



ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Product Name: Wireless Digital Audio Module
Brand Name: N/A
Model No.: CPI-WAM002/XX-X
Model Difference: N/A
FCC ID: 2AHD2WAM002
Report No.: ER/2015/60026A-01
Issue Date: Mar. 24, 2016
FCC Rule Part: §15.247, Cat: DSS
Prepared for: CPI Technologies, Inc.
Yoshino Bldg., 3F, 1-1-13, Tenno-cho,
Hodogaya-ku, Yokohama, 2400003 Japan
Prepared by: SGS Taiwan Ltd.
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VERIFICATION OF COMPLIANCE

Applicant: CPI Technologies, Inc.
Yoshino Bldg., 3F, 1-1-13, Tenno-cho, Hodogaya-ku, Yokohama,
2400003 Japan

Product Name: Wireless Digital Audio Module

Brand Name: N/A

Model No.: CPI-WAM002/XX-X

Model Difference: N/A

FCC ID: 2AHD2WAM002

Report Number: ER/2015/60026A-01

Date of test: Jun. 04, 2015 ~ Jul. 10, 2015

Date of EUT Received: Jun. 04, 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:**Date**

Mar. 24, 2016

Jay Lin / Sr.Engineer**Prepared By:****Date**

Mar. 24, 2016

Allen Tsai / Engineer**Approved By:****Date**

Mar. 24, 2016

Jim Chang / Asst. Manager

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Revision History

Report Number	Revision	Description	Issue Date
ER/2015/60026A-01	Rev.00	Initial creation of document	Mar. 24, 2016

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1 GENERAL INFORMATION

1.1 Product description

General:

Product Name:	Wireless Digital Audio Module
Brand Name:	N/A
Model No.:	CPI-WAM002/XX-X
Model Difference:	N/A
Product SW/HW version:	PurePath Wireless Configurator FW1.4.2 / CC85XX
Radio SW/HW version:	N/A
Test SW Version:	N/A
RF power setting in TEST SW:	N/A
Power Supply:	3.3Vdc from DC power supply.

2.4GHz Pure path Wireless platform:

Frequency Range:	2406 – 2474MHz
Channel Number:	18 channels
Channel Space:	4MHz
Modulation Type:	8GFSK
Transmit Power:	12.66 dBm
Antenna Designation:	PCB Wire Antenna, Gain: 1.16dBi

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1.2 Product Feature of Equipment Under Test

The equipment under Test (Hereafter Called: EUT) is supporting 2.4GHz band, and below is details of information.

Product Feature	
Product Name:	Wireless Digital Audio Module
Brand Name:	N/A
Model No.:	CPI-WAM002/XX-X
Model Difference:	N/A
FCC ID:	2AHD2WAM002
Specification	2.4GHz Pure path Wireless platform

Note: The above EUT information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

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1.3 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC Public Notice DA 00-705 Measurement Guidelines

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 a DoC procedure.

1.4 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan. (TAF code 0513)

FCC Registration Numbers are: 990257

1.5 Special Accessories

There is no special accessory used while test was conducted.

1.6 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 plan. 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. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plan. For emission measurements above 1 GHz, the table height shall be 1.5 m. 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.
An offset computation example with cable loss(1dB) + attenuator(10dB) = 11dB.

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2.5 Configuration of Tested System

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

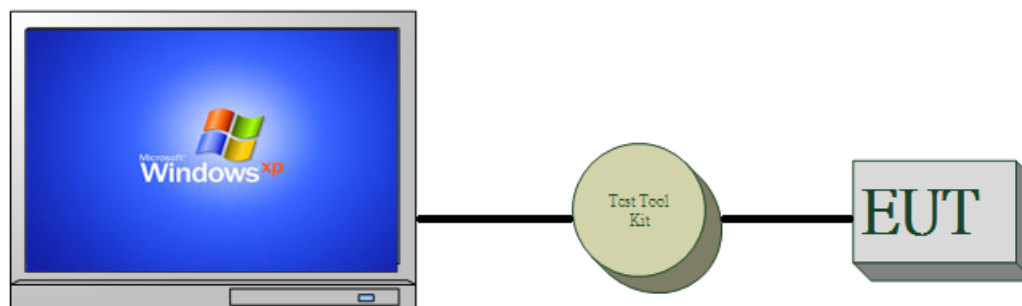


Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Model No.	Series No.	Data Cable	Power Cord
1.	2.4GHz wireless Test Software	N/A	N/A	N/A	N/A	N/A
2.	Notebook	DELL	E5400	3704625136	Shielded	Un-shielded
3.	Test tool kit	N/A	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	N/A
§15.247(b)(1)	Peak Output Power	Compliant
§15.247(a)(1)	20dB & 99% Bandwidth	Compliant
§15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency	Compliant
§15.247(a)(1)(iii)	Time of Occupancy	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

18 channels are provided for 2.4GHz Pure path Wireless platform

CHANNEL	FREQUENCY	CHANNEL	FREQUENCY	CHANNEL	FRE- QUENCY
1	2406 MHz	7	2430 MHz	13	2454 MHz
2	2410 MHz	8	2434 MHz	14	2458 MHz
3	2414 MHz	9	2438 MHz	15	2462 MHz
4	2418 MHz	10	2442 MHz	16	2466 MHz
5	2422 MHz	11	2446 MHz	17	2470 MHz
6	2426 MHz	12	2450 MHz	18	2474 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.
- 3 Investigation has been done on all the possible configurations for searching the worst case.

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
2.4GHz Pure path Wireless platform	1 to 18	1,10,18	8GFSK	5.0	MAIN
RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
2.4GHz Pure path Wireless platform	1 to 18	1,10,18	8GFSK	5.0	MAIN

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 Transmitter for channel Low, Mid and High, the worst case E2 position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
2.4GHz Pure path Wireless platform	1 to 18	1,10,18	8GFSK	5.0	MAIN

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
20dB Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 0.84 dB
Frequency Separation	+/- 51.33 Hz
Number of hopping frequency	+/- 51.33 Hz
Time of Occupancy	+/- 51.33 Hz
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, 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

Frequency within 150 kHz 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					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESC17	100760	05/04/2015	05/03/2016
LISN	SCHWARZBECK	NSLK 8127	8127-649	05/15/2015	05/14/2016
Coaxial Cables	N/A	WK CE Cable	N/A	11/26/2015	11/25/2016

6.3 EUT Setup

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
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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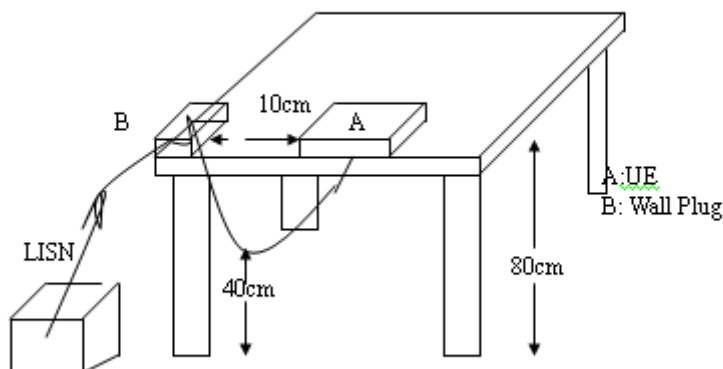
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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

6.6 Measurement Result

N/A This device is powered by DC power supply.

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7 PEAK OUTPUT POWER MEASUREMENT

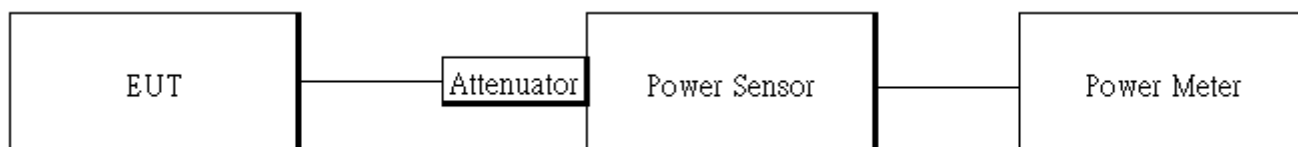
7.1 Standard Applicable

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, The Limit: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: The Limit: 0.125 Watts. The power limit for 1Mbps is 1watt, and 2Mbps, 3Mbps and AFH mode are 0.125 watts.

7.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2495A	1005007	12/09/2015	12/08/2016
Power Sensor	Anritsu	MA2411B	917032	12/09/2015	12/08/2016
Spectrum Analyzer	Agilent	N9010A	MY50420195	12/21/2015	12/20/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2016	01/01/2017
Coaxial Cable	HUBER+SUHNER	SUCOFLEX 102	23670/2	01/02/2016	01/01/2017
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2016	01/01/2017
DC Power Supply	Agilent	E3640A	MY52410006	11/05/2015	11/04/2016

7.3 Test Set-up:



7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW >=20dB bandwidth)
4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

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7.5 Measurement Result

2.4GHz mode (Peak):

Channel	Frequency (MHz)	Peak Output Power (dBm)	Output Power (mW)	Limit (mW)
1	2406.00	12.66	18.450	1000
10	2442.00	12.42	17.458	1000
18	2474.00	12.16	16.444	1000

2.4GHz mode (Average): Tune up tolerance ± 0.34 dBm

Channel	Frequency (MHz)	Max. Output include tune up tolerance Power (dBm)	Output Power (mW)	Limit (mW)
1	2406.00	12.34	17.140	1000
10	2442.00	12.01	15.885	1000
18	2474.00	11.73	14.894	1000

NOTE: cable loss as 11dB that offsets in the spectrum

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8 20DB BANDWIDTH MEASUREMENT

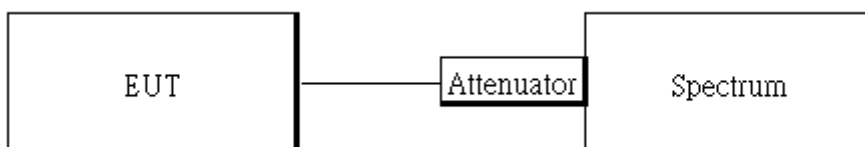
8.1 Standard Applicable

For frequency hopping systems operating in the 2400MHz-2483.5 MHz no limit for 20dB bandwidth.

8.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY50420195	12/21/2015	12/20/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2016	01/01/2017
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2016	01/01/2017

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 FCC Public Notice DA 00-705 Measurement Guidelines.
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 the spectrum analyzer as RBW=27 kHz (1 % of 20 dB Bandwidth.), VBW = 82 kHz, Span= 5MHz, Sweep=auto, Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and -20dB (upper and lower) frequency
6. Repeat above procedures until all test default channel is completed

NOTE:

1. cable loss as 11dB that offsets in the spectrum
2. For the plot of bandwidth measurement, the marker of the 20dB BW is arrow-mark

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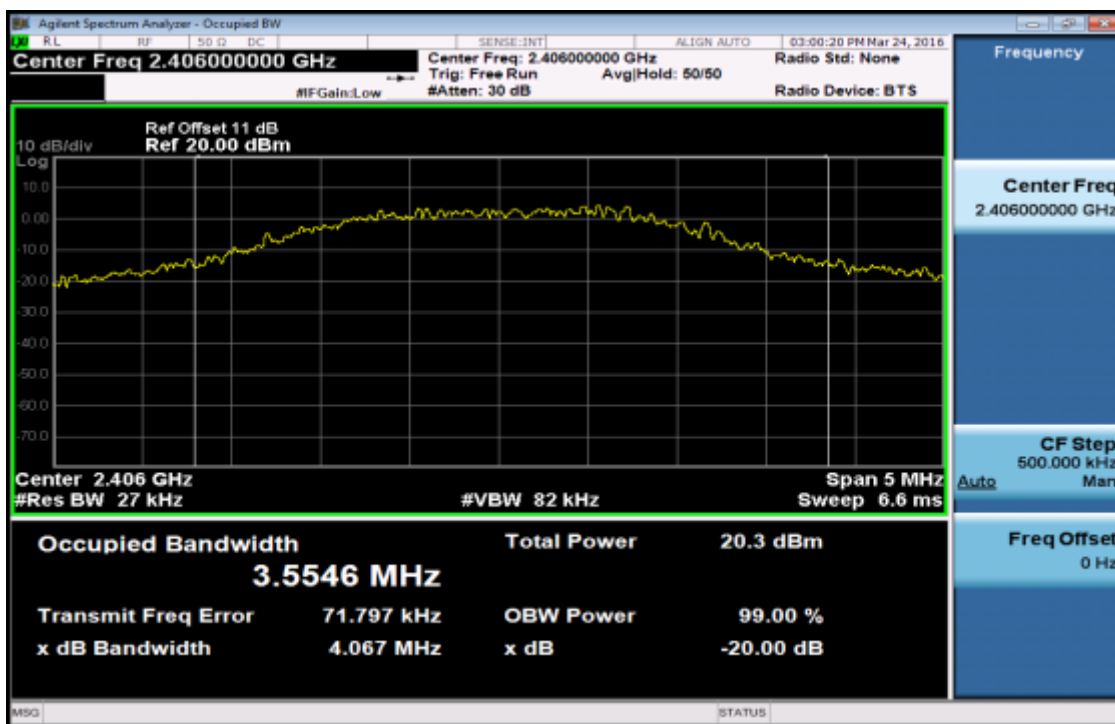
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8.5 Measurement Result

2.4GHz

Channel	20 dB Bandwidth (MHz)	2/3 Bandwidth (MHz)
Low	4.067	2.71
Mid	4.094	2.73
High	4.109	2.74

20dB Band Width Test Data CH-Low



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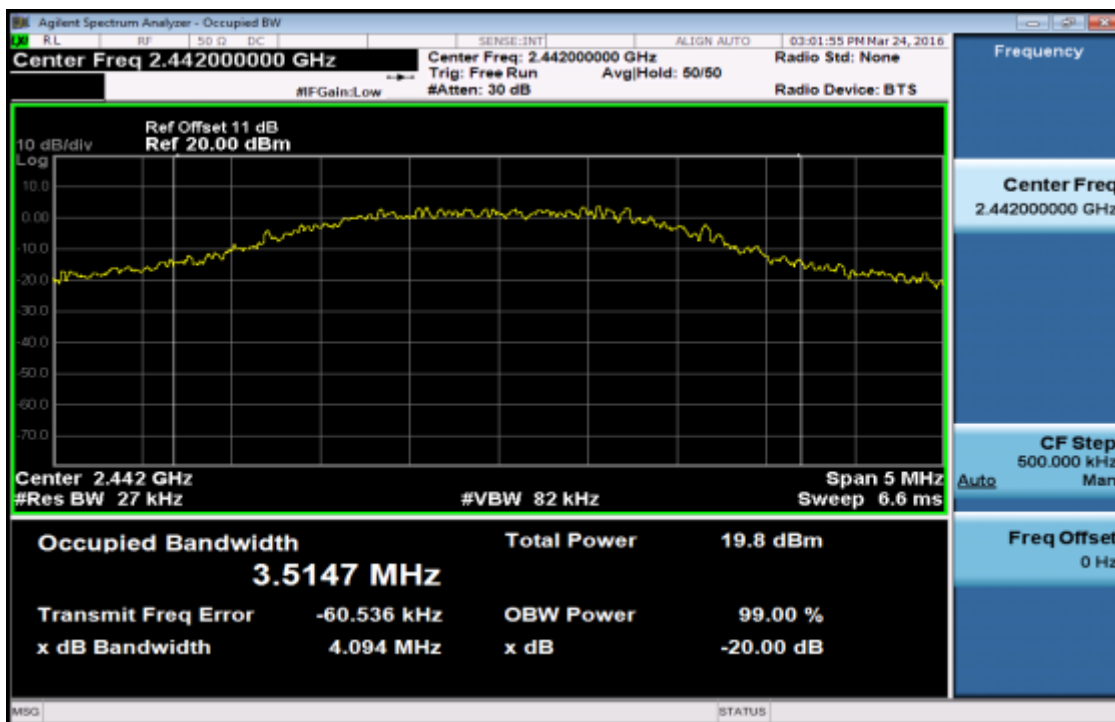
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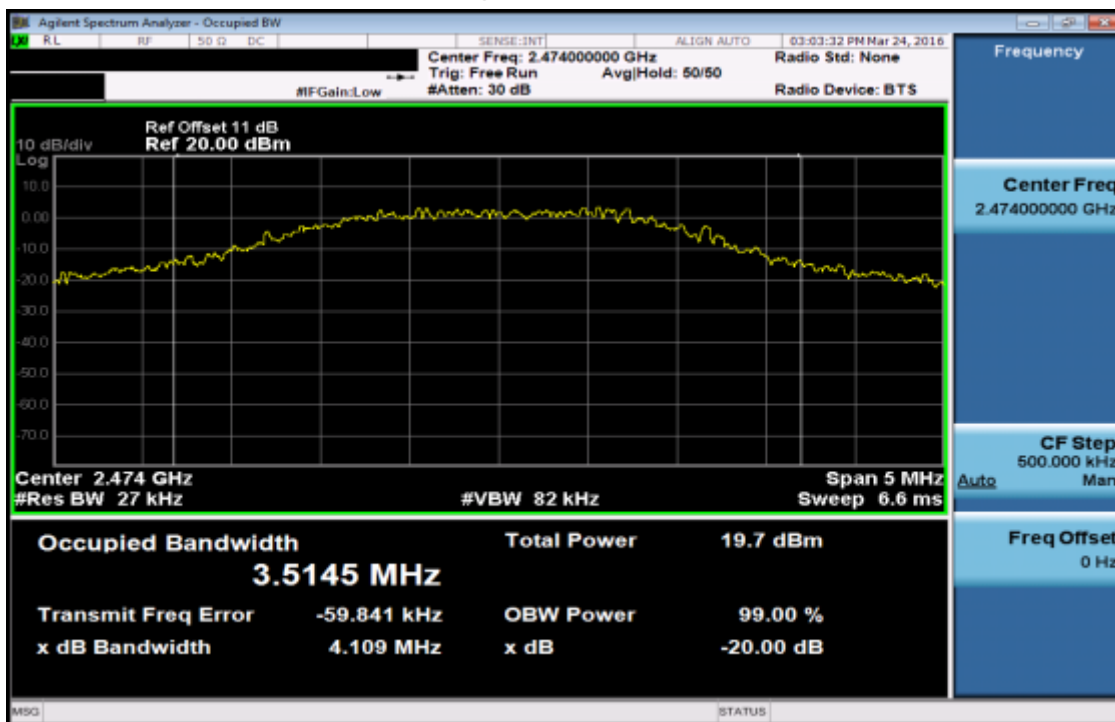
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20dB Band Width Test Data CH-Mid



20dB Band Width Test Data CH-Hig



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

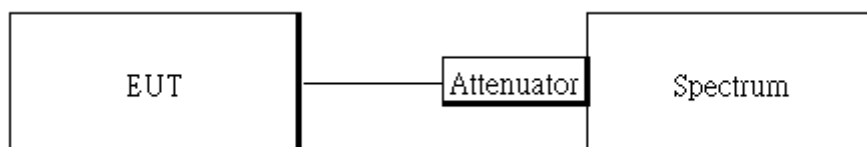
9.1 Standard Applicable

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	MY50420195	12/21/2015	12/20/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2016	01/01/2017
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2016	01/01/2017

9.3 Test SET-UP



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9.4 Measurement Procedure

Conducted Band Edge:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
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 center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Sweep = auto
6. Mark Peak, 2.3999GHz and 2.4836GHz and record the max. level.
7. Repeat above procedures until all frequency measured were complete.

Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Set RBW = 100 kHz & VBW = 300 kHz, 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.

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	

9.5 Measurement Result

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

1. Cable loss as 5.1dB that offsets in the spectrum
2. The occurrence of the spike on the conducted emission is the signal of the fundamental emission.

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Band Edges Test Data CH-Low (Hopping mode)



Band Edges Test Data CH-High



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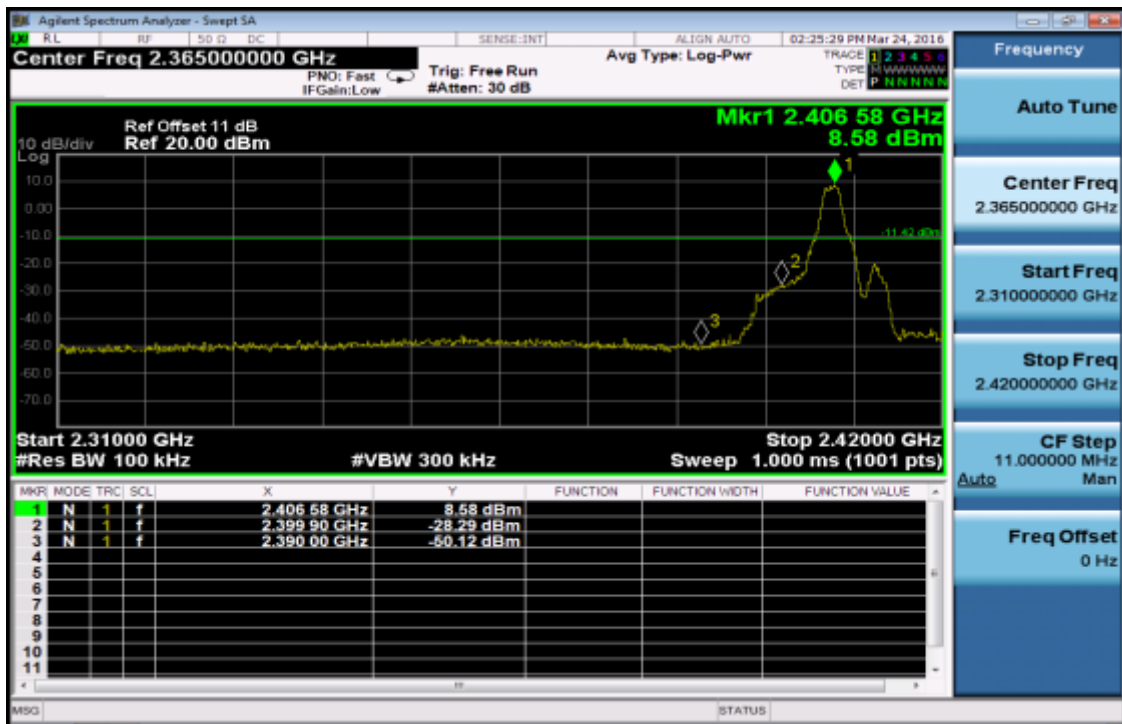
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Band Edges Test Data CH-Low (Non-Hopping mode)



Band Edges Test Data CH-High



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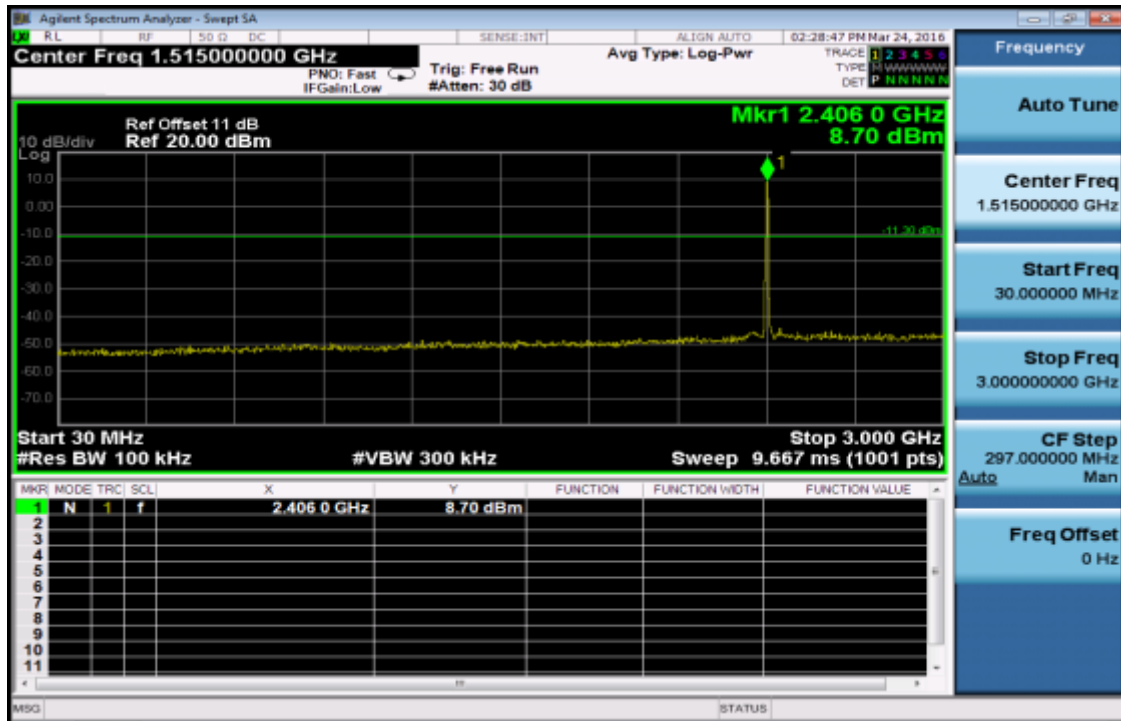
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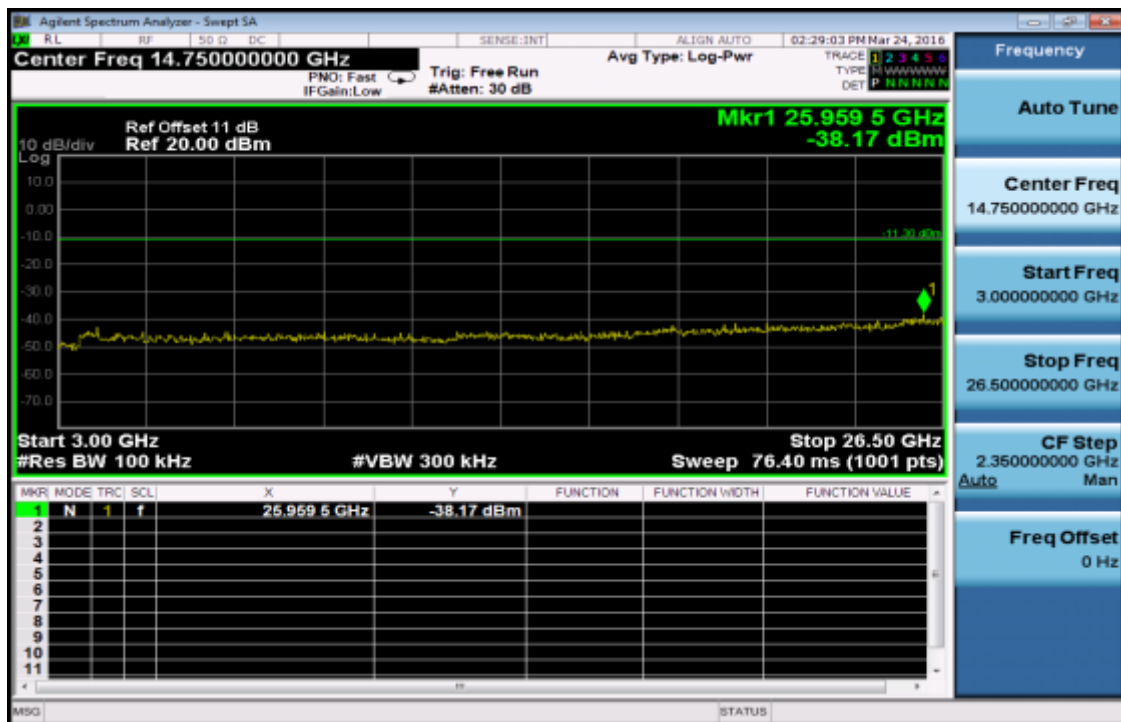
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Conducted Spurious Emission Measurement Result Ch Low 30MHz – 3GHz



Ch Low 3GHz – 26.5GHz



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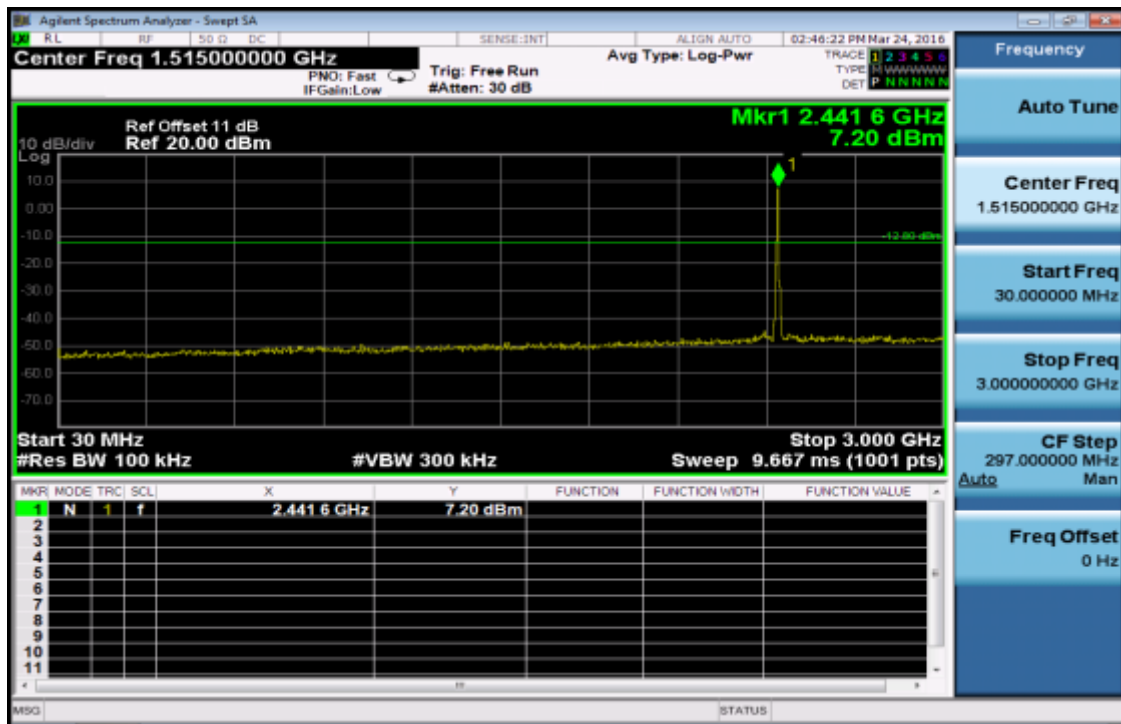
t (886-2) 2299-3279

f (886-2) 2298-0488

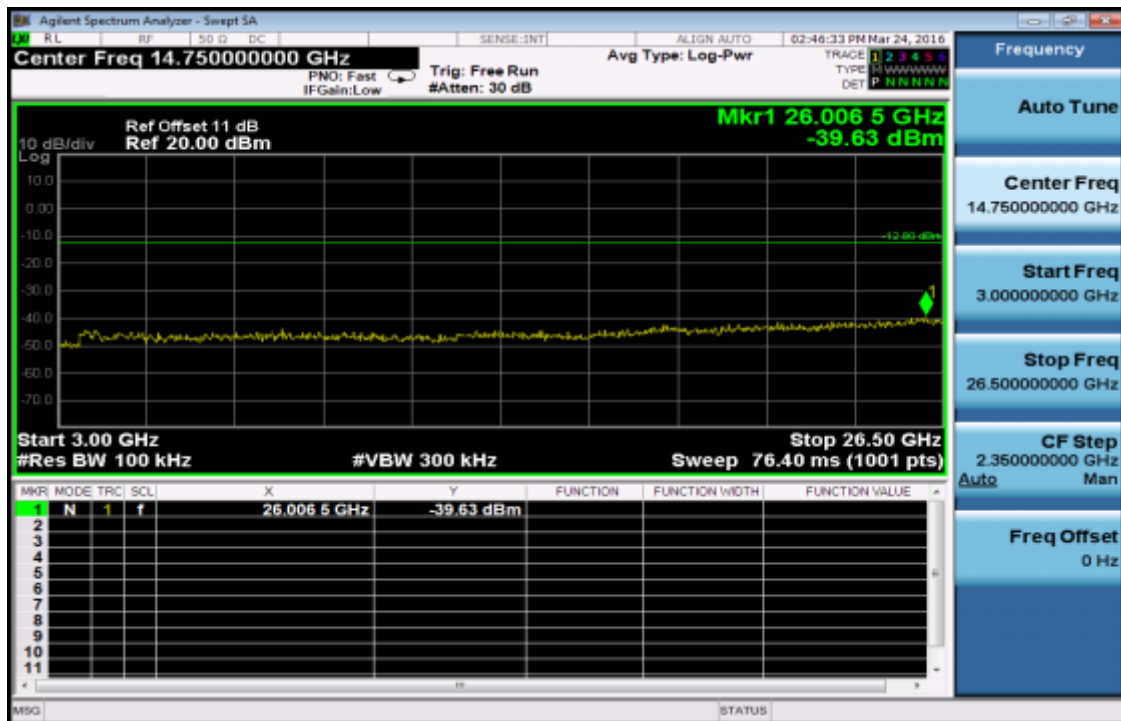
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Ch Mid 30MHz – 3GHz



Ch Mid 3GHz – 26.5GHz



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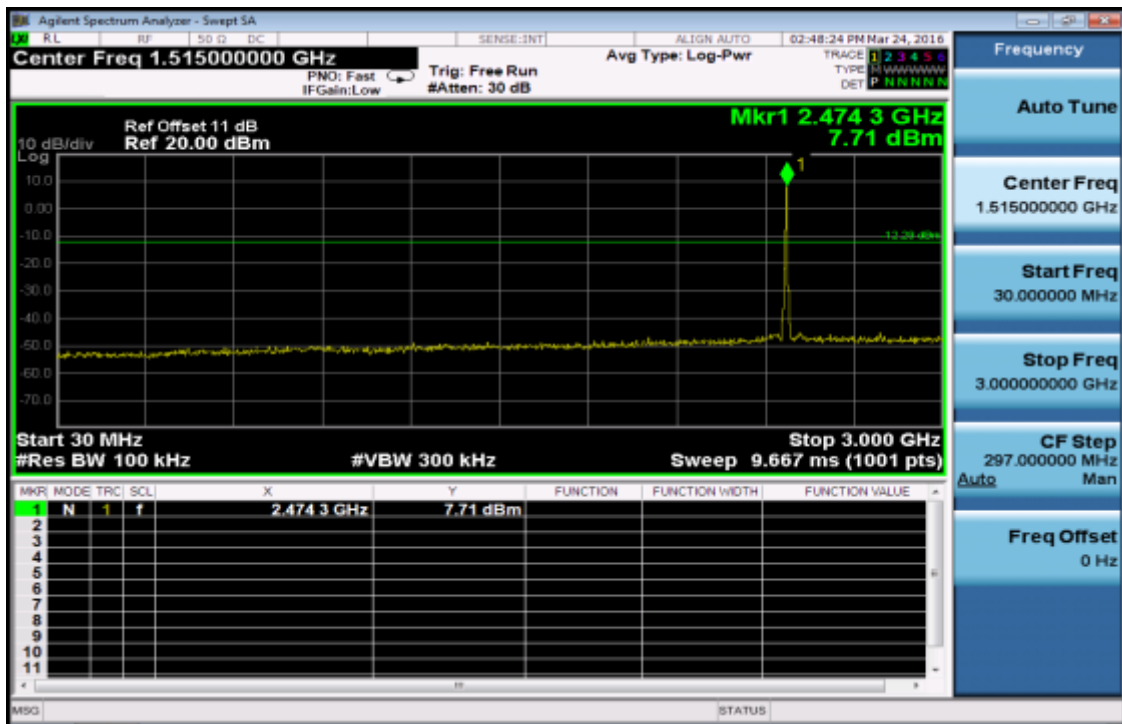
t (886-2) 2299-3279

f (886-2) 2298-0488

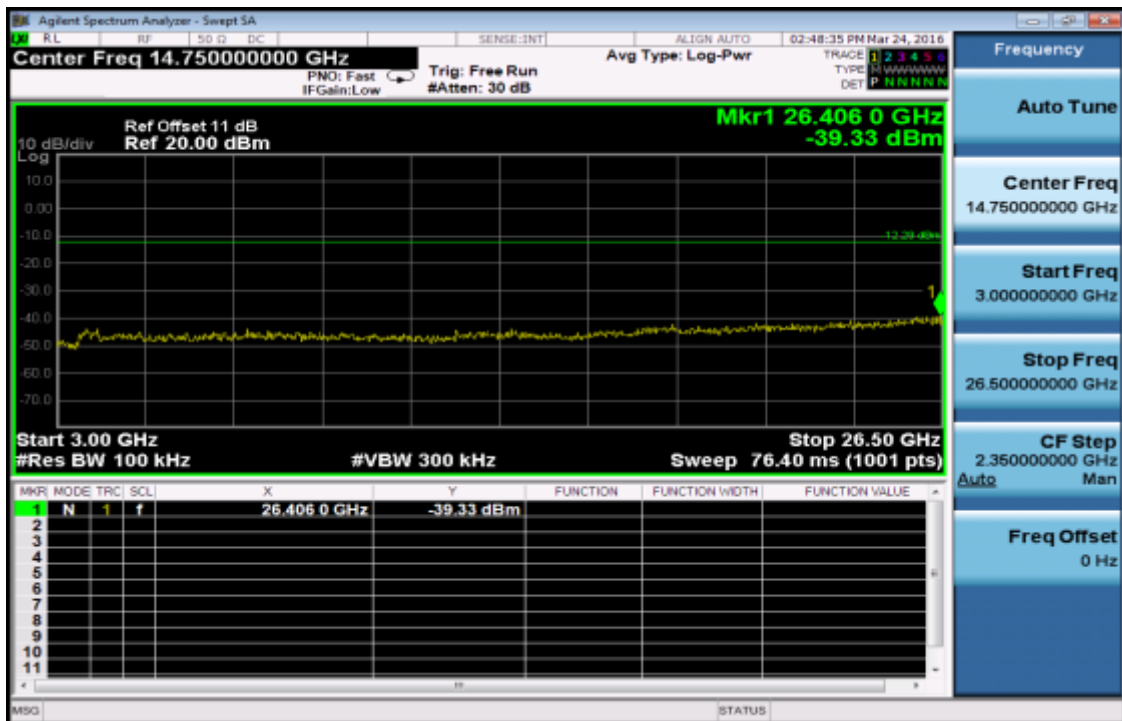
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Ch High 30MHz – 3GHz



Ch High 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	ESCI7	100760	05/04/2015	05/03/2016
Spectrum Analyzer	Agilent	E4446A	MY51100003	01/28/2016	01/27/2017
Loop Antenna	ETS.LINDGREN	6502	148045	09/07/2015	09/06/2016
Bilog Antenna	SCHWAZBECK	VULB9168	378	12/14/2015	12/13/2016
Horn antenna	ETS.LINDGREN	3117	123995	05/05/2015	05/04/2016
Pre-Amplifier	Agilent	8447D	2944A07676	01/02/2016	01/01/2017
Pre-Amplifier	EMC Instruments Corp.	EMC0126530	980038	01/02/2016	01/01/2017
Turn Table	HD	DT420	N/A	N.C.R	N.C.R
Antenna Tower	ChamPro	AM-BS-4500-B	060776-ABS	N.C.R	N.C.R
Controller	ChamPro	EM1000	60776	N.C.R	N.C.R
Low Loss Cable	Huber Suhner	966_RX	9	01/02/2016	01/01/2017
3m Site NSA	SGS	966 chamber	N/A	07/02/2015	07/01/2016
Low Loss Cable	Huber Suhner	966 TX	1	01/02/2016	01/01/2017

NOTE: N.C.R refers to Not Calibrated Required.

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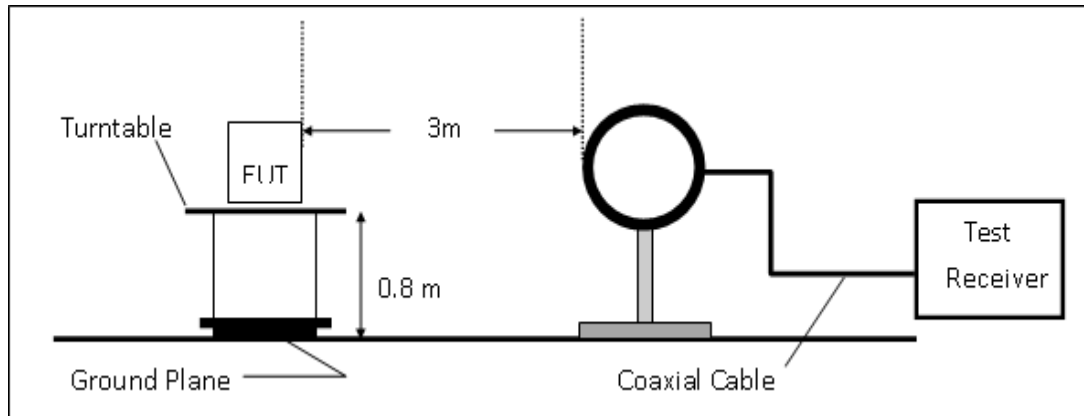
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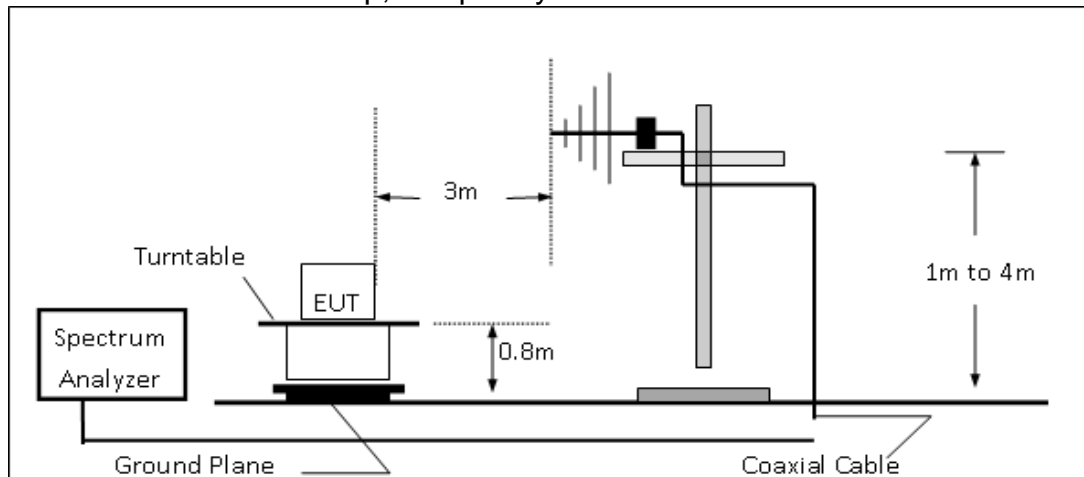
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10.3 Test SET-UP

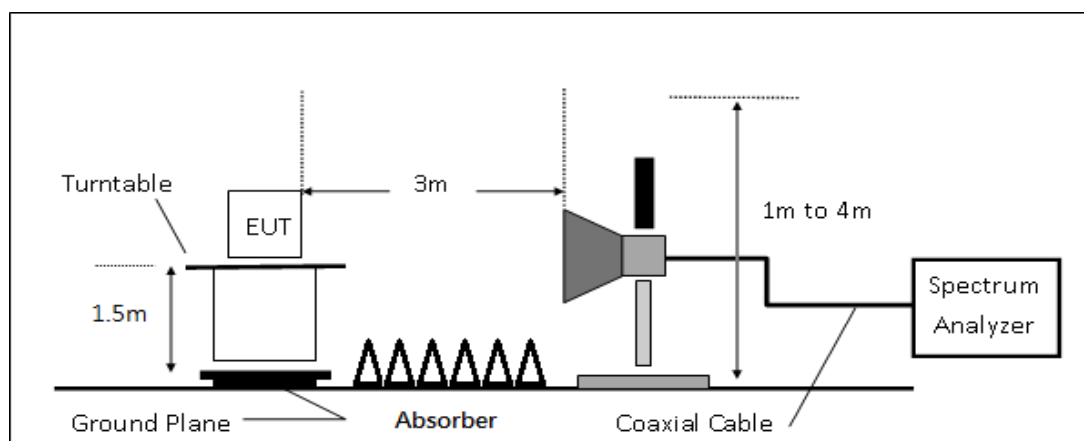
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(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

Radiated Emission

1. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 0.8m for frequency > 1GHz above ground plan.
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. Use the follow spectrum analyzer setting:
 - (1) Span = wide enough to fully capture the emission being measured
 - (2) RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz, VBW \geq RBW, Sweep = auto, Detector function = peak, Trace = max hold
 - (3) For average measurement: use duty cycle correction factor method per 15.35(c)
Duty Cycle = On time/100 milliseconds
$$\text{On time} = N1 * L1 = N2 * L2 + \dots + N(n-1) * LN(n-1) + N(n) * L(n)$$
Where N1 is number of type 1 pulses, L1 is length of type 1 pulses, etc.
Average Emission Level = Peak Emission Level + $20 * \log(\text{duty Cycle})$
6. 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.
7. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
8. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
9. Repeat above procedures until all frequency of the interest 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	

The limit of the emission level is expressed in dBuV/m, which converts $20 \cdot \log(uV/m)$

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

Factor(dB) = Antenna Factor(dBuV/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: (Hopping Mode)

Operation Mode : 2.4G Hopping Test Date : 03/21/2016 18:45:21
 Fundamental Frequency : 2406 MHz Temp. / Humi. : 21 deg_C / 54 RH
 Operation Band : Bandedge CH LOW Test Engineer : Tin
 EUT Pol. : E2 Plane Measurement Antenna Pol. : VERTICAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2390.00	E	26.14	27.88	-1.74	54.00	-27.86
2390.00	E	40.71	42.45	-1.74	74.00	-33.29

Operation Mode : 2.4G Hopping Test Date : 03/21/2016 18:38:55
 Fundamental Frequency : 2406 MHz Temp. / Humi. : 21 deg_C / 54 RH
 Operation Band : Bandedge CH LOW Test Engineer : Tin
 EUT Pol. : E2 Plane Measurement Antenna Pol. : HORIZONTAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2390.00	E	26.24	27.98	-1.74	54.00	-27.76
2390.00	E	45.53	47.28	-1.74	74.00	-28.47

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Operation Mode : 2.4G Hopping Test Date : 03/21/2016 19:03:45
 Fundamental Frequency : 2474 MHz Temp. / Humi. : 21 deg_C / 54 RH
 Operation Band : Bandedge CH HIGH Test Engineer : Tin
 EUT Pol. : E2 Plane Measurement Antenna Pol. : VERTICAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2483.50	E	26.32	27.94	-1.62	54.00	-27.68
2483.50	E	61.93	63.55	-1.62	74.00	-12.07

Operation Mode : 2.4G Hopping Test Date : 03/21/2016 19:15:56
 Fundamental Frequency : 2474 MHz Temp. / Humi. : 21 deg_C / 54 RH
 Operation Band : Bandedge CH HIGH Test Engineer : Tin
 EUT Pol. : E2 Plane Measurement Antenna Pol. : HORIZONTAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2483.50	E	26.43	28.05	-1.62	54.00	-27.57
2483.50	E	64.57	66.19	-1.62	74.00	-9.43

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Radiated Emission – Band Edge (Non-Hopping Mode):

Operation Mode :	2.4G	Test Date :	03/22/2016 14:50:33
Fundamental Frequency :	2406 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Bandedge CH LOW	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	VERTICAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2390.00	E	37.35	39.09	-1.74	54.00	-16.65
2390.00	E	50.41	52.16	-1.74	74.00	-23.59

Operation Mode :	2.4G	Test Date :	03/22/2016 14:57:27
Fundamental Frequency :	2406 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Bandedge CH LOW	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	HORIZONTAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2390.00	E	40.39	42.13	-1.74	54.00	-13.61
2390.00	E	54.19	55.93	-1.74	74.00	-19.81

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Operation Mode :	2.4G	Test Date :	03/22/2016 15:03:45
Fundamental Frequency :	2474 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Bandedge CH HIGH	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	VERTICAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2483.50	E	46.50	48.12	-1.62	54.00	-7.50
2483.50	E	62.62	64.23	-1.62	74.00	-11.38

Operation Mode :	2.4G	Test Date :	03/22/2016 15:19:53
Fundamental Frequency :	2474 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Bandedge CH HIGH	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	HORIZONTAL

Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
2483.50	E	51.98	53.60	-1.62	54.00	-2.02
2483.50	E	71.72	73.33	-1.62	74.00	-2.28

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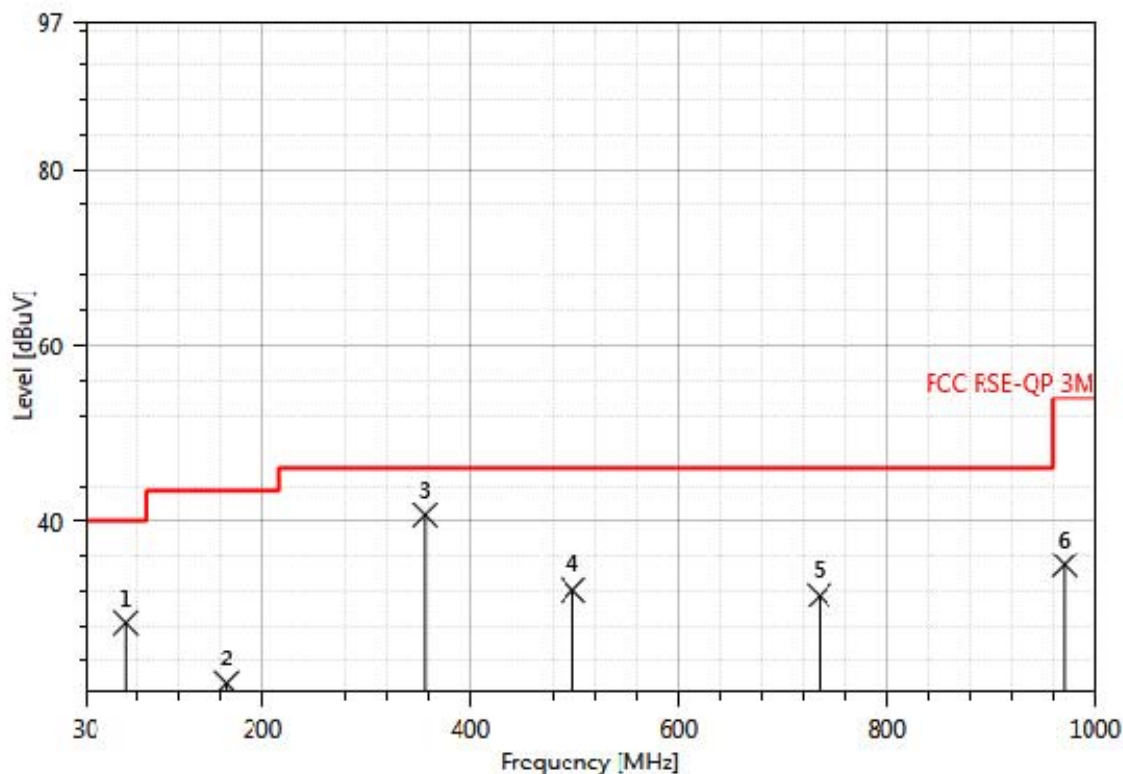
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Radiated Spurious Emission Measurement Result:

For Frequency form 30MHz to 1000MHz

Operation Mode :	2.4G	Test Date :	03/22/2016 10:43:11
Fundamental Frequency :	2406 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Tx CH LOW	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	VERTICAL



Freq.	Note	Emission	Spectrum	Factor	Limit	Margin
MHz	F/H/E/S	Level	Reading Level		@ 3m	
		dBuV/m	dBuV	dB	dBuV/m	dB
68.80	S	28.34	38.32	-9.98	40.00	-11.66
165.80	S	21.48	28.88	-7.39	43.50	-22.02
356.89	S	40.64	45.39	-4.75	46.00	-5.36
498.51	S	32.16	34.68	-2.52	46.00	-13.84
735.19	S	31.52	29.51	2.01	46.00	-14.48
970.90	S	34.97	28.69	6.28	54.00	-19.03

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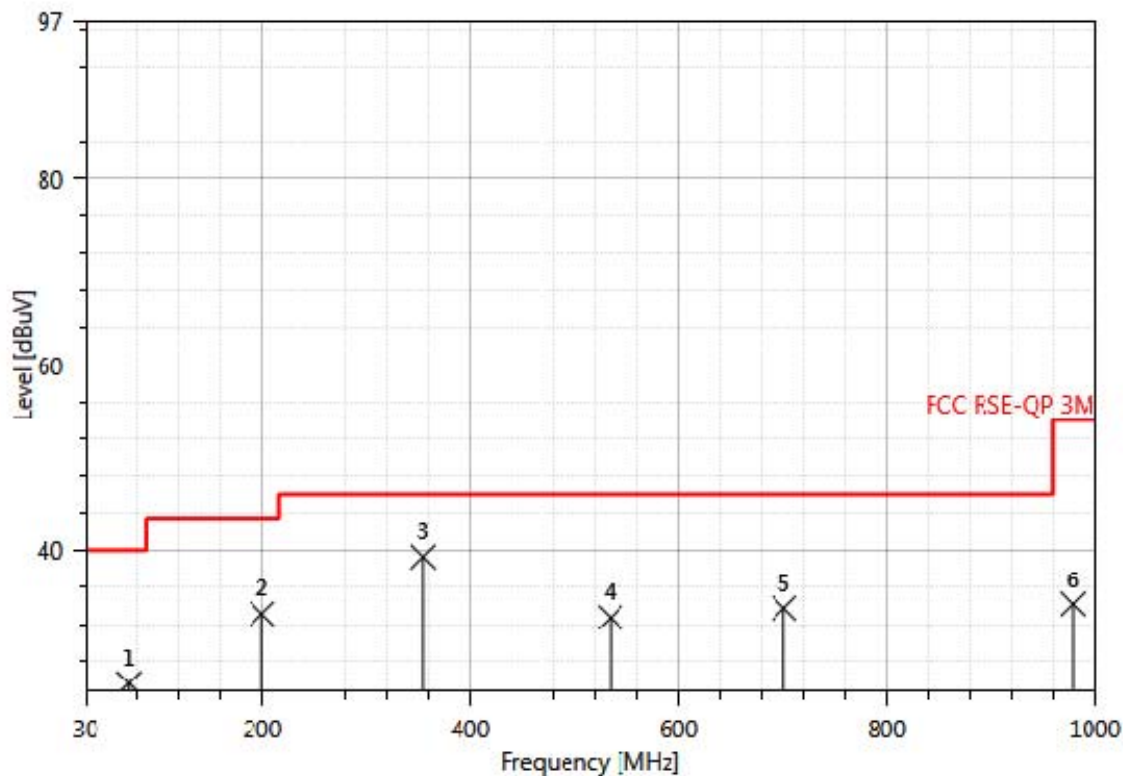
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Operation Mode :	2.4G	Test Date :	03/22/2016 10:43:12
Fundamental Frequency :	2406 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Tx CH LOW	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	HORIZONTAL



Freq.	Note	Emission	Spectrum	Factor	Limit	Margin
MHz	F/H/E/S	Level dBuV/m	Reading Level dBuV	dB	@ 3m dBuV/m	dB
71.71	S	25.68	36.30	-10.62	40.00	-14.32
199.75	S	33.18	42.78	-9.60	43.50	-10.32
354.95	S	39.29	44.04	-4.76	46.00	-6.71
534.40	S	32.77	34.44	-1.67	46.00	-13.23
701.24	S	33.78	32.35	1.43	46.00	-12.22
978.66	S	34.22	27.94	6.28	54.00	-19.78

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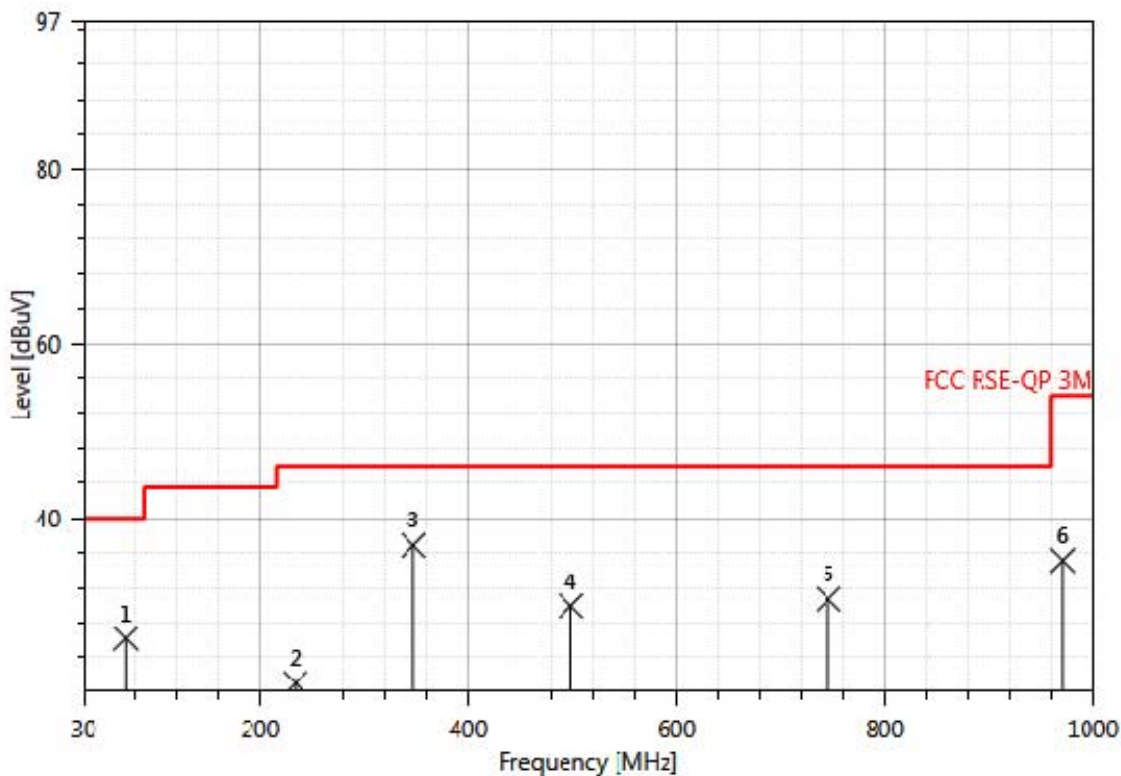
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Operation Mode :	2.4G	Test Date :	03/22/2016 10:43:13
Fundamental Frequency :	2442 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Tx CH MID	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	VERTICAL



Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
70.74	S	26.18	36.60	-10.42	40.00	-13.82
233.70	S	21.06	29.66	-8.60	46.00	-24.94
347.19	S	36.85	41.81	-4.96	46.00	-9.15
498.51	S	29.93	32.45	-2.52	46.00	-16.07
745.86	S	30.70	28.40	2.30	46.00	-15.30
970.90	S	35.15	28.86	6.28	54.00	-18.85

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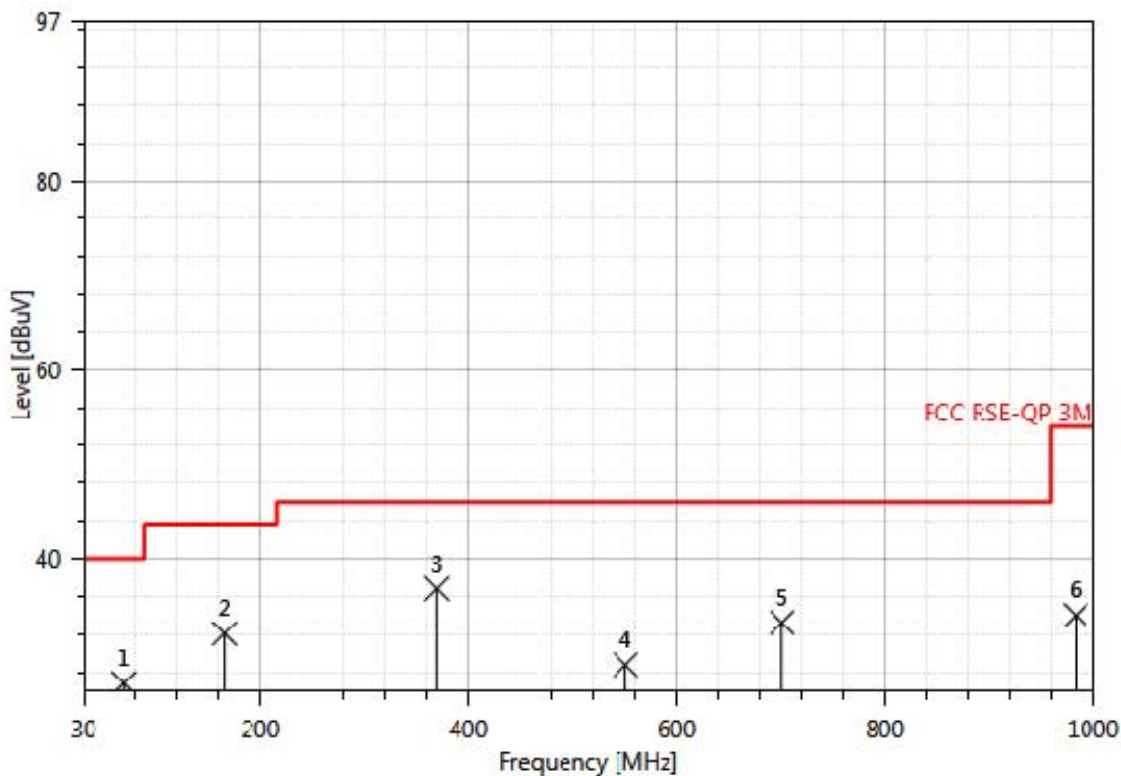
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Operation Mode : 2.4G Test Date : 03/22/2016 10:43:14
Fundamental Frequency : 2442 MHz Temp. / Humi. : 21 deg_C / 54 RH
Operation Band : Tx CH MID Test Engineer : Tin
EUT Pol. : E2 Plane Measurement Antenna Pol. : HORIZONTAL



Freq. MHz	Note F/H/E/S	Emission Level dBuV/m	Spectrum Reading Level dBuV	Factor dB	Limit @ 3m dBuV/m	Margin dB
68.80	S	26.80	36.79	-9.98	40.00	-13.20
165.80	S	32.08	39.47	-7.39	43.50	-11.42
369.50	S	36.80	41.45	-4.65	46.00	-9.20
550.89	S	28.77	30.54	-1.77	46.00	-17.23
701.24	S	33.22	31.79	1.43	46.00	-12.78
983.51	S	33.99	27.98	6.01	54.00	-20.01

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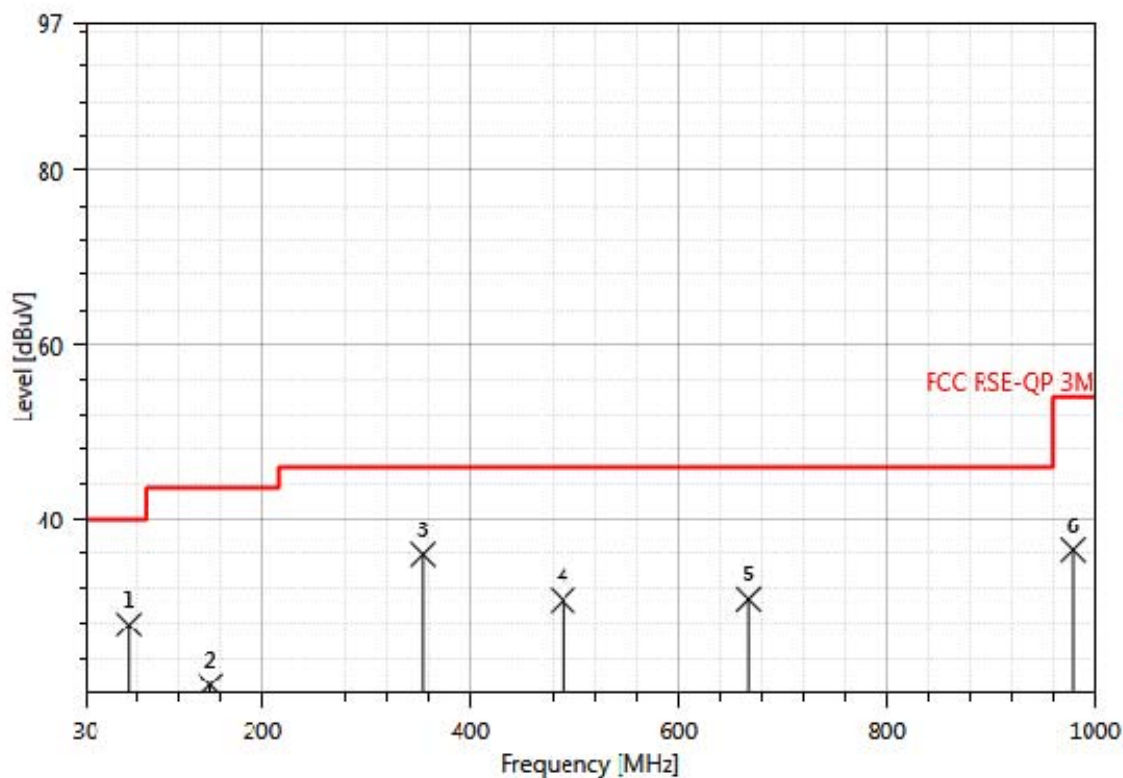
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Operation Mode : 2.4G Test Date : 03/22/2016 10:43:15
Fundamental Frequency : 2474 MHz Temp. / Humi. : 21 deg_C / 54 RH
Operation Band : Tx CH HIGH Test Engineer : Tin
EUT Pol. : E2 Plane Measurement Antenna Pol. : VERTICAL



Freq. MHz	Note F/H/E/S	Emission Level dBuV/m	Spectrum Reading Level dBuV	Factor dB	Limit @ 3m dBuV/m	Margin dB
71.71	S	27.82	38.44	-10.62	40.00	-12.18
150.28	S	20.87	28.61	-7.74	43.50	-22.63
354.95	S	35.93	40.68	-4.76	46.00	-10.07
488.81	S	30.61	32.99	-2.38	46.00	-15.39
667.29	S	30.73	30.30	0.43	46.00	-15.27
978.66	S	36.42	30.15	6.28	54.00	-17.58

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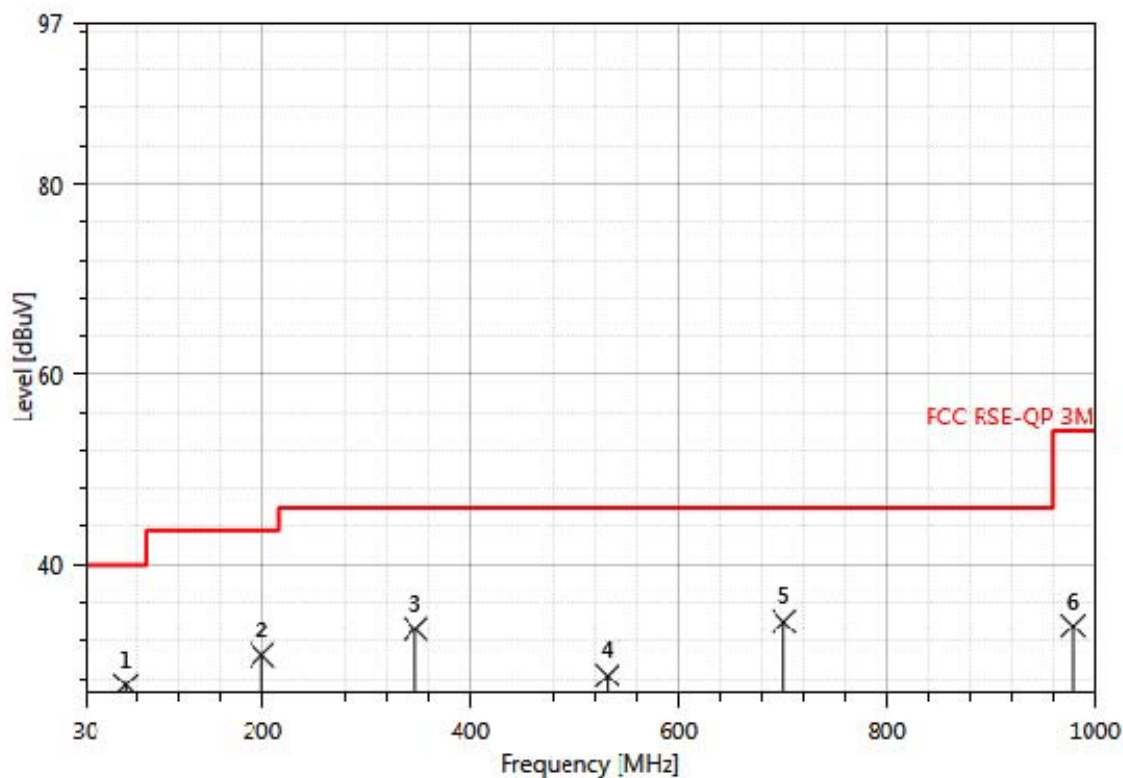
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Operation Mode : 2.4G Test Date : 03/22/2016 10:43:16
Fundamental Frequency : 2474 MHz Temp. / Humi. : 21 deg_C / 54 RH
Operation Band : Tx CH HIGH Test Engineer : Tin
EUT Pol. : E2 Plane Measurement Antenna Pol. : HORIZONTAL



Freq. MHz	Note F/H/E/S	Emission Level dBuV/m	Spectrum Reading Level dBuV	Factor dB	Limit @ 3m dBuV/m	Margin dB
68.80	S	27.30	37.29	-9.98	40.00	-12.70
199.75	S	30.48	40.08	-9.60	43.50	-13.02
347.19	S	33.23	38.19	-4.96	46.00	-12.77
531.49	S	28.31	29.87	-1.57	46.00	-17.69
701.24	S	34.01	32.58	1.43	46.00	-11.99
978.66	S	33.54	27.26	6.28	54.00	-20.46

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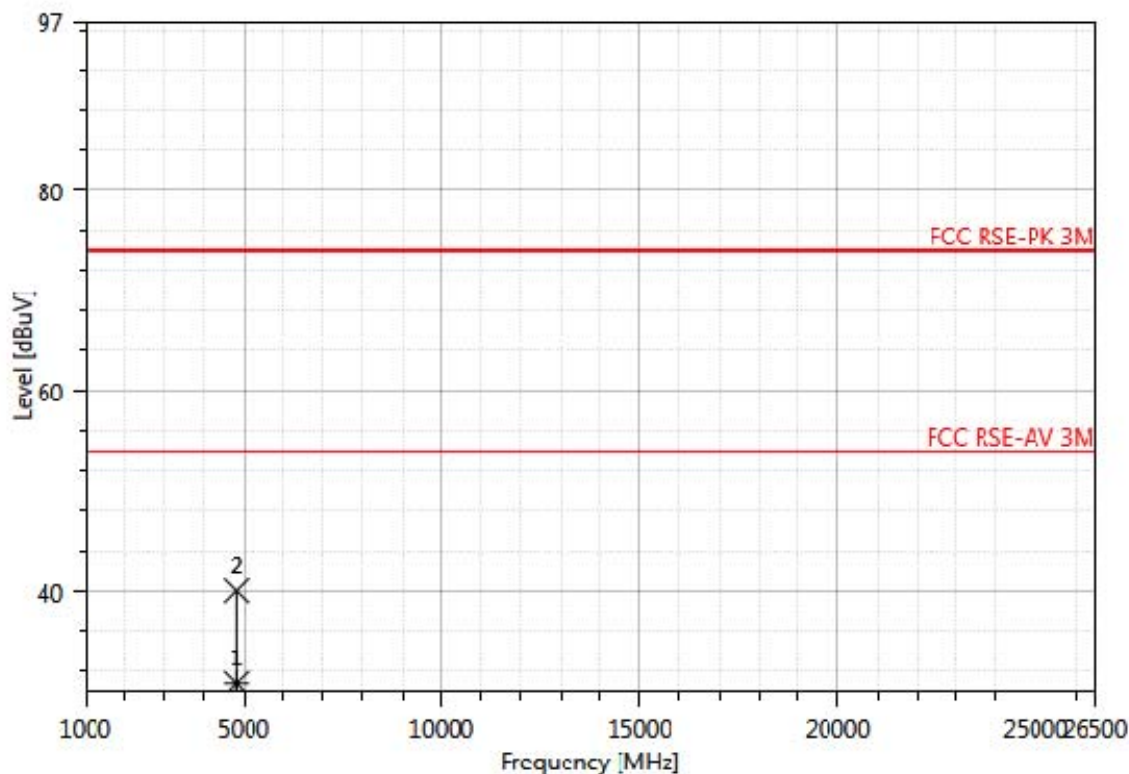
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Radiated Spurious Emission Measurement Result: For Frequency above 1 GHz

Operation Mode :	2.4G	Test Date :	03/22/2016 15:50:16
Fundamental Frequency :	2406 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Tx CH LOW	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	VERTICAL



Freq.	Note	Emission	Spectrum	Factor	Limit	Margin
MHz	F/H/E/S	Level dBuV/m	Reading Level dBuV	dB	@ 3m dBuV/m	dB
4812.00	H	30.80	25.87	4.93	54.00	-23.20
4812.00	H	40.11	35.18	4.93	74.00	-33.89

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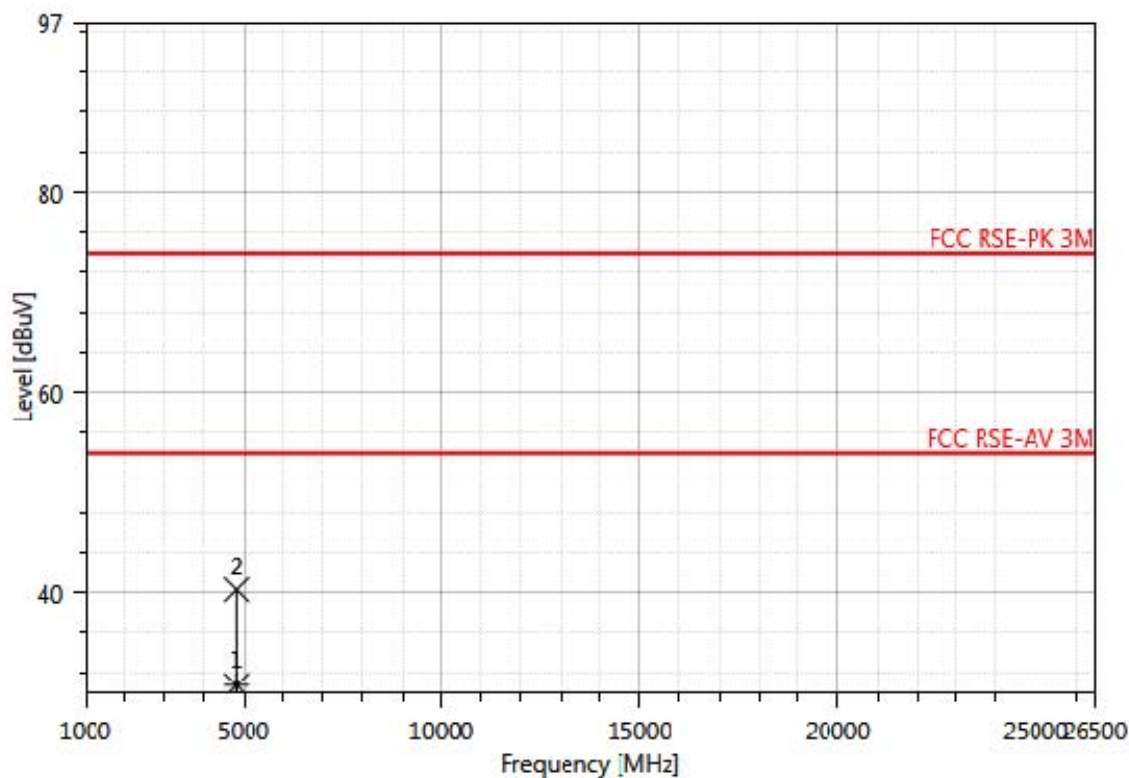
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Operation Mode : 2.4G Test Date : 03/22/2016 15:53:44
Fundamental Frequency : 2406 MHz Temp. / Humi. : 21 deg_C / 54 RH
Operation Band : Tx CH LOW Test Engineer : Tin
EUT Pol. : E2 Plane Measurement Antenna Pol. : HORIZONTAL



Freq.	Note	Emission	Spectrum	Factor	Limit	Margin
MHz	F/H/E/S	Level dBuV/m	Reading Level dBuV	dB	@ 3m dBuV/m	dB
4812.00	H	30.79	25.86	4.93	54.00	-23.21
4812.00	H	40.30	35.37	4.93	74.00	-33.70

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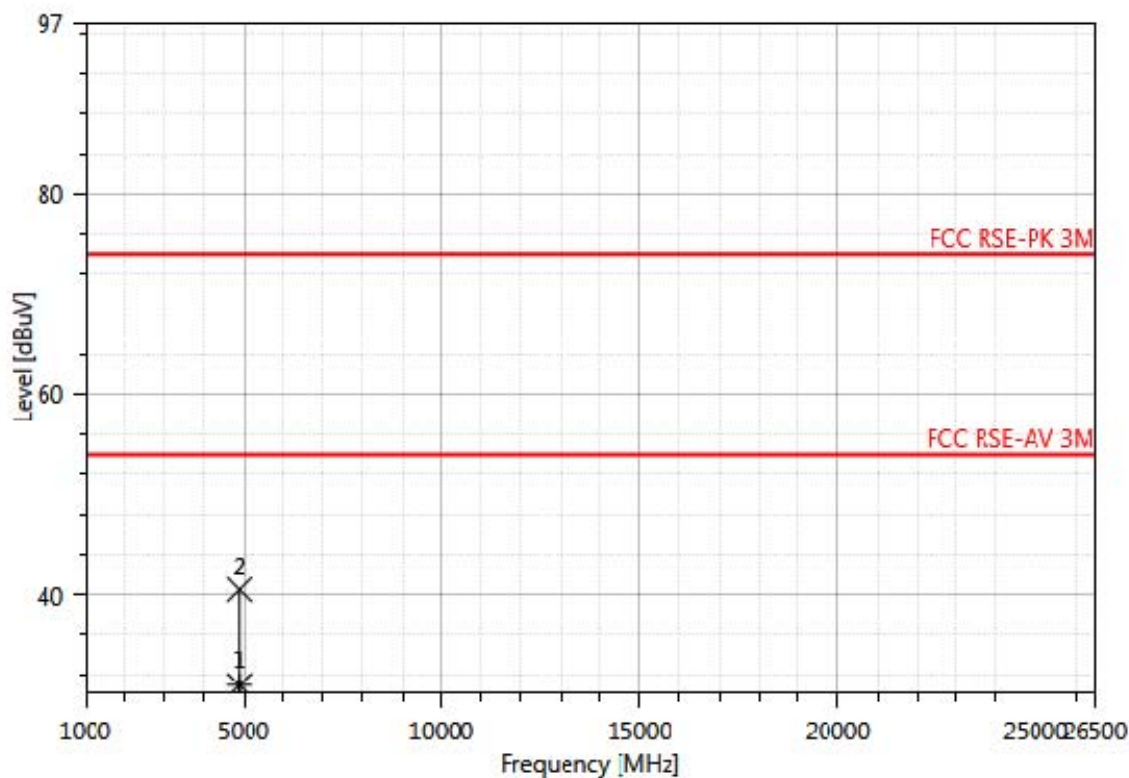
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Operation Mode :	2.4G	Test Date :	03/22/2016 15:39:28
Fundamental Frequency :	2442 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Tx CH MID	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	VERTICAL



Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
4884.00	H	31.00	25.81	5.19	54.00	-23.00
4884.00	H	40.49	35.29	5.19	74.00	-33.51

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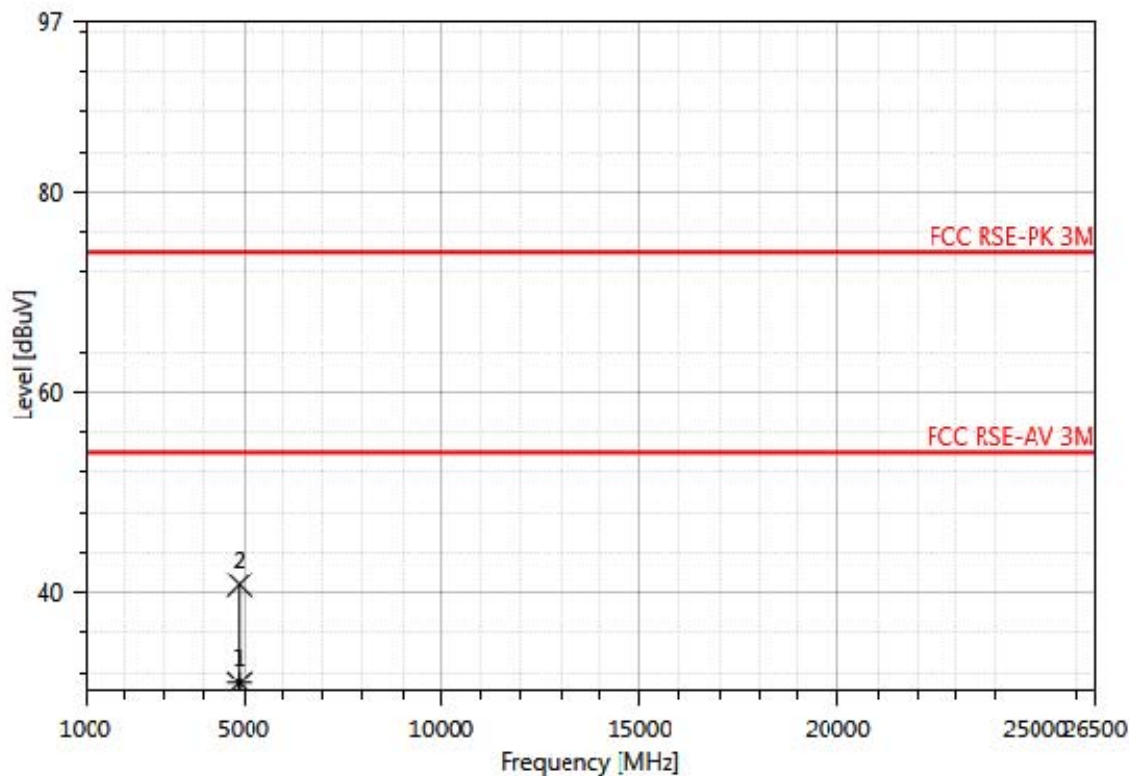
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Operation Mode :	2.4G	Test Date :	03/22/2016 15:43:48
Fundamental Frequency :	2442 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Tx CH MID	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	HORIZONTAL



Freq.	Note	Emission Level	Spectrum Reading Level	Factor	Limit @ 3m	Margin
MHz	F/H/E/S	dBuV/m	dBuV	dB	dBuV/m	dB
4884.00	H	30.98	25.78	5.19	54.00	-23.02
4884.00	H	40.78	35.59	5.19	74.00	-33.22

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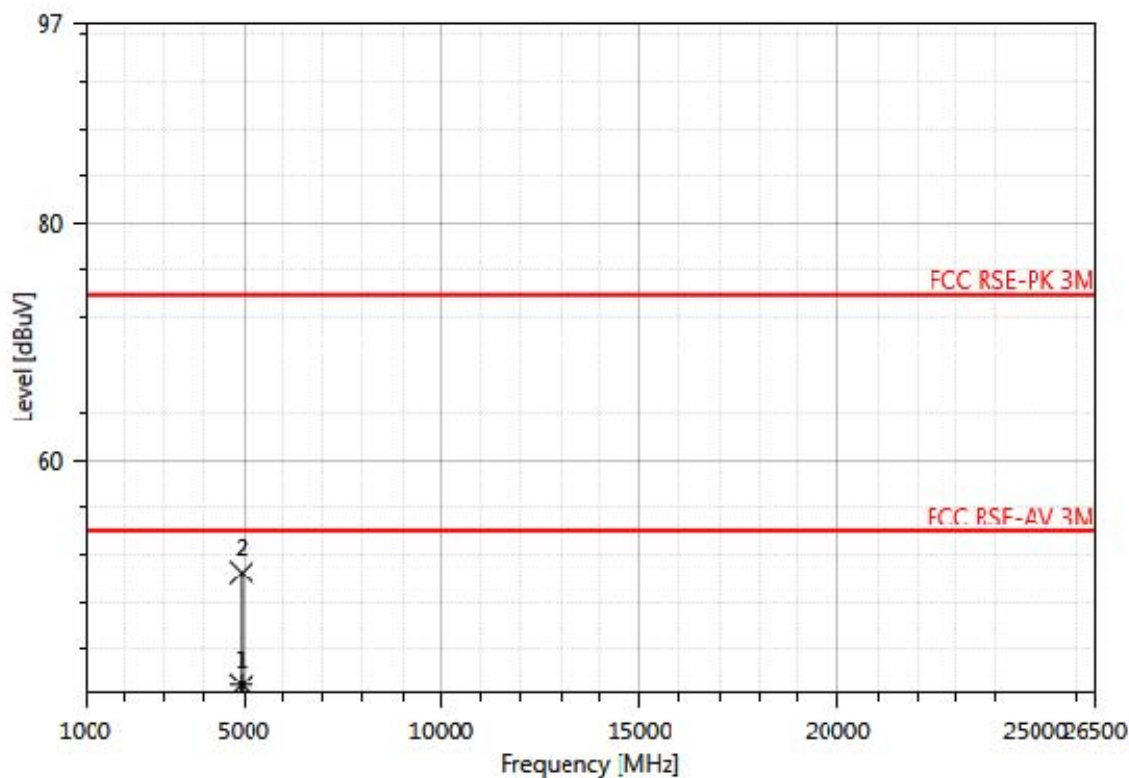
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Operation Mode :	2.4G	Test Date :	03/22/2016 15:28:38
Fundamental Frequency :	2474 MHz	Temp. / Humi. :	21 deg_C / 54 RH
Operation Band :	Tx CH HIGH	Test Engineer :	Tin
EUT Pol. :	E2 Plane	Measurement Antenna Pol. :	VERTICAL



Freq.	Note	Emission	Spectrum	Factor	Limit	Margin
MHz	F/H/E/S	Level dBuV/m	Reading Level dBuV	dB	@ 3m dBuV/m	dB
4948.00	H	40.97	35.69	5.28	54.00	-13.03
4948.00	H	50.49	45.21	5.28	74.00	-23.51

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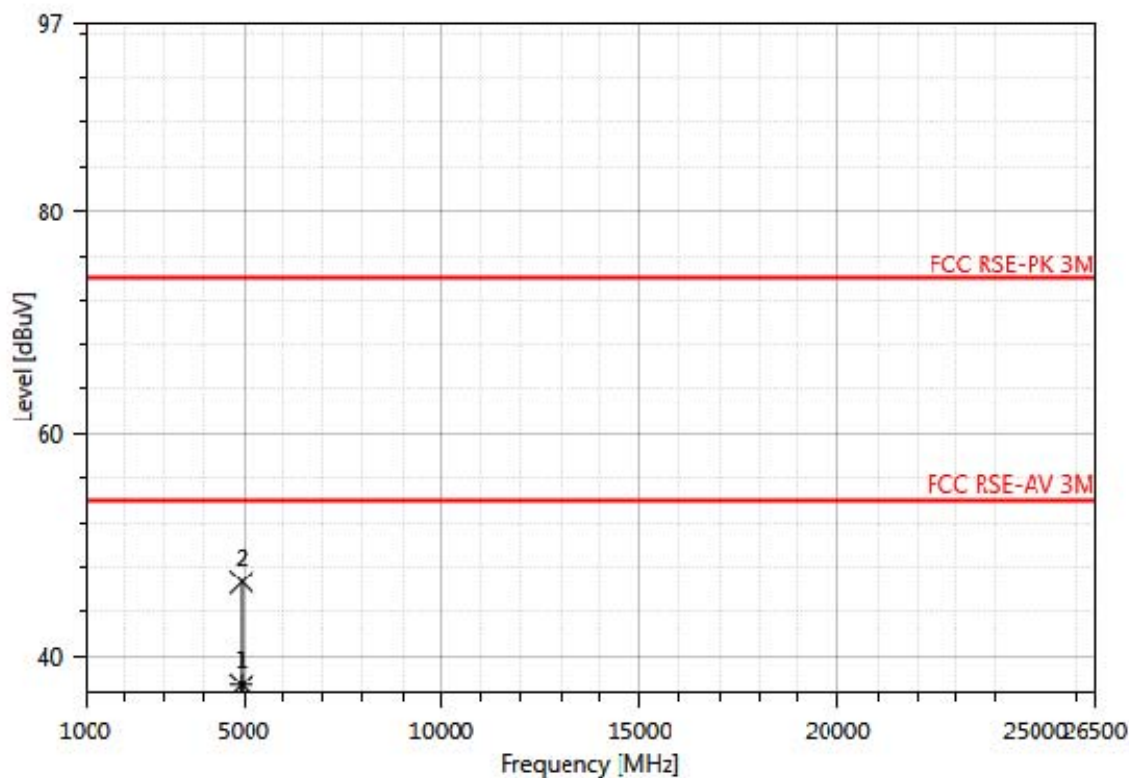
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Operation Mode : 2.4G Test Date : 03/22/2016 15:32:55
Fundamental Frequency : 2474 MHz Temp. / Humi. : 21 deg_C / 54 RH
Operation Band : Tx CH HIGH Test Engineer : Tin
EUT Pol. : E2 Plane Measurement Antenna Pol. : HORIZONTAL



Freq.	Note	Emission	Spectrum	Factor	Limit	Margin
MHz	F/H/E/S	Level	Reading Level		@ 3m	
		dBuV/m	dBuV	dB	dBuV/m	dB
4948.00	H	37.36	32.08	5.28	54.00	-16.64
4948.00	H	46.64	41.36	5.28	74.00	-27.36

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11 FREQUENCY SEPARATION

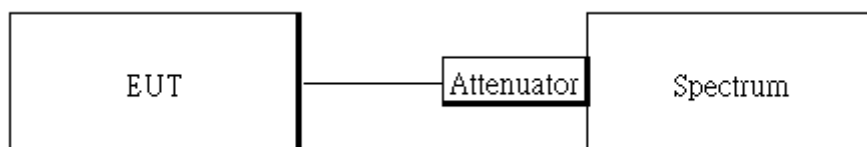
11.1 Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the $2/3 \times 20\text{dB}$ bandwidth of the hopping channel, whichever is greater.

11.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY50420195	12/21/2015	12/20/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2016	01/01/2017
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2016	01/01/2017

11.3 Test Set-up



11.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
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 center frequency of spectrum analyzer = middle of hopping channel.
5. Set the spectrum analyzer as RBW, VBW=100 kHz, Adjust Span to 5MHz, Sweep = auto.
6. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

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11.5 Measurement Result

Channel separation (MHz)	Limit	Result
4	≥ 25 kHz or 2/3 times 20dB bandwidth	PASS

Frequency Separation Test Data



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12 NUMBER OF HOPPING FREQUENCY

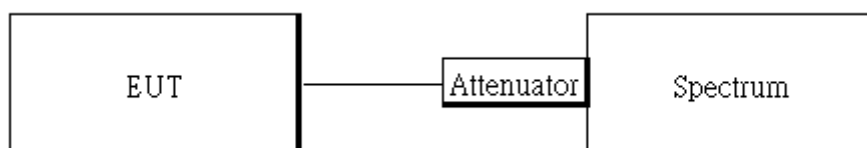
12.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

12.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY50420195	12/21/2015	12/20/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2016	01/01/2017
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2016	01/01/2017

12.3 Test Set-up



12.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
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 spectrum analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.
5. Set the spectrum analyzer as RBW=430 kHz, VBW=1.5MHz., Detector = Peak
6. Max hold, view and count how many channel in the band.

12.5 Measurement Result

Tabular Data of Total Channel Number

	Channel Number	Limit
2.4 GHz – 2.4835GHz	18	>15

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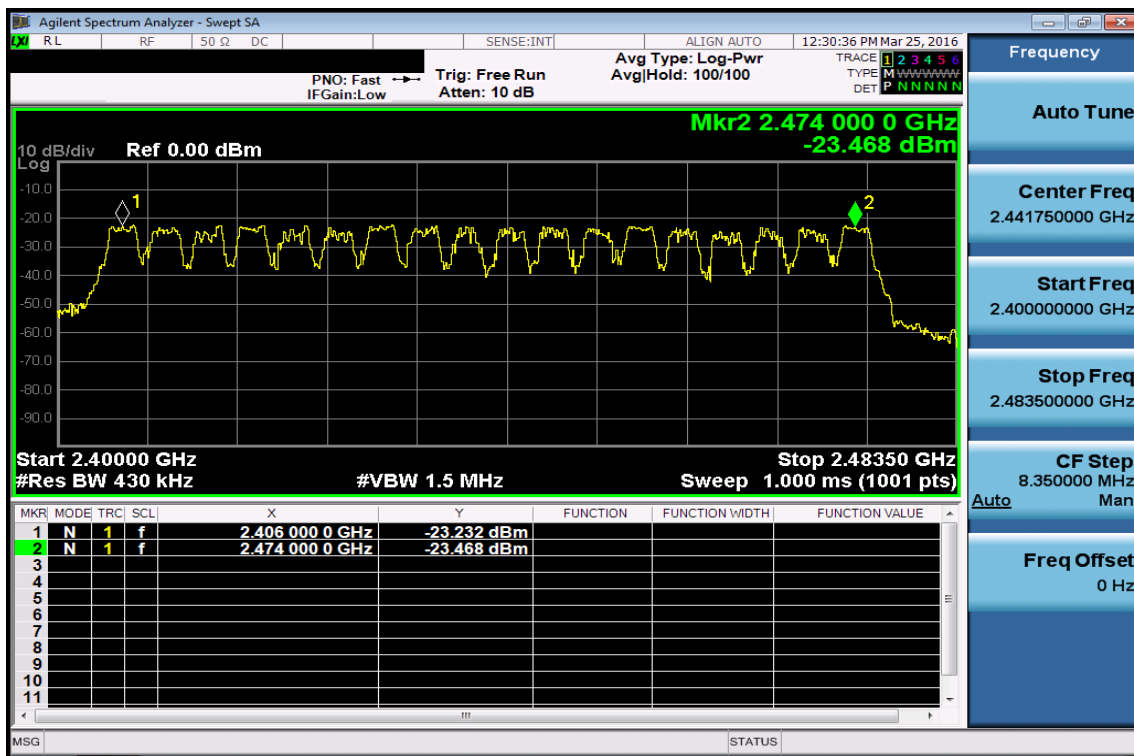
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Channel Number

2.4 GHz – 2.4835GHz



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13 TIME OF OCCUPANCY (DWELL TIME)

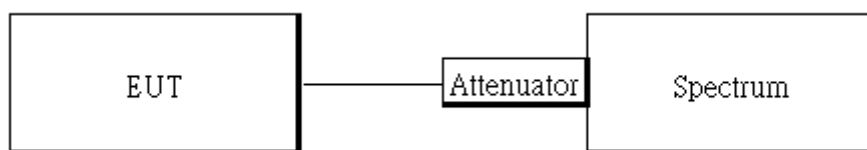
13.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 seconds multiplied by the number of hopping channel employed.

13.2 Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY50420195	12/21/2015	12/20/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2016	01/01/2017
Attenuator	Mini-Circuit	BW-S10W2+	2	01/02/2016	01/01/2017

13.3 Test Set-up



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13.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
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 center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW, VBW=1MHz, 3MHz, Span = 0Hz , Detector = Peak, Adjust Sweep = 2~8ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

Formula Deduced: time occupancy of one time slot X Hopping rate / total slot in one channel / total channel that hops X period of working channels.

Where, standard hopping rate is 1600 hops/s, slot in one channel f is 2.

single time slot of the uplink, and one slot of the downlink Total Slot: 2

13.5 Tabular Result of the Measurement

Ton(ms)	Ton+Toff(ms)	Duty Cycle
0.375	20	1.88%

Channel	Measurement Result (ms)	Limit (ms)
10	6.08	400ms

A period time = 0.4 (s) * 18 = 7.2 (s)

Time slot = 0.019 * (1600/2/18) * 7.2 = 6.08 (ms)

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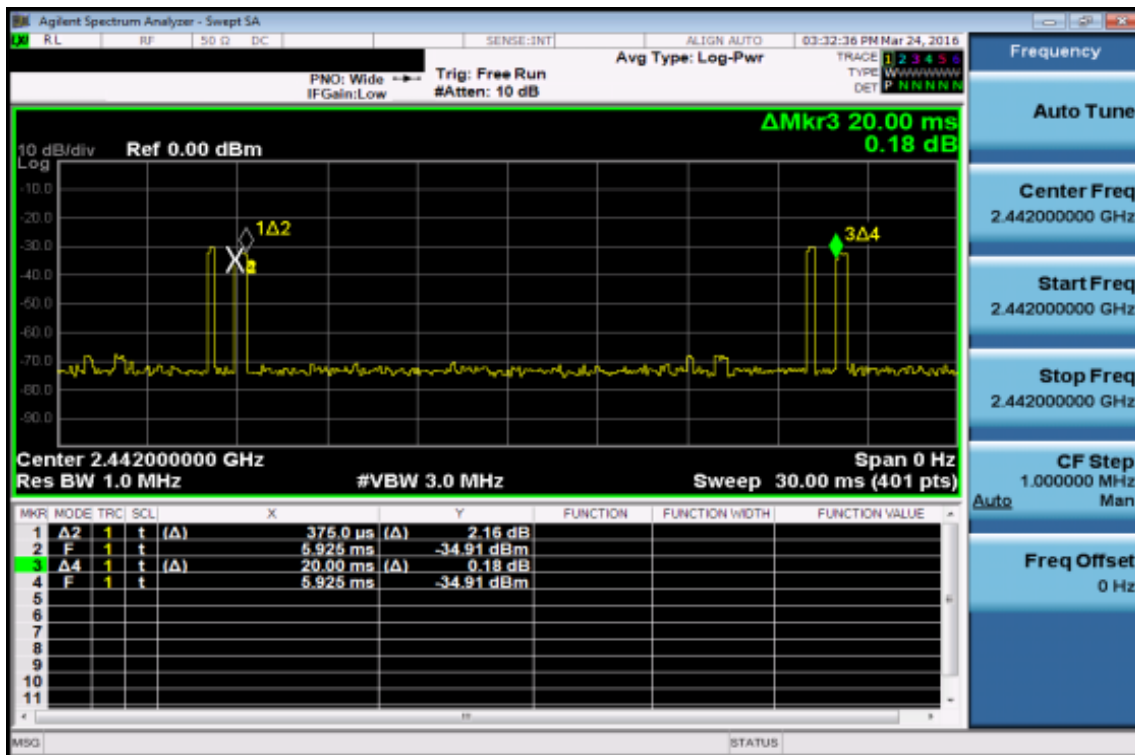
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13.6 Measurement Result

CH-Mid



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14 ANTENNA REQUIREMENT

14.1 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.

14.2 Antenna Connected Construction

An embedded-in antenna design is used.

The antenna is designed as permanent attached 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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