

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Product Name: ESL Base station

Brand Name: OPTICON

Model No.: EBS-40

Model Difference: N/A

FCC ID: Q2Q-EBS40

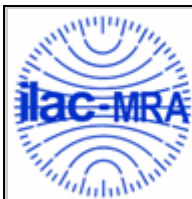
Report No.: E2/2015/20008

Issue Date: Apr. 02, 2015

FCC Rule Part: §15.247, Cat: DTS

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

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Electronics & Communication Laboratory
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VERIFICATION OF COMPLIANCE

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

Product Name: ESL Electronic Shelf Label

Brand Name: OPTICON

Model No.: EBS-40

Model Difference: N/A

FCC ID: Q2Q-EBS40

File Number: E2/2015/20008

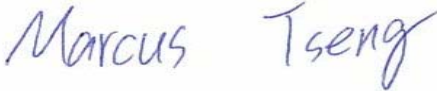
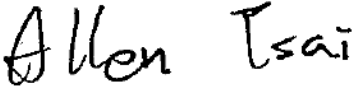

Date of test: Feb. 10, 2015 ~ Apr. 02, 2015

Date of EUT Received: Feb. 10, 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 C63.4:2014 & 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:		Date	Apr. 02, 2015
	_____ <i>Marcus Tseng / Engineer</i>		_____
Prepared By:		Date	Apr. 02, 2015
	_____ <i>Allen Tsai / Engineer</i>		_____
Approved By:		Date	Apr. 02, 2015
	_____ <i>Jim Chang / Asst. Manager</i>		_____

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Revision History

Report Number	Revision	Description	Issue Date
E2/2015/20008	Rev.00	Initial creation of document	Apr. 02, 2015

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1 GENERAL INFORMATION

1.1 Product Description

General:

Product Name:	ESL Base station	
Brand Name:	OPTICON	
Model No.:	EBS-40	
Model Difference:	N/A	
Product SW/HW version:	DVT / IBMV0016	
Radio SW/HW version:	N/A	
Test SW Version:	N/A	
RF power setting in TEST SW:	N/A	
Power Supply:	6Vdc from AC/DC adapter	
	Adapter:	Model No.:_SA115C-05 Supplier: OPTICON

Zigbee:

Operation Frequency:	2405~2480 MHz
Channel Number:	16 channels
Channel Spacing	5 MHz
Output Power:	-0.76dBm (Peak)
Modulation Type:	DSSS
Antenna Designation:	1/4 Wavelength Dipole Antenna, Gain: 2dBi

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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.
3. The EUT was placed 1.5m height for frequency above 1GHz in accordance with ANSI C63.10:2013.

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 a placed on as 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 30MHz,. The CISPR Quasi-Peak and Average detector mode is employed according to §15.107. 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 a placed on as 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 0.6 dB and 10 dB attenuator.

Offset = RF cable loss (dB)+ attenuation factor(dB) =0.6+10=10.6(dB)

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2.5 Configuration of Tested System

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

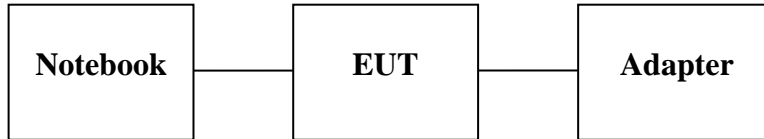


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Test Software	ESL Sever Application	N/A	N/A	N/A	N/A
2.	Notebook	Lenovo	L430	R9-YYG88	Shielded	Unshielded

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Fig. 2-2 AC Power Line Conducted Emission

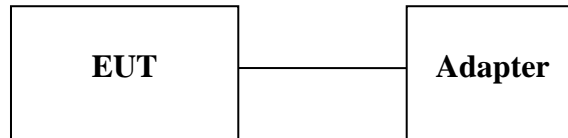


Table 2-2 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Test Software	ESL Sever Application	N/A	N/A	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(a)(2)	6dB Bandwidth	Compliant
§15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	Peak Power Density	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	FREQUENCY	CHANNEL	FREQUENCY
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 Bluetooth LE 4.1 Transmitter for channel Low, Mid and High, the worst case E1 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 CONDUCTED EMISSION TEST

6.1 Standard Applicable:

According to §15.207, frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note

- 1.The lower limit shall apply at the transition frequencies
- 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

6.2 Measurement Equipment Used:

Conducted Emission Test Site					
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
EMI Test Receiver	R&S	ESCI 3	101311	06/20/2014	06/19/2015
Coaxial Cables	N/A	N30N30-1042-150cm	N/A	01/06/2015	01/07/2016
LISN	Schwarzbeck	NSLK 8127	8127-648	06/10/2014	06/09/2015
LISN	Rolf-Heine	NNB-2/16Z	99012	03/04/2015	03/03/2016
Test Software	Farad	EZ-EMC	Ver. SGS-03A2	N.C.R.	N.C.R.

6.3 EUT Setup:

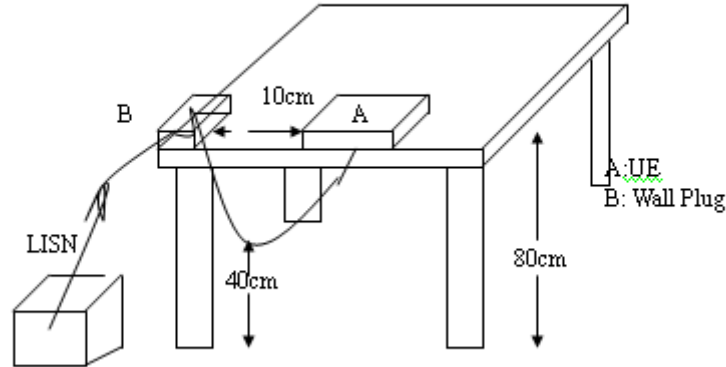
1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.4:2014 & ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

6.6 Measurement Result:

The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. Significant peaks are then marked as shown on the following data page, and these signals are then quasi-peaked.

Note: Refer to next page for measurement data and plots.

Note2: The * reveals the worst-case results that closet to the limit

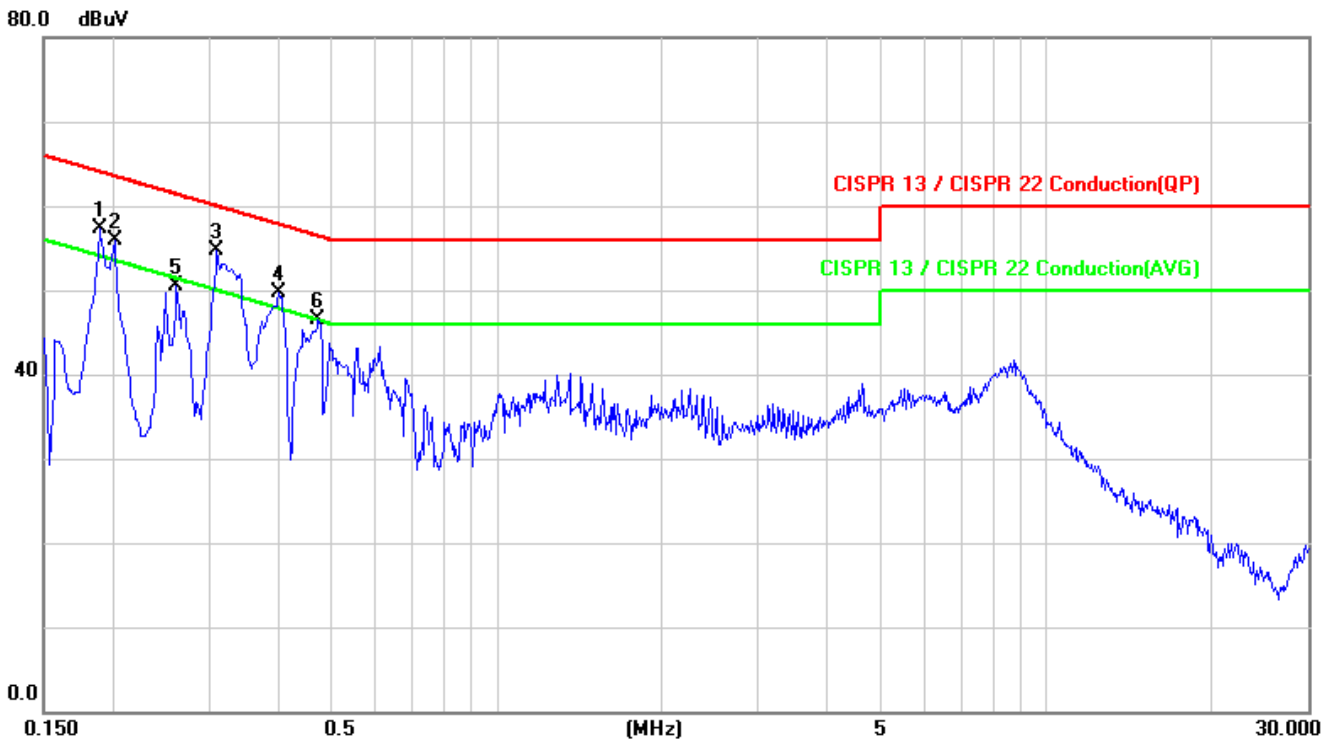
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Operation mode			Test Date:	Mar. 06, 2015
Temperature:	21	Humidity:	70 %	Test By:	Vito
Model No.:	SA115C-05				
Phase:	L1				



No.	Mk.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Measurement (dBuV)	Limit (dBuV)	Over (dB)	Detector	Comment
1		0.1900	57.01	0.31	57.32	64.04	-6.72	peak	
2		0.2020	55.57	0.29	55.86	63.53	-7.67	peak	
3	*	0.3100	54.39	0.29	54.68	59.97	-5.29	peak	
4		0.4020	49.48	0.28	49.76	57.81	-8.05	peak	
5		0.2620	50.22	0.29	50.51	61.37	-10.86	peak	
6		0.4740	46.17	0.32	46.49	56.44	-9.95	peak	

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Operation Mode:	Operation mode		Test Date:	Mar. 06, 2015	
Temperature:	21	Humidity:	70 %	Test By:	Vito
Model No.:	SA115C-05				
Phase:	N				

80.0 dBuV



No.	Mk.	Freq. (MHz)	Reading dBuV	Factor (dB)	Measurement (dBuV)	Limit (dBuV)	Over (dB)	Detector	Comment
1		0.1860	47.72	0.04	47.76	64.21	-16.45	peak	
2		0.3140	45.49	0.09	45.58	59.86	-14.28	peak	
3	*	0.4780	43.11	0.18	43.29	56.37	-13.08	peak	
4		0.6020	42.65	0.21	42.86	56.00	-13.14	peak	
5		1.4340	38.94	0.43	39.37	56.00	-16.63	peak	
6		8.8380	36.97	0.48	37.45	60.00	-22.55	peak	

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7 PEAK OUTPUT POWER MEASUREMENT

7.1 Standard Applicable:

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

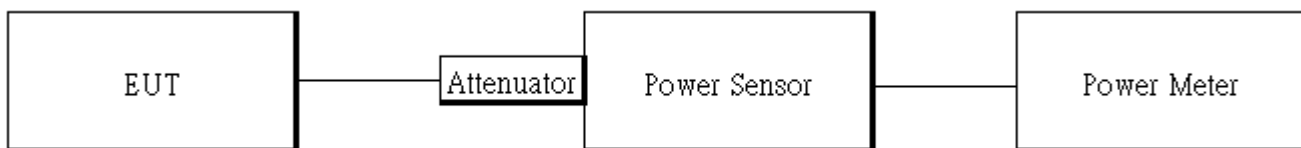
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

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.

7.2 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	06/21/2014	06/20/2015
Power Sensor	Anritsu	MA2411B	1315048	06/21/2014	06/20/2015
DC Block	PASTERNAK	PE8210	RF29	12/19/2014	12/18/2015
Coaxial Cable 30cm	WOKEN	00100A1F1A19 5C	RF01	12/19/2014	12/18/2015
Attenuator	WOKEN	218FS-10	RF23	12/19/2014	12/18/2015

7.3 Test Set-up:



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7.4 Measurement Procedure:

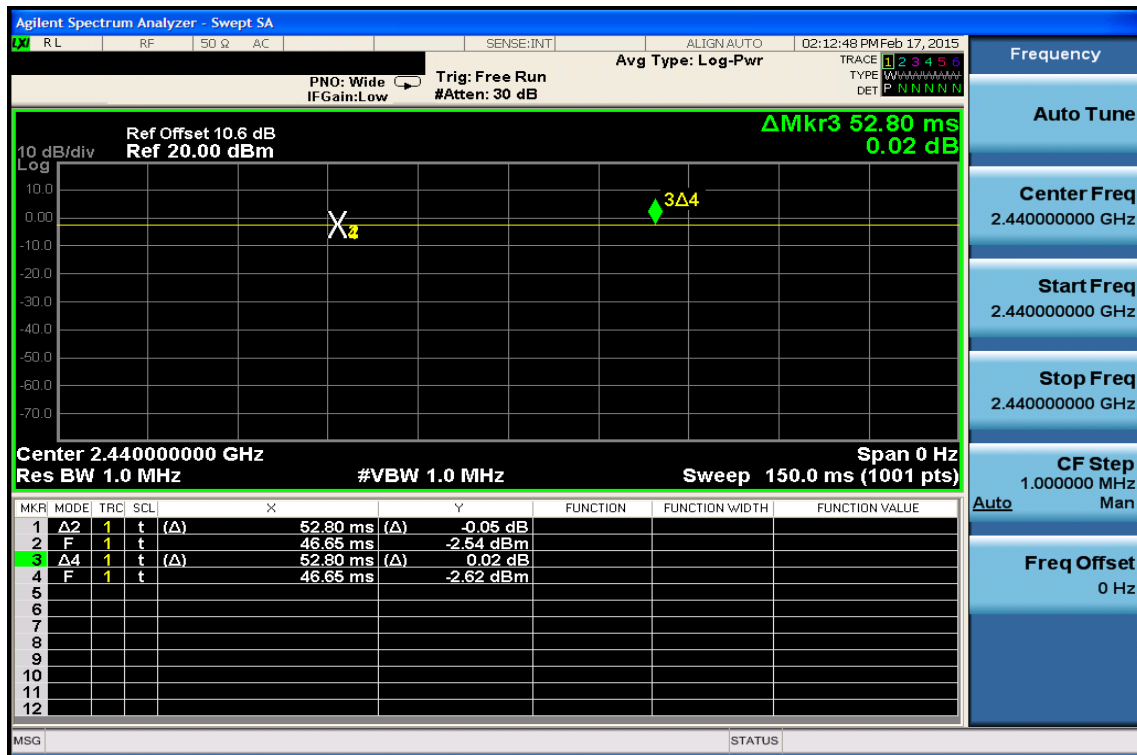
1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

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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7.5 Measurement Result:

Zigbee mode:

CH	Frequency (MHz)	Peak Power Output(dBm)	Required Limit
11	2405	-1.09	1 Watt = 30 dBm
18	2440	-0.76	1 Watt = 30 dBm
26	2480	-7.19	1 Watt = 30 dBm

CH	Frequency (MHz)	Average Power Output(dBm)	Required Limit
11	2405	-1.32	1 Watt = 30 dBm
18	2440	-1.01	1 Watt = 30 dBm
26	2480	-7.46	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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8 6dB BANDWIDTH

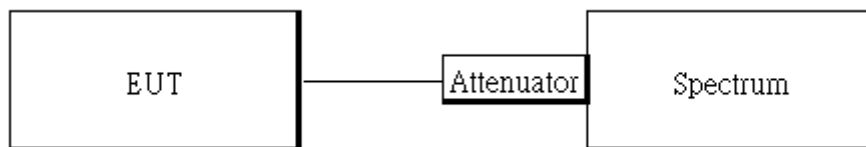
8.1 Standard Applicable

The minimum 6 dB bandwidth shall be at least 500 kHz .

8.2 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
DC Block	PASTERNAK	PE8210	RF29	12/19/2014	12/18/2015
Attenuator	WOKEN	218FS-10	RF23	12/19/2014	12/18/2015

8.3 Test Set-up:



8.4 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.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as RBW = 100 kHz, VBW = 3*RBW, Span = 5MHz, Detector=Peak, Sweep=auto.
4. Mark the peak frequency and -6dB (upper and lower) frequency.
5. Repeat above procedures until all test default channel measured were complete.

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8.5 Measurement Result:

Zigbee mode

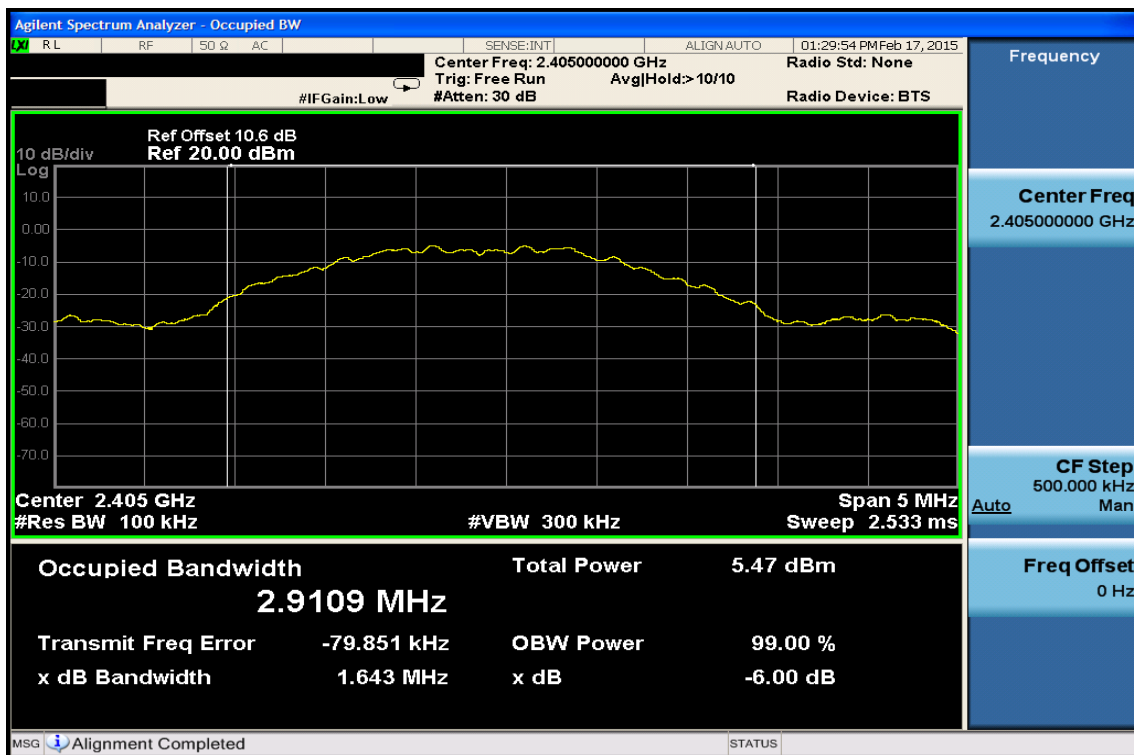
Frequency (MHz)	Bandwidth (kHz)	Bandwidth (kHz)	Result
2405	1.643	> 500	PASS
2440	1.640	> 500	PASS
2480	1.644	> 500	PASS

* Note: The arrow “->” reveals X decibel level

Note: Refer to next page for plots.

Zigbee mode

6dB Band Width Test Data CH-Low



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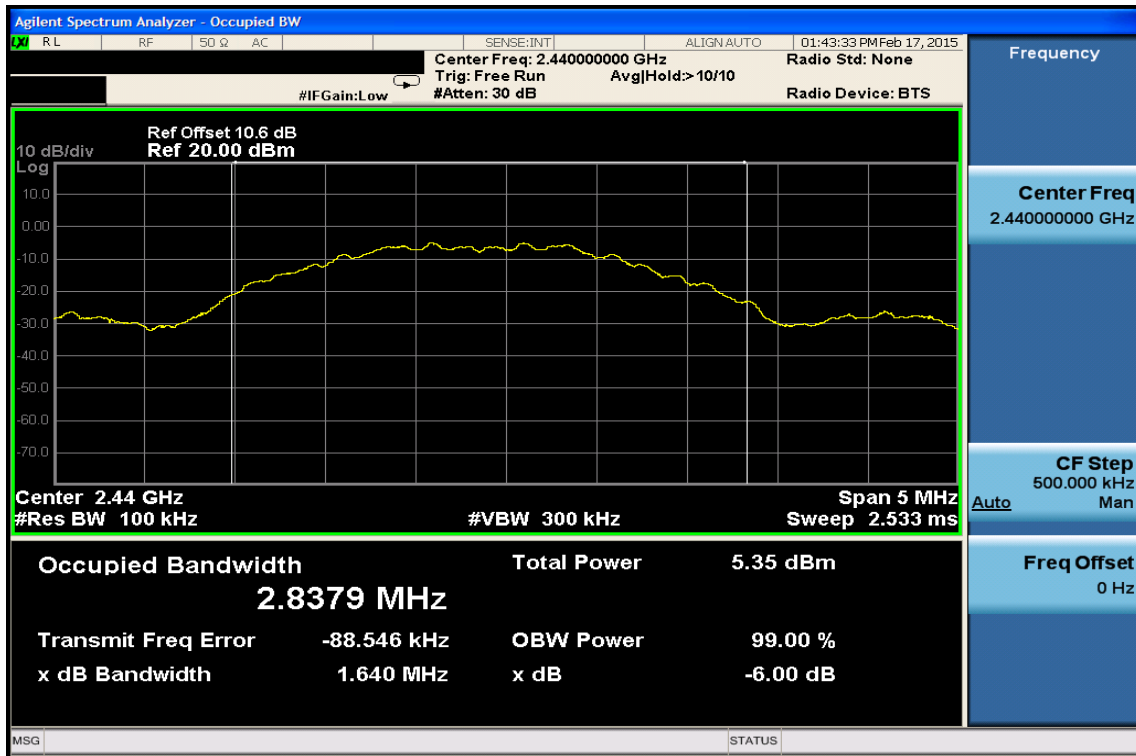
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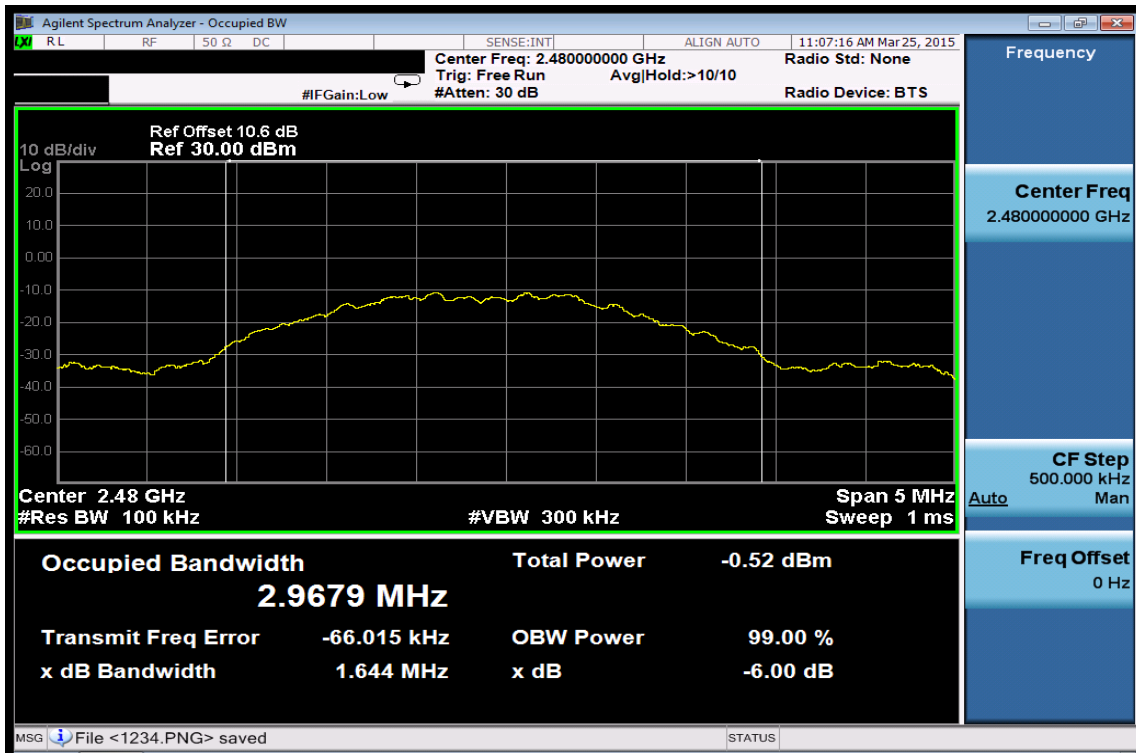
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6dB Band Width Test Data CH-Mid



6dB Band Width Test Data CH-High



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

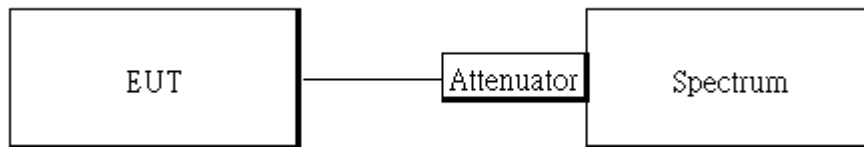
9.1 Standard Applicable

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, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

9.2 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
DC Block	PASTERNAK	PE8210	RF29	12/19/2014	12/18/2015
Attenuator	WOKEN	218FS-10	RF23	12/19/2014	12/18/2015

9.3 Test SET-UP:



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9.3.1 Measurement Procedure

Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
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 spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW, VBW=300KHz, Detector = Peak, Sweep = auto
6. Mark the highest reading of the emission as the reference level measurement.
7. Set DL as the limit = reading on marker 1 – 20dBm
8. Marker on frequency, 2.3999GHz and 2.4836GHz, and examine shall 100 KHz immediately outside the authorized (2400~2483.5) be attenuated by 20dB at least relative to the maximum emission of power.
9. Repeat above procedures until all default test channel (low, middle, and high) was complete.

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
3. Set RBW = 100K & VBW \geq 300K, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

9.3.2 Measurement Result

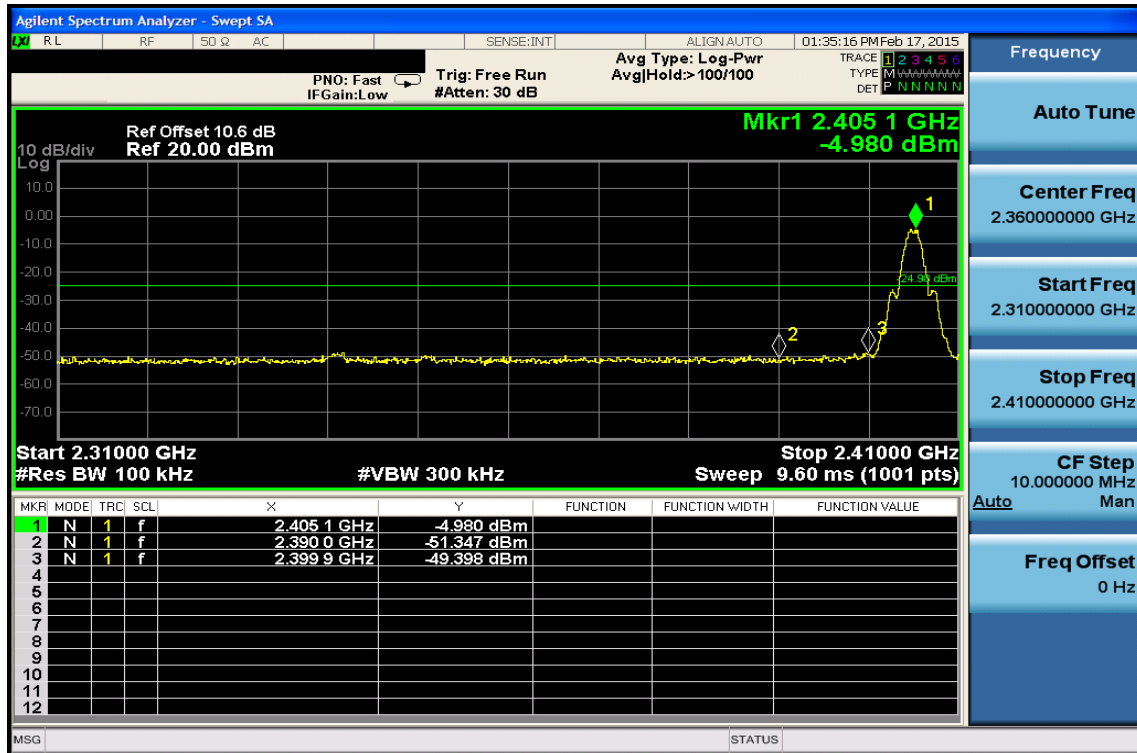
Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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Zigbee mode Band Edges Test Data CH-Low



Band Edges Test Data CH-High



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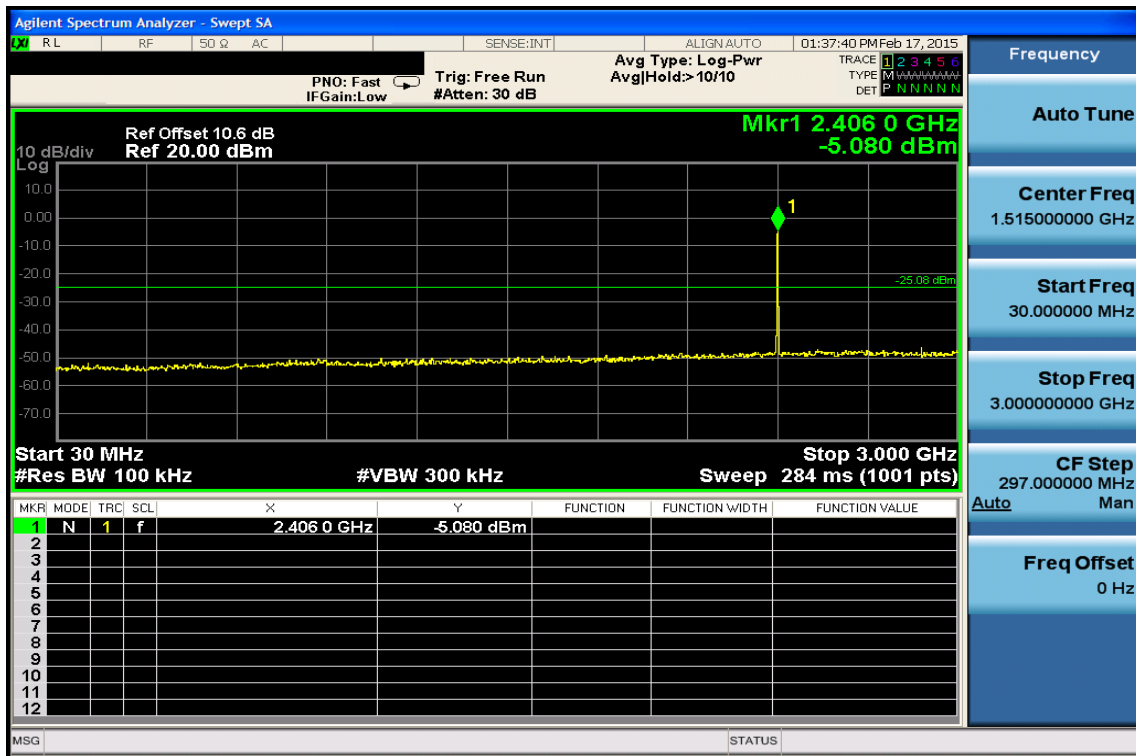
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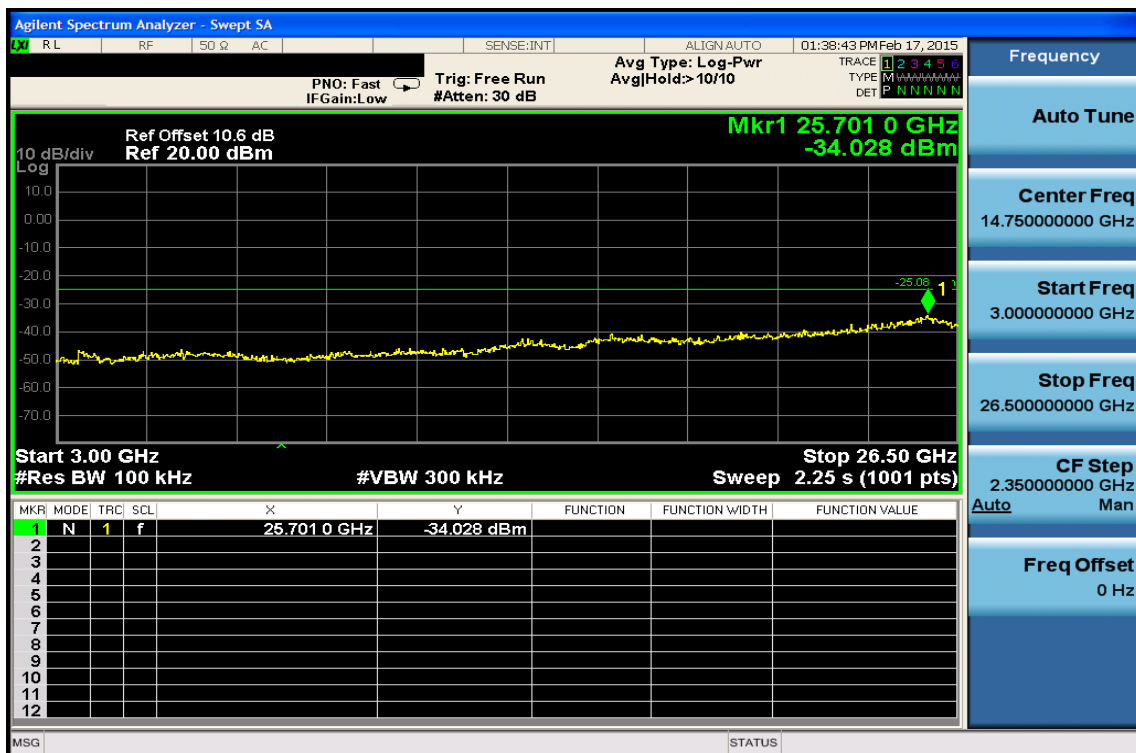
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Spurious Emission Test Data CH-Low

30M – 3GHz



3GHz-26.5GHz



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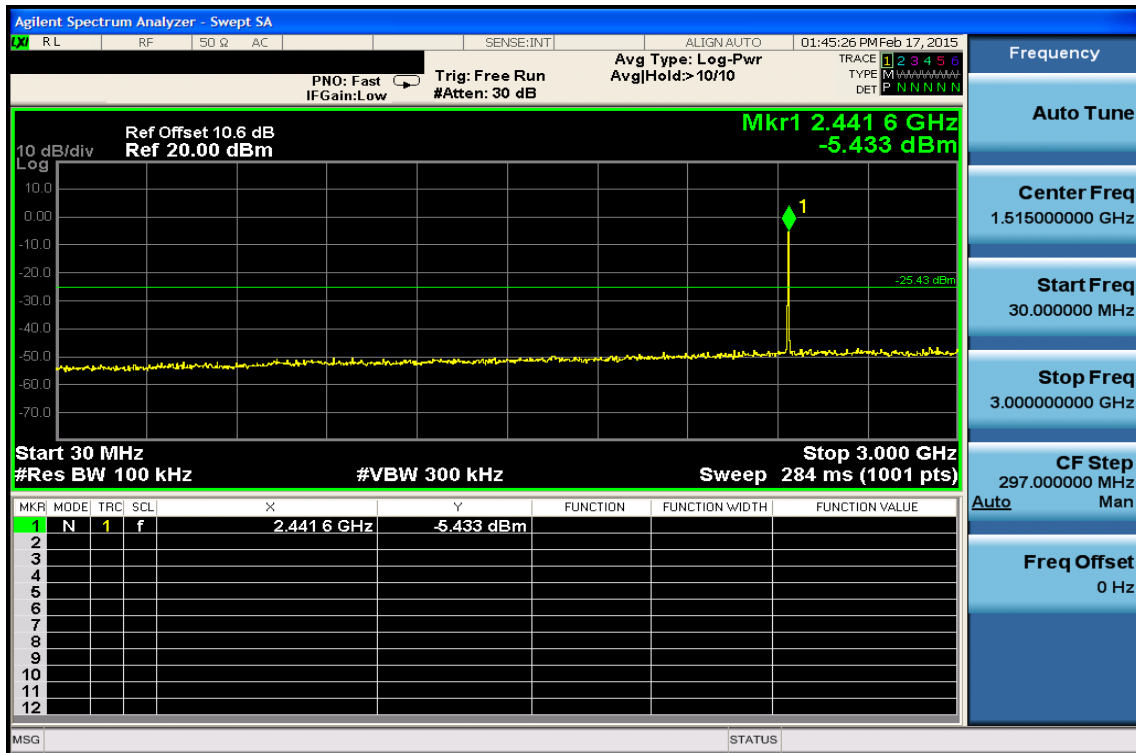
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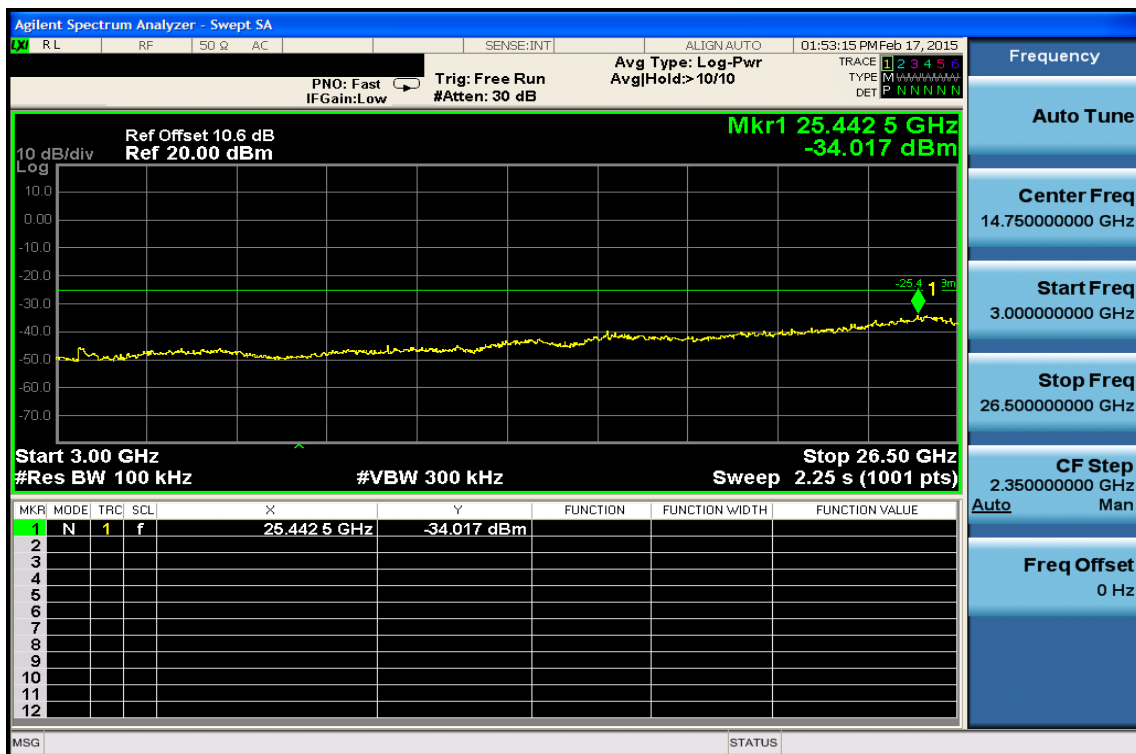
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Spurious Emission Test Data CH-Mid 30M – 3GHz



Frequency
Auto Tune
Center Freq 1.515000000 GHz
Start Freq 30.000000 MHz
Stop Freq 3.000000000 GHz
CF Step 297.000000 MHz Auto Man
Freq Offset 0 Hz

3GHz-26.5GHz



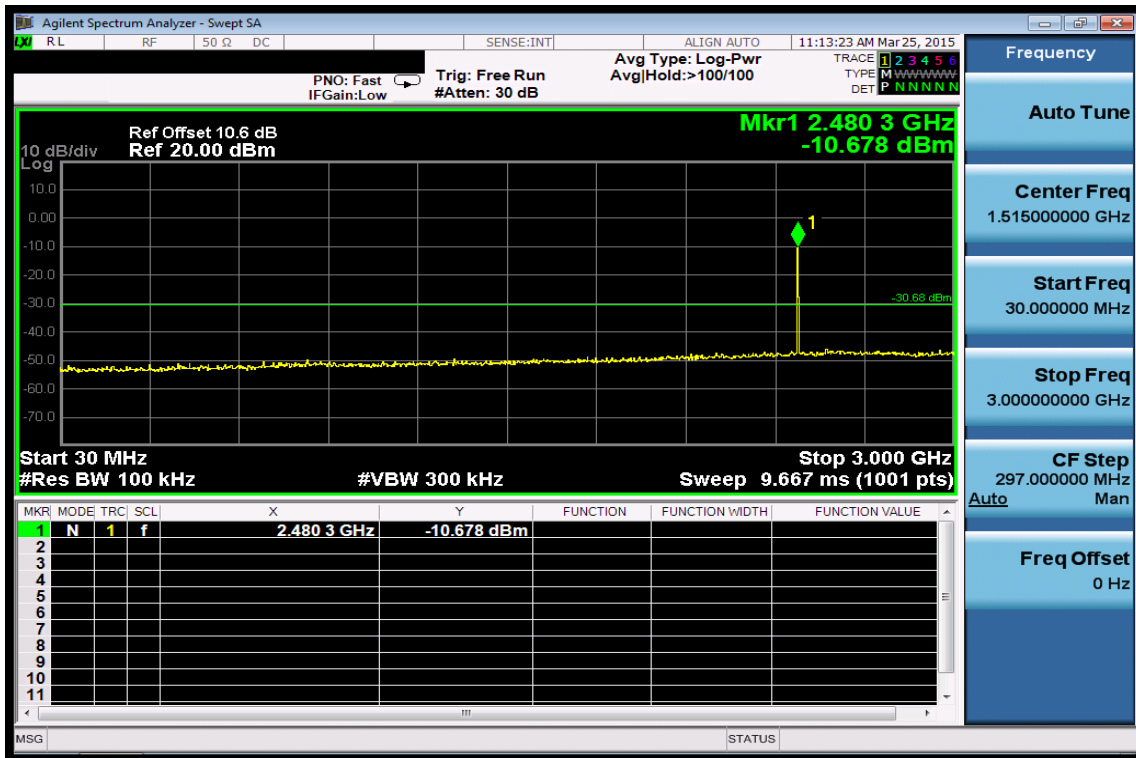
Frequency
Auto Tune
Center Freq 14.750000000 GHz
Start Freq 3.000000000 GHz
Stop Freq 26.500000000 GHz
CF Step 2.350000000 GHz Auto Man
Freq Offset 0 Hz

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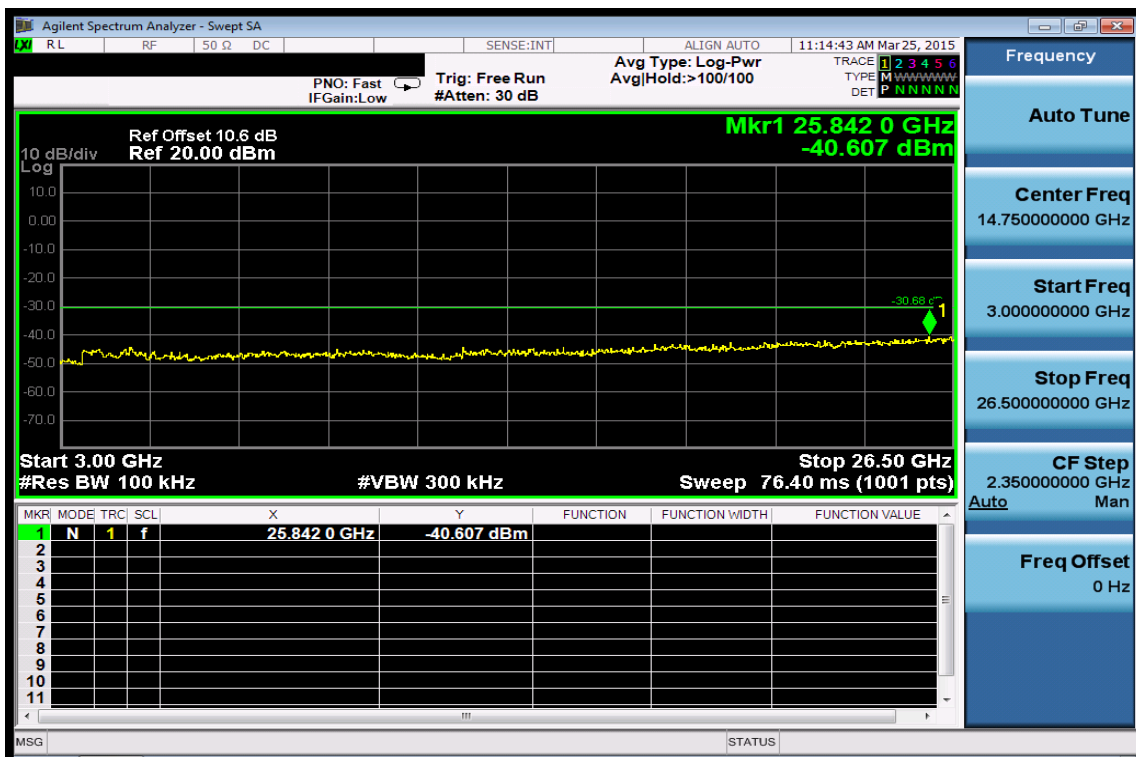
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Spurious Emission Test Data CH-High 30M – 3GHz



3GHz-26.5GHz



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10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

10.1 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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10.2 Measurement Equipment Used

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESU 40	100363	04/12/2014	04/11/2015
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	05/31/2014	05/30/2015
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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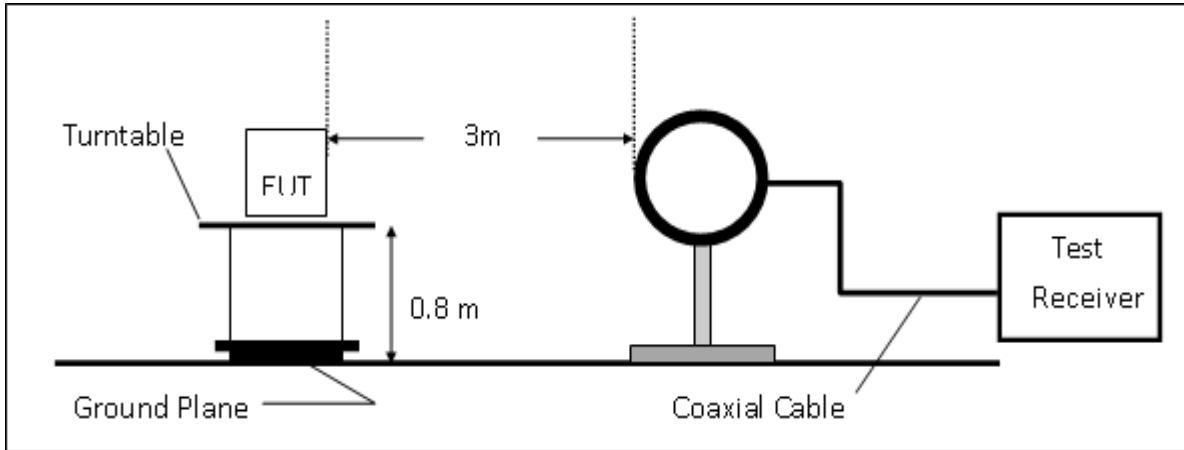
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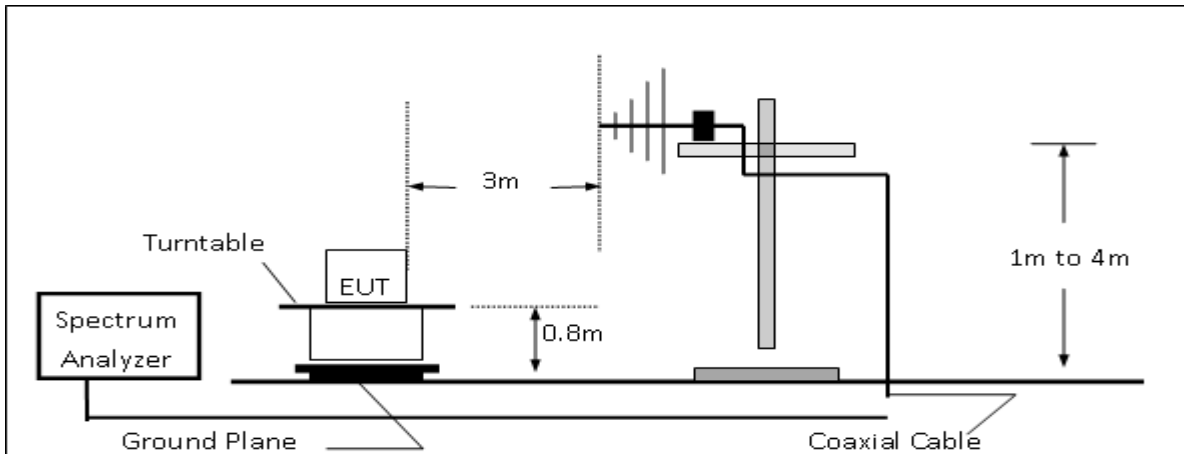
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10.3 Test SET-UP

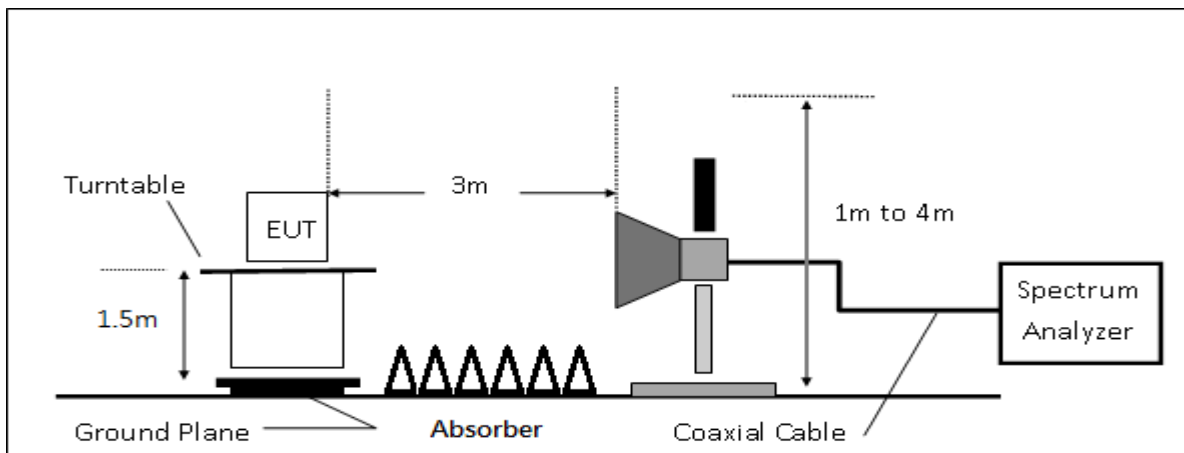
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(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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10.4 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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10.5 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.

10.6 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.

10.7 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	:2015-03-30
Fundamental Frequency	:2405 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	:Vito
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:VERTICAL

Freq.	Detector Mode	Note	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	F/H/E/S	dBμV	dB	dBμV/m	dBμV/m	dB
2341.13	Peak	S	45.29	6.48	51.77	74.00	-22.23
2341.13	Average	S	38.47	6.48	44.95	54.00	-9.05
2390.00	Peak	E	38.22	6.62	44.84	74.00	-29.16
2390.00	Average	E	25.93	6.62	32.55	54.00	-21.45

Operation Band	: Zigbee	Test Date	:2015-03-30
Fundamental Frequency	:2405 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	:Vito
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:HORIZONTAL

Freq.	Detector Mode	Note	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	F/H/E/S	dBμV	dB	dBμV/m	dBμV/m	dB
2341.13	Peak	S	41.46	6.48	47.94	74.00	-26.06
2341.13	Average	S	30.70	6.48	37.18	54.00	-16.82
2390.00	Peak	E	37.94	6.62	44.56	74.00	-29.44
2390.00	Average	E	24.91	6.62	31.53	54.00	-22.47

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Operation Band	: Zigbee	Test Date	:2015-03-30
Fundamental Frequency	:2480 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	:Vito
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:VERTICAL

Freq.	Detector Mode	Note	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	F/H/E/S	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Peak	E	56.64	6.96	63.61	74.00	-10.39
2483.50	Average	E	45.65	6.96	52.61	54.00	-1.39

Operation Band	: Zigbee	Test Date	:2015-03-30
Fundamental Frequency	:2480 MHz	Temp./Humi.	:19.5 deg_C/ 65 RH
Operation Mode	:Bandedge LOW	Engineer	:Vito
EUT Pol.	:E2 Plan	Measurement Antenna Pol.	:HORIZONTAL

Freq.	Detector Mode	Note	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	F/H/E/S	dBμV	dB	dBμV/m	dBμV/m	dB
2483.50	Peak	E	45.12	6.96	52.08	74.00	-21.92
2483.50	Average	E	33.32	6.96	40.28	54.00	-13.72

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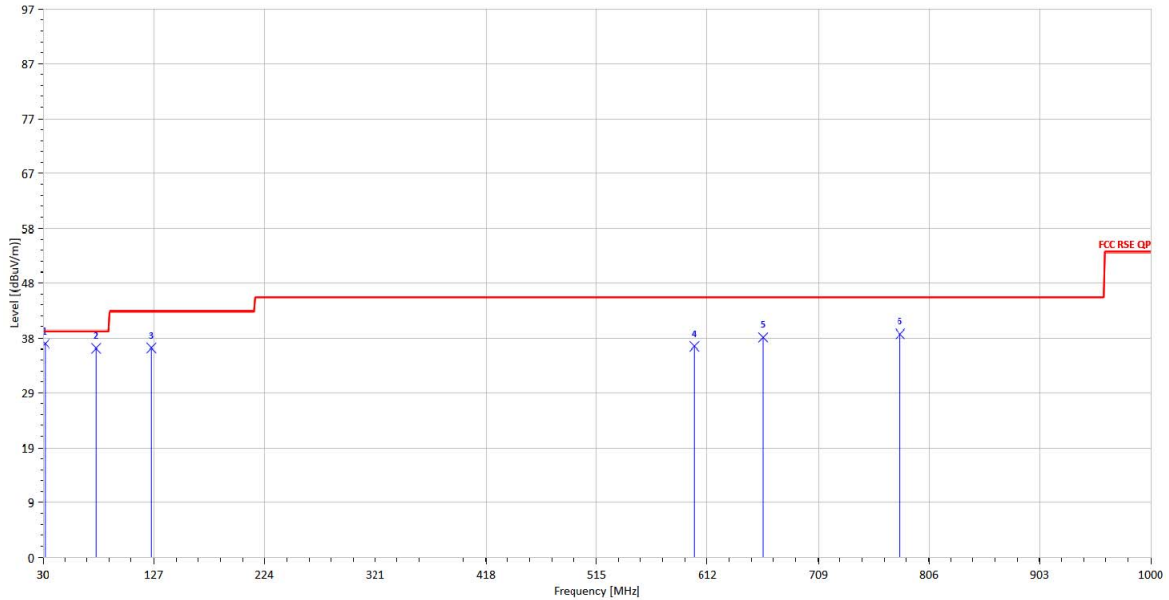
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Radiated Spurious Emission Measurement Result (Zigbee mode)

Operation Band	:Zigbee	Test Date	:2014-11-07
Fundamental Frequency	:2405 MHz	Temp./Humi.	:23 deg_C / 58 RH
Operation Mode	:TX LOW	Engineer	:Vito
EUT Pol.	:E2 Plane	Measurement Antenna Pol.	:VERTICAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
31.94	Peak	S	51.93	-14.17	37.76	40.00	-2.24
76.56	Peak	S	64.14	-27.18	36.96	40.00	-3.04
125.06	Peak	S	58.41	-21.38	37.03	43.50	-6.47
600.36	Peak	S	49.77	-12.45	37.31	46.00	-8.69
660.50	Peak	S	50.44	-11.54	38.90	46.00	-7.10
780.78	Peak	S	49.75	-10.25	39.50	46.00	-6.50

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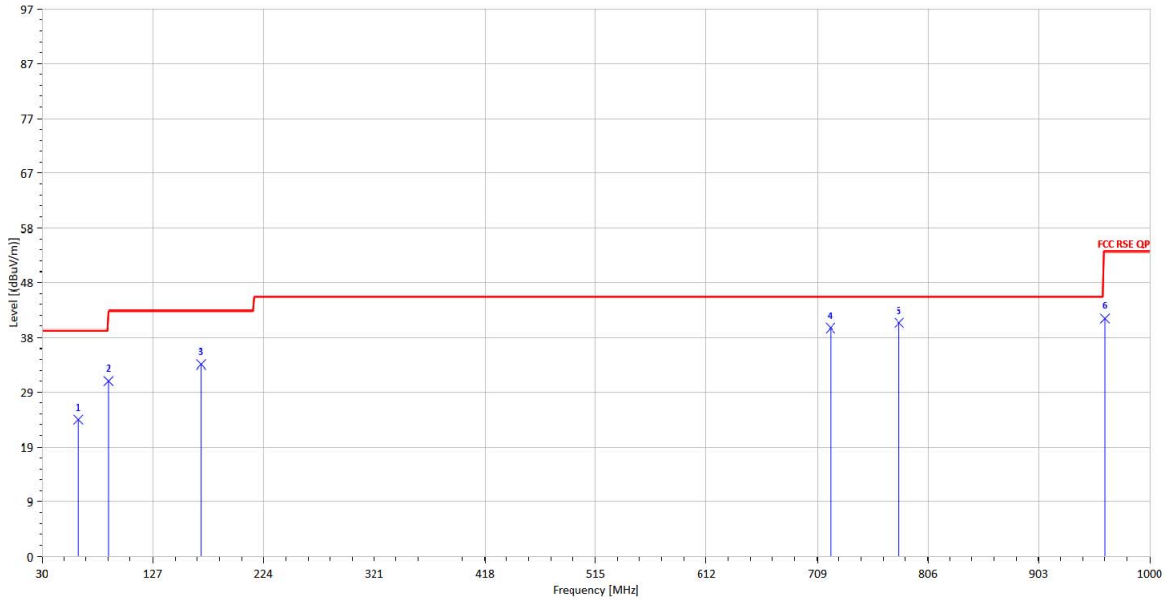
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2405 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX LOW	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: HORIZONTAL



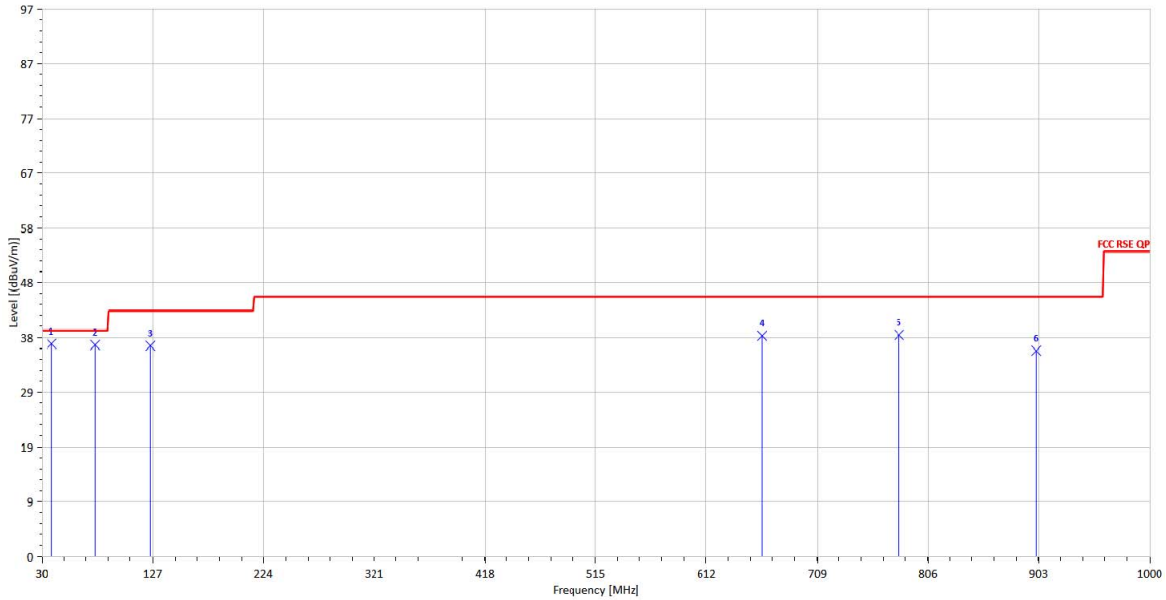
Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
62.01	Peak	S	52.54	-28.34	24.20	40.00	-15.80
88.20	Peak	S	56.88	-25.86	31.03	43.50	-12.47
169.68	Peak	S	57.69	-23.70	33.99	43.50	-9.51
720.64	Peak	S	51.23	-10.77	40.45	46.00	-5.55
780.78	Peak	S	51.61	-10.25	41.36	46.00	-4.64
961.20	Peak	S	49.66	-7.53	42.13	54.00	-11.87

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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2440 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX MID	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: VERTICAL



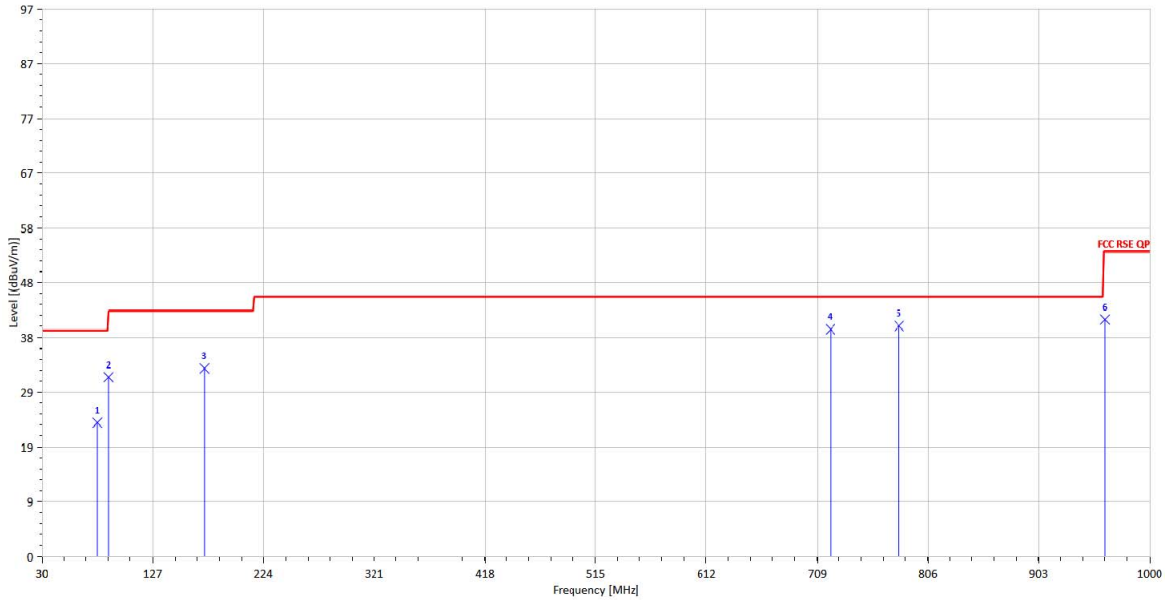
Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
38.73	Peak	S	55.85	-18.19	37.66	40.00	-2.34
76.56	Peak	S	64.63	-27.18	37.45	40.00	-2.55
125.06	Peak	S	58.69	-21.38	37.31	43.50	-6.19
660.50	Peak	S	50.64	-11.54	39.09	46.00	-6.91
780.78	Peak	S	49.51	-10.25	39.25	46.00	-6.75
901.06	Peak	S	44.55	-8.12	36.43	46.00	-9.57

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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2440 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX MID	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: HORIZONTAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
78.50	Peak	S	50.68	-27.00	23.68	40.00	-16.32
88.20	Peak	S	57.60	-25.86	31.74	43.50	-11.76
172.59	Peak	S	57.24	-23.96	33.28	43.50	-10.22
720.64	Peak	S	50.99	-10.77	40.22	46.00	-5.78
780.78	Peak	S	51.07	-10.25	40.82	46.00	-5.18
961.20	Peak	S	49.49	-7.53	41.96	54.00	-12.04

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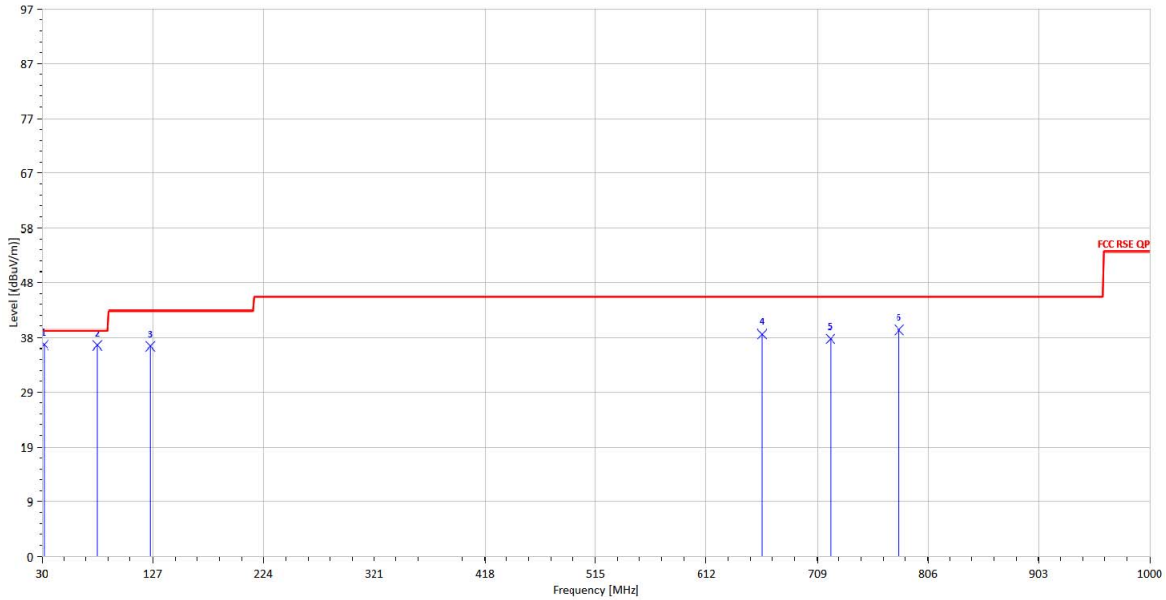
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2480 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX HIGH	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: VERTICAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
31.94	Peak	S	51.65	-14.17	37.49	40.00	-2.51
78.50	Peak	S	64.38	-27.00	37.38	40.00	-2.62
125.06	Peak	S	58.60	-21.38	37.22	43.50	-6.28
660.50	Peak	S	50.91	-11.54	39.37	46.00	-6.63
720.64	Peak	S	49.30	-10.77	38.53	46.00	-7.47
780.78	Peak	S	50.36	-10.25	40.11	46.00	-5.89

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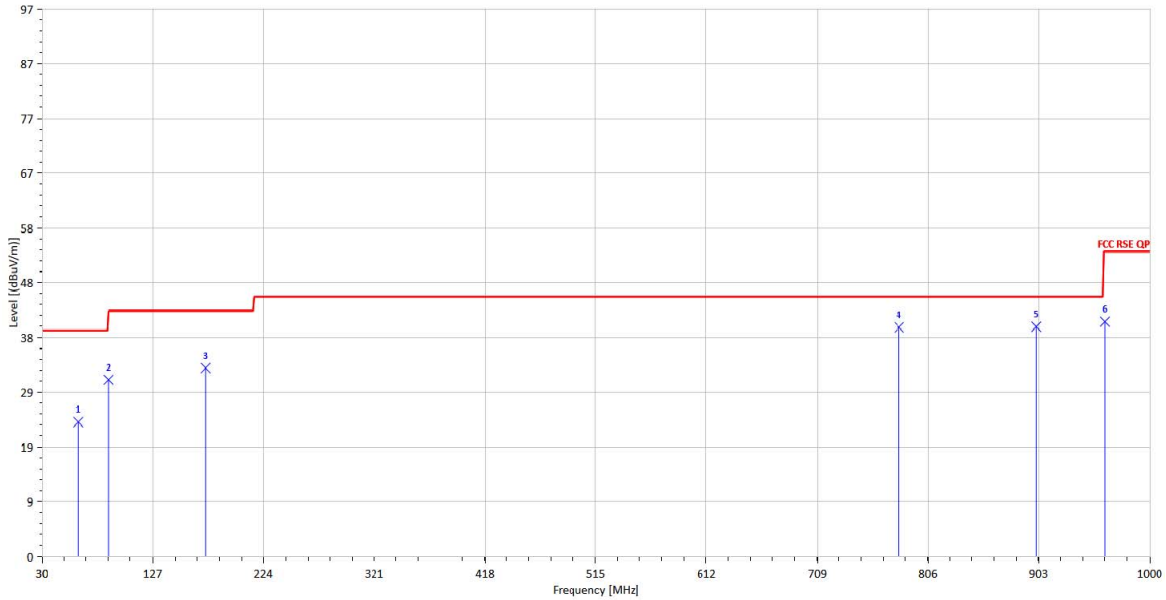
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2480 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX HIGH	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: HORIZONTAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
62.01	Peak	S	52.13	-28.34	23.79	40.00	-16.21
88.20	Peak	S	57.12	-25.86	31.26	43.50	-12.24
173.56	Peak	S	57.36	-23.99	33.37	43.50	-10.13
780.78	Peak	S	50.83	-10.25	40.58	46.00	-5.42
901.06	Peak	S	48.81	-8.12	40.69	46.00	-5.31
961.20	Peak	S	49.11	-7.53	41.58	54.00	-12.42

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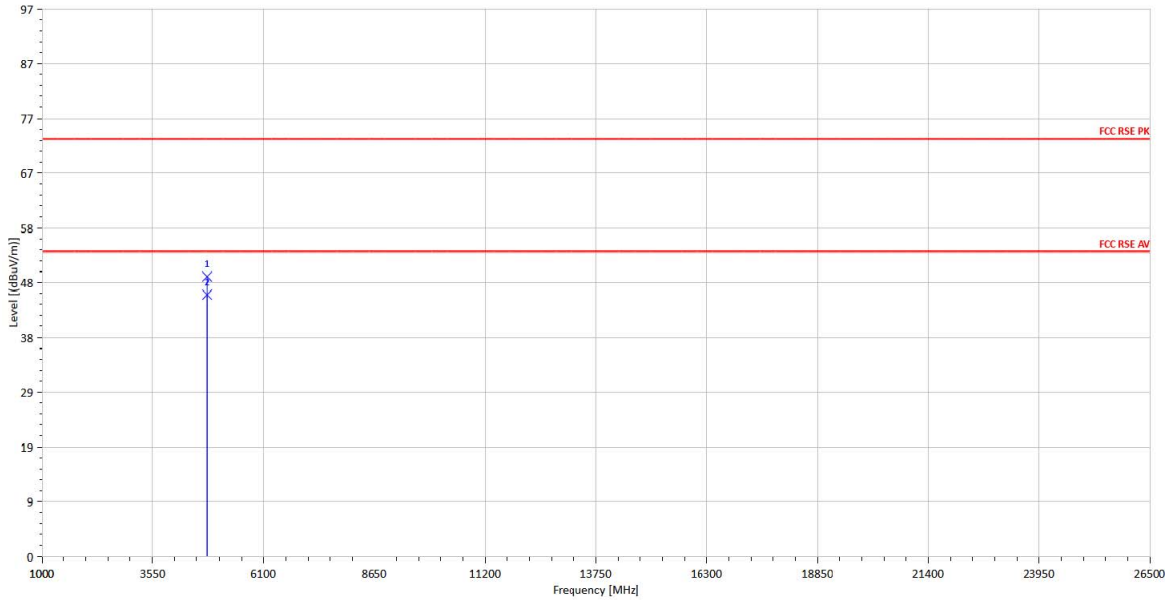
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2405 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX LOW	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: VERTICAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4810.00	Peak	H	38.57	10.99	49.56	74.00	-24.44
4810.00	Average	H	35.36	10.99	46.35	54.00	-7.65

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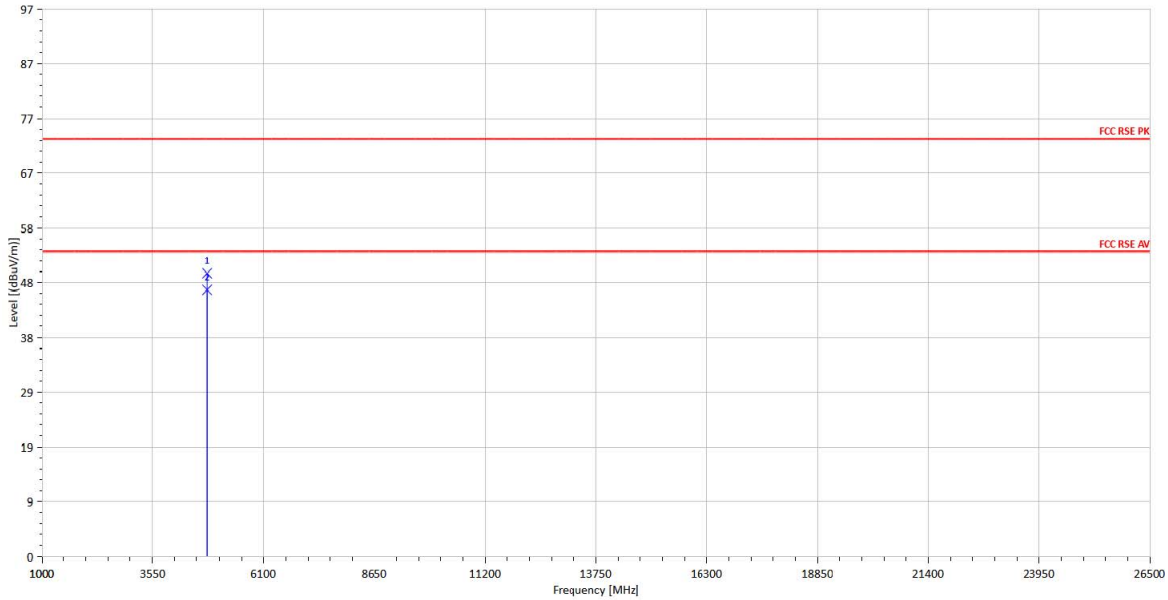
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2405 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX LOW	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: HORIZONTAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4810.00	Peak	H	39.14	10.99	50.13	74.00	-23.87
4810.00	Average	H	36.23	10.99	47.22	54.00	-6.78

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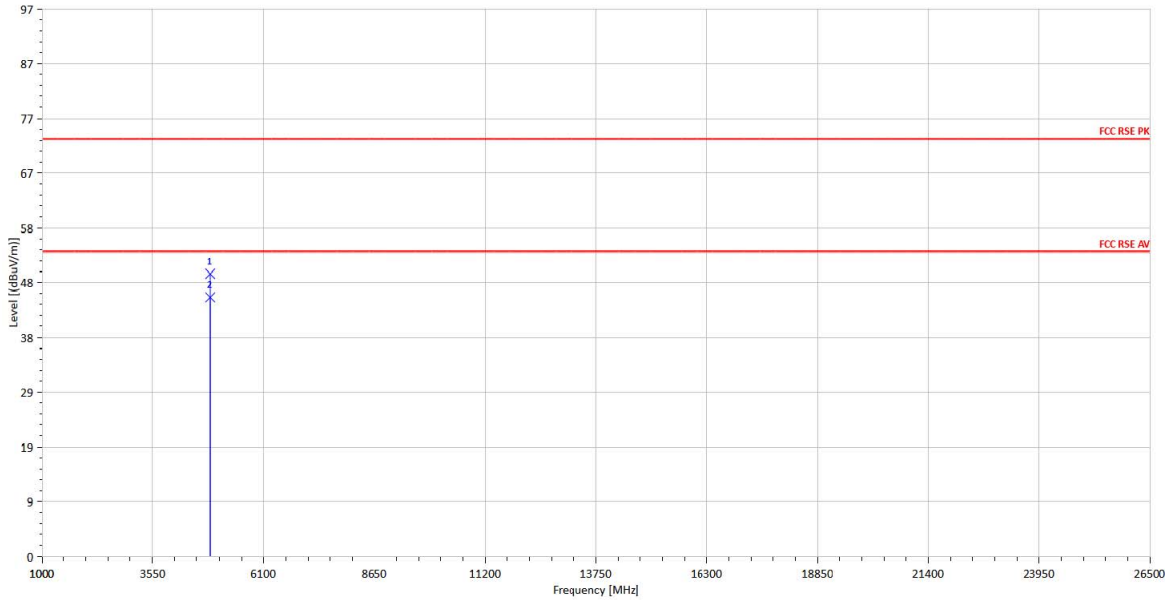
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2440 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX MID	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: VERTICAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4880.00	Peak	H	39.15	10.89	50.04	74.00	-23.96
4880.00	Average	H	35.00	10.89	45.89	54.00	-8.11

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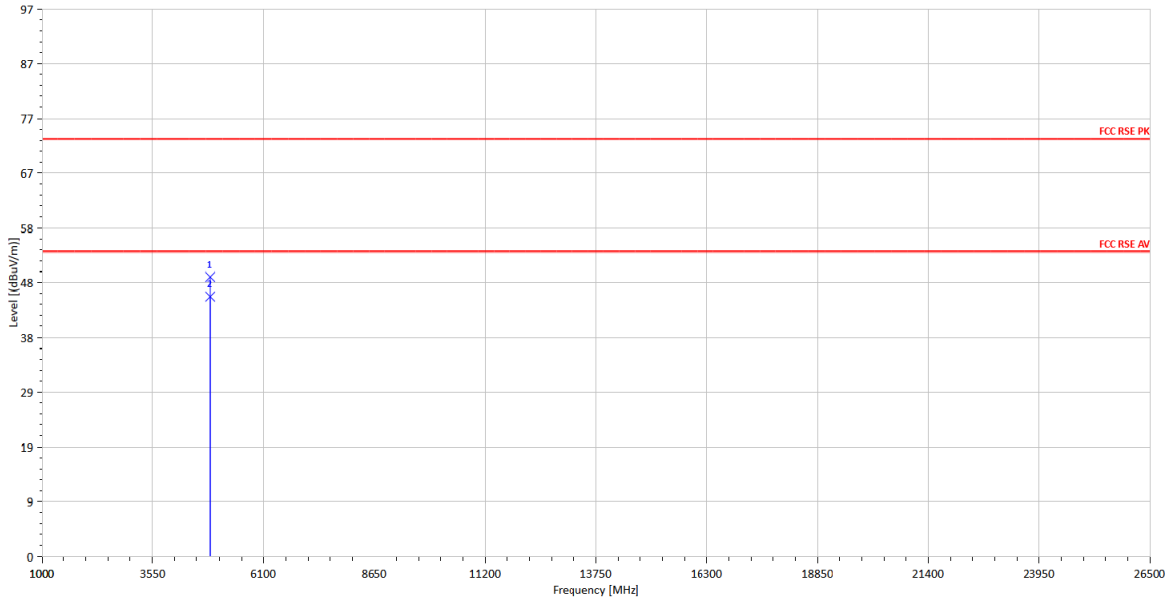
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2440 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX MID	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: HORIZONTAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4880.00	Peak	H	38.61	10.89	49.50	74.00	-24.50
4880.00	Average	H	35.13	10.89	46.02	54.00	-7.98

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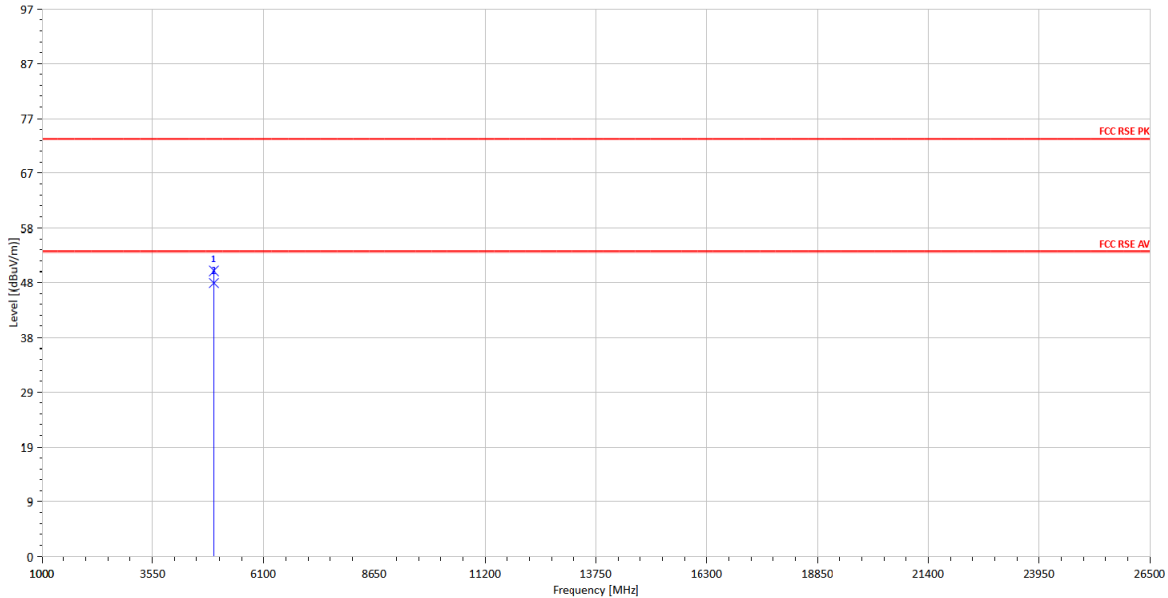
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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2480 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX HIGH	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: VERTICAL



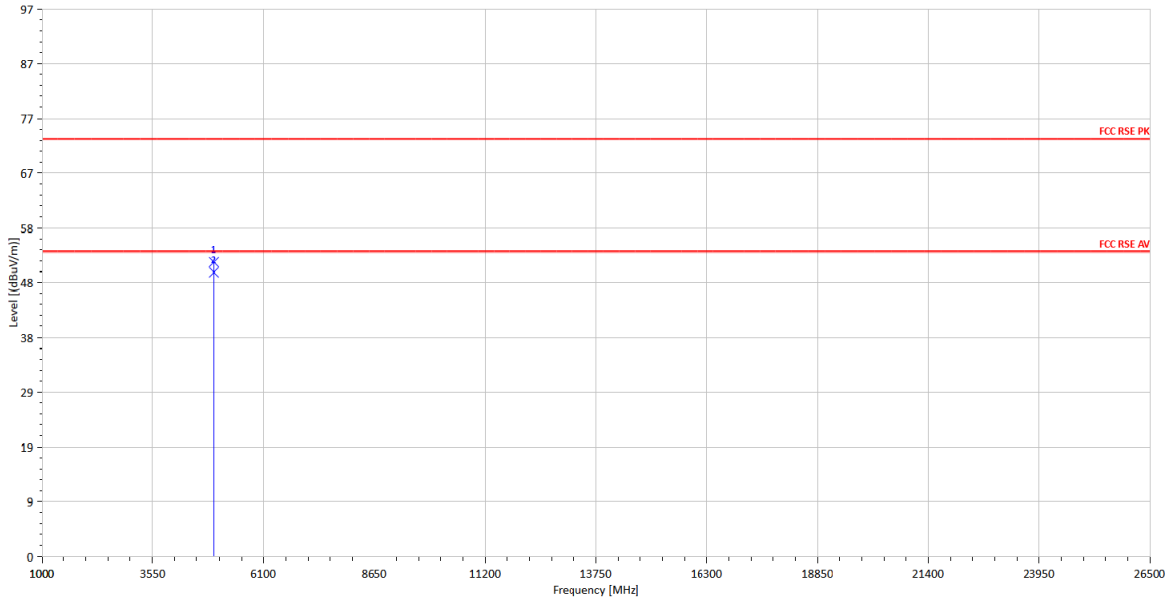
Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4960.00	Peak	H	39.58	10.99	50.57	74.00	-23.43
4960.00	Average	H	37.41	10.99	48.40	54.00	-5.60

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Operation Band	: Zigbee	Test Date	: 2014-11-07
Fundamental Frequency	: 2480 MHz	Temp./Humi.	: 23 deg_C / 58 RH
Operation Mode	: TX HIGH	Engineer	: Vito
EUT Pol.	: E2 Plane	Measurement Antenna Pol.	: HORIZONTAL



Freq. MHz	Detector Mode	Note F/H/E/S	Spectrum Reading Level dBµV	Factor dB	Actual FS dBµV/m	Limit @3m dBµV/m	Margin dB
4960.00	Peak	H	41.16	10.99	52.15	74.00	-21.85
4960.00	Average	H	39.32	10.99	50.31	54.00	-3.69

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11 PEAK POWER SPECTRAL DENSITY

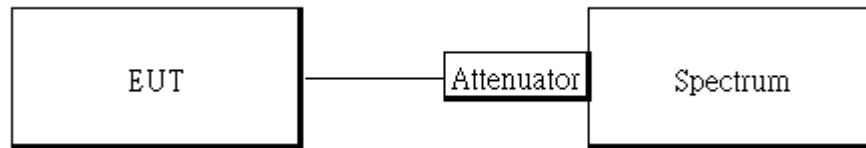
11.1 Standard Applicable:

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 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
DC Block	PASTERNAK	PE8210	RF29	12/19/2014	12/18/2015
Attenuator	WOKEN	218FS-10	RF23	12/19/2014	12/18/2015

11.3 Test Set-up:



11.4 Measurement Procedure:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance V03r02.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW ≥ 3 kHz.
4. Set the VBW $\geq 3 \times$ RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

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11.5 Measurement Result:

Zigbee mode

Frequency MHz	RF Power Density (dBm)	Limit (dBm)	Result
2405	-16.56	8	PASS
2440	-15.20	8	PASS
2480	-21.46	8	PASS

Note: Refer to next page for plots.

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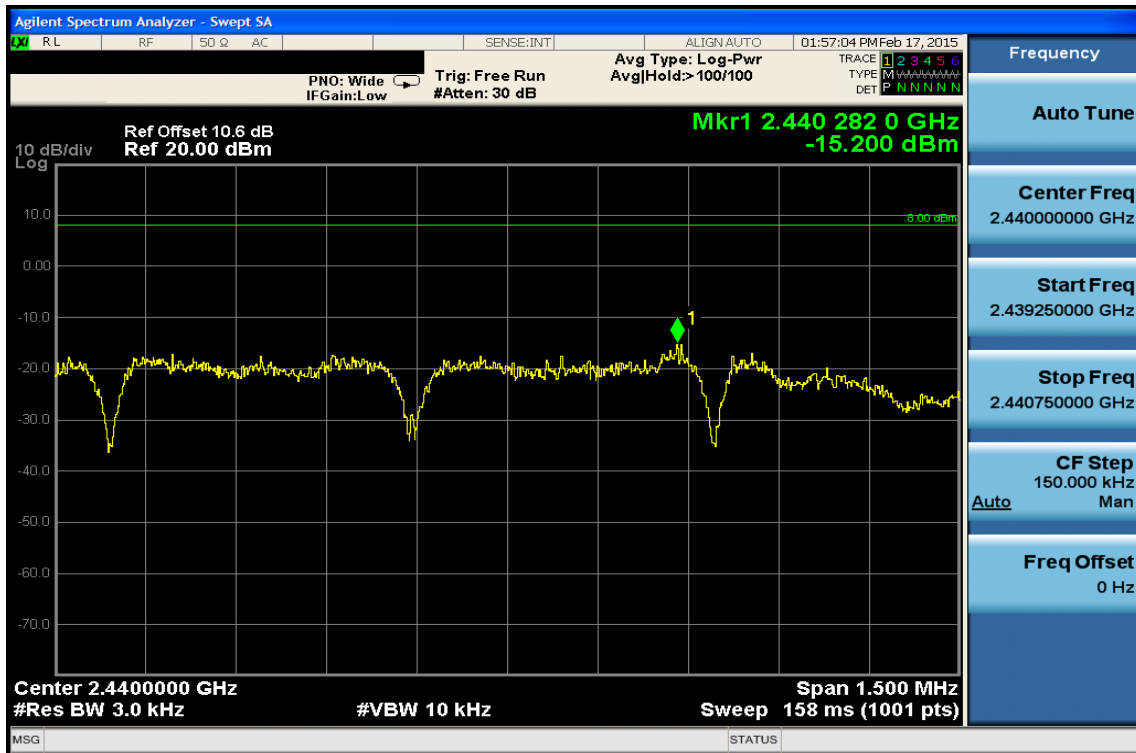
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Zigbee mode

Power Spectral Density Test Plot (CH-Low)



Power Spectral Density Test Plot (CH-Mid)



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Power Spectral Density Test Plot (CH-High)



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12 ANTENNA REQUIREMENT

12.1 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.

12.2 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.

~ End of Report ~

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