RF TEST REPORT

Test item	:	ESL Graphic TAG
Model No.	:	ST-GM29HG1
Order No.	:	DEMC1405-01813
Date of receipt	:	2014-05-14
Test duration	:	2014-05-26 ~ 2014-06-14
Date of issue	:	2014-09-23
Use of report	:	FCC Original Grant

Applicant : Samsung Electro Mechanics
314 Maetan-3 Dong Pal Dal-Ku Kyungki-Do, Suwon-City, Korea, 442-743

Test laboratory : DT&C Co., Ltd.
42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935

Test specification	:	FCC Part 15 Subpart C 247
Test environment	:	See appended test report
Test result	:	☒ Pass ☐ Fail

Tested by:

Engineer
OhHyun Kwon

Reviewed by:

Technical Manager
WonJung Lee

Test Report Version

Test Report No.	Date	Description
DRTFCC1409-1210	Sep. 23, 2014	Initial issue

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1. EUT DESCRIPTION

Product	ESL Graphic TAG
Model Name	ST-GM29HG1
Power Supply	DC 3.0V(Lithium Ion Battery)
Frequency Range	2405 ~ 2480MHz(16 channels)
Modulation Type	OQPSK(ZIGBEE)
Antenna Specification	Antenna Type: InternalAntenna Antenna Gain: 1.70 dBi(PK)

2. SUMMARY OF TESTS

FCC Part Section(s)	RSS Section(s)	Parameter	Limit	Test Condition	Status Note 1
I. Transmitter Mode (TX)					
15.247(a)	RSS-210 [A8.2]	6 dB Bandwidth	> 500 kHz	Conducted	**C**
15.247(b)	RSS-210 [A8.4]	Transmitter Output Power	< 1Watt		**C**
15.247(d)	RSS-210 [A8.5]	Out of Band Emissions / Band Edge	20dBc in any 100kHz BW		**C**
15.247(e)	RSS-210 [A8.2]	Transmitter Power Spectral Density	< 8dBm / 3kHz		**C**
-	RSS Gen [4.6.1]	Occupied Bandwidth (99%)	RSS-Gen(4.6.1)		**NA**
15.205 15.209	RSS-210 [A8.5]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	<FCC 15.209 limits	Radiated	**C**Note2
15.207	RSS-Gen [7.2.4]	AC Conducted Emissions	< FCC 15.207 limits	AC Line Conducted	**NA**Note3
15.203	-	Antenna Requirements	FCC 15.203	-	**C**

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable

Note 2: This test item was performed in each axis and the worst case data was reported.

Note 3: The power of this device is only DC(Not rechargeable Battery).

3. TEST METHODOLOGY

Generally the tests were performed according to the KDB558074 v03r02. And ANSI C63.10-2009 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing.

3.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet theCommissions requirement and operating in a manner that intends to maximize its emissioncharacteristics in a continuous normal application.

3.2 EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose ofthe measurements. According to its specifications, the EUT must comply with the requirements ofthe Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

3.3 General Test Procedures

Conducted Emissions

According to therequirements in Section 6.2 of ANSI C63.10, the EUT is placed on the turntable, which is 0.8 m above ground plane and the conducted emissions from theEUT are measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peakand Average detector.

Radiated Emissions

The EUT is placed on a turntable, which is 0.8 m above ground plane. The turntable shall rotate360 degrees to determine the position of maximum emission level. EUT is set 3 m away from thereceiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, eachemission was to be maximized by changing the polarization of receiving antenna both horizontaland vertical. In order to find out the highest emission, the relative positions of this hand-heldtransmitter (EUT) was rotated through three orthogonal axis according to the requirements inSection6.3 of ANSI C63.10

3.4 Description of Test Modes

The EUT has been tested withthe operating condition for maximizing the emission characteristics. Atest program is used to control the EUT forstaying in transmitting.

Test Mode	Channel	Frequency [MHz]
ZIGBEE	Lowest	2405
	Middle	2440
	Highest	2480

4. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, hasbeen calibrated in accordance with the manufacturer's recommendations for utilizing calibrationequipments, which is traceable to recognized national standards.

5. FACILITIES AND ACCREDITATIONS

5.1 Facilities

The open area test site(OATS) or semi anechoic chamber and conducted measurement facilityused to collect the radiated and conducted test data are located at the 38, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 449-935. The site is constructed in conformance with the requirements.

- Semi anechoic chamber registration Number:678747

5.2 Equipment

Radiated emissions are measured with one or more of the following types of Linearly polarizedantennas: tuned dipole, loop, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrumanalyzers with pre-selectors and peak, quasi-peak detectors are used to perform radiated measurements.
Conducted emissions are measured with Line Impedance Stabilization Networks and EMI TestReceivers.
Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are alsoused for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference MeasuringApparatus and Measurement Methods.”

6. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

“An intentional radiator antenna shall be designed to ensure that no antenna other than thatfurnished by the responsible party can be used with the device. The use of a permanently attachedantenna or of an antenna that uses a unique coupling to the intentional radiator shall beconsidered sufficientto comply with the provisions of this section.”

The antenna of this E.U.T is permanently attached using the soldering.

Therefore this E.U.T Complies with the requirement of §15.203

7. TEST RESULT

7.1 6dB Bandwidth

▣Test Requirements and limit, §15.247(a)&RSS-210[A8.2]

The minimum 6 dB band-width shall be at least 500 kHz.

▣Test Configuration

Refer to the APPENDIX I.

▣Test Procedure

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function.
When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

▣Test Results: *Comply*

Test Mode	Channel	Results [MHz]
ZIGBEE	Lowest	1.579
	Middle	1.575
	Highest	1.583

▣Result Plots

6 dB Bandwidth — Lowest channel

6 dB Bandwidth — Middle channel

6 dB Bandwidth Highest channel

7.2 Maximum Peak Conducted Output Power

▣ Test Requirements and limit, §15.247(b)&RSS-210[A8.4]

The maximum peak conducted power shall not exceed 1 Watt.

▣Test Configuration

Refer to the APPENDIX I.

▣TestProcedure

Maximum Peak Conducted Output Power is measured using the following procedure(RBW ≥ DTS bandwidth).

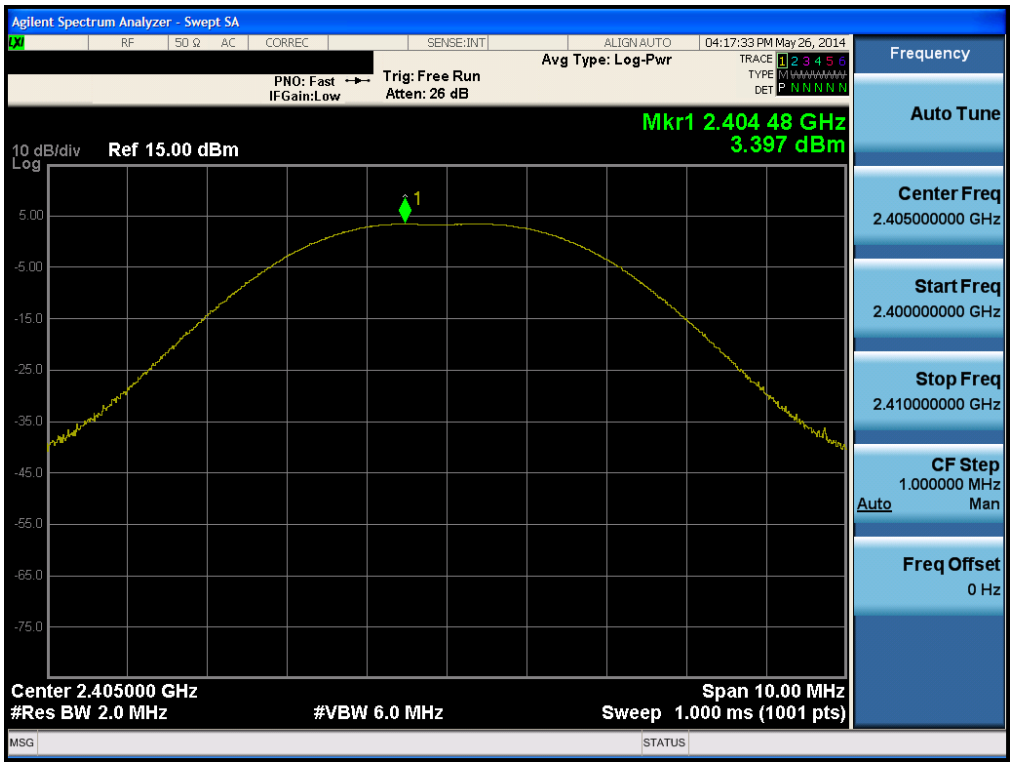
1. Set the RBW ≥ DTS bandwidth.
2. Set VBW ≥ 3 x RBW.
3. Set span ≥ 3 x RBW.
4. Sweep time = auto couple
5. Detector = peak
6. Trace mode = max hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

▣Test Results: *Comply*

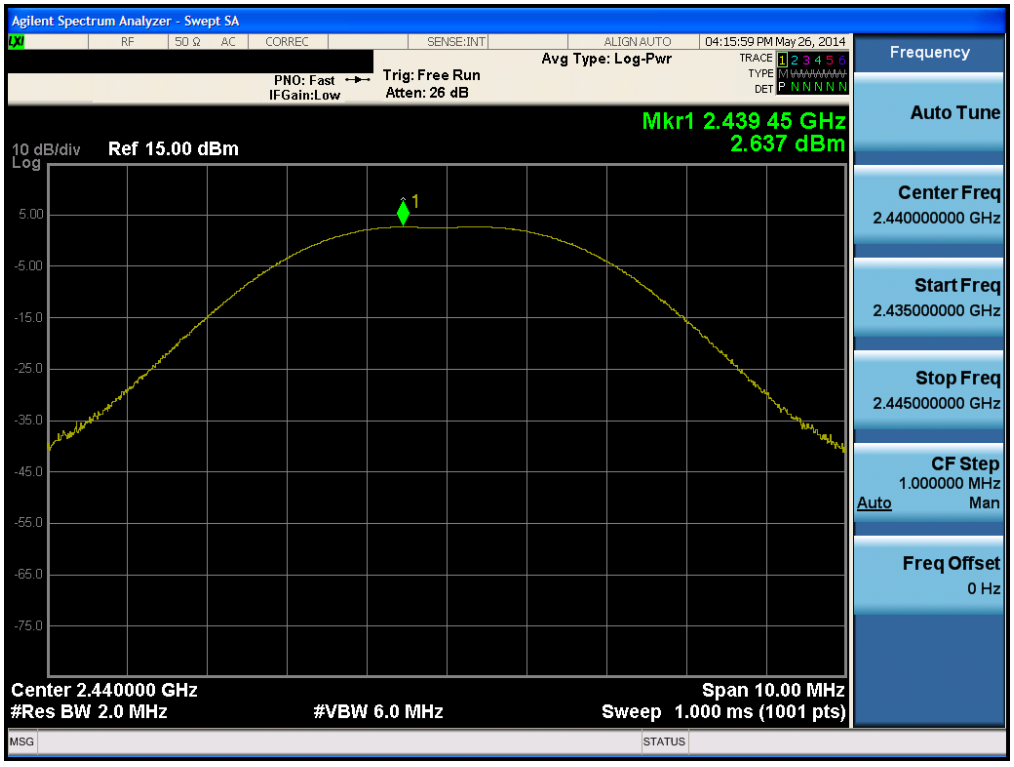
Test Mode	Channel	Results [dBm]
ZIGBEE	Lowest	3.397
	Middle	2.637
	Highest	**3.733**

▣Result Plots

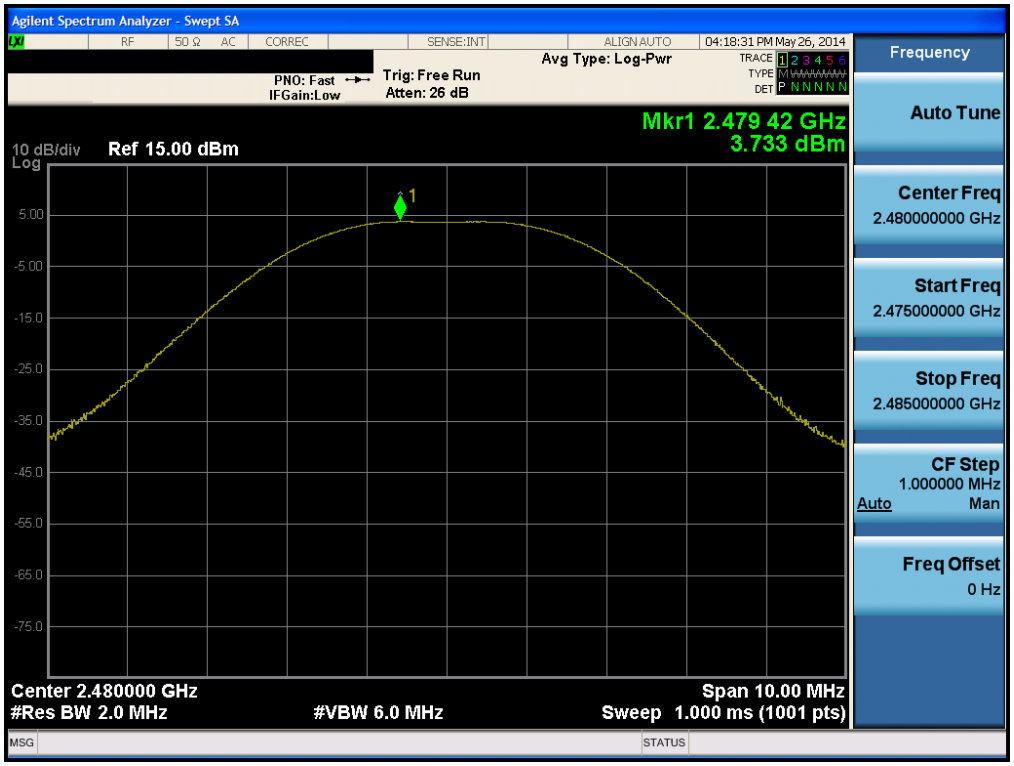
Maximum Peak Conducted Output Power Lowest channel



Maximum Peak Conducted Output Power Middle channel



Maximum Peak Conducted Output Power Highest channel



7.3 Maximum Power Spectral Density.

▣ Test requirements and limit, §15.247(e)&RSS-210[A8.2]

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

▣Test Configuration

Refer to the APPENDIX I.

▣Test Procedure

The power spectral densityis measured using the following procedure(PKPSD method).

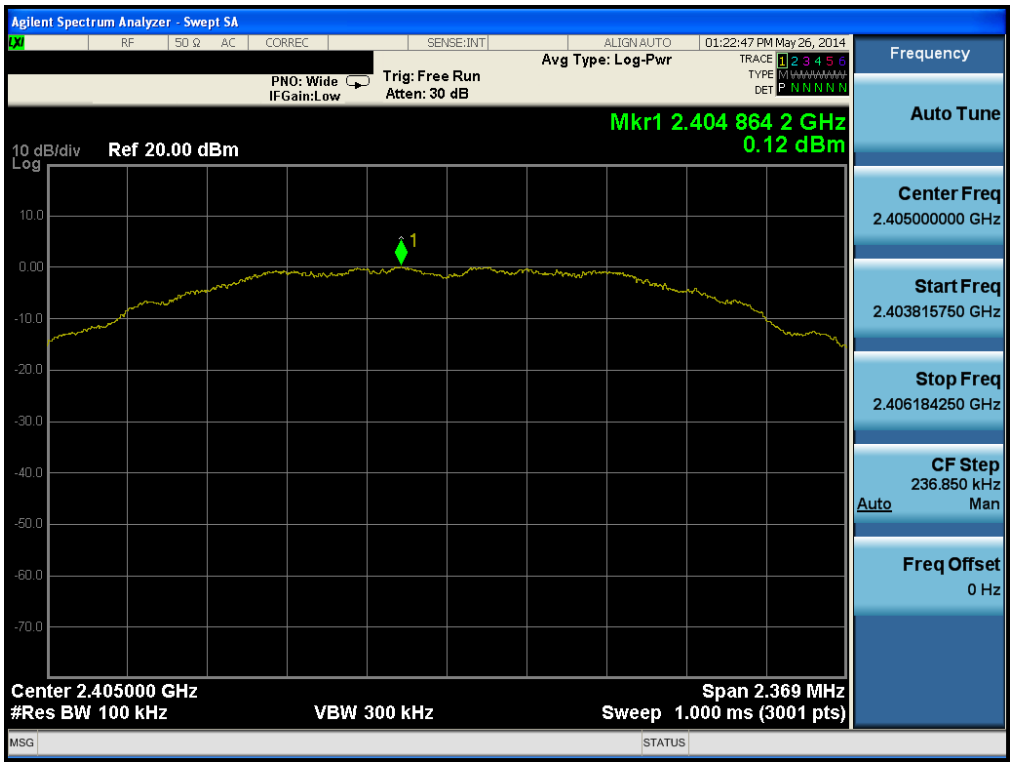
1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTSbandwidth.
3. Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

▣Test Results: *Comply*

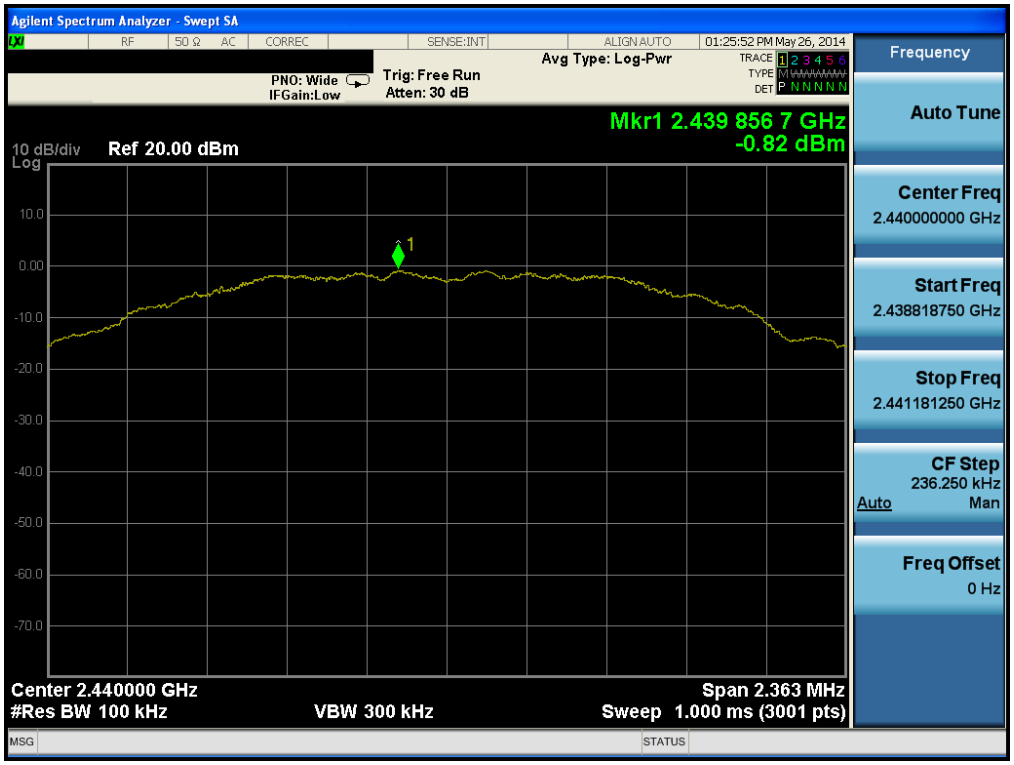
Test Mode	Channel	Result [dBm]
ZIGBEE	Lowest	0.12
	Middle	-0.82
	Highest	0.01

▣Result Plots

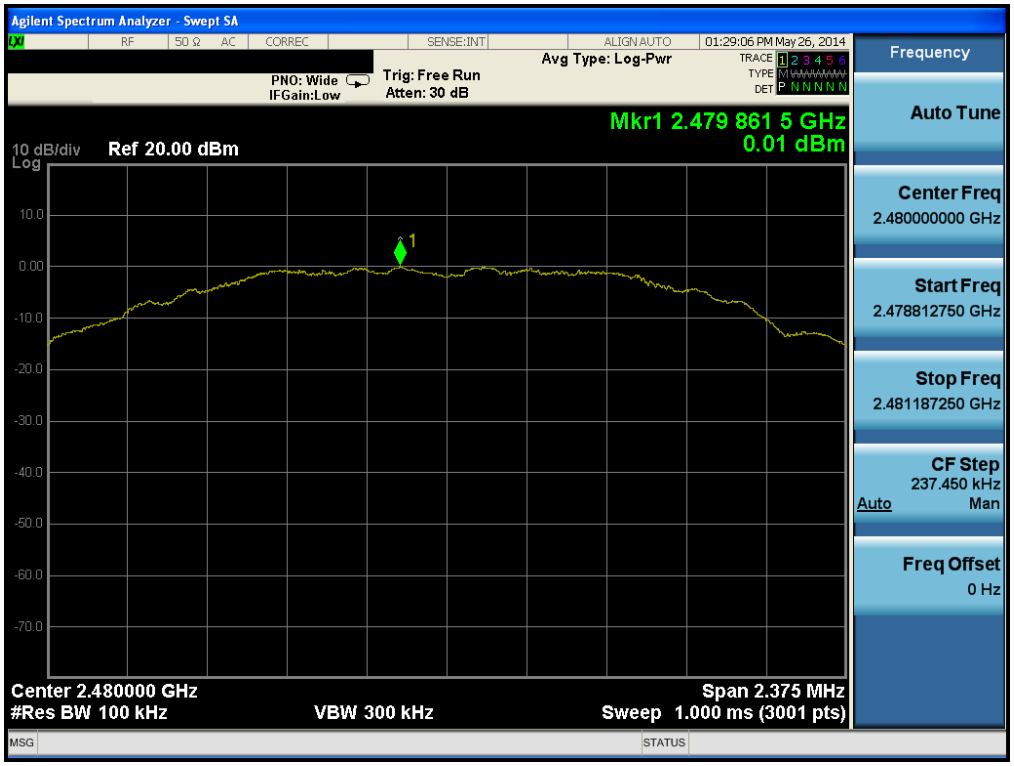
Maximum Power Spectral Density — Lowest channel



Maximum Power Spectral Density — Middle channel



Maximum Power Spectral Density Highest channel



7.4 Out of Band Emissions in non-restricted frequency band

▣ Test requirements and limit, §15.247(d)&RSS-210[A8.5]

If the maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc).

In either case, attenuation to levels below the 15.209 general radiated emissions limits is not required.

▣Test Configuration

Refer to the APPENDIX I.

▣Test Procedure

The transmitter output is connected to a spectrum analyzer.

▪Measurement Procedure 1 – Reference level measurement

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to ≥ 1.5 times the DTS bandwidth.
3. Set the RBW = 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum PSD level

▪Measurement Procedure 2– Emissions level measurement

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = 100 kHz(See below note for actual setting)
3. Set the VBW ≥3 x RBW (See below note for actual setting)
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow the trace to stabilize.
8. Use the peak marker function to determine the maximum amplitude level.

Note:This test item was tested with below settings.

- RBW= 100kHz, VBW= 300kHz for frequency range: 9 kHz ~ 30 MHz
- RBW= 1MHz, VBW= 3MHz for frequency range: 30 MHz ~ 10 GHz and 10 GHz~25 GHz

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.

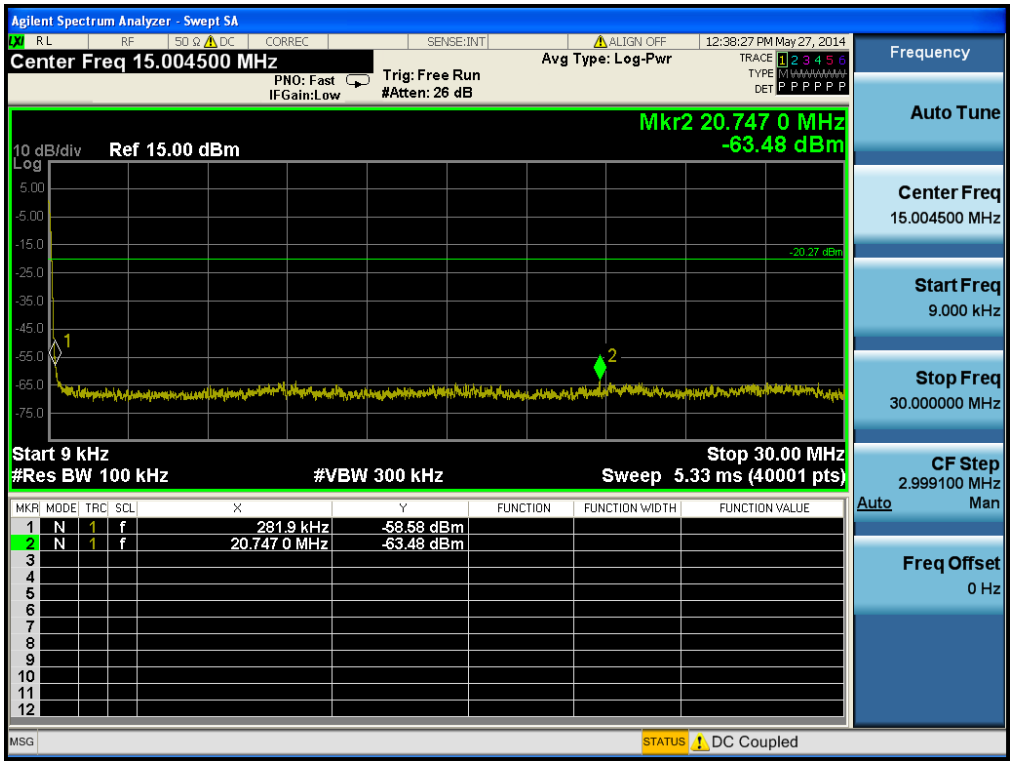
▣ Test Results: *Comply*

▣TestPlots

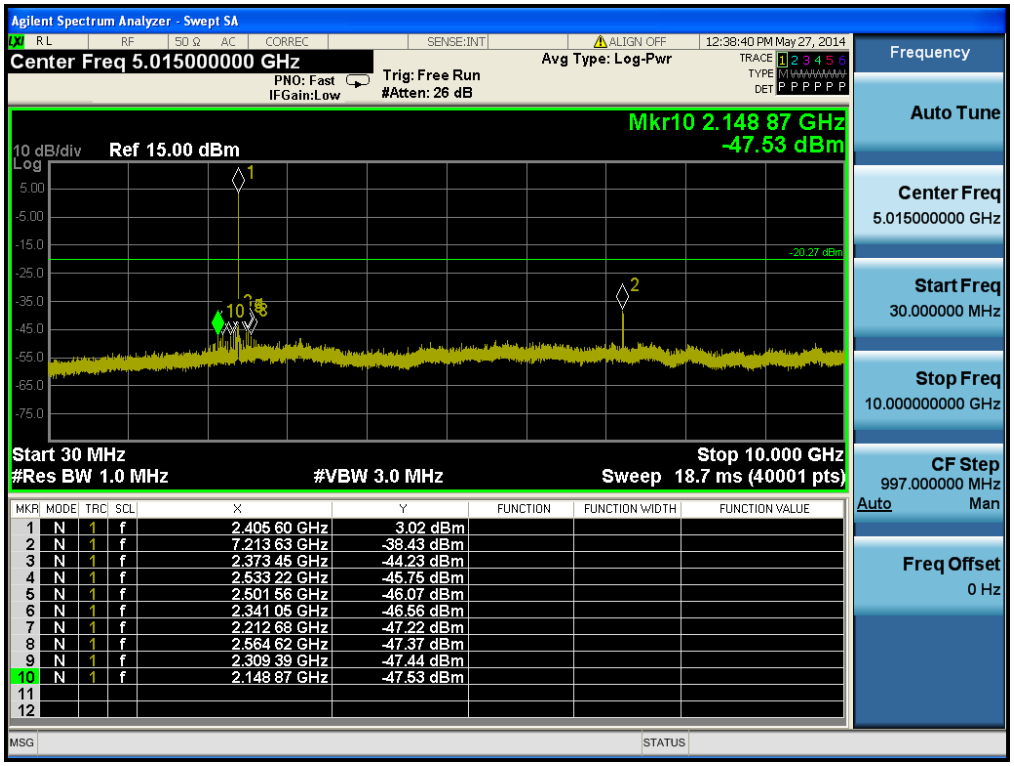
Lowest channel

Reference level measurement

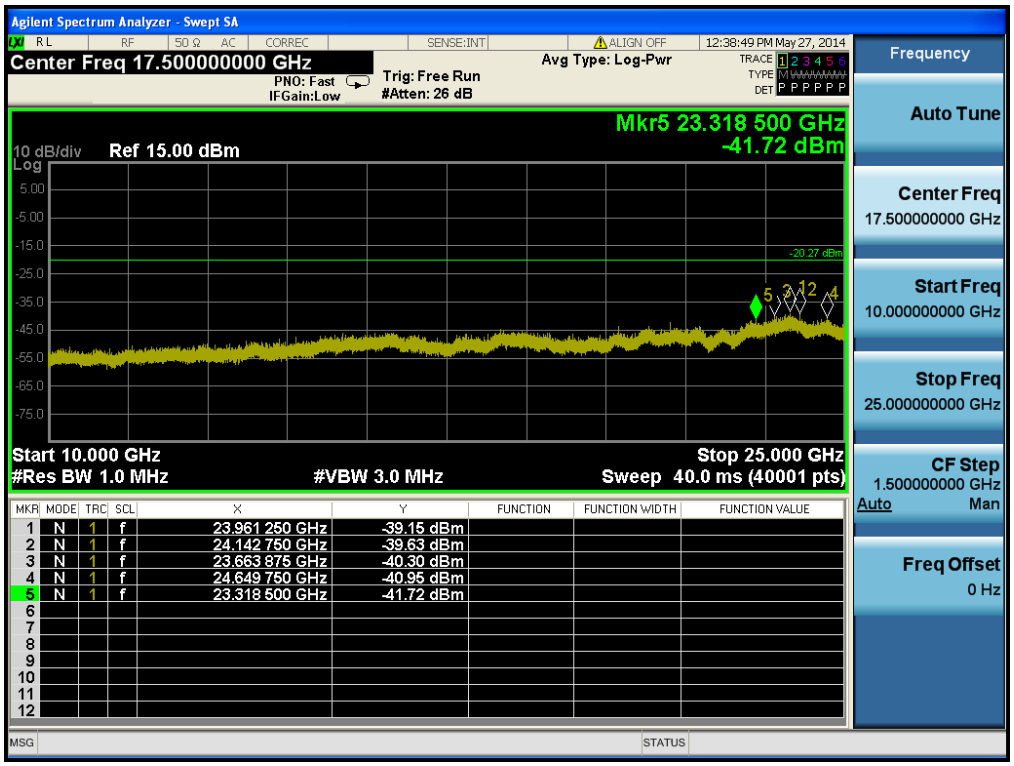
Emissions level measurement 1



Emissions level measurement 2

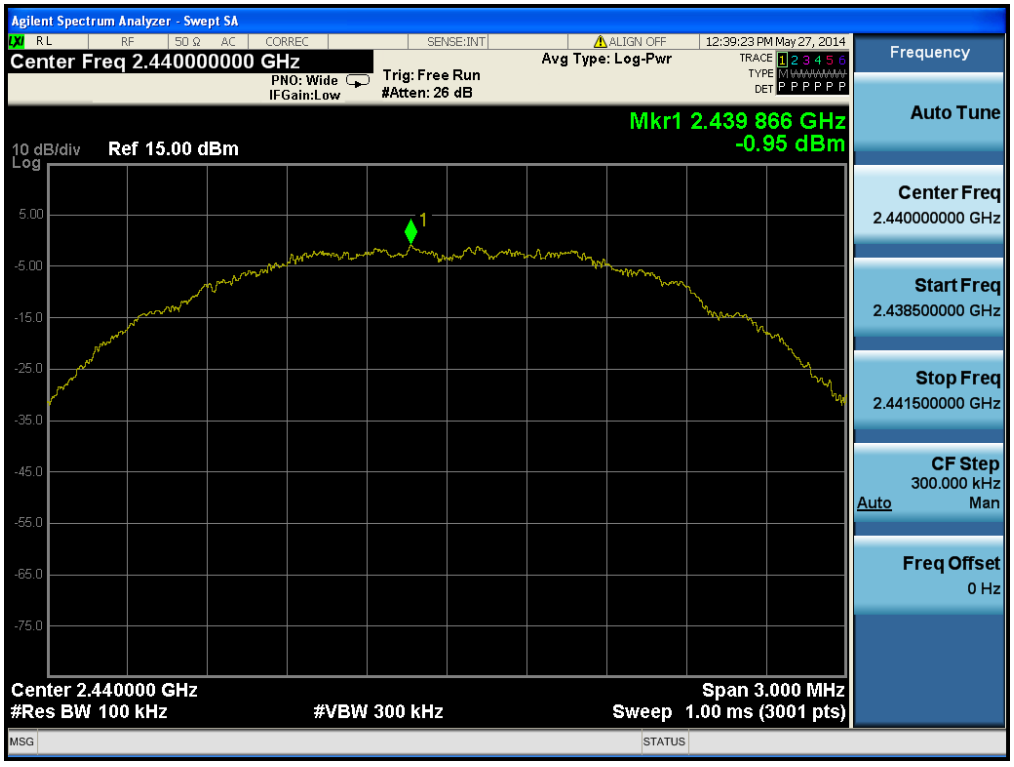


Emissions level measurement 3

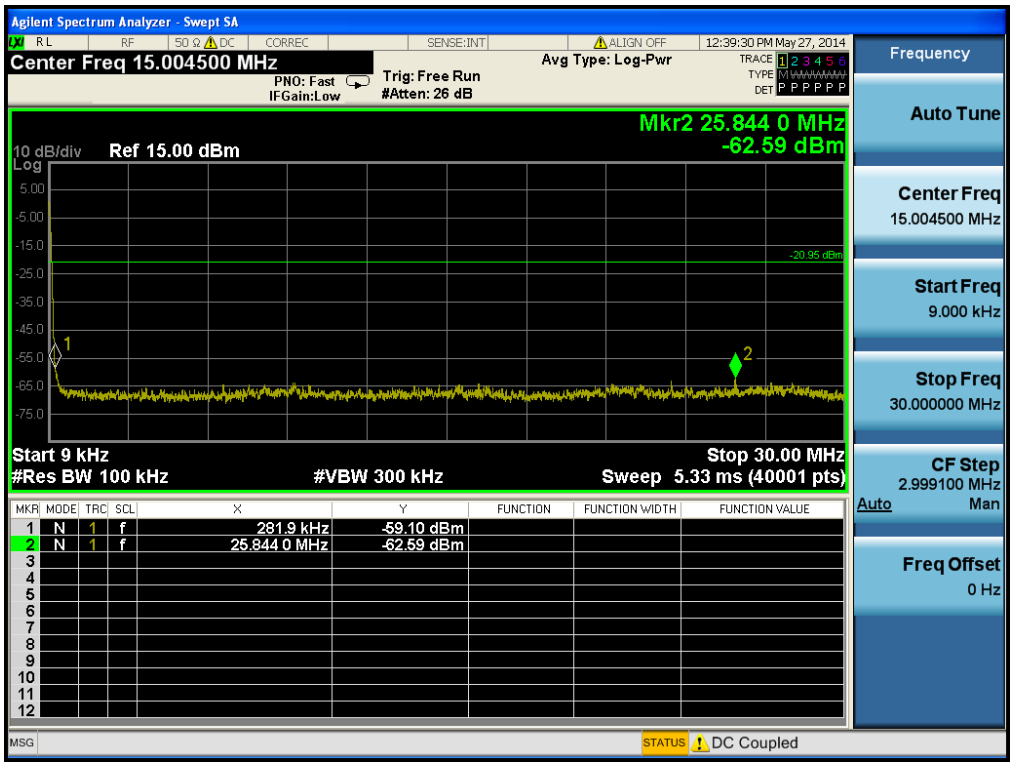


Middle channel

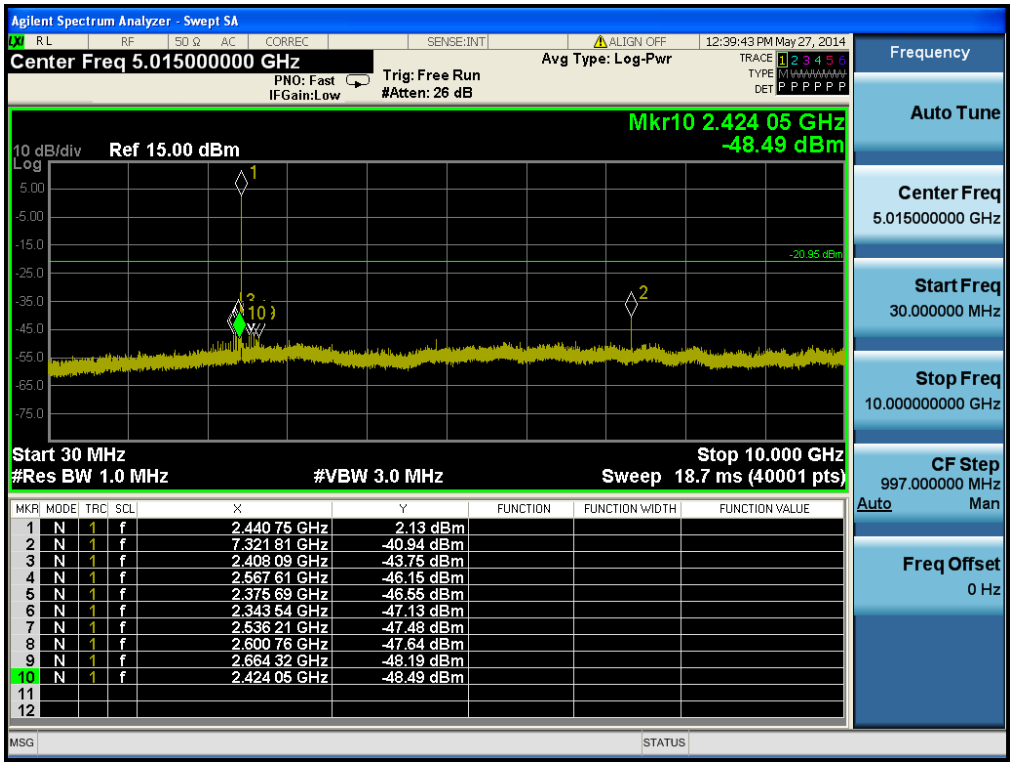
Reference level measurement



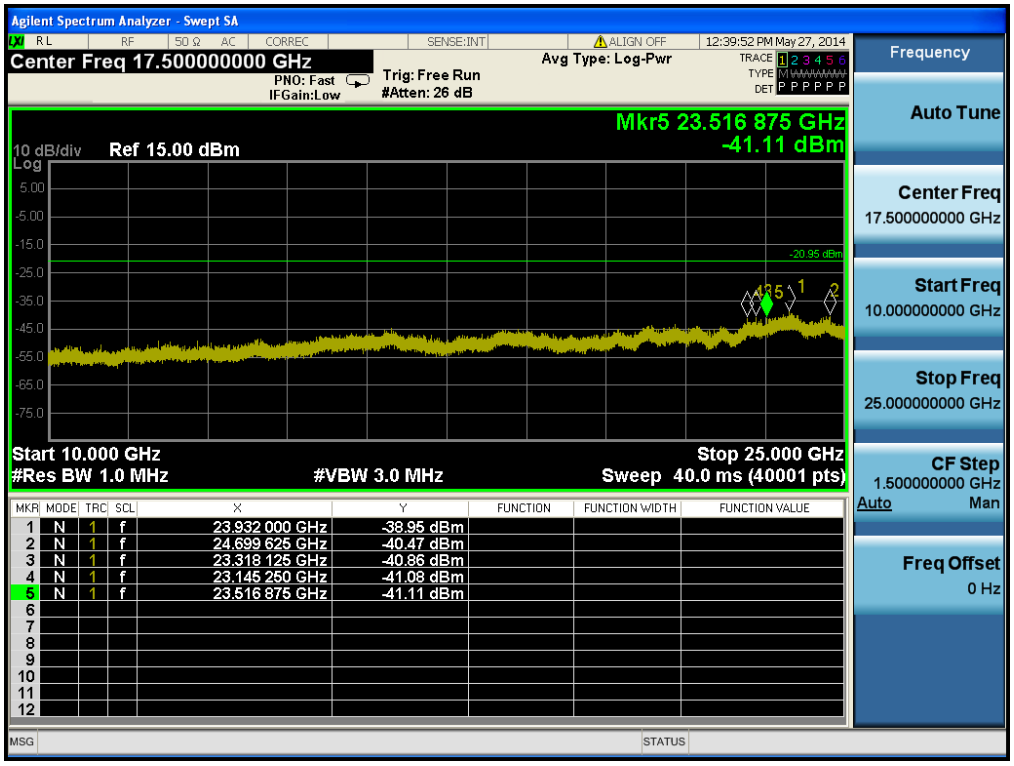
Emissions level measurement 1



Emissions level measurement 2

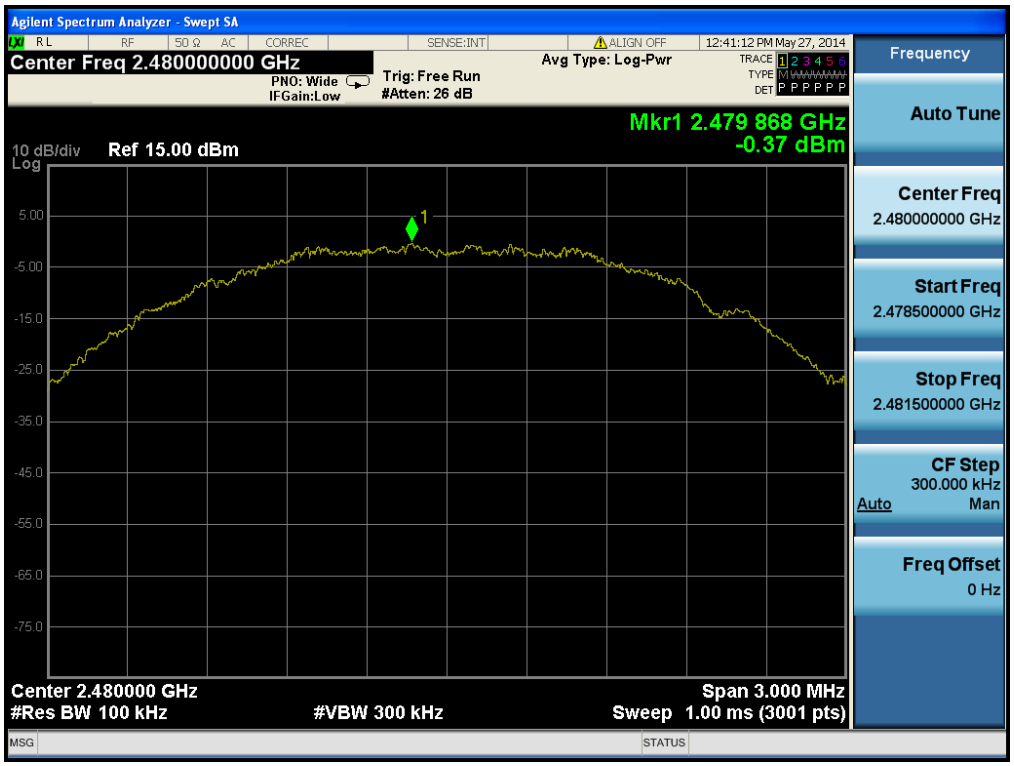


Emissions level measurement 3

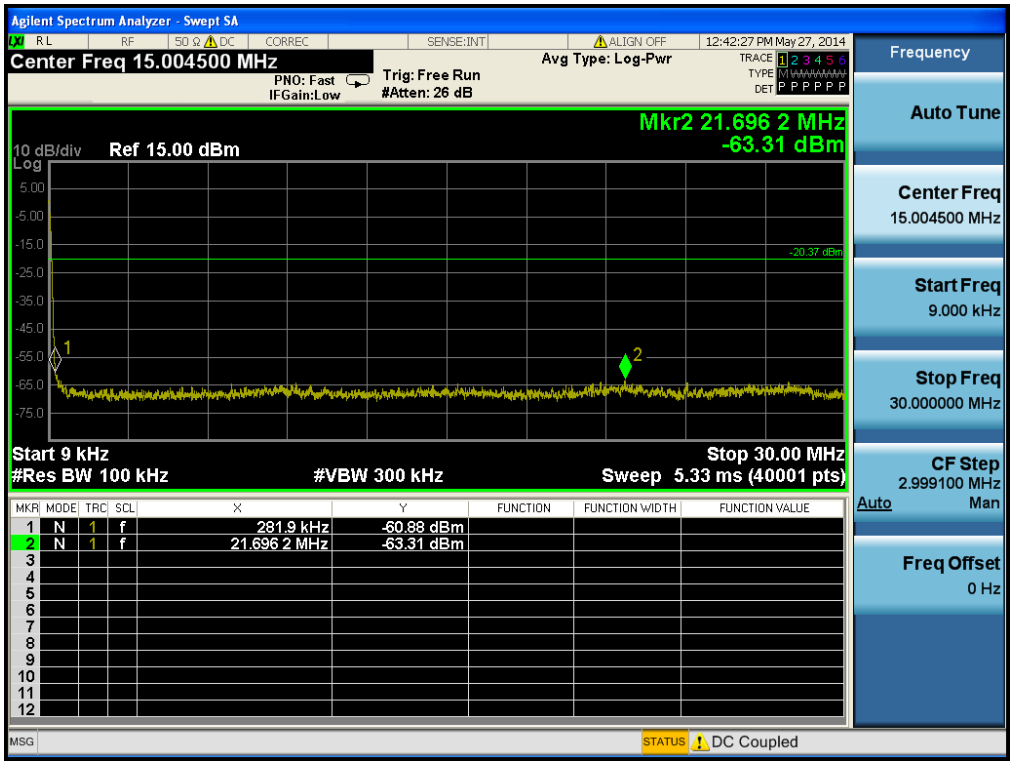


Highest channel

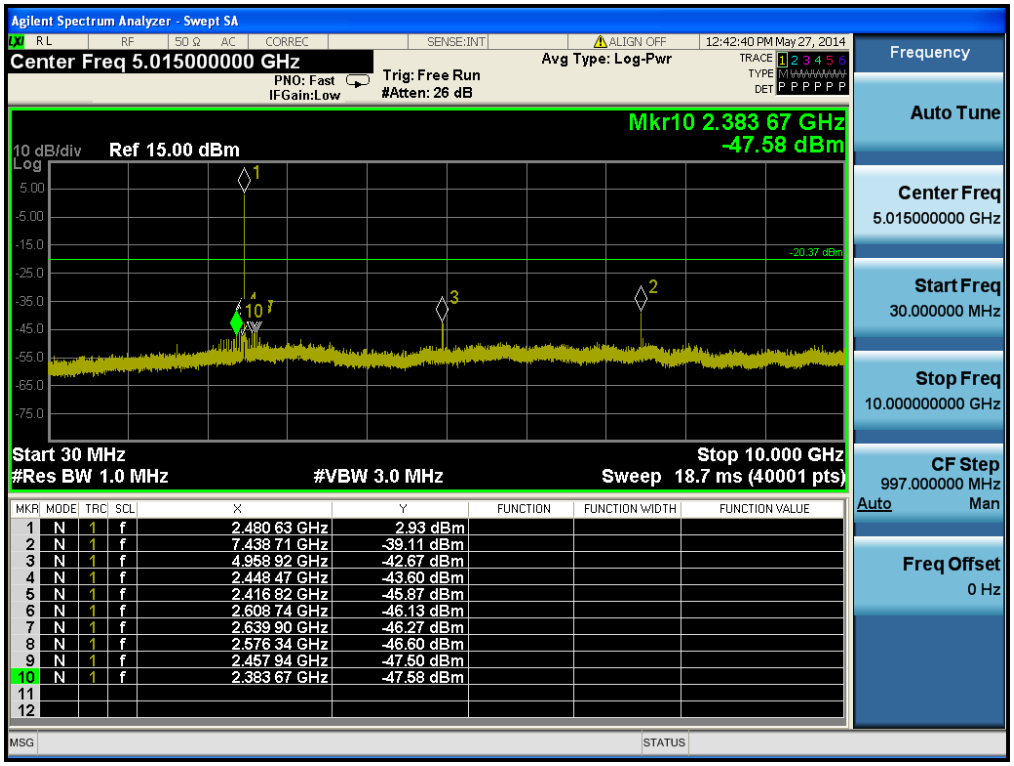
Reference level measurement



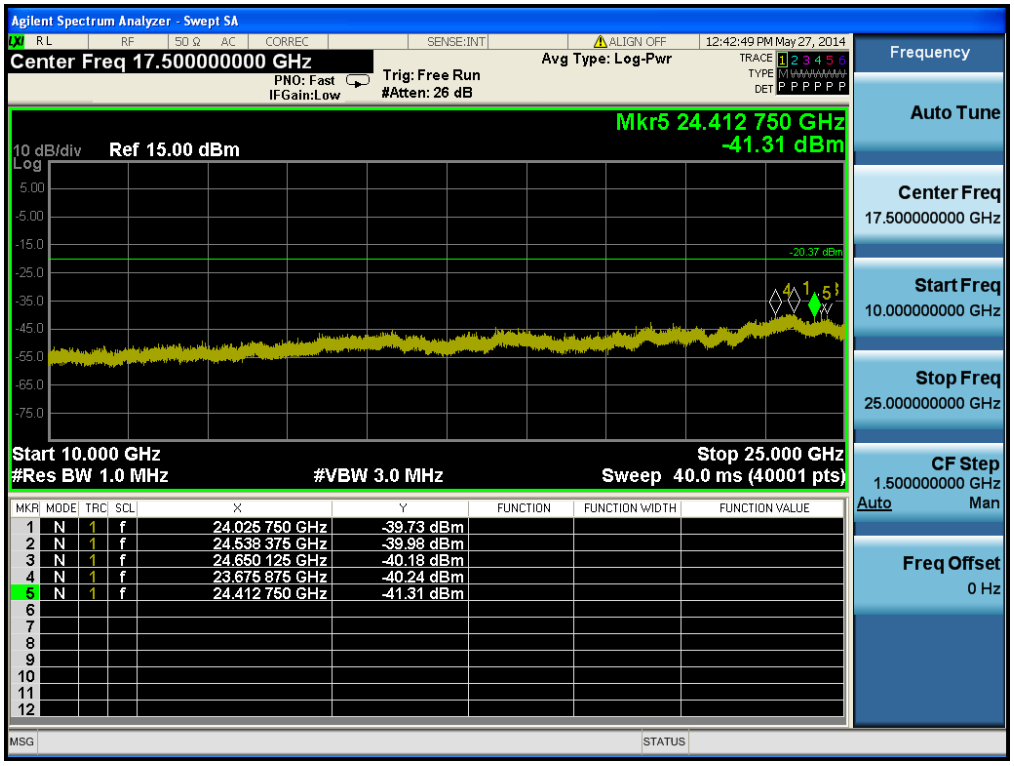
Emissions level measurement 1



Emissions level measurement 2



Emissions level measurement 3



7.5 Out of Band Emissions in restricted frequency band

▣Test Requirements and limit, §15.247(d)&RSS-210[A8.5]

In any 100kHz bandwidth outside the operating frequency band. In case the emissionfall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table belowhas to be followed

▪ **FCC Part 15.209(a) and (b)**

Frequency (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

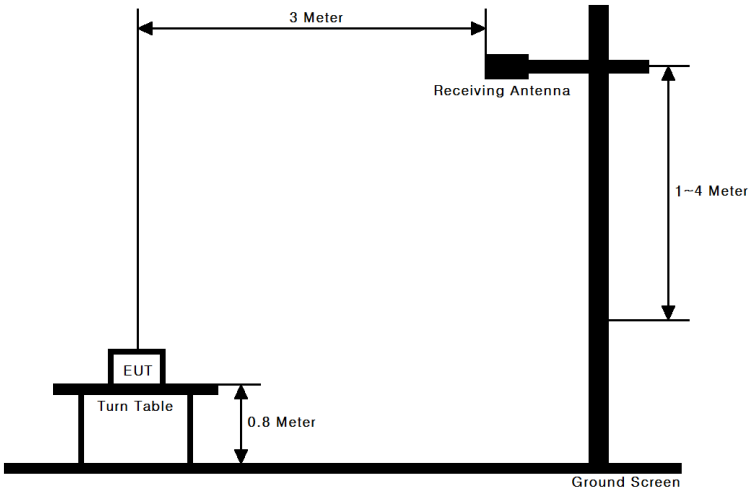
** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88MHz, 174-216MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

▪ **FCC Part 15.205 (a):** Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~ 12.52025	149.9 ~ 150.05	1645.5 ~ 1646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.57675 ~ 12.57725	156.52475 ~	1660 ~ 1710	8.025 ~ 8.5	22.01 ~ 23.12
4.17725 ~ 4.17775	13.36 ~ 13.41	156.52525	1718.8 ~ 1722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.20725 ~ 4.20775	16.42 ~ 16.423	156.7 ~ 156.9	2200 ~ 2300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	16.69475 ~ 16.69525	162.0125 ~ 167.17	2310 ~ 2390	10.6 ~ 12.7	36.43 ~ 36.5
6.26775 ~ 6.26825	16.80425 ~ 16.80475	167.72 ~ 173.2	2483.5 ~ 2500	13.25 ~ 13.4	Above 38.6
6.31175 ~ 6.31225	25.5 ~ 25.67	240 ~ 285	2655 ~ 2900		
8.291 ~ 8.294	37.5 ~ 38.25	322 ~ 335.4	3260 ~ 3267		
8.362 ~ 8.366	73 ~ 74.6	399.90 ~ 410	3332 ~ 3339		
8.37625 ~ 8.38675	74.8 ~ 75.2	608 ~ 614	3345.8 ~ 3358		
		960 ~ 1240	3600 ~ 4400		

▪ **FCC Part 15.205(b):** The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

▣Test Configuration



▣Test Procedure

1. The EUT is placed on a turntable, which is 0.8 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

Note: Measurement Instrument Setting for Radiated Emission Measurements.

Peak Measurement

- RBW = As specified in below table

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

- VBW ≥ 3 x RBW
- Sweep = Auto
- Detector = Peak
- Trace mode = Max Hold until the trace stabilizes.

▣ **TestResults:** ***Comply***

9 kHz ~ 25GHz Data

▪ Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2373.60	H	X	PK	55.97	1.89	N/A	57.86	74.00	16.14
2373.60	H	X	AV	N/A	N/A	-29.22	28.64	54.00	25.36
2373.60	V	Y	PK	56.14	1.89	N/A	58.03	74.00	15.97
2373.60	V	Y	AV	N/A	N/A	-29.22	28.81	54.00	25.19
4809.14	H	Z	PK	50.00	7.72	N/A	57.72	74.00	16.28
4809.14	H	Z	AV	N/A	N/A	-29.22	28.50	54.00	25.50
4810.76	V	Z	PK	51.53	7.72	N/A	59.25	74.00	14.75
4810.76	V	Z	AV	N/A	N/A	-29.22	30.03	54.00	23.97

▪ Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4879.32	H	Z	PK	48.20	7.94	N/A	56.14	74.00	17.86
4879.32	H	Z	AV	N/A	N/A	-29.22	26.92	54.00	27.08
4880.98	V	Z	PK	53.17	7.95	N/A	61.12	74.00	12.88
4880.98	V	Z	AV	N/A	N/A	-29.22	31.90	54.00	22.10

▪ Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCF	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.69	H	X	PK	57.38	2.19	N/A	59.57	74.00	14.43
2483.69	H	X	AV	N/A	N/A	-29.22	30.35	54.00	23.65
2483.50	V	Y	PK	60.07	2.19	N/A	62.26	74.00	11.74
2483.50	V	Y	AV	N/A	N/A	-29.22	33.04	54.00	20.96
4959.26	H	Z	PK	44.58	8.20	N/A	52.78	74.00	21.22
4959.26	H	Z	AV	N/A	N/A	-29.22	23.56	54.00	30.44
4959.60	V	Z	PK	45.73	8.20	N/A	53.93	74.00	20.07
4959.60	V	Z	AV	N/A	N/A	-29.22	24.71	54.00	29.29

Note.

1.No other spurious and harmonic emissions were reported greater than listed emissions above table.

2.Sample Calculation for PK result

Margin = Limit – Result / Result = Reading + T.F / T.F = AF + CL – AG

Where, T.F = Total Factor / AF = Antenna Factor / CL = Cable Loss

AG = Amplifier Gain

3. The AV result was calculated using a duty correction factor(DCF).

And the Duty cycle information is declared from applicant.

DCF = 20log(t/100ms), t = sum of the individual on-time in 100ms

20log(3.46ms/100ms) = - 29.22dB

AV result = PK result + DCF

7.6AC Power-line Conducted Emissions

▣Test Requirements and limit, §15.207&RSS-Gen[7.2.2]

For an intentional radiator which is designed to be connected to the public utility (AC) power line,the radio frequency voltage that is conducted back onto the AC power line on any frequency orfrequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

▣Test Configuration

See test photographs for the actual connections between EUT and support equipment.

▣Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference groundplane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained using quasi-peak and average detector mode.

▣Test Results: N/A

7.7Occupied Bandwidth

▣Test Requirements, RSS-Gen [4.6.1]

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

▣Test Configuration

Refer to the APPENDIX I.

▣Test Procedure

The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%.
The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted.
Where practical,a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

▣Test Results: N/A

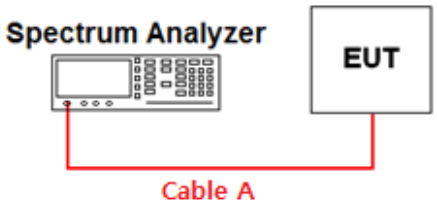
8. LIST OF TEST EQUIPMENT

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	N9020A	14/05/09	15/05/09	MY50200666
Digital Multimeter	H.P	34401A	14/02/27	15/02/27	3146A13475
Vector Signal Generator	Rohde Schwarz	SMBV100A	14/01/07	15/01/07	255571
Signal Generator	Rohde Schwarz	SMF100A	13/07/22	14/07/22	102341
Thermo hygrometer	BODYCOM	BJ5478	14/05/13	15/05/13	120612-1
DC Power Supply	SM techno	SDP30-5D	14/05/13	15/05/13	305DKA013
High-pass filter	Wainwright	WHKX3.0	13/09/12	14/09/12	9
LOOP Antenna	Schwarzbeck	FMZB1513	14/04/29	16/04/29	1513-128
BILOG ANTENNA	SCHAFFNER	CBL6112B	12/11/06	14/11/06	2737
Horn Antenna	ETS-LINDGREN	3117	14/05/12	16/05/12	00140394
HORN ANT	A.H.Systems	SAS-574	13/03/20	15/03/20	154
Amplifier (22dB)	H.P	8447E	14/01/07	15/01/07	2945A02865
Amplifier (30dB)	Agilent	8449B	14/02/27	15/02/27	3008A00370
EMI TEST RECEIVER	Rohde Schwarz	ESU	14/01/08	15/01/08	100014
EMI TEST RECEIVER	ROHDE&SCHWARZ	ESR	14/02/07	15/02/07	101767
CVCF	NF	4420	14/02/28	15/02/28	3049354420023
LISN	R&S	ESH2-Z5	13/09/12	14/09/12	828739/006

APPENDIX I

Conducted Test set up Diagram&Path lossInformation

▪Conducted Measurement



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	0.09	5	0.59
1	0.18	10	1.67
2.405	0.31	15	1.84
2.440	0.39	20	2.30
2.480	0.42	25	2.96

Note. 1: The path loss from EUT to Spectrum analyzer was measured and used for test.