TEST REPORT

Reference No.	:	WTZ21F11126549E003
FCC ID	:	2A3SYMBL01
Applicant	:	Hesung Innovation Limited
Address	:	Room 803, Chevalier House, 45-51 Chatham Road South, Tsim Sha Tsui, Kowloon, Hong Kong, 999077
Manufacturer	:	Guangdong Migair Electric Science and Technology Industrial Company Limited Beijiao First Branch
Address	:	No.6 Huancun Road, Guangjiao,Beijiao Town, Shunde, Foshan, Guangdong, 528311
Product Name	:	WiFi Module
Model No.	:	MBL01
Standards	:	FCC CFR47 Part 15 Subpart C (Section 15.247): 2020
Date of Receipt sample	:	2021-10-30
Date of Test	:	2021-11-04 to 2021-11-23
Date of Issue	:	2021-12-08
Test Result	:	**Pass**

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:
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Compiled by:

Roy Hong / Project Engineer

Approved by:

Danny Zhou / Manager

1 Revision History

Test Report No.	Date of Issue	Description	Status
WTZ21F11126549E003	2021-12-08	Original	Valid

2 Contents

3 General Information

3.1 General Description of E.U.T

Product Name ..... : WiFi Module

Model No. ..... : MBL01

Model Description ..... : ---

Rated Voltage..... : DC 3.3V

Battery Capacity ..... : ---

Power Adapter ..... : ---

3.2 Technical Characteristics of EUT

Support Standards ..... : 802.11b, 802.11g, 802.11n

Frequency Range ..... : 2412-2462MHz for 802.11b/g/n(HT20)

RF Output Power ..... : 18.87dBm (Conducted)

Modulation ..... : 802.11b: DSSS(DBPSK/DQPSK/CCK)
802.11g/n: OFDM (BPSK/QPSK/16QAM/64QAM)

Data Rate ..... : 1Mbps for 802.11b; 6Mbps for 802.11g;MCS0 for 802.11n

Quantity of Channels ..... : 11

Channel Separation..... : 5MHz

Type of Antenna ..... : FPC Antenna

Antenna Gain ..... : 1.9dBi

Lowest Oscillation..... : 26MHz

3.3 Standards Applicable for Testing

The tests were performed according to following standards:

FCC Rules Part 15.247	Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz
558074 D01 15.247 Meas Guidance v05r02	Guidance For Compliance Measurements On Digital Transmission System, Frequency Hopping Spread Spectrum System, And Hybrid System Devices Operating Under Section 15.247 Of The FCC Rules
662911 D01 Multiple Transmitter Output v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

3.4 Test Facility

The test facility has a test site registered with the following organizations:

- **IC – Registration No.: 21895-1**

Waltek Testing Group (Foshan) Co., Ltd. has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files. Registration IC number:21895-1, Nov. 14, 2016.

- **FCC – Registration No.: 820106**

Waltek Testing Group (Foshan) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 820106, August 16, 2018

- **FCC – Designation No.: CN5034**

Waltek Testing Group (Foshan) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Designation No. CN5034.

- **NVLAP – Lab Code: 600191-0**

Waltek Testing Group (Foshan) Co., Ltd. EMC Laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP/NIST). NVLAP Code: 600191-0.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

3.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

☐ Yes ☒ No

If Yes, list the related test items and lab information:

Test items: ---

Lab information: ---

3.6 Abnormalities from Standard Conditions

None.

4 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, with a duty cycle equal to 100%, and to measure its highest possible emissions level, more detailed description as follows:

Test Mode List

Test Mode	Description	Remark
TM1	802.11b	Low:2412MHz, Middle:2437MHz, High:2462MHz
TM2	802.11g	Low:2412MHz, Middle:2437MHz, High:2462MHz
TM3	802.11n-HT20	Low:2412MHz, Middle:2437MHz, High:2462MHz

Test Conditions

Temperature:	22~25℃
Relative Humidity:	50~55%
Atmospheric pressure:	101.9kPa

5 Equipment Used during Test

5.1 Equipment List

Conducted Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Cal Date**	**Cal Due Date**
1.	EMI Test Receiver	RS	ESCI	101178	2021-01-09	2022-01-08
2.	LISN	RS	ENV216	101215	2021-01-09	2022-01-08
3.	Cable	HUBER+SUHNER	CBL2-NN-3M	223NN322	2021-01-09	2022-01-08
4.	Test Software	FARATRONIC	EZ-EMC CON-03A1	-	-	-
3m Semi-anechoic Chamber for Radiation Emissions						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	EMI Test Receiver	RS	ESR7	101566	2021-01-09	2022-01-08
2.	EMC Analyzer	Agilent	N9020A	MY48011796	2021-01-09	2022-01-08
3.	Active Loop Antenna	SCHWARZBECK	FMZB1519B	00004	2021-01-09	2022-01-08
4.	Trilog Broadband Antenna	SCHWARZBECK	VULB 9162	9162-117	2021-01-09	2022-01-08
5.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	01561	2021-01-09	2022-01-08
6.	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2021-01-09	2022-01-08
7.	Amplifier	Lunar E M	LNA1G18-40	20160501002	2021-01-09	2022-01-08
8.	Coaxial Cable (below 1GHz)	H+S	CBL3-NN-12+3 m	214NN320	2021-01-09	2022-01-08
9.	Coaxial Cable (above 1GHz)	Times-Micorwave	CBL5-NN	-	2021-01-09	2022-01-08
10.	Test Software	FARATRONIC	EZ-EMC RA-03A1-1	-	-	-
RF Conducted Testing						
Item	**Equipment**	**Manufacturer**	**Model No.**	**Serial No.**	**Last Calibration Date**	**Calibration Due Date**
1.	Spectrum Analyzer	Agilent	N9020A	MY48011796	2021-01-09	2022-01-08
2.	Spectrum Analyzer	R&S	FSP40	100501	2021-01-09	2022-01-08
3.	Vector Signal Generator	Agilent	N5182A	MY50141533	2021-01-09	2022-01-08
4.	Analog Signal Generator	Agilent	N5181A	MY48180720	2021-01-09	2022-01-08
5.	Environmental Chamber	KSON	THS-D4C-100	5244K	2021-01-09	2022-01-08
6.	RF Control Unit	CHANGCHUANG	JS0806-2	-	2021-01-09	2022-01-08

5.2 Special Accessories and Auxiliary Equipment

Item	Equipment	Manufacturer	Model No.	Serial No.
1.	/	/	/	/

5.3 Measurement Uncertainty

Parameter	Uncertainty
RF Output Power	±0.95dB
Occupied Bandwidth	±1.5%
Conducted Spurious Emission	±2.7dB
Conducted Emission	±2.7dB
Transmitter Spurious Emission	±3.8dB (for 25MHz-1GHz)
	±5.0dB (for 1GHz-18GHz)

6 Summary of Test Result

Test Items	FCC Rules	Result
Antenna Requirement	§15.203; §15.247(b)(4)(i)	Compliant
Restricted Band of Operation	§15.205	Compliant
Conducted Emissions	§15.207(a)	Compliant
Radiated Spurious Emissions	§15.209(a)	Compliant
Power Spectral Density	§15.247(e)	Compliant
DTS Bandwidth	§ 15.247(a)(2)	Compliant
RF Output Power	§15.247(b)(3)	Compliant
Band edge (Out of Band Emissions)	§15.247(d)	Compliant
RF Exposure	§2.1093	Compliant

Remark:

Pass Test item meets the requirement

Fail Test item does not meet the requirement

N/A Test case does not apply to the test object

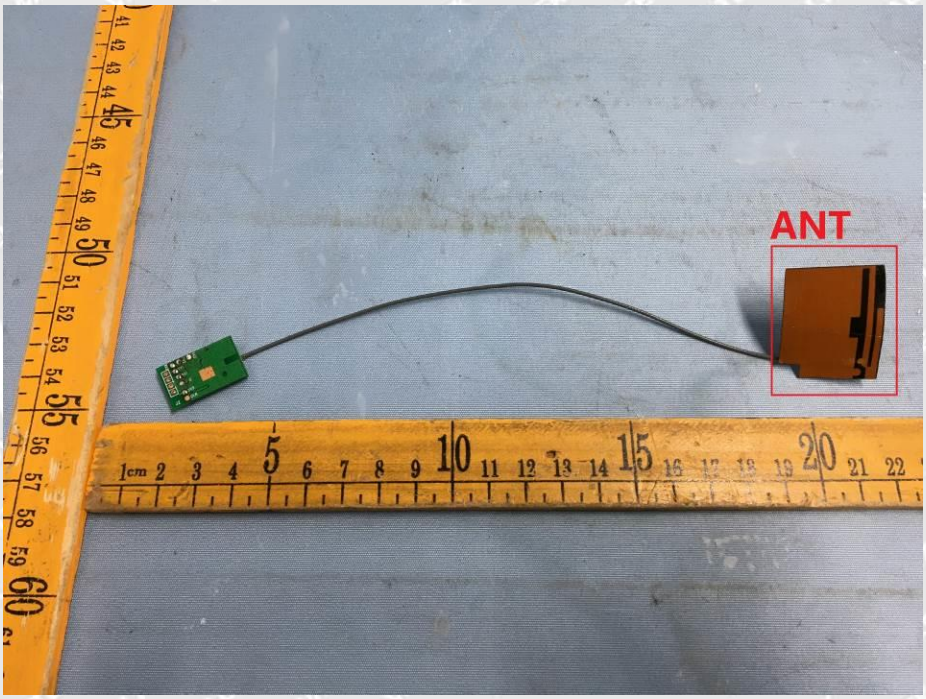
6.1 Antenna Requirement

6.1.1 Standard Applicable

According to FCC Part 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

6.1.2 Evaluation Information

The EUT has an FPC Antenna, the gain is 1.9dBi, fulfil the requirement of this section.



6.2 RF Exposure Requirement

6.2.1 Standard Applicable

According to§1.1307 and §2.1093, the portable transmitter must comply the RF exposure requirements.

6.2.2 Test Result

This product complied with the requirement of the RF exposure, please see the RF Exposure Report WTZ21F11126549E004.

6.3 Radiated Spurious Emissions

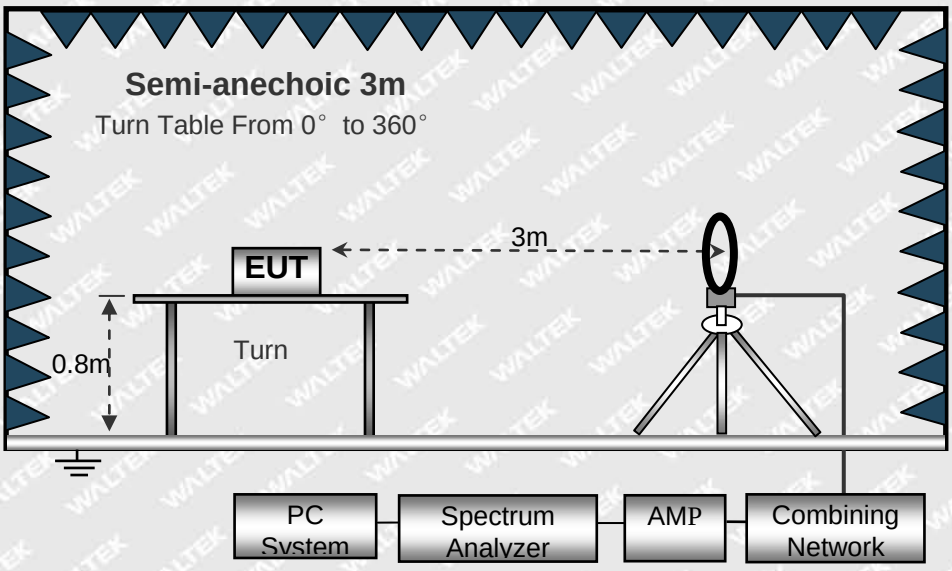
6.3.1 Standard Applicable

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

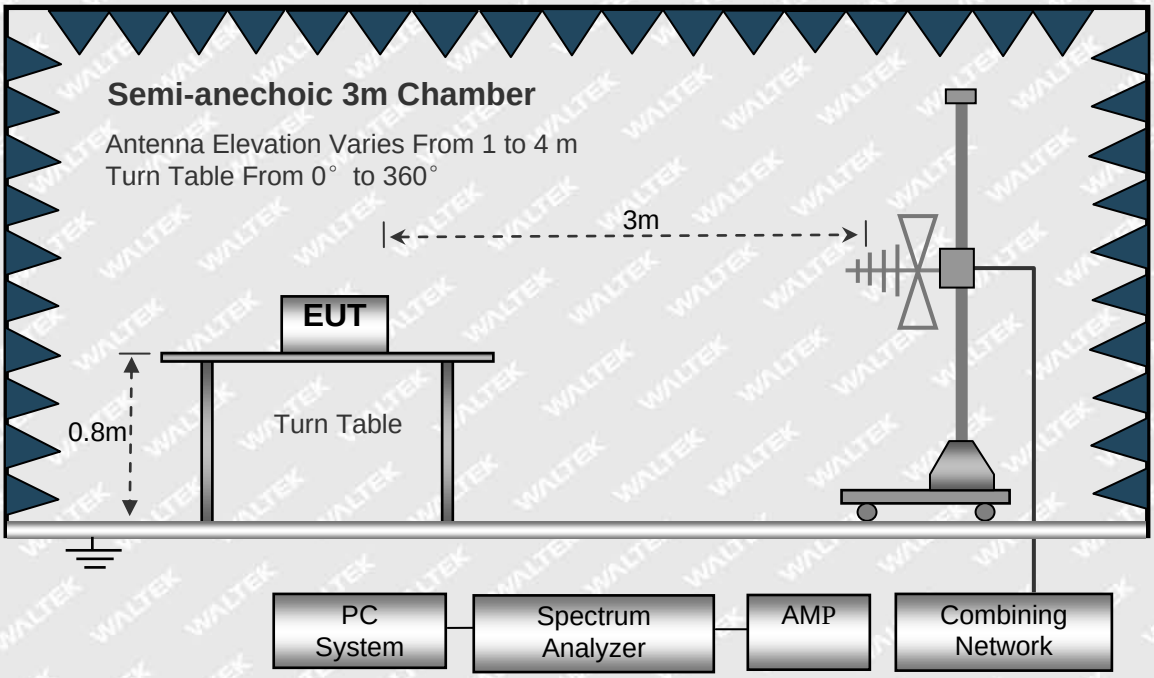
The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

6.3.2 Test Procedure

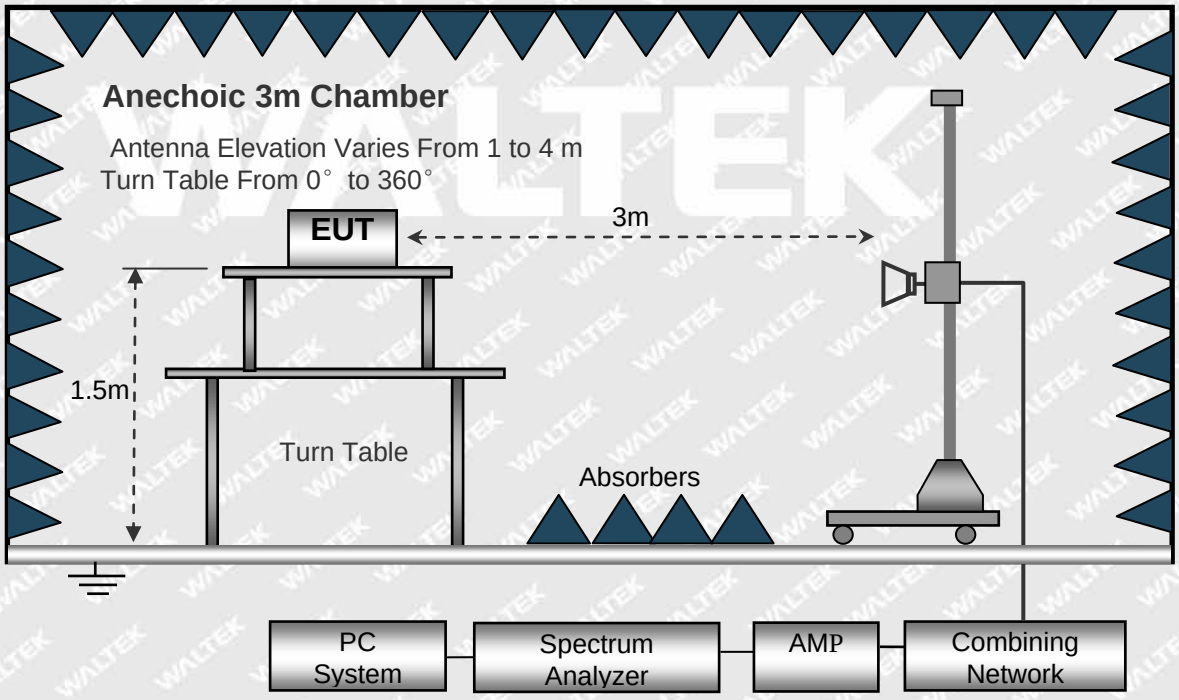
The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle. The spacing between the peripherals was 10 cm.
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz.



6.3.3 Spectrum Analyzer Setup

9KHz-30MHz	30MHz-1GHz	Above 1GHz
RBW=10kHz	RBW=120kHz	RBW=1MHz
VBW=30kHz	VBW=300kHz	VBW=3MHz(Peak), 10MHz(AV)
Sweep time=Auto	Sweep time=Auto	Sweep time=Auto
Trace=Max hold	Trace=Max hold	Trace=Max hold
Detector function=peak	Detector function=peak, QP	Detector function=peak, AV

6.3.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Corr. Factor

Corr.Factor=Antenna Factor + Cable Factor - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

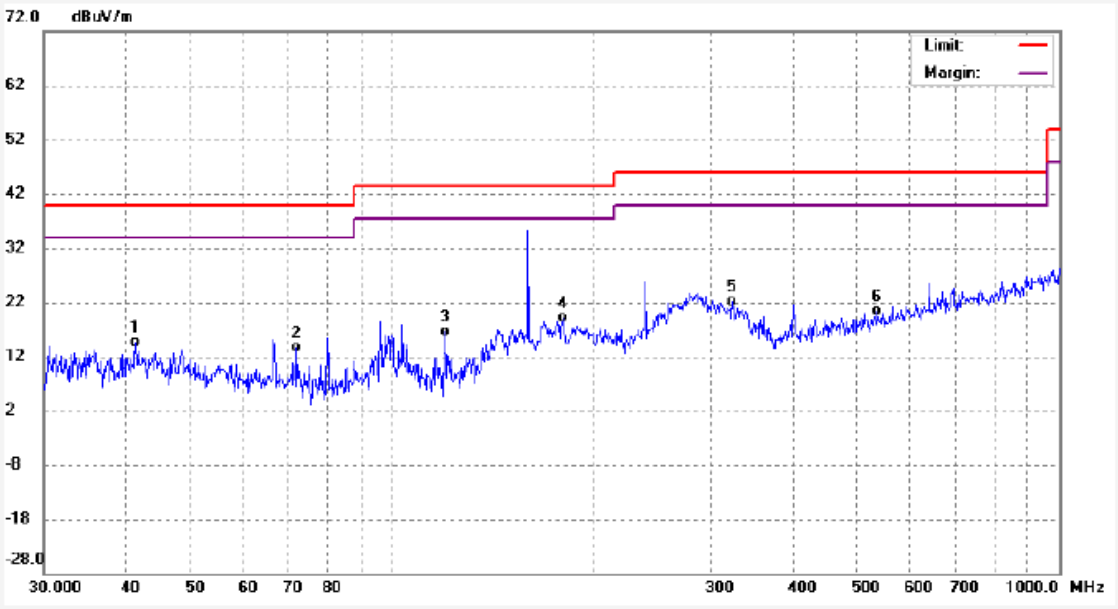
6.3.5 Test Results

Note: All test modes (different data rate and different modulation) are performed, but only the worst case is recorded in this report.

Test Frequency: 30MHz ~ 1GHz

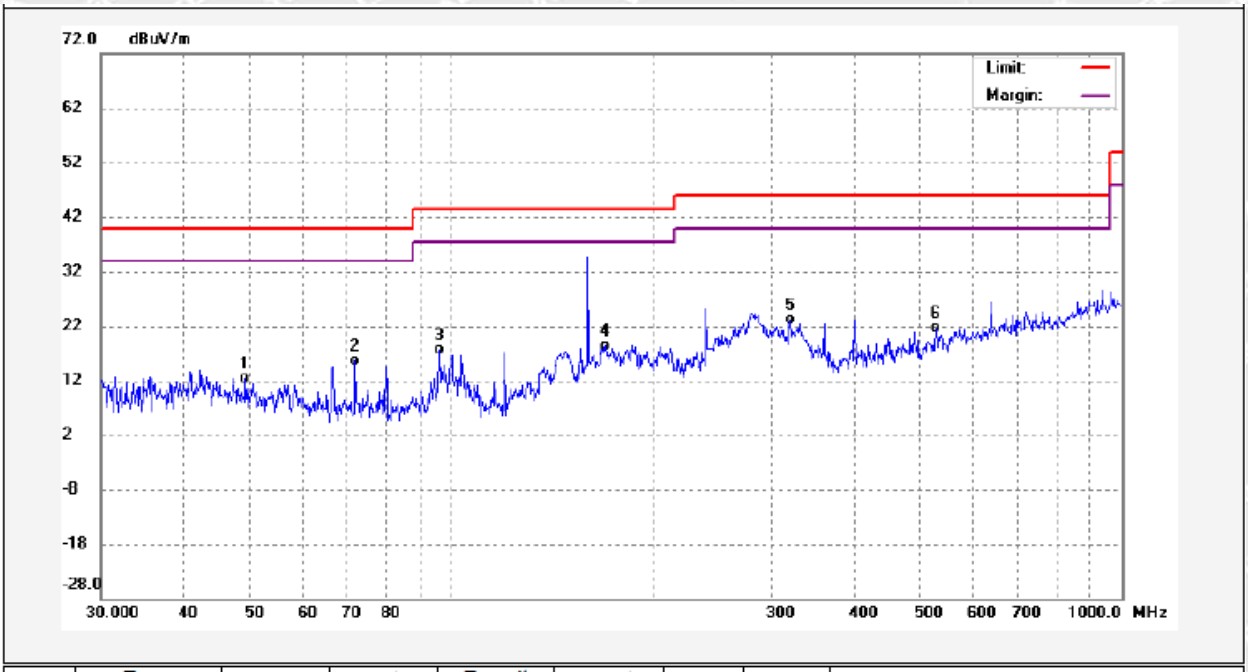
802.11n20 (worst case)

Test Channel Low **Polarization** Vertical



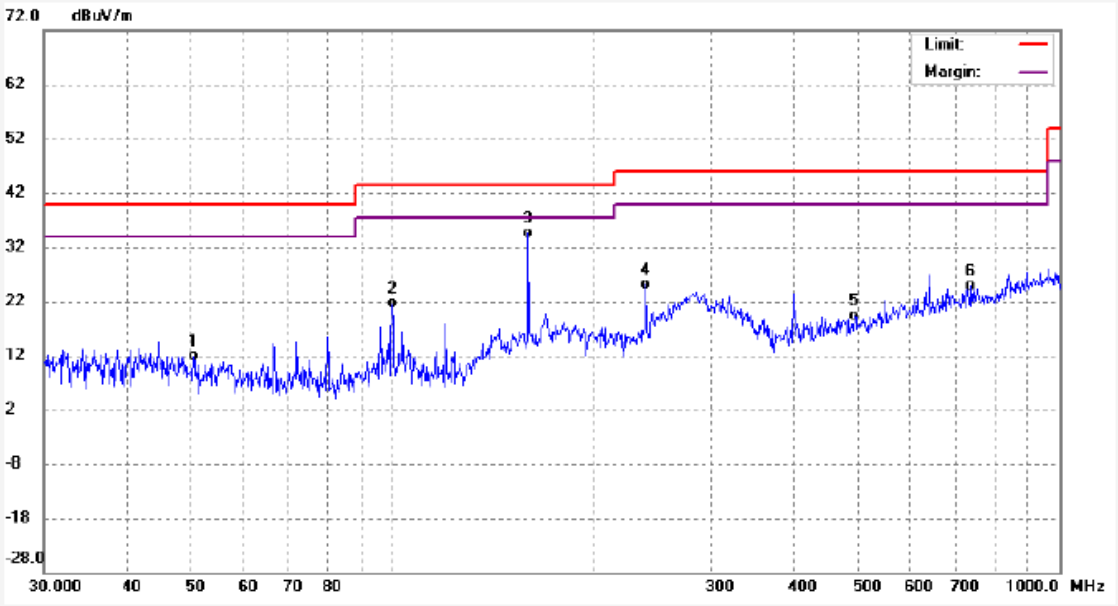
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	41.1753	-0.23	14.85	14.62	40.00	-25.38	QP	
2	72.0591	3.75	9.91	13.66	40.00	-26.34	QP	
3	119.9818	5.63	11.06	16.69	43.50	-26.81	QP	
4	180.0165	7.76	11.39	19.15	43.50	-24.35	QP	
5	323.7742	5.76	16.45	22.21	46.00	-23.79	QP	
6	533.8321	-0.50	20.81	20.31	46.00	-25.69	QP	

Test Channel Low **Polarization** Horizontal



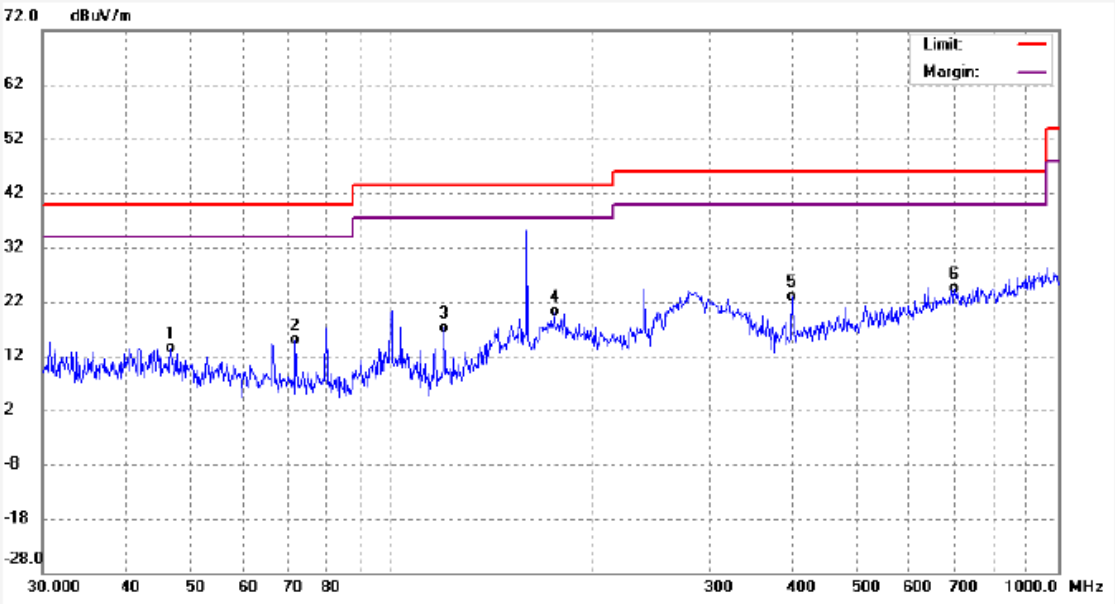
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	49.2039	-1.61	14.07	12.46	40.00	-27.54	QP	
2	71.9833	5.67	9.92	15.59	40.00	-24.41	QP	
3	95.9975	5.82	11.90	17.72	43.50	-25.78	QP	
4	169.7180	7.38	10.92	18.30	43.50	-25.20	QP	
5	320.0492	6.79	16.40	23.19	46.00	-22.81	QP	
6	529.1728	0.84	20.68	21.52	46.00	-24.48	QP	

Test Channel Middle Channel **Polarization** Vertical



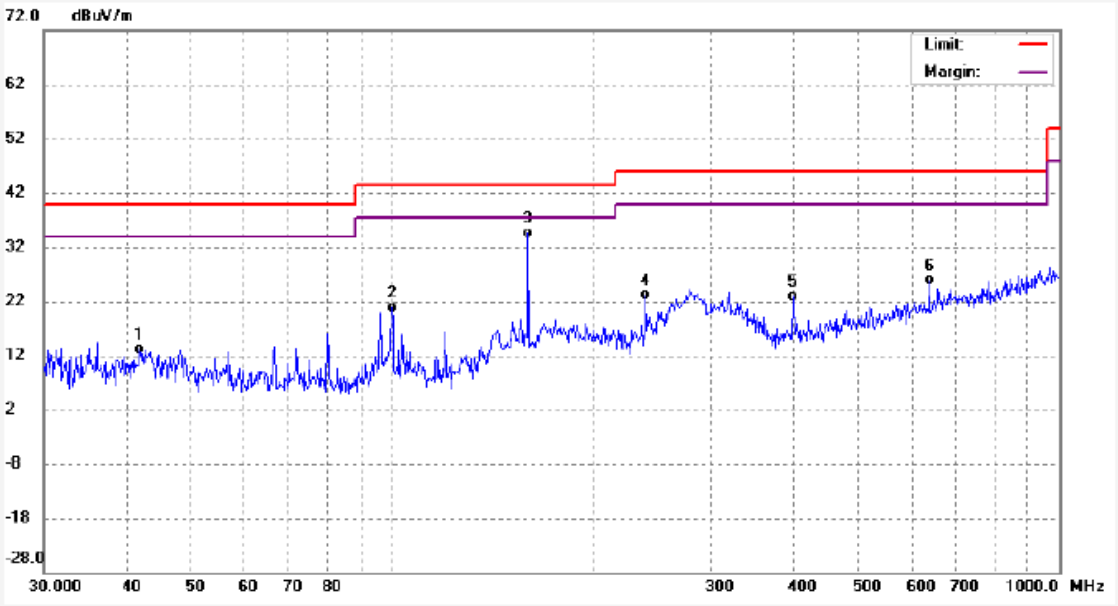
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	50.3206	-1.93	13.85	11.92	40.00	-28.08	QP	
2	99.9128	9.39	12.24	21.63	43.50	-21.87	QP	
3	160.0087	24.07	10.48	34.55	43.50	-8.95	QP	
4	239.9873	10.25	14.77	25.02	46.00	-20.98	QP	
5	492.9869	-0.34	19.78	19.44	46.00	-26.56	QP	
6	737.8472	0.30	24.53	24.83	46.00	-21.17	QP	

Test Channel Middle Channel **Polarization** Horizontal



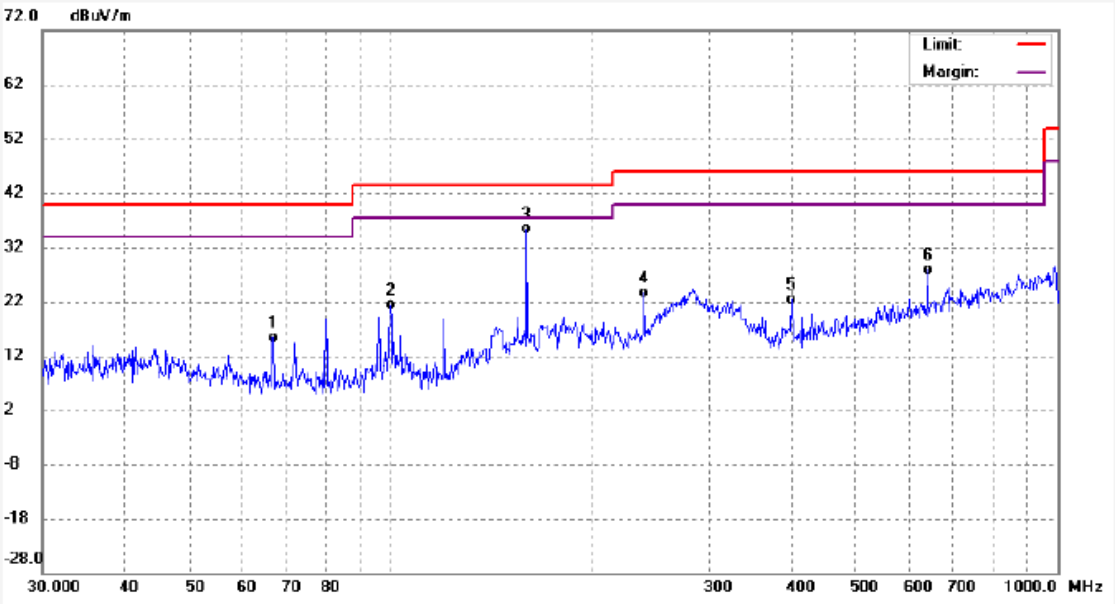
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	46.8138	-1.10	14.59	13.49	40.00	-26.51	QP	
2	72.0085	4.86	9.92	14.78	40.00	-25.22	QP	
3	120.0238	6.19	11.06	17.25	43.50	-26.25	QP	
4	175.9598	9.03	11.13	20.16	43.50	-23.34	QP	
5	400.0109	4.98	17.90	22.88	46.00	-23.12	QP	
6	700.0406	0.43	23.84	24.27	46.00	-21.73	QP	

Test Channel High Channel **Polarization** Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	41.7716	-1.78	15.03	13.25	40.00	-26.75	QP	
2	99.9829	8.75	12.25	21.00	43.50	-22.50	QP	
3	160.0087	24.07	10.48	34.55	43.50	-8.95	QP	
4	239.9873	8.47	14.77	23.24	46.00	-22.76	QP	
5	400.0109	5.03	17.90	22.93	46.00	-23.07	QP	
6	640.1619	3.08	22.87	25.95	46.00	-20.05	QP	

Test Channel High Channel **Polarization** Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Remark
1	66.6390	4.17	11.18	15.35	40.00	-24.65	QP	
2	99.9128	9.12	12.24	21.36	43.50	-22.14	QP	
3	160.0087	24.86	10.48	35.34	43.50	-8.16	QP	
4	239.9873	8.86	14.77	23.63	46.00	-22.37	QP	
5	400.0109	4.50	17.90	22.40	46.00	-23.60	QP	
6	640.1619	5.02	22.87	27.89	46.00	-18.11	QP	

Test Frequency: 1GHz ~ 18GHz.

Frequency (MHz)	Receiver Reading (dBμV/m)	Detector (PK/QP/AVG)	Turn table Angle (°)	RX Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247	
				Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
802.11b_Low Channel									
4818.75	54.18	Peak	125	1.2	H	-3.44	50.74	74	-23.26
4818.75	46.48	AVG	133	1.3	H	-3.44	43.04	54	-10.96
10893.50	40.21	Peak	238	2	H	9.27	49.48	74	-24.52
10893.50	32.95	AVG	251	2	H	9.27	42.22	54	-11.78
4818.75	56.2	Peak	230	1.9	V	-3.56	52.64	74	-21.36
4818.75	49.91	AVG	260	1.6	V	-3.56	46.35	54	-7.65
10024.00	42.05	Peak	250	1	V	7.54	49.59	74	-24.41
10024.00	33.97	AVG	299	1	V	7.54	41.51	54	-12.49
802.11b_Middle Channel									
4889.25	57.69	Peak	262	1.1	H	-3.23	54.46	74	-19.54
4889.25	55.41	AVG	138	1.1	H	-3.23	52.18	54	-1.82
10588.00	41.31	Peak	108	1.8	H	8.41	49.72	74	-24.28
10588.00	33.23	AVG	276	1.4	H	8.41	41.64	54	-12.36
4877.50	41.11	Peak	180	2	V	-3.41	37.70	74	-36.30
4877.50	49.63	AVG	179	1.8	V	-3.41	46.22	54	-7.78
11445.75	40.79	Peak	260	1.2	V	10.59	51.38	74	-22.62
11445.75	33.15	AVG	309	1.4	V	10.59	43.74	54	-10.26
802.11b_High Channel									
4948.00	55.66	Peak	119	1.8	H	-3.24	52.42	74	-21.58
4948.00	47.19	AVG	303	1.4	H	-3.24	43.95	54	-10.05
11351.75	42.12	Peak	250	1.2	H	10.53	52.65	74	-21.35
11351.75	34.17	AVG	167	1.5	H	10.53	44.70	54	-9.30
4936.25	57.54	Peak	147	1.3	V	-3.09	54.45	74	-19.55
4936.25	47.14	AVG	226	1	V	-3.09	44.05	54	-9.95
11610.25	42.96	Peak	272	1.5	V	10.17	53.13	74	-20.87
11610.25	34.57	AVG	282	1.4	V	10.17	44.74	54	-9.26

Frequency (MHz)	Receiver Reading (dBμV/m)	Detector (PK/QP/AVG)	Turn table Angle (°)	RX Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247	
				Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
802.11g_Low Channel									
4818.75	54.64	Peak	125	1.7	H	-3.56	51.08	74	-22.92
4818.75	51.66	AVG	211	1.7	H	-3.56	48.10	54	-5.90
11163.70	41.90	Peak	201	1.3	H	10.39	52.29	74	-21.71
11163.70	33.01	AVG	135	1.2	H	10.39	43.40	54	-10.60
4818.75	54.71	Peak	241	1	V	-3.44	51.27	74	-22.73
4818.75	46.67	AVG	271	1.1	V	-3.44	43.23	54	-10.77
10705.50	40.06	Peak	310	2	V	8.74	48.80	74	-25.20
10705.50	32.52	AVG	310	1	V	8.74	41.26	54	-12.74
802.11g_Middle Channel									
4889.25	51.18	Peak	132	1.4	H	-3.39	47.79	74	-26.21
4889.25	48.83	AVG	114	1	H	-3.39	45.44	54	-8.56
10940.50	41.76	Peak	260	1.8	H	10.08	51.84	74	-22.16
10940.50	32.97	AVG	239	2	H	10.08	43.05	54	-10.95
4877.50	61.64	Peak	121	1.3	V	-3.26	58.38	74	-15.62
4877.50	49.68	AVG	124	1.4	V	-3.26	46.42	54	-7.58
10940.50	41.52	Peak	276	1.7	V	9.41	50.93	74	-23.07
10940.50	34.45	AVG	286	1.6	V	9.41	43.86	54	-10.14
802.11g_High Channel									
4936.25	57.54	Peak	137	1.7	H	-3.27	54.27	74	-19.73
4936.25	48.35	AVG	186	1.8	H	-3.27	45.08	54	-8.92
11434.00	41.48	Peak	246	1.4	H	10.59	52.07	74	-21.93
11434.00	33.79	AVG	196	1.1	H	10.59	44.38	54	-9.62
4936.25	57.66	Peak	310	2	V	-3.09	54.57	74	-19.43
4936.25	46.69	AVG	206	1.1	V	-3.09	43.60	54	-10.40
11880.50	42.85	Peak	217	1.8	V	10.28	53.13	74	-20.87
11880.50	35.17	AVG	190	1.9	V	10.28	45.45	54	-8.55

Frequency (MHz)	Receiver Reading (dBμV/m)	Detector (PK/QP/AVG)	Turn table Angle (°)	RX Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247	
				Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
802.11n20_Low Channel									
4818.75	53.73	Peak	201	1.9	H	-3.56	50.17	74	-23.83
4818.75	51.68	AVG	240	1.1	H	-3.56	48.12	54	-5.88
11034.50	40.70	Peak	317	1.6	H	10.31	51.01	74	-22.99
11034.50	33.01	AVG	280	1.7	H	10.31	43.32	54	-10.68
4818.75	57.05	Peak	142	1.9	V	-3.44	53.61	74	-20.39
4818.75	50.68	AVG	182	1.7	V	-3.44	47.24	54	-6.76
10623.25	41.54	Peak	193	1.8	V	8.51	50.05	74	-23.95
10623.25	32.98	AVG	206	2	V	8.51	41.49	54	-12.51
802.11n20_Middle Channel									
4889.25	57.69	Peak	203	1.5	H	-3.39	54.30	74	-19.70
4889.25	55.16	AVG	241	1.3	H	-3.39	51.77	54	-2.23
11128.50	42.58	Peak	263	1.1	H	10.36	52.94	74	-21.06
11128.50	35.32	AVG	305	1.6	H	10.36	45.68	54	-8.32
4889.25	57.79	Peak	246	1.1	V	-3.23	54.56	74	-19.44
4889.25	54.32	AVG	116	1.7	V	-3.23	51.09	54	-2.91
11199.00	42.56	Peak	198	1.7	V	9.80	52.36	74	-21.64
11199.00	34.08	AVG	166	1.7	V	9.80	43.88	54	-10.12
802.11n20_High Channel									
4948.00	51.476	Peak	262	1.8	H	-3.24	48.24	74	-25.76
4948.00	41.78	AVG	302	1.4	H	-3.24	38.54	54	-15.46
9883.00	43.46	Peak	101	1.8	H	7.33	50.79	74	-23.21
9883.00	34.32	AVG	151	1.9	H	7.33	41.65	54	-12.35
4936.25	55.04	Peak	289	1.4	V	-3.09	51.95	74	-22.05
4936.25	43.87	AVG	115	1.2	V	-3.09	40.78	54	-13.22
10646.75	40.76	Peak	169	1.1	V	8.58	49.34	74	-24.66
10646.75	34.19	AVG	203	1	V	8.58	42.77	54	-11.23

Note: Testing is carried out with frequency rang 9kHz to the tenth harmonics, other than listed in the table above are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

6.4 Power Spectral Density

6.4.1 Standard Applicable

According to 15.247(a)(1)(iii), 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.

6.4.2 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.4 and ANSI C63.10-2013 Subclause11.10.3, such specifications require that the same method as used to determine the conducted output power shall also be used to determine the power spectral density. The test method of power spectral density as below:

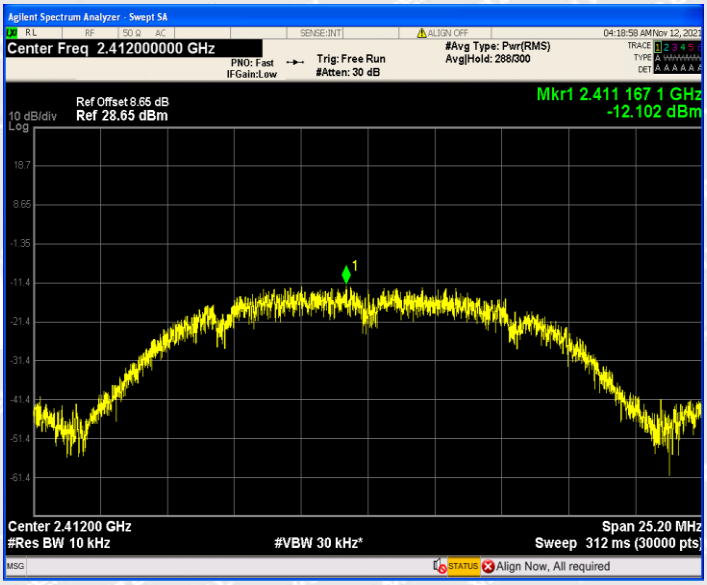
a) Set instrument center frequency to DTS channel center frequency.
b) Set span to at least 1.5 times the OBW.
c) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz. .
d) Set VBW ≥3 x RBW.
e) Detector = power averaging (RMS) or sample detector (when RMS not available).
f) Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
g) Sweep time = auto couple.
h) Employ trace averaging (RMS) mode over a minimum of 100 traces.
i) Use the peak marker function to determine the maximum amplitude level.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

6.4.3 Test Result

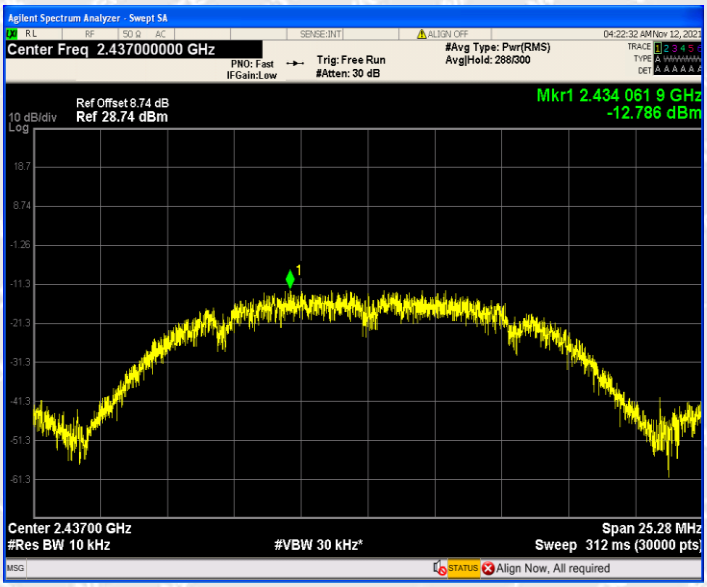
Test Mode	Test Channel(MHz)	Test Result (dBm/10kHz)	Limit (dBm/3kHz)
802.11b	2412	-12.12	8
	2437	-12.80	8
	2462	-11.48	8
802.11g	2412	-15.41	8
	2437	-15.39	8
	2462	-14.50	8
802.11n-HT20	2412	-15.97	8
	2437	-16.45	8
	2462	-15.59	8

Test plots:

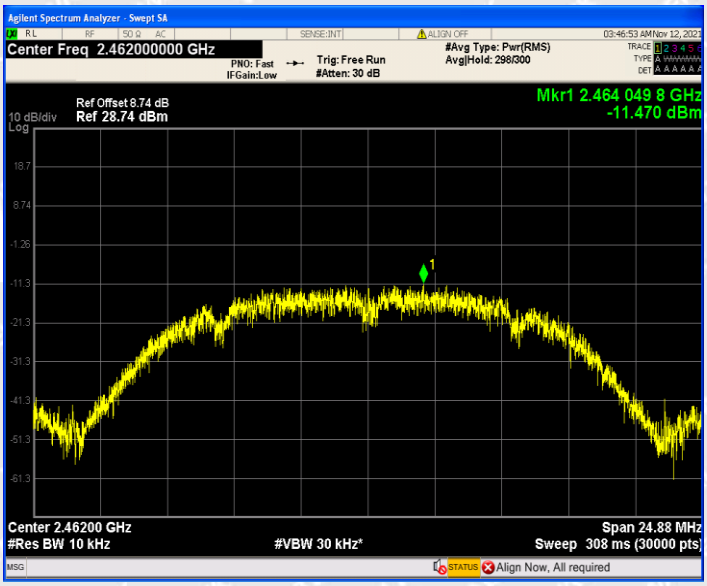
802.11b_Low Channel



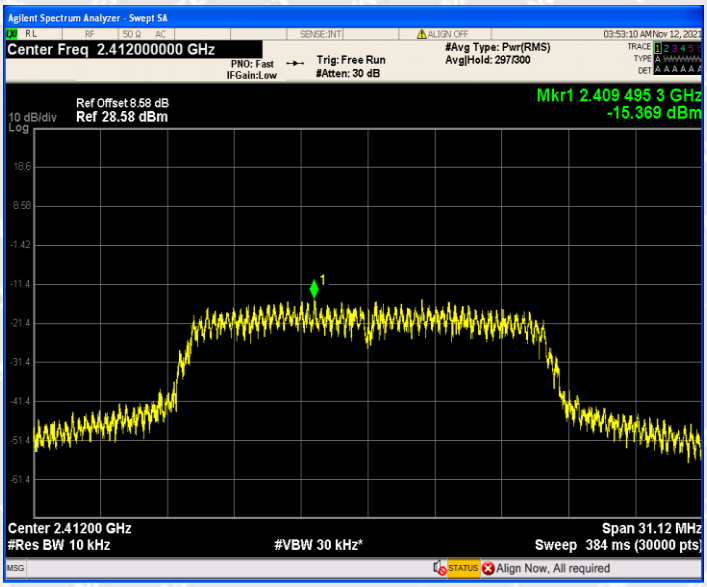
802.11b_Middle Channel



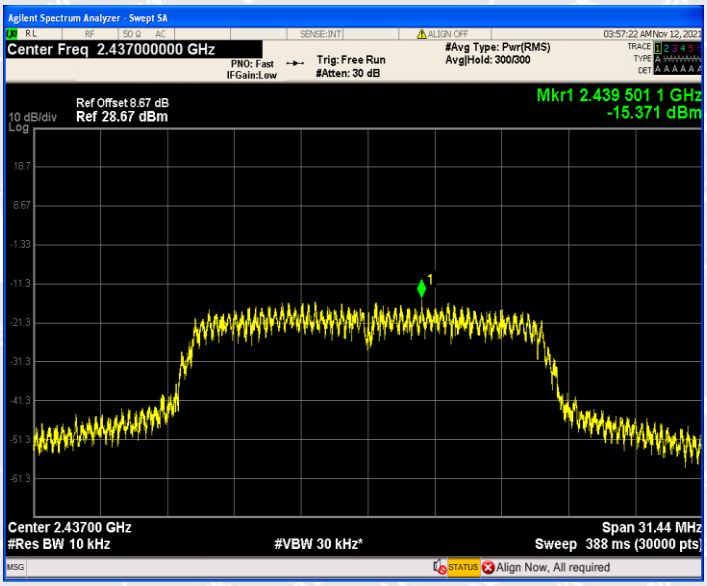
802.11b_High Channel



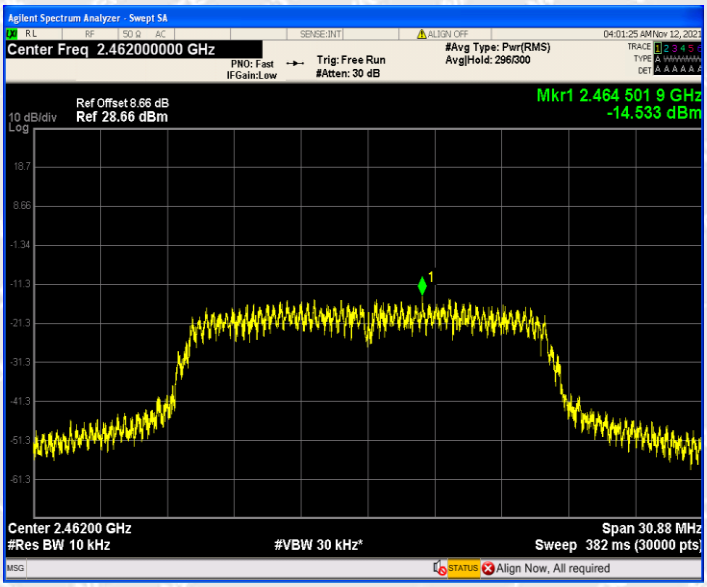
802.11g_Low Channel



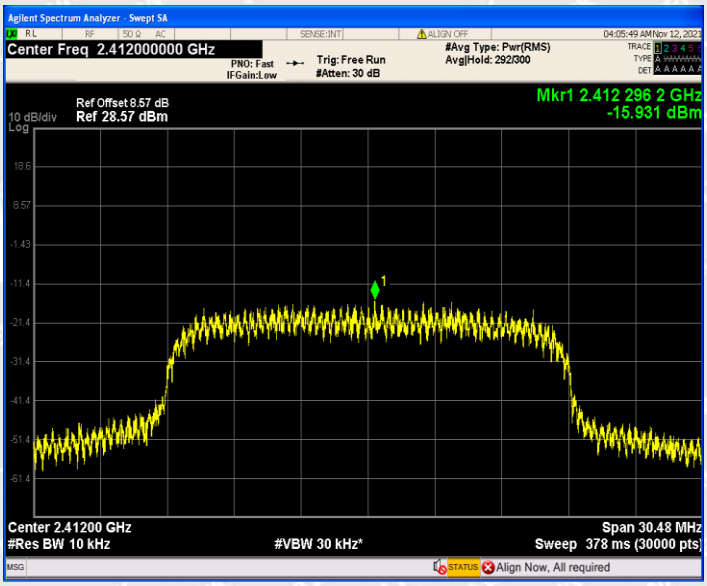
802.11g_Middle Channel



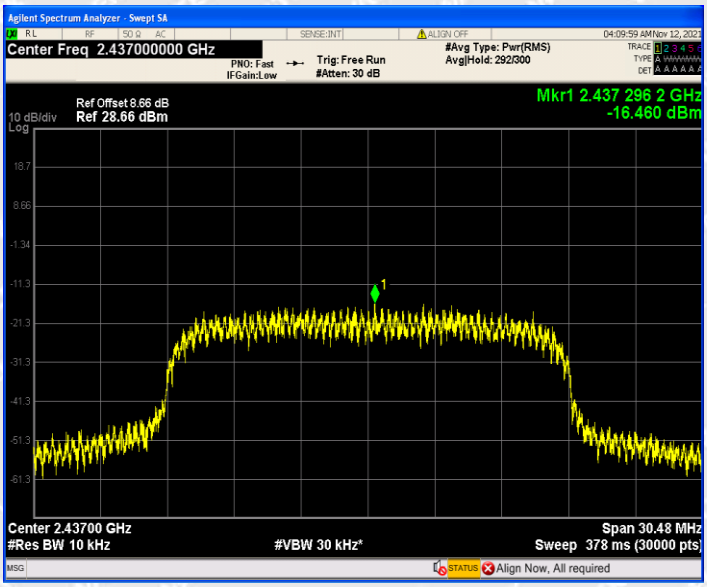
802.11g_High Channel



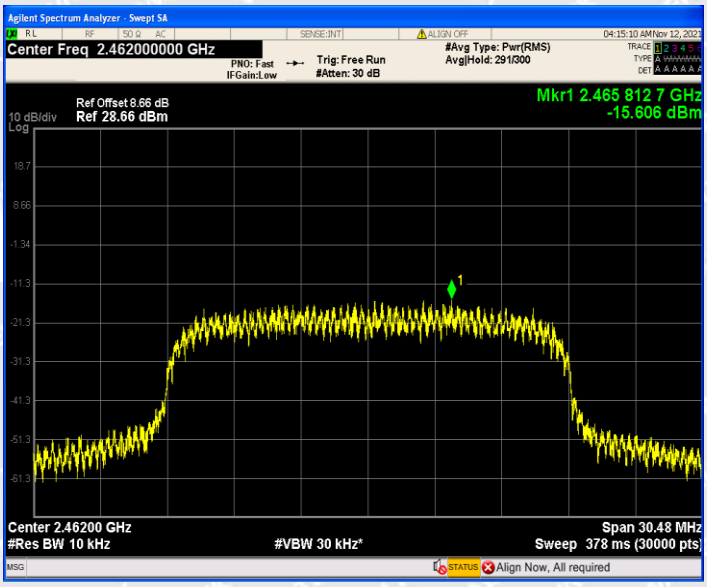
802.11n-HT20_Low Channel



802.11n-HT20_Middle Channel



802.11n-HT20_High Channel



6.5 DTS Bandwidth

6.5.1 Standard Applicable

According to 15.247(a)(2). Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

6.5.2 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.2 and ANSI C63.10-2013 Subclause 11.8.1, the test method of DTS Bandwidth as below:

a) Set RBW = 100 kHz.

b) Set the video bandwidth (VBW) ≥ 3 × RBW.

c) Detector = Peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

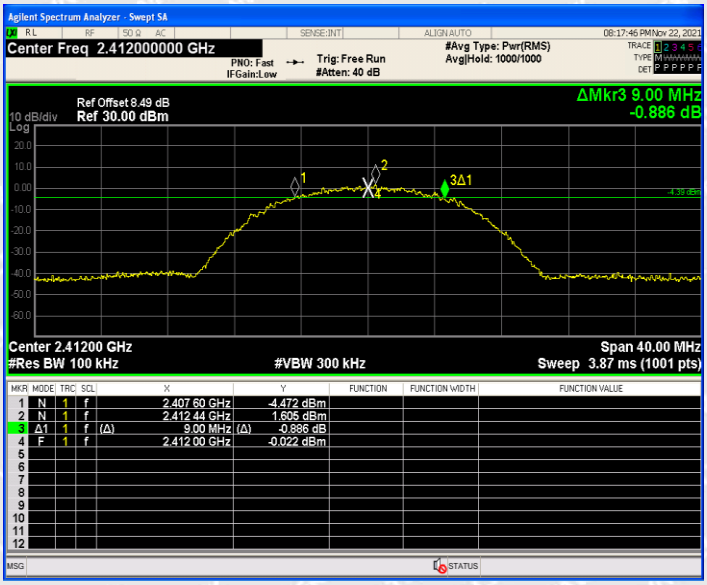
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

6.5.3 Test Result

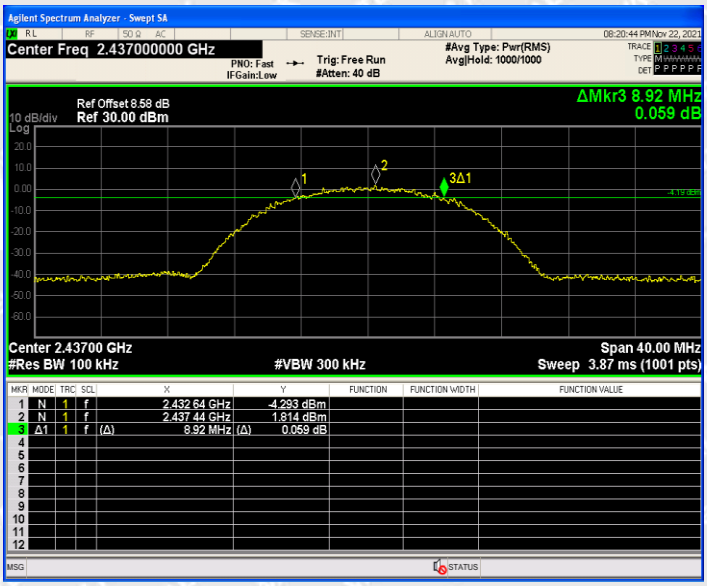
Test Mode	Test Channel(MHz)	Test Result (MHz)	Limit kHz
802.11b	2412	9.000	≥ 500
	2437	8.920	≥ 500
	2462	9.600	≥ 500
802.11g	2412	15.240	≥ 500
	2437	15.240	≥ 500
	2462	15.240	≥ 500
802.11n-HT20	2412	15.200	≥ 500
	2437	15.200	≥ 500
	2462	15.160	≥ 500

Test plots:

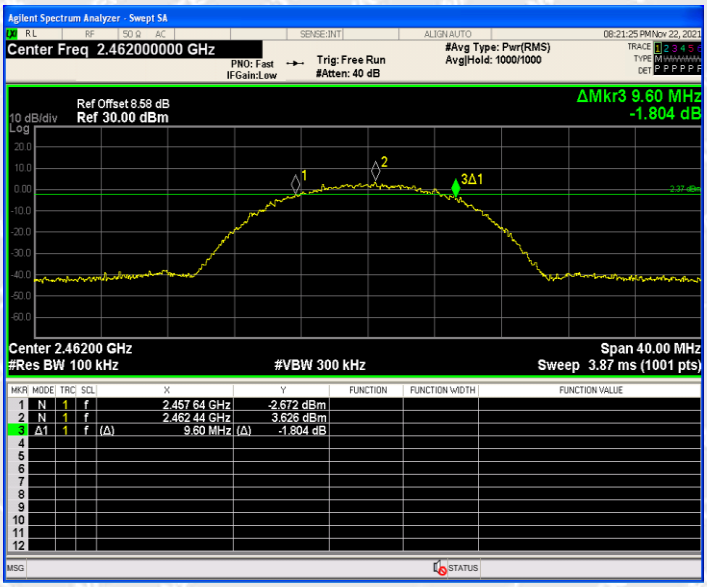
802.11b_Low Channel



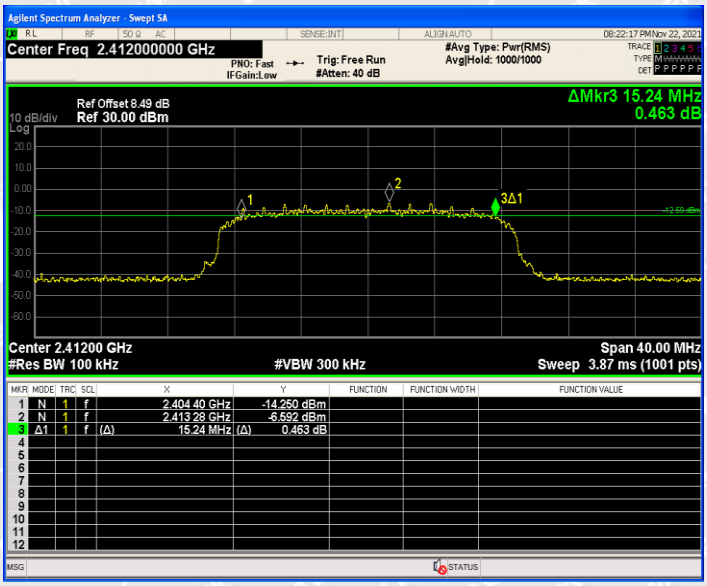
802.11b_Middle Channel



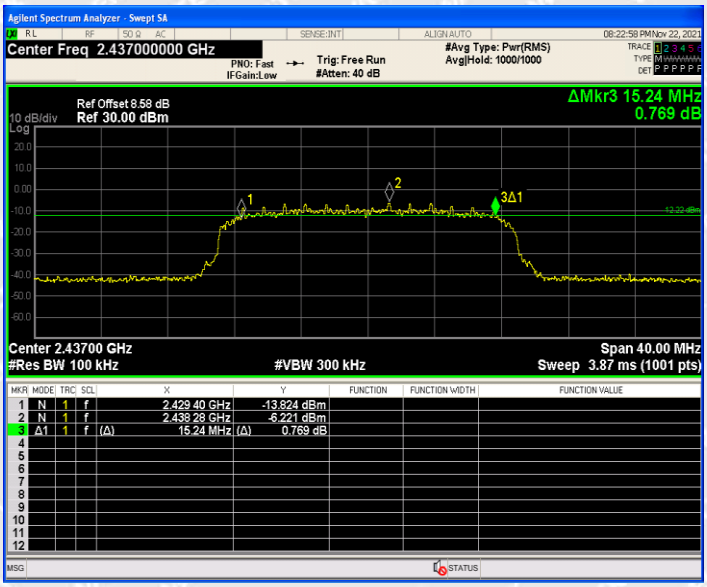
802.11b_High Channel



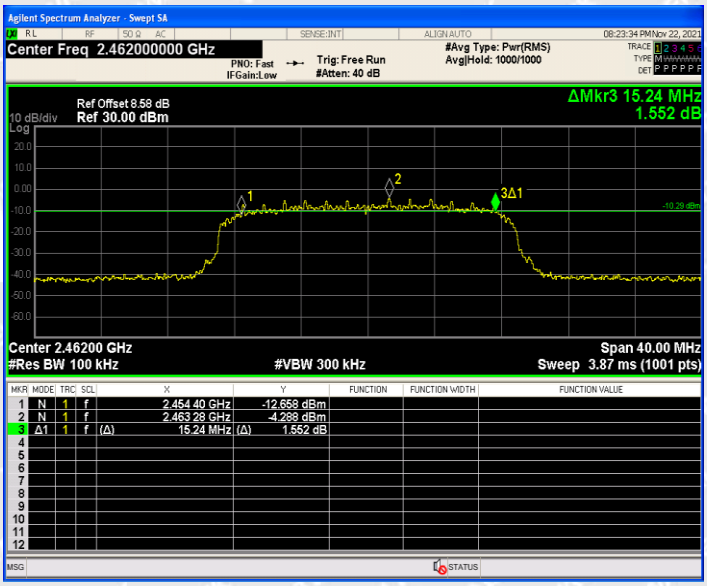
802.11g_Low Channel



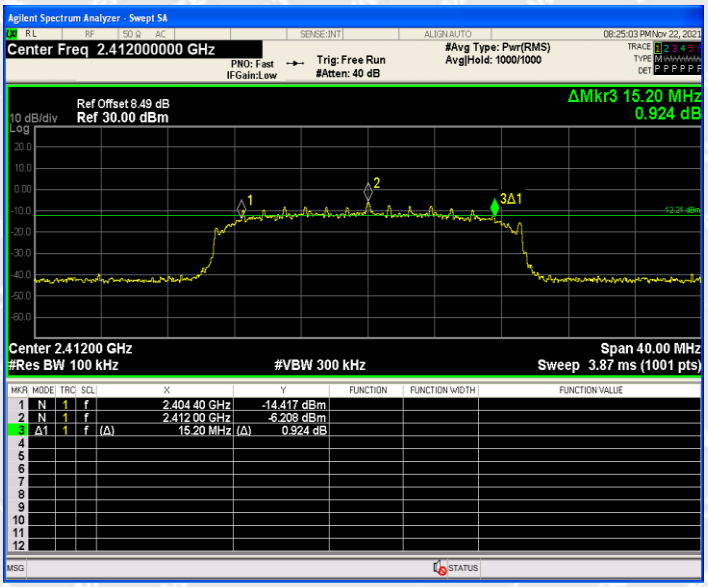
802.11g_Middle Channel



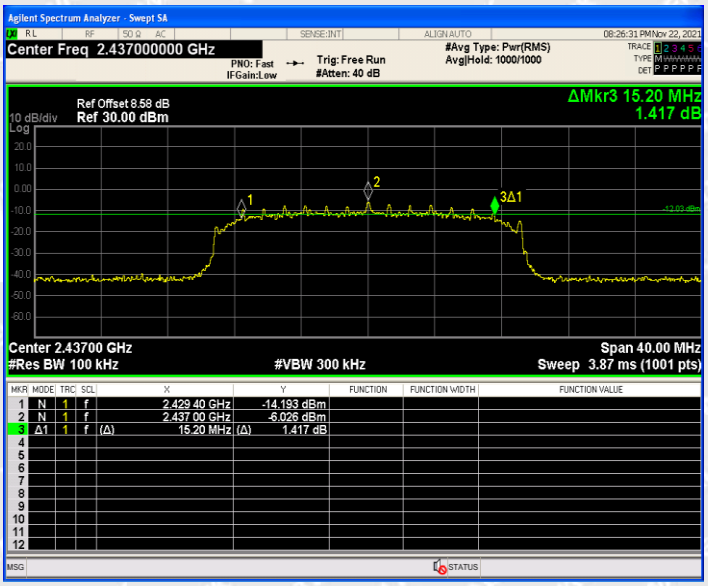
802.11g_High Channel



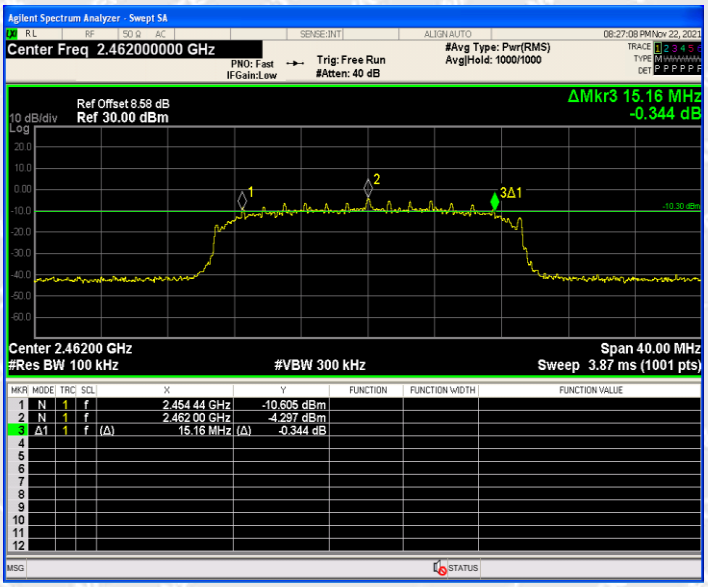
802.11n-HT20_Low Channel



802.11n-HT20_Middle Channel



802.11n-HT20_High Channel



6.6 RF Output Power

6.6.1 Standard Applicable

According to 15.247(b)(3). For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

6.6.2 Test Procedure

According to the KDB-558074 D01 v05r02 Subclause 8.3.2.2 and ANSI C63.10-2013 Subclause11.9.2.2, when this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth

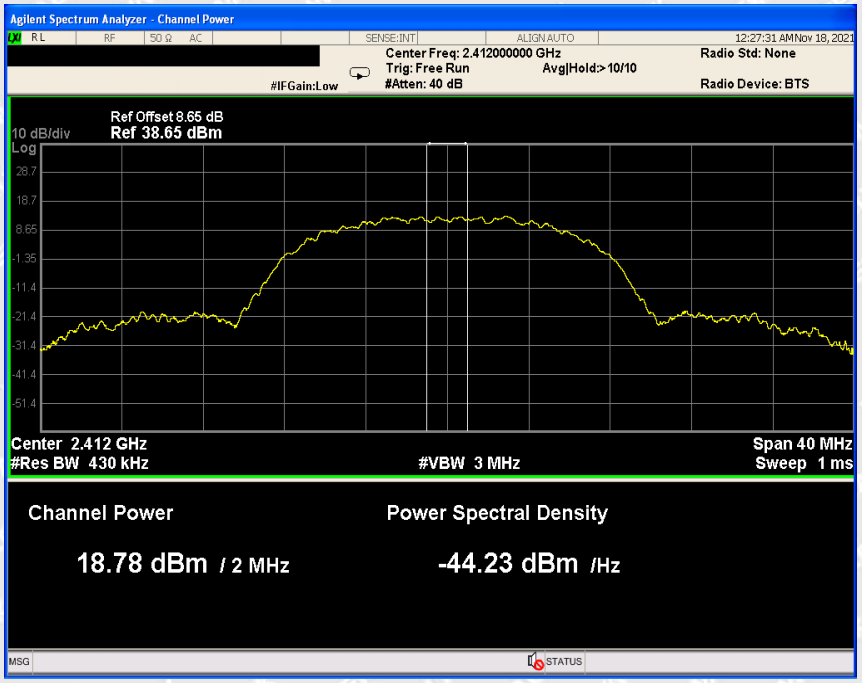
a) Set span to at least 1.5 times the OBW.
b) Set RBW = 1-5% of the OBW, not to exceed 1 MHz.
c) Set VBW ≥ 3 x RBW.
d) Number of points in sweep ≥ 2 × span / RBW. (This gives bin-to-bin spacing ≥RBW/2, so that narrowband signals are not lost between frequency bins.)
e) Sweep time = auto.
f) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
g) If transmit duty cycle < 98 %, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 %, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run”.
h) Trace average at least 100 traces in power averaging (i.e., RMS) mode.
i) Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

6.6.3 Test Result

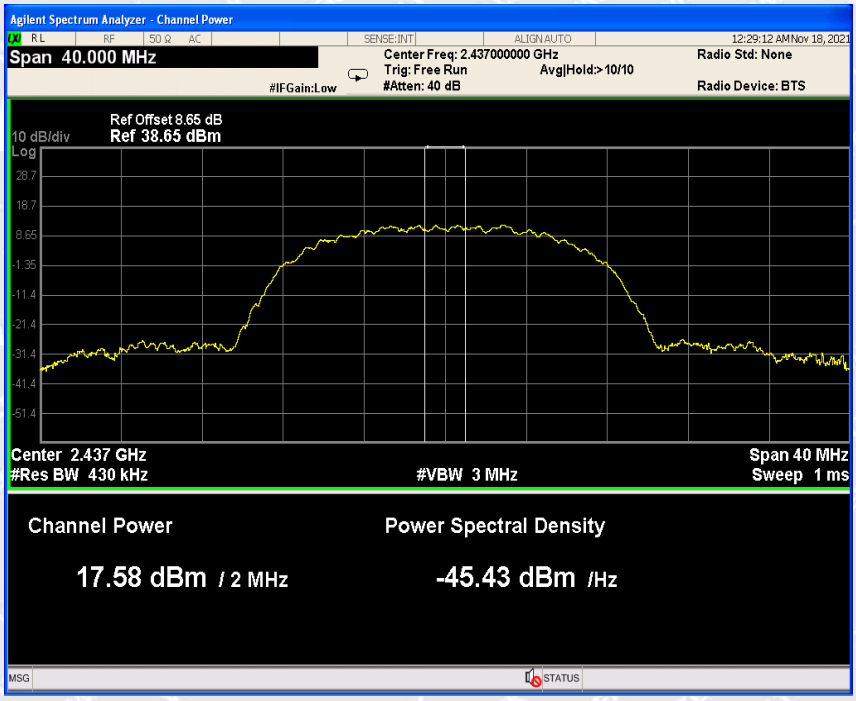
Modulation	Test Channel (MHz)	Reading (dBm)	Output Power (mW)	Limit (mW)
802.11b	2412	18.78	75.509	1000
	2437	17.58	57.279	1000
	2462	18.24	66.680	1000
802.11g	2412	18.35	68.391	1000
	2437	18.13	65.012	1000
	2462	18.14	65.162	1000
802.11n-HT20	2412	18.87	77.090	1000
	2437	18.71	74.301	1000
	2462	18.36	68.548	1000

Test plots:

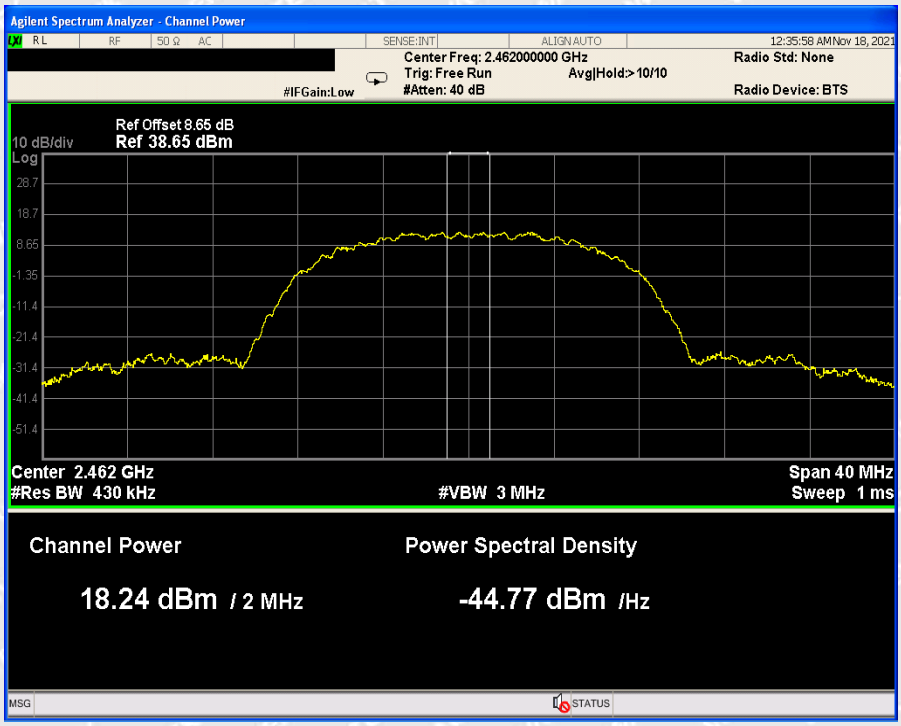
802.11b_Low Channel



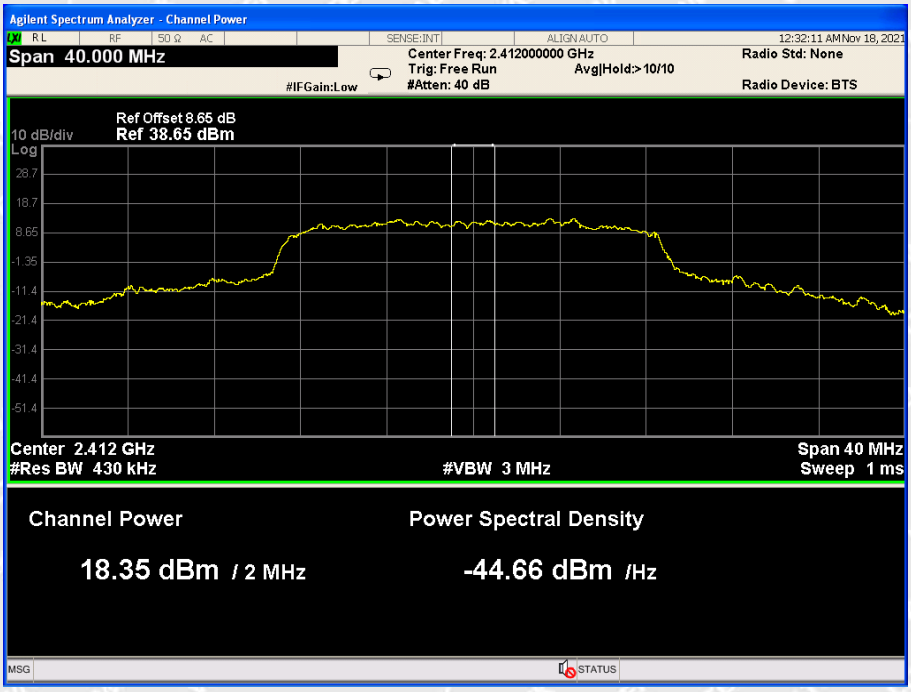
802.11b_Middle Channel



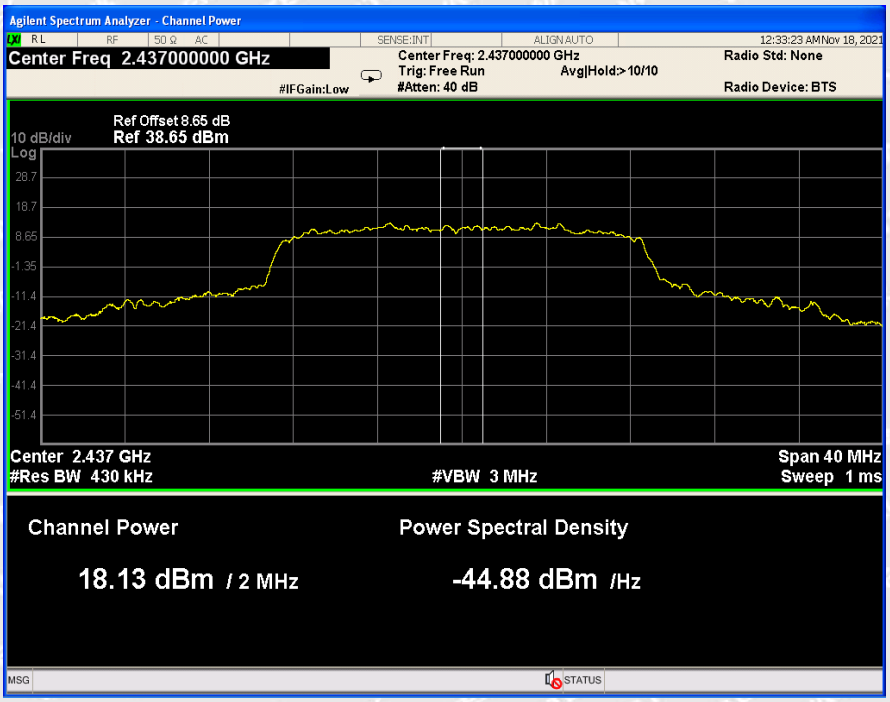
802.11b_High Channel



802.11g_Low Channel

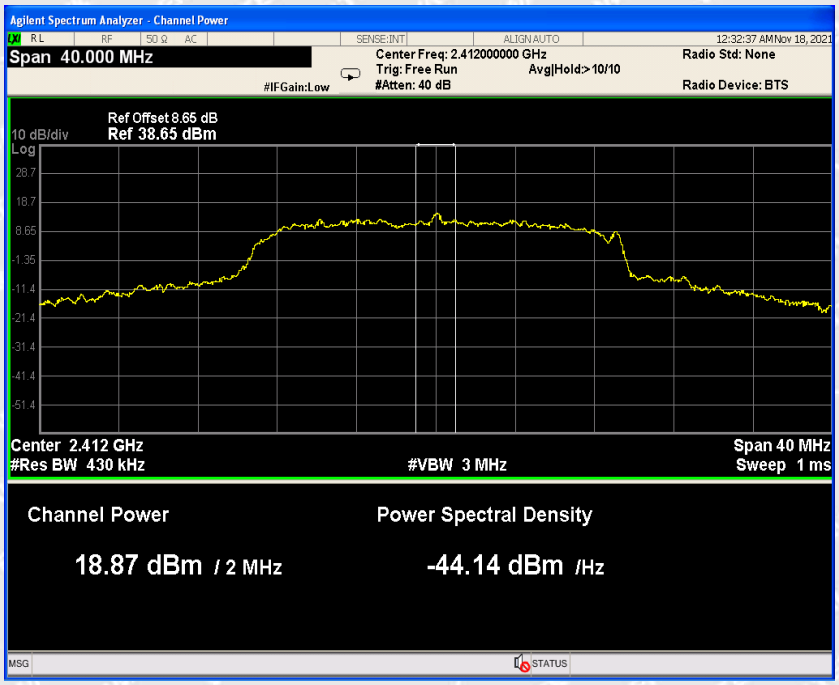


802.11g_Middle Channel

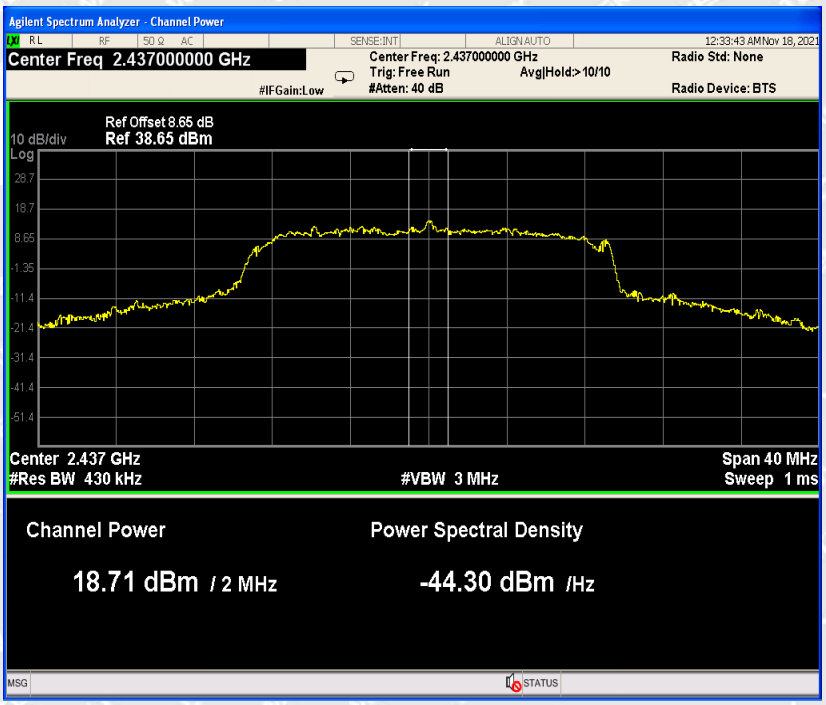


802.11g_High Channel

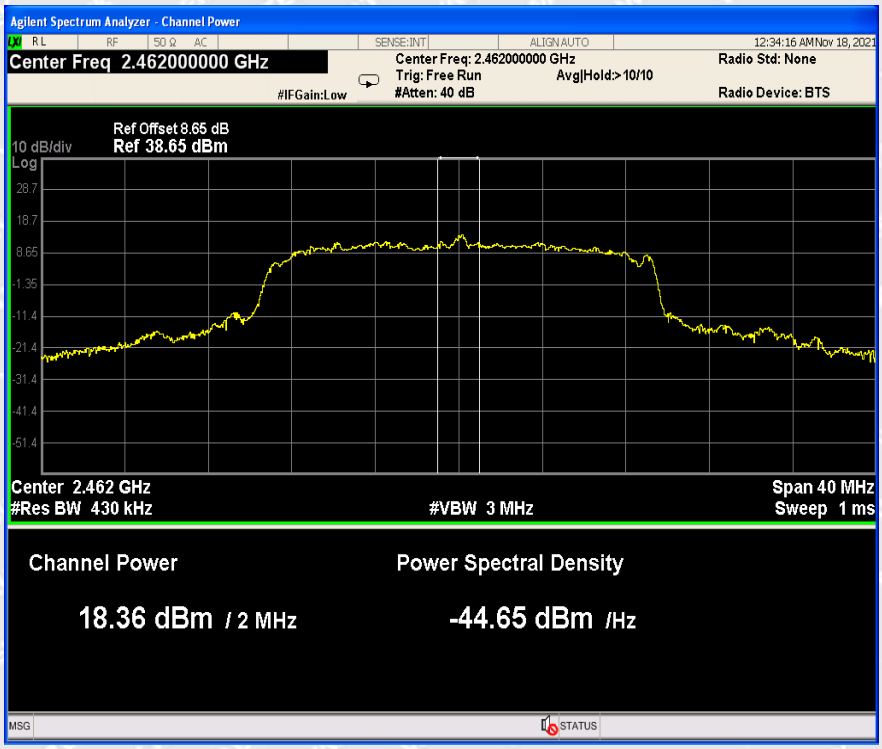
802.11n-HT20_Low Channel



802.11n-HT20_Middle Channel



802.11n-HT20_High Channel



6.7 Out of Band Emissions

6.7.1 Standard Applicable

According to §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

6.7.2 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.4 and ANSI C63.10-2013 Subclause 11.11, the Emissions in nonrestricted frequency bands test method as follows:

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.

According to the KDB 558074 D01 v05r02 Subclause 8.5 and ANSI C63.10-2013 Subclause 11.12, the Emissions in restricted frequency bands test method as follows:

A. Radiated emission measurements:
Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge,
as well as any modulation products which fall outside of the authorized band of operation (2310MHz to 2420MHz
for low bandedge, 2460MHz to 2500MHz for the high bandedge)
RBW = 1MHz, VBW = 1MHz for peak value measured
RBW = 1MHz, VBW = 10Hz for average value measured
Sweep = auto; Detector function = peak/average; Trace = max hold
All the trace to stabilize, set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emissions must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205.

Note that the method of measurement KDB publication number: 913591 may be used for the radiated band edge measurements.

B. Antenna-port conducted measurements

Peak emission levels are measured by setting the instrument as follows:

a) RBW = as specified in Table 9/

b) VBW ≥ [3 × RBW].

c) Detector = peak.

d) Sweep time = auto.

e) Trace mode = max hold.

f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be lengthened for low-duty-cycle applications.)

Table 9—RBW as a function of frequency

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1000 MHz	100 kHz to 120 kHz
>1000 MHz	1 MHz

If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

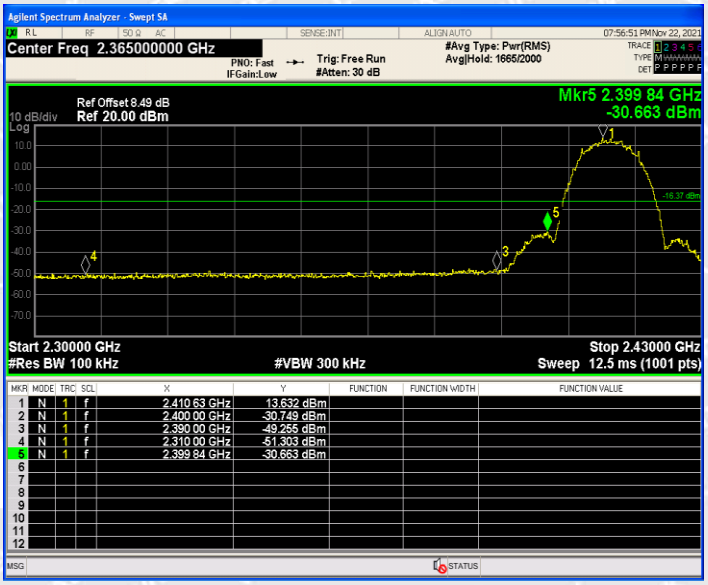
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in section 8.1.

6.7.3 Test Result

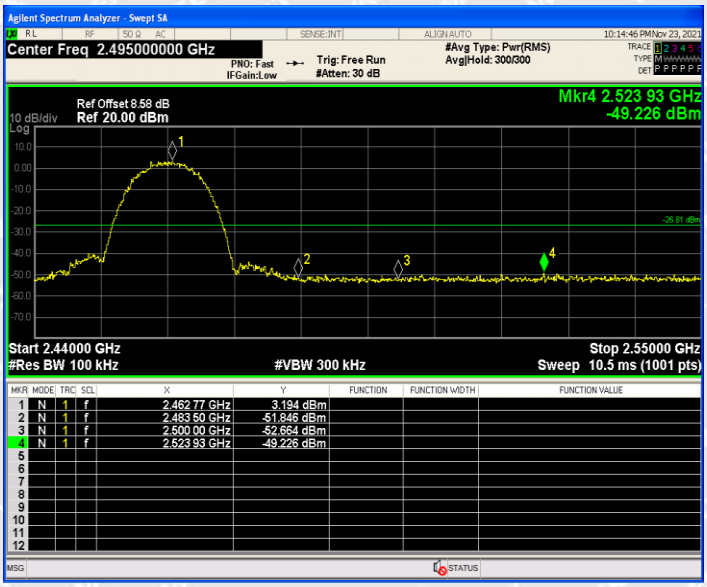
Test Mode	Channel (MHz)	Ref Level (dBm)	Result (dBm)	Limit (dBm)	Verdict
802.11b	2412	13.63	-30.66	<=-16.37	Pass
	2462	3.19	-49.23	<=-26.81	Pass
802.11g	2412	-6.31	-47.87	<=-36.31	Pass
	2462	-4.26	-49.47	<=-34.26	Pass
802.11n-HT20	2412	-6.23	-49.57	<=-36.23	Pass
	2462	-4.66	-49.6	<=-34.66	Pass

Test Plots:

802.11b_Low Channel

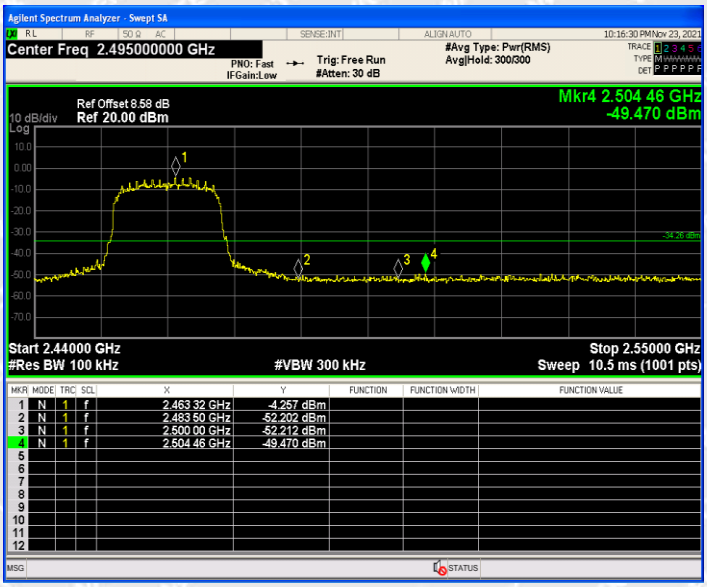


802.11b_High Channel

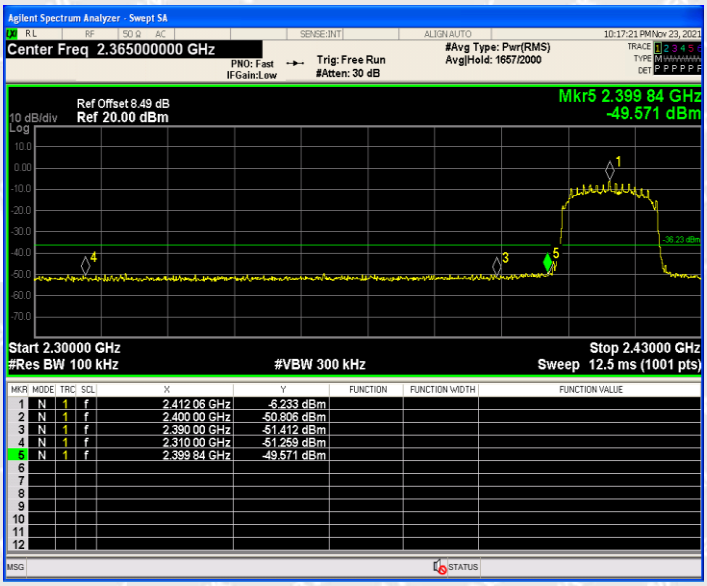


802.11g_Low Channel

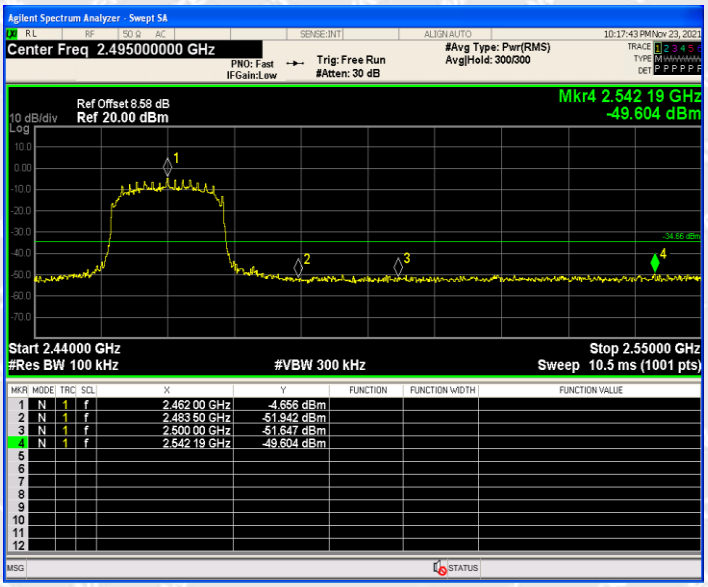
802.11g_High Channel



802.11n(HT20)_Low Channel



802.11n(HT20)_High Channel



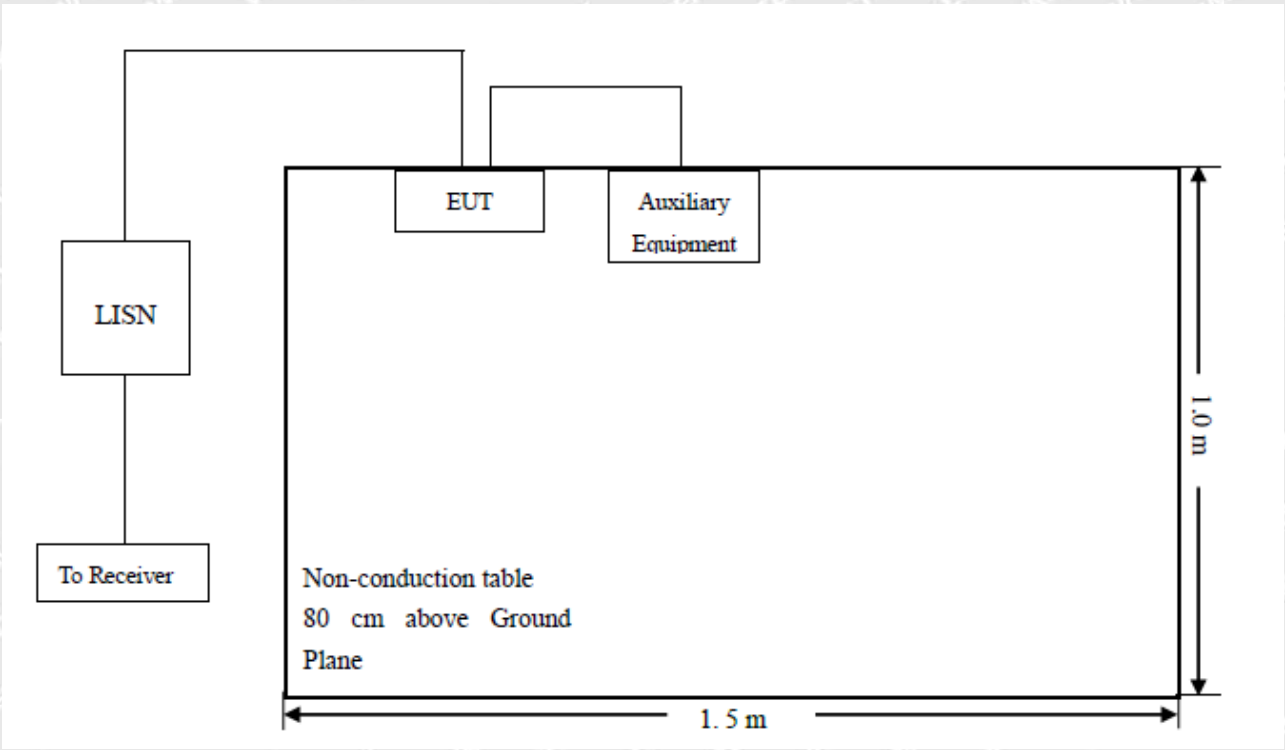
6.8 Conducted Emissions

6.8.1 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013measurement procedure. The specification used was with the FCC Part 15.207Limit.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in themiddle. The spacing between the peripherals was 10 cm.

6.8.2 Basic Test Setup Block Diagram



6.8.3 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency.....150 kHz

Stop Frequency.....30 MHz

Sweep Speed.....Auto

IF Bandwidth.....10 kHz

Quasi-Peak Adapter Bandwidth.....9 kHz

Quasi-Peak Adapter Mode.....Normal

6.8.4 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

6.8.5 Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF(Voltage Division Facotr), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Measurement=Reading Level+Correct Factor

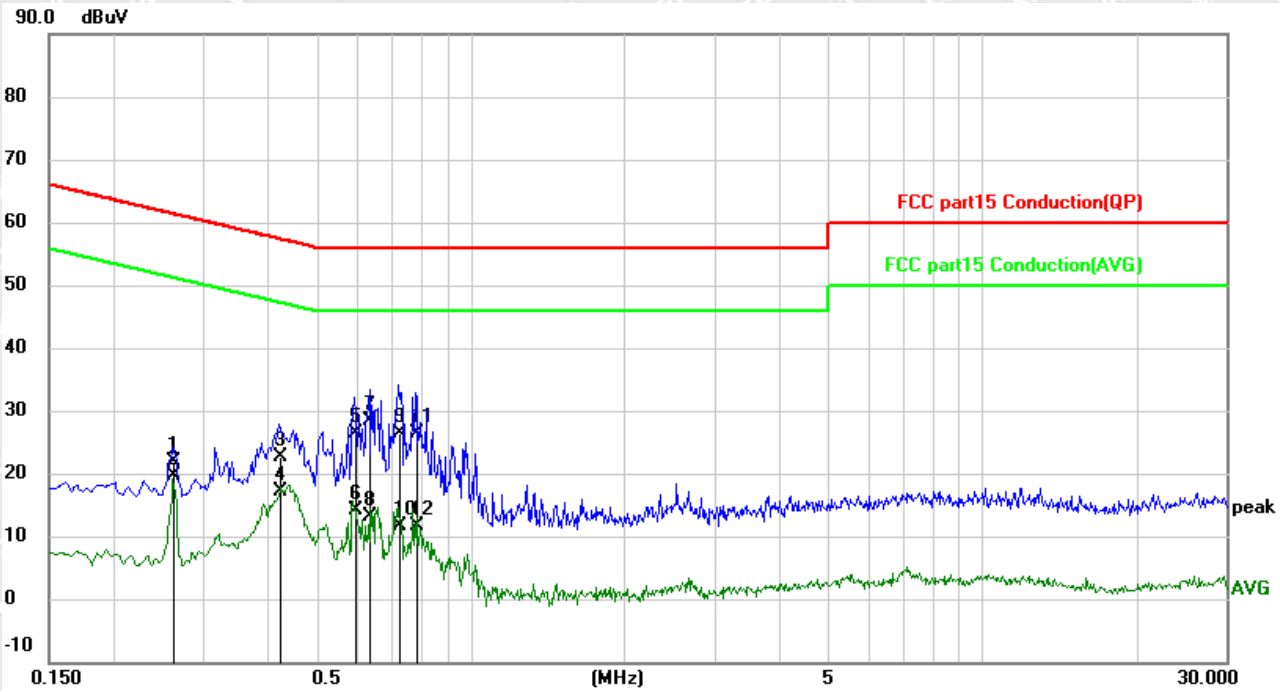
Correct Facotor=LISN VDF+Cable Loss

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin=Limit-Measurement

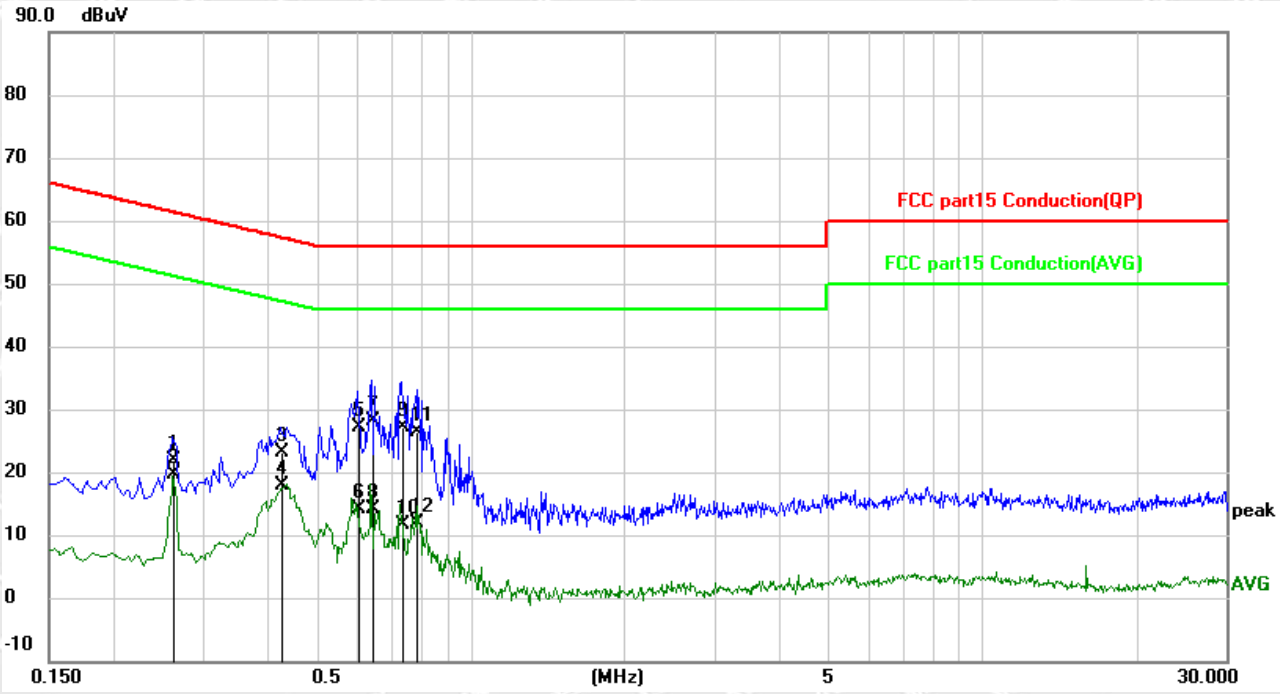
6.8.6 Test Result

Test Mode Communication mode (DC 3.3V) **Polarity** Line



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.2620	12.18	9.64	21.82	61.37	-39.55	QP	
2		0.2620	10.02	9.64	19.66	51.37	-31.71	AVG	
3		0.4220	12.89	9.66	22.55	57.41	-34.86	QP	
4		0.4220	7.58	9.66	17.24	47.41	-30.17	AVG	
5		0.5940	16.81	9.66	26.47	56.00	-29.53	QP	
6		0.5940	4.38	9.66	14.04	46.00	-31.96	AVG	
7	*	0.6340	18.72	9.66	28.38	56.00	-27.62	QP	
8		0.6340	3.51	9.66	13.17	46.00	-32.83	AVG	
9		0.7260	16.62	9.66	26.28	56.00	-29.72	QP	
10		0.7260	2.04	9.66	11.70	46.00	-34.30	AVG	
11		0.7820	16.64	9.67	26.31	56.00	-29.69	QP	
12		0.7820	1.99	9.67	11.66	46.00	-34.34	AVG	

Test Mode Communication mode (DC 3.3V) **Polarity** Neutral

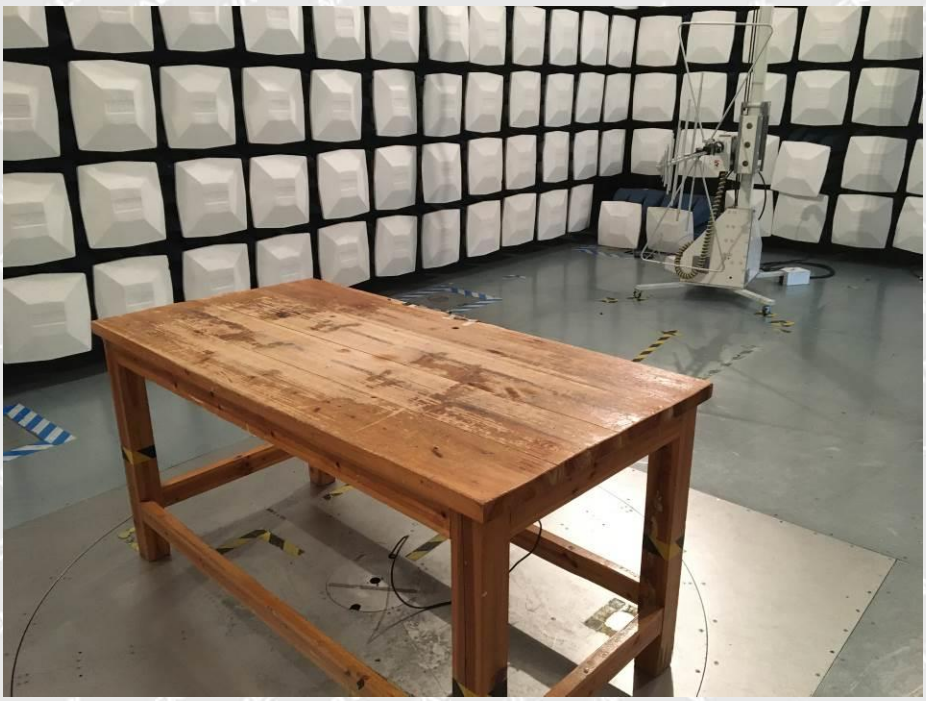


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.2620	12.26	9.63	21.89	61.37	-39.48	QP	
2		0.2620	10.10	9.63	19.73	51.37	-31.64	AVG	
3		0.4260	13.50	9.66	23.16	57.33	-34.17	QP	
4		0.4260	8.17	9.66	17.83	47.33	-29.50	AVG	
5		0.6020	17.47	9.67	27.14	56.00	-28.86	QP	
6		0.6020	4.40	9.67	14.07	46.00	-31.93	AVG	
7	*	0.6419	18.44	9.67	28.11	56.00	-27.89	QP	
8		0.6419	4.45	9.67	14.12	46.00	-31.88	AVG	
9		0.7340	17.35	9.67	27.02	56.00	-28.98	QP	
10		0.7340	2.04	9.67	11.71	46.00	-34.29	AVG	
11		0.7860	16.66	9.67	26.33	56.00	-29.67	QP	
12		0.7860	2.23	9.67	11.90	46.00	-34.10	AVG	

7 Photographs Test Setup

7.1 Photographs - Radiated Emission Test Setup

30MHz-1GHz

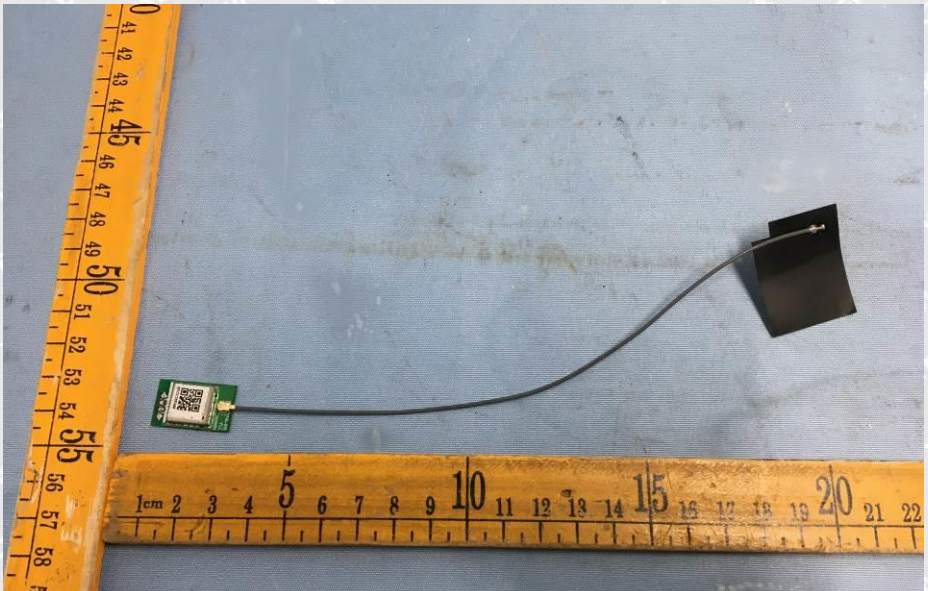


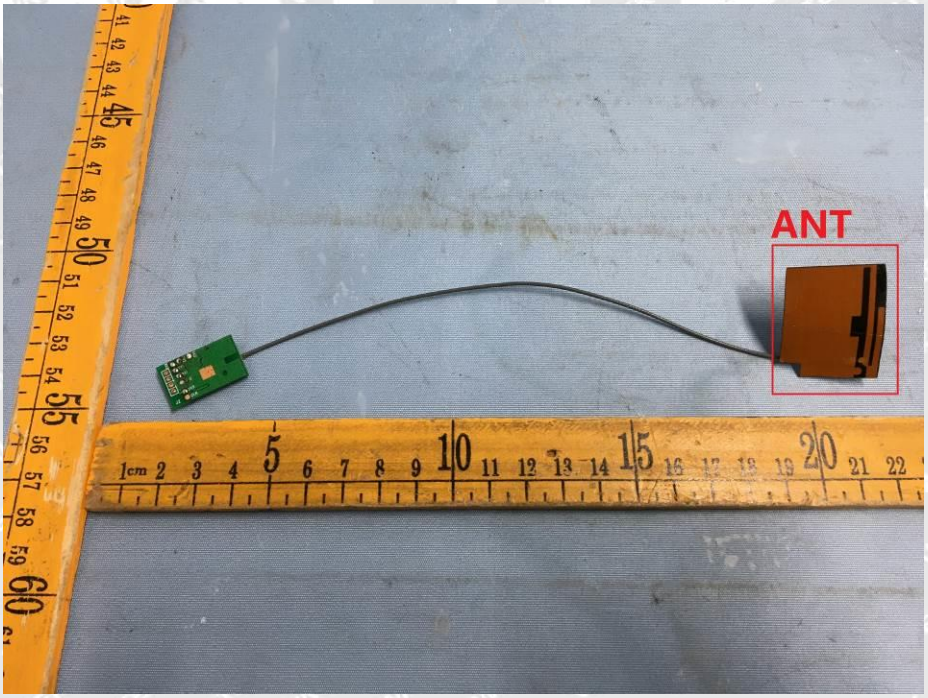
Above 1GHz

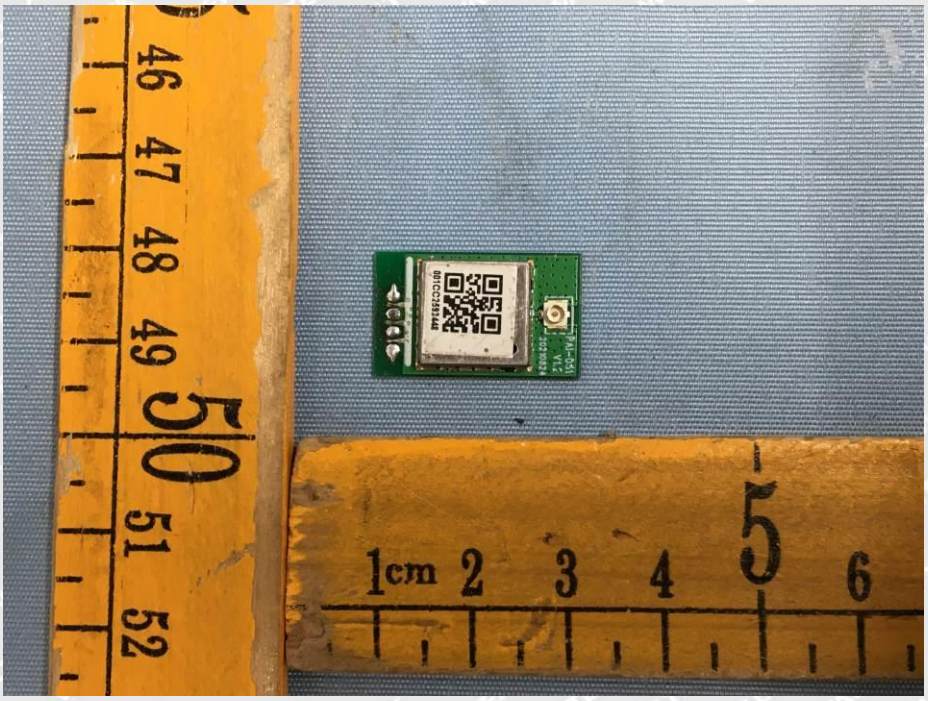
7.2 Photographs - Conducted Emission Test Setup

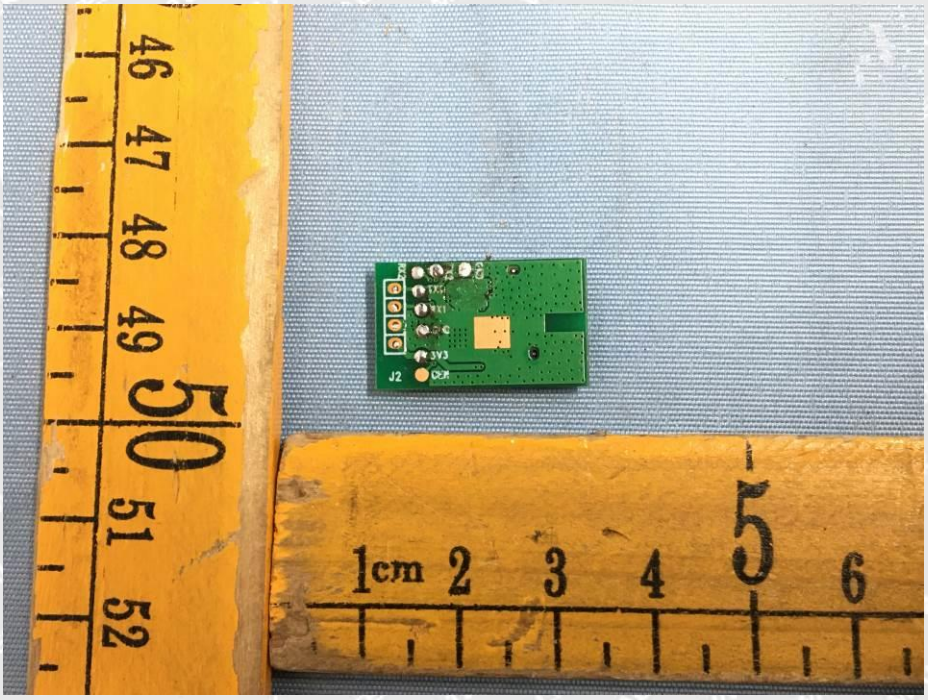
8 Photographs - Constructional Details

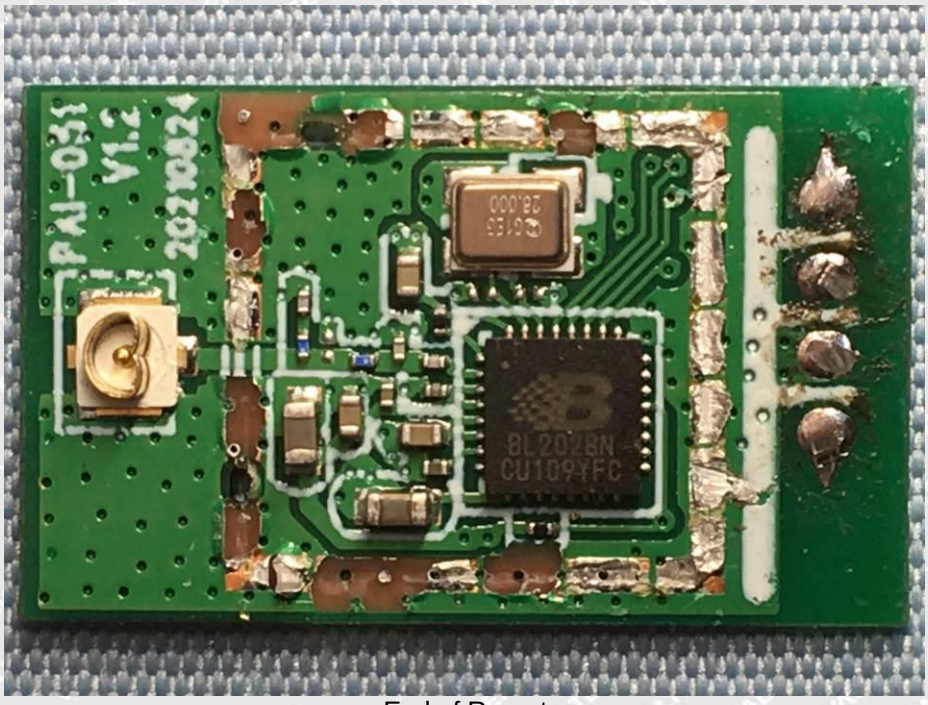
8.1 EUT - External Photos






46 47 48 49 50 51 52
1cm 2 3 4 5 6


46 47 48 49 50 51 52
1cm 2 3 4 5 6



======End of Report======