

FCC / IC Zigbee REPORT

Class II Permissive Change

FCC/ IC Applicant Name:

Sena Technologies, Inc.

Date of Issue:

November 14, 2018

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Korea

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(Republic Of)

Report No.: HCT-RF-1811-FI003

FCC ID:	S7A-SP57
IC:	8154A-SP57
APPLICANT:	Sena Technologies, Inc.

Model: SP57

EUT Type: Motorcycle Bluetooth Communication System with Mesh Intercom

Frequency Range: 2410 MHz - 2475 MHz (Zigbee Mode)

Modulation type: O-QPSK

FCC Classification: Digital Transmission System(DTS)

FCC Rule Part(s): Part 15.247

IC Rule Part(s): 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)



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Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-RF-1811-FI003	November 14, 2018	- First Approval Report

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1. EUT DESCRIPTION

Model	SP57
EUT Type	Motorcycle Bluetooth Communication System with Mesh Intercom
Power Supply	DC 3.70 V
Frequency Range	2410 MHz ~ 2475 MHz
Modulation Type	O-QPSK
Number of Channels	14 Channels
Antenna Specification	Antenna type: PCB Pattern Antenna Peak Gain : 0.21 dBi
Date(s) of Tests	October 22, 2018 ~ November 01, 2018

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 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 September 18, 2018(Registration Number: 5944A-6)

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 ($\pm$ 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

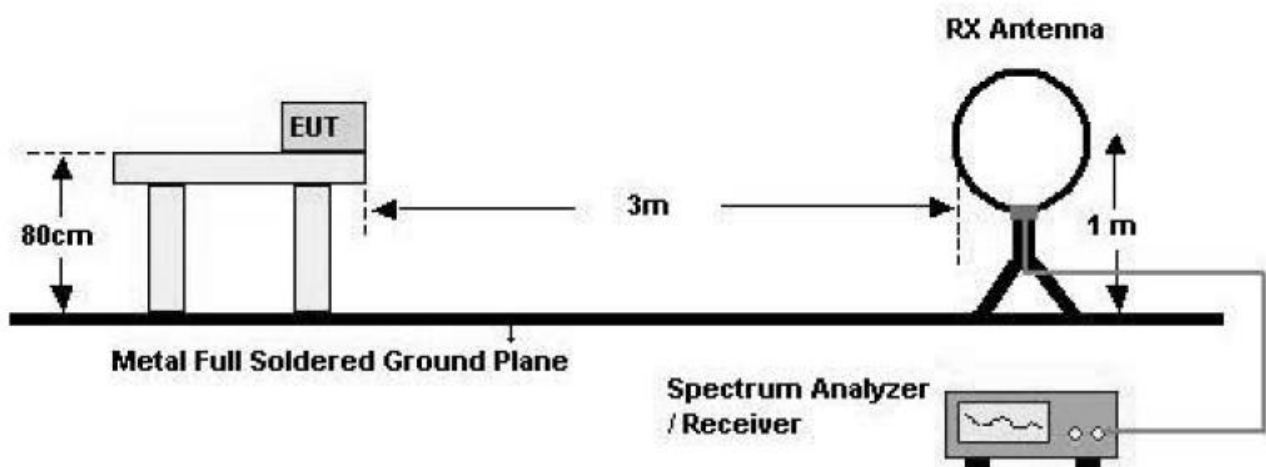
7.1. Radiated Test

Limit

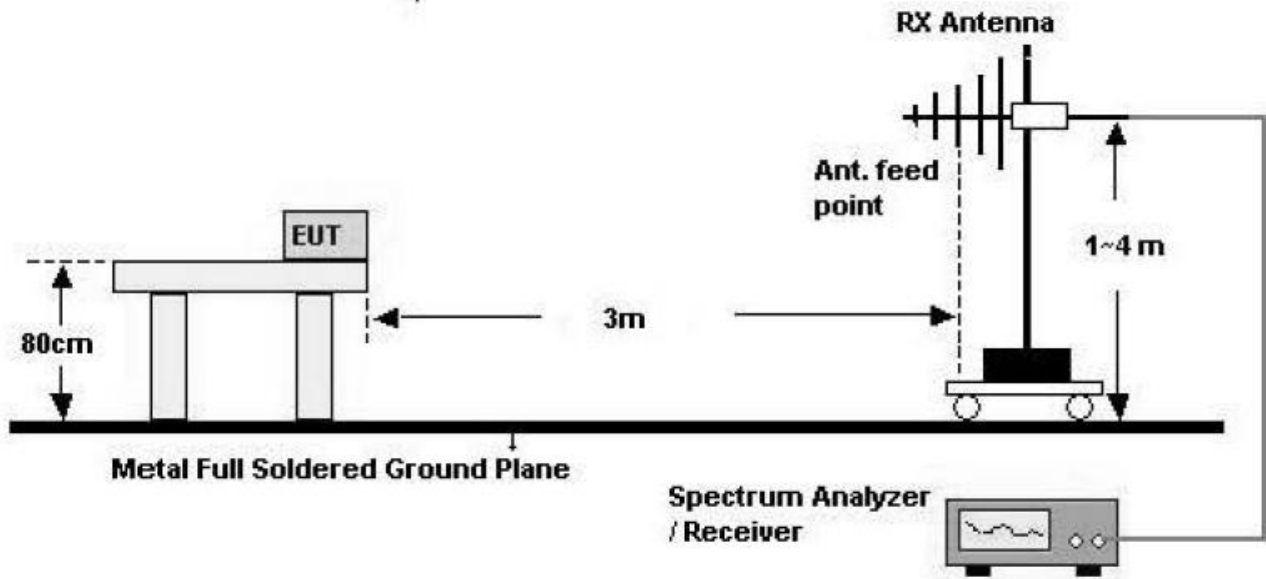
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

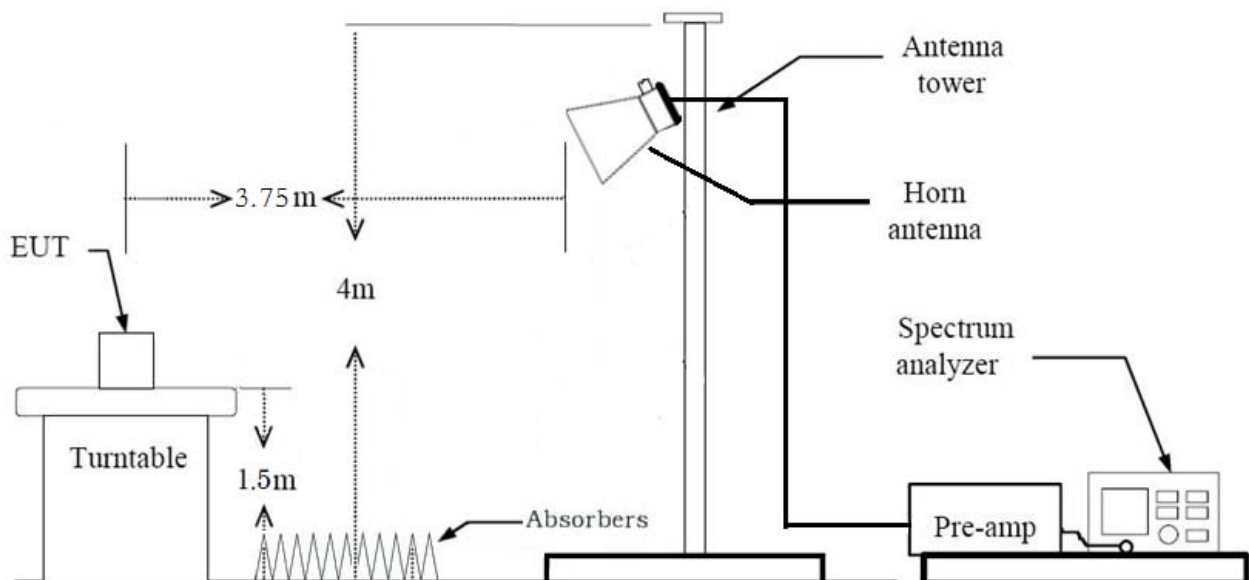
Below 30 MHz



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 = $20 \cdot \log (\text{test distance} / \text{specific distance})$ (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 $\geq 3 \cdot \text{RBW}$

(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 = $20 \cdot \log_{10}(\text{Pulse width} / \text{Period of the pulse train})$

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)

= Peak Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)
+ Distance Factor(D.F) + Duty Cycle Correction 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 = $20 \cdot \log (\text{test distance} / \text{specific distance})$ (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, 11.13 in ANSI 63.10-2013)

(1) Measurement Type(Peak):

- Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
- Detector = Peak
- Trace = Maxhold
- RBW = 1 MHz
- VBW $\geq 3 \cdot \text{RBW}$

(2) Measurement Type(Peak Integration method):

- Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).
- RBW = 100 kHz.
- VBW $\geq [3 \times \text{RBW}]$.
- Detector = peak.
- Sweep time = auto.
- Trace mode = max hold.

(3) 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 = $20 \cdot \log_{10}(\text{Pulse width} / \text{Period of the pulse train})$

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)

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

7.2. Receiver Spurious Emissions

Limit

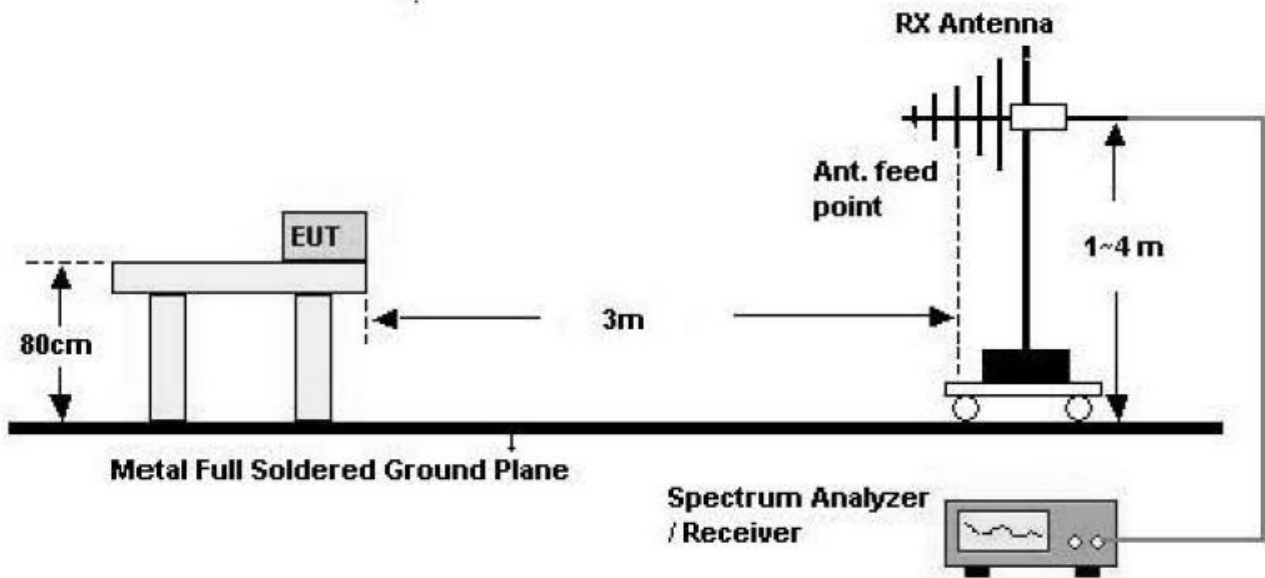
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

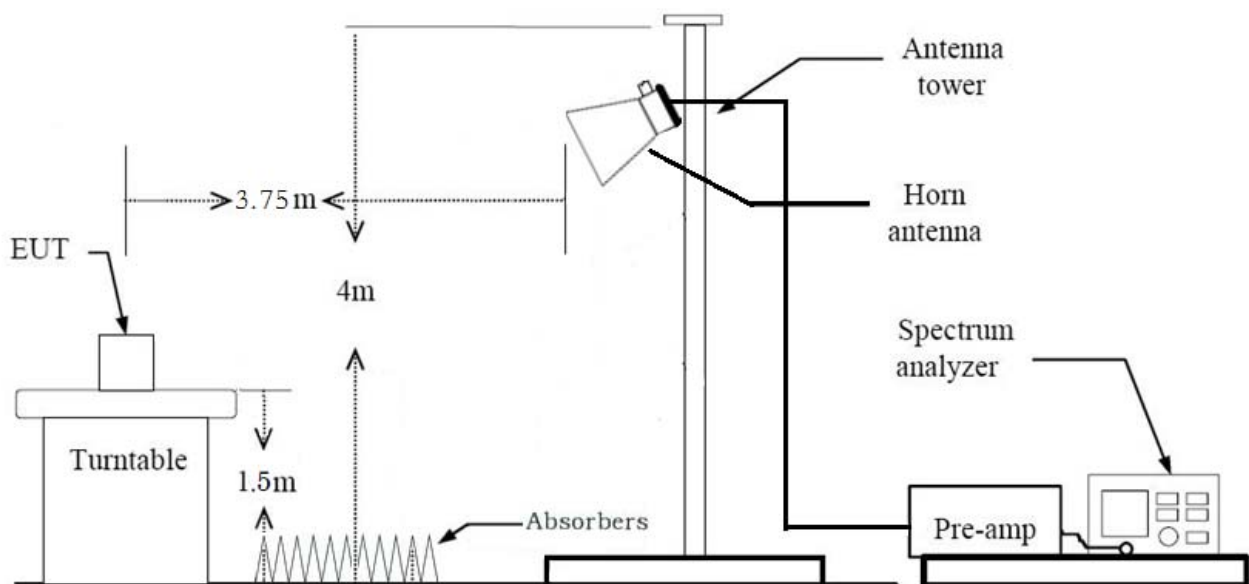
Measurements for compliance with the limits in table may be performed at distances other than 3 meters.

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 = $20 \cdot \log (\text{test distance} / \text{specific distance})$ (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 $\geq 3 \cdot \text{RBW}$
 - (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 $\geq 1/\tau$ 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)

7.3. 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 : X
3. Duty cycle factor applies (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

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	NT ^{Note1}
Occupied Bandwidth	N/A	RSS-GEN, 6.7	N/A		NT ^{Note1}
Conducted Maximum Peak Output Power	§15.247(b)(3)	RSS-247, 5.4.(d)	< 1 Watt		NT ^{Note1}
Power Spectral Density	§15.247(e)	RSS-247, 5.2.(b)	< 8 dBm / 3 kHz Band		NT ^{Note1}
Band Edge (Out of Band Emissions)	§15.247(d)	RSS-247, 5.5	Conducted > 20 dBc		NT ^{Note1}
AC Power line Conducted Emissions	§15.207	RSS-GEN, 8.8	<u>See Note1</u>		NT ^{Note1}
Radiated Spurious Emissions	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9	cf. Section 7.1	Radiated	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9 RSS-GEN, 8.10	cf. Section 7.1		PASS
Receiver Spurious Emissions	N/A	RSS-GEN, 7.3	cf. Section 7.2		PASS

Note:

1. NT = Not Tested, NA = Not Applicable

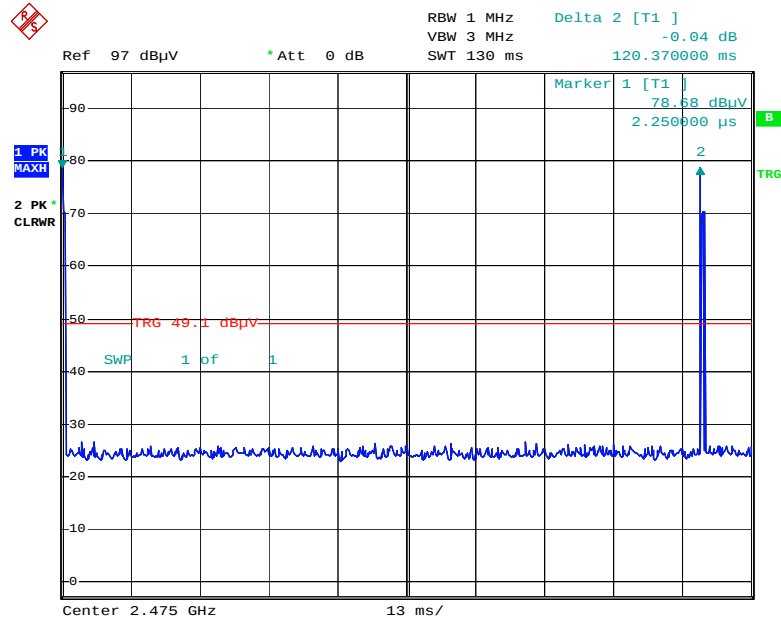
9. TEST RESULT

9.1 DUTY CYCLE

DCCF = $20 \cdot \log_{10}(\text{Pulse width} / \text{Period of the pulse train})$

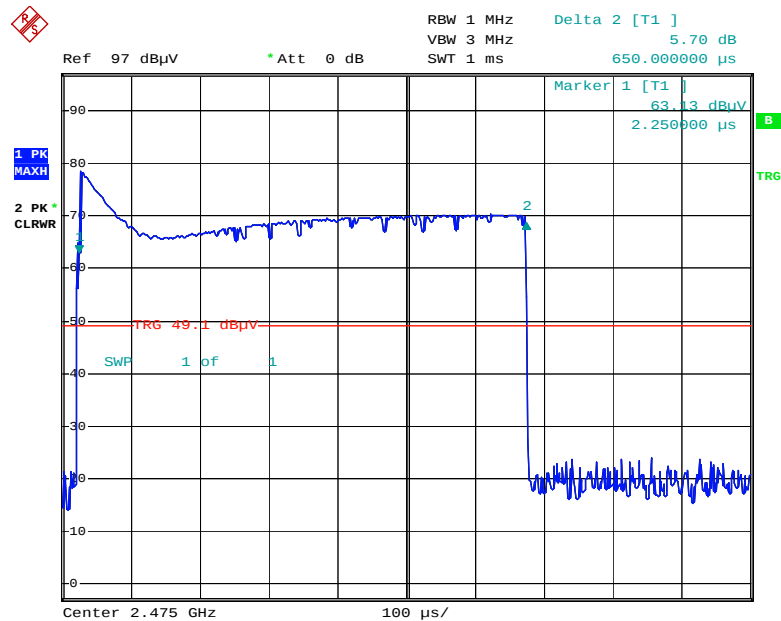
$$= 20 \cdot \log_{10}(1 \times 0.65 \text{ ms} / 100 \text{ ms}) = -43.74 \text{ dB}$$

Period



Date: 22.OCT.2018 07:27:16

Pulse width



Date: 22.OCT.2018 07:27:46

9.2 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 = $40 \cdot \log(\text{specific distance} / \text{test distance})$ (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: 2410

Channel No. CH 12

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.- A.G+D.F. [dB]	ANT. POL [H/V]	Duty Cycle Correction [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4820	68.49	-0.42	V	0	68.07	73.98	5.91	PK
4820	68.49	-0.42	V	-43.74	24.33	53.98	29.65	AV
7230	64.96	5.40	V	0	70.36	73.98	3.63	PK
7230	64.96	5.40	V	-43.74	26.61	53.98	27.37	AV
4820	68.04	-0.42	H	0	67.62	73.98	6.36	PK
4820	68.04	-0.42	H	-43.74	23.88	53.98	30.10	AV
7230	63.17	5.40	H	0	68.57	73.98	5.42	PK
7230	63.17	5.40	H	-43.74	24.82	53.98	29.16	AV

Operation Mode: Zigbee

Operating Frequency: 2445

Channel No. CH 19

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.- A.G+D.F. [dB]	ANT. POL [H/V]	Duty Cycle Correction [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4890	68.22	-0.27	V	0	67.96	74	6.05	PK
4890	68.22	-0.27	V	-43.74	24.21	54	29.79	AV
7335	62.39	5.42	V	0	67.81	74	6.19	PK
7335	62.39	5.42	V	-43.74	24.07	54	29.93	AV
4890	67.94	-0.27	H	0	67.68	74	6.33	PK
4890	67.94	-0.27	H	-43.74	23.93	54	30.07	AV
7335	61.47	5.42	H	0	66.89	74	7.11	PK
7335	61.47	5.42	H	-43.74	23.15	54	30.85	AV

Operation Mode: Zigbee

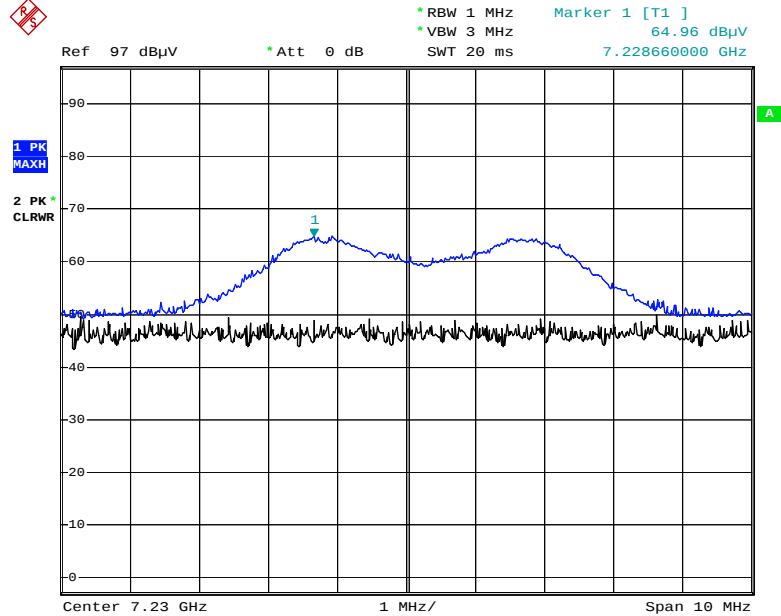
Operating Frequency: 2475

Channel No. CH 25

Frequency [MHz]	Reading [dBuV]	A.F.+C.L.- A.G+D.F. [dB]	ANT. POL [H/V]	Duty Cycle Correction [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4950	66.01	-0.67	V	0	65.34	74.00	8.66	PK
4950	66.01	-0.67	V	-43.74	21.60	54.00	32.40	AV
7425	58.00	5.70	V	0	63.70	74	10.30	PK
7425	58.00	5.70	V	-43.74	19.96	54	34.04	AV
4950	64.87	-0.67	H	0	64.20	74	9.80	PK
4950	64.87	-0.67	H	-43.74	20.46	54	33.54	AV
7425	56.69	5.70	H	0	62.39	74	11.61	PK
7425	56.69	5.70	H	-43.74	18.65	54	35.35	AV

■ Test Plots(Worst case : X-V)

Radiated Spurious Emissions plot – Peak Reading (CH.12 3rd Harmonic)



Date: 22.OCT.2018 13:17:15

Note:

Plot of worst case are only reported.

9.3 RADIATED RESTRICTED BAND EDGES

Operation Mode: Zigbee

Operating Frequency: 2410 MHz

Channel No. 12 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
2390.0	32.49	34.42	H	0	66.91	73.98	7.07	PK
2390.0	32.49	34.42	H	-43.74	23.17	53.98	30.81	AV
2390.0	31.74	34.42	V	0	66.16	73.98	7.82	PK
2390.0	31.74	34.42	V	-43.74	22.42	53.98	31.56	AV

Operation Mode: Zigbee

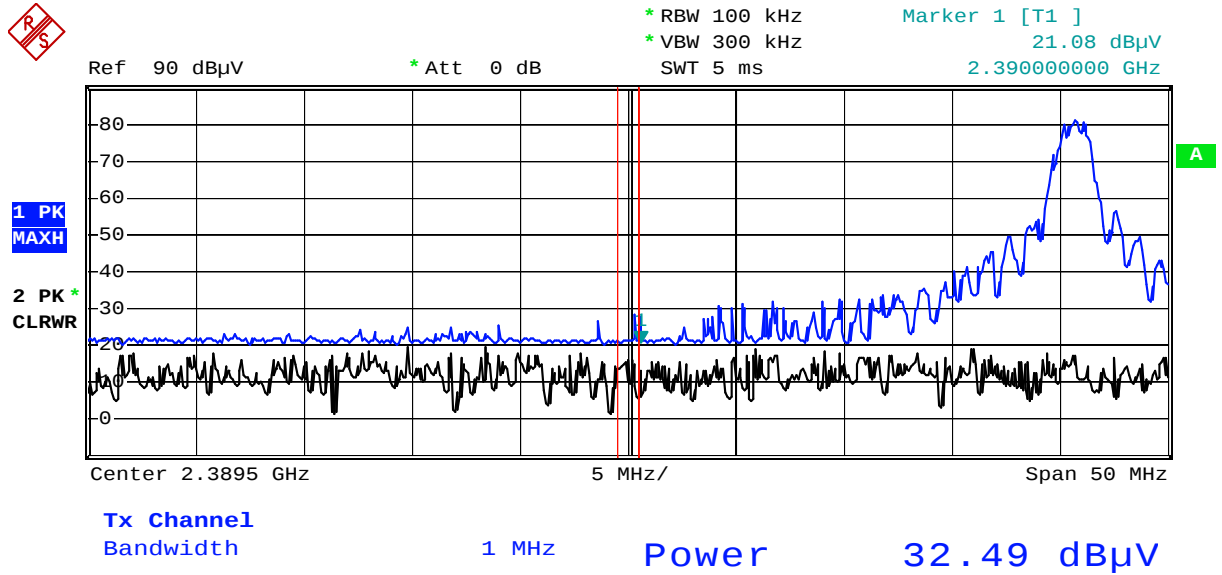
Operating Frequency: 2475 MHz

Channel No. 25 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	36.57	33.59	H	0	70.16	73.98	3.82	PK
2483.5	36.57	33.59	H	-43.74	26.42	53.98	27.56	AV
2483.5	35.84	33.59	V	0	69.43	73.98	4.55	PK
2483.5	35.84	33.59	V	-43.74	25.69	53.98	28.29	AV

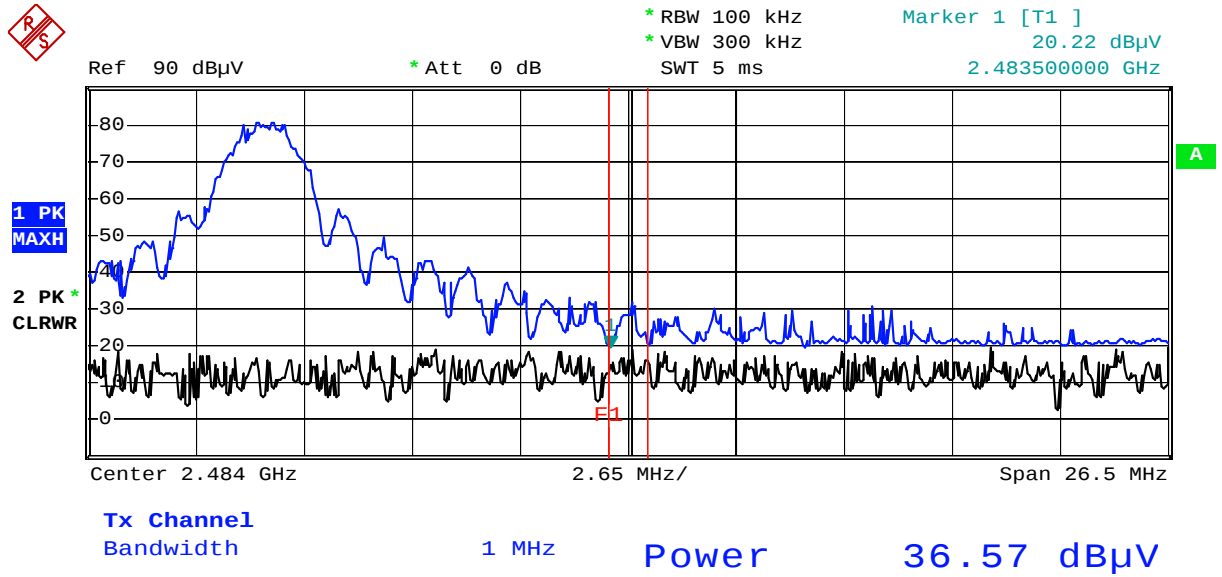
■ Test Plots

Radiated Restricted Band Edges plot – Peak Reading (CH.12, X-H)



Date: 23.OCT.2018 10:02:24

Radiated Restricted Band Edges plot – Peak Reading (CH.25 X-H)



Date: 23.OCT.2018 09:51:25

Note:

Plot of worst case are only reported.

9.4 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							

10. LIST OF TEST EQUIPMENT

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 9160 / Hybrid Antenna	08/09/2018	Biennial	3368
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	09/03/2018	Annual	100688
Rohde & Schwarz	FSV40-N / Spectrum Analyzer	09/28/2018	Annual	101068-SZ
Wainwright Instruments	WHK3.0/18G-10EF / High Pass Filter	06/07/2018	Annual	8
Wainwright Instruments	WHKX7.0/18G-8SS / High Pass Filter	05/09/2018	Annual	29
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	1
Agilent	8493C-10 / Attenuator(10 dB)	07/17/2018	Annual	08285
CERNEX	CBLU1183540 / Power Amplifier	07/10/2018	Annual	22964
CERNEX	CBL06185030 / Power Amplifier	07/10/2018	Annual	22965
CERNEX	CBL18265035 / Power Amplifier	01/10/2018	Annual	22966
CERNEX	CBL26405040 / Power Amplifier	06/29/2018	Annual	25956
TESCOM	TC-3000C / Bluetooth Tester	03/27/2018	Annual	3000C000276

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-1811-FI003-P