ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

FCC Applicant:	Opticon sensors Europé B.V. Opaallaan 35, 2132 XV Hoofddorp, The Netherlands
FCC Manufacturer:	Opticon sensors Europé B.V. Opaallaan 35, 2132 XV Hoofddorp, The Netherlands
Product Name:	ESL Base station
Brand Name:	Opticon
Model No.:	EBS-50
Model Difference:	N/A
Report Number:	E2/2021/20062
FCC ID	Q2Q-EBS50
Issue Date:	April 29, 2021
Date of Test:	March 2, 2021～April 22, 2021
Date of EUT Received:	March 2, 2021

Approved By Jay. Lin

Jay Lin

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.247.

Revision History

Report Number	Revision	Description	Issue Date	Revised By
E2/2021/20062	00	Original.	April 29, 2021	Elle Chang

Note:

1、Antenna information is provided by the applicant, test results of this report are applicable to the sample EUT received.

Contents

1 GENERAL INFORMATION

1.1 Product Description

Product Name:	ESL Base station
Brand Name:	Opticon
Model No.:	EBS-50
Model Difference:	N/A
Hardware Version:	N/A
Firmware Version:	N/A
Power Supply:	Adapter 12Vdc

1.2 RF Specification

Radio Technology:	Zigbee
Frequency Range:	2405 – 2480MHz
Channel number:	16 channels
Modulation type:	O-QPSK
Transmit Power:	6.22 dBm

1.3 Antenna Designation

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
1/4-dipole	Opticon	N/A	2.4G	2.00

1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247
FCC KDB 558074 D01 15.247 Meas Guidance v05r02
RSS-247 issue 2 Feb. 2017
RSS-Gen. issue 5, Amendment 1, March 2019
ANSI C63.10:2013
Note: All test items have been performed and record as per the above standards.

1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction A	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
		Conducted G		
Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.				

1.6 Special Accessories

There are no special accessories used while test was conducted.

1.7 Equipment Modifications

There was no modification incorporated into the EUT.

2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3 Radiated Emissions

The EUT is a placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m*9m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.4.2 For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

2.5 Configuration of Tested System

Fig. 2-1 Conducted (Antenna Port) Emission Configuration

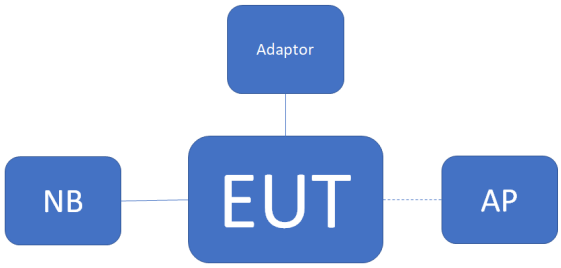


Fig 2-2 Radiated Emission

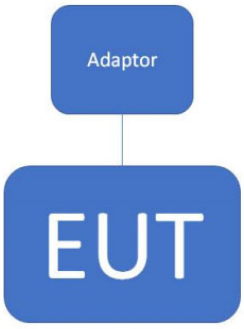


Fig 2-3 Conduction (AC Power Line) Radiated Emission

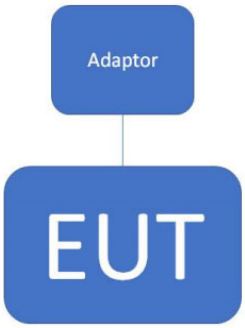


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1	Zigbee Test Software	N/A	N/A	N/A	N/A	N/A
2	Notebook	Lenovo	L420	S0011721	N/A	N/A
3	AP	ASUS	RT-AX88U	LAITHP000108	N/A	N/A
4	Adapter	Kuantech	KSASB0241200150M2	161-0046	N/A	N/A

3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(a)(2)	Emission Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.205 §15.209 §15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	Peak Power Density	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

16nnels are provided for Zigbee

ITEM	FREQUENCY	ITEM	FREQUENCY	ITEM	FREQUENCY	ITEM	FREQUENCY
1	2405 MHz	5	2425 MHz	9	2445 MHz	13	2465 MHz
2	2410 MHz	6	2430 MHz	10	2450 MHz	14	2470 MHz
3	2415 MHz	7	2435 MHz	11	2455 MHz	15	2475 MHz
4	2420 MHz	8	2440 MHz	12	2460 MHz	16	2480 MHz

4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. Investigation has been done on all the possible configurations for searching the worst case.

MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION
RADIATED EMISSION TEST (BELOW 1 GHz)			
Zigbee	2405 to 2480	2440	O-QPSK
RADIATED EMISSION TEST (ABOVE 1 GHz)			
Zigbee	2405 to 2480	2405, 2440, 2480	O-QPSK
Note: The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for channel Low, Mid and High, the worst case position was reported.			

ANTENNA PORT CONDUCTED MEASUREMENT			
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION
Zigbee	2405 to 2480	2405, 2440, 2480	O-QPSK

5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.34 dB
Peak Output Power	+/- 1 dB
6dB Bandwidth	+/- 1.54 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 1.69 dB
Peak Power Density	+/- 1.54 dB
Temperature	+/- 0.4 °C
Humidity	+/- 3.5 %
DC / AC Power Source	DC= +/- 1%, AC= +/- 1%

Radiated Spurious Emission Measurement Uncertainty		
Polarization: Vertical	+/- 2.64 dB	9kHz~30MHz: +-2.3dB
	+/- 4.93 dB	30MHz - 1000MHz: +/- 3.37dB
	+/- 4.81 dB	1GHz - 18GHz: +/- 4.04dB
	+/- 4.52 dB	18GHz - 40GHz: +/- 4.04dB
Polarization: Horizontal	+/- 2.64 dB	9kHz~30MHz: +-2.3dB
	+/- 4.45 dB	30MHz - 1000MHz: +/- 4.22dB
	+/- 4.81 dB	1GHz - 18GHz: +/- 4.08dB
	+/- 4.52 dB	18GHz - 40GHz: +/- 4.08dB

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

6 CONDUCTED EMISSION TEST

6.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB(μV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note 1.The lower limit shall apply at the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

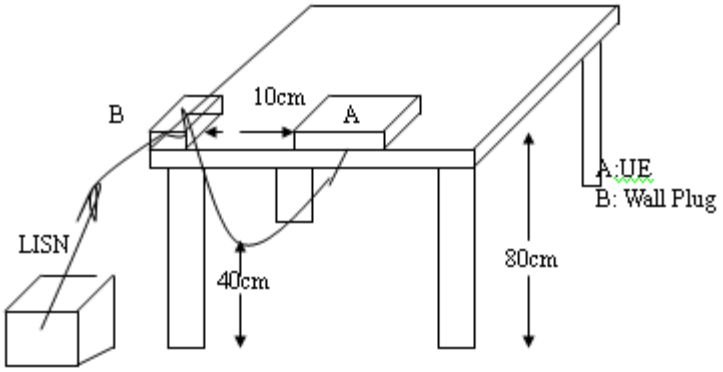
6.2 Measurement Equipment Used:

Radiated Emission Test Site: Conduction A					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Test Software	audix	e3	Ver. 6.11-20180419c	N.C.R	N.C.R
LISN	SCHWARZBECK Mess-Elektronik	NSLK8127	973	03/25/2021	03/24/2022
Coaxial Cable	EC Lab	RF-HY-CAB-250	RF-HY-CAB-250-01	03/27/2021	03/26/2022
Pulse Limiter	EC Lab	VTSD 9561F-N	485	03/27/2021	03/26/2022

6.3 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

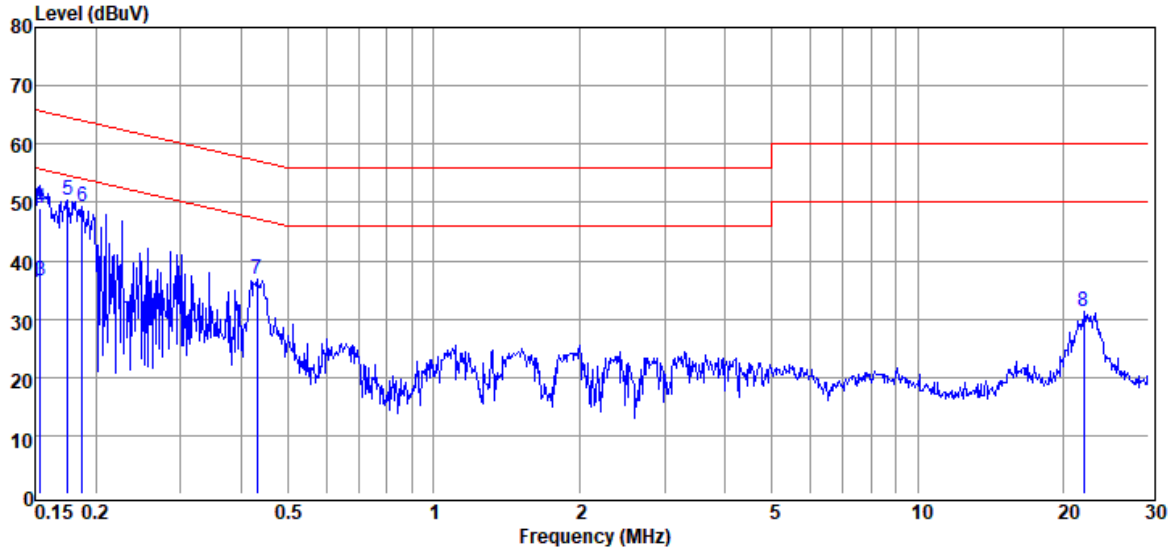
6.6 Measurement Result:

Note: Refer to next page for measurement data and plots.

Note2: The * reveals the worst-case results that closet to the limit.

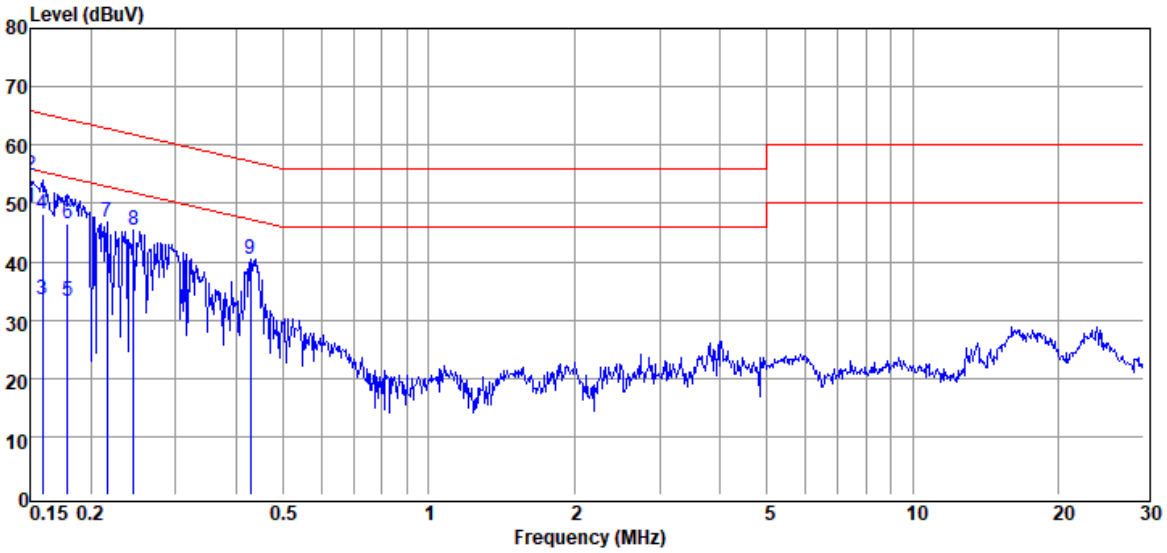
AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number	:E2/2021/20062	Test Site	:Conduction Room C
Test Mode	:Zigbee	Test Date	:2021-04-13
Power	:120V/60Hz	Temp./Humi.	:24.9/62
Probe	:L1	Engineer	:Ashton Chiu
Note:	: Adapter:KSAB0241200150M2		



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV	dBµV	dB
0.15	Average	25.90	10.30	36.20	56.00	-19.80
0.15	QP	38.82	10.30	49.12	66.00	-16.88
0.15	Average	26.20	10.30	36.50	55.78	-19.28
0.15	QP	38.80	10.30	49.10	65.78	-16.68
0.17	Peak	39.97	10.30	50.27	64.72	-14.45
0.19	Peak	39.02	10.30	49.32	64.15	-14.83
0.43	Peak	26.38	10.31	36.69	57.24	-20.55
22.06	Peak	20.30	10.93	31.23	60.00	-28.77

Report Number	:E2/2021/20062	Test Site	:Conduction Room C
Test Mode	:Zigbee	Test Date	:2021-04-13
Power	:120V/60Hz	Temp./Humi.	:24.9/62
Probe	:N	Engineer	:Ashton Chiu
Note:	: Adapter:KSAB0241200150M2		



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV	Limit dBµV	Margin dB
0.15	Average	38.90	10.31	49.21	56.00	-6.79
0.15	Peak	44.54	10.31	54.85	66.00	-11.15
0.16	Average	23.30	10.31	33.61	55.52	-21.91
0.16	QP	37.80	10.31	48.11	65.52	-17.41
0.18	Average	22.90	10.30	33.20	54.50	-21.30
0.18	QP	36.10	10.30	46.40	64.50	-18.10
0.22	Peak	36.48	10.30	46.78	62.96	-16.18
0.25	Peak	34.97	10.30	45.27	61.91	-16.64
0.43	Peak	30.10	10.32	40.42	57.29	-16.87

7 PEAK OUTPUT POWER MEASUREMENT

7.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

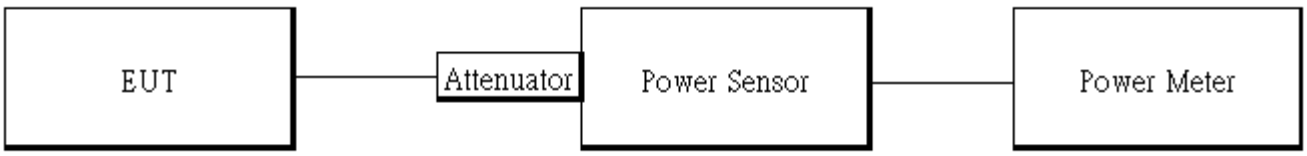
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

7.2 Measurement Equipment Used:

Conducted Emission Test Site: Conducted C					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Power Meter	Anritsu	ML2496A	1512003	07/23/2020	07/22/2021
Power Sensor	Anritsu	MA2411B	1339378	07/23/2020	07/22/2021
Power Sensor	Anritsu	MA2411B	1339379	07/23/2020	07/22/2021
Attenuator	Marvelous	MVE2213-10	RF09	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F2A196C	RF70	11/19/2020	11/18/2021

7.3 Test Set-up:



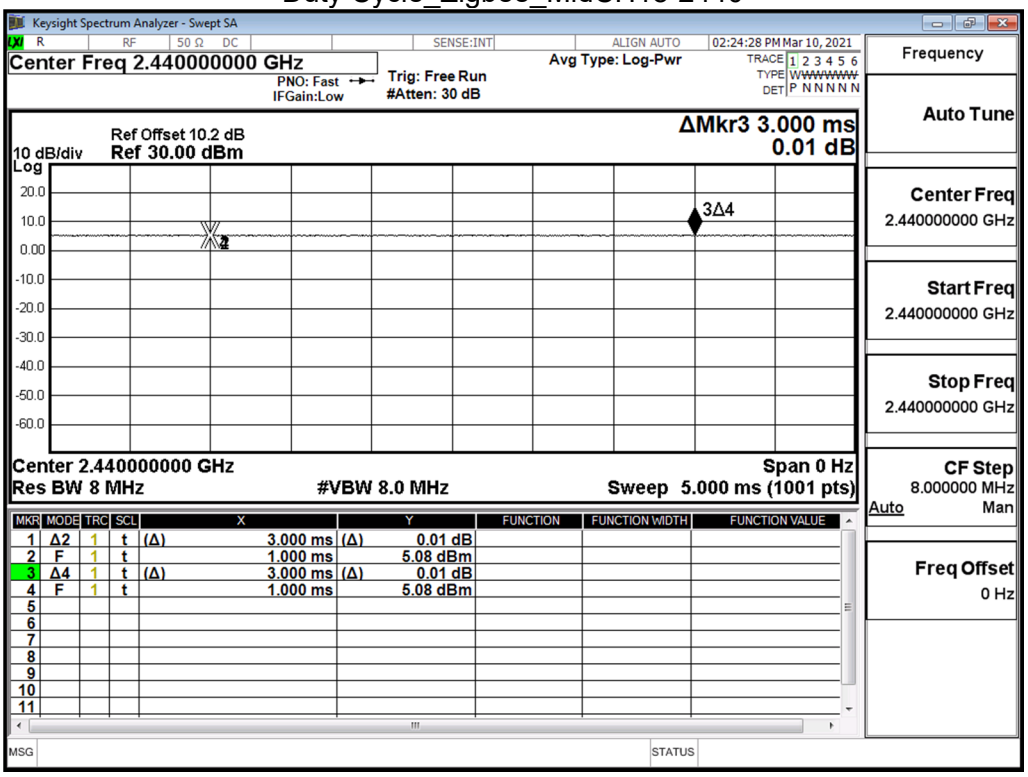
7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

7.5 Duty Factor:

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
Zigbee	100.00	0.00	0.33	0.01

Duty Cycle_Zigbee_MidCH18-2440



Duty Cycle Factor:10*log(1/(100/100))=0

7.6 Output Power:

7.6.1 Peak & Avg

Zigbee mode:

CH	Frequency (MHz)	Power set	Peak Power Output (dBm)	Required Limit
Low	2405	default	**6.22**	1 Watt = 30 dBm
Mid	2440	default	5.38	1 Watt = 30 dBm
High	2480	default	4.26	1 Watt = 30 dBm
CH	**Frequency (MHz)**	**Power set**	**Max. Avg. Output include tune up tolerance Power (dBm)**	**Required Limit**
Low	2405	default	5.98	1 Watt = 30 dBm
Mid	2440	default	5.01	1 Watt = 30 dBm
High	2480	default	3.90	1 Watt = 30 dBm

Note: Measured by power meter, cable loss 10.2 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

8 EMISSION BANDWIDTH MEASUREMENT

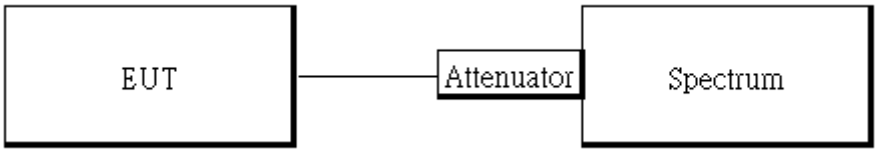
8.1 Standard Applicable

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

8.2 Measurement Equipment Used

Conducted Emission Test Site: Conducted C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	07/08/2020	07/07/2021
Attenuator	Marvelous	MVE2213-10	RF09	11/19/2020	11/18/2021
DC Block	PASTER-NACK	PE8210	RF151	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F2A196C	RF70	11/19/2020	11/18/2021

8.3 Test Set-up:



8.4 Measurement Procedure:

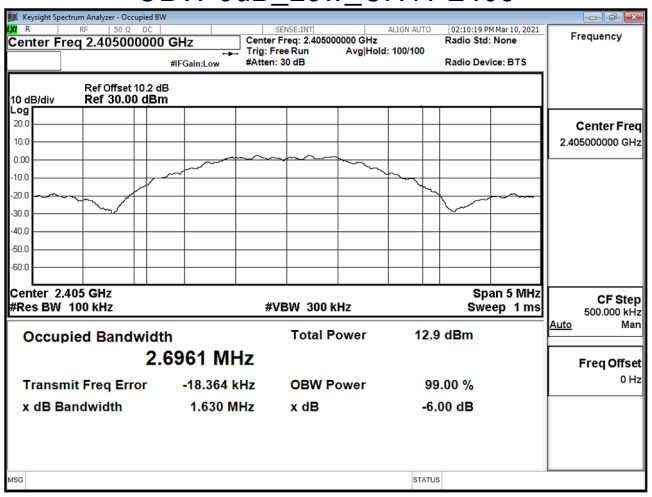
1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set the spectrum analyzer as
   RBW= 1 % to 5% of OBW ,
   VBW = 3 X RBW,
   Span= 2 to 5 times of the OBW,
   Sweep=auto,
   Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and –20dB (upper and lower) frequency
6. Repeat above procedures until all test default channel is completed

8.5 Measurement Result:

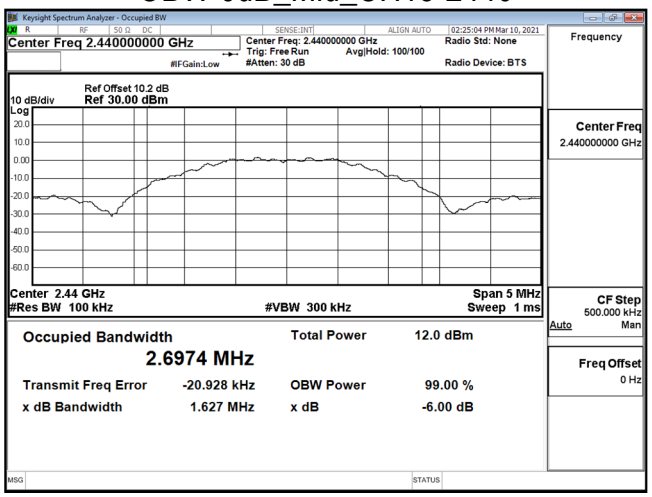
Zigbee mode

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2405	1.63	> 0.5	PASS
2440	1.627	> 0.5	PASS
2480	1.631	> 0.5	PASS

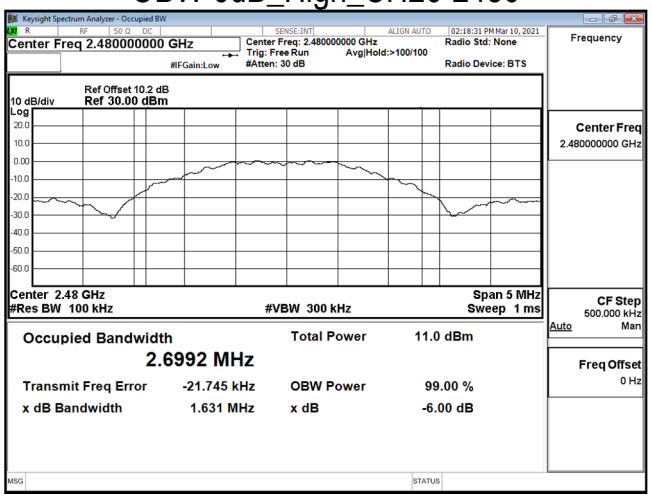
OBW 6dB_Low_CH11-2405



OBW 6dB_Mid_CH18-2440



OBW 6dB_High_CH26-2480



9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

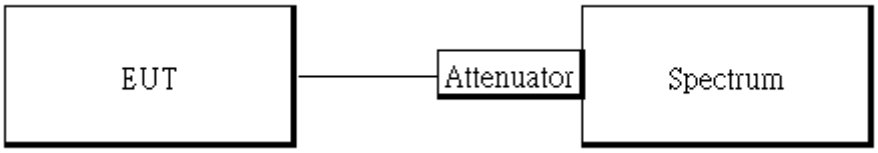
9.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

9.2 Measurement Equipment Used:

Conducted Emission Test Site: Conducted C					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	07/08/2020	07/07/2021
Attenuator	Marvelous	MVE2213-10	RF09	11/19/2020	11/18/2021
DC Block	PASTER-NACK	PE8210	RF151	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F2A196C	RF70	11/19/2020	11/18/2021

9.3 Test SET-UP:



9.4 Measurement Procedure

9.4.1 Reference Level of Emission Limit:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

9.4.2 Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Set DL as the limit = reading on marker of reference level measurement – 20dBm
7. Mark the highest readings of the emissions outside of 2400MHz~2483.5MHz.
8. Repeat above procedures until all default test channel (low, middle, and high) was complete.

9.4.3 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

9.5 Measurement Result

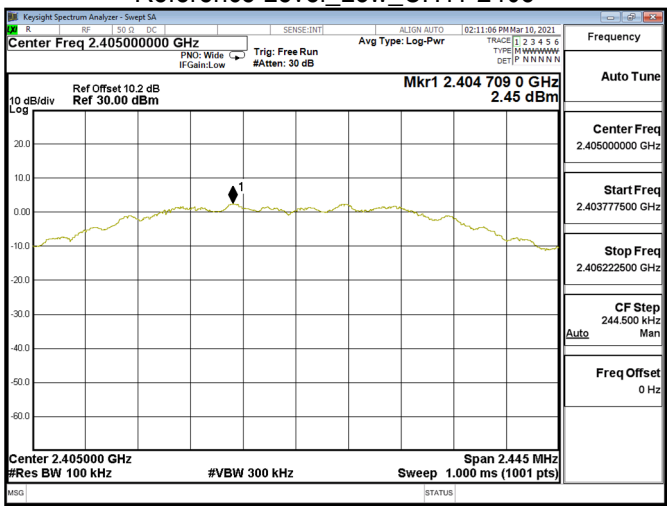
Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2405	2.45	-17.55
2440	1.55	-18.45
2480	0.53	-19.47

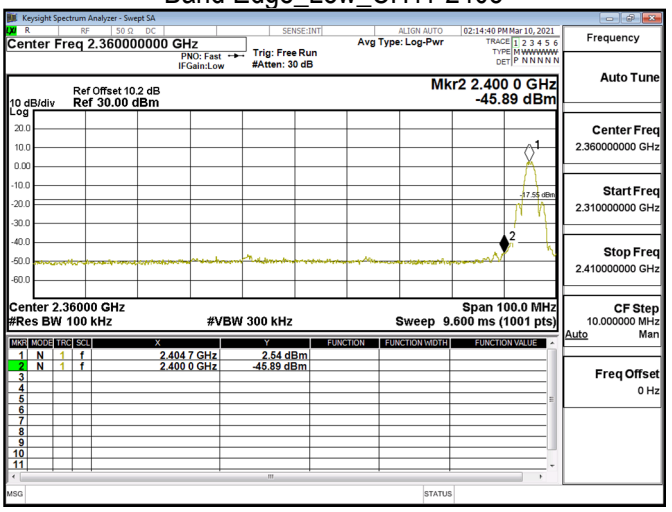
NOTE: cable loss as 10.2dB that offsets in the spectrum

NOTE: Refer to next page for plots.

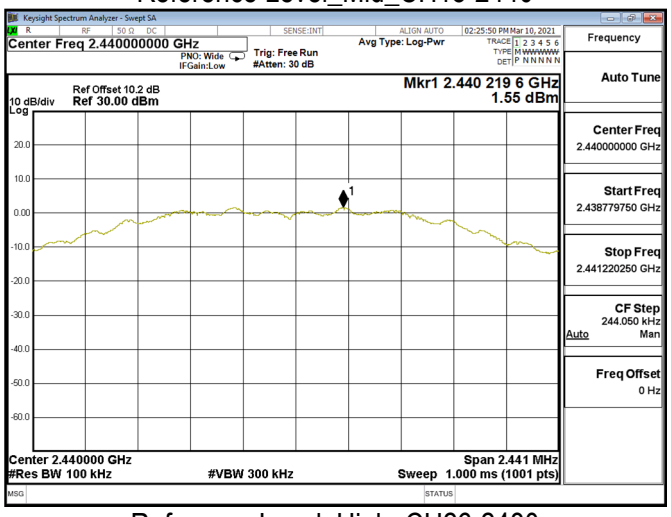
Reference Level_Low_CH11-2405



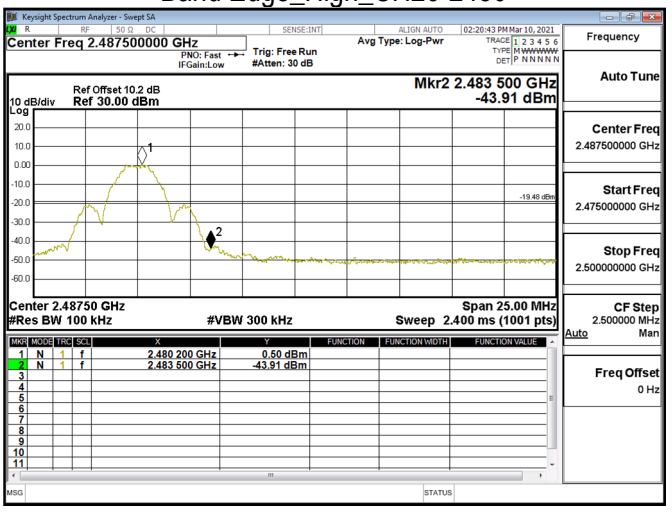
Band Edge_Low_CH11-2405



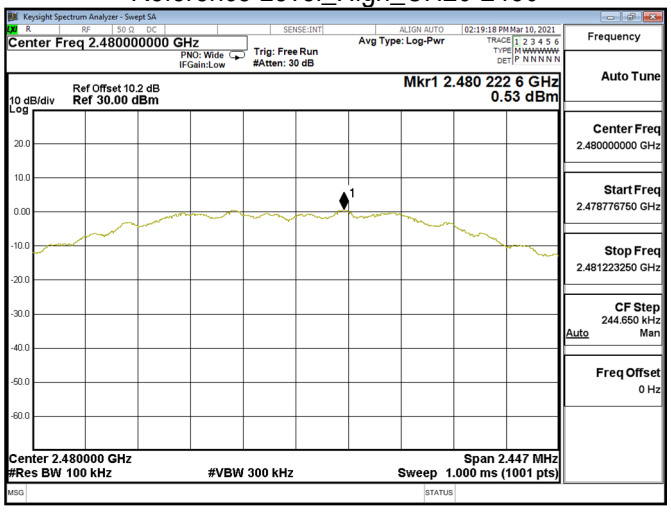
Reference Level_Mid_CH18-2440



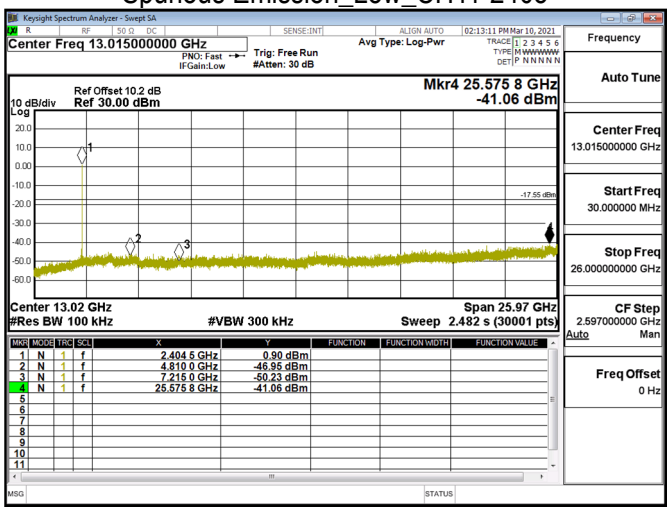
Band Edge_High_CH26-2480



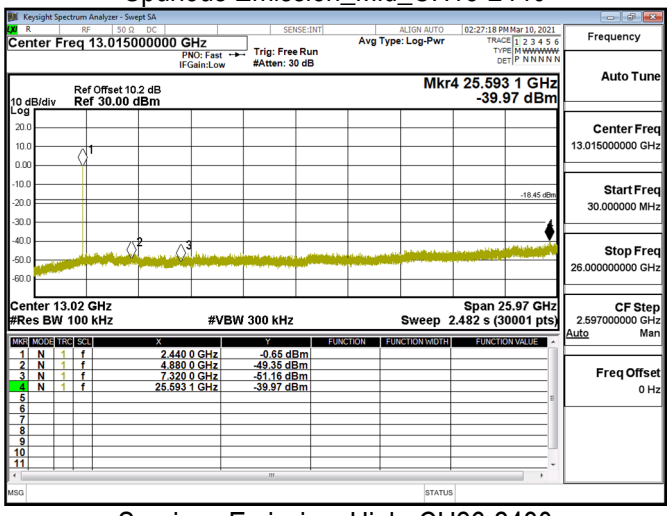
Reference Level_High_CH26-2480



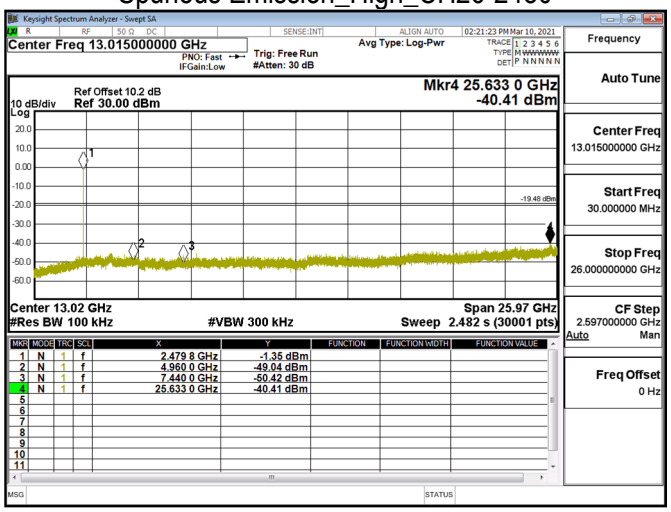
Spurious Emission_Low_CH11-2405



Spurious Emission_Mid_CH18-2440



Spurious Emission_High_CH26-2480



10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 limit as below.

And according to §15.33(a) (1) for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

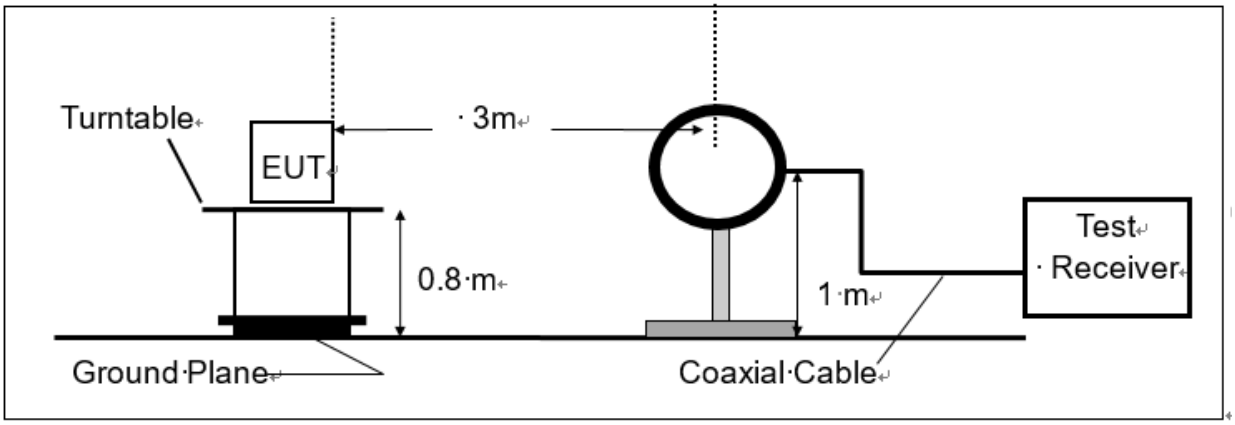
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBμV/m) = 20 log Emission level (μV/m)

10.2 Measurement Equipment Used

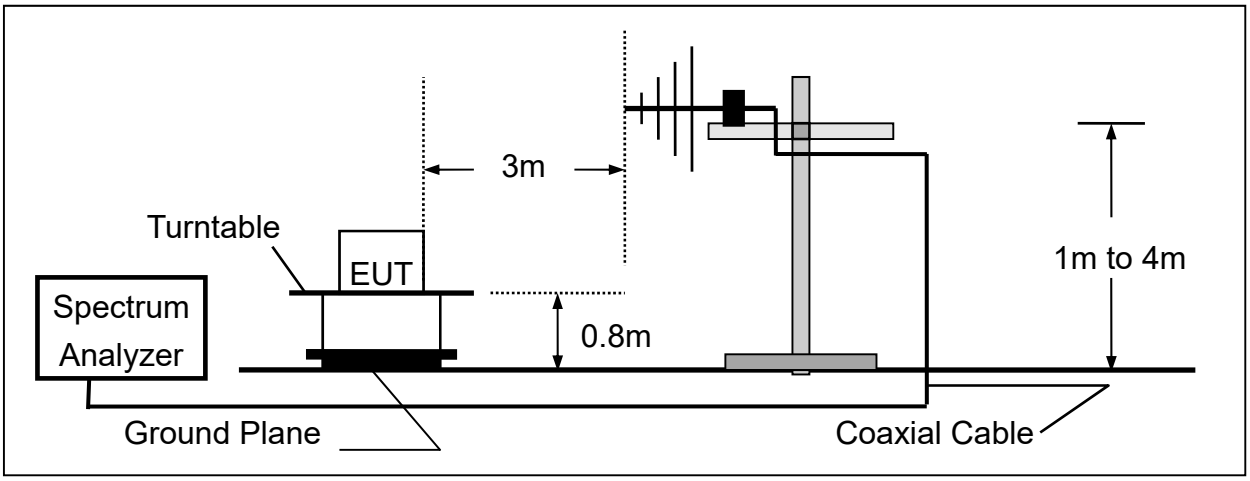
Radiated Emission Test Site: SAC D					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Broadband Antenna	TESEQ	CBL 6112D	35240	09/08/2020	09/07/2021
Horn Antenna	Schwarzbeck	BBHA9120D	1341	06/22/2020	06/21/2021
Horn Antenna	Schwarzbeck	BBHA9170	185	07/30/2020	07/29/2021
Loop Antenna	ETS.LINDGREN	6502	143303	04/28/2020	04/27/2021
3m Site NSA	SGS	966 chamber D	N/A	07/12/2020	07/11/2021
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	07/08/2020	07/07/2021
Pre-Amplifier	EMC Instruments	EMC184045B	980135	10/27/2020	10/26/2021
Pre-Amplifier	EMC Instruments	EMC9135	980234	11/19/2020	11/18/2021
Pre-Amplifier	EMC Instruments	EMC12630SE	980271	11/19/2020	11/18/2021
Attenuator	Marvelous	WATT-218FS-10	RF25	11/19/2020	11/18/2021
High Pass Filter	R&S	F13 HPF 3GHz	RF175	11/19/2020	11/18/2021
Lowpass Filter	Woken	EWT-56-0019	RF173	11/19/2020	11/18/2021
Notch Filter	Woken	EWT-54-0038	RF178	11/19/2020	11/18/2021
Coaxial Cable	Huber Suhner	EMC106-SM-SM-7200	150703	11/19/2020	11/18/2021
Coaxial Cable	Huber+Suhner	RG 214/U	W21.01	11/19/2020	11/18/2021
Coaxial Cable	Huber Suhner	SUCOFLEX 104	MY17413/4	11/19/2020	11/18/2021

10.3 Test SET-UP

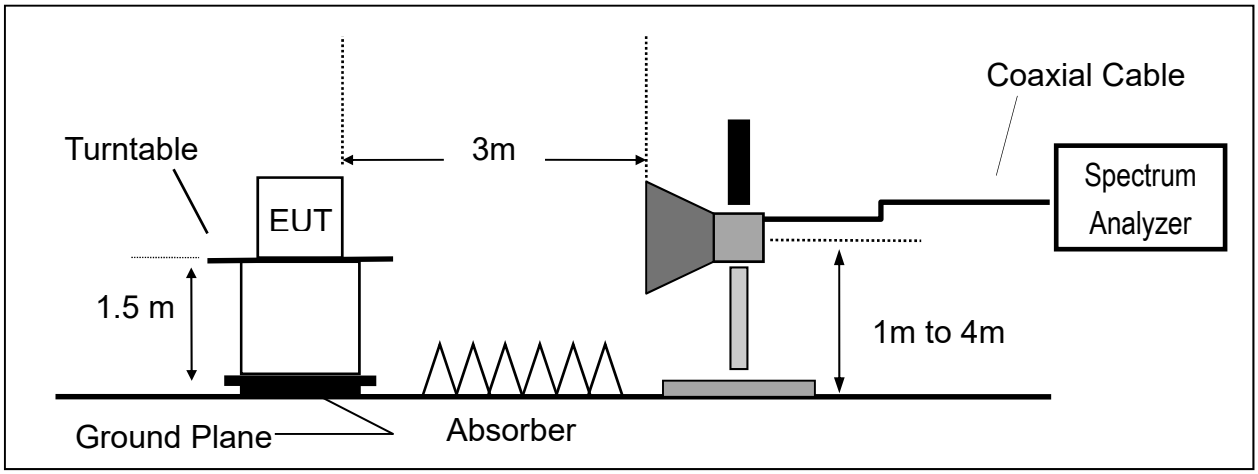
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



10.4 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plan.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

10.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL – AG$$

Where *FS = Field Strength* *CL = Cable Attenuation Factor (Cable Loss)*
RA = Reading Amplitude *AG = Amplifier Gain*
AF = Antenna Factor

*The limit of the emission level is expressed in dBuV/m, which converts 20*log(uV/m)*

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

10.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

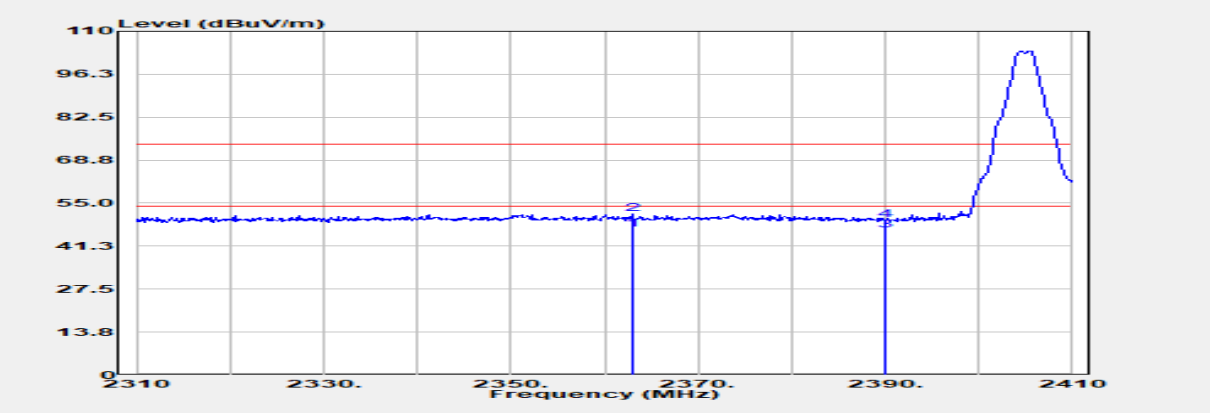
The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

10.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

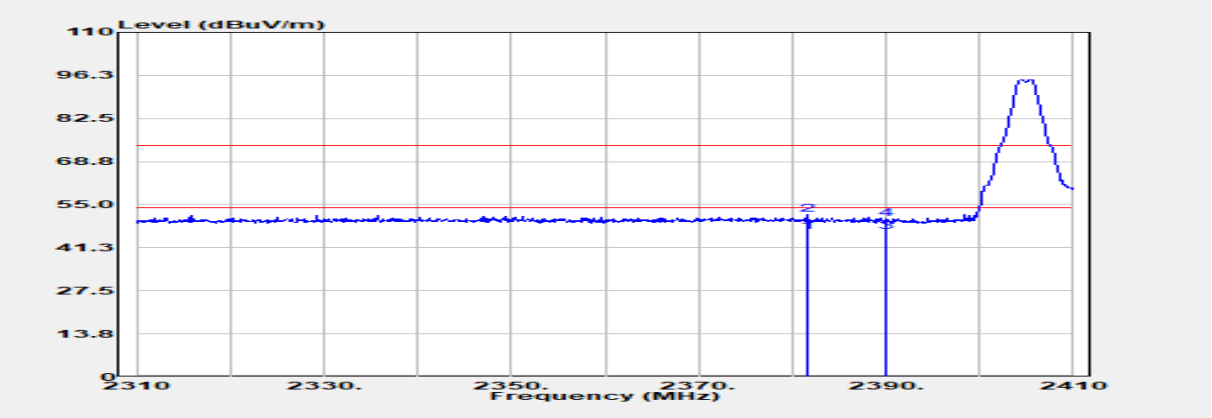
10.7.1 Radiated Band Edge Measurement Result

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-11
Test Frequency	:2405 MHz	Temp./Humi.	:21.8/67
Test Mode	:BE CH LOW	Antenna Pol.	:Vertical
EUT Pol	:E2 Plan	Engineer	:Jack Tseng



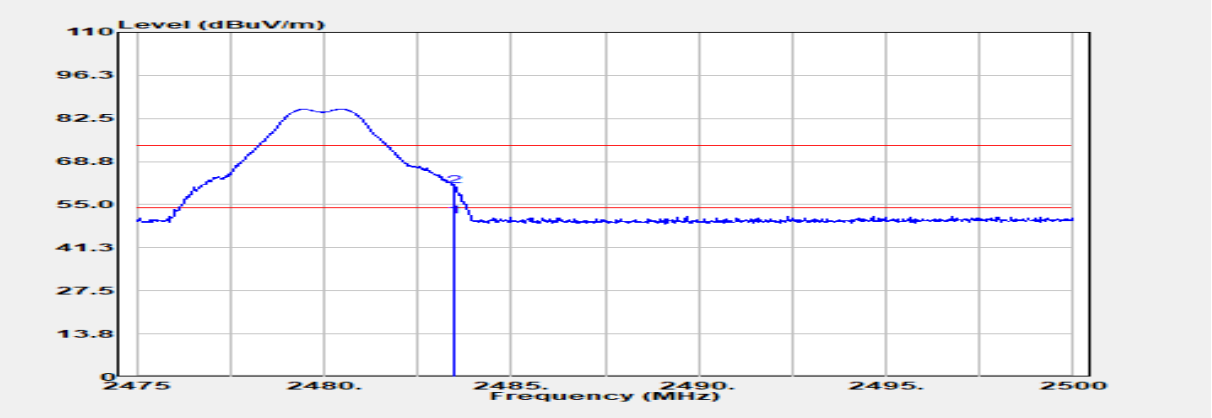
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2362.900	Average	54.50	-7.89	46.61	54.00	-7.39
2362.900	Peak	59.37	-7.89	51.48	74.00	-22.52
2390.000	Average	54.35	-7.99	46.36	54.00	-7.64
2390.000	Peak	57.72	-7.99	49.73	74.00	-24.27

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-11
Test Frequency	:2405 MHz	Temp./Humi.	:21.8/67
Test Mode	:BE CH LOW	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plan	Engineer	:Jack Tseng



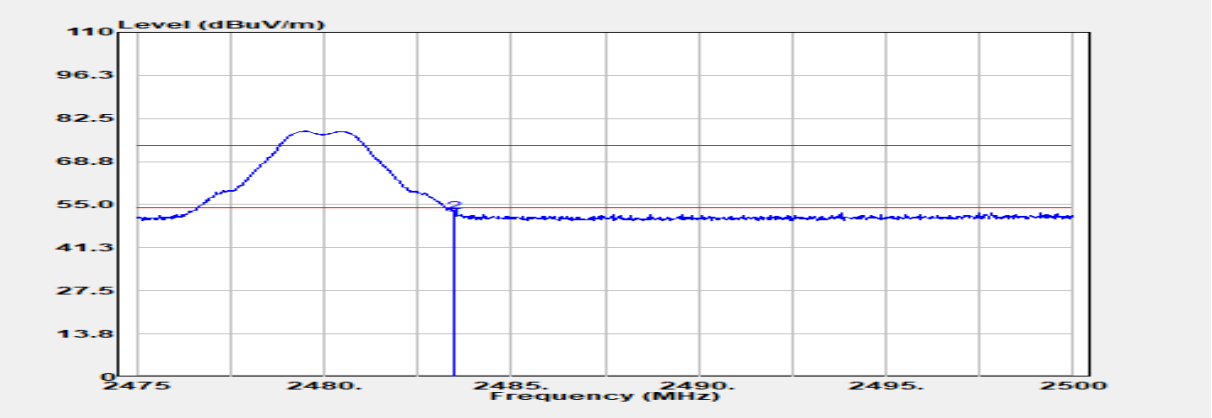
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
2381.500	Average	53.98	-7.73	46.25	54.00	-7.75
2381.500	Peak	59.70	-7.73	51.96	74.00	-22.04
2390.000	Average	54.20	-7.99	46.21	54.00	-7.79
2390.000	Peak	58.35	-7.99	50.36	74.00	-23.64

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-04-08
Test Frequency	:2480 MHz	Temp./Humi.	:21.2/66
Test Mode	:BE CH HIGH	Antenna Pol.	:Vertical
EUT Pol	:E2 Plan	Engineer	:Jack Tseng



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.500	Average	59.34	-8.12	51.22	54.00	-2.78
2483.500	Peak	68.97	-8.12	60.85	74.00	-13.15

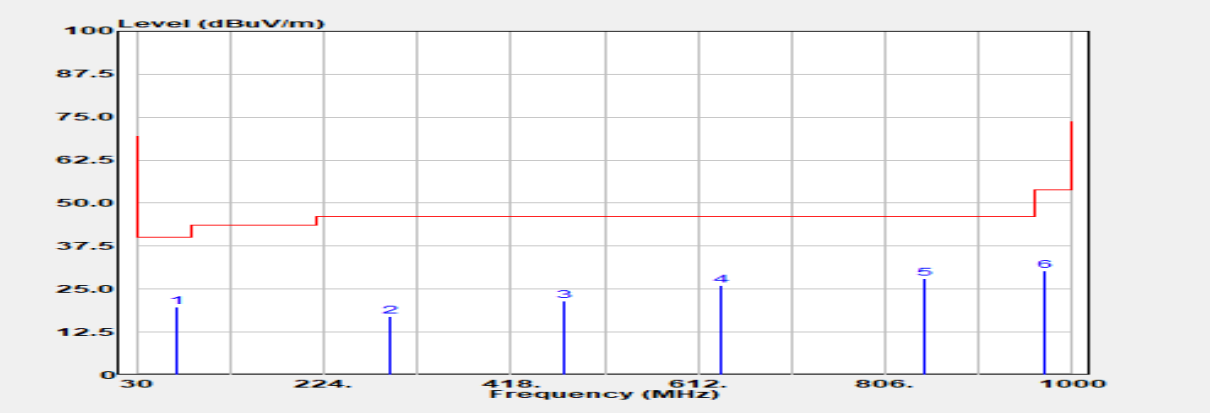
Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-04-08
Test Frequency	:2480 MHz	Temp./Humi.	:21.2/66
Test Mode	:BE CH HIGH	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plan	Engineer	:Jack Tseng



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
2483.500	Average	58.32	-8.12	50.20	54.00	-3.80
2483.500	Peak	60.87	-8.12	52.75	74.00	-21.25

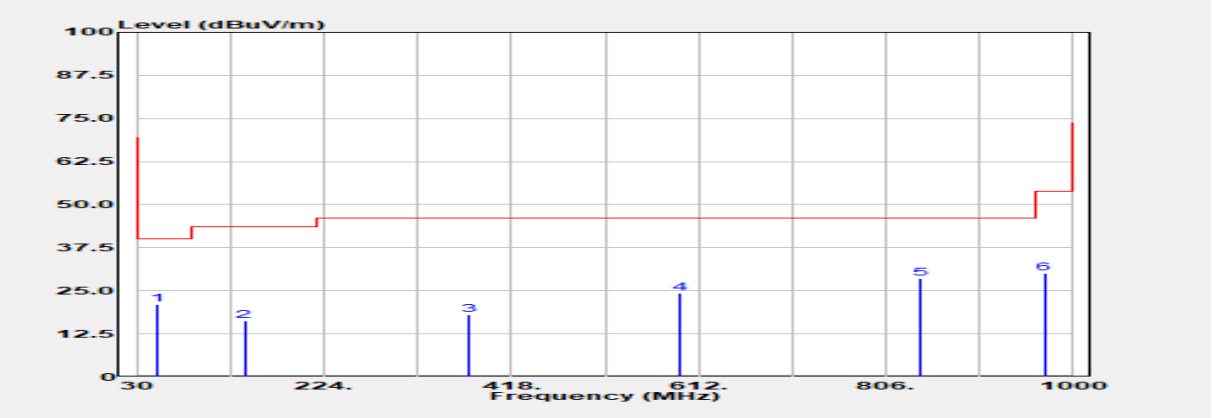
10.7.2 Radiated Spurious Emission from 30MHz to 1000MHz

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2440 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH MID	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
70.740	Peak	38.99	-19.32	19.68	40.00	-20.32
292.870	Peak	33.42	-16.30	17.12	46.00	-28.88
473.290	Peak	33.59	-11.96	21.63	46.00	-24.37
635.280	Peak	34.69	-8.57	26.12	46.00	-19.88
846.740	Peak	34.36	-6.40	27.96	46.00	-18.04
971.870	Peak	34.44	-4.05	30.39	54.00	-23.61

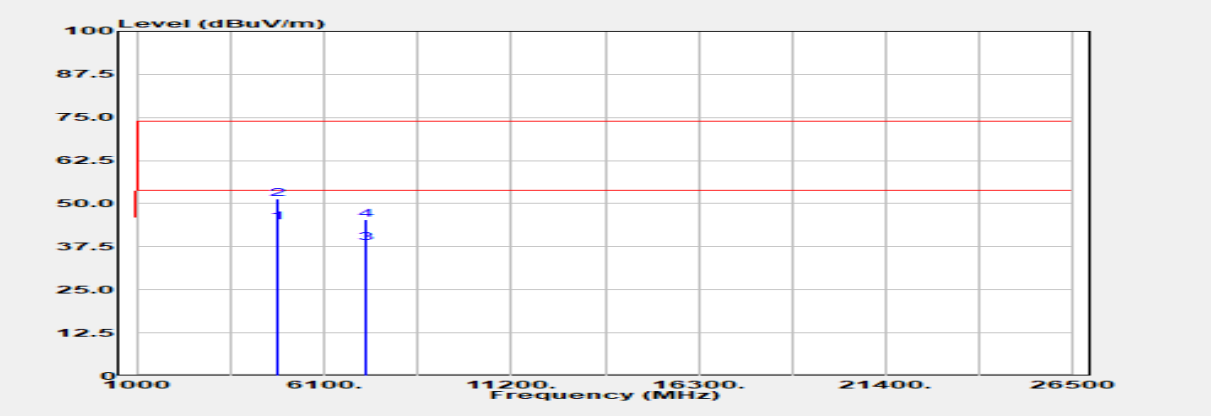
Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2440 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH MID	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
50.370	Peak	38.78	-17.62	21.16	40.00	-18.84
141.550	Peak	33.38	-16.98	16.40	43.50	-27.10
374.350	Peak	32.69	-14.54	18.15	46.00	-27.85
593.570	Peak	33.62	-9.37	24.25	46.00	-21.75
840.920	Peak	34.84	-6.36	28.47	46.00	-17.53
969.930	Peak	33.93	-3.85	30.08	54.00	-23.92

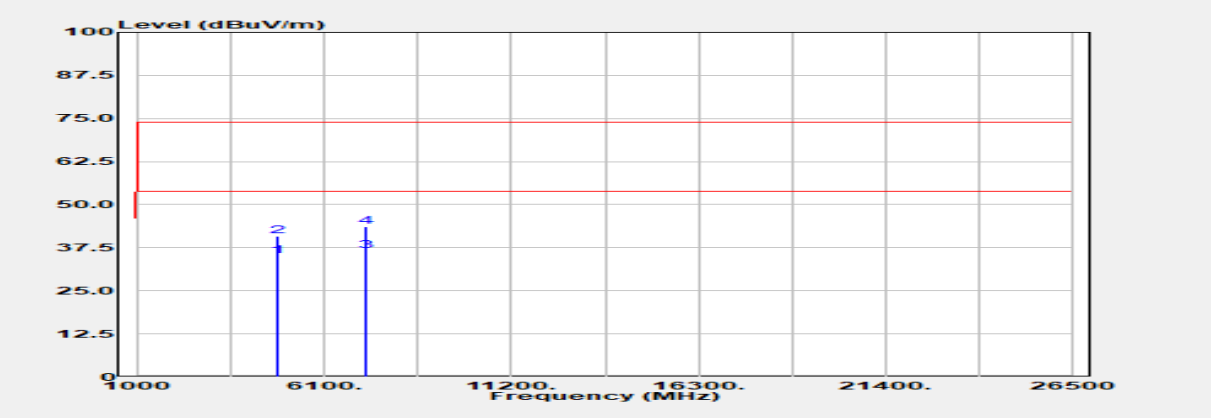
10.7.3 Radiated Spurious Emission above 1GHz

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2405 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH LOW	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



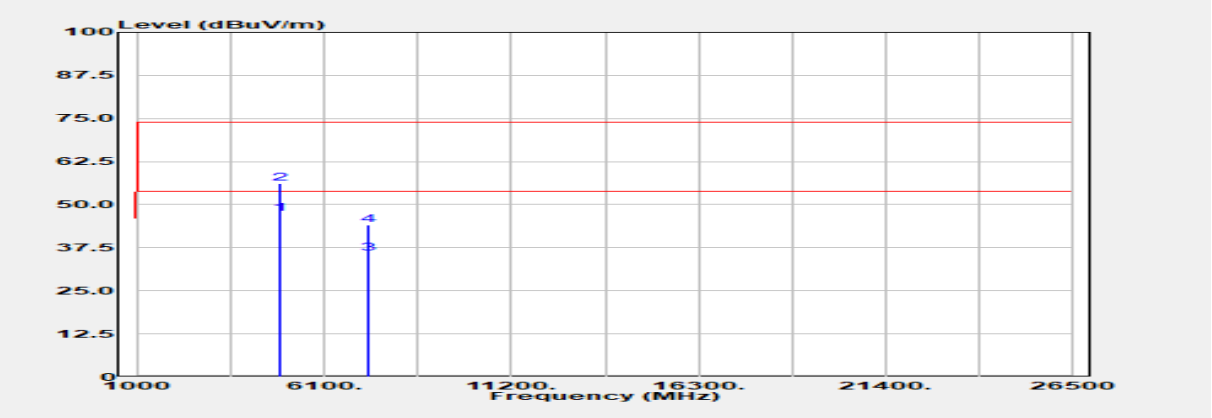
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4810.000	Average	47.85	-3.23	44.62	54.00	-9.38
4810.000	Peak	54.52	-3.23	51.29	74.00	-22.71
7215.000	Average	35.30	3.23	38.53	54.00	-15.47
7215.000	Peak	42.03	3.23	45.25	74.00	-28.75

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2405 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH LOW	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



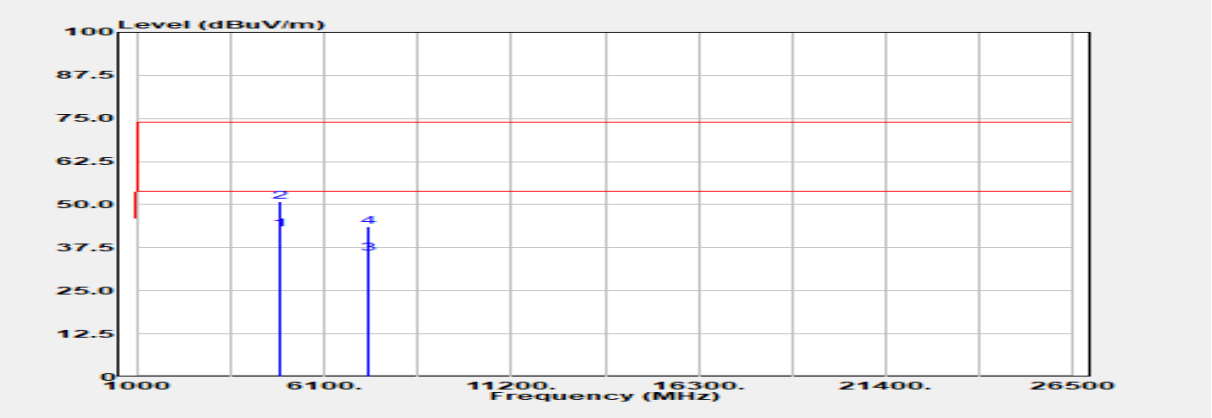
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4810.000	Average	38.30	-3.23	35.07	54.00	-18.93
4810.000	Peak	44.00	-3.23	40.77	74.00	-33.23
7215.000	Average	33.26	3.23	36.49	54.00	-17.51
7215.000	Peak	40.43	3.23	43.66	74.00	-30.34

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2440 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH MID	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



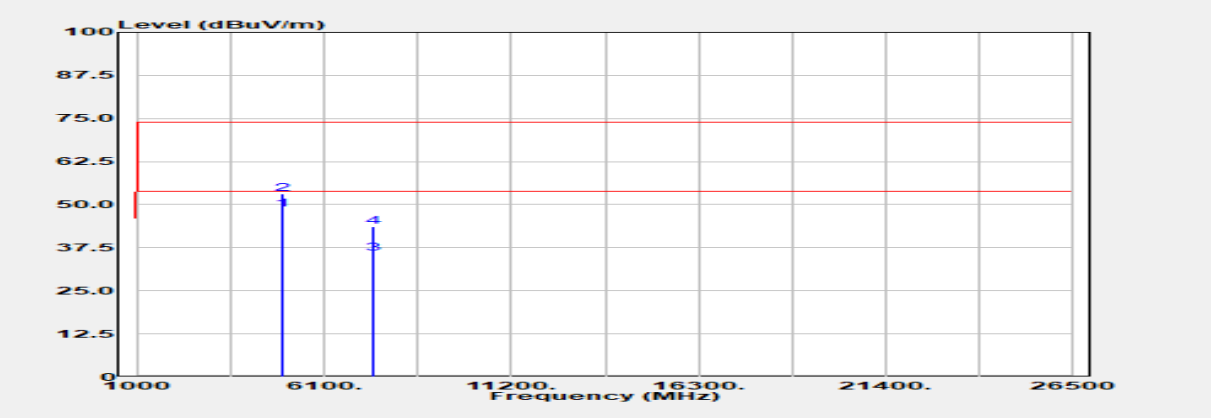
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4880.000	Average	50.22	-2.87	47.36	54.00	-6.64
4880.000	Peak	58.92	-2.87	56.05	74.00	-17.95
7320.000	Average	32.48	3.42	35.89	54.00	-18.11
7320.000	Peak	40.72	3.42	44.13	74.00	-29.87

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2440 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH MID	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



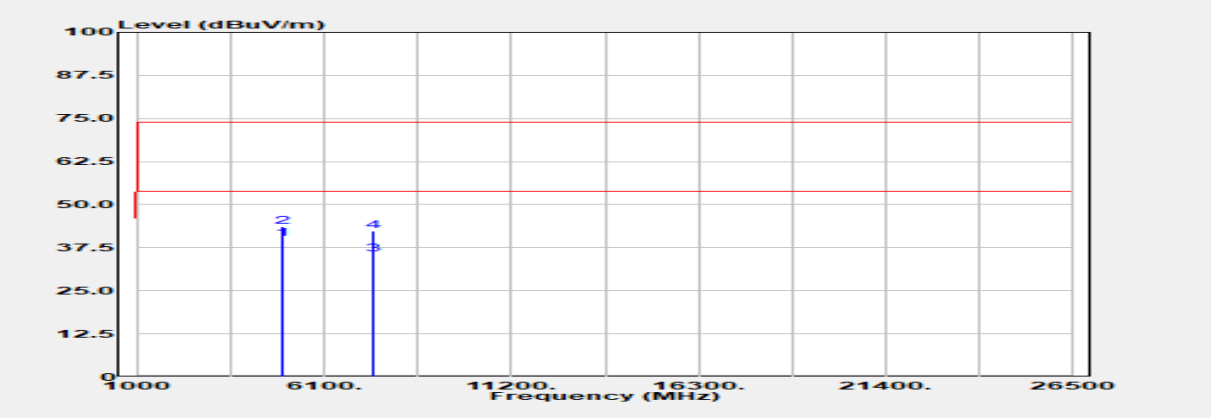
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4880.000	Average	45.67	-2.87	42.80	54.00	-11.20
4880.000	Peak	53.77	-2.87	50.90	74.00	-23.10
7320.000	Average	32.34	3.42	35.75	54.00	-18.25
7320.000	Peak	40.09	3.42	43.51	74.00	-30.49

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2480 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH HIGH	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.000	Average	51.52	-2.89	48.63	54.00	-5.37
4960.000	Peak	56.05	-2.89	53.15	74.00	-20.85
7440.000	Average	32.26	3.65	35.91	54.00	-18.09
7440.000	Peak	39.98	3.65	43.63	74.00	-30.37

Report Number	:E2/2021/20062	Test Site	:966 Chamber D
Operation Mode	:Zigbee	Test Date	:2021-03-12
Test Frequency	:2480 MHz	Temp./Humi.	:21.8/68
Test Mode	:TX CH HIGH	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Jack Tseng



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.000	Average	43.10	-2.89	40.21	54.00	-13.79
4960.000	Peak	46.58	-2.89	43.69	74.00	-30.31
7440.000	Average	31.92	3.65	35.57	54.00	-18.43
7440.000	Peak	38.63	3.65	42.28	74.00	-31.72

11 POWER SPECTRAL DENSITY

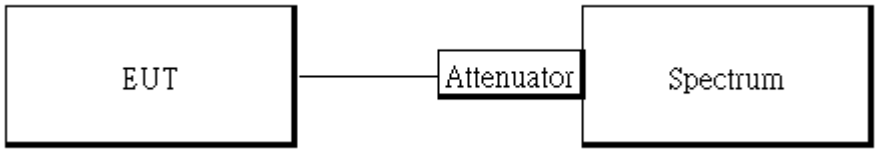
11.1 Standard Applicable:

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 Measurement Equipment Used:

Conducted Emission Test Site: Conducted C					
EQUIPMENT TYPE	**MFR**	**MODEL NUMBER**	**SERIAL NUMBER**	**LAST CAL.**	**CAL DUE.**
Spectrum Analyzer	KEYSIGHT	N9010A	MY54510568	07/08/2020	07/07/2021
Attenuator	Marvelous	MVE2213-10	RF09	11/19/2020	11/18/2021
DC Block	PASTER-NACK	PE8210	RF151	11/19/2020	11/18/2021
Coaxial Cables	Woken	00100A1F2A196C	RF70	11/19/2020	11/18/2021

11.3 Test Set-up:



11.4 Measurement Procedure:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 3 kHz. & the VBW = 10 kHz
5. For defining Restricted Band Edge Limit:
   Set the RBW = 100kHz & VBW = 300 kHz.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum amplitude level.

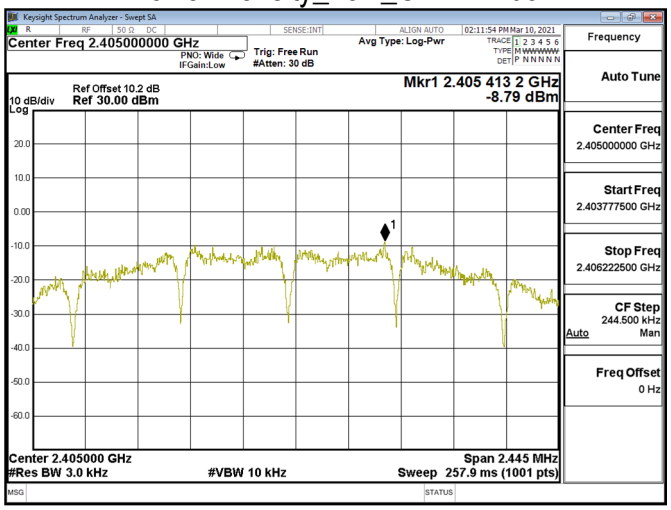
11.5 Measurement Result:

Zigbee mode

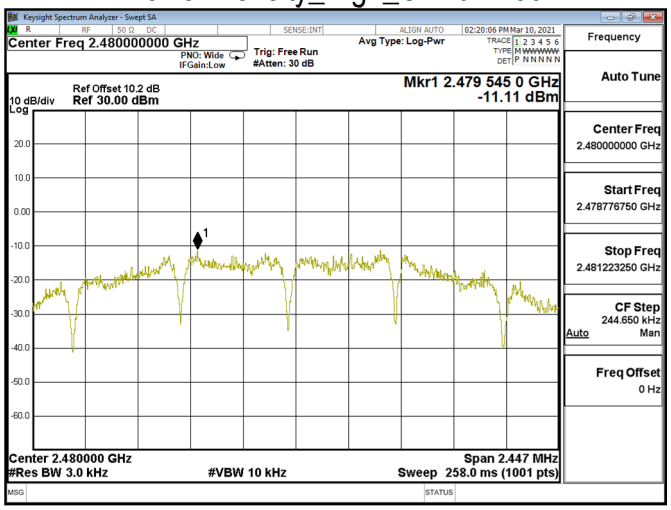
Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2405	-8.790	8	PASS
2440	-10.810	8	PASS
2480	-11.110	8	PASS

NOTE: cable loss as 10.2dB that offsets in the spectrum

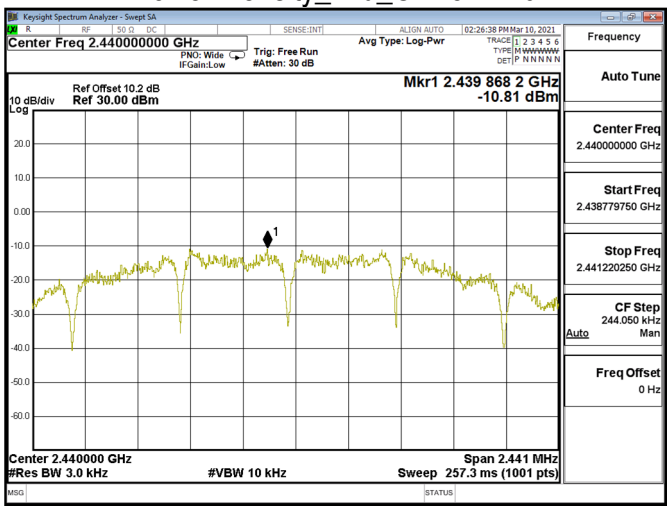
Power Density_Low_CH11-2405



Power Density_High_CH26-2480



Power Density_Mid_CH18-2440



12 ANTENNA REQUIREMENT

12.1 Standard Applicable:

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

In case of point-to-point operation, the power shall be reduced by the one dB for every 3 dB that the directional gain of antenna exceeds 6dBi.

12.2 Antenna Connected Construction:

The antenna is designed with unique RF connector and no consideration of replacement. Please see EUT photo for details.

~ End of Report ~