

5.7. Power line conducted emissions

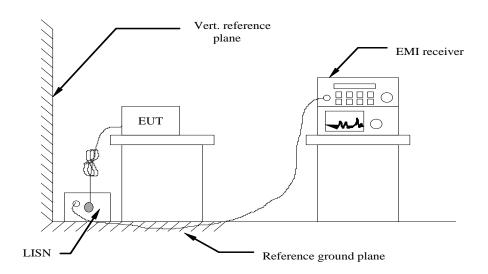
5.7.1 Standard Applicable

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



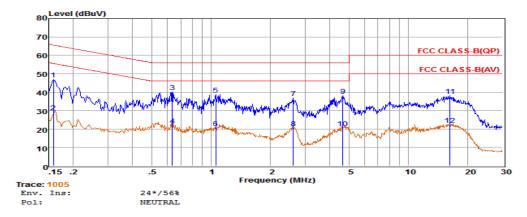
5.7.3 Test Results

PASS.

The test data please refer to following page.

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

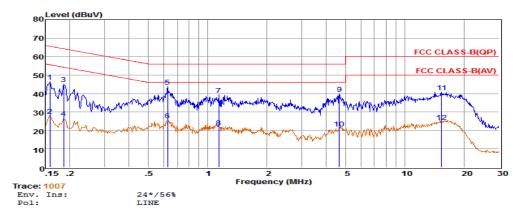
Live Line:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measu	red Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.16	27.15	9.68	0.02	10.00	46.85	65.56	-18.71	QP
2	0.16	9.32	9.68	0.02	10.00	29.02	55.55	-26.53	Average
3	0.63	20.48	9.63	0.04	10.00	40.15	56.00	-15.85	QP
4	0.63	2.38	9.63	0.04	10.00	22.05	46.00	-23.95	Average
5	1.05	19.05	9.63	0.05	10.00	38.73	56.00	-17.27	QP
6	1.06	0.86	9.63	0.05	10.00	20.54	46.00	-25.46	Average
7	2.61	17.11	9.64	0.05	10.00	36.80	56.00	-19.20	QP
8	2.61	0.80	9.64	0.05	10.00	20.49	46.00	-25.51	Average
9	4.65	18.49	9.66	0.06	10.00	38.21	56.00	-17.79	QP
10	4.65	0.93	9.66	0.06	10.00	20.65	46.00	-25.35	Average
11	16.23	18.29	9.75	0.11	10.00	38.15	60.00	-21.85	QP
12	16.23	2.45	9.75	0.11	10.00		50.00	-27.69	Average

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

Neutral Line:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measur	red Limit	0ver	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.16	26.92	9.58	0.02	10.00	46.52	65.56	-19.04	QP
2	0.16	8.32	9.58	0.02	10.00	27.92	55.55	-27.63	Average
3	0.19	25.42	9.62	0.02	10.00	45.06	64.20	-19.14	QP
4	0.19	7.05	9.62	0.02	10.00	26.69	54.19	-27.50	Average
5	0.63	24.03	9.63	0.04	10.00	43.70	56.00	-12.30	QP
6	0.63	6.05	9.63	0.04	10.00	25.72	46.00	-20.28	Average
7	1.14	19.65	9.63	0.05	10.00	39.33	56.00	-16.67	QP
8	1.14	2.02	9.63	0.05	10.00	21.70	46.00	-24.30	Average
9	4.65	20.07	9.65	0.06	10.00	39.78	56.00	-16.22	QP
10	4.65	1.44	9.65	0.06	10.00	21.15	46.00	-24.85	Average
11	15.31	20.91	9.71	0.10	10.00	40.72	60.00	-19.28	QP
12	15.31	4.92	9.71	0.10	10.00	24.73	50.00	-25.27	Average

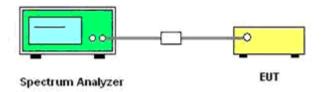
^{***}Note: Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11b).

5.8. 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 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) (see §15.205(c)).

5.8.2. Test Setup Layout



5.8.3. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of Spectrum Analyzer.

5.8.4. Test Procedures

According to KDB 558074 D01 V03 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 Peak detector.
- 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 + 104.8

Where:

 $E = electric field strength in dB\mu V/m$,

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. Compare the resultant electric field strength level to the applicable regulatory limit.
- 13. Perform radiated spurious emission test duress until all measured frequencies were complete.

5.8.5 Test Results

			IEEE 8	802.11b			
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-51.163	2.000	0.00	45.995	Peak	74.00	PASS
2310.000	-61.637	2.000	0.00	35.521	AV	54.00	PASS
2390.000	-50.176	2.000	0.00	46.982	Peak	74.00	PASS
2390.000	-61.305	2.000	0.00	35.853	AV	54.00	PASS
2413.397	3.706	2.000	0.00	100.864	Peak		PASS
2412.764	0.084	2.000	0.00	97.242	AV		PASS
2463.394	3.611	2.000	0.00	100.769	Peak		PASS
2462.767	0.025	2.000	0.00	97.183	AV		PASS
2483.500	-49.888	2.000	0.00	47.270	Peak	74.00	PASS
2483.500	-60.280	2.000	0.00	36.878	AV	54.00	PASS
2500.000	-50.687	2.000	0.00	46.471	Peak	74.00	PASS
2500.000	-61.038	2.000	0.00	36.120	AV	54.00	PASS

	IEEE 802.11g								
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict		
2310.000	-51.287	2.000	0.00	45.871	Peak	74.00	PASS		
2310.000	-61.644	2.000	0.00	35.514	AV	54.00	PASS		
2390.000	-50.573	2.000	0.00	46.585	Peak	74.00	PASS		
2390.000	-61.261	2.000	0.00	35.897	AV	54.00	PASS		
2418.652	1.612	2.000	0.00	98.770	Peak		PASS		
2419.078	-8.180	2.000	0.00	88.978	AV		PASS		
2467.595	0.387	2.000	0.00	97.545	Peak		PASS		
2469.102	-9.114	2.000	0.00	88.044	AV		PASS		
2483.500	-50.034	2.000	0.00	47.124	Peak	74.00	PASS		
2483.500	-59.356	2.000	0.00	37.802	AV	54.00	PASS		
2500.000	-50.739	2.000	0.00	46.419	Peak	74.00	PASS		
2500.000	-61.049	2.000	0.00	36.109	AV	54.00	PASS		

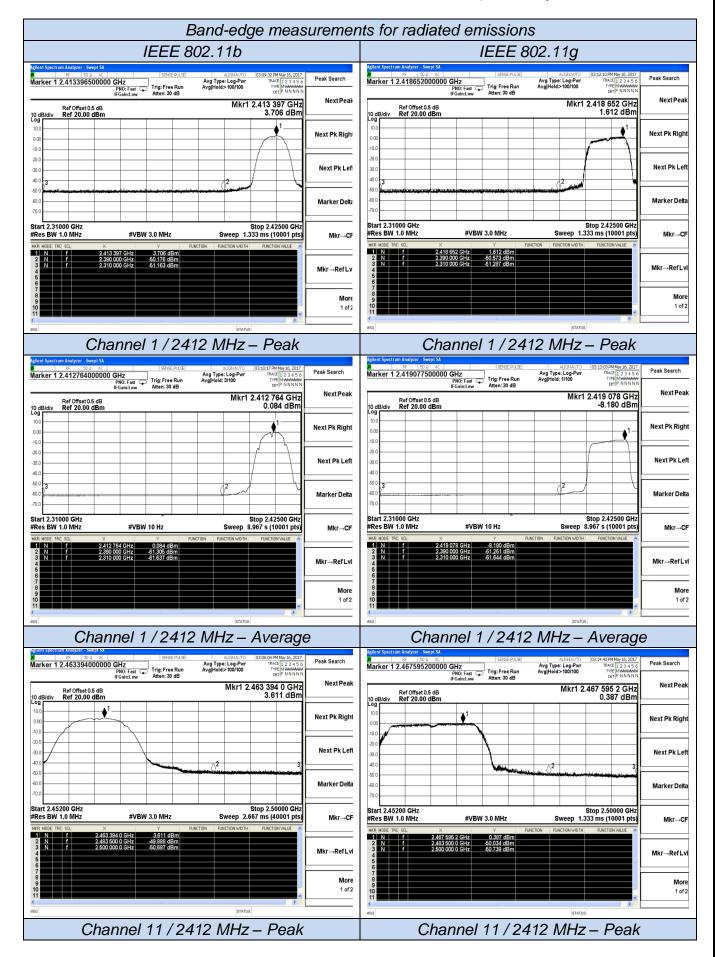
	IEEE 802.11n HT20							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict	
2310.000	-48.741	2.000	0.00	48.417	Peak	74.00	PASS	
2310.000	-61.046	2.000	0.00	36.112	AV	54.00	PASS	
2390.000	-43.542	2.000	0.00	53.616	Peak	74.00	PASS	
2390.000	-58.672	2.000	0.00	38.486	Peak	74.00	PASS	
2419.434	0.509	2.000	0.00	97.667	AV	54.00	PASS	
2415.042	-9.500	2.000	0.00	87.658	Peak		PASS	
2469.534	0.825	2.000	0.00	97.983	AV		PASS	
2470.124	-9.122	2.000	0.00	88.036	Peak		PASS	
2483.500	-49.293	2.000	0.00	47.865	AV		PASS	
2483.500	-59.170	2.000	0.00	37.988	Peak	74.00	PASS	
2500.000	-50.765	2.000	0.00	46.393	AV	54.00	PASS	
2500.000	-61.105	2.000	0.00	36.053	Peak	74.00	PASS	

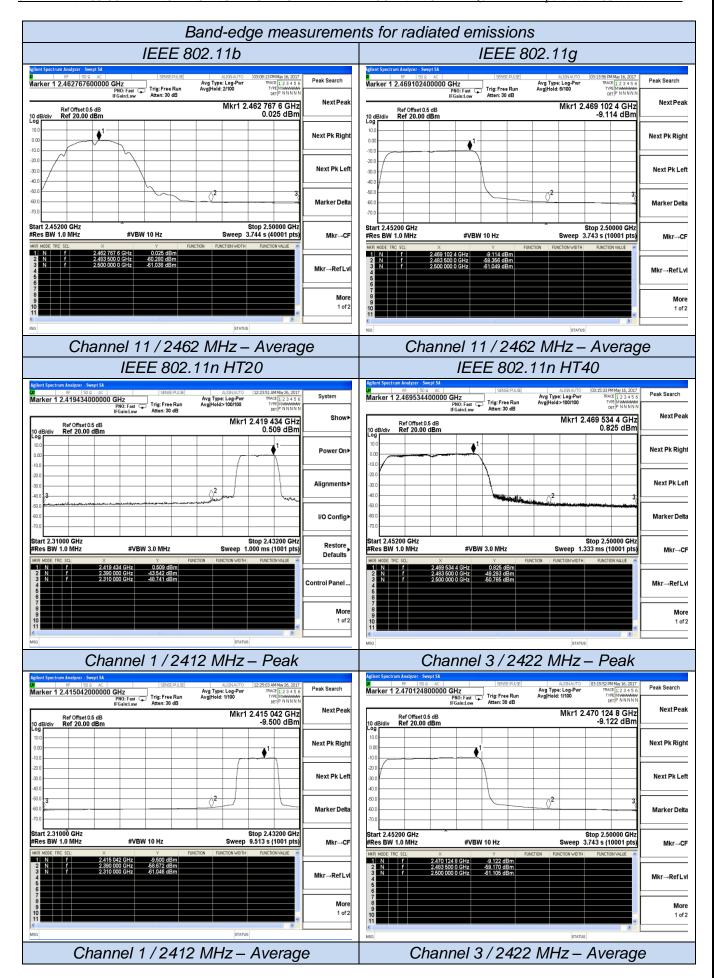
	IEEE 802.11n HT40								
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict		
2310.000	-50.471	2.000	0.00	46.687	Peak	74.00	PASS		
2310.000	-61.684	2.000	0.00	35.474	AV	54.00	PASS		
2390.000	-49.992	2.000	0.00	47.166	Peak	74.00	PASS		
2390.000	-61.186	2.000	0.00	35.972	AV	54.00	PASS		
2419.692	-0.271	2.000	0.00	96.887	Peak		PASS		
2420.141	-10.440	2.000	0.00	86.718	AV		PASS		
2468.869	-1.875	2.000	0.00	95.283	Peak		PASS		
2468.937	-11.713	2.000	0.00	85.445	AV		PASS		
2483.500	-49.429	2.000	0.00	47.729	Peak	74.00	PASS		
2483.500	-29.225	2.000	0.00	67.933	AV	54.00	PASS		
2500.000	-50.366	2.000	0.00	46.792	Peak	74.00	PASS		
2500.000	-61.045	2.000	0.00	36.113	AV	54.00	PASS		

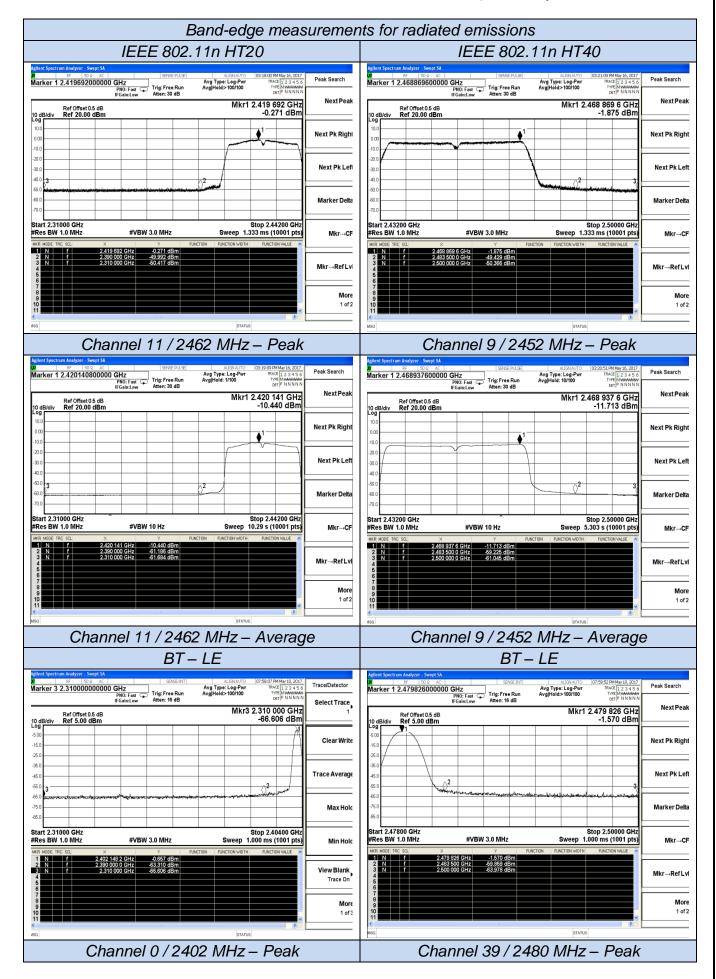
	BT – LE								
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict		
2390.000	-72.577	2.000	0.00	24.581	Peak	74.00	PASS		
2400.000	-61.468	2.000	0.00	35.690	Peak	74.00	PASS		
2402.026	-1.318	2.000	0.00	95.840	Peak		PASS		
2480.244	-2.217	2.000	0.00	94.941	Peak		PASS		
2483.500	-71.312	2.000	0.00	25.846	Peak	74.00	PASS		

Remark:

- 1. Measured Band-edge radiated 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; 13.5Mbps at IEEE 802.11n HT40;
- 4. "---"means that the fundamental frequency not for 15.209 limits requirement.
- 5. No need measure Average values if Peak values meets Average limits;
- 6. Please refer to following plots;







5.9. Antenna Requirements

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 2.00 dBi, and the antenna is an internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

The WLAN and Bluetooth share same antenna.

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				

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 normal WLAN devices, the IEEE 802.11b mode is used.

Limits

FCC	IC
Antenna	Gain
6 dB	İ

T _{nom}	V _{nom}	lowest channel 2412 MHz	middle channel 2437 MHz	highest channel 2462 MHz
Conducted power [dBm] Measured with DSSS modulation		3.709	3.717	3.612
Measi	Radiated power [dBm] Measured with DSSS modulation		5.161	4.427
Gain [dBi] Calculated		-0.262	1.444	0.815
Measurement uncertainty			± 1.6 dB (cond.)	/ ± 3.8 dB (rad.)

T_nom	V _{nom}	lowest channel 2402 MHz	middle channel 2440 MHz	highest channel 2480 MHz
Conducted power [dBm] Measured with GFSK modulation		-1.516	-1.808	-2.234
Measu	Radiated power [dBm] Measured with GFSK modulation		-0.491	-1.740
Gain [dBi] Calculated		-0.617	1.317	0.494
M	easurement unce	ertainty	± 1.6 dB (cond.)	/ ± 3.8 dB (rad.)

6. LIST OF MEASURING EQUIPMENTS

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Cal Date	Due Date
EMC Receiver	R&S	ESCS 30	100174	9kHz – 2.75GHz	Jun 18, 2016	Jun 17, 2017
Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	9kHz~40GHz	Jul 16, 2016	Jul 15, 2017
LISN	MESS Tec	NNB-2/16Z	99079	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
LISN	EMCO	3819/2NM	9703-1839	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
RF Cable-CON	UTIFLEX	3102-26886-4	CB049	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
ISN	SCHAFFNER	ISN ST08	21653	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30M-18GHz	Jun 18, 2016	Jun 17, 2017
Amplifier	SCHAFFNER	COA9231A	18667	9kHz-2GHzz	Apr 18, 2016	Apr 17, 2017
Amplifier	Agilent	8449B	3008A02120	1GHz-26.5GHz	Apr 18, 2016	Apr 17, 2017
Amplifier	MITEQ	AMF-6F-260400	9121372	26.5GHz-40GHz	Apr 18, 2016	Apr 17, 2017
Loop Antenna	R&S	HFH2-Z2	860004/001	9k-30MHz	Apr 18, 2016	Apr 17, 2017
By-log Antenna	SCHWARZBECK	VULB9163	9163-470	30MHz-1GHz	Apr 18, 2016	Apr 17, 2017
Horn Antenna	EMCO	3115	6741	1GHz-18GHz	Apr 18, 2016	Apr 17, 2017
Horn Antenna	SCHWARZBECK	BBHA9170	BBHA917015	15GHz-40GHz	Apr 18, 2016	Apr 17, 2017
RF Cable-R03m	Jye Bao	RG142	CB021	30MHz-1GHz	Jun 18, 2016	Jun 17, 2017
RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	1GHz-40GHz	Jun 18, 2016	Jun 17, 2017
Power Meter	R&S	NRVS	100444	DC-40GHz	Jun 18, 2016	Jun 17, 2017
Power Sensor	R&S	NRV-Z81	100458	DC-30GHz	Jun 18, 2016	Jun 17, 2017
Power Sensor	R&S	NRV-Z32	10057	30MHz-6GHz	Jun 18, 2016	Jun 17, 2017
DC power Source	GW	GPC-6030D	C671845	DC 1V-60V	Jun 18, 2016	Jun 17, 2017
RF CABLE-1m	JYE Bao	RG142	CB034-1m	20MHz-7GHz	Jun 18, 2016	Jun 17, 2017
RF CABLE-2m	JYE Bao	RG142	CB035-2m	20MHz-1GHz	Jun 18, 2016	Jun 17, 2017
Signal Generator	R&S	SMR40	10016	10MHz~40GHz	Jul 16, 2016	Jul 15, 2017
MXA Signal Analyzer	Agilent	N9020A	MY50510140	10Hz~26.5GHz	Oct 27, 2016	Oct 26, 2017
RF Control Unit	Tonscend	JS0806-1	/	1	Nov 19,	Nov 18, 2017
Test Software	Ascentest	AT890-SW	20141230	Version:	N/A	N/A
Splitter/Combiner(Qty: 2)	Mini-Circuits	ZAPD-50W 4.2-6.0 GHz	NN25640042 4	/	Oct 27, 2016	Oct 26, 2017
Splitter/Combine (Qty: 2)	MCLI	PS3-7	4463/4464	/	Oct 27, 2016	Oct 26, 2017
ATT (Qty: 1)	Mini-Circuits	VAT-30+	30912	/	Oct 27, 2016	Oct 26, 2017
EMC Test Software	Audix	E3	1	/	1	1