RESOLUCION 737 - SUBTEL

Fecha de publicación: 10/2/2026

Información Comercial

Nombre comercial del equipo

Código	Descripción
915005822401	COL Hue Go V2 JP/TW/LATAM White

Fabricante: Signify (China) Investment Co., Ltd.

Importador o representante en Chile: SIGNIFY CHILENA S.A.

Domicilio: *El Bosque Norte 0211, Las Condes - Santiago*

Correo electrónico de contacto: tomas.aragona@signify.com

Sitio Web: philips-hue.com/es-cl

Características técnicas

Tipo de equipo	Luminaria Smart
Marca	Philips
Modelo	COL Hue Go V2 JP/TW/LATAM White
Módulo	Hue Engine - 2AGBW9290019683X
Tecnología o modulación	O-QPSK PHY (Zigbee), GFSK (BT)
Frecuencias	BT: 2.400-2.483,5 ; Zigbee: 2.405-2.480 MHz.
Ganancia de antena (dBi)	3.48dBi (Zigbee y BT)
P.I.R.E. (EIRP)	12.81 dBm (Zigbee)

Declaración de conformidad

"El equipo previamente individualizado cumple con las disposiciones establecidas en la Norma Técnica de Equipos de alcance reducido, aprobada por la resolución exenta N° 1.985, de 2017, de la Subsecretaría de Telecomunicaciones."

Firma del Importador/Responsable: 

Nombre de quien firma: Tomás Aragona

Cargo: Representante Legal

Oficio Nº 3559 / 2024
Santiago, 22 de marzo de 2024

Exp. 2024005999

DO 105.711/F-25

ANT.: 1) Nota ingreso Subtel Nº 29.758 de 01.03.2024.
2) Resolución Exenta N° 1.985 de 2017 y sus modificaciones, de la Subsecretaría de Telecomunicaciones.
3) Resolución Exenta N° 3.103 de 2012, de la Subsecretaría de Telecomunicaciones.
4) Ley Nº 18.168, General de Telecomunicaciones.
5) Resolución Exenta N° 470 de 13.02.2013, que Faculta a los Jefes de División y de Departamento para firmar "Por orden del Subsecretario de Telecomunicaciones" y delega las facultades que indica.

MAT.: Certifica equipo de alcance reducido.

DE : SUBSECRETARÍA DE TELECOMUNICACIONES

A : SIGNIFY CHILENA S.A.

1. De acuerdo a la información proporcionada por documento de ANT. 1), esta Subsecretaría de Estado extiende el presente certificado para operar dentro del país, condicionado al estricto cumplimiento de lo señalado en letra j.1) del artículo 1° de la norma de ANT. 2).

- Tipo de equipo : Luminaria Smart.
- Marca : PHILIPS.
- Modelo(s) : COL Hue Go V2 JP/TW/LATAM White.
- Fabricante : Signify (China) Investment Co., Ltd.
- Frecuencias de operación : BT: 2.400-2.483,5 ; Zigbee: 2.405-2.480 MHz.
- Potencia máxima radiada : BT: 12,02 mW (10,80 dBm) ; Zigbee: 19,10 mW (12,81 dBm).

2. El incumplimiento de lo dispuesto en el presente certificado, será sancionado de acuerdo a las disposiciones legales vigentes. Estos equipos no deberán provocar interferencias a servicios de concesionarias de telecomunicaciones y no estarán protegidos respecto de interferencias que eventualmente puedan recibir.

Saluda atentamente a Ud.,
Por orden del Subsecretario de Telecomunicaciones,

DISTRIBUCIÓN:
- Signify Chilena S.A.: ivan.ruhl@intertek.com
- Oficina de Partes.

Francisco Javier Pizarro Sepulveda
Jefe División Fiscalización
22/03/2024 13:29

FIRMA ELECTRÓNICA SUBSECRETARÍA DE TELECOMUNICACIONES
SUBTEL
Ministerio de Transportes y Telecomunicaciones

VARG MAVJ LTT

China

FCC/IC- TEST REPORT

Report Number	:	**7088818001181-00**	Date of Issue:	October 31, 2018

Model	:	9290019683
Product Name	:	9290019683
Product Description	:	Hue Engine
FCC ID	:	2AGBW9290019683X
IC	:	20812-9683X
Applicant	:	Philips Lighting(China) Investment Co.,Ltd.
Address	:	Building 9, Lane 888, Tian Lin Road, Min Hang District Shangha, P.R.C.
Production Facility	:	Philips Lighting(China) Investment Co.,Ltd.
Address	:	Building 9, Lane 888, Tian Lin Road, Min Hang District Shangha, P.R.C.

Test Result	:	■ **Positive**	☐ **Negative**
Total pages including Appendices	:	38	

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1 Table of Contents

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2 Details about the Test Laboratory

Details about the Test Laboratory
Test Site 1

Company name:	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch No.16 Lane, 1951 Du Hui Road, Shanghai 201108, P.R. China
FCC Registration No.:	820234
Telephone:	+86 21 6141 0123
Fax:	+86 21 6140 8600

Test Site 2

Company name:	MRT Technology (Suzhou) Co., Ltd. D8 Building, Youxin Industrial Park, No. 2 Tina'ed Wuzhong Economic Development Zone, Suzhou, China
FCC Registration No.:	893164
IC Registration No.:	11384A-1
Telephone:	+86-512-66308358
Fax:	+86-512-66308368

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3 Description of the Equipment under Test

Description of the Equipment Under Test

Product: Hue Engine

Model no.: 9290019683

FCC ID: 2AGBW9290019683X

IC: 20812-9683X

Options and accessories: NA

Input Rated Voltage: DC 3.3V with power module 24V input
Extreme Voltage: NA

RF Transmission Frequency: 2405MHz ~ 2480MHz

No. of Operated Channel: 5

Channel list:

Operation Frequency each of channel	
Channel	**Frequency**
11	2405MHz
15	2425MHz
20	2450MHz
25	2475MHz
26	2480MHz

Radio technology: Zigbee
Modulation: 16-ary orthogonal modulation, O-QPSK PHY
Data speed: 250kbps MAX
Hardware version: HW v1.0
Software version: SW v1.0
Antenna Type: Integrated
Antenna Gain: 3.48dBi
Description of the EUT: The Equipment Under Test (EUT) is a Zigbee Module, the TX and RX frequency range is 2405MHz-2480MHz.

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4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators
RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

All the test methods were according to KDB558074 D01 DTS Measurement Guidance v04 and ANSI C63.10 (2013).

China

5 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C & RSS-210 Issue 2						
Test Condition		Pages	Test Site	Test Result		
				Pass	Fail	N/A
§15.207 RSS-Gen [8.8]	Conducted emission AC power port	---	---	☐	☐	☒
§15.247 (b) (1) RSS-247 [5.4(4)]	Conducted peak output power	11	Site 2	☒	☐	☐
§15.247(a)(1)	20dB bandwidth	---	---	☐	☐	☒
§15.247(a)(1)	Carrier frequency separation	---	---	☐	☐	☒
§15.247(a)(1)(iii)	Number of hopping frequencies	---	---	☐	☐	☒
§15.247(a)(1)(iii)	Dwell Time	---	---	☐	☐	☒
§15.247(e) RSS-247 [5.2]	Power spectral density	12	Site 2	☒	☐	☐
§15.247(a)(2) RSS-247 [5.2]	6dB bandwidth and 99% Occupied Bandwidth	14	Site 2	☒	☐	☐
§15.247(d) RSS-247 [5.5]	Spurious RF conducted emissions	16	Site 2	☒	☐	☐
§15.247(d) & §15.209 RSS-247 [5.5]	Spurious radiated emissions and Band edge for transmitter	20	Site 2	☒	☐	☐
§15.203	Antenna requirement	See note 1		☒	☐	☐

Remark 1: N/A – Not Applicable.
Note 1: §15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(c) (1)(i) requirement: (i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.
E.U.T Antenna: The Zigbee module antenna is an integrated PCB antenna, the best-case gain of the antenna is 3.48 dBi.
The antenna of the **Hue Engine**, is permanently attached.
There are no provisions for connection to an external antenna.

Conclusion: The EUT unit complies with the requirement of §15.203.

Note 2: All modes of operation were investigated. For radiated emission test, every axis (X, Y, Z) was also verified. The test results shown in the following sections represent the worst-case emissions.

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6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2AGBW9290019683X, IC: 20812-9683X complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules and RSS-247 Issue 2.

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SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

☐ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

☐ - **Does not** fulfill the general approval requirements.

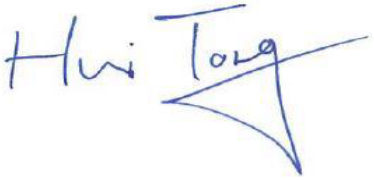
Sample Received Date: September 29, 2018

Testing Start Date: September 30, 2018

Testing End Date: October 31, 2018

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

Reviewed by: Prepared by:



Hui TONG
Review Engineer

Jiaxi XU
Project Engineer

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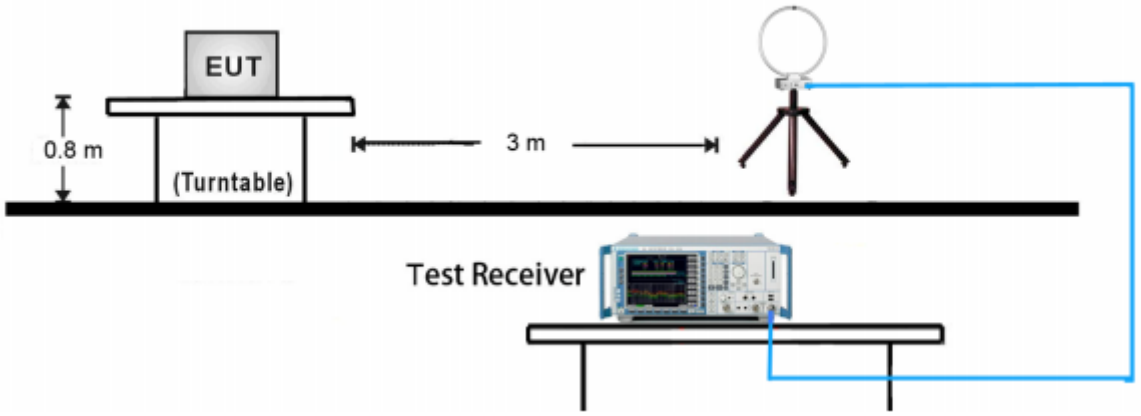
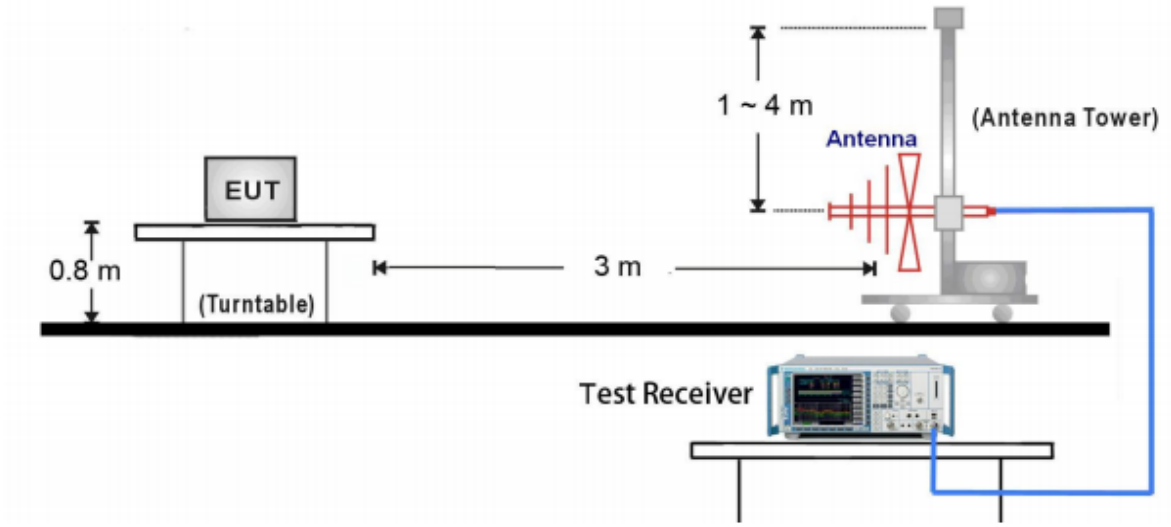
7 Test Setups

7.1 Radiated test setups

9kHz ~ 30MHz Test Setup:



30MHz ~ 1GHz Test Setup:



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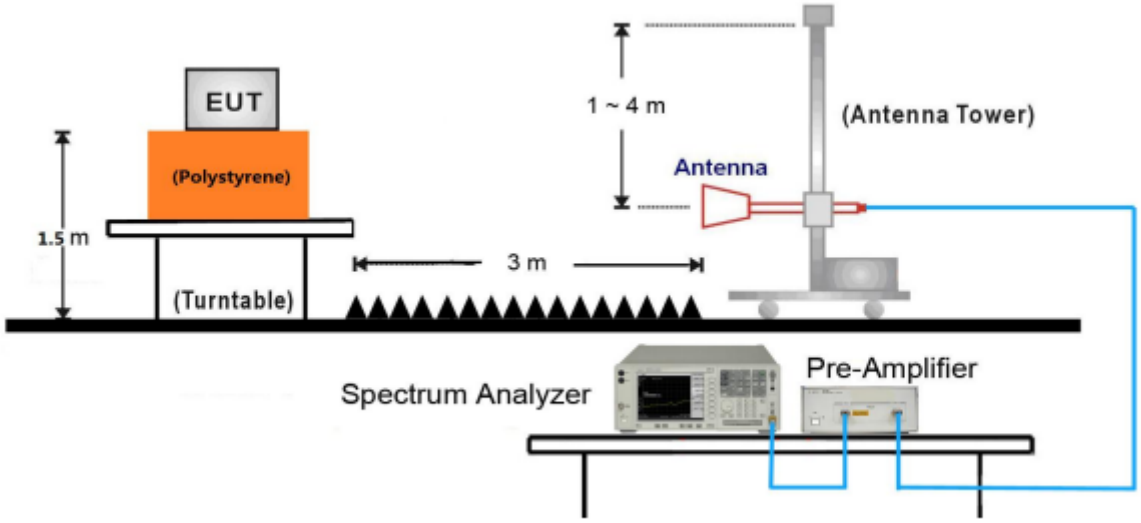
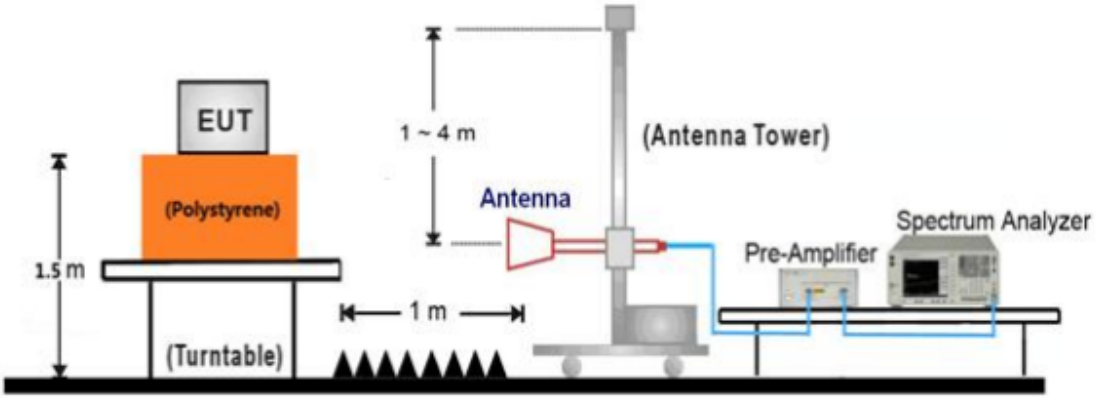
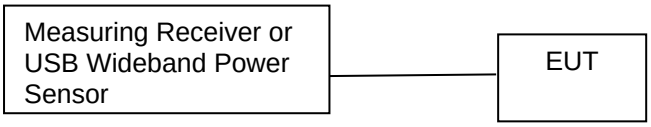
1GHz ~ 18GHz Test Setup:



18GHz ~ 25GHz Test Setup:



7.2 Conducted RF test setups



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8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)
Notebook	Lenovo	X240

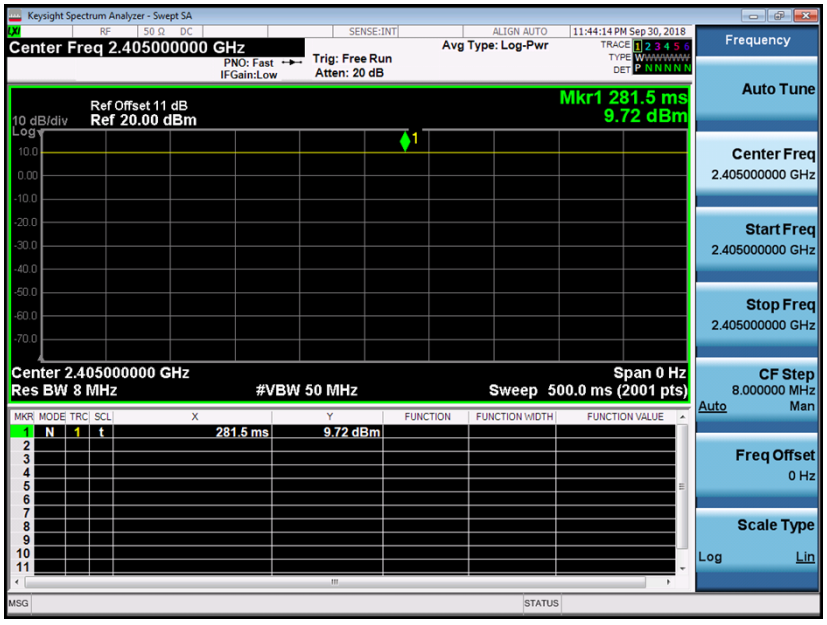
Test channel & mode:
The Hue Engine was configured using a proprietary communication interface provided by the client. The interface allows channel control required to support the evaluation.

Test software	HueApprobationTool.exe

Test mode	Channel	Frequency (MHz)
Tx	11	2405
Tx	20	2450
Tx	26	2480

Device Capabilities
This device contains the following capabilities:
ZigBee Module Device.
Note: The maximum achievable duty cycles was determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = peak per the guidance of Section 6.0 b) of KDB 558074 D01v04. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Test Mode	Duty Cycle
O-QPSK	100%



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9 Technical Requirement

9.1 Conducted peak output power

Test Method

KDB 558074 D01 v04 – Section 9.1.3 PKPM1 – Peak Power Method

9.1.3 PKPM1 Peak-reading power meter method:
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

Limits

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

Test result as below table

Model	Ch.	Freq. (MHz)	Peak Power (dBm)	Limit (dBm)
O-QPSK	11	2405	9.20	30
	18	2450	9.33	30
	26	2480	9.00	30

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9.2 6dB bandwidth and 99% Occupied Bandwidth

Test Method

1. Use the following spectrum analyzer settings:
   RBW=100K, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
3. Allow the trace to stabilize, record the 6 dB Bandwidth value.

Limit

Limit [kHz]
≥500

Test result

Test Mode	Channel No.	Freq. (MHz)	6db Bandwidth (MHz)	Limit (MHz)	Result
O-QPSK	11	2405	1.691	≥ 0.5	Pass
	20	2450	1.684	≥ 0.5	Pass
	26	2480	1.666	≥ 0.5	Pass

Test Mode	Channel No.	Freq. (MHz)	99% Bandwidth (MHz)	Limit	Result
O-QPSK	11	2405	2.2583	NA	NA
	20	2450	2.2643		
	26	2480	2.2689		

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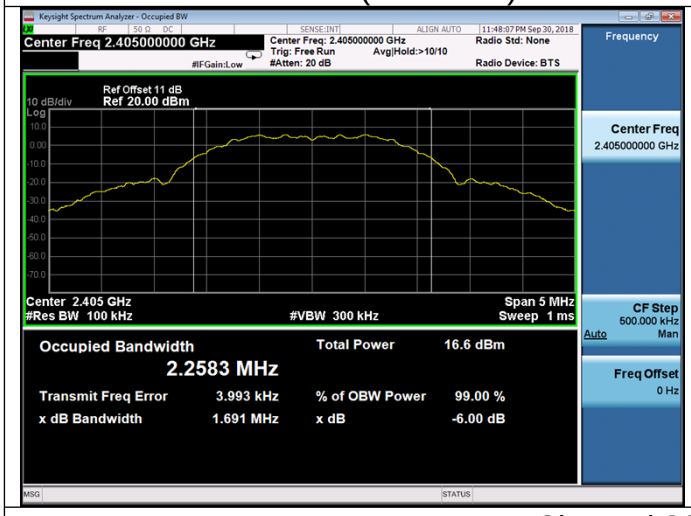
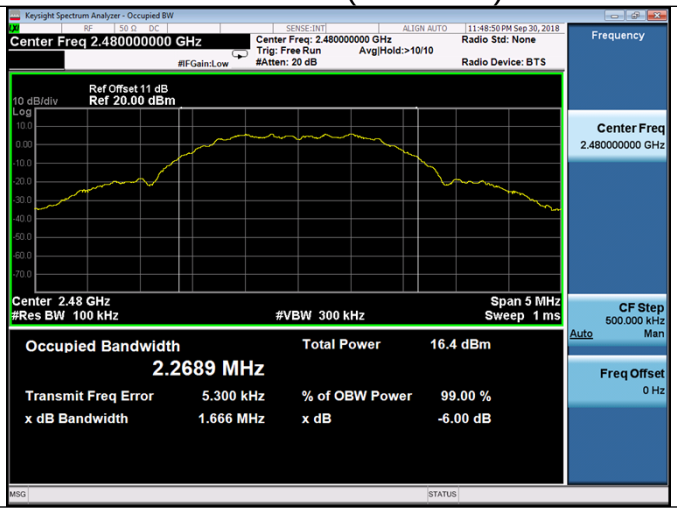
Zigbee O-QPSK 6dB Bandwidth

Channel 11 (2405MHz)



Channel 20 (2450MHz)

Channel 26 (2480MHz)



9.3 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW≥3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Limit [dBm]
≤8

Test result

Test Mode	Channel No.	Freq. (MHz)	PKPSD (dBm / 10kHz)	Limit (dBm/3kHz)	Result
O-QPSK	11	2405	-5.358	≤8	Pass
	20	2450	-5.616	≤8	Pass
	26	2480	-5.356	≤8	Pass

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Zigbee O-QPSK PKPSD	
Channel 11 (2405MHz)	Channel 20 (2450MHz)
	
Channel 26 (2480MHz)	
	

9.4 Conducted Band Edge and Out-of-Band Emissions

Test Method

1. Establish a reference level by using the following procedure:
   a. Set RBW=100 kHz. VBW≥3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
   b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
   a. Set the center frequency and span to encompass frequency range to be measured.
   b. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

Limit

Frequency Range MHz	Limit (dBc)
30-25000	-20

Test result

Test Mode	Channel No.	Freq. (MHz)	Limit	Result
O-QPSK	11	2405	20dBc	Pass
	20	2450	20dBc	Pass
	26	2480	20dBc	Pass

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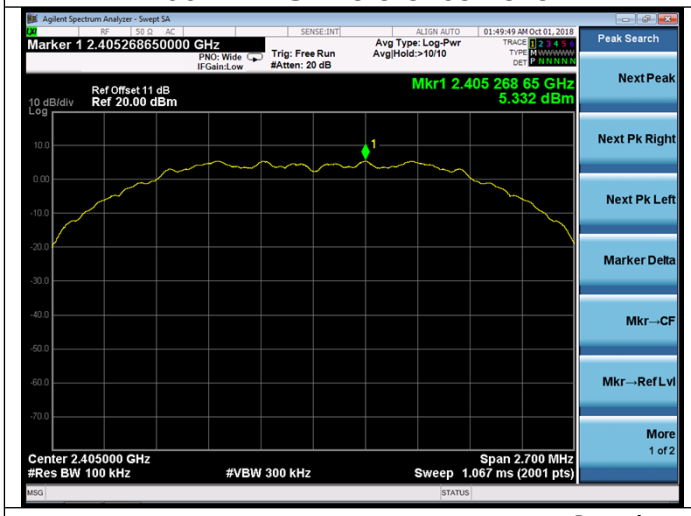
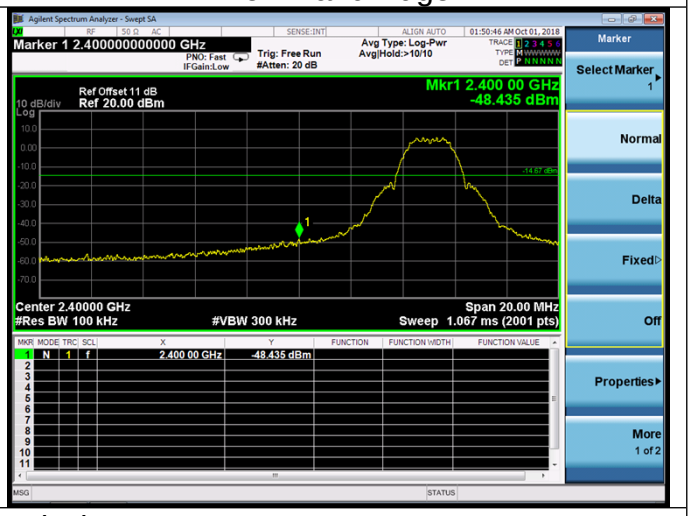
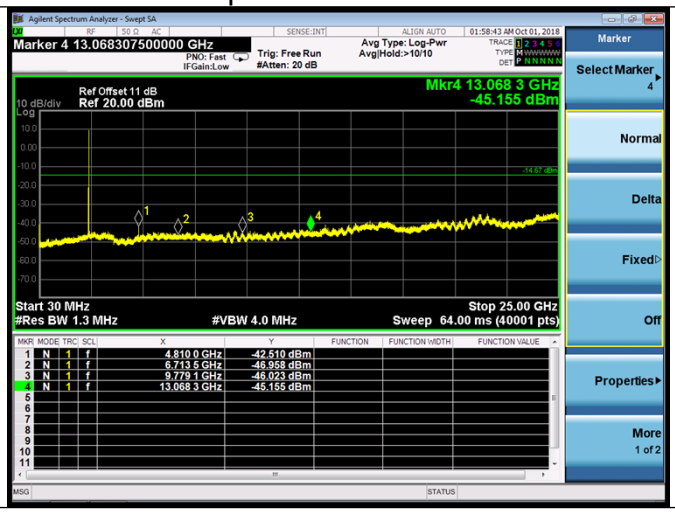
Spurious RF conducted emissions

Zigbee O-QPSK Out-of-Band Emissions	
Channel 11 (2405MHz)	
100kHz PSD reference Level	Low Band Edge
	
Spurious Emission	
	

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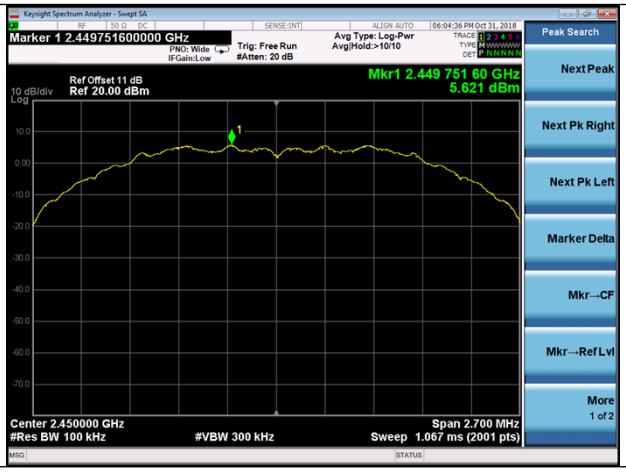
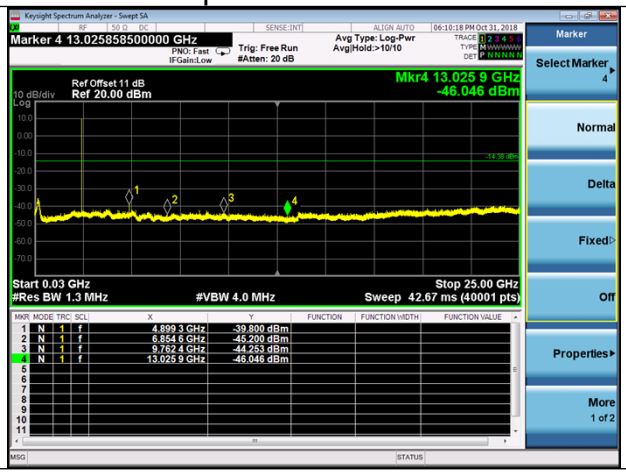
Channel 20 (2450MHz)

100kHz PSD reference Level

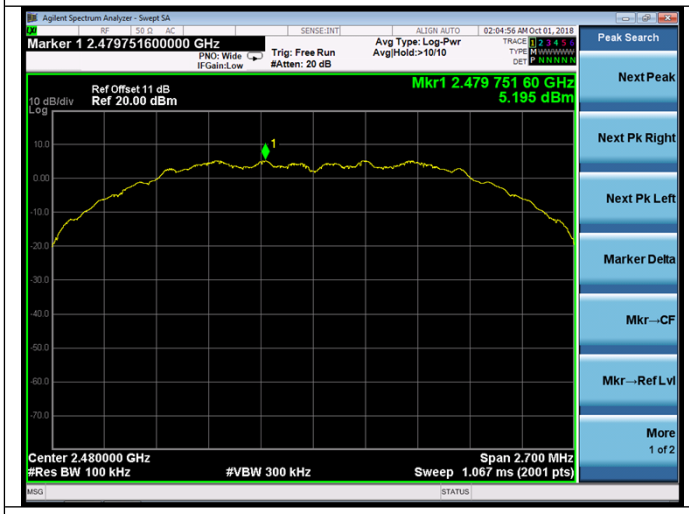


Spurious Emission

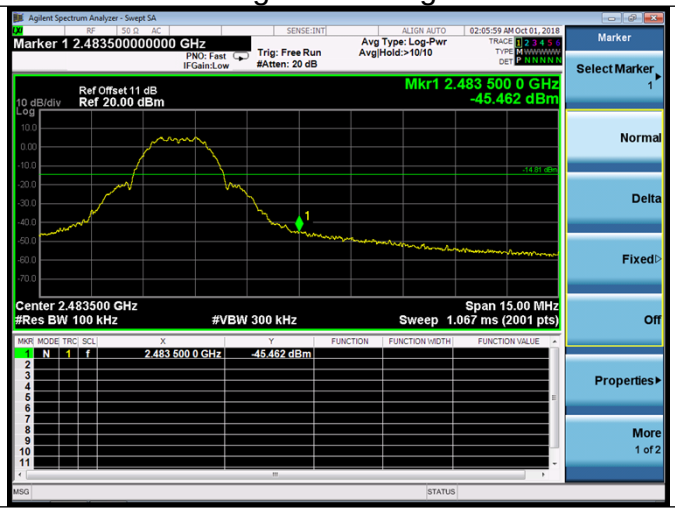


Channel 26 (2480MHz)

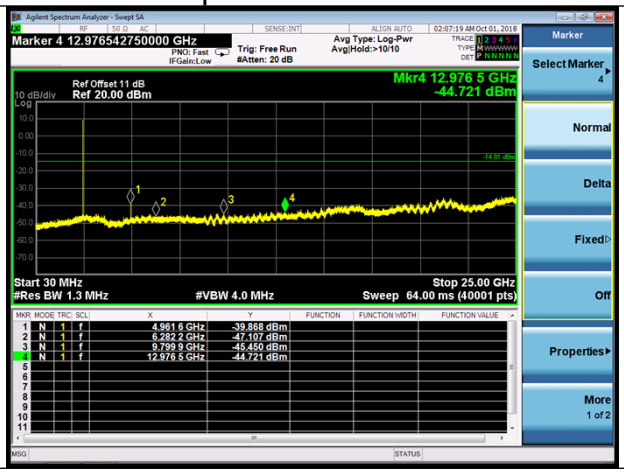
100kHz PSD reference Level



High Band Edge



Spurious Emission



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9.5 Spurious radiated emissions for transmitter

Test Method

1: The EUT was place on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3-meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

2: The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.

3: The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

4: For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

5: Use the following spectrum analyzer settings According to C63.10:

For Above 1GHz

Span = wide enough to capture the peak level of the in-band emission and all spurious

RBW = 1MHz, VBW≥RBW for peak measurement and VBW = 10Hz for average measurement, Sweep = auto, Detector function = peak, Trace = max hold.

For Below 1GHz

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious

RBW = 100 KHz, VBW≥RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

Note:

1: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 KHz for Quasi-peak detection (QP) at frequency below 1GHz.

2: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for peak detection (PK) at frequency above 1GHz.

3: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for RMS Average ((duty cycle < 98%) for Average detection (AV) at frequency above 1GHz, then the measurement results was added to a correction factor (20log(1/duty cycle)).

4: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz (duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.

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Limit

The radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section15.205, must comply with the radiated emission limits specified in section 15.209.

LIMITS OF RADIATED EMISSION MEASUREMENT (Frequency Range 9kHz-1000MHz)

Frequency MHz	Field Strength uV/m	Measured 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
960~1000	500	3

LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

Frequency MHz	Field Strength (dBuv/m) (at 3M)	
	PEAK	AVERAGE
Above 1000	74	54

Notes:

(1) The limit for radiated test was performed according to FCC PART 15C.
(2) The tighter limit applies at the band edges.
(3) Emission level (dBuV/m)=20logEmission level (uV/m).

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Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Transmitting spurious emission test result as below:
Remark 1: There are the ambient noise within frequency range 9kHz ~ 30MHz and 18GHz ~ 25GHz, the permissible value is not show in the report.
Remark 2: Average measurement was not performed if peak level lower than average limit.
Remark 3: Other frequency was 20dB below limit line with 1-18GHz, there is not show in the report.

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Test Result

Test mode: Zigbee O-QPSK							
Channel 11 (2405MHz)							
Frequency (MHz)	**Reading Level (dBuV)**	**Factor (dB)**	**Measure Level (dBuV/m)**	**Limit (dBuV/M)**	**Margin (dB)**	**Detector**	**Polarization**
4808.0	40.3	5.9	46.2	74.0	-27.8	Peak	Horizontal
8199.5	35.5	13.1	48.6	74.0	-25.4	Peak	Horizontal
8769.0	36.0	13.2	49.2	82.1	-32.9	Peak	Horizontal
10120.5	35.9	16.9	52.8	82.1	-29.3	Peak	Horizontal
7638.5	36.6	12.6	49.2	74.0	-24.8	Peak	Vertical
8352.5	35.0	12.6	47.6	74.0	-26.4	Peak	Vertical
9840.0	35.5	16.7	52.2	82.1	-29.9	Peak	Vertical
10443.5	33.6	17.2	50.8	82.1	-31.3	Peak	Vertical

Test mode: Zigbee O-QPSK							
Channel 20 (2450MHz)							
Frequency (MHz)	**Reading Level (dBuV)**	**Factor (dB)**	**Measure Level (dBuV/m)**	**Limit (dBuV/M)**	**Margin (dB)**	**Detector**	**Polarization**
4896.0	40.7	6.0	46.7	74.0	-27.3	Peak	Horizontal
7349.5	40.9	12.9	53.8	74.0	-20.2	Peak	Horizontal
9798.0	36.1	16.8	52.9	74.0	-21.1	Peak	Horizontal
4900.0	36.4	6.0	42.4	74.0	-31.6	Peak	Vertical
7350.5	37.5	12.6	50.1	74.0	-23.9	Peak	Vertical
9801.0	35.2	16.8	52.0	74.0	-22.0	Peak	Vertical

Test mode: Zigbee O-QPSK							
Channel 26 (2480MHz)							
Frequency (MHz)	**Reading Level (dBuV)**	**Factor (dB)**	**Measure Level (dBuV/m)**	**Limit (dBuV/M)**	**Margin (dB)**	**Detector**	**Polarization**
4961.0	40.2	6.1	46.3	74.0	-27.7	Peak	Horizontal
7511.0	36.3	12.7	49.0	74.0	-25.0	Peak	Horizontal
8786.0	37.0	13.3	50.3	81.8	-31.5	Peak	Horizontal
10018.5	35.9	16.6	52.5	81.8	-29.3	Peak	Horizontal
7511.0	36.2	12.7	48.9	74.0	-25.1	Peak	Vertical
8284.5	36.6	12.7	49.3	74.0	-24.7	Peak	Vertical
9704.0	34.9	15.5	50.4	81.8	-31.4	Peak	Vertical
10078.0	33.9	17.0	50.9	81.8	-30.9	Peak	Vertical

Remark:

(1) Emission level= Original Receiver Reading + Correct Factor
(2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
(3) Margin = limit – Corrected Reading

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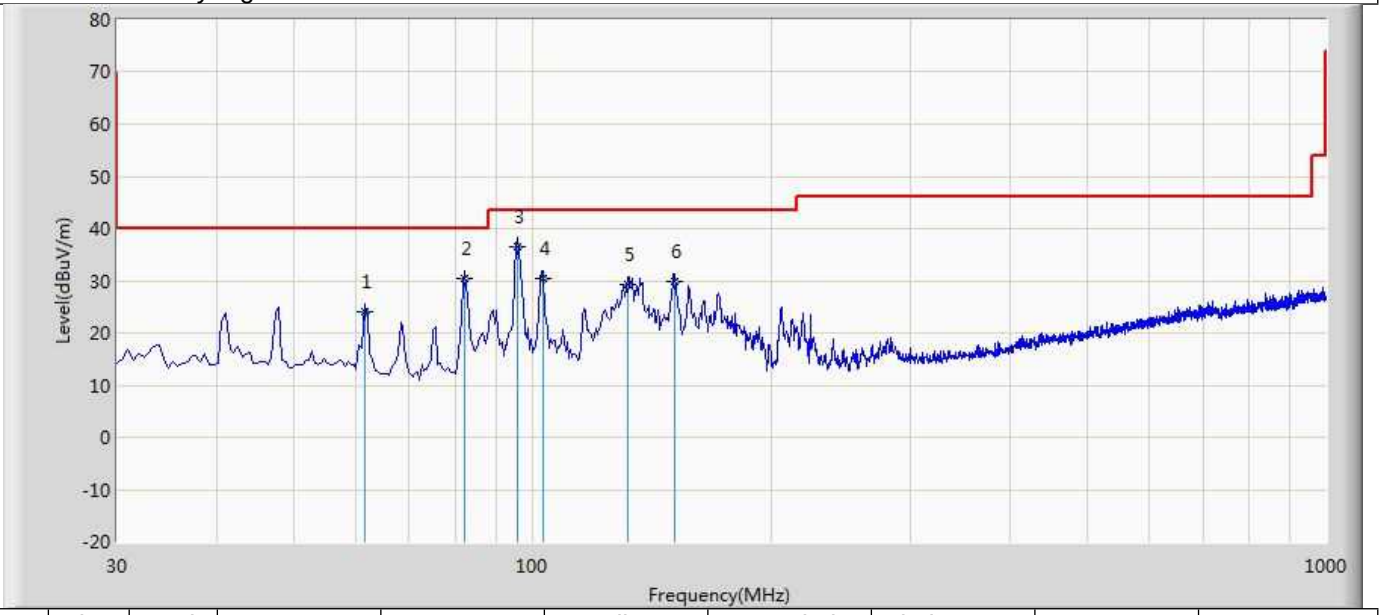
The worst case of Radiated Emission below 1GHz:

Site: AC1	Time: 2018/09/30 - 20:54
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: VULB 9168 _20-2000MHz	Polarity: Horizontal
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2405MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			61.525	24.130	10.957	-15.870	40.000	13.173	QP
2			82.380	30.312	20.154	-9.688	40.000	10.158	QP
3		*	95.960	36.488	25.726	-7.012	43.500	10.762	QP
4			103.235	30.450	19.053	-13.050	43.500	11.397	QP
5			131.850	29.410	15.437	-14.090	43.500	13.973	QP
6			151.250	29.811	14.526	-13.689	43.500	15.285	QP

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)
Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

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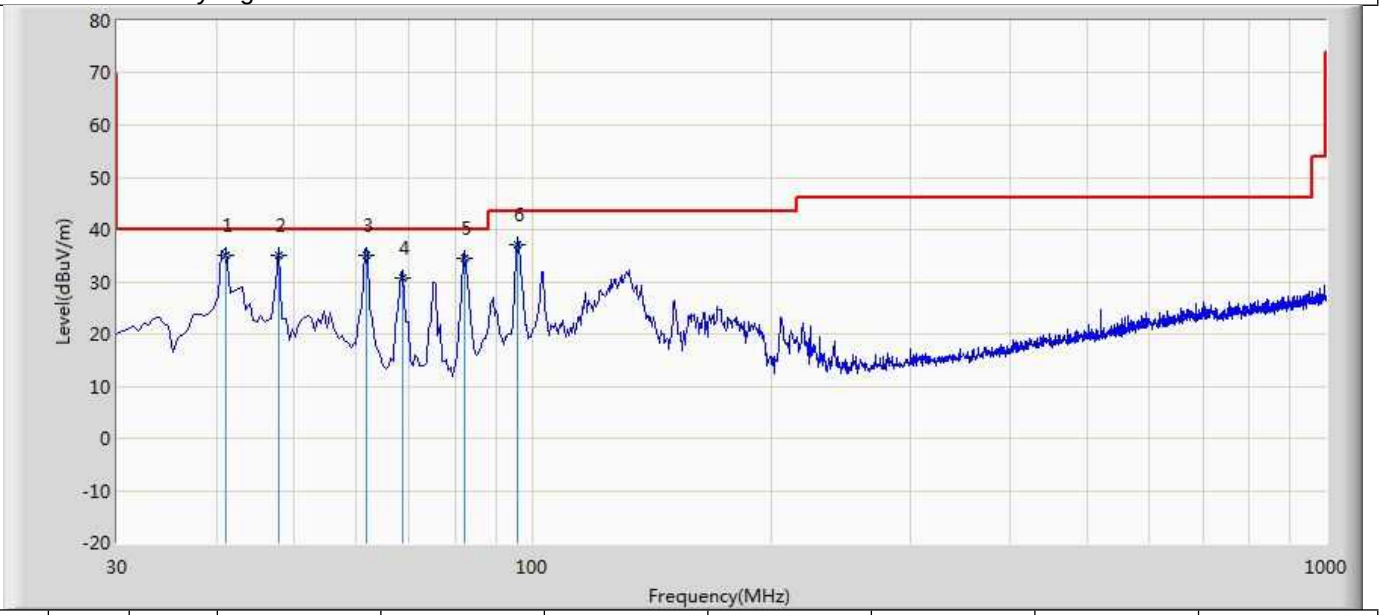
Site: AC1	Time: 2018/09/30 - 20:56
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: VULB 9168 _20-2000MHz	Polarity: Vertical
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2405MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	41.155	35.115	20.563	-4.885	40.000	14.552	QP
2			47.945	34.985	20.759	-5.015	40.000	14.226	QP
3			61.965	34.992	21.900	-5.008	40.000	13.092	QP
4			68.800	30.749	18.937	-9.251	40.000	11.812	QP
5			82.380	34.442	24.284	-5.558	40.000	10.158	QP
6			95.960	37.066	26.304	-6.434	43.500	10.762	QP

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)
Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

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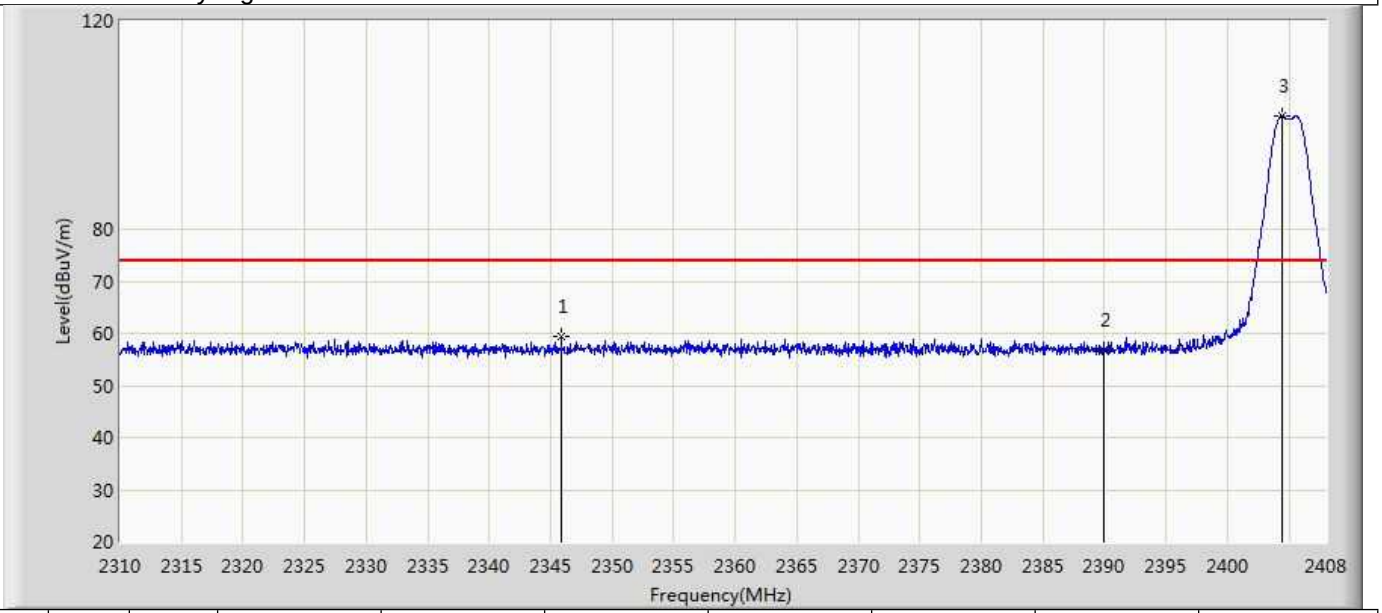
Radiated Restricted Band Edge Measurement
Test Result:

Site: AC1	Time: 2018/09/30 - 18:42
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Horizontal
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2405MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			2345.868	59.331	26.919	-14.669	74.000	32.412	PK
2			2390.000	56.731	24.404	-17.269	74.000	32.327	PK
3		*	2404.423	101.657	69.358	N/A	N/A	32.300	PK

Note: Measure Level (dBµV/m) = Reading Level (dBµV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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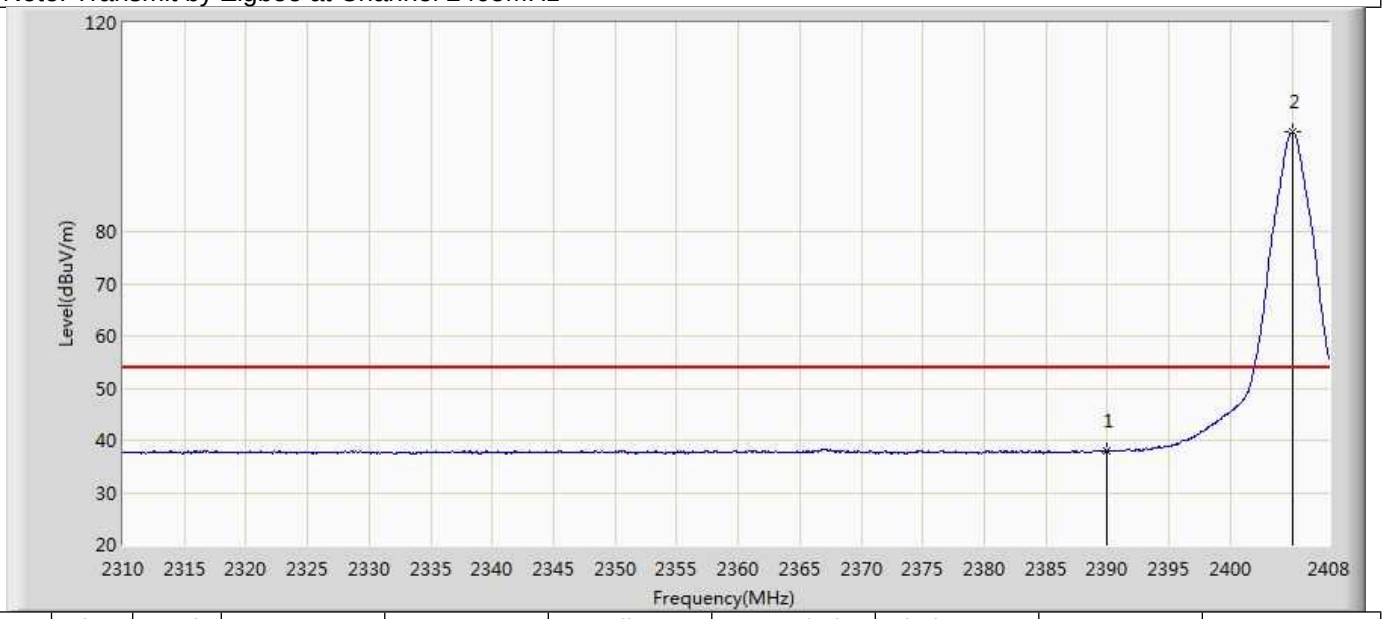
Site: AC1	Time: 2018/09/30 - 18:56
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Horizontal
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2405MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			2390.000	38.037	5.710	-15.963	54.000	32.327	AV
2		*	2405.060	99.025	66.727	N/A	N/A	32.298	AV

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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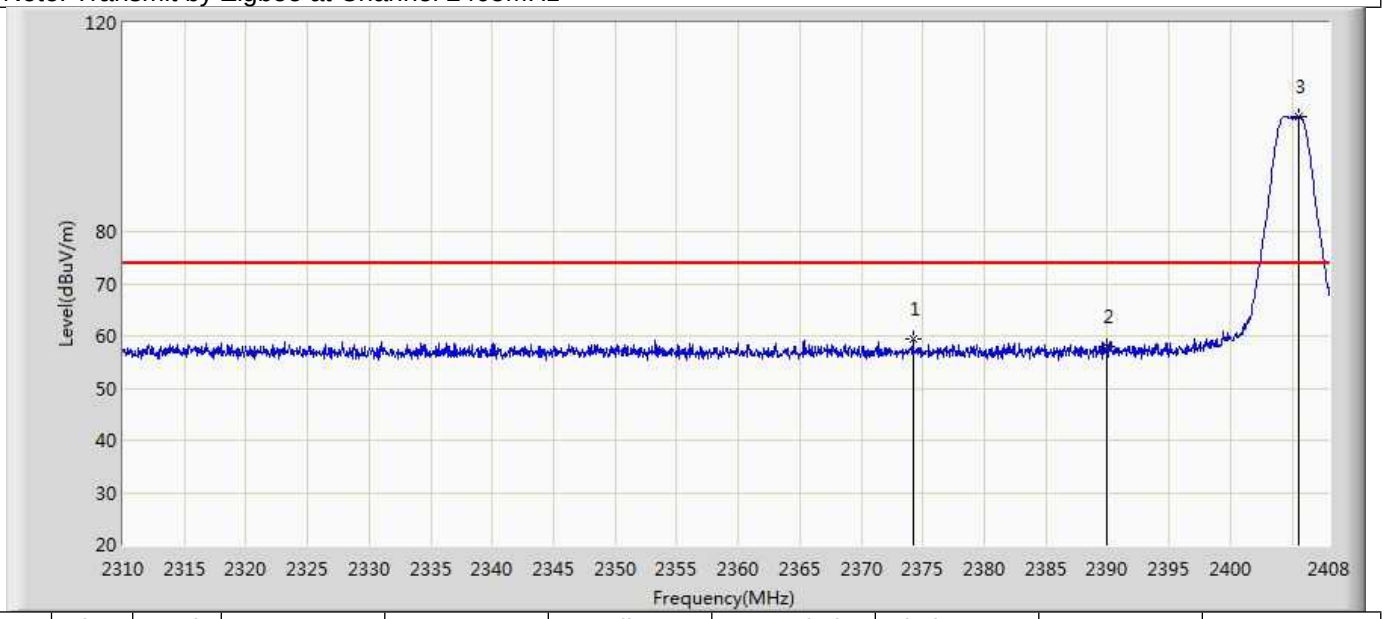
China

Site: AC1	Time: 2018/09/30 - 18:59
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Vertical
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2405MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			2374.190	59.420	27.070	-14.580	74.000	32.350	PK
2			2390.000	57.873	25.546	-16.127	74.000	32.327	PK
3		*	2405.599	102.131	69.834	N/A	N/A	32.297	PK

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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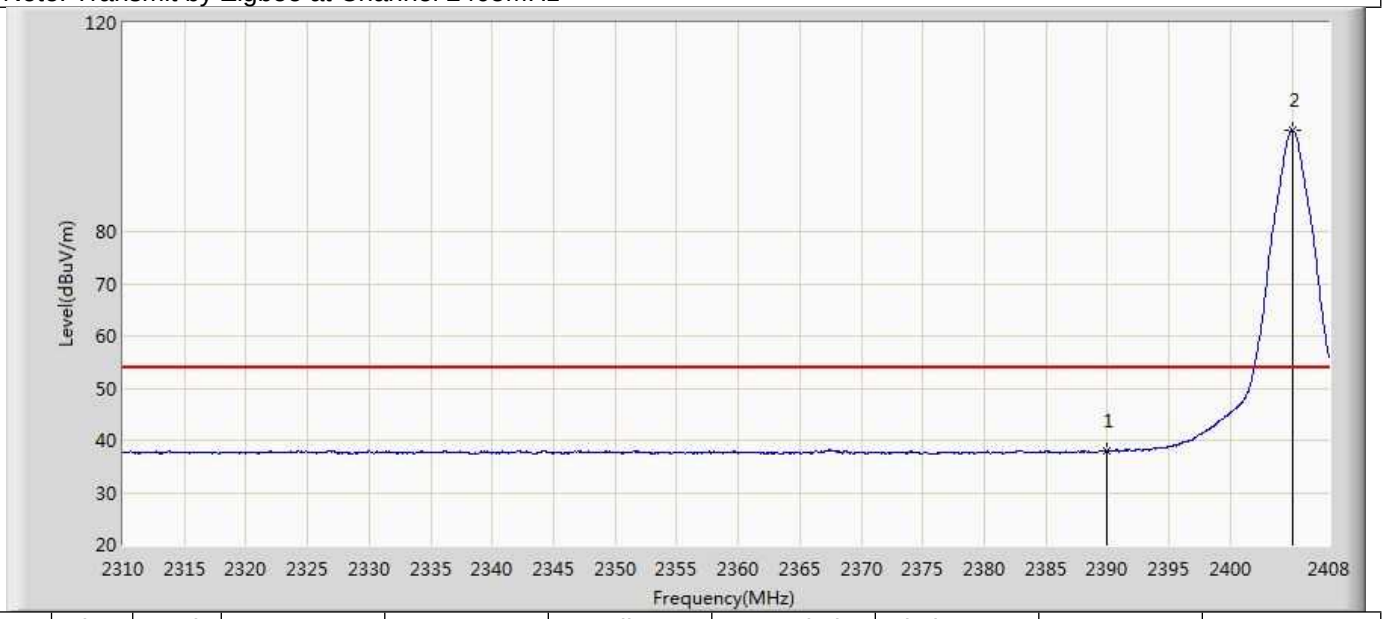
China

Site: AC1	Time: 2018/09/30 - 19:01
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Vertical
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2405MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1			2390.000	37.960	5.633	-16.040	54.000	32.327	AV
2		*	2405.060	99.327	67.029	N/A	N/A	32.298	AV

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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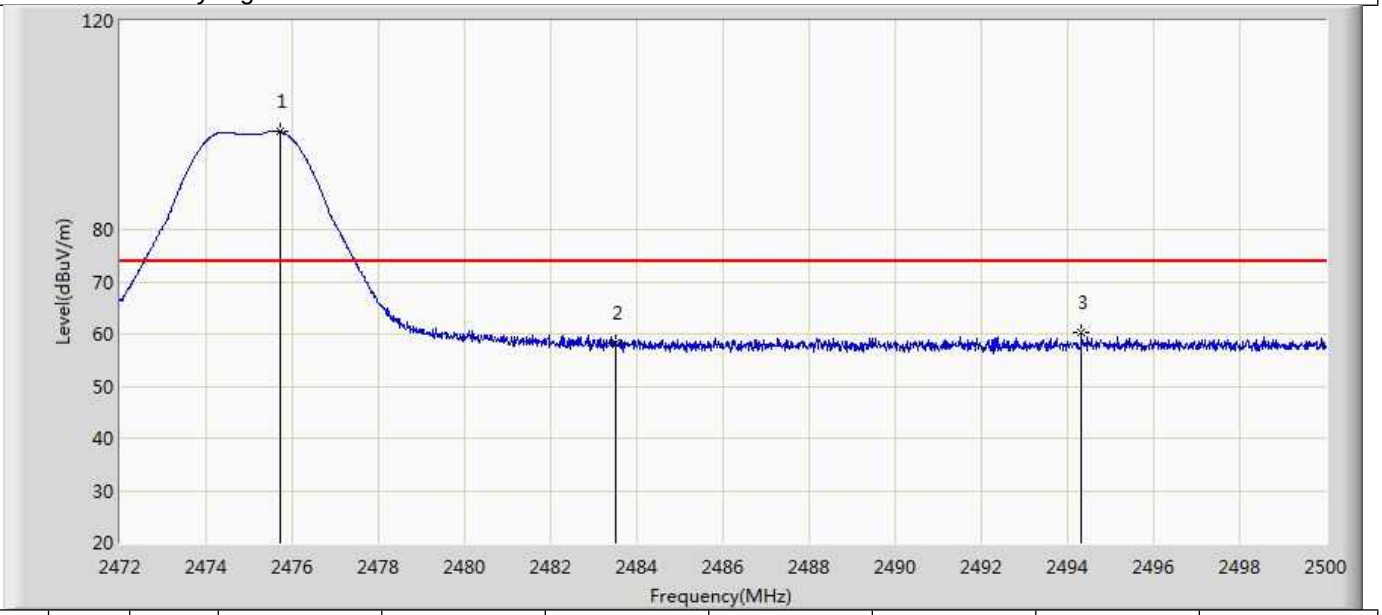
China

Site: AC1	Time: 2018/09/30 - 19:02
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Horizontal
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2475MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2475.724	98.824	66.511	N/A	N/A	32.314	PK
2			2483.500	58.162	25.823	-15.838	74.000	32.340	PK
3			2494.330	60.434	28.052	-13.566	74.000	32.381	PK

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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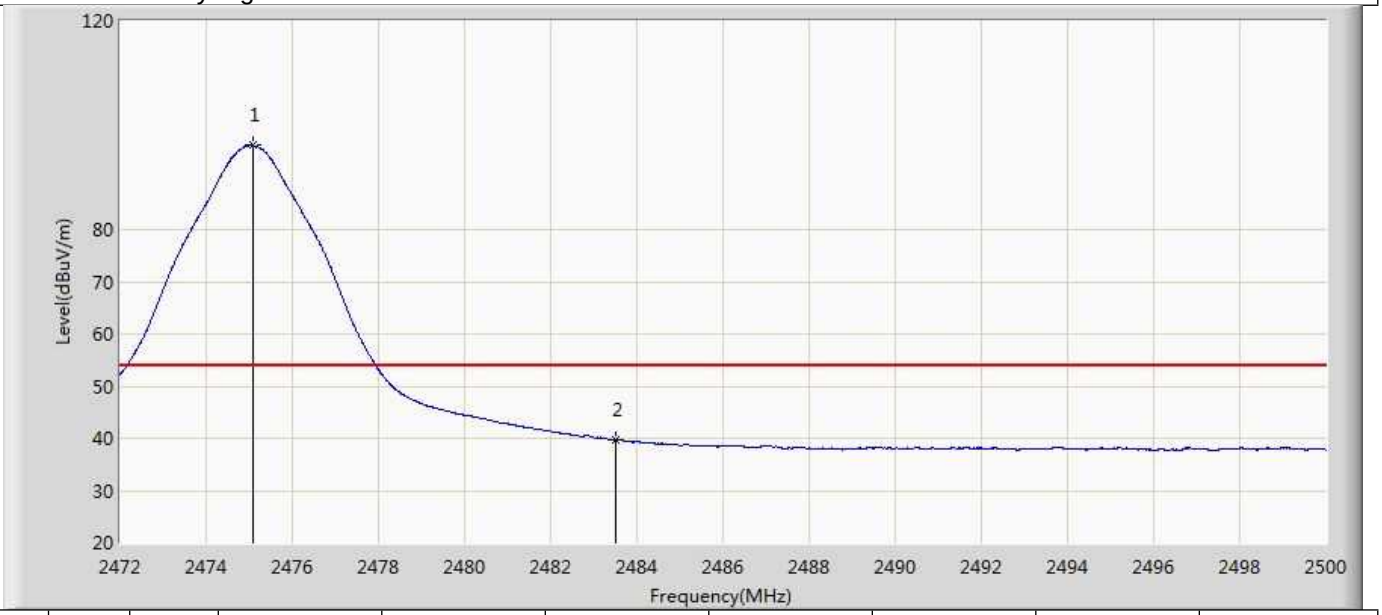
China

Site: AC1	Time: 2018/09/30 - 19:08
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Horizontal
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2475MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2475.080	96.090	63.778	N/A	N/A	32.311	AV
2			2483.500	39.638	7.299	-14.362	54.000	32.340	AV

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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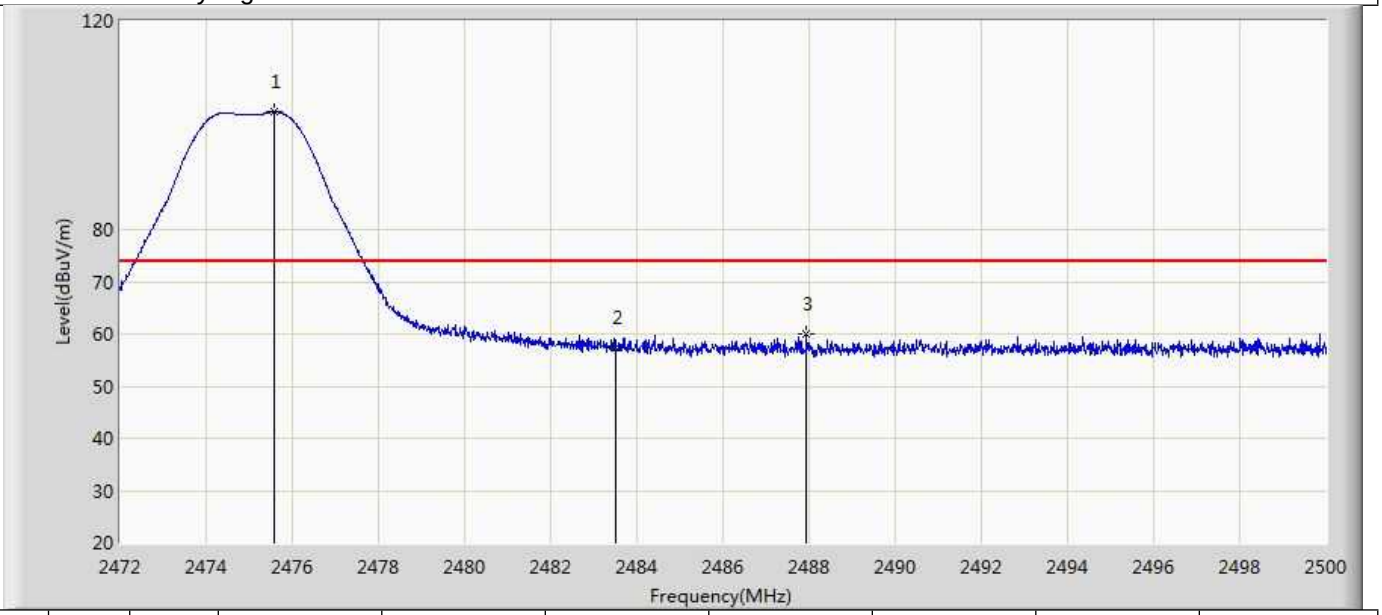
Site: AC1	Time: 2018/09/30 - 19:09
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Vertical
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2475MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2475.584	102.483	70.170	N/A	N/A	32.313	PK
2			2483.500	57.263	24.924	-16.737	74.000	32.340	PK
3			2487.946	59.928	27.571	-14.072	74.000	32.357	PK

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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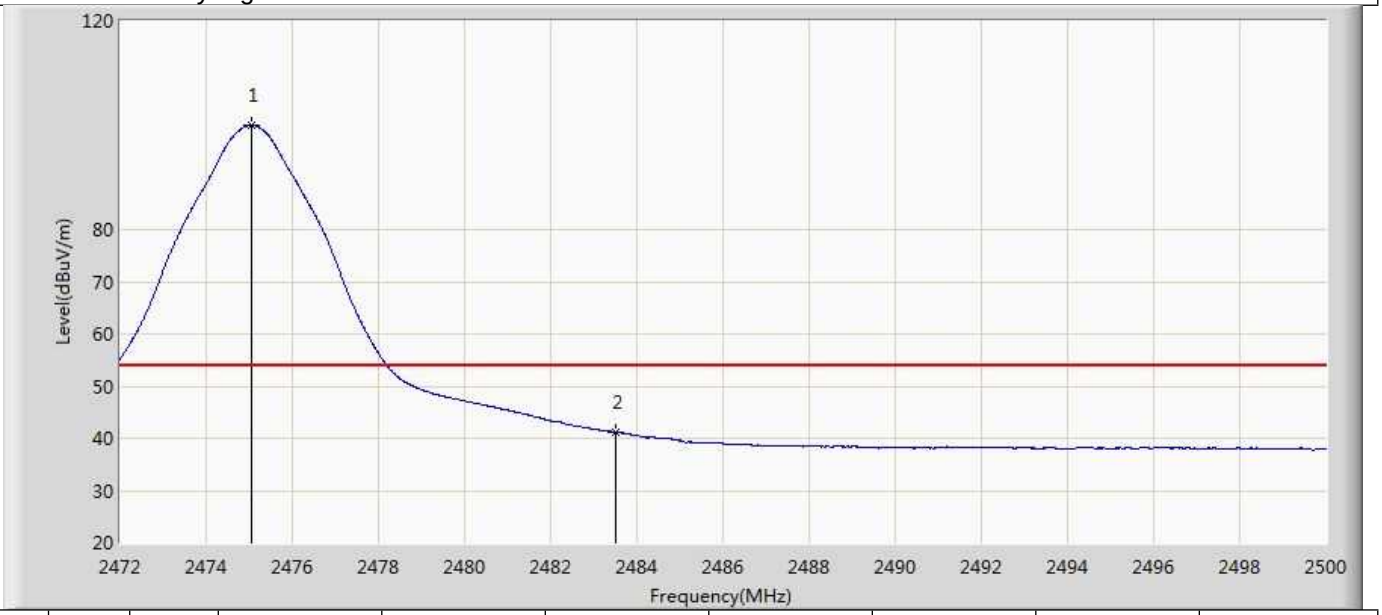
Site: AC1	Time: 2018/09/30 - 19:10
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Vertical
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2475MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2475.052	99.954	67.642	N/A	N/A	32.311	AV
2			2483.500	41.223	8.884	-12.777	54.000	32.340	AV

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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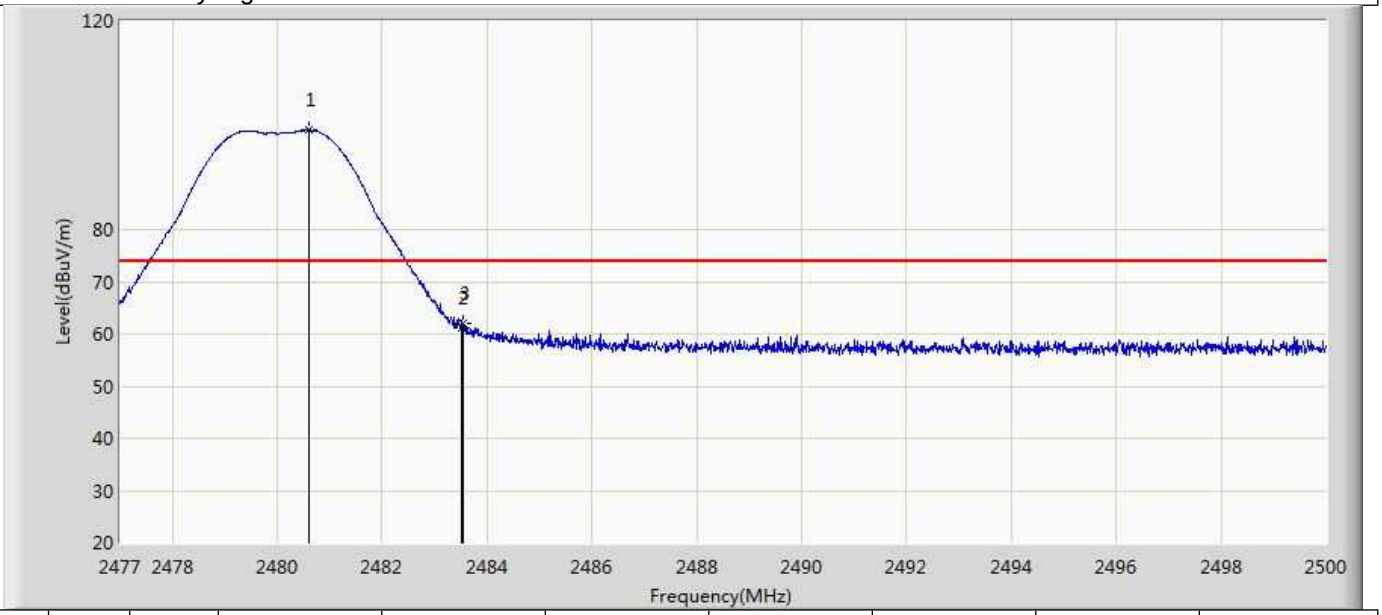
Site: AC1	Time: 2018/09/30 - 19:12
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Horizontal
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2480MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2480.611	99.009	66.681	N/A	N/A	32.327	PK
2			2483.500	61.102	28.763	-12.898	74.000	32.340	PK
3			2483.555	61.943	29.604	-12.057	74.000	32.340	PK

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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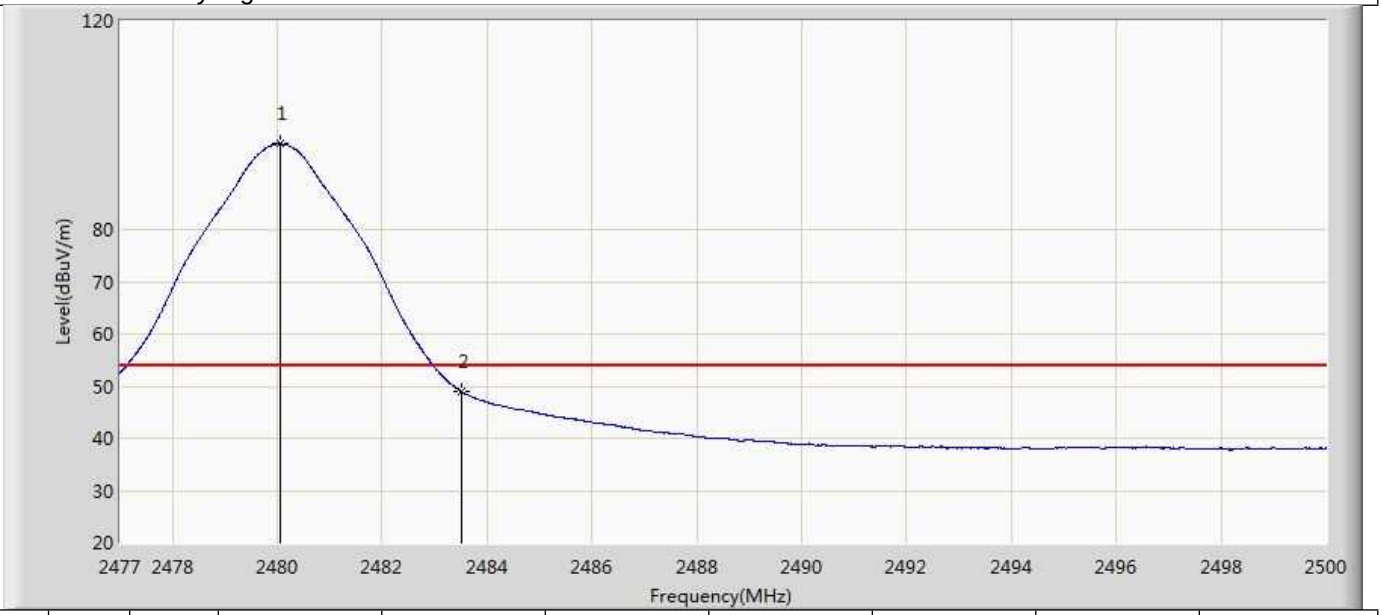
Site: AC1	Time: 2018/09/30 - 19:15
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Horizontal
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2480MHz	

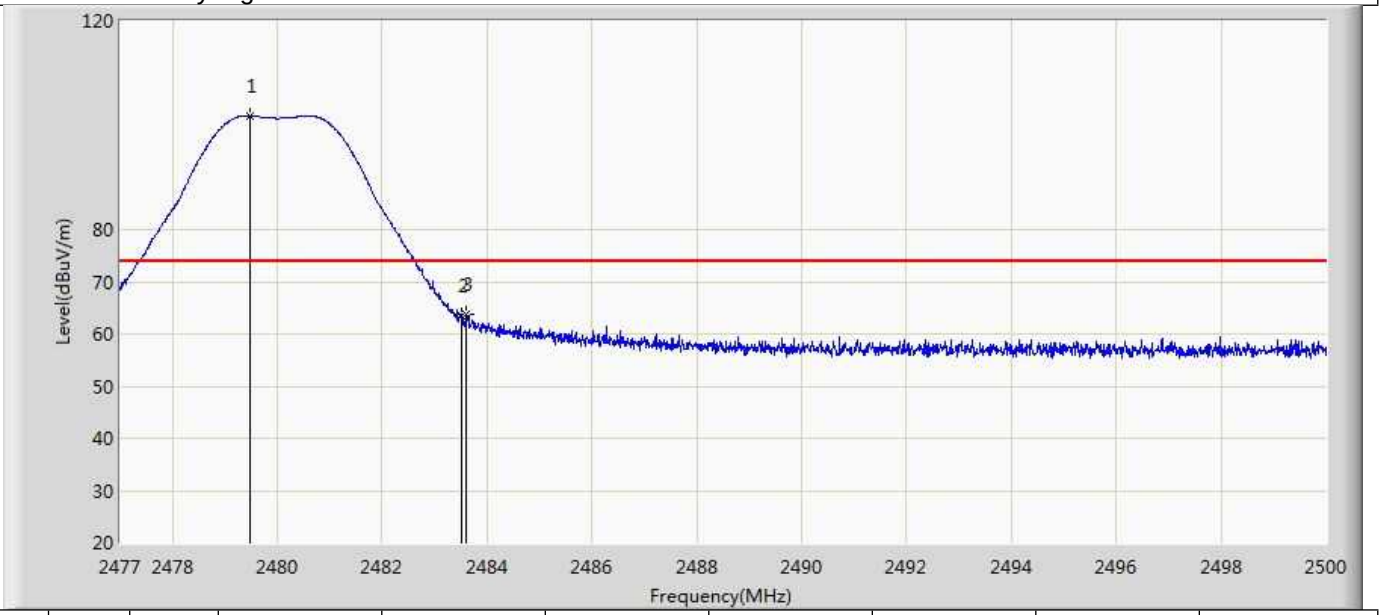


No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2480.059	96.412	64.086	N/A	N/A	32.325	AV
2			2483.500	49.019	16.680	-4.981	54.000	32.340	AV

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Site: AC1	Time: 2018/09/30 - 19:16
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Vertical
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2480MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2479.472	101.827	69.504	N/A	N/A	32.323	PK
2			2483.500	63.409	31.070	-10.591	74.000	32.340	PK
3			2483.601	63.631	31.291	-10.369	74.000	32.340	PK

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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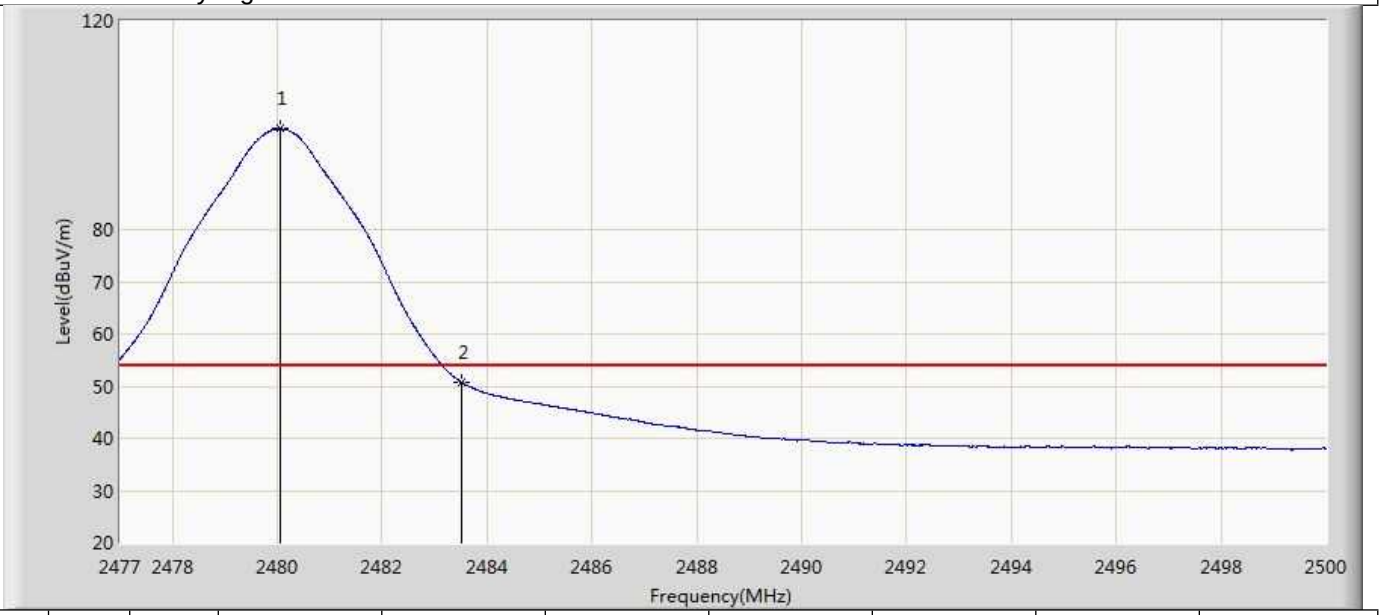
Site: AC1	Time: 2018/09/30 - 19:17
Limit: FCC_Part15.209_RE(3m)	Engineer: Jone Zhang
Probe: BBHA9120D_1-18GHz	Polarity: Vertical
EUT: Hue Engine	Power: DC 24V
Note: Transmit by Zigbee at Channel 2480MHz	



No	Flag	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Factor (dB)	Type
1		*	2480.048	99.305	66.979	N/A	N/A	32.325	AV
2			2483.500	50.803	18.464	-3.197	54.000	32.340	AV

Note: Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

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10 Test Equipment List

List of Test Instruments

Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
C	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2019-8-6
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2019-8-6
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9163	848	2021-6-10
	Horn Antenna	Rohde & Schwarz	HF907	102393	2021-4-1
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2019-8-6
	3m Semi-anechoic chamber	TDK	9X6X6	----	2021-5-10
CE	EMI Test Receiver	Rohde & Schwarz	ESR 3	101907	2019-8-6
	LISN	Rohde & Schwarz	ENV4200	100224	2019-8-6
	LISN	Rohde & Schwarz	ENV216	101924	2019-8-6

Test Site2

Radiated Emissions – AC1

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Broadband TRILOG Antenna	SCHWARZBECK	VULB 9162	MRTTWA00001	1 year	2019/5/22
EMI Test Receiver	R&S	ESR3	MRTTWA00009	1 year	2019/3/19
Acitve Loop Antenna	Schwarzbeck	FMZB 1519B	MRTTWA00002	1 year	2019/4/24
Broadband Horn antenna	SCHWARZBECK	BBHA 9120D	MRTTWA00003	1 year	2019/4/24
Breitband Hornantenna	Schwarzbeck	BBHA 9170	MRTTWA00004	1 year	2019/4/23
Broadband Amplifier	Schwarzbeck	BBV 9721	MRTTWA00006	1 year	2019/4/23
Broadband Preamplifier	SCHWARZBECK	BBV 9718	MRTTWA00005	1 year	2019/4/23
Cable	HUBERSUHNER	SF106	MRTTWA00010	1 year	2019/5/18
Cable	Rosnol	K1K50-UP0264-K1K50-4M	MRTTWA00012	1 year	2019/7/30

Conducted Test Equipment – SR2

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Spectrum Analyzer	KEYSIGHT	N9010A	MRTTWA00012	1 year	2019/7/30
USB Wideband Power Sensor	KEYSIGHT	U2021XA	MRTTWA00015	1 year	2019/3/20

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density*
- Spurious RF conducted emissions
- Conducted Band edge

China

11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

Test Site1

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, ±2.73dB
Radiated Disturbance	30MHz to 1GHz, ±5.03dB (Horizontal) ±5.11dB (Vertical) 1GHz to 18GHz, ±5.15dB (Horizontal) ±5.12dB (Vertical) 18GHz to 25GHz, ±4.76dB

Test Site2

AC Conducted Emission Measurement - SR2

Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)):

150kHz~30MHz: 3.46dB

Radiated Emission Measurement – AC1

Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)):

9kHz ~ 1GHz: 4.18dB

1GHz ~ 25GHz: 4.76dB

THE END

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Report on the Radio Testing of:

HUE ENGINE

Model(s): 9290019683

In accordance with
47 CFR FCC Part 15C

PSB Singapore

Add value.
Inspire trust.

Prepared for:
Signify (China) Investment Co., Ltd.
Building 9, Lane 888, Tianlin Road, Minhang District Shanghai, China

COMMERCIAL-IN-CONFIDENCE

Document Number: 7191214765-EEC19/03 | Issue: 01
FCC ID: 2AGBW9290019683X

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Foo Kai Maun	16 Jul 2019	
Authorised Signatory	Quek Keng Huat	16 Jul 2019	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD PSB document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with the mentioned standard(s).

TÜV SÜD PSB

ilac-MRA

Accredited Laboratory SAC-SINGLAS

LA-2007-0380-A	LA-2007-0385-E
LA-2007-0381-F	LA-2007-0386-C
LA-2007-0382-B	LA-2010-0464-D
LA-2007-0383-G	LA-2018-0702-B
LA-2007-0384-G	LA-2018-0703-G

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council. Inspections/Calibrations/Tests marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our inspection body/laboratory.

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Contents

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	16 Jul 2019

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1.2 Introduction

Applicant	:	Signify (China) Investment Co., Ltd. Building 9, Lane 888, Tianlin Road, Minhang District Shanghai, China
Manufacturer	:	Same as applicant
Factory	:	Same as applicant
Model Number(s)	:	9290019683
Serial Number(s)	:	Conducted: EB2572 Radiated: A14E18
Number of Samples Tested	:	1
Test Sample(s) Condition	:	Good
Quotation Reference	:	5219630
Test Specification/Issue/Date	:	FCC 47 CFR Part 15C
Test Sample(s) Received Date	:	2 Jul 2019
Start of Test	:	10 Jul 2019
Finish of Test	:	12 Jul 2019

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1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with specifications as shown below.

Specification Clause	Test Description	Result	Comments/Base Standard
47 CFR FCC Part 15			
15.107(a), 15.207	Conducted Emissions	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2018
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(a)(2)	Spectrum Bandwidth (6dB Bandwidth Measurement)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(b)(3)	Maximum Peak Power	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	RF Conducted Spurious Emissions (Non-Restricted Bands)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	RF Conducted Spurious Emissions (Restricted Bands)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	Band Edge Compliance (Conducted)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	Band Edge Compliance (Radiated)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(e)	Peak Power Spectral Density	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.35(c)	Duty Cycle Factor Computation	Not Applicable *See Note 4	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
2.1091	Maximum Permissible Exposure	*See Note 5	

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Notes

1. All the measurements in section 15.247 were done based on conducted measurements except Band Edge Compliance (Radiated) test.

2. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.

3. The maximum measured RF power of the Equipment Under Test is 7.32dBm.

4. The EUT was operated in continuous transmission, i.e. 100% duty cycle.

5. Specific Absorption Rate (SAR) exemption for this product was carried out. Please refer to Signify (China) Investment Co., Ltd. for more details.

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1.4 Product Information

1.4.1 Technical Description

Description	:	The Equipment Under Test(s) (EUT(s)) is a **HUE ENGINE.**
Microprocessor	:	Silicon Labs EFR32™
Operating Frequency	:	Bluetooth: 2.402GHz – 2.480GHz
Clock / Oscillator Frequency	:	40MHz
Modulation	:	Bluetooth: Gaussian Frequency Shift Keying (GFSK)
Antenna Gain	:	3.48 dBi
Port / Connectors	:	Nil
Rated Power	:	24Vdc
Accessories	:	Nil

1.4.2 Test Configuration and Modes of Operation

Mode(s)	**Description**
Maximum RF power transmission	The EUT was tested using fully charged batteries with DC voltage of 24V. The EUT was exercised in the mode, transmitting at lower, middle and upper channels as shown below one at a time with all supported modulation schemes were evaluated. For Band Edge Compliance, only lower and upper channels were evaluated.

Transmit Channel	Frequency (GHz)
Channel 0 (Lower Channel)	2.402
Channel 19 (Middle Channel)	2.440
Channel 39 (Upper Channel)	2.480

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1.5 Deviations from the Standard

Nil.

1.6 EUT Modification Record

No modifications were made.

1.7 Test Location(s)

TÜV SÜD PSB Pte Ltd
Electrical & Electronics Centre (EEC), Product Services,
No. 1 Science Park Drive, Singapore 118221

1.8 Test Facilities Registrations

Requirements	Registration Numbers
FCC	994109 (Test Firm Registration Number) SG0002 (Designation Number)
ISED	SGAP01 (CAB Identifier) Science Park 2932I-1 (3m and 10m Semi-Anechoic Chamber) International Business Park 2932N-1 (10m Semi-Anechoic Chamber)
VCCI	Science Park R-1335 (10m ANC) C-2306 (C.E @ Lab 3) T-1471 (Telecom Ports @ Lab 3) International Business Park R-3324 (10m ANC), G-203 (10mANC) C-4933 (C.E @ CEIBP) T-2403 (Telecom Ports @ CEIBP)
BSMI	SL2-IS-E-6001R *[CNS-13803 (ISM Equipment)]* SL2-IN-E-6001R *[CNS-13438 (IT Equipment)]* SL2-R1/R2-E-6001R *[CNS-13439 (Broadcast Receivers)]* SL2-A1-E-6001R *[CNS-13783-1 (Household Appliances)]* SL2-L1-E-6001R *[CNS-14115 (Lighting Equipment)]*
SABS	SABS/A-LAB/0029/2018

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1.9 Supporting Equipment

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Lenovo R400 Laptop	M/N: 7440-C97 S/N: L3-ALB2G 09/05 FCC ID: DoC	Nil
Lenovo AC Adapter	M/N: 42T4432 S/N: 11S42T4432Z1ZF3J0170HL FCC ID: DoC	1.80m unshielded power cable
Aztech AC Adapter	M/N: LDC50H S/N: Nil FCC ID: DoC	1.00m unshielded power cable

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2 Test Details

2.1 Conducted Emissions

2.1.1 Test Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (Q-P)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

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2.1.2 Test Setup

2.1.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.1.2.2 The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.

2.1.2.3 The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.

2.1.2.4 All other supporting equipment were powered separately from another LISN.

2.1.3 Test Method

2.1.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.1.3.2 A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.

2.1.3.3 High peaks, relative to the limit line, were then selected.

2.1.3.4 The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.

2.1.3.5 The measurements were then repeated for the LIVE line .

Sample Calculation Example

At 20 MHz Q-P limit = 60.0 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)
Therefore, Q-P margin = 60.0 - 40.0 = 20.0 i.e. 20.0 dB below Q-P limit

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2.1.4 Test Results

Test Input Power	120V 60Hz	Temperature	23ºC
Line Under Test	AC Mains	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	12 Jul 2019

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line	Channel (Worst)
0.5303	43.5	56.0	12.5	33.1	46.0	12.9	Neutral	19
0.5411	43.5	56.0	12.5	33.8	46.0	12.2	Live	19
0.5721	39.2	56.0	16.8	29.5	46.0	16.5	Live	19
0.6533	35.2	56.0	20.8	25.6	46.0	20.4	Live	19
0.6558	35.2	56.0	20.8	25.9	46.0	20.1	Neutral	19
0.8470	32.1	56.0	23.9	24.9	46.0	21.1	Live	19

Notes

1.	All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 9kHz - 30MHz RBW: 9kHz VBW: 30kHz

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2.2 Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)

2.2.1 Test Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m)
0.009 - 0.490 *	20 log [2400 / F (kHz)] @ 300m
0.490 - 1.705	20 log [24000 / F (kHz)] @ 30m
1.705 - 30.0	30.0 @ 30m
30 – 88	40.0 @ 3m
88 – 216	43.5 @ 3m
216 – 960	46.0 @ 3m
Above 960 *	54.0 @ 3m
* For frequency bands 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

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2.2.2 Test Setup

2.2.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.2.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

2.2.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.2.3 Test Method

2.2.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.2.3.2 A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.

2.2.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:

a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
b. The EUT was then rotated to the direction that gave the maximum emission.
c. Finally, the antenna height was adjusted to the height that gave the maximum emission

2.2.3.4 A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz.For frequency point in range of 9kHz – 90kHz, 110kHz – 49k0kHz and above 1GHz, both Peak and Average measurements were carried out.

2.2.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

2.2.3.6 The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10th harmonics of the EUT fundamental frequency, using the loop antenna for frequency below 30MHz, Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

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2.2.5 Test Results

Test Input Power	24Vdc	Temperature	24ºC
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Dylan Lin
		Test Date	12 Jul 2019

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 2 & 3

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
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Spurious Emissions ranging from 9kHz – 30MHz *See Note 2 & 3

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel
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Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
45.1850	33.8	40.0	6.2	100	276	V	19
51.7490	29.4	40.0	10.6	299	188	V	19
63.4080	27.0	40.0	13.0	100	294	V	19
138.4530	28.8	43.5	14.7	200	360	H	19
151.5810	27.8	43.5	15.7	200	155	H	19
575.7910	34.1	46.0	11.9	100	189	V	19

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Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
4.8029	48.1	74.0	25.9	39.6	54.0	14.4	300	17	H	0
4.8101	46.9	74.0	27.1	42.0	54.0	12.0	300	355	V	0
6.0000	44.8	74.0	29.2	37.6	54.0	16.4	100	301	V	0
7.2072	46.0	74.0	28.0	35.6	54.0	18.4	100	42	H	0
14.1380	52.5	74.0	21.5	41.2	54.0	12.8	300	203	H	0
17.7273	55.2	74.0	18.8	43.7	54.0	10.3	100	252	H	0

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.4141	40.1	74.0	33.9	39.0	54.0	15.0	398	39	V	19
1.5080	44.5	74.0	29.5	30.8	54.0	23.2	398	359	V	19
1.5937	38.3	74.0	35.7	33.1	54.0	20.9	398	359	V	19
2.1249	45.4	74.0	28.6	30.3	54.0	23.7	398	169	V	19
2.2401	40.2	74.0	33.8	32.4	54.0	21.6	300	340	V	19
4.5005	44.3	74.0	29.7	41.0	54.0	13.0	200	253	V	19

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.5981	49.8	74.0	24.2	30.6	54.0	23.4	200	344	V	39
2.2399	46.1	74.0	27.9	29.1	54.0	24.9	102	334	V	39
4.5005	45.9	74.0	28.1	41.1	54.0	12.9	200	256	V	39
4.8101	44.4	74.0	29.6	40.9	54.0	13.1	200	40	V	39
4.9601	51.0	74.0	23.0	45.6	54.0	8.4	102	313	H	39
6.0000	53.2	74.0	20.8	38.6	54.0	15.4	200	106	V	39

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Notes

1.	All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	"--" indicates no emissions were found and shows compliance to the limits.
3.	The measurement was done at 3m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
4.	Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
5.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
6.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
7.	The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33 (a) for intentional radiators & Section 15.33 (b) for unintentional radiators.
8.	The channel in the table refers to the transmit channel of the EUT.

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2.3 Spectrum Bandwidth (6db Bandwidth Measurement)

2.3.1 Test Limits

The EUT shows compliance to the requirements of this section, which states that the minimum bandwidth of the EUT employing digital modulation techniques shall be at least 500kHz.

2.3.2 Test Setup

2.3.2.1 The EUT and supporting equipment were set up as shown in the set up photo.

2.3.2.2 The power supply for the EUT was connected to a filtered mains.

2.3.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.3.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 3 times of RBW.

2.3.2.5 All other supporting equipment were powered separately from another filtered mains.

2.3.3 Test Method

2.3.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.3.3.2 The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 6dB bandwidth of the transmitting frequency.

2.3.3.3 The spectrum analyser was set to max hold to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed.

2.3.3.4 The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. The frequencies below the 6dB peak frequency at lower (f_L) and upper (f_H) sides of the transmitting frequency were marked and measured by using the marker-delta function of the spectrum analyser.

2.3.3.5 The 6dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H - f_L |$.

2.3.3.6 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.3.3.7 The measurements were repeated with the transmitting frequency was set to middle and upper channel respectively.

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2.3.4 Test Results

Test Input Power	24Vdc	Temperature	24ºC
Attached Plots	1 – 3	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	10 Jul 2019

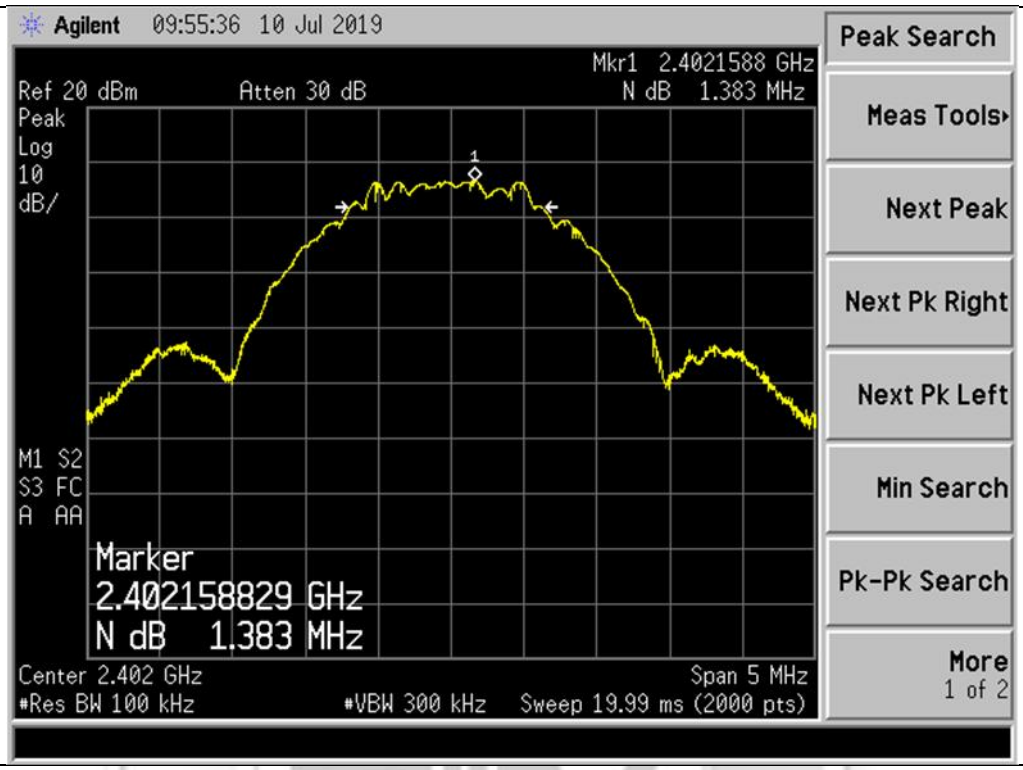
Channel	Channel Frequency (GHz)	6dB Bandwidth (MHz) *See Note 1	Limit (kHz)
Lower	2.402	1.383	≥ 500
Middle	2.440	1.323	≥ 500
Upper	2.480	1.380	≥ 500

Notes

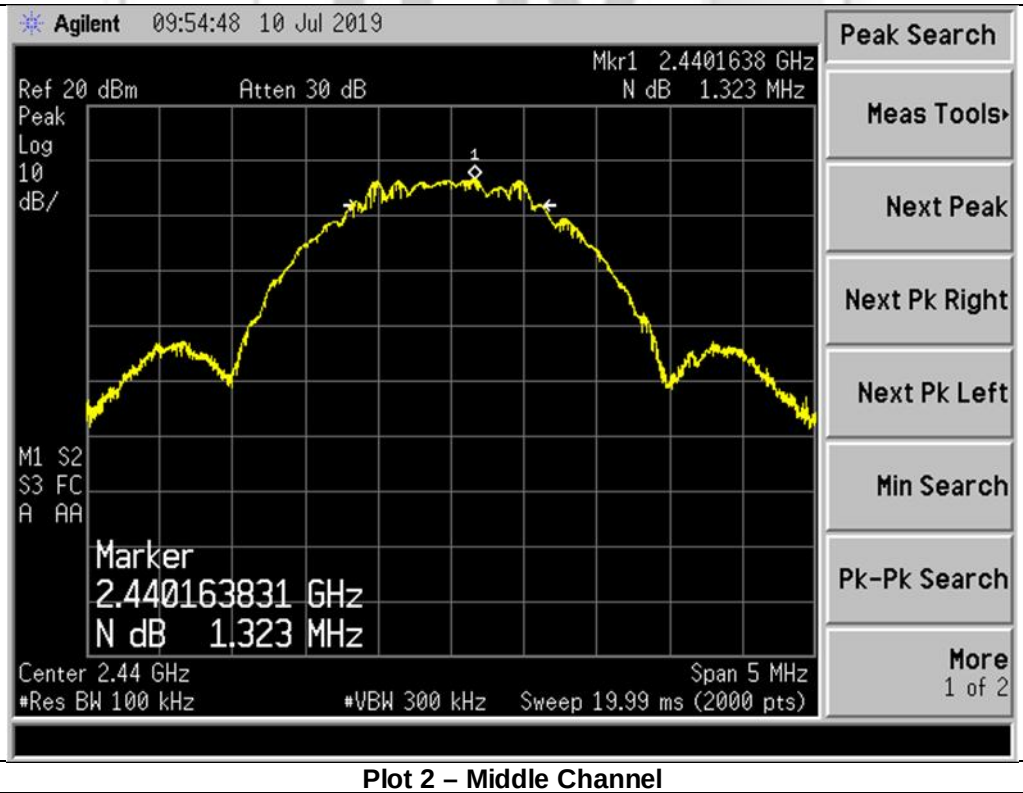
1.	Only the largest measured bandwidths were reported. Refer to plots for all measured bandwidth.

PSB Singapore

Spectrum Bandwidth (6dB Bandwidth Measurement) Plots



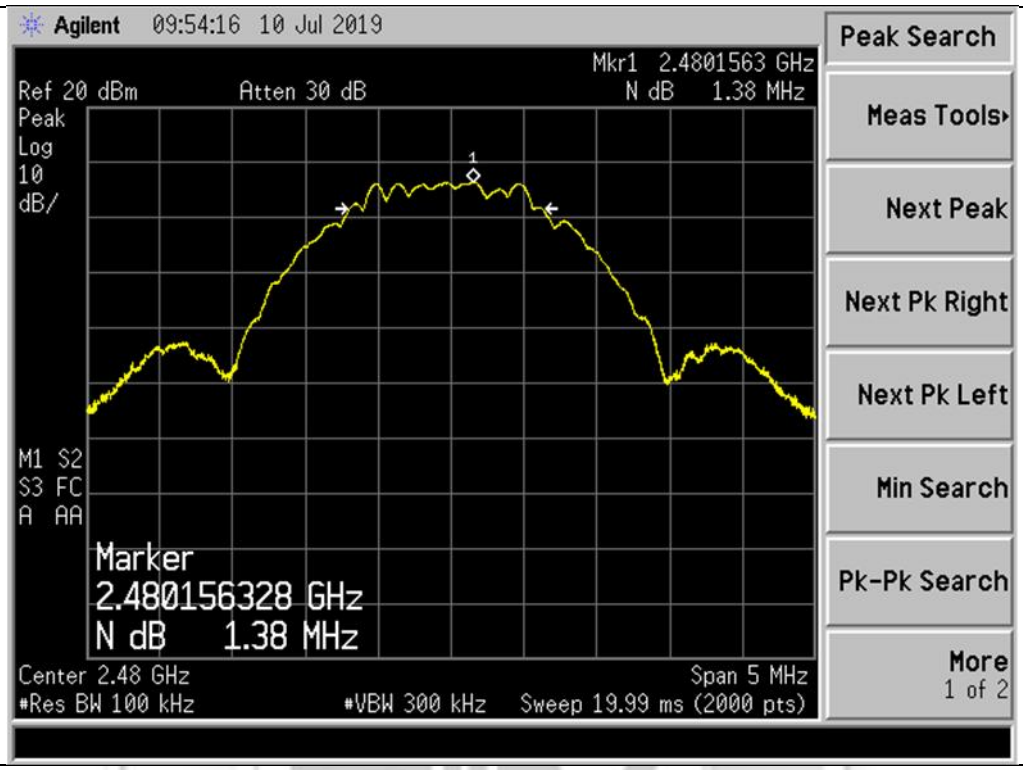
Plot 1 – Lower Channel



Plot 2 – Middle Channel

PSB Singapore

Spectrum Bandwidth (6dB Bandwidth Measurement) Plots



Plot 3 – Upper Channel

PSB Singapore

2.4 Maximum Peak Power

2.4.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the maximum peak power of the EUT employing digital modulation shall not exceed 1W (30dBm).

2.4.2 Test Setup

2.4.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.4.2.2 The power supply for the EUT was connected to a filtered mains.

2.4.2.3 The RF antenna connector was connected to a power meter.

2.4.2.4 All other supporting equipment were powered separately from another filtered mains.

2.4.3 Test Method

2.4.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.4.3.2 The maximum peak power of the transmitting frequency was detected and recorded.

2.4.3.3 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.4.3.4 The measurement was repeated with the transmitting frequency was set to middle channel and upper channel respectively.

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2.4.4 Test Results

Test Input Power	24Vdc	Temperature	24ºC
Antenna Gain	3.48 dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	10 Jul 2019

Channel	Channel Frequency (GHz)	Maximum Peak Power (W) *See Note 1	Limit (W)
Lower	2.402	0.0050	1.0
Middle	2.440	0.0054	1.0
Upper	2.480	0.0053	1.0

Notes

1.	Only the highest measured peak power were reported.

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2.5 RF Conducted Spurious Emissions (Non-Restricted Bands)

2.5.1 Test Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

2.5.2 Test Setup

2.5.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.5.2.2 The power supply for the EUT was connected to a filtered mains.

2.5.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.5.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 3 times of RBW.

2.5.2.5 All other supporting equipment were powered separately from another filtered mains.

2.5.3 Test Method

2.5.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, with transmitting frequency at lower channel.

2.5.3.2 The start and stop frequencies of the spectrum analyser were set to 30MHz and 10GHz.

2.5.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

2.5.3.4 The measurements were repeated with frequency span was set from 10GHz to 25GHz.

2.5.3.5 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.5.3.6 The measurements were repeated with the transmitting frequency was set to middle channel and upper channel respectively.

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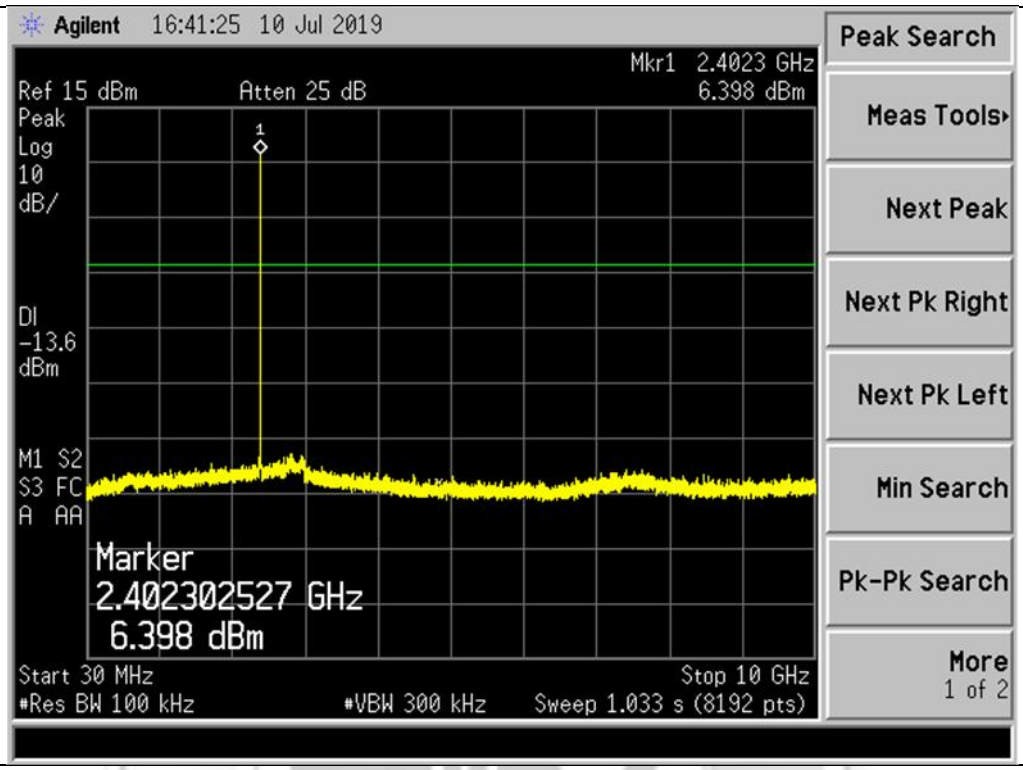
2.5.4 Test Results

Test Input Power	24Vdc	Temperature	24ºC
Attached Plots	4 – 9	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	10 Jul 2019

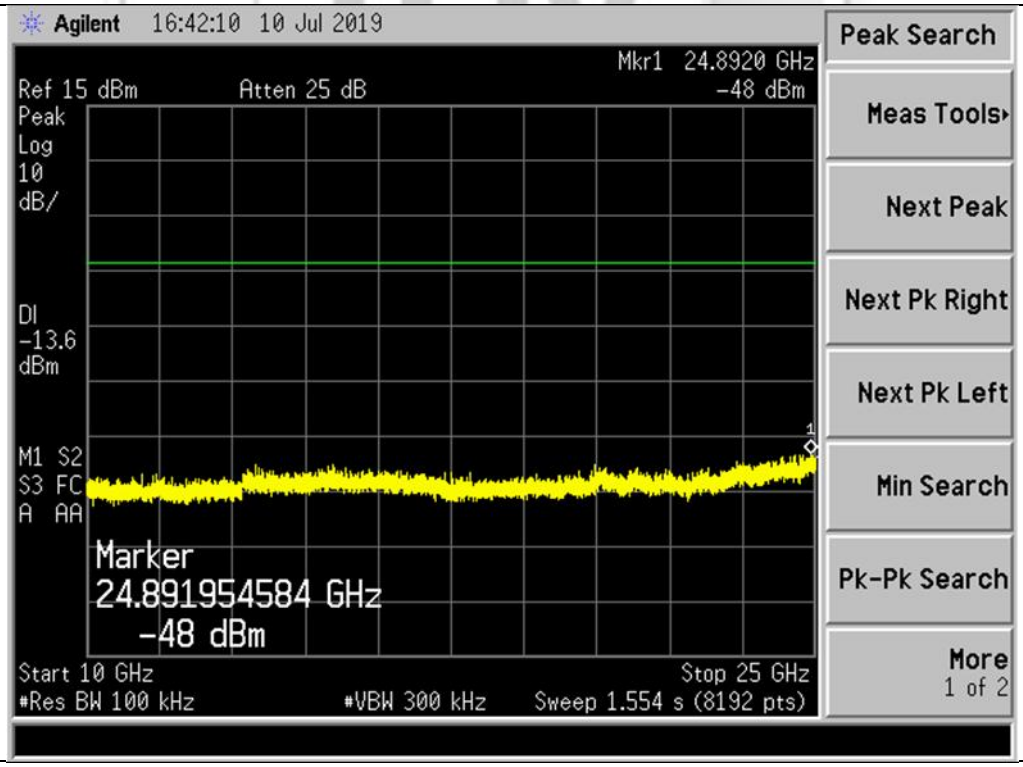
All spurious signals found were below the specified limit. Please refer to the attached plots.

PSB Singapore

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots



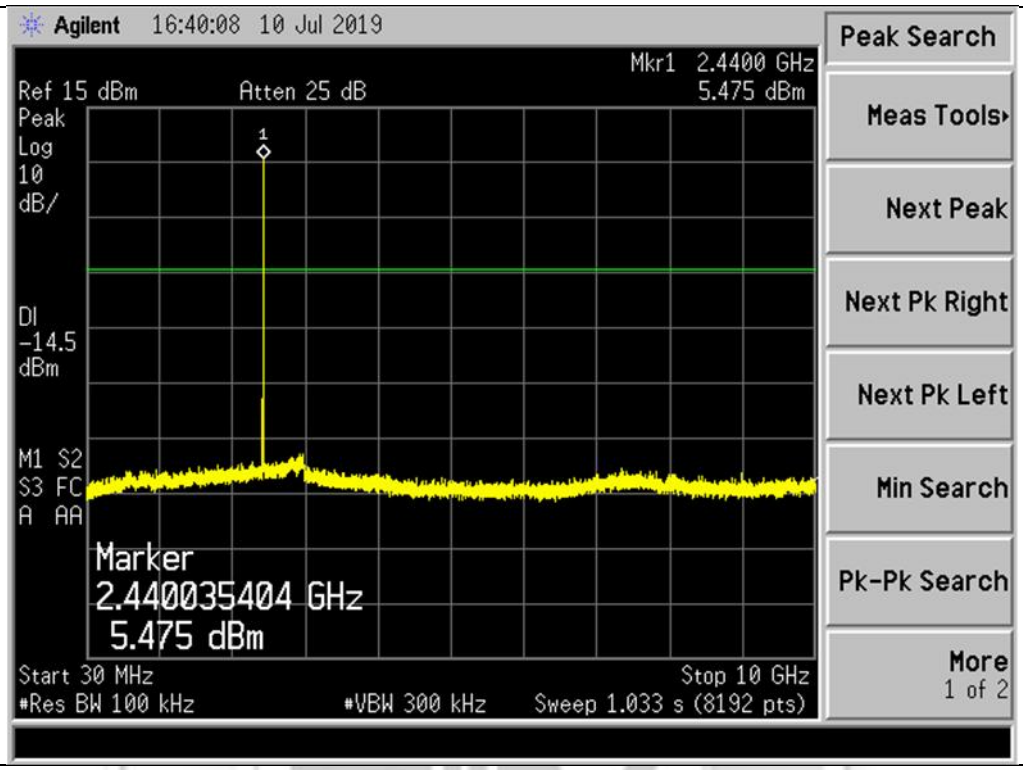
Plot 4 – Lower Channel



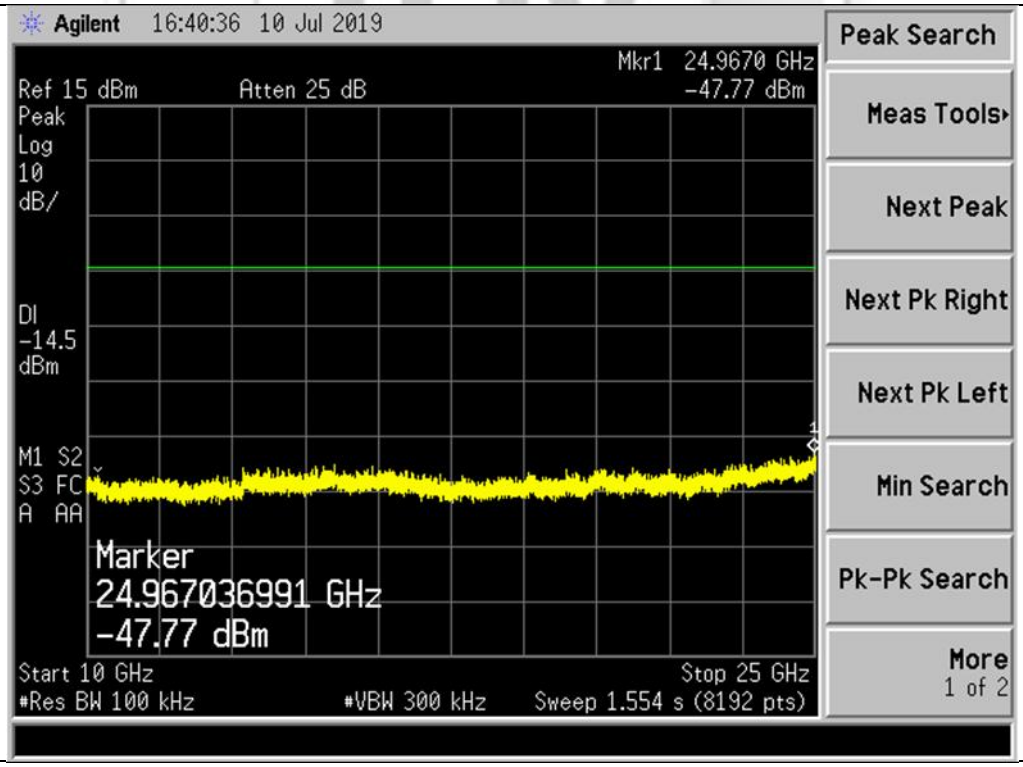
Plot 5 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots



Plot 6 – Middle Channel



Plot 7 – Middle Channel

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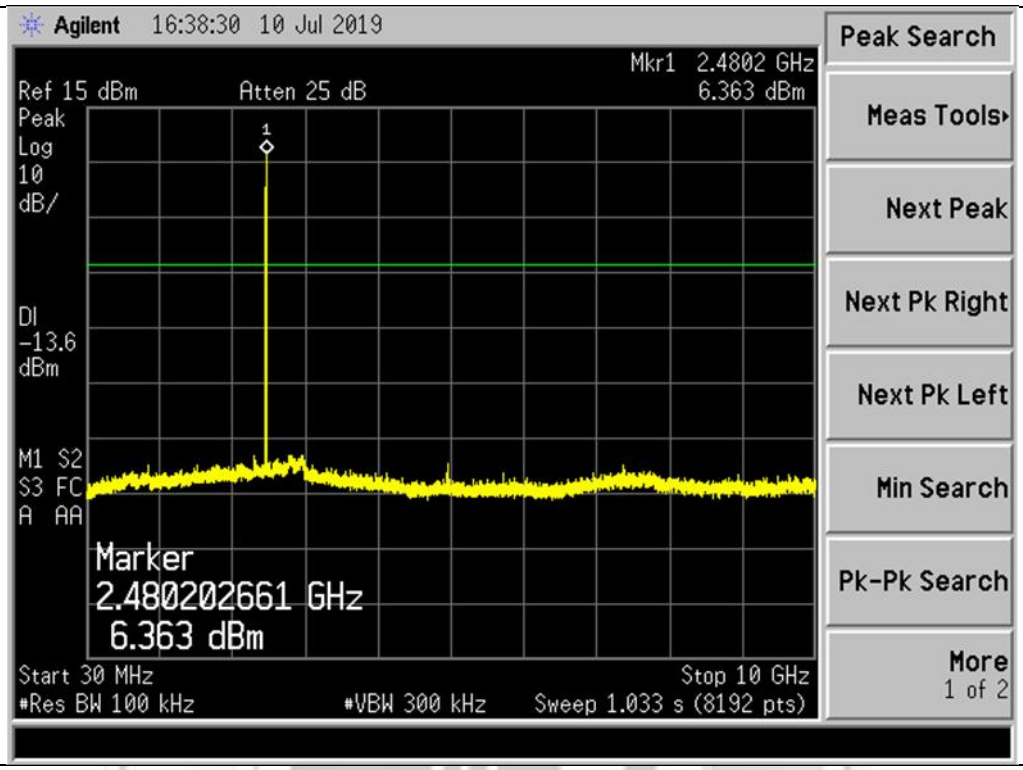
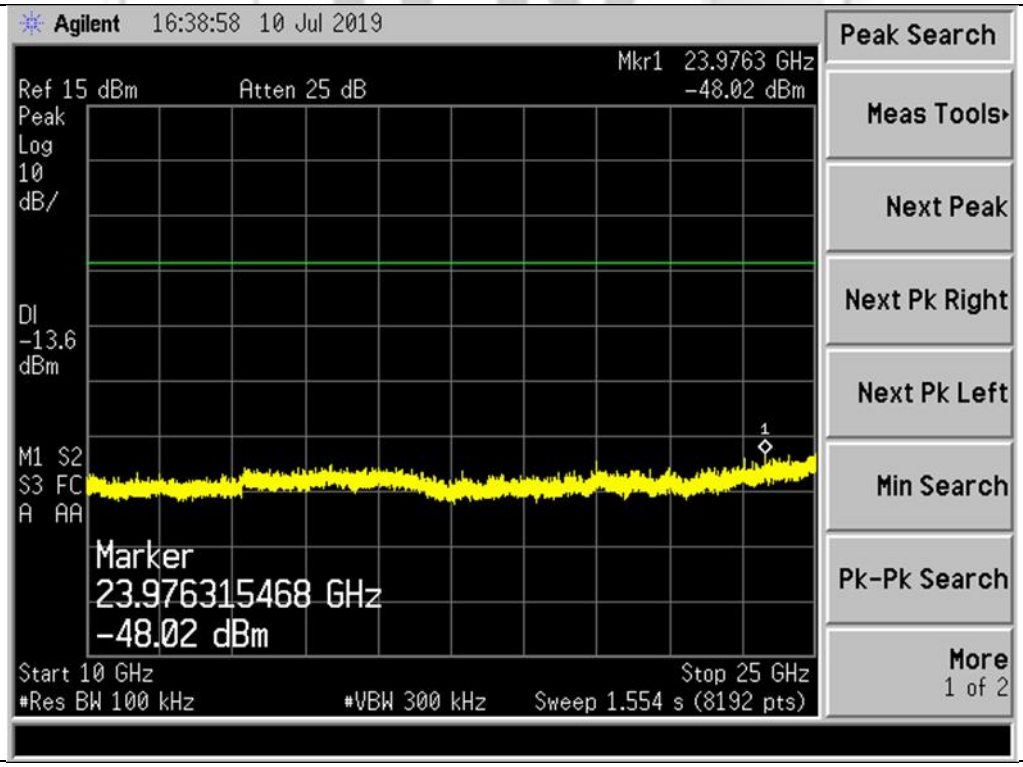
RF Conducted Spurious Emissions (Non-Restricted Bands) Plots



Plot 8 – Upper Channel



Plot 9 – Upper Channel

PSB Singapore

2.6 RF Conducted Spurious Emissions (Restricted Bands)

2.6.1 Test Limits

The EUT shows compliance to the requirements of this section, which states that emissions which fall in the restricted bands must comply with the radiated emission limits specified in the table below:

Frequency Range (MHz)	EIRP (dBm)	Radiated Emissions (dBµV/m)
0.009 – 0.490	-6.7 – (-41.4) **	67.6 – 20logF* @ 300m **
0.490 – 1.705	-41.4 – (-52.3) **	87.6 – 20logF* @ 30m **
1.705 – 30	-45.7	29.5 @ 30m
30 - 88	-55.2	40.0 @ 3m
88 - 216	-51.7	43.5 @ 3m
216 - 960	-49.2	46.0 @ 3m
>960	-41.2 ***	54.0 @ 3m ***
* F is frequency in kHz.		
** Decreasing linearly with the logarithm of the frequency.		
*** Above 1GHz, a peak limit of 20dB above the average limit does apply.		

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MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

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2.6.2 Test Setup

2.6.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.6.2.2 The power supply for the EUT was connected to a filtered mains.

2.6.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.6.2.4 The resolution bandwidth (RBW) of the spectrum analyser was set to the following settings. The video bandwidth (VBW) was set to at least three times of the RBW.

Frequency (MHz)	RBW (kHz)
0.009 – 0.150	0.2
0.150 – 30.0	9.0
30.0 - 1000	100.0
> 1000	1000.0

2.6.2.5 The detector of the spectrum analyser was set to peak detection mode.

2.6.2.6 All other supporting equipment were powered separately from another filtered mains.

2.6.3 Test Method

Measurement in the range 9kHz – 1000MHz

2.6.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, with the transmitting frequency was set to lower channel.

2.6.3.2 The start and stop frequencies of the spectrum analyser were set according to the supported RBW.

2.6.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected. The antenna gain of the EUT was added to the captured spurious emissions.

2.6.3.4 No further measurement was required if all the captured emissions complied to the limits. Else, the spectrum analyser was set to zoom to the captured emission with the detector of the spectrum analyser was set to quasi-peak. The emission level of the captured frequency was measured.

2.6.3.5 The measurements were repeated until all the captured emissions which exceeding the limits were measured.

2.6.3.6 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.6.3.7 The measurements were repeated with the transmitting frequency was set to middle and upper channel respectively

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Measurement above 1000MHz

2.6.3.8 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, with the transmitting frequency was set to lower channel.

2.6.3.9 The start and stop frequencies of the spectrum analyser were set according to the supported frequency band of the set RBW with the number of points in a sweep was set to equal or greater than 2 times of the ratio of span over RBW.

2.6.3.10 The detector of the spectrum analyser was set to power average (RMS) mode with the sweep time was set to equal or greater than 10 times of the product of number of measurement points in a sweep and transmission symbol time.

2.6.3.11 The spectrum analyser was then allowed to capture any spurious emissions within a single sweep. The peak marker function of the spectrum analyser was used to locate the highest power level. The antenna gain of the EUT was added to the captured spurious emissions.

2.6.3.12 The measurements were repeated until all the required frequency bands were measured.

2.6.3.13 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.6.3.14 The measurements were repeated with the transmitting frequency was set to middle and upper channel respectively.

2.6.3.15 The measurements were repeated with the detector of the spectrum analyser was set to peak detecting mode. The sweep time was set to auto coupler.

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2.6.4 Test Results

Test Input Power	24Vdc	Temperature	24ºC
Attached Plots	10 – 29 (Peak)	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	10 Jul 2019

All spurious signals found were below the specified limit. Please refer to the attached plots.

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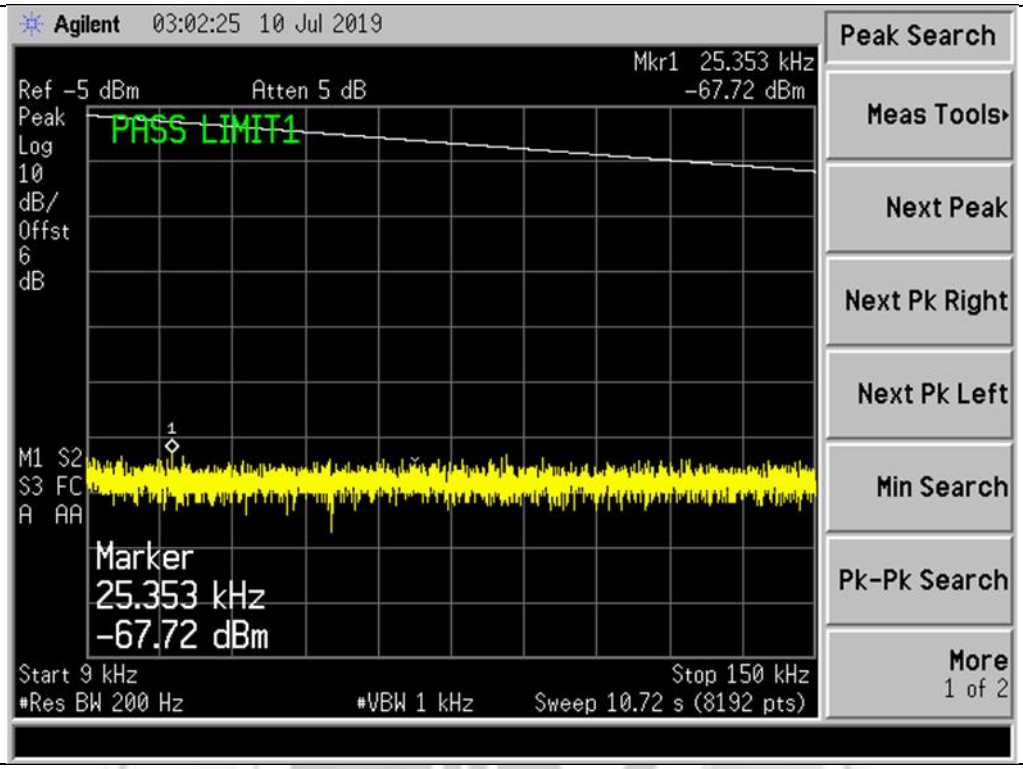
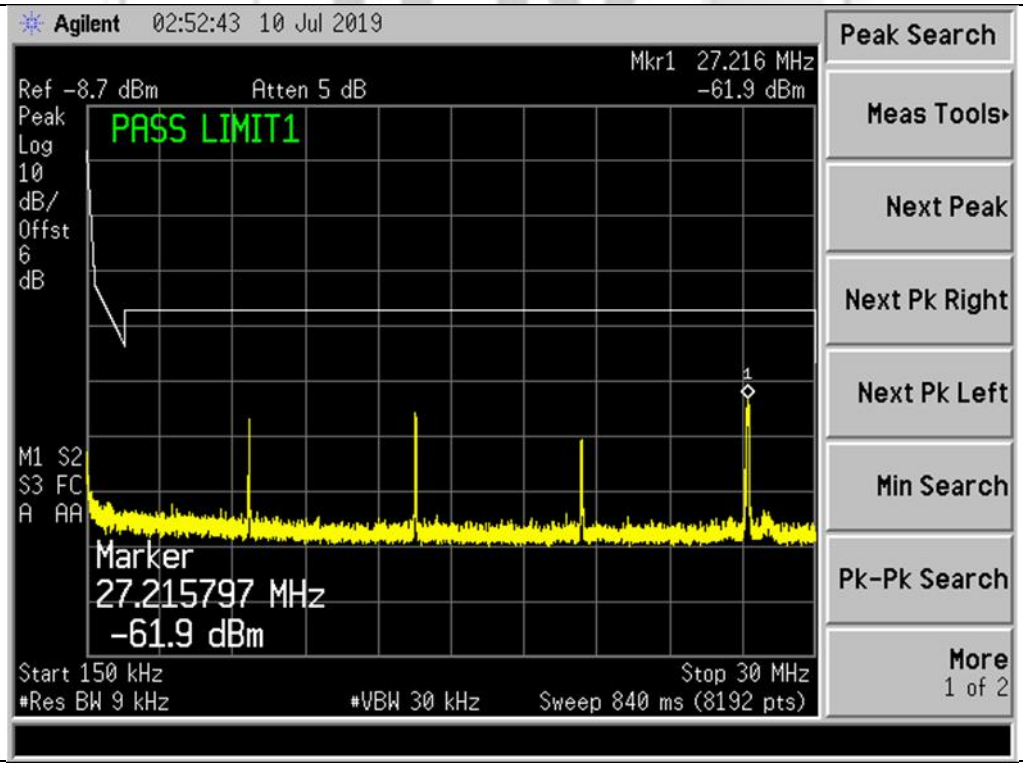
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



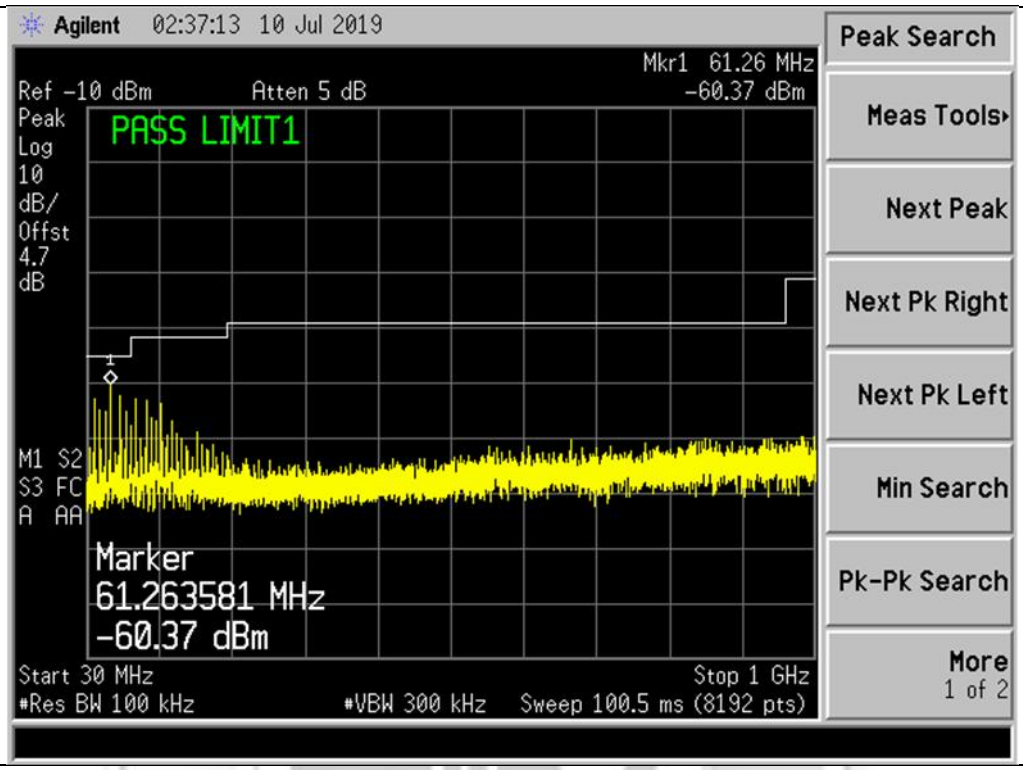
Plot 10 – Lower Channel



Plot 11 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



Plot 12 – Lower Channel

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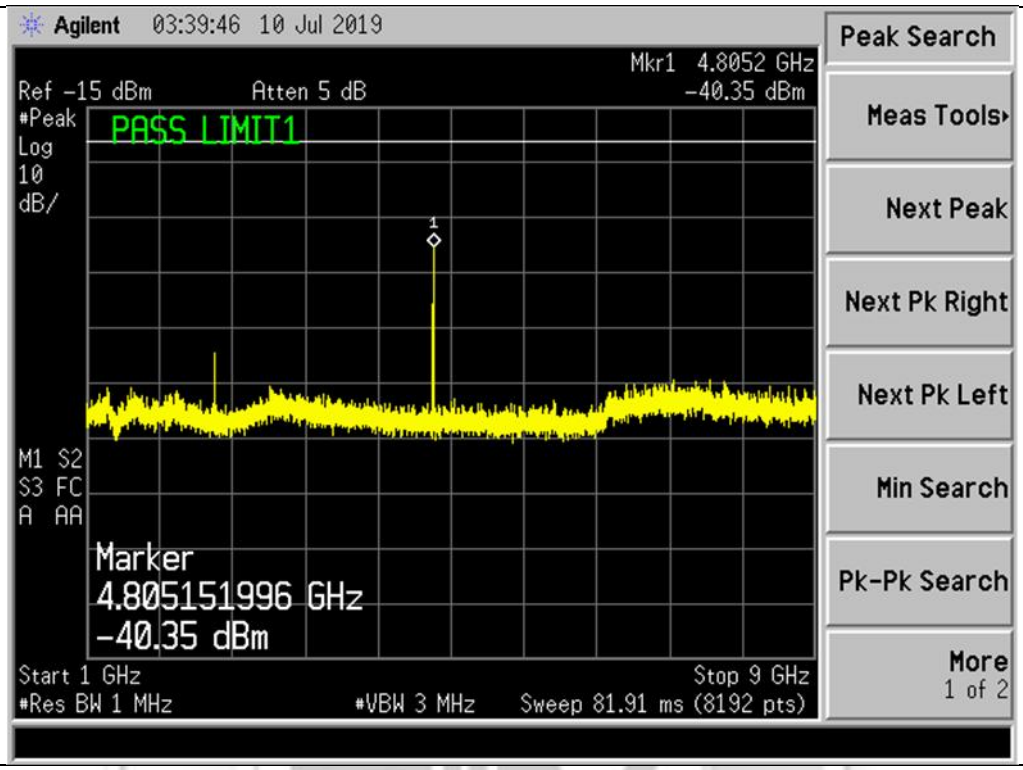
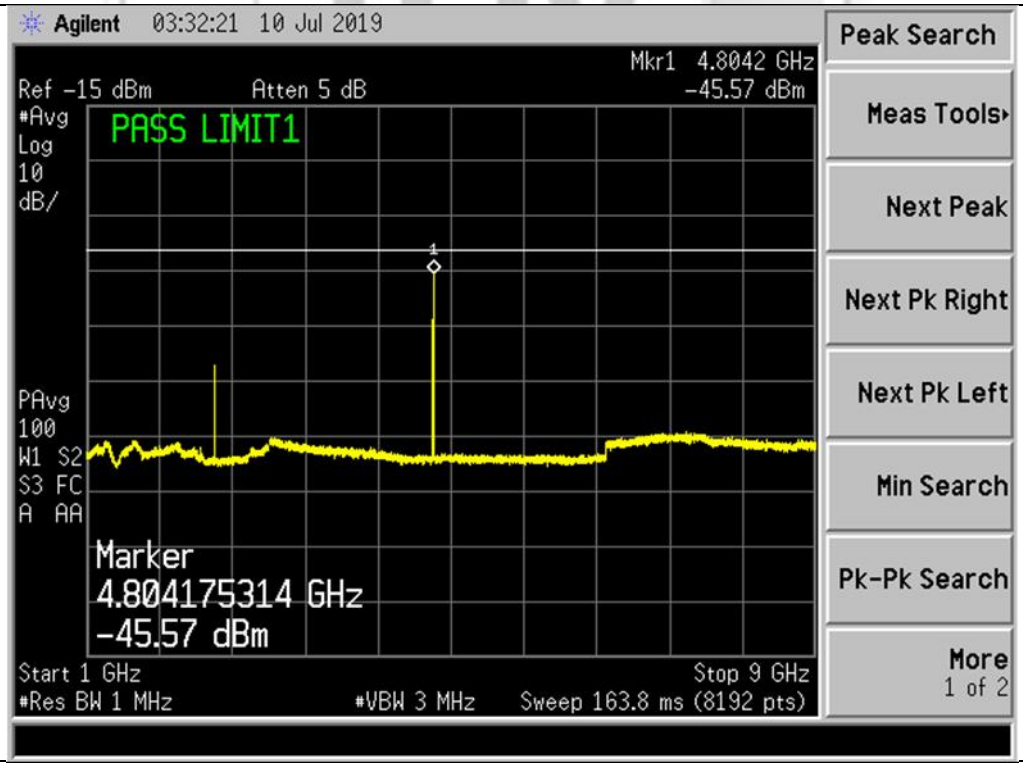
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak & Average



Plot 13 – Lower Channel



Plot 14 – Lower Channel

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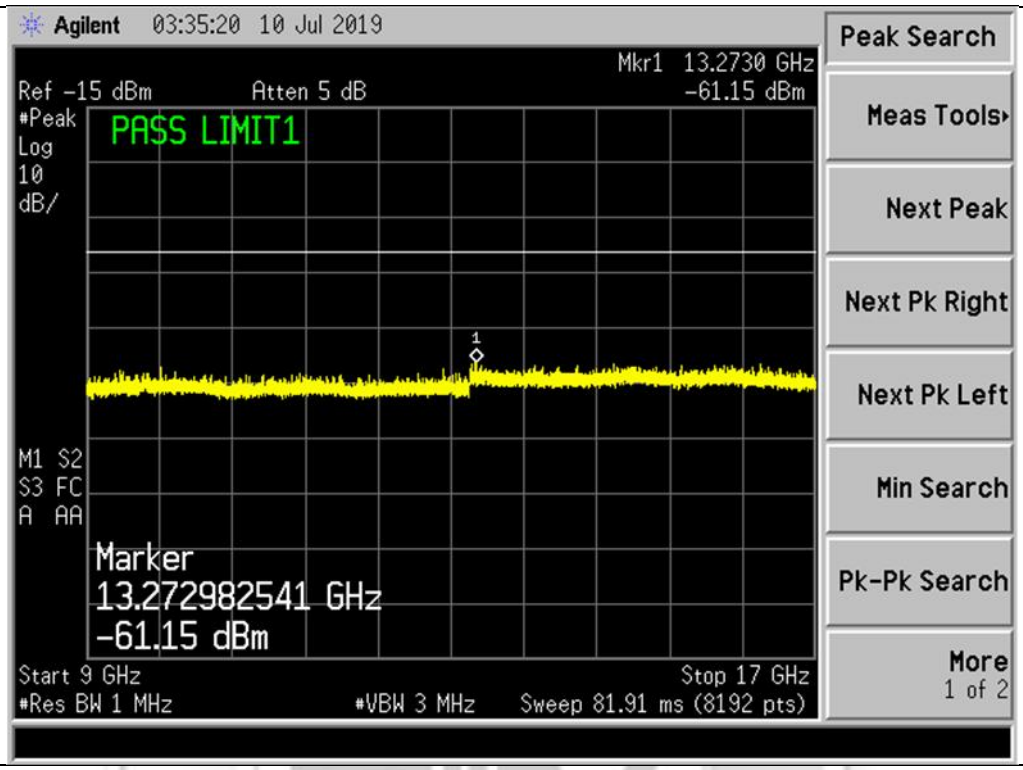
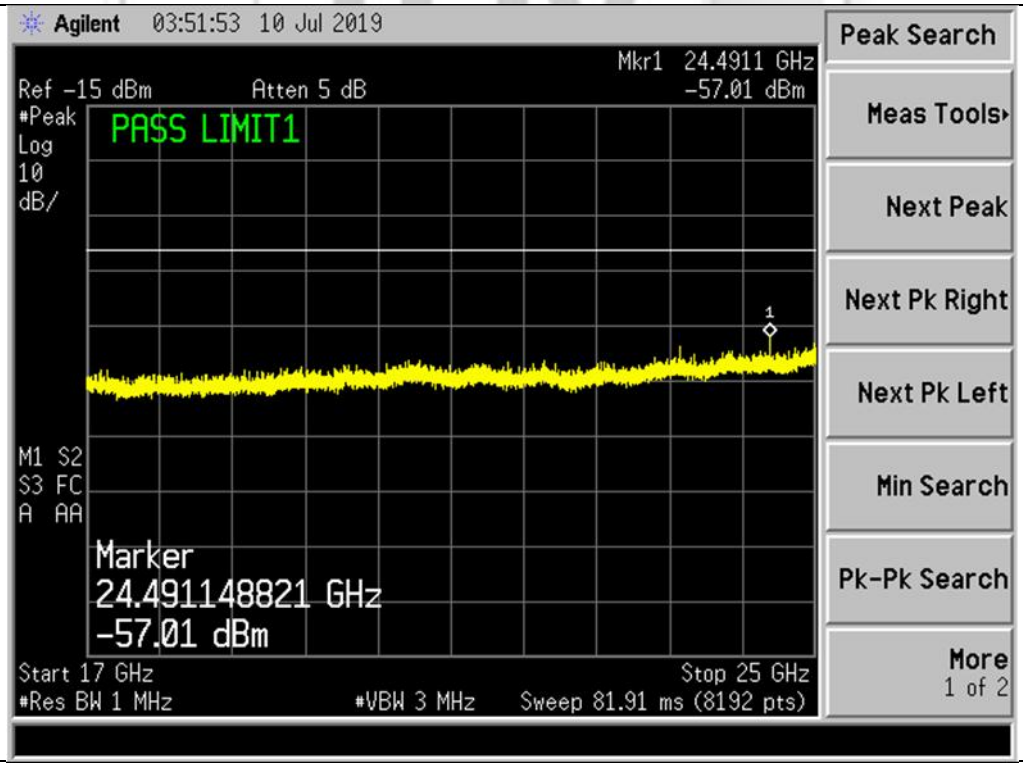
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



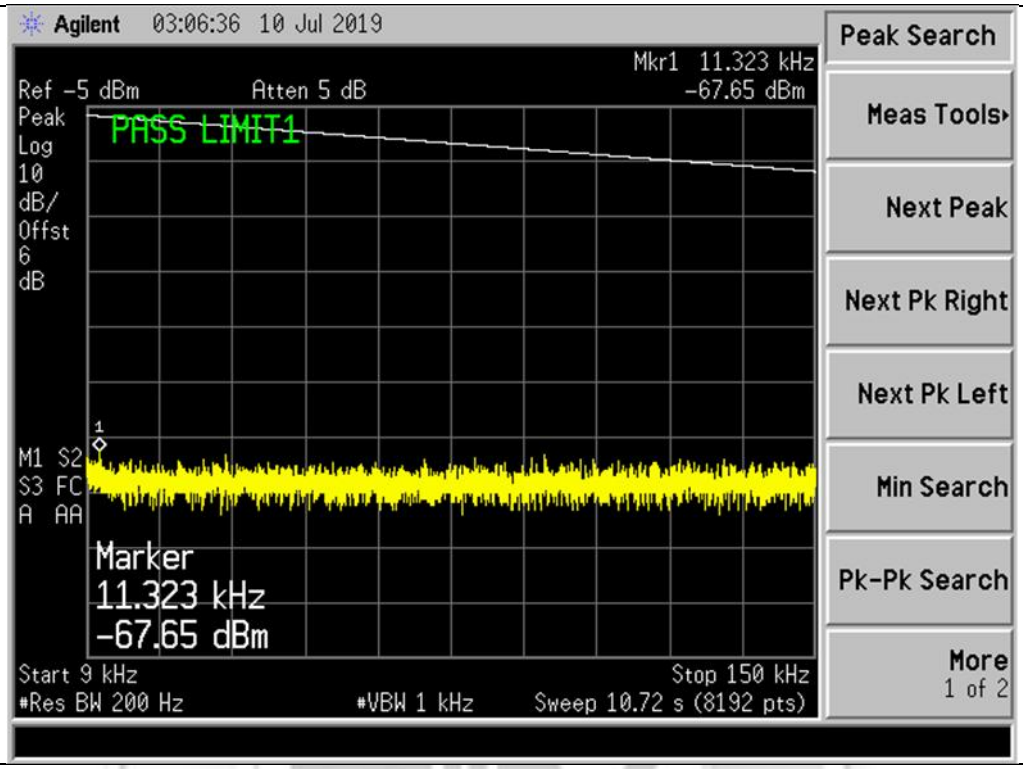
Plot 15 – Lower Channel



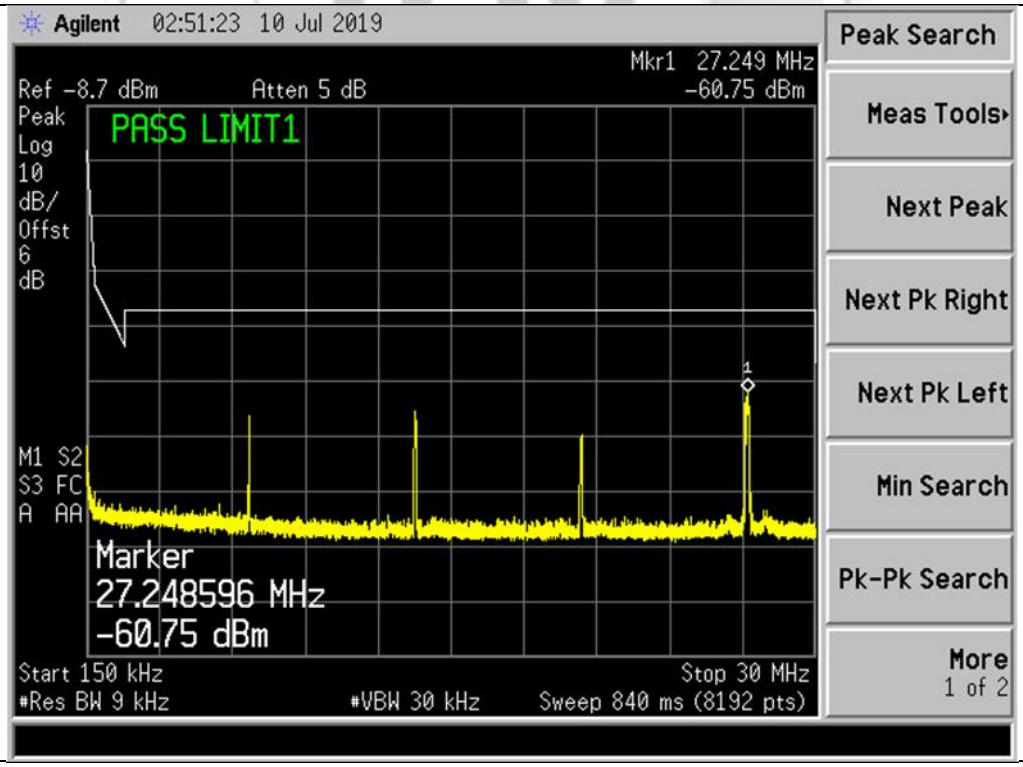
Plot 16 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



Plot 17 – Middle Channel



Plot 18 – Middle Channel

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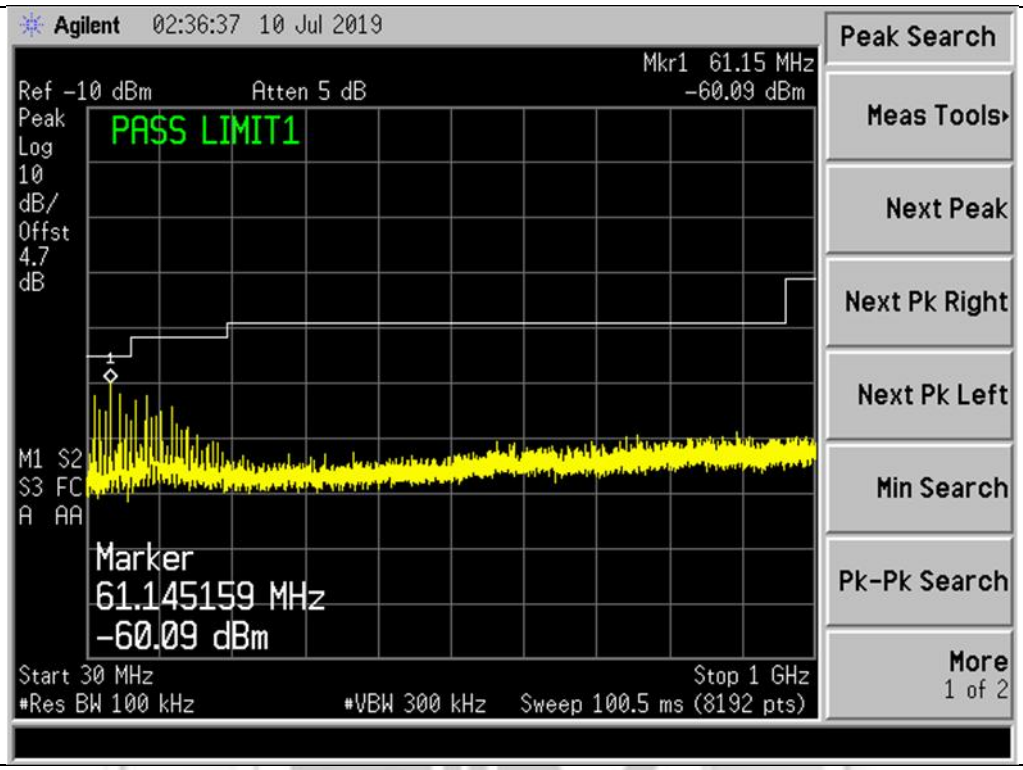
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



Plot 19 – Middle Channel

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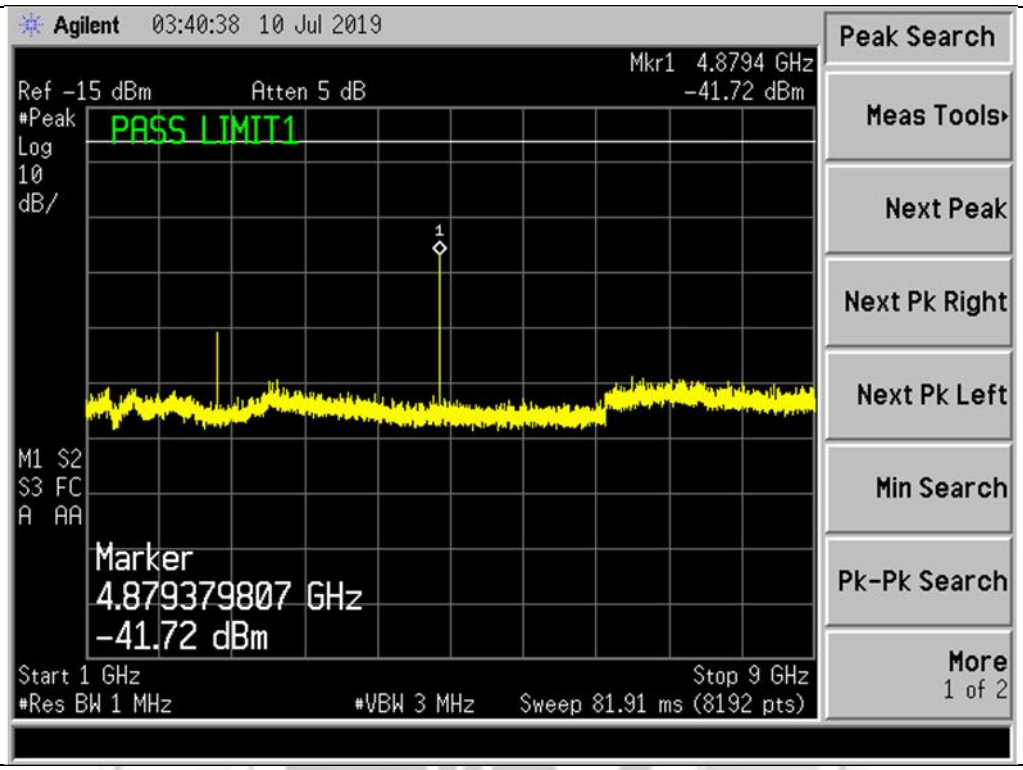
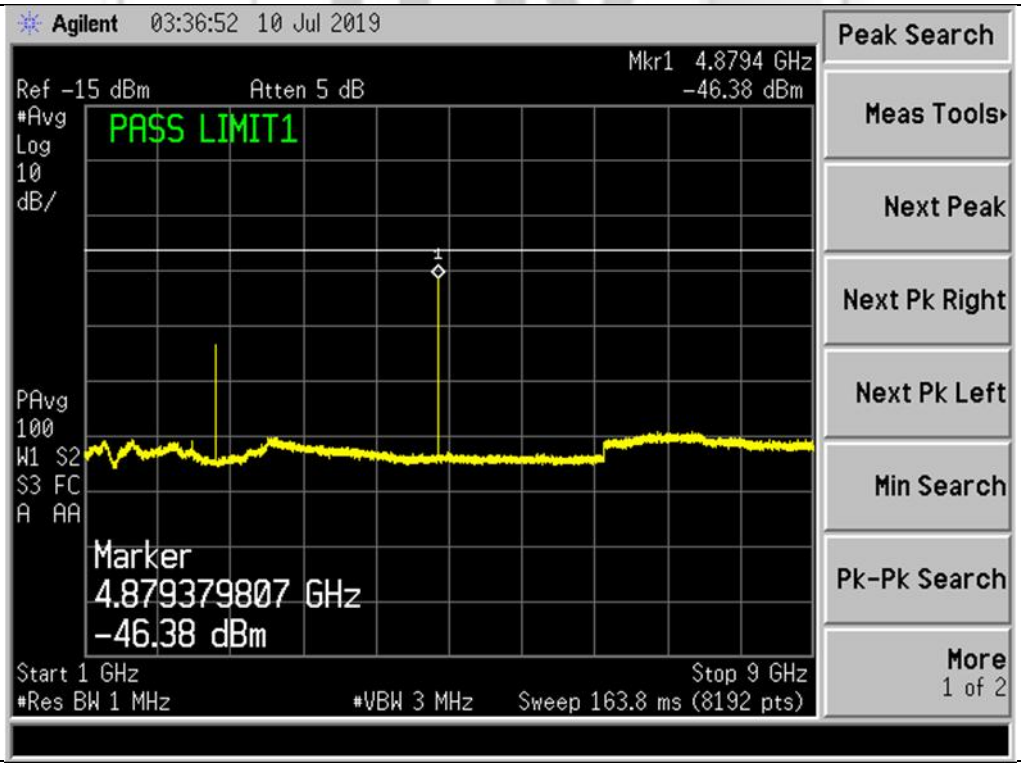
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak & Average



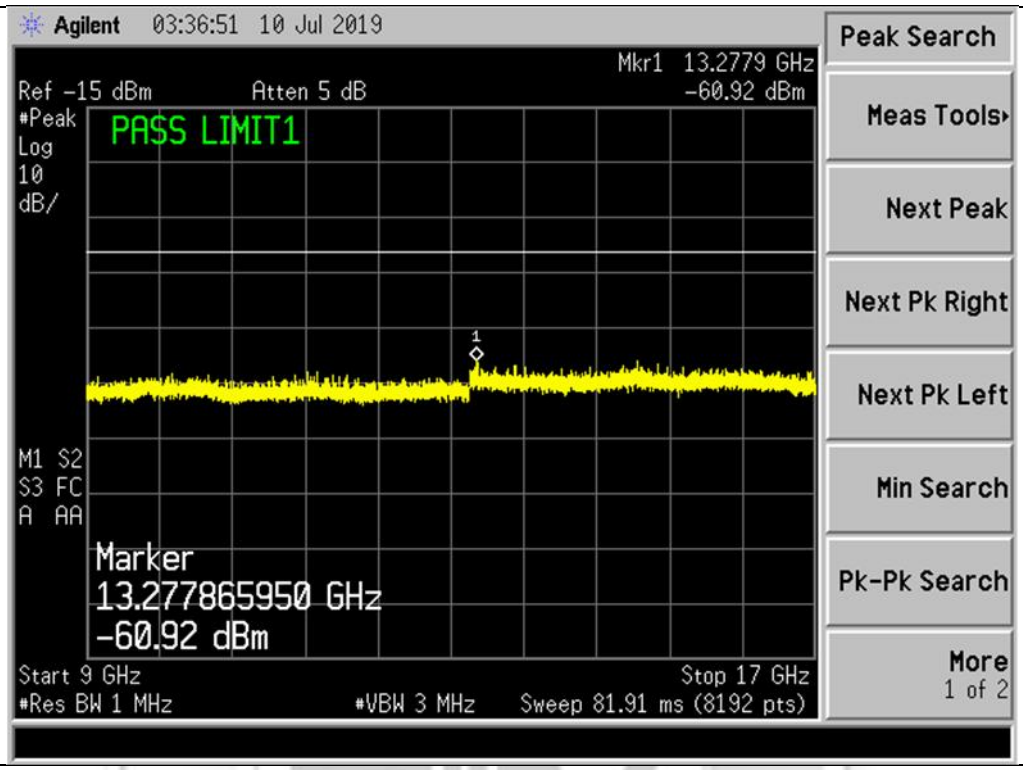
Plot 20 – Middle Channel



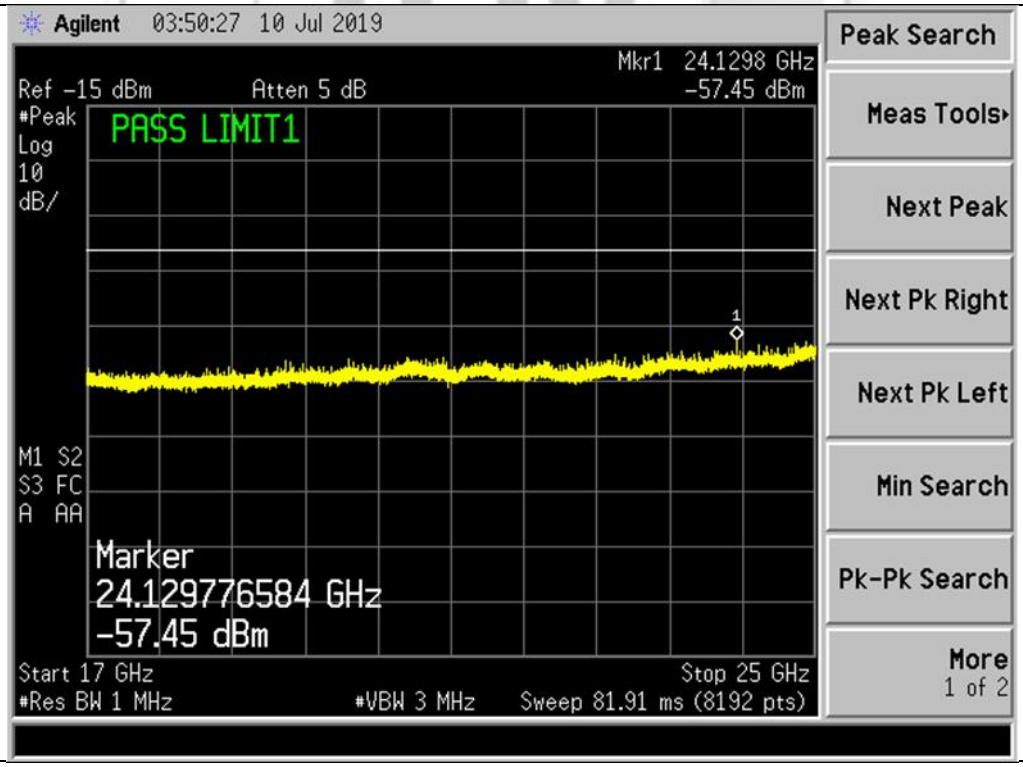
Plot 21 – Middle Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



Plot 22 – Middle Channel



Plot 23 – Middle Channel

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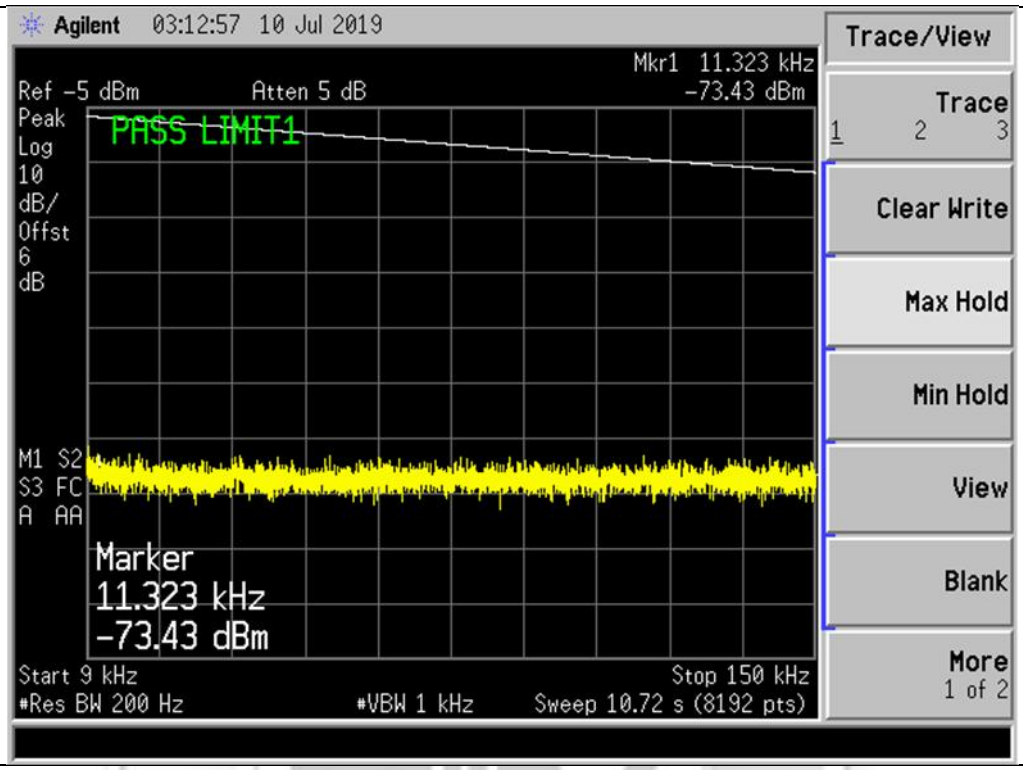
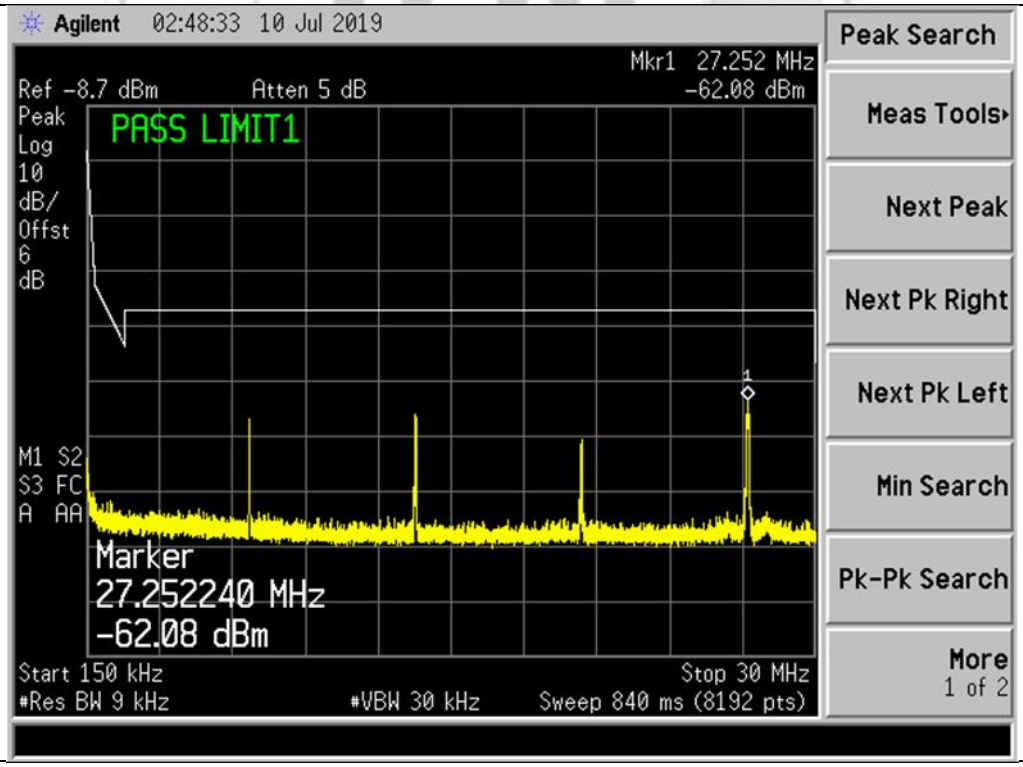
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



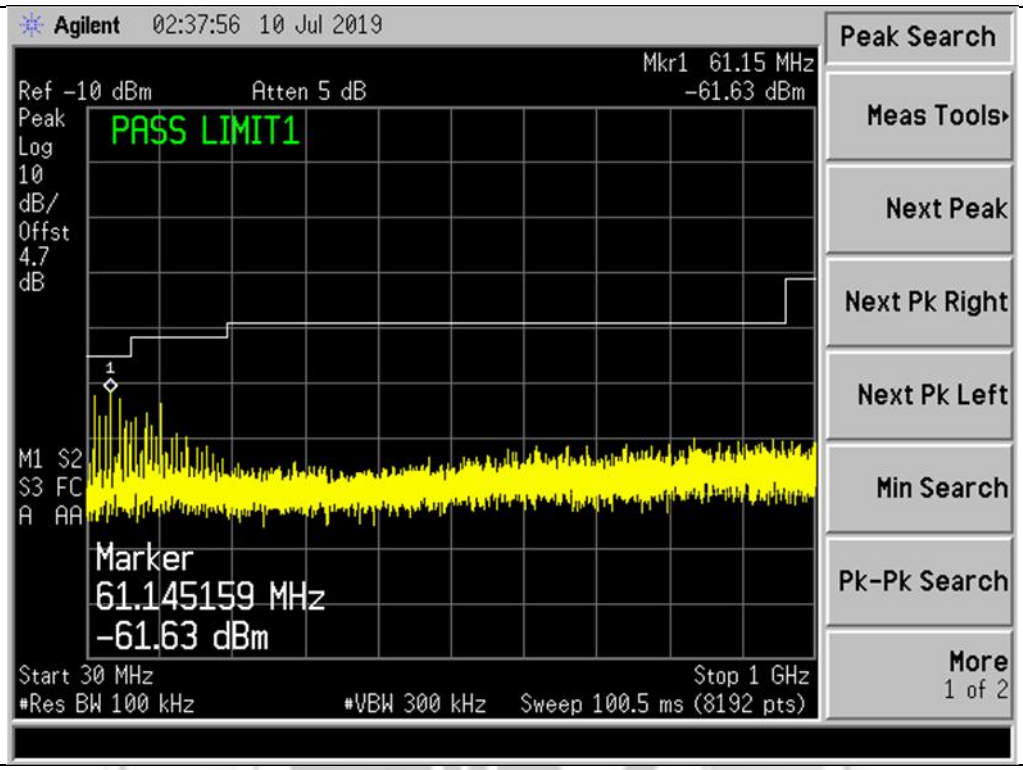
Plot 24 – Upper Channel



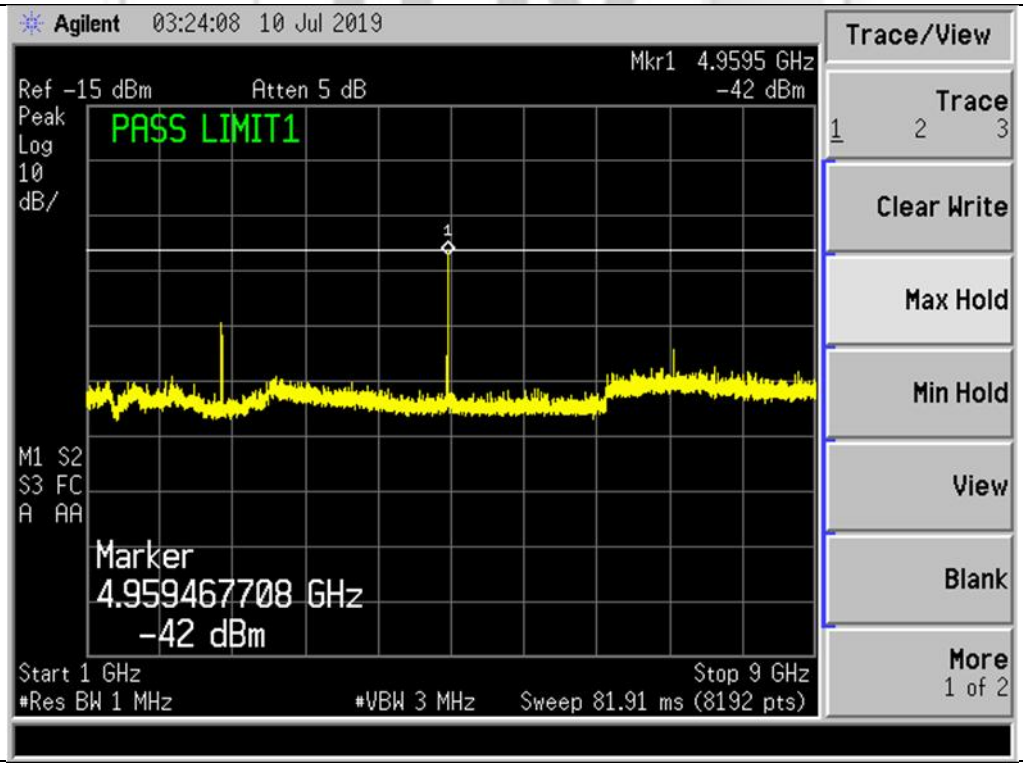
Plot 25 – Upper Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



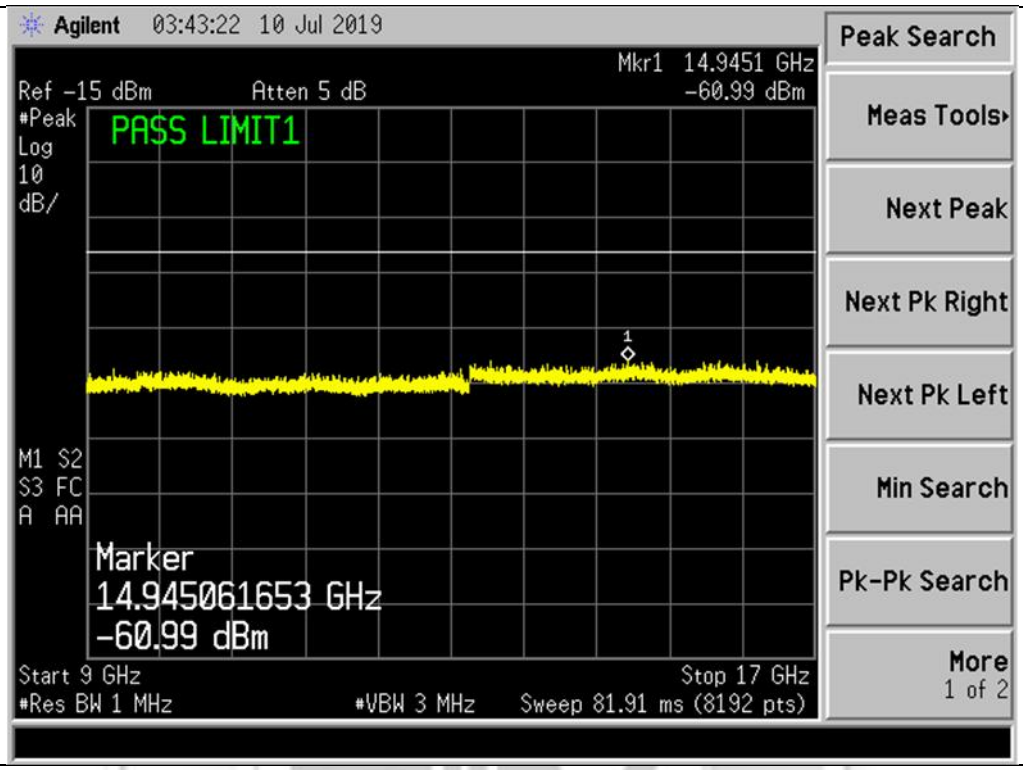
Plot 26 – Upper Channel



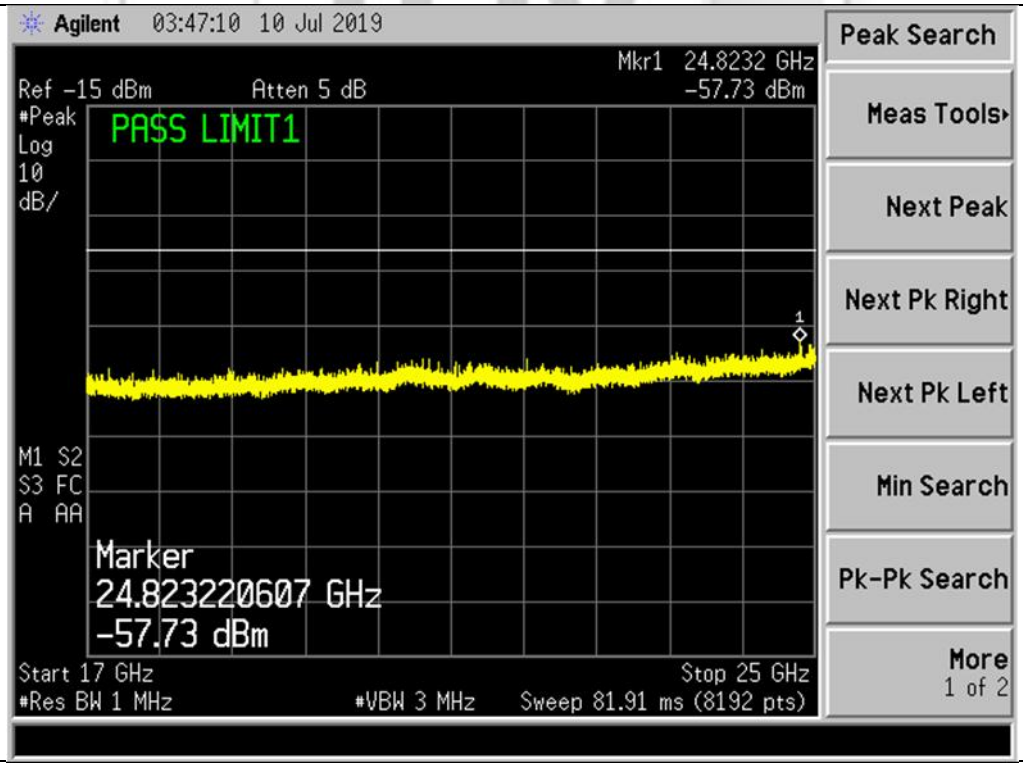
Plot 27 – Upper Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



Plot 28 – Upper Channel



Plot 29 – Upper Channel

PSB Singapore

2.7 Band Edge Compliance (Conducted)

2.7.1 Test Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

2.7.2 Test Setup

2.7.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.7.2.2 The power supply for the EUT was connected to a filtered mains.

2.7.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.7.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.

2.7.2.5 All other supporting equipment were powered separately from another filtered mains.

2.7.3 Test Method

2.7.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode.

2.7.3.2 The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge (within 2MHz of the band edge).

2.7.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

2.7.3.4 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.7.3.5 The measurements were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

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2.7.4 Test Results

Test Input Power	24Vdc	Temperature	24ºC
Attached Plots	30 – 31	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	10 Jul 2019

No significant signal was found and they were below the specified limit.

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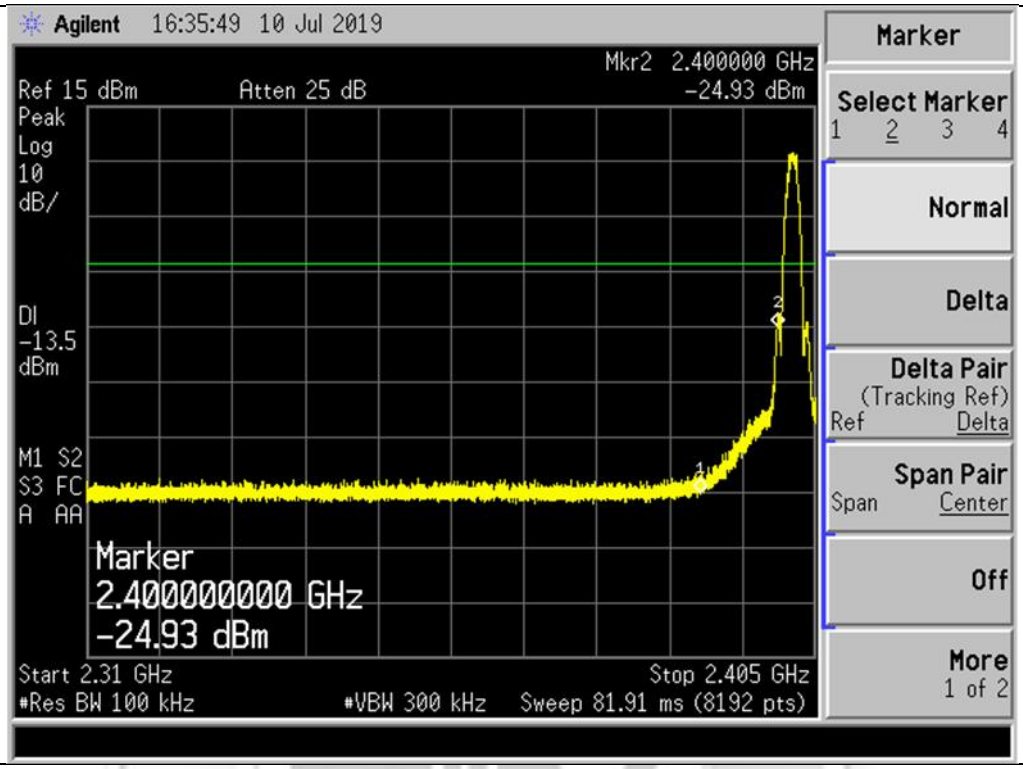
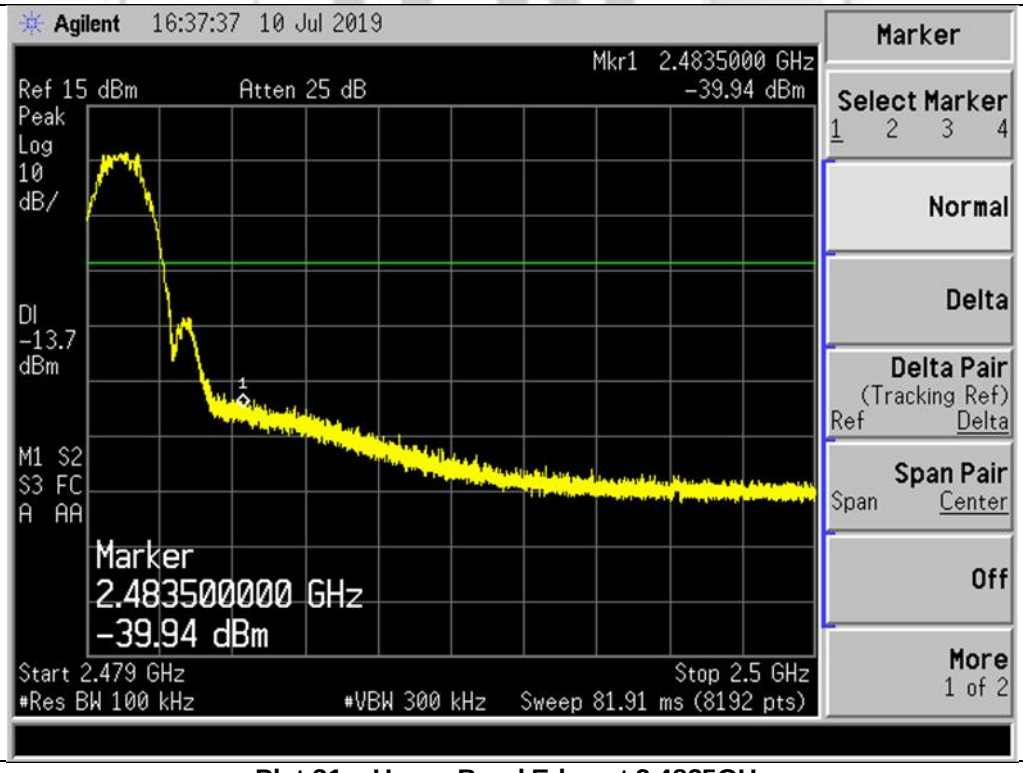
Band Edge Compliance (Conducted) Plots



Plot 30 – Lower Band Edge at 2.4000GHz



Plot 31 – Upper Band Edge at 2.4835GHz

PSB Singapore

2.8 Band Edge Compliance (Radiated)

2.8.1 Test Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands shall comply to the radiated emission limits specified in 15.209.

2.8.2 Test Setup

2.8.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.8.2.2 The power supply for the EUT was connected to a filtered mains.

2.8.2.3 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz to show compliance of spurious at band edges are at least 20dB below the carriers. For restricted band spurious at band edges, peak and average measurement plots were taken using the following setting:

a. Peak Plot:
RBW = 1MHz, VBW = 3RBW

b. Average Plot
RBW = 1MHz, VBW = 10Hz

2.8.2.4 All other supporting equipment were powered separately from another filtered mains.

2.8.3 Test Method

2.8.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode.

2.8.3.2 The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge.

2.8.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

2.8.3.4 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.8.3.5 The measurements were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

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2.8.4 Test Results

Test Input Power	3.7Vdc	Temperature	24ºC
Attached Plots	32 – 37	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Dylan Lin
		Test Date	12 Jul 2019

No significant signal was found and they were below the specified limit.

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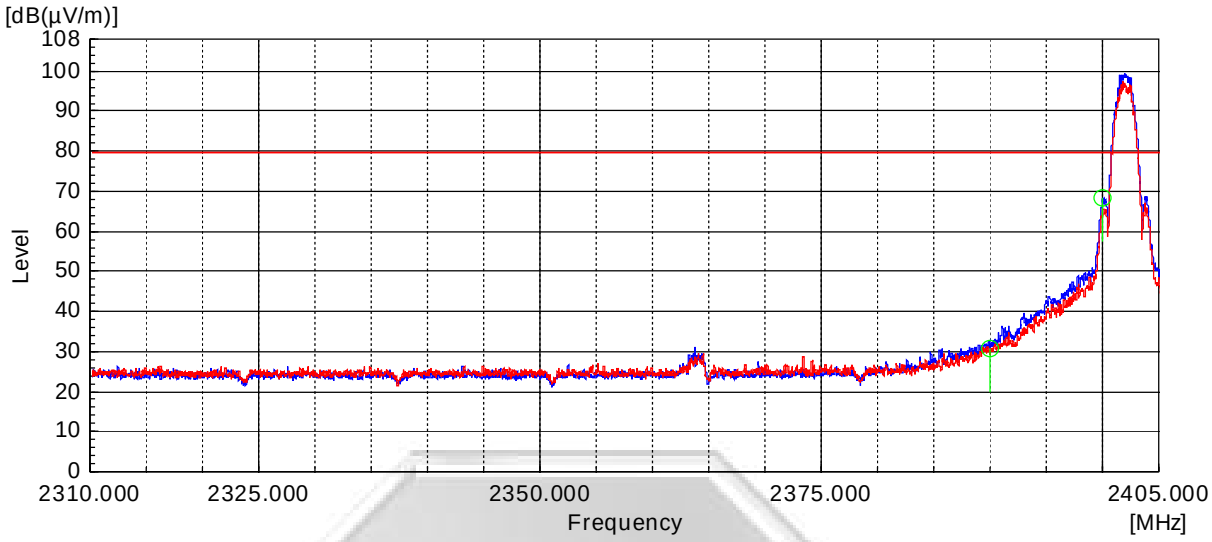
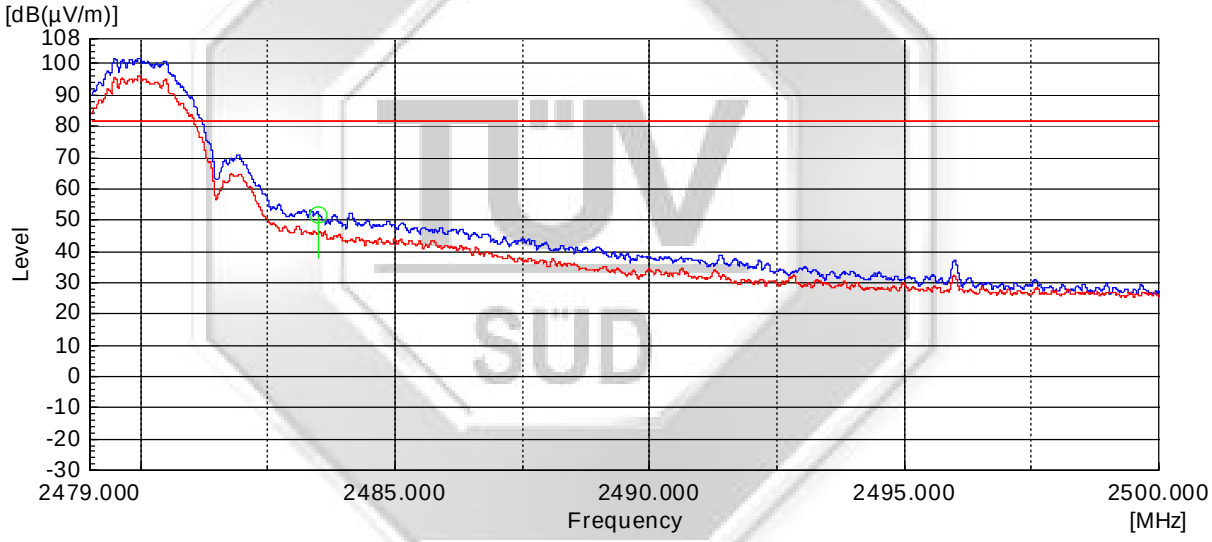
Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge)



Plot 32 – Lower Band Edge at 2.4000GHz



Plot 33 – Upper Band Edge at 2.4835GHz

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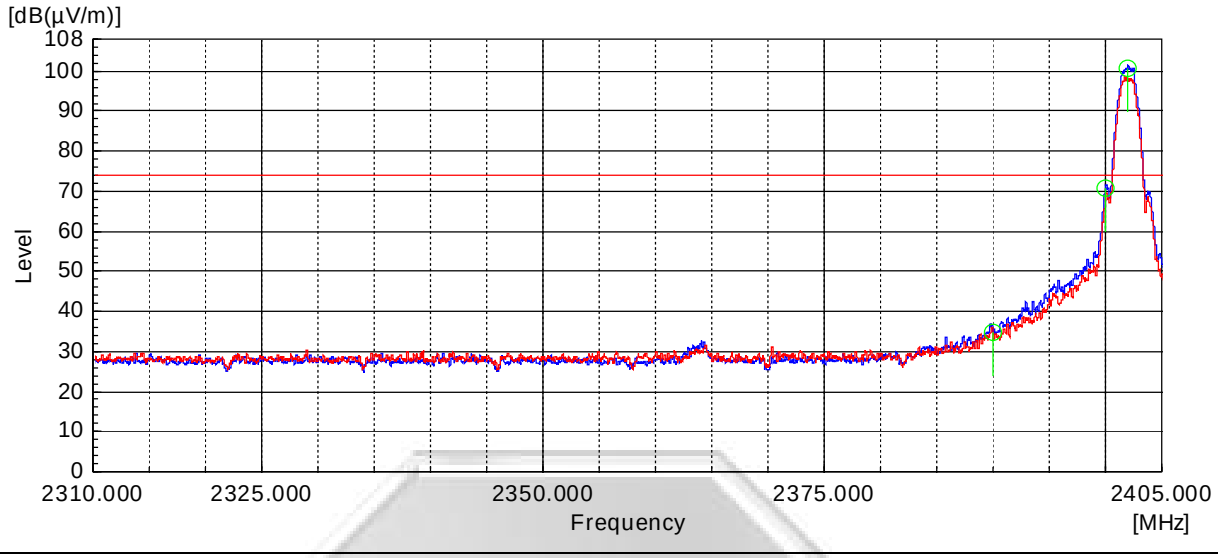
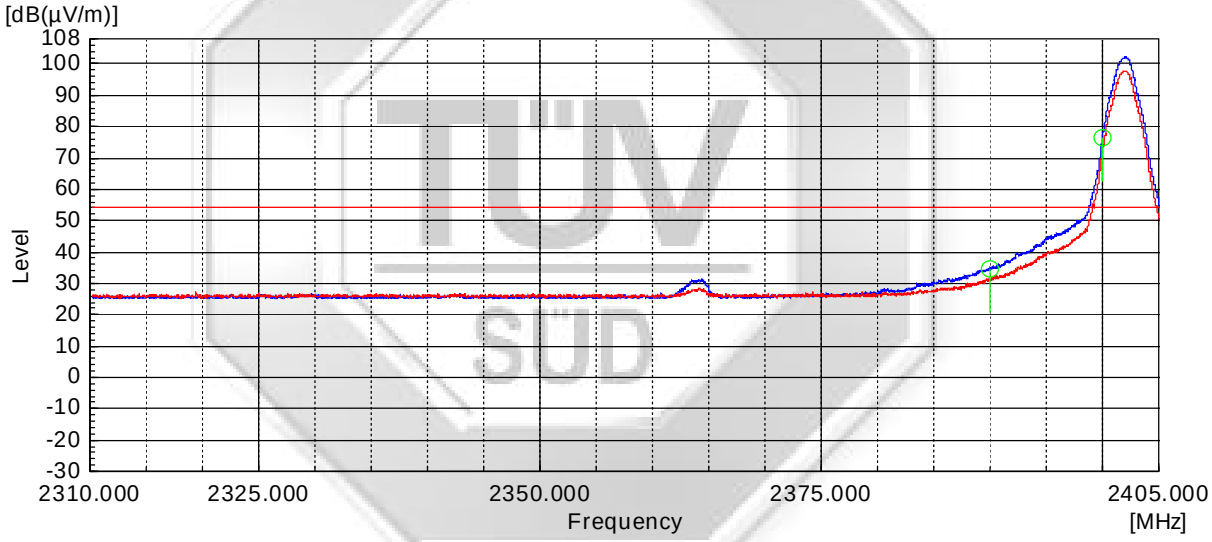
Band Edge Compliance (Radiated) Plots (Restricted Band)



Plot 34 – Peak Plot at Lower Band Edge at 2.4000GHz



Plot 35 – Average Plot at Lower Band Edge at 2.4000GHz

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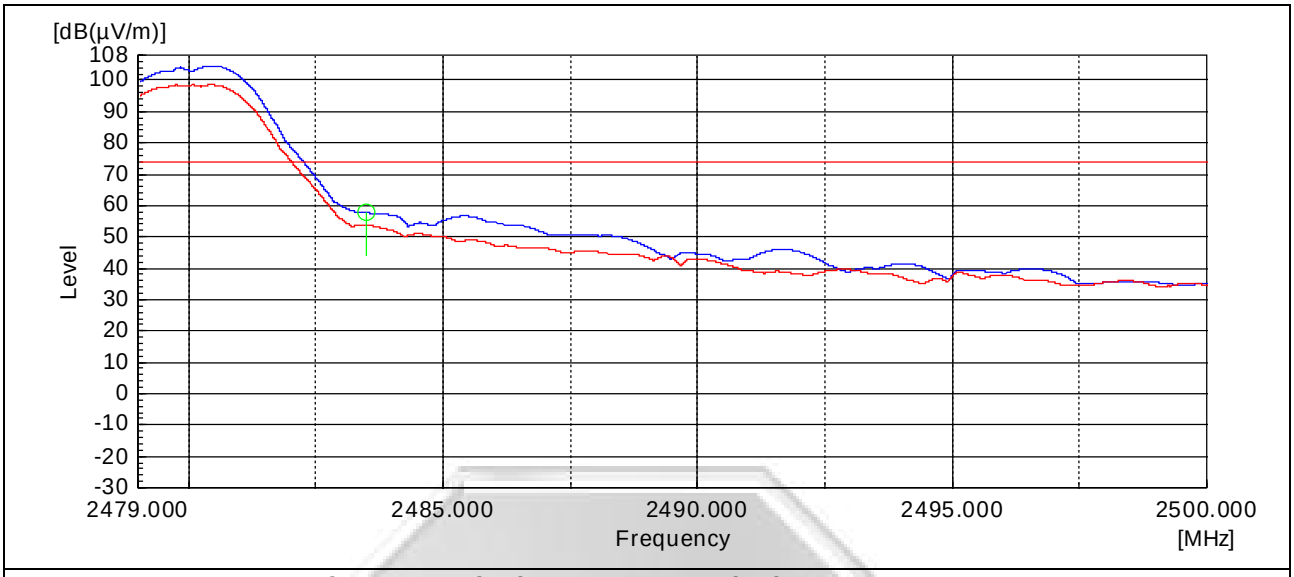
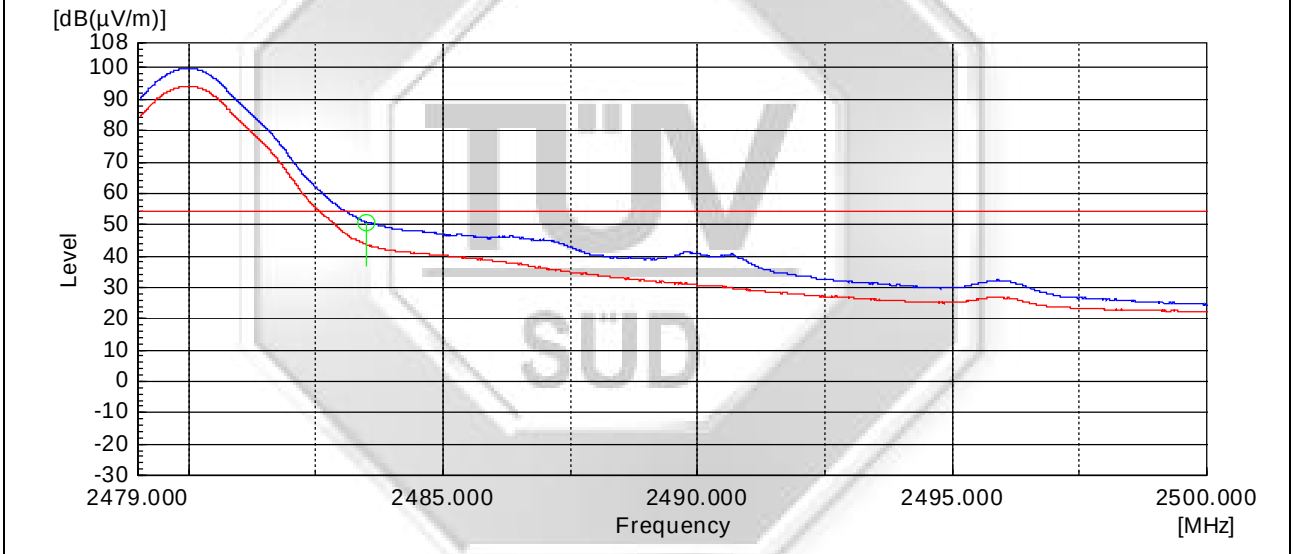
Band Edge Compliance (Radiated) Plots (Restricted Band)



Plot 36 – Peak Plot at Upper Band Edge at 2.4835GHz



Plot 37 – Average Plot at Upper Band Edge at 2.4835GHz

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2.9 Peak Power Spectral Density

2.9.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the peak power spectral density conducted from the intentional radiator (EUT) to the antenna shall not be greater than 8dBm (6.3mW) in any 3kHz band during any time interval of continuous transmission.

2.9.2 Test Setup

2.9.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.9.2.2 The power supply for the EUT was connected to a filtered mains.

2.9.2.3 The RF antenna connector was connected to the spectrum via a low-loss coaxial cable.

2.9.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were set to the following:
RBW = 3kHz
VBW = 3RBW
Span = 1.5 times the channel bandwidth (6dB Bandwidth)
Sweep time = auto couple

2.9.2.5 All other supporting equipment were powered separately from another filtered mains.

2.9.3 Test Method

2.9.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.9.3.2 The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser.

2.9.3.3 The peak power density of the transmitting frequency was plotted and recorded.

2.9.3.4 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.9.3.5 The measurement was repeated with the transmitting frequency was set to middle channel and upper channel respectively.

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2.9.4 Test Results

Test Input Power	24Vdc	Temperature	24ºC
Attached Plots	38 – 40	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	10 Jul 2019

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW) *See Note 1	Limit (mW)
Lower	2.402	0.103	6.3
Middle	2.440	0.101	6.3
Upper	2.480	0.097	6.3

Notes

1.	Only the highest measured peak power spectral density was reported. Refer to plots for all measured peak power spectral density.

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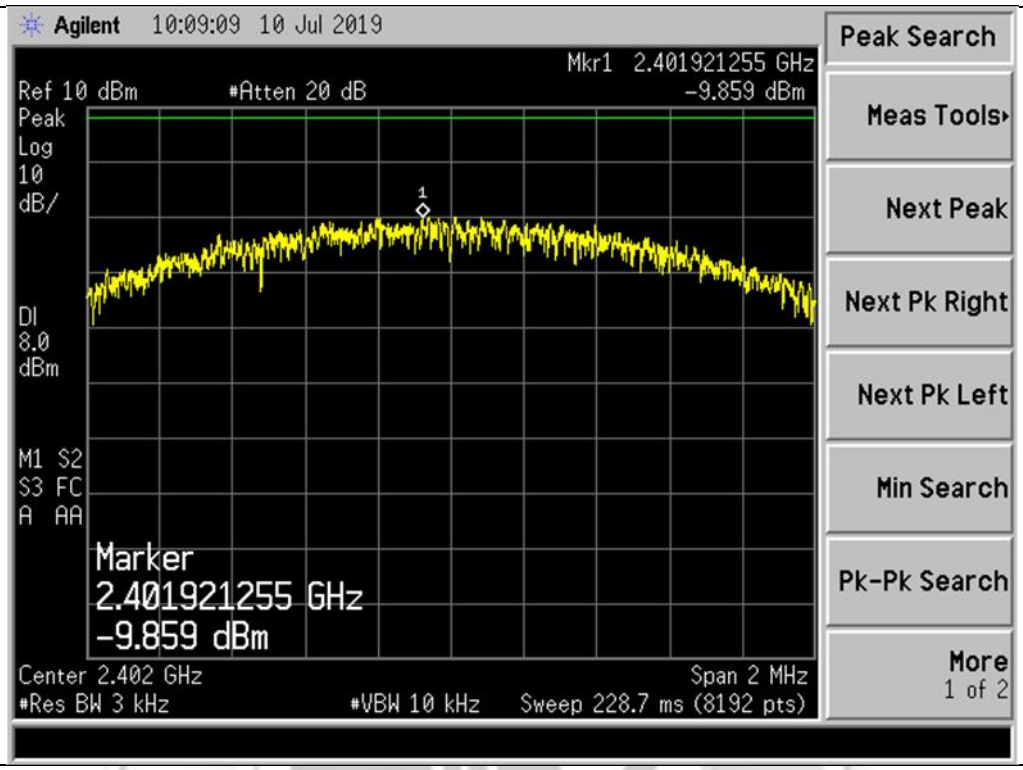
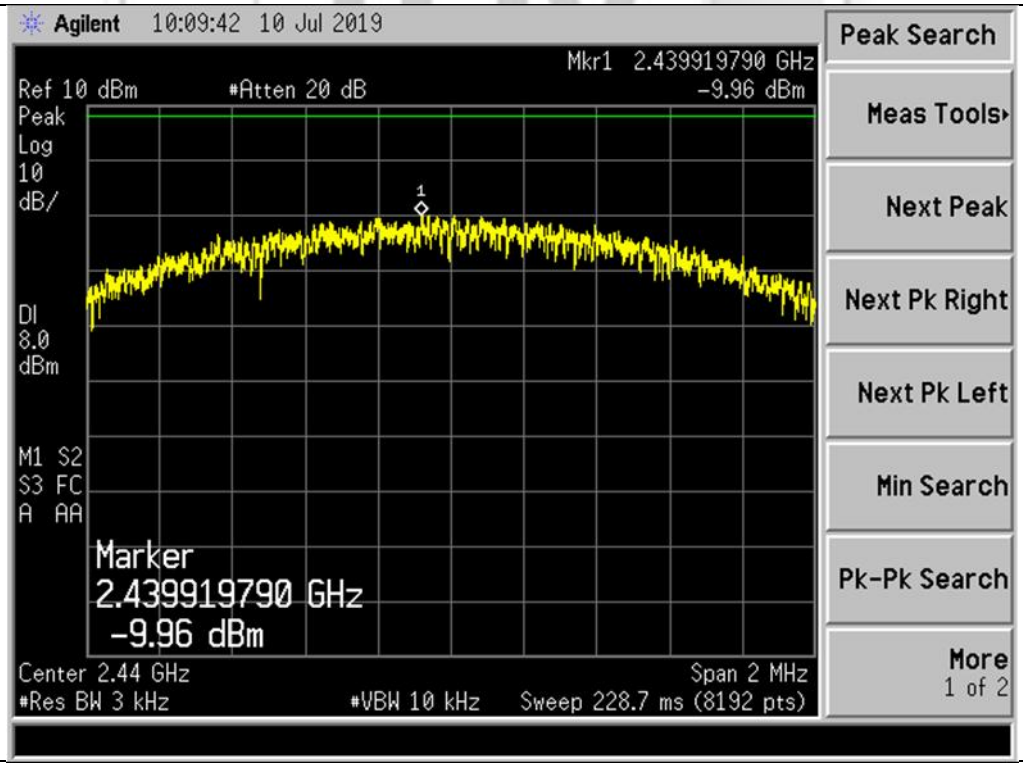
Peak Power Spectral Density Plots



Plot 38 – Lower Channel



Plot 39 – Middle Channel

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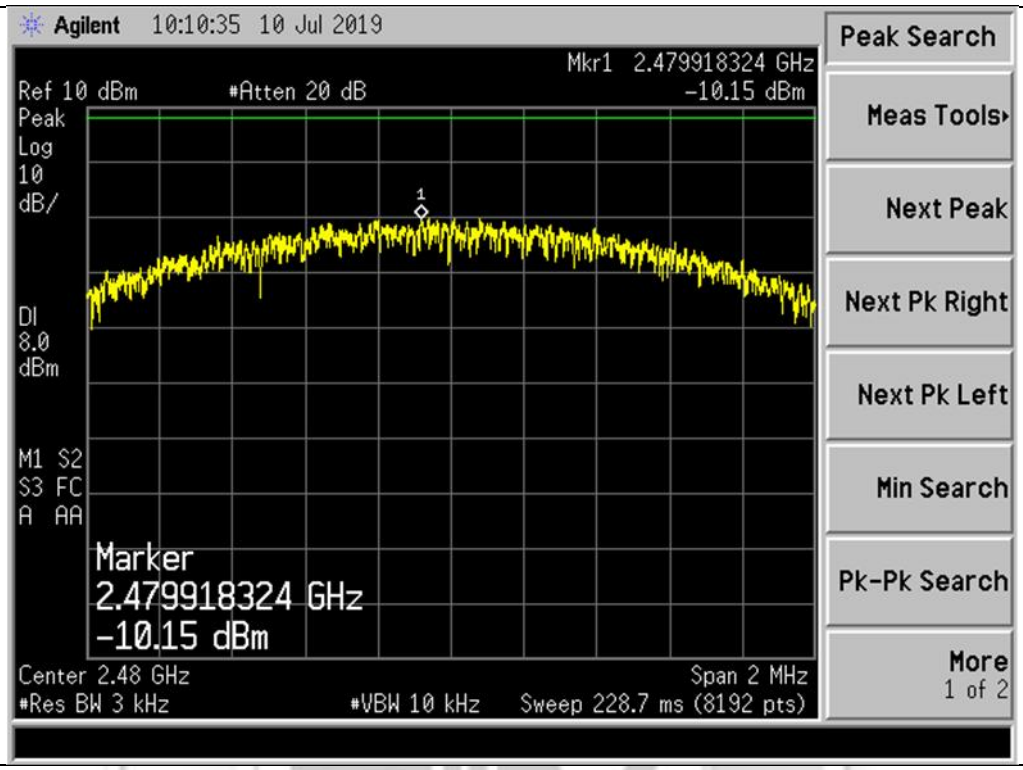
Peak Power Spectral Density Plots



Plot 40 – Upper Channel

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4 Test Equipment

Instrument	Model	S/No	Cal Due Date
Conducted Emissions			
R&S Test Receiver	ESPI3	100349	01 Feb 2020
Agilent EMC Analyzer	E7403A	US41160166	06 Oct 2019
Schaffner LISN	NNB42	00008	08 May 2020
Schaffner LISN (EUT)	NNB42	04/10055	04 Oct 2019
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)			
R&S EMI Test Receiver	ESW44	101661	30 May 2020
Schaffner Bilog Antenna (30MHz-2GHz)	CBL6112B	2597	27 Mar 2020
TDK-RF Horn Antenna	HRN-0118	130256	20 Mar 2020
ETS Horn Antenna (18GHz-40GHz)	3116	0004-2474	07 Jan 2020
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441158	18 Jul 2019
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	15 Jan 2020
Agilent Preamplifier (1GHz-26.5GHz)	8449D	3008A02305	28 Sep 2019
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2019
Spectrum Bandwidth (6dB Bandwidth Measurement), RF Conducted Spurious Emissions (Non-Restricted Bands), Band Edge Compliance (Conducted), Peak Power Spectral Density			
Agilent EMC Analyzer	E7405A	MY40240195	16 Apr 2020
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
Maximum Peak Power			
Boonton RF Power Meter	4532	97701	13 Aug 2019
Boonton Power Sensor	56218-S/1	1414	13 Aug 2019
RF Conducted Spurious Emissions (Restricted Bands)			
Agilent EMC Analyzer	E7405A	MY40240195	16 Apr 2020
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2019
Band Edge Compliance (Radiated)			
R&S EMI Test Receiver	ESW44	101661	30 May 2020
TDK-RF Horn Antenna	HRN-0118	130256	20 Mar 2020
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	15 Jan 2020

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5 Measurement Uncertainty

All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2.

Test Name	Measurement Uncertainty
Conducted Emissions	9kHz to 30MHz, ±2.4dB
Radiated Emissions	9kHz to 30MHz @ 10m, ±2.3dB 30MHz to 1GHz @ 10m, ±4.0dB 30MHz to 1GHz @ 3m, ±5.6dB >1GHz to 40GHz @3m, ±5.0dB
Maximum Permissible Exposure	0.1MHz – 3GHz is ±15.0%

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July 2011

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End of the Test Report

Maximum Public Exposure to RF (MPE) CFR 15.247 (i), CFR 1.1310 (e) & RSS-102, 2.5.2

The maximum exposure level to the public from the RF power of the EUT shall not exceed a power density, **S**, of 1 mW/cm^2 at a distance, d, of 20 cm from the EUT.

Therefore, for:

Maximum Peak Power (dBm) = 9.33 dBm at Zigbee 2450MHz
Peak Power (Watts) = 0.0086 W
Maximum Gain of Transmit Antenna = 3.48 dBi =2.23, numeric
d = Distance = 20 cm = 0.2 m

$S = (PG/ 4 \pi d^2) = EIRP/4A = 0.0086*(2.23)/4*\pi*0.2*0.2$
$= 0.0191/0.5030 = 0.03685$ W/m^2
$= (0.03797$ W/m$^2)$ (1m^2/W) / (0.1 mW/cm^2)
$= 0.3797$ mW/cm^2

which is << less than 1.0 mW/cm^2

RSS-102, 2.5.2 Compliance for 2405 MHz ~ 2480 MHz band:

At or above 300 MHz and below 6 GHz and the source based time averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ in Watts (adjusted for tune-up tolerance where applicable), where f = frequency in MHz.

$1.31 * 10^{-2} * 2450^{0.6834} = 2.71$ W

EUT max EIRP = 9.33 dBm + 3.48 dBi = 12.81 dBm EIRP = 0.0191 W
Which is << than 2.71 W

The MPE limits are below the threshold as stated in KDB447498 D01 V06 in Section 4.3. The calculations above are presented to show that the EUT meets the exclusion requirements.