FCC 47 CFR PART 15 SUBPART C AND ANSI C63.10:2013 TEST REPORT

For

AC1300 IoT Router

Model: X10R

Data Applies To: X10 ; X10S

Trade Name: ASRock

Issued for

ASRock Incorporation

2F., No.37, Sec. 2, Jhongyang S. Rd., Beitou Dist., Taipei City 11270, Taiwan (R.O.C.)

Issued by

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Issued Date: March 02, 2017

Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	02/18/2017	Initial Issue	All Page 54	Michelle Chiu
01	03/02/2017	Revised Modulation	Page 5	Gloria Chang

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1. TEST REPORT CERTIFICATION

Applicant	：	ASRock Incorporation
Address	：	2F., No.37, Sec. 2, Jhongyang S. Rd., Beitou Dist., Taipei City 11270, Taiwan (R.O.C.)
Equipment Under Test	：	AC1300 IoT Router
Model	：	X10R
Data Applies To	：	X10 ; X10S
Trade Name	：	ASRock
Tested Date	：	October 24 ~ December 27, 2016

APPLICABLE STANDARD	
Standard	**Test Result**
FCC Part 15 Subpart C AND ANSI C63.10:2013	PASS

WE HEREBY CERTIFY THAT: The above equipment has been tested by Compliance Certification Services Inc., and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product/system, which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Approved by:

Sb. Lu
Sr. Engineer

Reviewed by:

Gundam Lin
Sr. Engineer

2. EUT DESCRIPTION

Product Name	AC1300 IoT Router
Model Number	X10R
Data Applies To	X10 ; X10S
Identify Number	T161103D21
Received Date	October 24, 2016
Frequency Range	902.5 MHz to 927.5 MHz
Transmit Power	18.77 dBm (0.0753W)
Channel Spacing	500 kHz
Channel Number	51 Channels
Transmit Data Rate	976.56bps
Type of Modulation	FSK (with FHSS technology)
Antenna Type	Dipole Antenna × 1, Antenna Gain: 1.17 dBi
Power Rating	12Vdc
Test Voltage	120Vac, 60Hz
DC Power Cable Type	Non-shielded cable, 1.5m × 1 (Non-detachable)
I/O Port	USB Port × 2, WAN(RJ-45) Port × 1, LAN(RJ-45) Port × 4, Power Port × 1
Signal Cable	Non-shielded RJ-45 cable, 1.2 m × 1 (Detachable)

Power Adapter:

No.	Manufacturer	Model No.	Power Input	Power Output
1	APD	WB-18D12R	100-240Vac, 50-60Hz, 0.5A Max.	12Vdc, 1.5A

The difference of the series model

Model Number	Difference	
	Function	External Antenna Quantity
X10	Router + Zigbee	2
X10R	Router + Zigbee+LoRa(Sub-G)	3
X10S	Router + Zigbee+LoRa(Sub-G)	3

Remark:

1. *The sample selected for test was engineering sample that approximated to production product and was provided by manufacturer.*
2. *For more details, please refer to the User's manual of the EUT.*
3. *This submittal(s) (test report) is intended for FCC ID: 2AFEB-X10 filing to comply with Section 15.207, 15.209 and 15.247 of the FCC Part 15, Subpart C Rules.*
4. *The model X10R was considered the main model for testing.*

3. DESCRIPTION OF TEST MODES

The EUT (AC1300 IoT Router) had been tested under operating condition.

There are three channels have been tested as following:

Channel	Frequency (MHz)
Low	902.5
Middle	915.0
High	927.5

Conducted Emission / Radiated Emission Test (Below 1 GHz)

1. The following test modes were scanned during the preliminary test:

No.	Pre-Test mode
1	TX Mode

2. After the preliminary scan, the following test mode was found to produce the highest emission level.

Final Test mode		
Emission	Radiated Emission	Mode 1
	Conducted Emission	Mode 1

Remark: *Then, the above highest emission mode of the configuration of the EUT and cable was chosen for all final test items.*

Radiated Emission Test (Above 1 GHz) / Conducted Measurement:

TX Mode

Remark：*The field strength of spurious emission was measured in the following position: EUT stand-up position(Y axis), lie-down position(X, Z axis). The worst emission was found in stand-up position(Y axis) and the worst case was recorded.*

4. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10:2013 and FCC CFR 47, 15.207, 15.209 and 15.247.

5. FACILITIES AND ACCREDITATION

5.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

NO. 989-1 Wen Shan Rd., Shang Shan Village,
Qionglin Township, Hsinchu County 30741, Taiwan (R.O.C.)

The sites are constructed in conformance with the requirements of ANSI C63.10:2013 and CISPR 22. All receiving equipment conforms to CISPR 16-1-1, CISPR 16-1-2, CISPR 16-1-3, CISPR 16-1-4 and CISPR 16-1-5.

5.2 ACCREDITATIONS

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

Taiwan	TAF

The measuring facility of laboratories has been authorized or registered by the following approval agencies.

Canada	INDUSTRY CANADA
Japan	VCCI
Taiwan	BSMI
USA	FCC MRA

Copies of granted accreditation certificates are available for downloading from our web site, http:///www.ccsrf.com

Remark: *FCC Designation Number TW1027.*

5.3 MEASUREMENT UNCERTAINTY

The following table is for the measurement uncertainty, which is calculated as per the document CISPR 16-4-2.

PARAMETER	UNCERTAINTY
Semi Anechoic Chamber (966 Chamber_B) / Radiated Emission, 30 to 1000 MHz	+/- 3.97
Semi Anechoic Chamber (966 Chamber_B) / Radiated Emission, 1 to 18GHz	+/- 3.58
Semi Anechoic Chamber (966 Chamber_B) / Radiated Emission, 18 to 26 GHz	+/- 3.59
Semi Anechoic Chamber (966 Chamber_B) / Radiated Emission, 26 to 40 GHz	+/- 3.81
Conducted Emission (Mains Terminals), 9kHz to 30MHz	+/- 2.48

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Consistent with industry standard (e.g. CISPR 22, clause 11, Measurement Uncertainty) determining compliance with the limits shall be base on the results of the compliance measurement. Consequently the measure emissions being less than the maximum allowed emission result in this be a compliant test or passing test.

The acceptable measurement uncertainty value without requiring revision of the compliance statement is base on conducted and radiated emissions being less than U_{CISPR} which is 3.6dB and 5.2dB respectively. CCS values (called U_{Lab} in CISPR 16-4-2) is less than U_{CISPR} as shown in the table above. Therefore, MU need not be considered for compliance.

6. SETUP OF EQUIPMENT UNDER TEST

SUPPORT EQUIPMENT

No.	Product	Manufacturer	Model No.	Serial No.
1	Notebook PC	TOSHIBA	PORTEGE R30-A	7F097009H

No.	Signal Cable Description
1	Non-shielded RJ-45 cable, 12m × 1

SETUP DIAGRAM FOR TESTS

EUT & peripherals setup diagram is shown in appendix setup photos.

EUT OPERATING CONDITION

1. EUT & peripherals setup diagram is shown in appendix setup photos.
2. TX Mode:
   ⇨ **Power control:**
   Channel Low (902.5MHz) Power set 20.
   Channel Middle (915MHz) Power set 20.
   Channel High (927.5MHz) Power set 20.
3. All of the functions are under run.
4. Start test.

7. FCC PART 15.247 REQUIREMENTS

7.1 20dB BANDWIDTH FOR HOPPING

LIMITS

Limit: N/A

TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EXA Signal Analyzer	Agilent	N9010A	MY52220817	03/15/2017
Test S/W	N/A			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP

TEST PROCEDURE

The 20dB band width was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer. Display Line and Marker Delta functions, the 20dB band width of the emission was determined.

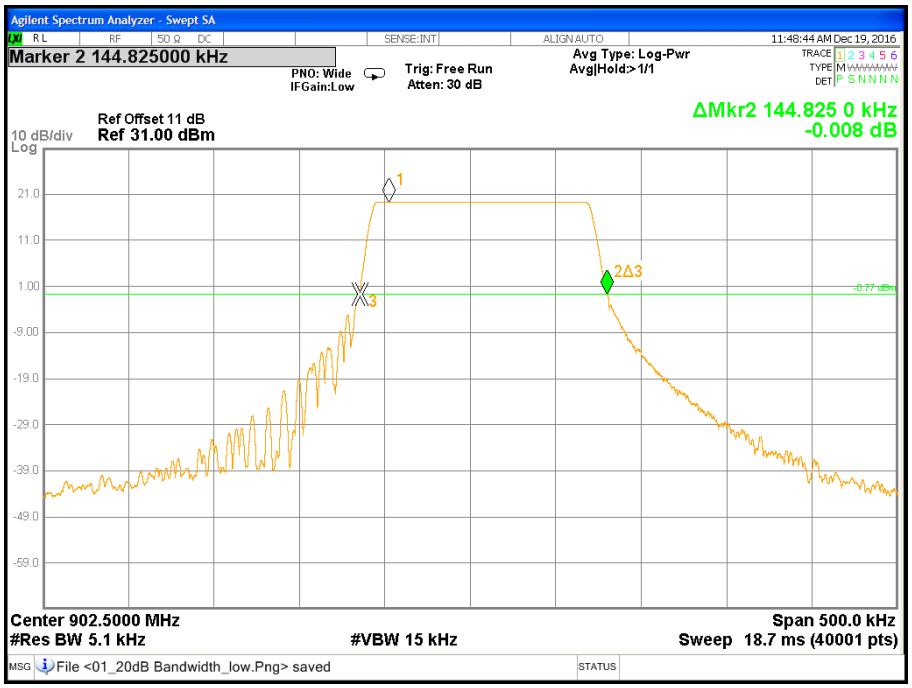
TEST RESULTS

Product Name	AC1300 IoT Router	**Test By**	Waternil Guan
Test Model	X10R	**Test Date**	2016/12/19
Test Mode	TX Mode	**Temp. & Humidity**	17°C, 53%

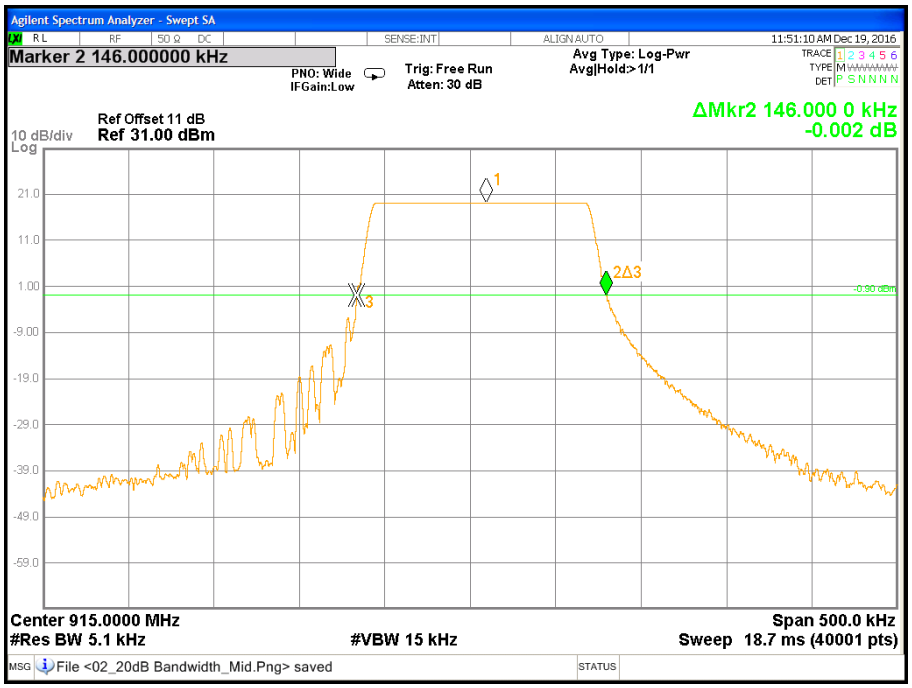
Channel	**Channel Frequency (MHz)**	**20dB Bandwidth (MHz)**	**Result**
Low	902.5	0.1448	N/A
Middle	915.0	0.1460	N/A
High	927.5	0.1445	N/A

20dB BANDWIDTH

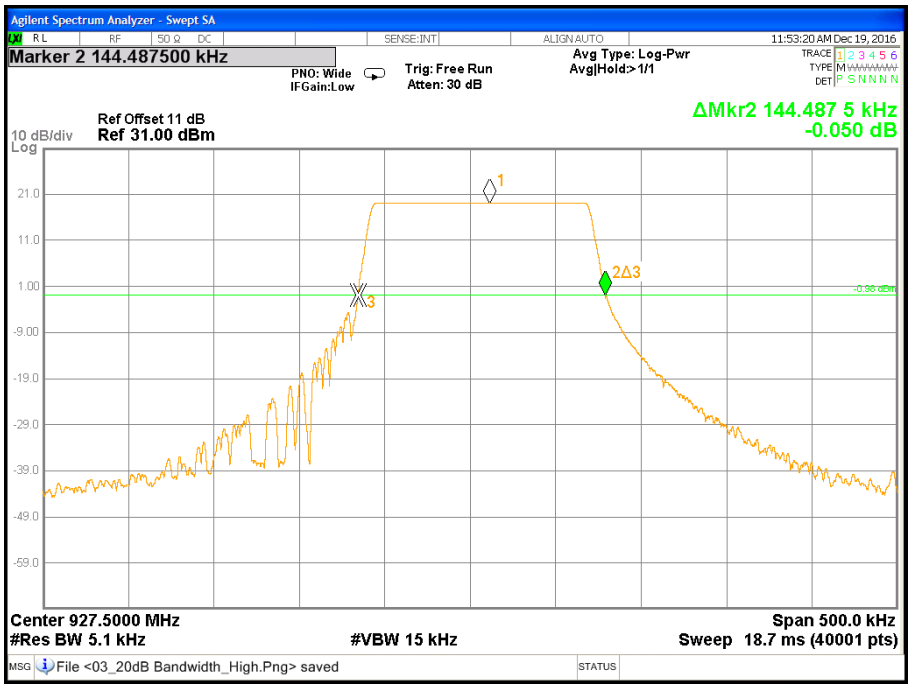
CH Low



CH Middle



CH High



7.2 HOPPING CHANNEL SEPARATION

LIMITS

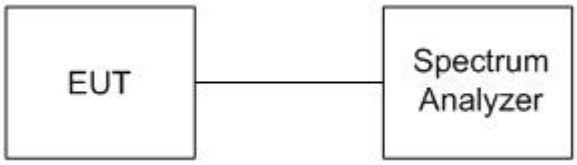
§15.247(a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EXA Signal Analyzer	Agilent	N9010A	MY52220817	03/15/2017
Test S/W	N/A			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP



TEST PROCEDURE

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the MaxHold function record the separation of adjacent channels.
4. Measure the frequency difference of these two adjacent channels by spectrum analyzer MARK function. And then plot the result on spectrum analyzer screen.
5. Repeat above procedures until all frequencies measured were complete.

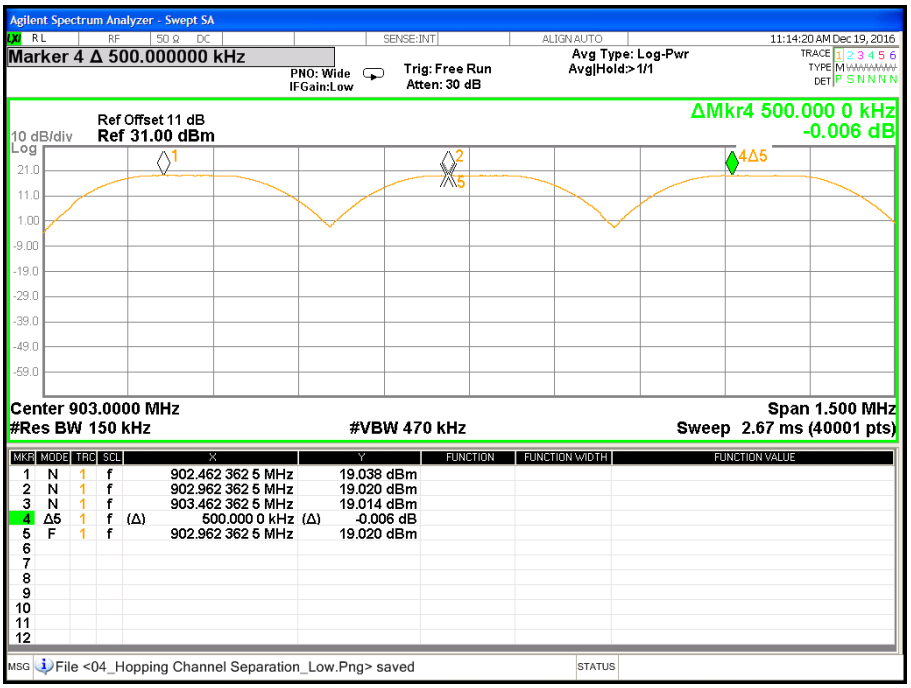
TEST RESULTS

Product Name	AC1300 IoT Router	**Test By**	Waternil Guan
Test Model	X10R	**Test Date**	2016/12/19
Test Mode	TX Mode	**Temp. & Humidity**	17°C, 53%

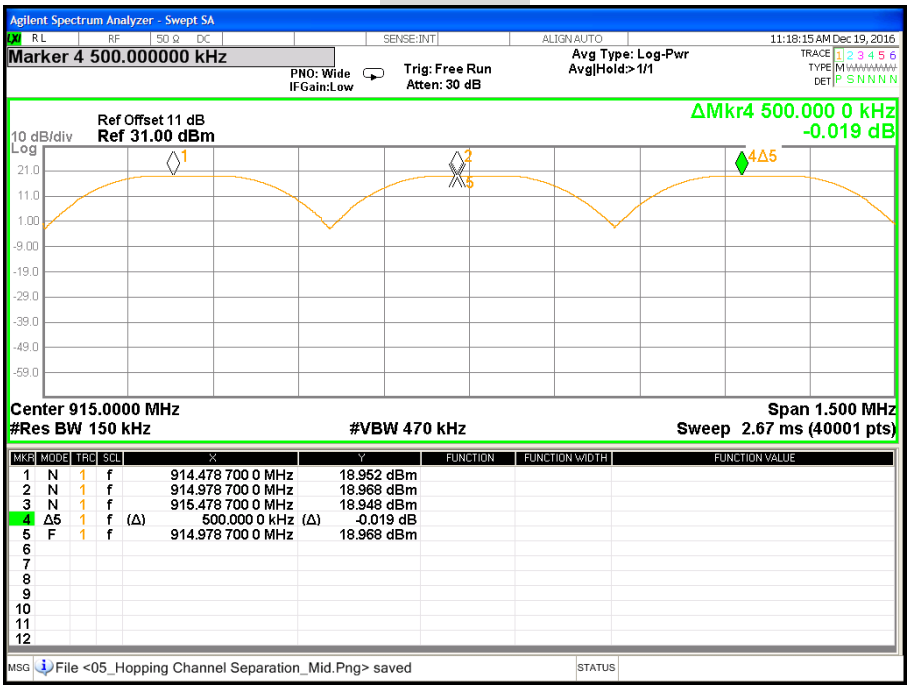
Channel	**Channel Frequency (MHz)**	**Adjacent Hopping Channel Separation (kHz)**	**20dB Bandwidth (kHz)**	**Minimum Bandwidth (kHz)**	**Result**
Low	902.5	500	144.8	25	PASS
Middle	915.0	500	146.0	25	PASS
High	927.5	500	144.5	25	PASS

HOPPING CHANNEL SEPARATION

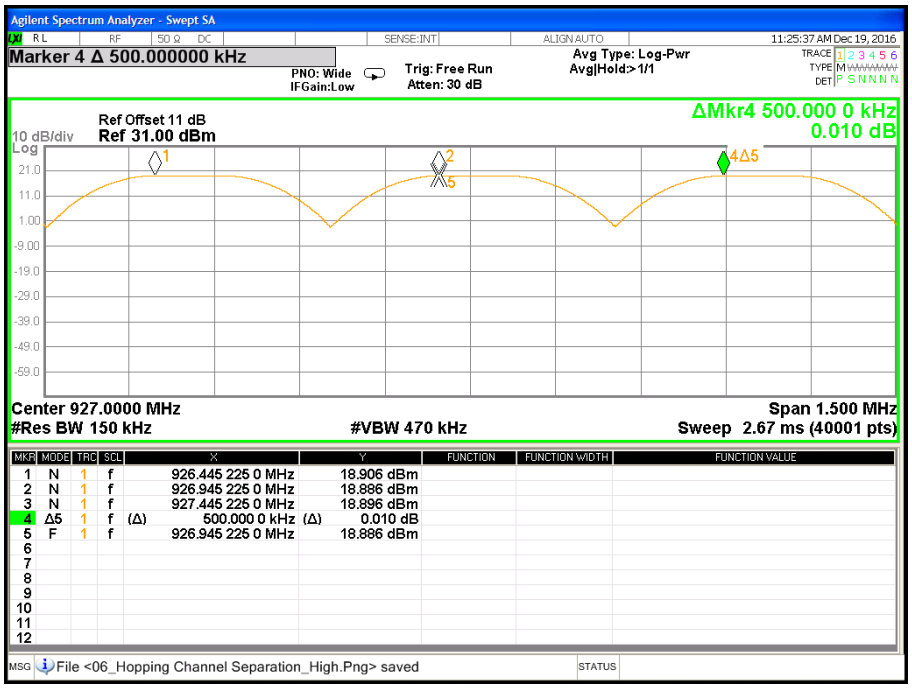
CH Low



CH Middle



CH High



7.3 NUMBER OF HOPPING FREQUENCY USED

LIMITS

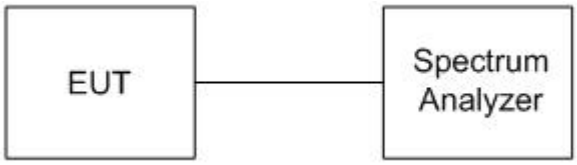
§15.247(a)(1)(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EXA Signal Analyzer	Agilent	N9010A	MY52220817	03/15/2017
Test S/W	N/A			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP



TEST PROCEDURE

1. Check the calibration of the measuring instrument (spectrum analyzer) using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Set the spectrum analyzer on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
4. Set the spectrum analyzer on View mode and then plot the result on spectrum analyzer screen.
5. Repeat above procedures until all frequencies measured were complete.

TEST RESULTS

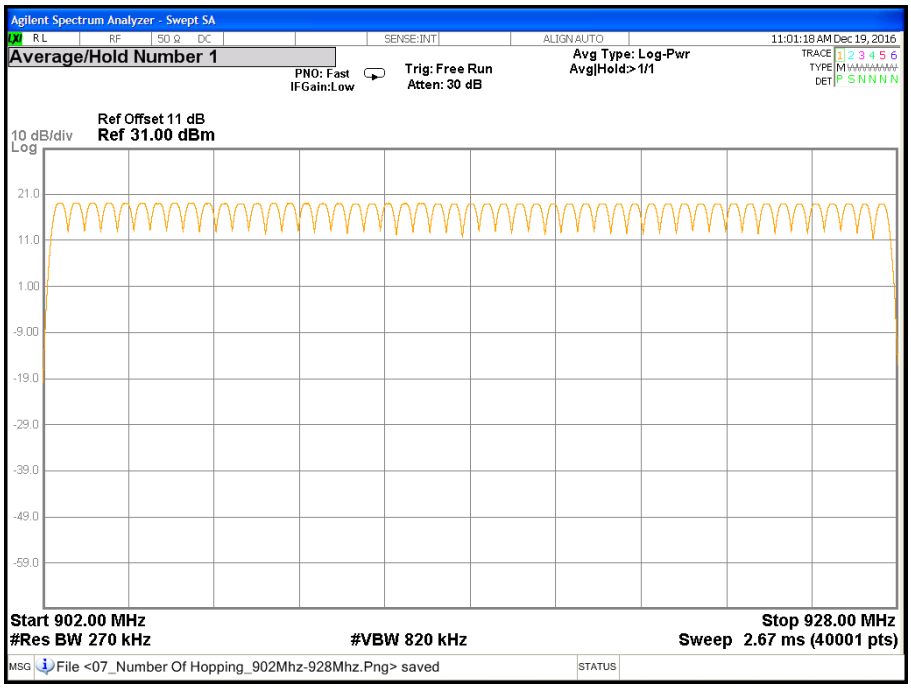
Product Name	AC1300 IoT Router	Test By	Waternil Guan
Test Model	X10R	Test Date	2016/12/19
Test Mode	TX Mode	Temp. & Humidity	17°C, 53%

Channel	Channel Frequency (MHz)	20dB bandwidth (kHz)	20dB Bandwidth Limit (kHz)	Minimum Channel Number	Result
Low	902.5	144.8	<250	50	PASS
Middle	915.0	146.0	<250	50	PASS
High	927.5	144.5	<250	50	PASS

Refer to the attached plot.

There are 51 hopping frequencies in a hopping sequence.

NUMBER OF HOPPING FREQUENCY USED



7.4 MAXIMUM PEAK OUTPUT POWER

LIMITS

§15.247(b)(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Power Meter	Anritsu	ML2495A	1149001	12/05/2017
Power Sensor	Anritsu	MA2411B	1126148	12/05/2017
Test S/W	N/A			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP

TEST PROCEDURE

The transmitter output is connected to the power meter. The power meter is set to the peak power detection.

TEST RESULTS

Product Name	AC1300 IoT Router	Test By	Waternil Guan
Test Model	X10R	Test Date	2016/12/19
Test Mode	TX Mode	Temp. & Humidity	17°C, 53%

Channel	Channel Frequency (MHz)	Maximum Peak Output Power				Result
		Measured Value		Limit		
		(dBm)	(W)	(dBm)	(W)	
Low	902.5	18.77	0.0753	30.00	1.0000	PASS
Middle	915.0	18.71	0.0743	30.00	1.0000	PASS
High	927.5	18.61	0.0726	30.00	1.0000	PASS

Remark: *The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for direct reading of power.*

7.5 AVERAGE POWER

LIMITS

None: For reporting purposes only.

TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Power Meter	Anritsu	ML2495A	1149001	12/05/2017
Power Sensor	Anritsu	MA2411B	1126148	12/05/2017
Test S/W	N/A			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP

TEST PROCEDURE

The transmitter output is connected to the power meter. The power meter is set to the average power detection.

TEST RESULTS

Product Name	AC1300 IoT Router	Test By	Waternil Guan
Test Model	X10R	Test Date	2016/12/19
Test Mode	TX Mode	Temp. & Humidity	17°C, 53%

Channel	Channel Frequency (MHz)	Average Power (dBm)
Low	902.5	18.74
Middle	915.0	18.68
High	927.5	18.59

Remark: *The cable assembly insertion loss of 11 dB (including 10 dB pad and 1 dB cable) was entered as an offset in the power meter to allow for direct reading of power.*

7.6 DWELL TIME ON EACH CHANNEL

LIMITS

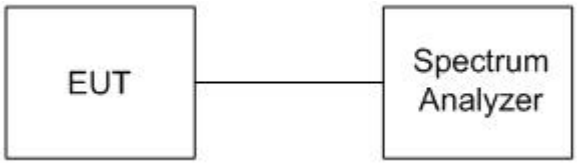
§15.247(a)(1)(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EXA Signal Analyzer	Agilent	N9010A	MY52220817	03/15/2017
Test S/W	N/A			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP



TEST PROCEDURE

1. The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan.
2. The number of pulses is measured in a slow scan.

TEST RESULTS

Product Name	AC1300 IoT Router	Test By	Waternil Guan
Test Model	X10R	Test Date	2016/12/19
Test Mode	TX Mode	Temp. & Humidity	17°C, 53%

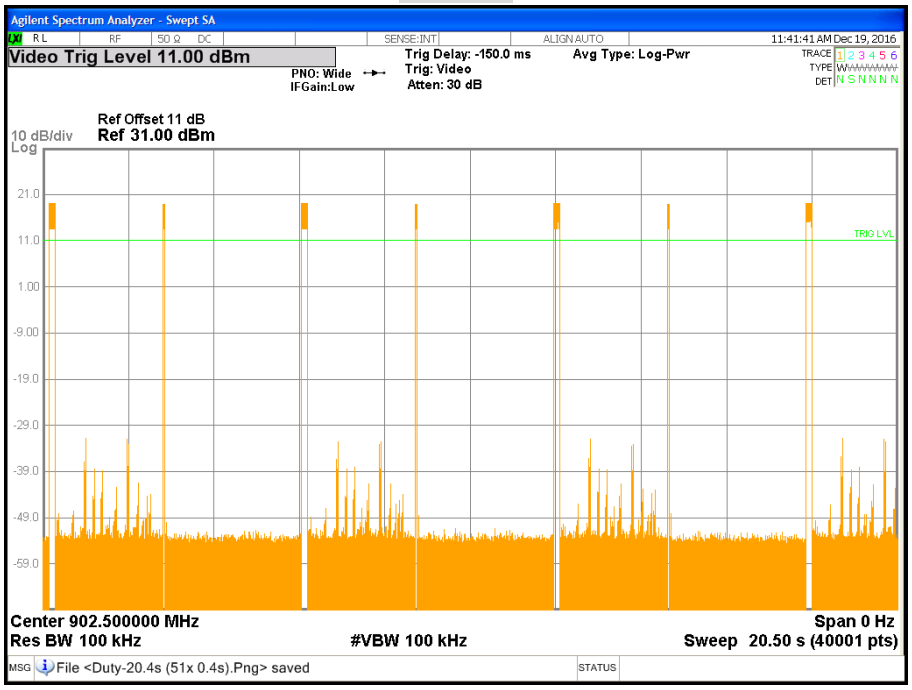
Channel	Channel Frequency (MHz)	Pulse width (ms)	Number of Pulse in 20.4 Seconeds	Average Time of Occupancy (ms)	Limit (ms)	Results
Low	902.5	40.850	7	285.95	400	PASS
Middle	915.0	40.850	7	285.95	400	PASS
High	927.5	40.850	7	285.95	400	PASS

Remark:
Ch Low:
Cycle = Hopping Channel × 0.4sec= 51× 0.4 = 20.4 sec
Average Time of Occupancy = Pulse Width × Hopping Channel = 40.85 ms × 7 = 285.95 ms
Ch Middle:
Cycle = Hopping Channel × 0.4sec= 51× 0.4 = 20.4 sec
Average Time of Occupancy = Pulse Width × Hopping Channel = 40.85 ms × 7 = 285.95 ms
Ch High:
Cycle = Hopping Channel × 0.4sec= 51× 0.4 = 20.4 sec
Average Time of Occupancy = Pulse Width × Hopping Channel = 40.85 ms × 7 = 285.95 ms

DWELL TIME ON EACH PAYLOAD

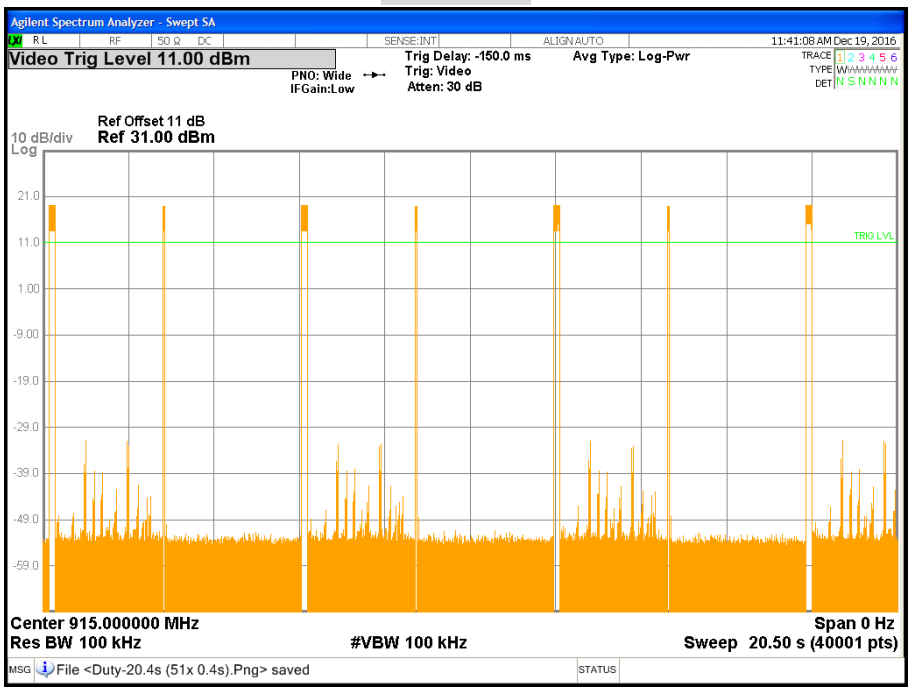
CH Low

CH Low



CH Middle

CH Middle



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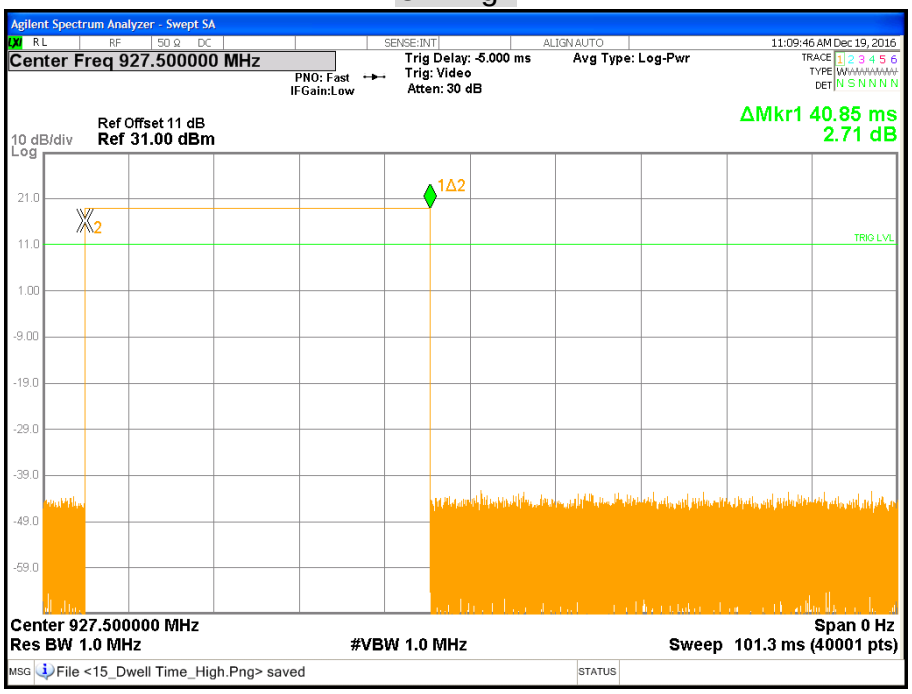
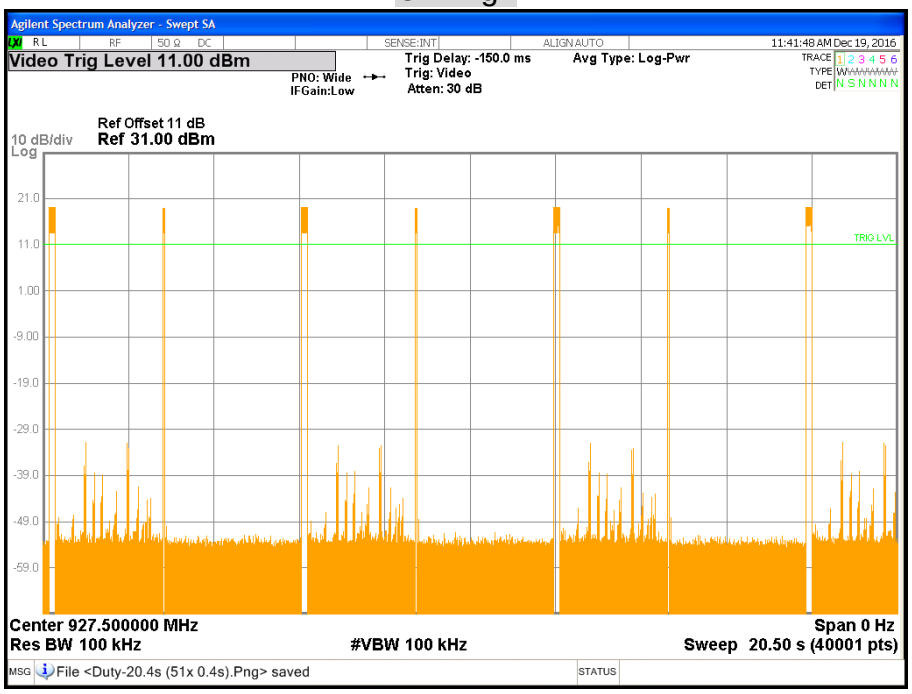


CH High



7.7 CONDUCTED SPURIOUS EMISSION

LIMITS

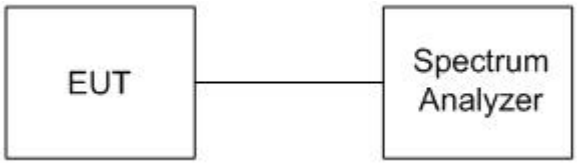
§ 15.247(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the and that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. 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)).

TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EXA Signal Analyzer	Agilent	N9010A	MY52220817	03/15/2017
Test S/W	N/A			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP



TEST PROCEDURE

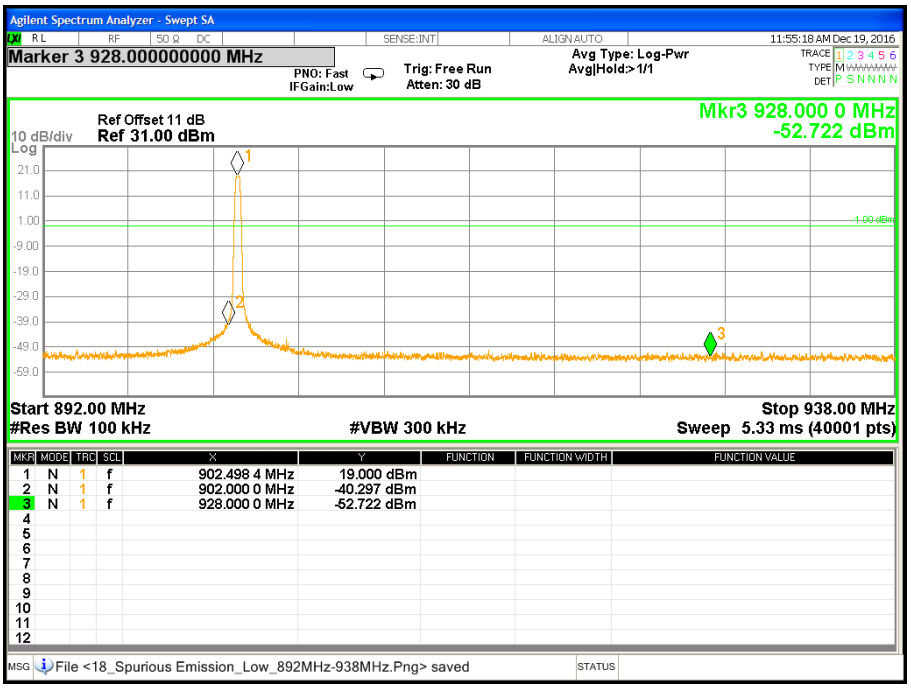
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.
The spectrum from 30 MHz to 10 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 902 ~ 928 MHz band.

TEST RESULTS

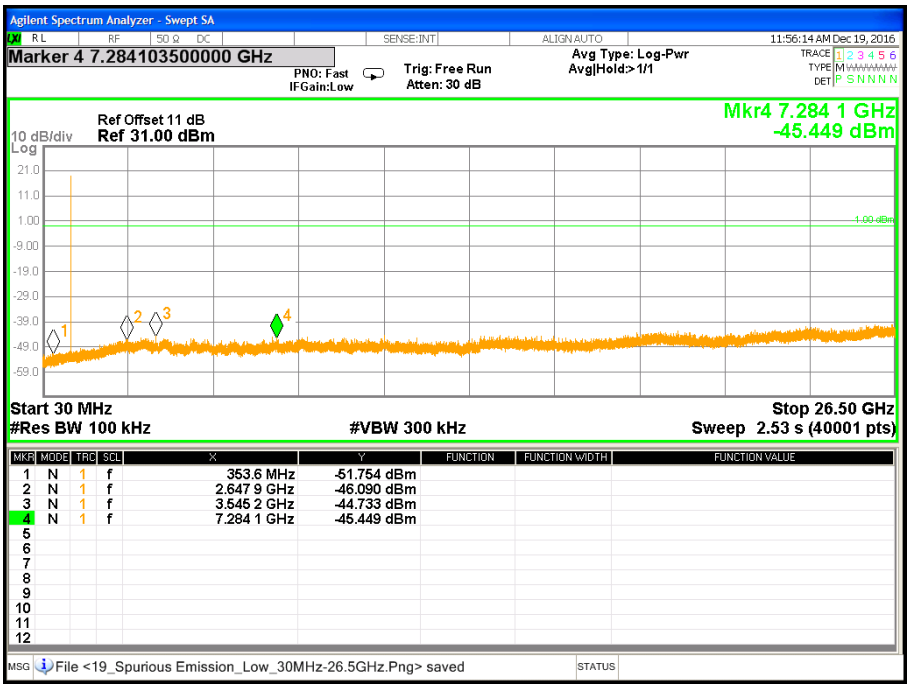
Product Name	AC1300 IoT Router	Test By	Waternil Guan
Test Model	X10R	Test Date	2016/12/19
Test Mode	TX Mode	Temp. & Humidity	17°C, 53%

OUT-OF-BAND SPURIOUS EMISSIONS-CONDUCTED MEASUREMENT

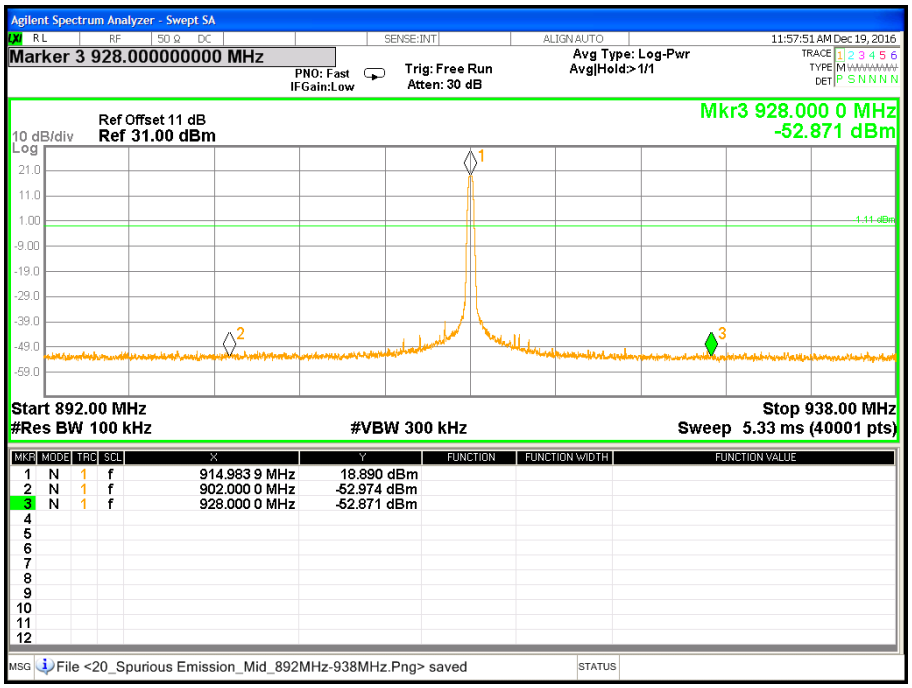
CH Low (892MHz ~ 938MHz)



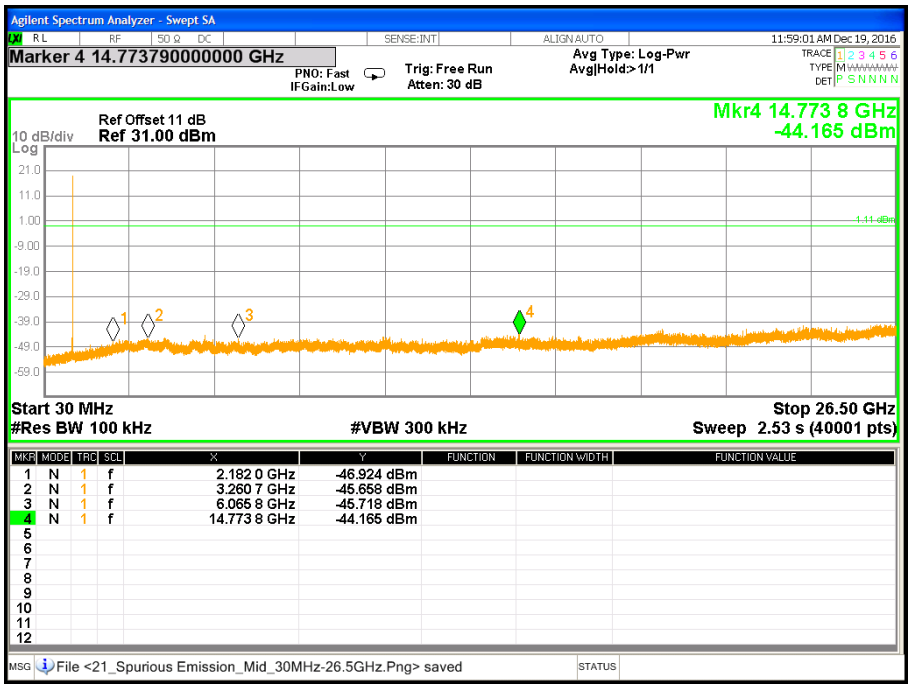
CH Low (30MHz ~ 26.5GHz)



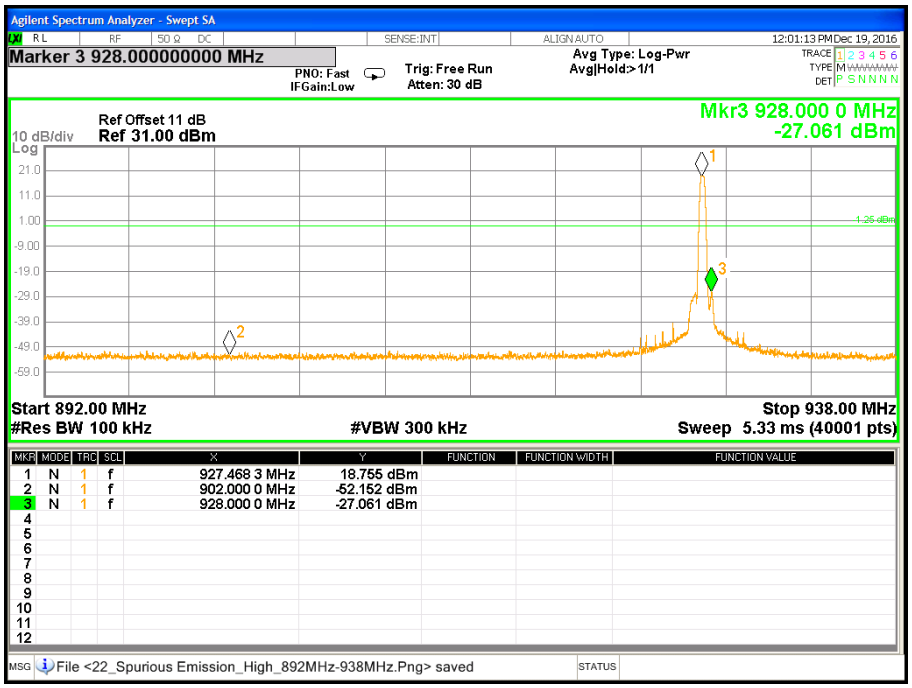
CH Middle (892MHz ~ 938MHz)



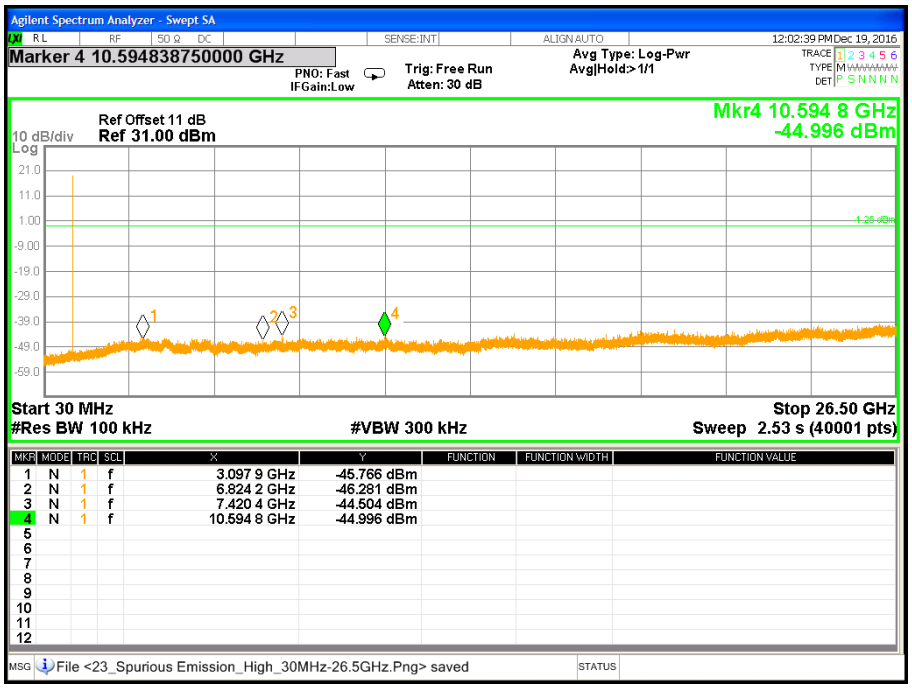
CH Middle (30MHz ~ 26.5GHz)



CH High (892MHz ~ 938MHz)

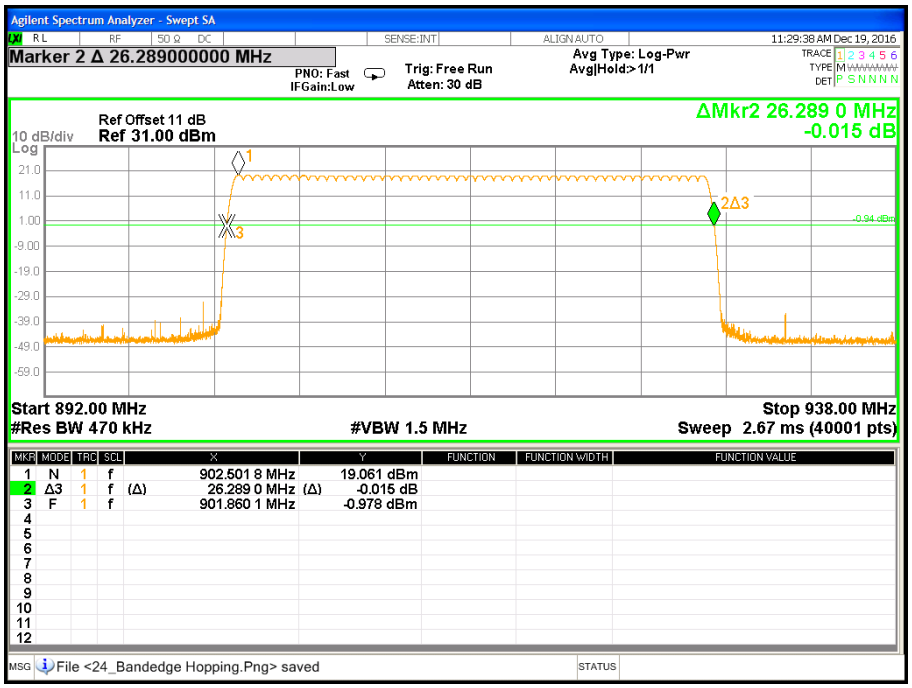


CH High (30MHz ~ 26.5GHz)



CONDUCTED MEASUREMENT HOPPING BAND EDGES

Hopping



7.8 RADIATED EMISSION

LIMITS

(1) According to § 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 -1710	10.6 -12.7
6.26775 - 6.26825	108 -121.94	1718.8 - 1722.2	13.25 -13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 – 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 -16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3338	36.43 - 36.5
12.57675 - 12.57725	322 -335.4	3600 - 4400	([2])
13.36 - 13.41			

Remark:
1. [1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
2. [2] Above 38.6

(2) According to § 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown is Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

(3) According to § 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(KHz)	300
0.490 – 1.705	24000/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

Remark: ***Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.*

(4) According to § 15.209 (b) in the emission table above, the tighter limit applies at the band edges.

TEST EQUIPMENT

Radiated Emission / 966Chamber_B

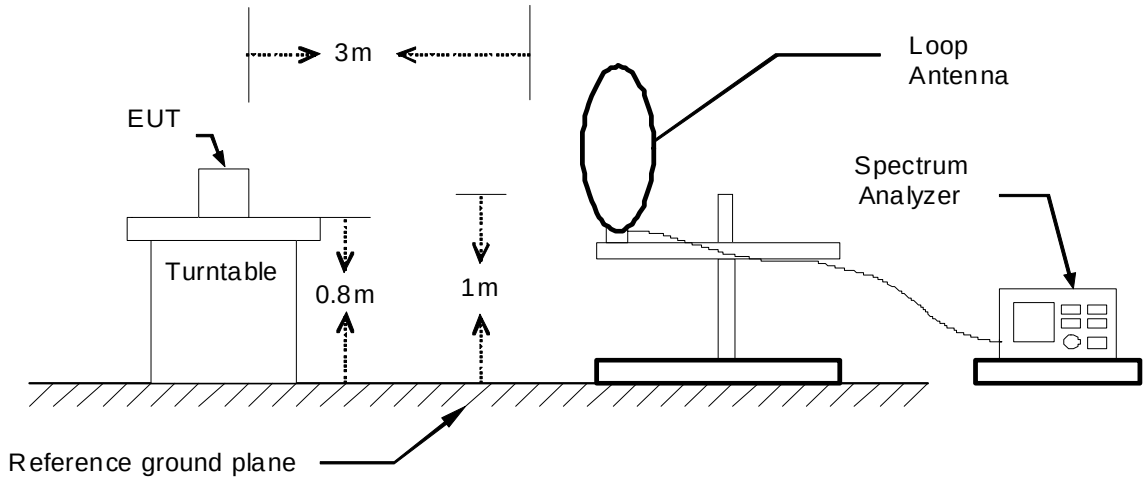
Name of Equipment	Manufacture	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	E4446A	MY46180323	04/12/2017
EMI Test Receiver	Rohde & Schwarz	ESCI	100221	04/26/2017
Bi-log Antenna	TESEQ	CBL 6112D	35403	07/02/2017
Broad-Band Horn Antenna	Schwarzbeck	BBHA 9120 D	9120D-778	07/14/2017
Double-Ridged Waveguide Horn	ETS-LINDGREN	3117	00078733	11/16/2017
Horn Antenna	COM-POWER	AH-840	03077	12/01/2017
Pre-Amplifier	Agilent	8447D	2944A10052	07/12/2017
Pre-Amplifier	Agilent	8449B	3008A01916	07/12/2017
LOOP Antenna	COM-POWER	AL-130	121060	05/23/2017
Test S/W	E3.815206a			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

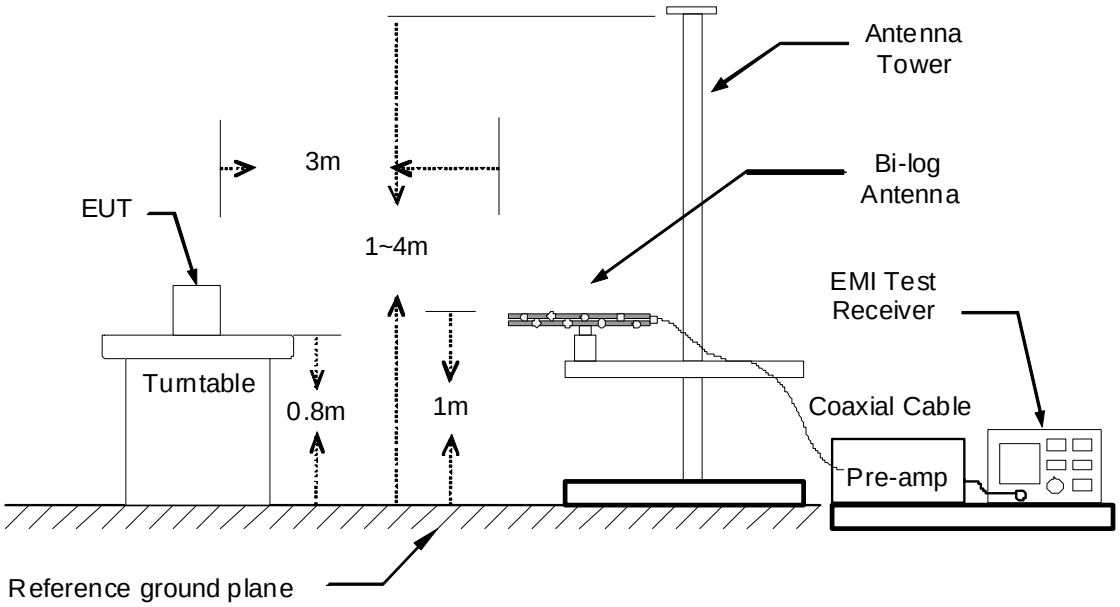
TEST SETUP

The diagram below shows the test setup that is utilized to make the measurements for emission below 1GHz.

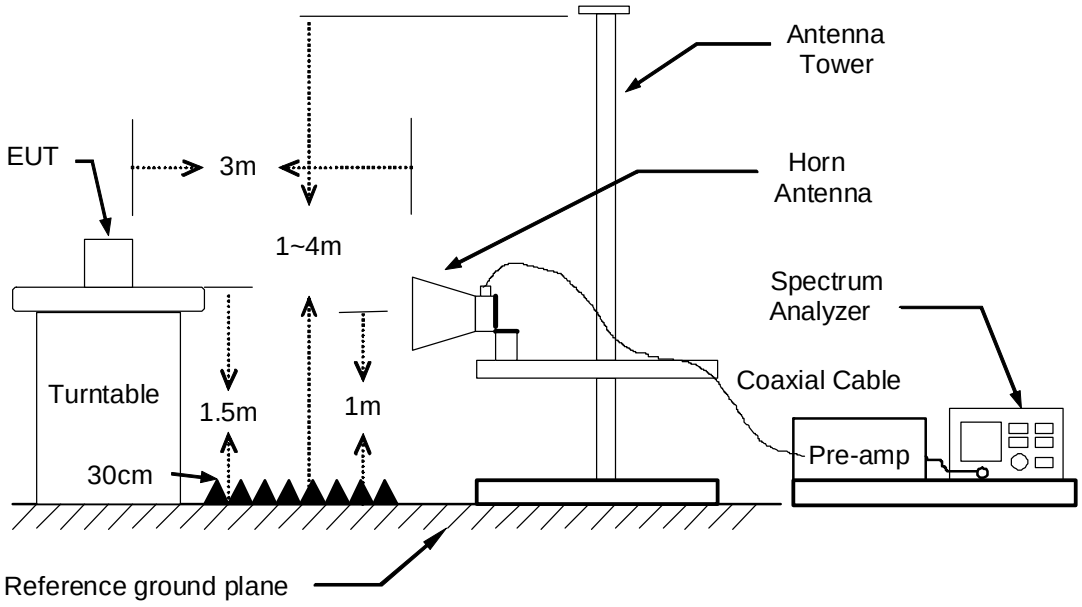
9kHz ~ 30MHz



30MHz ~ 1GHz



The diagram below shows the test setup that is utilized to make the measurements for emission above 1GHz.



TEST PROCEDURE

1. The EUT was placed on the top of a rotating table 0.8 and 1.5 meters above the ground. The table was rotated 360 degrees to determine the position of the highest radiation.
2. While measuring the radiated emission below 1GHz, the EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. While measuring the radiated emission above 1GHz, the EUT was set 3 meters away from the interference-receiving antenna.
3. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarization of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Remark:

1. *The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 KHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1GHz.*
2. *The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1GHz.*
3. *The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz for Average detection (AV) at frequency above 1GHz.*

TEST RESULTS

Below 1 GHz (9kHz ~ 30MHz)

No emission found between lowest internal used/generated frequency to 30MHz.

Below 1 GHz (30MHz ~ 1GHz)

Product Name	AC1300 IoT Router	Test By	Rex Chiu
Test Model	X10R	Test Date	2016/11/23
Test Mode	TX / CH Low	Temp. & Humidity	25°C, 58%

966Chamber_B at 3Meter / Horizontal

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
118.27	51.00	-14.32	36.68	43.50	-6.82	145	100	Peak
157.07	52.94	-15.83	37.11	43.50	-6.39	122	200	Peak
212.36	50.79	-15.62	35.17	43.50	-8.33	145	100	Peak
256.98	51.01	-12.04	38.97	46.00	-7.03	2	100	Peak
326.82	50.96	-10.83	40.13	46.00	-5.87	187	100	Peak
379.20	51.02	-9.58	41.44	46.00	-4.56	164	100	Peak

966Chamber_B at 3Meter / Vertical

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
81.41	52.41	-19.47	32.94	40.00	-7.06	358	200	Peak
126.03	51.22	-14.38	36.84	43.50	-6.66	151	200	Peak
200.72	50.16	-15.92	34.24	43.50	-9.26	63	100	Peak
272.50	51.26	-11.92	39.34	46.00	-6.66	285	100	Peak
327.79	51.12	-10.80	40.32	46.00	-5.68	213	200	Peak
370.47	51.12	-9.77	41.35	46.00	-4.65	129	200	Peak

Remark:

1. *Quasi-peak test would be performed if the peak result were greater than the quasi-peak limit.*
2. *Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) – PreAmp.Gain (dB)*
3. *Result (dBuV/m) = Reading (dBuV) + Correction Factor (dB/m)*
4. *Margin (dB) = Remark result (dBuV/m) - Quasi-peak limit (dBuV/m).*

Product Name	AC1300 IoT Router	Test By	Rex Chiu
Test Model	X10R	Test Date	2016/11/23
Test Mode	TX / CH Middle	Temp. & Humidity	25°C, 58%

966Chamber_B at 3Meter / Horizontal

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
125.06	47.43	-10.75	36.68	43.50	-6.82	222	200	Peak
157.07	50.40	-12.54	37.86	43.50	-5.64	110	200	Peak
206.54	47.96	-12.82	35.14	43.50	-8.36	212	100	Peak
258.92	48.00	-8.18	39.82	46.00	-6.18	259	200	Peak
352.04	48.35	-7.17	41.18	46.00	-4.82	311	200	Peak
410.24	48.03	-5.74	42.29	46.00	-3.71	320	200	Peak

966Chamber_B at 3Meter / Vertical

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
109.54	47.07	-11.09	35.98	43.50	-7.52	264	100	Peak
153.19	48.73	-12.38	36.35	43.50	-7.15	8	100	Peak
260.86	47.48	-8.09	39.39	46.00	-6.61	191	100	Peak
295.78	47.69	-8.37	39.32	46.00	-6.68	214	100	Peak
349.13	48.02	-7.26	40.76	46.00	-5.24	276	200	Peak
406.36	48.91	-5.92	42.99	46.00	-3.01	122	200	Peak

Remark:

1. *Quasi-peak test would be performed if the peak result were greater than the quasi-peak limit.*
2. *Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) – PreAmp.Gain (dB)*
3. *Result (dBuV/m) = Reading (dBuV) + Correction Factor (dB/m)*
4. *Margin (dB) = Remark result (dBuV/m) - Quasi-peak limit (dBuV/m).*

Product Name	AC1300 IoT Router	Test By	Rex Chiu
Test Model	X10R	Test Date	2016/11/23
Test Mode	TX / CH High	Temp. & Humidity	25°C, 58%

966Chamber_B at 3Meter / Horizontal

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
105.66	48.93	-11.42	37.51	43.50	-5.99	121	200	Peak
158.04	49.22	-12.57	36.65	43.50	-6.85	107	200	Peak
212.36	48.59	-12.80	35.79	43.50	-7.71	112	100	Peak
274.44	48.10	-8.60	39.50	46.00	-6.50	116	100	Peak
312.27	47.77	-8.01	39.76	46.00	-6.24	275	100	Peak
369.50	48.27	-6.89	41.38	46.00	-4.62	204	100	Peak

966Chamber_B at 3Meter / Vertical

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
117.30	47.59	-10.77	36.82	43.50	-6.68	294	100	Peak
160.95	47.87	-12.66	35.21	43.50	-8.29	254	100	Peak
217.21	47.71	-12.74	34.97	46.00	-11.03	360	100	Peak
250.19	47.33	-9.27	38.06	46.00	-7.94	360	100	Peak
314.21	48.68	-7.98	40.70	46.00	-5.30	360	100	Peak
380.17	48.69	-6.79	41.90	46.00	-4.10	108	100	Peak

Remark:

1. *Quasi-peak test would be performed if the peak result were greater than the quasi-peak limit.*
2. *Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) – PreAmp.Gain (dB)*
3. *Result (dBuV/m) = Reading (dBuV) + Correction Factor (dB/m)*
4. *Margin (dB) = Remark result (dBuV/m) - Quasi-peak limit (dBuV/m).*

Above 1 GHz

Product Name	AC1300 IoT Router	Test By	Rex Chiu
Test Model	X10R	Test Date	2016/11/23
Test Mode	TX / CH Low	Temp. & Humidity	25°C, 58%

966Chamber_B at 3Meter / Horizontal

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
1805.00	45.21	-4.94	40.27	74.00	-33.73	212	100	Peak
2710.00	47.23	-1.59	45.64	74.00	-28.36	221	100	Peak
3330.00	44.46	0.13	44.59	74.00	-29.41	242	200	Peak
4510.00	40.62	4.43	45.05	74.00	-28.95	297	200	Peak
7900.00	38.38	12.99	51.37	74.00	-22.63	193	100	Peak
8856.00	38.14	13.59	51.73	74.00	-22.27	133	100	Peak

966Chamber_B at 3Meter / Vertical

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
1805.00	54.72	-4.94	49.78	74.00	-24.22	0	100	Peak
2710.00	51.85	-1.59	50.26	74.00	-23.74	278	100	Peak
3470.00	44.30	0.50	44.80	74.00	-29.20	162	200	Peak
4510.00	41.61	4.43	46.04	74.00	-27.96	278	200	Peak
7220.00	37.39	12.38	49.77	74.00	-24.23	4	100	Peak
8828.00	37.36	13.56	50.92	74.00	-23.08	16	200	Peak

Remark:

1. *Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.*
2. *Average test would be performed if the peak result were greater than the average limit.*
3. *Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.*
4. *Result = Reading + Correction Factor*
   Margin = Result – Limit
   Remark Peak = Result(PK) – Limit(PK)
   Remark AVG = Result(AV) – Limit(AV)

Product Name	AC1300 IoT Router	Test By	Rex Chiu
Test Model	X10R	Test Date	2016/11/23
Test Mode	TX / CH Middle	Temp. & Humidity	25°C, 58%

966Chamber_B at 3Meter / Horizontal

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
1495.00	47.12	-6.10	41.02	74.00	-32.98	188	100	Peak
2745.00	48.56	-1.48	47.08	74.00	-26.92	217	100	Peak
3330.00	44.56	0.13	44.69	74.00	-29.31	242	200	Peak
3995.00	41.94	2.56	44.50	74.00	-29.50	240	100	Peak
7152.00	37.66	12.34	50.00	74.00	-24.00	86	200	Peak
9148.00	37.73	13.88	51.61	74.00	-22.39	69	100	Peak

966Chamber_B at 3Meter / Vertical

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
1830.00	50.62	-4.84	45.78	74.00	-28.22	349	100	Peak
2745.00	48.84	-1.48	47.36	74.00	-26.64	0	200	Peak
3470.00	43.23	0.50	43.73	74.00	-30.27	159	200	Peak
4575.00	41.68	4.60	46.28	74.00	-27.72	29	100	Peak
7784.00	37.84	12.87	50.71	74.00	-23.29	261	100	Peak
9144.00	36.20	13.88	50.08	74.00	-23.92	109	100	Peak

Remark:

1. *Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.*
2. *Average test would be performed if the peak result were greater than the average limit.*
3. *Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.*
4. *Result = Reading + Correction Factor*
   Margin = Result – Limit
   Remark Peak = Result(PK) – Limit(PK)
   Remark AVG = Result(AV) – Limit(AV)

Product Name	AC1300 IoT Router	Test By	Rex Chiu
Test Model	X10R	Test Date	2016/11/23
Test Mode	TX / CH High	Temp. & Humidity	25°C, 58%

966Chamber_B at 3Meter / Horizontal

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
1855.00	44.85	-4.75	40.10	74.00	-33.90	214	200	Peak
2780.00	47.25	-1.38	45.87	74.00	-28.13	209	100	Peak
3330.00	45.70	0.13	45.83	74.00	-28.17	246	200	Peak
3995.00	41.70	2.56	44.26	74.00	-29.74	150	200	Peak
7212.00	37.66	12.38	50.04	74.00	-23.96	335	200	Peak
9276.00	37.38	14.03	51.41	74.00	-22.59	71	100	Peak

966Chamber_B at 3Meter / Vertical

Freq. MHz	Reading dBuV	C.F. dB/m	Result dBuV/m	Limit dBuV/m	Margin dB	Azimuth deg	Height cm	Remark
1855.00	50.22	-4.75	45.47	74.00	-28.53	22	100	Peak
2780.00	46.84	-1.38	45.46	74.00	-28.54	17	200	Peak
3470.00	43.90	0.50	44.40	74.00	-29.60	216	100	Peak
4640.00	41.58	4.76	46.34	74.00	-27.66	120	100	Peak
6696.00	36.37	11.62	47.99	74.00	-26.01	148	200	Peak
8040.00	36.49	13.11	49.60	74.00	-24.40	18	100	Peak

Remark:

1. *Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.*
2. *Average test would be performed if the peak result were greater than the average limit.*
3. *Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.*
4. *Result = Reading + Correction Factor*
   Margin = Result – Limit
   Remark Peak = Result(PK) – Limit(PK)
   Remark AVG = Result(AV) – Limit(AV)

7.9 CONDUCTED EMISSION

LIMITS

§ 15.207 (a) Except as shown in paragraph (b) and (c) this section, for an intentional radiator that 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 the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

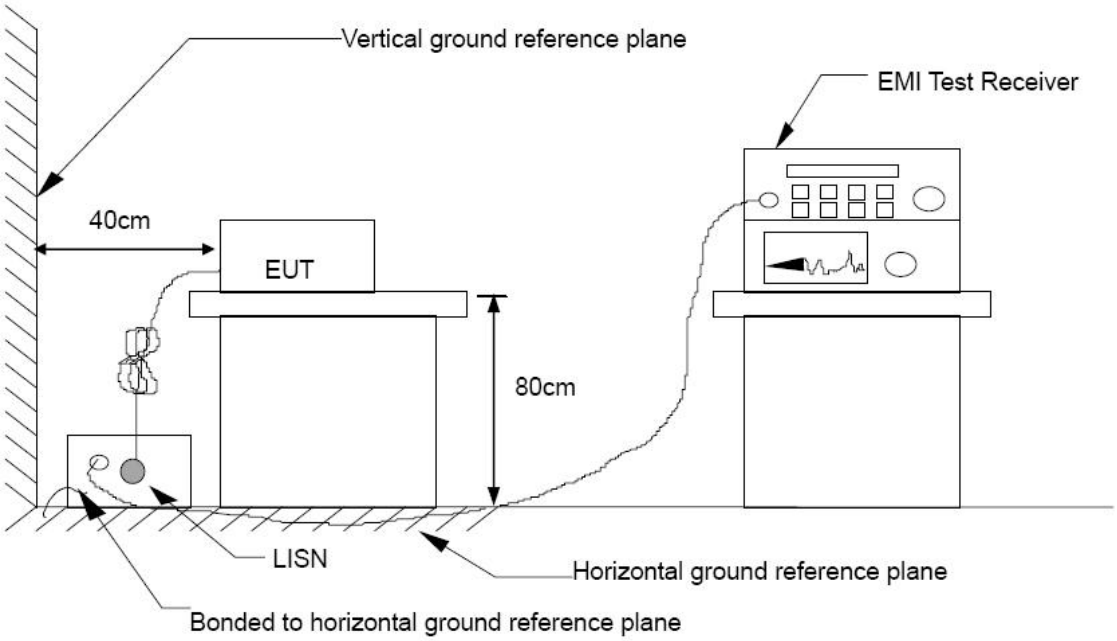
Frequency Range (MHz)	Conducted Limit (dBμv)	
	Quasi-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5.00	56	46
5.00 - 30.0	60	50

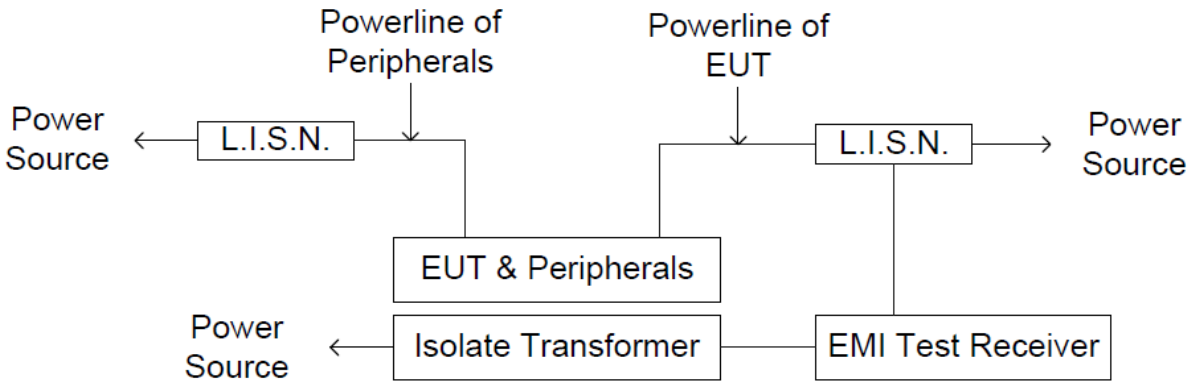
TEST EQUIPMENT

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
L.I.S.N	Schwarzbeck	NSLK 8127	8127465	07/28/2017
L.I.S.N	Schwarzbeck	NSLK 8127	8127473	03/10/2017
EMI Test Receiver	Rohde & Schwarz	ESHS 30	838550/003	10/25/2017
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100111	06/27/2017
Test S/W	E3.815206a			

Remark: *Each piece of equipment is scheduled for calibration once a year.*

TEST SETUP





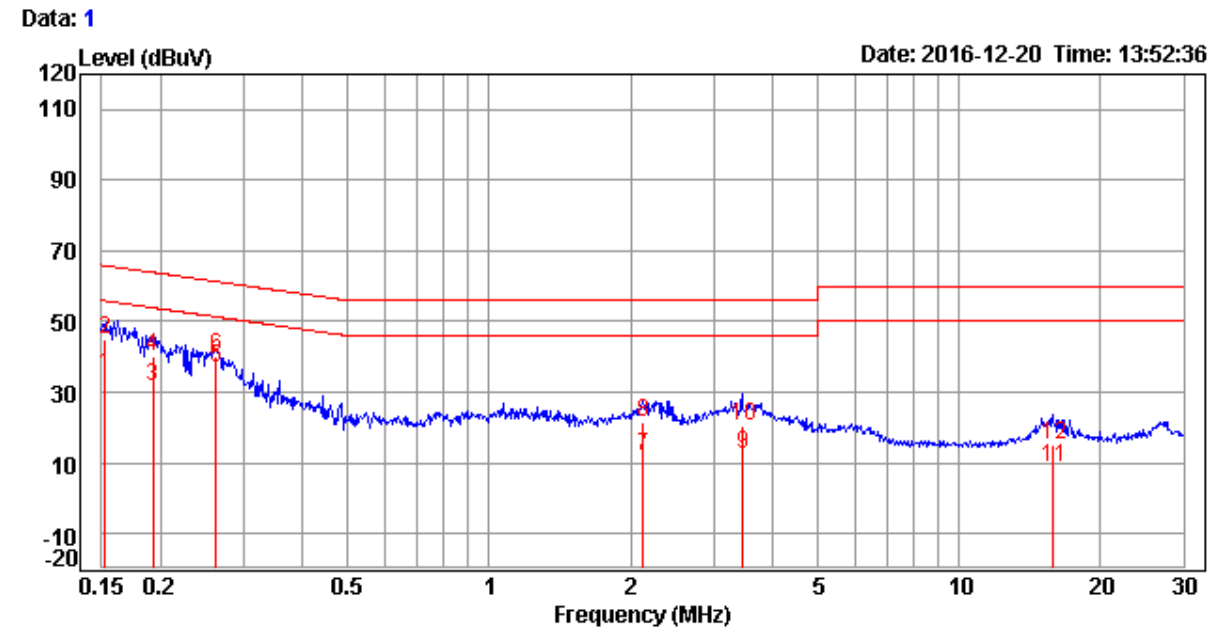
TEST PROCEDURE

The basic test procedure was in accordance with ANSI C63.10:2013.
The test procedure is performed in a 4m × 3m × 2.4m (L×W×H) shielded room.
The EUT along with its peripherals were placed on a 1.0m (W) × 1.5m (L) and 0.8m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
The EUT was located so that the distance between the boundary of the EUT and the closest surface of the LISN is 0.8 m. Where a mains flexible cord was provided by the manufacturer shall be 1 m long, or if in excess of 1 m, the excess cable was folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

TEST RESULTS

Product Name	AC1300 IoT Router	Test By	Allen Liu
Test Model	X10R	Test Date	2016/12/20
Test Mode	Mode 1	Temp. & Humidity	26°C, 46%

LINE



Trace:

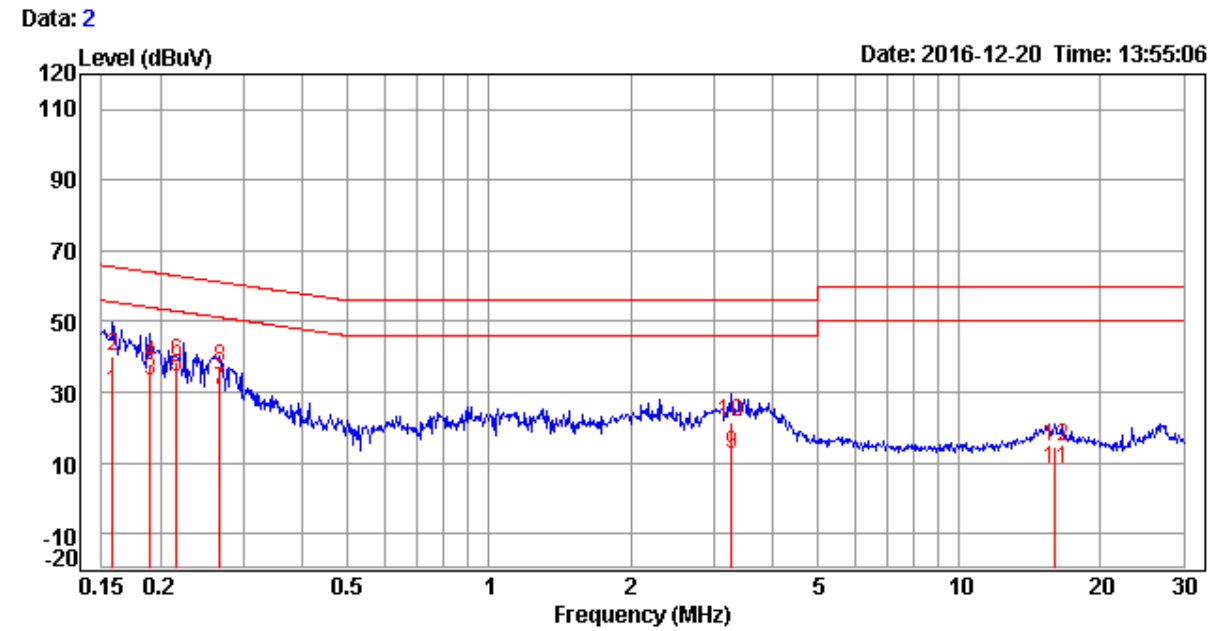
Freq. MHz	Reading dBuV Q.P.	Reading dBuV AV.	C.F. dB	Result dBuV Q.P.	Result dBuV AV.	Limit dBuV Q.P.	Limit dBuV AV.	Margin dB Q.P.	Margin dB AV.
0.152	35.05	24.81	10.00	45.05	34.81	65.87	55.87	-20.82	-21.06
0.192	30.13	21.84	9.97	40.10	31.81	63.93	53.93	-23.83	-22.12
0.262	30.13	26.78	9.92	40.05	36.70	61.38	51.38	-21.33	-14.68
2.121	11.36	2.06	10.07	21.43	12.13	56.00	46.00	-34.57	-33.87
3.454	10.45	2.37	10.14	20.59	12.51	56.00	46.00	-35.41	-33.49
15.801	4.63	-1.87	10.69	15.32	8.82	60.00	50.00	-44.68	-41.18

Remark:

1. *Correction Factor = Insertion loss + Cable loss*
2. *Emission level = Reading Value + Correction factor*
3. *Margin value = Emission level – Limit value*

Product Name	AC1300 IoT Router	Test By	Allen Liu
Test Model	X10R	Test Date	2016/12/20
Test Mode	Mode 1	Temp. & Humidity	26°C, 46%

NEUTRAL



Trace:

Freq. MHz	Reading dBuV Q.P.	Reading dBuV AV.	C.F. dB	Result dBuV Q.P.	Result dBuV AV.	Limit dBuV Q.P.	Limit dBuV AV.	Margin dB Q.P.	Margin dB AV.
0.158	30.19	20.17	9.99	40.18	30.16	65.56	55.56	-25.38	-25.40
0.189	28.06	23.22	10.00	38.06	33.22	64.06	54.06	-26.00	-20.84
0.217	28.72	24.08	9.98	38.70	34.06	62.95	52.95	-24.25	-18.89
0.266	27.23	20.53	9.93	37.16	30.46	61.25	51.25	-24.09	-20.79
3.258	11.61	2.41	10.12	21.73	12.53	56.00	46.00	-34.27	-33.47
15.970	4.26	-2.33	10.53	14.79	8.20	60.00	50.00	-45.21	-41.80

Remark:

1. *Correction Factor = Insertion loss + Cable loss*
2. *Emission level = Reading Value + Correction factor*
3. *Margin value = Emission level – Limit value*