Report on the Radio Testing of:

BEOREMOTE HALO WALL

Model: 3055

In accordance with
47 CFR FCC Part 15C

PSB Singapore

Add value.
Inspire trust.

Prepared for:
Bang & Olufsen a/s
Bang og Olufsen Allé 1, Struer, 7600 Denmark

COMMERCIAL-IN-CONFIDENCE

Document Number: 7191217919-EEC19/23 | Issue: 01
FCC ID: TTU-HALOWALL

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Foo Kai Maun	20 Dec 2019	
Authorised Signatory	Quek Keng Huat	19 Dec 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.

Laboratory:
TÜV SÜD PSB Pte. Ltd.
No.1 Science Park Drive
Singapore 118221

Phone : +65-6885 1333
Fax : +65-6776 8670
E-mail: enquiries@tuv-sud-psb.sg
www.tuv-sud-psb.sg
Co. Reg : 199002667R

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
1 Science Park Drive, #02-01
Singapore 118221

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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	20 Dec 2019

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1.2 Introduction

Applicant	:	Bang & Olufsen a/s Bang og Olufsen Allé 1, Struer, 7600 Denmark
Manufacturer	:	Same as applicant
Factory	:	PCI Kunshan Electronics Company Limited
Item Number(s)	:	3055
Serial Number(s)	:	32587260
Number of Samples Tested	:	1
Test Sample(s) Condition	:	Good
Quotation Reference	:	5231291
Test Specification/Issue/Date	:	FCC 47 CFR Part 15C
Test Sample(s) Received Date	:	20 Aug 2019
Start of Test	:	20 Aug 2019
Finish of Test	:	02 Oct 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)	Not Tested *See Note 3	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)	Not Tested *See Note 3	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	RF Conducted Spurious Emissions (Restricted Bands)	Not Tested *See Note 3	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	Band Edge Compliance (Conducted)	Not Tested *See Note 3	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	Not Tested *See Note 3	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.35(c)	Duty Cycle Factor Computation	Not Tested *See Note 4	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
2.1091	Maximum Permissible Exposure	Pass	

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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 WLAN module of the Equipment Under Test (EUT) is a FCC certified module. The module was integrated into the main board without modifications in hardware nor firmware. Refer to FCC Grant bearing FCC ID: VPYLBEE59B1LV for details.

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

5. The maximum measured RF power of the Equipment Under Test is 18.6dBm.

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1.4 Product Information

1.4.1 Technical Description

Description	:	The Equipment Under Test(s) (EUT(s)) is a **BBEOREMOTE HALO WALL.**
Microprocessor	:	STMicroelectronics STM32l4S9AII
Operating Frequency	:	Microcontroller: 120MHz Bluetooth Low Energy: 2402MHz – 2480MHz 802.11b/g/n: 2412MHz – 2462MHz 802.11a/n: 5180MHz – 5240MHz, 5260MHz – 5320MHz, 5500MHz – 5720MHz, 5745MHz – 5825MHz
Clock / Oscillator Frequency	:	16MHz
Modulation	:	Bluetooth Low Energy: Gaussian Frequency Shift Keying (GFSK) 802.11b: Direct Sequence Spread Spectrum (DSSS) 802.11g: Orthogonal Frequency Division Multiplexing (OFDM) 802.11a: Orthogonal Frequency Division Multiplexing (OFDM) 802.11n: Orthogonal Frequency Division Multiplexing (OFDM)
Antenna Gain	:	1.66dBi (BLE) 1.66dBi (2.4GHz WLAN) 4.79dBi (5GHz WLAN)
Port / Connectors	:	1 x USB-C Port (USB SHIELDED I/O RECP TYPE C)
Rated Power	:	DC 12 – 30V 0.5A
Accessories	:	Nil

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1.4.2 Test Configuration and Modes of Operation

<table>
<tr><th>Mode(s)</th><th>Description</th></tr>
<tr><td>Maximum RF power transmission</td><td>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.
<table>
<tr><th>Transmit Channel</th><th>Frequency (GHz)</th></tr>
<tr><td>Channel 1 (Lower Channel)</td><td>2.412</td></tr>
<tr><td>Channel 6 (Middle Channel)</td><td>2.437</td></tr>
<tr><td>Channel 11 (upper Channel)</td><td>2.462</td></tr>
</table>
</td></tr>
</table>

1.5 Deviations from the Standard

Nil.

1.6 EUT Modification Record

No modifications were made.

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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-10203 (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)
Fujitsu Lifebook	M/N: SH560 S/N: R0400172 FCC ID: EJE-WB0001	Nil
Fujitsu AC Adaptor	M/N: CP311808-01 S/N: 08903690B FCC ID: DoC	1.80m 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	24ºC
Line Under Test	AC Mains	Relative Humidity	60%
Worst Mode	802.11b (11Mbps)	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	04 Sep 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)
0.1508	43.4	66.0	22.6	30.5	56.0	25.5	Live	1
0.1795	42.5	64.5	22.0	29.5	54.5	25.0	Neutral	1
0.2131	36.8	63.1	26.3	24.1	53.1	29.0	Neutral	1
0.2514	35.9	61.7	25.8	22.5	51.7	29.2	Live	1
0.5186	31.9	56.0	24.1	22.0	46.0	24.0	Neutral	1
0.7396	28.3	56.0	27.7	16.0	46.0	30.0	Live	1

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	120V 60Hz	Temperature	22ºC
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	56%
Worst Mode	802.11b (11Mbps)	Atmospheric Pressure	1029mbar
		Tested By	Dylan Lin
		Test Date	22 Aug 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)
31.0290	25.2	40.0	14.8	400	110	H	1
32.4000	23.8	40.0	16.2	299	2	V	1
94.9540	22.7	43.5	20.8	100	208	H	1
657.2040	29.4	46.0	16.6	100	274	V	1
874.7460	31.6	46.0	14.4	299	11	V	1
965.2220	32.5	54.0	21.5	100	310	V	1

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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
1.0481	36.2	74.0	37.8	24.6	54.0	29.4	200	94	H	1
1.5951	43.3	74.0	30.7	25.3	54.0	28.7	398	177	H	1
2.2104	38.6	74.0	35.4	27.4	54.0	26.6	200	344	V	1
4.8243	40.3	74.0	33.7	36.5	54.0	17.5	300	351	V	1
7.2325	61.1	74.0	12.9	50.0	54.0	4.0	398	5	H	1
12.0606	56.1	74.0	17.9	47.8	54.0	6.2	102	8	V	1

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
1.6218	39.1	74.0	34.9	25.3	54.0	28.7	300	296	H	6
1.0238	35.8	74.0	38.2	24.6	54.0	29.4	200	293	V	6
1.2068	36.0	74.0	38.0	23.9	54.0	30.1	200	141	V	6
2.0072	42.1	74.0	31.9	26.4	54.0	27.6	300	345	V	6
9.6477	53.1	74.0	20.9	51.8	54.0	2.2	200	25	V	6
16.6770	60.5	74.0	13.5	43.4	54.0	10.6	398	32	V	6

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
1.0654	40.5	74.0	33.5	25.1	54.0	28.9	200	50	H	11
1.3478	45.0	74.0	29.0	24.6	54.0	29.4	398	44	V	11
1.4690	40.5	74.0	33.5	24.9	54.0	29.1	398	71	V	11
2.5116	43.3	74.0	30.7	35.4	54.0	18.6	200	308	H	11
7.2357	61.1	74.0	12.9	49.9	54.0	4.1	200	5	H	11
12.0583	56.1	74.0	17.9	44.2	54.0	9.8	300	353	H	11

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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 RSS-GEN 6.4 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 Maximum Peak Power

2.3.1 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).

2.3.2 Test Setup

2.3.2.1 The EUT and supporting equipment were set up as shown in the setup 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 a power meter.

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

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

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

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2.3.4 Test Results

Test Input Power	120V 60Hz	Temperature	24ºC
Antenna Gain	1.66 dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit
		Test Date	04 Sep 2019

802.11b

Channel	Channel Frequency (GHz)	Maximum Conducted Output Power (W)			Limit (W)
		1Mbps	2Mbps	11Mbps	
Lower	2.412	0.062	0.071	0.072	1.0
Middle	2.437	0.062	0.072	0.071	1.0
Upper	2.462	0.061	0.065	0.067	1.0

802.11g

Channel	Channel Frequency (GHz)	Maximum Conducted Output Power (W)				Limit (W)
		9Mbps	18Mbps	36Mbps	54Mbps	
Lower	2.412	0.051	0.054	0.054	0.053	1.0
Middle	2.437	0.047	0.050	0.050	0.049	1.0
Upper	2.462	0.044	0.049	0.048	0.049	1.0

802.11n

Channel	Channel Frequency (GHz)	Maximum Conducted Output Power (W)				Limit (W)
		6.5Mbps	19.5Mbps	39Mbps	65Mbps	
Lower	2.412	0.051	0.055	0.055	0.068	1.0
Middle	2.437	0.051	0.052	0.052	0.065	1.0
Upper	2.462	0.051	0.049	0.048	0.064	1.0

Notes

1.	Only the highest measured peak power were reported.

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2.4 Band Edge Compliance (Radiated)

2.4.1 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.

2.4.2 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 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

2.4.2.4 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.

2.4.3.2 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.

2.4.3.3 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.

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

2.4.3.5 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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2.4.4 Test Results

Test Input Power	120V 60Hz	Temperature	22ºC
Attached Plots	1 - 6	Relative Humidity	56%
		Atmospheric Pressure	1029mbar
		Tested By	Dylan Lin
		Test Date	22 Aug 2019

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

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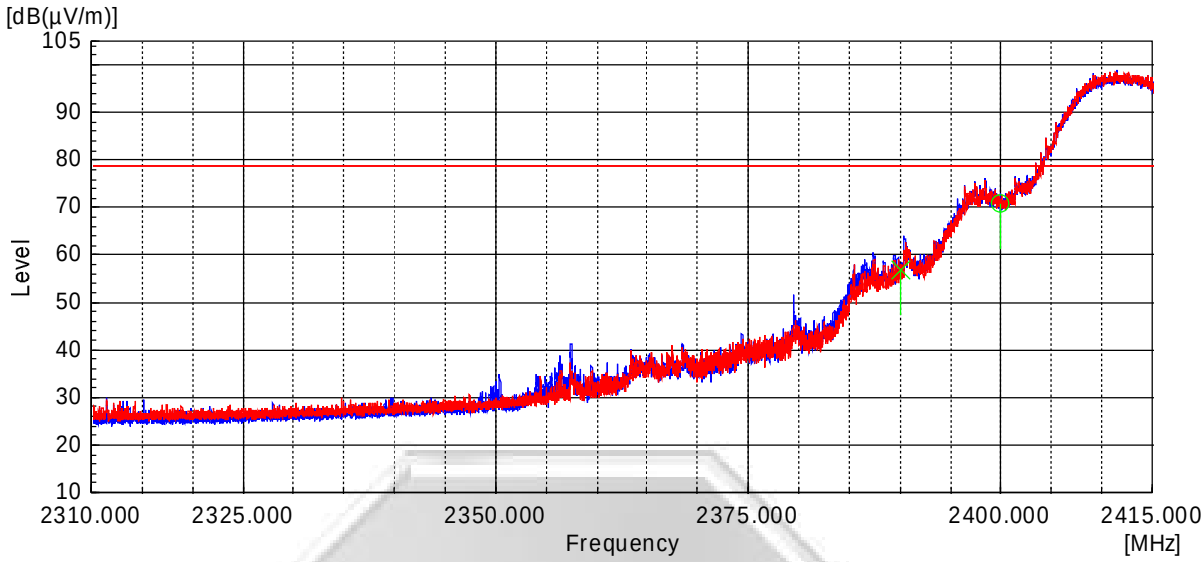
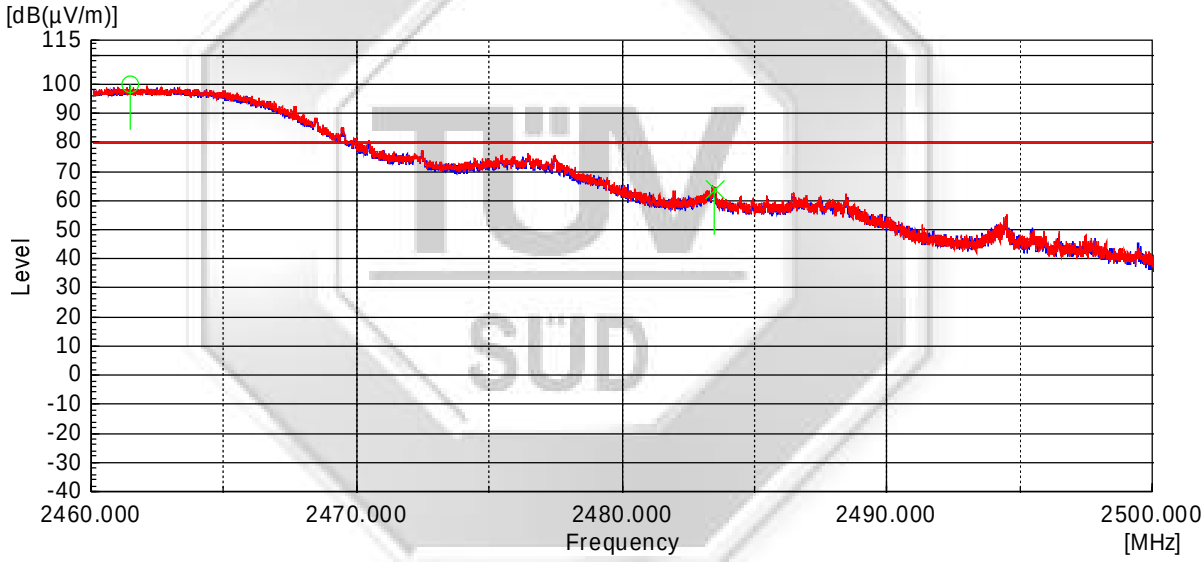
Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge)



Plot 1 – Lower Band Edge at 2.4000GHz



Plot 2 – Upper Band Edge at 2.4835GHz

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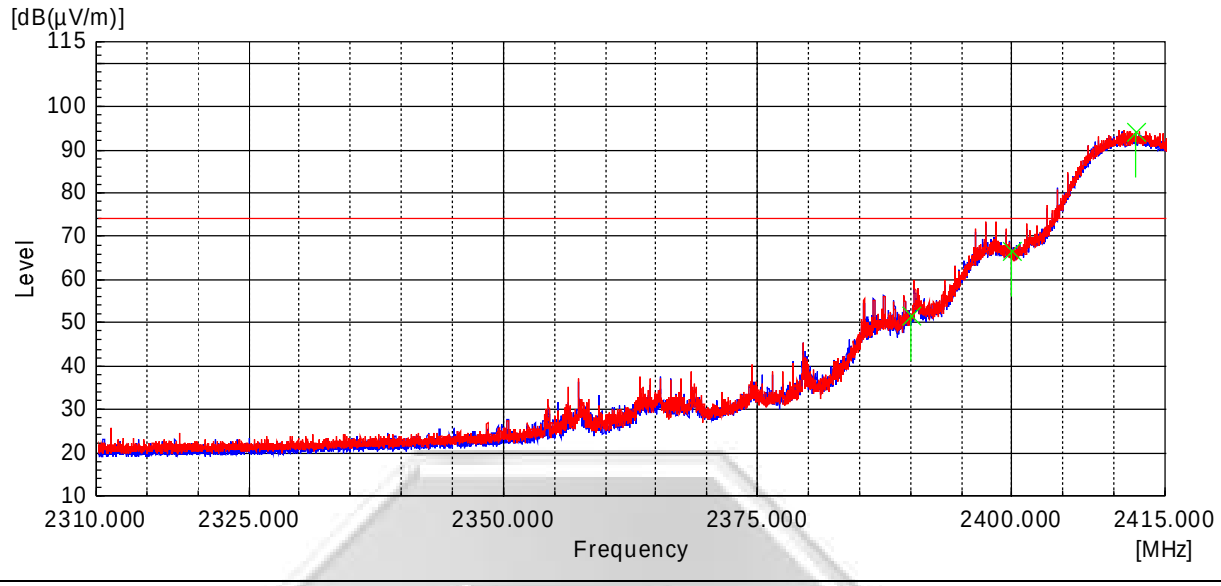
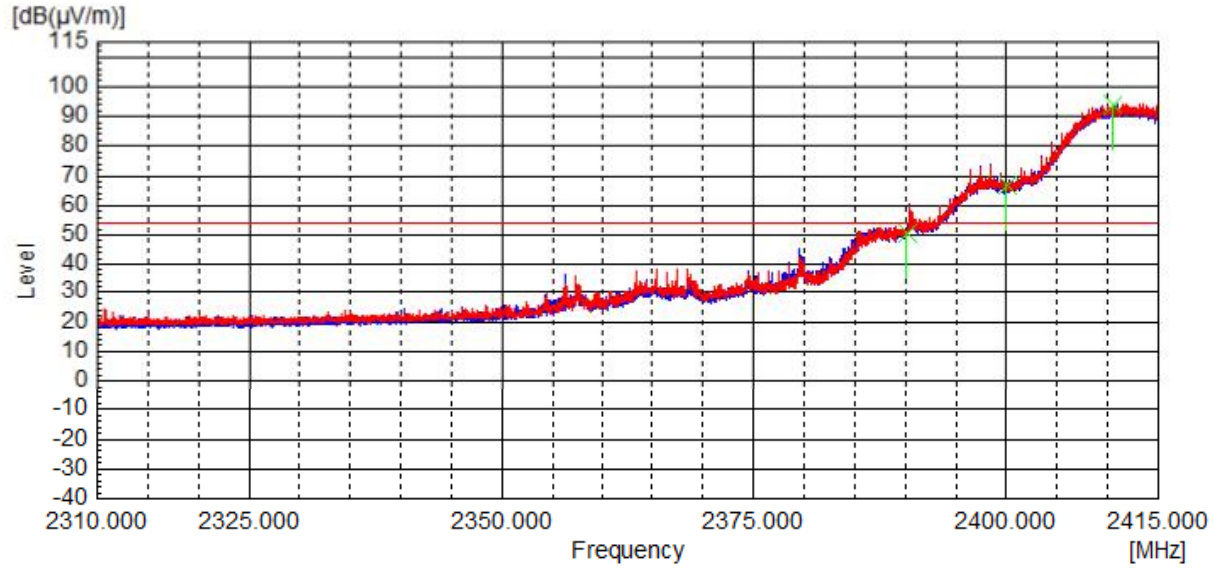
Band Edge Compliance (Radiated) Plots (Restricted Band)



Plot 3 – Peak Plot at Lower Band Edge at 2.4000GHz



Plot 4 – Average Plot at Lower Band Edge at 2.4000GHz

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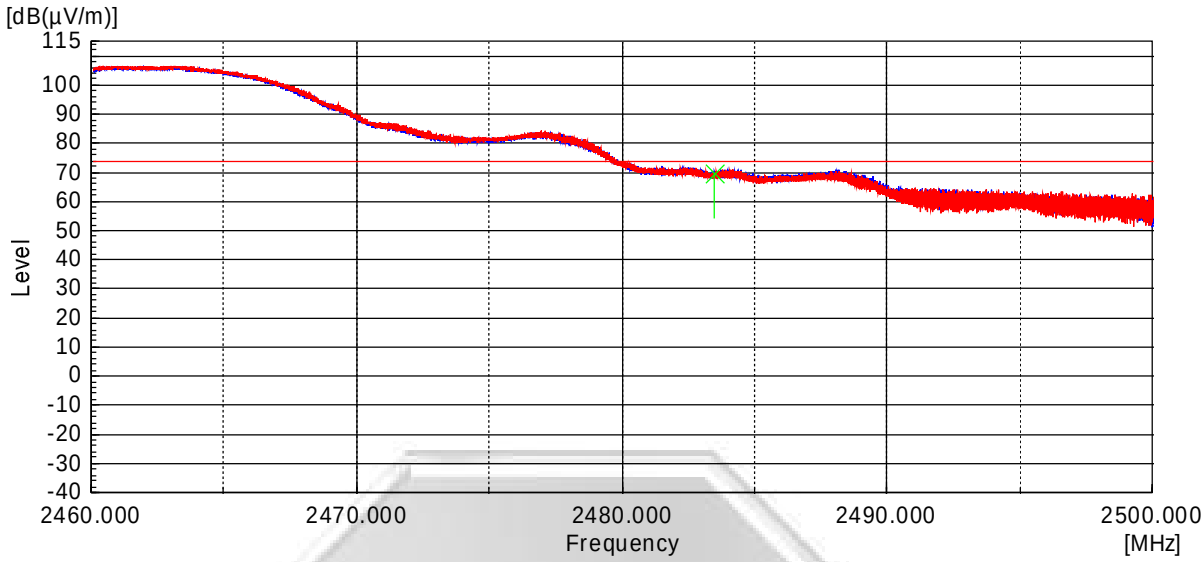
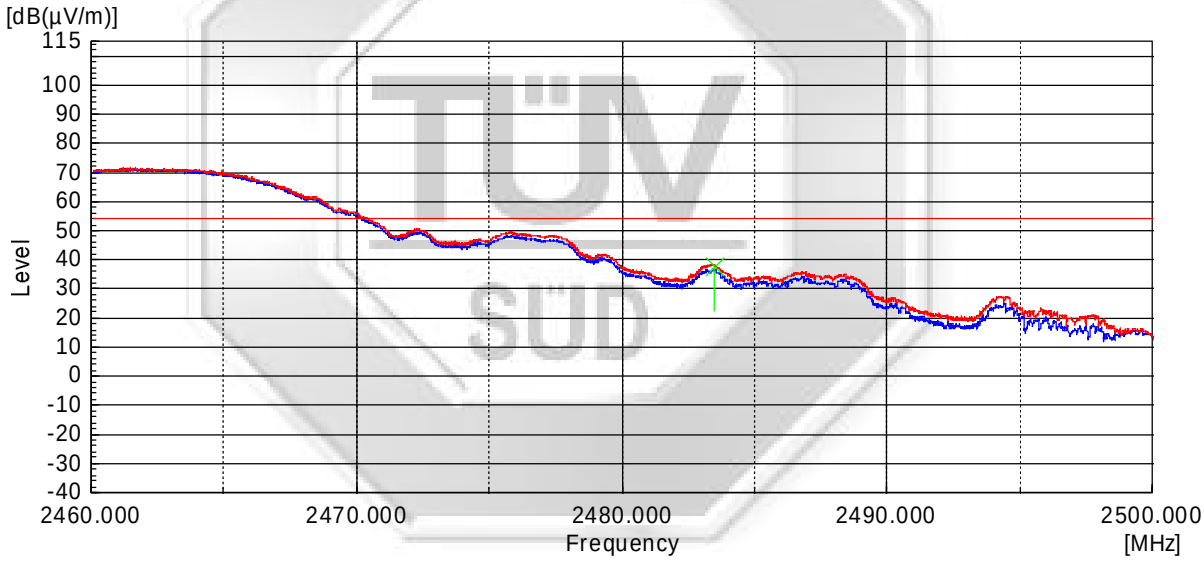
Band Edge Compliance (Radiated) Plots (Restricted Band)



Plot 5 – Peak Plot at Upper Band Edge at 2.4835GHz



Plot 6 – Average Plot at Upper Band Edge at 2.4835GHz

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2.5 Maximum Permissible Exposure (MPE)

2.5.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (min)
0.3 - 1.34	614	1.63	100 Note 2	30
1.34 - 30	824 / f	2.19 / f	$180 / f^2$ Note 2	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f / 1500	30
1500 - 100000	-	-	1.0	30
Notes				
1. f = frequency in MHz				
2. Plane wave equivalent power density				

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2.5.2 Test Setup

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

2.5.2.2 The relevant field probe was positioned at least 20cm away from the EUT and supporting equipment boundary.

2.5.3 Test Method

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

2.5.3.2 The test was first carried out at one of the positions / sides of the EUT.

2.5.3.3 Power density measurement (mW/cm^2) was made using the field meter set to the required averaging time.

2.5.3.4 Measurements were repeated for the next position and its associate EUT operating mode, until all possible positions and modes were measured.

Sample Calculation Example

At 2400 MHz, limit = 1.0 mW/cm^2
Power density reading obtained directly from field meter = 0.3 mW/cm^2 averaged over the required 30 minutes.
Therefore, margin = 0.3 – 1.0 = -0.7 mW/cm^2 i.e. 0.7 mW/cm^2 below limit

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2.5.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Test Distance	20cm	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Anthony Toh
		Test Date	18 Sep 2019

Channel	Channel Frequency (GHz)	Power Density Value (mW/cm^2)	Margin (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)
Lower	2.412	0.44	0.56	30	1.0
Middle	2.437	0.43	0.57	30	1.0
Upper	2.462	0.42	0.58	30	1.0

Notes

1.	All possible modes of operation were investigated. Only the worst case highest radiation levels were measured. Measurements were taken at the required averaging time. All other radiation levels 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.

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4 Test Equipment

Instrument	Model	S/No	Cal Due Date
Conducted Emissions			
Schaffner EMI Receiver	SMR4503	40	24 Jul 2020
Agilent EMC Analyzer	E7403A	US41160166	17 Jun 2020
Schaffner LISN (EUT)	NNB42	04/10055	04 Jan 2020
EMCO LISN (for supporting)	3825/2	9309-2127	06 Jan 2020
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)			
R&S EMI Test Receiver	ESR26	101671	14 Mar 2020
EMCO Loop Antenna	6502	9108-2673	13 Nov 2019
Schaffner Bilog Antenna (30MHz-2GHz)	CBL6112B	2597	27 Mar 2020
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	18 Jul 2020
TDK-RF Horn Antenna	HRN-0118	130256	20 Mar 2020
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	15 Jan 2020
ETS Horn Antenna (18GHz-40GHz)	3116	0004-2474	07 Jan 2020
Agilent Preamplifier (1GHz-26.5GHz)	8449D	3008A02305	28 Dec 2019
Micro-Tronics Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Nov 2019
Maximum Peak Power			
Boonton Electronics RF Power Meter	4532	97701	13 Nov 2019
Boonton Electronics Peak Power Sensor	56218-S/1	1417	13 Nov 2019
Band Edge Compliance (Radiated)			
R&S EMI Test Receiver	ESR26	101671	14 Mar 2020
TDK-RF Horn Antenna	HRN-0118	130256	20 Mar 2020
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	15 Jan 2020
Maximum Permissible Exposure (MPE)			
PMM Portable Field Meter	PMM8053	0220J10308	07 Mar 2021
PMM Electric Field Probe	EP183	0000J10206	07 Mar 2021

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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%