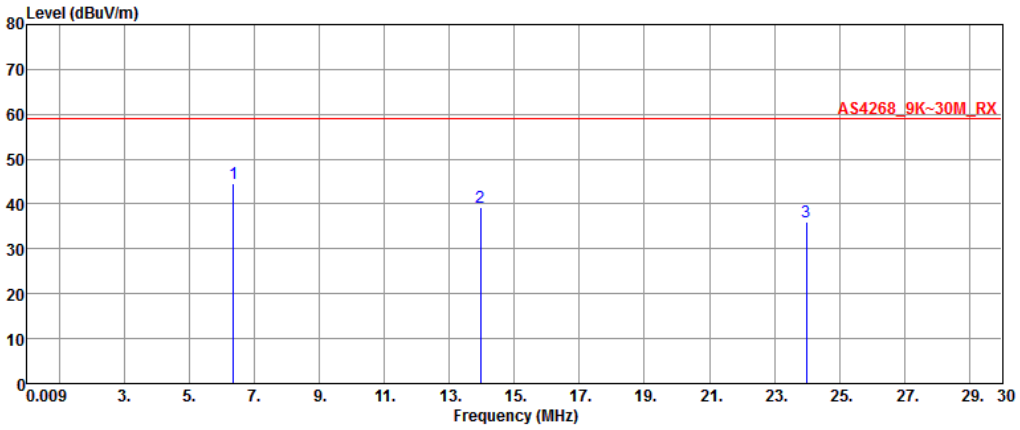
Modulation	GFSK	Test Freq. (MHz)	2402



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBuV/m	dBuV/m	dB	dB	dBuV
1	6.34	44.32	59.00	-14.68	19.95	24.37
2	13.32	39.34	59.00	-19.66	20.94	18.40
3	23.35	34.54	59.00	-24.46	21.97	12.57

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

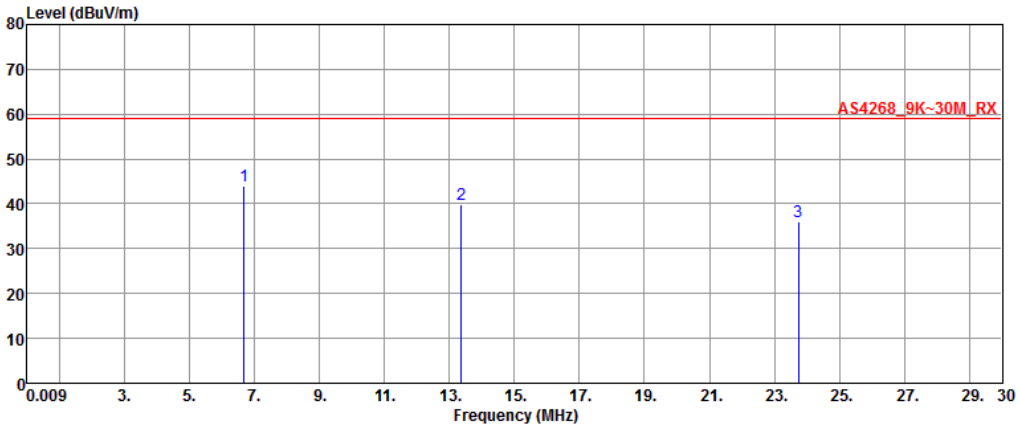
Modulation	GFSK	Test Freq. (MHz)	2440



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBuV/m	dBuV/m	dB	dB	dBuV
1	6.35	44.69	59.00	-14.31	19.95	24.74
2	13.95	39.35	59.00	-19.65	21.03	18.32
3	23.98	35.87	59.00	-23.13	22.00	13.87

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	GFSK	Test Freq. (MHz)	2480

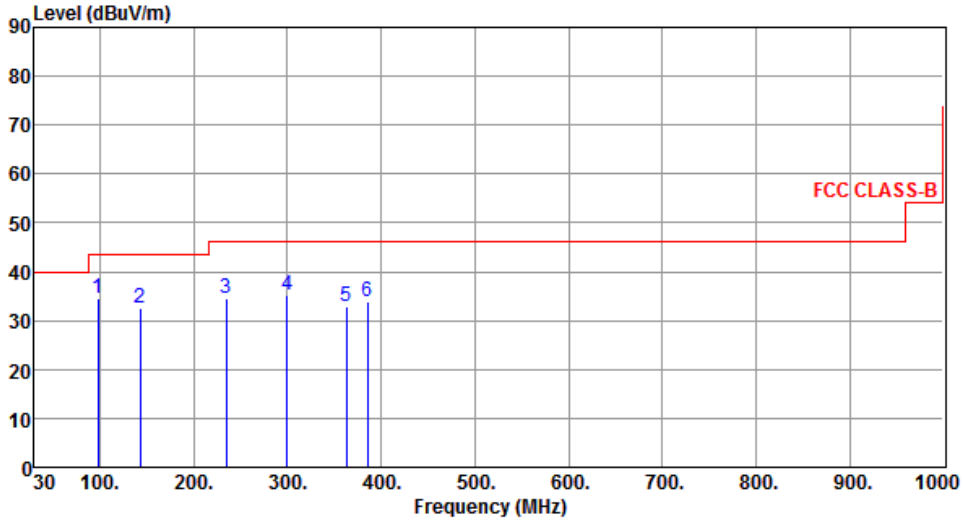


	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBuV/m	dBuV/m	dB	dB	dBuV
1	6.69	44.00	59.00	-15.00	19.99	24.01
2	13.35	39.85	59.00	-19.15	20.94	18.91
3	23.75	35.99	59.00	-23.01	21.99	14.00

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

4.1.5 Receiver Radiated Unwanted Emissions (Below 1GHz)

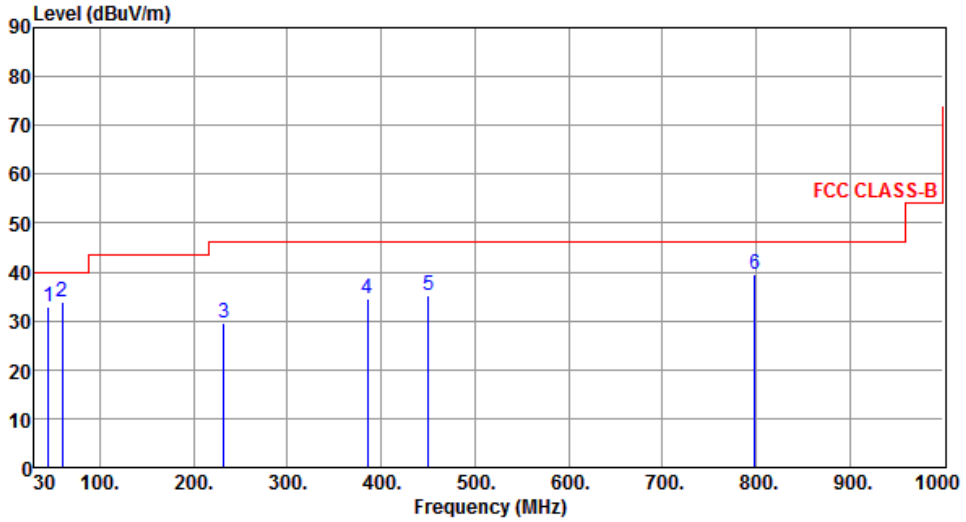
Modulation	GFSK	**Test Freq. (MHz)**	2440
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	97.65	34.65	43.50	-8.85	48.09	-13.44	Peak	---	---
2	142.65	32.56	43.50	-10.94	41.12	-8.56	Peak	---	---
3	234.65	34.65	46.00	-11.35	44.60	-9.95	Peak	---	---
4	299.65	35.23	46.00	-10.77	43.04	-7.81	Peak	---	---
5	362.56	32.87	46.00	-13.13	38.88	-6.01	Peak	---	---
6	385.64	33.75	46.00	-12.25	39.09	-5.34	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).

Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Vertical		

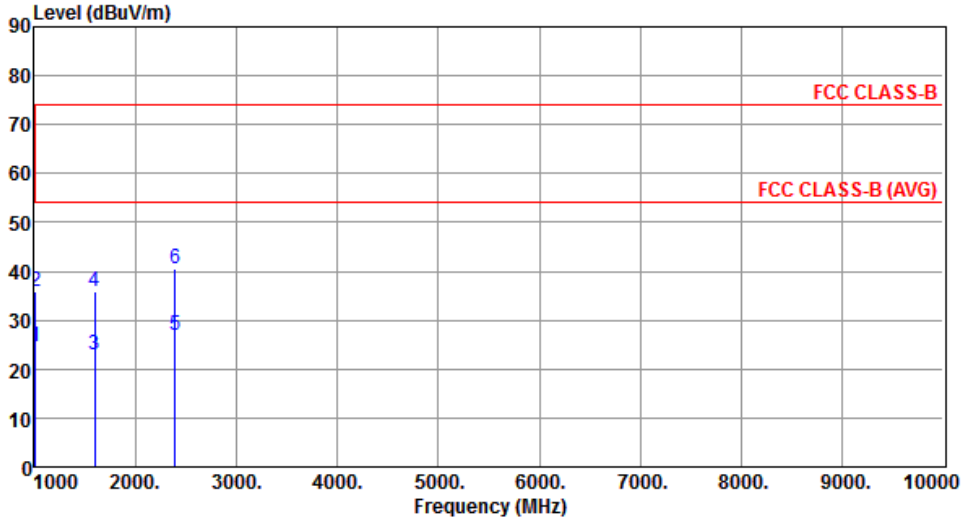


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	44.87	32.87	40.00	-7.13	40.72	-7.85	Peak	---	---
2	59.56	33.87	40.00	-6.13	42.48	-8.61	Peak	---	---
3	231.98	29.56	46.00	-16.44	39.72	-10.16	Peak	---	---
4	385.64	34.56	46.00	-11.44	39.90	-5.34	Peak	---	---
5	450.35	35.23	46.00	-10.77	39.12	-3.89	Peak	---	---
6	798.56	39.56	46.00	-6.44	37.37	2.19	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).

4.1.6 Receiver Radiated Unwanted Emissions (Above 1GHz)

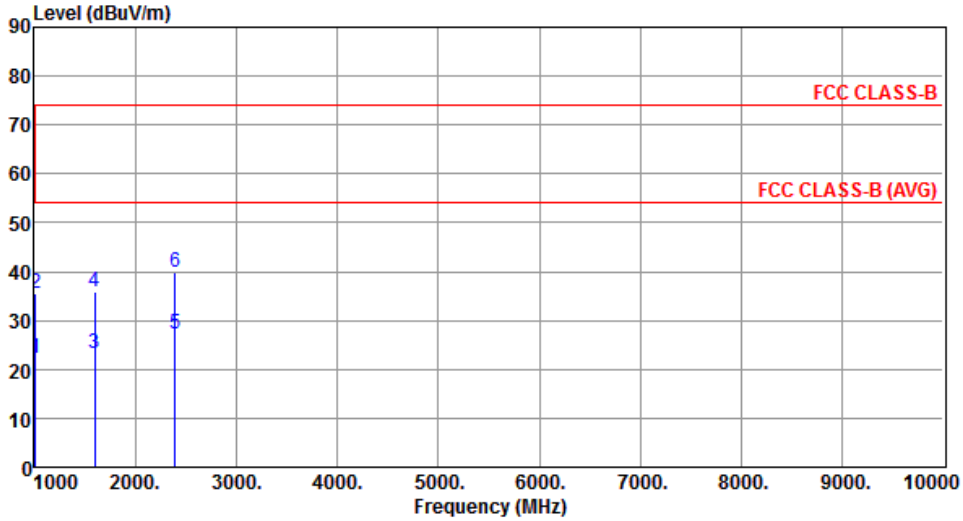
Modulation	GFSK	**Test Freq. (MHz)**	2440
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1010.00	24.62	54.00	-29.38	34.85	-10.23	Average	100	70
2	1010.00	35.73	74.00	-38.27	45.96	-10.23	Peak	100	70
3	1600.00	22.77	54.00	-31.23	29.77	-7.00	Average	100	241
4	1600.00	35.93	74.00	-38.07	42.93	-7.00	Peak	100	241
5	2395.00	26.81	54.00	-27.19	29.89	-3.08	Average	100	252
6	2395.00	40.50	74.00	-33.50	43.58	-3.08	Peak	100	252

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		

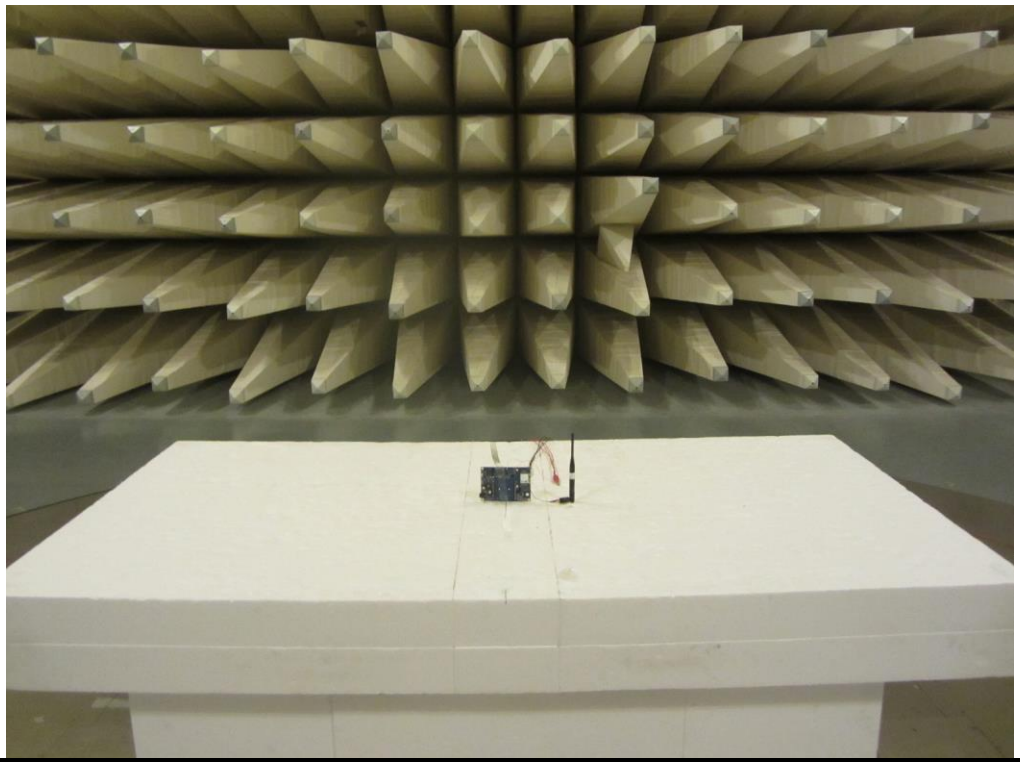


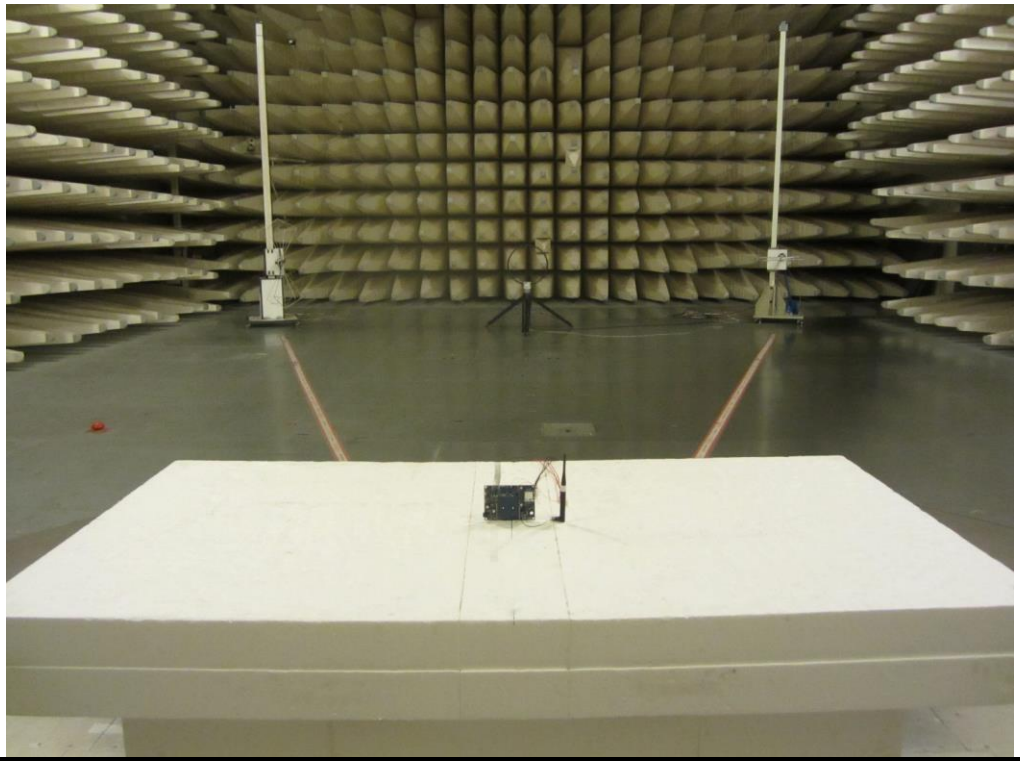
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1010.00	22.33	54.00	-31.67	32.56	-10.23	Average	100	250
2	1010.00	35.43	74.00	-38.57	45.66	-10.23	Peak	100	250
3	1600.00	23.21	54.00	-30.79	30.21	-7.00	Average	100	195
4	1600.00	35.96	74.00	-38.04	42.96	-7.00	Peak	100	195
5	2395.00	27.13	54.00	-26.87	30.21	-3.08	Average	100	95
6	2395.00	39.88	74.00	-34.12	42.96	-3.08	Peak	100	95

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).

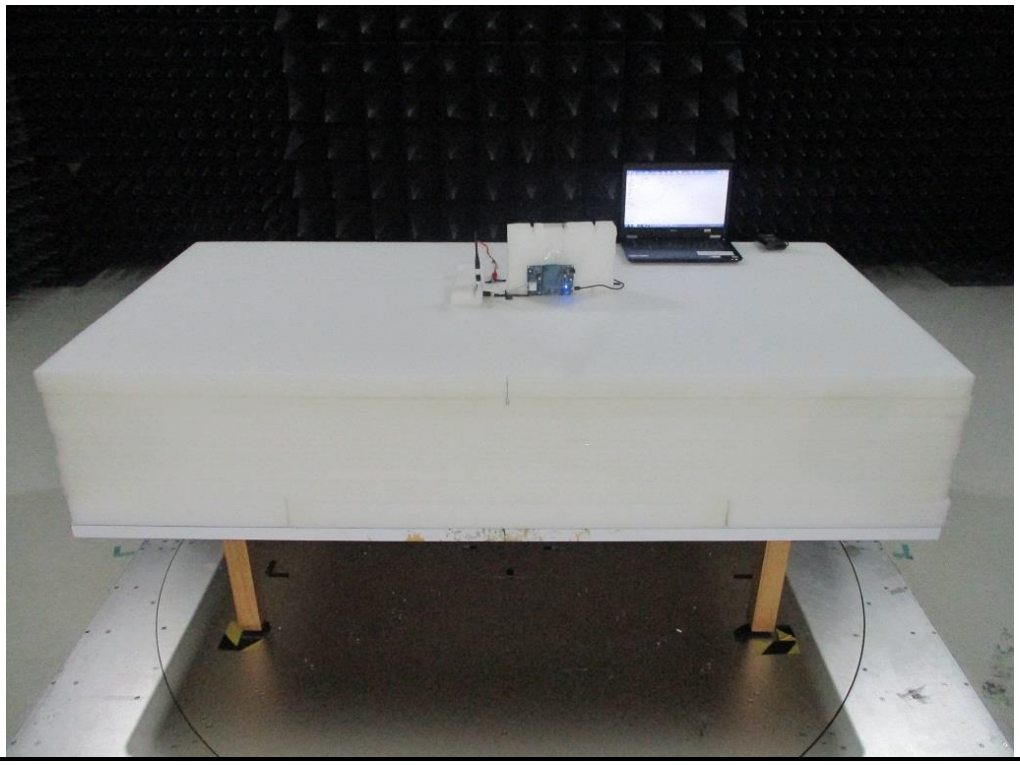
5 Photographs of the Test Configuration

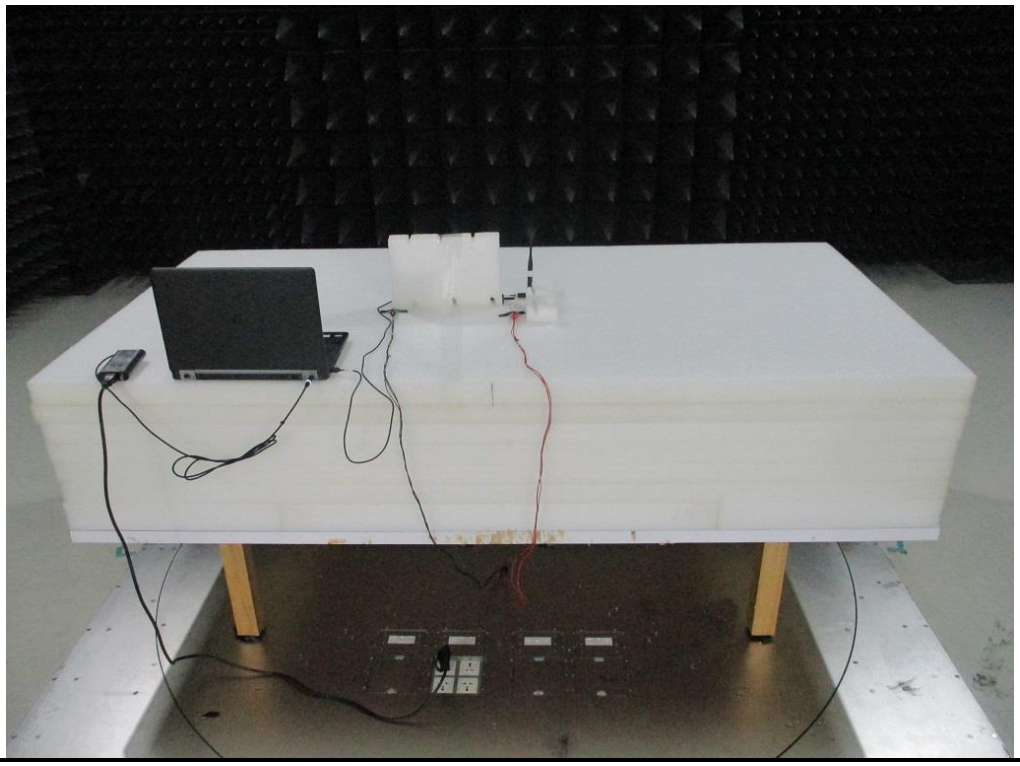
Spurious Emission below 30MHz Test



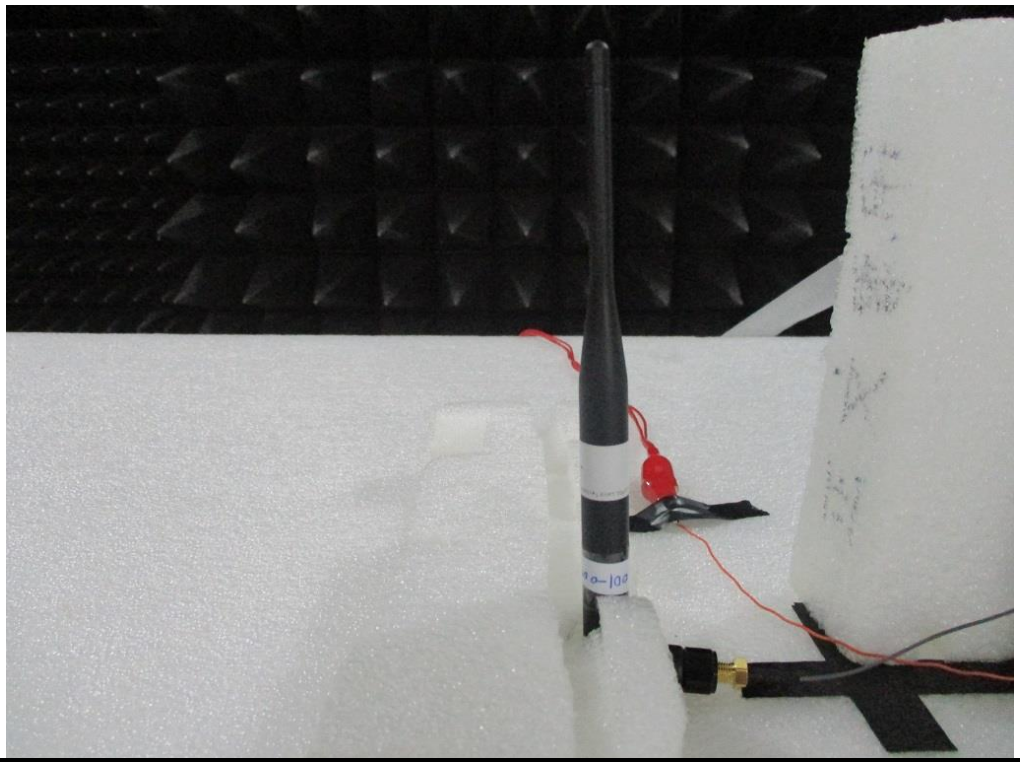


Spurious Emission Below 1GHz Test

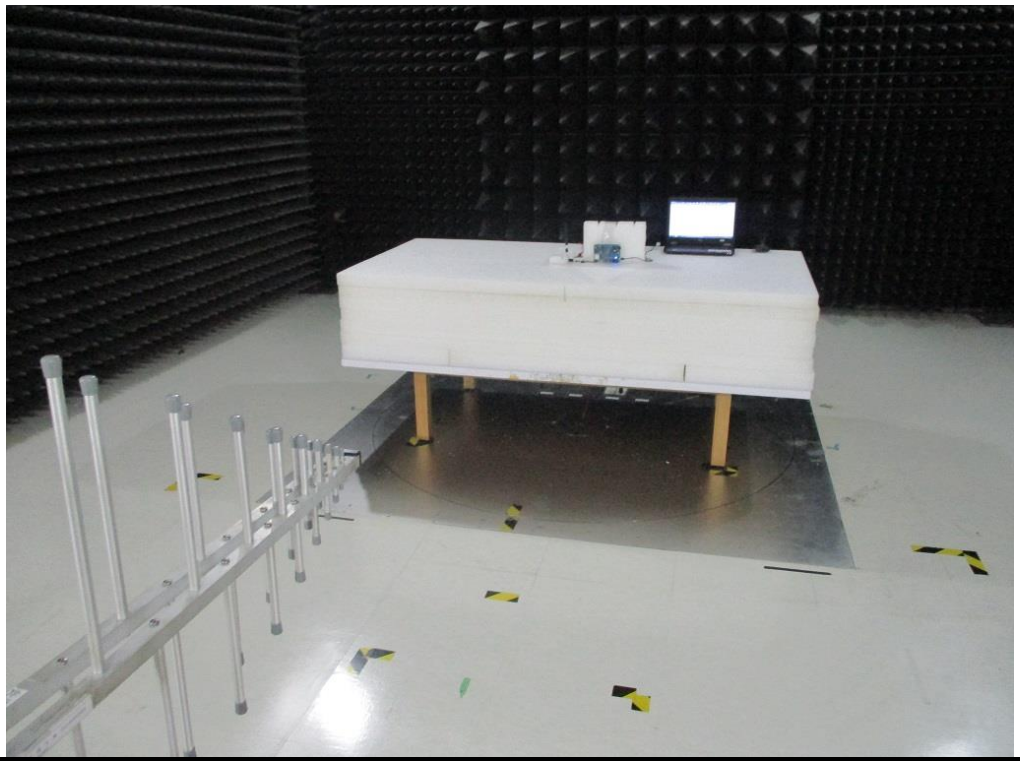




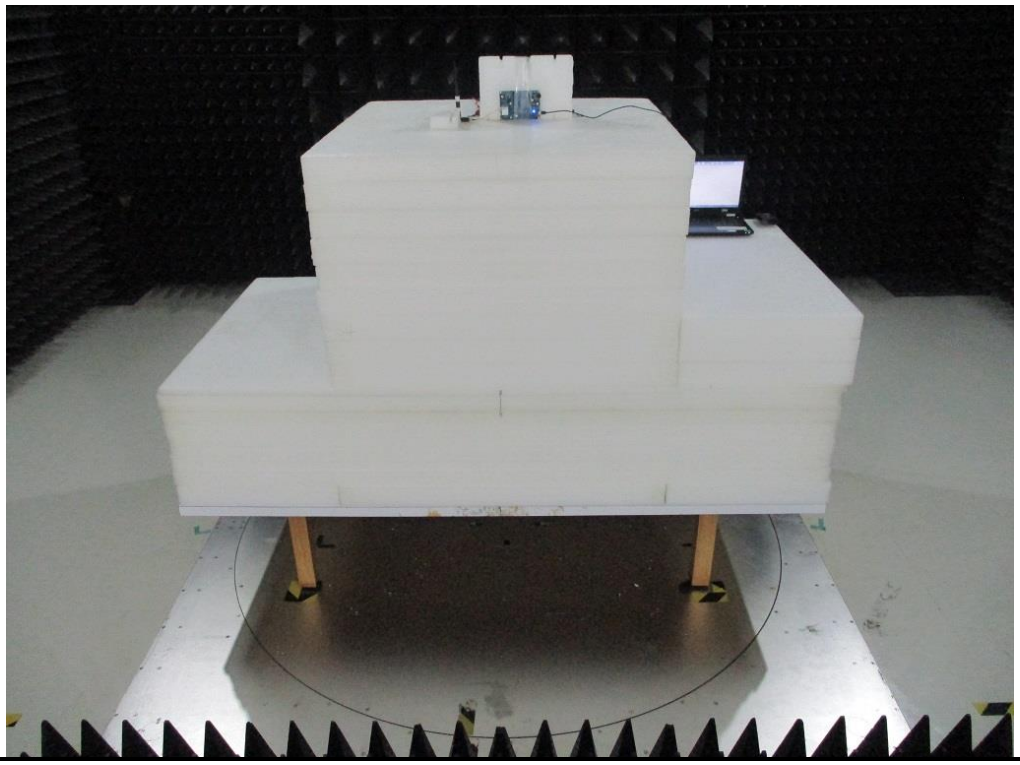
Spurious Emission Below 1GHz Test

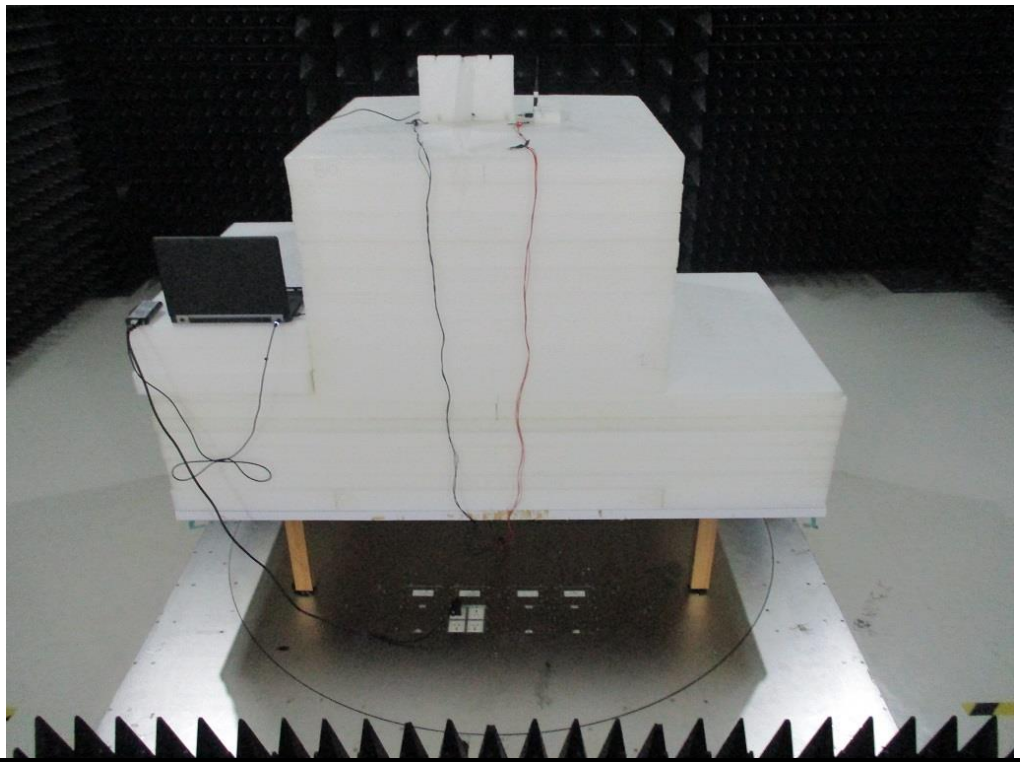


Spurious Emission Below 1GHz Test

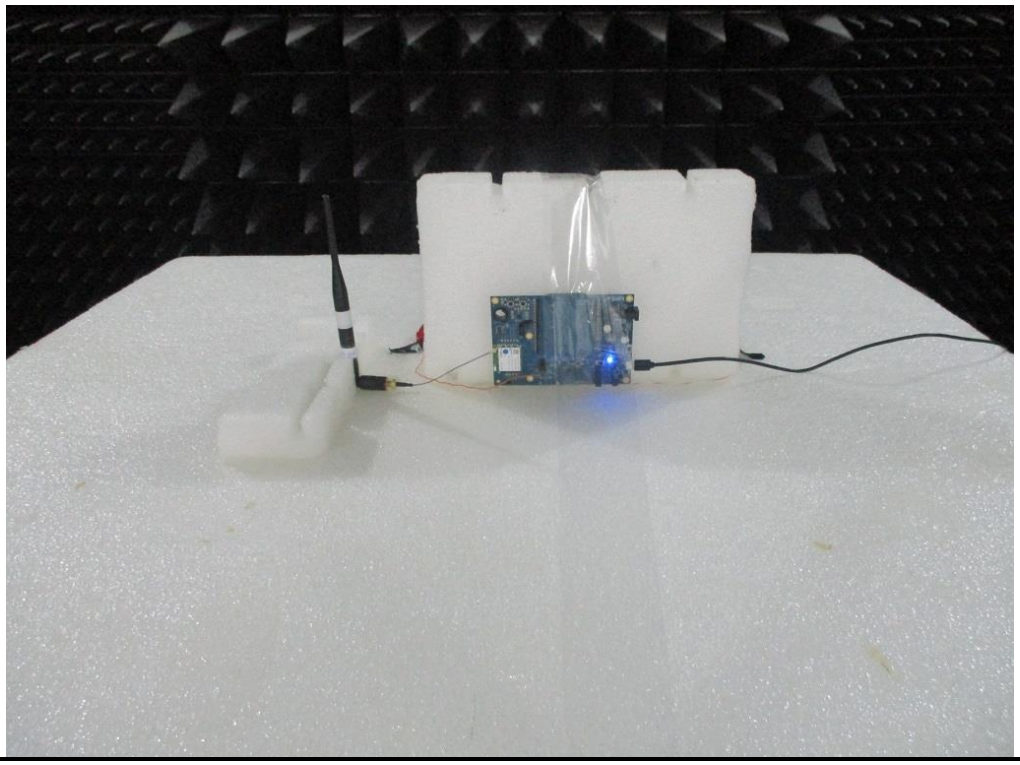


Spurious Emission Above 1GHz Test

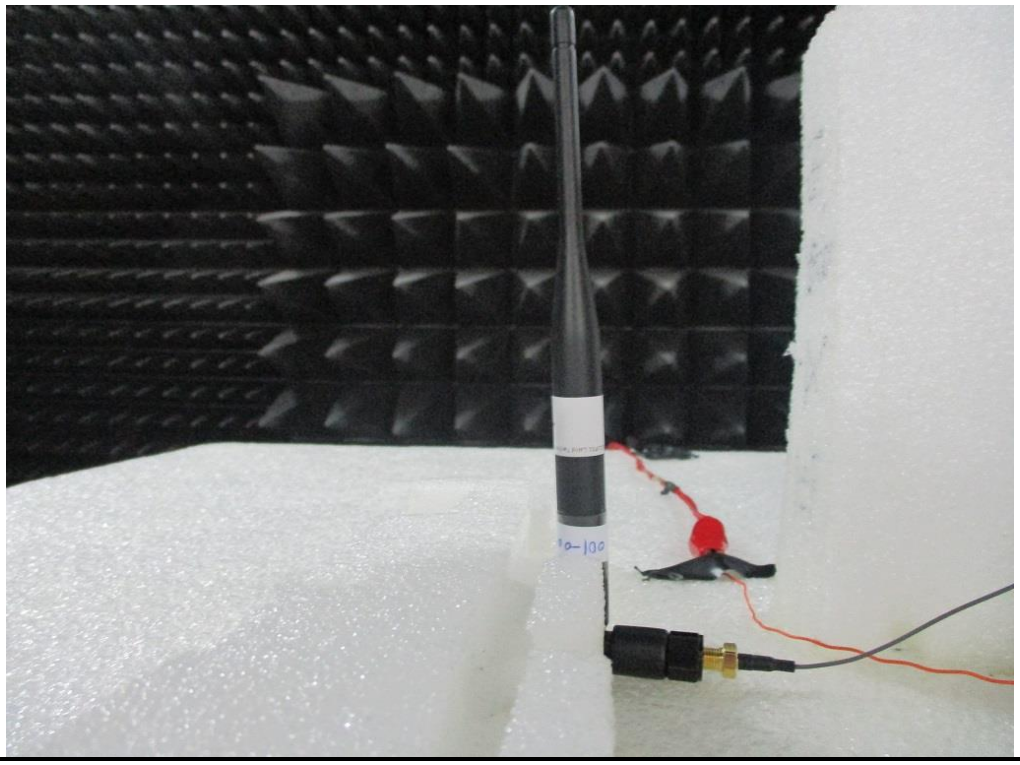


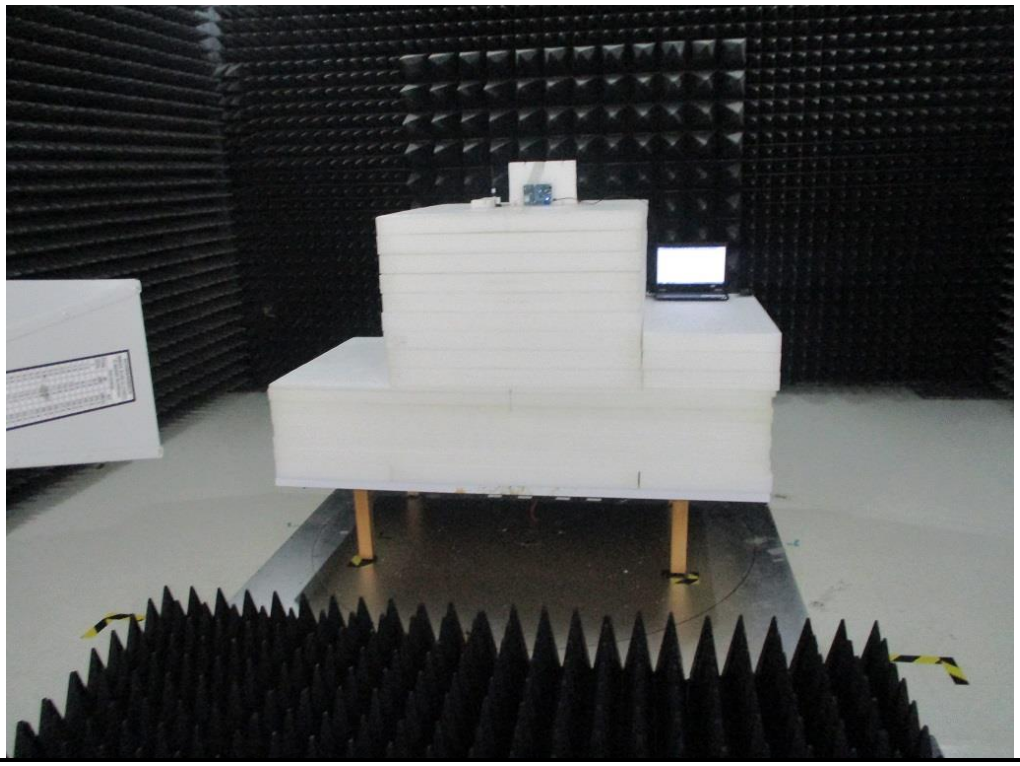


Spurious Emission Above 1GHz Test



Spurious Emission Above 1GHz Test





6 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

Tel: 886-3-271-8666
Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

═END═