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FCC / IC Zigbee REPORT

Certification

Applicant Name:
LG Electronics Inc.

Address:
84, Wanam-ro, Seongsan-gu, Changwon-si, Gyeongsangnam-do, 51554, Korea

Date of Issue:
October 26, 2018

Test Site/Location:
HCT CO., LTD., 74,Seoicheon-ro 578beon-gil,Majang-myeo,Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

Report No.: HCT-RF-1810-FI021

FCC ID:	**BEJ-LZM001**
IC:	**2703N-LZM001**
APPLICANT:	**LG Electronics Inc.**

Model:	LZM-001
EUT Type:	Zigbee Module
Peak Output Power:	6.48 dBm (4.446 mW)
Frequency Range:	2405 MHz -2480 MHz (Zigbee Mode)
Modulation type:	O-QPSK
FCC Classification:	Digital Transmission System(DTS)
FCC Rule Part(s):	Part 15.247, RSS-247 Issue 2, RSS-Gen Issue 5

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

Report prepared by : Jeong Ho Kim
Engineer of Telecommunication testing center

Approved by : Jong Seok Lee
Manager of Telecommunication testing center

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Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-RF-1810-FI021	October 26, 2018	- First Approval Report

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1. EUT DESCRIPTION

Model	LZM-001
EUT Type	Zigbee Module
Manufacturer Name Address	LG Electronics Inc. 84, Wanam-ro, Seongsan-gu, Changwon-si, Gyeongsangnam-do, 51554, Korea
Factory Name Address	LG Innotek Indonesia PT. Bekasi International Estate Block C8 NO.12&12A Lemahabang Bekasi Timur 17550 Jawa Barat, Indonesia
Power Supply	DC 5.00 V
Frequency Range	2405 MHz ~ 2480 MHz
Max. RF Output Power (Peak)	6.48 dBm (4.446 mW)
Max. RF Output Power (Average)	6.08 dBm (4.055 mW)
Modulation Type	O-QPSK
Number of Channels	16 Channels
Antenna Specification	Antenna type: PIFA Antenna Peak Gain : 1.50 dBi
Date(s) of Tests	October 15, 2018 ~ October 25, 2018
PMN	LZM-001
HVIN	LZM-001
FVIN	V 1.0
HMN	N/A

2. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05 dated August 24, 2018 entitled “guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices and the measurement procedure described in ANSI C63.10(Version : 2013) ‘the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices’.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpse of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3.75 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

Conducted Antenna Terminal

See Section from 8.3.(KDB 558074 v05)

DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.

Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA.

The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.

Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032).

For ISED, test facility was accepted dated July 30, 2018(Registration Number: 5944A-5)

EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

5. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antennas of this E.U.T are permanently attached.

* The E.U.T Complies with the requirement of §15.203

According to RSS-GEN(Issue 5) Section 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested..

6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence.

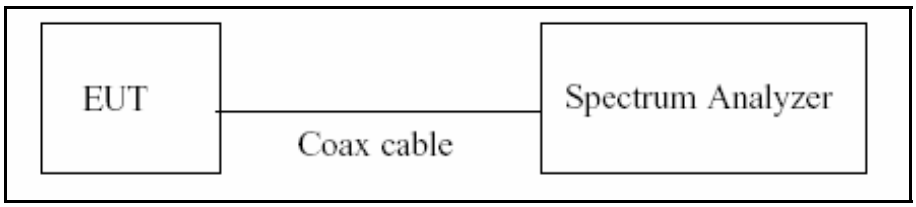
The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.71

7. DESCRIPTION OF TESTS

7.1. Duty Cycle

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method, 6.0)b) in KDB 558074 v05.

The largest availble value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

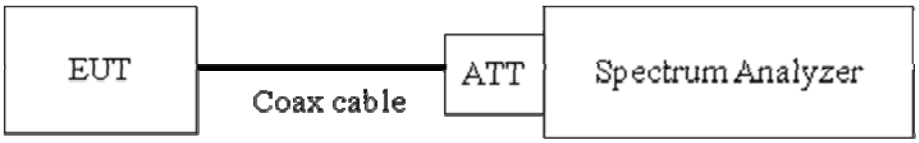
1. RBW = 8 MHz (the largest availble value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10*log(1/Duty Cycle)

7.2. 6dB Bandwidth

Limit

The minimum permissible 6 dB bandwidth is 500 kHz.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.2 in KDB 558074 v05, Procedure 11.8.1 in ANSI 63.10-2013)

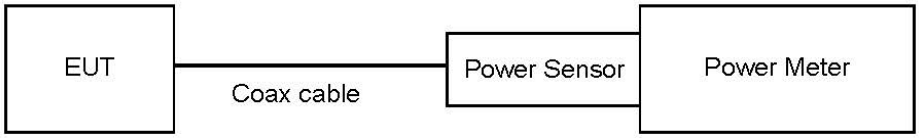
1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Detector = Peak
4) Trace mode = max hold
5) Sweep = auto couple
6) Allow the trace to stabilize
7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

7.3. Output Power

Limit

The maximum permissible conducted output power is 1 Watt.

Test Configuration



Test Procedure

The transmitter output is connected to the Power Meter.

▪ Peak Power (Procedure 8.3.1.3 in KDB 558074 v05, Procedure 11.9.1.3 in ANSI 63.10-2013)
: Measure the peak power of the transmitter.

▪ Average Power (Procedure 8.3.2.3 in KDB 558074 v05, Procedure 11.9.2.3 in ANSI 63.10-2013)

1) Measure the duty cycle.
2) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
3) Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Sample Calculation

▪ Conducted Output Power(Peak) = Reading Value + ATT loss + Cable loss

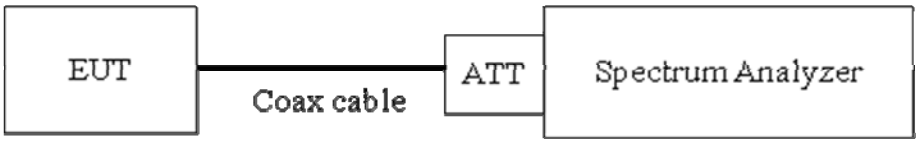
▪ Conducted Output Power(Average) = Reading Value + ATT loss + Cable loss + Duty Cycle Factor

7.4. Power Spectral Density

Limit

The transmitter power density average over 1-second interval shall not be greater than 8dBm in any 3kHz BW.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05, Procedure 11.10.2 in ANSI 63.10-2013.

The spectrum analyzer is set to :

1) Set analyzer center frequency to DTS channel center frequency.
2) Span = 1.5 times the DTS channel bandwidth.
3) RBW = 3 kHz ≤ RBW ≤ 100 kHz.
4) VBW ≥ 3 x RBW.
5) Sweep = auto couple
6) Detector = peak
7) Trace Mode = max hold
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum amplitude level within the RBW.
   If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Sample Calculation

▪ Power Spectral Density = Reading Value + ATT loss + Cable loss

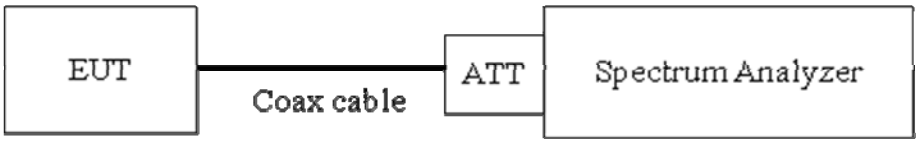
7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

Limit

The maximum conducted (average) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz.

[Conducted > 20 dBc]

Test Configuration



Test Procedure

The transmitter output is connected to the spectrum analyzer.

(Procedure 8.5 in KDB 558074 v05, Procedure 11.11 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Set span to encompass the spectrum to be examined
4) Detector = Peak
5) Trace Mode = max hold
6) Sweep time = auto couple
7) Ensure that the number of measurement points ≥ 2*Span/RBW
8) Allow trace to fully stabilize.
9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.

Factors for frequency

Freq(MHz)	Factor(dB)
30	10.12
100	10.13
200	10.19
300	10.13
400	10.23
500	10.25
600	10.32
700	10.35
800	10.35
900	10.34
1000	10.39
2000	10.64
2400*	10.70
2500*	10.67
3000	10.68
4000	10.89
5000	11.07
6000	11.06
7000	11.35
8000	11.32
9000	11.48
10000	11.56
11000	11.56
12000	11.68
13000	11.83
14000	11.90
15000	11.98
16000	12.04
17000	12.02
18000	12.08
19000	12.07
20000	12.14
21000	12.17
22000	12.31
23000	12.60
24000	12.34
25000	12.53
26000	12.02

Note : 1. '*' is fundamental frequency range.
2. Factor = Attenuator loss + Cable loss

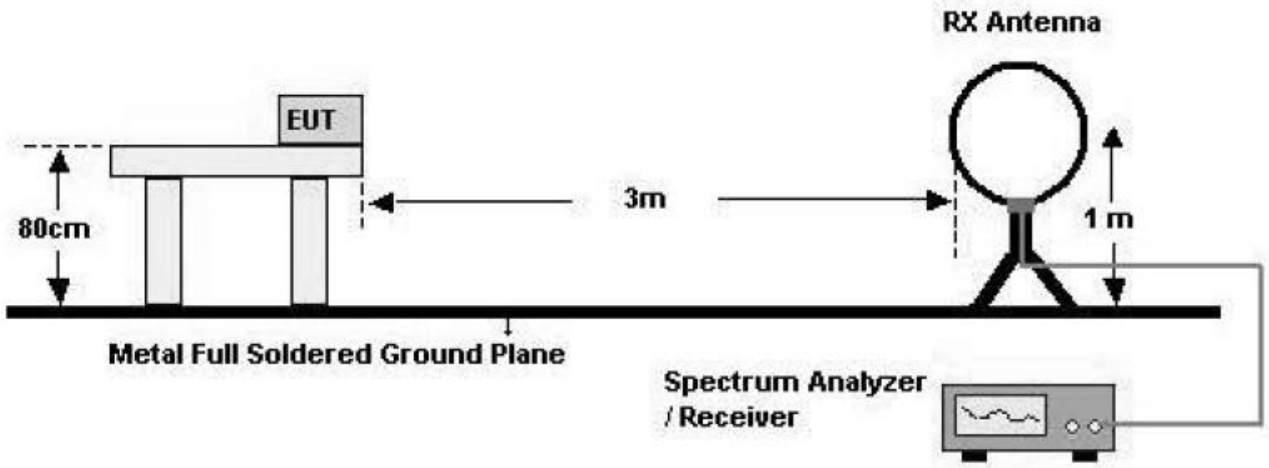
7.6. Radiated Test

Limit

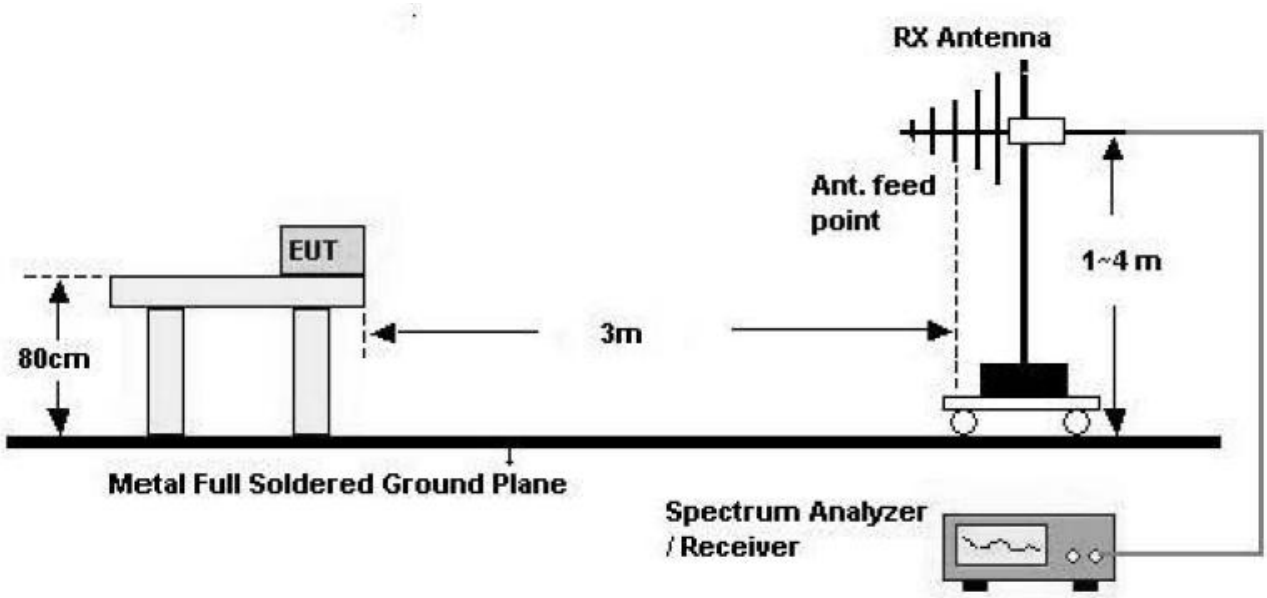
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

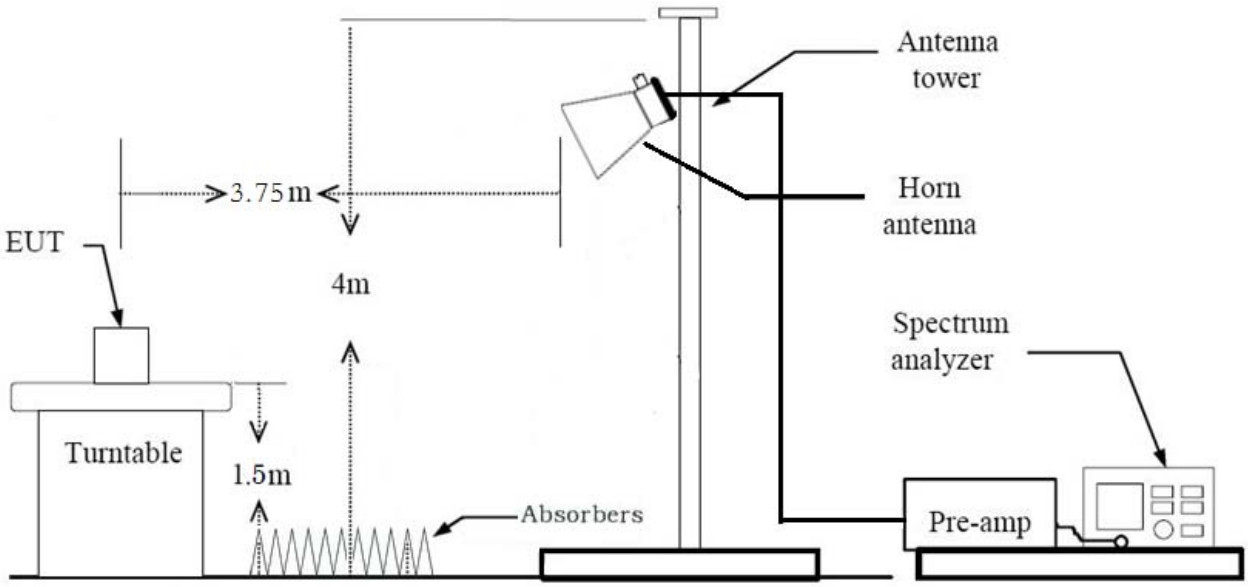
Below 30 MHz



30 MHz - 1 GHz



Above 1 GHz



Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
   *Distance extrapolation factor = 20*log (test distance / specific distance) (dB)
6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. The unit was tested with its standard battery.
9. Spectrum Setting (Method 8.6 in KDB 558074 v05, Procedure 11.12 in ANSI 63.10-2013)
   (1) Measurement Type(Peak):
   - Measured Frequency Range : 1 GHz – 25 GHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 1 MHz
   - VBW ≥ 3*RBW

   (2) Measurement Type(Average): Duty cycle ≥ 98%
   - Measured Frequency Range : 1 GHz – 25 GHz
   - Detector = RMS
   - Averaging type = power (*i.e.*, RMS)
   - RBW = 1 MHz
   - VBW ≥ 3*RBW
   - Sweep time = auto.
   - Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle < 98%, duty cycle variations are less than ±2%

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW ≥ 3*RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).
- Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.
- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

(4) Measurement Type(Average):

- We performed using a reduced video BW method was done with the analyzer in linear mode
- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = Peak
- Trace = Maxhold
- RBW = 1 MHz
- VBW ≥ 1/τ Hz, where τ = pulse width in seconds

  The actual setting value of VBW = 1 kHz

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

11. Total(Measurement Type : Peak)

= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average, Duty cycle ≥ 98%)

= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average, Duty cycle < 98%)

= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F) + Duty Cycle Factor

Test Procedure of Radiated Restricted Band Edge

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
   *Distance extrapolation factor = 20*log (test distance / specific distance) (dB)
6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. The unit was tested with its standard battery.
9. Spectrum Setting
   (1) Measurement Type(Peak):
   - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 1 MHz
   - VBW ≥ 3*RBW

   (2) Measurement Type(Average):
   - Average value of pulsed emissions
   - Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission and pulsed operation is employed, the average measurement shall determined from the peak field strength after correcting for the worst-case duty cycle as described in section 9.1.
   - DCCF = $20*\log_{10}$(Pulse width / Period of the pulse train)

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

11. Total(Measurement Type : Peak)
= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average, Duty cycle ≥ 98%)
= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average, Duty cycle < 98%)
= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)
+ Duty Cycle Factor

7.7. AC Power line Conducted Emissions

Limit

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).

Frequency Range (MHz)	Limits (dBμV)	
	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

*Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

7.8. Receiver Spurious Emissions

Limit

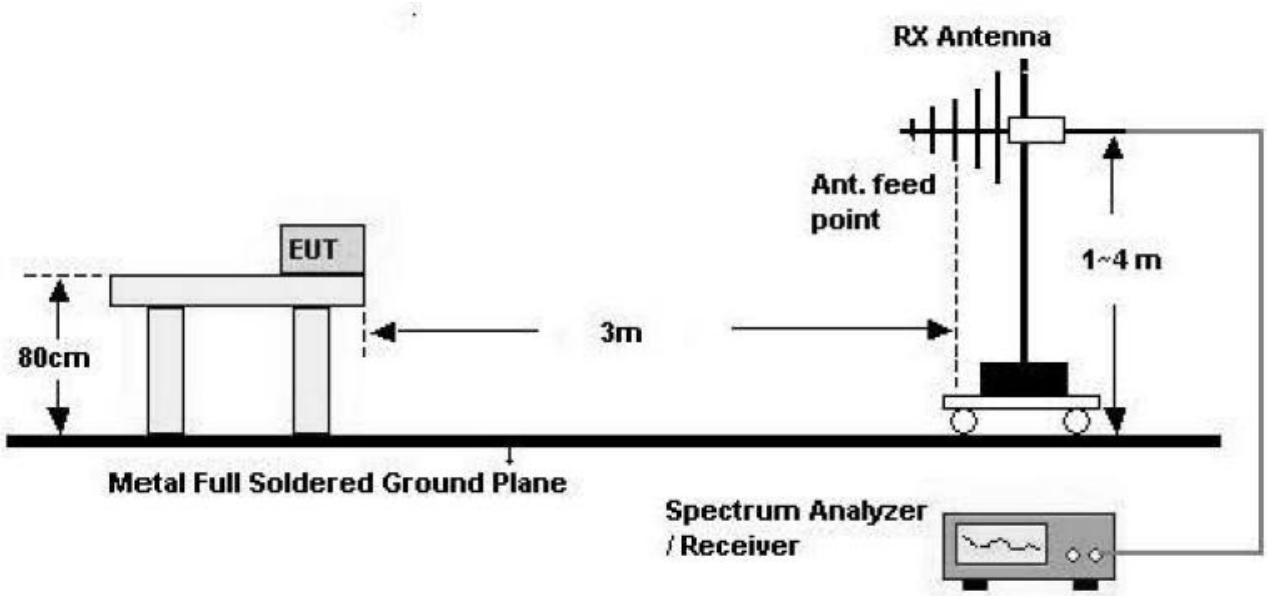
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

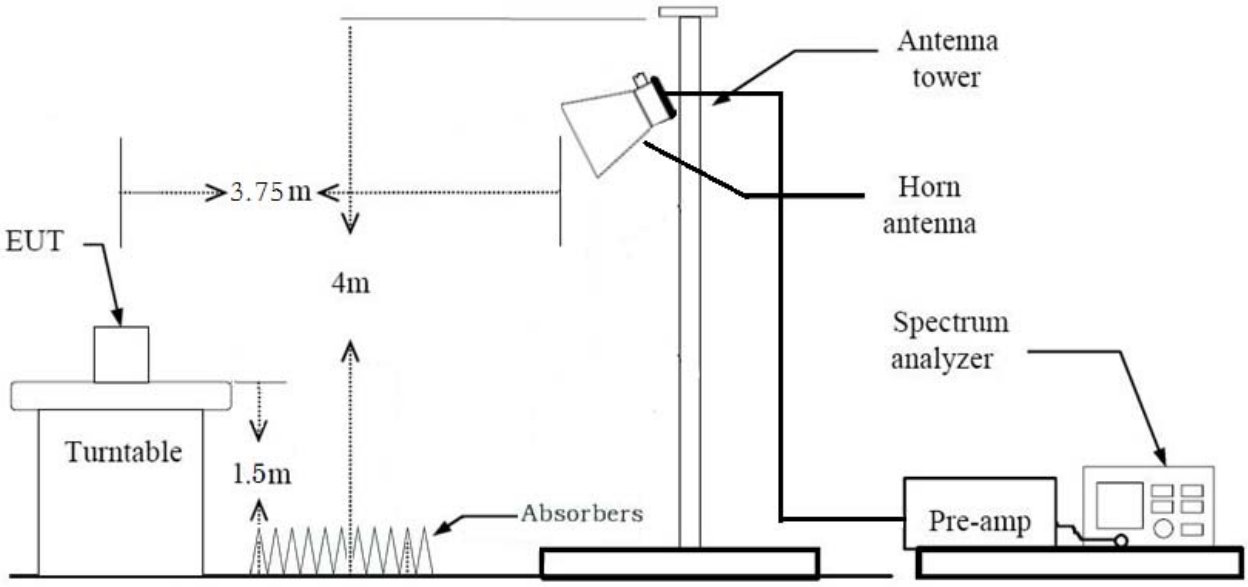
Measurements for compliance with the limits in table may be performed at distances other than 3 metres.

Test Configuration

30 MHz - 1 GHz



Above 1 GHz



Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
   *Distance extrapolation factor = 20*log (test distance / specific distance) (dB)
6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. The unit was tested with its standard battery.
9. Spectrum Setting
   (1) Measurement Type(Peak):
   - Measured Frequency Range : 1 GHz – 25 GHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 1 MHz
   - VBW ≥ 3*RBW

   (2) Measurement Type(Average):
   - We performed using a reduced video BW method was done with the analyzer in linear mode
   - Measured Frequency Range : 1 GHz – 25 GHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 1 MHz
   - VBW ≥ 1/τ Hz, where τ = pulse width in seconds
     The actual setting value of VBW = 1 kHz
10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
11. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

7.9. Worst case configuration and mode

Radiated test

1. All modes of operation were investigated and the worst case configuration results are reported.
2. EUT Axis
   - Radiated Spurious Emissions : X
   - Radiated Restricted Band Edge : Y
3. Duty cycle factor applies only Radiated Restricted band edges(Duty cycle < 98%).
4. All data rate of operation were investigated and the test results are worst case in lowest datarate of each mode.
   - Zigbee Mode
5. EUT were tested and the worst case results are reported.

AC Power line Conducted Emissions

1. All modes of operation were investigated and the worst case configuration results are reported.

Conducted test

1. The EUT was configured with data rate of highest power.

8. SUMMARY TEST OF RESULTS

Test Description	FCC Part Section(s)	IC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	RSS-247, 5.2.(a)	> 500 kHz	Conducted	PASS
Occupied Bandwidth	N/A	RSS-GEN, 6.7	N/A		PASS
Conducted Maximum Peak Output Power	§15.247(b)(3)	RSS-247, 5.4.(d)	< 1 Watt		N/A
Power Spectral Density	§15.247(e)	RSS-247, 5.2.(b)	< 8 dBm / 3 kHz Band		PASS
Band Edge (Out of Band Emissions)	§15.247(d)	RSS-247, 5.5	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§15.207	RSS-GEN, 8.8	cf. Section 7.7		**See Note1**
Radiated Spurious Emissions	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9 RSS-GEN, 8.10	cf. Section 7.6		PASS
Receiver Spurious Emissions	N/A	RSS-GEN, 7.3	cf. Section 7.8		PASS

Note:

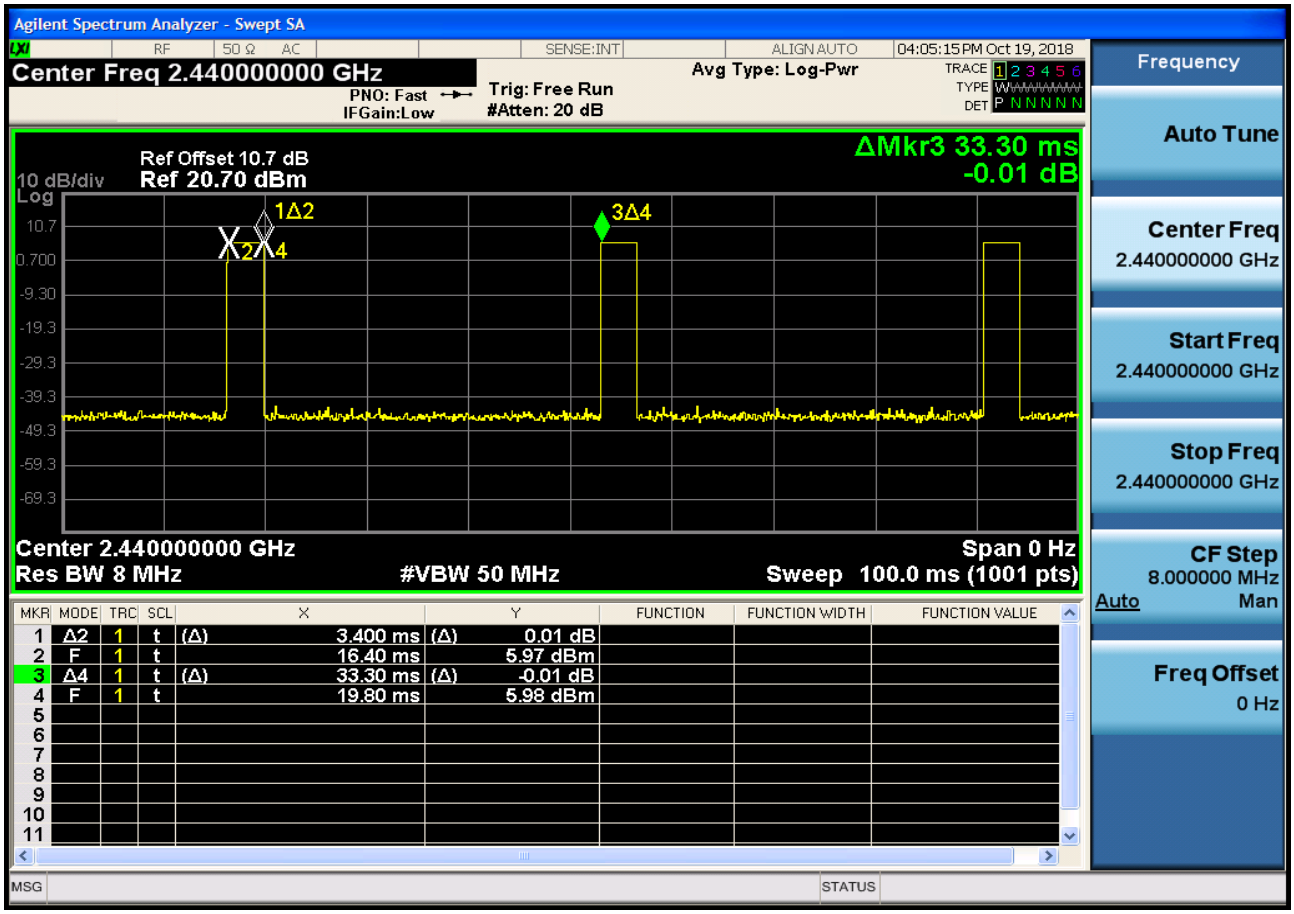
1. We are performed the AC Power Line Conducted Emission test for Ch.11 on Zigbee mode. Because Ch.11 on Zigbee mode is worst case.

9. TEST RESULT

9.1 DUTY CYCLE & DCCF

Zigbee Mode	T_{on} (ms)	T_{total} (ms)	Duty Cycle	VBW(1/T) Hz
	3.4	33.3	0.1	294

DCCF Plot



DCCF = 20log10(Pulse width / Period of the pulse train)

=20log[(3.4x3)/100] = -19.83

Duty Cycle Correction Factor	**-19.83 dB**

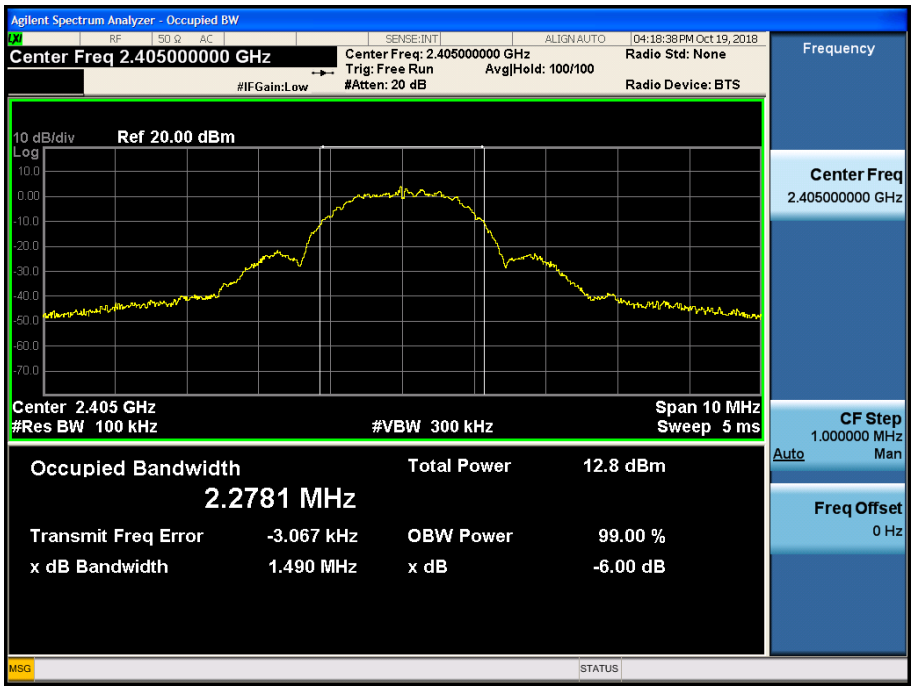
Note : * Duty cycle correction factor used (ANSI C63.10-2013 Section 7.5)

9.2 BANDWIDTH

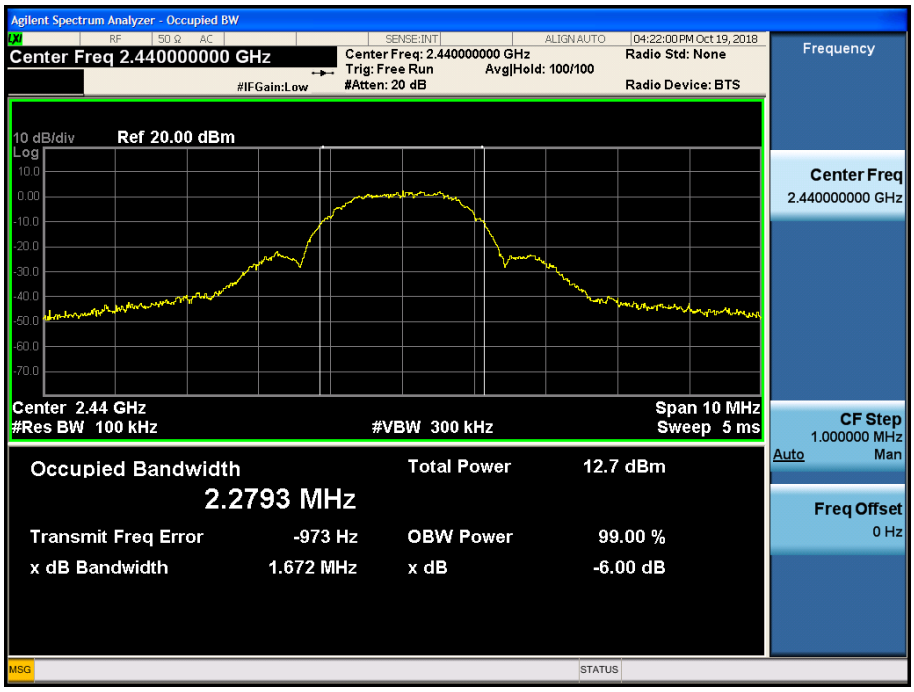
Zigbee Mode		6dB Bandwidth [MHz]	Occupied Bandwidth [MHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.			
2405	11	1.490	2.2781	0.5
2440	18	1.672	2.2793	0.5
2480	26	1.483	2.2700	0.5

▣ Test Plots

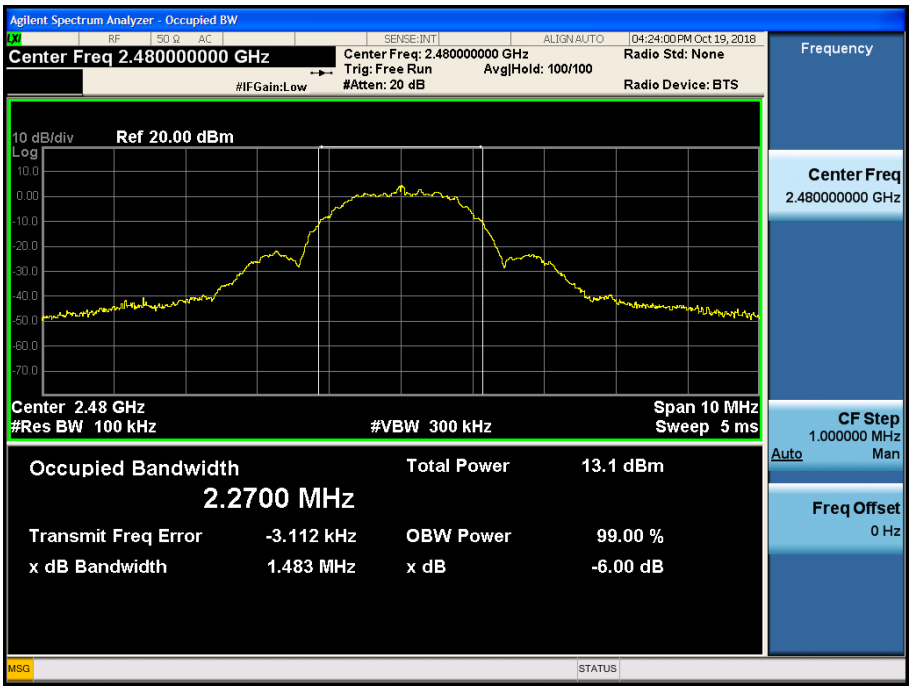
6dB Bandwidth plot (CH 11)



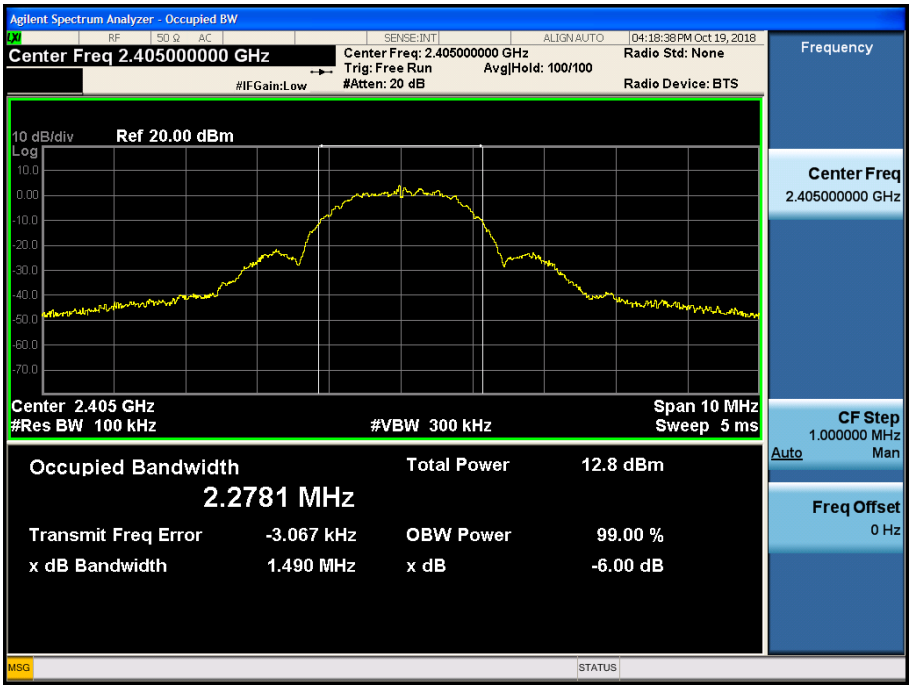
6dB Bandwidth plot (CH 18)



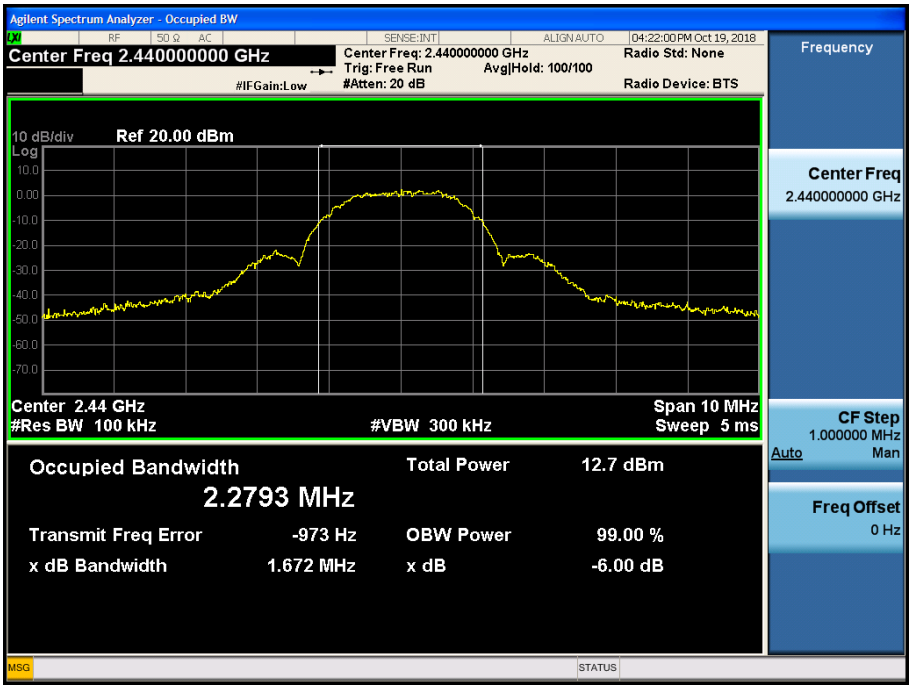
6dB Bandwidth plot (CH 26)



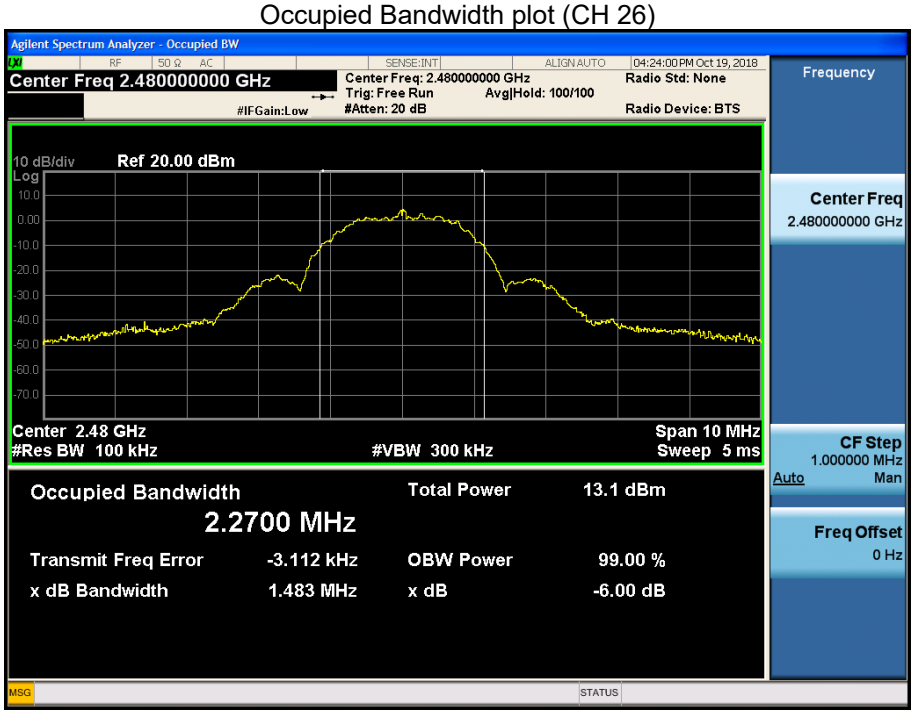
Occupied Bandwidth plot (CH 11)



Occupied Bandwidth plot (CH 18)



Occupied Bandwidth plot (CH 26)



9.3 OUTPUT POWER

Peak Conducted Output Power Measurements

Conducted Output Power Measurements (Zigbee Mode: 2405~2480)

Mode	Channel / Freq	Measured Power(dBm)	Limit (dBm)
ZigBee	ch.11 / 2405MHz	6.47	30
	ch.18 / 2440MHz	6.48	
	ch.26/ 2480MHz	6.40	

Avg Conducted Output Power Measurements

Conducted Output Power Measurements (Zigbee Mode: 2405~2480)

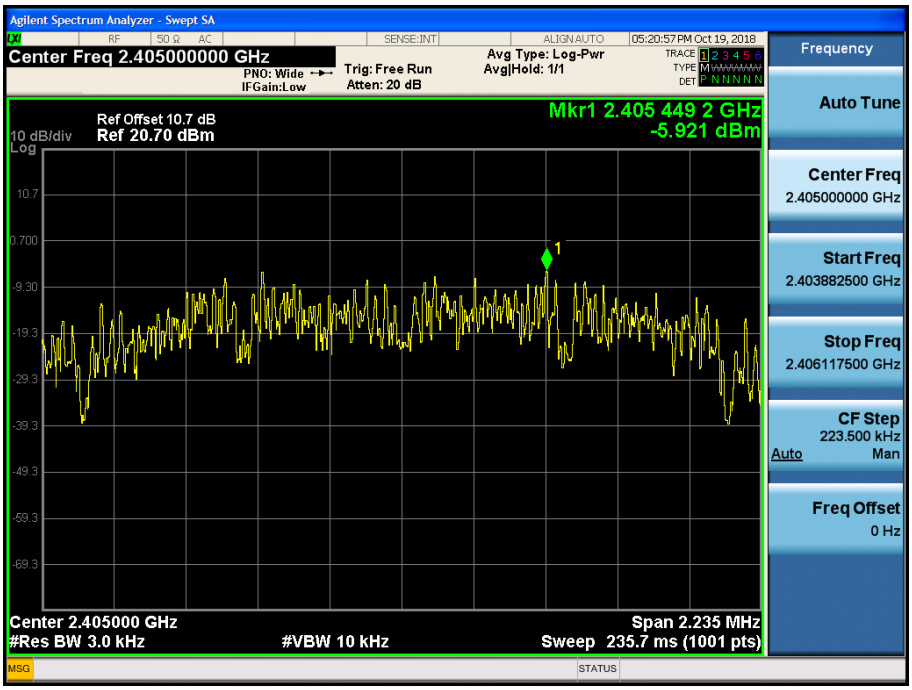
Mode	Channel / Freq	Measured Power(dBm)	Limit (dBm)
ZigBee	ch.11 / 2405MHz	6.08	30
	ch.18 / 2440MHz	6.06	
	ch.26/ 2480MHz	6.03	

9.4 POWER SPECTRAL DENSITY

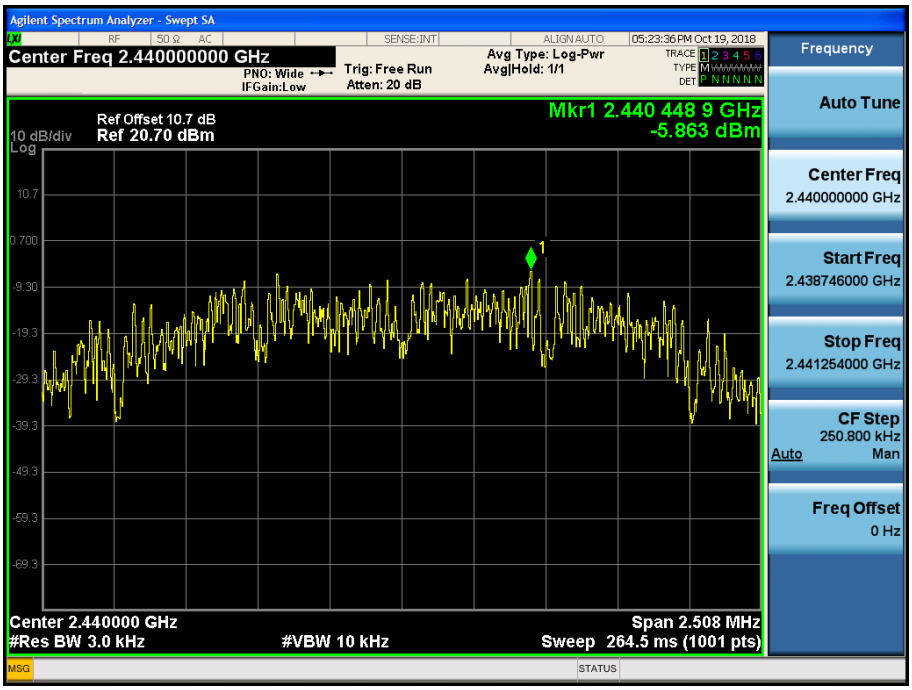
Frequency (MHz)	Channel No.	Mode	Test Result		
			PSD (dBm)	Limit (dBm)	Pass/Fail
2405	11	ZigBee	-5.921	8	Pass
2440	18		-5.863	8	Pass
2480	26		-6.052	8	Pass

▣ Test Plots

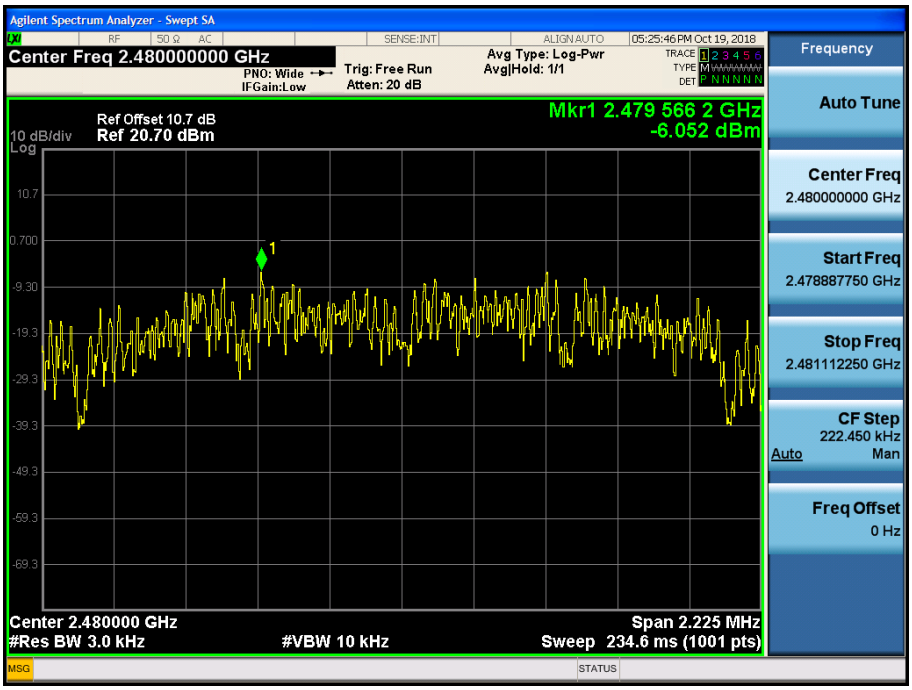
Power Spectral Density (CH 11)



Power Spectral Density (CH 18)



Power Spectral Density (CH 26)



9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

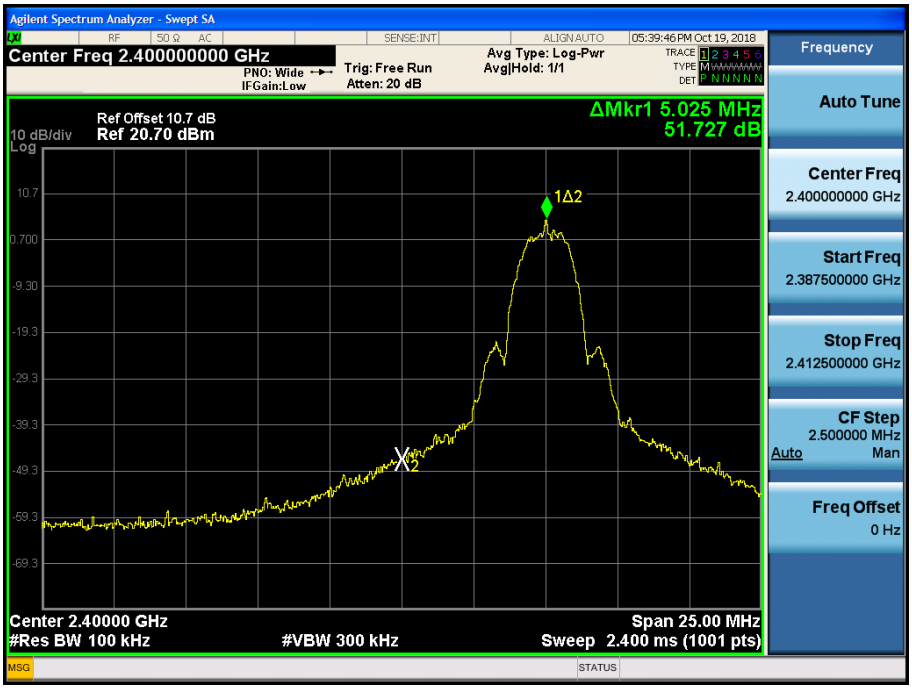
Test Result : please refer to the plot below.

In order to simplify the report, attached plots were only the worst case channel and data rate.

▣ Test Plots

Band Edge

Band Edge (CH11)

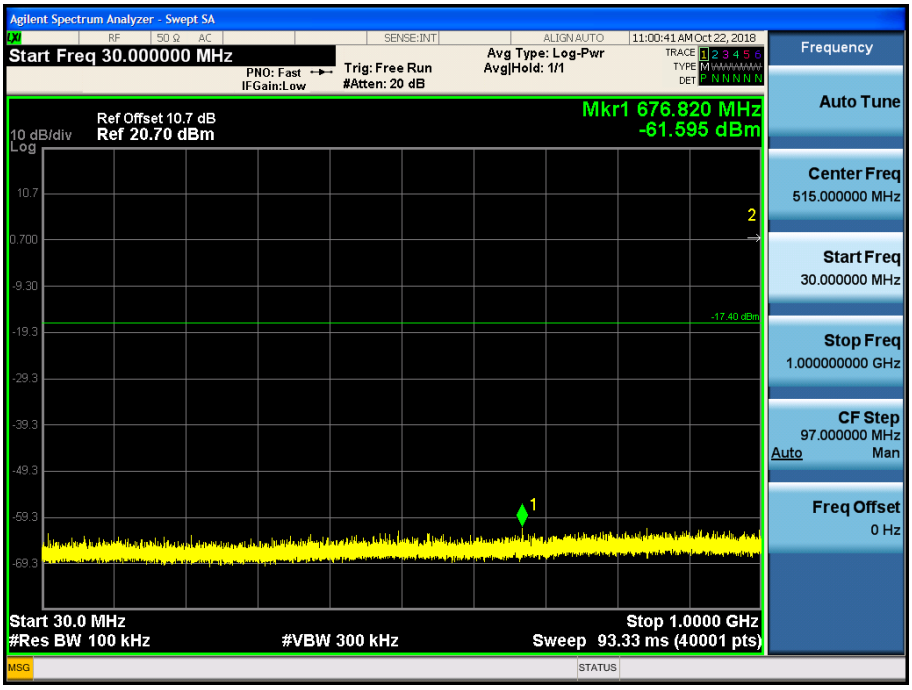


Band Edge (CH26)

Conducted Spurious Emission

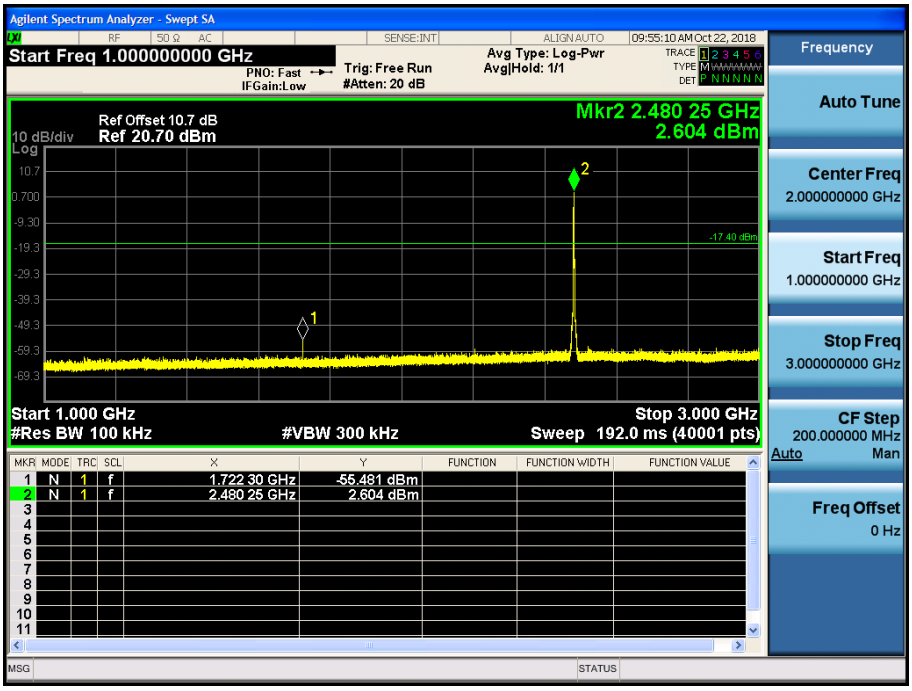
30 MHz ~ 1 GHz

Conducted Spurious Emission (CH 26)



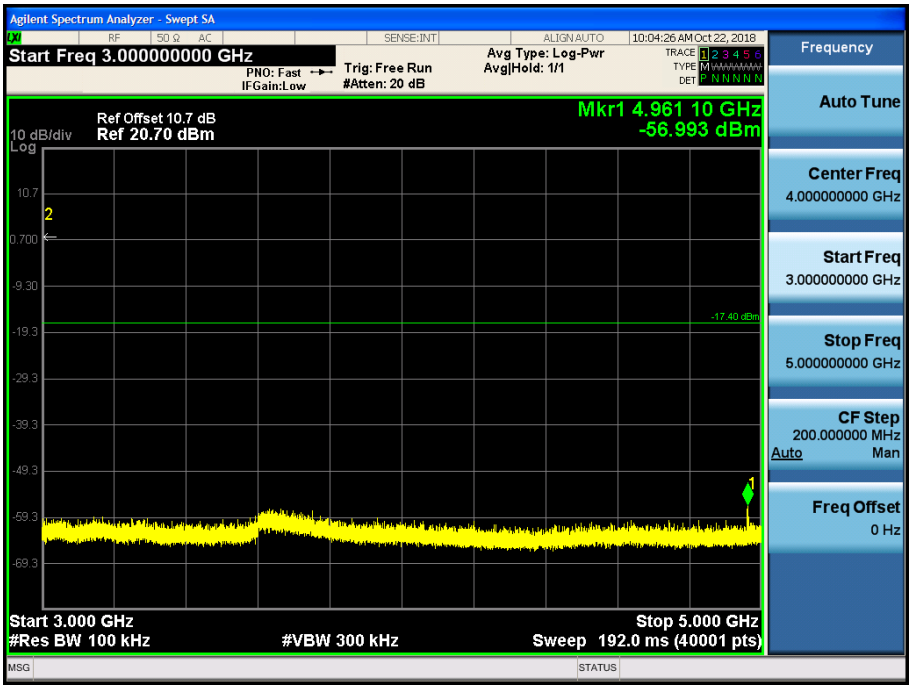
1 GHz ~ 3 GHz

Conducted Spurious Emission (CH 26)



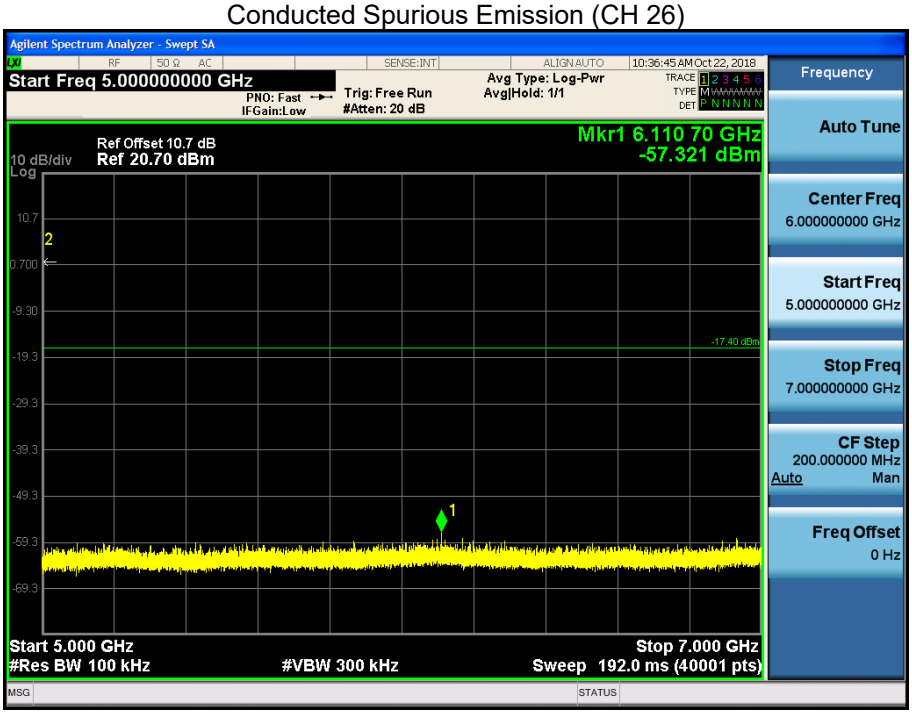
3 GHz ~ 5 GHz

Conducted Spurious Emission (CH 26)



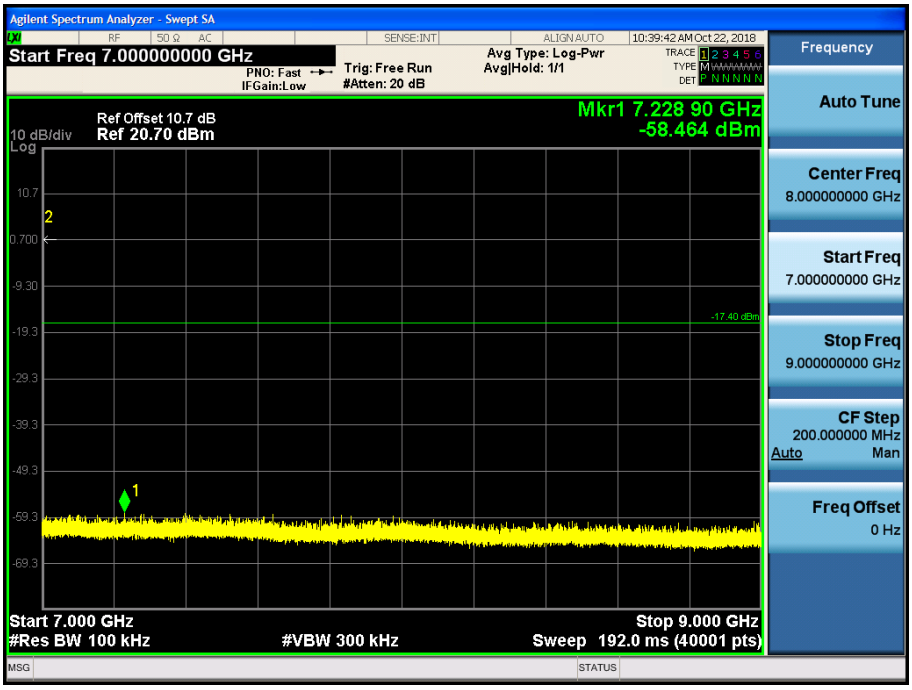
5 GHz ~ 7 GHz

Conducted Spurious Emission (CH 26)



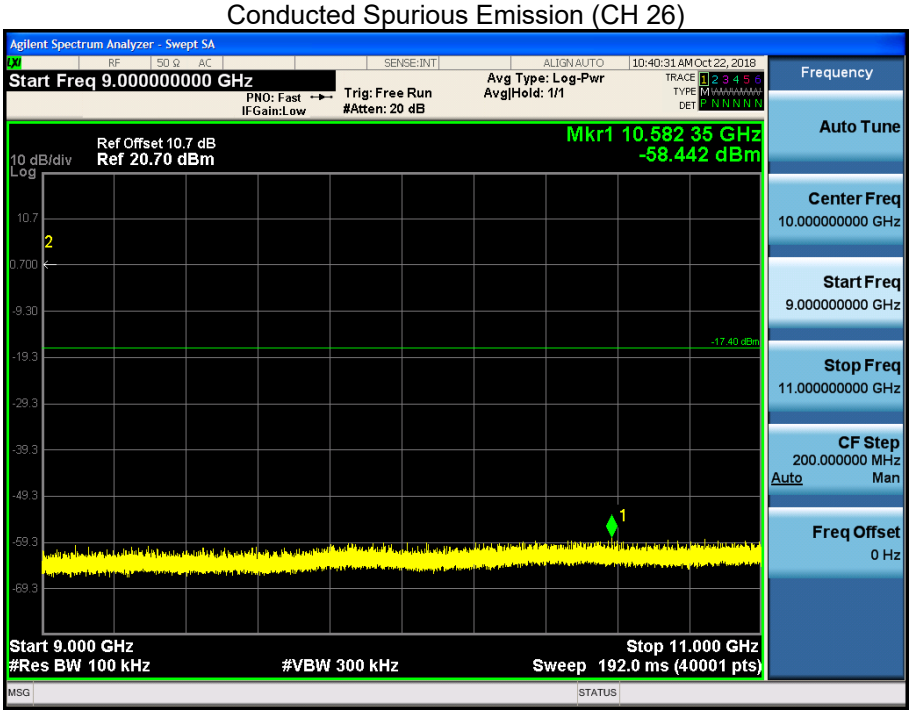
7 GHz ~ 9 GHz

Conducted Spurious Emission (CH 26)



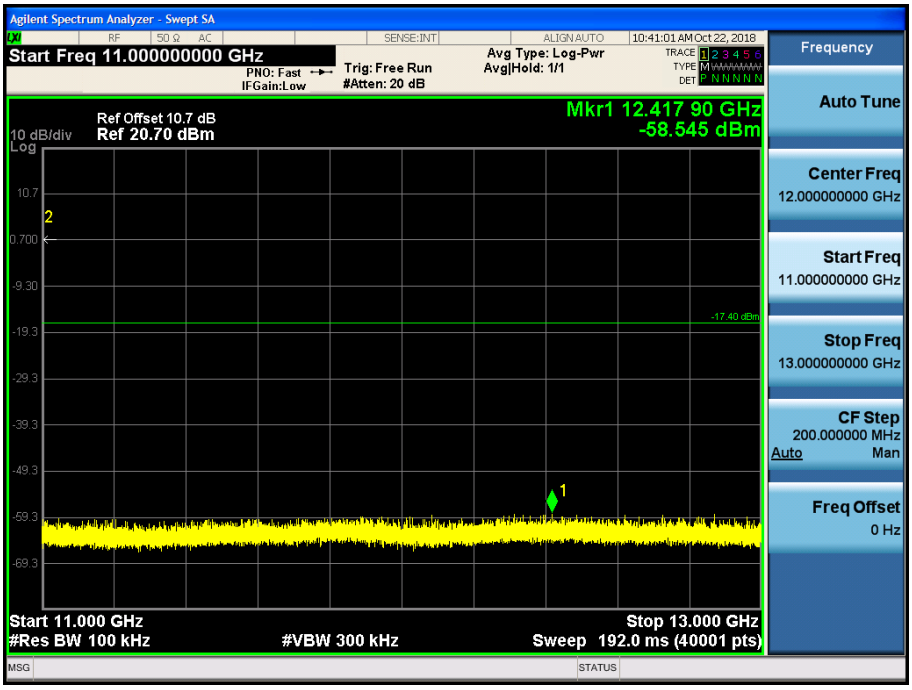
9 GHz ~ 11 GHz

Conducted Spurious Emission (CH 26)



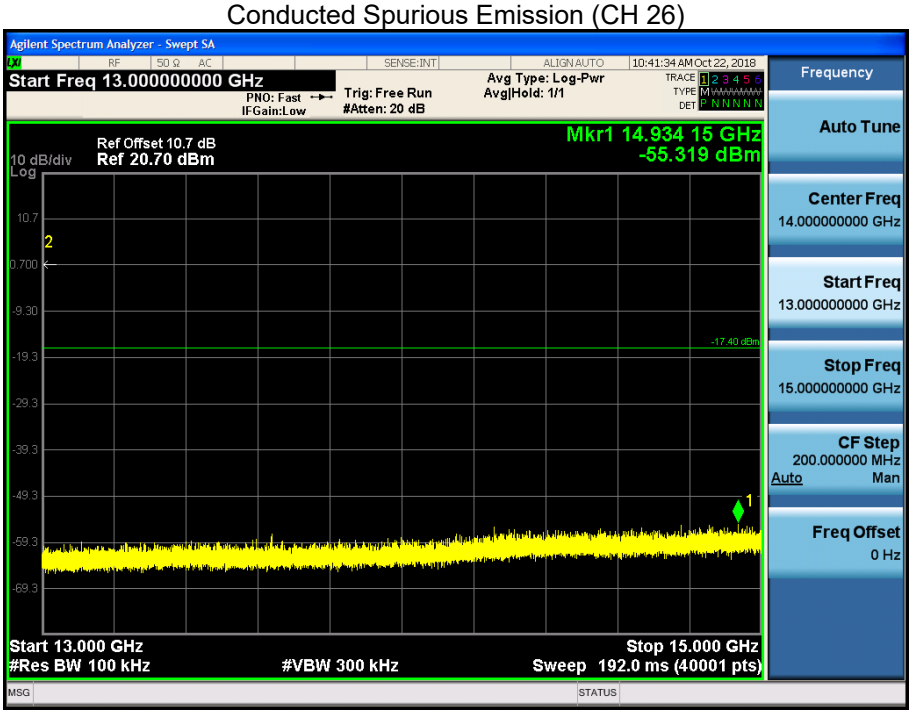
11 GHz ~ 13 GHz

Conducted Spurious Emission (CH 26)



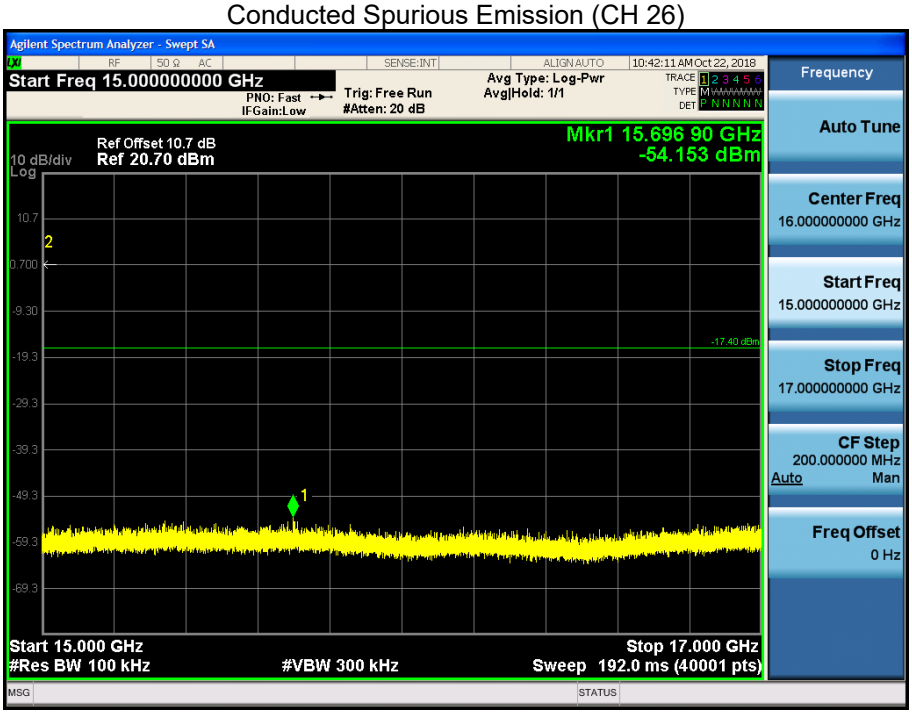
13 GHz ~ 15 GHz

Conducted Spurious Emission (CH 26)



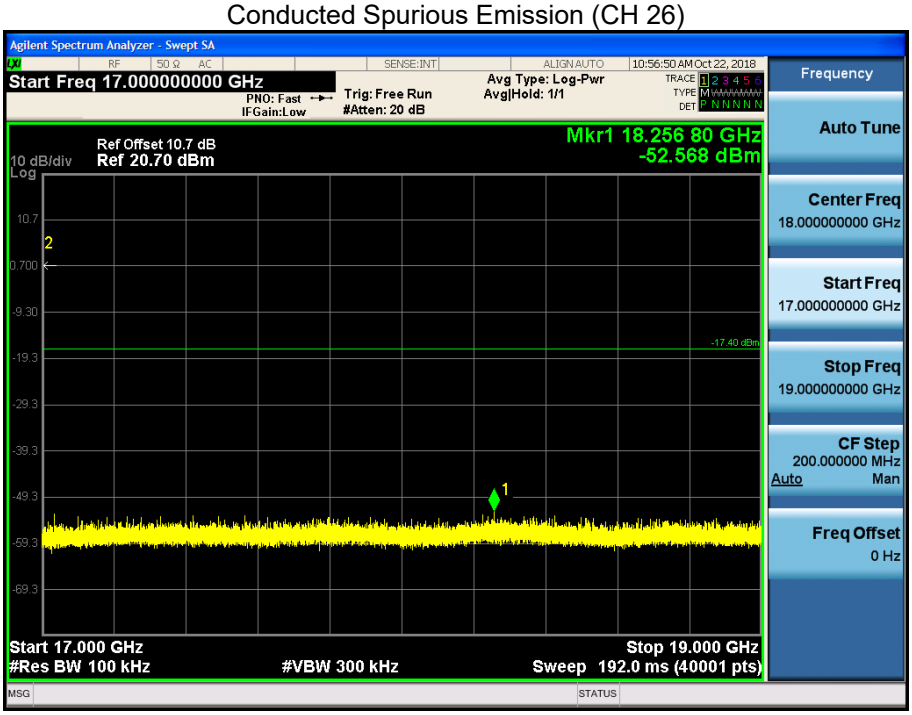
15 GHz ~ 17 GHz

Conducted Spurious Emission (CH 26)



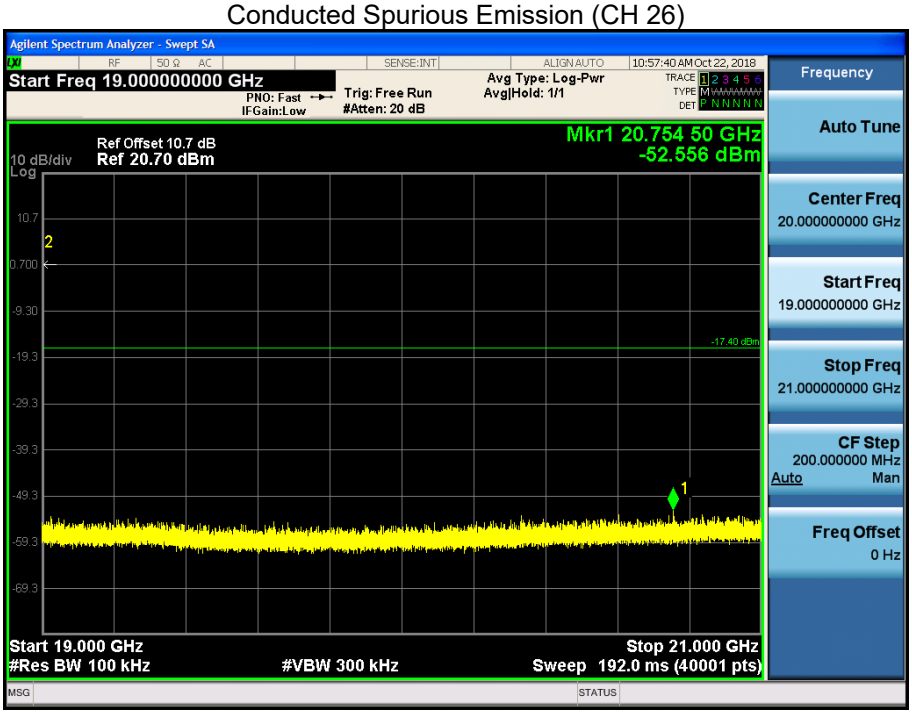
17 GHz ~ 19 GHz

Conducted Spurious Emission (CH 26)



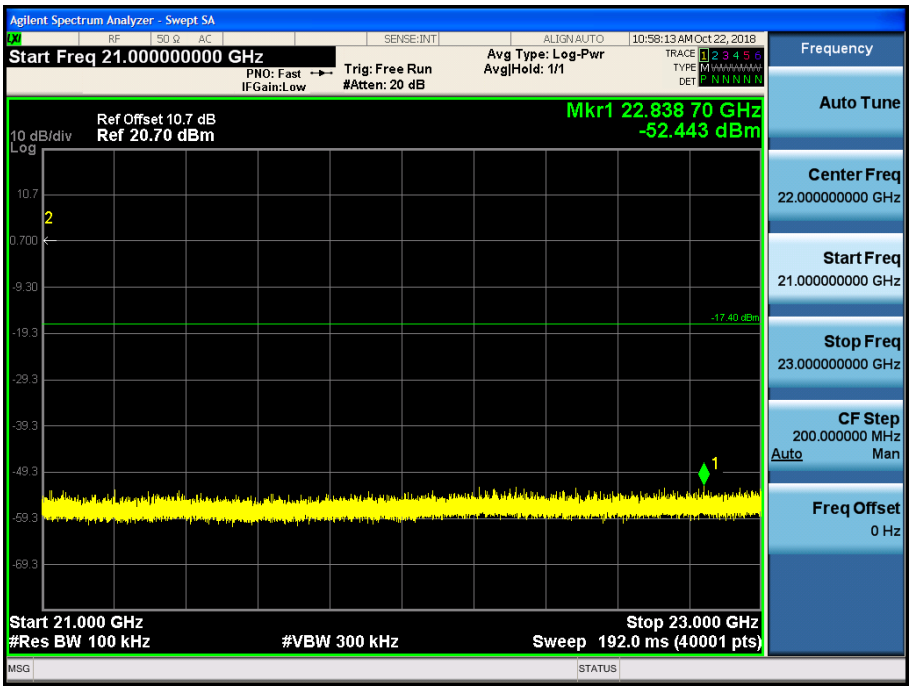
19 GHz ~ 21 GHz

Conducted Spurious Emission (CH 26)



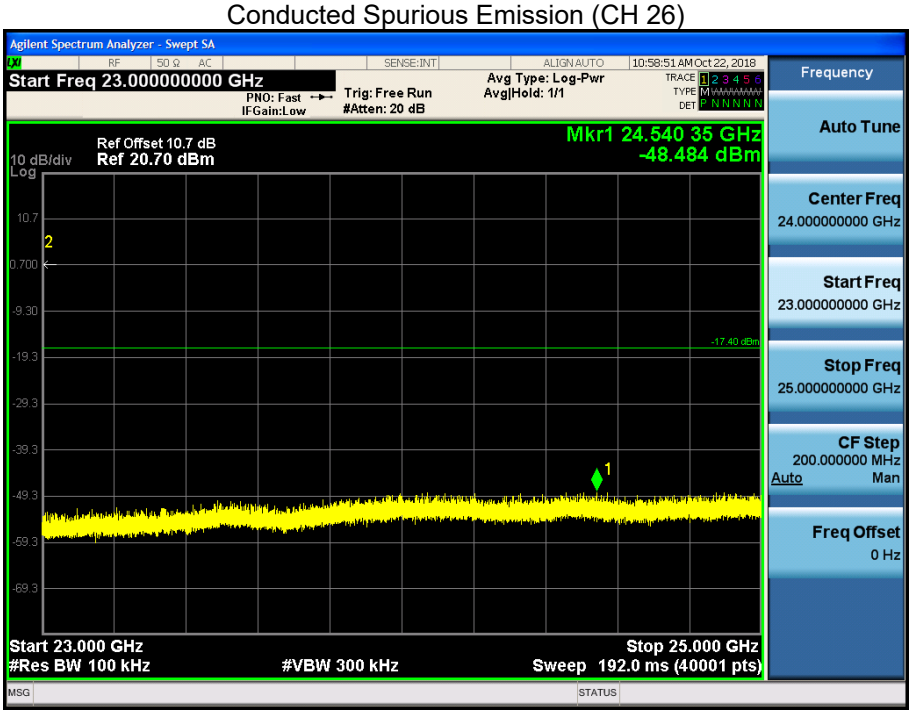
21 GHz ~ 23 GHz

Conducted Spurious Emission (CH 26)



23 GHz ~ 25 GHz

Conducted Spurious Emission (CH 26)



9.6 RADIATED SPURIOUS EMISSIONS

Frequency Range : 9 kHz – 30MHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Note:

1. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
2. Distance extrapolation factor = 40*log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBuV) + Distance extrapolation factor
4. The test results for below 30 MHz is correlated to an open site.
   The result on OATS is about 2 dB higher than semi-anechoic chamber(10 m chamber)

Frequency Range : Below 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

Frequency Range : Above 1 GHz

Operation Mode: Zigbee

Operating Frequency 2405

Channel No. CH 11

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4810	56.25	-0.42	V	55.83	73.98	18.15	PK
4810	48.16	-0.42	V	47.74	53.98	6.24	AV
7215	51.22	5.40	V	56.62	73.98	17.37	PK
7215	37.37	5.40	V	42.77	53.98	11.22	AV
4810	59.47	-0.42	H	59.05	73.98	14.93	PK
4810	49.41	-0.42	H	48.99	53.98	4.99	AV
7215	51.68	5.40	H	57.08	73.98	16.91	PK
7215	37.55	5.40	H	42.95	53.98	11.04	AV

Operation Mode: Zigbee

Operating Frequency 2440

Channel No. CH 18

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4880	59.25	-0.27	V	58.99	73.98	15.00	PK
4880	48.12	-0.27	V	47.86	53.98	6.13	AV
7320	50.41	5.42	V	55.83	73.98	18.15	PK
7320	36.94	5.42	V	42.36	53.98	11.62	AV
4880	60.13	-0.27	H	59.87	73.98	14.12	PK
4880	49.87	-0.27	H	49.61	53.98	4.38	AV
7320	51.66	5.42	H	57.08	73.98	16.90	PK
7320	36.99	5.42	H	42.41	53.98	11.57	AV

Operation Mode: Zigbee

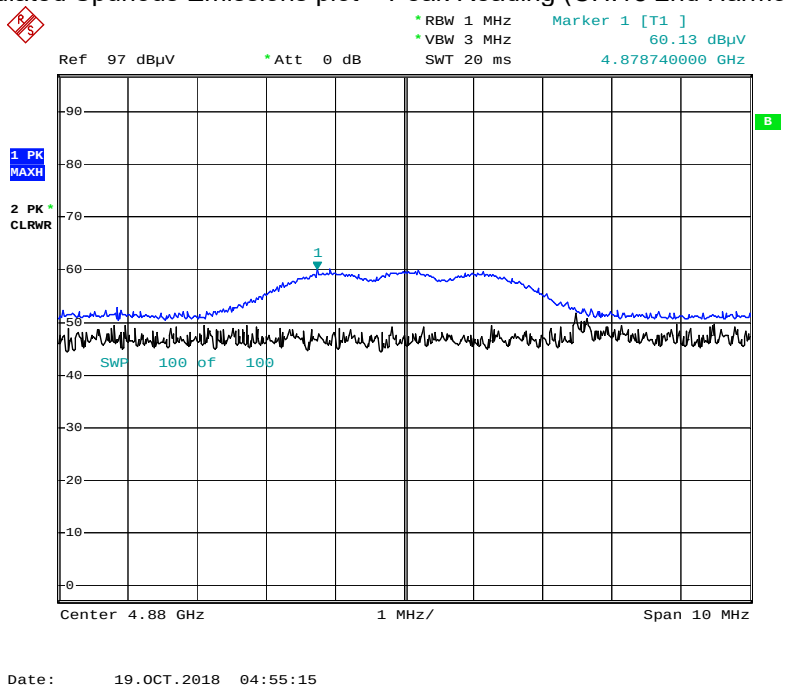
Operating Frequency 2480

Channel No. CH 26

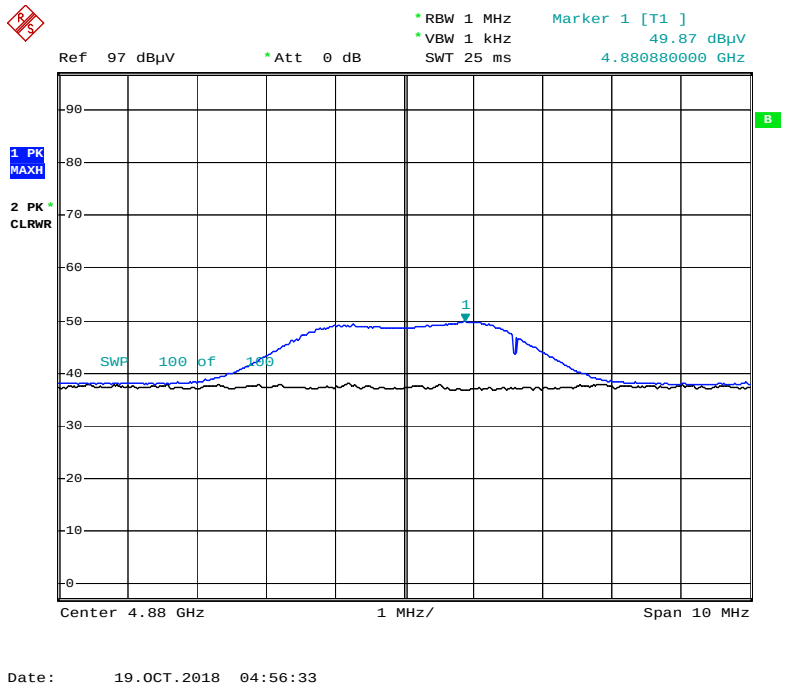
Frequency [MHz]	Reading [dBuV]	A.F.+C.L.-A.G+D.F [dB]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4960	57.20	-0.67	V	56.53	73.98	17.45	PK
4960	46.77	-0.67	V	46.10	53.98	7.88	AV
7440	49.51	5.70	V	55.21	73.98	18.77	PK
7440	36.05	5.70	V	41.75	53.98	12.23	AV
4960	57.53	-0.67	H	56.86	73.98	17.12	PK
4960	47.89	-0.67	H	47.22	53.98	6.76	AV
7440	49.66	5.70	H	55.36	73.98	18.62	PK
7440	36.69	5.70	H	42.39	53.98	11.59	AV

▣ Test Plots

Radiated Spurious Emissions plot – Peak Reading (CH.18 2nd Harmonic)



Radiated Spurious Emissions plot – Average Reading (CH.18 2nd Harmonic)



Note:

Plot of worst case are only reported.

9.7 RADIATED RESTRICTED BAND EDGES

Operation Mode: Zigbee

Operating Frequency 2405 MHz

Channel No. 11 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.+D.F [dB]	ANT. POL [H/V]	Duty Cycle Correction [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2400.0	25.30	34.42	H	0	59.72	73.98	14.26	PK
2400.0	25.30	34.42	H	-19.83	39.89	53.98	14.09	AV
2400.0	24.99	34.42	V	0	59.41	73.98	14.57	PK
2400.0	24.99	34.42	V	-19.83	39.58	53.98	14.40	AV

Operation Mode: Zigbee

Operating Frequency 2480 MHz

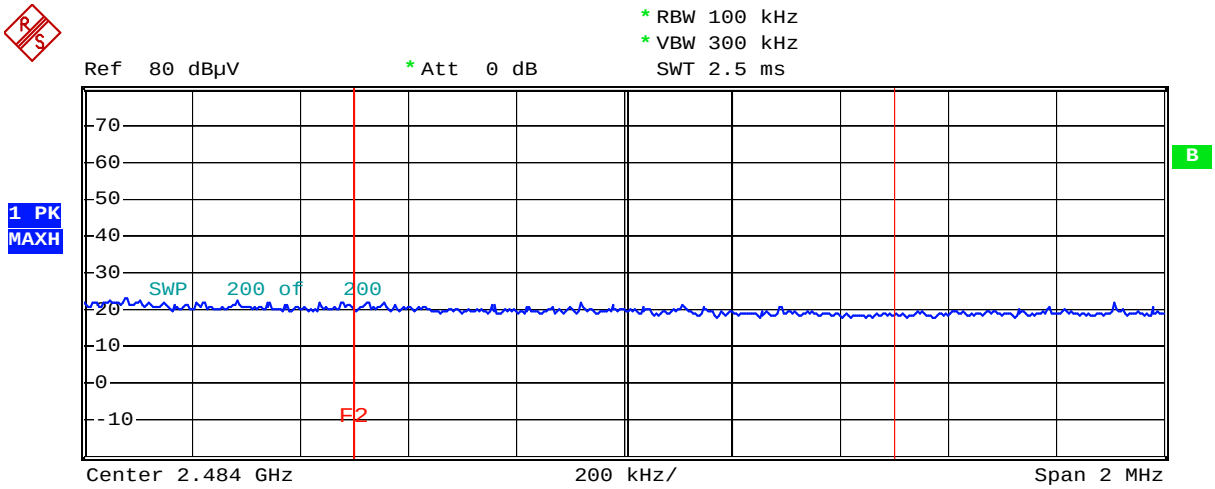
Channel No. 26 Ch

Frequency [MHz]	Reading [dBuV]	A.F.+C.L+D.F [dB]	ANT. POL [H/V]	**Duty Cycle Correction** [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2483.5(2484MHz)*	29.33	33.59	H	0	62.92	73.98	11.06	PK
2483.5(2484MHz)*	29.33	33.59	H	-19.83	43.09	53.98	10.89	AV
2483.5(2485MHz)*	28.46	33.59	H	0	62.05	73.98	11.93	PK
2483.5(2485MHz)*	28.46	33.59	H	-19.83	42.22	53.98	11.76	AV
2483.5 (2485.5MHz~2500.0MHz)	27.84	33.59	H	0	61.43	73.98	12.55	PK
2483.5 (2485.5MHz~2500.0MHz)	27.84	33.59	H	-19.83	41.60	53.98	12.38	AV
2483.5(2484MHz)*	28.54	33.59	V	0	62.13	73.98	11.85	PK
2483.5(2484MHz)*	28.54	33.59	V	-19.83	42.30	53.98	11.68	AV
2483.5(2485MHz)*	27.35	33.59	V	0	60.94	73.98	13.04	PK
2483.5(2485MHz)*	27.35	33.59	V	-19.83	41.11	53.98	12.87	AV
2483.5 (2485.5MHz~2500.0MHz)	26.21	33.59	V	0	59.80	73.98	14.18	PK
2483.5 (2485.5MHz~2500.0MHz)	26.21	33.59	V	-19.83	39.97	53.98	14.01	AV

Note : * integration method Used (ANSI C63.10-2013 Section11.13.3)

▣ Test Plots

Radiated Restricted Band Edges plot – Peak & Average Reading (CH.26: 2484 MHz)*

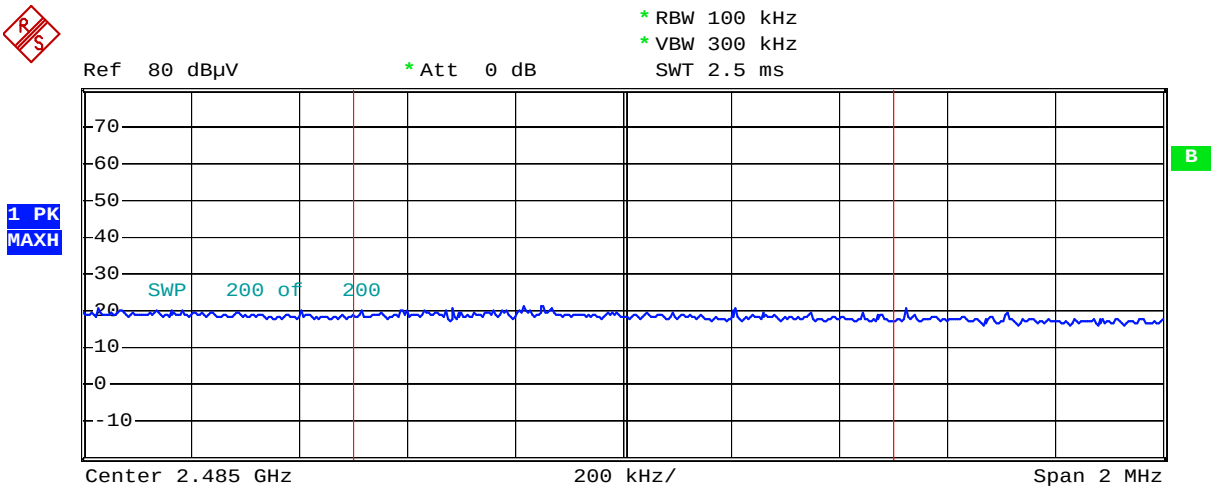


Tx Channel
Bandwidth 1 MHz Power 29.33 dBµV

Date: 23.OCT.2018 14:09:34

Note : * integration method Used (ANSI C63.10-2013 Section11.13.3)

Radiated Restricted Band Edges plot – Peak & Average Reading (CH.26: 2485 MHz)*

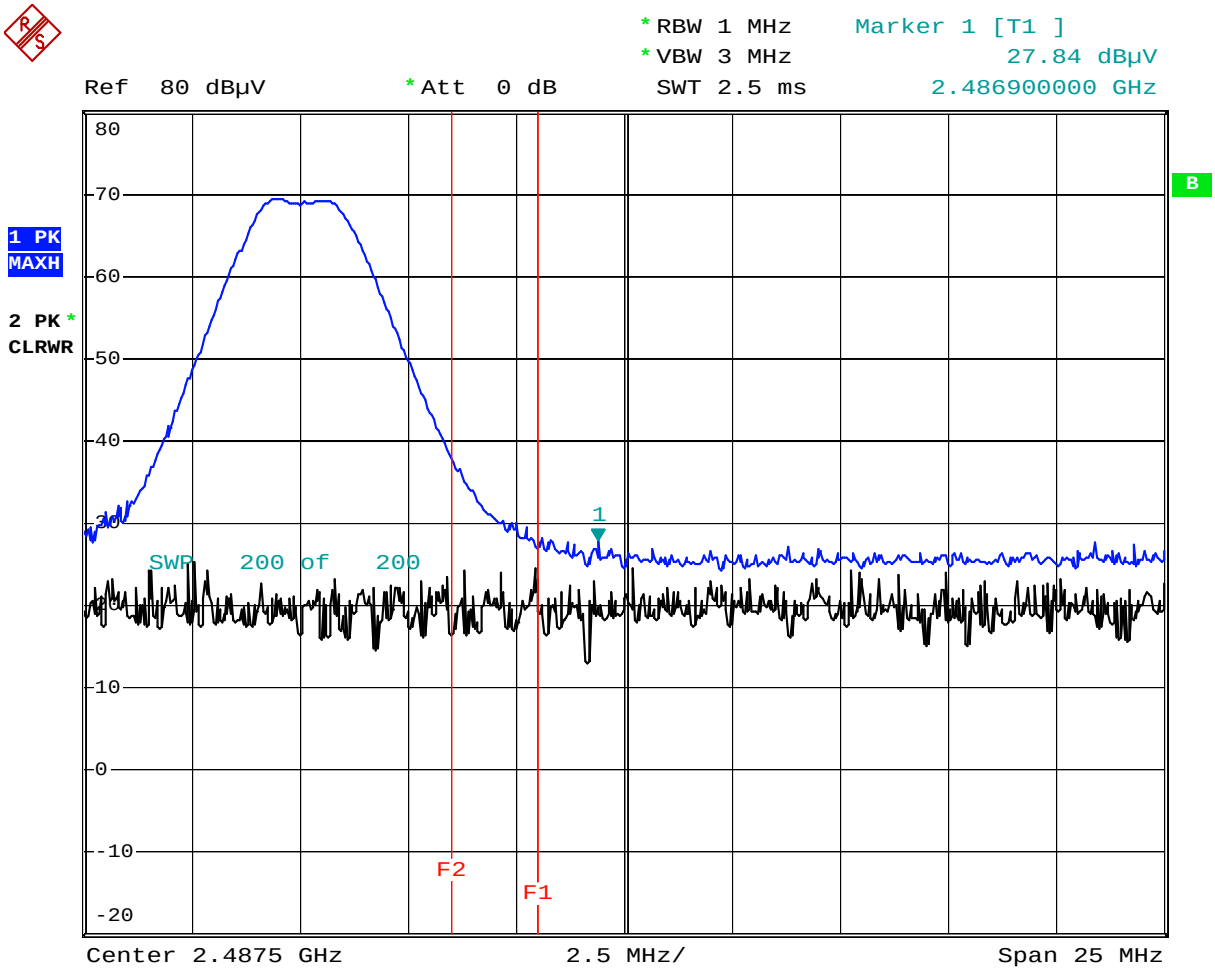


Tx Channel
Bandwidth 1 MHz Power 28.46 dBµV

Date: 23.OCT.2018 14:15:41

Note : * integration method Used (ANSI C63.10-2013 Section11.13.3)

Radiated Restricted Band Edges plot – Peak & Average Reading (CH.26: 2485.5 ~ 2500 MHz)



Date: 23.OCT.2018 14:18:13

Note:

Plot of worst case are only reported.

9.8 RECEIVER SPURIOUS EMISSIONS

Frequency Range : Below 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

Frequency Range : Above 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

9.9 POWERLINE CONDUCTED EMISSIONS

Conducted Emissions (Line 1)

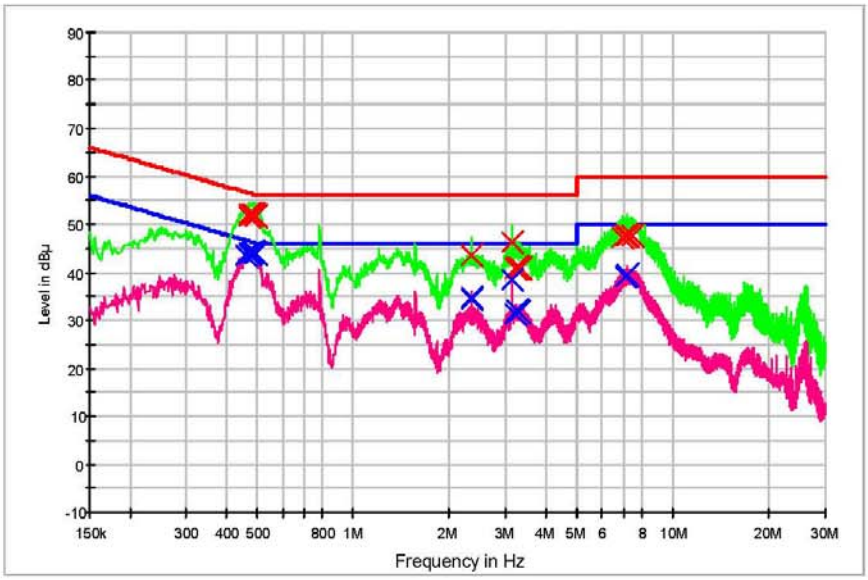
Zigbee_N 1 / 2

HCT TEST Report

Common Information

EUT:	LZM-001
Manufacturer:	LG Electronics Inc.
Test Site:	SHIELD ROOM
Operating Conditions:	Zigbe_N

FCC CLASS B_Exten Cable



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.470000	51.7	9.000	Off	N	9.7	4.8	56.5
0.474000	51.9	9.000	Off	N	9.7	4.5	56.4
0.478000	51.9	9.000	Off	N	9.8	4.5	56.4
0.484000	52.0	9.000	Off	N	9.8	4.3	56.3
0.488000	51.9	9.000	Off	N	9.8	4.3	56.2
0.492000	51.8	9.000	Off	N	9.8	4.3	56.1
2.348000	43.4	9.000	Off	N	9.9	12.6	56.0
3.130000	46.2	9.000	Off	N	9.9	9.8	56.0
3.198000	41.0	9.000	Off	N	9.9	15.0	56.0
3.236000	41.1	9.000	Off	N	9.9	14.9	56.0
3.290000	40.9	9.000	Off	N	9.9	15.1	56.0
3.320000	40.8	9.000	Off	N	9.9	15.2	56.0
6.920000	47.1	9.000	Off	N	10.1	12.9	60.0
7.080000	47.6	9.000	Off	N	10.1	12.4	60.0
7.188000	47.6	9.000	Off	N	10.1	12.4	60.0
7.192000	47.8	9.000	Off	N	10.1	12.2	60.0
7.230000	47.8	9.000	Off	N	10.1	12.2	60.0
7.462000	47.5	9.000	Off	N	10.2	12.5	60.0

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Zigbee_N 2 / 2

Final Result 2

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.460000	43.6	9.000	Off	N	9.7	3.1	46.7
0.472000	44.0	9.000	Off	N	9.7	2.5	46.5
0.476000	44.0	9.000	Off	N	9.8	2.4	46.4
0.482000	44.1	9.000	Off	N	9.8	2.2	46.3
0.486000	44.2	9.000	Off	N	9.8	2.1	46.2
0.494000	43.8	9.000	Off	N	9.8	2.3	46.1
2.344000	34.4	9.000	Off	N	9.9	11.6	46.0
2.348000	34.9	9.000	Off	N	9.9	11.1	46.0
3.130000	38.5	9.000	Off	N	9.9	7.5	46.0
3.198000	31.5	9.000	Off	N	9.9	14.5	46.0
3.236000	31.9	9.000	Off	N	9.9	14.1	46.0
3.290000	31.7	9.000	Off	N	9.9	14.3	46.0
7.082000	39.3	9.000	Off	N	10.1	10.7	50.0
7.112000	39.3	9.000	Off	N	10.1	10.7	50.0
7.188000	39.4	9.000	Off	N	10.1	10.6	50.0
7.206000	39.6	9.000	Off	N	10.1	10.4	50.0
7.222000	39.6	9.000	Off	N	10.1	10.4	50.0
7.230000	39.4	9.000	Off	N	10.1	10.6	50.0

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Conducted Emissions (Line 2)

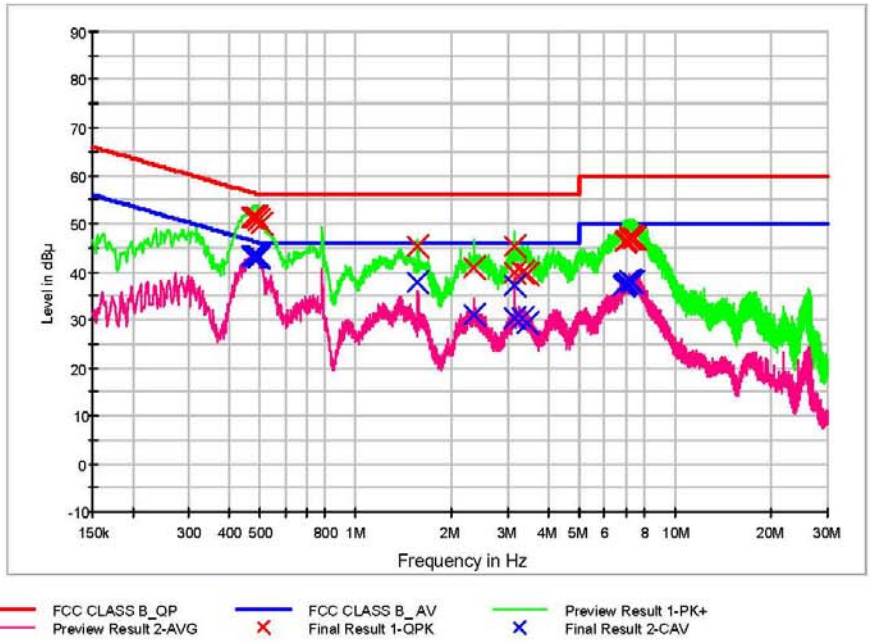
Zigbee_L1 1 / 2

HCT TEST Report

Common Information

EUT:	LZM-001
Manufacturer:	LG Electronics Inc.
Test Site:	SHIELD ROOM
Operating Conditions:	Zigbe_L1

FCC CLASS B_Exten Cable



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.472000	51.4	9.000	Off	L1	9.7	5.1	56.5
0.478000	51.4	9.000	Off	L1	9.7	5.0	56.4
0.484000	51.5	9.000	Off	L1	9.7	4.8	56.3
0.490000	51.2	9.000	Off	L1	9.7	4.9	56.2
0.496000	50.8	9.000	Off	L1	9.7	5.2	56.1
0.504000	49.9	9.000	Off	L1	9.8	6.1	56.0
1.564000	45.2	9.000	Off	L1	9.9	10.8	56.0
2.346000	41.0	9.000	Off	L1	9.9	15.0	56.0
3.130000	45.1	9.000	Off	L1	9.9	10.9	56.0
3.142000	39.8	9.000	Off	L1	9.9	16.2	56.0
3.328000	40.0	9.000	Off	L1	9.9	16.0	56.0
3.464000	39.4	9.000	Off	L1	9.9	16.6	56.0
6.982000	46.4	9.000	Off	L1	10.1	13.6	60.0
7.012000	46.7	9.000	Off	L1	10.1	13.3	60.0
7.170000	47.0	9.000	Off	L1	10.1	13.0	60.0
7.196000	47.2	9.000	Off	L1	10.1	12.8	60.0
7.398000	46.9	9.000	Off	L1	10.1	13.1	60.0
7.444000	46.9	9.000	Off	L1	10.1	13.1	60.0

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Zigbee_L1 2 / 2

Final Result 2

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.470000	43.1	9.000	Off	L1	9.7	3.4	46.5
0.478000	43.1	9.000	Off	L1	9.7	3.2	46.4
0.482000	43.4	9.000	Off	L1	9.7	2.9	46.3
0.486000	43.1	9.000	Off	L1	9.7	3.1	46.2
0.492000	43.1	9.000	Off	L1	9.7	3.1	46.1
0.496000	42.7	9.000	Off	L1	9.7	3.3	46.1
1.564000	37.7	9.000	Off	L1	9.9	8.3	46.0
2.344000	31.1	9.000	Off	L1	9.9	14.9	46.0
3.130000	37.0	9.000	Off	L1	9.9	9.0	46.0
3.142000	30.2	9.000	Off	L1	9.9	15.8	46.0
3.328000	30.5	9.000	Off	L1	9.9	15.5	46.0
3.464000	29.3	9.000	Off	L1	9.9	16.7	46.0
6.898000	37.2	9.000	Off	L1	10.1	12.8	50.0
6.982000	37.4	9.000	Off	L1	10.1	12.6	50.0
7.012000	37.8	9.000	Off	L1	10.1	12.2	50.0
7.214000	38.0	9.000	Off	L1	10.1	12.0	50.0
7.244000	37.8	9.000	Off	L1	10.1	12.2	50.0
7.398000	37.8	9.000	Off	L1	10.1	12.2	50.0

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10. LIST OF TEST EQUIPMENT

Conducted Test

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Rohde & Schwarz	ENV216 / LISN	12/20/2017	Annual	102245
Rohde & Schwarz	ESCI / Test Receiver	06/27/2018	Annual	100033
ESPAC	SU-642 /Temperature Chamber	03/30/2018	Annual	0093008124
Agilent	N9020A / Signal Analyzer	06/08/2018	Annual	MY51110085
Agilent	N9030A / Signal Analyzer	11/22/2017	Annual	MY49431210
Agilent	N1911A / Power Meter	04/16/2018	Annual	MY45100523
Agilent	N1921A / Power Sensor	04/16/2018	Annual	MY52260025
Agilent	87300B / Directional Coupler	11/20/2017	Annual	3116A03621
Hewlett Packard	11667B / Power Splitter	06/07/2018	Annual	05001
Hewlett Packard	E3632A / DC Power Supply	06/26/2018	Annual	KR75303960
Agilent	8493C / Attenuator(10 dB)	07/10/2018	Annual	07560
Rohde & Schwarz	EMC32 / Software	N/A	N/A	N/A
HCT CO., LTD.	FCC WLAN&BT&BLE Conducted Test Software v3.0	N/A	N/A	N/A

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

Radiated Test

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
Innco system	MA4640/800-XP-EP / Antenna Position Tower	N/A	N/A	N/A
Audix	EM1000 / Controller	N/A	N/A	060520
Audix	Turn Table	N/A	N/A	N/A
Rohde & Schwarz	Loop Antenna	08/23/2018	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	04/06/2017	Biennial	760
Schwarzbeck	BBHA 9120D / Horn Antenna	05/02/2017	Biennial	9120D-937
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	12/04/2017	Biennial	BBHA9170541
Rohde & Schwarz	FSP(9 kHz ~ 30 GHz) / Spectrum Analyzer	09/19/2018	Annual	836650/016
Rohde & Schwarz	FSV40-N / Spectrum Analyzer	09/28/2018	Annual	101068-SZ
Wainwright Instruments	WHKX10-2700-3000-18000-40SS / High Pass Filter	07/16/2018	Annual	4
Wainwright Instruments	WHKX8-6090-7000-18000-40SS / High Pass Filter	07/10/2018	Annual	5
Wainwright Instruments	WRCJV2400/2483.5-2370/2520-60/12SS / Band Reject Filter	06/29/2018	Annual	2
Wainwright Instruments	WRCJV5100/5850-40/50-8EEK / Band Reject Filter	01/03/2018	Annual	2
Api tech.	18B-03 / Attenuator (3 dB)	06/07/2018	Annual	2
WEINSCHEL	56-10 / Attenuator(10 dB)	10/10/2018	Annual	72316
CERNEX	CBLU1183540 / Broadband Low Noise Amplifier	01/03/2018	Annual	24613
CERNEX	CBL06185030 / Broadband Low Noise Amplifier	01/03/2018	Annual	24615
CERNEX	CBL18265035 / Power Amplifier	01/10/2018	Annual	22966
CERNEX	CBL26405040 / Power Amplifier	06/29/2018	Annual	25956

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

11. ANNEX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-1810-FI021-P