FCC EVALUATION REPORT FOR CERTIFICATION

Manufacturer: Ohsung Electronics Co., Ltd.
#181 Gongdan-dong, Gumi-si, Gyeongsangbuk-Do
South Korea
Attn: Mr. Hak Ki, Kim / General Manager

Date of Issue: Jan. 04, 2019
Order Number: GETEC-C1-18-469
Test Report Number: GETEC-E3-18-025-R1
Test Site: GUMI UNIVERSITY EMC CENTER
(Test firm Registration Number: 269701)

FCC ID. : OZ5URCTDC9100

Applicant : Ohsung Electronics Co., Ltd.

Rule Part(s)	**: FCC Part 15 Subpart C-Intentional Radiator § 15.247**
Test Method	**: ANSI C63.10 (2013)**
Equipment Class	**: Digital Transmission System(DTS)**
EUT Type	**: Table top networking keypad**
Type of Authority	**: Certification**
Model Name	**: TDC-9100**

This equipment has been shown to be in compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10 (2013)

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the vest of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested by,

Hyun Kim, Senior Engineer
GUMI UNIVERSITY EMC CENTER

Reviewed by,

Jae-Hoon Jeong, Technical Manager
GUMI UNIVERSITY EMC CENTER

Version

Test Report No.	Date	Description
GETEC-E3-18-025	Dec. 28, 2018	- First Approval Report
GETEC-E3-18-025-R1	Jan. 04. 2019	- A revised test report that separated the test report based on the equipment class.

CONTENTS

Scope: *Measurement and determination of electromagnetic emissions (EME) of radio frequency devices including intentional and / or unintentional radiators for compliance with technical rules and regulations of the Federal Communications Commission.*

1. General Information

Applicant: Ohsung Electronics Co., Ltd.

Applicant Address: #181 Gongdan-dong, Gumi-si, Gyeongsangbuk-Do, South Korea

Manufacturer: Ohsung Electronics Co., Ltd.

Manufacturer Address: #181 Gongdan-dong, Gumi-si, Gyeongsangbuk-Do, South Korea

Contact Person: Hak Ki, Kim / General Manager

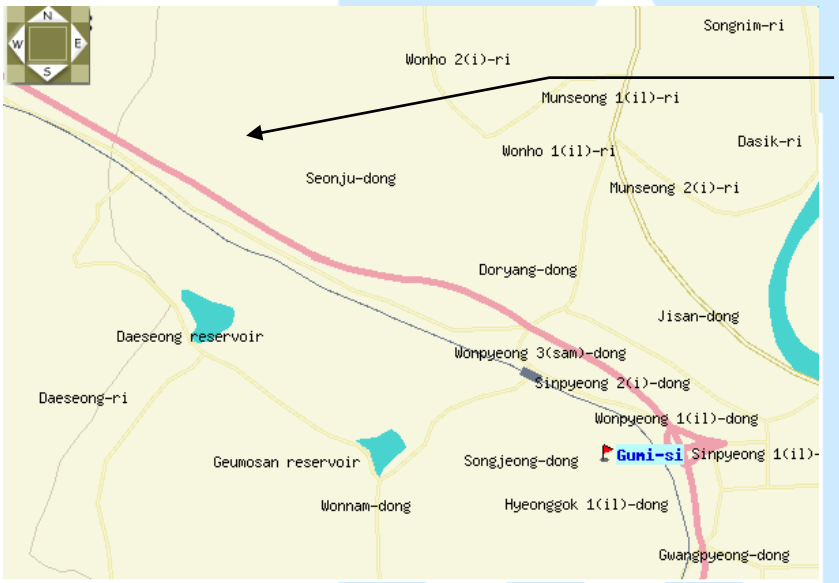
Telephone Number: +82-54-468-7281 Fax Number: +82-54-461-8368

- **FCC ID.** OZ5URCTDC9100
- **Equipment Class** Digital Transmission System (DTS)
- **EUT Type** Table top networking keypad
- **Model Name** TDC-9100
- **Rule Part(s)** FCC Part 15 Subpart C-Intentional Radiator § 15.247
- **Test Method** ANSI C63.10 (2013)
- **Type of Authority** Certification
- **Test Procedure(s)** ANSI C63.10 (2013), KDB558074 D01 DTS Meas Guidance v04(April 5,2017),
- **Dates of Test** Sep. 28, 2018 ~ Dec. 28, 2018
- **Place of Test** **GUMI UNIVERSITY EMC CENTER** (FCC Test firm Registration No.: 269701)
  37 Yaeun-ro, Gumi-si, Gyeongsangbuk-do, 730-711, Republic of Korea
- **Test Report Number** GETEC-E3-18-025-R1
- **Dates of Issue** Jan. 04, 2019

2. Introduction

The measurement procedure described in American National Standard for Methods of Measurement of Radio-Nose Emissions From Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2009) was used in determining radiated and conducted emissions emanating from **Ohsung Electronics Co., Ltd. Table top networking keypad (Model name: TDC-9100)**

These measurement tests were conducted at **GUMI UNIVERSITY EMC CENTER**.
The site address is 37 Yaeun-ro, Gumi-si, Gyeongsangbuk-do, 730-711, Republic of Korea
This test site is one of the highest point of GUMI UNIVERSITY at about 200 kilometers away from Seoul city and 40 kilometers away from Daege city. It is located in the valley surrounded by mountains in all directions where ambient radio signal conditions are quiet and a favorable area to measure the radio frequency interference on open field test site for the computing and ISM devices manufactures. The detailed description of the measurement facility was found to be in compliance with the requirements of §2.948 according to ANSI C63.10 (2013)



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37 Yaeun-ro, Gumi-si,
Gyeongsangbuk-do, 730-711,
Republic of Korea
Tel: +82-54-440-1195
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Fig 1. The map above shows the Gumi University in vicinity area.

3. Product Information

3.1 Description of EUT

The Equipment under Test (EUT) is the **Ohsung Electronics Co., Ltd. Table top networking keypad (Model Name: TDC-9100) FCC ID.: OZ5URCTDC9100**

-. Equipment	: Table top networking keypad	
-. Model name	: TDC-9100	
-. Serial number	: Proto type	
-. Electrical Rating	: DC 3.65 V	
-. Manufacturer	: Ohsung Electronics Co., Ltd.	
-. Frequency Range (DTS band)	TX 20 MHz BW:	2412 MHz - 2462 MHz
	RX 20 MHz BW:	2412 MHz - 2462 MHz
-. Frequency Range (UNII band)	TX 20 MHz BW:	5180 MHz - 5240 MHz (UNII 1) / 5260 MHz - 5320 MHz (UNII 2A) 5500 MHz - 5720 MHz (UNII 2C) / 5745 MHz - 5825 MHz (UNII 3)
	40 MHz BW:	5190 MHz - 5230 MHz (UNII 1) / 5270 MHz - 5310 MHz (UNII 2A) 5510 MHz - 5710 MHz (UNII 2C) / 5755 MHz - 5795 MHz (UNII 3)
	80 MHz BW:	5210 Mhz (UNII 1) / 5290 MHz (UNII 2A) / 5530 MHz - 5690 MHz (UNII 2C) / 5775 MHz (UNII 3)
	RX 20 MHz BW:	5180 MHz - 5240 MHz (UNII 1) / 5260 MHz - 5320 MHz (UNII 2A) 5500 MHz - 5720 MHz (UNII 2C) / 5745 MHz - 5825 MHz (UNII 3)
	40 MHz BW:	5190 MHz - 5230 MHz (UNII 1) / 5270 MHz - 5310 MHz (UNII 2A) 5510 MHz - 5710 MHz (UNII 2C) / 5755 MHz - 5795 MHz (UNII 3)
	80 MHz BW:	5210 Mhz (UNII 1) / 5290 MHz (UNII 2A) / 5530 MHz - 5690 MHz (UNII 2C) / 5775 MHz (UNII 3)
-. Modulation	: BPSK, QPSK, QAM, CCK, OFDM	
-. Antenna Specification	: Manufacturer: Electronic Device Works Antenna type : PCB pattern antenna Gain : 4.20 dBi (DTS) / 4.42 dBi (UNII 1) / 4.42 dBi (UNII 2A) / 4.74 dBi (UNII 2C) / 4.29 dBi (UNII 3)	
-. Type (DFS)	: Client (without radar detection)	

3.2 Definition of models

-None.

3.3 Support Equipment / Cables used

3.3.1 Used Support Equipment

Description	Manufacturer	Model Name	S/N & FCC ID.
Notebook Computer 1)	SAMSUNG	NT500R3W	S/N: 0Q2V91JJ100096T FCC ID.: N/A

Note)
1) The Support Equipment use only setting to the test mode.

3.3.2 System configuration

Description	Manufacturer	Model Name	S/N & FCC ID.
-	-	-	-

3.3.3 Used Cable(s)

Cable Name	Condition	Description
-	-	-

3.4 Modification Item(s)

-. None

4. Antenna Requirement - §15.203

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the applicant can be used with the device. The use of permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with this requirement.

4.1 Description of Antenna

The **Ohsung Electronics Co., Ltd. Table top networking keypad.** comply with the requirement of §15.203 with a PCB pattern antenna permanently attached to the transmitter.

5. Description of tests

5.1 Test Condition

The EUT was installed, arranged and operated in a manner that is most representative of equipment as typically used.

The measurements were carried out while varying operating modes and cable positions within typically arrangement to determine maximum emission level.

The representative and worst test mode(s) were noted in the test report.

- Test Voltage / Frequency: 3.65 V / DC

- Operating condition during the test(s) :
  -. Continuous RF transmitting mode with nominal maximum RF output power.
  -. Operating channel frequency and modulation technology

Mode		Available channel	Frequency	Modulation Technology
DTS	802.11b	1 ~ 11	2412 ~ 2462 MHz	DSSS
	802.11g	1 ~ 11	2412 ~ 2462 MHz	OFDM
	802.11n	1 ~ 11	2412 ~ 2462 MHz	OFDM

-. EUT set condition (Test Software)

Test Software	Tera Term Pro
Test Software version	2.3

6. References Standards

- FCC Part 15 (2009) Subpart C-Intentional Radiator §15.247
- ANSI C 63.10 (2013): American National Standard for Testing Unlicensed Wireless Devices
- KDB 558074 D01 DTS meas Guidance v04 (April 5, 2017): Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

7. SUMMARY OF TEST RESULTS

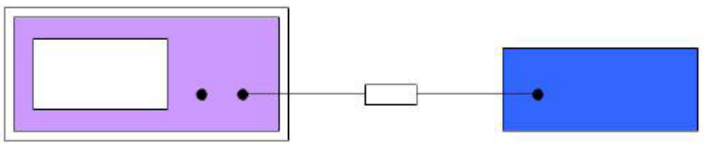
FCC Part Section(s)	Test Description	Test Result
§15.247(a)(2)	6 dB Bandwidth	Pass
§15.247(b)(3)	Conducted Maximum Output Power	Pass
§15.247(e)	Power Spectral Density	Pass
§15.247(d)	Conducted Out of Band Emission Emissions	Pass
§15.207(a)	AC Power line Conducted Emissions	Pass
§15.205, 15.209	Radiated Spurious Emissions	Pass
§15.247(d), 15.205, 15.209	Radiated Restricted Band Edge	Pass

8. 6 dB Bandwidth Measurement

8.1 Operating environment

Temperature : 20.6 °C
Relative Humidity : 42.5 % R.H.

8.2 Test Set-up (Layout)



8.3 Limit

For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz

8.4 Test Equipment used

	Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ -	FSV	Rohde & Schwarz	Signal Analyzer	101552	Apr. 16, 2019
■ -	56-10	Weinschel	10 dB Attenuator	53184	Apr. 17. 2019

8.5 Test Test Procedure

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 x RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.6 Test result

-. Test Date : November 06, 2018
-. Reference Standard : Part 15 Subpart C, Sec. 15.247(a)(2)
-. Test Procedure(s) : ANSI C63.10 (2013), KDB558074 D01 DTS Meas Guidance v04(April 5,2017)
-. Operating Condition : RF transmitting mode (1 ch: 2 412 MHz, 6 ch: 2 437 MHz, 11 ch: 2 462 MHz)
-. Power Source : DC 3.65 V

IEEE 802.11b

Frequency (MHz)	6 dB Bandwidth (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Min. Limit (MHz)	Result
2 412	7.481	2 408.309	2 415.791	0.50	Complies
2 437	8.479	2 433.010	2 441.489	0.50	Complies
2 462	8.479	2 458.010	2 466.489	0.50	Complies

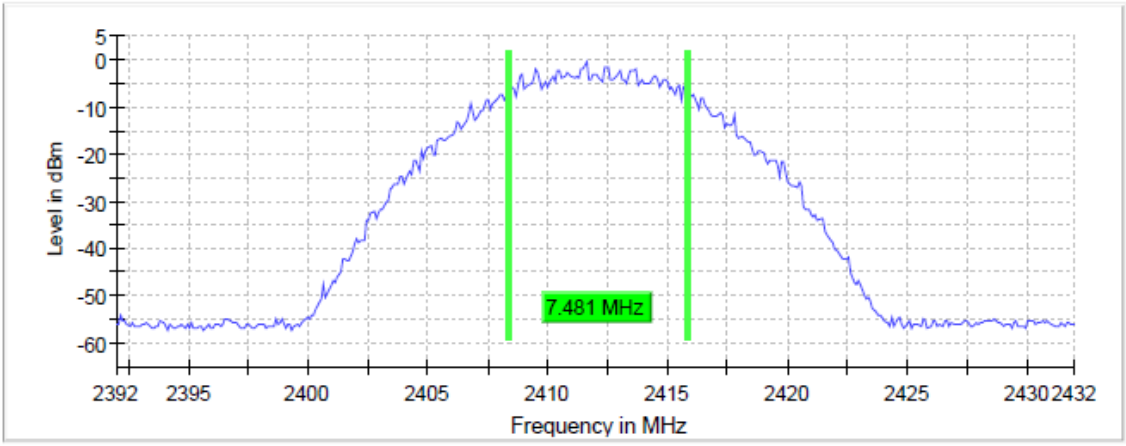
IEEE 802.11g

Frequency (MHz)	6 dB Bandwidth (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Min. Limit (MHz)	Result
2 412	15.262	2 404.319	2 419.581	0.50	Complies
2 437	15.262	2 429.319	2 444.581	0.50	Complies
2 462	15.262	2 454.319	2 469.581	0.50	Complies

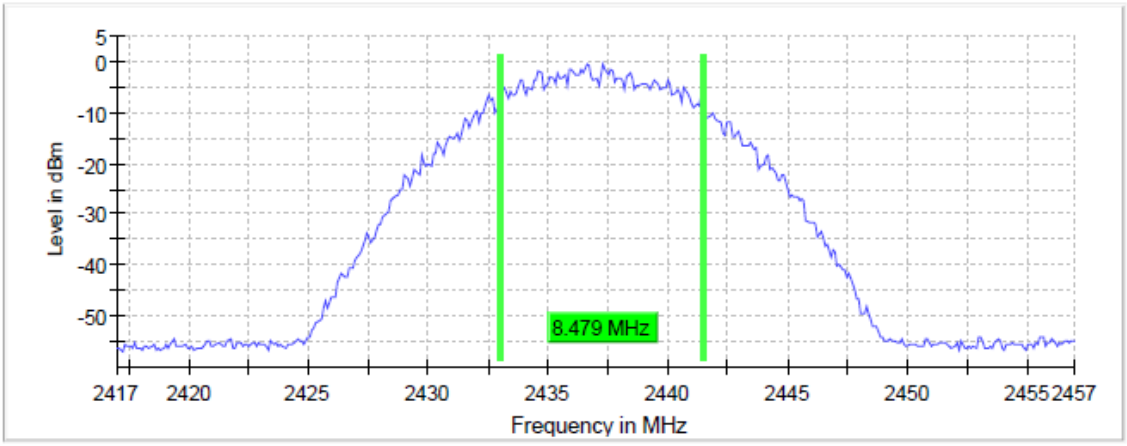
IEEE 802.11n

Frequency (MHz)	6 dB Bandwidth (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Min. Limit (MHz)	Result
2 412	17.855	2 403.022	2 420.878	0.50	Complies
2 437	17.855	2 428.022	2 445.878	0.50	Complies
2 462	17.855	2 453.022	2 470.878	0.50	Complies

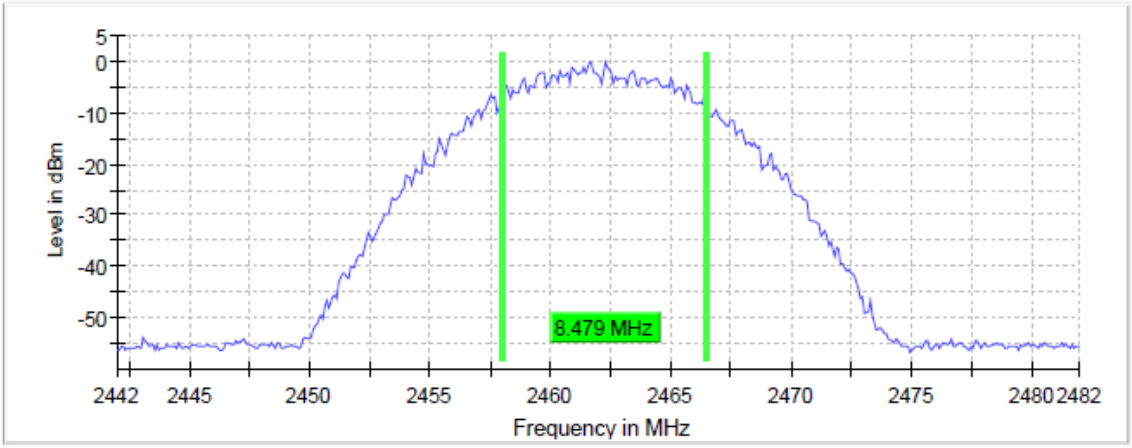
6 dB Bandwidth Plot on Configuration : IEEE 802.11b 1ch



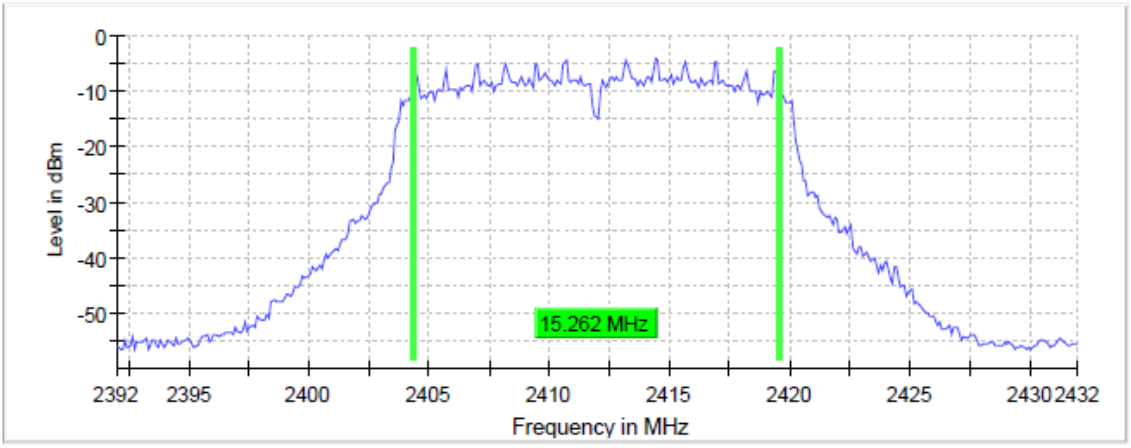
6 dB Bandwidth Plot on Configuration : IEEE 802.11b 6ch



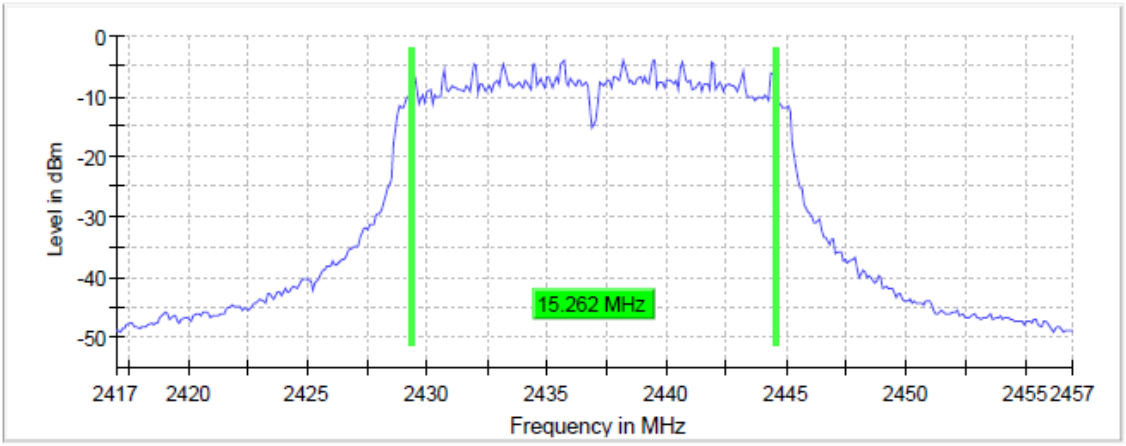
6 dB Bandwidth Plot on Configuration : IEEE 802.11b 11ch



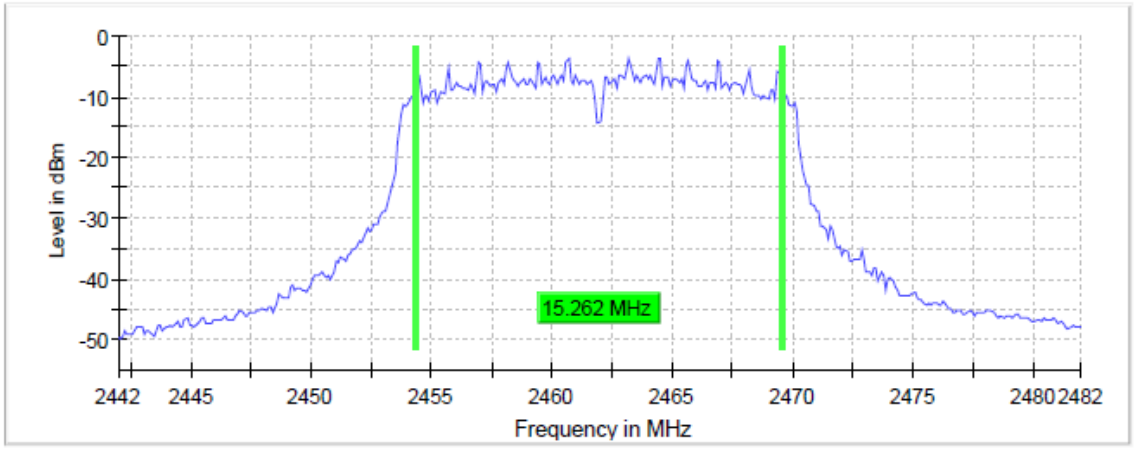
6 dB Bandwidth Plot on Configuration : IEEE 802.11g 1ch



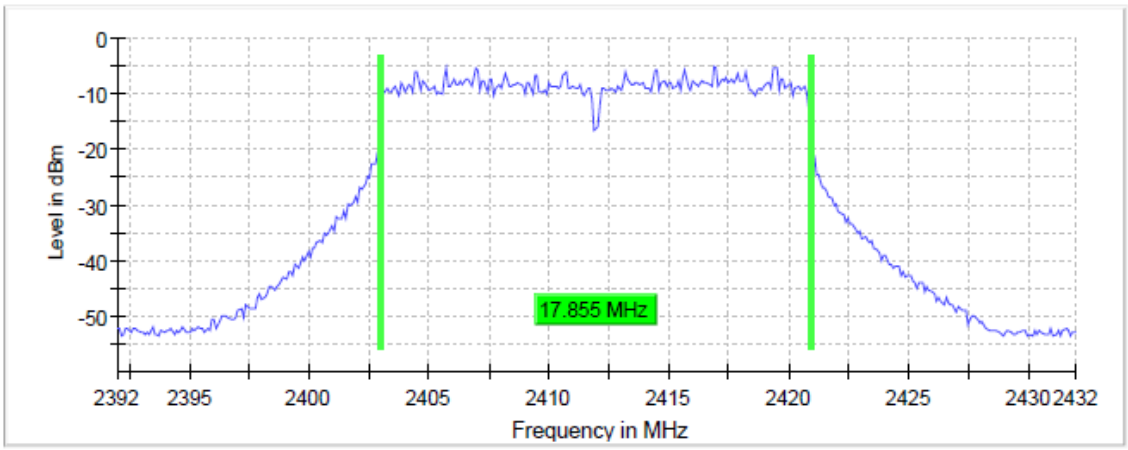
6 dB Bandwidth Plot on Configuration : IEEE 802.11g 6ch



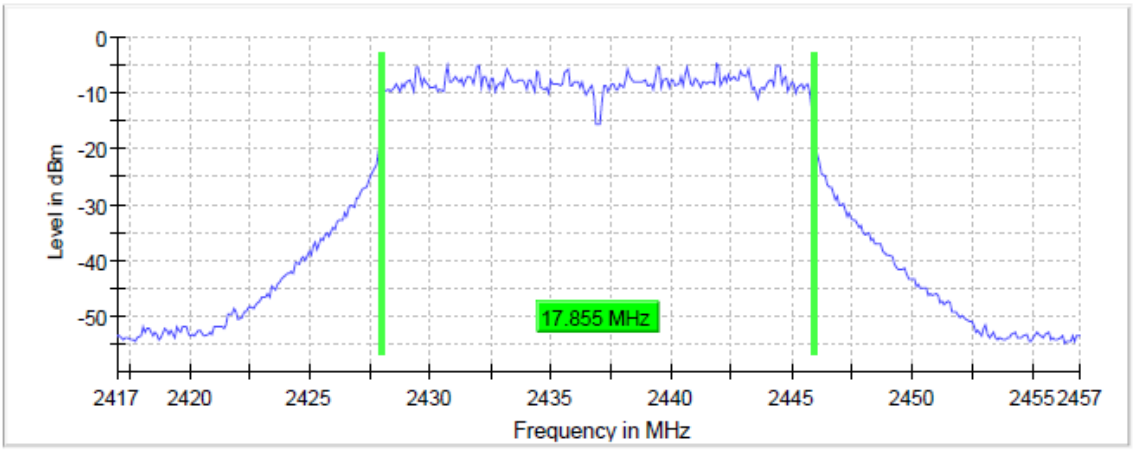
6 dB Bandwidth Plot on Configuration : IEEE 802.11g 11ch



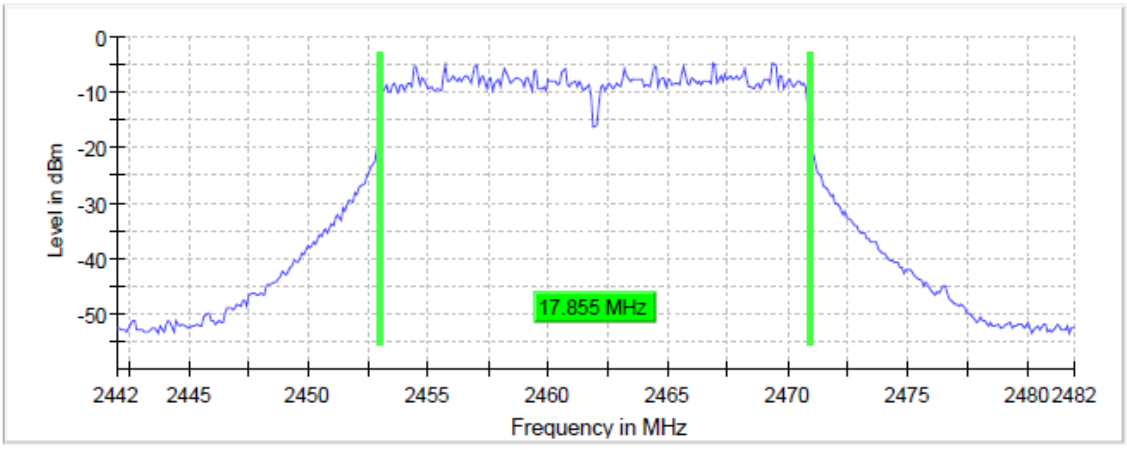
6 dB Bandwidth Plot on Configuration : IEEE 802.11n 1ch



6 dB Bandwidth Plot on Configuration : IEEE 802.11n 6ch



6 dB Bandwidth Plot on Configuration : IEEE 802.11n 11ch

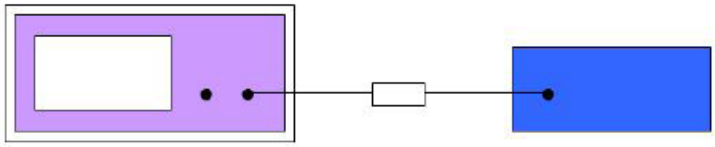


9. Conducted Maximum Output Power Measurement

9.1 Operating environment

Temperature : 20.6 °C
Relative Humidity : 42.5 % R.H.

9.2 Test Set-up (Layout)



9.3 Limit

For systems using digital modulation in the (2 400~2 483.5) MHz, the limit for peak output power is 30 dBm The limited has to be reduced by the amount in dB that the gain of the antenna exceed 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

9.4 Test Equipment used

	Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ -	NRV-Z32	Rohde & Schwarz	Peak Power sensor	100049	Apr. 17, 2019
■ -	NRVS	Rohde & Schwarz	Single Channel Power Meter	101008	Apr. 17, 2019
■ -	NRP-Z51	Rohde & Schwarz	Power sensor	1138.0005.02	Apr. 17, 2019
■ -	56-10	Weinschel	10 dB Attenuator	53184	Apr. 17. 2019

9.5 Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

9.6 Test Result

-. Test Date : November 06, 2018
-. Reference Standard : Part 15 Subpart C, Sec. 15.247(b)(3)
-. Test Procedure(s) : ANSI C63.10 (2013), KDB558074 D01 DTS Meas Guidance v04(April 5,2017)
-. Operating Condition : RF transmitting mode (1 ch: 2 412 MHz, 6 ch: 2 437 MHz, 11 ch: 2 462 MHz)
-. Power Source : DC 3.65 V

IEEE 802.11b

Frequency (MHz)	Average Conducted Power[1)] (dBm)	Max. Limit (dBm)	Result
2 412	6.80	30.00	Complies
2 437	7.10	30.00	Complies
2 462	7.40	30.00	Complies

Note: 1) The Average output power is reference data for RF Exposure.

IEEE 802.11g

Frequency (MHz)	Average Conducted Power[1)] (dBm)	Max. Limit (dBm)	Result
2 412	6.40	30.00	Complies
2 437	6.60	30.00	Complies
2 462	6.90	30.00	Complies

Note: 1) The Average output power is reference data for RF Exposure.

IEEE 802.11n

Frequency (MHz)	Average Conducted Power[1)] (dBm)	Max. Limit (dBm)	Result
2 412	6.20	30.00	Complies
2 437	6.50	30.00	Complies
2 462	6.60	30.00	Complies

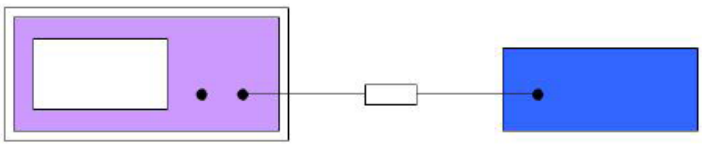
Note: 1) The Average output power is reference data for RF Exposure.

10. Power Spectral Density Measurement

10.1 Operating Environment

Temperature : 20.6 °C
Relative Humidity : 42.5 % R.H.

10.2 Test Set-up (Layout)



10.3 Limit

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

10.4 Test Equipment used

	Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ -	FSV	Rohde & Schwarz	Signal Analyzer	101552	Apr. 16, 2019
■ -	56-10	Weinschel	10 dB Attenuator	53184	Apr. 17. 2019

10.5 Test Procedure

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz
d) Set the VBW to 10 kHz
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.

10.6 Test Result

-. Test Date : November 06, 2018
-. Reference Standard : Part 15 Subpart C, Sec. 15.247(e)
-. Test Procedure(s) : ANSI C63.10 (2013), KDB558074 D01 DTS Meas Guidance v04(April 5,2017)
-. Operating Condition : RF transmitting mode (1 ch: 2 412 MHz, 6 ch: 2 437 MHz, 11 ch: 2 462 MHz)
-. Power Source : DC 3.65 V

IEEE 802.11b

Frequency	PSD (dBm/3kHz)	Max. Limit (dBm/3kHz)	Result
2 412 MHz	-13.860	8.00	Complies
2 437 MHz	-15.793	8.00	Complies
2 462 MHz	-15.497	8.00	Complies

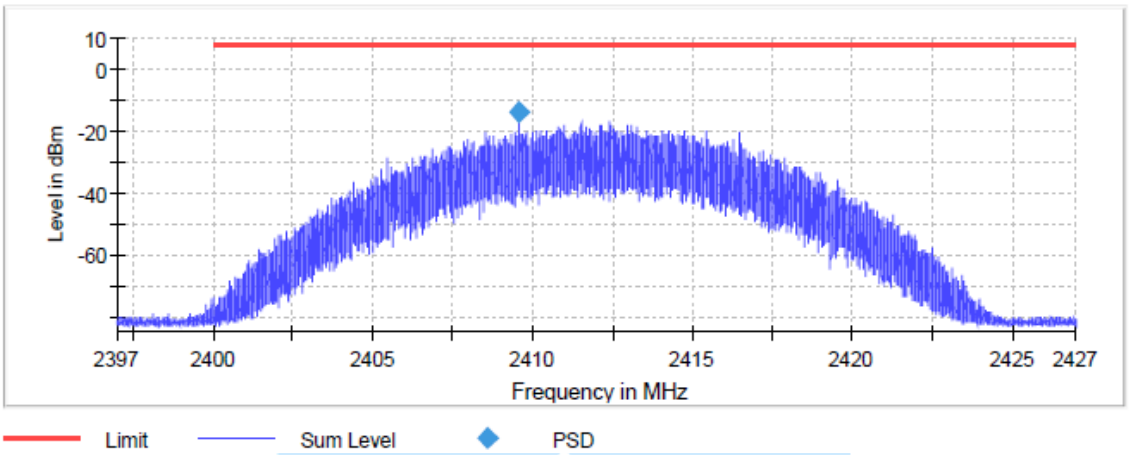
IEEE 802.11g

Frequency	PSD (dBm/3kHz)	Max. Limit (dBm/3kHz)	Result
2 412 MHz	-25.881	8.00	Complies
2 437 MHz	-24.374	8.00	Complies
2 462 MHz	-24.180	8.00	Complies

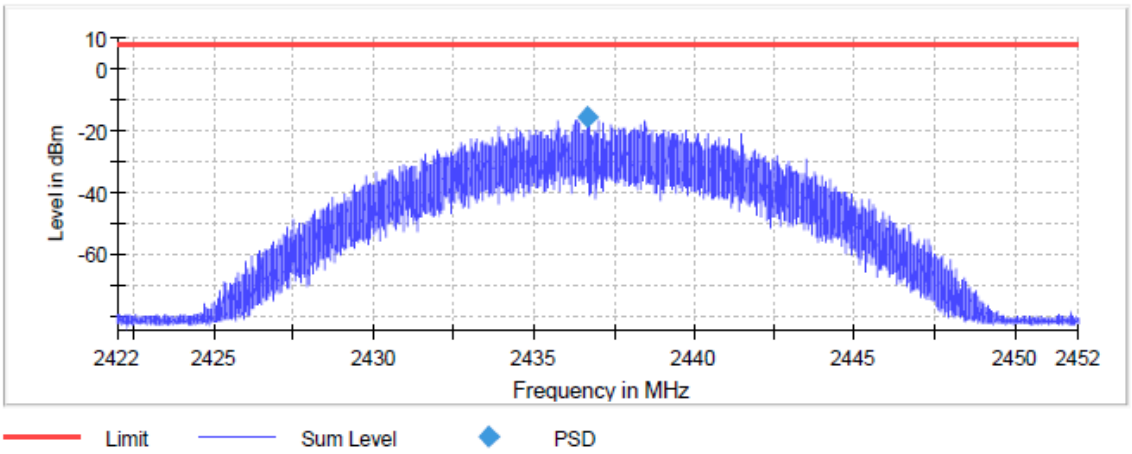
IEEE 802.11n

Frequency	PSD (dBm/3kHz)	Max. Limit (dBm/3kHz)	Result
2 412 MHz	-24.690	8.00	Complies
2 437 MHz	-24.037	8.00	Complies
2 462 MHz	-24.096	8.00	Complies

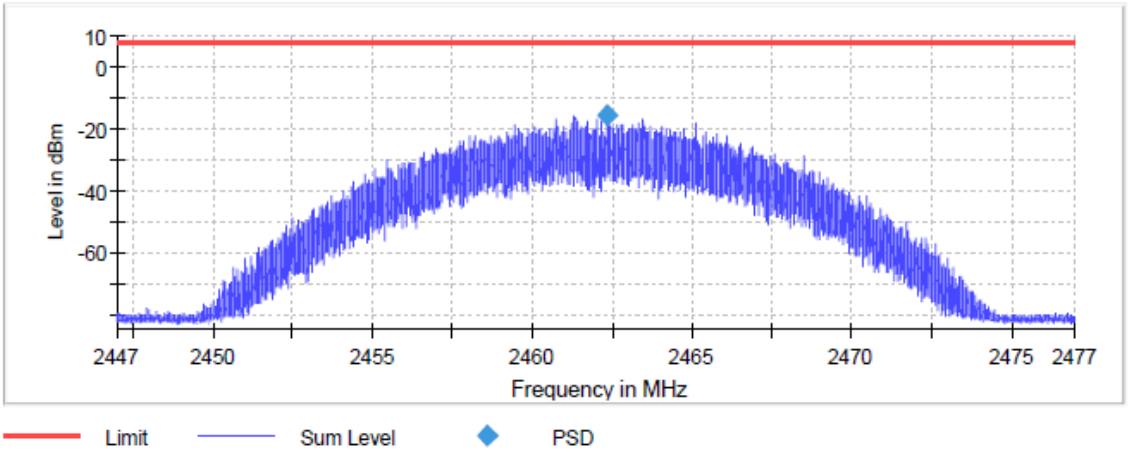
Power Density Plot on configuration : IEEE 802.11b 1ch



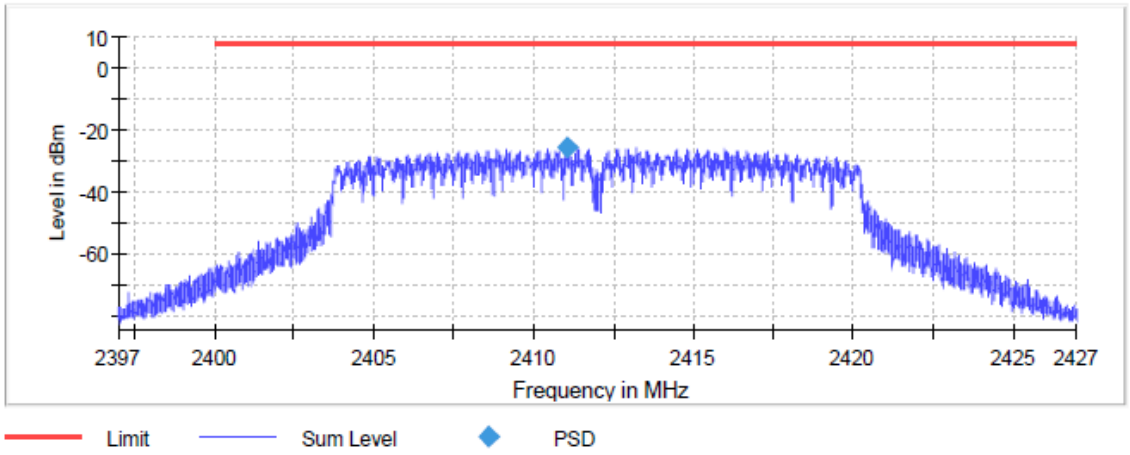
Power Density Plot on configuration : IEEE 802.11b 6ch



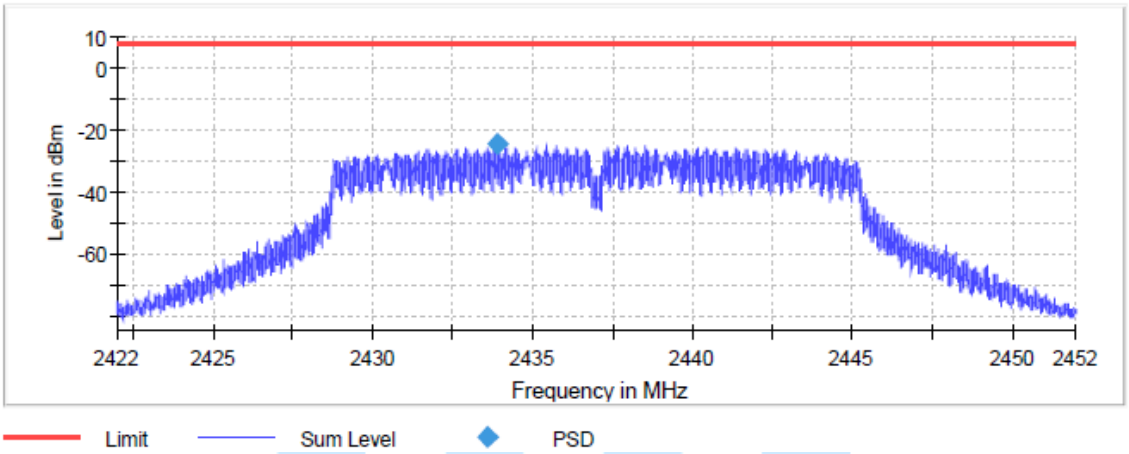
Power Density Plot on configuration : IEEE 802.11b 11ch



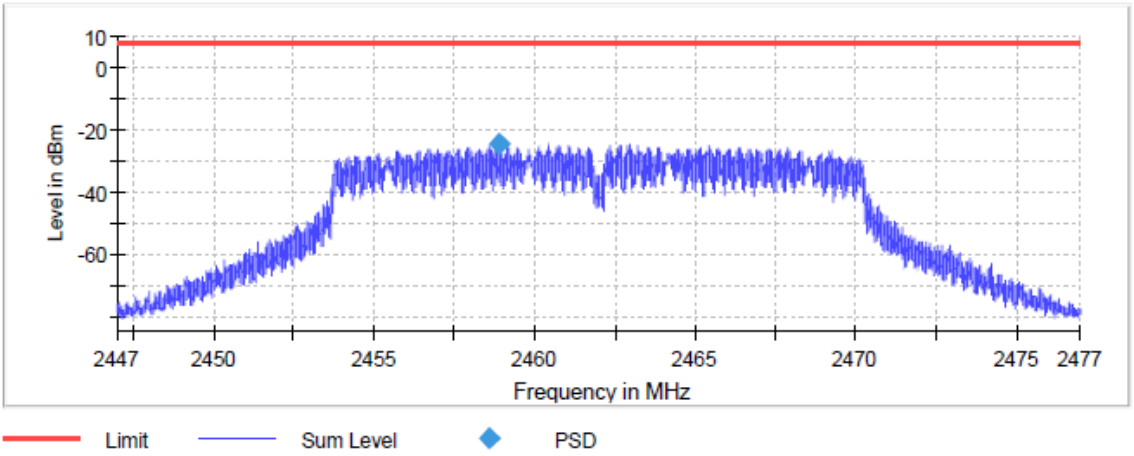
Power Density Plot on configuration : IEEE 802.11g 1ch



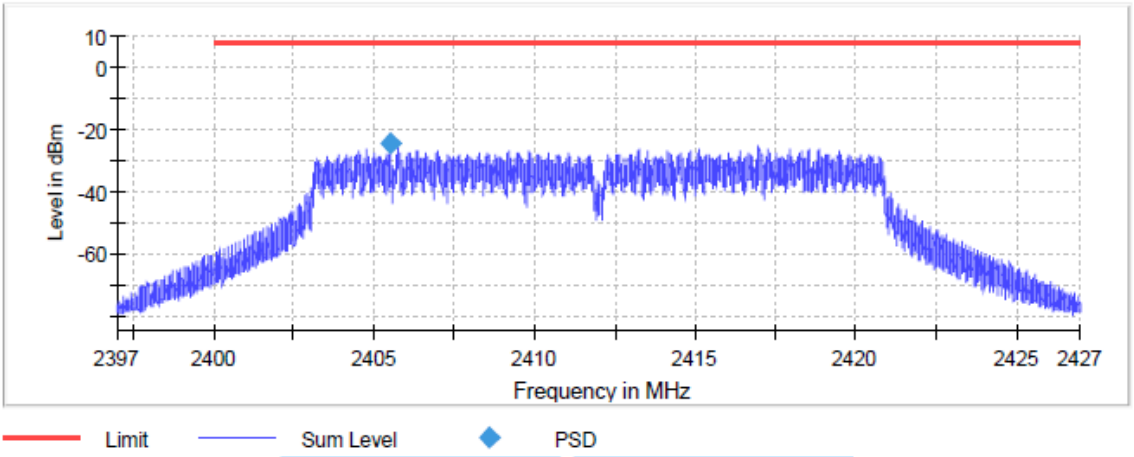
Power Density Plot on configuration : IEEE 802.11g 6ch



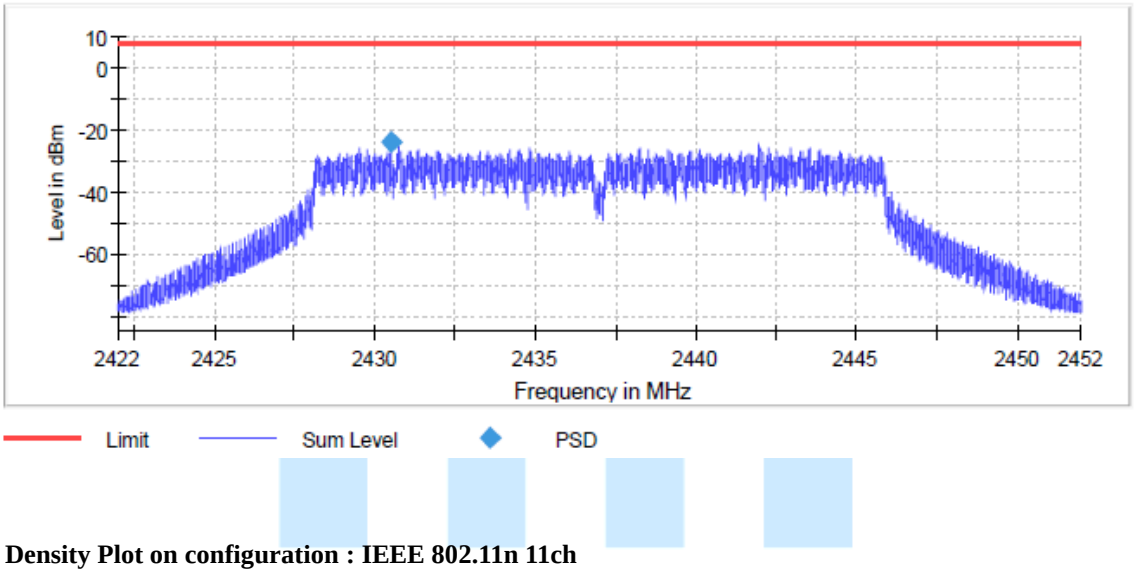
Power Density Plot on configuration : IEEE 802.11g 11ch



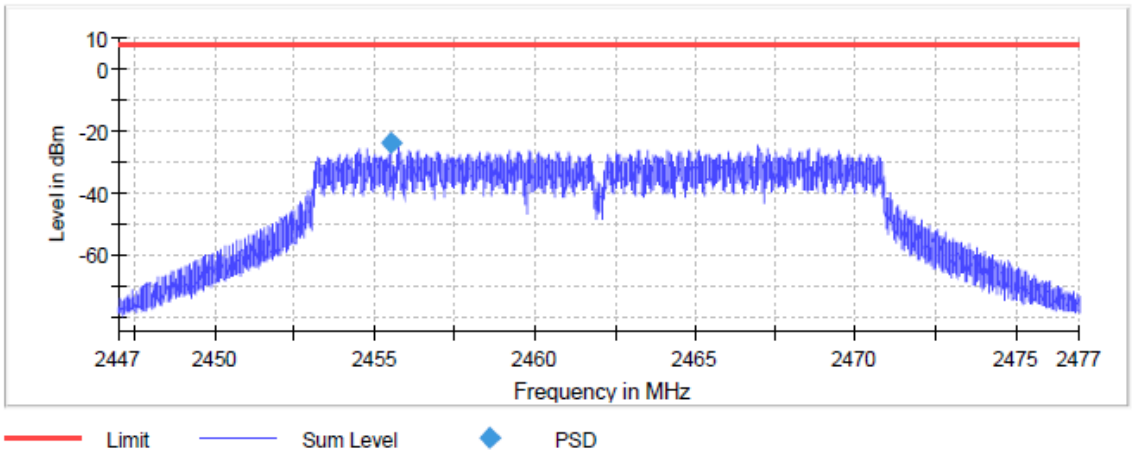
Power Density Plot on configuration : IEEE 802.11n 1ch



Power Density Plot on configuration : IEEE 802.11n 6ch



Power Density Plot on configuration : IEEE 802.11n 11ch

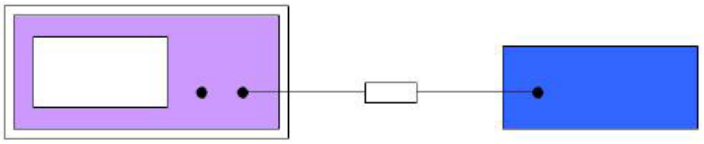


11. Conducted Spurious Emission & Out of Band Emission

11.1 Operating environment

Temperature : 19.9 °C
Relative Humidity : 58.8 % R.H.

11.2 Test set-up (Lay-out)



11.3 Limit

Below -20 dB of the highest emission level of operating band (in 100 kHz resolution band width)

11.4 Test equipment used

	Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ -	FSV	Rohde & Schwarz	Signal Analyzer	101552	Apr. 16, 2019
■ -	56-10	Weinschel	10 dB Attenuator	53184	Apr. 17. 2019

11.5 Test Procedure

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz
d) Set the VBW to 10 kHz
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.

11.6 Test Result

-. Test Date : November 07, 2018
-. Reference standard : Part 15 Subpart C, Sec. 15.247(d)
-. Test Procedure(s) : ANSI C63.10 (2013), KDB558074 D01 DTS Meas Guidance v04(April 5,2017)
-. Operating condition : RF transmitting mode (1 ch: 2 412 MHz, 6 ch: 2 437 MHz, 11 ch: 2 462 MHz)
-. Power Source : DC 3.65 V

Conducted Spurious Emission

IEEE 802.11b

Operating Frequency	Fundamental Level (dBm)	Spurious Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 412 MHz	-0.70	-51.31	-50.61	-20.00	Complies
2 437 MHz	0.47	-51.59	-52.06		Complies
2 462 MHz	0.96	-51.71	-52.67		Complies

IEEE 802.11g

Operating Frequency	Fundamental Level (dBm)	Spurious Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 412 MHz	-3.12	-51.65	-48.53	-20.00	Complies
2 437 MHz	-2.79	-50.18	-47.39		Complies
2 462 MHz	-2.45	-51.39	-48.94		Complies

IEEE 802.11n

Operating Frequency	Fundamental Level (dBm)	Spurious Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 412 MHz	-4.18	-51.46	-47.28	-20.00	Complies
2 437 MHz	-3.78	-51.62	-47.84		Complies
2 462 MHz	-3.47	-51.70	-48.23		Complies

Conducted Out of Band(Band Edge) Emission

IEEE 802.11b

Operating Frequency	Fundamental Level (dBm)	Bandedge Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 412 MHz	-0.70	-55.10	-54.40	-20.00	Complies
2 462 MHz	0.96	-54.16	-55.12		Complies

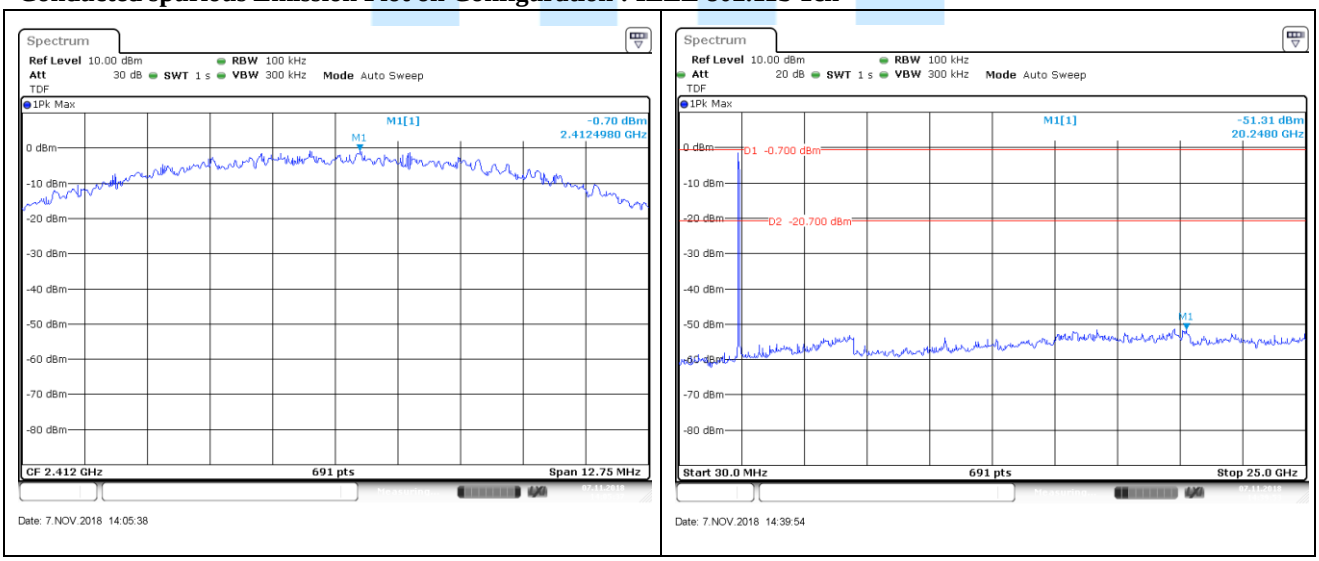
IEEE 802.11g

Operating Frequency	Fundamental Level (dBm)	Bandedge Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 412 MHz	-3.12	-55.23	-52.11	-20.00	Complies
2 462 MHz	-2.45	-46.90	-44.45		Complies

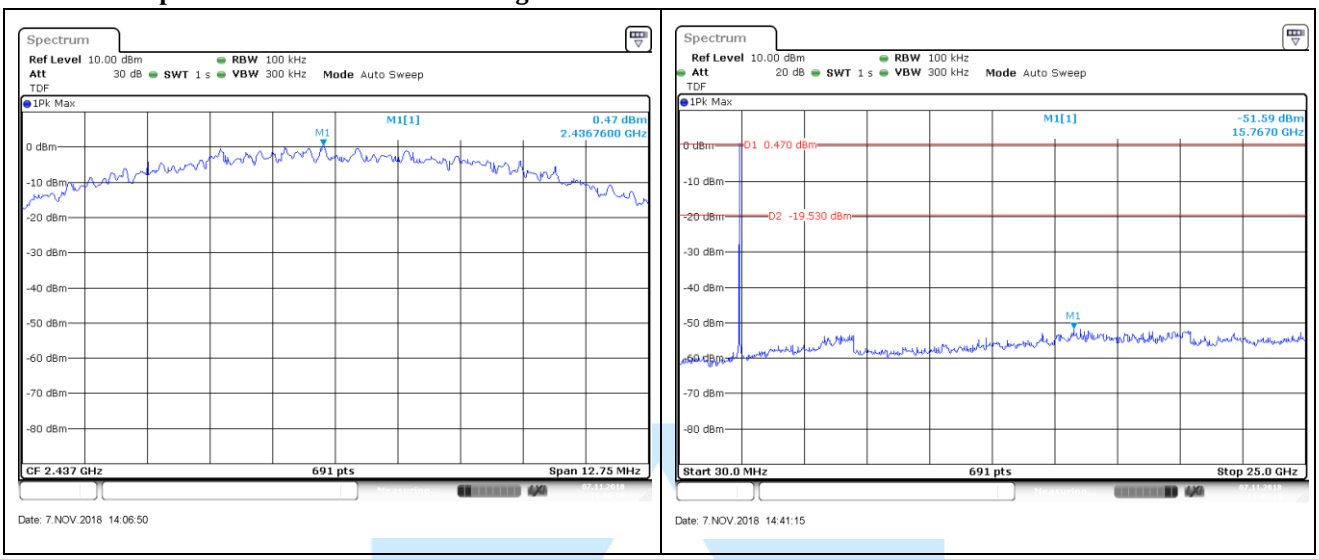
IEEE 802.11n

Operating Frequency	Fundamental Level (dBm)	Bandedge Level (dBm)	Deviation (dBc)	Limits (dBc)	Result
2 412 MHz	-4.18	-53.68	-49.50	-20.00	Complies
2 462 MHz	-3.47	-53.21	-49.74		Complies

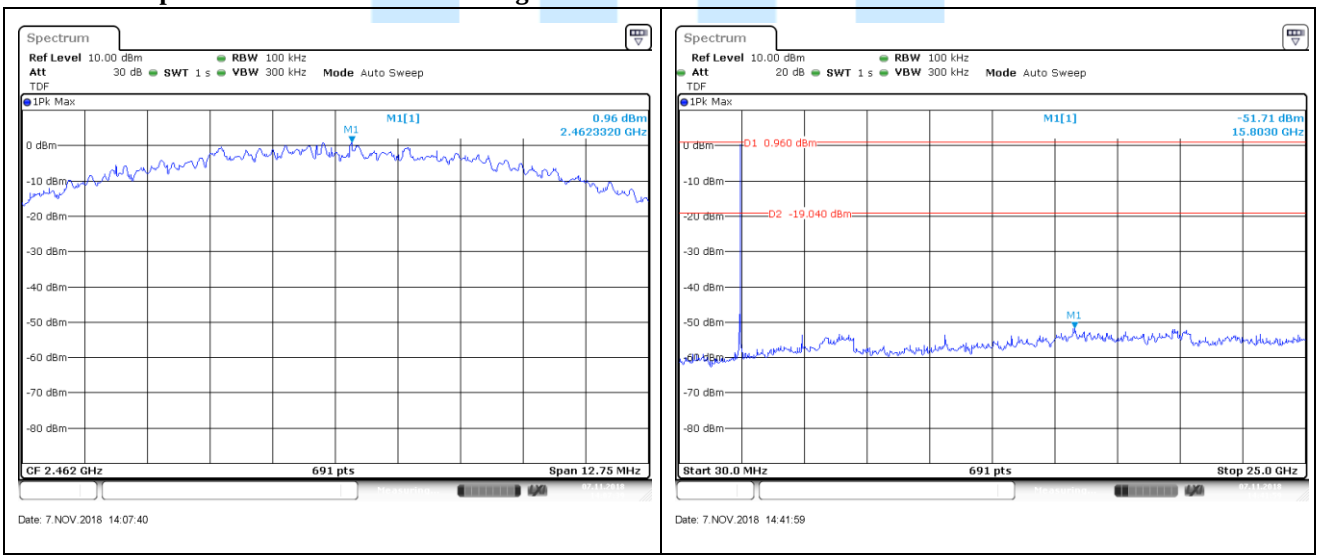
Conducted spurious Emission Plot on Configuration : IEEE 802.11b 1ch



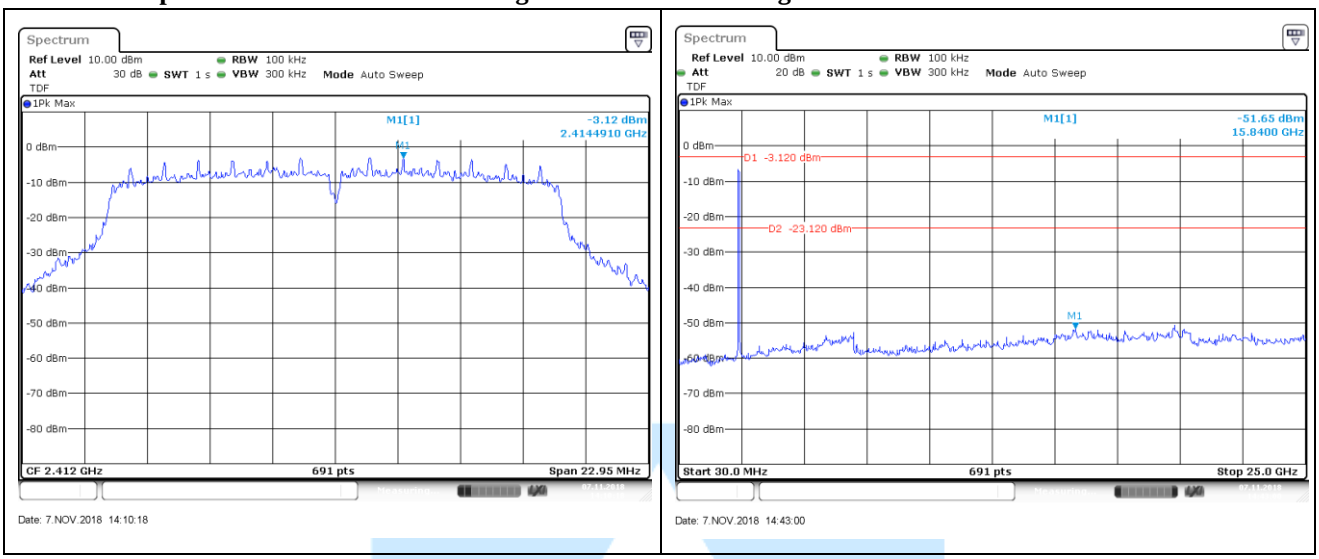
Conducted spurious Emission Plot on Configuration : IEEE 802.11b 6ch



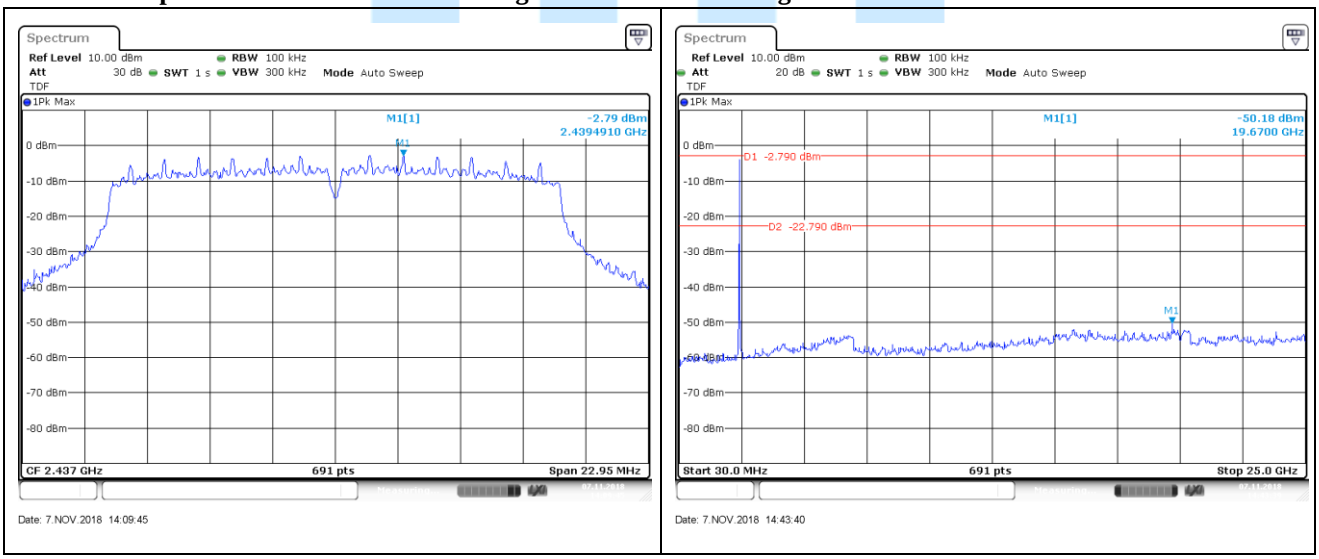
Conducted spurious Emission Plot on Configuration : IEEE 802.11b 11ch



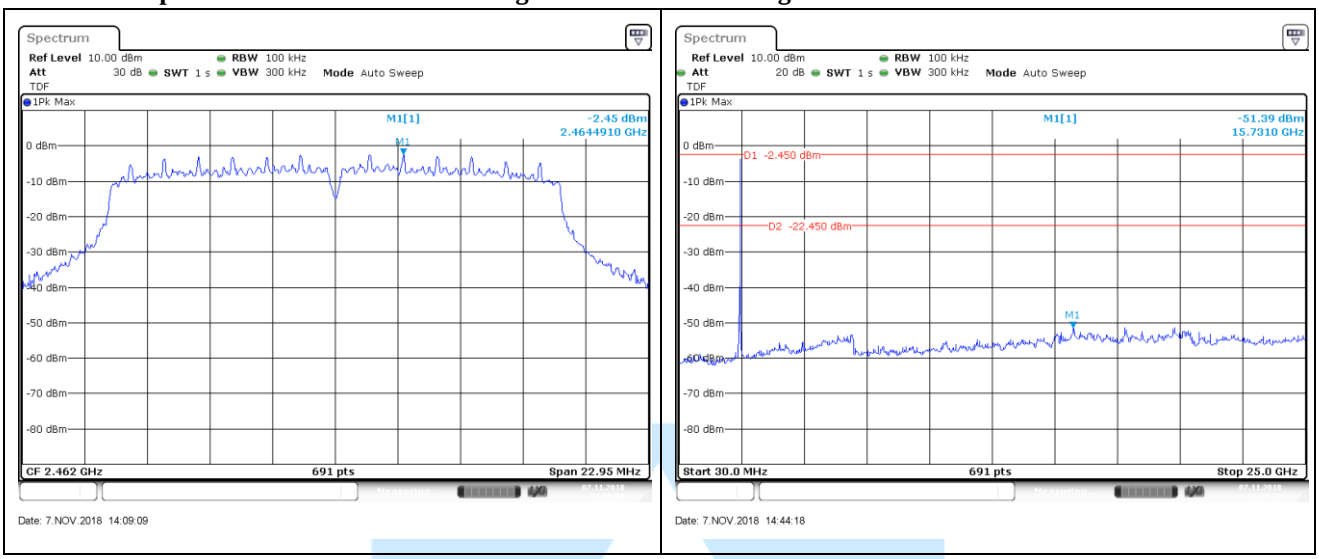
Conducted spurious Emission Plot on Configuration : IEEE 802.11g 1ch



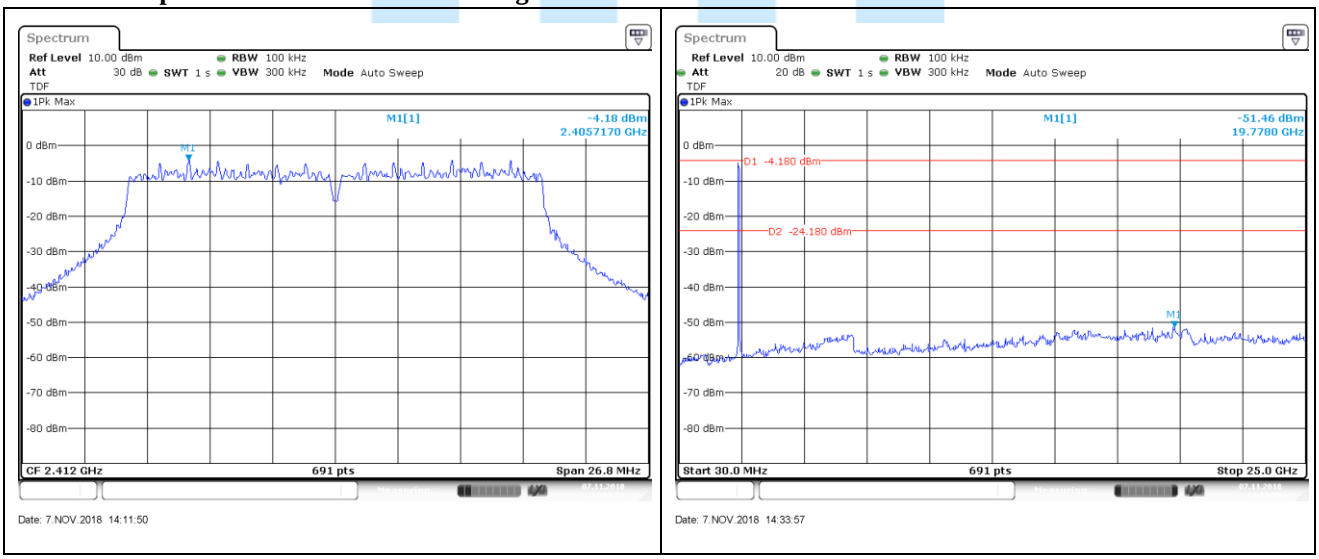
Conducted spurious Emission Plot on Configuration : IEEE 802.11g 6ch



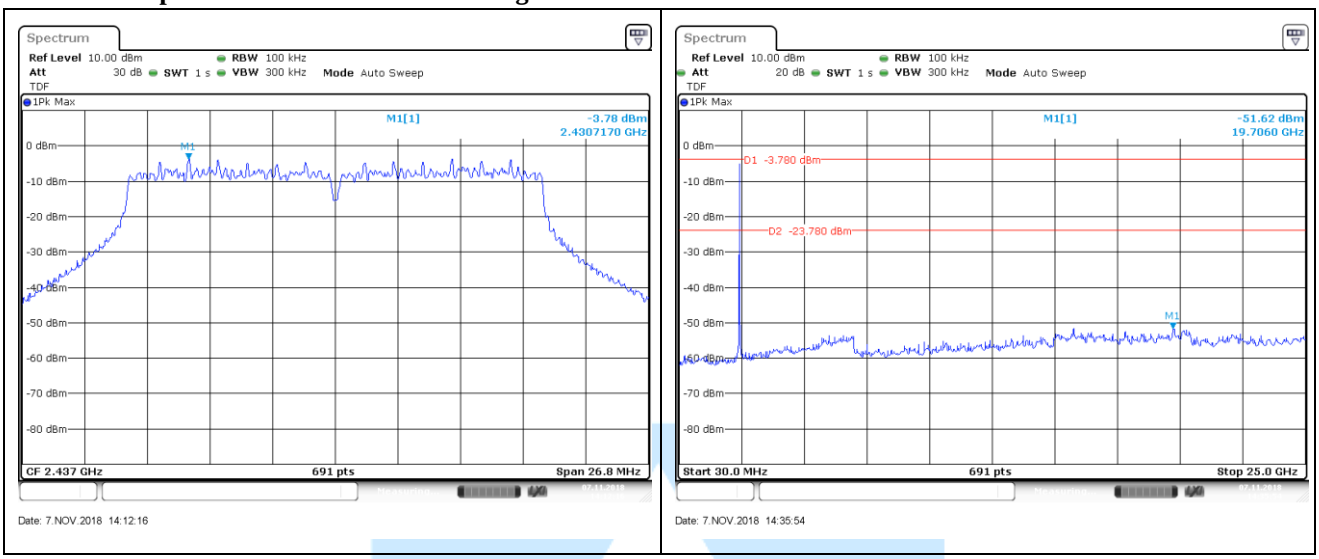
Conducted spurious Emission Plot on Configuration : IEEE 802.11g 11ch



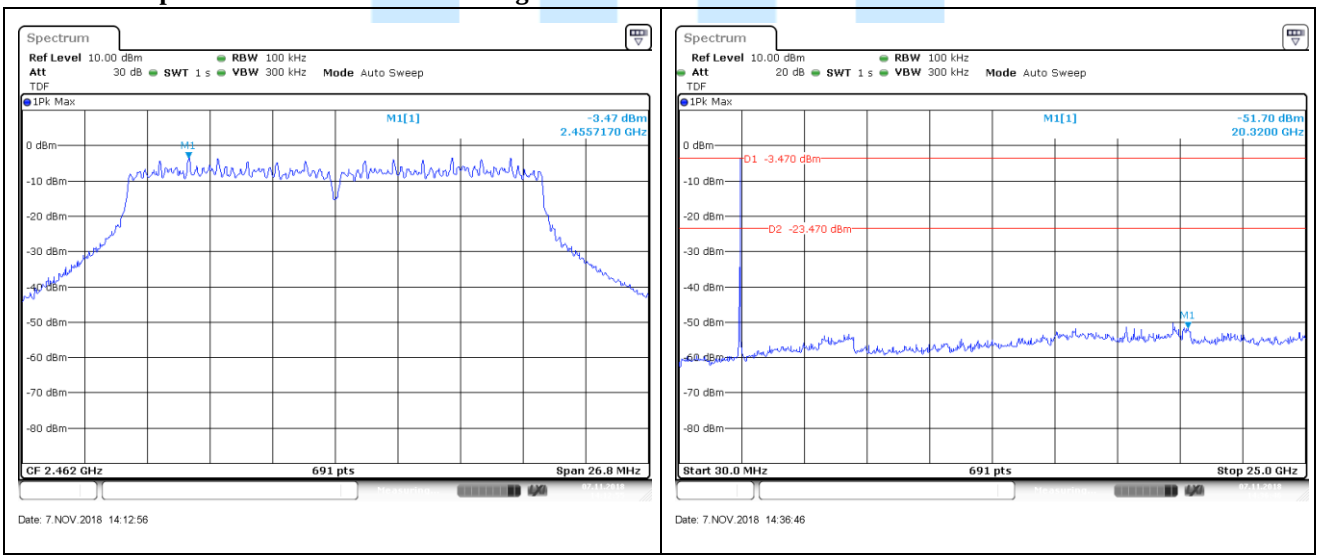
Conducted spurious Emission Plot on Configuration : IEEE 802.11n 1ch



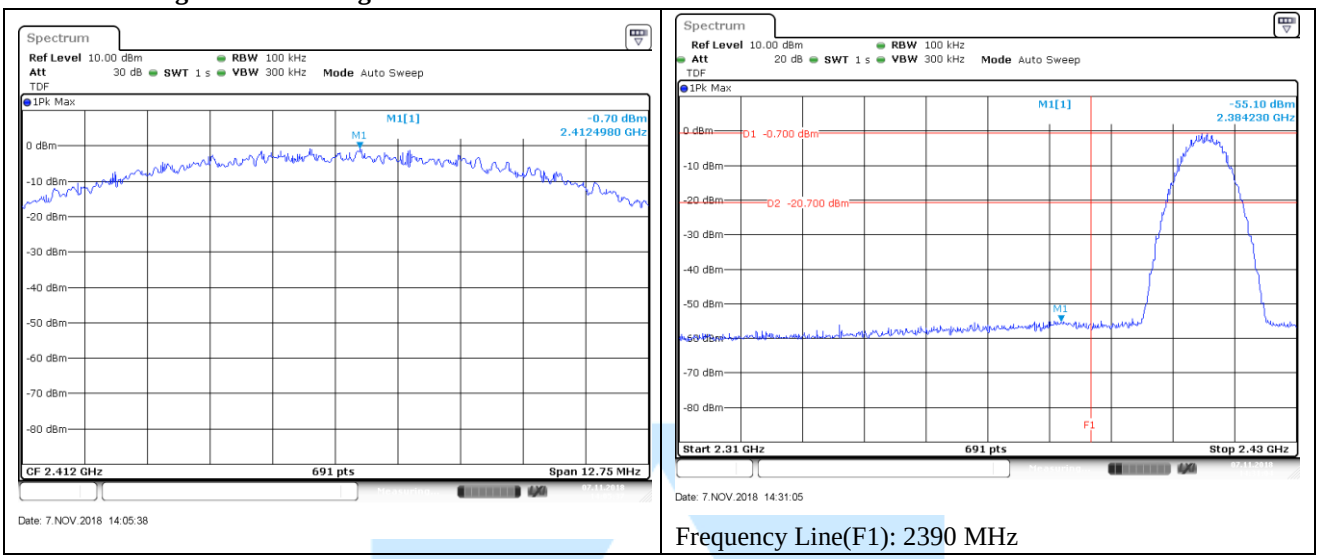
Conducted spurious Emission Plot on Configuration : IEEE 802.11b 6ch



Conducted spurious Emission Plot on Configuration : IEEE 802.11b 11ch

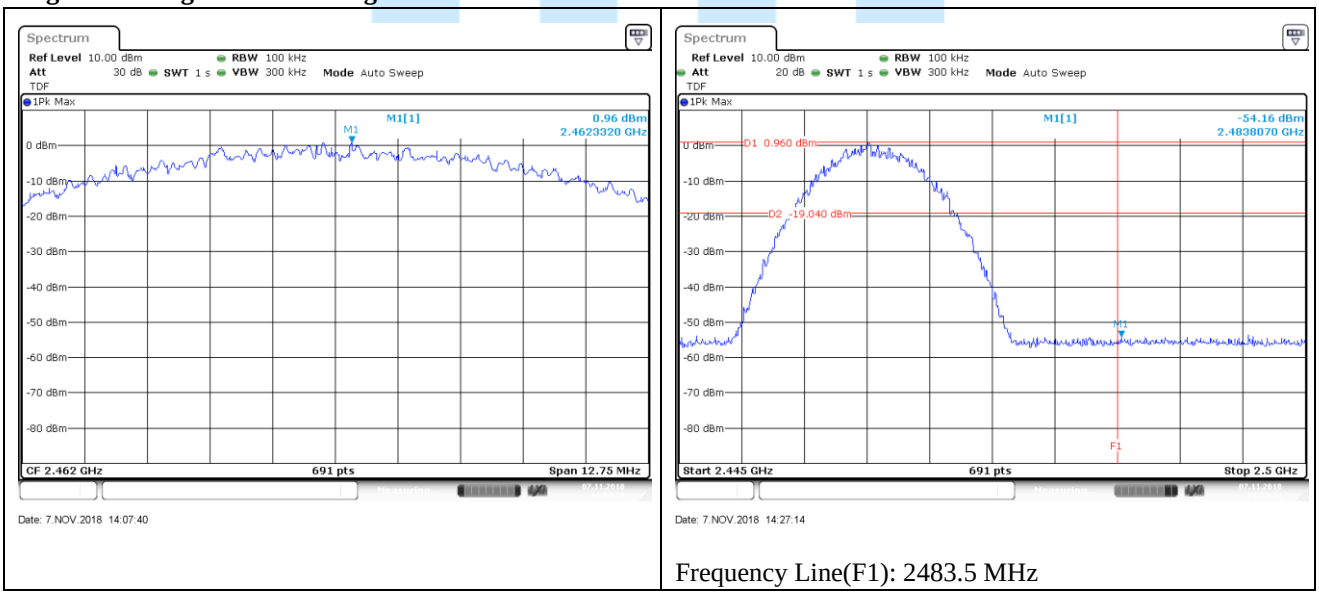


Low Band Edge Plot on Configuration : IEEE 802.11b 1ch



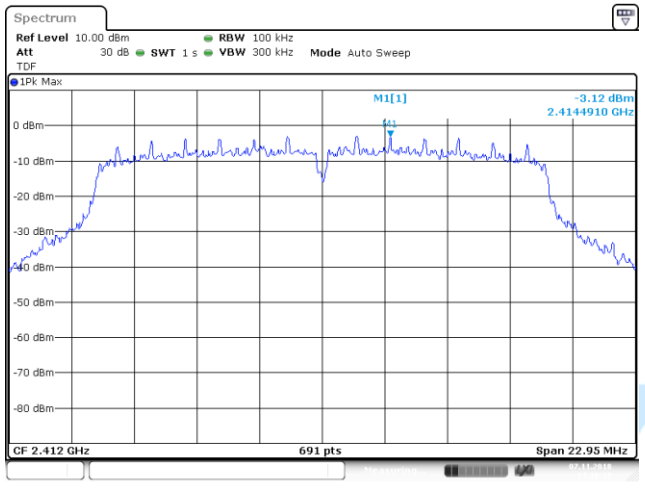
Frequency Line(F1): 2390 MHz

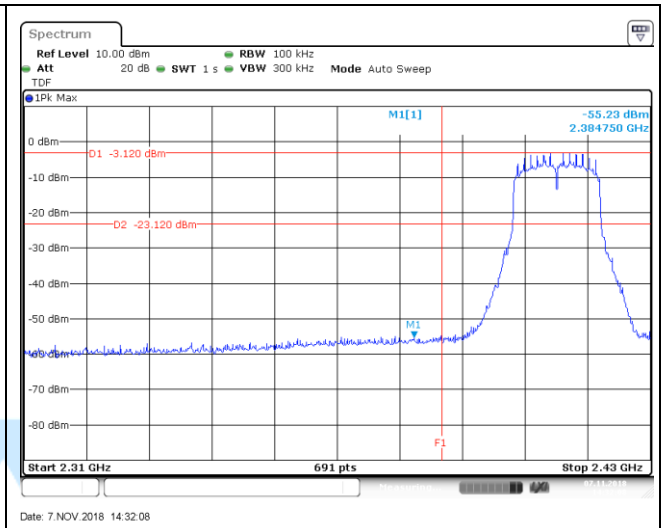
High Band Edge Plot on Configuration : IEEE 802.11b 11ch



Frequency Line(F1): 2483.5 MHz

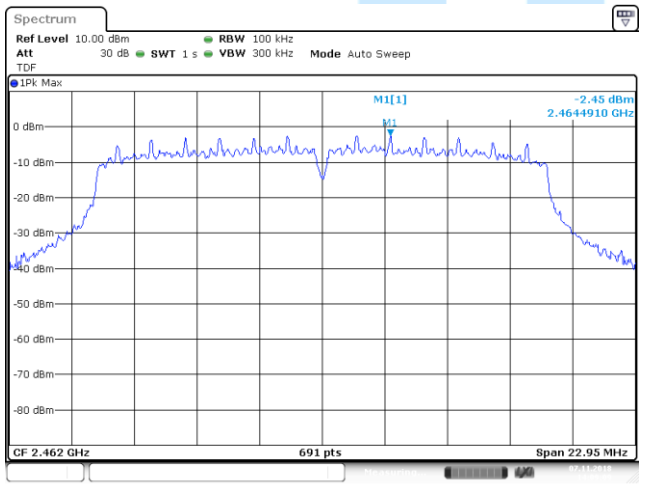
Low Band Edge Plot on Configuration : IEEE 802.11g 1ch

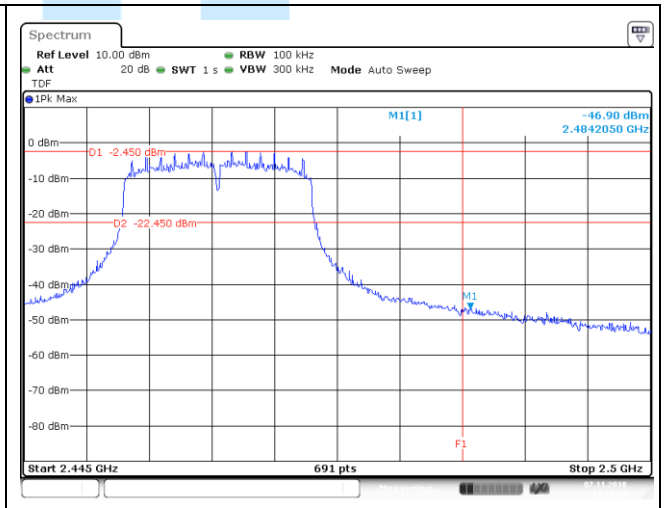




Frequency Line(F1): 2390 MHz

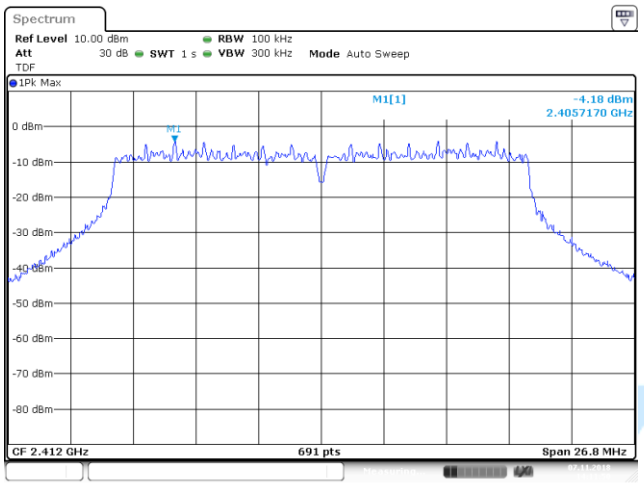
High Band Edge Plot on Configuration : IEEE 802.11g 11ch

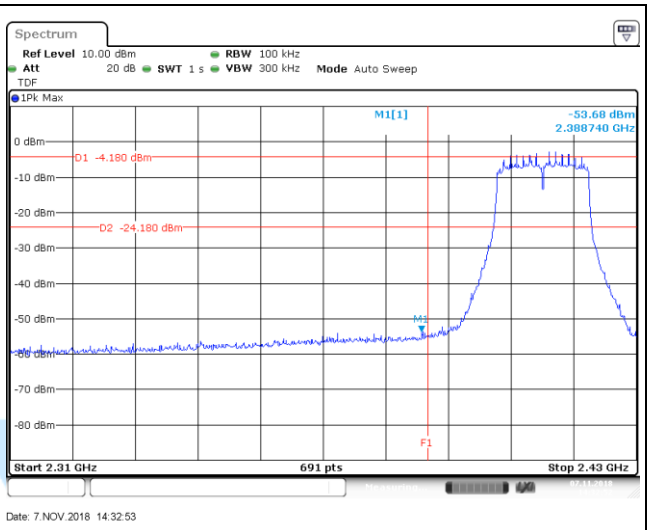




Frequency Line(F1): 2483.5 MHz

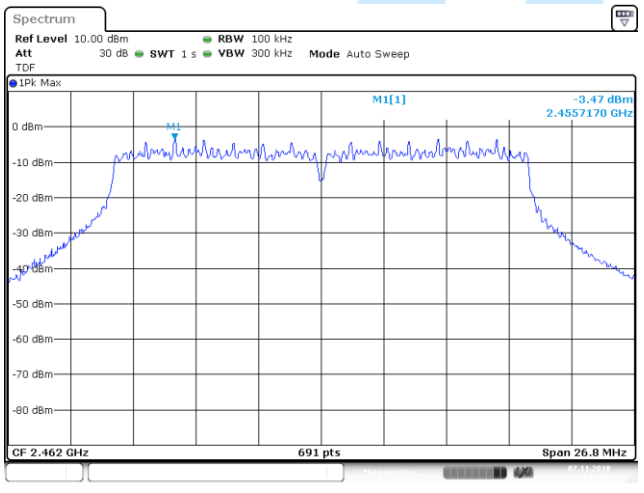
Low Band Edge Plot on Configuration : IEEE 802.11n 1ch

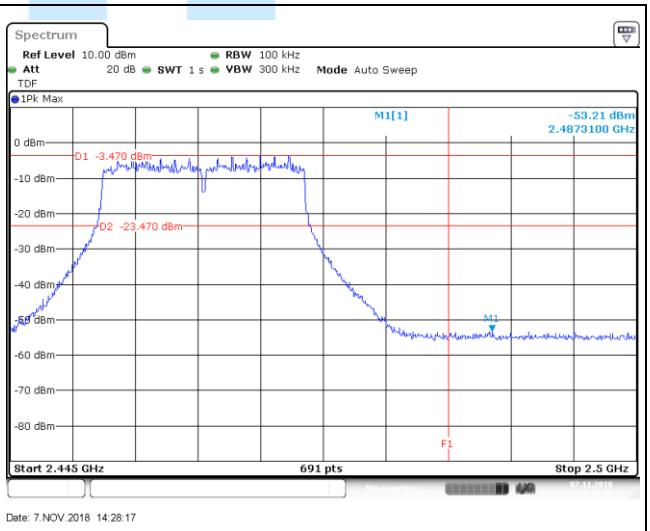




Frequency Line(F1): 2390 MHz

High Band Edge Plot on Configuration : IEEE 802.11n 11ch





Frequency Line(F1): 2483.5 MHz

12. AC Power line Conducted emission

-Test Description

The Line conducted emission test facility is inside a 4 m × 8 m × 2.5 m shielded enclosure. (Test firm Registration Number: 269701)

The EUT was placed on a non-conducting 1.0 m by 1.5 m table, which is 0.8 m in height and 0.4 m away from the vertical wall of the shielded enclosure.

The EUT is powered from the Rohde & Schwarz LISN (ENV216) and the support equipment is powered from the Rohde & Schwarz LISN (ENV216). Powers to the LISN are filtered by high-current high insertion loss power line filter.

Sufficient time for EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition.

The RF output of the LISN was connected to the EMI test receiver (Rohde & Schwarz, ESCI).

Exploratory measurements were conducted to identify the highest emission by operating the EUT in a range of typical modes of operation, cable positions, system configuration and arrangement.

Based on exploratory measurements, the final measurements were conducted at the worst test conditions.

Exploratory measurements were scanned using Peak mode of EMI Test receiver from 150 kHz to 30 MHz with 20 ms sweep time. The final measurements were measured with Quasi-Peak and Average mode.

The bandwidth of EMI Test Receiver was set to 9 kHz. Interface cables were connected to the available interface ports of the test unit. Excess cable lengths were bundled at center with 30 cm ~ 40 cm.

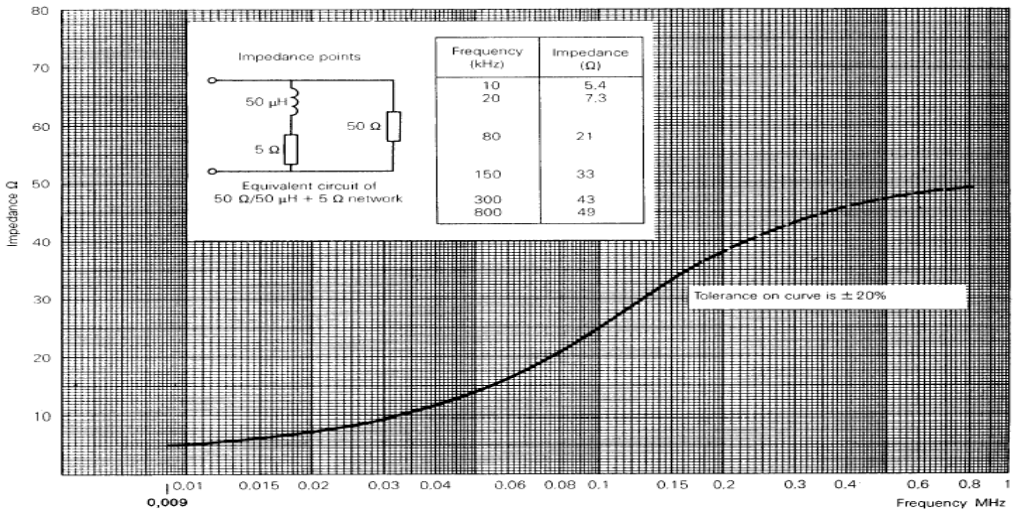


Fig 2. Impedance of LISN

12.1 Operating Environment

Temperature : 23.9 °C
Relative Humidity : 50.9 % R.H.

12.2 Test Set-up

The conducted emission measurements were performed in the shielded room.
The EUT was placed on wooden table, 0.8 m heights above the floor, 0.4 m from the reference ground plane (GRP) wall and 0.8 m from AMN & ISN.
AMN is bonded on horizontal reference ground plane.
The ground plane, which was electrically bonded to the shield room, ground system and all power lines entering the shield room, were filtered.

12.3 Measurement Uncertainty

The measurement uncertainty was calculated in accordance with ISO "Guide to the expression of uncertainty in measurement."
The measurement uncertainty was given with a confidence of 95 %.

Test Items	Uncertainty	Remark
Conducted emission (9 kHz ~ 150 kHz)	3.84 dB	Confidence level of approximately 95 % (k = 2)
Conducted emission (150 kHz ~ 30 MHz)	3.31 dB	Confidence level of approximately 95 % (k = 2)

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.
The listed uncertainties are the worst case uncertainty for the entire range of measurement. please note that the uncertainty values are provided for informational purposes only are not used in determining the PASS/FAIL results

12.4 Limit

RFI Conducted	FCC Limit(dBµV/m) Class B	
Freq. Range	Quasi-Peak	Average
150 kHz ~ 0.5 MHz	66 ~ 56*	56 ~ 46*
0.5 MHz ~ 5 MHz	56	46
5 MHz ~ 30 MHz	60	50
*Limits decreases linearly with the logarithm of frequency.		

12.5 Test Equipment used

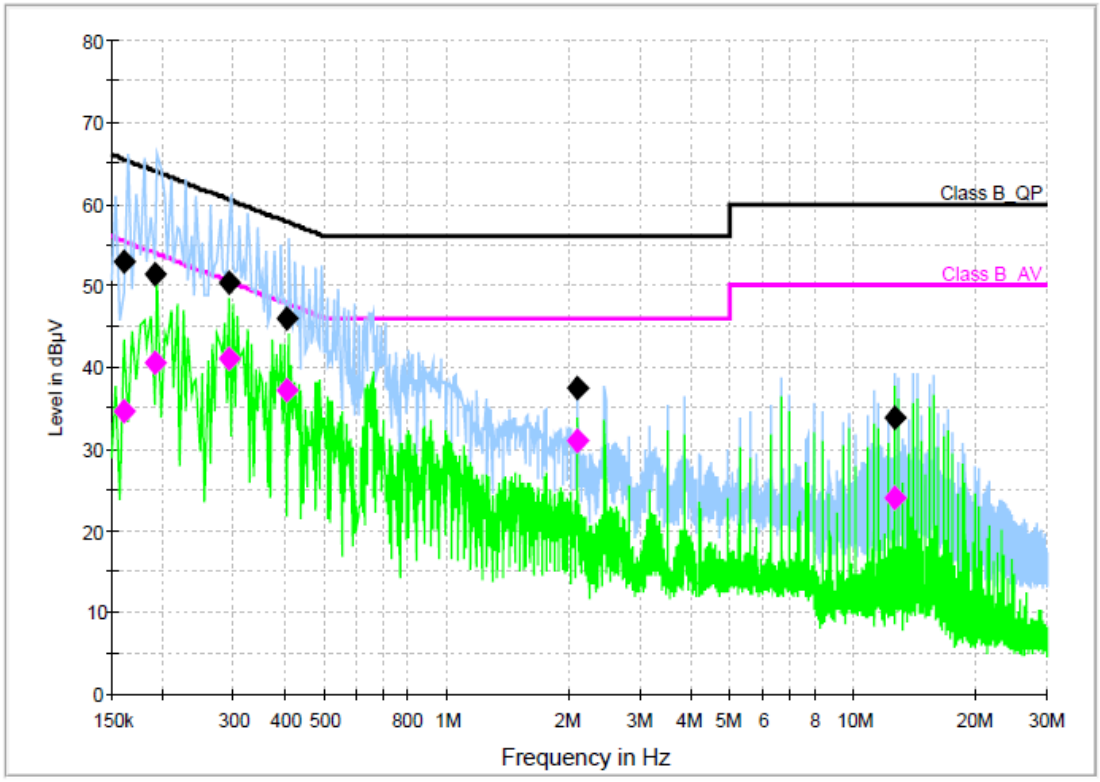
	Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■-	ESCI	Rohde & Schwarz	EMI test receiver	100237	Apr 16. 2019
■-	ENV216	Rohde & Schwarz	LISN	100172	Apr 12. 2019
□-	ENV216	Rohde & Schwarz	LISN	100173	Apr 12. 2019
□ -	ISN T8	TESEQ. GmbH	ISN	24568	May 02. 2019
■-	EMC 32	Rohde & Schwarz	Testing Software	VER8.53	N/A

12.6 Test data for Conducted Emission

-. Test Date : Oct. 29, 2018
-. Reference Standard : Part 15 Subpart C, Sec. 15.207
-. Test Procedure(s) : ANSI C63.10 (2013)
-. Operating Condition : Charging mode
-. Power Source : AC 120 V / 60 Hz
-. Frequency rage : 0.15 MHz to 30 MHz
-. Line : AC Power Line (Live and Neutral)
-. Comment :

12.7 Test Result

AC Power line Conducted emission



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.161000	52.9	1000.0	9.000	Off	N	9.8	12.5	65.4	
0.191275	51.5	1000.0	9.000	Off	N	9.8	12.5	64.0	
0.292019	50.3	1000.0	9.000	Off	L1	9.8	10.1	60.5	
0.405688	45.9	1000.0	9.000	Off	N	9.8	11.8	57.7	
2.100213	37.4	1000.0	9.000	Off	N	9.9	18.6	56.0	
12.602413	33.9	1000.0	9.000	Off	L1	10.6	26.1	60.0	

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.161000	34.5	1000.0	9.000	Off	N	9.8	20.9	55.4	
0.191275	40.4	1000.0	9.000	Off	N	9.8	13.5	54.0	
0.292019	41.0	1000.0	9.000	Off	L1	9.8	9.5	50.5	
0.405688	37.2	1000.0	9.000	Off	N	9.8	10.5	47.7	
2.100213	31.0	1000.0	9.000	Off	N	9.9	15.0	46.0	
12.602413	24.0	1000.0	9.000	Off	L1	10.6	26.0	50.0	

13. Radiated Spurious & Restricted Band Edge Emission

Exploratory Radiated measurements were conducted at the 3m semi anechoic chamber in order to identify the highest emission by operating the EUT in a range of typical modes of operation, cable positions, system configuration and arrangement.
Based on exploratory measurements, the final measurements were conducted at the worst test conditions.

Final measurements of below 1GHz were made at 3m or 10 m Chamber that complies with CISPR 16/ANSI C63.10.
Above 1GHz final measurements were conducted at the 3m Chamber only.

For measurements above 1GHz, the bottom side of 3m chamber was installed with absorbers in order to meet SVSWR Limit.
Exploratory measurements were scanned using Peak mode of EMI Test receiver and final measurements were measured with Quasi-Peak mode (Below 1GHz) and Peak & Average mode (Above 1GHz).

The measurements were performed by rotating the EUT 360° and adjusting the receive antenna height from 1.0 m to 4.0 m. All frequencies were investigated in both horizontal and vertical antenna polarity.

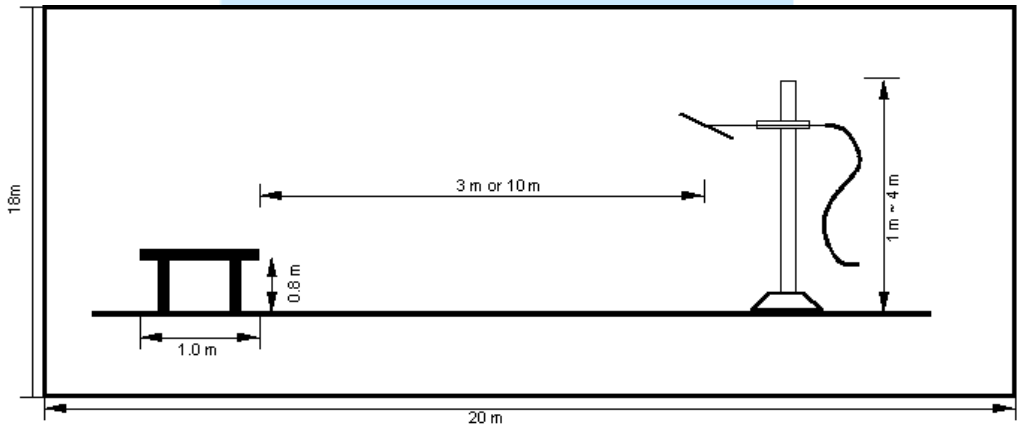


Fig 3. Dimensions of test site (Below 1GHz)

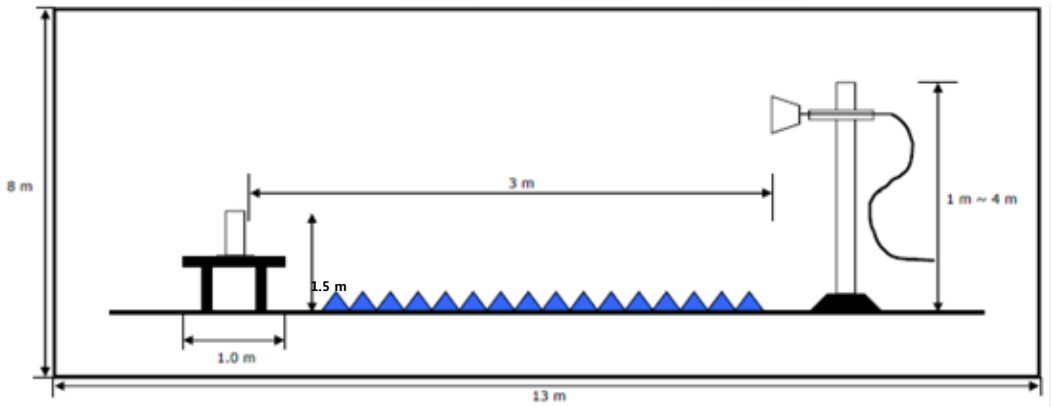


Fig 4. Dimensions of test site (Above 1GHz)

13.1 Operating environment

Temperature : 23.7 ℃
Relative humidity : 51.3 % R.H.

13.2 Test set-up

A preliminary and final measurement was at 3 m anechoic chamber.
The EUT was placed on a non-conducting table.
For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane.
For emission measurements above 1 GHz, the table height is 1.5 m above the reference ground plane.

The turntable with EUT was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels.
This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

13.3 Measurement uncertainty

The measurement uncertainty was calculated in accordance with ISO “Guide to the expression of uncertainty in measurement”.
The measurement uncertainty was given with a confidence of 95 %.

Test items(Anechoic Chamber)	Uncertainty	Remark
Radiated emission (30 MHz ~ 300 MHz, 3 m, Vertical)	5.14 dB	Confidence level of approximately 95 % (k = 2)
Radiated emission (30 MHz ~ 300 MHz, 3 m, Horizontal)	5.10 dB	Confidence level of approximately 95 % (k = 2)
Radiated emission (300 MHz ~ 1 000 MHz, 3 m, Vertical)	6.05 dB	Confidence level of approximately 95 % (k = 2)
Radiated emission (300 MHz ~ 1 000 MHz, 3 m, Horizontal)	5.19 dB	Confidence level of approximately 95 % (k = 2)
Radiated emission (1 000 MHz ~ 6 000 MHz, 3 m, V/H)	5.77 dB	Confidence level of approximately 95 % (k = 2)
Radiated emission (6 000 MHz ~ 18 000 MHz, 3 m, V/H)	5.77 dB	Confidence level of approximately 95 % (k = 2)

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.
The listed uncertainties are the worst case uncertainty for the entire range of measurement. please note that the uncertainty values are provided for informational purposes only are not used in determining the PASS/FAIL results

13.4 Limit

20 dB in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2 400/F (kHz)	300
0.490 ~ 1.705	2 400/F (kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

13.5 Test Equipment used

Model Name	Manufacturer	Description	Serial Number	Due to Calibration
■ - ESU40	Rohde & Schwarz	EMI Test Receiver	100266	Apr. 17, 2019
■ - HFH2-Z2	Rohde & Schwarz	Loop Antenna	100041	Dec. 6, 2019
■ - VULB9160	Schwarzbeck	Broadband Test Antenna	3099	Sep. 29, 2019
■ - BBHA9120D	Schwarzbeck	Horn Antenna	207	Sep. 14, 2019
■ - 3160-09	Schwarzbeck	Horn Antenna	LM3981	Dec. 20. 2019
■ - MCU066	maturo GmbH	Position Controller	1390306	N/A
■ - TT2.5SI	maturo GmbH	Turntable	1390307	N/A
■ - AM 4.0	maturo GmbH	Antenna Mast	1390308	N/A
■ - AFS 44 00101800-25-10P-44	MITEQ	Preamplifier	1258943	Apr. 18, 2019
■ - SCU-F1826-G47-BZ42-CSS	BONN Elektronik	Preamplifier	10003	Apr. 18, 2019
■ - WHKX3.0/18G-10SS	WAINWRIGHT INSTRUMENTS	High pass filter	SN31	Apr. 12, 2019

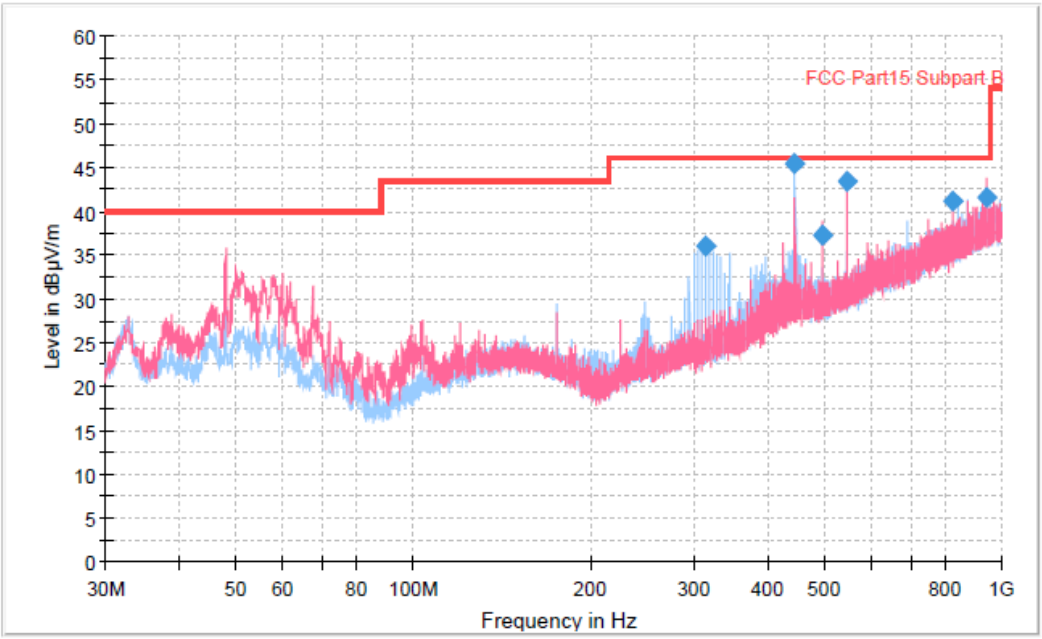
13.6 Test data for Radiated Spurious Emission

-. Test Date : September 28 ~ November 15, 2018
-. Reference Standard : Part 15 Subpart C, Sec. 15.247(d)
-. Measuring Distance : 3 m
-. Resolution Bandwidth : 200 Hz, 9 kHz(Below 30 MHz) / 120 kHz(30 MHz ~ 1GHz) / 1 MHz(Above 1GHz)
-. Detector mode : Quasi Peak detector mode / Peak detector mode / Average detector mode
-. Power Source : DC 3.65 V
-. Note : Through three orthogonal axes were investigated and the worst case is report

Radiated Spurious Emission (9 kHz to 30 MHz)

※ The emission level was not found.

Radiated Spurious Emission (30 MHz to 1 000 MHz)



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
313.483	36.07	46.00	9.93	1000.0	120.000	109.0	H	8.0
445.491	45.51	46.00	0.49	1000.0	120.000	203.0	H	204.0
494.970	37.26	46.00	8.74	1000.0	120.000	106.0	V	72.0
544.448	43.34	46.00	2.66	1000.0	120.000	100.0	V	269.0
824.964	41.10	46.00	4.90	1000.0	120.000	225.0	V	251.0
940.491	41.57	46.00	4.43	1000.0	120.000	100.0	V	279.0

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11b 1ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2665.81	V	26.10	35.1	-	61.20	74.00	12.80	PK
2665.81	V	13.32	35.1	-	48.42	54.00	5.58	AV
9648.00	H	41.13	13.9	-	55.03	74.00	18.97	PK
9648.00	H	36.12	13.9	-	50.02	54.00	3.98	AV

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11b 6ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2967.39	V	25.00	36.2	-	61.20	74.00	11.37	PK
2967.39	V	12.96	36.2	-	49.16	54.00	4.84	AV
4924.00	H	51.57	-3.1	-	48.47	74.00	25.53	PK
9748.10	H	39.69	14.3	-	53.99	74.00	20.01	PK

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11b 11ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2967.62	V	25.67	36.2	-	61.87	74.00	12.13	PK
2967.39	V	12.95	36.2	-	49.15	54.00	4.85	AV
4924.00	H	51.50	-3.8	-	47.70	74.00	26.30	PK
9848.00	H	40.01	14.7	-	54.71	74.00	19.29	PK
9848.00	H	33.30	14.7	-	48.00	54.00	6.00	AV

Note:
If the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.
Test Result = Reading + AF+AMP / CL
Where, ACF : Antenna Collection Factor,
AMP / CL = Cable loss + Preamplifier gain + High Pass Filter
Pol.: H(Horizontal), V(Vertical)

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11g 1ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2984.26	H	25.33	36.2	-	61.53	74.00	12.47	PK
2984.26	H	13.00	36.2	-	49.20	54.00	4.80	AV
6390.20	V	41.2	1.6	-	42.80	74.00	31.20	PK
9648.10	H	40.42	13.9	-	54.32	74.00	19.68	PK
9648.10	H	35.14	13.9	-	49.04	54.00	4.96	AV

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11g 6ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2955.89	V	25.54	36.2	-	61.74	74.00	12.26	PK
2955.89	V	12.92	36.2	-	49.12	54.00	4.88	AV
9748.00	H	39.89	14.3	-	54.19	74.00	19.81	PK
9748.00	H	33.75	14.3	-	48.05	54.00	5.95	AV

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11g 11ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2831.19	V	25.99	35.9	-	61.89	74.00	12.11	PK
2831.19	V	12.65	35.9	-	48.55	54.00	5.45	AV
4924.00	H	52.67	-3.8	-	48.87	74.00	25.13	PK

Note:
If the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.
Test Result = Reading + AF+AMP / CL
Where, ACF : Antenna Collection Factor,
AMP / CL = Cable loss + Preamplifier gain + High Pass Filter
Pol.: H(Horizontal), V(Vertical)

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11n 1ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2977.00	V	25.81	36.2	-	62.01	74.00	11.99	PK
2984.26	H	13.03	36.2	-	49.23	54.00	4.77	AV
9648.00	H	42.59	13.9	-	56.49	74.00	17.51	PK
9648.00	H	36.71	13.9	-	50.61	54.00	3.39	AV
12985.60	V	35.46	15.9	-	51.36	74.00	22.64	PK

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11n 6ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2944.34	V	25.48	36.2	-	61.68	74.00	12.32	PK
2944.34	V	12.91	36.2	-	49.11	54.00	4.89	AV
9748.00	H	39.98	14.3	-	54.28	74.00	19.72	PK
9748.00	H	33.06	14.3	-	47.36	54.00	6.64	AV
14833.70	V	34.93	18.7	-	53.63	74.00	20.37	PK

Radiated Spurious Emission (1 GHz to 25 GHz): IEEE 802.11n 11ch

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2970.84	H	26.02	36.2	-	62.22	74.00	11.78	PK
2970.84	H	12.96	36.2	-	49.16	54.00	4.84	AV
9748.00	H	41.47	14.3	-	55.77	74.00	18.23	PK
9748.00	H	35.33	14.3	-	49.63	54.00	4.37	AV

Note:
If the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.
Test Result = Reading + AF+AMP / CL
Where, ACF : Antenna Collection Factor,
AMP / CL = Cable loss + Preamplifier gain + High Pass Filter
Pol.: H(Horizontal), V(Vertical)

13.7 Test data for Radiated Restricted Band Edge Emission

-. Test Date : September 28, 2018
-. Reference Standard : Part 15 Subpart C, Sec. 15.247(d)
-. Measuring Distance : 3 m
-. Resolution Bandwidth : 1 MHz
-. Detector mode : Peak detector mode / Average detector mode
-. Power Source : DC 3.65 V
-. Note : Through three orthogonal axes were investigated and the worst case is report

IEEE 802.11b(1ch, 11ch)

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2388.78	H	25.80	34.40	-	60.20	74.00	13.80	PK
2388.78	H	13.24	34.40	-	47.64	54.00	6.36	AV
2498.60	H	26.93	34.40	-	61.33	74.00	12.67	PK
2498.60	H	13.88	34.40	-	48.28	54.00	5.72	AV

IEEE 802.11g(1ch, 11ch)

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2387.25	H	26.07	34.40	-	60.47	74.00	13.53	PK
2387.25	H	13.47	34.40	-	47.87	54.00	6.13	AV
2484.56	H	36.29	34.40	-	70.69	74.00	3.31	PK
2484.56	H	13.98	34.40	-	48.38	54.00	5.62	AV

IEEE 802.11n(1ch, 11ch)

Frequency [MHz]	Pol.	Reading [dBuV]	Transducer Factor [dB]	DCCF [dB]	Test Result [dBuV/m]	Limits [dBuV/m]	Margin [dB]	Detector Type
2387.19	H	26.87	34.40	-	61.27	74.00	12.73	PK
2387.19	H	13.77	34.40	-	48.17	54.00	5.83	AV
2499.07	H	25.76	34.40	-	60.16	74.00	13.84	PK
2498.60	H	12.94	34.40	-	47.34	54.00	6.66	AV

Note:
If the maximized peak measured value complies with the average limit, then it is unnecessary to perform an average measurement.
Test Result = Reading + Tranducer Factor
Where, ACF : Antenna Collection Factor,
CL = Cable loss + Preamplifier gain + High Pass Filter
※ High Pass Filter use to range of 3 GHz to 18 GHz
Pol.: H(Horizontal), V(Vertical)

14. Sample Calculations

$$dB\mu V = 20 \text{ Log } {}_{10}(\mu V/m)$$
$$dB\mu V = dBm + 107$$
$$\mu V = 10^{(dB\mu V/20)}$$

14.1 Example 1 :

■ **20.3 MHz**

Class B Limit	**= 250 µV = 48 dBµV**
Reading	**= 39.2 dBµV**
$10^{(39.2dB\mu V/20)}$	**= 91.2 µV**
Margin	**= 48 dBµV - 39.2 dBµV**
	= 8.8 dB

14.2 Example 2 :

■ **66.7 MHz**

Class B Limit	**= 100 µV/m = 40.0 dBµV/m**
Reading	**= 31.0 dBµV**
Antenna Factor + Cable Loss	**= 5.8 dB**
Total	**= 36.8 dBµV/m**
Margin	**= 40.0 dBµV/m – 36.8 dBµV/m**
	= 3.2 dB

15. Recommendation & Conclusion

The data collected shows that the **Ohsung Electronics Co., Ltd. Table top networking keypad (Model Name: TDC-9100)** was complies with §15.247 of the FCC Rules.

- The end -