

5.7. Power line conducted emissions

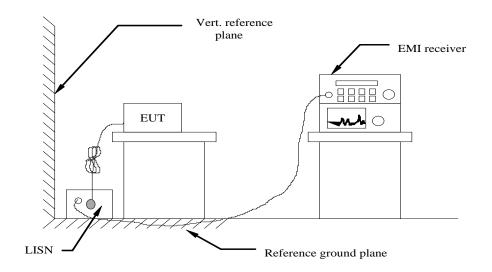
5.7.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range	Limits (dBµV)				
(MHz)	Quasi-peak	Average			
0.15 to 0.50	66 to 56	56 to 46			
0.50 to 5	56	46			
5 to 30	60	50			

^{*} Decreasing linearly with the logarithm of the frequency

5.7.2 Block Diagram of Test Setup



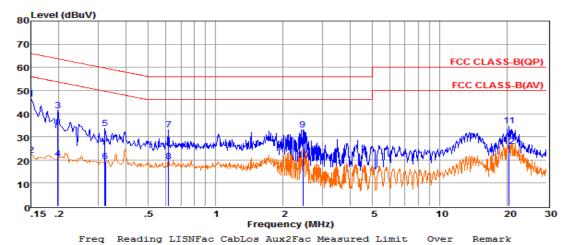
5.7.3 Test Results

PASS.

The test data please refer to following page.

AC Conducted Emission of power adapter @ AC 120V/60Hz @ IEEE 802.11b (worst case)

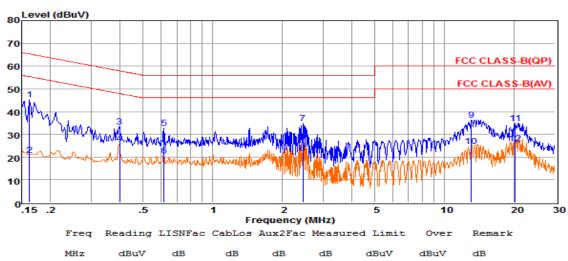
Line



	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.15	26.93	9.57	0.02	10.00	46.52	66.00	-19.48	QP
2	0.15	2.44	9.57	0.02	10.00	22.03	55.99	-33.96	Average
3	0.20	21.59	9.63	0.02	10.00	41.24	63.71	-22.47	QP
4	0.20	0.82	9.63	0.02	10.00	20.47	53.71	-33.24	Average
5	0.32	14.03	9.62	0.03	10.00	33.68	59.66	-25.98	QP
6	0.32	-0.41	9.62	0.03	10.00	19.24	49.66	-30.42	Average
7	0.62	13.37	9.63	0.04	10.00	33.04	56.00	-22.96	QP
8	0.62	-0.25	9.63	0.04	10.00	19.42	46.00	-26.58	Average
9	2.45	13.36	9.64	0.05	10.00	33.05	56.00	-22.95	QP
10	2.45	0.15	9.64	0.05	10.00	19.84	46.00	-26.16	Average
11	20.38	15.06	9.75	0.12	10.00	34.93	60.00	-25.07	QP
12	20.38	6.13	9.75	0.12	10.00	26.00	50.00	-24.00	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

Neutral



	_								
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.16	25.57	9.67	0.02	10.00	45.26	65.34	-20.08	QP
2	0.16	1.13	9.67	0.02	10.00	20.82	55.33	-34.51	Average
3	0.40	13.79	9.61	0.04	10.00	33.44	57.90	-24.46	QP
4	0.40	6.13	9.61	0.04	10.00	25.78	47.90	-22.12	Average
5	0.62	13.11	9.63	0.04	10.00	32.78	56.00	-23.22	QP
6	0.62	0.77	9.63	0.04	10.00	20.44	46.00	-25.56	Average
7	2.45	15.22	9.64	0.05	10.00	34.91	56.00	-21.09	QP
8	2.45	2.16	9.64	0.05	10.00	21.85	46.00	-24.15	Average
9	13.06	16.52	9.73	0.09	10.00	36.34	60.00	-23.66	QP
10	13.06	4.81	9.73	0.09	10.00	24.63	50.00	-25.37	Average
11	20.16	14.92	9.88	0.12	10.00	34.92	60.00	-25.08	QP
12	20.16	5.89	9.88	0.12	10.00	25.89	50.00	-24.11	Average

Remarks: 1. Measured = Reading + LISNFac + Cable Loss + Aux2 Fac.

The emission levels that are 20dB below the official limit are not reported.

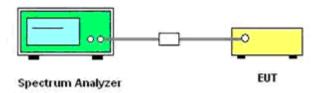
^{***}Note: Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11b).

5.8. Restrict-band band-edge measurements for radiated emissions

5.8.1 Standard Applicable

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 20dB 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 20dB. 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) (see §15.205(c)).

5.8.2. Test Setup Layout



5.8.3. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of Spectrum Analyzer.

5.8.4. Test Procedures

According to KDB 558074 D01 for Antenna-port conducted measurement. Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to an EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
- 3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, for Radiated emissions restricted band RBW=1MHz, VBW=3MHz for peak detector and RBW=1MHz, VBW=1/B for AV detector.
- 4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
- 5. Repeat above procedures until all measured frequencies were complete.
- 6. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 12.2.2, 12.2.3, and 12.2.4 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
- 7. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
- 8. Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
- 9. For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
- 10. Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

E = EIRP - 20log D + 104.77 = EIRP + 95.23

Where:

E = electric field strength in dBµV/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

- 11. Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.
- 12. Per KDB662911 D01 section b) In cases where a combination of conducted measurements and cabinet radiated measurements are permitted to demonstrate compliance with absolute radiated out-of-band and spurious limits (e.g., KDB Publications 558074 for DTS and 789033 for U-NII), the conducted measurements must be combined with directional gain to compute the radiated levels of the out-of-band and spurious emissions as described in this section.
- 13. Compare the resultant electric field strength level to the applicable regulatory limit.
- 14. Perform radiated spurious emission test duress until all measured frequencies were complete.

5.8.5 Test Results

	IEEE 802.11b											
Frequency (MHz)	Conducted Power (dBm)				Antenna Gain (dBi)		Ground Covert Reflection		adiated E Lev (dBuV/m)	el At 3m	Limit	Vardiat
	Antenna 0	Antenna 1	Sum	Antenna 0	Antenna 1	Gain (dBi)	Factor (dB)	Antenna 0	Antenna 1	Sum	(dBuV/m)	Verdict
2310.000	-41.878	-52.183	-/-	0.00	0.00	-/-	0.00	55.350	45.045	-/-	74.00	PASS
2310.000	-52.721	-62.733	-/-	0.00	0.00	-/-	0.00	44.507	34.495	-/-	54.00	PASS
2390.000	-42.048	-48.335	-/-	0.00	0.00	-/-	0.00	55.180	48.893	-/-	74.00	PASS
2390.000	-52.303	-59.320	-/-	0.00	0.00	-/-	0.00	44.925	37.908	-/-	54.00	PASS
2483.500	-40.436	-48.270	-/-	0.00	0.00	-/-	0.00	56.792	48.958	-/-	74.00	PASS
2483.500	-52.168	-59.489	-/-	0.00	0.00	-/-	0.00	45.060	37.739	-/-	54.00	PASS
2500.000	-41.824	-49.110	-/-	0.00	0.00	-/-	0.00	55.404	48.118	-/-	74.00	PASS
2500.000	-52.412	-60.349	-/-	0.00	0.00	-/-	0.00	44.816	36.879	-/-	54.00	PASS

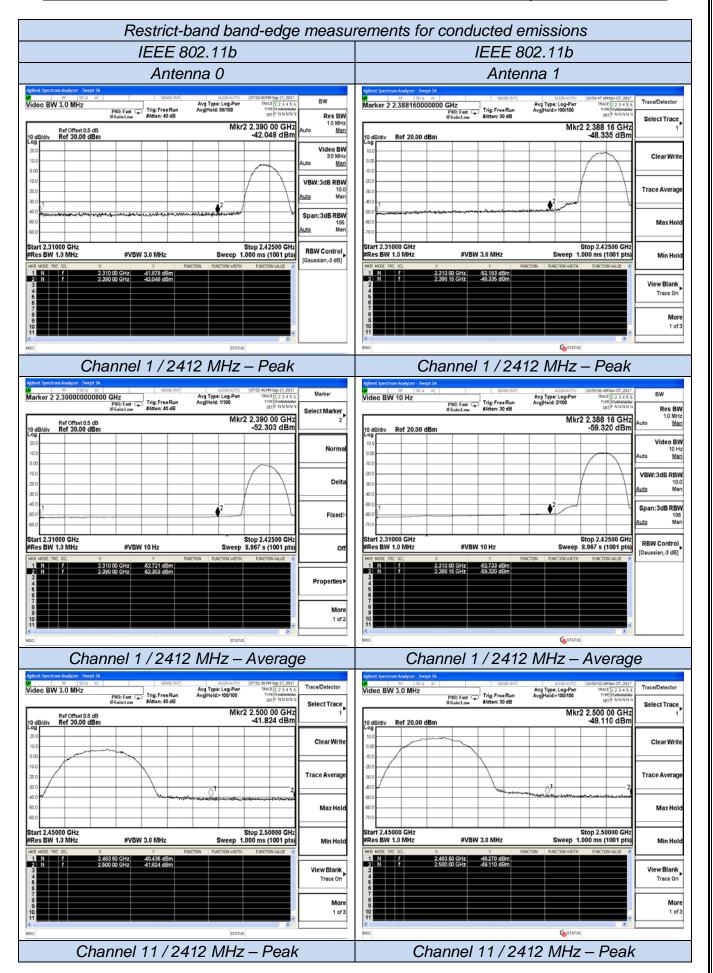
	IEEE 802.11g											
Frequency (MHz)	Conducted Power (dBm)		Antenna Gain (dBi)		Directional	Ground Reflection	Covert Ra	Covert Radiated E Level At 3m (dBuV/m)			\	
	Antenna 0	Antenna 1	Sum	Antenna 0	Antenna 1	Gain (dBi)	Factor (dB)	Antenna 0	Antenna 1	Sum	(dBuV/m)	Verdict
2310.000	-42.226	-50.336	-/-	0.00	0.00	-/-	0.00	55.002	46.892	-/-	74.00	PASS
2310.000	-52.745	-61.752	-/-	0.00	0.00	-/-	0.00	44.483	35.476	-/-	54.00	PASS
2390.000	-40.143	-42.725	-/-	0.00	0.00	-/-	0.00	57.085	54.503	-/-	74.00	PASS
2390.000	-51.578	-54.641	-/-	0.00	0.00	-/-	0.00	45.650	42.587	-/-	54.00	PASS
2483.500	-40.892	-40.880	-/-	0.00	0.00	-/-	0.00	56.336	56.348	-/-	74.00	PASS
2483.500	-50.789	-54.231	-/-	0.00	0.00	-/-	0.00	46.439	42.997	-/-	54.00	PASS
2500.000	-42.565	-45.457	-/-	0.00	0.00	-/-	0.00	54.663	51.771	-/-	74.00	PASS
2500.000	-52.423	-56.743	-/-	0.00	0.00	-/-	0.00	44.805	40.485	-/-	54.00	PASS

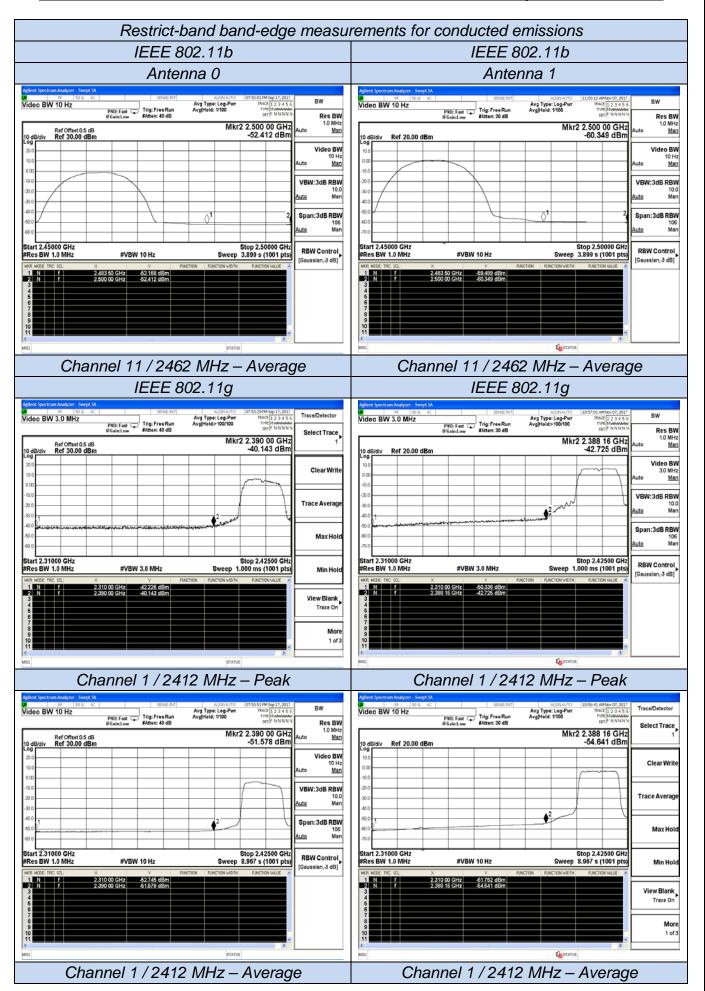
	IEEE 802.11n HT20											
Frequency	Conducted Power (dBm)				Antenna Gain (dBi)		Ground Reflection	Covert Ra	Covert Radiated E Level At 3m (dBuV/m)			Vardiat
(MHz)	Antenna 0	Antenna 1	Sum	Antenna 0	Antenna 1	Gain (dBi)	Factor (dB)	Antenna 0	Antenna 1	Sum	(dBuV/m)	Verdict
2310.000	-41.198	-50.841	-40.750	0.00	0.00	3.00	0.00	56.030	46.387	57.478	74.00	PASS
2310.000	-52.764	-61.181	-52.180	0.00	0.00	3.00	0.00	44.464	36.047	46.048	54.00	PASS
2390.000	-37.290	-38.636	-34.901	0.00	0.00	3.00	0.00	59.938	58.592	63.327	74.00	PASS
2390.000	-50.475	-54.985	-49.159	0.00	0.00	3.00	0.00	46.753	42.243	49.069	54.00	PASS
2483.500	-40.052	-41.512	-37.711	0.00	0.00	3.00	0.00	57.176	55.716	60.517	74.00	PASS
2483.500	-49.268	-54.211	-48.061	0.00	0.00	3.00	0.00	47.960	43.017	50.167	54.00	PASS
2500.000	-40.483	-46.452	-39.504	0.00	0.00	3.00	0.00	56.745	50.776	58.724	74.00	PASS
2500.000	-52.393	-56.560	-50.984	0.00	0.00	3.00	0.00	44.835	40.668	47.244	54.00	PASS

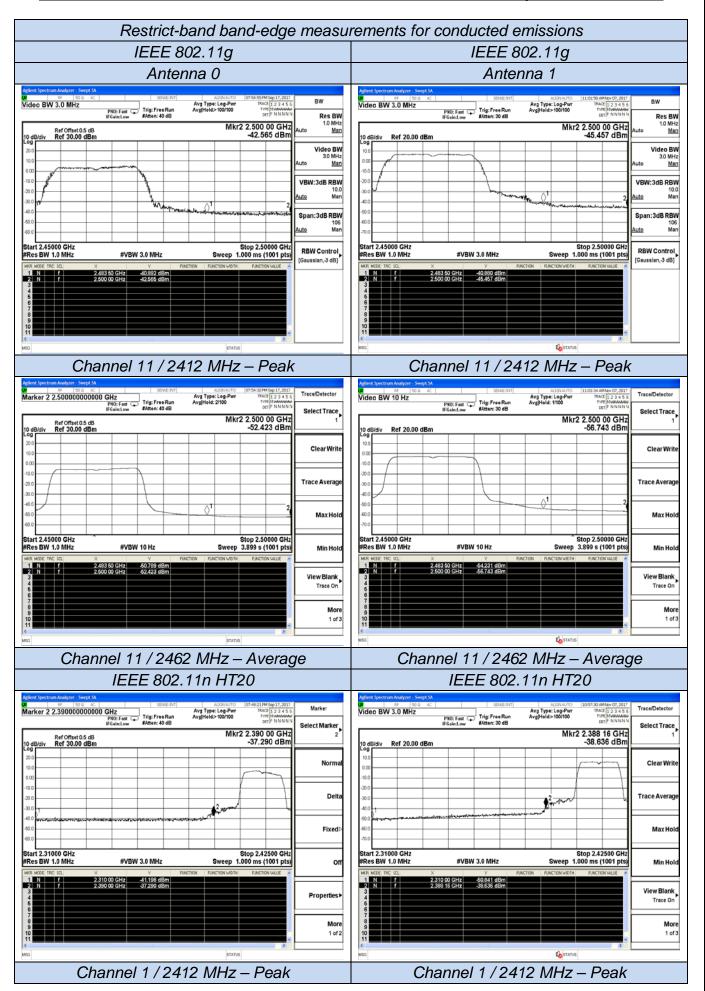
SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD. FCC ID: 2ANTM-D100 Report No.: LCS170821141AE

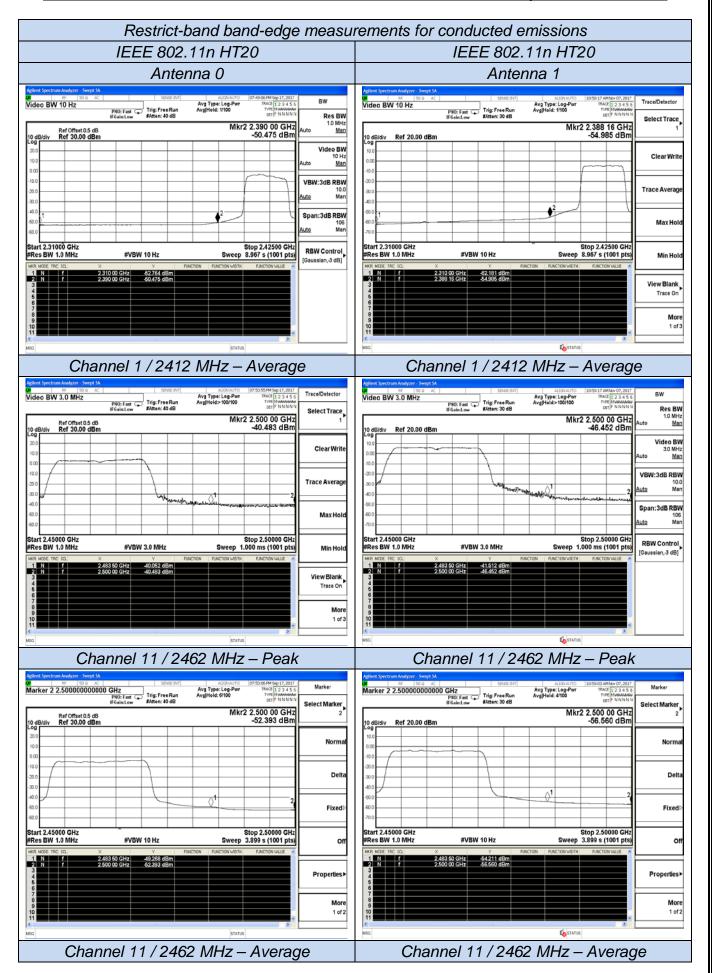
Remark:

- 1. Measured Band edge measurement for radiated emission at difference data rate for each mode and recorded worst case for each mode.
- 2. Test results including cable loss;
- 3. Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20;
- 4. "---"means that the fundamental frequency not for 15.209 limits requirement.
- 5. "-/-" means no need measured or sum as cannot work at MIMO mode;
- 6. Directional Gain = G_{ANT} + 10 $log(N_{ANT})$ dBi = 0 +10 log(2) dBi = 3.00 dBi;
- 7. Please refer to following plots;









5.9. Antenna Requirements

5.9.1 Standard Applicable

According to antenna requirement of §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. The manufacturer may design the unit so that a broken antenna can be re-placed by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

5.9.2 Antenna Connected Construction

5.9.2.1. Standard Applicable

According to § 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.

5.9.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 0dBi, and the antennas are two PIFA antennas connect to PCB board and no consideration of replacement. Please see EUT photo for details. The WLAN ant 1 and BT share same antenna, ant 2 only support WLAN.

5.9.2.3. Results: Compliance.

Measurement

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

Conducted power refers ANSI C63.10:2013 Output power test procedure for DTS devices. Radiated power refers to ANSI C63.10:2013 Radiated emissions tests.

Measurement parameters

Measurement parameter							
Detector:	Peak						
Sweep Time:	Auto						
Resolution bandwidth:	1MHz						
Video bandwidth:	3MHz						
Trace-Mode:	Max hold						

Limits

FCC	ISED					
Antenna Gain						
6 dB	si					

Note: The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For WLAN devices, the DSSS mode is used;

Antenna 0

T _{nom}	V _{nom}	Lowest Channel 2412 MHz	Middle Channel 2437 MHz	Highest Channel 2462 MHz	
Measu	power [dBm] ired with nodulation	9.496	9.377	9.291	
Radiated power [dBm] Measured with DSSS modulation		8.605	9.143	8.613	
Gain [dBi]	Gain [dBi] Calculated		-0.234	-0.678	
M	easurement unce	ertainty	± 1.6 dB (cond.) / ± 3.8 dB (rad.)		

Antenna 1

T_nom	V_{nom}	Lowest Channel 2412 MHz	Middle Channel 2437 MHz	Highest Channel 2462 MHz	
Measu DSSS m	power [dBm] red with nodulation	9.088	9.088 9.112		
Measu	Radiated power [dBm] Measured with DSSS modulation		8.900	8.437	
Gain [dBi]	Gain [dBi] Calculated		-0.212	-0.727	
Me	easurement unce	ertainty	± 1.6 dB (cond.) / ± 3.8 dB (rad.)		

6. LIST OF MEASURING EQUIPMENTS

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
1	Power Meter	R&S	NRVS	100444	2017-06-17	2018-06-16
2	Power Sensor	R&S	NRV-Z81	100458	2017-06-17	2018-06-16
3	Power Sensor	R&S	NRV-Z32	10057	2017-06-17	2018-06-16
4	EPM Series Power Meter	Agilent	E4419B	MY45104493	2017-06-17	2018-06-16
5	E-SERIES AVG POWER SENSOR	Agilent	E9301H	MY41495234	2017-06-17	2018-06-16
6	ESA-E SERIES SPECTRUM ANALYZER	Agilent	E4407B	MY41440754	2016-11-18	2017-11-17
7	MXA Signal Analyzer	Agilent	N9020A	MY49100040	2017-06-17	2018-06-16
8	SPECTRUM ANALYZER	R&S	FSP	100503	2017-06-17	2018-06-16
9	3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	2017-06-17	2018-06-16
10	Positioning Controller	MF	MF-7082	/	2017-06-17	2018-06-16
11	EMI Test Software	AUDIX	E3	N/A	2017-06-17	2018-06-16
12	EMI Test Receiver	R&S	ESR 7	101181	2017-06-17	2018-06-16
13	AMPLIFIER	QuieTek	QTK-A2525G	CHM10809065	2016-11-18	2017-11-17
14	Active Loop Antenna	SCHWARZBECK	FMZB 1519B	00005	2017-06-23	2018-06-22
15	By-log Antenna	SCHWARZBECK	VULB9163	9163-470	2017-05-02	2018-05-01
16	Horn Antenna	EMCO	3115	6741	2017-06-23	2018-06-22
17	RF Cable-R03m	Jye Bao	RG142	CB021	2017-06-17	2018-06-16
18	RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	2017-06-17	2018-06-16
19	TEST RECEIVER	R&S	ESCI	101142	2017-06-17	2018-06-16
20	RF Cable-CON	UTIFLEX	3102-26886-4	CB049	2017-06-17	2018-06-16
21	10dB Attenuator	SCHWARZBECK	MTS-IMP136	261115-001-0032	2017-06-17	2018-06-16
22	Artificial Mains	R&S	ENV216	101288	2017-06-17	2018-06-16
23	X-series USB Peak and Average Power Sensor Aglient	Agilent	U2021XA	MY54080022	2016-10-27	2017-10-26
24	4 CH. Simultaneous Sampling 14 Bits 2MS/s	Agilent	U2531A	MY54080016	2016-10-27	2017-10-26
25	Test Software	Ascentest	AT890-SW	20160630	N/A	N/A
26	RF Control Unit	Ascentest	AT890-RFB	N/A	2017-06-17	2018-06-16
27	Universal Radio Communication Tester	R&S	CMU 200	105788	2017-06-17	2018-06-16
28	WIDEBAND RADIO COMMUNICATION TESTER	R&S	CMW 500	103818	2017-06-17	2018-06-16
29	RF Control Unit	Tonscend	JS0806-1	N/A	2017-06-17	2018-06-16
30	DC Power Supply	Agilent	E3642A	N/A	2016-11-18	2017-11-17
31	LTE Test Software	Tonscend	JS1120-1	N/A	N/A	N/A

7. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separate file for test setup photographs.

8. EXTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separate file for exterior photographs.

9. INTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separate file for interior photographs.	
THE END OF REPORT	