

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT CLASS II PC REPORT

OF

Product Name: Opticon EE201

Brand Name: Opticon

Model No.: EE202

Model Difference: N/A

FCC ID: Q2Q-EE201

Report No.: E2/2013/80018-01

Issue Date: Sep. 08, 2015

FCC Rule Part: §15.247, Cat: DTS

Opticon Sensors Europe B.V.

Prepared for: Opaallaan 35, 2132 XV Hoofddorp,
The Netherlands
SGS Taiwan Ltd.

Prepared by: Electronics & Communication Laboratory
No.2, Keji 1st Rd., Guishan District, Taoyuan City,
Taiwan 333



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VERIFICATION OF COMPLIANCE

Applicant: Opticon Sensors Europe B.V.
Opaallaan 35, 2132 XV Hoofddorp, The Netherlands

Product Name: Opticon EE201

Brand Name: Opticon

Model No.: EE202

Model Difference: N/A

FCC ID: Q2Q-EE201

File Number: E2/2013/80018-01

Date of test: Aug. 18, 2015 ~ Sep. 08, 2015

Date of EUT Received: Aug. 18, 2015

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Test By:

Aken Huang

Date

Sep. 08, 2015

Aken Huang / Engineer

Prepared By:

Tiffany Kao

Date

Sep. 08, 2015

Tiffany Kao / Clerk

Approved By:

Jim Chang

Date

Sep. 08, 2015

Jim Chang / Asst. Manager

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Revision History

Report Number	Revision	Description	Issue Date
E2/2013/80018-01	Rev.00	Initial creation of document	Sep. 08, 2015

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1 GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	Opticon EE201	
Brand Name:	Opticon	
Model No.:	EE202	
Model Difference:	N/A	
Product SW/HW version:	IBHV0035 / OP1207_B	
Radio SW/HW version:	N/A	
Test SW Version:	N/A	
RF power setting in TEST SW:	N/A	
Scope:	The test report covers the radiated emissions requirements of the standards referenced in the report to allow system level approval.	
Class II Permissive change:	Antenna Change: Original antenna is a sheet metal PIFA with -4dBi Gain. New antenna is an IFA type printed directly on the PCB. Gain value is -5dBi	
Power Supply:	3.0Vdc from Li-ion batteries*2	
	Battery:	Model No.: CR2450, Supplier: MITSUBISHI

Zigbee:

Operation Frequency:	2405~2480 MHz
Channel Number:	16 channels
Channel Spacing	5 MHz
Output Power:	-3.11dBm (Peak)
Modulation Type:	DSSS
Antenna Designation:	Printed Antenna, Gain: -5dBi

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1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 DTS Meas. Guidance V03r02

ANSI C63.4:2014

ANSI C63.10:2013

Note:

1. All test items have been performed and record as per the above standards.
2. The composite system is compliance with FCC Subpart B is authorized under the certification procedure.

1.3 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333. (TAF code 0513)

FCC Registration Numbers are: 628985

Canada Registration Number: 4620A

1.4 Special Accessories

There are no special accessories used while test was conducted.

1.5 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

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

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Radiated Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m 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 and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

Note:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Following shows an offset computation example with cable loss 1 dB and 3.3 dB attenuator.

Offset = RF cable loss (dB) + attenuation factor (dB) = 1 + 3.3 = 4.3 (dB)

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2.5 Configuration of Tested System

Fig. 2-1 Radiated Emission (Antenna Port) Configuration

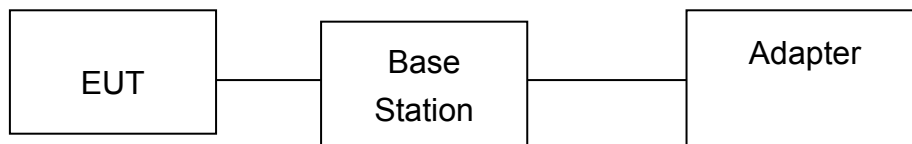


Fig. 2-2 Conducted (Antenna Port) Configuration



Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Test Software	ESL	N/A	Version2.4.8	N/A	N/A
2.	Notebook	Lenovo	L420	LR-7HXZA	Shielded	Unshielded

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

16 channels are provided for Zibgee

CHANNEL	FREQUEN- CY	CHANNEL	FREQUEN- CY
11	2405 MHz	25	2475 MHz
12	2410 MHz	26	2480 MHz
13	2415 MHz		
14	2420 MHz		
15	2425 MHz		
16	2430 MHz		
17	2435 MHz		
18	2440 MHz		
19	2445 MHz		
20	2450 MHz		
21	2455 MHz		
22	2460 MHz		
23	2465 MHz		
24	2470 MHz		

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4.2 The Worst Test Modes and Channel Details

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

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)		
MODE	AVAILABLE CHANNEL	TESTED CHANNEL
Zigbee	11 to 26	11,18,26
RADIATED EMISSION TEST (ABOVE 1 GHz)		
MODE	AVAILABLE CHANNEL	TESTED CHANNEL
Zigbee	11 to 26	11,18,26

Note:

The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for zigbee Transmitter for channel Low, Mid and High, the worst case H position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST		
MODE	AVAILABLE CHANNEL	TESTED CHANNEL
Zigbee	11 to 26	11,18,26

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 1.42 dB
6dB Bandwidth	+/- 123.36 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 1.55 dB
Peak Power Density	+/- 1.55 dB
Temperature	+/- 0.8 °C
Humidity	+/- 4.7 %
DC / AC Power Source	DC= +/- 1%, AC=+/- 0.2%

Radiated Spurious Emission:

Measurement uncertainty (Polarization : Vertical)	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB

Measurement uncertainty (Polarization : Horizontal)	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

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

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6 PEAK OUTPUT POWER MEASUREMENT

6.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

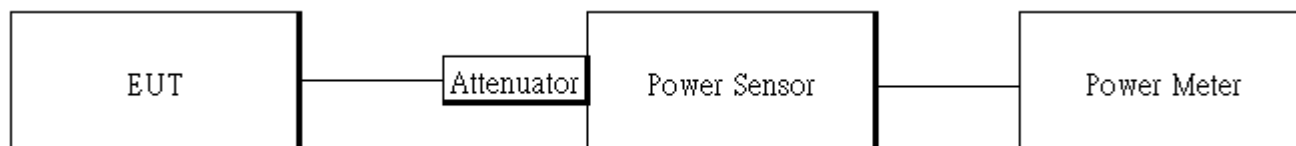
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

6.2 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY53400256	10/15/2014	10/14/2015
Power Meter	Anritsu	ML2496A	1326001	06/23/2015	06/22/2016
Power Sensor	Anritsu	MA2411B	1315048	06/23/2015	06/22/2016
Power Sensor	Anritsu	MA2411B	1315049	06/23/2015	06/22/2016
Coaxial Cable 30cm	WOKEN	00100A1F1A195C	RF01	12/19/2014	12/18/2015
DC Block	PASTERNAK	PE8210	RF29	12/19/2014	12/18/2015
Splitter	RF-LAMBDA	RFLT2W1G18G	RF35	12/19/2014	12/18/2015
Attenuator	WOKEN	218FS-10	RF23	12/19/2014	12/18/2015
DC Power Supply	Agilent	E3640A	MY53140006	05/04/2015	05/03/2016

6.3 Test Set-up:



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6.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

Power Meter:

It is used as the auxiliary test equipment to conduct the output power measurement.

4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

Duty Factor:



	Duty Cycle	Duty Factor (dBm)
Zigbee	1	0

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6.5 Measurement Result:

Zigbee mode:

CH	Frequency (MHz)	Peak Power Output(dBm)	Required Limit
11	2405	-3.71	1 Watt = 30 dBm
18	2440	-3.59	1 Watt = 30 dBm
26	2480	-3.11	1 Watt = 30 dBm

CH	Frequency (MHz)	Average Power Output(dBm)	Required Limit
11	2405	-4.19	1 Watt = 30 dBm
18	2440	-3.81	1 Watt = 30 dBm
26	2480	-3.41	1 Watt = 30 dBm

**Note: Measured by power meter, as cable loss+ Duty cycle factor that offsets on the power meter*

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7 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

7.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 limit as below.

And according to §15.33(a) (1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
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

Note:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBμV/m) = 20 log Emission level (dBμV/m)

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7.2 Measurement Equipment Used

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESU 40	100363	04/09/2015	04/08/2016
Loop Antenna	ETS-Lindgren	6502	00143303	12/09/2014	12/08/2015
Broadband Antenna	TESEQ	CBL 6112D	35240	12/05/2014	12/04/2015
Horn Antenna	ETS-Lindgren	3117	00143272	12/08/2014	12/07/2015
Horn Antenna	ETS-Lindgren	3160-09	00117911	11/13/2014	11/12/2015
Horn Antenna	ETS-Lindgren	3160-10	00117783	11/13/2014	11/12/2015
Pre Amplifier	EMC Instruments	EMC330	980096	12/19/2014	12/18/2015
Pre Amplifier	EMC Instruments	EMC0011830	980199	12/19/2014	12/18/2015
Pre Amplifier	R&S	SCU-18	10204	12/19/2014	12/18/2015
Pre Amplifier	R&S	SCU-26	100780	12/19/2014	12/18/2015
Coaxial Cable	Huber+Suhner	RG 214/U	966Rx 9K-30M	12/19/2014	12/18/2015
Coaxial Cable	Huber+Suhner	RG 214/U SUCOFLEX 104	966Rx 30M-3G	12/19/2014	12/18/2015
Coaxial Cable	Huber+Suhner	SUCOFLEX 104	966Rx 1G-18G	12/19/2014	12/18/2015
Coaxial Cable	Huber+Suhner	mini 141-12 SUCOFLEX 104	966Rx 18G-40G	12/19/2014	12/18/2015
Coaxial Cable	Huber+Suhner	SUCOFLEX 104	966Tx 30M-18G	12/19/2014	12/18/2015
Coaxial Cable	Huber+Suhner	SUCOFLEX 102	966Tx 18G-40G	12/19/2014	12/18/2015
Attenuator	WOKEN	218FS-10	RF27	12/19/2014	12/18/2015
Site NSA	SGS	966 Chamber C	SAC-C	03/04/2015	03/03/2016
Site VSWR	SGS	966 Chamber C	SAC-C	03/04/2015	03/03/2016
DC Power Supply	HOLA	DP-3003	D7070035	05/04/2015	05/03/2016
Controller	MF	MF-7802	N/A	N.C.R.	N.C.R.
Antenna Master	MF	N/A	N/A	N.C.R.	N.C.R.
Turn Table	MF	N/A	N/A	N.C.R.	N.C.R.
Test Software	World-Pallas	Dr. E	V 3.0 Lite	N.C.R.	N.C.R.

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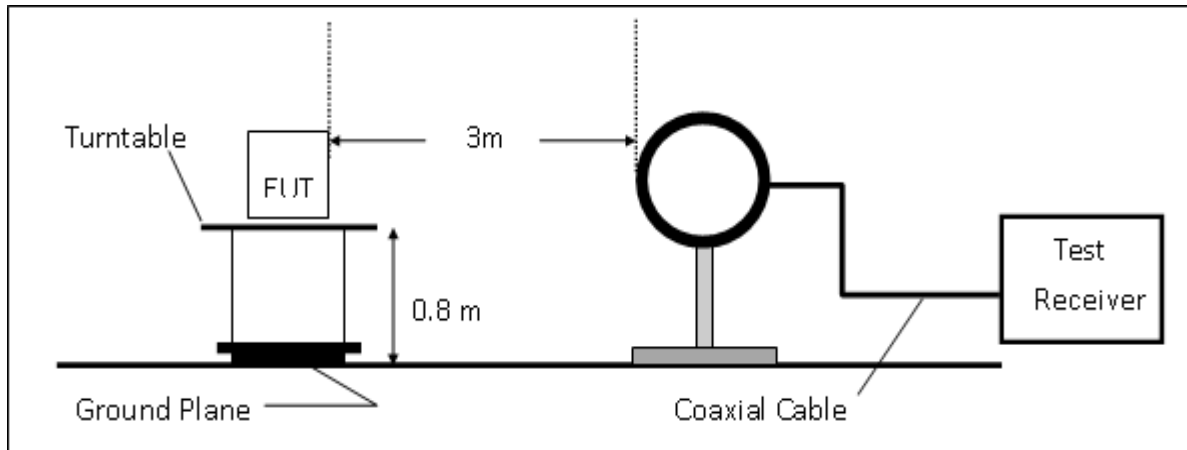
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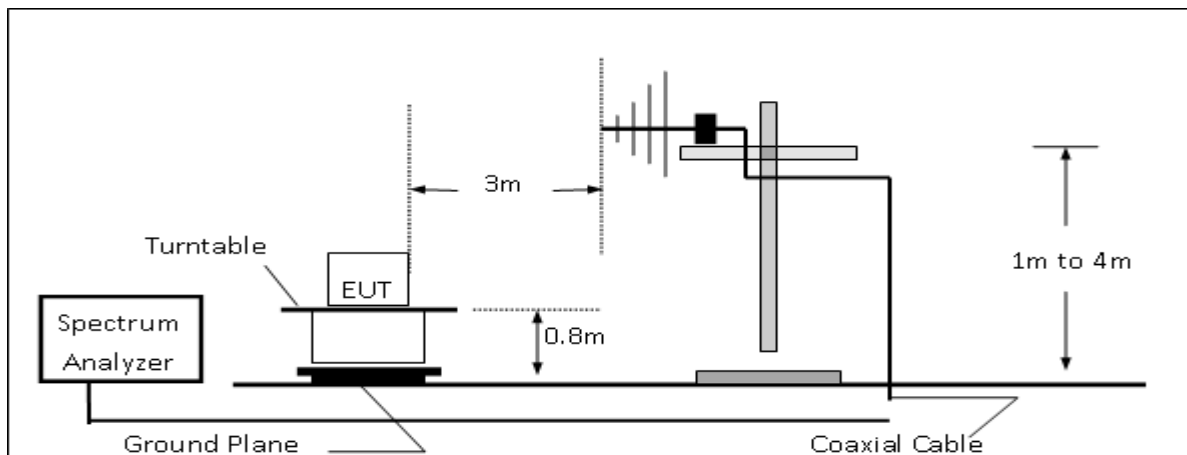
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7.3 Test SET-UP

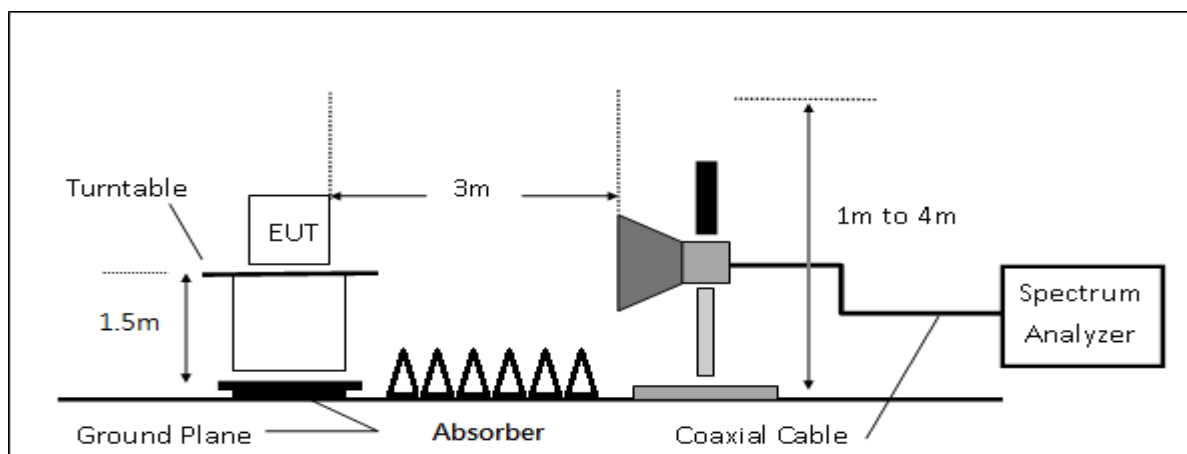
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-UP, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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7.4 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

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7.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

Note :

“F” : denotes Fundamental Frequency. ; “H” : denotes Harmonic Frequency.

“E” : denotes Band Edge Frequency. ; “S” : denotes Spurious Frequency.

7.6 Test Results of Radiated Spurious Emissions form 9 KHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

7.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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**Radiated Band Edge Measurement Result (Zigbee mode)**

(Unwanted Emissions into Restricted Frequency Bands):

Operation Band	: Zigbee	Test Date	:2015-08-26
Fundamental Frequency	:2405 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	: Ashton
EUT Pol.	:H Plan	Measurement Antenna Pol.	:VERTICAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	E	Peak	45.15	6.62	51.77	74	-22.23
2390.00	E	Average	33.12	6.62	39.74	54	-14.26

Operation Band	: Zigbee	Test Date	:2015-08-26
Fundamental Frequency	:2405 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	: Ashton
EUT Pol.	:H Plan	Measurement Antenna Pol.	:HORIZONTAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
2390.00	E	Peak	45.09	6.62	51.71	74	-22.29
2390.00	E	Average	33.45	6.62	40.07	54	-13.93

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Operation Band	: Zigbee	Test Date	:2015-08-26
Fundamental Frequency	:2480 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	: Ashton
EUT Pol.	:H Plan	Measurement Antenna Pol.	:VERTICAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB
2483.50	E	Peak	48.66	6.96	55.62	74	-18.38
2483.50	E	Average	36.78	6.96	43.74	54	-10.26

Operation Band	: Zigbee	Test Date	:2015-08-26
Fundamental Frequency	:2480 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	: Ashton
EUT Pol.	:H Plan	Measurement Antenna Pol.	:HORIZONTAL

Freq.	Note	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	F/H/E/S	PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB
2483.50	E	Peak	52.52	6.96	59.48	74	-14.52
2483.50	E	Average	41.78	6.96	48.74	54	-5.26

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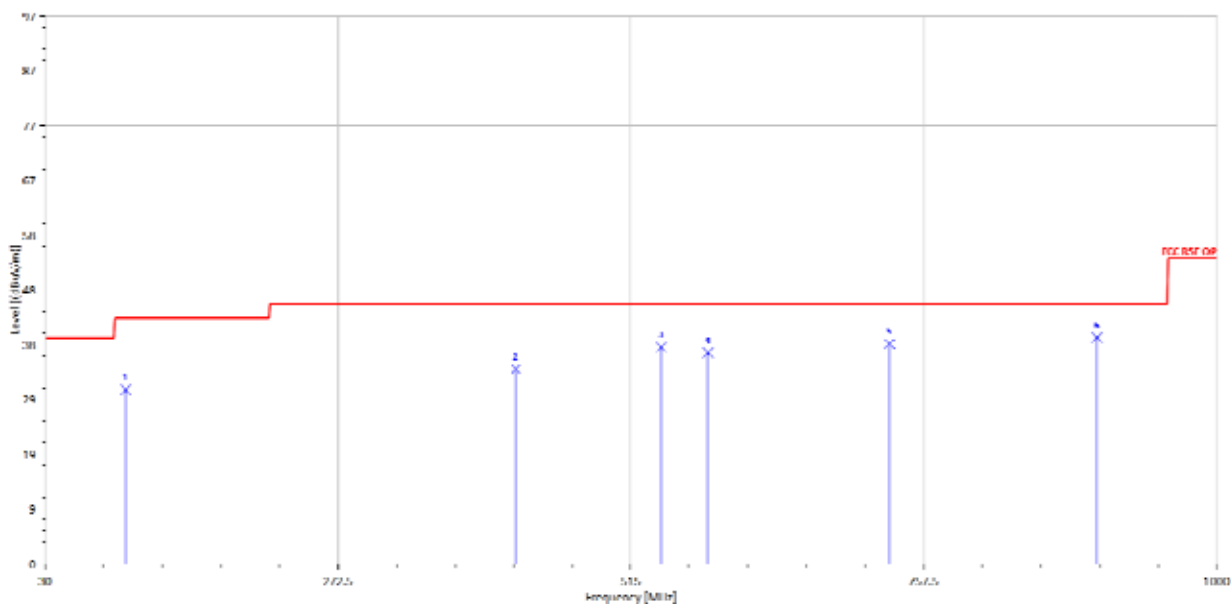
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Radiated Spurious Emission Measurement Result (Zigbee mode) For Frequency form 30MHz to 1000MHz

Operation Band	:Zigbee	Test Date	:2015-08-26
Fundamental Frequency	:2405 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:TX LOW	Engineer	: Ashton
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
96.93	S	Peak	55.14	-24.36	30.78	43.5	-12.72
419.94	S	Peak	49.85	-15.40	34.45	46	-11.55
540.22	S	Peak	51.59	-13.28	38.31	46	-7.69
579.02	S	Peak	49.91	-12.52	37.39	46	-8.61
729.37	S	QP	49.60	-10.66	38.94	46	-7.06
901.06	S	Peak	48.17	-8.12	40.05	46	-5.95

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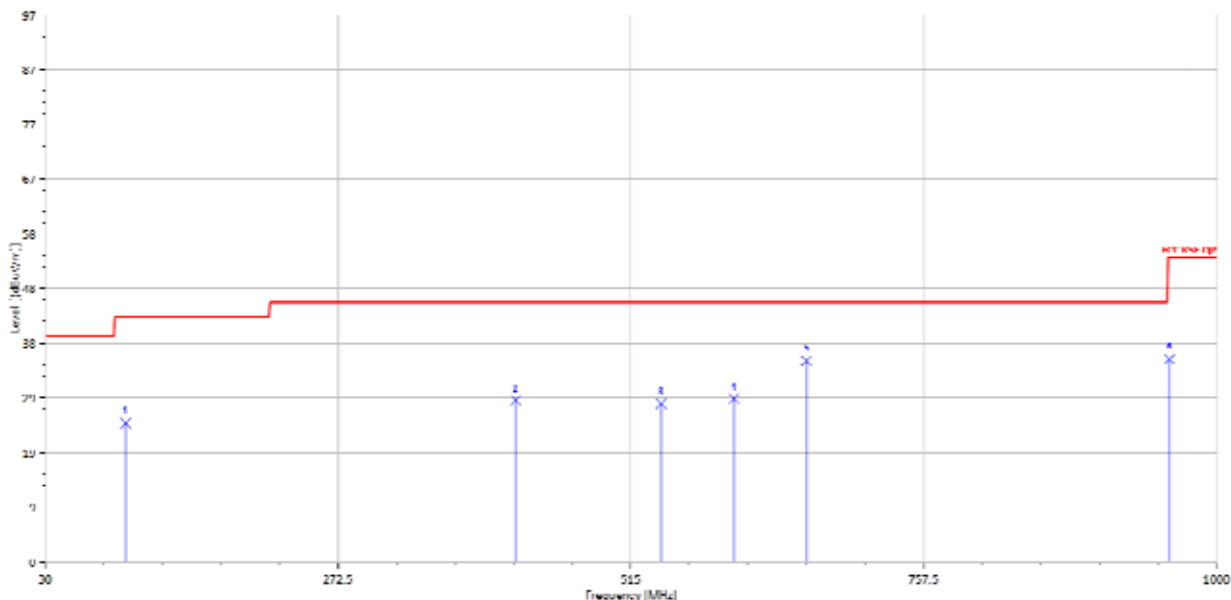
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Operation Band :Zigbee
Fundamental Frequency :2405 MHz
Operation Mode :TX LOW
EUT Pol. :H Plane

Test Date :2015-08-26
Temp./Humi. :19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. :HORIZONTAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
96.93	S	Peak	48.95	-24.36	24.58	43.5	-18.92
419.94	S	Peak	44.04	-15.40	28.64	46	-17.36
540.22	S	Peak	41.30	-13.28	28.02	46	-17.98
600.36	S	Peak	41.39	-12.45	28.94	46	-17.06
660.50	S	Peak	47.20	-11.54	35.65	46	-10.35
961.20	S	Peak	43.48	-7.53	35.95	54	-18.05

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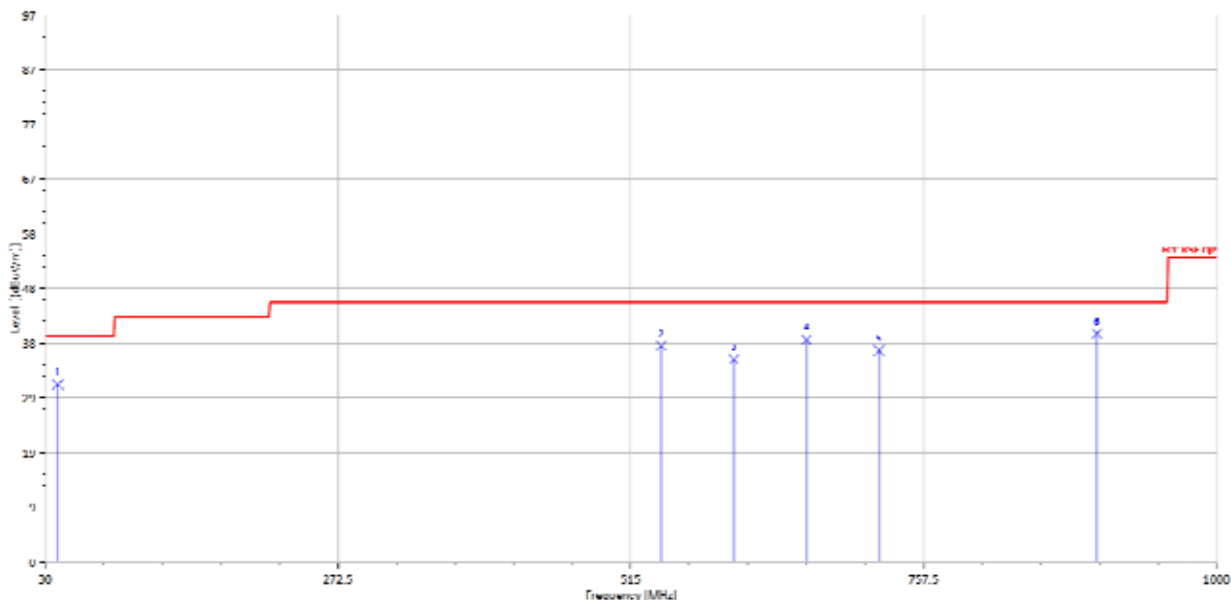
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Operation Band : Zigbee
Fundamental Frequency : 2445 MHz
Operation Mode : TX MID
EUT Pol. : H Plane

Test Date : 2015-08-26
Temp./Humi. : 19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. : VERTICAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
40.67	S	Peak	50.87	-19.43	31.44	40	-8.56
540.22	S	Peak	51.55	-13.28	38.27	46	-7.73
600.36	S	Peak	48.35	-12.45	35.90	46	-10.10
660.50	S	Peak	50.95	-11.54	39.40	46	-6.60
720.64	S	Peak	48.24	-10.77	37.47	46	-8.53
901.06	S	Peak	48.58	-8.12	40.46	46	-5.54

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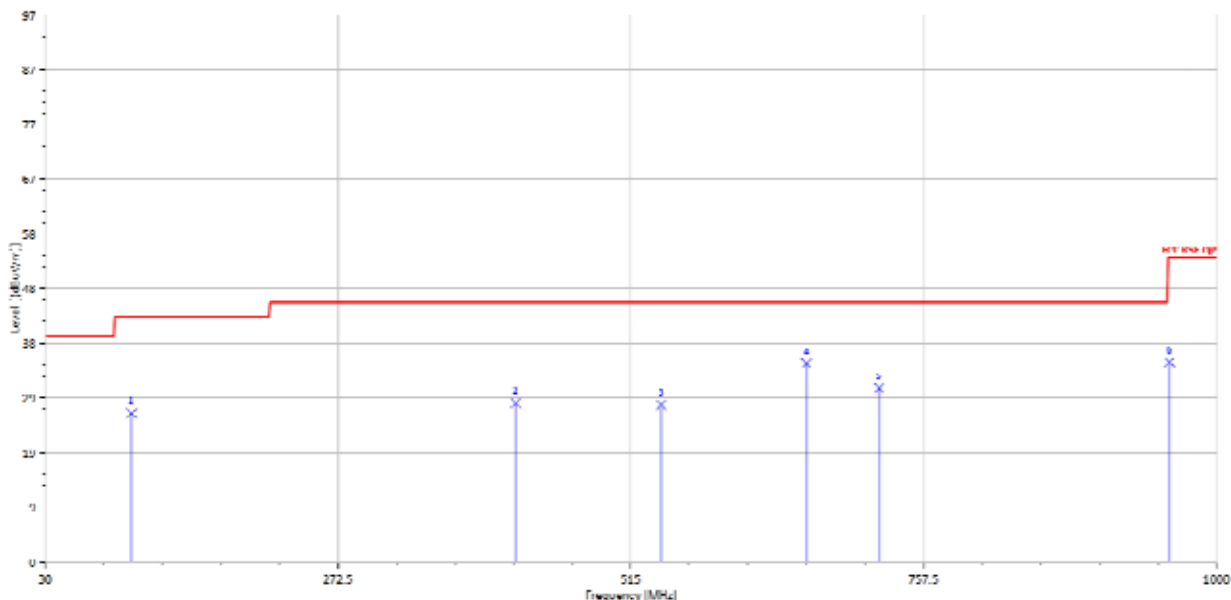
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Operation Band :Zigbee
Fundamental Frequency :2445 MHz
Operation Mode :TX MID
EUT Pol. :H Plane

Test Date :2015-08-26
Temp./Humi. :19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. :HORIZONTAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level	dB	FS	@3m	dB
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
101.78	S	Peak	49.89	-23.54	26.35	43.5	-17.15
419.94	S	Peak	43.52	-15.40	28.12	46	-17.88
540.22	S	Peak	41.09	-13.28	27.82	46	-18.18
660.50	S	Peak	46.69	-11.54	35.15	46	-10.85
720.64	S	Peak	41.59	-10.77	30.82	46	-15.18
961.20	S	Peak	42.90	-7.53	35.37	54	-18.63

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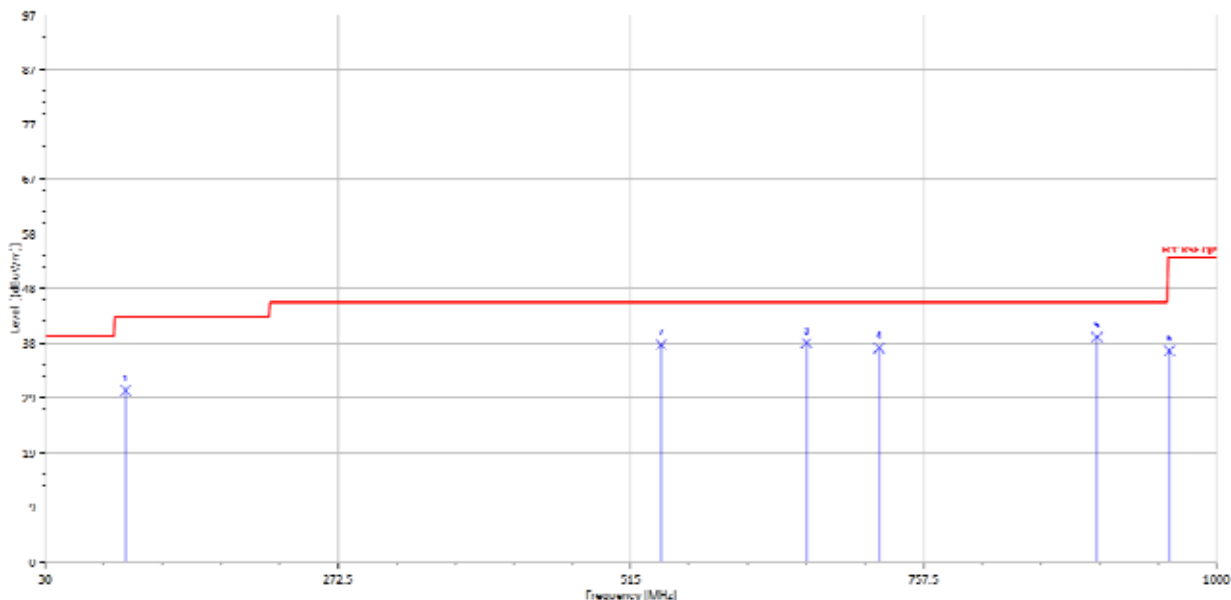
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Operation Band :Zigbee
Fundamental Frequency :2480 MHz
Operation Mode :TX HIGH
EUT Pol. :H Plane

Test Date :2015-08-26
Temp./Humi. :19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. :VERTICAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
96.93	S	Peak	54.74	-24.36	30.38	43.5	-13.12
540.22	S	Peak	51.73	-13.28	38.46	46	-7.54
660.50	S	Peak	50.35	-11.54	38.81	46	-7.19
720.64	S	Peak	48.68	-10.77	37.90	46	-8.10
901.06	S	Peak	47.99	-8.12	39.87	46	-6.13
961.20	S	Peak	44.94	-7.53	37.41	54	-16.59

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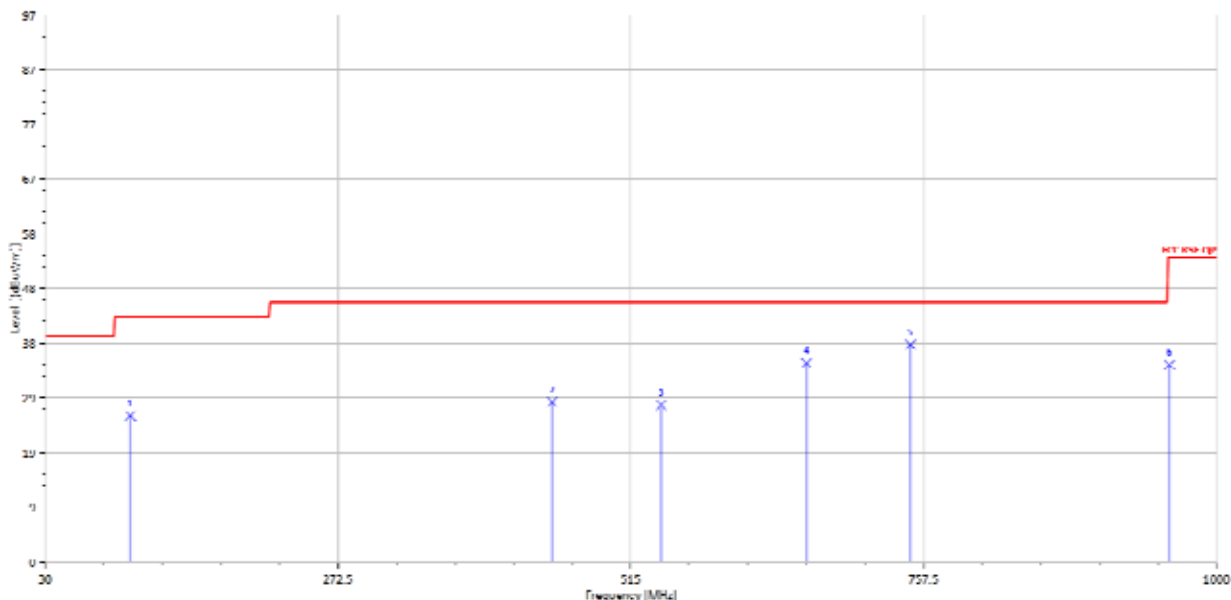
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Operation Band :Zigbee
Fundamental Frequency :2480 MHz
Operation Mode :TX HIGH
EUT Pol. :H Plane

Test Date :2015-08-26
Temp./Humi. :19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. :HORIZONTAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
100.81	S	Peak	49.61	-23.69	25.93	43.5	-17.57
450.01	S	Peak	43.28	-15.00	28.28	46	-17.72
540.22	S	Peak	41.07	-13.28	27.80	46	-18.20
660.50	S	Peak	46.72	-11.54	35.17	46	-10.83
746.83	S	Peak	48.44	-9.95	38.48	46	-7.52
961.20	S	Peak	42.44	-7.53	34.91	54	-19.09

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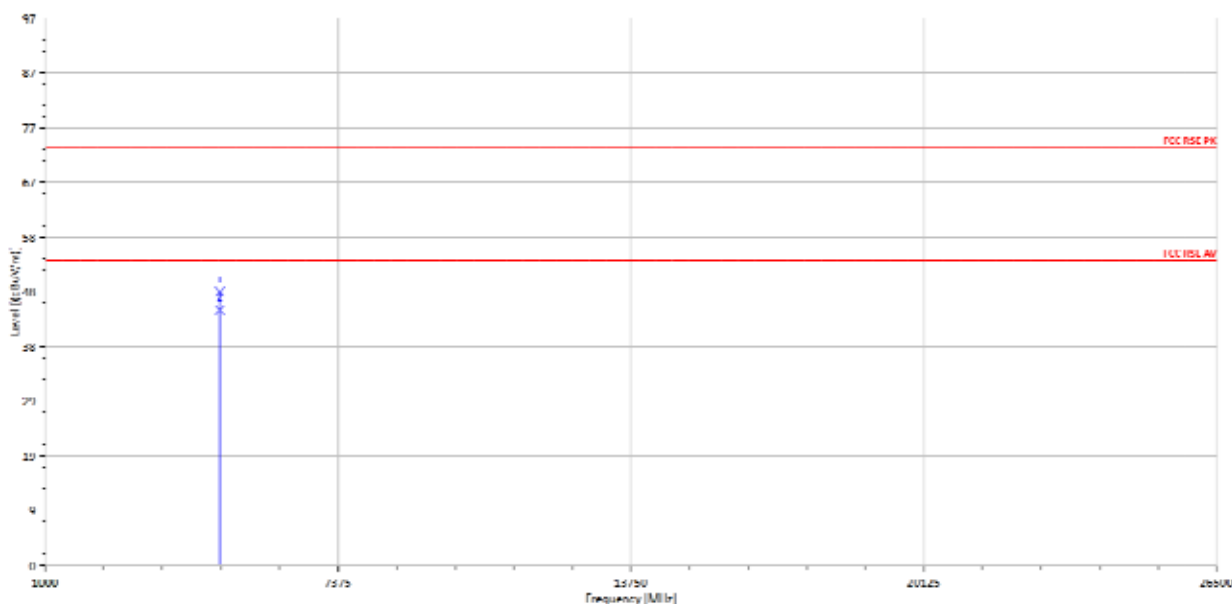
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Radiated Spurious Emission Measurement Result (Zigbee mode) For Frequency above 1GHz

Operation Band	:Zigbee	Test Date	:2015-08-26
Fundamental Frequency	:2405 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:TX LOW	Engineer	: Ashton
EUT Pol.	:H Plane	Measurement Antenna Pol.	:VERTICAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level	dB	FS	@3m	dB
		PK/QP/AV	dBμV		dBμV/m	dBμV/m	
4810.00	H	Peak	37.46	10.99	48.45	74	-25.55
4810.00	H	Average	34.26	10.99	45.25	54	-8.75

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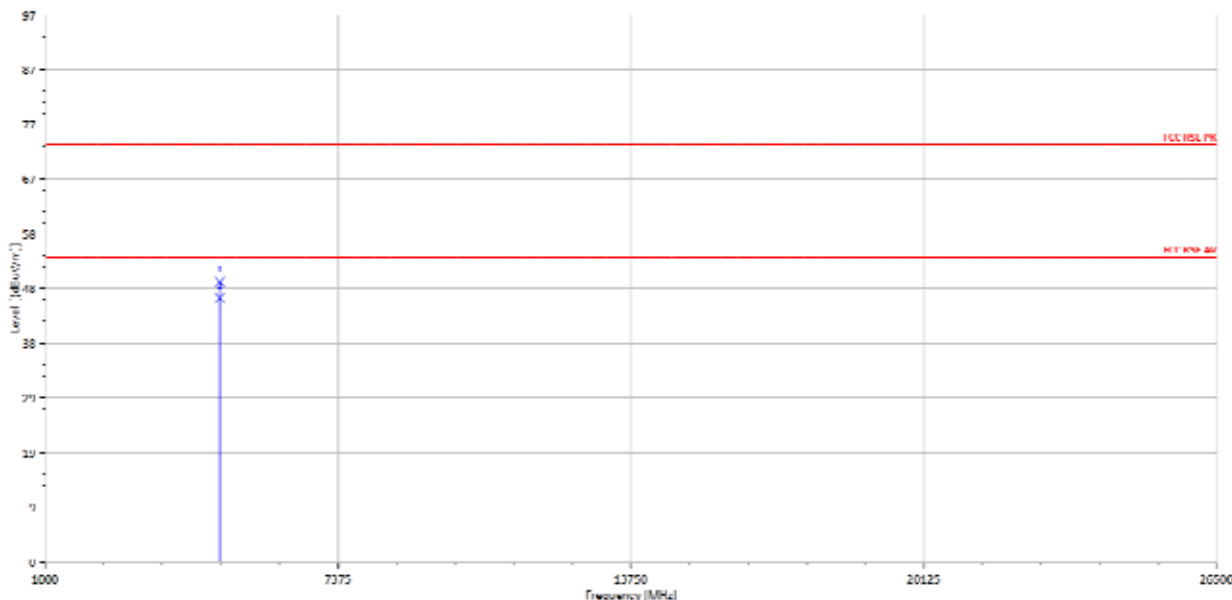
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Operation Band : Zigbee
Fundamental Frequency : 2405 MHz
Operation Mode : TX LOW
EUT Pol. : H Plane

Test Date : 2015-08-26
Temp./Humi. : 19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. : HORIZONTAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level	dB	FS	@3m	dB
4810.00	H	Peak	38.69	10.99	49.68	74	-24.32
4810.00	H	Average	35.80	10.99	46.79	54	-7.21

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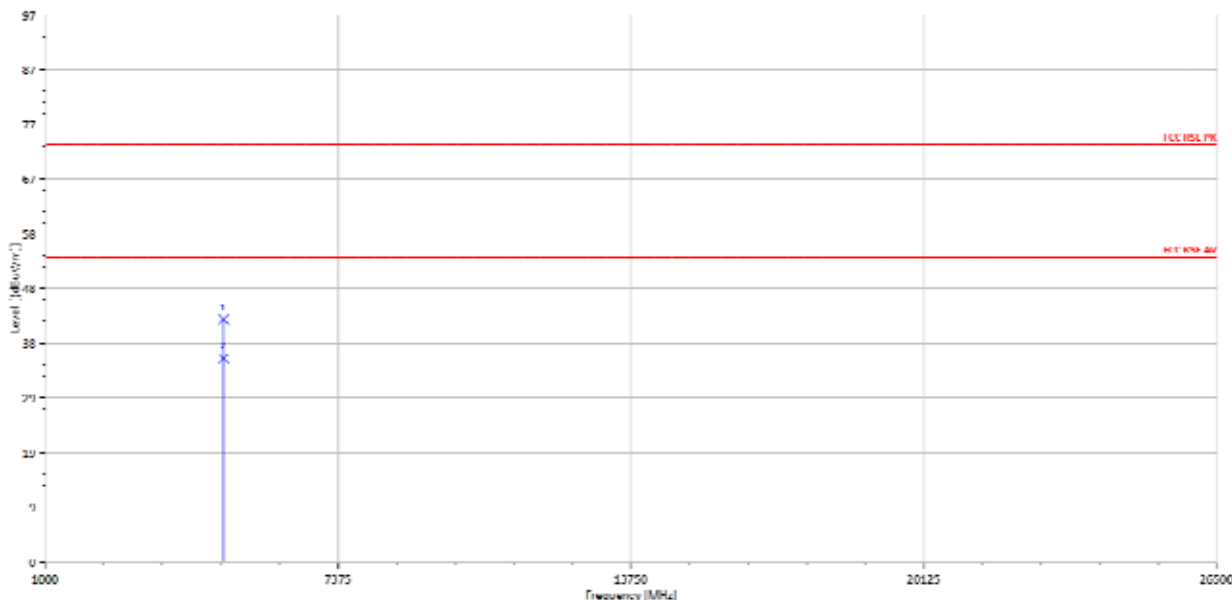
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Operation Band :Zigbee
Fundamental Frequency :2445 MHz
Operation Mode :TX MID
EUT Pol. :H Plane

Test Date :2015-08-26
Temp./Humi. :19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. :VERTICAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4890.00	H	Peak	32.07	10.95	43.02	74	-30.98
4890.00	H	Average	25.15	10.95	36.10	54	-17.90

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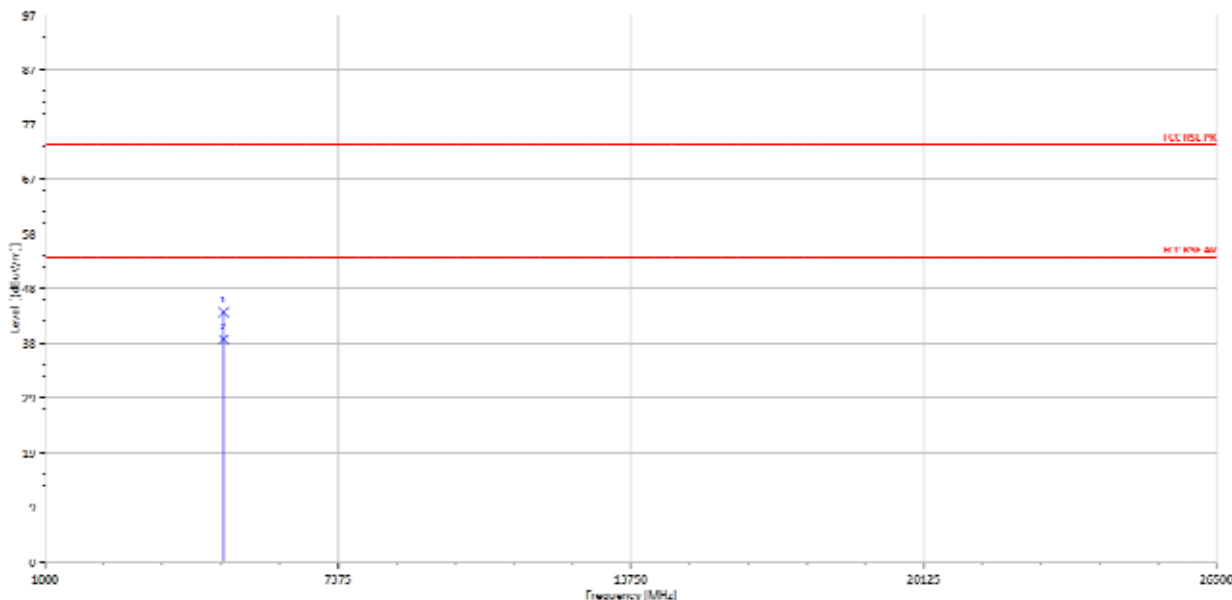
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Operation Band :Zigbee
Fundamental Frequency :2445 MHz
Operation Mode :TX MID
EUT Pol. :H Plane

Test Date :2015-08-26
Temp./Humi. :19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. :HORIZONTAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
		Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4890.00	H	Peak	33.27	10.95	44.23	74	-29.77
4890.00	H	Average	28.53	10.95	39.48	54	-14.52

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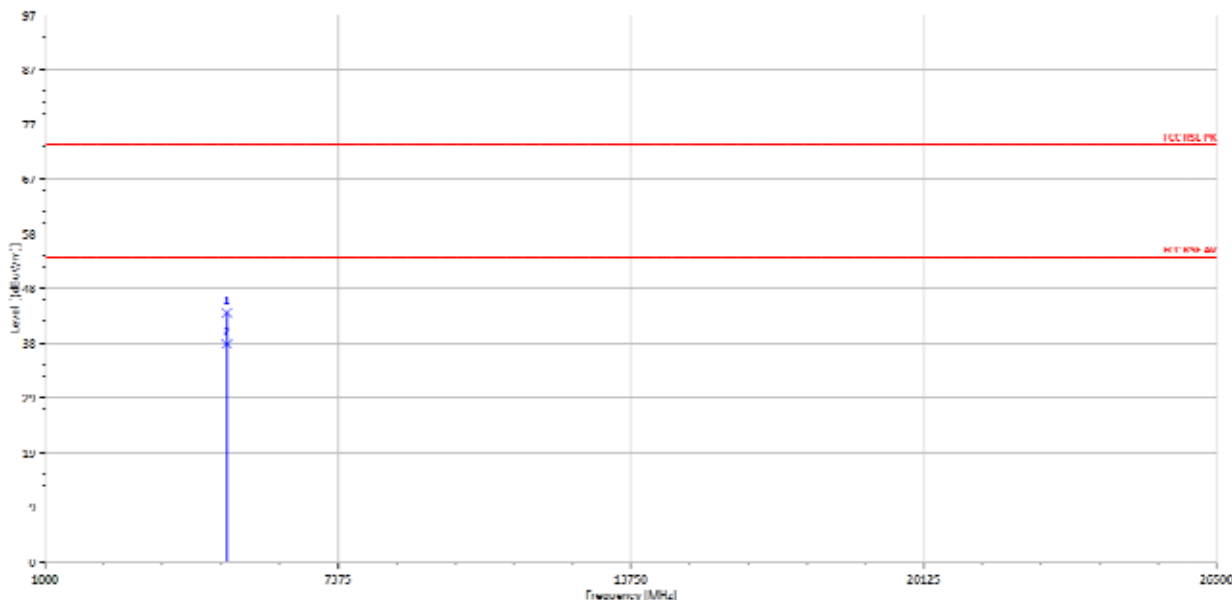
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Operation Band : Zigbee
Fundamental Frequency : 2480 MHz
Operation Mode : TX HIGH
EUT Pol. : H Plane

Test Date : 2015-08-26
Temp./Humi. : 19.5 deg_C/ 65 RH
Engineer : Ashton
Measurement Antenna Pol. : VERTICAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
		Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4960.00	H	Peak	33.14	10.99	44.13	74	-29.87
4960.00	H	Average	27.59	10.99	38.58	54	-15.42

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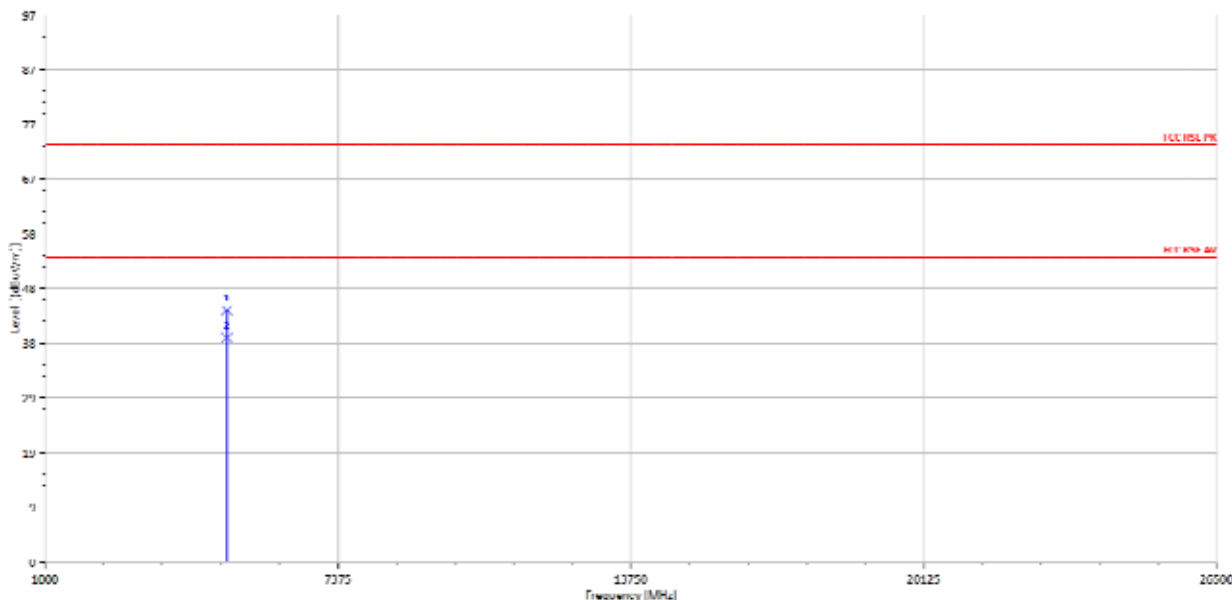
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Engineer : Ashton
Measurement Antenna Pol. :HORIZONTAL



Freq.	Note	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	F/H/E/S	Mode	Reading Level		FS	@3m	
MHz	F/H/E/S	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
4960.00	H	Peak	33.60	10.99	44.59	74	-29.41
4960.00	H	Average	28.76	10.99	39.75	54	-14.25

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8 ANTENNA REQUIREMENT

8.1 Standard Applicable:

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

In case of point-to-point operation, the power shall be reduced by the one dB for every 3 dB that the directional gain of antenna exceeds 6dBi.

8.2 Antenna Connected Construction:

An embedded-in antenna design is used.

The antenna connector is designed with unique type RF connector and no consideration of replacement. Please see EUT photo and antenna spec. for details.

The antenna gain is less than 6dBi. Therefore, it is not necessary to reduce maximum output power limit.

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9 MAXIMUM PERMISSIBLE EXPOSURE (MPE)

9.1 Standard Applicable

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

This is a Mobile device, the MPE is required.

According to §1.1310 and §2.1093 RF exposure is calculated.

Limits for Maximum Permissive Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

F = frequency in MHz

* = Plane-wave equipment power density

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9.2 Maximum Permissible Exposure (MPE) Evaluation

Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)
2405	-4.19	0.00038	1
2440	-3.81	0.00042	1
2480	-3.41	0.00046	1

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = Power density

P = Power input to antenna

G = Power gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna

Maximum peak output power at antenna input	-3.41	(dBm)
Maximum peak output power at antenna input	0.4560369	(mW)
Duty cycle:	100	(%)
Maximum Pav :	0.4560369	(mW)
Antenna gain (Peak):	-5	(dBi)
Antenna gain (linear):	0.3162278	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2480	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.0000287	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.00003 mW/cm². This is below the uncontrolled exposure limit of 1 mW/cm² at 2480MHz.

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