

**Electromagnetic Compatibility
INTENTIONAL RADIATOR
TEST REPORT
IC RSS-210; FCC 47 CFR Part 15/C 15.247**

Report Reference No.: E10612-1403A Rev 2.0
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Testing Laboratory.....: Quality Auditing Institute
Address.....: 16 – 211 Schoolhouse Street, Coquitlam, BC, V3K 4X9, Canada

Accreditations (ISO 17025):



Standard Council of Canada: Accredited Laboratory No. 743

International Accreditation Service Inc. : Accredited Laboratory: No. TL-239

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Applicant's name: LED Roadway Lighting Ltd.
Address.....: 115 Chain Lake Drive, Halifax Nova Scotia B3S1B3 Canada
Contact.....: Simon Lightbody, slightbody@ledroadwaylighting.com
Phone.....: (250)544-0143

Test Standard.....: RSS-210 Issue 8, FCC 47 CFR Part15 Subpart C 15.247

Test item description.....: IEEE 802.15.4 Wireless module

Model.....: ASM0115

Trade Mark



Manufacturer.....: LED Roadway Lighting Ltd.

Registrations: : FCC ID: 2ACR30115
IC: 12047A-0115



ASM0115 Module installed onto Demo PCB



ASM0115 Module installed onto LED Roadway PCB

Revision History

Date	Report Number	Rev #	Details	Authors Initials
Sep 05, 2014	E10612-1403A	0.0	Draft Test Report	DJ
Sep 09, 2014	E10612-1403A	1.0	Client changes added and final Release	DJ
Sep 16, 2014	E10612-1403A	2.0	Page 5 updated Statement of Compliance table Page 19 – updated version number of KDB 558074 Page 11-14 – added 99% OBW plots Page 29-30 – added RF Exposure evaluation	DJ
<i>Note: All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.</i>				

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Statement of Compliance

The following tests demonstrate testimony for the FCC & IC Marks for Transceivers / electromagnetic compatibility testing for this EUT as required by FCC Part 15 Section 15.247 and IC RSS-210 Appendix8.

Test / Requirement Description	Applicable FCC Rule Parts	Applicable Industry Canada Rule Parts	Results		Pass / Fail
			Limit	Measured	
Antenna Requirement	15.203	RSS-Gen (7.1.2)	Approved Antenna	PCB Antenna	Pass
Maximum Peak Conducted Output Power Level	15.247 (b)(3)	RSS-210 A8.4(4)	Max Peak: 1W Max Peak EIRP 4W	19.6dBm 91mW	Pass
Emission Bandwidth (EBW)	15.247(a)(2);	RSS-210 A8.2(a)	Min. 500kHz	1.62MHz (6dB) 2.42MHz (99%)	Pass
Spurious Emissions at antenna terminals	15.247 (d)	RSS-210 A8.5	Min 20dBc	22.2dBc	Pass
Spurious Emissions Radiated Field Strength	15.247 (d) 15.205 (c)	RSS-210 A8.5 RSS-Gen	Min 20dBc and 54dBuV	1.8dB Margin	Pass
Maximum Power Spectral Density Level in Fundamental Emission	15.247 (e)	RSS-210 A8.2(b)	8dBm	3.94dBm	
Frequency Stability	15.215 (c)	RSS-Gen	+/- 5.0ppm	+/-4.2ppm	Pass
Duty Cycle Correction	15.247(a)(1) (iii)	RSS-Gen.		17.6dB	Pass
RF Exposure Evaluation Safe Distance for General Population for 1mW/cm ²	1.1307(b) 15.247 (b)(5)	Safety Code 6 RSS-Gen (5.6) and RSS-102 (2.5)	>20cm	4cm	Pass

Tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with CFR 47 FCC Part 15 and Industry Canada RSS-210. The manufacturer is responsible for the tested product configuration, continued product compliance with these standards listed, and for the appropriate auditing of subsequent products as required.

X

Tested By & Report Written By David Johanson,
RF/EMC Test Engineer

X

Reviewed By Amandeep Jathaul
RF/EMC Test Engineer

Testing Location and Procedures

Testing Laboratory:	Quality Auditing Institute
Testing location/ address	16 – 211 Schoolhouse Street, Coquitlam, BC, 3K 4X9, Canada
Associated Laboratory.....:	Quality Auditing Institute (Remote location)
Testing location/ address	19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada
FCC Test Site Registration Number (OATS 10m and SAC-3m):	226383
FCC Accredited CAB Designation Number:	CA9543
FCC Accredited Test Firm Registration #:	388697
Industry Canada Site Registration Number (SAC-3m).....:	9543B-1
Industry Canada Test Site Registration Number (OATS-10m)..:	9543C-1
Tested by: David Johanson Reviewed by.....: Aman Jathaul	
Sample Information:	
Product Name.....:	IEEE 802.15.4 Wireless Communications Module
Part Number.....:	ASM0115
Company:.....:	LED Roadway
Received Date:.....:	03July2014
Received By.....:	Aman Jathaul
Sample Log.....:	QAI Product Control Log (QM 1301 - Sample Inventory)
Environmental Conditions:	
Indoor:	Temperature: 22°C R.H.: 40.0%

Measurement Uncertainty

Radio Frequency: $\pm 1,5 \times 10^{-5}$ MHz
Total RF power, conducted.....: ± 1 dB
RF power density, conducted.....: ± 2.75 dB
Spurious emissions, conducted.....: ± 3 dB
All emissions, radiated.....: ± 3.5 dB
Temperature.....: $\pm 1^{\circ}\text{C}$
Humidity.....: ± 5 %
DC and low frequency voltages.....: ± 3 %

Test Bench Equipment List

Manufacturer	Model	Description	Serial No.	Last Cal	Cal Due Date
Tektronix	TDS754C	Oscilloscope	B012403	10-Oct-2013	10-Oct-2016
HP	8648C	Signal Generator	3623A03622	30-Oct-2012	30-Oct-2015
Boonton	4200-S/17	RF MicroWattmeter	430519 BG	13-Mar-2013	13-Mar-2016
Boonton	51033-6E	Power Sensor 100kHz-18GHz	15779	18-Mar-2013	18-Mar-2016
Rohde & Schwarz	ESU40	EMI Receiver	100011	26-June-2012	26-Jun-2015
Rohde & Schwarz	ESCI	EMI Receiver	1000123	29-Mar-2012	29-Mar-2015

Semi-Anechoic Chamber Equipment List

Manufacturer	Model	Description	Serial No.	Last Cal	Cal Due Date
ETS Lindgren	2165	Turntable	00043677	N/A	N/A
ETS Lindgren	2125	Mast	00077487	N/A	N/A
Rohde & Schwarz	ESU40	EMI Receiver	100011	26-June-2012	26-Jun-2015
FCC	FCC-LISN-50-25-2	LISN	9927	30-Nov-2012	30-Nov-2015
EMCO	6502	60cm Active Loop Antenna 9kHz to 30MHz	2178	14-Jun-2013	10-Jun-2015
Sunol Sciences	JB3	Biconilog Antenna 30MHz – 3GHz	A042004	31-Oct-2012	31-Oct-2015
AILTECH/Eaton	94455-1	Biconical Antenna 20-200MHz	0931	14-Jun-2013	14-Jun-2016
EMCO	93146	Log Periodical Antenna 200-1000MHz	9811-5136	14-Jun-2013	10-Jun-2016
COM-POWER	AHA-118	Dual Ridge Horn Antenna 1-18GHz	711040	14-Jun-2013	14-Jun-2016
EMCO	3160-09	Pyramidal Horn Antenna 18-26GHz	9701-1071	30-Aug-2013	30-Aug-2016
EMCO	3160-10	Pyramidal Horn Antenna 26-40GHz	9708-1055	30-Aug-2013	30-Aug-2016
ETS Lindgren	S201	3 meter Semi-Anechoic Chamber	1030	N/A	N/A

Product Description

Introduction:

The ASM0115 is a IEEE 802.15.4 wireless communications module employed only in a number of LED Roadway Lighting Luminaire Control Systems. It plugs onto the application PCB, which varies with each application. It is the same module as produced by ST Microelectronics as part number SPZB32W1C1.1 (FCC ID: S9NZB32C1) and is licensed to be manufactured by LED Roadway. It comes with an integrated UFL connector for use with various antennas

ASM0115 requires +3.3VDC nominal to operate, which it receives from a regulated power supply on the application board.

EUT Test Configuration:

The ASM0115 (EUT) was provided preprogrammed with custom firmware for EMC compliance testing. It was provided with 2 modules.

One module was mounted to an LED Roadway PCB that is used to control an LED Street Light with a Molex 2.4GHz/5GHz Combo PCB antenna that comes with a 10cm (nom.) flexible cable. This PCB was used to verify the AC mains conducted emissions when connected to an AC power source in a typical normal configuration. It was powered using 120Vac 60Hz or 230Vac 50Hz.

The other module was mounted to an ST Microelectronics Demo Evaluation PCB. This PCB was used to verify the Radiated and RF Conducted emissions from the transmitter using a flexible cable connected to the UFL RF connector. It was powered using 3.3Vdc from an Auxiliary AC/DC power adapter.

The EUT was programmed using a USB interface and Hyperterminal command strings provided by LED Roadway. The EUT was verified in various orientations for the radiated emissions to find the worst case orientation. All radiated emissions were done with the EUT in the Horizontal orientation with the antenna in a vertical orientation which was designated the worst case orientation.

Equipment Under Test Information

Manufacturer	LED Roadway Lighting Ltd.
Product Name	IEEE 802.15.4 Wireless Communications Module
Model Name	ASM0115
Serial No.	PROTO-001 (Radiated) and PROTO-002 (conducted)

AC-DC Power Adapter

Manufacturer	MicroWC
Product Name	Switching power supply 5.0Vdc
Model	188594
Input	AC100-240V, 50/60Hz,
Output	DC 5.0V 1A

PC Laptop

Manufacturer	Dell
Product Name	Latitude D630
Model	Pp18L
Operating System	Windows
Software	Hyperterminal and LumenAppTest3.2.0.0-DEV

Controller Cabling Configuration

Description	Number of Lines	Connection Type	Load or Termination	Shielded	Ferrites
DC Power Cord from -AC Power	2	2.5mm barrel DC plug	No	No	No

Test Results

Antenna Requirements

DATE: July 10, 2014

TEST STANDARD: FCC 15.203; IC RSS-Gen (7.1.2)

APPLICABLE REGULATIONS : - "An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited." ... "the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded."

RESULT : This unit meets this requirement. The antenna uses a UFL connector antenna connected to a PCB trace based antenna.

It is installed by the manufacturer into the final product.

The End User will have no access to change the antenna.

The only tested antenna for this product is:

- Molex #47950-0001
Omnidirectional 2.4GHz / 5GHz Wifi Stand Alone Antenna, 9.00mm, Cable Length 100.00mm
- Peak Gain (dBi) 3.5



(Reference image only)

Maximum Peak Conducted Output Power Level

DATE(s): July 22, 2014

TEST STANDARD: FCC Part 15.247 (b)(3); IC RSS-210 (A8.2(a))

TEST PROCEDURE: ANSI c63.10

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

MINIMUM STANDARD: 1 Watt (30dBm)

TEST SETUP: The EUT was programmed for maximum output. The antenna port of EUT was directly connected to an RF Power Meter through a 10dB Attenuator.

MEASUREMENT METHOD: As called by the standards above.

DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

EMISSIONS DATA:

20°Cel

Frequency (GHz)	Pwr meter (dB)	Correction Factor (dB)	Corrected Power (dBm)
2405	7.93	11.18	19.11
2440	8.45	10.74	19.19
2480	8.50	11.10	19.60

OBSERVATIONS: The EUT performed as expected.

PERFORMANCE: Complies.

Occupied Bandwidth

DATE(s): July 18, 2014

TEST STANDARD: FCC Part 15.247(a)(2) RSS-210 (A8.2(a))

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

MINIMUM STANDARD: the 6dB bandwidth must be greater than 500kHz

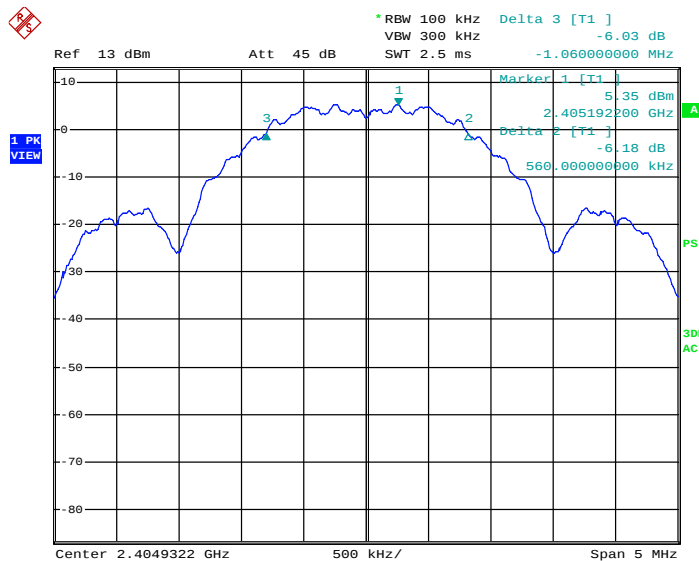
TEST SETUP: The antenna port of EUT was directly connected to a Spectrum Analyzer through a 30dB Attenuator.

MEASUREMENT METHOD: As called by the standards above.

DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

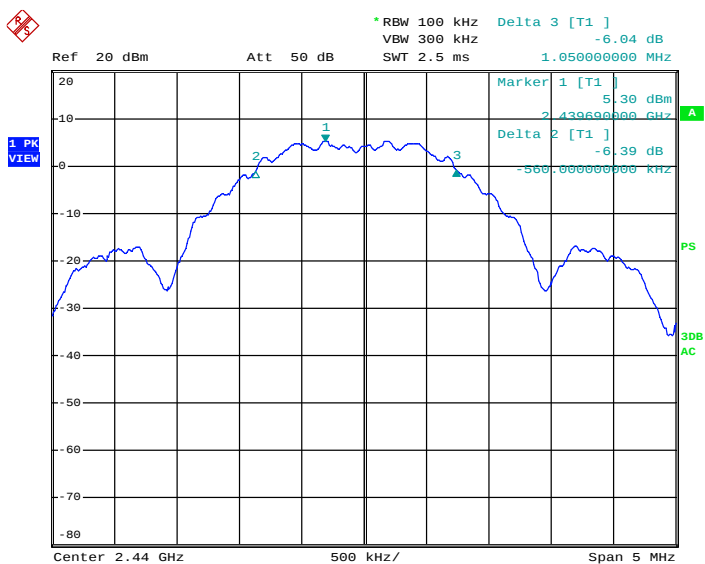
EMISSIONS DATA:

Frequency (GHz)	Measured 6dB (MHz)	Measured 99% (MHz)
2.405	1.62	2.43
2.440	1.61	2.41
2.480	1.62	2.43



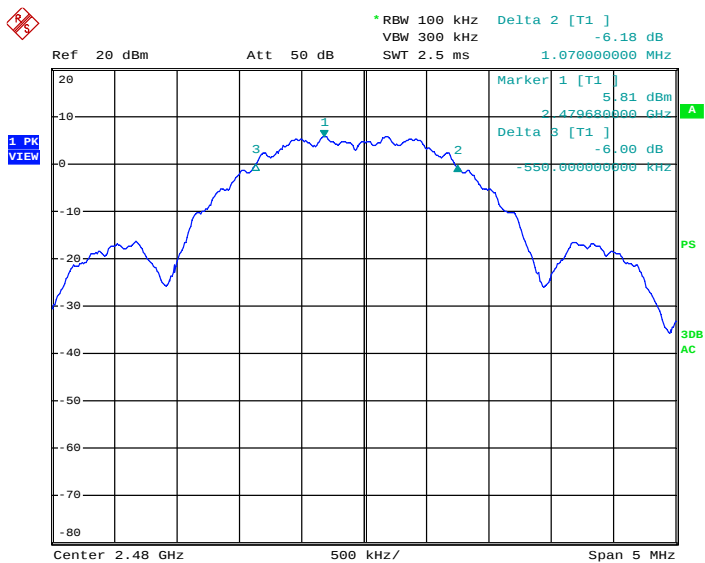
Date: 18.JUL.2014 15:20:22

6dB Occupied Band Width – Low Channel



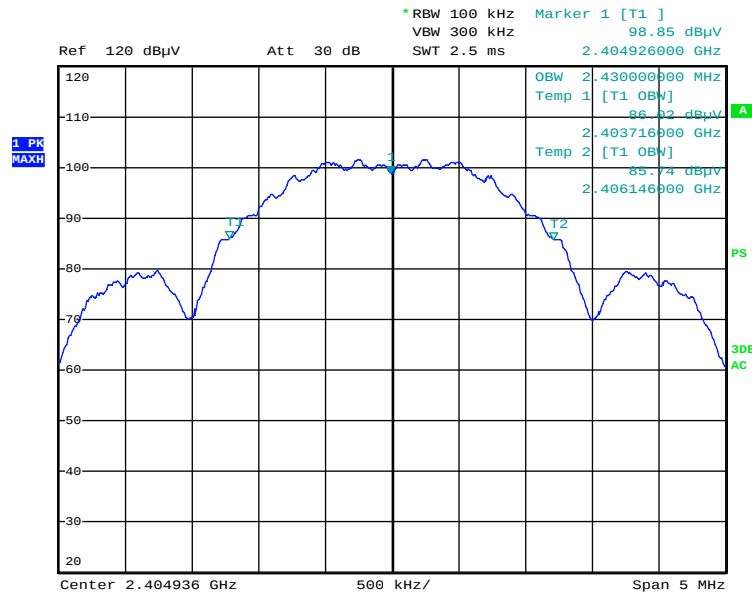
Date: 18.JUL.2014 16:13:50

6dB Occupied Band Width – Middle Channel



Date: 18.JUL.2014 15:37:51

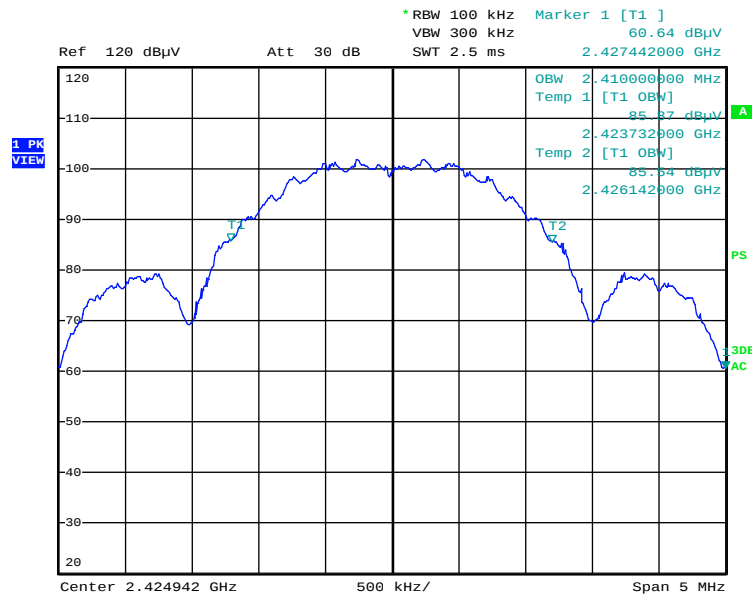
6dB Occupied Band Width – High Channel



120V

Date: 17.SEP.2014 17:49:23

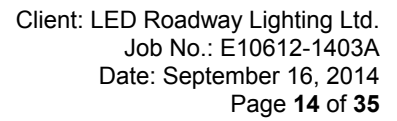
99% Occupied Band Width – Low Channel



120V

Date: 17.SEP.2014 17:46:57

99% Occupied Band Width – Middle Channel



Date: 17.SEP.2014 17:45:20

99% Occupied Band Width – High Channel

Out Of Band Spurious Emissions Conducted

DATE: July 21, 2014

TEST STANDARD: FCC Part 15.247(d) RSS-210(A8.5)

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

MINIMUM STANDARD: Emissions must be at least 20dB down from the highest emission level within the authorized band as measured with a 100kHz RBW

TEST SETUP: The antenna port of EUT was directly connected to a Spectrum Analyzer through a 20dB Attenuator and appropriated RF Filters.

Conversion Formulas used: For the frequency measurement:
 $E(\text{dBm}) = \text{Meas}(\text{dBm}) + \text{Cable Loss}(\text{dB}) + \text{Attenuator/Filter Loss}(\text{dB})$

MEASUREMENT METHOD: Measurements were made using spectrum analyser and receiver using the appropriate attenuators and filters to optimize the reading. The settings used were:

200Hz RBW average detector for the frequency range 9kHz-150kHz
 9kHz RBW average detector for the Frequency range 150kHz to 30MHz
 120kHz RBW quasi-peak detector for the frequency range 30MHz to 1GHz
 1MHz RBW Average detector for the frequency range 1GHz to 20GHz

DEVICE DESCRIPTIONS: As described in the above EUT description and setup section.

EMISSIONS DATA: No transmitter Conducted Spurious Emissions were detected 9kHz to 2.4GHz.
 Highest power level within the band: 19.6dBm

Low Channel

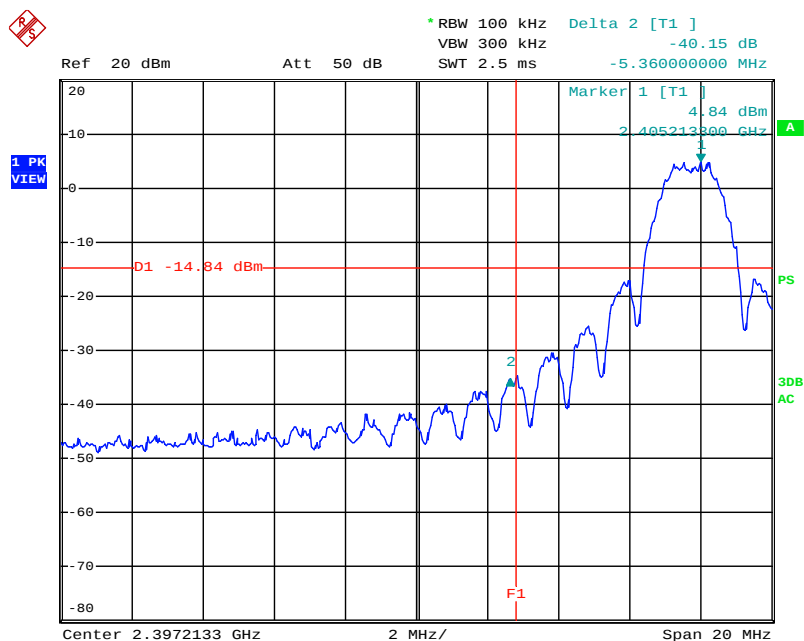
Frequency	Uncorr-Peak	Bandwidth	Correction Factors	Corr. Peak	Limit (19.6dBm - 20dB)	Margin
GHz	dBm	kHz		dBm	dBm	dB
4.810800	-64.14	1000.00	10.83	-53.31	-0.4	52.9
7.216000	-68.57	1000.00	12.55	-56.02	-0.4	55.6
9.617720	-71.35	1000.00	14.06	-57.29	-0.4	56.9
12.022000	-75.66	1000.00	12.46	-63.20	-0.4	62.8
14.426000	-75.90	1000.00	16.03	-59.87	-0.4	59.5
16.833000	-80.09	1000.00	14.59	-65.50	-0.4	65.1

Middle Channel

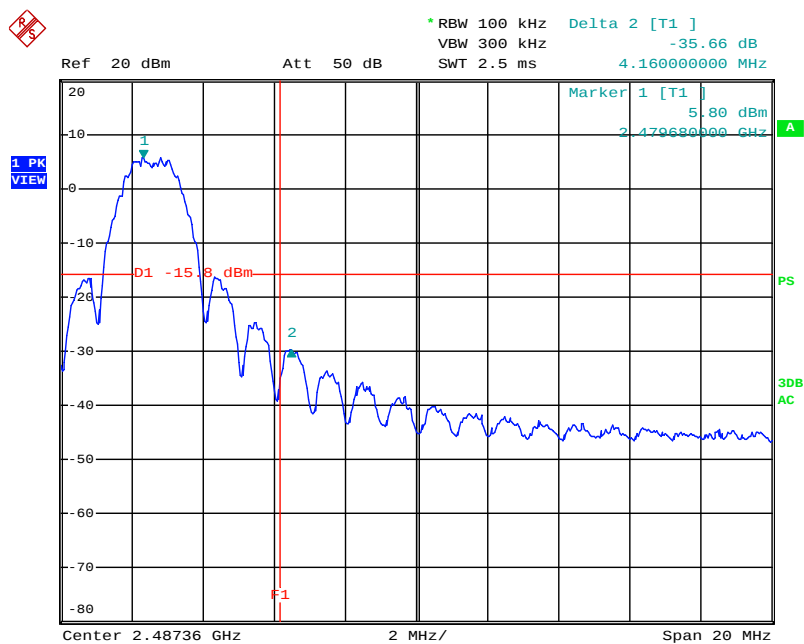
Frequency	Uncorr-Peak	Bandwidth	Correction Factors	Corr. Peak	Limit (19.6dBm - 20dB)	Margin
GHz	dBm	kHz		dBm	dBm	dB
4.880850	-65.97	1000.00	22.00	-53.83	-0.4	53.4
7.321100	-55.15	1000.00	22.20	-41.80	-0.4	41.4
9.761760	-71.00	1000.00	22.10	-57.38	-0.4	57.0
12.199900	-77.97	1000.00	21.00	-65.44	-0.4	65.0
14.607900	-79.80	1000.00	24.20	-61.60	-0.4	61.2

High Channel

Frequency	Uncorr-Peak	Bandwidth	Correction Factors	Corr. Peak	Limit (19.6dBm - 20dB)	Margin
GHz	dBm	kHz		dBm	dBm	dB
4.958800	-69.60	1000.00	12.33	-57.27	-0.4	56.9
7.441290	-56.50	1000.00	13.06	-43.44	-0.4	43.0
9.921730	-67.48	1000.00	13.30	-54.18	-0.4	53.8
12.401100	-78.59	1000.00	13.47	-65.12	-0.4	64.7
14.642800	-80.00	1000.00	18.30	-61.70	-0.4	61.3



Band Edge Low Channel



Band Edge High Channel

Out Of Band Spurious Emissions Radiated

DATE: July 11, 2014

TEST STANDARD: FCC Part 15.247(d) RSS-210(A8.5)

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

MINIMUM STANDARD: All emissions that fall in the restricted bands (15.205 or RSS-Gen (7.2.2)) must comply with the limits as listed in 15.209 and RSS-Gen (7.2.5). All other emissions must be at least 20dB down from the highest emission level within the authorized band as measured with a 100kHz RBW

TEST SETUP: The EUT was tested in our 3 m SAC and was positioned on the center of the turntable and powered up. The Transmitter Output was connected to its standard antenna. The transmitter was set for continuous transmission. The lowest, middle and highest channels were measured for all radiated emissions 10kHz to 25 GHz. The EUT was verified in 3 orthogonal orientations and the worst orientation was used for the final measurements. The EUT was tested and placed in the Vertical orientation on the table top as indicated in the test photos.

MEASUREMENT METHOD: Measurements were made using spectrum analyser and receiver using the appropriate antennas, amplifiers, attenuators and filters as per ANSI c63.10 and FCC KDB 558074 D01 DTS Meas Guidance v03r02

Because the EUT is using a pulsed train transmission a Duty Cycle correction of 17.6dB was used for the spurious emissions. Refer to Duty Cycle Section contained in this document for details.

DEVICE DESCRIPTIONS: As described in the above EUT description and setup section.

EMISSIONS DATA: No transmitter Radiated Spurious Emissions were detected 9kHz to 2.4GHz and above 12.5GHz.

Low Channel – Streaming Mode

Frequency	Corrected Peak	Antenna height	Pol	Turntable position	Duty Cycle Corrected Average based on Peak	Margin Corrected Avg	Average Limit
(GHz)	(dBµV/m)	(cm)		(deg)	(dB)	(dB)	(dBµV/m)
2.4050	115.6	100.0	V	339.0			
4.8088	63.5	100.0	V	73.0	45.9	8.1	54.0
7.2133	68.6	100.0	V	87.0	51.0	3.0	54.0
9.6177	64.1	148.0	V	66.0	46.5	7.5	54.0
12.0222	65.9	100.0	V	112.0	48.3	5.7	54.0

Middle Channel – Streaming Mode

Frequency	Corrected Peak	Antenna height	Pol	Turntable position	Duty Cycle Corrected Average based on Peak	Margin Corrected Avg	Limit
(GHz)	(dB μ V/m)	(cm)		(deg)	(dB)	(dB)	(dB μ V/m)
2.4400	113.7	100.0	V	340.0			
4.8789	66.3	100.0	V	8.0	48.7	5.3	54.0
7.3183	65.8	150.0	V	84.0	48.2	5.8	54.0
9.7577	69.5	156.0	V	345.0	52.0	2.0	54.0
12.1972	69.1	155.0	V	304.0	51.5	2.5	54.0

High Channel – Streaming Mode

Frequency	Corrected Peak	Antenna height	Pol	Turntable position	Duty Cycle Corrected Average based on Peak	Margin Corrected Avg	Limit
(GHz)	(dB μ V/m)	(cm)		(deg)	(dB)	(dB)	(dB μ V/m)
2.4800	121.6	100.0	V	340.0			
4.9609	69.0	122.0	V	13.0	51.4	2.6	54.0
7.4413	69.8	100.0	V	342.0	52.2	1.8	54.0
9.9217	67.5	152.0	V	198.0	49.9	4.1	54.0
12.4021	63.8	136.0	V	318.0	46.2	7.8	54.0

Power Spectral Density

DATE(s): July 18, 2014

TEST STANDARD: FCC Part 15.247(e) RSS-210 (A8.2(b))

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

MINIMUM STANDARD: Maximum of 8dBm in any 3kHz band

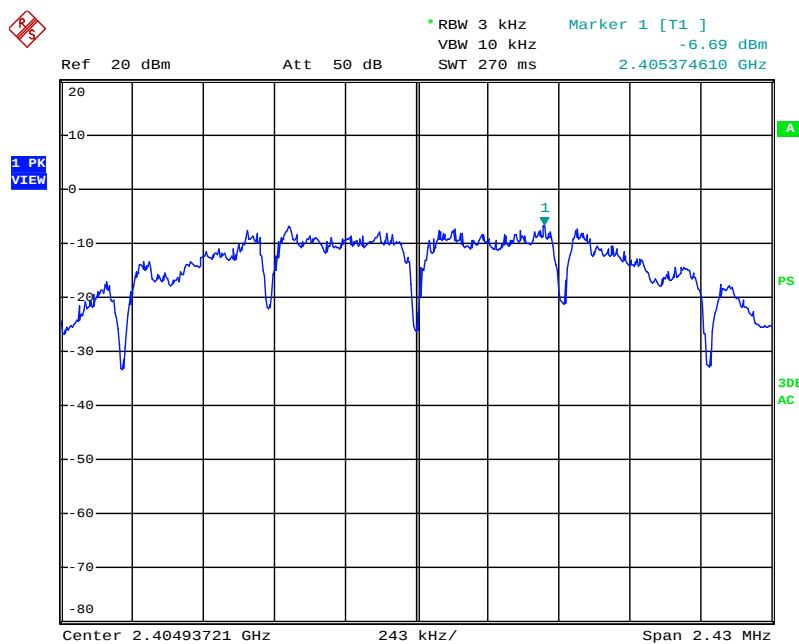
TEST SETUP: The antenna port of EUT was directly connected to a Spectrum Analyzer through a 10dB Attenuator.

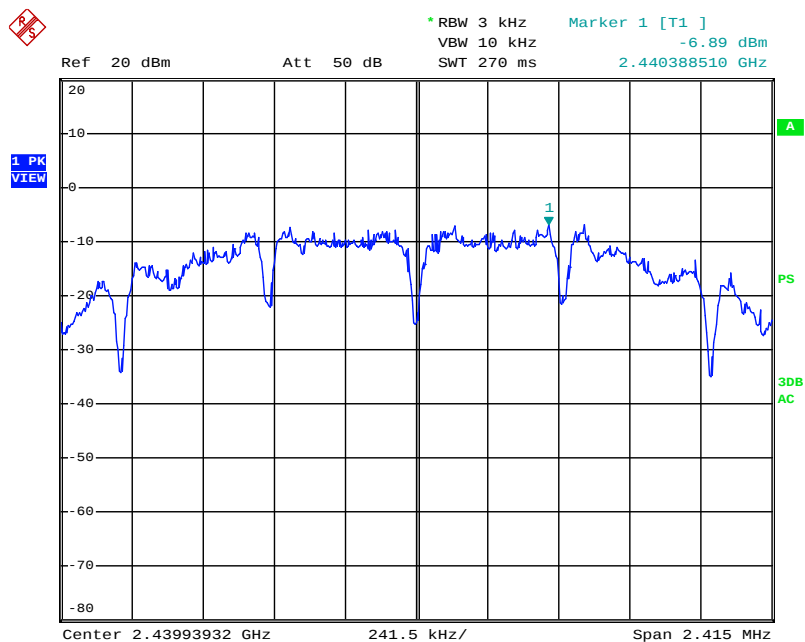
MEASUREMENT METHOD: As called by the standards above.

DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

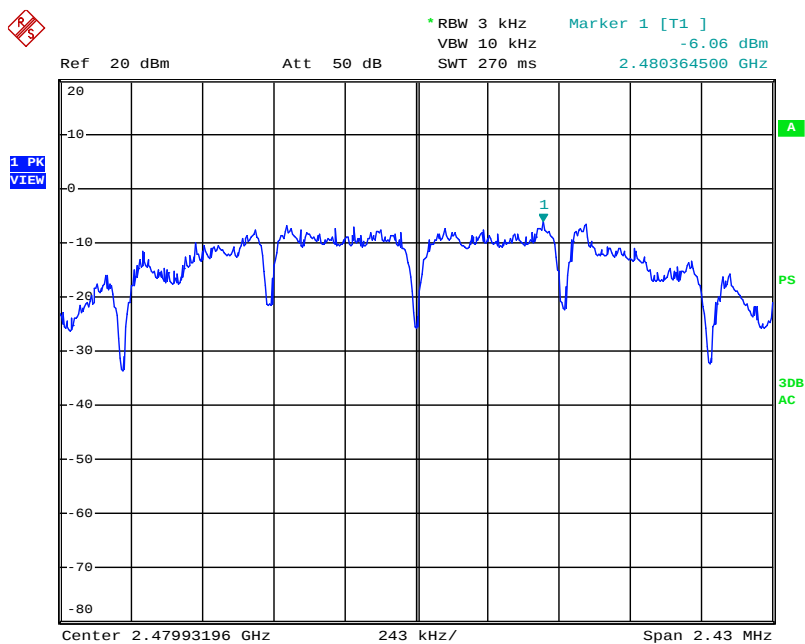
EMISSIONS DATA:

Frequency (GHz)	Measured (dBm)
2.40537	3.31
2.44039	3.11
2.48036	3.94





Date: 18.JUL.2014 16:28:42



Date: 18.JUL.2014 16:38:12

Frequency Stability

DATE:	July 23, 2014
TEST STANDARD:	FCC Part 15.215(c) and RSS-Gen Section (4.7) and (7.2.6)
TEST VOLTAGE:	2.6-5Vdc
MINIMUM STANDARD:	Not specified. RSS-Gen (4.7) With the transmitter installed in an environment test chamber, the unmodulated carrier frequency shall be measured under the conditions specified below: (a) at temperatures of -30°C, +20°C and +55°C, at the manufacturer's rated supply voltage of the battery. (b) at a temperature of +20°C and at ±15 percent of the manufacturer's rated supply voltage. RSS-Gen (7.2.6) Transmitter frequency stability for licence-exempt radio apparatus shall be measured in accordance with Section 4.7. Also, for licence-exempt radio apparatus, the frequency stability shall be measured at temperatures of -20°C, +20°C and +55°C instead of at the temperatures specified in Section 4.7(a). If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable standards, measurement of the frequency stability is not required provided that the occupied bandwidth of the licence-exempt radio apparatus lies entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-806 MHz. FCC (15.215(c)) The 20dB bandwidth must remain within the designated frequency band over the expected variations in temperature and voltage range
TEST SETUP:	The EUT was bench tested and in our temperature chamber. Due to the outdoor location and mounting method of the EUT, the EUT voltage and temperature range was specified by the manufacturer and verified at 2.6, 3 and 5Vdc; +85, +20, and -40° Celsius. The transmitter was set for Carrier Wave (CW) mode and the lowest and highest channel Frequency was measured at each Temperature setting, after the Transmitter stabilized at the temperature.
MEASUREMENT METHOD:	Measurements were made using a Spectrum Analyzer with 120kHz RBW Average detector while directly connected to the EUT through the antenna port.
DEVICE DESCRIPTIONS:	As described in the above EUT description and setup section.

DATA:
Low Channel

Temp (C)	Power Level (dBm)	Voltage	Frequency (GHz)	Drift (kHz)
20	19.11	3	2.4049	Ref
-40	15.08	2.6	2.4049	<100
-40	18.28	3	2.4049	<100
-40	20.28	5	2.4049	<100
85	14.43	2.6	2.4049	<100
85	16.18	3	2.4049	<100
85	17.19	5	2.4049	<100

Mid Channel

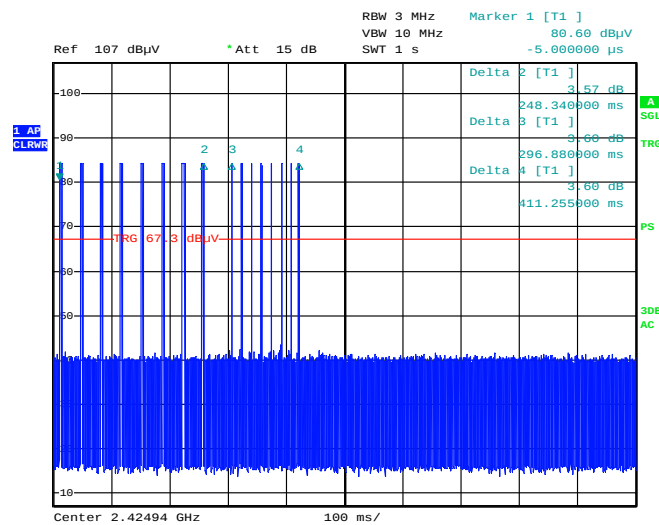
Temp (C)	Power Level (dBm)	Voltage	Frequency (GHz)	Drift (kHz)
20	19.19	3	2.4395	Ref
-40	14.04	2.6	2.4395	<100
-40	17.94	3	2.4395	<100
-40	20.14	5	2.4395	<100
85	14.32	2.6	2.4395	<100
85	16.04	3	2.4395	<100
85	17.00	5	2.4395	<100

High Channel

Temp (C)	Power Level (dBm)	Voltage	Frequency (GHz)	Drift (kHz)
20	19.60	3	2.4799	Ref
-40	15.00	2.6	2.4799	<100
-40	18.60	3	2.4799	<100
-40	21.00	5	2.4799	<100
85	15.06	2.6	2.4799	<100
85	16.84	3	2.4799	<100
85	17.88	5	2.4799	<100

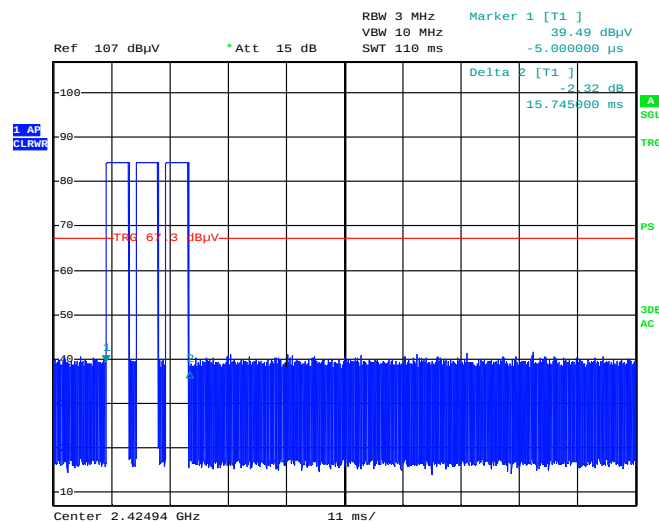
Duty Cycle Correction - Pulsed Train Average Time of Occupancy

DATE:	Aug 10, 2014
TEST STANDARD:	FCC Part 15.35(c) and RSS-Gen Section 4.5
TEST VOLTAGE:	120Vac 60Hz AC to 3.3Vdc Power Adapter
MINIMUM STANDARD:	Not specified. (4.5) Pulsed Operation When the field strength (or envelope power) is not constant or it is in pulses, and an average detector is specified to be used, the value of field strength or power shall be determined by averaging over one complete pulse train, including blanking intervals within the pulse train, as long as the pulse train does not exceed 0.1 seconds. In cases where the pulse train exceeds 0.1 second, the average value of field strength or output power shall be determined during a 0.1 second interval during which the field strength or power is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.
TEST SETUP:	The antenna port of EUT was directly connected to a Spectrum Analyzer through a 20dB Attenuator
MEASUREMENT METHOD:	Measurements were made using a Spectrum Analyzer with 3MHz RBW Peak detector using Zero Span mode.
DEVICE DESCRIPTIONS:	As described in the above EUT description and setup section. As per the manufacturer, the transmitter sends data packets of various lengths when requested. The requests for data is greater than once per second. During testing it was identified that there were 3 distinct patterns, depending on operation.
EMISSIONS DATA:	Pulse On Time: 4.4ms or 0.45ms per pulse; 3 wide pulses or 7 narrow pulses per 100ms; Maximum 13.2ms On time per 100ms Radiated emission Relaxation Correction for dBuV: $(20\text{Log}(13.2/100)) = 17.6\text{dB}$



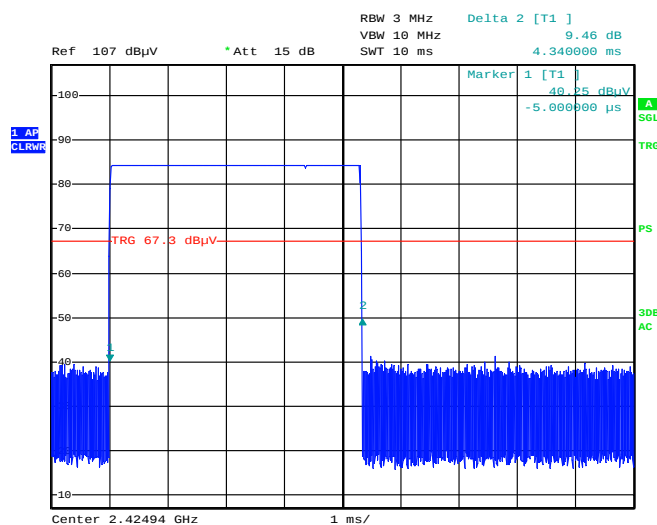
120V
Date: 28.AUG.2014 12:53:36

Normal Transmission sequence



120V
Date: 28.AUG.2014 12:57:07

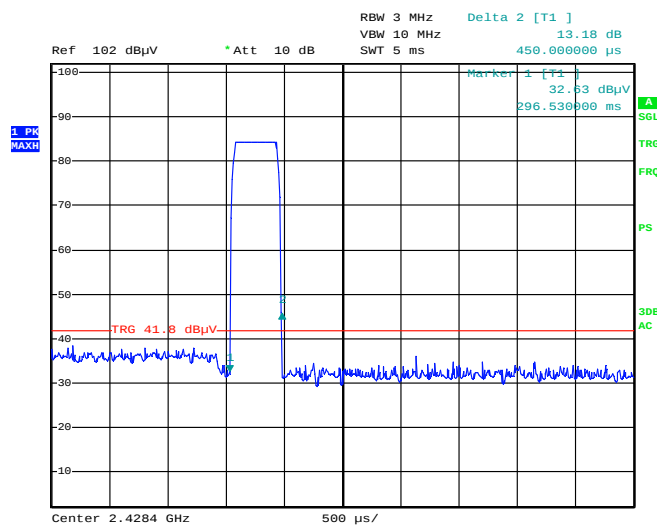
No receiver was present to receive transmission



120V

Date: 28.AUG.2014 12:36:52

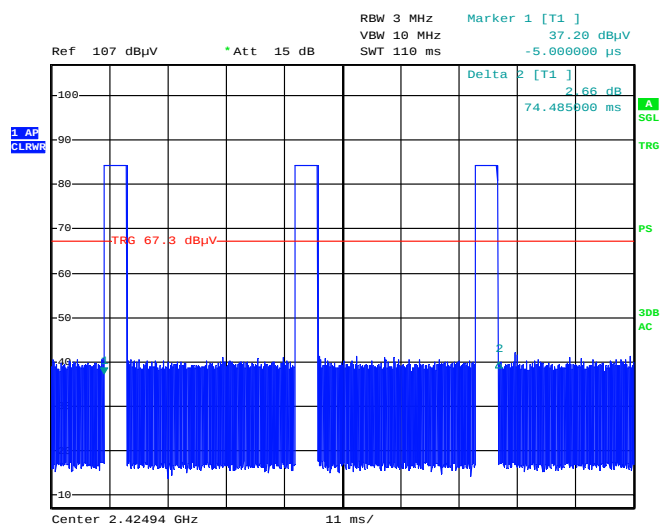
Wide pulse duration



120V

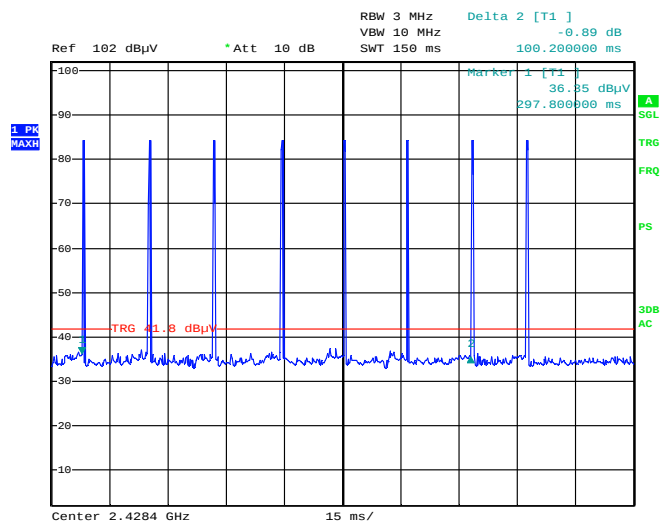
Date: 29.AUG.2014 23:30:11

Narrow pulse duration



120V
Date: 28.AUG.2014 12:55:08

3 Wide pulses per 100ms



120V

Date: 29.AUG.2014 23:13:11

7 Narrow pulses per 100ms

RF Exposure Evaluation

FCC 1.1310 states the criteria listed in the table below shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Section 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Section 2.1093. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation".

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (s)
(A) Limits for Occupational/Control Exposures				
300-1500	-	-	F/300	6
1500-100,000	-	-	5	6
(B) Limits for General Population/Uncontrolled Exposures				
300-1500	-	-	F/1500	6
1500-100,000	-	-	1	30

TABLE 1 - POWER DENSITY LIMITS

1.1 EUT OPERATING CONDITION

- The antenna used for this product is a Flexilbe PCB trace antenna connected to a UFL Connector and is designed for a Peak antenna gain of 3.5 dBi (peak)
- Highest measured conducted output level = 19.6dBm
- From Table 1, the Maximum Power Density safe exposure level for General Population Uncontrolled Exposure of 30 Seconds for the frequency range of 2.4 to 2.4835GHz is 1mW/cm².

Conducted Output Power (dBm)	Max Antenna Gain	Max EIRP (mW)	Power Density Limit Allowed (mW/cm ²)	Safe distance (cm)
19.6	3.5	204	1	4.1

1.2 RF EXPOSURE EVALUATION DISTANCE CALCULATION

$$d = \sqrt{\frac{EIRP}{4\pi S}}$$

where: d = Distance to the center of radiation of the antenna (cm) for the allowable Power Density
 S = Allowable Power density Limit (mW/cm²)
 EIRP = Equivalent isotropically radiated power (mW) = 10^[TX Power (dBm) + Ant Gain (dBi)/10]

As shown above, the minimum distance where the MPE limit is reached is 4.1 cm from the EUT with the 3.5dBi antenna.

It is recommended that the unit is positioned so that the typical distance from the antenna to the end user is 20cm or greater.

EUT photos during the testing





