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TEST REPORT

FCC Zigbee Test for SL300

APPLICANT
PASSTECH CO., LTD

REPORT NO.
HCT-RF-2108-FC038

DATE OF ISSUE
August 25, 2021

Tested by
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Technical Manager
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Additional Model
SL300E, SL300TWR, SL300EWR

Applicant	**PASSTECH CO., LTD** B-402. 215 Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, Rep. of Korea (Zip 13217)
Eut Type Model Name	SLIM LOCK SL300
FCC ID	W6YSL300
Peak Output Power	1.912 dBm (1.55 mW)
Modulation type	O-QPSK
FCC Classification	Digital Transmission System(DTS)
FCC Rule Part(s)	Part 15.247

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test results were applied only to the test methods required by the standard.

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	August 25, 2021	Initial Release

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. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules under normal use and maintenance. measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules under normal use and maintenance.

If this report is required to confirmation of authenticity, please contact to www.hct.co.kr

CONTENTS

1. EUT DESCRIPTION

Model	SL300
Additional model	SL300E, SL300TWR, SL300EWR
EUT Type	SLIM LOCK
Manufacturer Name Address	PASSTECH CO., LTD B-402. 215 Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, Rep. of Korea (Zip 13217)
Factory Name Address	PASSTECH CO., LTD B-402. 215 Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, Rep. of Korea (Zip 13217)
Power Supply	6 V
Frequency Range	2405 MHz ~ 2480 MHz
Max. RF Output Power (Peak)	1.912 dBm (1.55 mW)
Modulation Type	O-QPSK
Number of Channels	16 Channels
Antenna Specification	Antenna type: Multilayer Chip Antenna Peak Gain : 3.5 dBi
Date(s) of Tests	August 10, 2021~ August 24, 2021

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 purpose 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 30 MHz 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 1 GHz. Above 1 GHz with 1.5 m 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, 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).

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."

(1) The antennas of this E.U.T are permanently attached.

(2) The E.U.T Complies with the requirement of § 15.203

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.

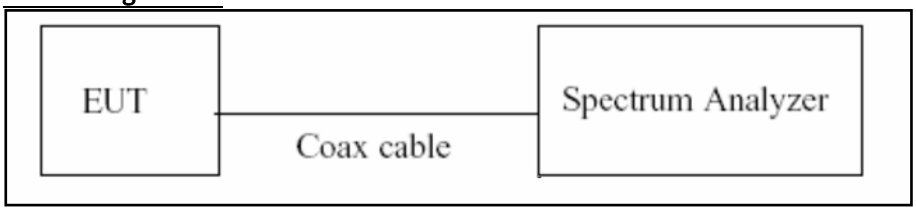
The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82 (Confidence level about 95 %, k=2)
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40 (Confidence level about 95 %, k=2)
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80 (Confidence level about 95 %, k=2)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70 (Confidence level about 95 %, k=2)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.05 (Confidence level about 95 %, k=2)

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 available 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*.

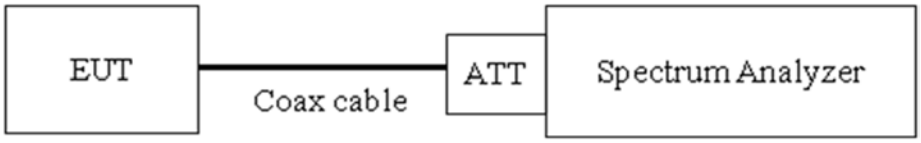
1. RBW = 8 MHz (the largest available value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10log(1/Duty Cycle)

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 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.

Test Procedure (99 % Bandwidth for IC)

The transmitter output is connected to the spectrum analyzer.

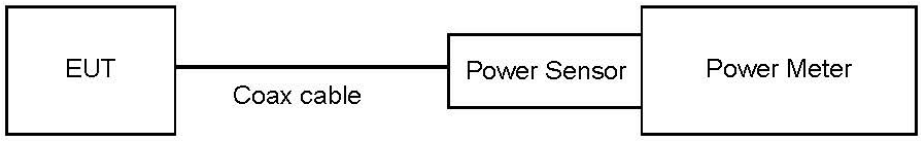
1) RBW = 1 % ~ 5 % of the occupied bandwidth
2) VBW ≒ 3 x RBW
3) Detector = Peak
4) Trace mode = max hold
5) Sweep = auto couple
6) Allow the trace to stabilize

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 11.9.1.3 in ANSI 63.10-2013)

: Measure the peak power of the transmitter.

▪ Average Power (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

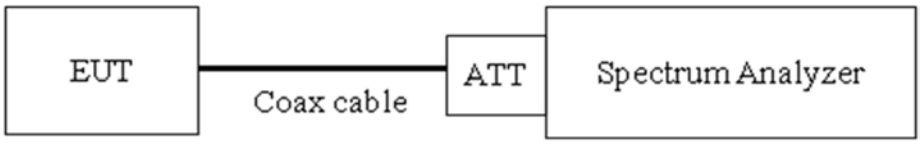
▪ Conducted Output Power(Average) = Reading Value + ATT loss + Cable loss + Duty Cycle Factor

7.4. Power Spectral Density

Limit

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

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05r02, Procedure 11.10 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

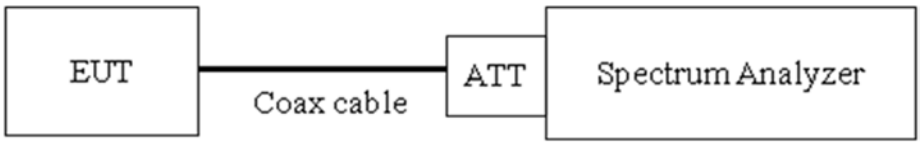
7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

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 20 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 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 x 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	11.05
100	11.10
200	11.14
300	11.19
400	11.25
500	11.25
600	11.26
700	11.27
800	11.28
900	11.30
1 000	11.35
2 000	11.50
2 400	11.53
2 412	11.55
2 437	11.55
2 462	11.55
2 500	11.54
3 000	11.64
4 000	11.72
5 000	11.79
5 700	11.80
5 800	11.87
6 000	11.88
7 000	12.01
8 000	12.01
9 000	12.09
10 000	12.19
11 000	12.28
12 000	12.37
13 000	12.38
14 000	12.41
15 000	12.51
16 000	12.59
17 000	12.80
18 000	12.93
19 000	12.85
20 000	12.52
21 000	12.65
22 000	12.64
23 000	12.65
24 000	12.66
25 000	12.76

Note : 1. 2400 ~ 2500 MHz is fundamental frequency range.

2. Factor = Attenuator loss(10 dB) + Cable loss + EUT Cable loss

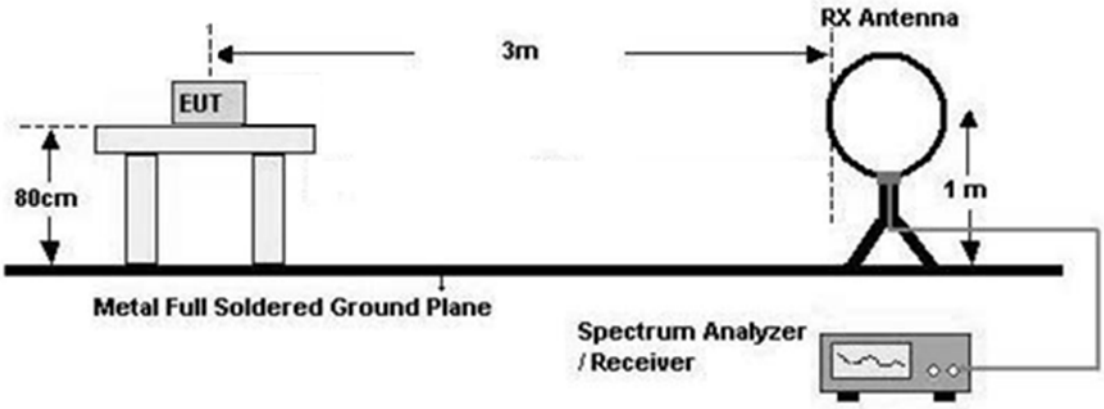
7.6. Radiated Test

Limit

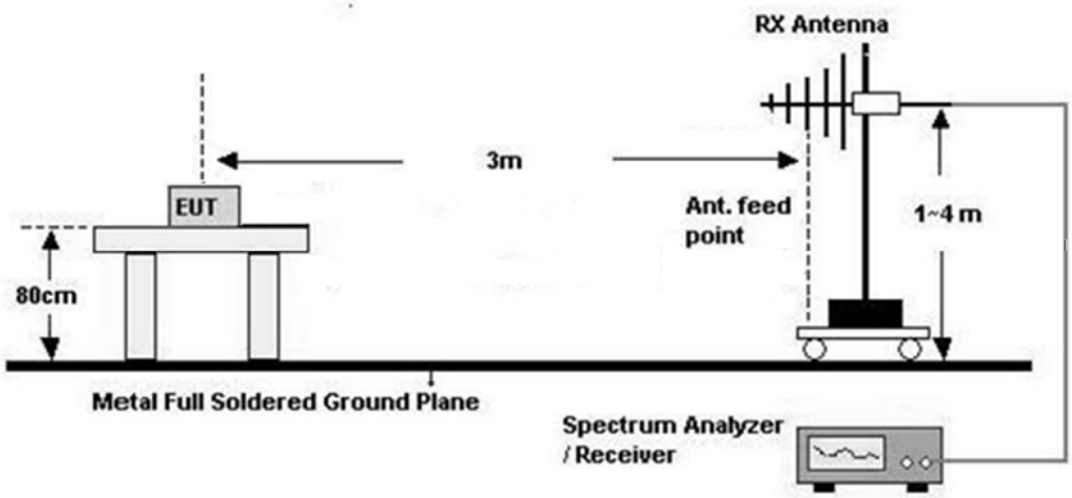
Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

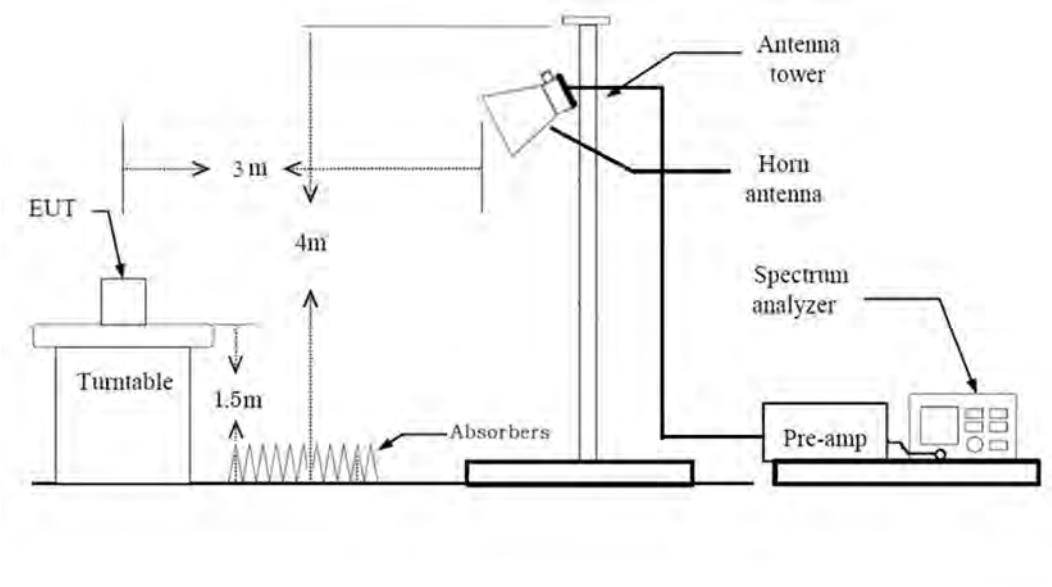
Below 30 MHz



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 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.
8. 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 ≥ 3xRBW
   (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 ≥ 3xRBW
- 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 ≥ 3xRBW
- 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):

- 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 determine 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)

9. 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.
10. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
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) + Duty Cycle Correction Factor(D.C.C.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. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.
8. 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 ≥ 3xRBW
   (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 determine 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)
9. 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.
10. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
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)+Duty Cycle Correction Factor(D.C.C.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) + Duty Cycle Correction Factor(D.C.C.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F) + Duty Cycle Factor

7.7. Receiver Spurious Emissions

Limit

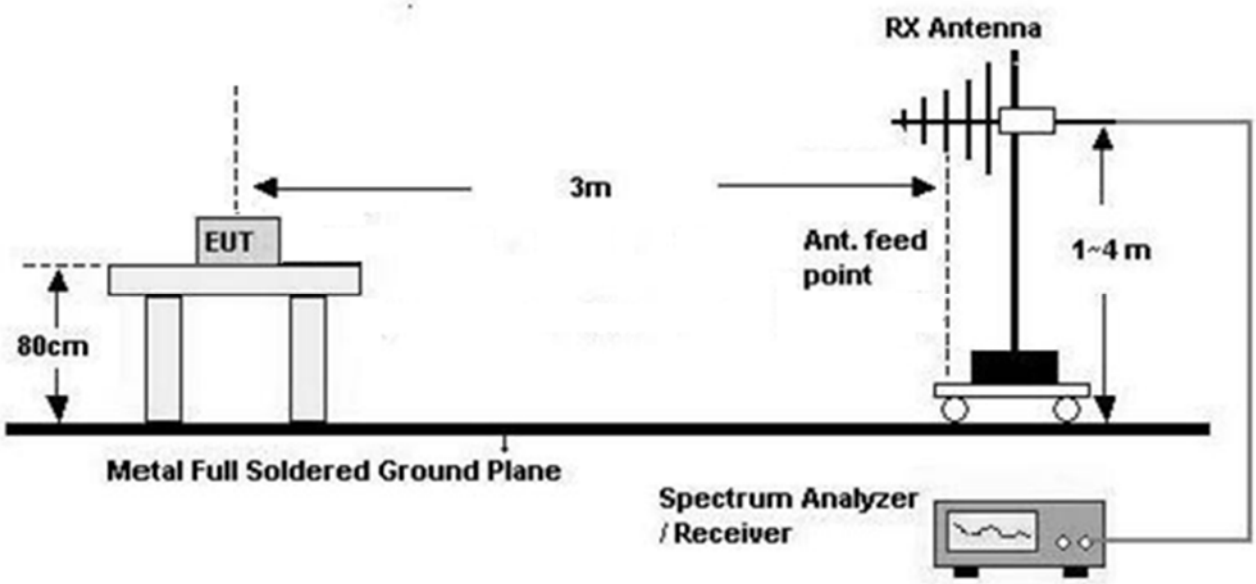
Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

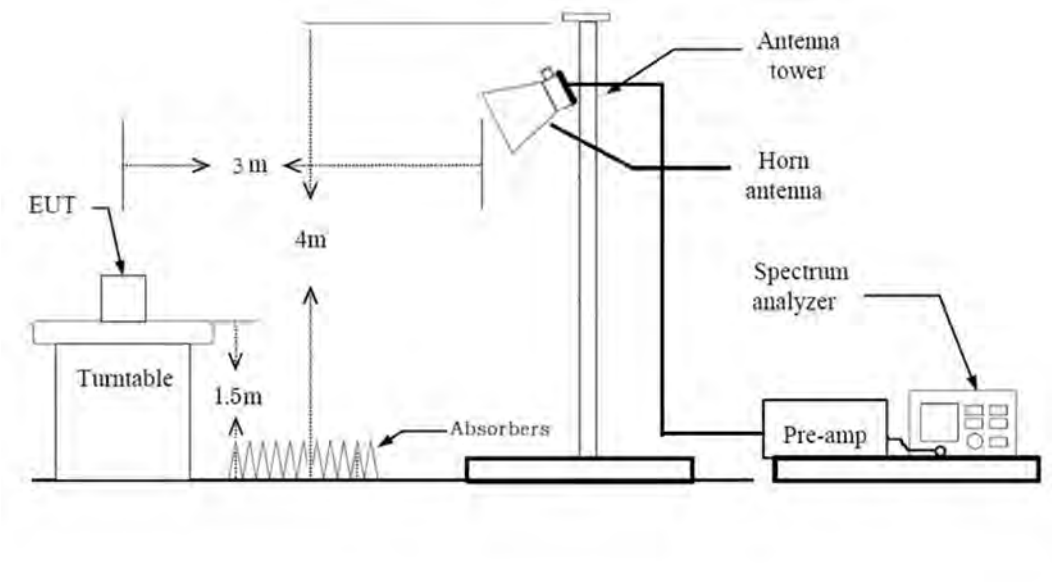
Measurements for compliance with the limits in table may be performed at distances other than 3 metres.

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 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.

8. Spectrum Setting

(1) Measurement Type(Peak):

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = Peak
- Trace = Maxhold
- RBW = 1 MHz
- VBW ≥ 3xRBW

(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

9. 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.

10. Distance extrapolation factor = 20log (test distance / specific distance) (dB)

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

7.8. Worst case configuration and mode

Radiated test

1. All modes of operation were investigated and the worst case configuration results are reported.
   - The worst case : SL300
2. EUT Axis
   - Radiated Spurious Emissions : Y
   - Radiated Restricted Band Edge : Y
3. Duty cycle factor applies only Radiated Restricted band edges(If Duty cycle < 98 %).
4. All data rate of operation were investigated and the test results are worst case in lowest data rate of each mode.
   - Zigbee Mode
5. EUT were tested and the worst case results are reported.
6. SL300, SL300E were tested and the worst case results are reported.
   - Worst case : SL300

AC Power line Conducted Emissions

1. We don’t perform powerline conducted emission test. Because this EUT is used DC.

Conducted test

1. The EUT was configured with data rate of highest power.
2. SL300, SL300E were tested and the worst case results are reported.
   - Worst case : SL300

8. SUMMARY OF TEST RESULTS

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

#Note1 : Not Tested

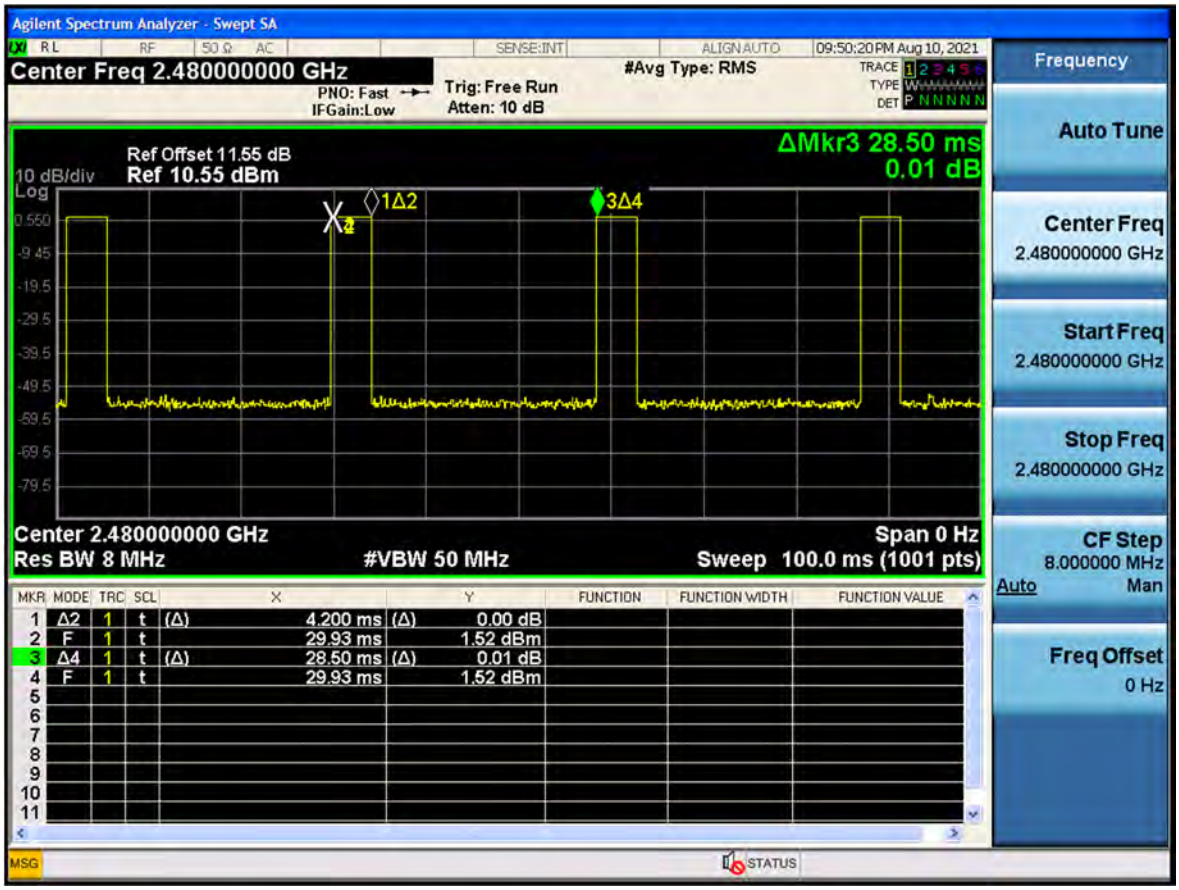
9. TEST RESULT

9.1 DUTY CYCLE & DCCF

Zigbee Mode	T_{on} (ms)	T_{total} (ms)	Duty Cycle	VBW(1/T) Hz
	-	-	-	-

Note : Test was performed with continuous Tx.

DCCF Plot



On time for one frame is 32 us/byte x 133 bytes = 4.256 ms

4 frames are transmitted for a total on time is 17.024 ms(4.256 ms x 4 frames)

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

=20log[(17.024)/100] = -15.3788

Duty Cycle Correction Factor	**-15.38 dB**

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

9.2 BANDWIDTH

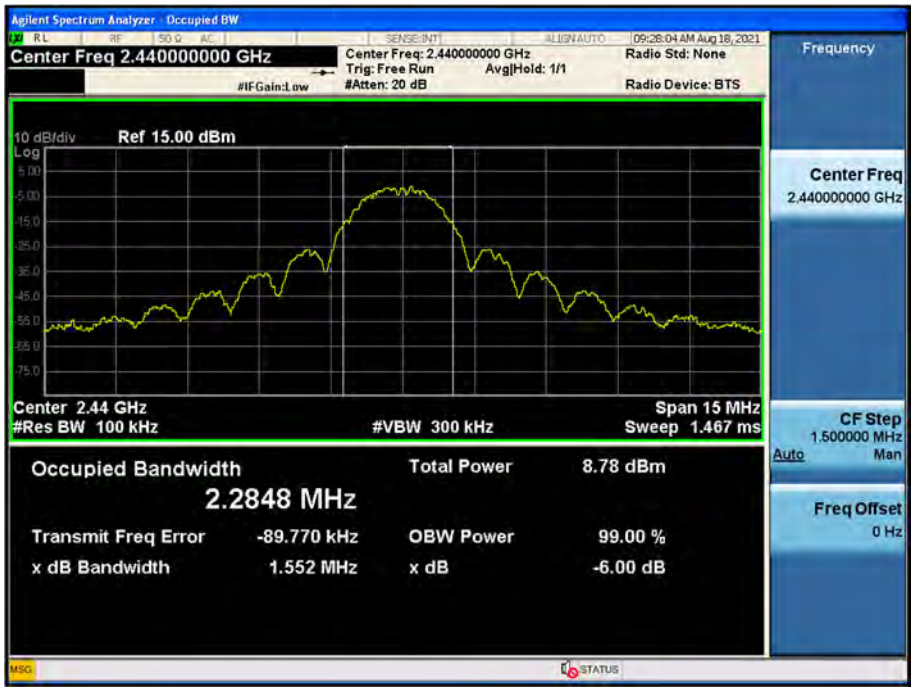
FCC

Zigbee Mode		6 dB Bandwidth [MHz]	Occupied Bandwidth [kHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.			
2405	11	1.558	2.2732	0.5
2440	18	1.552	2.2848	0.5
2480	26	1.470	2.3054	0.5

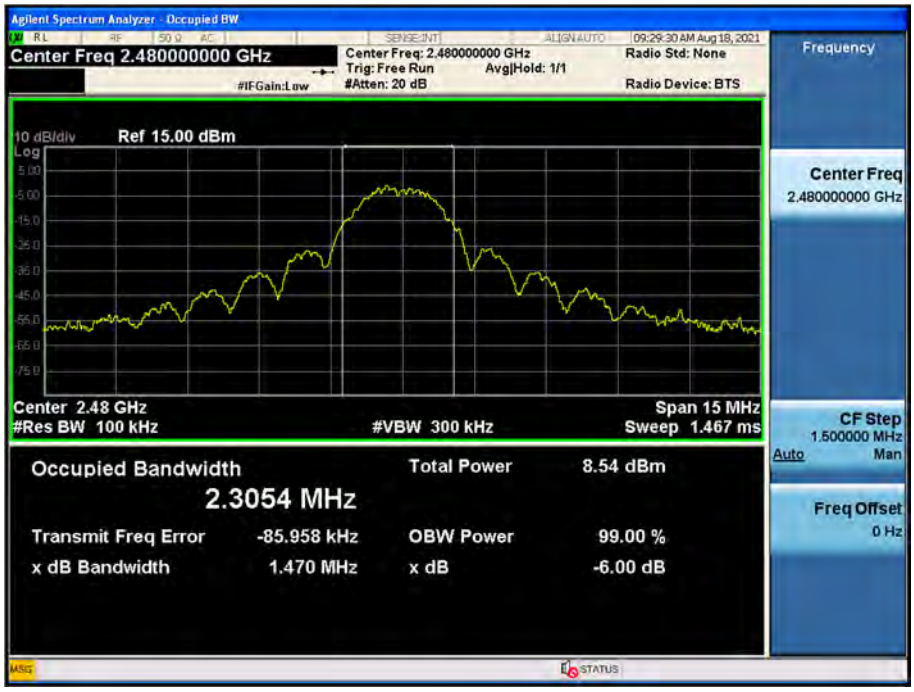
▣ Test Plots

6 dB Bandwidth plot (CH 11)

6 dB Bandwidth plot (CH 18)



6 dB Bandwidth plot (CH 26)



9.3 OUTPUT POWER

Peak Conducted Output Power Measurements

- **SL300**

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

Mode	Channel / Freq	Measured Power(dBm)	Limit (dBm)	PLS
ZigBee	ch.11 / 2405 MHz	1.663	30	8
	ch.18 / 2440 MHz	1.844		8
	ch.26 / 2480 MHz	1.912		8

- **SL300E**

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

Mode	Channel / Freq	Measured Power(dBm)	Limit (dBm)	PLS
ZigBee	ch.11 / 2405 MHz	0.385	30	0
	ch.18 / 2440 MHz	0.159		0
	ch.26 / 2480 MHz	-0.129		0

9.4 POWER SPECTRAL DENSITY

- **SL300**

Frequency (MHz)	Channel No.	Mode	Test Result	
			PSD (dBm)	Pass/Fail
2405	11	ZigBee	-12.501	Pass
2440	18		-10.857	Pass
2480	26		-10.997	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

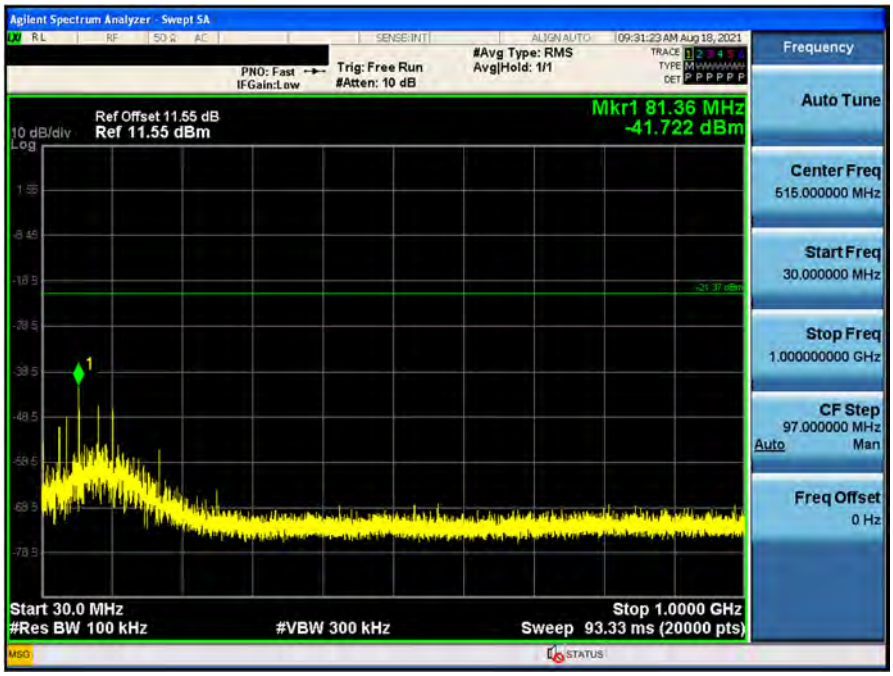
Band Edge (CH 11)

Band Edge (CH 26)

Conducted Spurious Emission

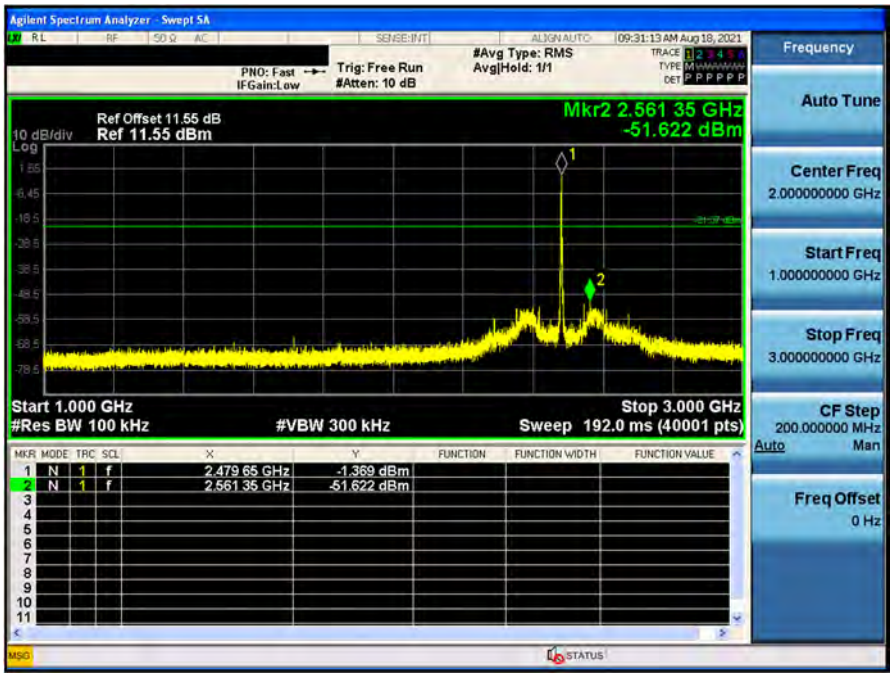
30 MHz ~ 1 GHz

Conducted Spurious Emission (CH 39)



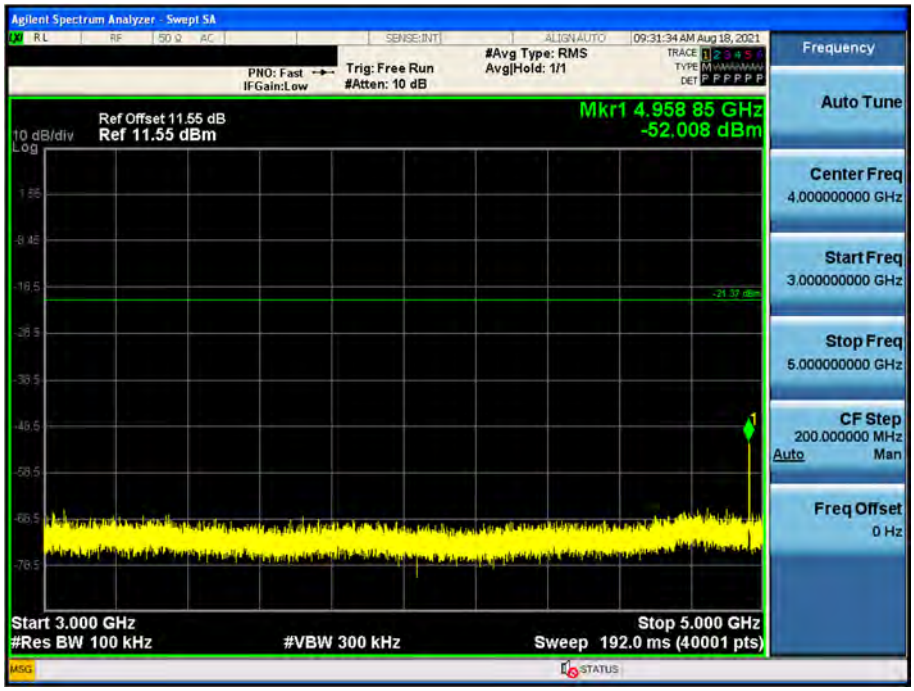
1 GHz ~ 3 GHz

Conducted Spurious Emission (CH 39)



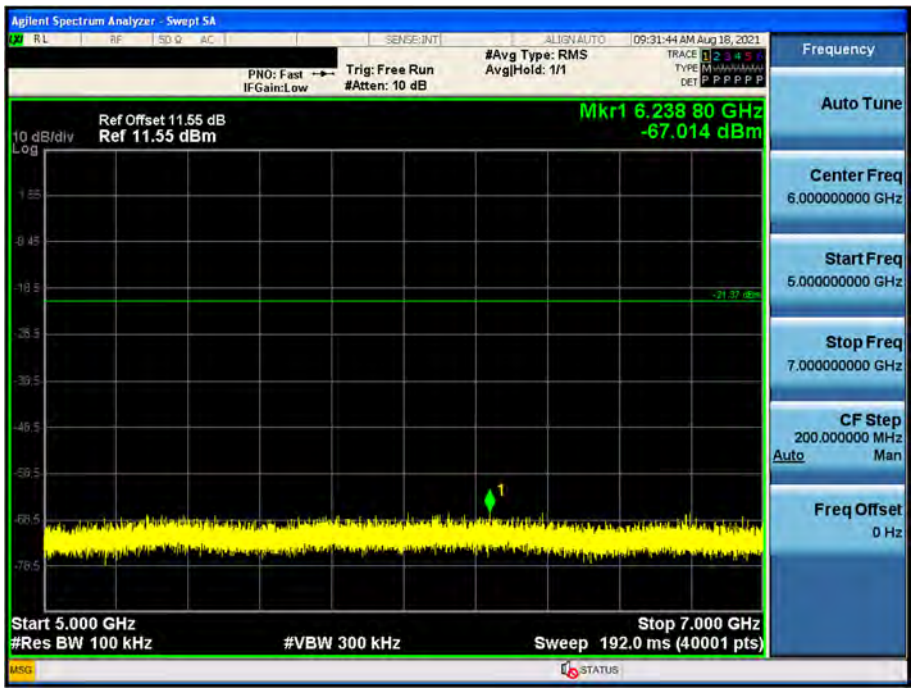
3 GHz ~ 5 GHz

Conducted Spurious Emission (CH 39)



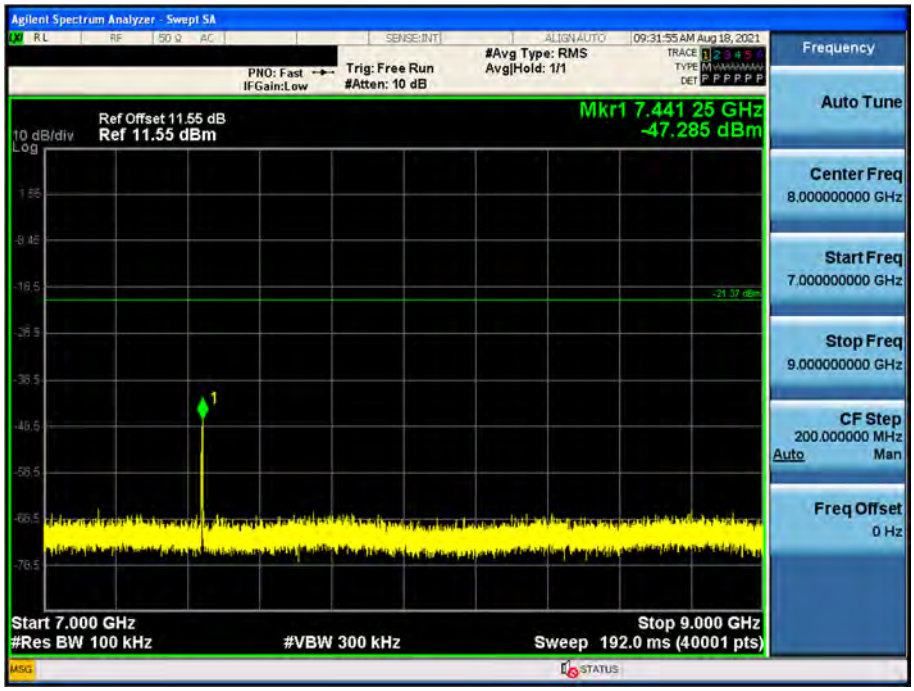
5 GHz ~ 7 GHz

Conducted Spurious Emission (CH 39)



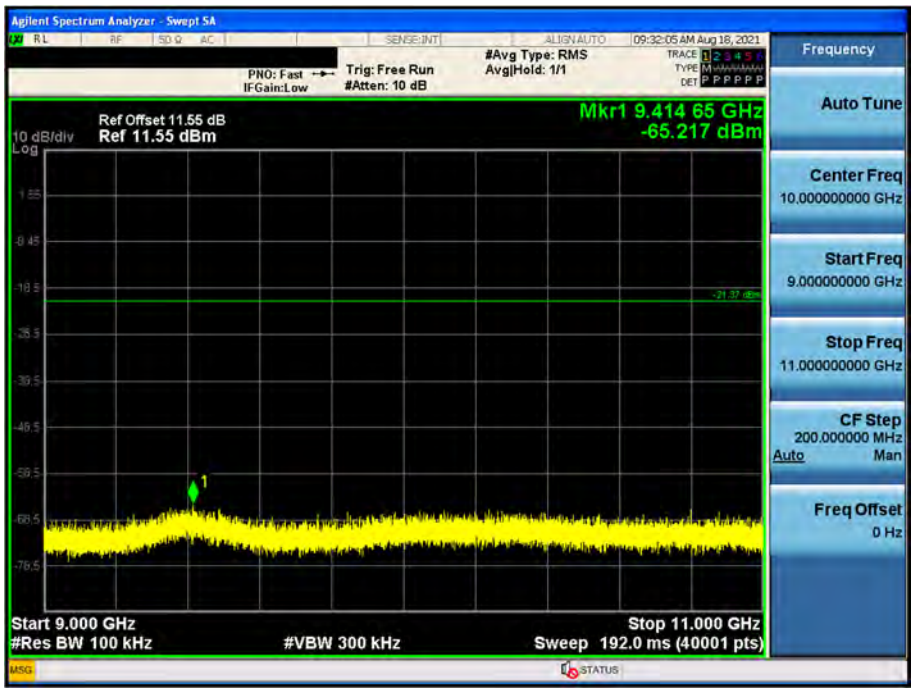
7 GHz ~ 9 GHz

Conducted Spurious Emission (CH 39)



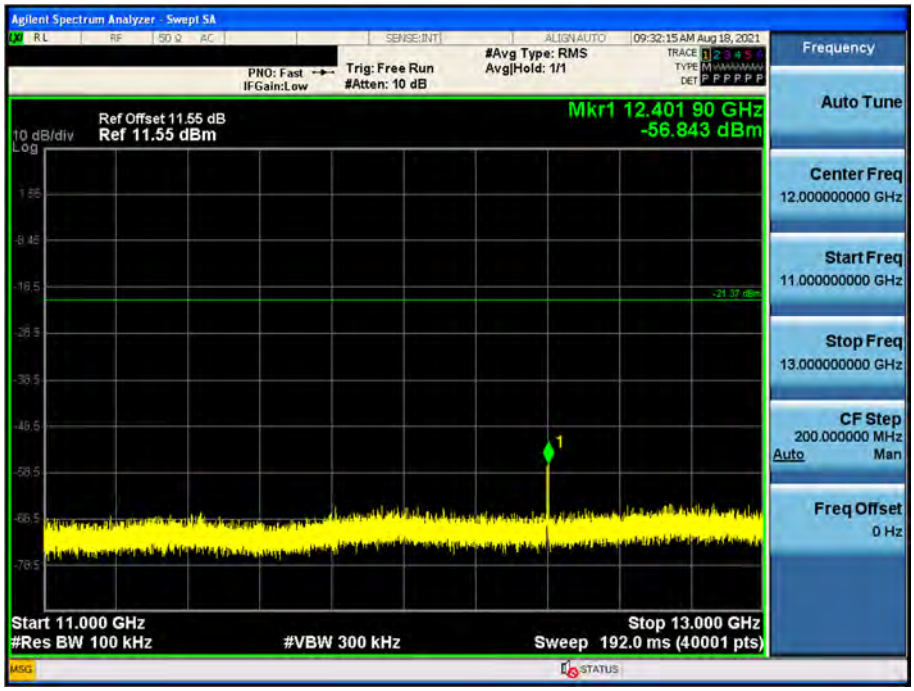
9 GHz ~ 11 GHz

Conducted Spurious Emission (CH 39)



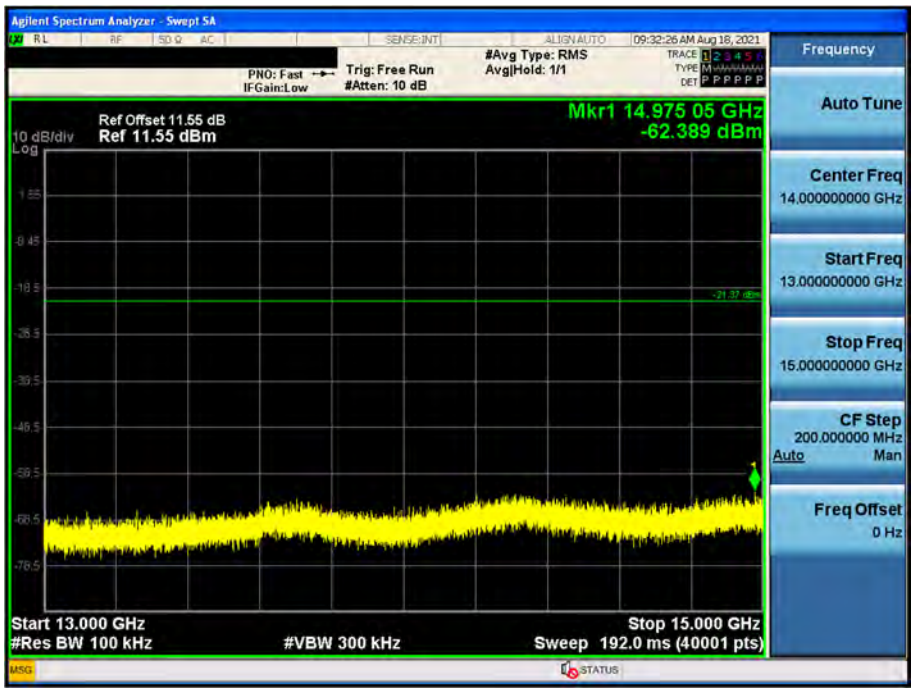
11 GHz ~ 13 GHz

Conducted Spurious Emission (CH 39)



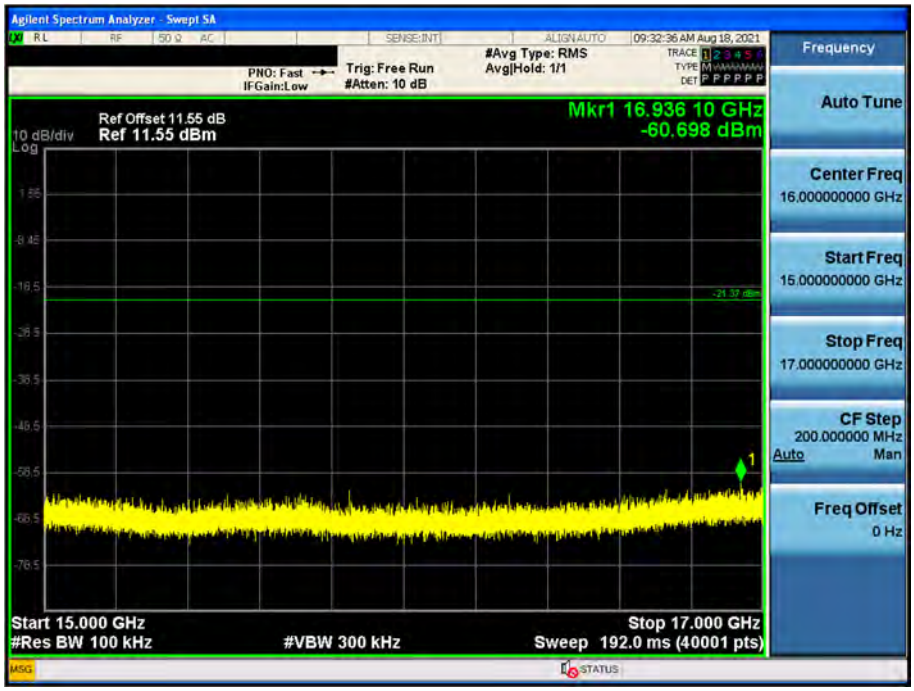
13 GHz ~ 15 GHz

Conducted Spurious Emission (CH 39)



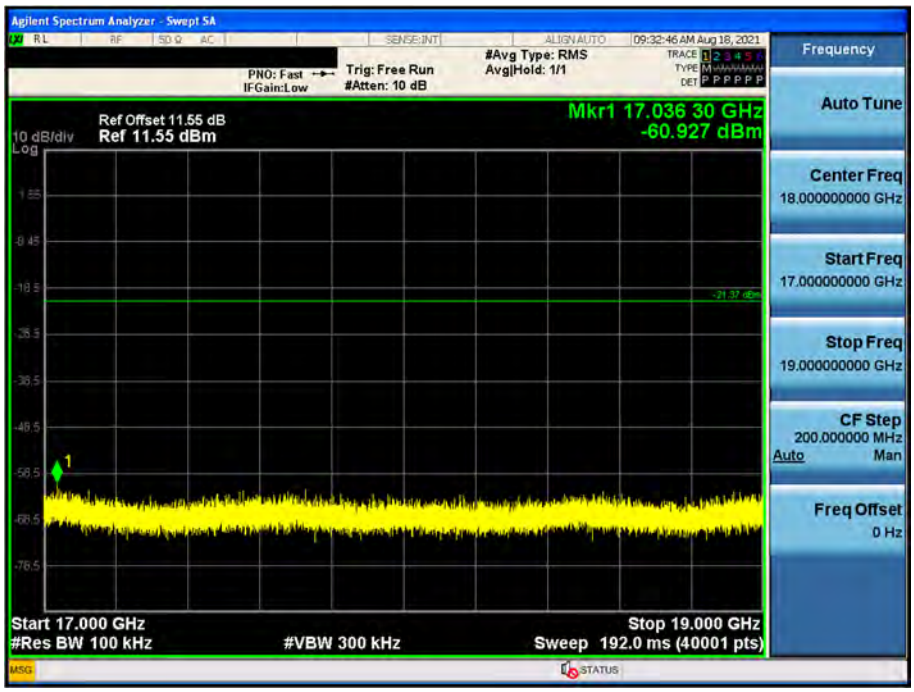
15 GHz ~ 17 GHz

Conducted Spurious Emission (CH 39)



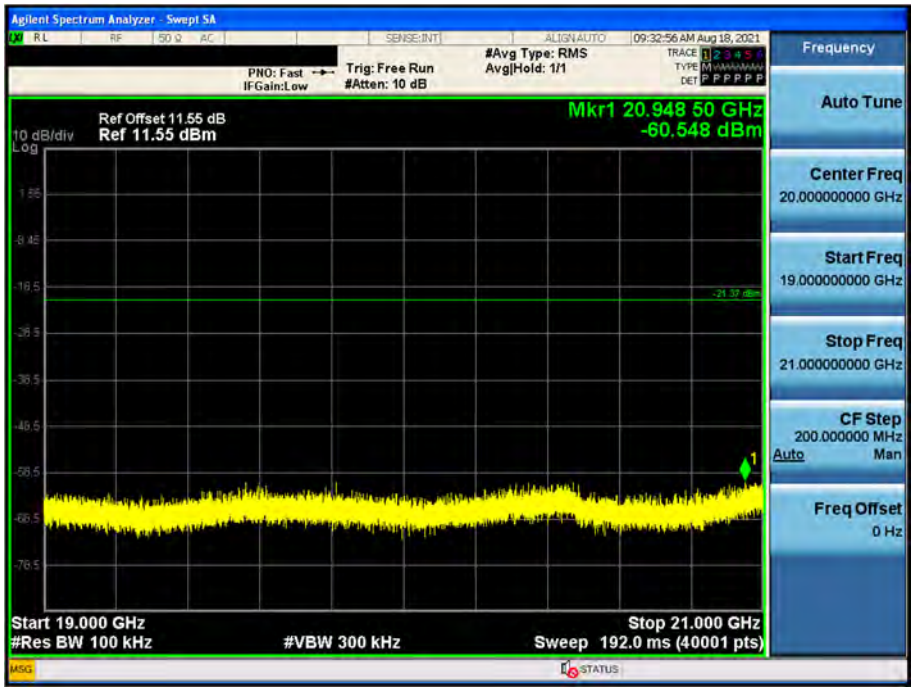
17 GHz ~ 19 GHz

Conducted Spurious Emission (CH 39)



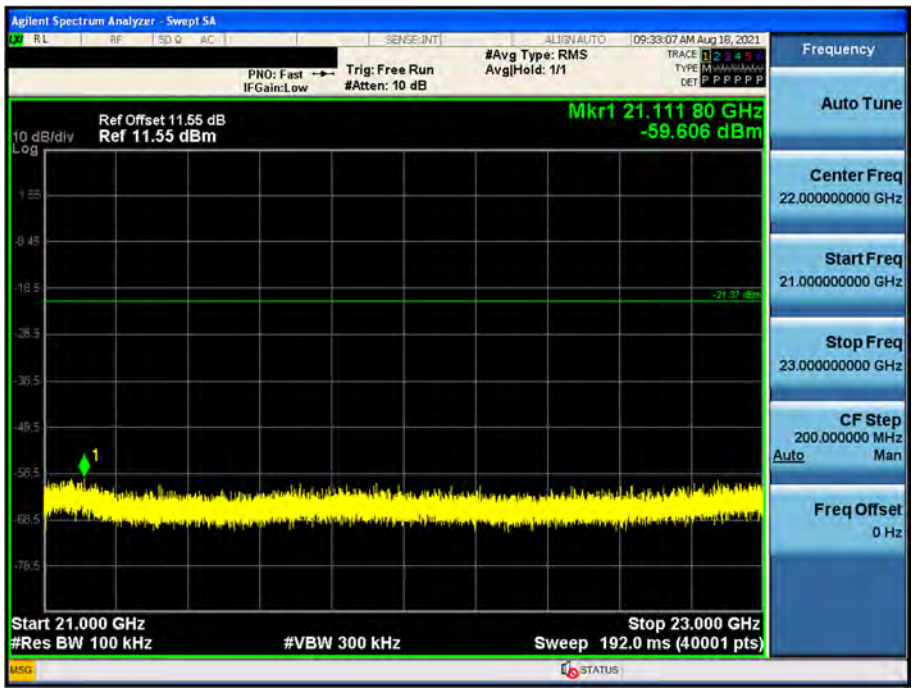
19 GHz ~ 21 GHz

Conducted Spurious Emission (CH 39)



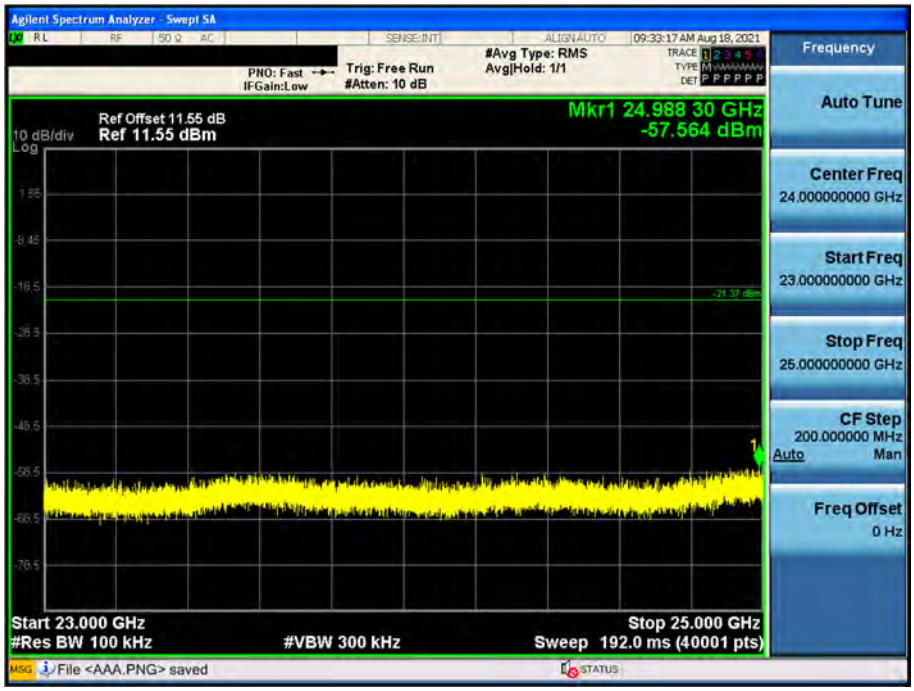
21 GHz ~ 23 GHz

Conducted Spurious Emission (CH 39)



23 GHz ~ 25 GHz

Conducted Spurious Emission (CH 39)



Limit : -21.37 dBm

9.6 RADIATED SPURIOUS EMISSIONS

Frequency Range : 9 kHz – 30 MHz

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

Note:

1. The Measured level 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 = 40log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBμV) + 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	Measured level	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμV/m	dBm/m	dBm	(H/V)	dBμV/m	dBμV/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

- SL300

Operation Mode: Zigbee

Operating Frequency 2405

Channel No. CH 11

Frequency	Reading	D.C.C.F	AN.+CL-AMP G	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	dBμV	Factor	[dB]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
4810	52.39	0.00	2.76	V	55.15	73.98	18.83	PK
4810	46.05	-15.49	2.76	V	33.31	53.98	20.67	AV
7215	58.58	0.00	8.96	V	67.54	73.98	6.44	PK
7215	48.64	-15.49	8.96	V	42.10	53.98	11.88	AV
4810	55.40	0.00	2.76	H	58.16	73.98	15.82	PK
4810	46.67	-15.49	2.76	H	33.93	53.98	20.05	AV
7215	52.48	0.00	8.96	H	61.44	73.98	12.54	PK
7215	45.98	-15.49	8.96	H	39.44	53.98	14.54	AV

Operation Mode: Zigbee

Operating Frequency 2440

Channel No. CH 18

Frequency	Reading	D.C.C.F	AN.+CL-AMP G	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	dBμV	Factor	[dB]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
4880	50.24	0.00	3.15	V	53.39	73.98	20.59	PK
4880	43.98	-15.49	3.15	V	31.63	53.98	22.35	AV
7320	57.32	0.00	9.45	V	66.77	73.98	7.21	PK
7320	47.44	-15.49	9.45	V	41.40	53.98	12.58	AV
4880	54.17	0.00	3.15	H	57.32	73.98	16.66	PK
4880	45.83	-15.49	3.15	H	33.48	53.98	20.50	AV
7320	51.83	0.00	9.45	H	61.28	73.98	12.70	PK
7320	46.56	-15.49	9.45	H	40.52	53.98	13.46	AV

Operation Mode: Zigbee

Operating Frequency 2480

Channel No. CH 26

Frequency	Reading	D.C.C.F	AN.+CL-AMP G	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	dBμV	[dB]	[dB]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
4960	50.85	0.00	2.23	V	53.08	73.98	20.90	PK
4960	42.16	-15.49	2.23	V	28.89	53.98	25.09	AV
7440	58.23	0.00	10.35	V	68.58	73.98	5.40	PK
7440	48.00	-15.49	10.35	V	42.86	53.98	11.12	AV
4960	52.50	0.00	2.23	H	54.73	73.98	19.25	PK
4960	43.47	-15.49	2.23	H	30.20	53.98	23.78	AV
7440	52.38	0.00	10.35	H	62.73	73.98	11.25	PK
7440	45.65	-15.49	10.35	H	40.51	53.98	13.47	AV

Note:

On time for one frame is 32 us/byte x 133 bytes = 4.256 ms

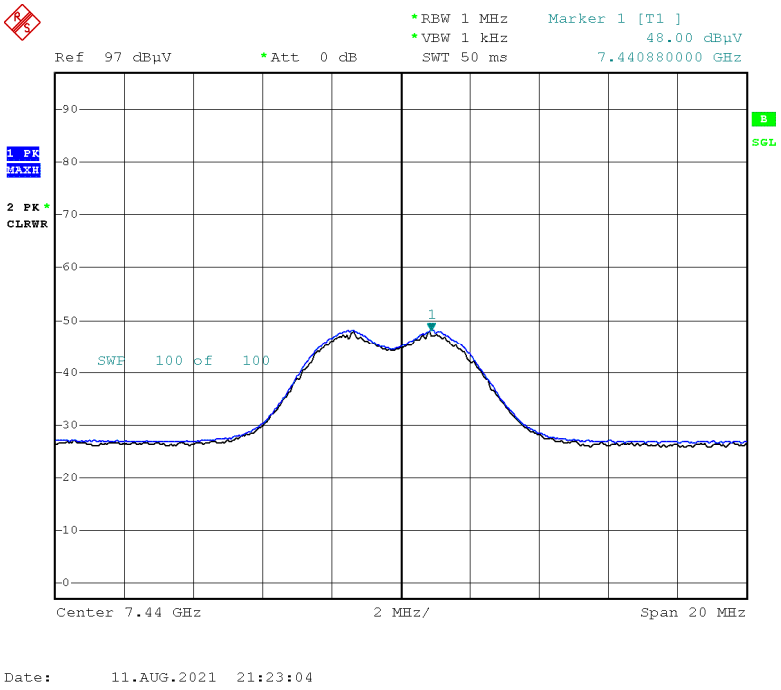
4 frames are transmitted for a total on time is 17.024 ms(4.256 ms x 4 frames)

DCCF = 20xlog(17.024 ms/100 ms) = -15.3788 dB

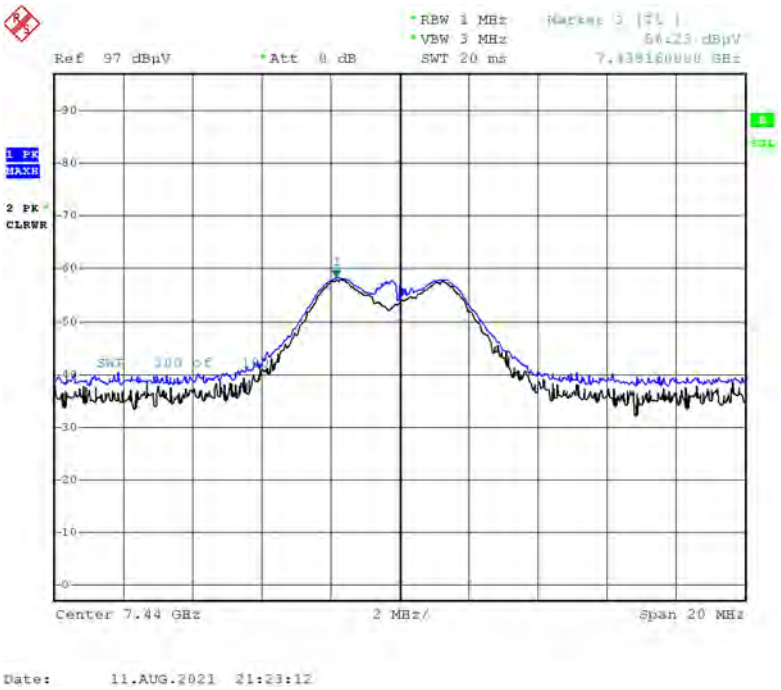
DCCF = -15.38 dB

▣ Test Plots

Radiated Spurious Emissions plot – Average Reading (CH.26 3rd Harmonic)



Radiated Spurious Emissions plot – Peak Reading (CH.26 3rd Harmonic)



Note:

Plot of worst case are only reported.

- SL300E

Operation Mode: Zigbee

Operating Frequency 2480

Channel No. CH 26

Frequency	Reading	D.C.C.F	AN.+CL-AMP G	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	dBµV	Factor	[dB]	[H/V]	[dBµV/m]	[dBµV/m]	[dB]	
7440	43.60	0.00	10.35	V	53.95	73.98	20.03	PK
7440	31.97	-15.49	10.35	V	26.83	53.98	27.15	AV

Note:

On time for one frame is 32 us/byte x 133 bytes = 4.256 ms

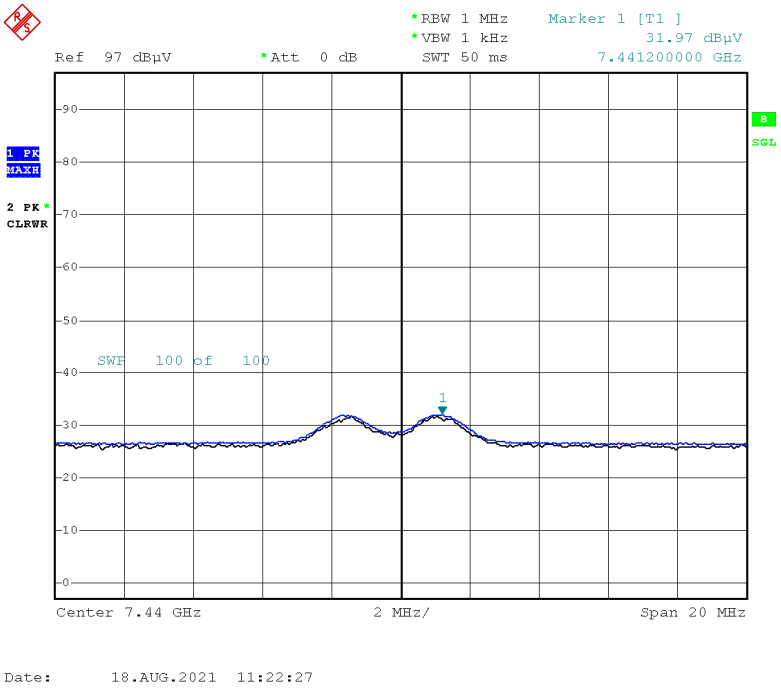
4 frames are transmitted for a total on time is 17.024 ms(4.256 ms x 4 frames)

DCCF = 20xlog(17.024 ms/100 ms) = -15.3788 dB

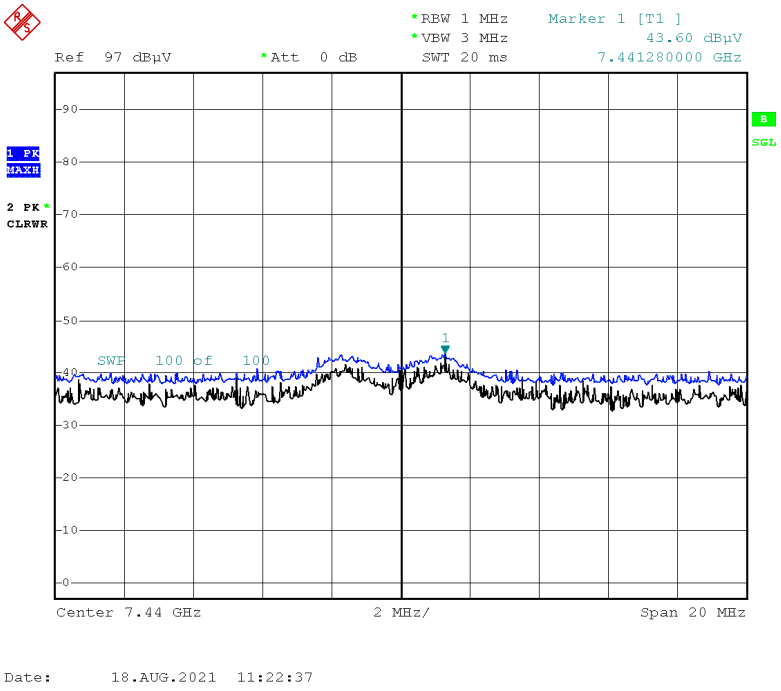
DCCF = -15.38 dB

▣ Test Plots

Radiated Spurious Emissions plot – Average Reading (CH.26 3rd Harmonic)



Radiated Spurious Emissions plot – Peak Reading (CH.26 3rd Harmonic)



Note:

Plot of worst case are only reported.

9.7 RADIATED RESTRICTED BAND EDGES

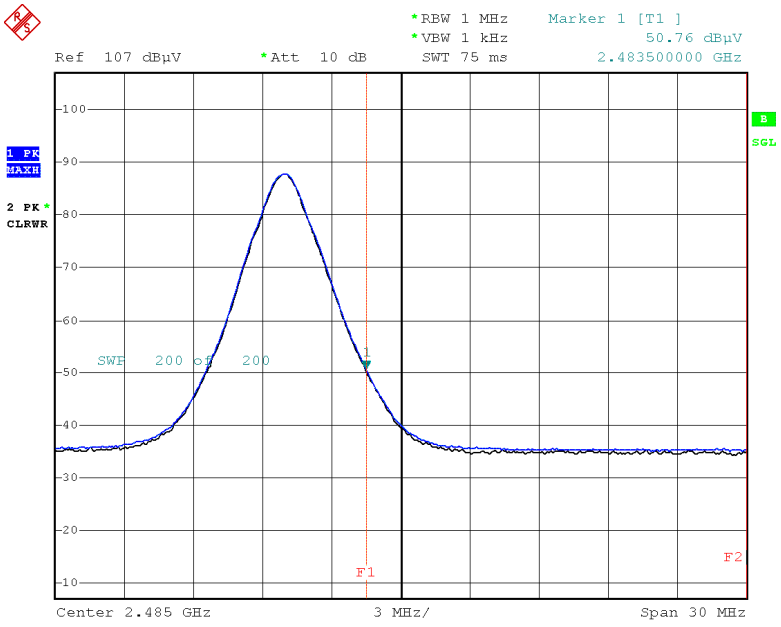
- **SL300**

Operation Mode:	Zigbee
Operating Frequency	2405 MHz & 2480 MHz
Channel No.	11 Ch & 26 ch

Frequency	Reading	D.C.C.F	AN.+CL-AMP G	ANT. POL	Total	Limit	Margin	Measurement
[MHz]	dBµV	[dB]	[dB]	[H/V]	[dBµV/m]	[dBµV/m]	[dB]	Type
2390.0	49.57	0.00	0.75	H	50.32	73.98	23.66	PK
2390.0	38.69	-15.49	0.75	H	23.94	53.98	30.04	AV
2390.0	46.96	0.00	0.75	V	47.71	73.98	26.27	PK
2390.0	33.07	-15.49	0.75	V	18.32	53.98	35.66	AV
2483.5	59.11	0.00	1.34	H	60.45	73.98	13.53	PK
2483.5	50.76	-15.49	1.34	H	36.61	53.98	17.37	AV
2483.5	57.91	0.00	1.34	V	59.25	73.98	14.73	PK
2483.5	50.27	-15.49	1.34	V	36.12	53.98	17.86	AV

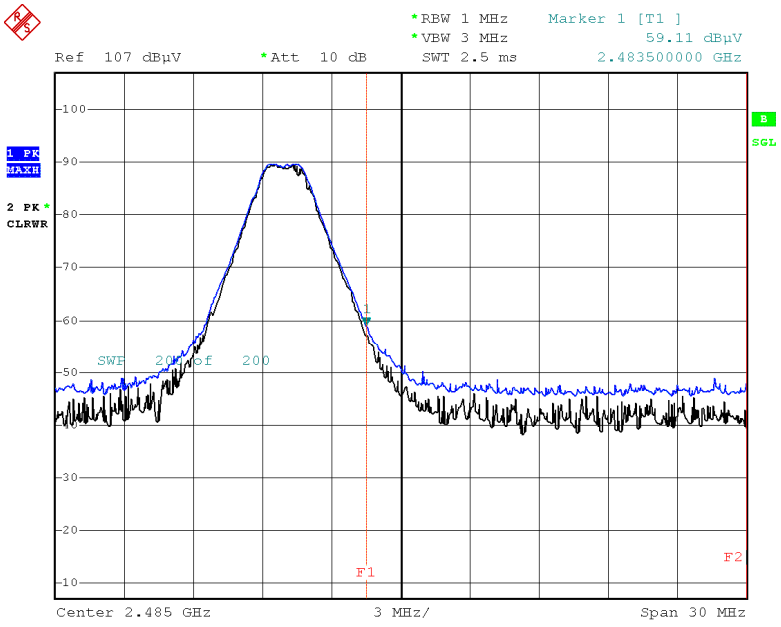
▣ Test Plots

Radiated Restricted Band Edges plot – Average Reading (CH.26: 2480 MHz)



Date: 11.AUG.2021 21:19:19

Radiated Restricted Band Edges plot – Peak Reading (CH.26: 2480 MHz)※



Date: 11.AUG.2021 21:19:30

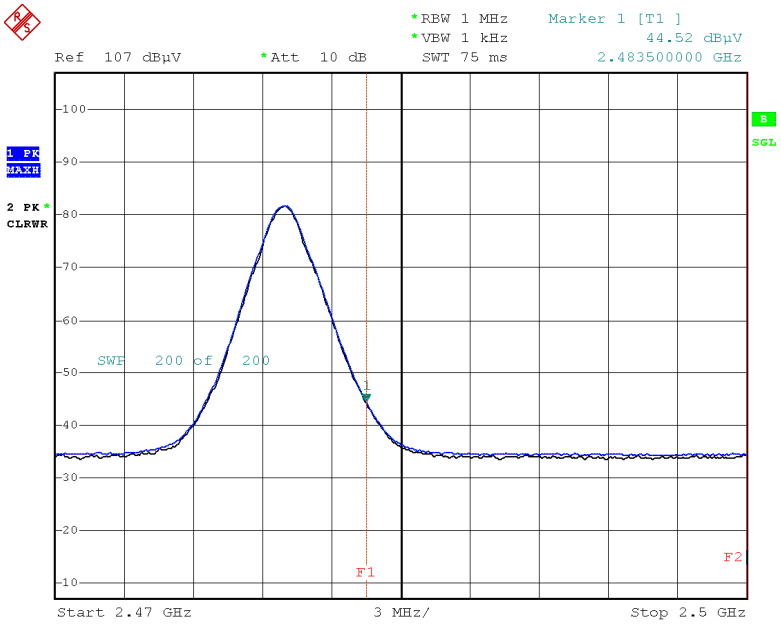
- **SL300E**

Operation Mode:	Zigbee
Operating Frequency	2405 MHz & 2480 MHz
Channel No.	26 ch

Frequency	Reading	D.C.C.F	AN.+CL-AMP G	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	dBµV	[dB]	[dB]	[H/V]	[dBµV/m]	[dBµV/m]	[dB]	
2483.5	53.38	0.00	1.34	H	54.72	73.98	19.26	PK
2483.5	44.52	-15.49	1.34	H	30.37	53.98	23.61	AV

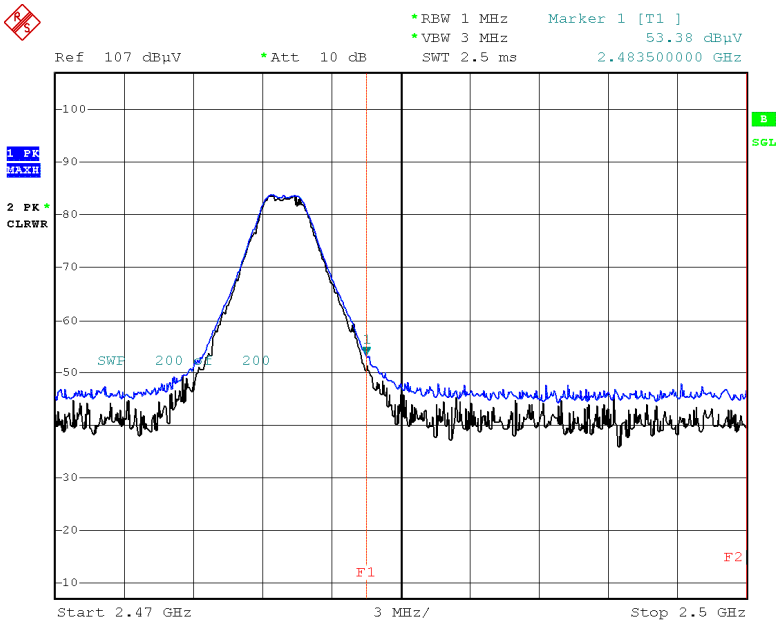
▣ Test Plots

Radiated Restricted Band Edges plot – Average Reading (CH.26: 2480 MHz)



Date: 18.AUG.2021 11:12:01

Radiated Restricted Band Edges plot – Peak Reading (CH.26: 2480 MHz)



Date: 18.AUG.2021 11:12:13

9.8 RECEIVER SPURIOUS EMISSIONS

Frequency Range : Below 1 GHz

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

11. LIST OF TEST EQUIPMENT

Conducted Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
LISN	ENV216	Rohde & Schwarz	102245	09/04/2021	Annual
Test Receiver	ESCI	Rohde & Schwarz	100033	06/15/2022	Annual
Temperature Chamber	SU-642	ESPAC	0093008124	03/15/2022	Annual
Signal Analyzer	N9020A	Agilent	MY47380318	01/28/2022	Annual
Signal Analyzer	N9030A	Agilent	MY49431210	01/11/2022	Annual
Power Meter	N1911A	Agilent	MY45100523	04/08/2022	Annual
Power Sensor	N1921A	Agilent	MY57820067	04/08/2022	Annual
Directional Coupler	87300B	Agilent	3116A03621	11/10/2021	Annual
Power Splitter	11667B	Hewlett Packard	05001	05/20/2022	Annual
DC Power Supply	E3632A	Hewlett Packard	KR75303960	06/10/2022	Annual
Attenuator (10 dB)	5910-N-50-010	H+S	00801	10/28/2021	Annual
Software	EMC32	Rohde & Schwarz	N/A	N/A	N/A
FCC WLAN&BT&BLE Conducted Test Software v3.0	FCC WLAN&BT&BLE Conducted Test Software v3.0	HCT CO., LTD.	N/A	N/A	N/A
Bluetooth Tester	CBT	Rohde & Schwarz	100422	05/04/2022	Annual

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

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
Controller (Antenna mast)	CO3000	Innco system	CO3000-4p	N/A	N/A
Antenna Position Tower	MA4640/800-XP-EP	Innco system	N/A	N/A	N/A
Controller	2090	Emco	060520	N/A	N/A
Turn Table	Turn Table	Ets	N/A	N/A	N/A
Loop Antenna	Loop Antenna	Rohde & Schwarz	1513-333	03/19/2022	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	9168-0895	09/04/2022	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	9120D-1191	11/18/2021	Biennial
Horn Antenna (15 GHz ~ 40 GHz)	BBHA9170	Schwarzbeck	BBHA9170541	11/29/2021	Biennial
Spectrum Analyzer	FSP (9 kHz ~ 30 GHz)	Rohde & Schwarz	836650/016	09/14/2021	Annual
Spectrum Analyzer	FSV40-N	Rohde & Schwarz	101068-SZ	09/22/2021	Annual
Band Reject Filter	WRCJV2400/2483.5-2370/2520-60/12SS	Wainwright Instruments	2	01/06/2022	Annual
Band Reject Filter	WRCJV5100/5850-40/50-8EEK	Wainwright Instruments	1	02/08/2022	Annual
Attenuator (10 dB) 56-10	CBLU1183540B-01 56-10	CERNEX WEINSCHEL	N/A	12/23/2021	Annual
Broadband Low Noise Amplifier Attenuator (3 dB)	CBL06185030 18B-03	CERNEX Api tech.	N/A	12/23/2021	Annual
High Pass Filter	WHKX10-2700-3000-18000-40SS	Wainwright Instruments	N/A	12/23/2021	Annual
High Pass Filter	WHKX8-6090-7000-18000-40SS	Wainwright Instruments	N/A	12/23/2021	Annual
Thru	COAXIAL ATTENUATOR	T&M SYSTEM	N/A	12/23/2021	Annual
Power Amplifier	CBL18265035	CERNEX	22966	12/04/2021	Annual
Power Amplifier	CBL26405040	CERNEX	25956	03/23/2022	Annual
Bluetooth Tester	TC-3000C	TESCOM	3000C000276	03/09/2022	Annual

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

12. ANNEX A_ TEST SETUP PHOTO

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

No.	Description
1	HCT-RF-2108-FC038-P