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TEST REPORT

Report No.: 23010135HKG-002

iopool SA

Application For Original Grant of 47 CFR Part 15 Certification

Wi-Fi gateway for swimming pool equipment

FCC ID: 2AVNQGTW-V3

Prepared and Checked by:	**Approved by:**
Signed on File Wong Cheuk Ho, Herbert Lead Engineer	Digitally signed by Kenneth Wong Location: Intertek Testing Services Hong Kong Limited Wong Kwok Yeung, Kenneth Assistant Supervisor Date: April 24, 2023

TEST REPORT

GENERAL INFORMATION

Grantee:	iopool SA
Grantee Address:	Avenue du Pre Aily 24 Liege, 4031 Belgium.
FCC Specification Standard:	FCC Part 15, October 1, 2021 Edition
FCC ID:	2AVNQGTW-V3
FCC Model(s):	cOnnect
Type of EUT:	Spread Spectrum Transmitter
Description of EUT:	Wi-Fi gateway for swimming pool equipment
Brand Name:	iopool
Serial Number:	N/A
Sample Receipt Date:	January 05, 2023
Date of Test:	January 05, 2023 to April 04, 2023
Report Date:	April 24, 2023
Environmental Conditions:	Temperature: +10 to 40°C Relative Humidity: 10 to 90%
Conclusion:	Test was conducted by client submitted sample. The submitted sample as received complied with the 47 CFR Part 15 Certification.

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SUMMARY OF TEST RESULT

Test Items	FCC Part 15 Section	Results
Antenna Requirement	15.203	Complied
Max. Conducted Output Power (Peak)	15.247(b)(3)&(4)	Complied
Min. 6dB RF Bandwidth	15.247(a)(2)	Complied
Max. Power Density (Average)	15.247(e)	Complied
Out of Band Antenna Conducted Emission	15.247(d)	Complied
Radiated Emission in Restricted Bands and Spurious Emissions	15.247(d), 15.209 & 15.109	Complied
AC Power Line Conducted Emission	15.207 & 15.107	Complied

Note: Pursuant to FCC Part 15 Section 15.215(c), the 20dB bandwidth of the emission was contained within the frequency band designated (mentioned as above) which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over expected variations in temperature and supply voltage were considered.

The equipment under test is found to be complying with the following standards:

FCC Part 15, October 1, 2021 Edition

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EXHIBIT 1 GENERAL DESCRIPTION

1.1 Product Description

The cOnnect is a Wi-Fi gateway for swimming pool equipment with Bluetooth BLE feature.

For wifi portion, the Equipment Under Test (EUT) operates at frequency range of 2412MHz to 2462MHz with 11 channels.

For IEEE 802.11b mode, it operates at frequency range of 2412.000MHz to 2462.000MHz with 11 channels. It transmits via Direct-sequence spread spectrum (DSSS) modulation. Maximum bit rate can be up to 11Mbps.

For IEEE 802.11g mode, it operates at frequency range of 2412.000MHz to 2462.000MHz with 11 channels. It transmits via Orthogonal Frequency Division Multiplexing (OFDM) modulation. Maximum bit rate can be up to 54Mbps.

For IEEE 802.11n (with 20MHz bandwidth) mode, it operates at frequency range of 2412.000MHz to 2462.000MHz with 11 channels. It transmits via Orthogonal Frequency Division Multiplexing (OFDM) modulation. Maximum bit rate can support up to 65Mbps.

For IEEE 802.11n (with 40MHz bandwidth) mode, it operates at frequency range of 2422.000MHz to 2452.000MHz with 7 channels. It transmits via Orthogonal Frequency Division Multiplexing (OFDM) modulation. Maximum bit rate can support up to 65Mbps.

The EUT is powered by AC/DC Adaptor.

The antenna(s) used in the EUT is external with unique connector (SMA Male Reverse).
Peak Antenna Gain: 2.7dBi

The circuit description is saved with filename: descri.pdf.

1.2 Test Methodology

Both AC power line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Preliminary radiated scans and all radiated measurements were performed in radiated emission test sites. All Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.
Antenna port conducted measurements were performed according to ANSI C63.10 (2013) and KDB Publication No. 558074 D01 v05r02 (April 02, 2019) All other measurements were made in accordance with the procedures in 47 CFR Part 2.

1.3 Test Facility

The radiated emission test site and antenna port conducted measurement facility used to collect the radiated data and conductive data are at Workshop No. 3, G/F., World-Wide Industrial Centre, 43-47 Shan Mei Street, Fo Tan, Sha Tin, N.T., Hong Kong SAR, China. This test facility and site measurement data have been fully placed on file with the FCC Designation No. "HK0005".

1.4 Related Submittal(s) Grants

This is a single application for certification of a transceiver (WiFi Portion).

TEST REPORT

EXHIBIT 2 SYSTEM TEST CONFIGURATION

2.1 Justification

For radiated emissions testing, the equipment under test (EUT) was setup to transmit / receive continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, all cables (if any) were manipulated to produce worst case emissions.

The EUT was powered by 120VAC during test.

For the measurements, the EUT was attached to a plastic stand if necessary and placed on the wooden turntable at 0.8m height from the ground plane for emission testing at or below 1GHz and 1.5m for emission measurements above 1GHz.

The signal was maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization were varied during the search for maximum signal level. The antenna height was varied from 1 to 4 meters. Radiated emissions were taken at three meters unless the signal level was too low for measurement at that distance. If necessary, a pre-amplifier was used and/or the test was conducted at a closer distance.

For any intentional radiator powered by AC power line, measurements of the radiated signal level of the fundamental frequency component of the emission was performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.

Radiated emission measurement for transmitter were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Emission that are directly caused by digital circuits in the transmit path and transmitter portion were measured, and the limit are according to FCC Part 15 Section 15.209. Digital circuitries used to control additional functions other than the operation of the transmitter are subject to FCC Part 15 Section 15.109 Limits.

TEST REPORT

2.1 Justification (Cont'd)

Detector function for radiated emissions was in peak mode. Average readings, when required, were taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings. A detailed description for the calculation of the average factor can be found in section 4.8.3.

Determination of pulse desensitization was made according to *Hewlett Packard Application Note 150-2, Spectrum Analysis... Pulsed RF.* The effective period (Teff) was referred to Exhibit 4.8.3. With the resolution bandwidth 1MHz and spectrum analyzer IF bandwidth 3dB, the pulse desensitization factor was 0dB.

For AC power line-conducted emission test, the EUT along with its peripherals were placed on a 1.0m(W)x1.5m(L) and 0.8m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane. The EUT was connected to power mains through a line impedance stabilization network (LISN), which provided 50ohm coupling impedance for measuring instrument. The LISN housing, measuring instrument case, reference ground plane, and vertical ground plane were bounded together. The excess power cable between the EUT and the LISN was bundled.

All connecting cables of EUT and peripherals were manipulated to find the maximum emission.

Different data rates have been tested. Worst case is reported only.

All relevant operation modes have been tested, and the worst-case data is included in this report.

For simultaneous transmission, both WiFi and Bluetooth portions are also switched on when taking radiated emission for determining worst-case spurious emission.

2.2 EUT Exercising Software

The EUT exercise program (Tera Terms Version 4.57) used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use.

2.3 Details of EUT and Description of Accessories

Details of EUT:

An AC/DC Adaptor (provided with the unit) was used to power the device.
Their descriptions are listed below.

(1) An AC adaptor (Input 100-240VAC 0.25A 50/60Hz to Output: 5VDC 1A, Model: KA06E-0501000US)
(2) USB cable in length of 2m
(Provided by Applicant)

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2.4 Measurement Uncertainty

Decision Rule for compliance: For FCC/IC standard, the measured value must be within the limits of applicable standard without accounting for the measurement uncertainty. For EN/IEC/HKTA/HKTC standard, conformity rules will be used as per standard directly excepted EN/IEC 61000-3-2, EN/IEC 61000-3-3, HKTA1004, HKCA1008, HKTA1019, HKTA1020, HKTA1041 and HKTA1044. For these excepted or not mentioned standards, Cl 4.2.2 of ILAC-G8:09/2019 decision rules will be reference and guard band will be equal to our measurement uncertainty with 95% confidence level (k=2). In case, the measured value is within guard band region, undetermined decision will be used.

Uncertainty and Compliance - Unless the standard specifically states that measured values are to be extended by the measurement uncertainty in determining compliance, all compliance determinations are based on the actual measured value.

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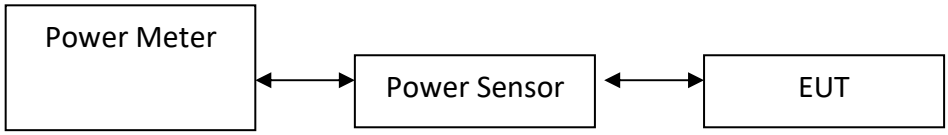
EXHIBIT 3 TEST RESULTS

3.1 Maximum Conducted (Peak) Output Power at Antenna Terminals

RF Conduct Measurement Test Setup

The figure below shows the test setup, which is utilized to make these measurements.



The antenna port of the EUT was connected to the input of a spectrum analyzer.

☒ The antenna power of the EUT was connected to the input of a power meter. Power was read directly and cable loss correction was added to the reading to the obtain power at the EUT antenna terminals. The measurement procedure 8.3.2.3 was used.

☐ The EUT should be configured to transmit continuously (at a minimum duty cycle of 98%) at full power over the measurement duration. The measurement procedure AVG1 was used.

IEEE 802.11b (DSSS, 1 Mbps) Peak Antenna Gain = 2.7 dBi

Frequency (MHz)		Output in dBm	Output in mW
Low Channel:	2412	5.8	3.8
Middle Channel:	2437	5.2	3.3
High Channel:	2462	6.2	4.2

IEEE 802.11g (DSSS, 1 Mbps) Antenna Gain = 2.7 dBi

Frequency (MHz)		Output in dBm	Output in mW
Low Channel:	2412	4.2	2.6
Middle Channel:	2437	3.8	2.4
High Channel:	2462	4.4	2.8

IEEE 802.11n (20MHz) (DSSS, 1 Mbps) Antenna Gain = 2.7 dBi

Frequency (MHz)		Output in dBm	Output in mW
Low Channel:	2412	4.6	2.9
Middle Channel:	2437	4.5	2.8
High Channel:	2462	4.8	3.0

IEEE 802.11n (40MHz) (DSSS, 1 Mbps) Antenna Gain = 2.7 dBi

Frequency (MHz)		Output in dBm	Output in mW
Low Channel:	2412	4.2	2.6
Middle Channel:	2437	4.6	2.9
High Channel:	2462	4.8	3.0

TEST REPORT

3.1 Maximum Conducted (Peak) Output Power at Antenna Terminals (Cont'd)

Cable loss: 0.5dB External Attenuation: 0dB

Cable loss, external attenuation: ☒ included in OFFSET function
☐ added to SA raw reading

IEEE 802.11b (DSSS, 1 Mbps)
Max. Conducted (Peak) Output Level = 6.2dBm

IEEE 802.11g (OFDM, 9 Mbps)
Max. Conducted (Peak) Output Level = 4.4dBm

IEEE 802.11n (20MHz) (OFDM, MCS0)
Max. Conducted (Peak) Output Level = 4.8dBm

IEEE 802.11n (40MHz) (OFDM, MCS0)
Max. Conducted (Peak) Output Level = 4.8dBm

Limits:

☒ 1W (30dBm) for antennas with gains of 6dBi or less.

☐ _____W (_____dBm) for antennas with gains more than 6dBi.

The plots of Maximum Conducted (Average) Output Power are saved in TestData.pdf.

TEST REPORT

3.2 Minimum 6dB RF Bandwidth

The antenna port of the EUT was connected to the input of a spectrum analyzer. The EBW measurement procedure was used. A PEAK output reading was taken, a DISPLAY line was drawn 6dB lower than PEAK level. The 6dB bandwidth was determined from where the channel output spectrum intersected the display line.

IEEE 802.11b (DSSS, 1 Mbps)

Frequency (MHz)		6dB Bandwidth (MHz)
Low Channel:	2412	9.0
Middle Channel:	2437	9.9
High Channel:	2462	8.0

IEEE 802.11g (OFDM, 6 Mbps)

Frequency (MHz)		6dB Bandwidth (MHz)
Low Channel:	2412	16.6
Middle Channel:	2437	16.6
High Channel:	2462	16.5

IEEE 802.11n (20MHz) (OFDM, MCS0)

Frequency (MHz)		6dB Bandwidth (MHz)
Low Channel:	2412	17.2
Middle Channel:	2437	17.1
High Channel:	2462	17.2

IEEE 802.11n (40MHz) (OFDM, MCS0)

Frequency (MHz)		6dB Bandwidth (MHz)
Low Channel:	2412	32.7
Middle Channel:	2437	31.5
High Channel:	2462	31.4

Limits:

6dB bandwidth shall be at least 500kHz.

The plots of 6dB RF bandwidth are saved TestData.pdf.

TEST REPORT

3.3 Minimum Power Spectral Density

Antenna output of the EUT was coupled directly to spectrum analyzer. The measurement procedure 10.2 PKPSD was used. If an external attenuator and/or cable was used, these losses are compensated for using the OFFSET function of the analyser.

IEEE 802.11b (DSSS, 1 Mbps)

Frequency (MHz)		PSD in 100kHz (dBm)
Low Channel:	2412	5.547
Middle Channel:	2437	5.132
High Channel:	2462	5.927

IEEE 802.11g (OFDM, 6 Mbps)

Frequency (MHz)		PSD in 100kHz (dBm)
Low Channel:	2412	-0.225
Middle Channel:	2437	-0.999
High Channel:	2462	-1.037

IEEE 802.11n (20MHz) (OFDM, MCS0)

Frequency (MHz)		PSD in 100kHz (dBm)
Low Channel:	2412	-1.445
Middle Channel:	2437	-1.167
High Channel:	2462	-1.073

IEEE 802.11n (40MHz) (OFDM, MCS0)

Frequency (MHz)		PSD in 100kHz (dBm)
Low Channel:	2412	-4.426
Middle Channel:	2437	-4.515
High Channel:	2462	-3.832

Cable Loss: 0.5dB

Limit: 8dBm in 3kHz

The plots of power spectral density are as TestData.pdf.

TEST REPORT

3.4 Out of Band Conducted Emissions

For IEEE 802.11b/g/n20/n40MHz, the maximum conducted (peak) output power was used to demonstrate compliance as described in 9.1. Then the display line (in red) shown in the following plots denotes the limit at 20dB below maximum measured in-band peak PSD level in 100 KHz bandwidth for IEEE 802.11b/g/n20/n40MHz.

The measurement procedures under sections 11 of KDB558074 D01 v05r02 (April 2, 2019) were used.

Furthermore, delta measurement technique for measuring bandedge emissions was incorporated in the test of the edge at 2483.5MHz.

Limits:

All spurious emission and up to the tenth harmonic was measured and they were found to be at least 20dB below the maximum measured in-band peak PSD level for IEEE 802.11b/g/n20/n40MHz.

The plots of out of band conducted emissions are as TestData.pdf.

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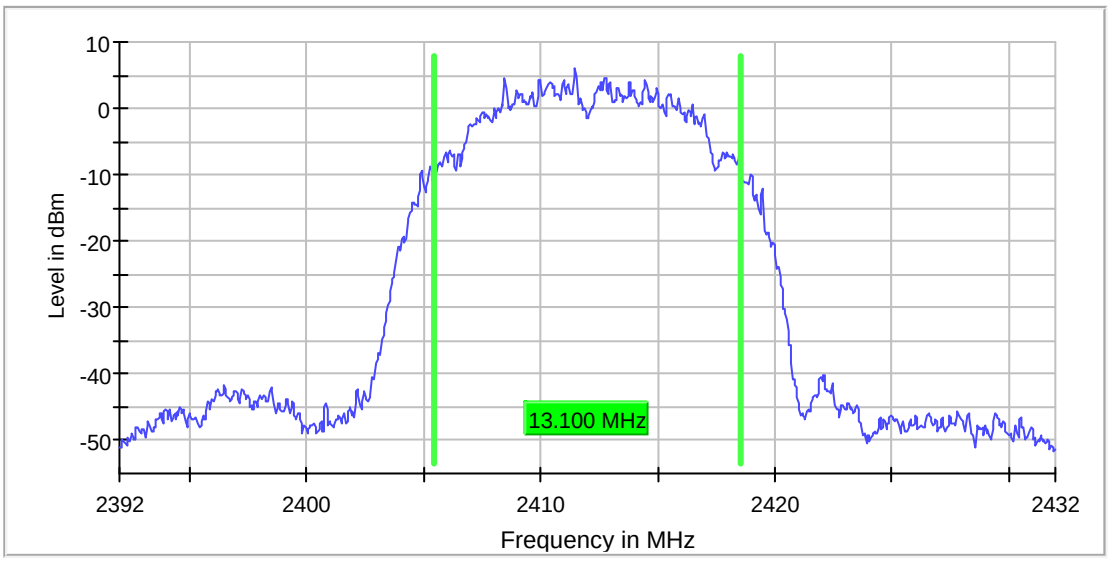
Occupied Bandwidth Results: (IEEE 802.11b)

(IEEE 802.11b)		Occupied Bandwidth (MHz)
Low Channel:	2412	13.10
Middle Channel:	2437	13.05
High Channel:	2462	13.10

The worst case is shown as below:

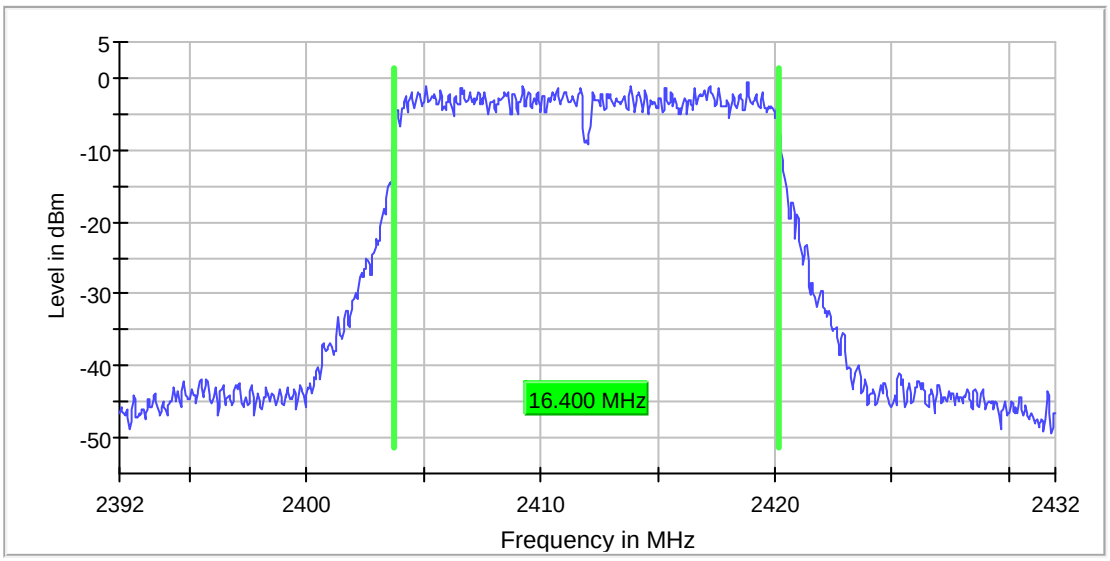


TEST REPORT

Occupied Bandwidth Results: (IEEE 802.11g)

(IEEE 802.11g)		Occupied Bandwidth (MHz)
Low Channel:	2412	16.40
Middle Channel:	2437	16.35
High Channel:	2462	16.30

The worst case is shown as below:



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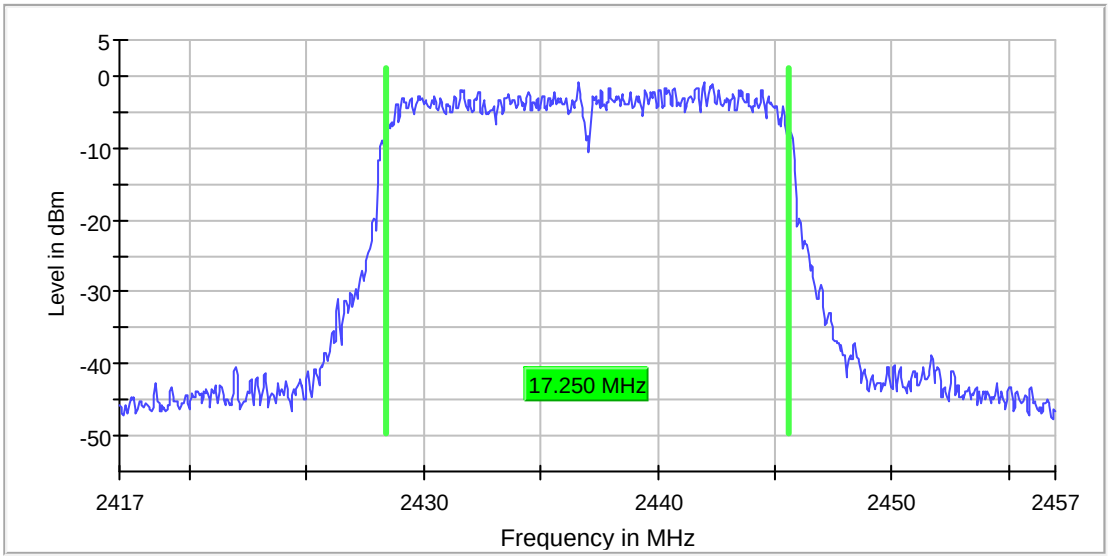
Occupied Bandwidth Results: (IEEE 802.11n (20MHz))

(IEEE 802.11n (20MHz))		Occupied Bandwidth (MHz)
Low Channel:	2412	17.15
Middle Channel:	2437	17.25
High Channel:	2462	17.20

The worst case is shown as below:



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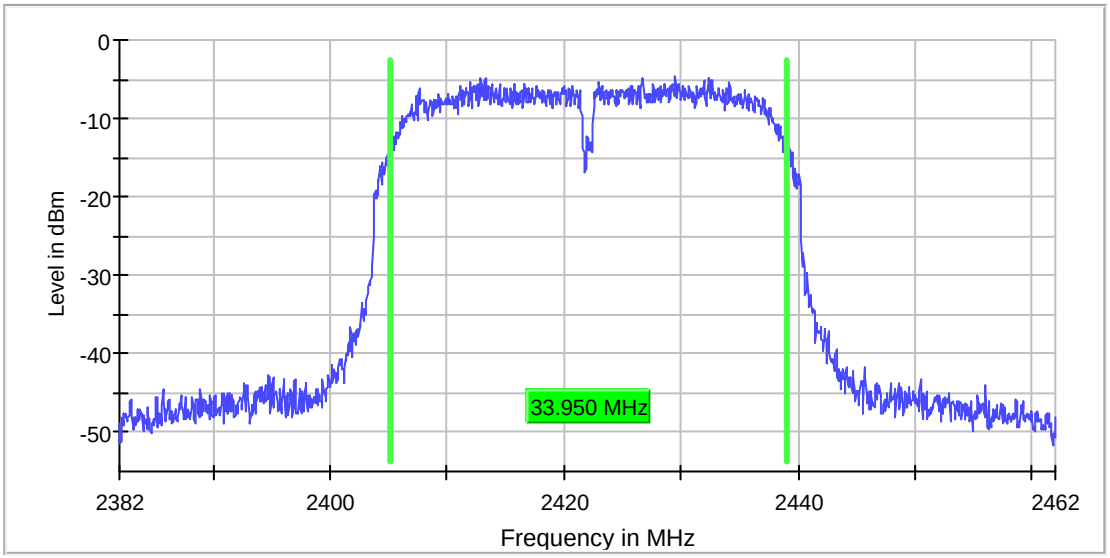
Occupied Bandwidth Results: (IEEE 802.11n (40MHz))

(IEEE 802.11n (40MHz))		Occupied Bandwidth (MHz)
Low Channel:	2412	33.95
Middle Channel:	2437	33.90
High Channel:	2462	33.80

The worst case is shown as below:



TEST REPORT

3.5 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

FS = RA + AF + CF - AG + PD + AV

Where	FS	=	Field Strength in dBµV/m
	RA	=	Receiver Amplitude (including preamplifier) in dBµV
	CF	=	Cable Attenuation Factor in dB
	AF	=	Antenna Factor in dB
	AG	=	Amplifier Gain in dB
	PD	=	Pulse Desensitization in dB
	AV	=	Average Factor in -dB

In the radiated emission table which follows, the reading shown on the data table may reflects the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

FS = RA + AF + CF - AG + PD + AV

Example:

Assume a receiver reading of 62.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29.0 dB is subtracted. The pulse desensitization factor of the spectrum analyzer is 0.0 dB, and the resultant average factor is -10.0 dB. The net field strength for comparison to the appropriate emission limit is 32.0 dBµV/m. This value in dBµV/m is converted to its corresponding level in µV/m.

RA	=	62.0 dBµV
AF	=	7.4 dB
CF	=	1.6 dB
AG	=	29.0 dB
PD	=	0.0 dB
AV	=	-10.0 dB
FS	=	62.0 + 7.4 + 1.6 – 29.0 + 0.0 + -10.0) = 32.0 dBµV/m

Level in µV/m = Common Antilogarithm [(32.0 dBµV/m)/20] = 39.8 µV/m

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3.6 Transmitter Radiated Emissions in Restricted Bands and Spurious Emissions

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

3.6.1 Radiated Emission Configuration Photograph

Worst Case Restricted Band Radiated Emission at 4824.000 MHz.

The worst case radiated emission configuration photographs are saved with filename:
config photos.pdf

3.6.2 Radiated Emission Data

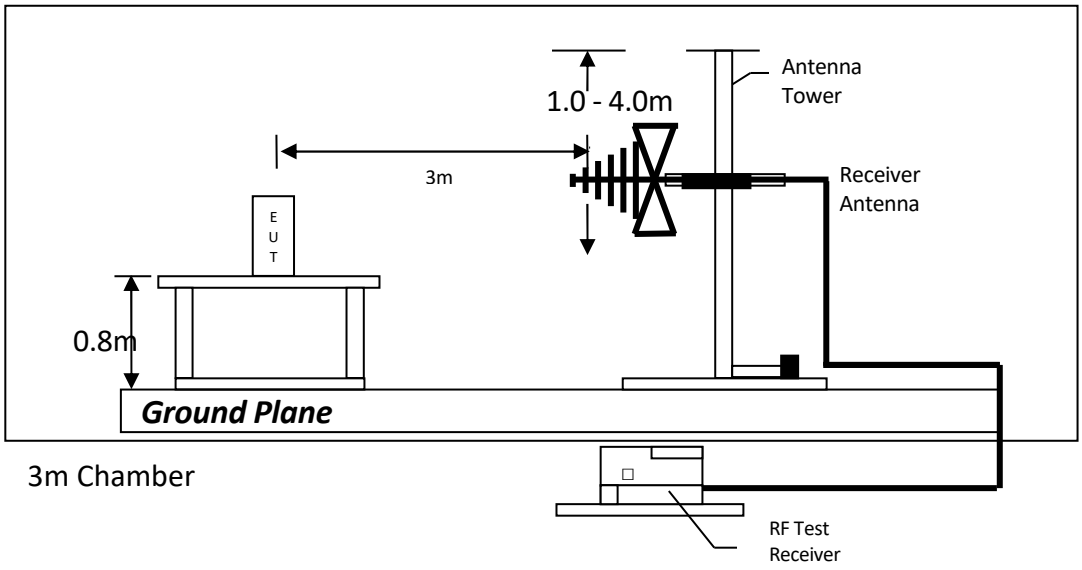
The data in tables 1-10 list the significant emission frequencies, the limit and the margin of compliance.

Judgement – Passed by 0.2 dB margin

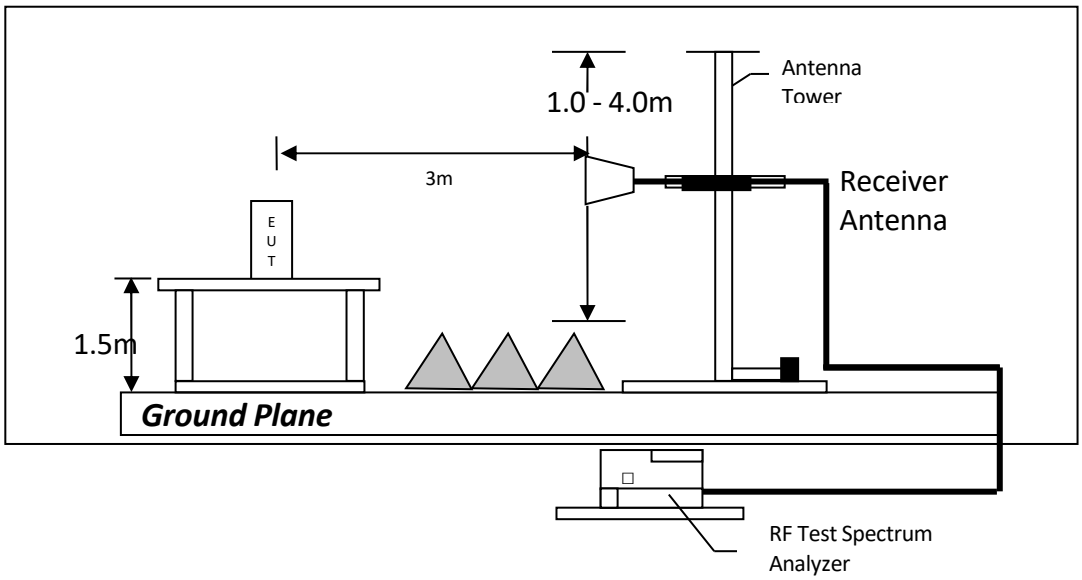
TEST REPORT

3.6.3 Radiated Emission Test Setup

The figure below shows the test setup, which is utilized to make these measurements.



Test setup of radiated emissions up to 1GHz



Test setup of radiated emissions above 1GHz

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 01

Table 1, IEEE 802.11b DSSS 1Mbps

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	53.5	33	29.4	49.9	54.0	-4.1
V	4824.000	51.9	33	34.9	53.8	54.0	-0.2
H	12060.000	40.3	33	40.5	47.8	54.0	-6.2

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	67.0	33	29.4	63.4	74.0	-10.6
V	4824.000	70.3	33	34.9	72.2	74.0	-1.8
H	12060.000	43.4	33	40.5	50.9	74.0	-23.1

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

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RADIATED EMISSION DATA

Mode: TX-Channel 07

Table 2, IEEE 802.11b DSSS 1Mbps

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	51.7	33	34.9	53.6	54.0	-0.4
H	7311.000	39.4	33	37.9	44.3	54.0	-9.7
H	12185.000	40.7	33	40.5	48.2	54.0	-5.8

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	70.1	33	34.9	72.0	74.0	-2.0
H	7311.000	42.8	33	37.9	47.7	74.0	-26.3
H	12185.000	44.1	33	40.5	51.6	74.0	-22.4

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

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RADIATED EMISSION DATA

Mode: TX-Channel 11

Table 3, IEEE 802.11b DSSS 1Mbps

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	54.5	33	29.4	50.9	54.0	-3.1
V	4924.000	51.3	33	34.9	53.2	54.0	-0.8
H	7386.000	39.6	33	37.9	44.5	54.0	-9.5
H	12310.000	40.6	33	40.5	48.1	54.0	-5.9

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	68.5	33	29.4	64.9	74.0	-9.1
V	4924.000	69.8	33	34.9	71.7	74.0	-2.3
H	7386.000	42.6	33	37.9	47.5	74.0	-26.5
H	12310.000	44.3	33	40.5	51.8	74.0	-22.2

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 01

Table 4, IEEE 802.11g OFDM, 6 Mbps

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	53.7	33	29.4	50.1	54.0	-3.9
V	4824.000	51.7	33	34.9	53.6	54.0	-0.4
H	12060.000	40.4	33	40.5	47.9	54.0	-6.1

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	67.8	33	29.4	64.2	74.0	-9.8
V	4824.000	66.4	33	34.9	68.3	74.0	-5.7
H	12060.000	43.4	33	40.5	50.9	74.0	-23.1

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 07

Table 5, IEEE 802.11g OFDM, 6 Mbps

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	51.5	33	34.9	53.4	54.0	-0.6
H	7311.000	39.0	33	37.9	43.9	54.0	-10.1
H	12185.000	40.8	33	40.5	48.3	54.0	-5.7

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	64.7	33	34.9	66.6	74.0	-7.4
H	7311.000	42.1	33	37.9	47.0	74.0	-27.0
H	12185.000	44.0	33	40.5	51.5	74.0	-22.5

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 11

Table 6, IEEE 802.11g OFDM, 6 Mbps

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	55.1	33	29.4	51.5	54.0	-2.5
V	4924.000	50.6	33	34.9	52.5	54.0	-1.5
H	7386.000	39.0	33	37.9	43.9	54.0	-10.1
H	12310.000	40.7	33	40.5	48.2	54.0	-5.8

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	68.4	33	29.4	64.8	74.0	-9.2
V	4924.000	65.8	33	34.9	67.7	74.0	-6.3
H	7386.000	42.4	33	37.9	47.3	74.0	-26.7
H	12310.000	44.1	33	40.5	51.6	74.0	-22.4

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 01

Table 7, IEEE 802.11n (20MHz) OFDM, MCS0

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	53.9	33	29.4	50.3	54.0	-3.7
V	4824.000	51.5	33	34.9	53.4	54.0	-0.6
H	12060.000	40.2	33	40.5	47.7	54.0	-6.3

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	66.6	33	29.4	63.0	74.0	-11.0
V	4824.000	65.8	33	34.9	67.7	74.0	-6.3
H	12060.000	43.6	33	40.5	51.1	74.0	-22.9

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 07

Table 8, IEEE 802.11n (20MHz) OFDM, MCS0

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	51.5	33	34.9	53.4	54.0	-0.6
H	7311.000	38.8	33	37.9	43.7	54.0	-10.3
H	12185.000	40.7	33	40.5	48.2	54.0	-5.8

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	65.1	33	34.9	67.0	74.0	-7.0
H	7311.000	41.7	33	37.9	46.6	74.0	-27.4
H	12185.000	43.9	33	40.5	51.4	74.0	-22.6

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 11

Table 9, IEEE 802.11n (20MHz) OFDM, MCS0

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	57.1	33	29.4	53.5	54.0	-0.5
V	4924.000	50.8	33	34.9	52.7	54.0	-1.3
H	7386.000	39.1	33	37.9	44.0	54.0	-10.0
H	12310.000	40.6	33	40.5	48.1	54.0	-5.9

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	68.5	33	29.4	64.9	74.0	-9.1
V	4924.000	66.1	33	34.9	68.0	74.0	-6.0
H	7386.000	42.6	33	37.9	47.5	74.0	-26.5
H	12310.000	44.5	33	40.5	52.0	74.0	-22.0

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 03

Table 10, IEEE 802.11n (40MHz) OFDM, MCS0

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	53.6	33	29.4	50.0	54.0	-4.0
V	4844.000	50.5	33	34.9	52.4	54.0	-1.6
H	12110.000	40.3	33	40.5	47.8	54.0	-6.2

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2390.000	66.6	33	29.4	63.0	74.0	-11.0
V	4844.000	62.7	33	34.9	64.6	74.0	-9.4
H	12110.000	43.7	33	40.5	51.2	74.0	-22.8

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 07

Table 11, IEEE 802.11n (40MHz) OFDM, MCS0

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	51.3	33	34.9	53.2	54.0	-0.8
H	7311.000	38.7	33	37.9	43.6	54.0	-10.4
H	12185.000	40.1	33	40.5	47.6	54.0	-6.4

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	4874.000	62.6	33	34.9	64.5	74.0	-9.5
H	7311.000	42.8	33	37.9	47.7	74.0	-26.3
H	12185.000	43.0	33	40.5	50.5	74.0	-23.5

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: TX-Channel 09

Table 12, IEEE 802.11n (40MHz) OFDM, MCS0

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (Average) (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	55.6	33	29.4	52.0	54.0	-2.0
V	4904.000	51.6	33	34.9	53.5	54.0	-0.5
H	7356.000	38.9	33	37.9	43.8	54.0	-10.2
H	12260.000	40.8	33	40.5	48.3	54.0	-5.7

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m - Peak (dBµV/m)	Peak Limit at 3m (dBµV/m)	Margin (dB)
V	2483.500	68.8	33	29.4	65.2	74.0	-8.8
V	4904.000	63.3	33	34.9	65.2	74.0	-8.8
H	7356.000	42.6	33	37.9	47.5	74.0	-26.5
H	12260.000	44.2	33	40.5	51.7	74.0	-22.3

Notes:
1. Peak detector is used for the emission measurement.
2. Average detector is used for the average data of emission measurement.
3. All measurements were made at 3 meters.
4. Negative value in the margin column shows emission below limit.
5. Horn antenna is used for the emission over 1000MHz.
6. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
7. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSION DATA

Mode: Wifi and Bluetooth Operating

Table 13

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-amp (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Limit at 3m (dBµV/m)	Margin (dB)
V	56.432	32.8	16	11.0	27.8	40.0	-12.2
V	61.042	34.8	16	10.0	28.8	40.0	-11.2
V	116.694	24.5	16	14.0	22.5	43.5	-21.0
H	800.615	18.2	16	31.0	33.2	46.0	-12.8
H	808.674	19.4	16	31.0	34.4	46.0	-11.6
V	826.672	20.2	16	31.0	35.2	46.0	-10.8

Notes:
1. Quasi-Peak detector is used for the emission measurement.
2. All measurements were made at 3 meters.
3. Negative value in the margin column shows emission below limit.
4. Emissions within the restricted band meets the requirement of FCC Part 15 Section 15.205.
5. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

3.7 Transmitter Duty Cycle Calculation

Not Applicable – No average factor is required

3.8 AC Power Line Conducted Emission

☐ Not Applicable – EUT is only powered by battery for operation.

☒ EUT connects to AC power line. Emission Data is listed in following pages.

☐ Base Unit connects to AC power line and has transmission. Handset connects to AC power line but has no transmission. Emission Data of Base Unit is listed in following pages.

3.8.1 AC Power Line Conducted Emission Configuration Photograph

Worst Case Line-Conducted Configuration at 0.173 MHz.

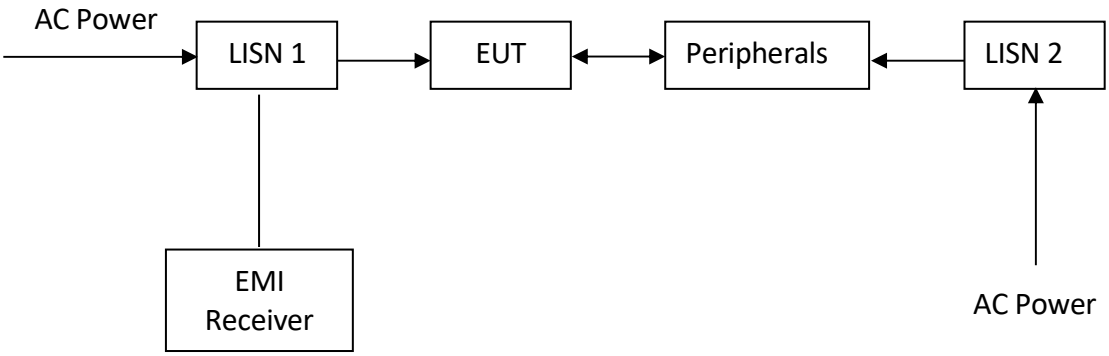
The worst-case line conducted configuration photographs are attached in the Appendix and saved with filename: config photos.pdf.

3.8.2 AC Power Line Conducted Emission Data

The plot(s) and data in the following pages list the significant emission frequencies, the limit and the margin of compliance.

Passed by 12.2 dB margin

3.8.3 Conducted Emission Test Setup



The EUT along with its peripherals were placed on a 1.0m(W)×1.5m(L) and 0.8m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane. The EUT was connected to power mains through a line impedance stabilization network (LISN), which provided 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. The excess power cable between the EUT and the LISN was bundled.

All connecting cables of EUT and peripherals were moved to find the maximum emission.

TEST REPORT

AC POWER LINE CONDUCTED EMISSION

Worst Case: Wifi and Bluetooth Operating

EDIT PEAK LIST (Final Measurement Results)				
Trace1:	CF15MQP			
Trace2:	CF15MAV			
Trace3:	---			
TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	172.5 kHz	52.61 N	-12.22
2	CISPR Average	172.5 kHz	32.99 N	-21.84
1	Quasi Peak	217.5 kHz	44.87 N	-18.03
1	Quasi Peak	397.5 kHz	42.07 L1	-15.82
2	CISPR Average	397.5 kHz	31.12 L1	-16.78
1	Quasi Peak	411 kHz	43.00 L1	-14.61
2	CISPR Average	415.5 kHz	32.60 L1	-14.93
2	CISPR Average	573 kHz	25.52 L1	-20.47
1	Quasi Peak	604.5 kHz	36.80 L1	-19.19
1	Quasi Peak	861 kHz	34.76 L1	-21.23
2	CISPR Average	1.059 MHz	26.99 L1	-19.00
1	Quasi Peak	1.1085 MHz	34.16 L1	-21.83
2	CISPR Average	1.2795 MHz	27.01 L1	-18.98
2	CISPR Average	1.536 MHz	26.42 L1	-19.57
1	Quasi Peak	1.5495 MHz	32.94 L1	-23.05
2	CISPR Average	2.8725 MHz	25.16 L1	-20.83
1	Quasi Peak	2.8815 MHz	31.40 L1	-24.59
2	CISPR Average	2.985 MHz	24.96 L1	-21.03
1	Quasi Peak	3.057 MHz	31.63 L1	-24.36
1	Quasi Peak	4.4295 MHz	30.70 L1	-25.29

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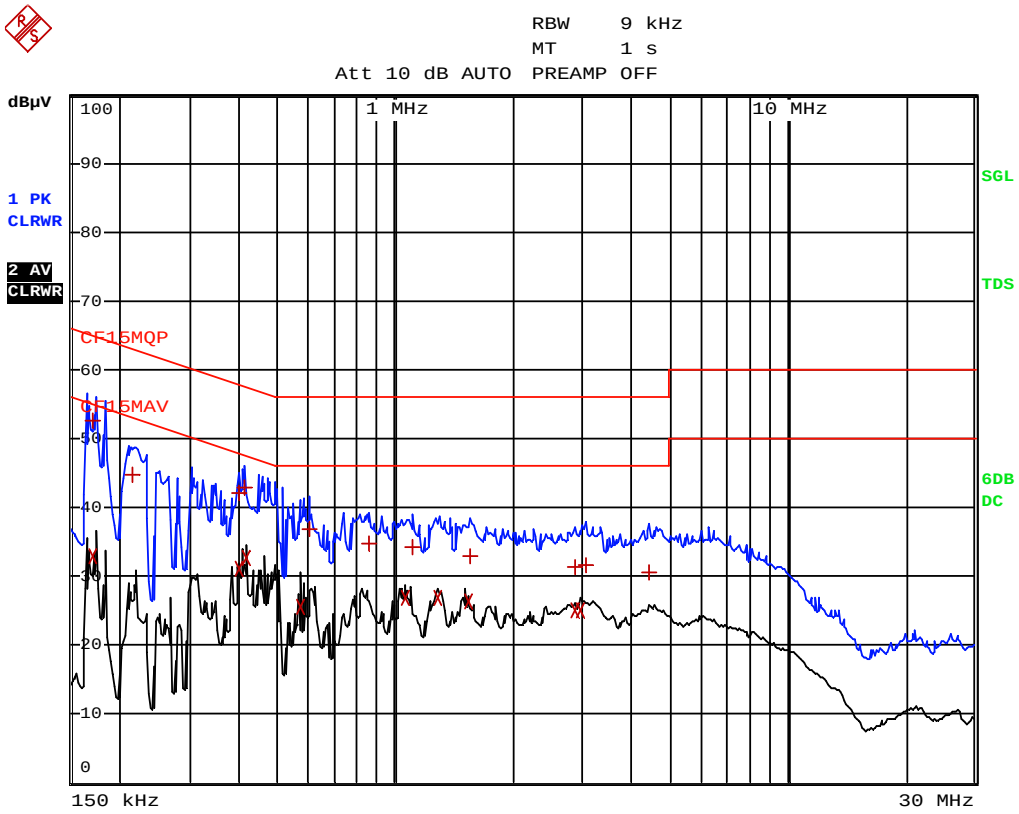
TEST REPORT

AC POWER LINE CONDUCTED EMISSION

Worst Case: Wifi and Bluetooth Operating



Date: 14.MAR.2023 10:57:53

TEST REPORT

EXHIBIT 4 EQUIPMENT LIST

1) Radiated Emissions Test

Equipment	Signal and Spectrum Analyzer (10Hz to 40GHz)	Biconical Antenna (30MHz to 300MHz)	EMI Test Receiver 7GHz
Registration No.	EW-3016	EW-3242	EW-3481
Manufacturer	ROHDESCHWARZ	EMCO	ROHDESCHWARZ
Model No.	FSV40	3110C	ESR7
Calibration Date	January 29, 2022	May 26, 2021	December 21, 2021
Calibration Due Date	April 29, 2023	May 26, 2023	June 21, 2023

Equipment	Log Periodic Antenna	Double Ridged Guide Antenna	Active Loop H-field (9kHz to 30MHz)
Registration No.	EW-3243	EW-1133	EW-3302
Manufacturer	EMCO	EMCO	EMCO
Model No.	3148B	3115	6502
Calibration Date	June 03, 2021	May 26, 2021	September 08, 2022
Calibration Due Date	June 30, 2023	May 26, 2023	September 08, 2023

Equipment	RF Preamplifier (9kHz to 6000MHz)	2.4GHz Notch Filter	14m Double Shield RF Cable (9kHz - 6GHz)
Registration No.	EW-3006b	EW-3435	EW-2376
Manufacturer	SCHWARZBECK	MICROWAVE	RADIALL
Model No.	BBV9718	N0324413	n m/br56/bnc m 14m
Calibration Date	February 15, 2022	June 16, 2022	January 26, 2022
Calibration Due Date	May 15, 2023	June 16, 2023	April 26, 2023

Equipment	RF Cable 14m (1GHz to 26.5GHz)	14m Double Shield RF Cable (20MHz to 6GHz)	Pyramidal Horn Antenna
Registration No.	EW-2781	EW-2074	EW-0905
Manufacturer	GREATBILLION	RADIALL	EMCO
Model No.	SMA m/SHF5MPU /SMA m ra14m,26G	N(m)-RG142-BNC(m) L=14M	3160-09
Calibration Date	November 24, 2021	December 10, 2021	July 20, 2021
Calibration Due Date	April 24, 2023	June 10, 2023	May 20, 2023

TEST REPORT

5.0 EQUIPMENT LIST (CONT'D)

2) Conducted Emissions Test

Equipment	RF Cable 80cm (RG142) (9kHz to 30MHz)	EMI Test Receiver 7GHz	Artificial Mains Network
Registration No.	EW-2451	EW-3481	EW-2501
Manufacturer	RADIALL	ROHDESCHWARZ	ROHDESCHWARZ
Model No.	bnc m st / 142 / bnc m st 80cm	ESR7	ENV-216
Calibration Date	May 06, 2022	December 21, 2021	November 09, 2021
Calibration Due Date	May 06, 2023	June 21, 2023	May 09, 2023

3. Conductive Measurement Test

Equipment	5m RF Cable (40GHz)	RF Power Meter with Power Sensor (N1921A)	Signal and Spectrum Analyzer (10Hz to 40GHz)
Registration No.	EW-2701	EW-3309	EW-3016
Manufacturer	RADIALL	ROHDESCHWARZ	ROHDESCHWARZ
Model No.	Sma m-m 5m 40G	NRP-Z81	FSV40
Calibration Date	November 24, 2021	December 01, 2021	January 29, 2022
Calibration Due Date	May 24, 2023	June 01, 2023	April 29, 2023

4. Control Software for Radiated Emission

Software Information	
Software Name	EMC32
Manufacturer	ROHDESCHWARZ
Software version	10.50.40

END OF TEST REPORT