

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Product Name: Handheld Type UHF RFID
Brand Name: SOYAL
Model No.: AR-661UG-L
Model Difference: N/A
FCC ID: 2ACLE-AR-661UG-L
Report No.: ER/2015/A0051
Issue Date: Nov. 16, 2015
FCC Rule Part: §15.247, Cat: DSS
Prepared for: SOYAL Technology CO., Ltd.
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Taipei City 221, Taiwan(R.O.C.)
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Testing Laboratory
0913

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VERIFICATION OF COMPLIANCE

Applicant: SOYAL Technology CO., Ltd.
11F., No.368, Gongjian Rd., Xizhi Dist., New Taipei City 221,
Taiwan(R.O.C.)

Product Name: Handheld Type UHF RFID

Brand Name: SOYAL

Model No.: AR-661UG-L

Model Difference: N/A

FCC ID: 2ACLE-AR-661UG-L

File Number: ER/2015/A0051

Date of test: Sep. 30, 2015 ~ Nov. 02, 2015

Date of EUT Received: Sep. 30, 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:

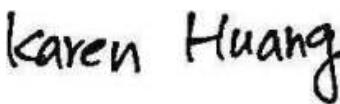


Date:

Nov. 16, 2015

Curry Chen / Engineer

Prepared By:

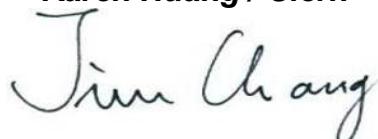


Date:

Nov. 16, 2015

Karen Huang / Clerk

Approved By:



Date:

Nov. 16, 2015

Jim Chang / Asst. Manager

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Revision History

Report Number	Revision	Description	Issue Date
ER/2015/A0051	Rev.00	Initial creation of document	Nov. 16, 2015

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1. GENERAL INFORMATION

1.1. Product description

General:

Product Name:	Handheld Type UHF RFID	
Brand Name:	SOYAL	
Model No.:	AR-661UG-L	
Model Difference:	N/A	
Hardware Version:	V1.0	
Software Version:	N/A	
Power Supply:	3.7Vdc Rechargeable Li-ion Battery or 5Vdc from USB port	
	Battery:	Model No.: MC-MLP554868-01, Supplier: N/A

RFID:

Frequency Range:	902.25 – 927.75MHz
Channel number:	52 channels
Modulation type:	PR-ASK
Transmit Power:	24.70dBm (Peak)
Dwell Time:	<= 0.4s
Operating Mode:	Point-to-Point
Antenna Designation:	Patch Antenna , Gain: 0.50dBi Model No.: 1037C20A021211 Supplier: Szok Energy and Communication Co., Ltd.

This test report applies for RFID function.

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1.2. Product Feature of Equipment Under Test

The equipment under Test (Hereafter Called: EUT) is Handheld Type UHF RFID supporting RFID features, and below is details of information

Product Feature	
Product Name:	Handheld Type UHF RFID
Brand Name:	SOYAL
Model No.:	AR-661UG-L
Model Difference:	N/A
FCC ID	2ACLE-AR-661UG-L
RFID Specification	RFID

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 the certification 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 (Wuku)

Canada Registration Number: 4620A-4.

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 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 §15.207. 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 plane. 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.

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

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2.5. Configuration of Tested System

Fig. 2-1 Radiated Emission & Conduction

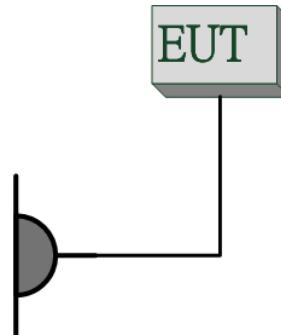


Fig. 2-2 Conducted (Antenna Port) Configuration



Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	NFC Test Software	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	Compliant
§15.247(b)(1)	Peak Output Power	Compliant
§15.247(a)(1)	20dB 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

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4. DESCRIPTION OF TEST MODES

4.1. Operated in 902.25 ~ 927.75MHz Band

52 channels are provided for RFID

CH	FREQUENCY	CH	FREQUENCY	CH	FREQUENCY
0	902.25MHz	20	912.25MHz	40	922.25MHz
1	902.75MHz	21	912.75MHz	41	922.75MHz
2	903.25MHz	22	913.25MHz	42	923.25MHz
3	903.75MHz	23	913.75MHz	43	923.75MHz
4	904.25MHz	24	914.25MHz	44	924.25MHz
5	904.75MHz	25	914.75MHz	45	924.75MHz
6	905.25MHz	26	915.25MHz	46	925.25MHz
7	905.75MHz	27	915.75MHz	47	925.75MHz
8	906.25MHz	28	916.25MHz	48	926.25MHz
9	906.75MHz	29	916.75MHz	49	926.75MHz
10	907.25MHz	30	917.25MHz	50	927.25MHz
11	907.75MHz	31	917.75MHz	51	927.75MHz
12	908.25MHz	32	918.25MHz		
13	908.75MHz	33	918.75MHz		
14	909.25MHz	34	919.25MHz		
15	909.75MHz	35	919.75MHz		
16	910.25MHz	36	920.25MHz		
17	910.75MHz	37	920.75MHz		
18	911.25MHz	38	921.25MHz		
19	911.75MHz	39	921.75MHz		

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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	PACKET TYPE	ANTENNA PORT
RFID	0 to 49	0,25,51	PR-ASK	---	MAIN

RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE	ANTENNA PORT
RFID	0 to 49	0,25,51	PR-ASK	---	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 BR+EDR Transmitter for channel Low, Mid and High, the worst case E2 position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST					
Peak Output Power, 20dB Band Width					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	PACKET TYPE	ANTENNA PORT
RFID	0 to 49	0,25,51	PR-ASK	---	MAIN

Band Edge					
RFID	0 to 49	0,25,51	PR-ASK	---	MAIN
Frequency Separation					
RFID	0 to 49	0,25,51	PR-ASK	---	MAIN

Number of hopping frequency					
RFID	0 to 49	0,25,51	PR-ASK	---	MAIN
Time of Occupancy (Dwell time)					
RFID	0 to 49	0,25,51	PR-ASK	---	MAIN

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5. MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 1.55 dB
20dB Bandwidth	+/- 123.36 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 1.55 dB
Frequency Separation	+/- 123.36 Hz
Number of hopping frequency	+/- 123.36 Hz
Time of Occupancy	+/- 123.36 Hz
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 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	ESCI7	100760	05/04/2015	05/03/2016
LISN	SCHWARZ BECK	NSLK 8127	8127-649	05/15/2015	05/14/2016
LISN	FCC	FCC-LISN-50/25 0-25-2-01	04034	03/13/2015	03/12/2016
Coaxial Cables	N/A	WK CE Cable	N/A	11/26/2014	11/25/2015

6.3. EUT Setup

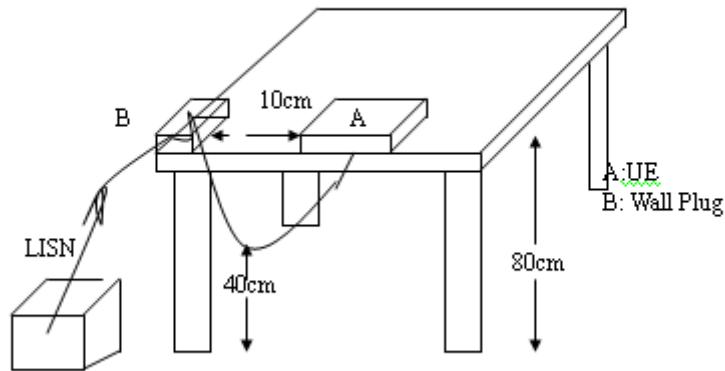
1. The conducted emission tests were performed in the test site, using the setup in accordance with the
ANSI C63.4:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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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 frequency measured were complete.

6.6. Measurement Result

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

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

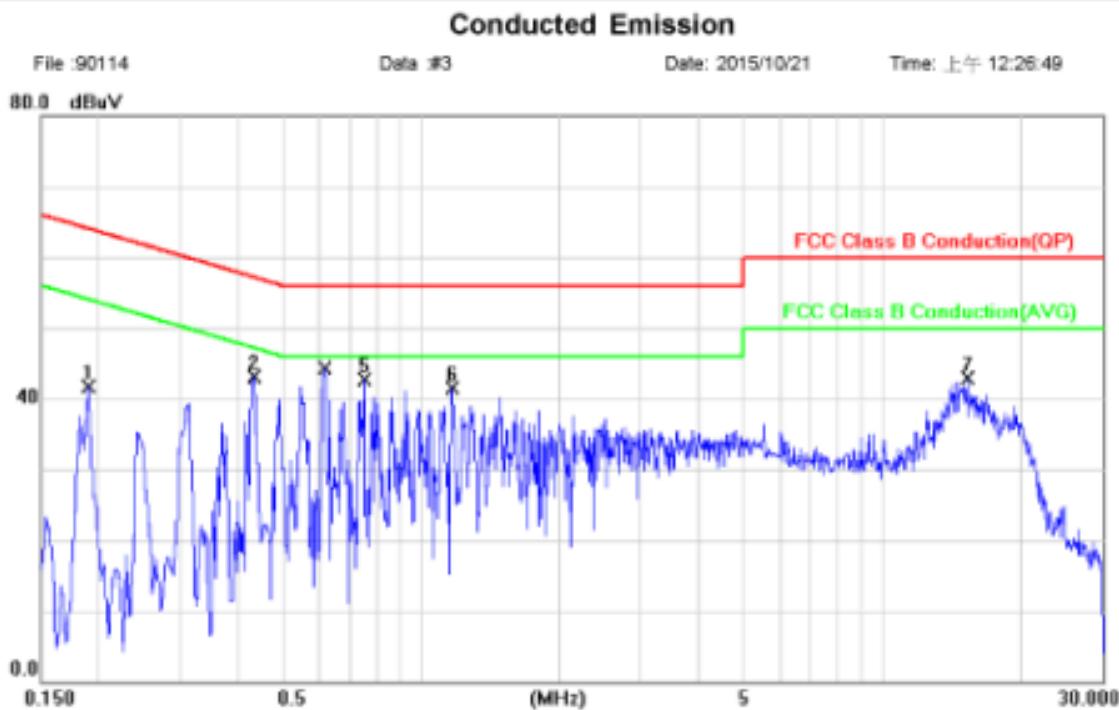
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AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Operation mode			Test Date:	Oct. 21, 2015
Temperature:	25 °C	Humidity:	70 %	Test By:	Marcus
				Phase:	L1



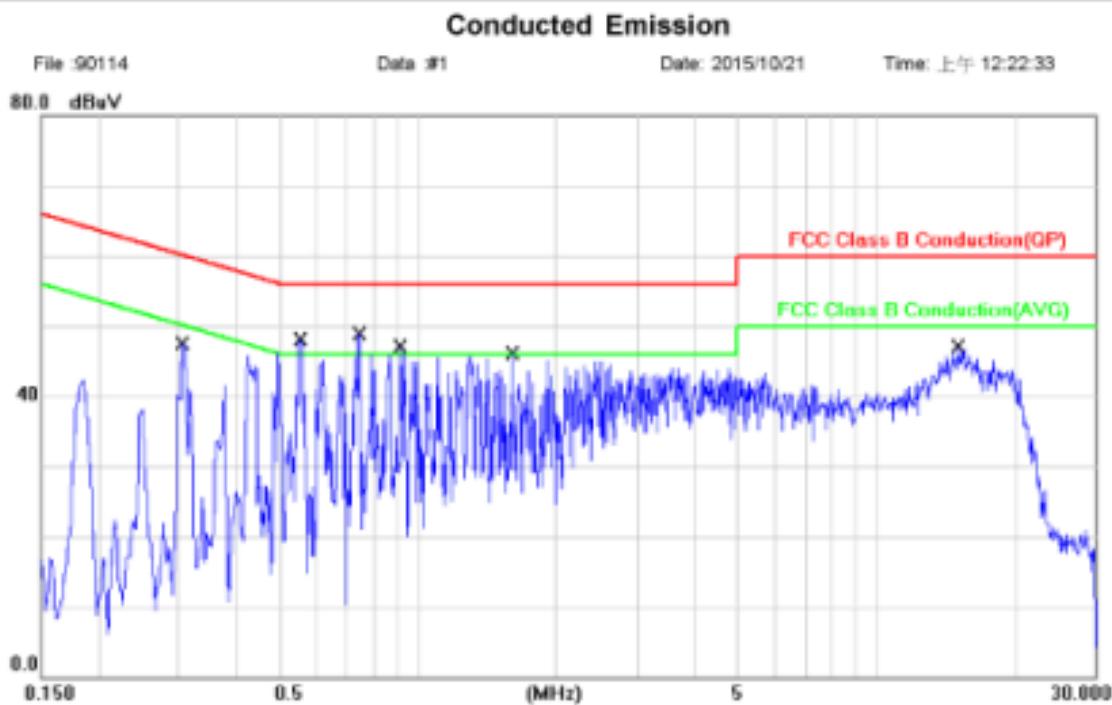
No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Detector	Comment
			Level	Factor	ment				
1		0.1900	41.67	0.04	41.71	64.04	-22.33	peak	
2		0.4340	43.16	0.04	43.20	57.18	-13.98	peak	
3		0.6180	42.40	0.04	42.44	56.00	-13.56	QP	
4 *		0.6180	34.60	0.04	34.64	46.00	-11.36	AVG	
5		0.7540	42.65	0.05	42.70	56.00	-13.30	peak	
6		1.1700	41.46	0.05	41.51	56.00	-14.49	peak	
7		15.2860	42.40	0.41	42.81	60.00	-17.19	peak	

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Operation Mode:	Operation mode			Test Date:	Oct. 21, 2015
Temperature:	25 °C	Humidity:	70 %	Test By:	Marcus
				Phase:	N



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	Detector	Comment
			Level	Factor	ment				
		MHz	dBuV	dB	dBuV	dBuV	dB		
1		0.3060	45.90	0.06	45.96	60.08	-14.12	QP	
2		0.3060	38.80	0.06	38.86	50.08	-11.22	AVG	
3		0.5540	48.10	0.06	48.16	56.00	-7.84	QP	
4 *		0.5540	41.20	0.06	41.26	46.00	-4.74	AVG	
5		0.7460	46.60	0.07	46.67	56.00	-9.33	QP	
6		0.7460	32.50	0.07	32.57	46.00	-13.43	AVG	
7		0.9180	43.50	0.07	43.57	56.00	-12.43	QP	
8		0.9180	30.80	0.07	30.87	46.00	-15.13	AVG	
9		1.6020	43.50	0.08	43.58	56.00	-12.42	QP	
10		1.6020	29.20	0.08	29.28	46.00	-16.72	AVG	
11		15.1340	41.00	0.35	41.35	60.00	-18.65	QP	
12		15.1340	29.70	0.35	30.05	50.00	-19.95	AVG	

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7. PEAK OUTPUT POWER MEASUREMENT

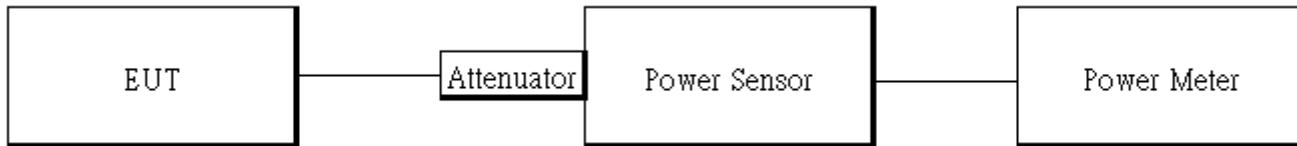
7.1. Standard Applicable

According to §15.247(b)(2), for frequency hopping systems operating in the 902-928 MHz band employing at least 50 hopping channels, The Limit: 1Watt. For systems employing less than 50 hopping channels, The Limit: 0.25 Watts. But at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

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	12/20/2014	12/19/2015
Power Sensor	Anritsu	MA2411B	917032	12/20/2014	12/19/2015
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016

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

Frequency (MHz)	Reading Power (dBm)	Output Power (W)	Limit (W)
902.25	24.700	0.29512	1
914.75	24.620	0.28973	1
927.75	23.930	0.24717	1

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8. 20dB BANDWIDTH MEASUREMENT

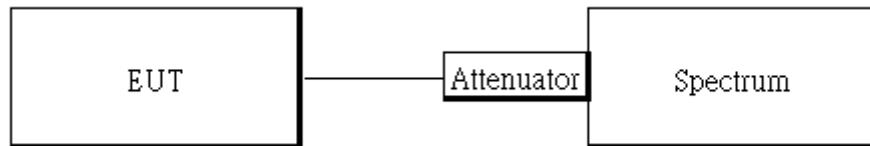
8.1. Standard Applicable

According to §15.247(a)(1)(i), for frequency hopping systems operating in the 902 MHz-928 MHz : if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

8.2. Measurement Equipment Used

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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=20kHz (1 % of 20 dB Bandwidth.), VBW = 300kHz, Span= 500MHz, 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. For the plot of bandwidth measurement, the marker of the 20dB BW is arrow-mark

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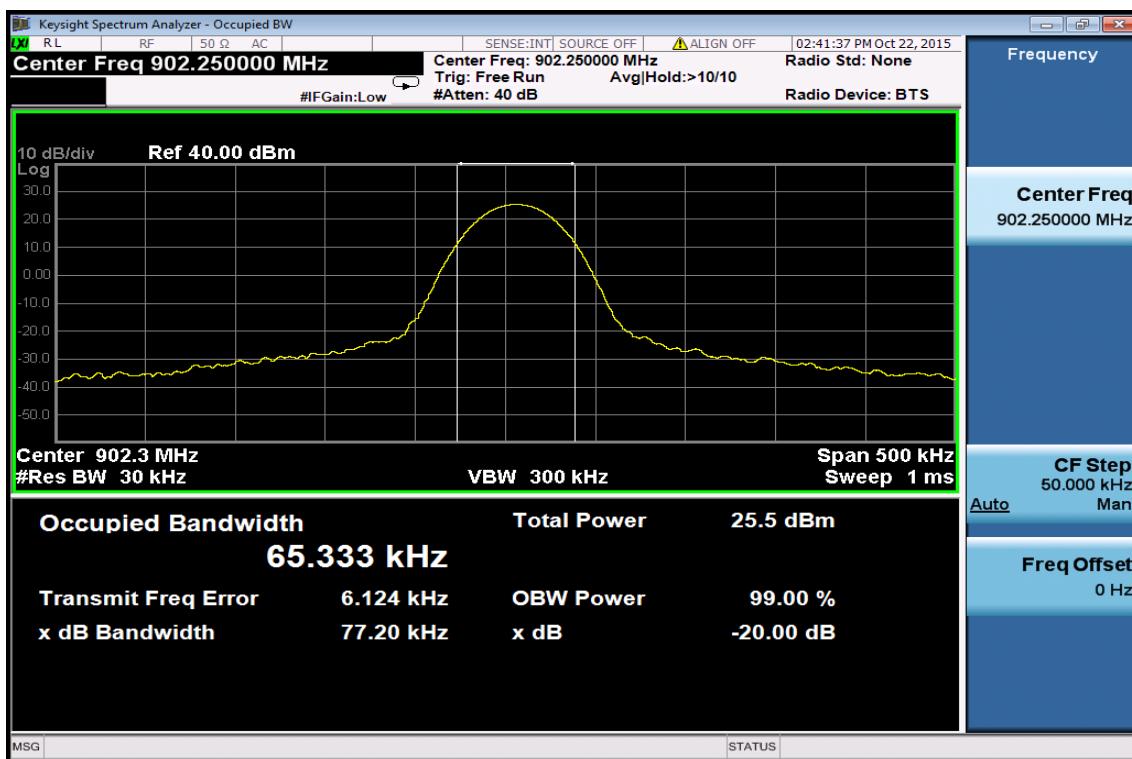
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8.5. Measurement Result:

CH	Bandwidth (kHz)
Low	77.20
Mid	77.22
High	76.84

20dB Band Width Test Data CH-Low

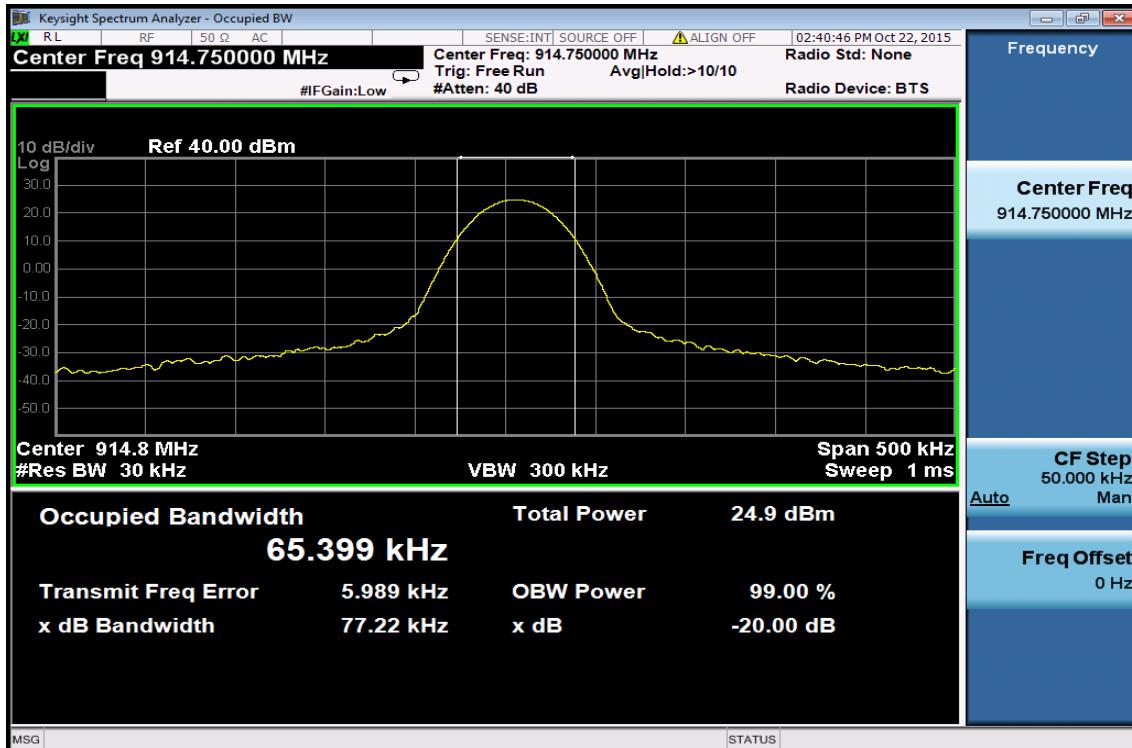


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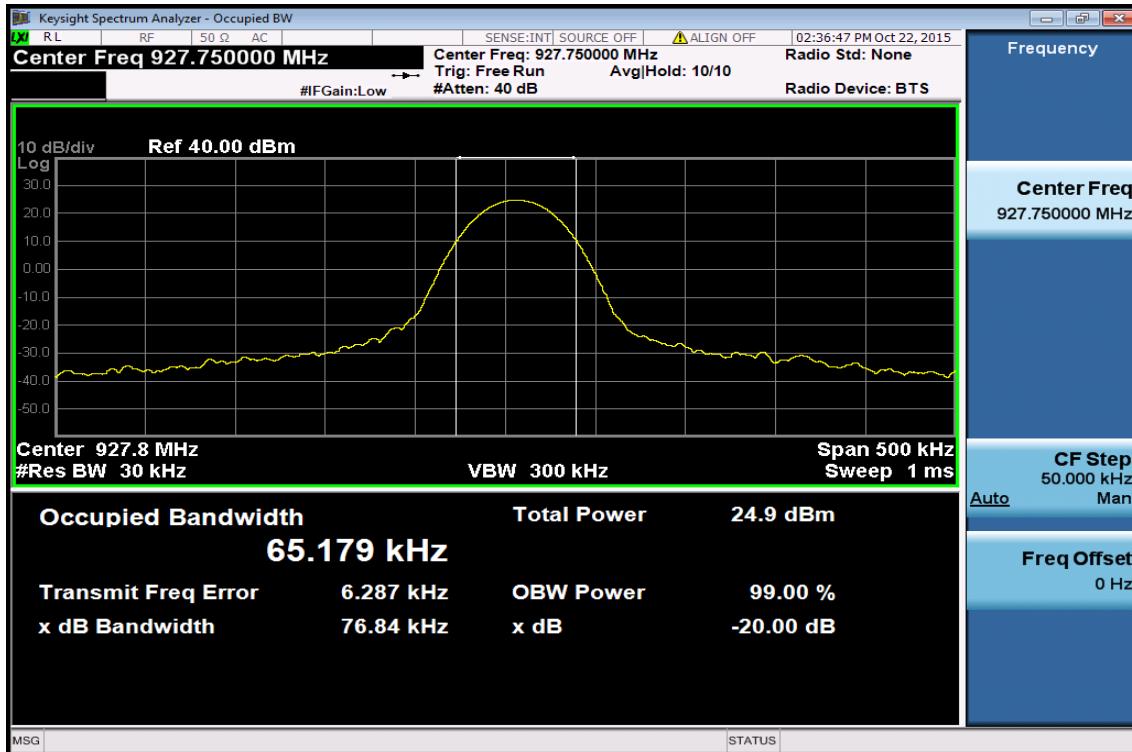
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20dB Band Width Test Data CH-Mid



20dB Width Test Data CH-High



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9. CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

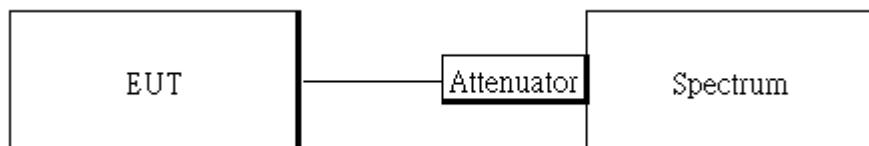
9.1. Standard Applicable

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	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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, VBW=300 kHz, Sweep = auto
6. Mark Peak, 902MHz and 928MHz 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 = 100K & VBW = 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.

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.

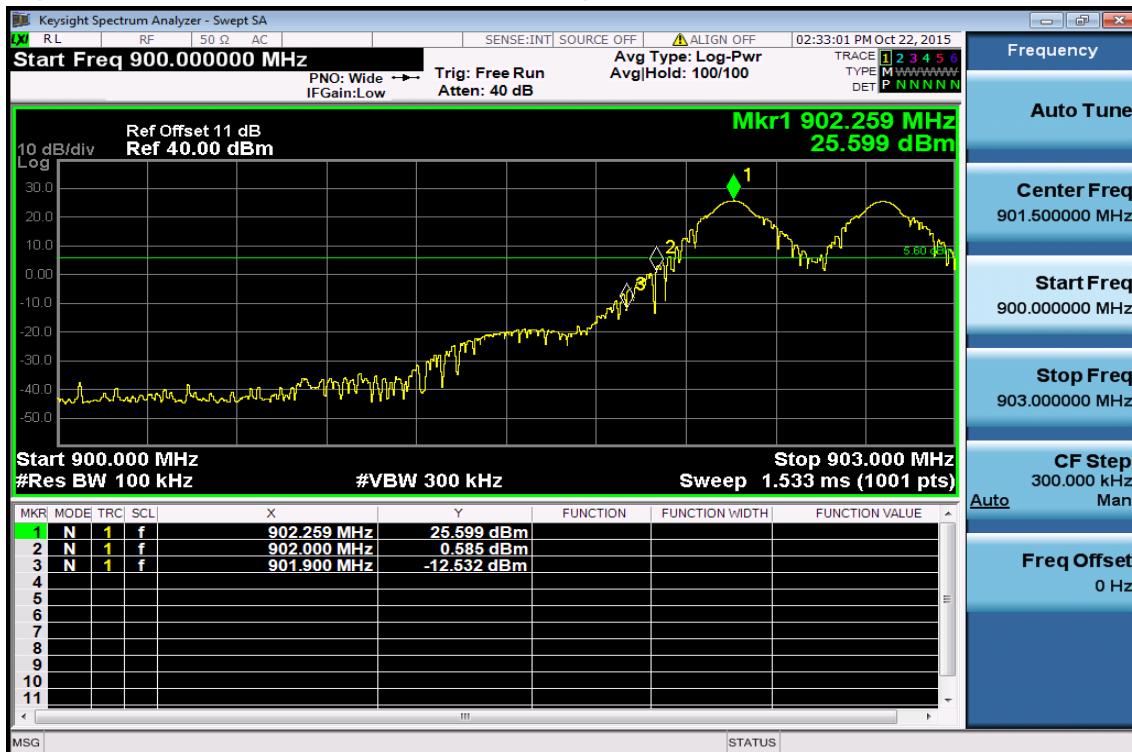
NOTE:

1. Cable loss as 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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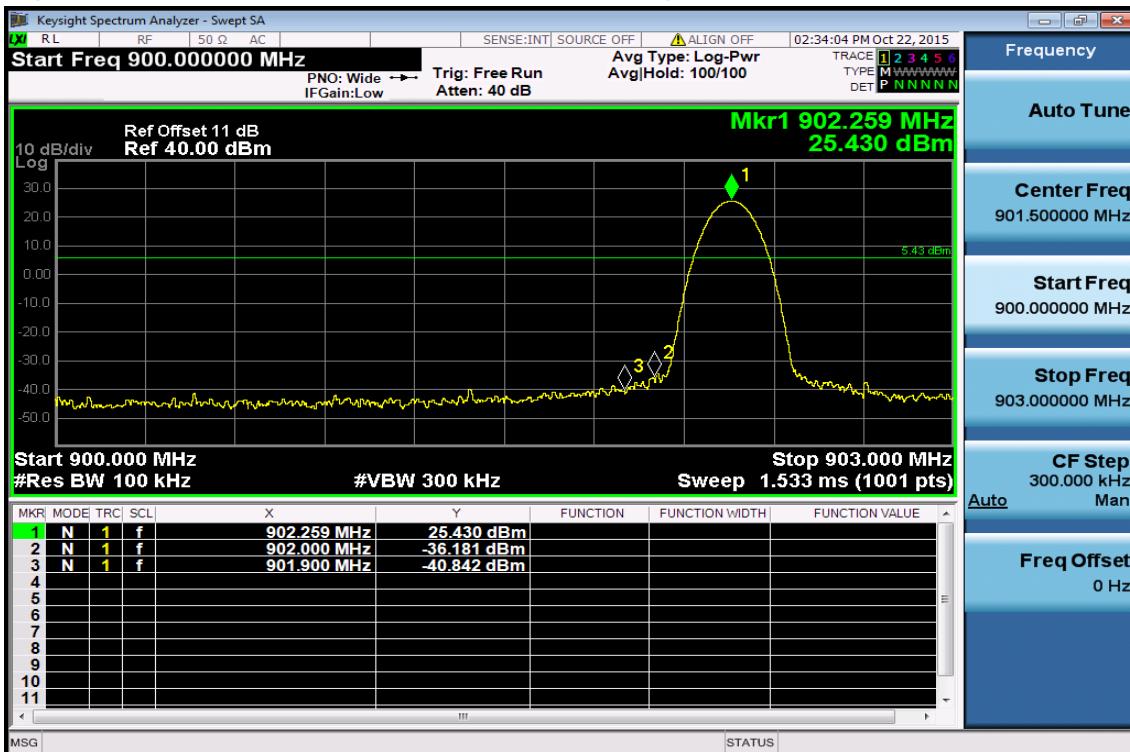
Band Edges Test Data CH-Low (Hopping mode)**Band Edges Test Data CH-High**

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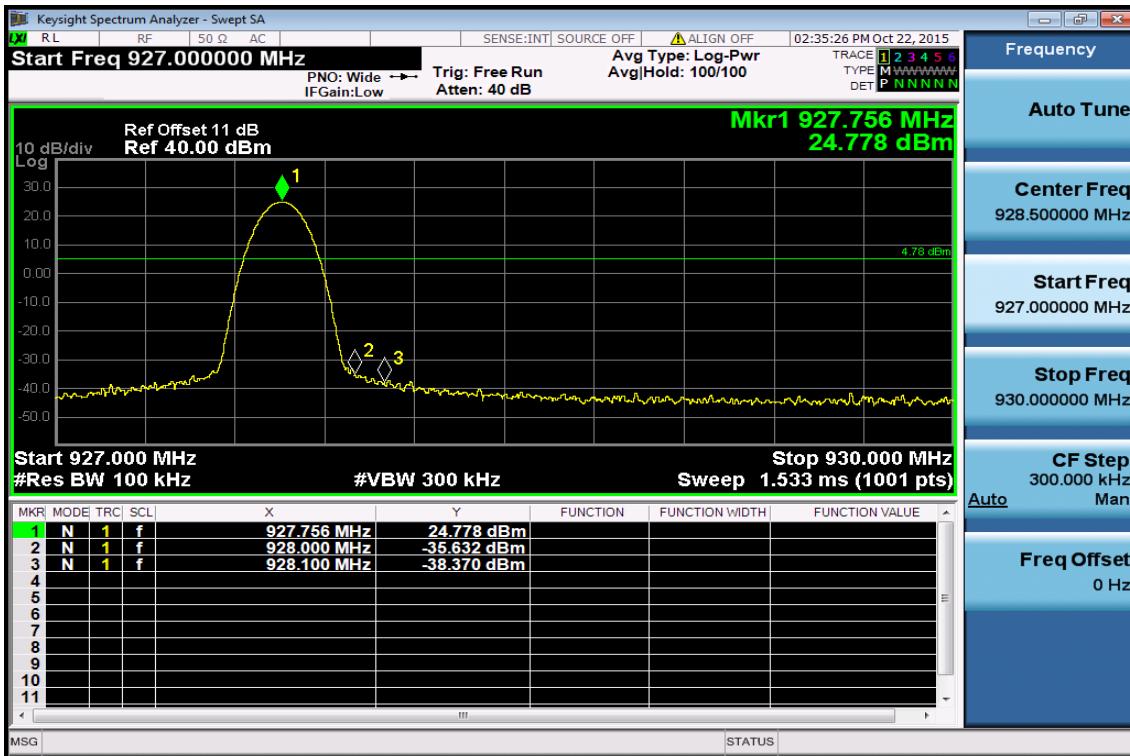
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Band Edges Test Data CH-Low (Non-Hopping mode)



Band Edges Test Data CH-High



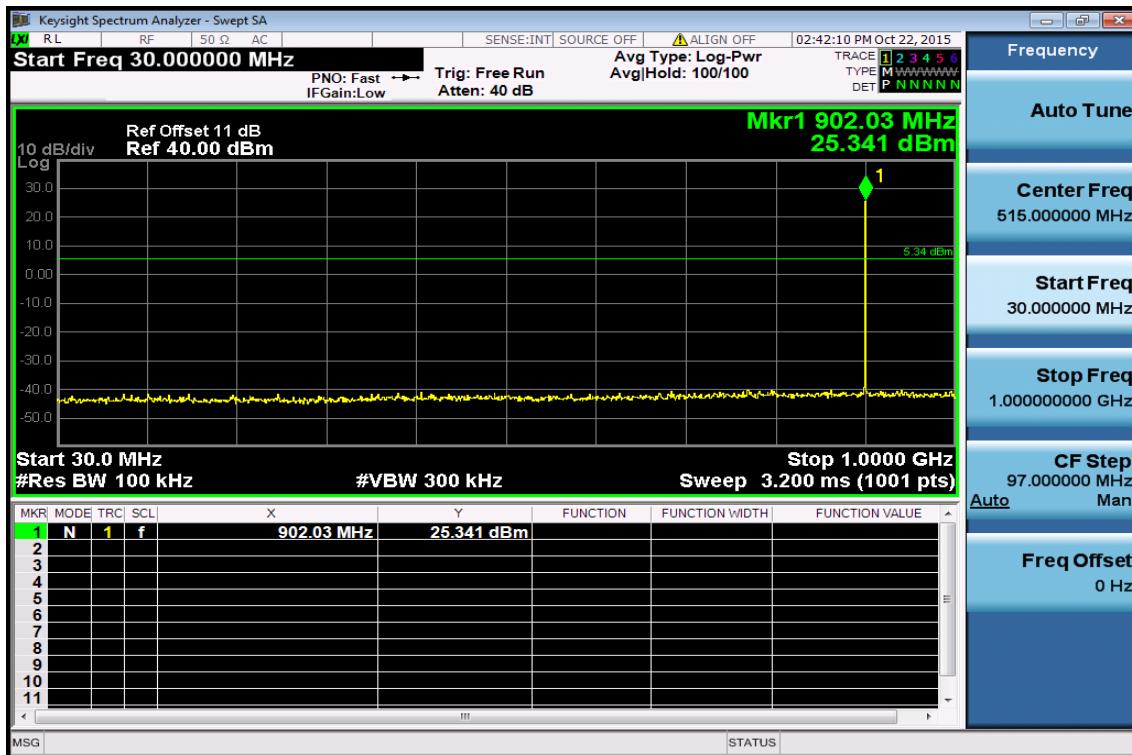
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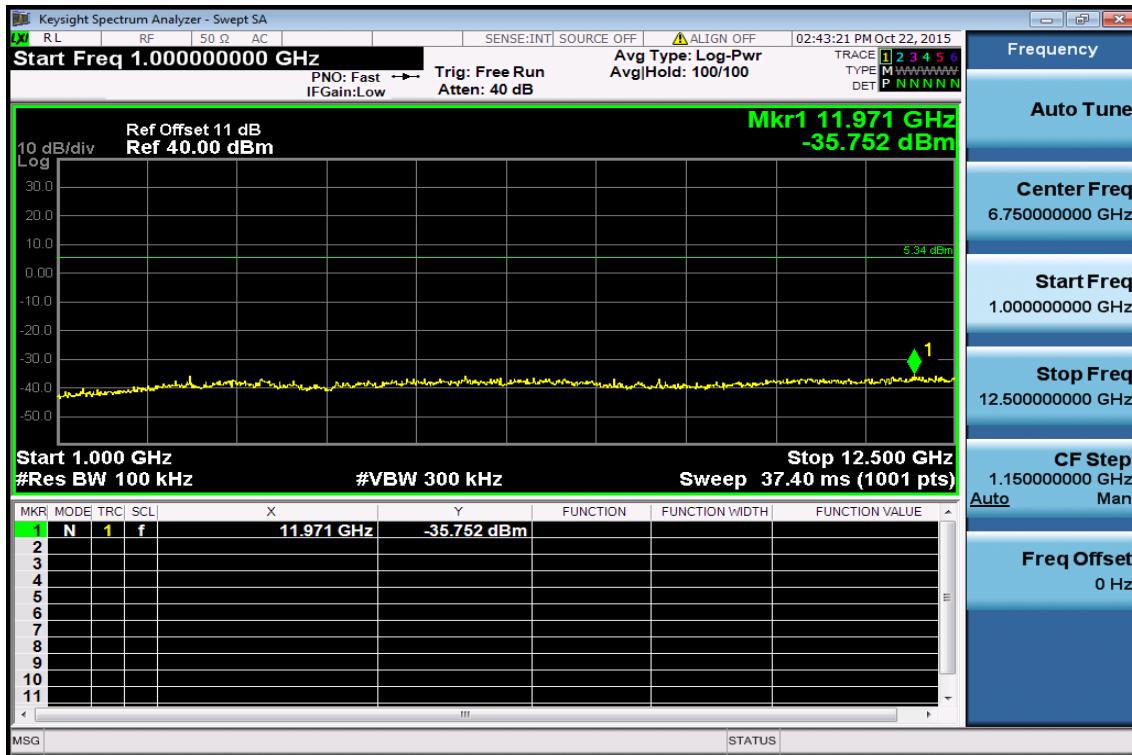
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Conducted Spurious Emission Measurement Result Ch Low 30MHz – 1GHz



Ch Low 1GHz – 12.5GHz

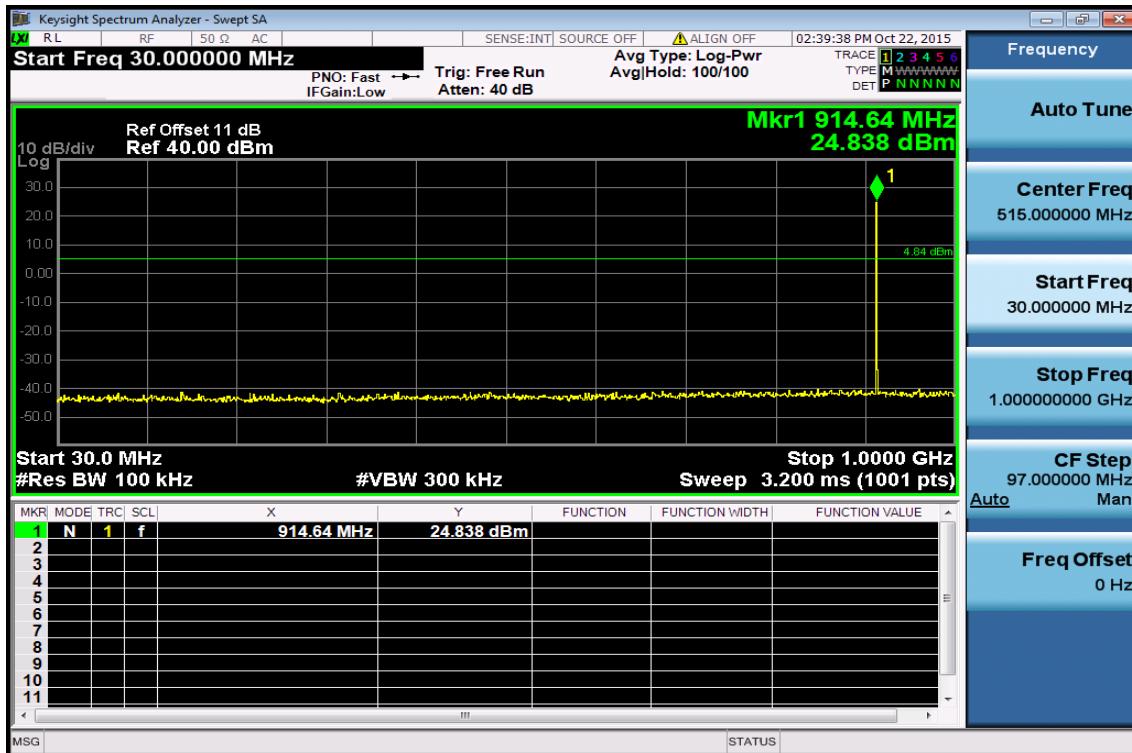


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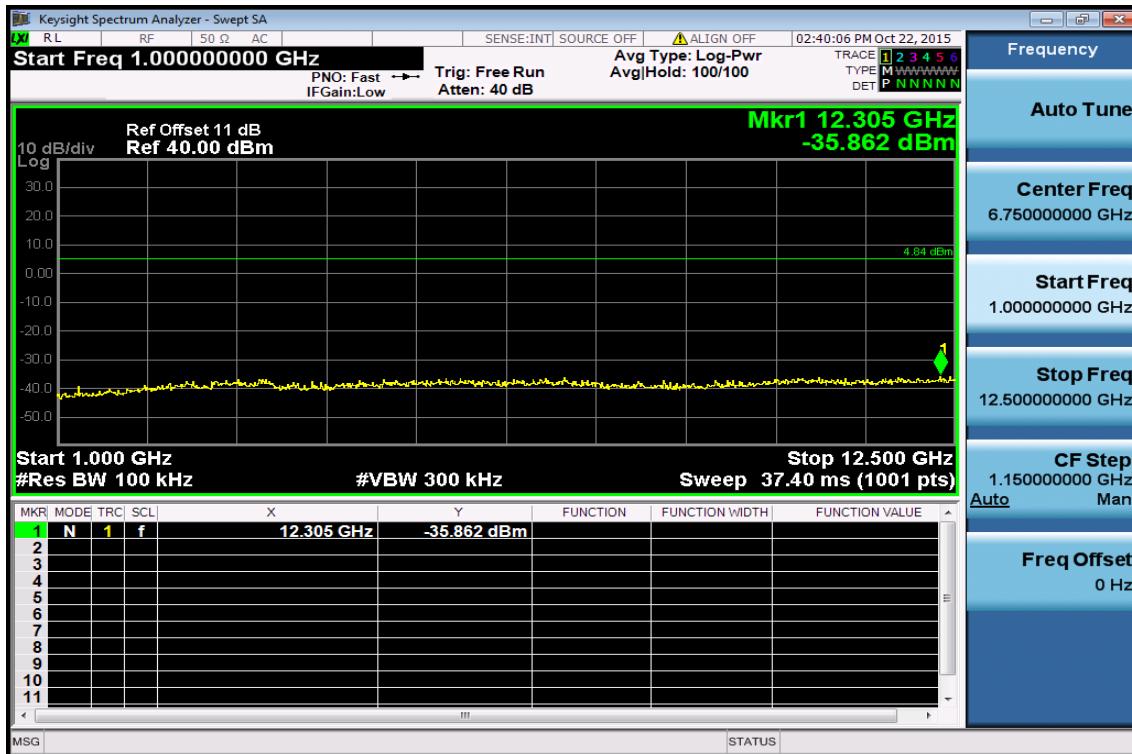
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Ch Mid 30MHz – 1GHz



Ch Mid 1GHz – 12.5GHz



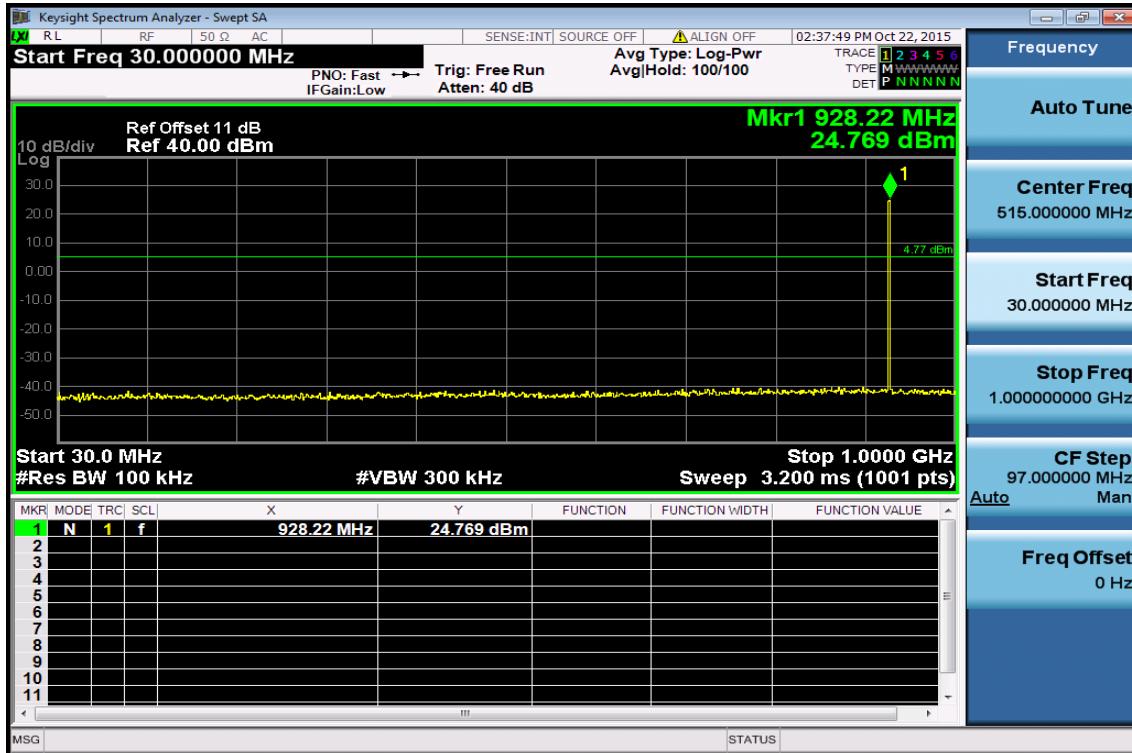
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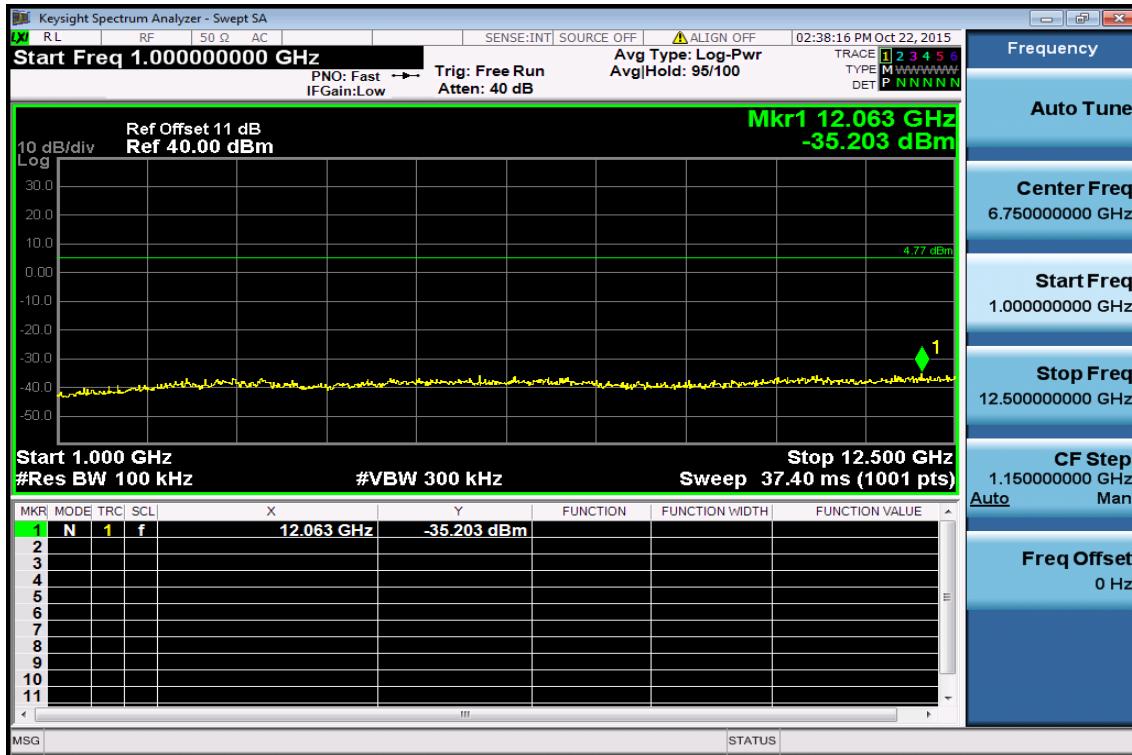
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Ch High 30MHz – 1GHz



Ch High 1GHz – 12.5GHz



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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 (dB μ V/m) = 20 log Emission level (dB μ V/m)

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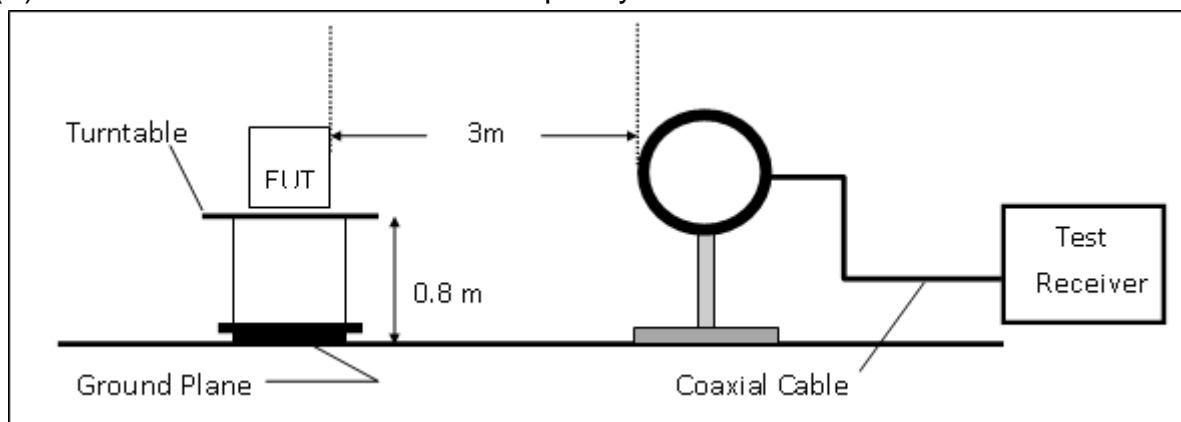
10.2. Measurement Equipment Used:

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
EXA Spectrum Analyzer	Agilent	N9010A	MY50420195	12/22/2014	12/21/2015
Loop Antenna	ETS.LINDGREN	6502	00143303	12/9/2014	12/08/2015
Bilog Antenna	SCHWAZBECK	VULB9168	378	12/23/2014	12/22/2015
Horn antenna	ETS.LINDGREN	3117	123995	05/05/2015	05/04/2016
Horn Antenna	Schwarzbeck	BBHA9170	184	12/25/2014	12/24/2015
Pre-Amplifier	Agilent	8447D	2944A07676	01/02/2015	01/01/2016
Pre-Amplifier	Agilent	8449B	3008A00578	01/02/2015	01/01/2016
Pre-Amplifier	EMC Instruments Corp.	EMC184045	980135	01/02/2015	01/01/2016
Filter 2400-2483.5 MHz	EWT	EWT-14-016 6	M2	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	004	01/02/2015	01/01/2016
Turn Table	HD	DT420	N/A	N.C.R	N.C.R
Antenna Tower	HD	MA240-N	240/657	N.C.R	N.C.R
Controller	HD	HD100	N/A	N.C.R	N.C.R
Low Loss Cable	Huber Suhner	966_Rx	9	01/02/2015	01/01/2016

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

10.3. Test SET-UP

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

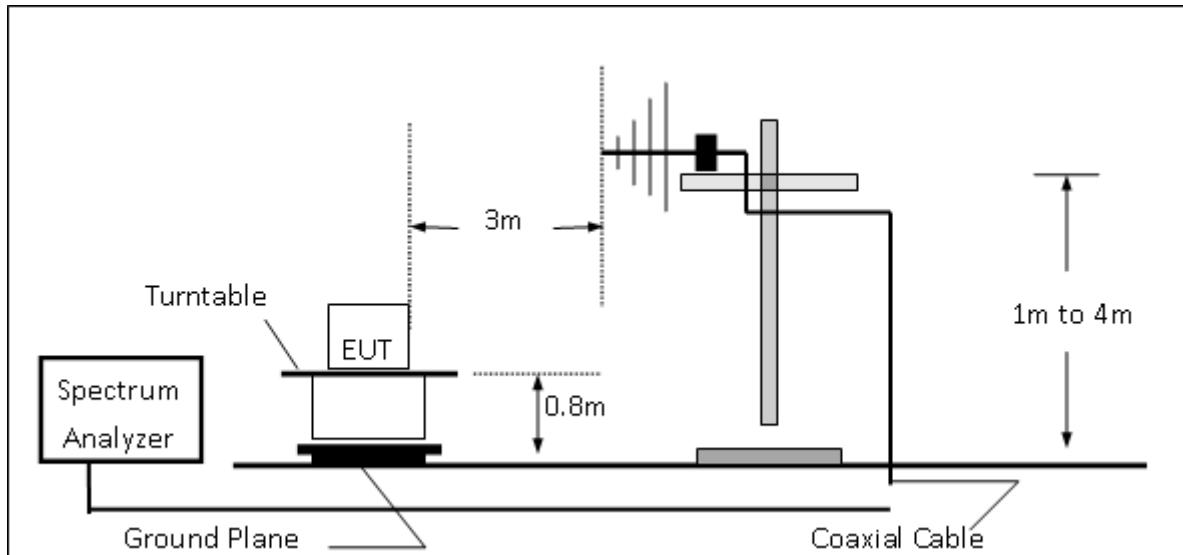


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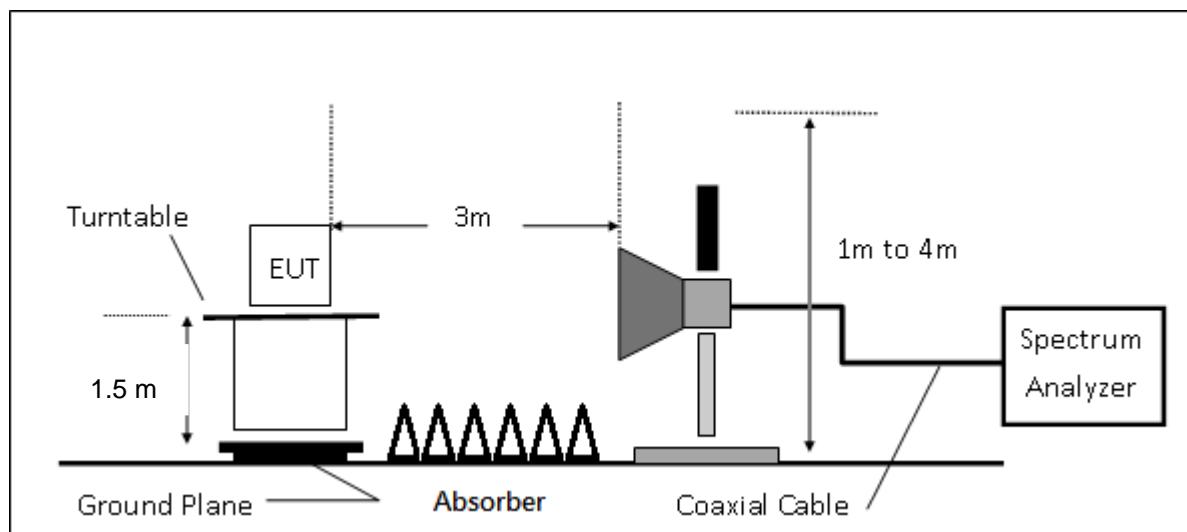
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(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(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 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. 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
On time = $N_1 \cdot L_1 = N_2 \cdot L_2 + \dots + N(n-1) \cdot L_{n-1} + N(n) \cdot L_n$
Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
Average Emission Level = Peak Emission Level + $20 \cdot \log_{10}$ (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 dB μ V/m, which converts $20 * \log(\mu\text{V}/\text{m})$

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

Factor(dB) = Antenna Factor(dB μ V/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 from 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.

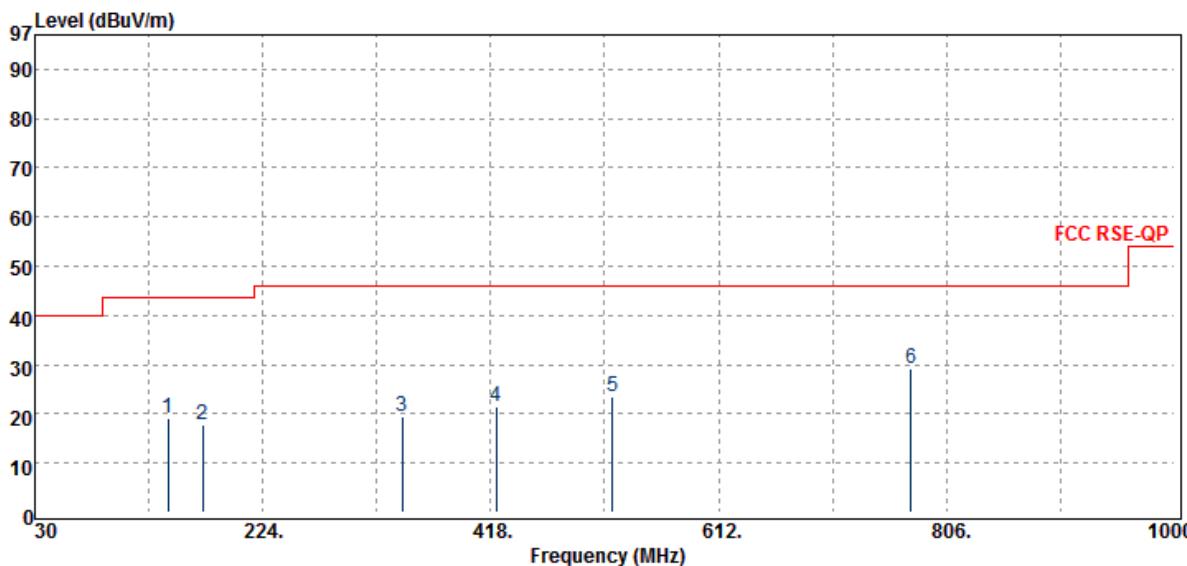
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Radiated Spurious Emission Measurement Result (Below 1GHz):

Operation Band	:RFID	Test Date	:2015-10-20
Fundamental Frequency	:902.25 MHz	Temp./Humi.	:23 deg_C / 60 RH
Operation Mode	:TX LOW	Engineer	:Curry
EUT Pol.	:E2 Plane	Measurement Pol.	Antenna :VERTICAL



Freq.	Note	Detector	Spectrum		Factor	Actual	Limit	Margin
			Mode	Reading Level				
MHz	F/H/E/S	PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB	
88.20	S	Peak	48.89	-15.13	33.76	43.50	-9.74	
162.89	S	Peak	34.75	-8.88	25.87	43.50	-17.63	
432.55	S	Peak	34.30	-5.81	28.49	46.00	-17.51	
551.86	S	Peak	28.26	-4.04	24.22	46.00	-21.78	
760.41	S	Peak	26.77	1.11	27.88	46.00	-18.12	
985.45	S	Peak	27.48	3.38	30.86	54.00	-23.14	

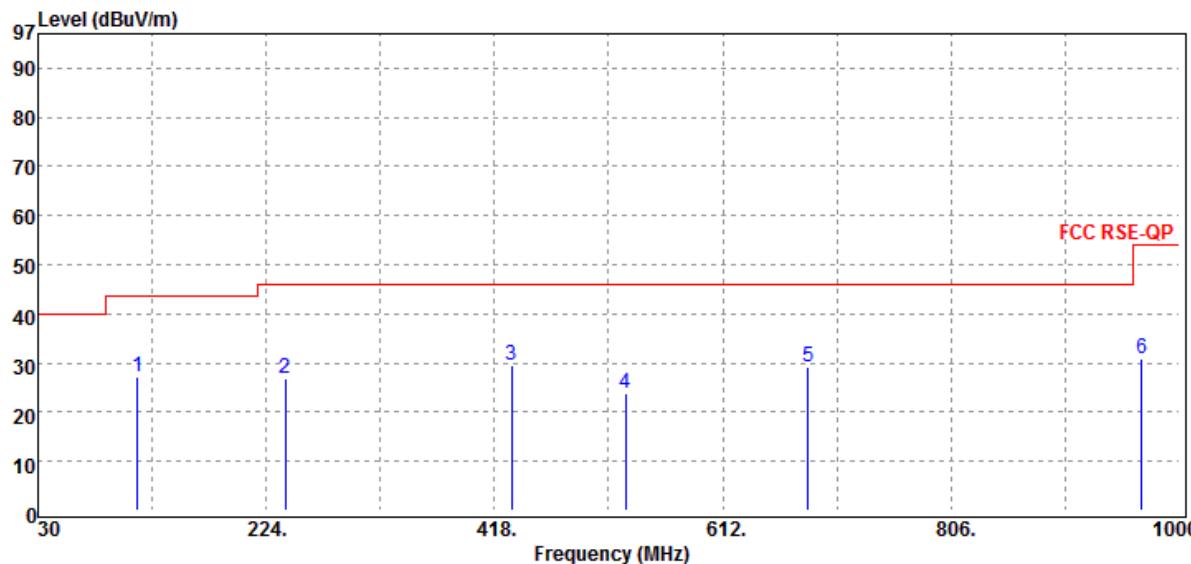
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Operation Band :RFID
 Fundamental Frequency :902.25 MHz
 Operation Mode :TX LOW
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Pol. Antenna :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
			PK/QP/AV	Reading Level dB μ V				
114.39	S	Peak	38.89	-11.80	27.09	43.50	-16.41	
240.49	S	Peak	37.19	-10.23	26.96	46.00	-19.04	
432.55	S	Peak	35.51	-5.81	29.70	46.00	-16.30	
529.55	S	Peak	28.04	-4.11	23.93	46.00	-22.07	
684.75	S	Peak	30.03	-0.95	29.08	46.00	-16.92	
967.99	S	Peak	27.14	3.66	30.80	54.00	-23.20	

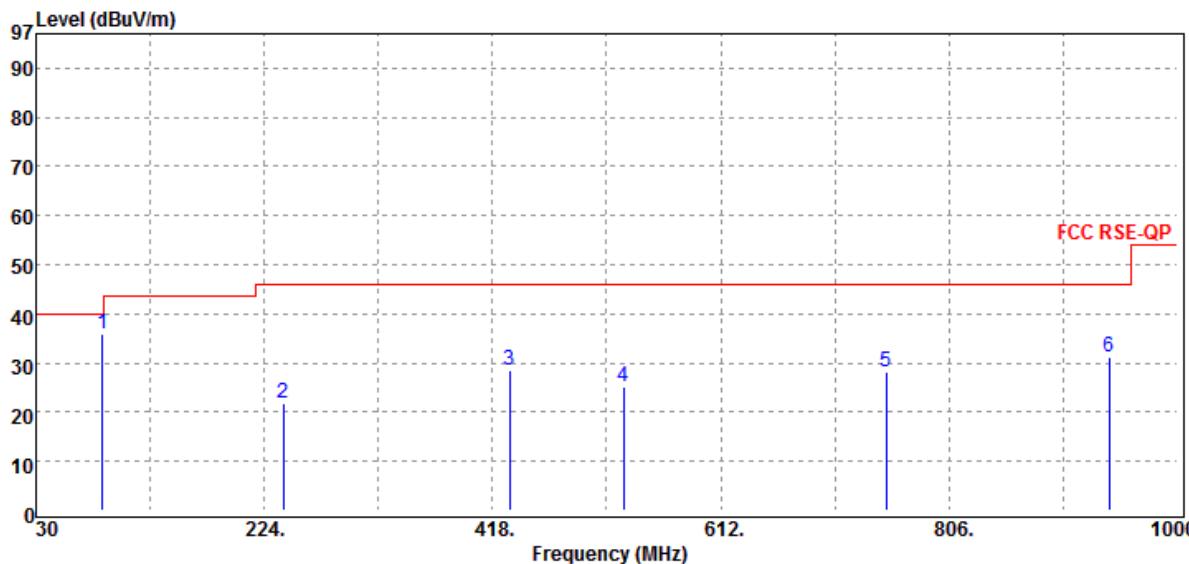
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Operation Band :RFID
 Fundamental Frequency :914.75 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dB ^μ V/m	Limit @3m dB ^μ V/m	Margin dB
			PK/QP/AV	Reading Level dB ^μ V				
86.26	S	Peak	50.45	-14.70	35.75	40.00	-4.25	
240.49	S	Peak	32.13	-10.23	21.90	46.00	-24.10	
432.55	S	Peak	34.25	-5.81	28.44	46.00	-17.56	
529.55	S	Peak	29.17	-4.11	25.06	46.00	-20.94	
752.65	S	Peak	27.76	0.54	28.30	46.00	-17.70	
941.80	S	Peak	28.35	2.97	31.32	46.00	-14.68	

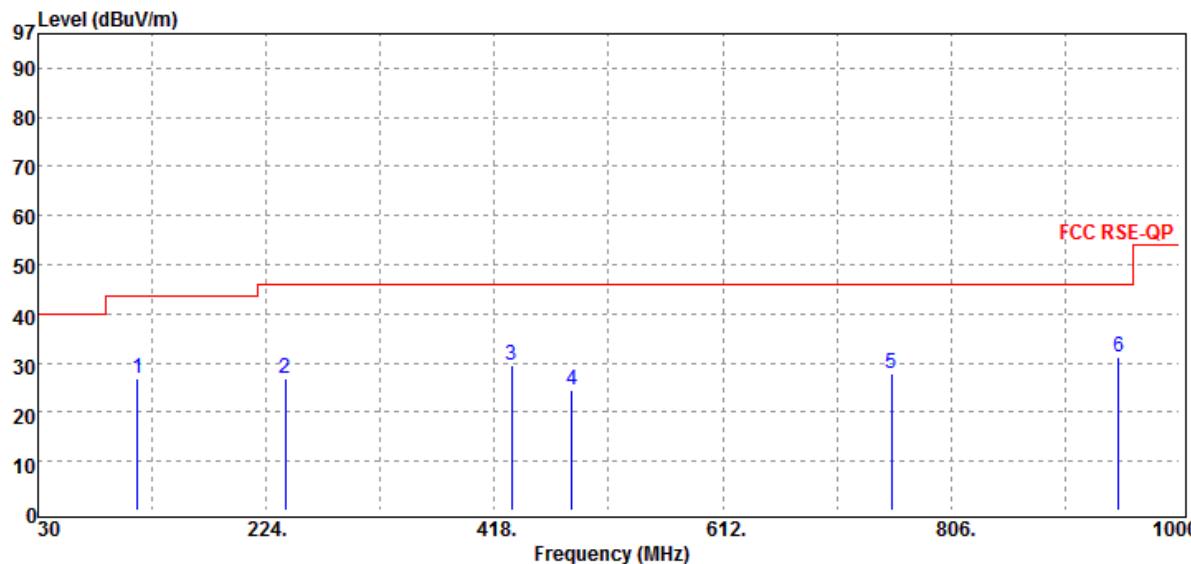
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Operation Band :RFID
 Fundamental Frequency :914.75 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dB ^μ V	Limit @3m dB ^μ V/m	Margin dB
			PK/QP/AV	Reading Level dB ^μ V				
114.39	S	Peak		38.65	-11.80	26.85	43.50	-16.65
240.49	S	Peak		37.18	-10.23	26.95	46.00	-19.05
432.55	S	Peak		35.31	-5.81	29.50	46.00	-16.50
483.96	S	Peak		28.82	-4.43	24.39	46.00	-21.61
755.56	S	Peak		27.17	0.80	27.97	46.00	-18.03
948.59	S	Peak		27.97	3.23	31.20	46.00	-14.80

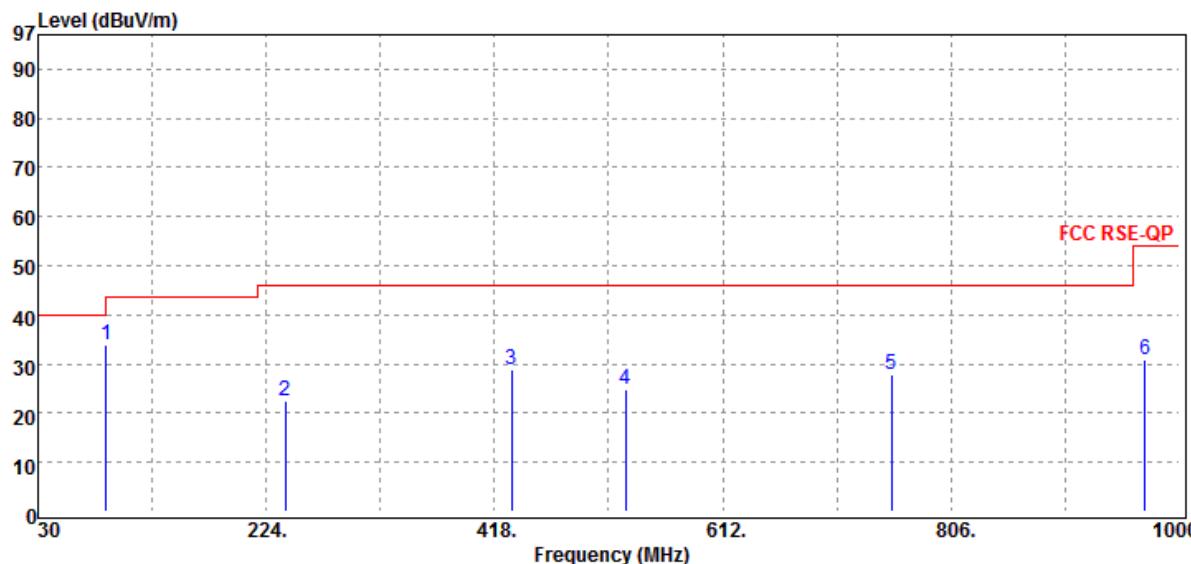
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Operation Band :RFID
 Fundamental Frequency :927.75 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			Reading	Level dB μ V				
88.20	S	Peak	49.09	-15.13	33.96	43.50	-9.54	
240.49	S	Peak	32.81	-10.23	22.58	46.00	-23.42	
432.55	S	Peak	34.57	-5.81	28.76	46.00	-17.24	
529.55	S	Peak	29.01	-4.11	24.90	46.00	-21.10	
755.56	S	Peak	27.07	0.80	27.87	46.00	-18.13	
970.90	S	Peak	27.32	3.60	30.92	54.00	-23.08	

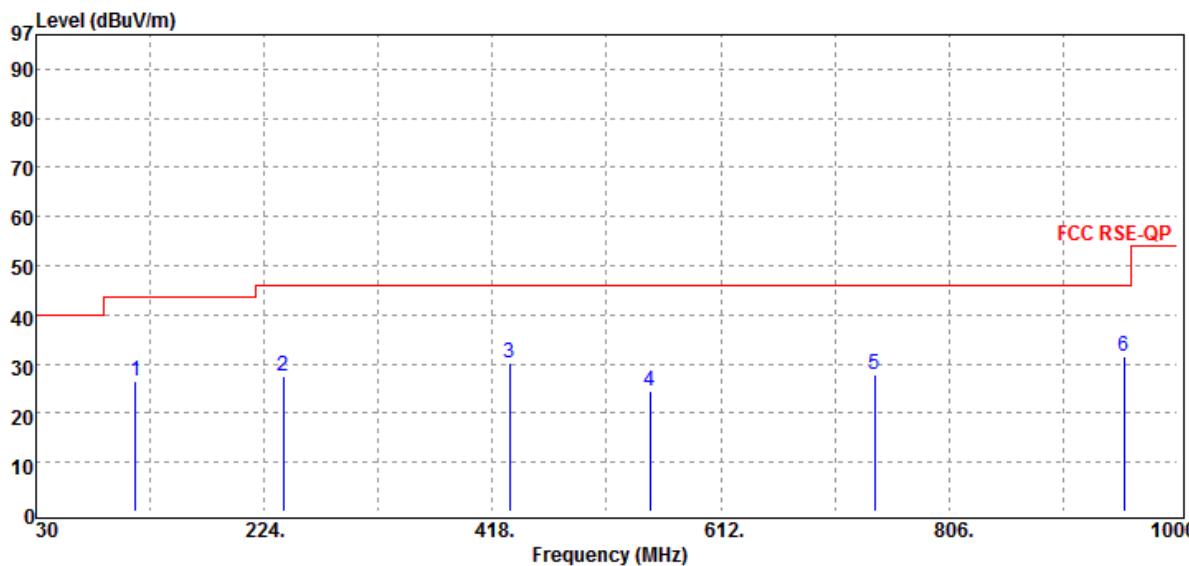
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Operation Band :RFID
 Fundamental Frequency :927.75 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			dB μ V					
114.39	S	Peak	38.25	-11.80	26.45	43.50	-17.05	
240.49	S	Peak	37.87	-10.23	27.64	46.00	-18.36	
432.55	S	Peak	36.08	-5.81	30.27	46.00	-15.73	
551.86	S	Peak	28.66	-4.04	24.62	46.00	-21.38	
742.95	S	Peak	28.19	-0.24	27.95	46.00	-18.05	
954.41	S	Peak	28.09	3.49	31.58	46.00	-14.42	

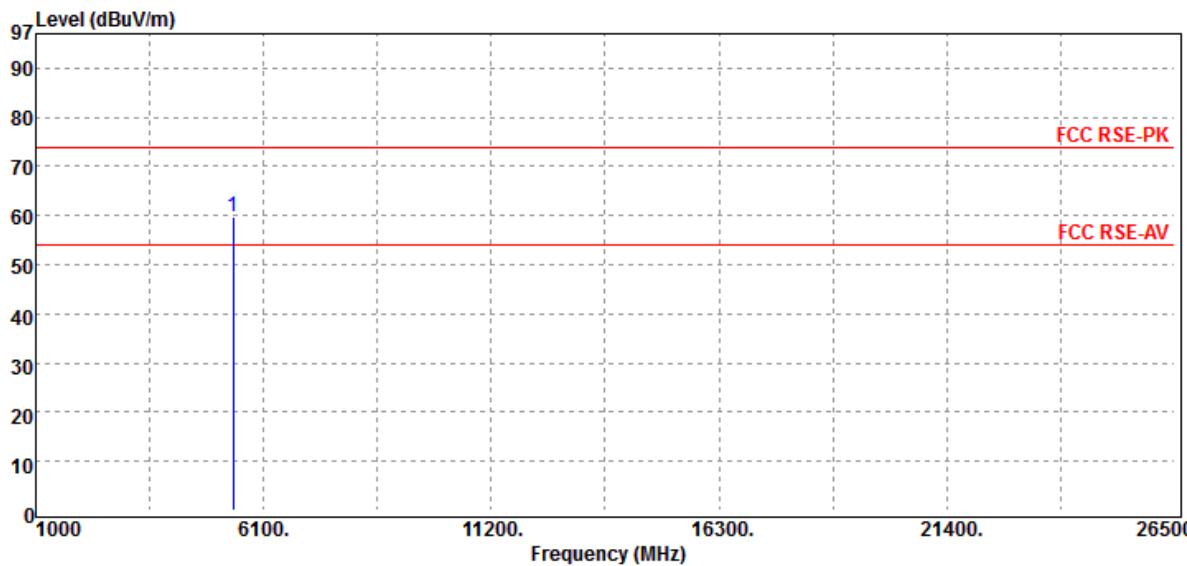
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Radiated Spurious Emission Measurement Result (Above 1GHz):

Operation Band	:RFID	Test Date	:2015-10-20
Fundamental Frequency	:902.25 MHz	Temp./Humi.	:23 deg_C / 60 RH
Operation Mode	:TX LOW	Engineer	:Curry
EUT Pol.	:E2 Plane	Measurement Pol.	Antenna :VERTICAL



Freq.	Note	Detector	Spectrum		Factor	Actual	Limit	Margin
			Mode	Reading Level				
MHz	F/H/E/S	PK/QP/AV	dB μ V	dB	dB μ V/m	dB μ V/m	dB	
5413.50	H	Peak	48.99	10.91	59.90	74.00	-14.10	
5413.50	H	Average	---	-19.87	40.03	54.00	-13.97	

Note: 20LOG(DEWLL TIME/100MS)

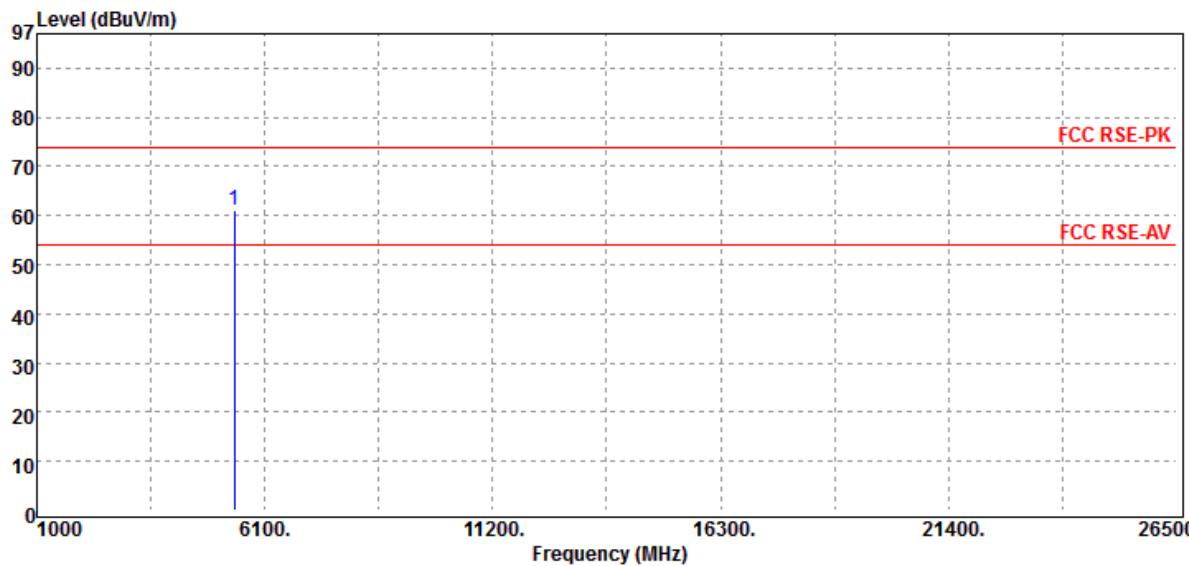
$$20\log(10.15/100) = -19.87$$

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Operation Band :RFID
 Fundamental Frequency :902.25 MHz
 Operation Mode :TX LOW
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Pol. Antenna :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	dB μ V				
5413.50	H	Peak	50.03		10.91	60.94	74.00	-13.06
5413.50	H	Average	---		-19.87	41.07	54.00	-12.93

Note: 20LOG(DEWLL TIME/100MS)

20LOG(10.15/100)=-19.87

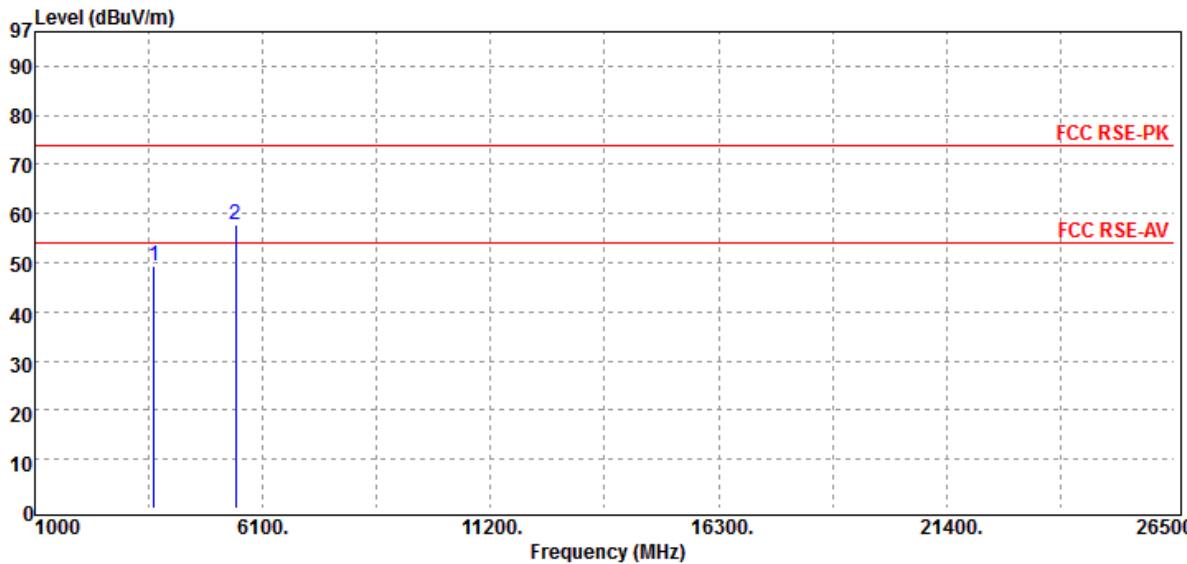
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Operation Band :RFID
 Fundamental Frequency :914.75 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum		Factor	Actual FS dB ^μ V	Limit @3m dB ^μ V/m	Margin dB
			PK/QP/AV	Reading Level dB ^μ V				
3659.00	H	Peak	41.87	7.47	49.34	74.00	-24.66	
3659.00	H	Average	---	-19.87	29.47	54.00	-24.53	
5488.50	H	Peak	46.95	10.94	57.89	74.00	-16.11	
5488.50	H	Average	---	-19.87	38.02	54.00	-15.98	

Note: 20LOG(DEWLL TIME/100MS)

20LOG(10.15/100)=-19.87

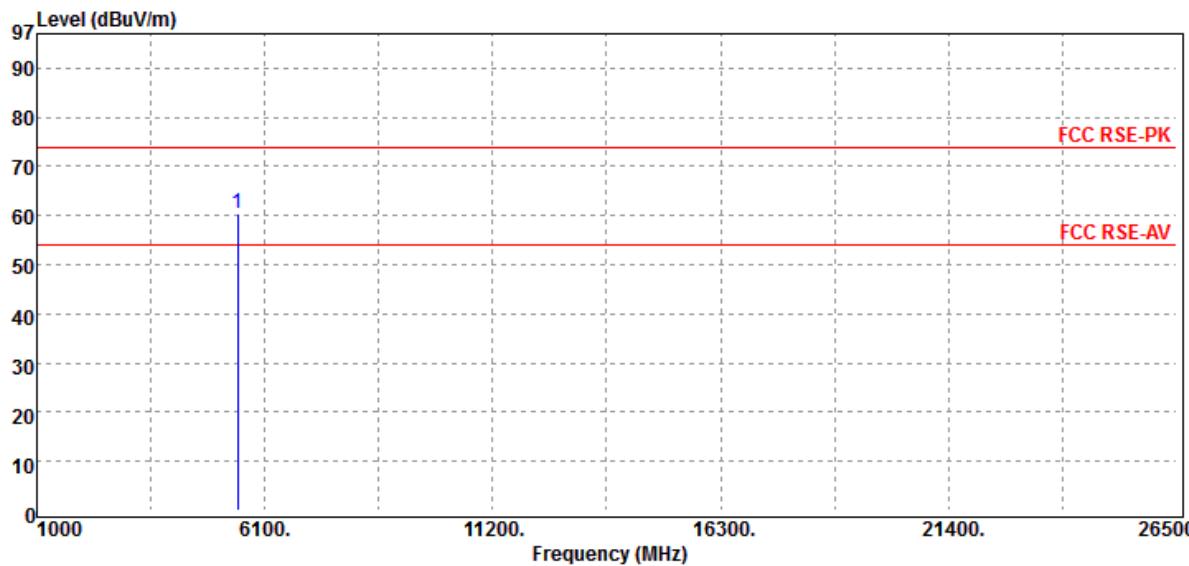
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Operation Band :RFID
 Fundamental Frequency :914.75 MHz
 Operation Mode :TX MID
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			PK/QP/AV	dB μ V				
5488.50	H	Peak	49.39		10.94	60.33	74.00	-13.67
5488.50	H	Average	---		-19.87	40.46	54.00	-13.54

Note: 20LOG(DEWLL TIME/100MS)

20LOG(10.15/100)=-19.87

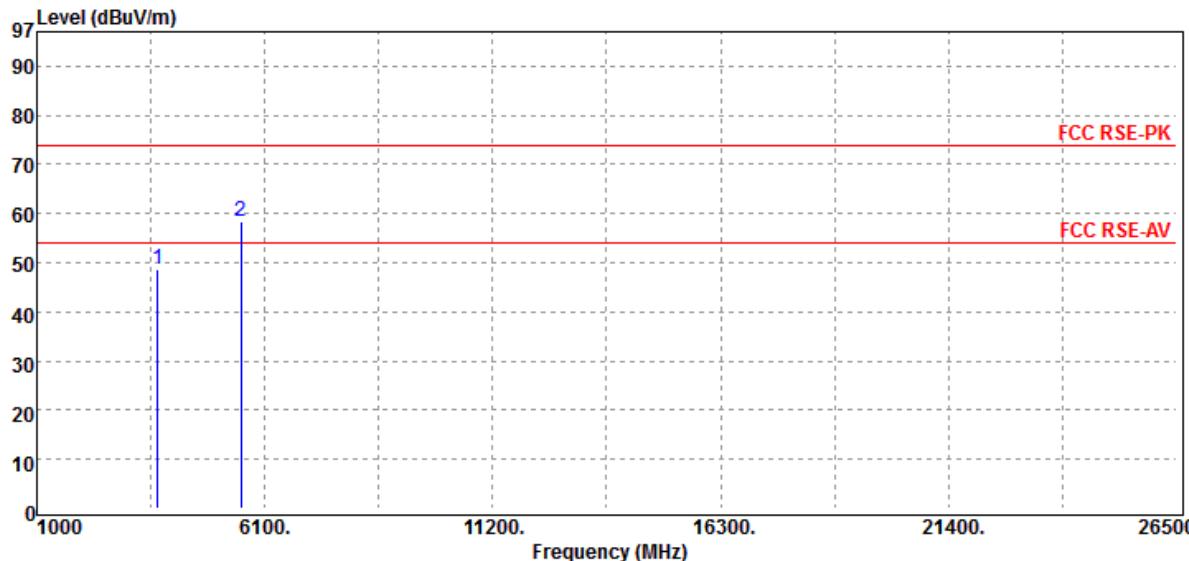
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Operation Band :RFID
 Fundamental Frequency :927.75 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :VERTICAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			Reading	Level dB μ V				
3711.00	H	Peak	40.63	7.88	48.51	74.00	-25.49	
3711.00	H	Average	---	-19.87	28.64	54.00	-25.36	
5566.50	H	Peak	47.00	11.43	58.43	74.00	-15.57	
5566.50	H	Average	---	-19.87	38.56	54.00	-15.44	

Note: 20LOG(DEWLL TIME/100MS)

20LOG(10.15/100)=-19.87

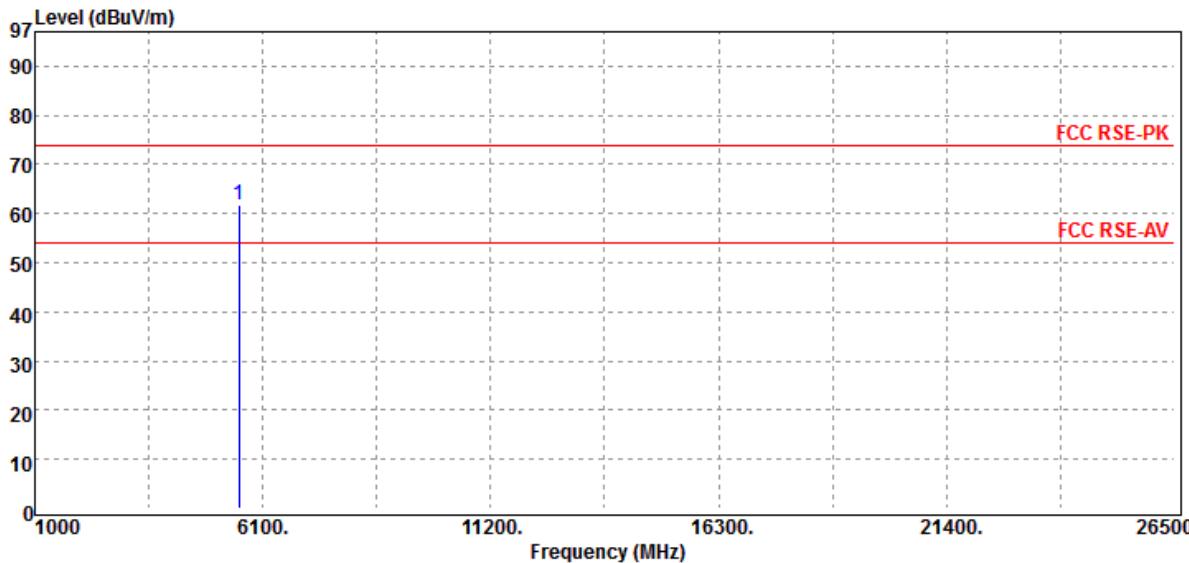
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Operation Band :RFID
 Fundamental Frequency :927.75 MHz
 Operation Mode :TX HIGH
 EUT Pol. :E2 Plane

Test Date :2015-10-20
 Temp./Humi. :23 deg_C / 60 RH
 Engineer :Curry
 Measurement Antenna Pol. :HORIZONTAL



Freq. MHz	Note F/H/E/S	Detector Mode PK/QP/AV	Spectrum Reading Level		Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
			dB μ V					
5566.50	H	Peak	50.44		11.43	61.87	74.00	-12.13
5566.50	H	Average	---		-19.87	42.00	54.00	-12.00

Note: 20LOG(DEWLL TIME/100MS)

20LOG(10.15/100)=-19.87

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11. FREQUENCY SEPARATION

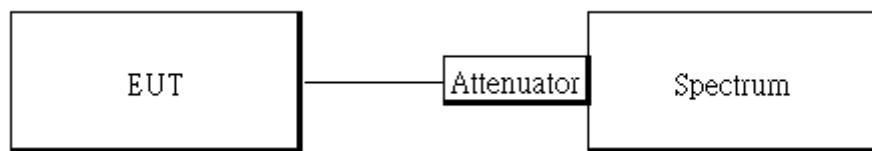
11.1. Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or 20dB 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	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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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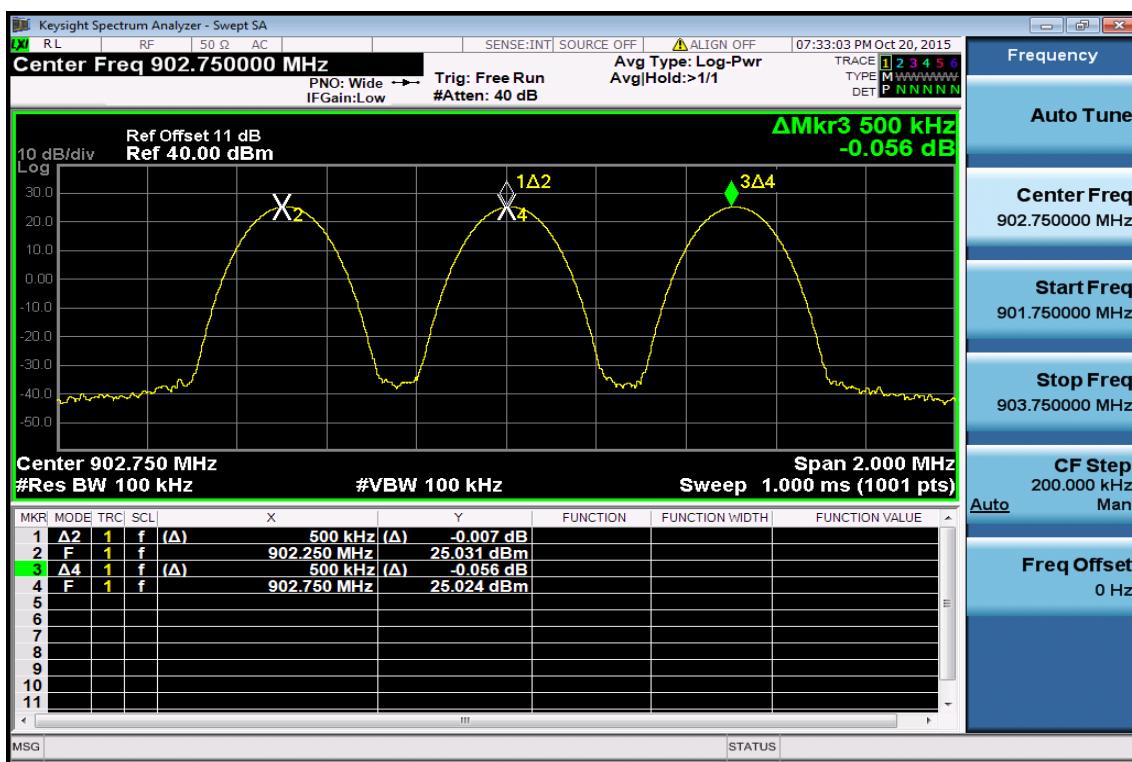
11.5. Measurement Result:

Channel separation (kHz)	Limit	Result
500	>=25 kHz or 20dB bandwidth (77.22kHz)	PASS

Frequency Separation Test Data

Note: 20LOG(DEWLL TIME/100MS)

20LOG(10.15/100)=-19.87



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12. NUMBER OF HOPPING FREQUENCY

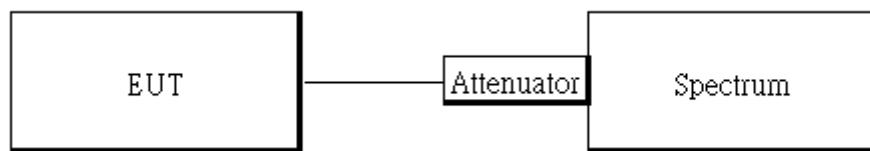
12.1. Standard Applicable

Frequency hopping systems operating in the 902MHz-928 MHz bands shall use at least 50 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	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

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=900MHz, Stop = 930MHz, Sweep = auto.
5. Set the spectrum analyzer as RBW=200 kHz, VBW=620KHz., Detector = Peak
6. Max hold, view and count how many channel in the band.

12.5. Measurement Result:

Note: Refer to next page for plots.

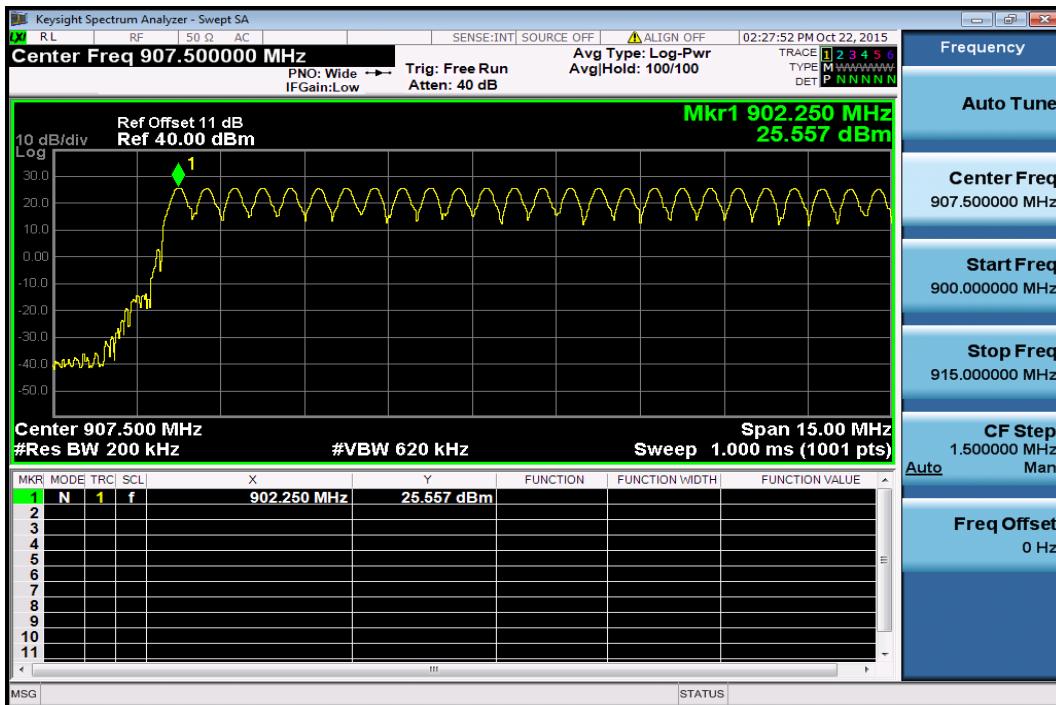
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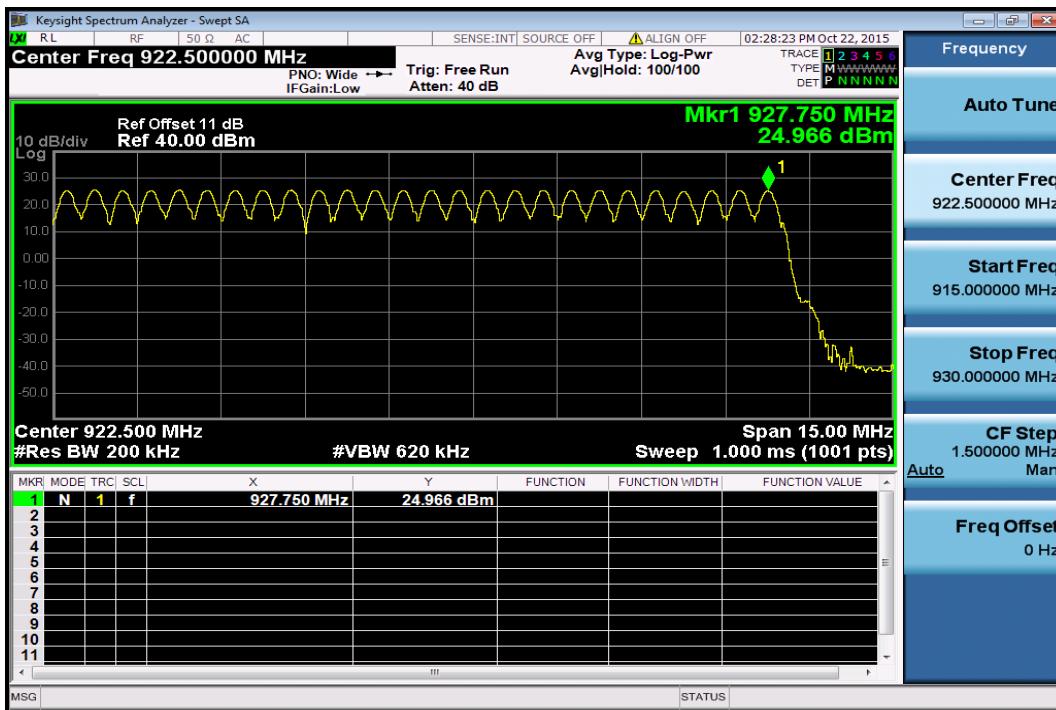
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Channel Number

900 MHz – 915 MHz



915 MHz – 930 MHz



Measurement Result: 52 Channels

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13. TIME OF OCCUPANCY (DWELL TIME)

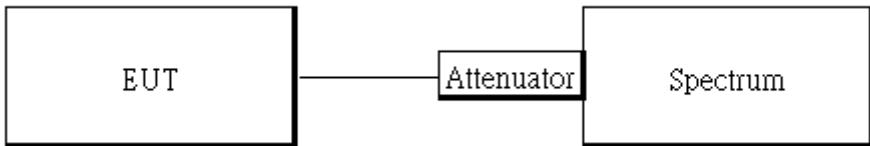
13.1. Standard Applicable

Frequency hopping systems operating in the 902MHz-928MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within a period of 20 seconds.

13.2. Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	E4446A	MY51100003	01/29/2015	01/28/2016
DC Block	Mini-Circuits	BLK-18-S+	1	01/02/2015	01/01/2016
Attenuator	Mini-Circuit	BW-S10W2+	002	01/02/2015	01/01/2016
Splitter	Agilent	11636B	N/A	01/02/2015	01/01/2016

13.3. Test Set-up:



13.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
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 center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW, VBW=100KHz, 300KHz, Span = 0Hz, Detector = Peak, Adjust Sweep = 50ms.
5. Repeat above procedures until all frequency of the interest measured were complete.

13.5. Tabular Result of the Measurement:

Number of transmission in a 20s	Length of transmission time (ms):	Measurement Result (ms):	Limit (ms):
22	10.15	223.3	400ms

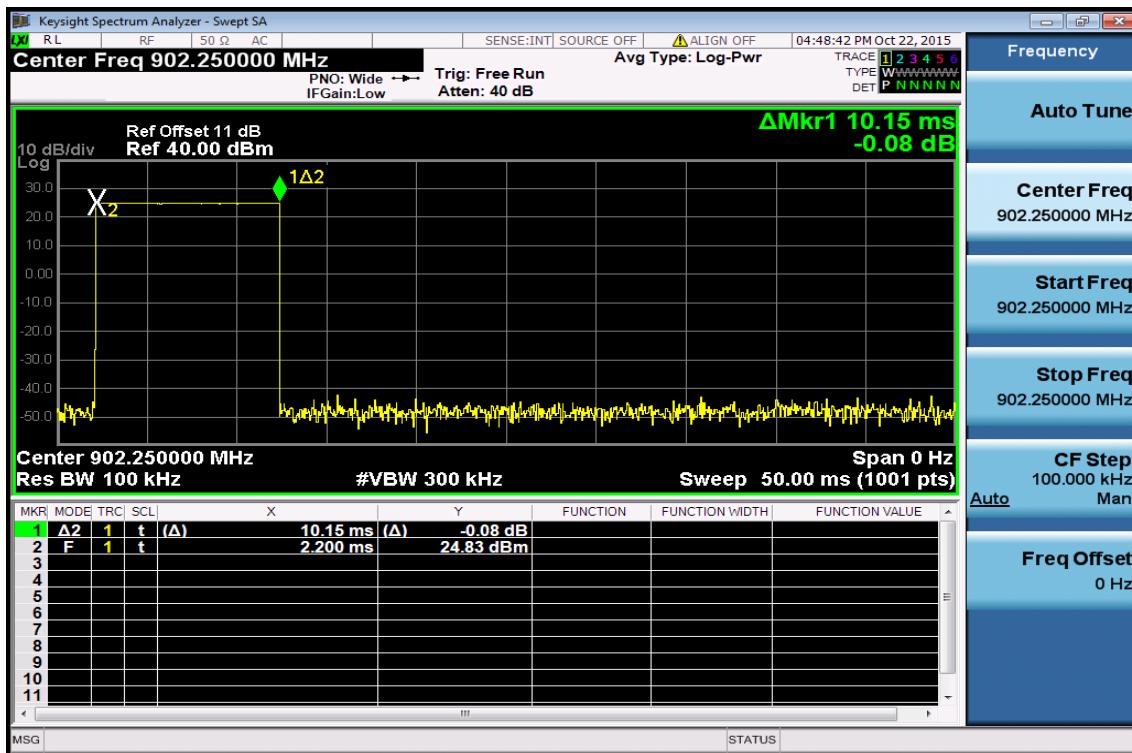
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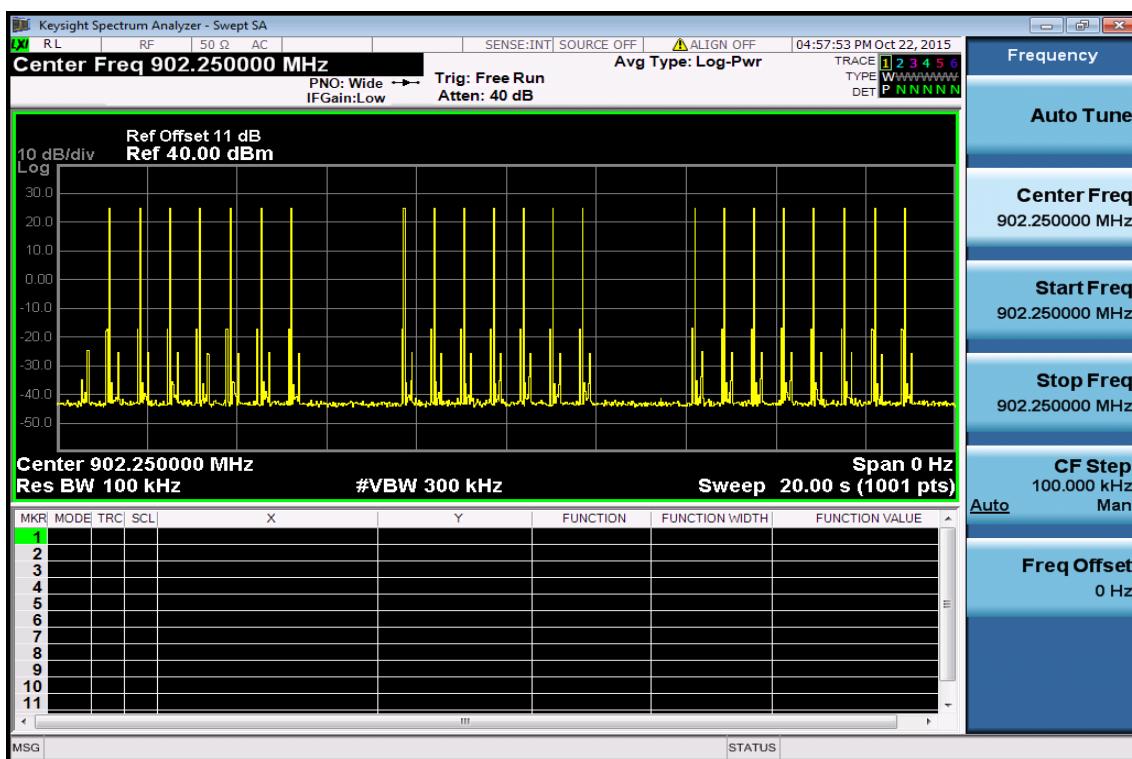
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13.6. Measurement Result:

Length of transmission time



Number of transmission in a 20s



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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.

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.

14.2. 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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