HCT CO.,LTD
74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea
TEL: +82-31-645-6300 FAX: +82-31-645-6401

FCC/IC BT LE REPORT

FCC/IC Certification

Applicant Name:
LG Electronics Inc.

Address:
222 LG-ro Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do
451-713, Korea

Date of Issue:
September 25, 2015
Test Site/Location:
HCT CO., LTD., 74,Seoicheon-ro 578beon-gil, Majang-myeo, Icheon-si, Gyeonggi-do,of KOREA
Report No.: HCT-R-1508-F020-1
HCT FRN: 0005866421
IC Recognition No.: 5944A-5

FCC ID	**: BEJLGSBWAC61**
IC	**: 2703H-LGSBWAC61**
APPLICANT	**: LG Electronics Inc.**

FCC/IC Model(s):	LGSBWAC61
EUT Type:	RF Module
Peak RF Output Power:	6.005 dBm (3.986 mW)
Frequency Range:	2402 MHz -2480 MHz
Modulation type	GFSK
FCC Classification:	Digital Transmission System(DTS)
FCC Rule Part(s):	Part 15.247
IC Rule Part(s):	RSS-GEN Issue 4 (November 2014), RSS-247 Issue 1 (May 2015)

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

Report prepared by
: Kyung Soo Kang
Test Engineer of RF Team

Approved by
: Sang Jun Lee
Manager of RF Team

This report only responds to the tested sample and may not be reproduced, except in full, without written approval of the HCT Co., Ltd.

Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-R-1508-F020	September 02, 2015	- First Approval Report
HCT-R-1508-F020-1	September 25, 2015	- Revised RF output power on page 1, 4.

Table of Contents

1. GENERAL INFORMATION 4
2. EUT DESCRIPTION 4
3. TEST METHODOLOGY 5
   3.1 EUT CONFIGURATION 5
   3.2 EUT EXERCISE 5
   3.3 GENERAL TEST PROCEDURES 5
   3.4 DESCRIPTION OF TEST MODES 5
4. INSTRUMENT CALIBRATION 6
5. FACILITIES AND ACCREDITATIONS 6
   5.1 FACILITIES 6
   5.2 EQUIPMENT 6
6. ANTENNA REQUIREMENTS 6
7. SUMMARY TEST OF RESULTS 7
   7.1 FCC Part 7
   7.2 IC Part 8
8. TEST RESULT 9
   8.1 DUTY CYCLE 9
   8.2 6dB BANDWIDTH MEASUREMENT 11
   8.3 99% BANDWIDTH 14
   8.4 OUTPUT POWER MEASUREMENT 18
   8.4 POWER SPECTRAL DENSITY 25
   8.5 OUT OF BAND EMISSIONS AT THE BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS 29
   8.6 RADIATED MEASUREMENT. 40
      8.6.1 RADIATED SPURIOUS EMISSIONS. 40
      8.6.2 RECEIVER SPURIOUS EMISSIONS 49
      8.6.3 RADIATED RESTRICTED BAND EDGES 50
   8.7 POWERLINE CONDUCTED EMISSIONS 52
9. LIST OF TEST EQUIPMENT 57
   9.1 LIST OF TEST EQUIPMENT(Conducted Test) 57
   9.2 LIST OF TEST EQUIPMENT(Radiated Test) 58

1. GENERAL INFORMATION

Applicant:	LG Electronics Inc.
Address:	222, LG-ro, Jinwi-myeon, Pyeongtaek-si, 451-713 Gyeonggi-do, South Korea
FCC ID:	BEJLGSBWAC61
IC:	2703H-LGWBWAC61
EUT Type:	RF Module
Model name(s):	LGSBWAC61
Date(s) of Tests:	July 21, 2015 ~ August 28, 2015 (Conducted Test) July 27, 2015 ~ August 28, 2015 (Radiated Test)
Place of Tests:	HCT CO., LTD., 74,Seoicheon-ro 578beon-gil, Majang-myeo,Icheon-si, Gyeonggi-do,17383, Rep. of KOREA

2. EUT DESCRIPTION

FCC/IC Model Name	LGSBWAC61	
EUT Type	RF Module	
Power Supply	DC 3.3 V	
Frequency Range	TX: 2402 MHz ~ 2480 MHz RX: 2402 MHz ~ 2480 MHz	
Max. RF Output Power	Peak	6.005 dBm (3.986 mW)
	Average	5.731 dBm (3.742 mW)
BT Operating Mode	BT _Low Energy Mode	
Modulation Type	GFSK	
Number of Channels	40 Channels	
Antenna Specification	Manufacturer: LG Innotek Co.,Ltd. Antenna type: PCB Antenna Peak Gain : 0.31 dBi	

3. TEST METHODOLOGY

FCC KDB 558074 D01 DTS Meas Guidance v03r03 dated June 09, 2015 entitled “Guidance for Performing Compliance Measurements on Digital Transmission Systems(DTS) and the measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) Operating Under §15.247” were used in the measurement.

3.1 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics 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 of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

3.3 GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m 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 according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

Conducted Antenna Terminal

See Section from 9.1 to 9.2.(KDB 558074)

3.4 DESCRIPTION OF TEST MODES

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

Channel low, mid and high with highest data rate (worst case) is chosen for full testing.

4. INSTRUMENT CALIBRATION

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

5. FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated July 07, 2015 (Registration Number: 90661)

5.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus 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 that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

* The antennas of this E.U.T are permanently attached.

*The E.U.T Complies with the requirement of §15.203

7. SUMMARY TEST OF RESULTS

7.1 FCC Part

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	> 500 kHz	CONDUCTED	PASS
Conducted Maximum Peak Output Power	§15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§15.247(e)	< 8 dBm / 3 kHz Band		PASS
Band Edge(Out of Band Emissions)	§15.247(d)	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§15.207	cf. Section 8.7		PASS
Radiated Spurious Emissions	§15.205, 15.209	cf. Section 8.6.1	RADIATED	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	cf. Section 8.6.2		PASS

7.2 IC Part

Test Description	IC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	RSS-247, 5.2	> 500 kHz	CONDUCTED	PASS
99% Bandwidth	RSS-GEN, 6.6	NA		NA
Conducted Maximum Peak Output Power And e.i.r.p.	RSS-247, 5.4.4	< 1 Watt <4 Watt(e.i.r.p.)		PASS
Power Spectral Density	RSS-247, 5.2	< 8 dBm / 3 kHz Band		PASS
Band Edge(Out of Band Emissions)	RSS-247, 5.5	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	RSS-GEN, 8.8	RSS-GEN section 8.8 table 3		PASS
Radiated Spurious Emissions	RSS-GEN, 8.9	RSS-GEN section 8.9 table 4, 5	RADIATED	PASS
Receiver Spurious Emissions	RSS-GEN, 5 RSS-GEN, 7.1.2	RSS-GEN section 7.1.2 table 2		PASS
Radiated Restricted Band Edge	RSS-GEN, 8.10	RSS-GEN section 8.10 table 6		PASS

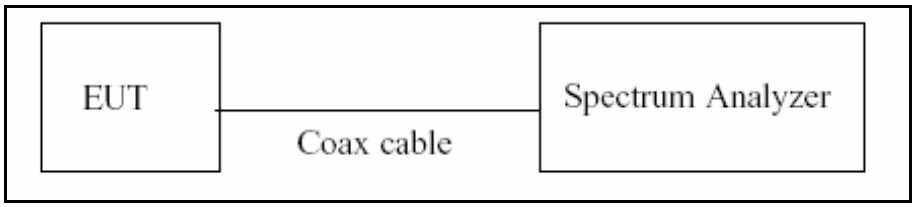
8. TEST RESULT

8.1 DUTY CYCLE

▣ TEST PROCEDURE

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We tested accroding to the zero-span measurement method, 6.0)b) in KDB 558074(issued 06/09/2015)

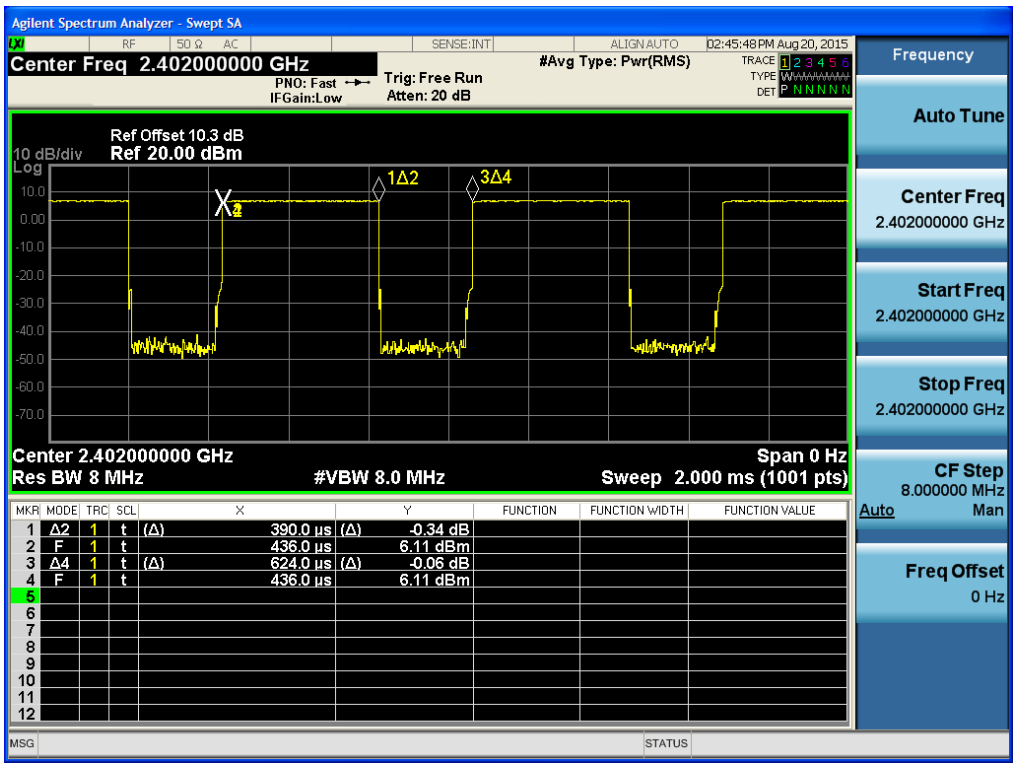
The largest availble value of RBW is 8 MHz and VBW is 50 MHz. The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

1. RBW = 8 MHz (the largest availble value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10*log(1/Duty Cycle)

LE Mode	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor
	0.3900	0.6240	0.6250	2.04

▣ RESULT PLOTS



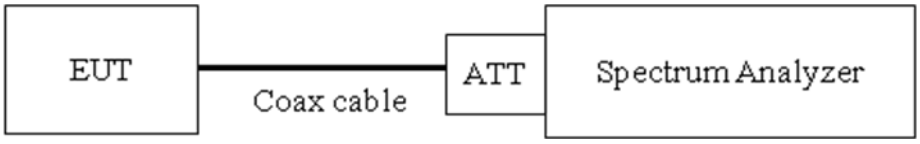
8.2 6dB BANDWIDTH MEASUREMENT

Test Requirements and limit, §15.247(a)(2) / RSS-247, 5.2

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6dB bandwidth is 500 kHz.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.1 in KDB 558074, issued 06/09/2015)

RBW = 100 kHz

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

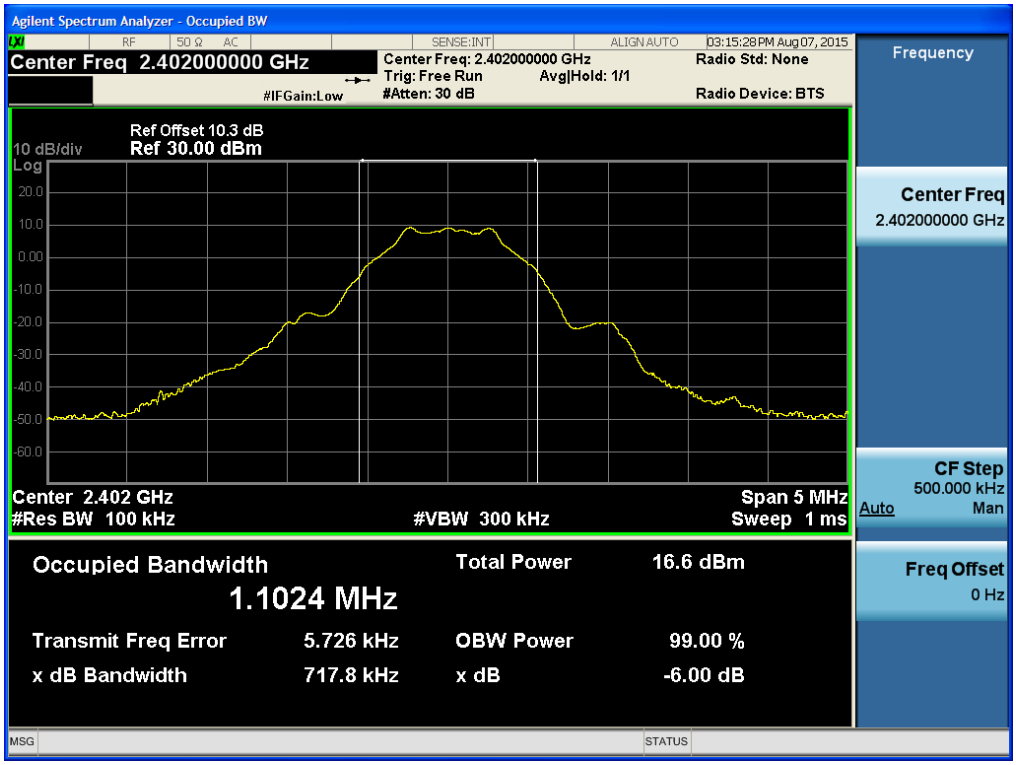
Sweep = auto couple

Allow the trace to stabilize

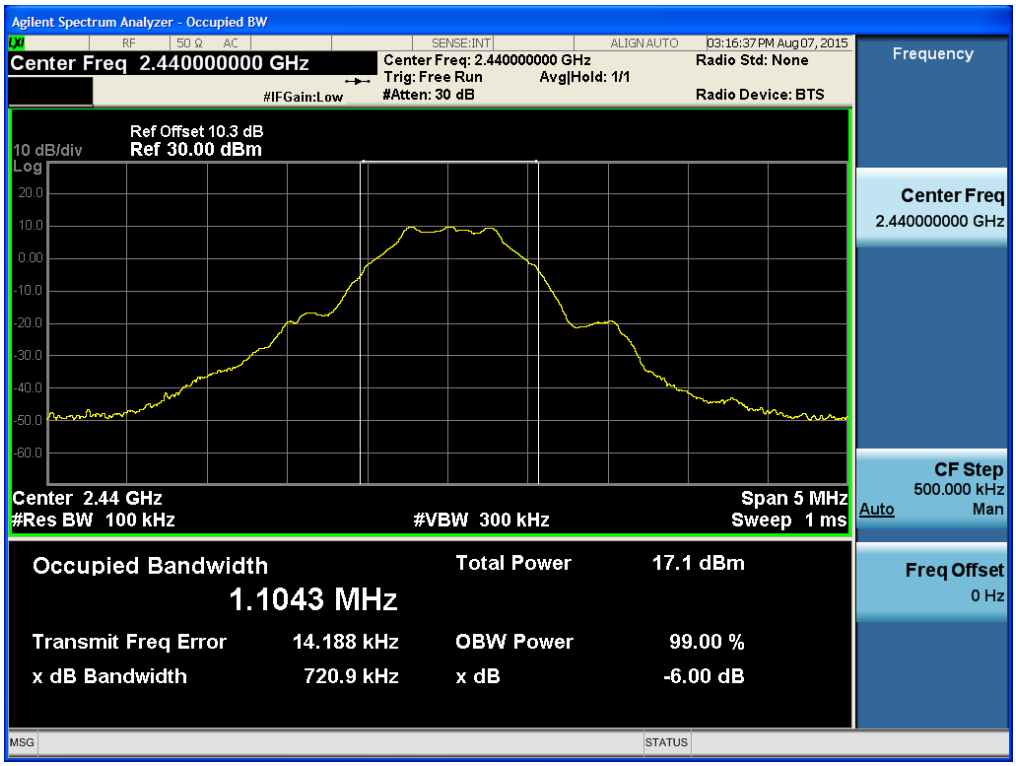
Note : We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

▣ RESULT PLOTS

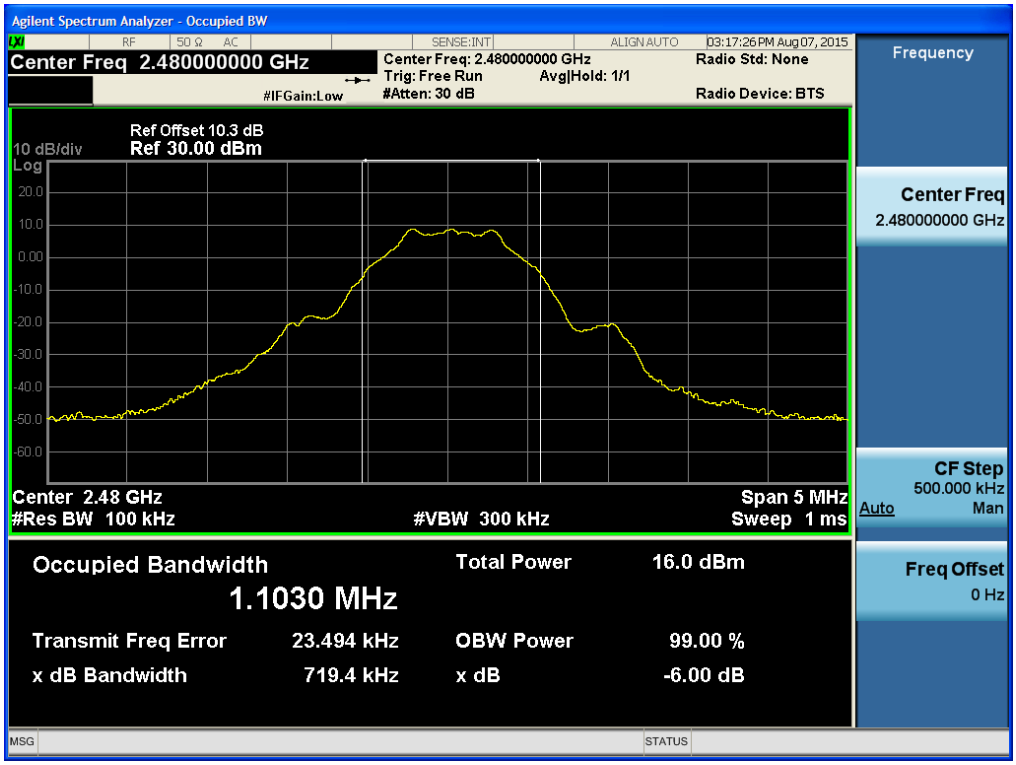
6dB Bandwidth plot (Low-CH 0)



6dB Bandwidth plot (Mid-CH 19)



6dB Bandwidth plot (High-CH 39)

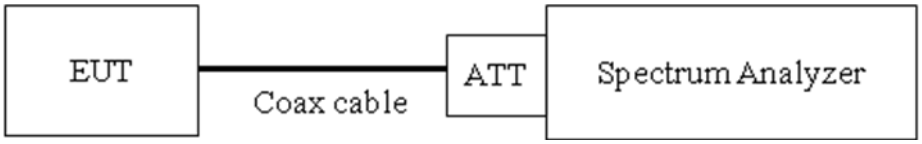


8.3 99% BANDWIDTH

limit

None; for IC reporting purposes only

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to as close to 5 % from 1 % of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99 % bandwidth function is utilized.

RBW = 1 ~ 5 % of the 99 % bandwidth

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

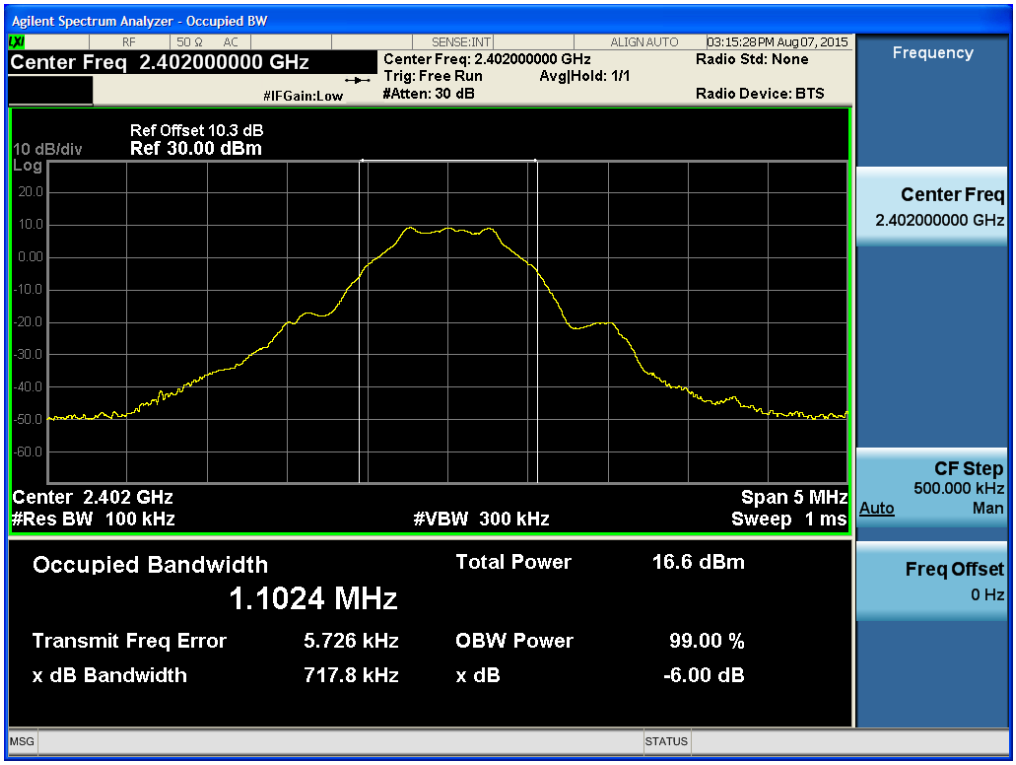
▣ TEST RESULTS

Conducted 99% Bandwidth Measurements for LE Mode

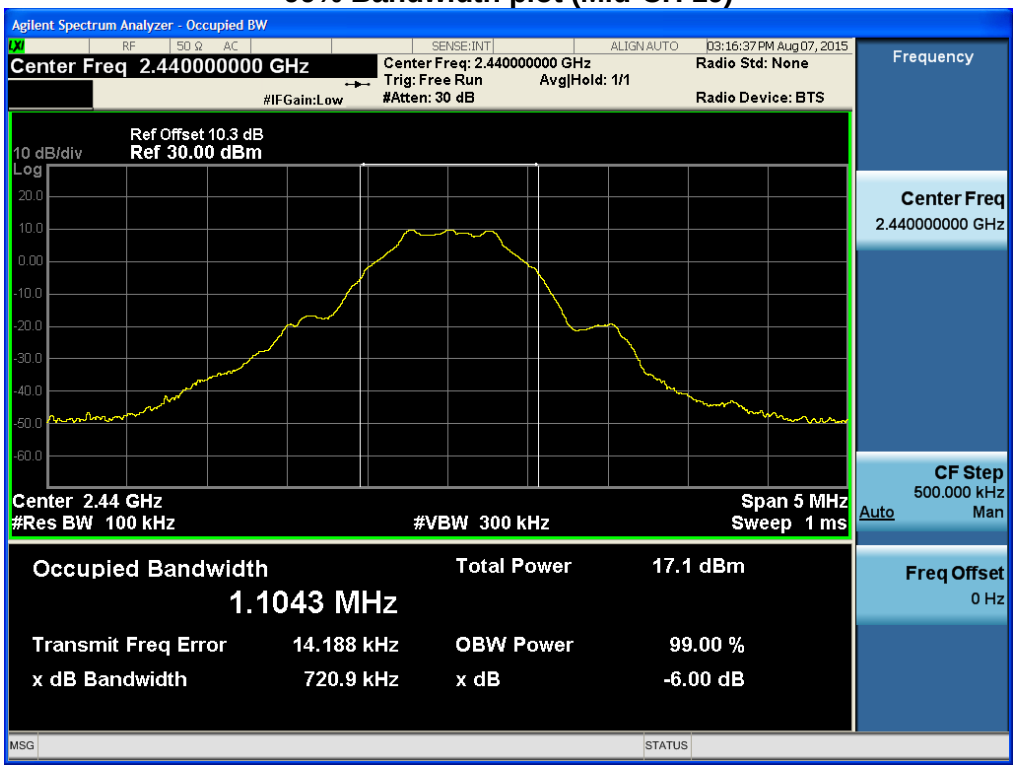
LE Mode		Measured Bandwidth [kHz]
Frequency [MHz]	Channel No.	
2402	0	1.102
2440	19	1.104
2480	39	1.103

▣ RESULT PLOTS

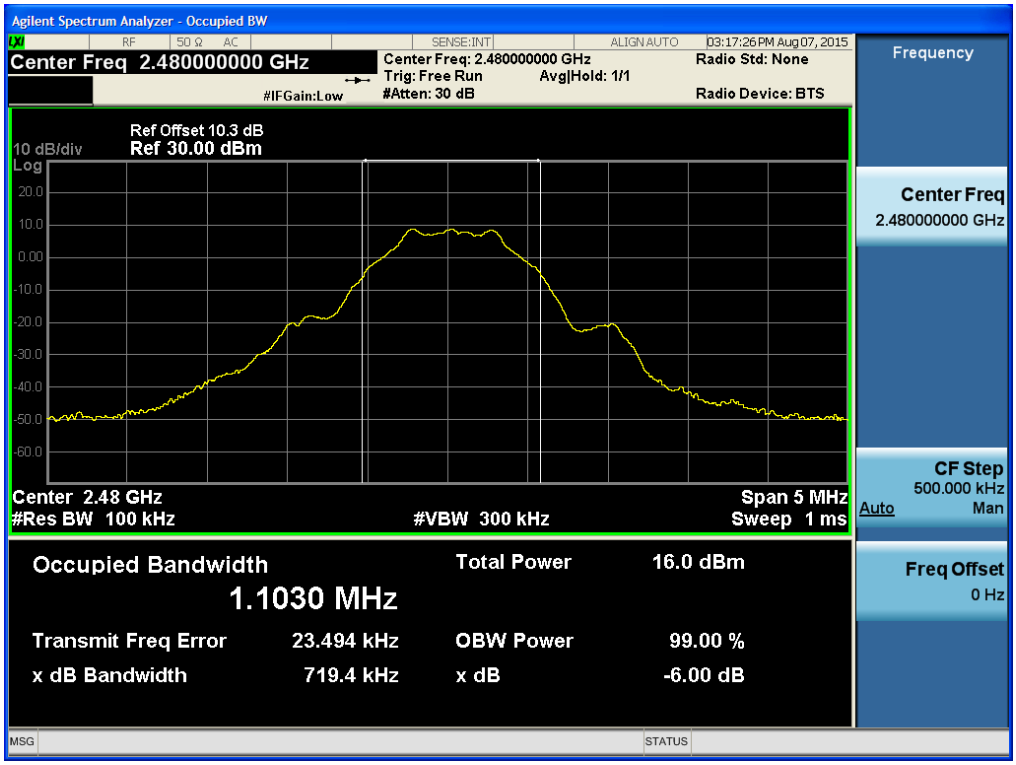
99% Bandwidth plot (Low-CH 0)



99% Bandwidth plot (Mid-CH 19)



99% Bandwidth plot (High-CH 39)



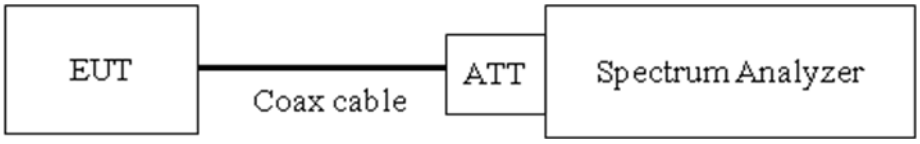
8.4 OUTPUT POWER MEASUREMENT

Test Requirements and limit, §15.247(b)(3) / RSS-247, 5.4.4

A transmitter antenna terminal of EUT is connected to the input of a Spectrum Analyzer. Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We use the spectrum analyzer's integrated band power measurement function.

This EUT TX condition is actual operating mode by BT LE mode test program.

The Spectrum Analyzer is set to

- Peak Power (Procedure 9.1.1 in KDB 558074, issued 06/09/2015)

  RBW ≥ DTS Bandwidth

  VBW ≥ 3 x RBW

  SPAN ≥ 3 x RBW

  Detector Mode = Peak

  Sweep = auto couple

  Trace Mode = max hold

  Allow trace to fully stabilize.

  Use peak marker function to determine the peak amplitude level

- Average Power (Procedure 9.2.2.4 in KDB 558074, issued 06/09/2015)

  Measure the duty cycle

  Set span to at least 1.5 times the OBW

  RBW = 1-5 % of the OBW, not to exceed 1 MHz.

  VBW ≥ 3 x RBW.

  Number of points in sweep ≥ 2 x span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)

  Sweep time = auto.

  Detector = RMS(i.e., power averaging)

  Do not use sweep triggering. Allow the sweep to "free run".

Trace average at least 100 traces in power averaging(RMS) mode.

Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges.

Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

▣ Sample Calculation

Output Power = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor

Output Power = 10 dBm + 10 dB + 0.8 dB + 0.2 dB = 21.0 dBm

Note :

1. Spectrum reading values are not plot data. The power results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 10.2 dB is offset for 2.4 GHz Band.

▣ TEST RESULTS-Peak

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Limit (dBm)
Frequency[MHz]	Channel No.		
2402	0	5.333	30
2440	19	6.005	30
2480	39	5.350	30

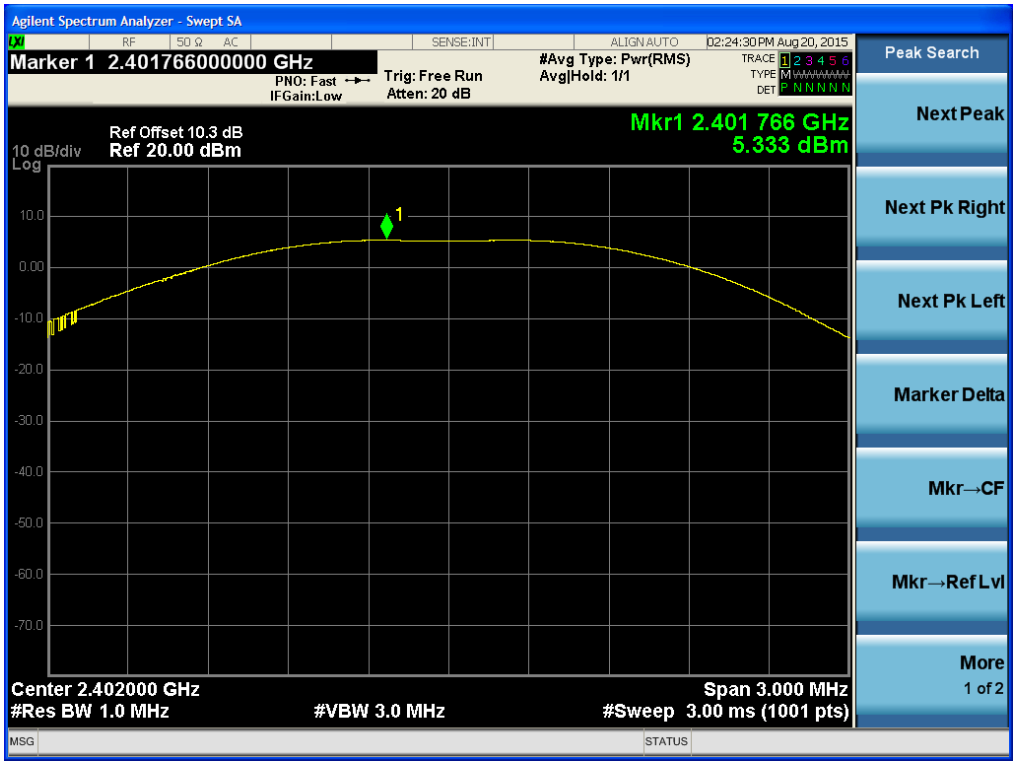
▣ TEST RESULTS-Average

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Duty Cycle Factor	Measured Power(dBm) + Duty Cycle Factor	Limit (dBm)
Frequency[MHz]	Channel No.				
2402	0	2.990	2.04	5.031	30
2440	19	3.690	2.04	5.731	30
2480	39	3.030	2.04	5.071	30

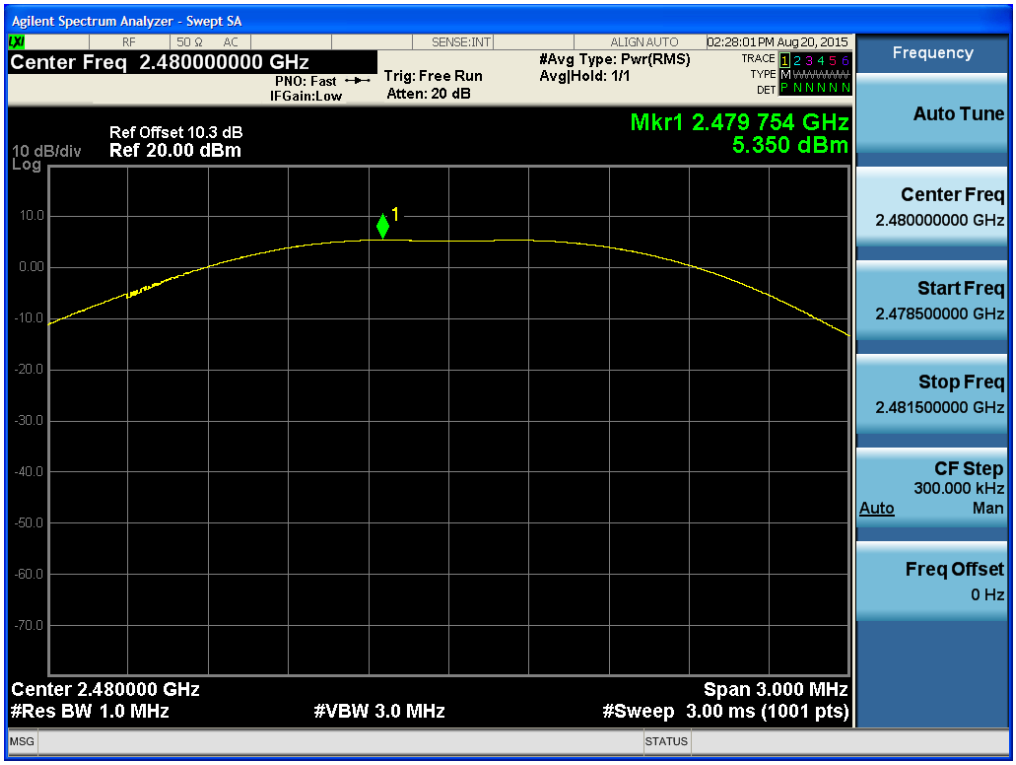
▣ RESULT PLOTS-Peak

Conducted Output Power (Low-CH 0)



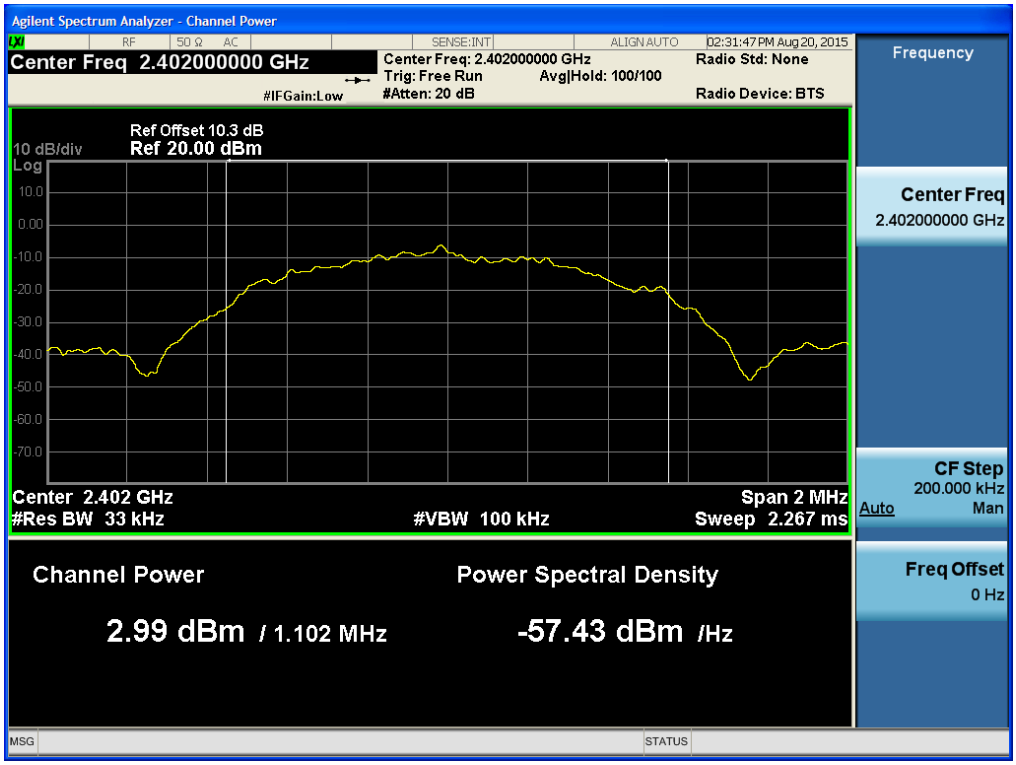
Conducted Output Power (Mid-CH 19)

Conducted Output Power (High-CH 39)



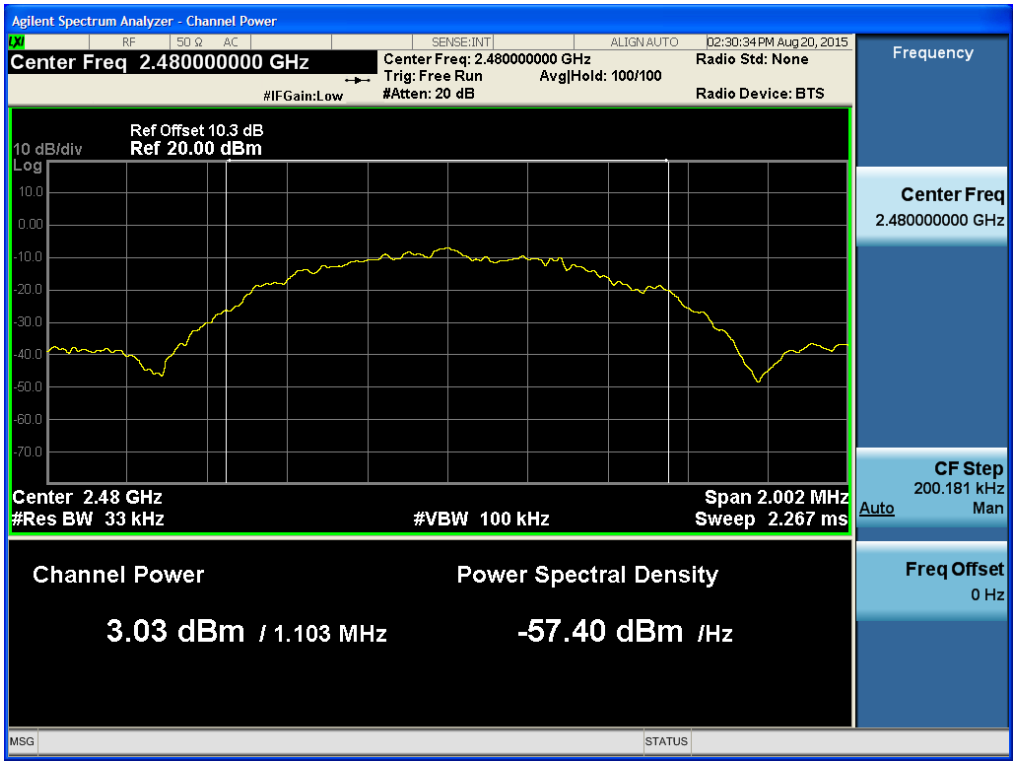
▣ RESULT PLOTS-Average

Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

Conducted Output Power (High-CH 39)



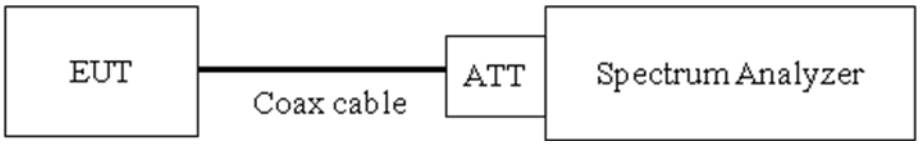
8.4 POWER SPECTRAL DENSITY

Test Requirements and limit, §15.247(e) / RSS-247, 5.2

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Minimum Standard – The transmitter power density average over 1-second interval shall not be greater than 8dBm in any 3kHz BW.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

We tested according to Procedure 10.2 in KDB 558074, issued 06/09/2015

The spectrum analyzer is set to :

Set analyzer center frequency to DTS channel center frequency.

Span = 1.5 times the DTS channel bandwidth.

RBW = 3 kHz ≤ RBW ≤ 100 kHz.

VBW ≥ 3 x RBW.

Sweep = auto couple

Detector = peak

Trace Mode = max hold

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

▣ Sample Calculation

PSD = Reading Value + ATT loss + Cable loss(1 ea)

Output Power = -5 dBm + 10 dB + 0.8 dB = 5.8 dBm

Note :

1. Spectrum reading values are not plot data. The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So,10.2 dB is offset for 2.4 GHz Band.

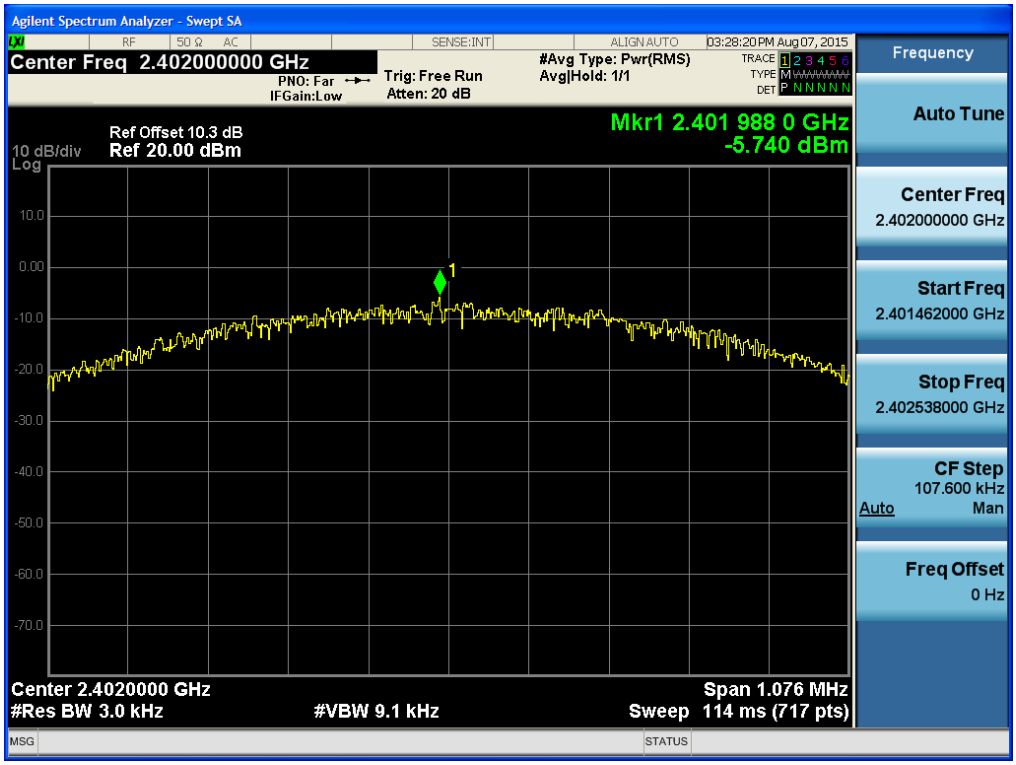
▣ TEST RESULTS

Conducted Power Density Measurements

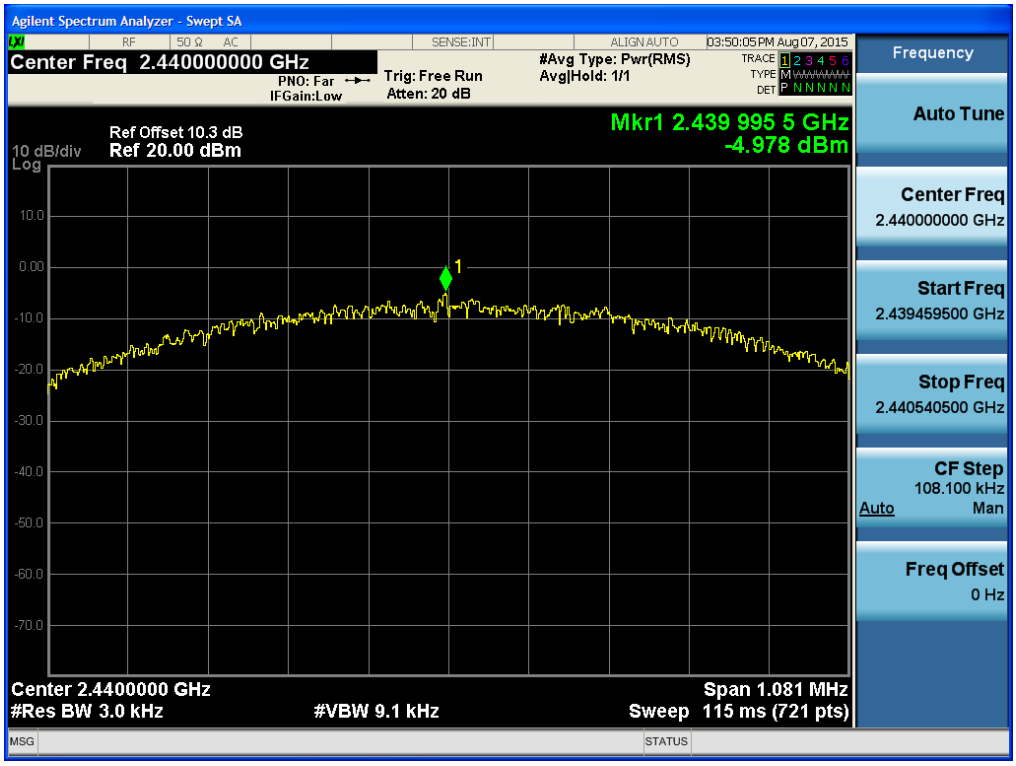
Frequency (MHz)	Channel No.	Mode	Test Result		
			PSD (dBm)	Limit (dBm)	Pass/ Fail
2402	0	LE	-5.740	8	Pass
2440	19		-4.978	8	Pass
2480	39		-6.247	8	Pass

▣ RESULT PLOTS

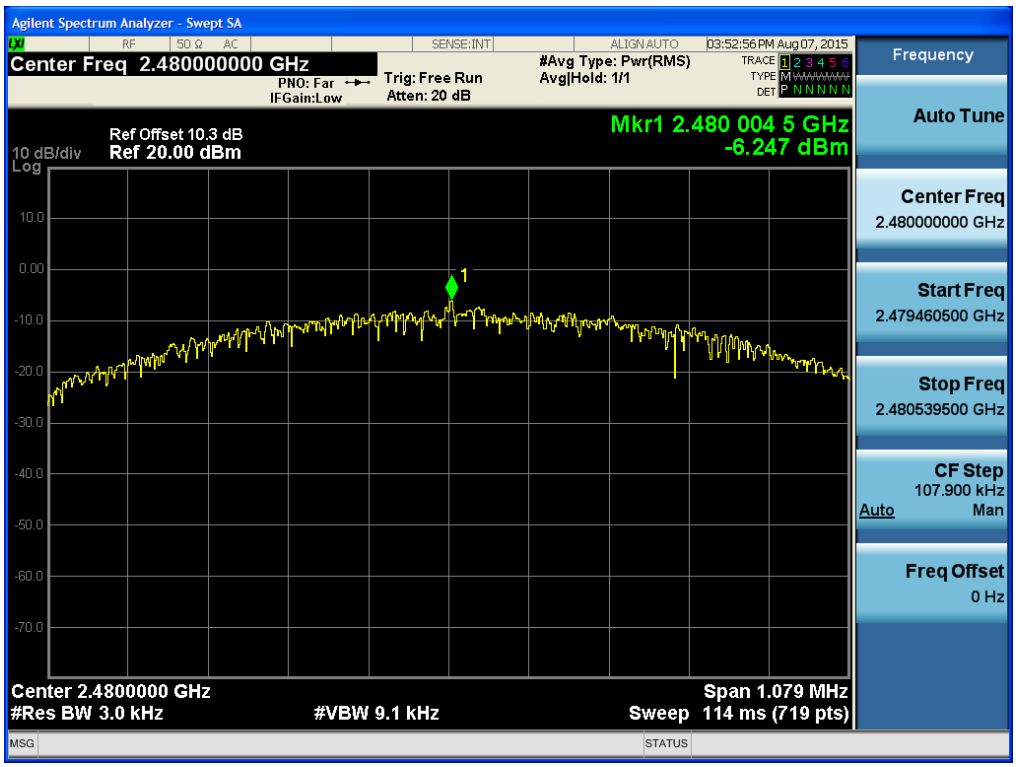
Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)



Power Spectral Density (High-CH 39)



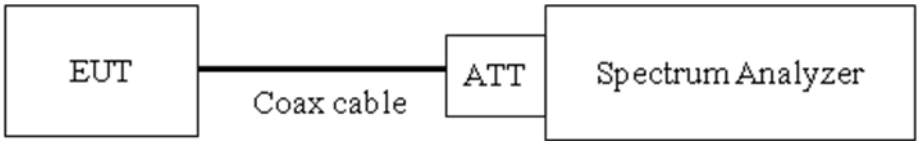
8.5 OUT OF BAND EMISSIONS AT THE BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

Test Requirements and limit, §15.247(d) / RSS-247, 5.5

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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. 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) (see § 15.205(c)).

Limit : 20 dBc

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. (Procedure 11.0 in KDB 558074, issued 06/09/2015)

RBW = 100 kHz

VBW ≥ 3 x RBW

Set span to encompass the spectrum to be examined

Detector = Peak

Trace Mode = max hold

Sweep time = auto couple

Ensure that the number of measurement points ≥ 2*Span/RBW

Allow trace to fully stabilize.

Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 10th harmonic range with the transmitter set to the lowest, middle, and highest channels.

Note :

1. The band edge results in plot is already including the actual values of loss for the attenuator and cable combination.

2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 10.2 dB is offset for 2.4 GHz Band.
4. In case of conducted spurious emissions test, please check factors blow table.
5. In order to simplify the report, attached plots were only the worst case channel and data rate.

▣ FACTORS FOR FREQUENCY

Freq(MHz)	Factor(dB)
30	9.95
100	10.01
200	10.03
300	10.04
400	10.05
500	10.04
600	10.03
700	10.09
800	10.10
900	10.08
1000	10.11
2000	10.25
2400*	10.19
2500*	10.24
3000	10.27
4000	10.22
5000	10.48
6000	10.48
7000	10.57
8000	10.45
9000	10.50
10000	10.64
11000	10.69
12000	10.75
13000	10.92
14000	11.90
15000	11.00
16000	11.03

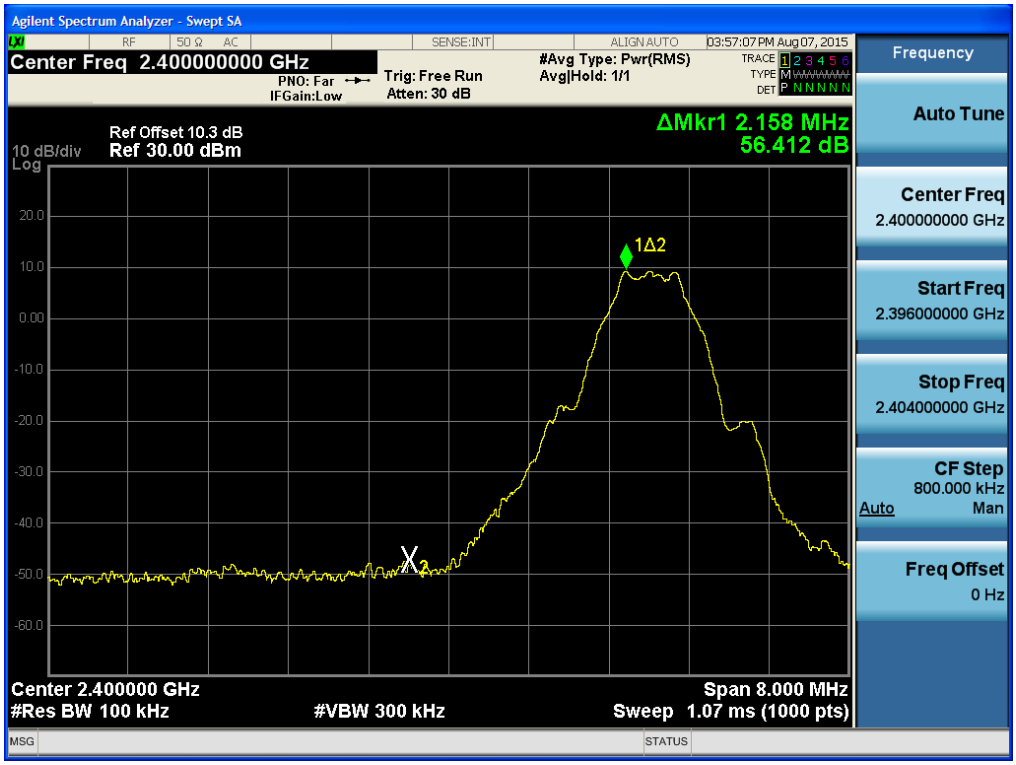
17000	10.93
18000	10.96
19000	10.85
20000	12.11
21000	11.17
22000	10.99
23000	11.12
24000	11.10
25000	11.42

Note : 1. '*' is fundamental frequency range.

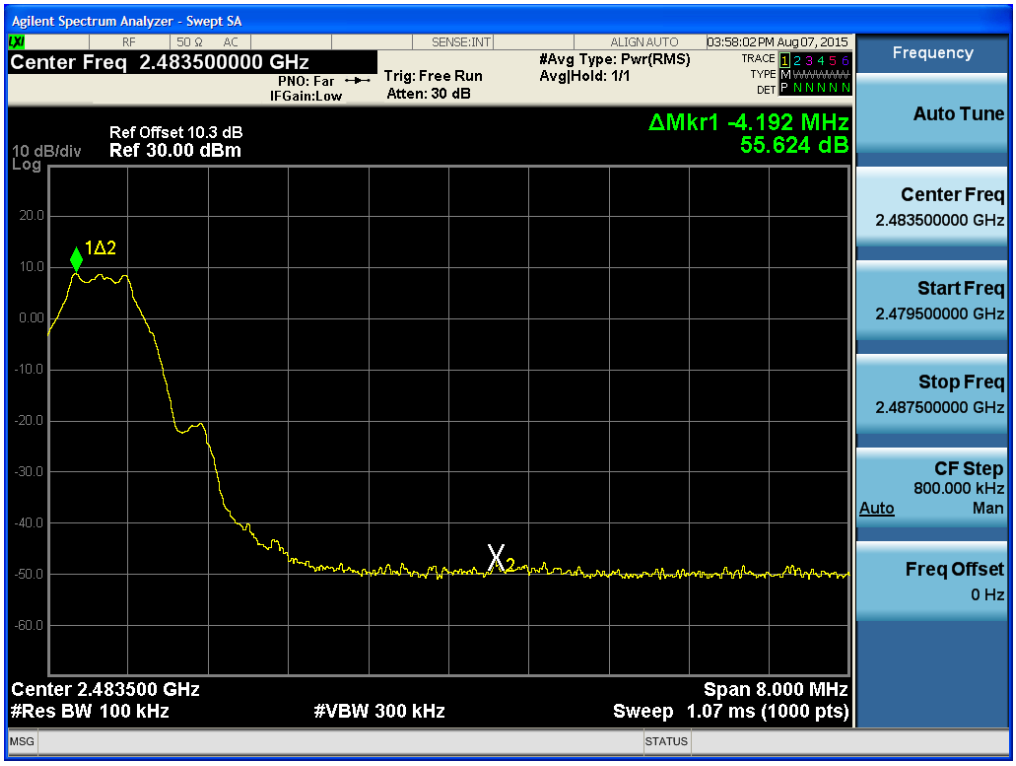
2. Factor = Cable loss + Attenuator loss

▣ RESULT PLOTS

BandEdge (Low-CH 0)

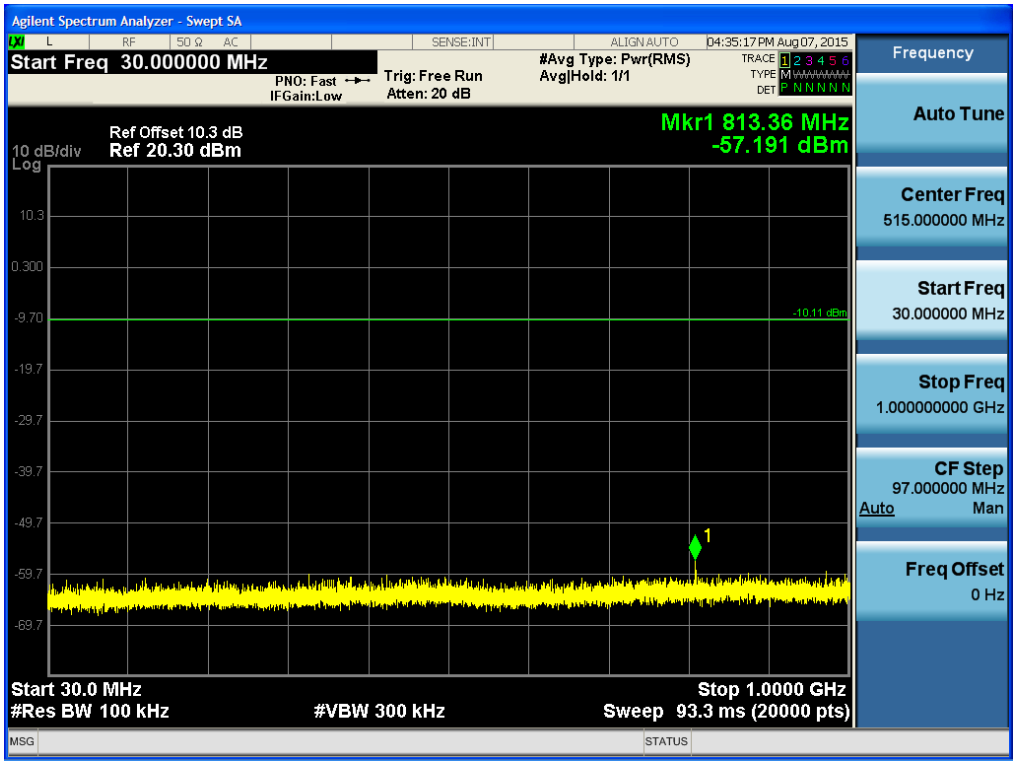


BandEdge (High-CH 39)



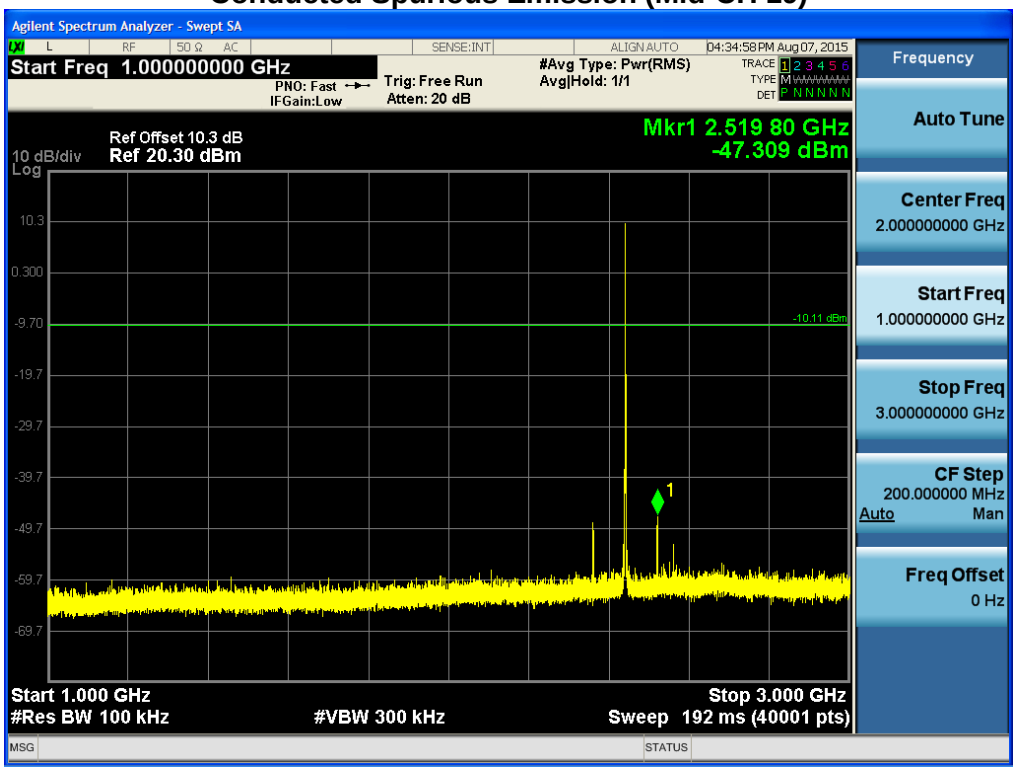
30 MHz ~ 1 GHz

Conducted Spurious Emission (Mid-CH 19)



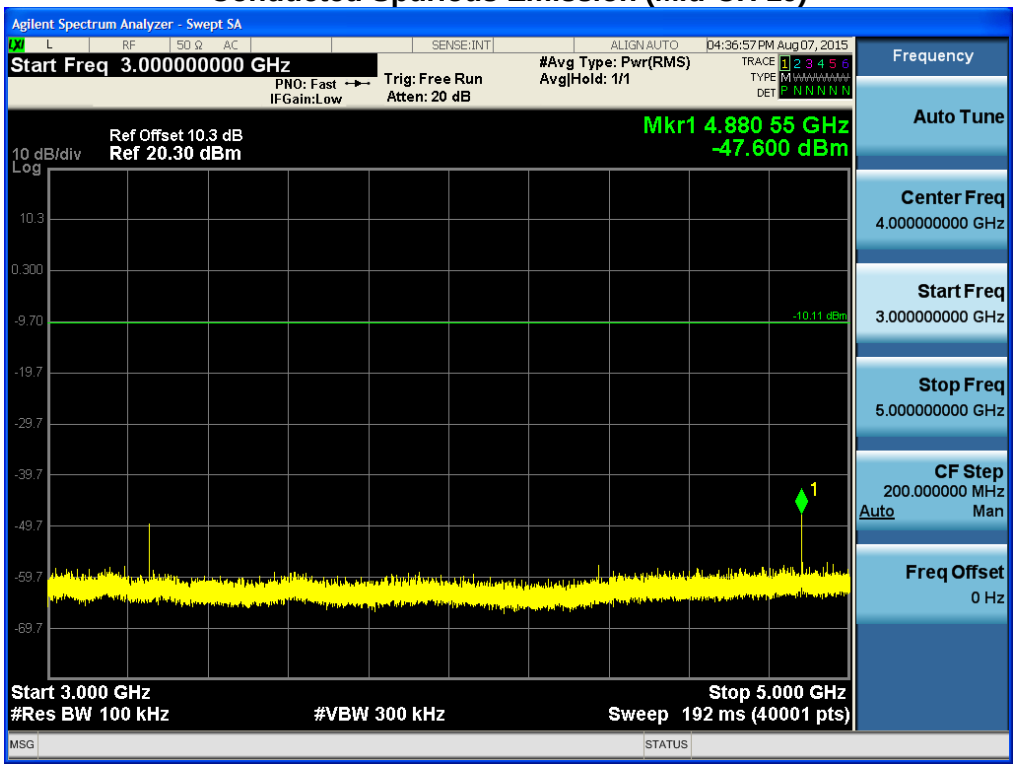
1 GHz ~ 3 GHz

Conducted Spurious Emission (Mid-CH 19)



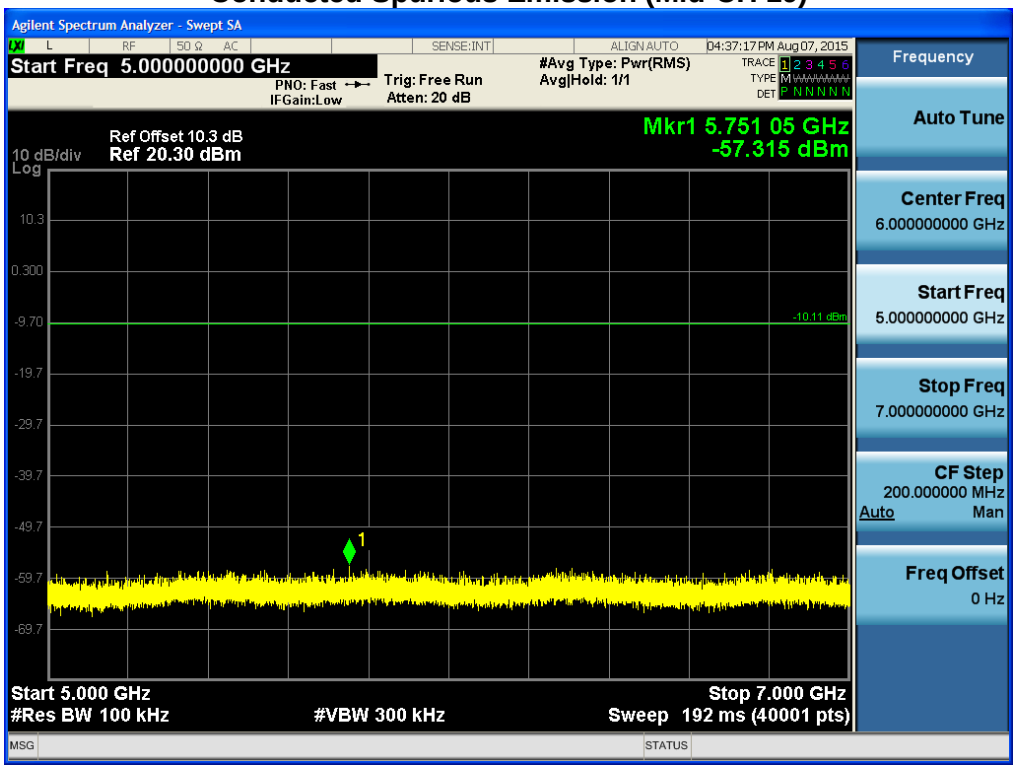
3 GHz ~ 5 GHz

Conducted Spurious Emission (Mid-CH 19)



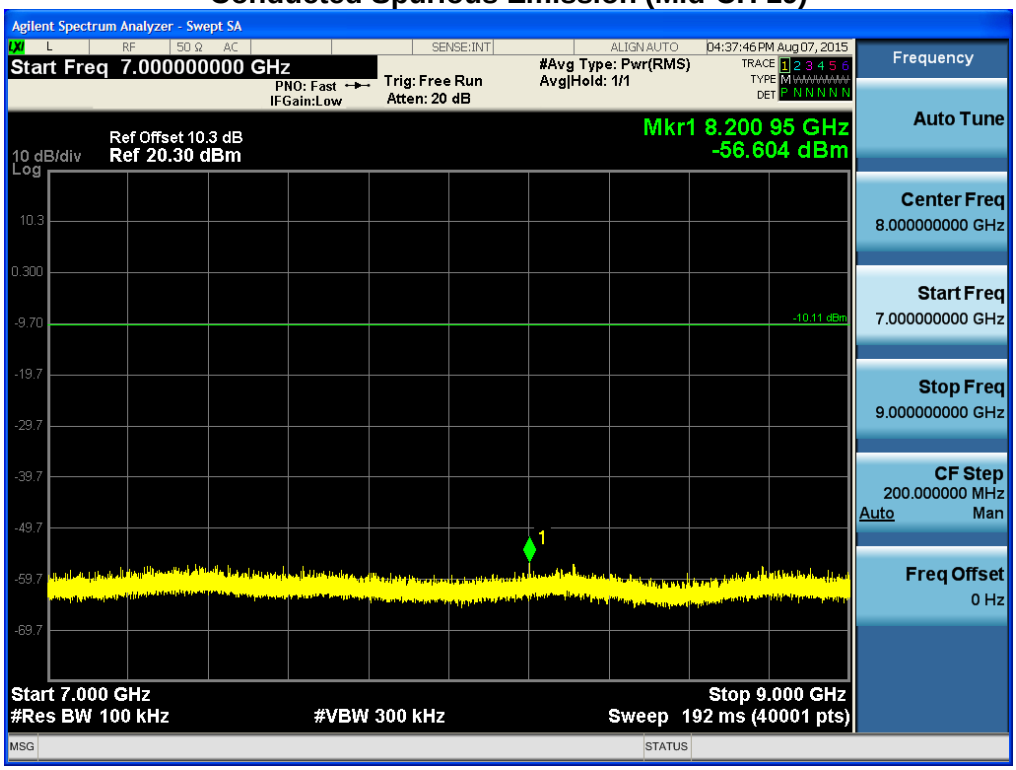
5 GHz ~ 7 GHz

Conducted Spurious Emission (Mid-CH 19)



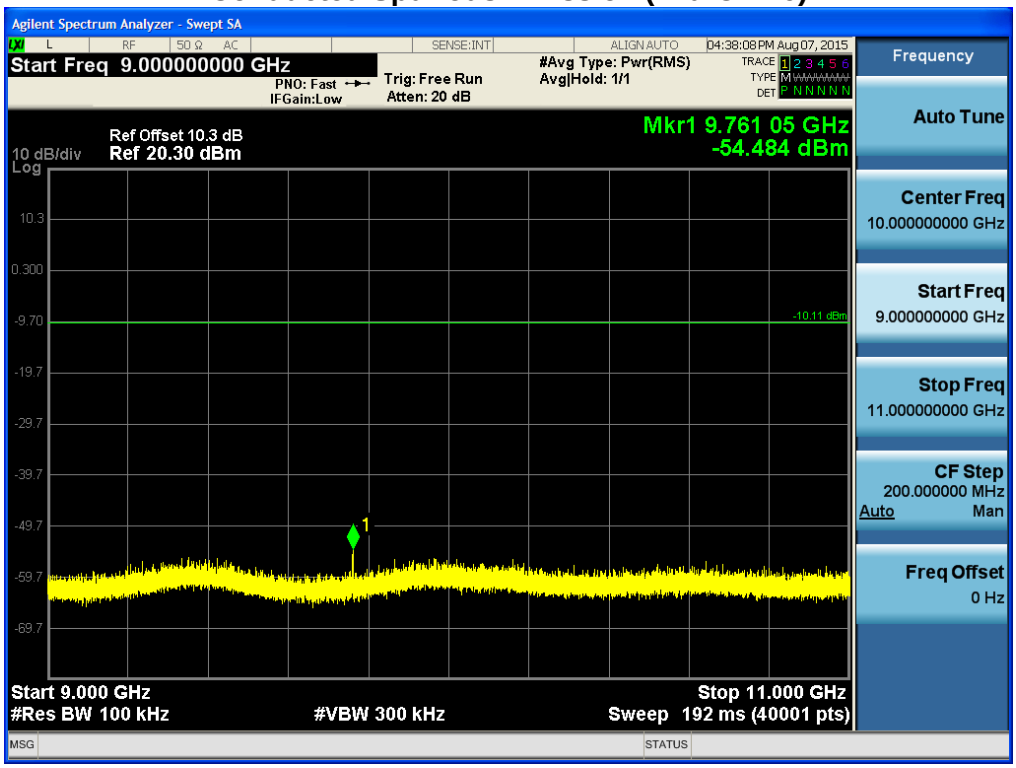
7 GHz ~ 9 GHz

Conducted Spurious Emission (Mid-CH 19)



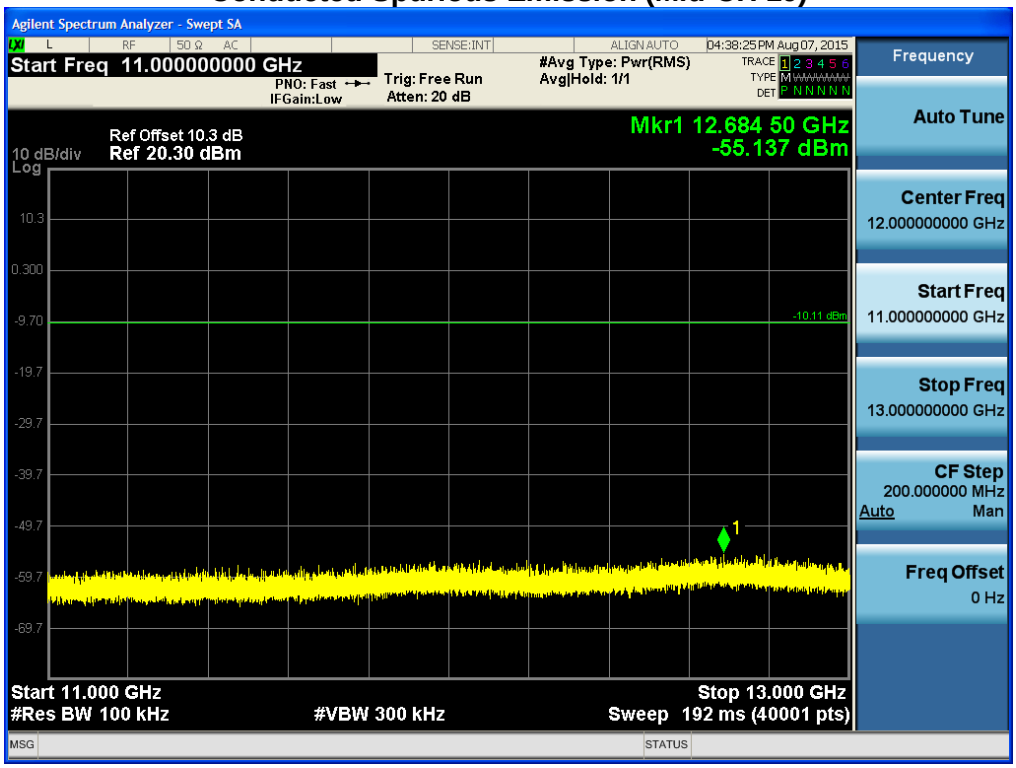
9 GHz ~ 11 GHz

Conducted Spurious Emission (Mid-CH 19)



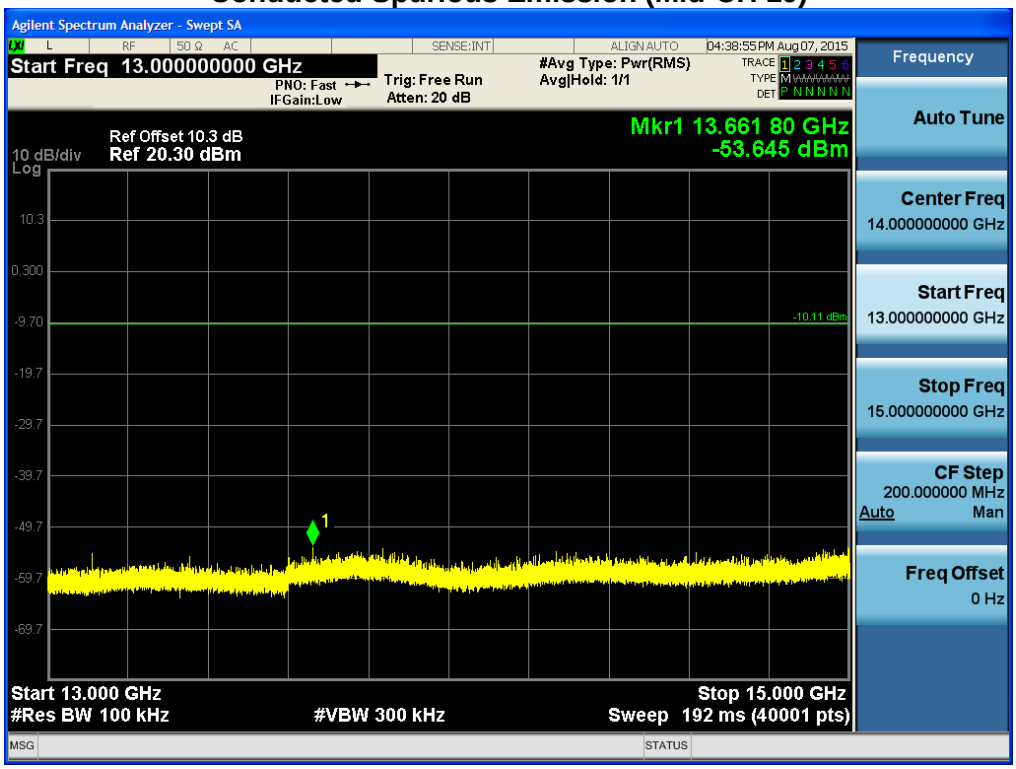
11 GHz ~ 13 GHz

Conducted Spurious Emission (Mid-CH 19)



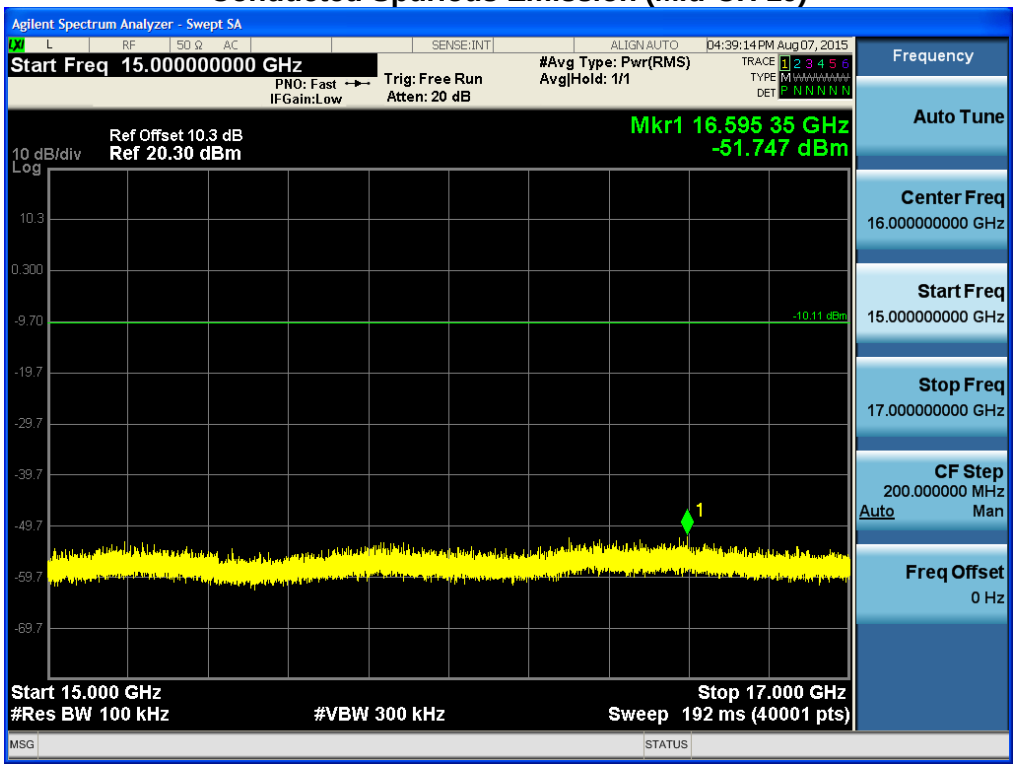
13 GHz ~ 15 GHz

Conducted Spurious Emission (Mid-CH 19)



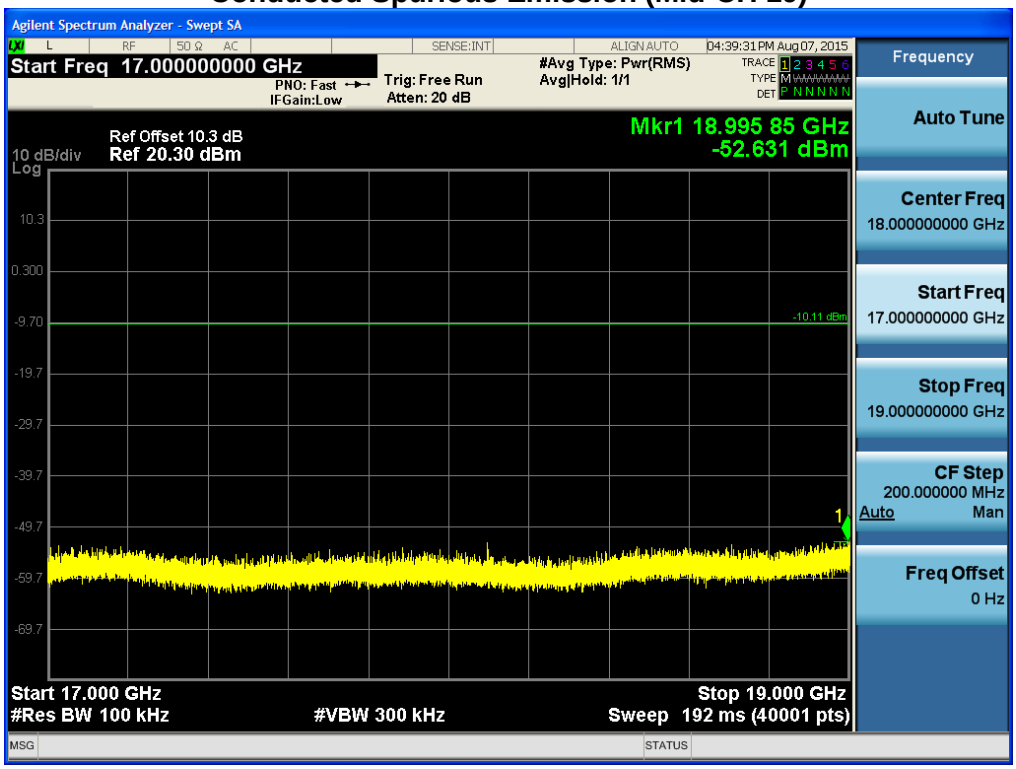
15 GHz ~ 17 GHz

Conducted Spurious Emission (Mid-CH 19)



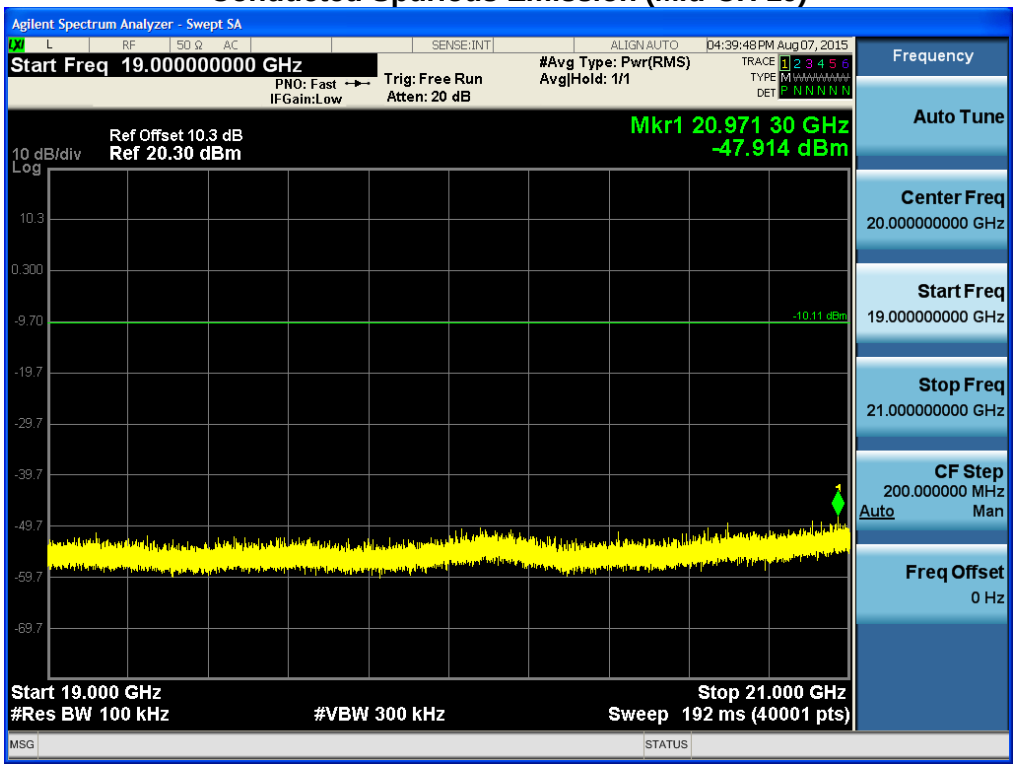
17 GHz ~ 19 GHz

Conducted Spurious Emission (Mid-CH 19)



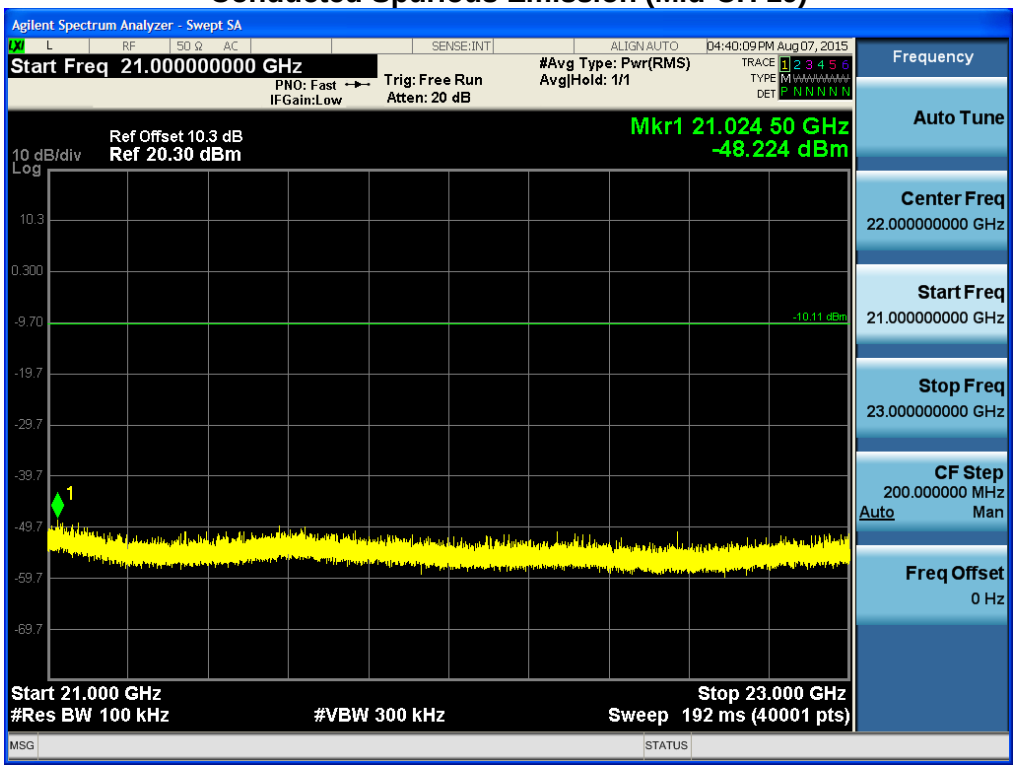
19 GHz ~ 21 GHz

Conducted Spurious Emission (Mid-CH 19)



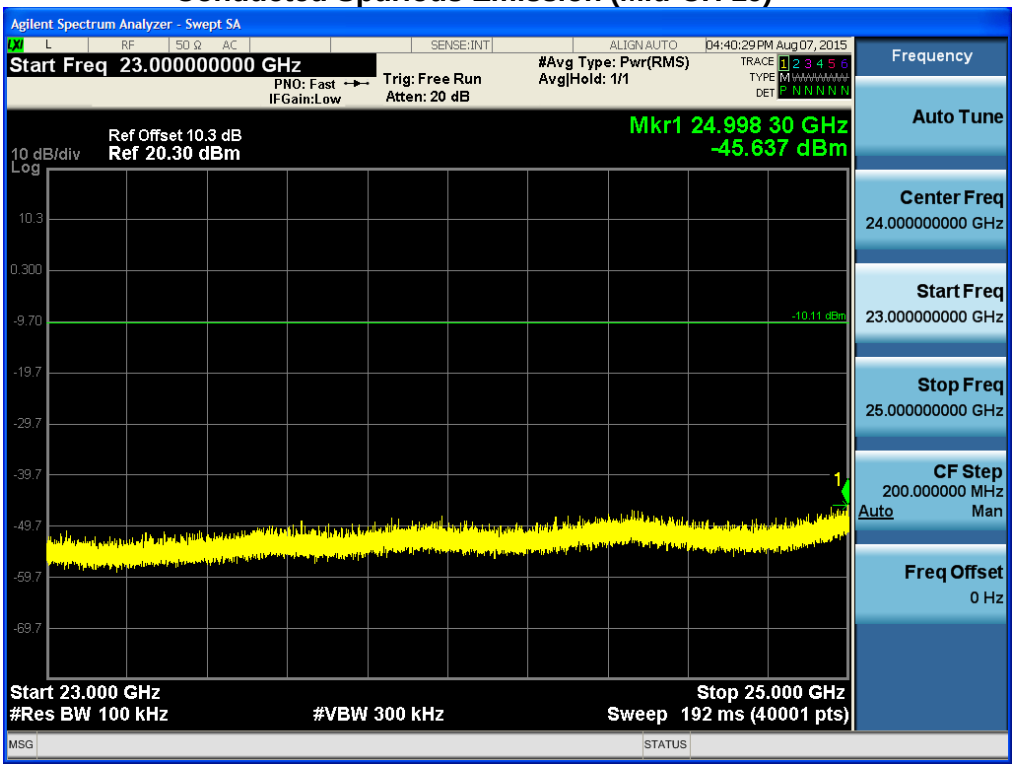
21 GHz ~ 23 GHz

Conducted Spurious Emission (Mid-CH 19)



23 GHz ~ 25 GHz

Conducted Spurious Emission (Mid-CH 19)



8.6 RADIATED MEASUREMENT.

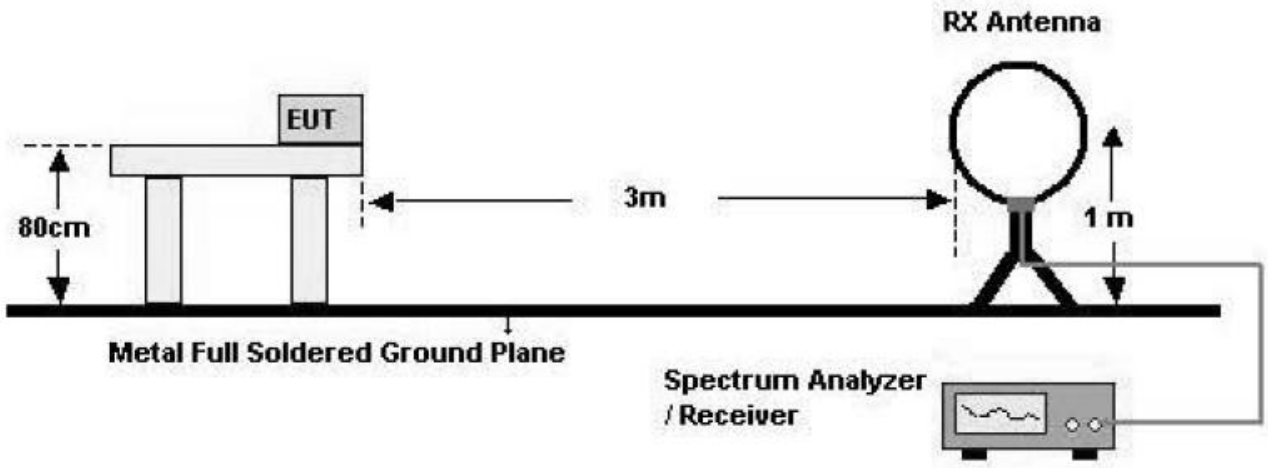
8.6.1 RADIATED SPURIOUS EMISSIONS.

Test Requirements and limit, §15.205, §15.209

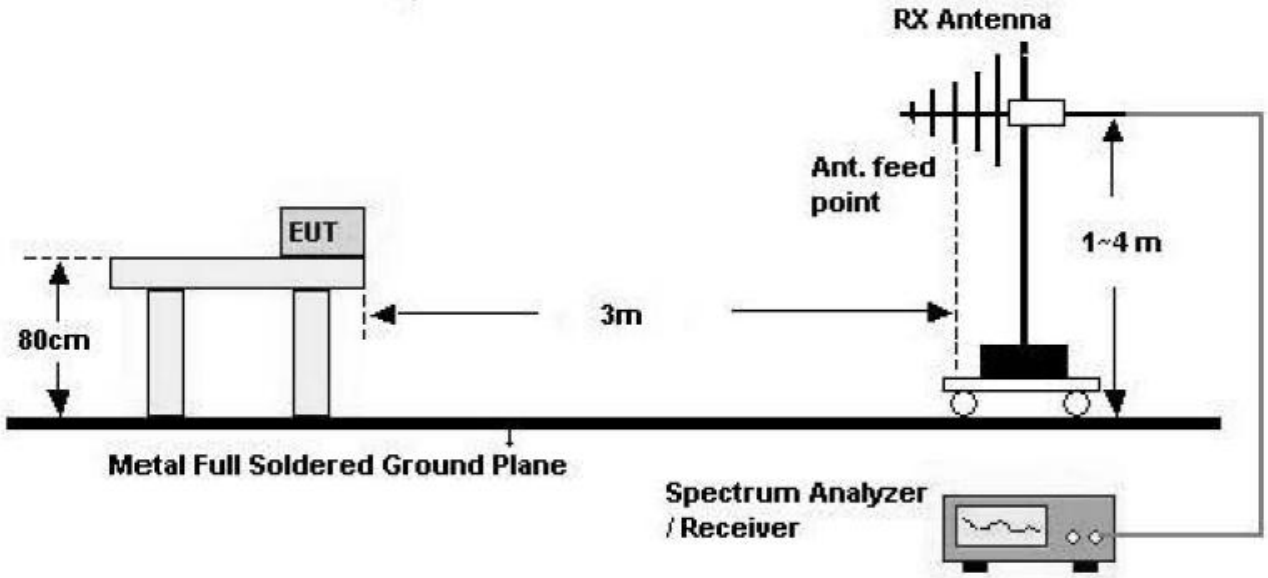
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

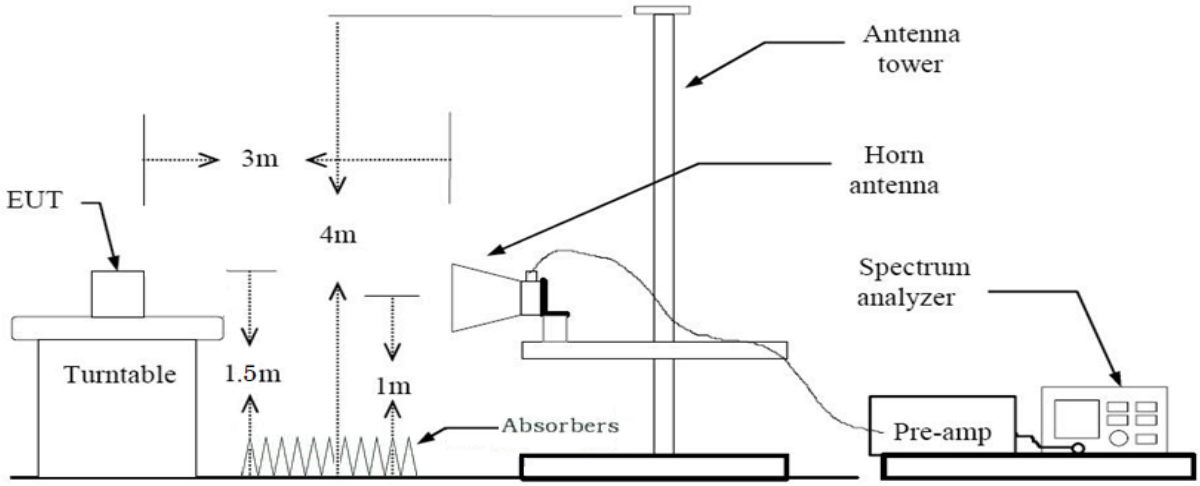
Below 30 MHz



30 MHz - 1 GHz



Above 1 GHz



TEST PROCEDURE USED

Method 12.1 in KDB 558074, issued 06/09/2015

Spectrum Setting

- Peak

Peak emission levels are measured by setting the instrument as follows:

RBW = cf. Table 1.

VBW ≥ 3 x RBW.

Detector = Peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweeps to continue until the trace stabilizes.

(Note that the required measurement time may be longer for low duty cycle applications).

Table 1 —RBW as a function of frequency

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

.

- Average (duty cycle ≥ 98%)

Set RBW = 1 MHz

Set VBW ≥ 3 x RBW

Detector = RMS

Averaging type = power (*i.e.*, RMS).

Sweep time = auto.

Trace mode = average (at least 100 traces).

- Average (duty cycle < 98%, duty cycle variations are less than ±2%)

Set RBW = 1 MHz

Set VBW ≥ 3 x RBW

Detector = RMS.

Averaging type = power (*i.e.*, RMS).

Sweep time = auto.

Trace mode = average (at least 100 traces).

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.

- Average (duty cycle < 98%)

Set RBW = 1 MHz

Set VBW ≥ 1/T.(at least 100 times less than the resolution bandwidth, but no less than 10 Hz.)

Select spectrum analyzer linear display mode.

Detector = Peak.

Sweep time = auto.

Trace mode = max hold.

Note :

1. We are performed the RSE and radiated band edge using standard radiated method.
2. The duty cycle factor for BT LE mode.

BT LE Mode	T_{on} (ms)	T_{total} (ms)	Duty Cycle (%)	Duty Cycle Factor	VBW(1/T) (Hz)
	0.3900	0.6240	0.6250	2.04	2564

TEST RESULTS

9 kHz – 30MHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμV/m	dBm /m	dBm	(H/V)	dBμV/m	dBμV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

TEST RESULTS

Below 1 GHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμV/m	dBm /m	dBm	(H/V)	dBμV/m	dBμV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Above 1 GHz

Operation Mode: CH Low(LE Mode)

Frequency [MHz]	Reading [dBuV/m]	A.F.+CL-AMP G [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4804	63.56	-7.66	V	55.90	73.98	18.08	PK
4804	55.68	-7.66	V	48.02	53.98	5.96	AV
7206	55.86	-1.98	V	53.88	73.98	20.10	PK
7206	42.24	-1.98	V	40.26	53.98	13.72	AV
4804	64.11	-7.66	H	56.45	73.98	17.53	PK
4804	56.40	-7.66	H	48.74	53.98	5.24	AV
7206	56.60	-1.98	H	54.62	73.98	19.36	PK
7206	42.65	-1.98	H	40.67	53.98	13.31	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. The Reading values are already added value of the duty cycle factor.
5. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Operation Mode: CH Mid(LE Mode)

Frequency [MHz]	Reading [dBuV/m]	A.F.+CL-AMP G [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4880	61.54	-7.45	V	54.09	73.98	19.89	PK
4880	56.43	-7.45	V	48.98	53.98	5.00	AV
7320	53.27	-1.66	V	51.61	73.98	22.37	PK
7320	39.55	-1.66	V	37.89	53.98	16.09	AV
4880	62.31	-7.45	H	54.86	73.98	19.12	PK
4880	57.20	-7.45	H	49.75	53.98	4.23	AV
7320	53.42	-1.66	H	51.76	73.98	22.22	PK
7320	39.62	-1.66	H	37.96	53.98	16.02	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. The Reading values are already added value of the duty cycle factor.
5. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

Operation Mode: CH High(LE Mode)

Frequency [MHz]	Reading [dBuV/m]	A.F.+CL-AMP G [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4960	62.95	-7.29	V	55.66	73.98	18.32	PK
4960	56.38	-7.29	V	49.09	53.98	4.89	AV
7440	53.12	-1.08	V	52.04	73.98	21.94	PK
7440	39.28	-1.08	V	38.20	53.98	15.78	AV
4960	63.18	-7.29	H	55.89	73.98	18.09	PK
4960	57.20	-7.29	H	49.91	53.98	4.07	AV
7440	53.64	-1.08	H	52.56	73.98	21.42	PK
7440	39.65	-1.08	H	38.57	53.98	15.41	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. The Reading values are already added value of the duty cycle factor.
5. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

8.6.2 RECEIVER SPURIOUS EMISSIONS

IC Rule(s)	**RSS-GEN**
Test Requirements:	**Blow the table**
Operating conditions:	**Under normal test conditions**
Method of testing:	**Radiated**
S/A. Settings:	**F < 1 GHz: RBW: 120 kHz, VBW: 300 kHz (Quasi Peak)** **F > 1 GHz: RBW: 1 MHz, VBW: 1 MHz (Peak)**
Mode of operation:	**Receive**

Frequency (MHz)	Field Strength (microvolts/m at 3 meters)
30 – 88	100
88 - 216	150
216 – 960	200
Above 960	500

Operation Mode: Receive:

30 MHz ~ 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμV	dB /m	dB	(H/V)	dBμV/m	dBμV/m	dB
222.63	15.09	10.8	1.27	H	27.16	46	18.84
630.09	15.41	20.5	1.96	V	37.87	46	8.13
914.38	15.35	23.9	2.38	H	41.63	46	4.37

Above 1 GHz

Frequency	Reading	Ant. factor+Cable loss- Amp Gain	Ant. POL	Total	Limit	Margin	Detect mode
MHz	dBμV	dB	(H/V)	dBμV/m	dBμV/m	dB	
1741	51.68	-12.78	V	38.9	73.98	35.08	PK
3720	51.59	-7.21	H	44.38	73.98	29.60	PK
6115	47.07	4.02	V	51.09	73.98	22.89	PK

Note : The result using peak detect mode is lower than average limit. So, there is no data for average detect mode.

8.6.3 RADIATED RESTRICTED BAND EDGES

Test Requirements and limit, §15.247(d) §15.205, §15.209

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c)).

Operation Mode	BT_LE
Operating Frequency	2402 MHz
Channel No	0 Ch

Frequency [MHz]	Reading [dBuV/m]	A.F.+CL [dBm]	Ant. Pol. [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2390.0	26.19	31.28	H	57.47	73.98	16.51	PK
2390.0	14.95	31.28	H	46.23	53.98	7.75	AV
2390.0	26.18	31.28	V	57.46	73.98	16.52	PK
2390.0	14.79	31.28	V	46.07	53.98	7.91	AV

Notes:

1. Frequency range of measurement = 2310 MHz ~ 2390 MHz
2. The Reading values are already added value of the duty cycle factor.
3. Total = Reading Value + Antenna Factor + Cable Loss
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The radiated restricted band edge measurements are measured with a spectrum analyzer connected to the receive antenna while the EUT is transmitting.

Operation Mode	BT _LE
Operating Frequency	2480 MHz
Channel No	39 Ch

Frequency [MHz]	Reading [dBuV/m]	A.F.+CL [dBm]	Ant. Pol. [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2483.5	36.32	31.28	H	67.60	73.98	6.39	PK
2483.5	18.00	31.28	H	49.28	53.98	4.71	AV
2483.5	35.28	31.28	V	66.56	73.98	7.43	PK
2483.5	17.65	31.28	V	48.93	53.98	5.06	AV

Notes:

1. Frequency range of measurement = 2483.5 MHz ~ 2500 MHz
2. The Reading values are already added value of the duty cycle factor.
3. Total = Reading Value + Antenna Factor + Cable Loss
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The radiated restricted band edge measurements are measured with a spectrum analyzer connected to the receive antenna while the EUT is transmitting.

8.7 POWERLINE CONDUCTED EMISSIONS

Test Requirements and limit, §15.207

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 or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	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

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Appendix 1 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 ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

▣ RESULT PLOTS

Conducted Emissions (Line 1)

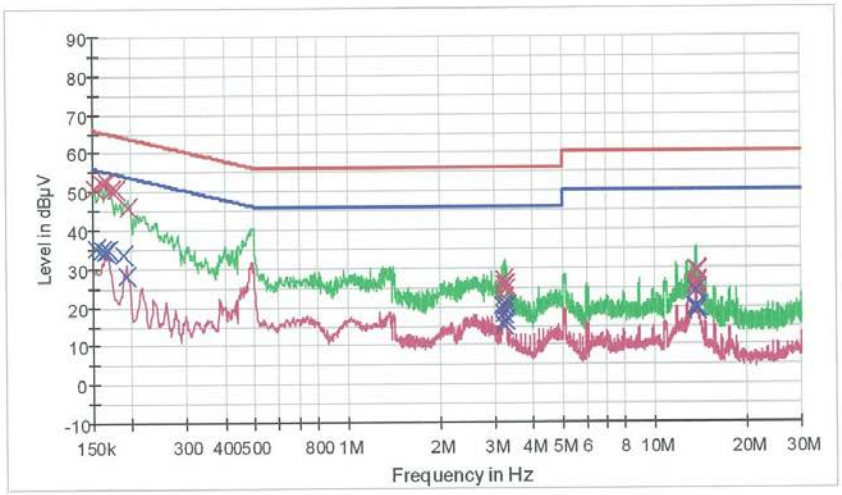
EMI Auto Test(10) 1 / 2

HCT TEST Report

Common Information

EUT:	LG-SBW61
Manufacturer:	LG
Test Site:	SHIELD ROOM
Operating Conditions:	BT LE MODE
Operator Name:	KS KANG

FCC CLASS B



FCC CLASS B_QP
Preview Result 2-AVG
FCC CLASS B_ AV
Final Result 1-QPK
Preview Result 1-PK+
Final Result 2-CAV

Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.152000	50.9	9.000	Off	L1	9.6	15.0	65.9
0.160000	52.0	9.000	Off	L1	9.6	13.5	65.5
0.166000	52.4	9.000	Off	L1	9.6	12.8	65.2
0.172000	50.6	9.000	Off	L1	9.6	14.3	64.9
0.178000	50.7	9.000	Off	L1	9.6	13.9	64.6
0.194000	45.9	9.000	Off	L1	9.6	18.0	63.9
3.212000	26.9	9.000	Off	L1	9.8	29.1	56.0
3.222000	25.6	9.000	Off	L1	9.8	30.4	56.0
3.236000	22.4	9.000	Off	L1	9.8	33.6	56.0
3.248000	25.9	9.000	Off	L1	9.8	30.1	56.0
3.264000	24.5	9.000	Off	L1	9.8	31.5	56.0
3.276000	24.6	9.000	Off	L1	9.8	31.4	56.0
13.634000	25.9	9.000	Off	L1	10.1	34.1	60.0
13.644000	24.7	9.000	Off	L1	10.1	35.3	60.0
13.668000	29.4	9.000	Off	L1	10.1	30.6	60.0
13.696000	26.5	9.000	Off	L1	10.1	33.5	60.0

8/27/2015 12:39:12

EMI Auto Test(10) 2 / 2

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
13.700000	26.0	9.000	Off	L1	10.1	34.0	60.0
13.712000	29.0	9.000	Off	L1	10.1	31.0	60.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.154000	35.4	9.000	Off	L1	9.6	20.4	55.8
0.160000	35.0	9.000	Off	L1	9.6	20.5	55.5
0.164000	34.4	9.000	Off	L1	9.6	20.9	55.3
0.168000	34.9	9.000	Off	L1	9.6	20.2	55.1
0.188000	33.6	9.000	Off	L1	9.6	20.5	54.1
0.192000	28.4	9.000	Off	L1	9.6	25.5	53.9
3.192000	20.3	9.000	Off	L1	9.8	25.7	46.0
3.214000	19.7	9.000	Off	L1	9.8	26.3	46.0
3.222000	18.0	9.000	Off	L1	9.8	28.0	46.0
3.236000	15.3	9.000	Off	L1	9.8	30.7	46.0
3.246000	16.4	9.000	Off	L1	9.8	29.6	46.0
3.282000	20.2	9.000	Off	L1	9.8	25.8	46.0
13.634000	19.7	9.000	Off	L1	10.1	30.3	50.0
13.644000	23.9	9.000	Off	L1	10.1	26.1	50.0
13.668000	19.0	9.000	Off	L1	10.1	31.0	50.0
13.696000	19.1	9.000	Off	L1	10.1	30.9	50.0
13.700000	20.0	9.000	Off	L1	10.1	30.0	50.0
13.724000	19.8	9.000	Off	L1	10.1	30.2	50.0

8/27/2015 12:39:12

Conducted Emissions (Line 2)

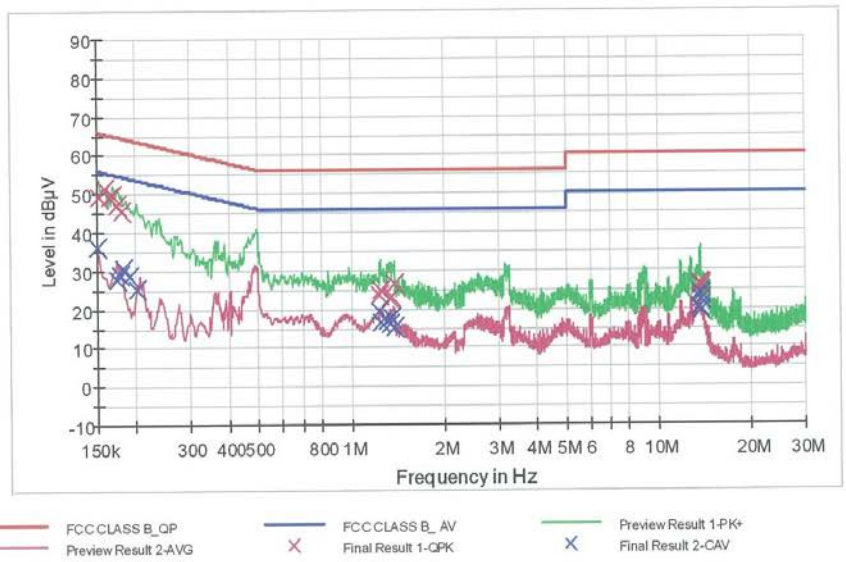
EMI Auto Test(10) 1 / 2

HCT TEST Report

Common Information

EUT:	LG-SBW61
Manufacturer:	LG
Test Site:	SHIELD ROOM
Operating Conditions:	BT LE MODE
Operator Name:	KS KANG

FCC CLASS B



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.152000	49.1	9.000	Off	N	9.6	16.8	65.9
0.158000	51.4	9.000	Off	N	9.6	14.2	65.6
0.164000	49.3	9.000	Off	N	9.6	16.0	65.3
0.168000	49.7	9.000	Off	N	9.6	15.5	65.1
0.174000	47.1	9.000	Off	N	9.6	17.7	64.8
0.180000	45.6	9.000	Off	N	9.6	18.9	64.5
1.238000	23.7	9.000	Off	N	9.7	32.3	56.0
1.242000	25.0	9.000	Off	N	9.7	31.0	56.0
1.338000	22.6	9.000	Off	N	9.7	33.4	56.0
1.342000	23.1	9.000	Off	N	9.7	32.9	56.0
1.350000	23.3	9.000	Off	N	9.7	32.7	56.0
1.376000	26.5	9.000	Off	N	9.7	29.5	56.0
13.588000	26.4	9.000	Off	N	10.1	33.6	60.0
13.600000	26.4	9.000	Off	N	10.1	33.6	60.0
13.610000	26.1	9.000	Off	N	10.1	33.9	60.0
13.664000	26.0	9.000	Off	N	10.1	34.0	60.0

8/27/2015 12:30:12

EMI Auto Test(10) 2 / 2

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
13.676000	25.9	9.000	Off	N	10.1	34.1	60.0
13.716000	25.7	9.000	Off	N	10.1	34.3	60.0

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	36.2	9.000	Off	N	9.6	19.8	56.0
0.174000	27.9	9.000	Off	N	9.6	26.9	54.8
0.178000	29.0	9.000	Off	N	9.6	25.6	54.6
0.182000	30.6	9.000	Off	N	9.6	23.8	54.4
0.190000	28.5	9.000	Off	N	9.6	25.5	54.0
0.202000	25.3	9.000	Off	N	9.6	28.2	53.5
1.238000	19.4	9.000	Off	N	9.7	26.6	46.0
1.242000	16.5	9.000	Off	N	9.7	29.5	46.0
1.310000	16.9	9.000	Off	N	9.7	29.1	46.0
1.328000	15.9	9.000	Off	N	9.7	30.1	46.0
1.342000	17.6	9.000	Off	N	9.7	28.4	46.0
1.374000	15.1	9.000	Off	N	9.7	30.9	46.0
13.588000	20.2	9.000	Off	N	10.1	29.8	50.0
13.600000	24.2	9.000	Off	N	10.1	25.8	50.0
13.664000	23.5	9.000	Off	N	10.1	26.5	50.0
13.704000	19.6	9.000	Off	N	10.1	30.4	50.0
13.716000	22.2	9.000	Off	N	10.1	27.8	50.0
13.720000	19.6	9.000	Off	N	10.1	30.4	50.0

8/27/2015 12:30:12

9. LIST OF TEST EQUIPMENT

9.1 LIST OF TEST EQUIPMENT(Conducted Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Rohde & Schwarz	ENV216/ LISN	01/13/2015	Annual	100073
Agilent	E4440A/ Spectrum Analyzer	03/18/2015	Annual	US45303008
Agilent	N9020A / SIGNAL ANALYZER	06/30/2015	Annual	MY51110085
Agilent	N9020A / SIGNAL ANALYZER	07/02/2015	Annual	MY50510304
Agilent	N1911A/Power Meter	07/09/2015	Annual	MY45100523
Agilent	N1921A /POWER SENSOR	07/09/2015	Annual	MY45241059
Agilent	87300B/Directional Coupler	12/08/2014	Annual	3116A03621
Hewlett Packard	11667B / Power Splitter	04/30/2015	Annual	11275
ITECH	IT6720 / DC POWER SUPPLY	11/04/2014	Annual	010002156287001199
Agilent	8493C / Attenuator(10 dB)	07/21/2015	Annual	07560

9.2 LIST OF TEST EQUIPMENT(Radiated Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Schwarzbeck	VULB 9160/ TRILOG Antenna	10/10/2014	Biennial	3368
HD	MA240/ Antenna Position Tower	N/A	N/A	556
EMCO	1050/ Turn Table	N/A	N/A	114
HD GmbH	HD 100/ Controller	N/A	N/A	13
HD GmbH	KMS 560/ SlideBar	N/A	N/A	12
CERNEX	CBL18265035 / POWER AMP	07/27/2015	Annual	22966
Schwarzbeck	BBHA 9120D/ Horn Antenna	05/07/2015	Biennial	937
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	04/30/2015	Biennial	BBHA9170124
Rohde & Schwarz	FSP / Spectrum Analyzer	10/23/2014	Annual	836650/016
Wainwright Instrument	WHF3.0/18G-10EF / High Pass Filter	06/28/2015	Annual	8
Wainwright Instrument	WRCJ2400/2483.5-2370/2520-60/14SS / Band Reject Filter	06/15/2015	Annual	1
Rohde & Schwarz	LOOP ANTENNA	09/03/2014	Biennial	1513-175
CERNEX	CBL06185030 / POWER AMP	07/21/2015	Annual	22965
CERNEX	CBLU1183540 / POWER AMP	07/21/2015	Annual	22964