HCT CO.,LTD. 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383.Rep. of KOREA
TEL: +82-31-645-6300 **FAX: +82-31-645-6401**

FCC / ISED BT LE REPORT

Certification

Applicant Name:
LG Electronics Inc.

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

Date of Issue:
July 20, 2018
Test Site/Location:
HCT CO., LTD., 74,Seoicheon-ro 578beon-gil,Majang-myeo,Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA
Report No.: HCT-RF-1807-FI014
ISED Registration Number: 5944A-6

FCC ID:	**BEJLGSBWAC92**
ISED:	**2703H-LGSBWAC92**
APPLICANT:	**LG Electronics Inc.**

Model:	LGSBWAC92
EUT Type:	RF Module
RF Peak Output Power:	5.0 LE: 1M PHY / 7.707 dBm (5.898 mW) 5.0 LE: 2M PHY / 7.683 dBm (5.865 mW) 5.0 LE: Coded PHY_S8 / 7.688 dBm (5.872 mW)
Frequency Range:	2402 MHz -2480 MHz
Modulation type	GFSK
FCC Classification:	Digital Transmission System(DTS)
FCC Rule Part(s):	Part 15.247
ISED Rule Part(s):	RSS-247 Issue 2 (February 2017), RSS-Gen Issue 5(April 2018)

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 : Se Wook Park
Engineer of Telecommunication testing center

Approved by : Jong Seok Lee
Manager of Telecommunication testing center

Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-RF-1807-FI014	July 20, 2018	- First Approval Report

Table of Contents

1. GENERAL INFORMATION

Applicant:	LG Electronics Inc.
Address:	222, LG-ro, Jinwi-myeon, Pyeongtaek-si, Gyeonggi-do,451-713, Korea
FCC ID:	BEJLGSBWAC92
IC:	2703H-LGSBWAC92
EUT Type:	RF Module
Model:	LGSBWAC92
Date(s) of Tests:	May 11, 2018 ~ July 20, 2018
Place of Tests:	HCT Co., Ltd. 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea

2. EUT DESCRIPTION

Model	LGSBWAC92	
EUT Type	RF Module	
Power Supply	3.30 V	
Frequency Range	TX: 2402 MHz ~ 2480 MHz RX: 2402 MHz ~ 2480 MHz	
Max. RF Output Power	Peak	5.0 LE: 1M PHY / 7.707 dBm (5.898 mW) 5.0 LE: 2M PHY / 7.683 dBm (5.865 mW) 5.0 LE: Coded PHY_S8 / 7.688 dBm (5.872 mW)
	Average	5.0 LE: 1M PHY / 7.52 dBm (5.652 mW) 5.0 LE: 2M PHY / 7.59 dBm (5.737 mW) 5.0 LE: Coded PHY_S8 / 7.42 dBm (5.515 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: Internal Antenna Peak Gain : 0.49 dBi	

3. TEST METHODOLOGY

FCC KDB 558074 D01 DTS Meas Guidance v04 dated April 5, 2017 entitled “Guidance for Performing Compliance Measurements on Digital Transmission Systems(DTS) and the measurement procedure described in ANSI C63.10(Version : 2013) ‘the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices’.

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 / RSS-Gen issue 5, RSS-247 issue 2.

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 3.75 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 v04)

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.
Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

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 / RSS-Gen(Issue 5) Section 8:

“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.”

*This module has SMA type antenna connector, not unique coupling. So it`s subject to Limited singl e-modular transmitter.
*The OEM manufacturer who will install this module into their device must not give an access to an tenna and connector by end-user in compliance with FCC Section 15.203.

7. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.71

.

8. SUMMARY TEST OF RESULTS

8.1 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 9.8		PASS
Radiated Spurious Emissions	§15.205, 15.209	cf. Section 9.7.1	RADIATED	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	cf. Section 9.7.2		PASS

8.2 ISED Part

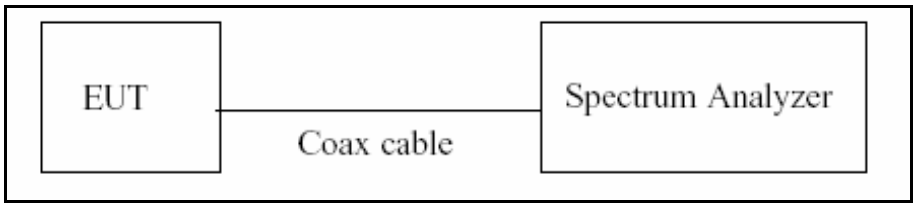
Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	RSS-247, 5.2	> 500 kHz	CONDUCTED	PASS
99% Bandwidth	RSS-GEN, 6.7	NA		NA
Conducted Maximum Peak Output Power And e.i.r.p.	RSS-247, 5.4.4	< 1 Watt <4 Watt(e.i.r.p.)		PASS
Power Spectral Density	RSS-247, 5.2	< 8 dBm / 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 4		PASS
Radiated Spurious Emissions	RSS-GEN, 8.9	RSS-GEN section 8.9 table 5, 6	RADIATED	PASS
Receiver Spurious Emissions	RSS-GEN, 5 RSS-GEN, 7.3	RSS-GEN section 7.3 table 3		PASS
Radiated Restricted Band Edge	RSS-GEN, 8.10	RSS-GEN section 8.10 table 7		PASS

9. TEST RESULT

9.1 DUTY CYCLE

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 according to the zero-span measurement method, 6.0)b) in KDB 558074 v04.

The largest available 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)

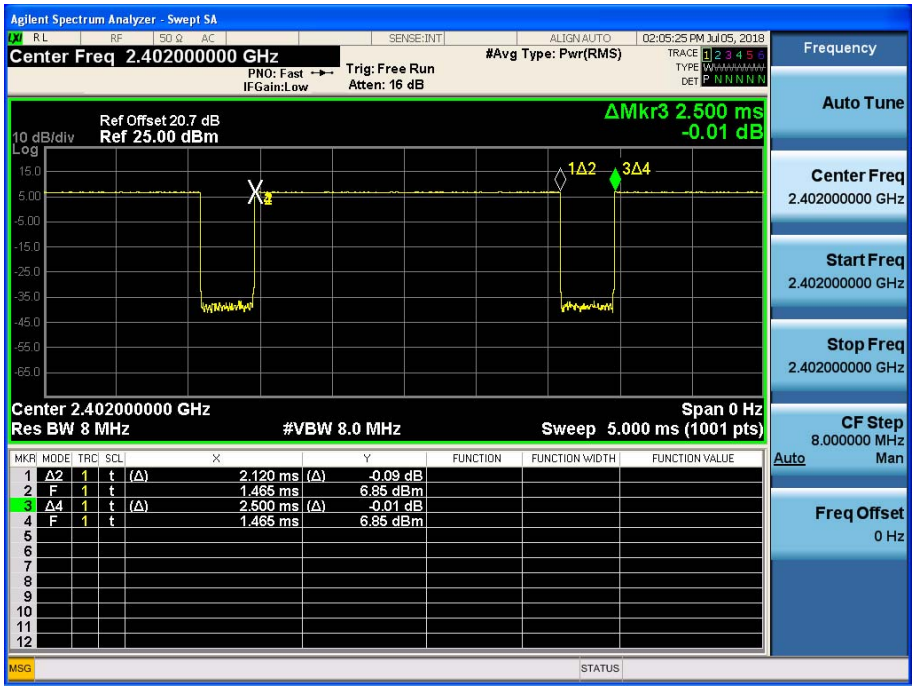
The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

1. RBW = 8 MHz (the largest available 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)

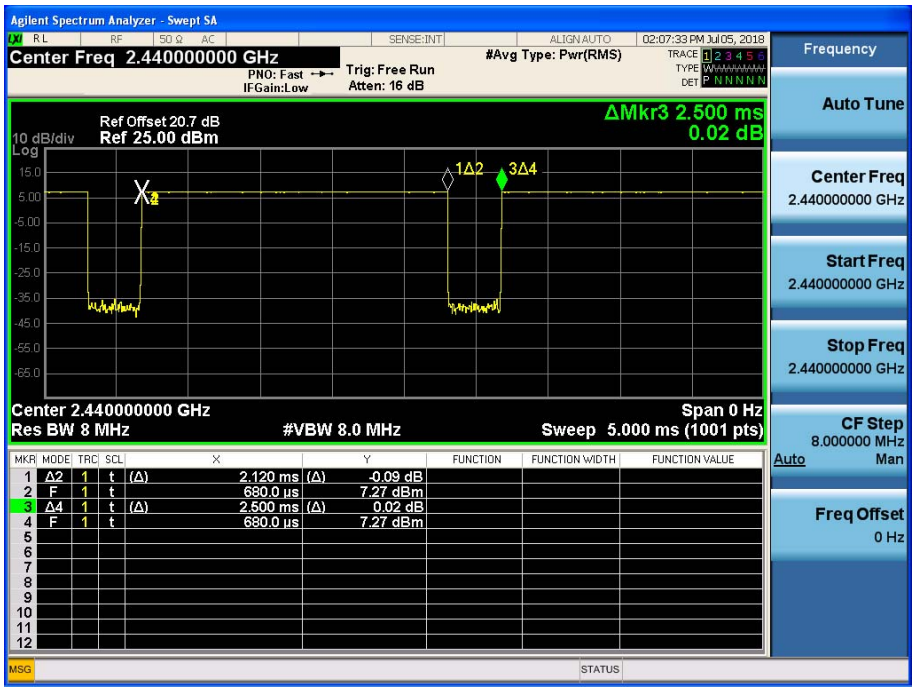
LE Mode	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
Bluetooth Version : 5.0 LE: 1M PHY	**2.1200**	**2.5000**	**0.8480**	**0.72**
Bluetooth Version : 5.0 LE: 2M PHY	**1.0650**	**1.8750**	**0.5680**	**2.46**
Bluetooth Version : 5.0 LE: Coded PHY_S8	**2.1250**	**2.5000**	**0.8500**	**0.71**

▣ 5.0 LE: 1M PHY Duty Cycle RESULT PLOTS

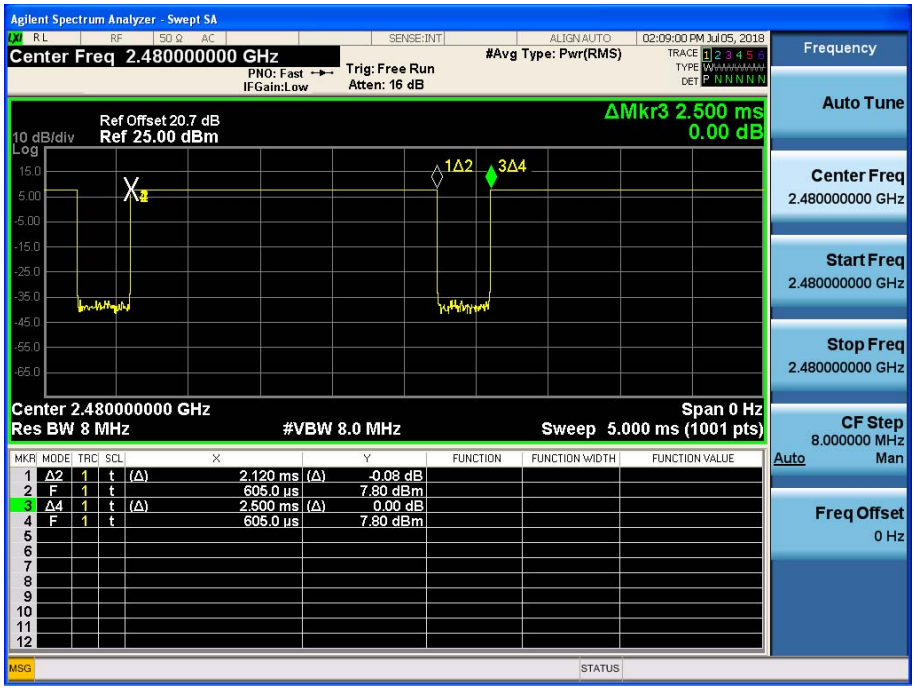
Low-CH 0



Mid-CH 19

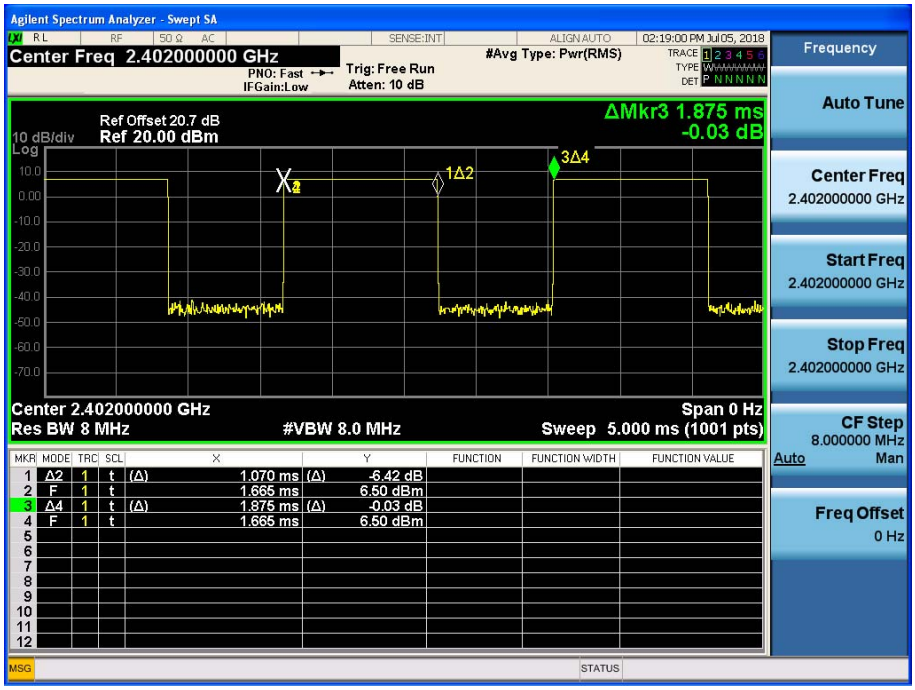


High-CH 39


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 16 dB
#Avg Type: Pwr(RMS)
02:09:00 PM Jul 05, 2018
Ref Offset 20.7 dB
10 dB/div
Ref 25.00 dBm
Log
ΔMkr3 2.500 ms
0.00 dB
1Δ2
3Δ4
Center 2.480000000 GHz
Res BW 8 MHz
#VBW 8.0 MHz
Span 0 Hz
Sweep 5.000 ms (1001 pts)
1 Δ2 1 t (Δ) 2.120 ms (Δ) -0.08 dB
2 F 1 t 605.0 µs 7.80 dBm
3 Δ4 1 t (Δ) 2.500 ms (Δ) 0.00 dB
4 F 1 t 605.0 µs 7.80 dBm
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.480000000 GHz
Stop Freq
2.480000000 GHz
CF Step
8.000000 MHz
Auto
Man
Freq Offset
0 Hz

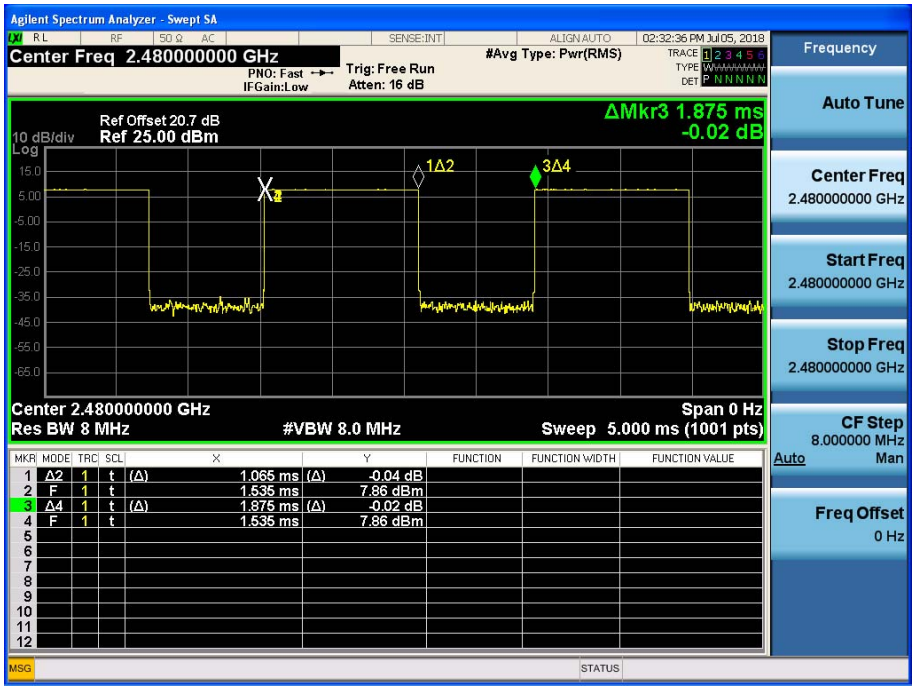
▣ 5.0 LE: 2M PHY Duty Cycle RESULT PLOTS

Low-CH 0



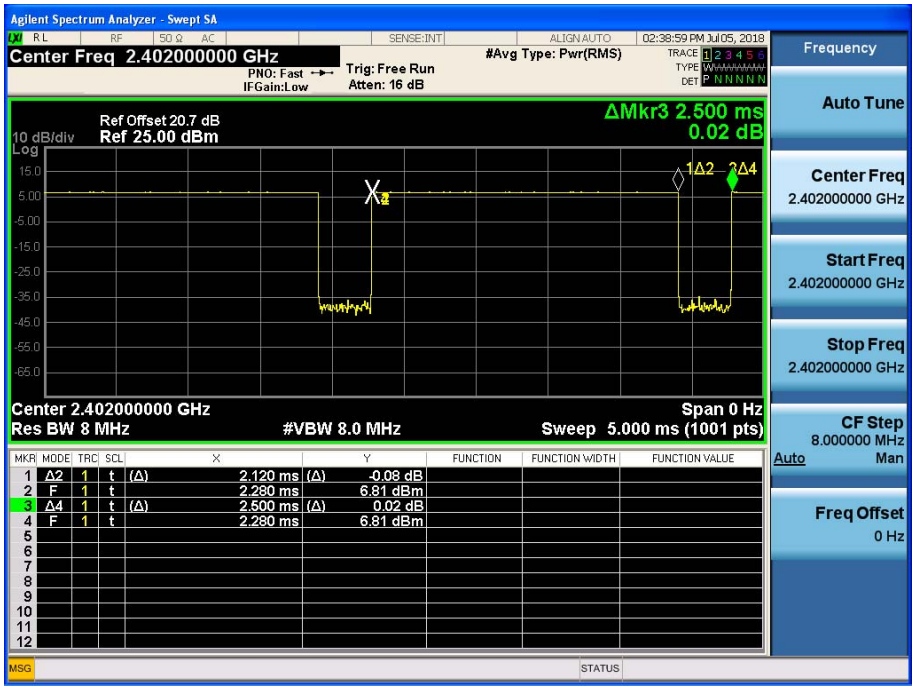
Mid-CH 19

High-CH 39

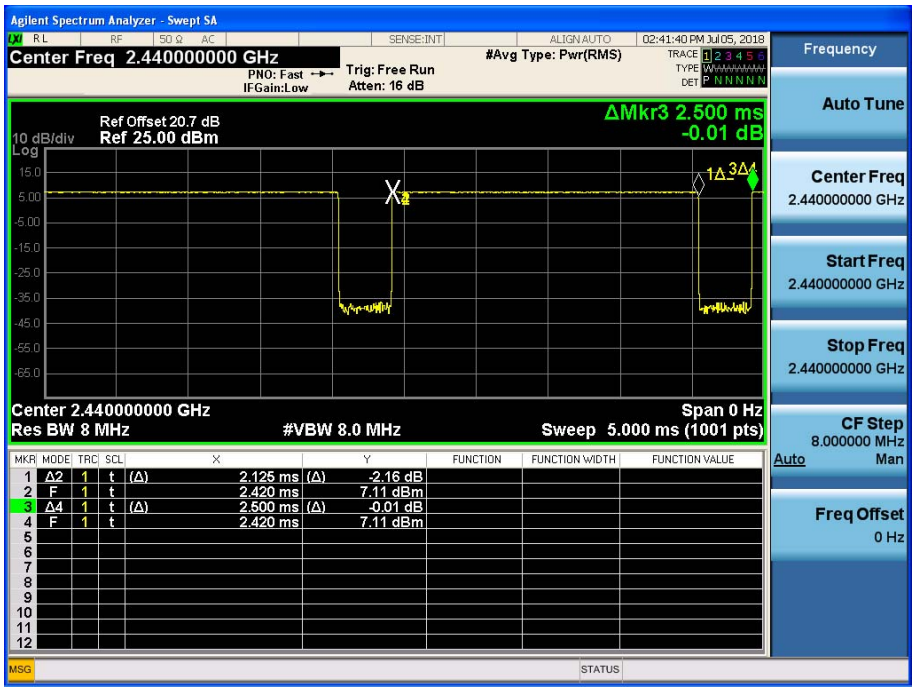

Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 16 dB
#Avg Type: Pwr(RMS)
02:32:36 PM Jul 05, 2018
Ref Offset 20.7 dB
10 dB/div
Log
Ref 25.00 dBm
ΔMkr3 1.875 ms
-0.02 dB
1Δ2
3Δ4
Center 2.480000000 GHz
Res BW 8 MHz
#VBW 8.0 MHz
Span 0 Hz
Sweep 5.000 ms (1001 pts)
1 Δ2 1 t (Δ) 1.065 ms (Δ) -0.04 dB
2 F 1 t 1.535 ms 7.86 dBm
3 Δ4 1 t (Δ) 1.875 ms (Δ) -0.02 dB
4 F 1 t 1.535 ms 7.86 dBm
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.480000000 GHz
Stop Freq
2.480000000 GHz
CF Step
8.000000 MHz
Auto
Man
Freq Offset
0 Hz

▣ 5.0 LE: Coded PHY_S8 Duty Cycle RESULT PLOTS

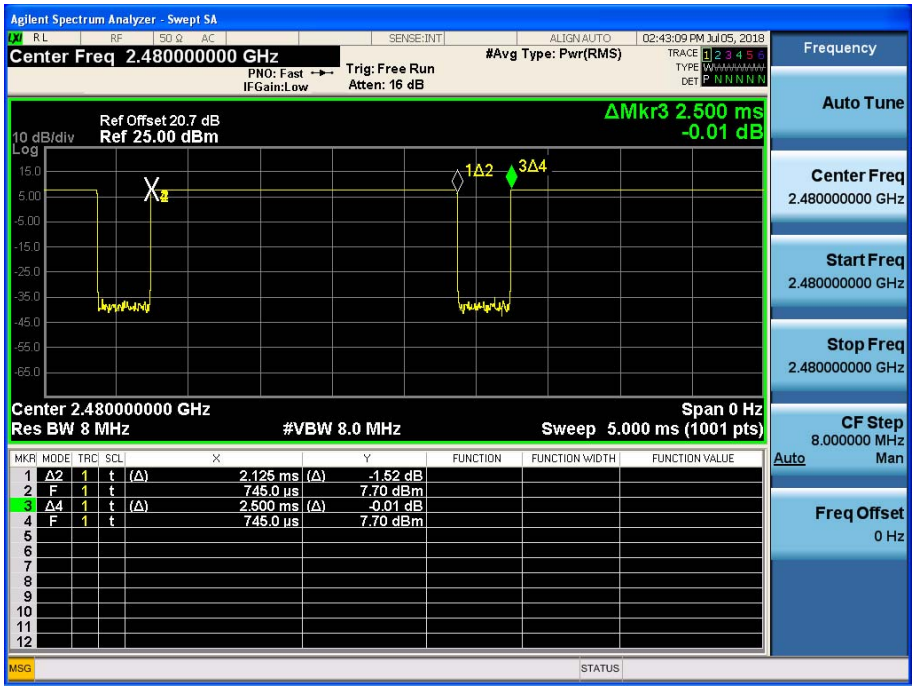
Low-CH 0



Mid-CH 19



High-CH 39


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 16 dB
#Avg Type: Pwr(RMS)
02:43:09 PM Jul 05, 2018
Ref Offset 20.7 dB
10 dB/div
Log
Ref 25.00 dBm
ΔMkr3 2.500 ms
-0.01 dB
1Δ2
3Δ4
Center 2.480000000 GHz
Res BW 8 MHz
#VBW 8.0 MHz
Span 0 Hz
Sweep 5.000 ms (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 Δ2 1 t (Δ) 2.125 ms (Δ) -1.52 dB
2 F 1 t 745.0 µs 7.70 dBm
3 Δ4 1 t (Δ) 2.500 ms (Δ) -0.01 dB
4 F 1 t 745.0 µs 7.70 dBm
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.480000000 GHz
Stop Freq
2.480000000 GHz
CF Step
8.000000 MHz
Auto
Man
Freq Offset
0 Hz
MSG
STATUS

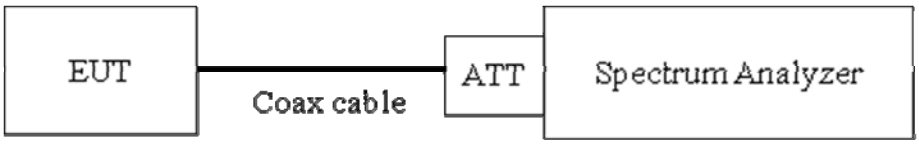
9.2 6 dB BANDWIDTH MEASUREMENT

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

The bandwidth at 6 dB 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 6 dB 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 v04)

RBW = 100 kHz

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

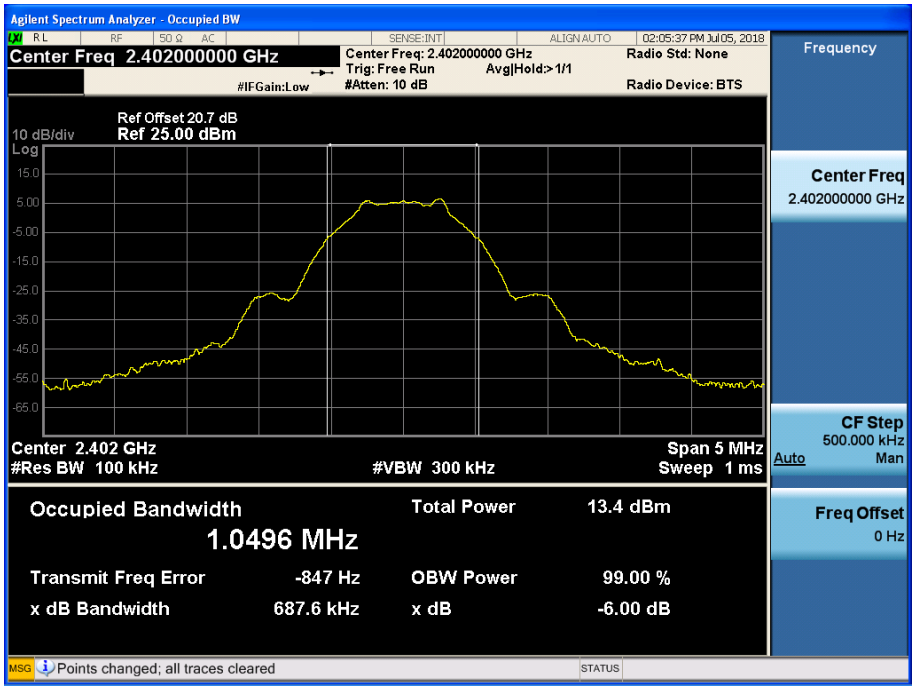
Note : We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

▣ TEST RESULT

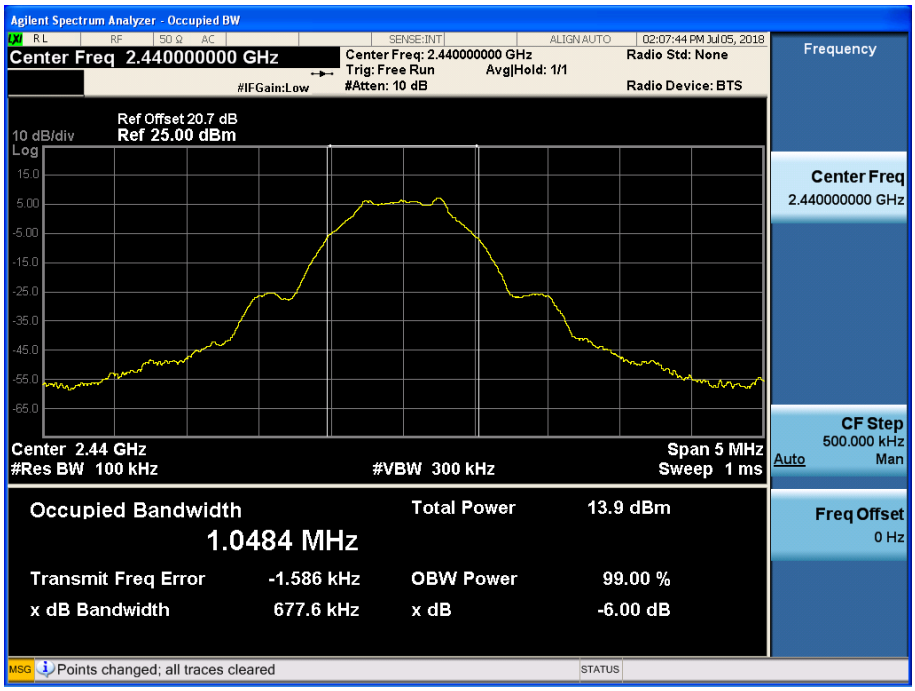
Mode	Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Pass/Fail
5.0 LE: 1M PHY	0	687.6	> 500	Pass
	19	677.6		Pass
	39	678.8		Pass
5.0 LE: 2M PHY	0	1246.8	> 500	Pass
	19	1246.2		Pass
	39	1245.1		Pass
5.0 LE: Coded PHY_S8	0	679.5	> 500	Pass
	19	681.6		Pass
	39	677.6		Pass

▣ 5.0 LE: 1M PHY RESULT PLOTS

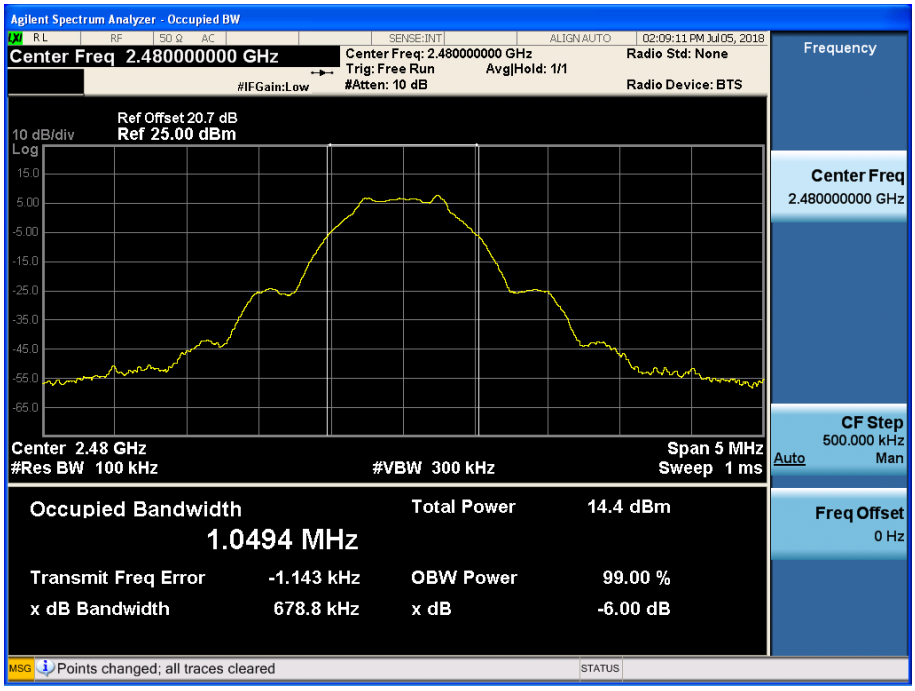
6 dB Bandwidth plot (Low-CH 0)



6 dB Bandwidth plot (Mid-CH 19)

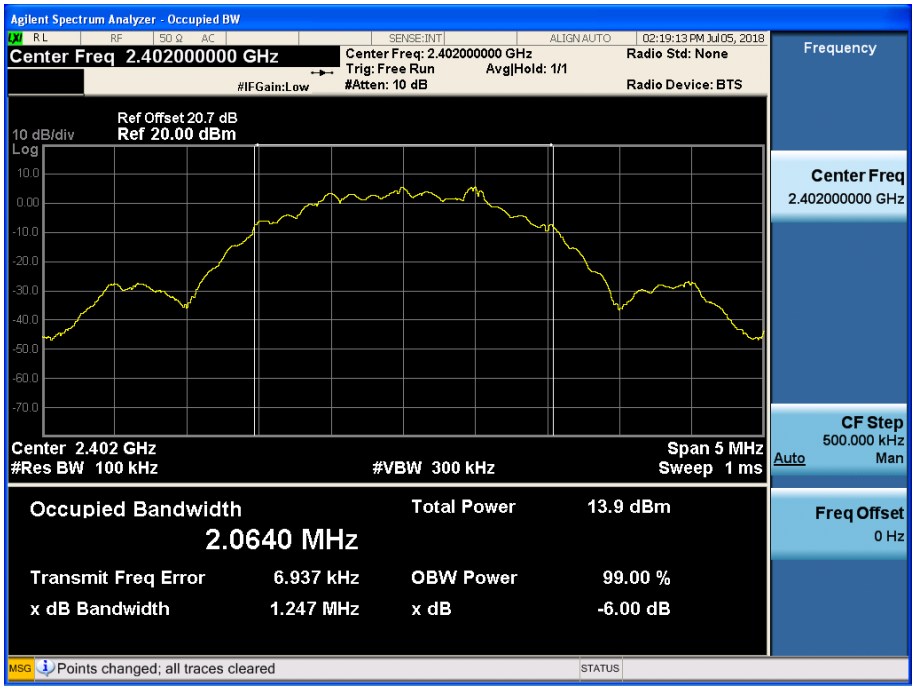


6 dB Bandwidth plot (High-CH 39)

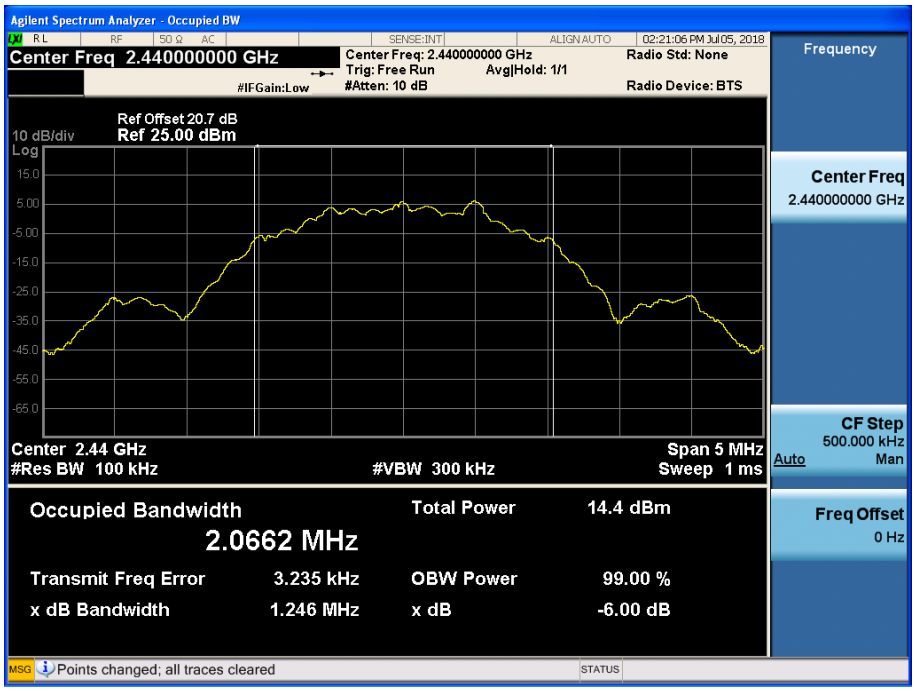


▣ 5.0 LE: 2M PHY RESULT PLOTS

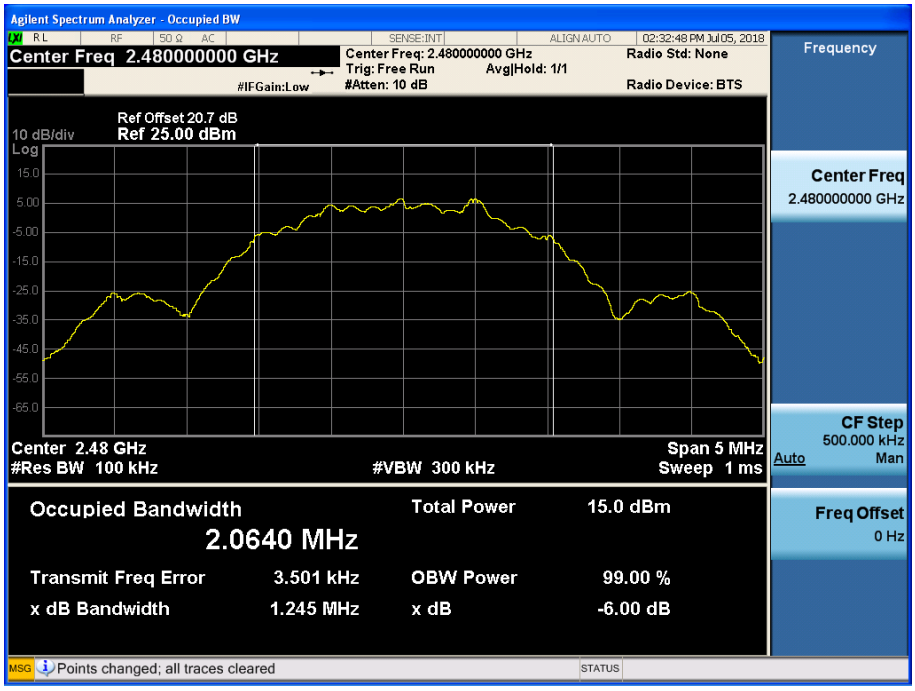
6 dB Bandwidth plot (Low-CH 0)



6 dB Bandwidth plot (Mid-CH 19)

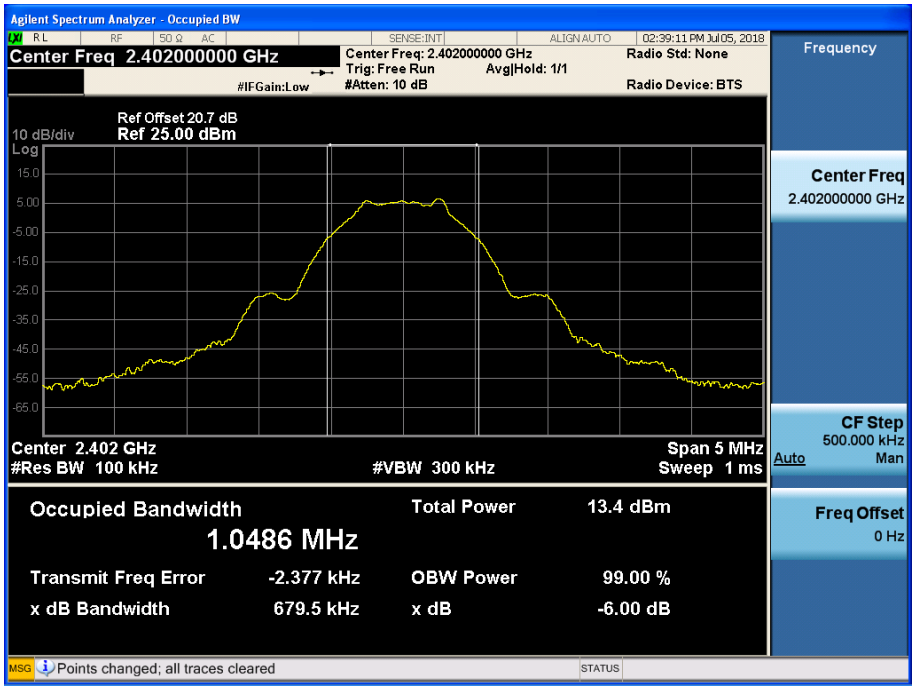


6 dB Bandwidth plot (High-CH 39)

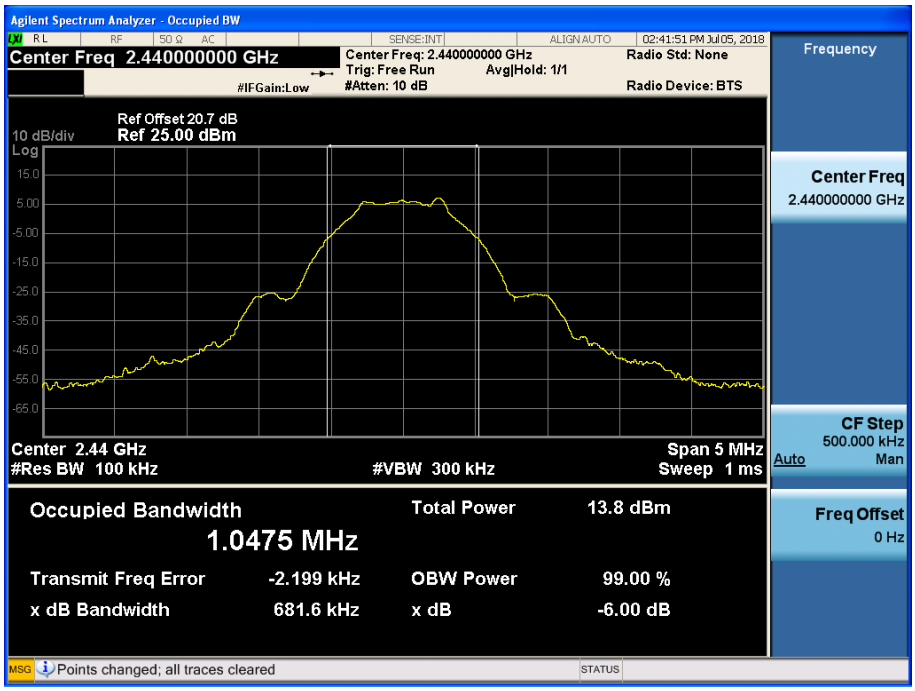


▣ 5.0 LE: Coded PHY_S8 RESULT PLOTS

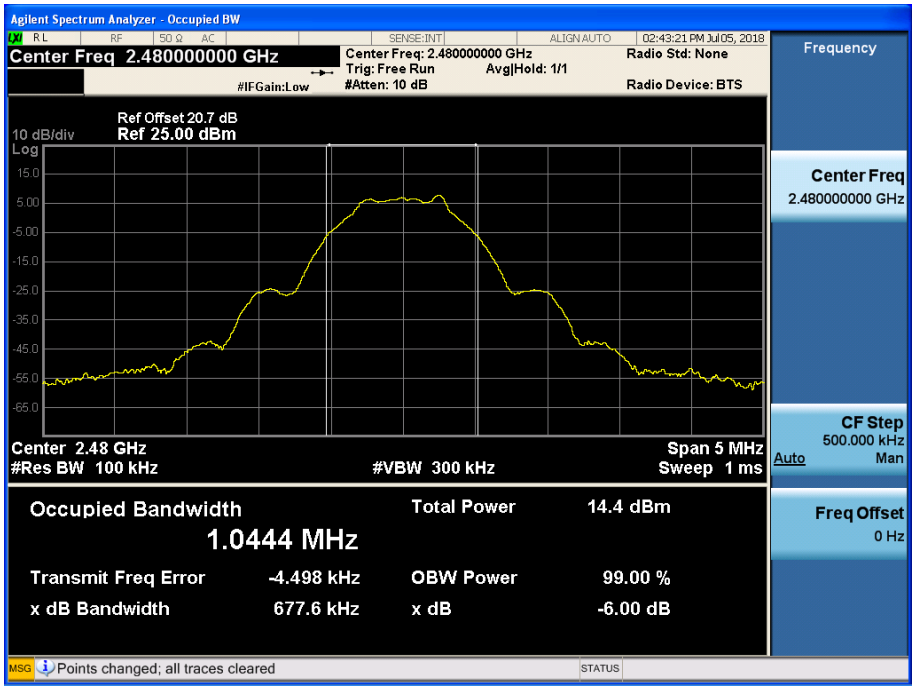
6 dB Bandwidth plot (Low-CH 0)



6 dB Bandwidth plot (Mid-CH 19)



6 dB Bandwidth plot (High-CH 39)

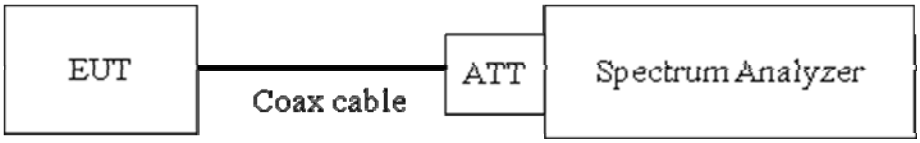


9.3 99% BANDWIDTH

Limit, RSS-Gen(Issue 5) Section 6.7

The 99 % bandwidth is used to determine the conducted power limits.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer.

RBW = 1% ~ 5% of the occupied bandwidth
VBW ≒ 3 x RBW
Detector = Peak
Trace mode = max hold
Sweep = auto couple
Allow the trace to stabilize

Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

▣ 5.0 LE: 1M PHY TEST RESULTS

Conducted 99% Bandwidth Measurements for LE Mode

LE Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
2402	0	1.0275
2440	19	1.0293
2480	39	1.0305

▣ 5.0 LE: 2M PHY TEST RESULTS

Conducted 99% Bandwidth Measurements for LE Mode

LE Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
2402	0	2.0707
2440	19	2.0676
2480	39	2.0694

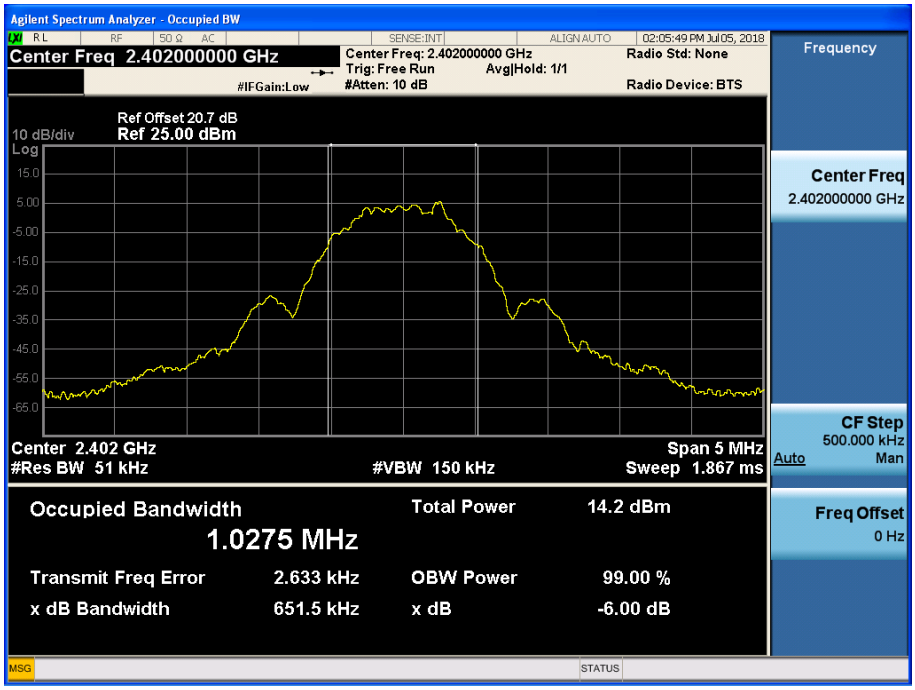
▣ 5.0 LE: Coded PHY_S8 TEST RESULTS

Conducted 99% Bandwidth Measurements for LE Mode

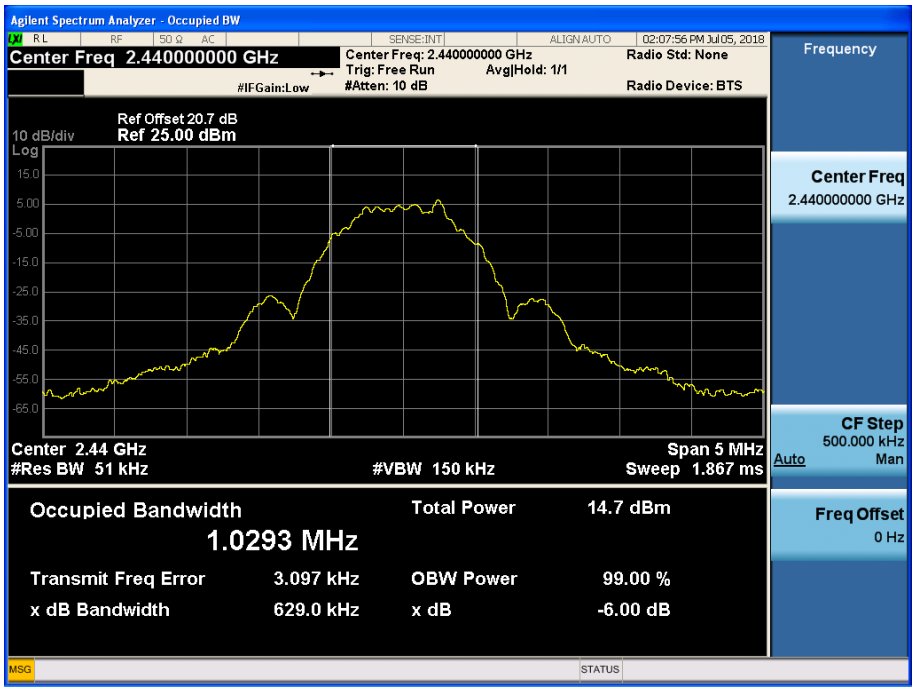
LE Mode		Measured Bandwidth [MHz]
Frequency [MHz]	Channel No.	
2402	0	1.0305
2440	19	1.0301
2480	39	1.0308

▣ 5.0 LE: 1M PHY RESULT PLOTS

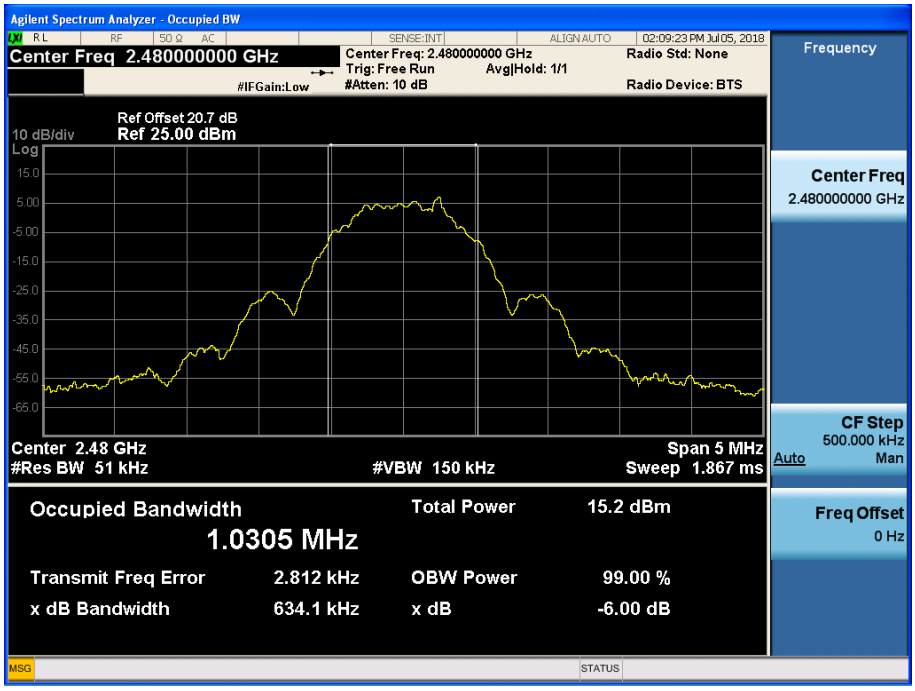
99% Bandwidth plot (Low-CH 0)



99% Bandwidth plot (Mid-CH 19)

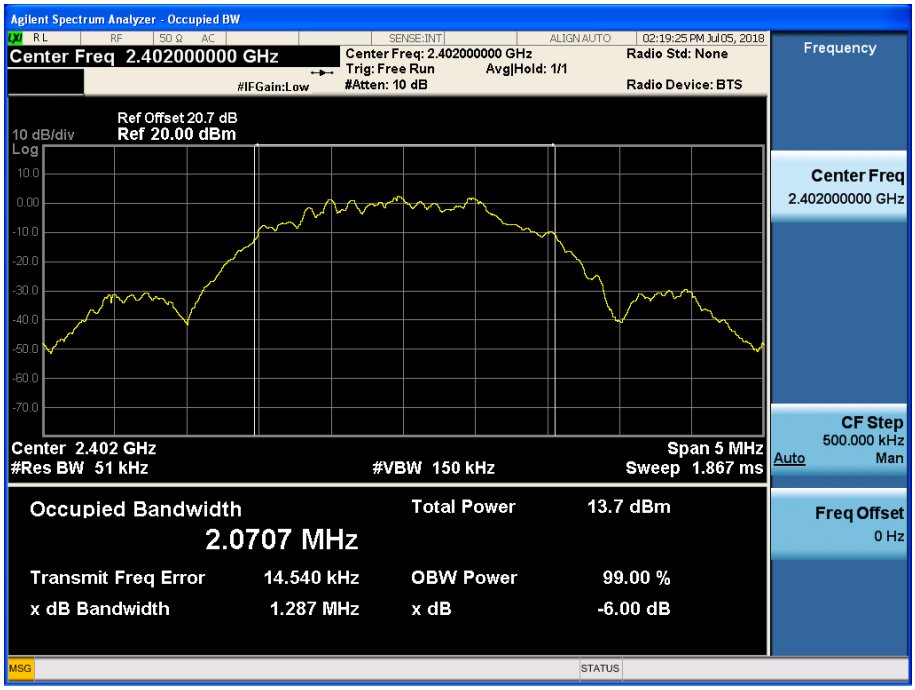


99% Bandwidth plot (High-CH 39)

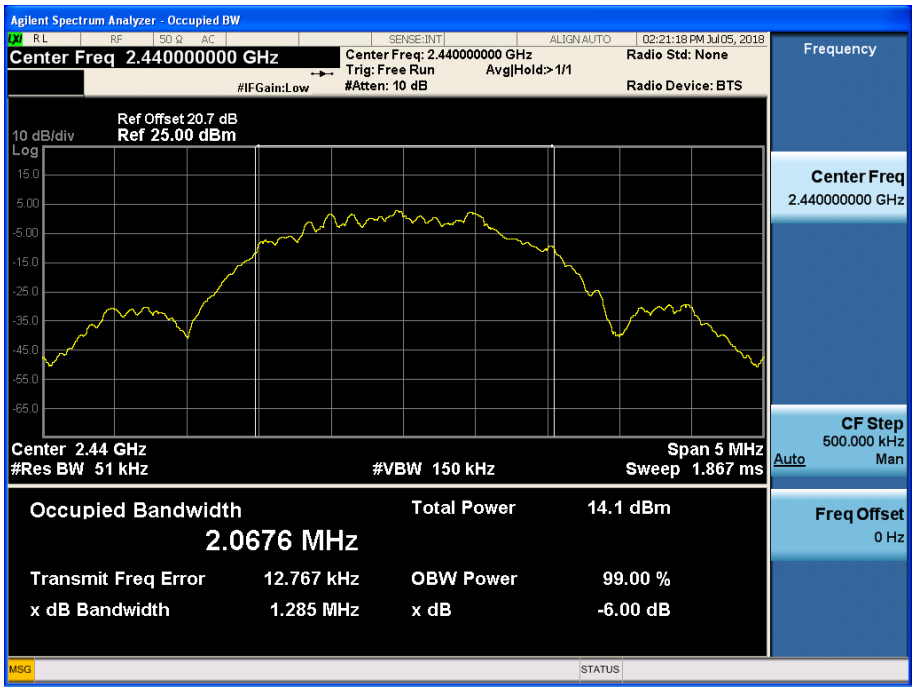


▣ 5.0 LE: 2M PHY RESULT PLOTS

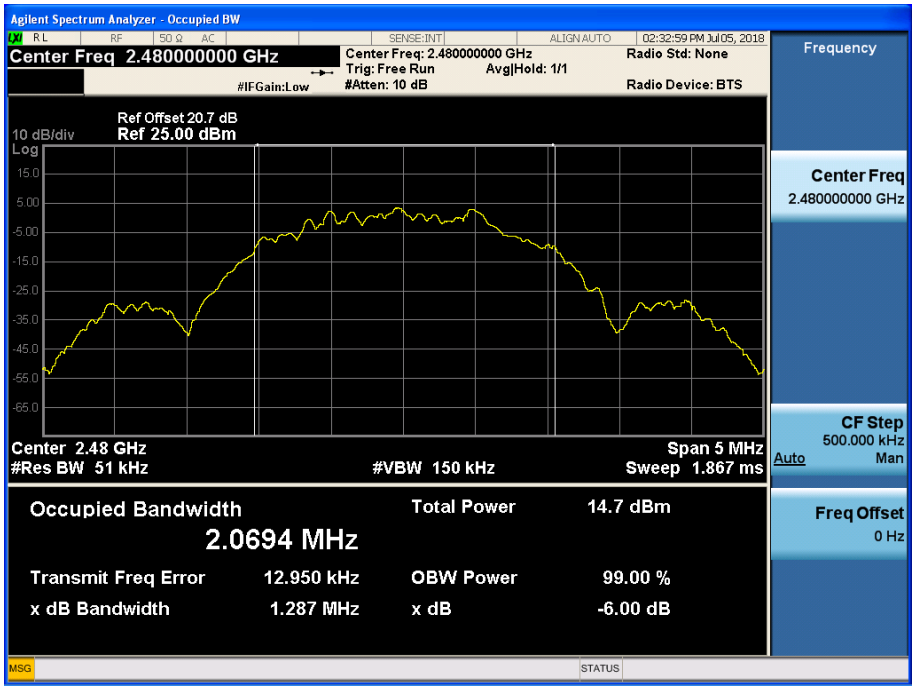
99% Bandwidth plot (Low-CH 0)



99% Bandwidth plot (Mid-CH 19)

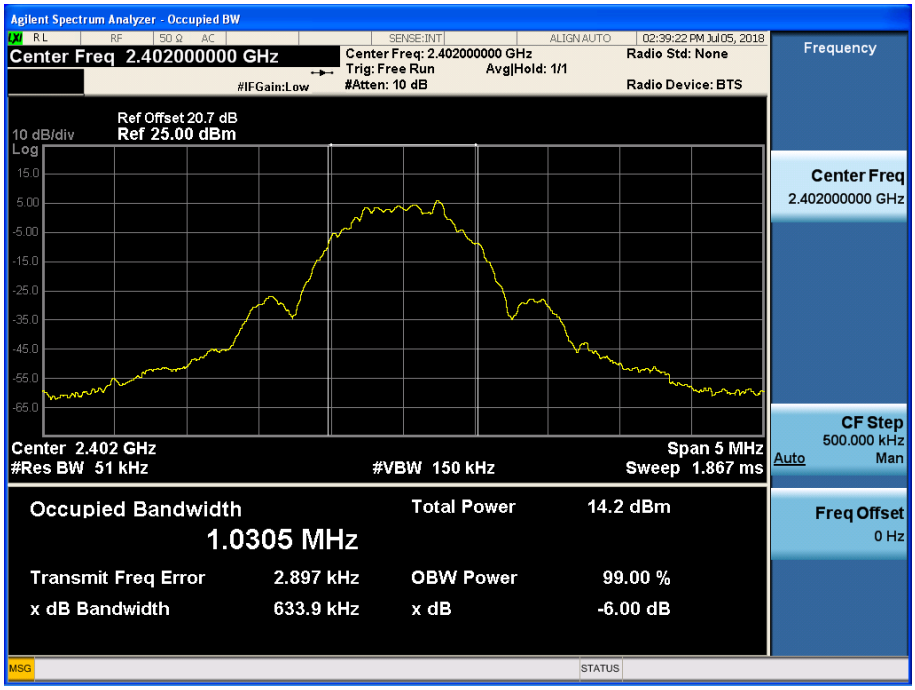


99% Bandwidth plot (High-CH 39)

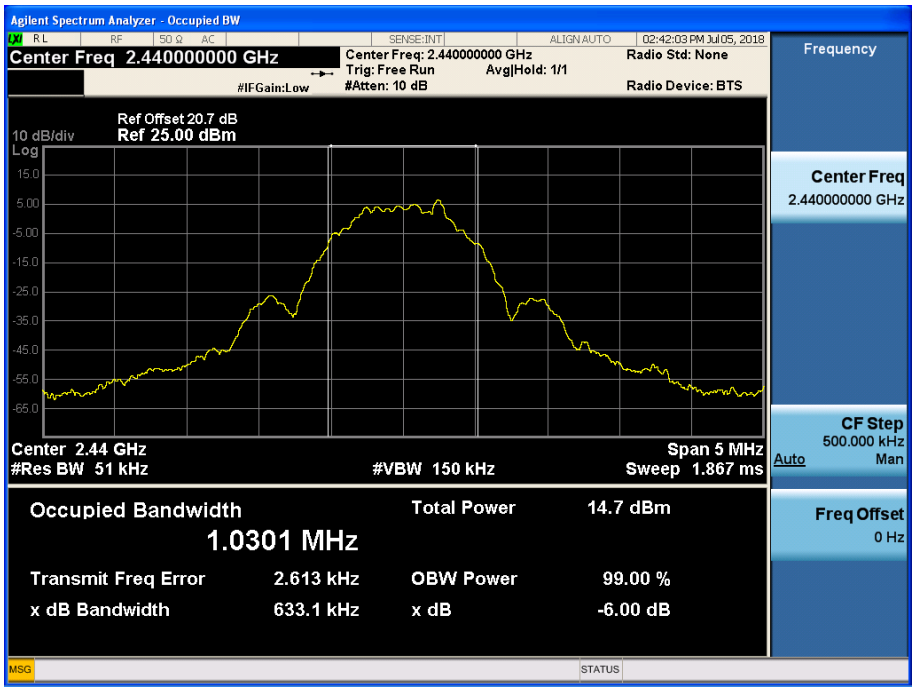


▣ 5.0 LE: Coded PHY_S8 RESULT PLOTS

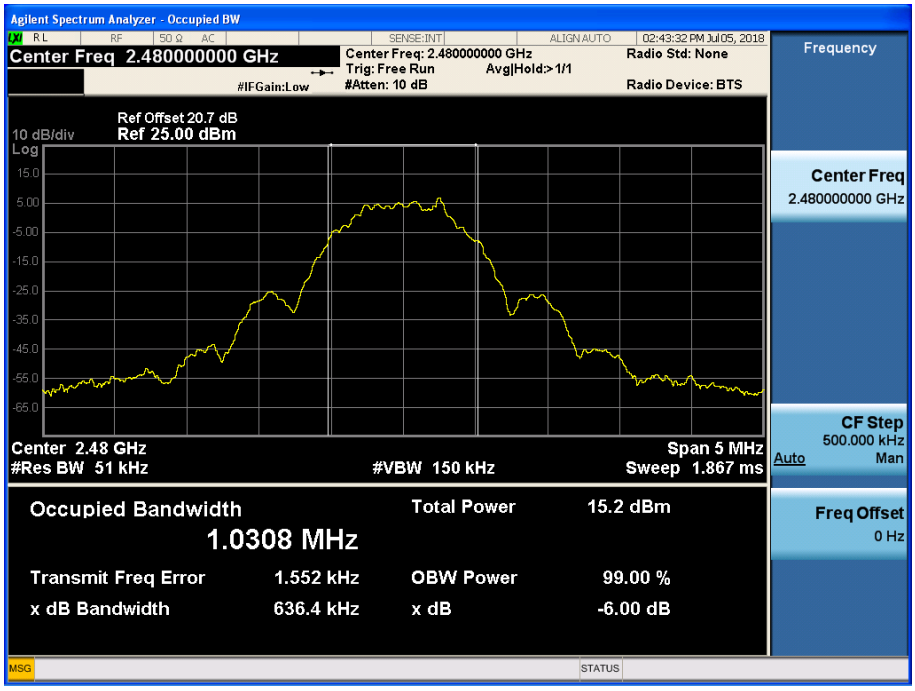
99% Bandwidth plot (Low-CH 0)



99% Bandwidth plot (Mid-CH 19)



99% Bandwidth plot (High-CH 39)



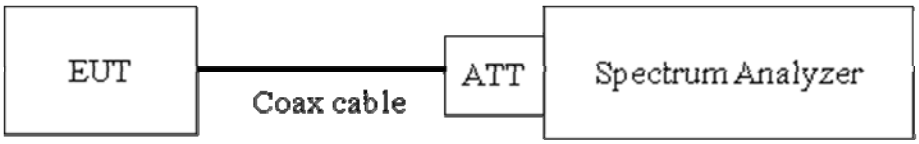
9.4 OUTPUT POWER MEASUREMENT

Test Requirements and limit, §15.247(b)(3) / RSS-247(Issue2) Section 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 v04)

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 v04)

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, 10.7 dB is offset for 2.4 GHz Band.

▣ 5.0 LE: 1M PHY TEST RESULTS-Peak

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Limit (dBm)
Frequency[MHz]	Channel No.		
2402	0	6.714	30
2440	19	7.160	30
2480	39	7.707	30

▣ TEST RESULTS-Average

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Duty Cycle Factor (dB)	Measured Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)
Frequency[MHz]	Channel No.				
2402	0	5.78	0.72	6.50	30
2440	19	6.23	0.72	6.94	30
2480	39	6.81	0.72	7.52	30

▣ 5.0 LE: 2M PHY TEST RESULTS-Peak

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Limit (dBm)
Frequency[MHz]	Channel No.		
2402	0	6.653	30
2440	19	7.097	30
2480	39	7.683	30

▣ TEST RESULTS-Average

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Duty Cycle Factor (dB)	Measured Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)
Frequency[MHz]	Channel No.				
2402	0	4.16	2.46	6.62	30
2440	19	4.53	2.46	6.98	30
2480	39	5.13	2.46	7.59	30

▣ 5.0 LE: Coded PHY_S8 TEST RESULTS-Peak

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Limit (dBm)
Frequency[MHz]	Channel No.		
2402	0	6.703	30
2440	19	7.128	30
2480	39	7.688	30

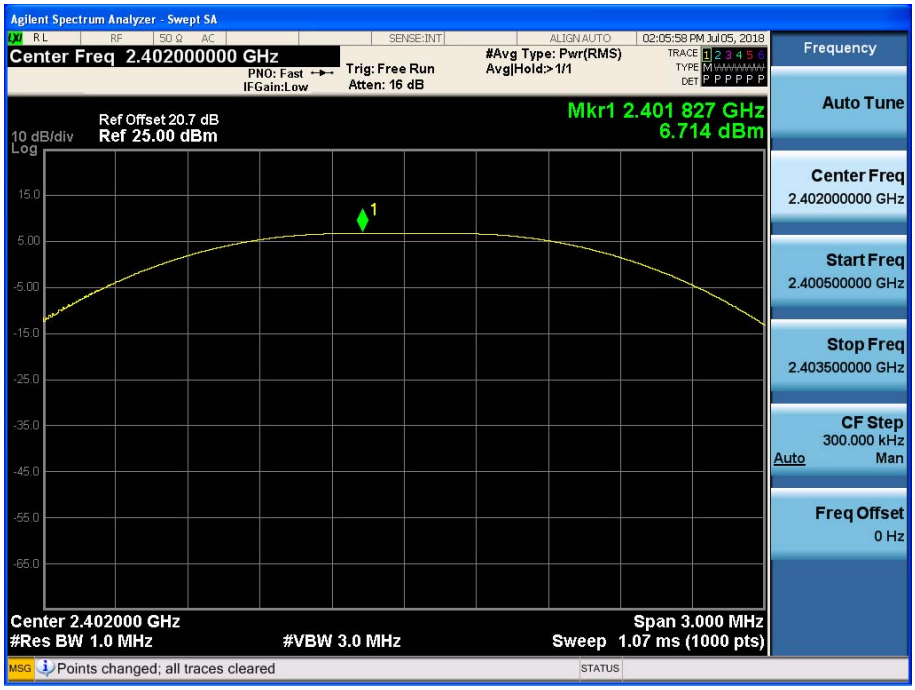
▣ TEST RESULTS-Average

Conducted Output Power Measurements

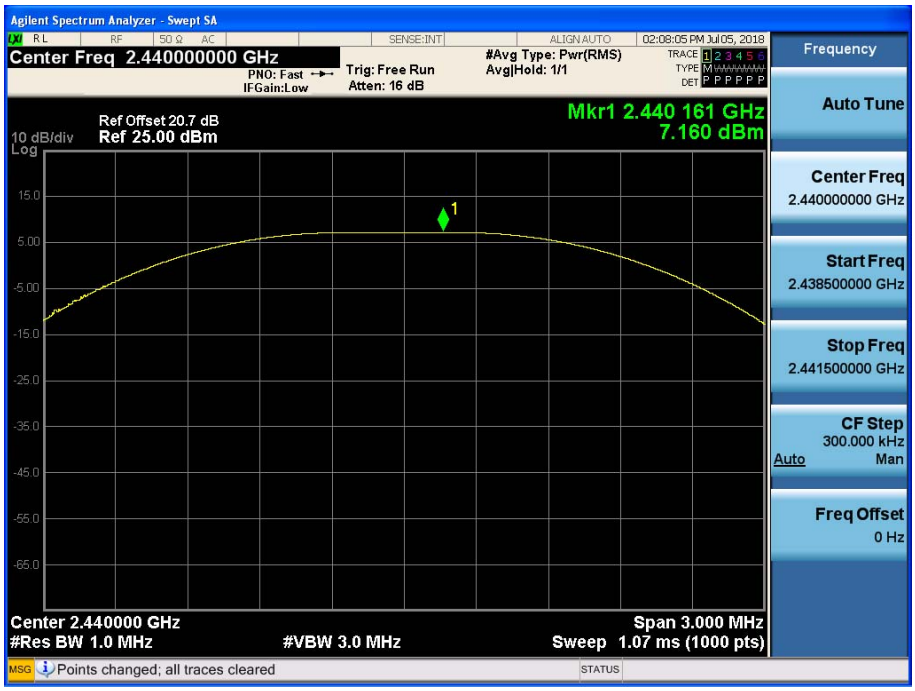
LE Mode		Measured Power(dBm)	Duty Cycle Factor (dB)	Measured Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)
Frequency[MHz]	Channel No.				
2402	0	5.93	0.71	6.64	30
2440	19	6.35	0.71	7.06	30
2480	39	6.71	0.71	7.42	30

▣ 5.0 LE: 1M PHY RESULT PLOTS-Peak

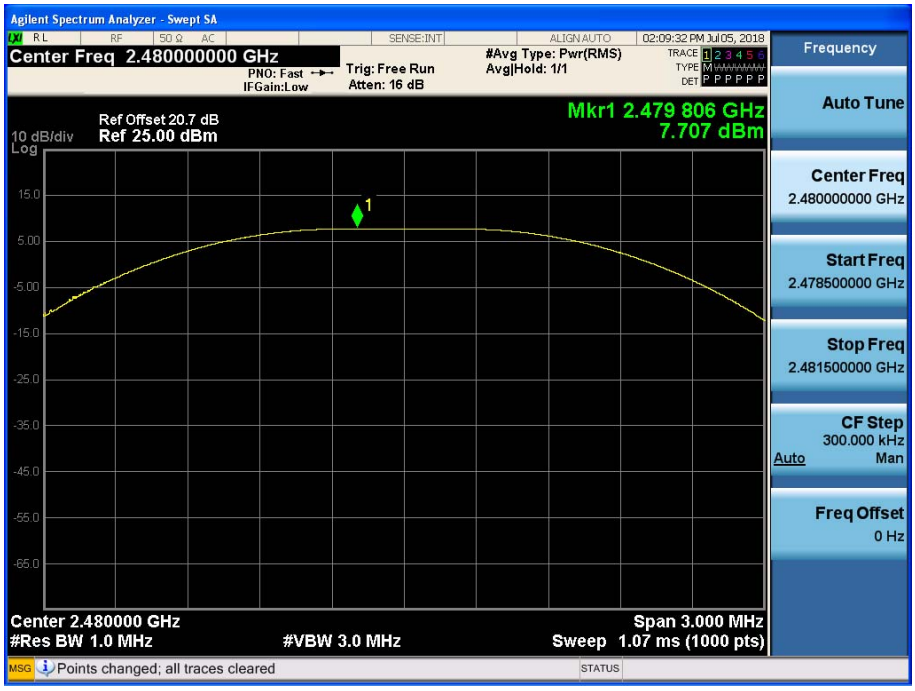
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

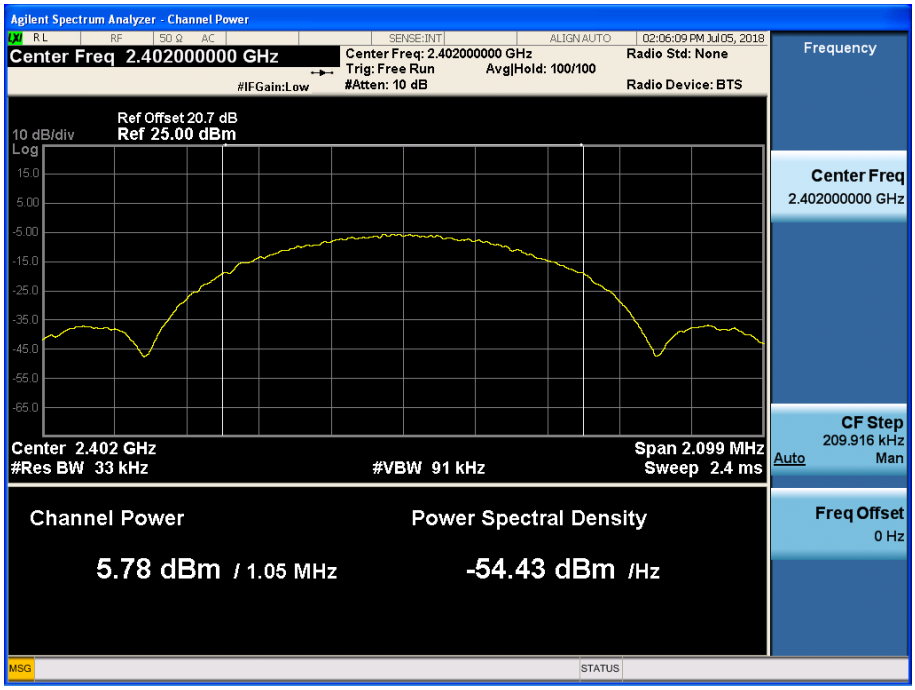


Conducted Output Power (High-CH 39)

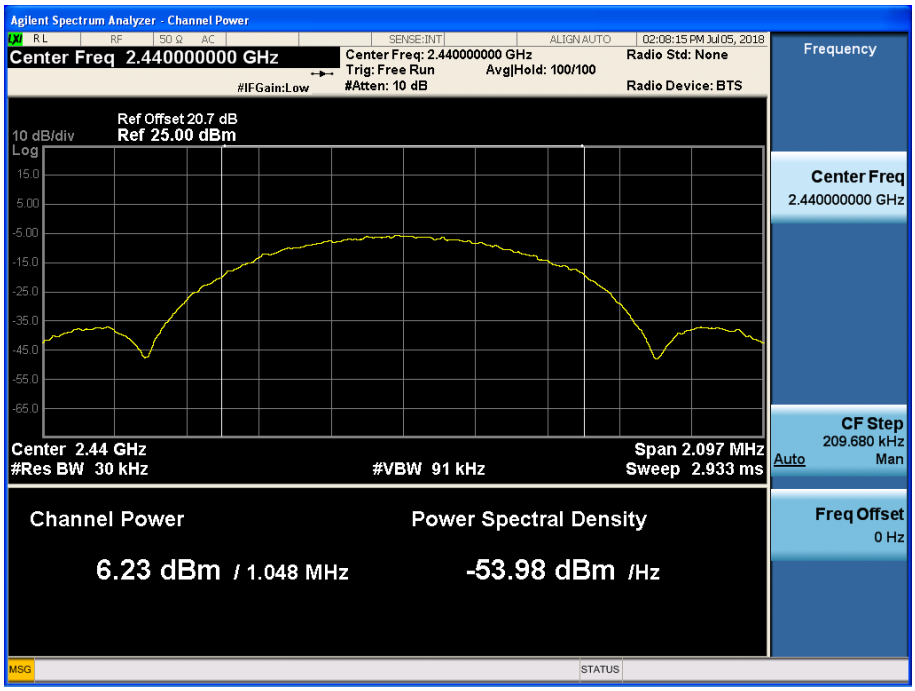


▣ 5.0 LE: 1M PHY RESULT PLOTS-Average

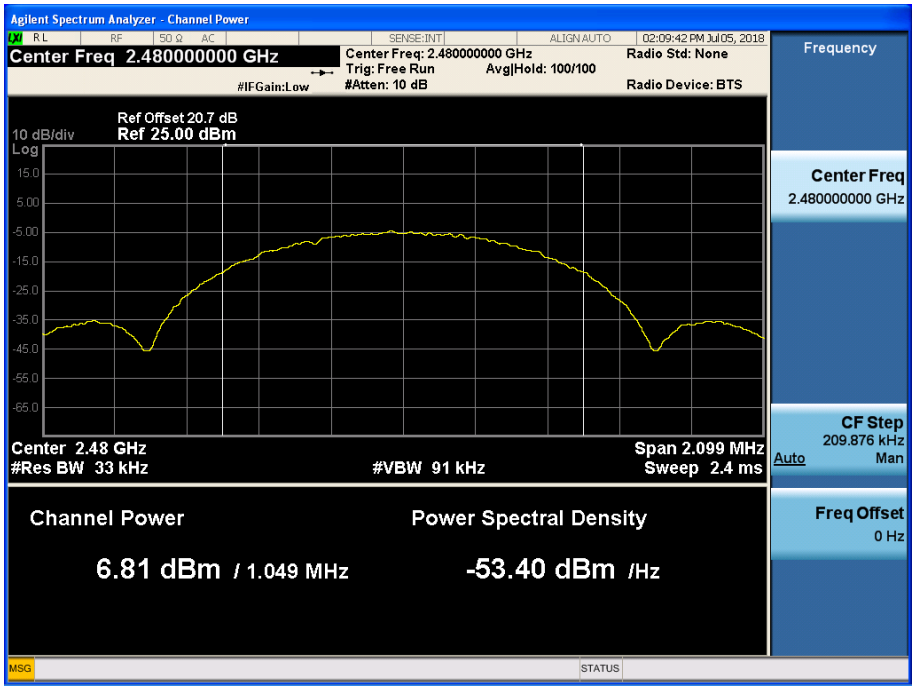
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

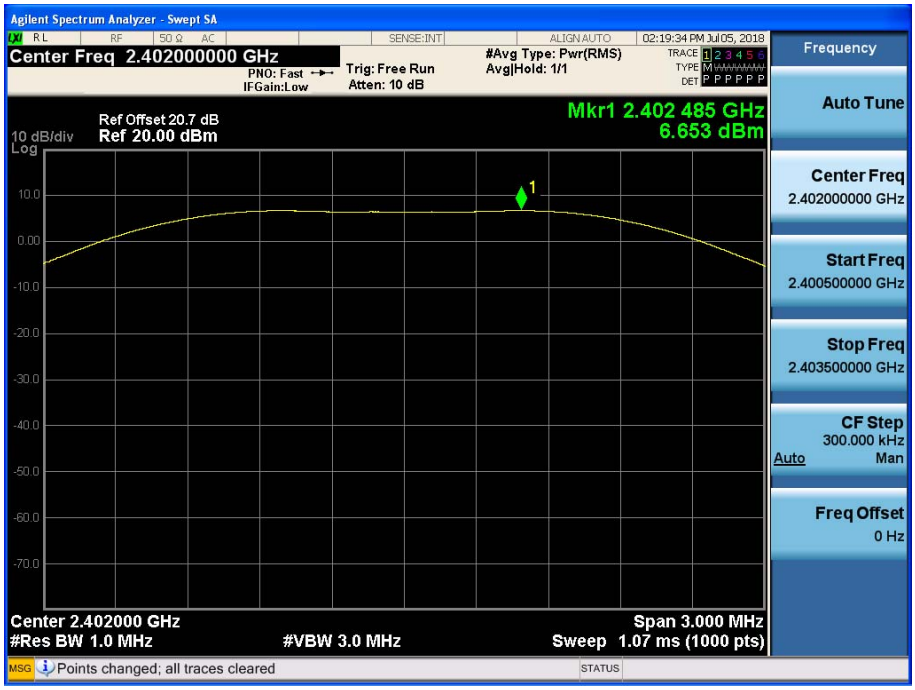


Conducted Output Power (High-CH 39)

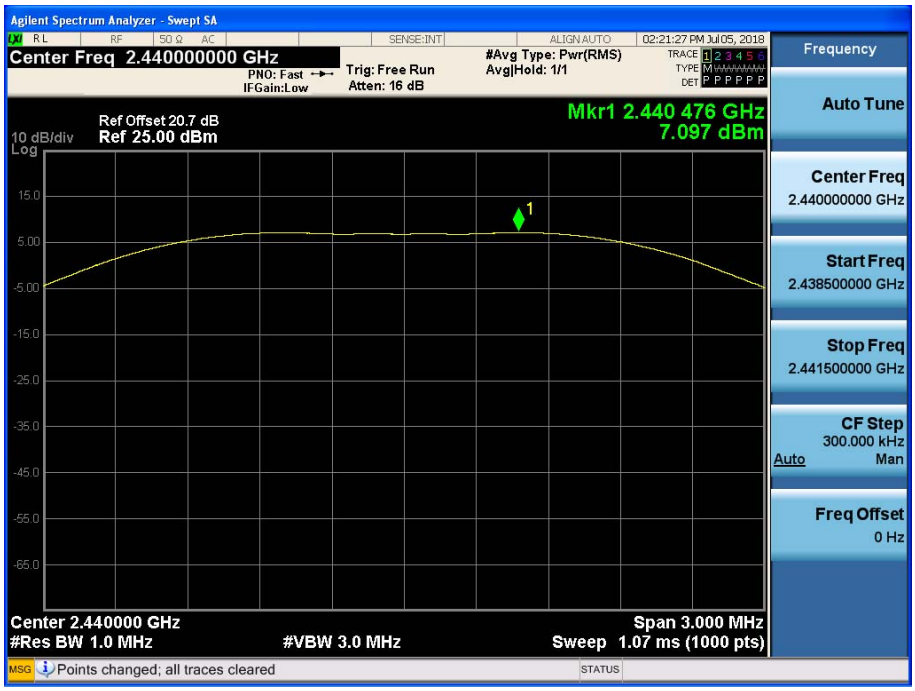


▣ 5.0 LE: 2M PHY RESULT PLOTS-Peak

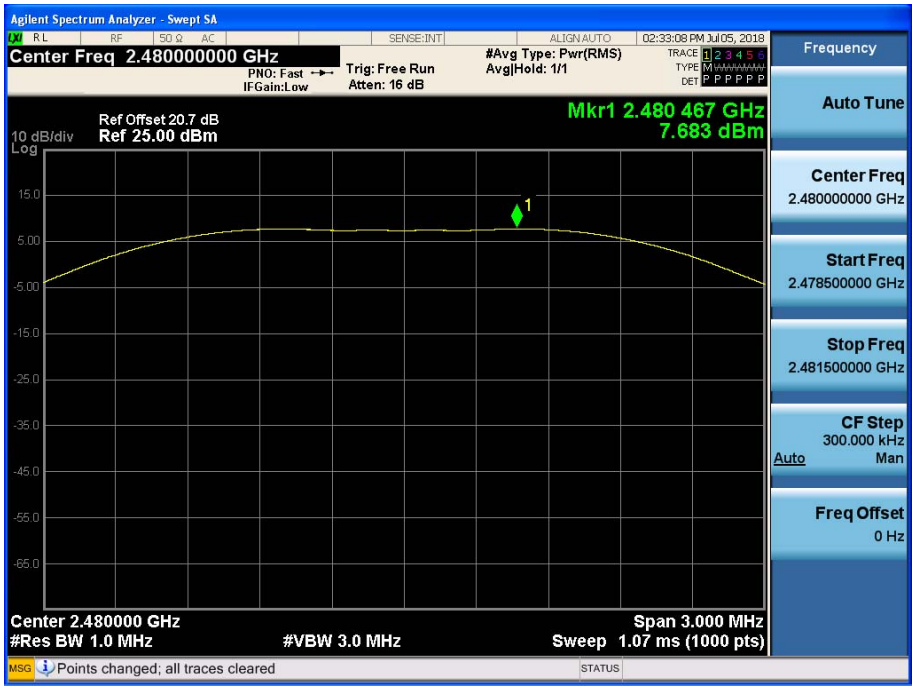
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

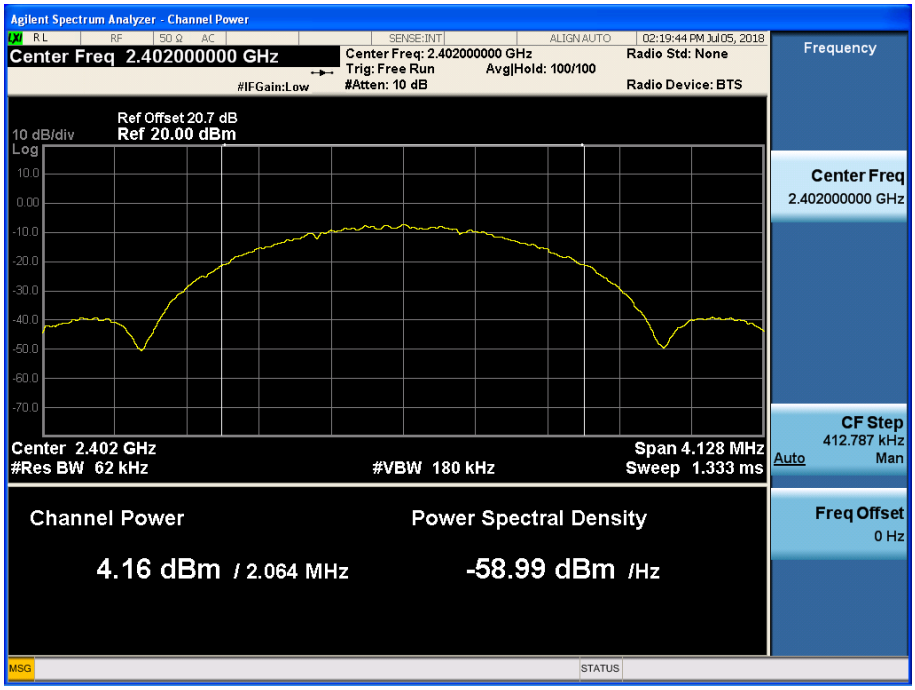


Conducted Output Power (High-CH 39)

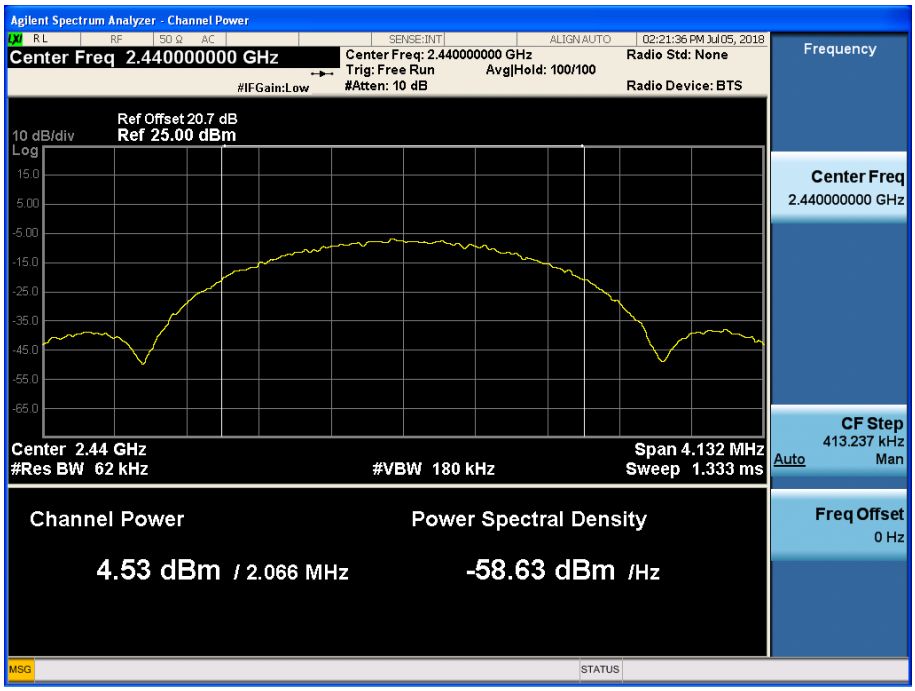


▣ 5.0 LE: 2M PHY RESULT PLOTS-Average

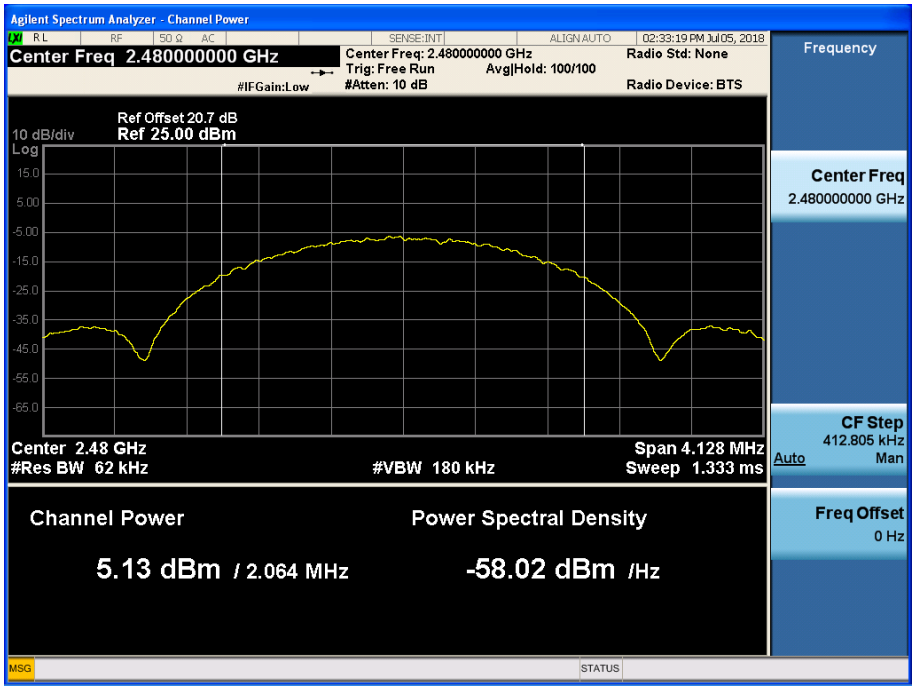
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

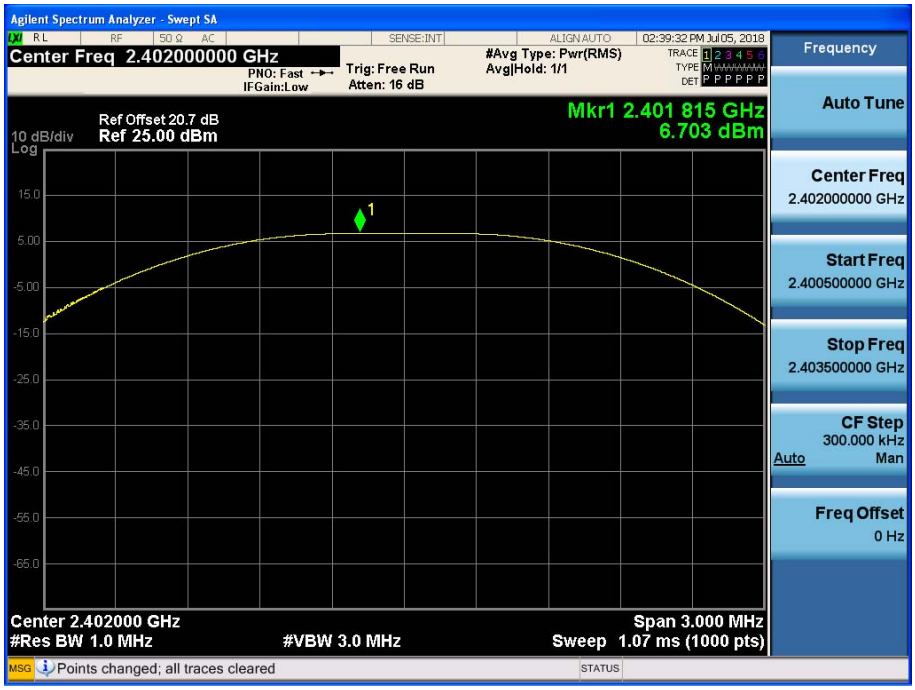


Conducted Output Power (High-CH 39)

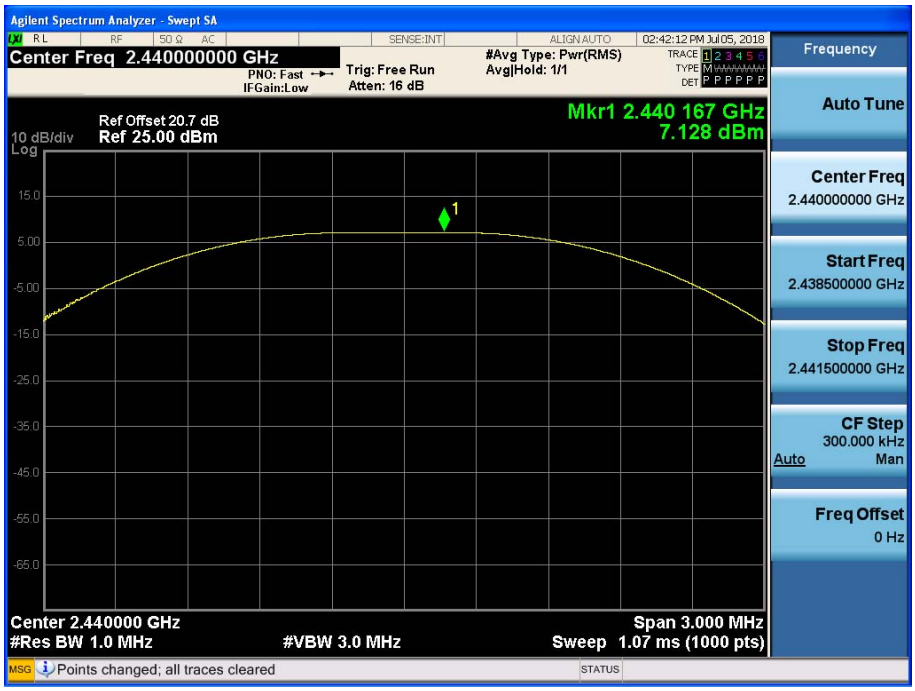


▣ 5.0 LE: Coded PHY_S8 RESULT PLOTS-Peak

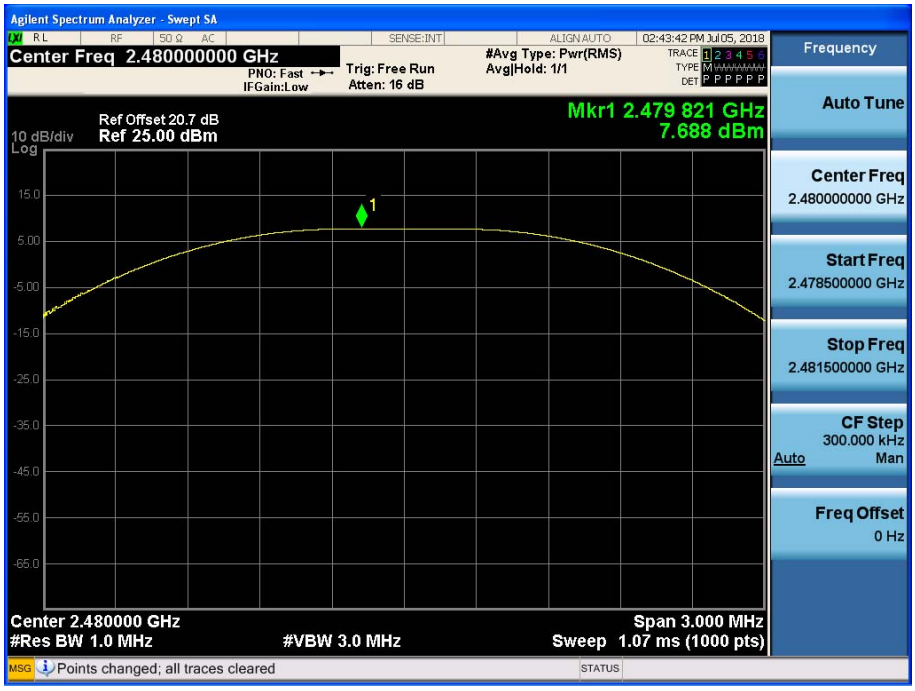
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

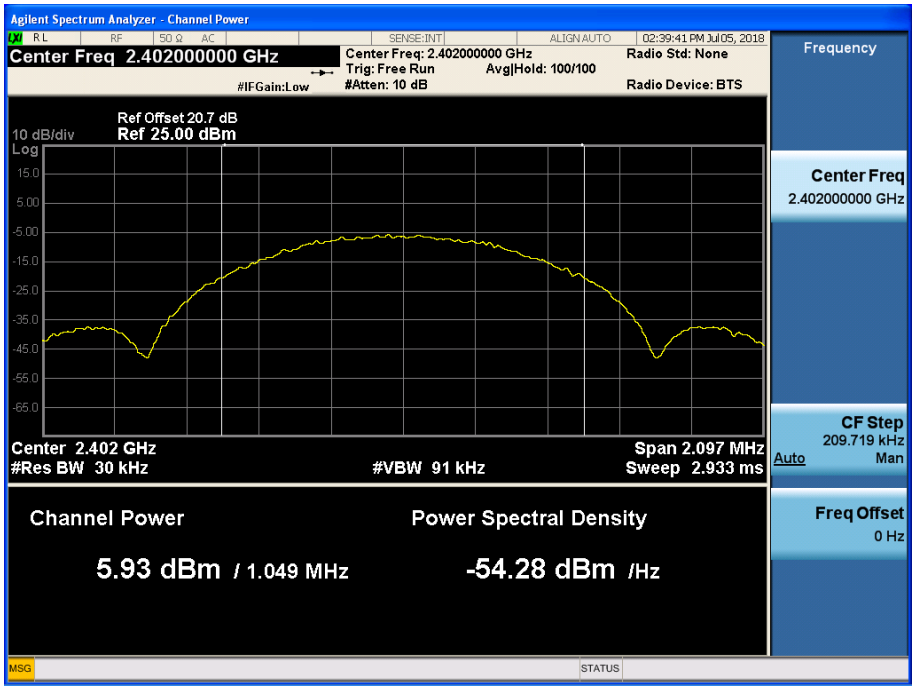


Conducted Output Power (High-CH 39)

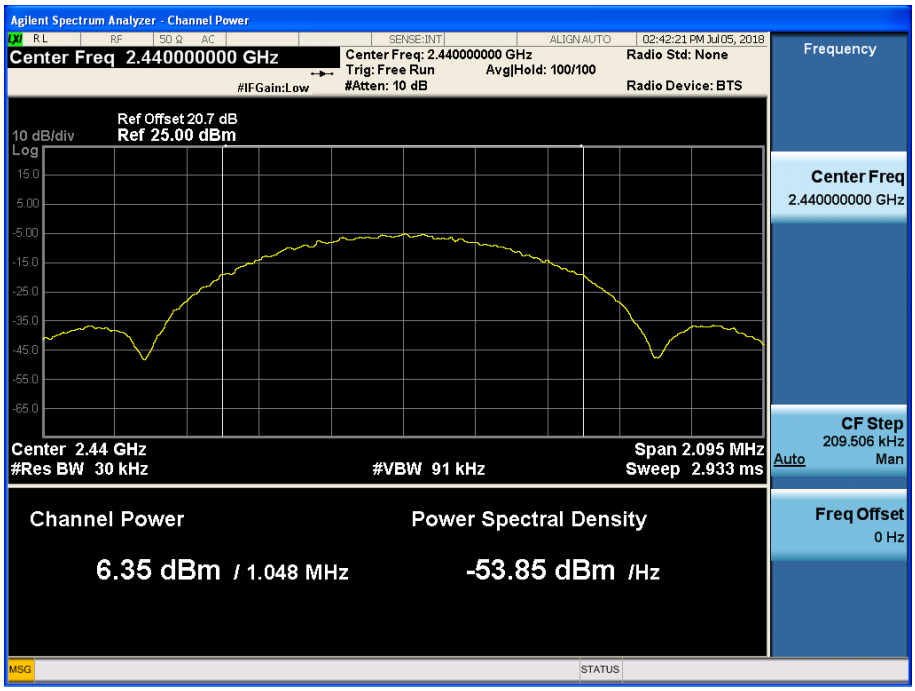


▣ 5.0 LE: Coded PHY_S8 RESULT PLOTS-Average

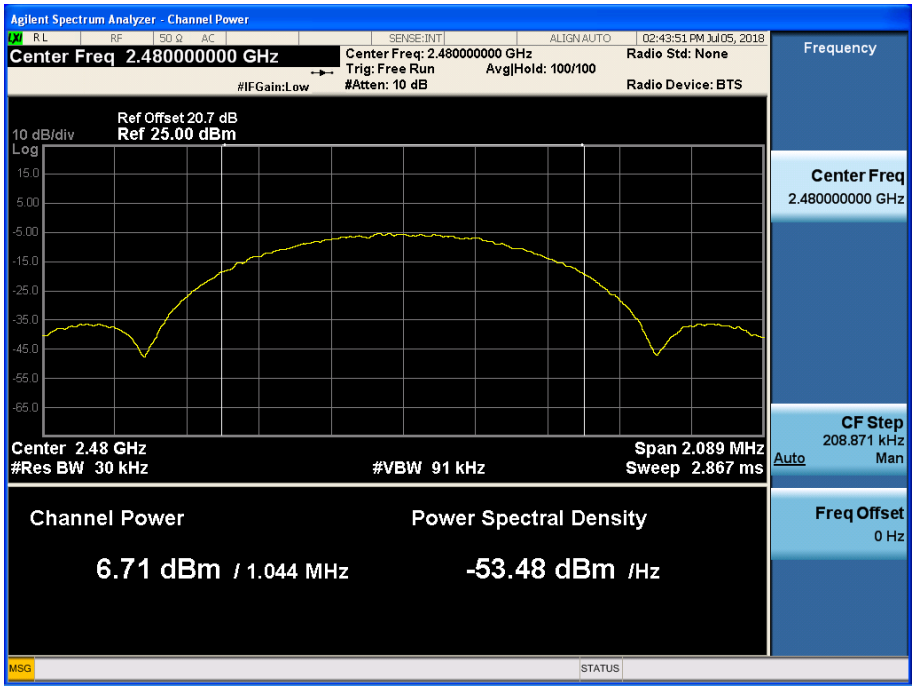
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)



Conducted Output Power (High-CH 39)



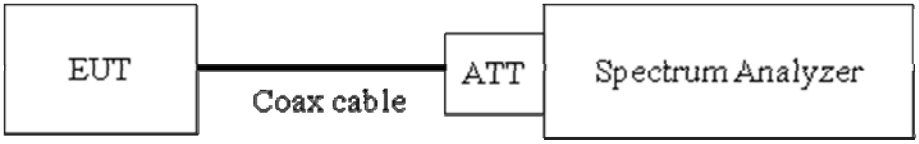
9.5 POWER SPECTRAL DENSITY

Test Requirements and limit, §15.247(e) / RSS-247(Issue 2) Section 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 04/05/2017

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 :

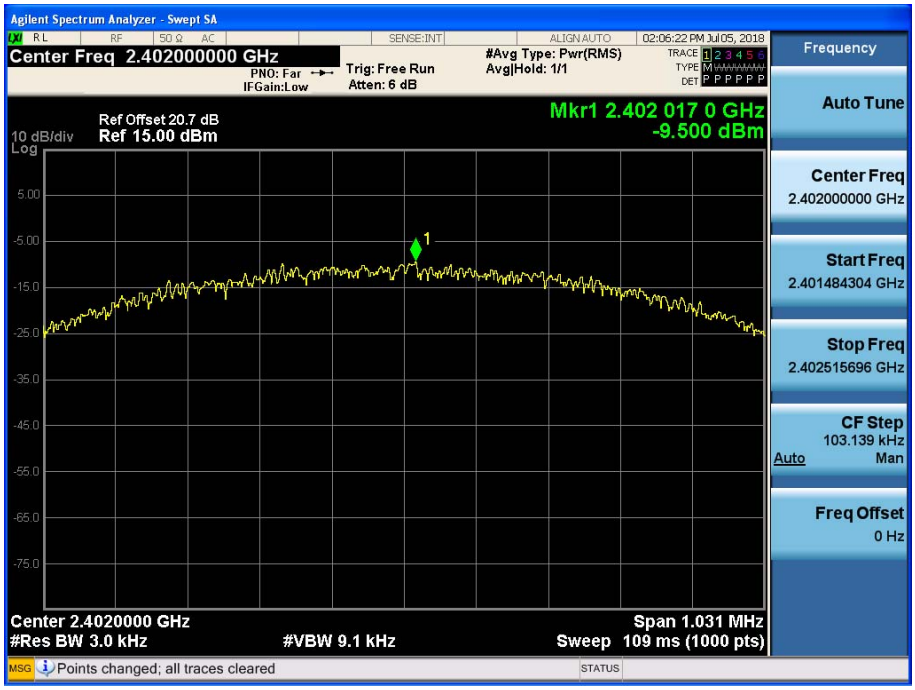
1. Spectrum reading values are not plot data. The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So,10.7 dB is offset for 2.4 GHz Band.

Conducted Power Density Measurements

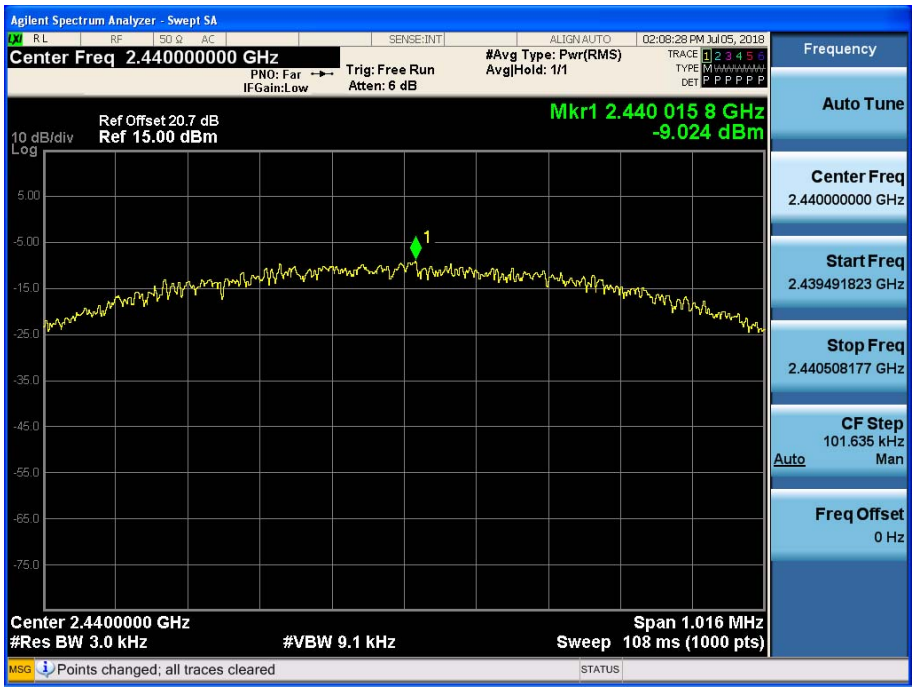
Frequency (MHz)	Channel No.	Mode	Test Result		
			PSD (dBm)	Limit (dBm)	Pass/ Fail
2402	0	5.0 LE: 1M PHY	-9.500	8	Pass
2440	19		-9.024	8	Pass
2480	39		-8.406	8	Pass
2402	0	5.0 LE: 2M PHY	-12.574	8	Pass
2440	19		-12.110	8	Pass
2480	39		-11.470	8	Pass
2402	0	5.0 LE: Coded PHY_S8	-9.498	8	Pass
2440	19		-9.001	8	Pass
2480	39		-8.446	8	Pass

▣ 5.0 LE: 1M PHY RESULT PLOTS

Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)



Power Spectral Density (High-CH 39)

▣ 5.0 LE: 2M PHY RESULT PLOTS

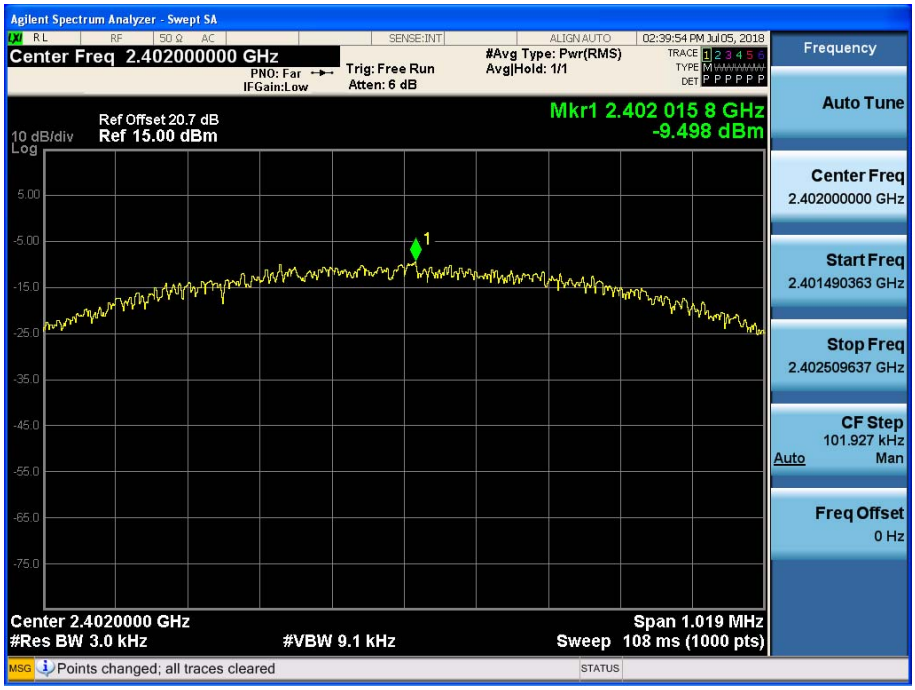
Power Spectral Density (Low-CH 0)

Power Spectral Density (Mid-CH 19)

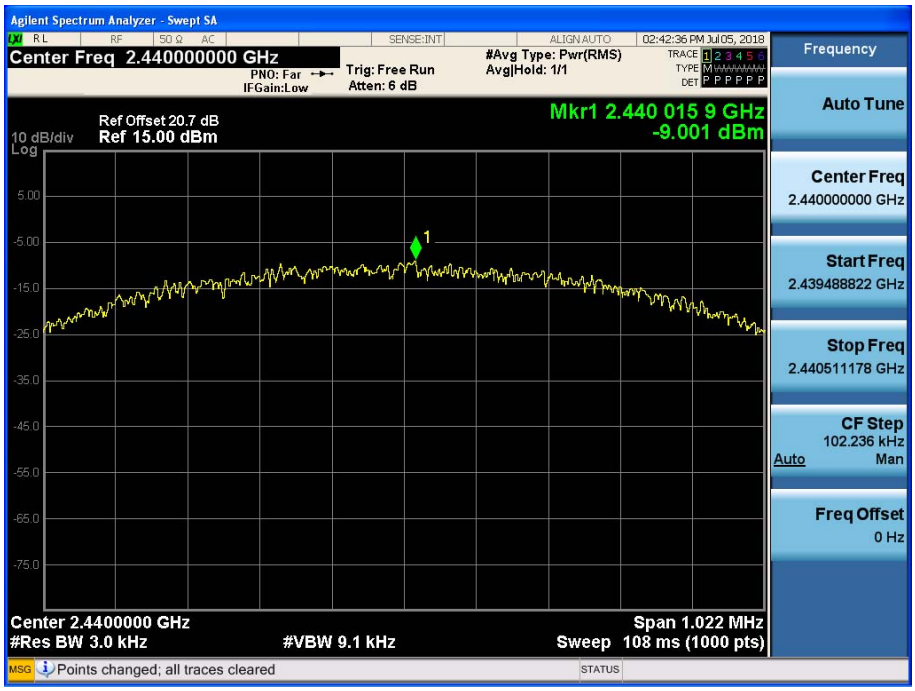
Power Spectral Density (High-CH 39)

▣ 5.0 LE: Coded PHY_S8 RESULT PLOTS

Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)



Power Spectral Density (High-CH 39)

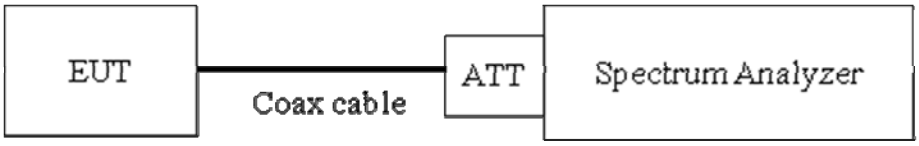
9.6 OUT OF BAND EMISSIONS AT THE BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

Test Requirements and limit, §15.247(d) / RSS-247(Issue 2) Section 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 04/05/2017)

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 maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1(KDB558074 v04), so 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).

2. The band edge results in plot is already including the actual values of loss for the attenuator and cable combination.
3. Spectrum offset = Attenuator loss + Cable loss
4. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 10.7 dB is offset for 2.4 GHz Band.
5. In case of conducted spurious emissions test, please check factors blow table.
6. 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	21.30
100	19.83
200	20.19
300	20.13
400	20.23
500	20.25
600	20.32
700	20.35
800	20.35
900	20.34
1000	20.39
2000	20.64
2400*	20.70
2500*	20.67
3000	20.68
4000	20.89
5000	21.07
6000	21.06
7000	21.35
8000	21.32
9000	21.48
10000	21.56
11000	21.56
12000	21.68
13000	21.83
14000	21.90
15000	21.98
16000	22.04

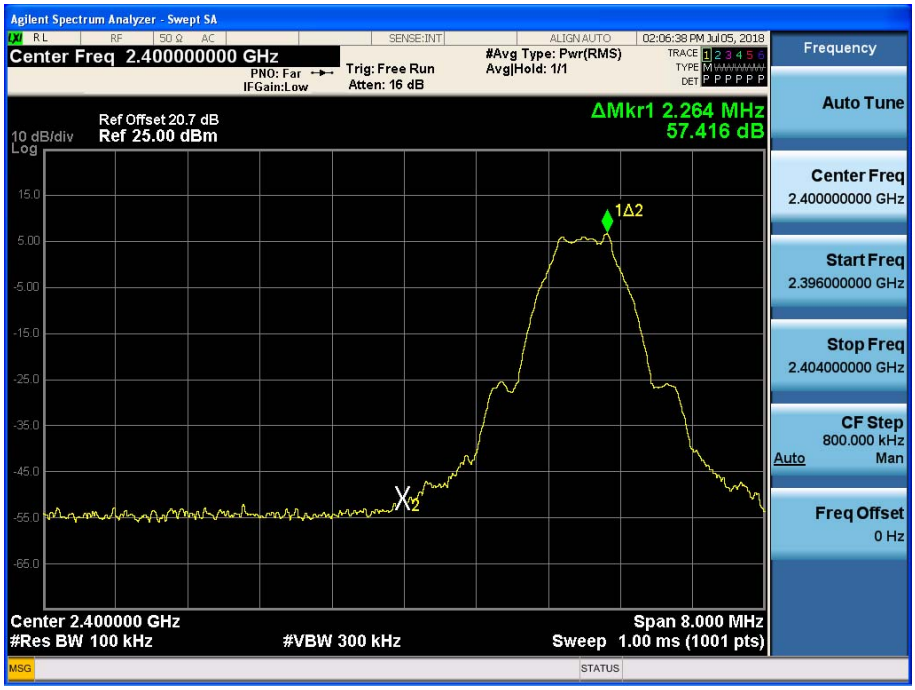
17000	22.02
18000	22.08
19000	22.07
20000	22.14
21000	22.17
22000	22.31
23000	22.60
24000	22.34
25000	22.53

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

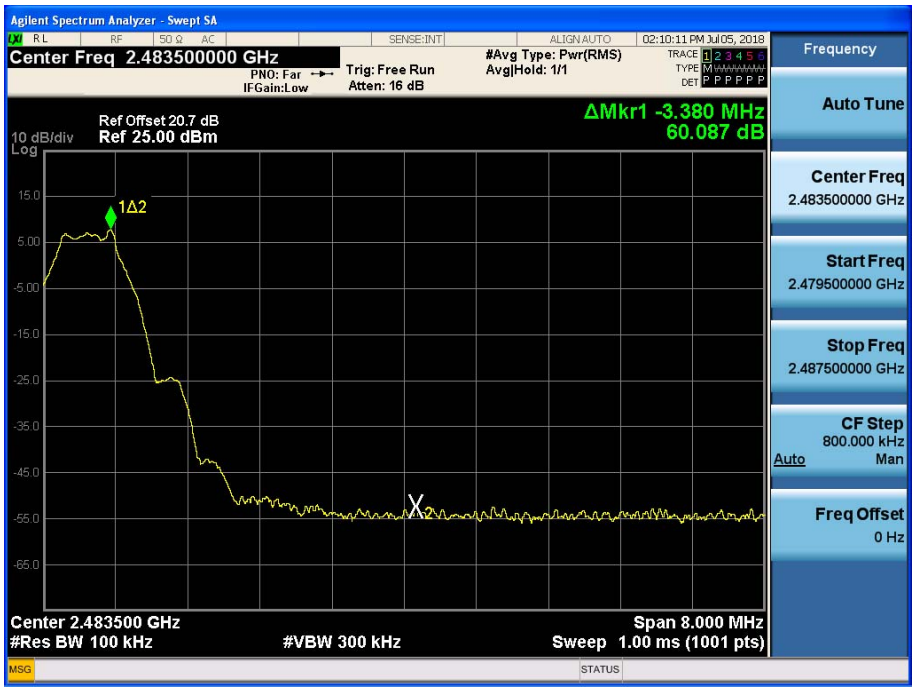
2. Factor = Cable loss + Attenuator loss

▣ 5.0 LE: 1M PHY RESULT PLOTS

BandEdge (Low-CH 0)

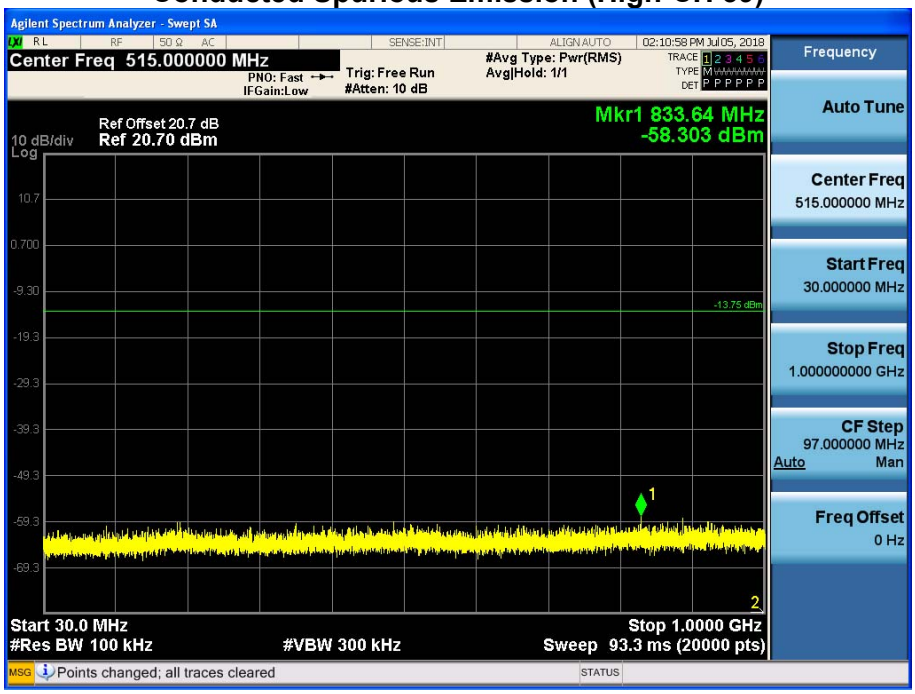


BandEdge (High-CH 39)



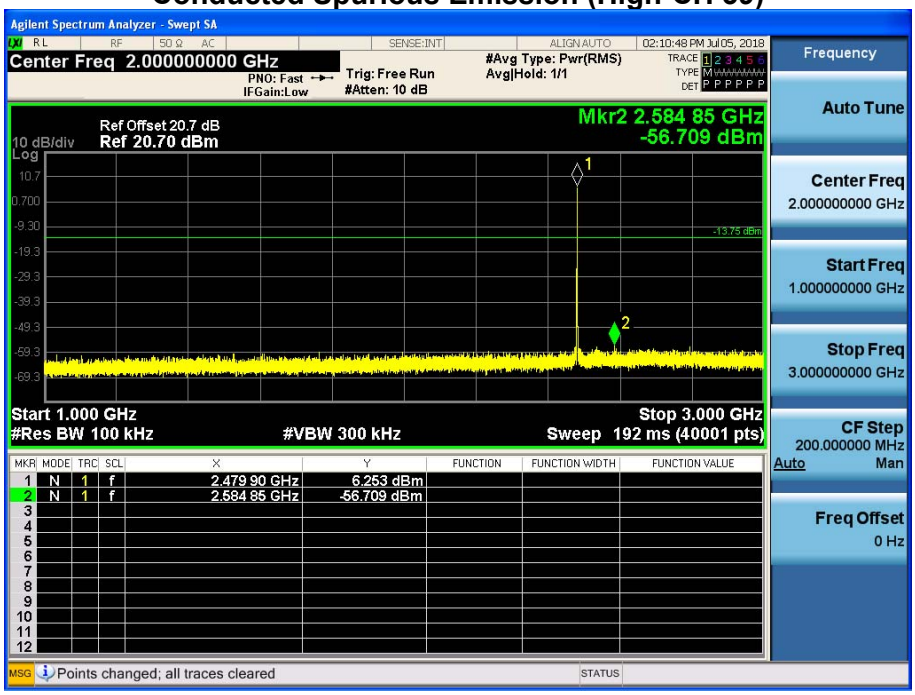
30 MHz ~ 1 GHz

Conducted Spurious Emission (High-CH 39)



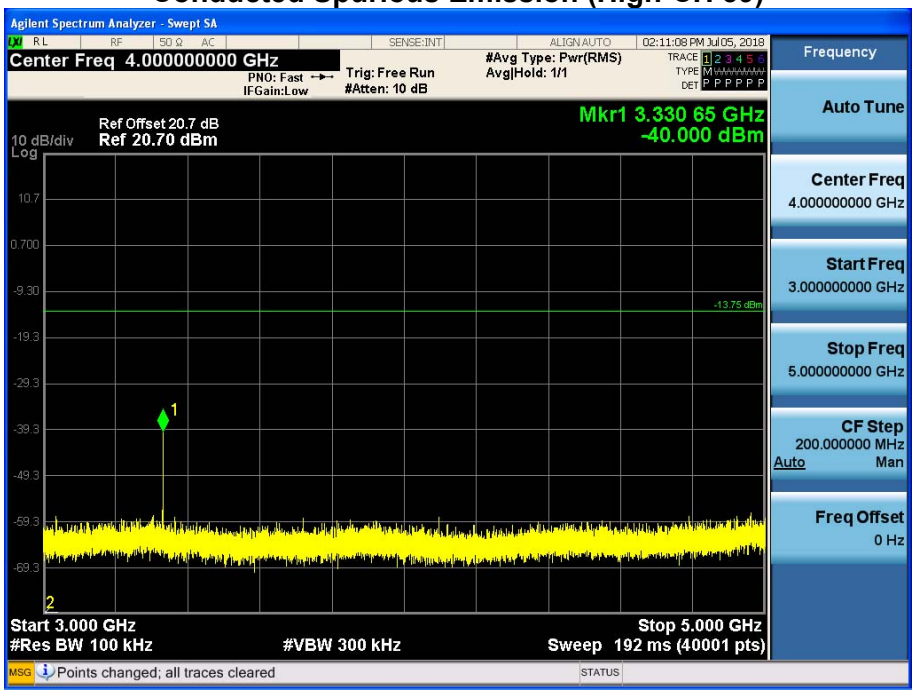
1 GHz ~ 3 GHz

Conducted Spurious Emission (High-CH 39)



3 GHz ~ 5 GHz

Conducted Spurious Emission (High-CH 39)



5 GHz ~ 7 GHz

Conducted Spurious Emission (High-CH 39)