FCC & IC TEST REPORT for Bluetooth EDR
No. 171100706SHA-004

Applicant	:	GES Singapore Pte Ltd. 28 Marsiling Lane, Singapore 739152
Manufacturing site	:	Same as applicant
Product Name	:	802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card
Type/Model	:	QCNFA364A
TEST RESULT	**:**	**PASS**

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 (2017): Radio Frequency Devices

ANSI C63.10 (2013): American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

RSS-247 Issue 2 (Feb 2017): Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen Issue 4 (December 2014): General Requirements for Compliance of Radio Apparatus

Date of issue: Dec 15, 2017

Prepared by:

Wakeyou Wang (*Project Engineer*)

Reviewed by:

Daniel Zhao (*Reviewer*)

Description of Test Facility

Name: Intertek Testing Services Limited Shanghai
Address: Building 86, No. 1198 Qinzhou Rd., North, Shanghai 200233, P.R. China

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IC Assigned Code: 2042B-1

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Content

1. General Information

1.1 Applicant Information

Applicant	:	GES Singapore Pte Ltd. 28 Marsiling Lane, Singapore 739152
Manufacturing site	:	Same as applicant

1.2 Identification of the EUT

Product Name	:	802.11a/b/g/n/ac + BT 4.1 M.2 2230 Type Card
Type/model	:	QCNFA364A
FCC ID	:	2AOJ9-7357622
IC	:	9871A -7357622

1.3 Technical specification

Operation Frequency Band	:	2402 - 2480 MHz
Type of Modulation	:	FHSS
EUT Modes of Modulation	:	GFSK, Pi/4 DQPSK, 8DQPSK
Channel Number	:	79 channels with spacing of 1MHz.
Description of EUT	:	This device is a module supporting 802.11a/b/g/n/ac as well as Bluetooth dual modes. Among this report, only Bluetooth EDR mode was assessed.
Port identification	:	N/A
Antenna	:	PIFA, 2.6dBi
Rating	:	3.3Vdc from host equipment
Declared Temperature range	:	-10℃ ~ 70℃
Category of EUT	:	Class B
EUT type	:	☒ Table top ☐ Floor standing
Sample received date	:	Nov 5, 2017
Sample Identification	:	/
Date of test	:	Nov 5, 2017 – Dec 15, 2017

2. TEST SPECIFICATIONS

2.1 Test Standard

47CFR Part 15 (2017)
ANSI C63.10 (2013)
RSS-247 Issue 2 (Feb 2017)
RSS-Gen Issue 4 (December 2014)
DA 00-705 (March 30, 2000)

2.2 Mode of operation during the test / Test peripherals used

While testing transmitting mode of EUT, the internal modulation was applied.

Test software setting: power setting = 9 among the software *QCARCT*

Test mode:
Mode 1: Hopping off, GFSK_DH5
Mode 2: Hopping off, Pi/4 DQPSK_DH5
Mode 3: Hopping off, 8DPSK_DH5
Mode 4: Hopping on, GFSK_DH5
Mode 5: Hopping on, Pi/4 DQPSK_DH5
Mode 6: Hopping on, 8DPSK_DH5

Test Channel:

Channel	Frequency (MHz)
L	2402
M	2441
H	2480

Frequency Hopping System Requirement

☒**Compliance for Section 15.247 (a)(1), (g), (h) requirement**
The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a

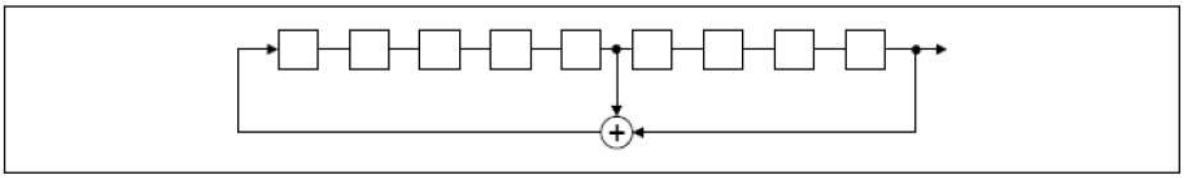
frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

☒ **Compliance for Section 15.247 (a)(1)**

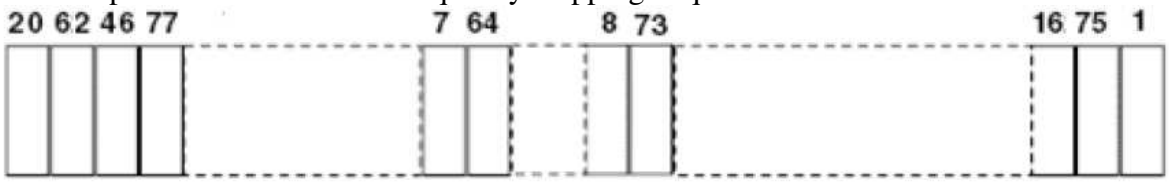
According to Bluetooth Core Specification, the pseudorandom sequence may be generated in a ninestage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

• Number of shift register stages: 9
• Length of pseudo-random sequence: 2^9 -1 = 511 bits
• Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.
According to Bluetooth Core Specification, Bluetooth receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any Bluetooth transmitters and shift frequencies in synchronization with the transmitted signals.

☒ **Compliance for section 15.247(g)**

According to Bluetooth Core Specification, the Bluetooth system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

☒ **Compliance for section 15.247(h)**

According to Bluetooth Core specification, the Bluetooth system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.
According to the Bluetooth Core specification, the Bluetooth system is designed not have the ability to coordinate with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

2.3 Test software list

Test Items	Software	Manufacturer	Version
Conducted emission	ESxS-K1	R&S	V2.1.0
Radiated emission	ES-K1	R&S	V1.71

2.4 Test peripherals list

Item No.	Name	Band and Model	Description
1	Laptop computer	HP ProBook 6470b	NA

2.5 Instrument list

Radiated Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	Test Receiver	R&S	ESIB 26	EC 3045	2018-10-18
☑	Bilog Antenna	TESEQ	CBL 6112D	EC 4206	2018-05-30
☑	Horn antenna	R&S	HF 906	EC 3049	2018-09-22
☐	Horn antenna	ETS	3117	EC 4792-1	2018-08-23
☑	Pre-amplifier	R&S	Pre-amp 18	EC5881	2018-06-19
☑	Semi-anechoic chamber	Albatross project	-	EC 3048	2018-09-08
RF test					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	PXA Signal Analyzer	Keysight	N9030A	EC 5338	2018-09-10
☑	Power sensor	Agilent	U2021XA	EC 5338-1	2018-03-03
☐	Vector Signal Generator	Agilent	N5182B	EC 5175	2018-03-06
☐	MXG Analog Signal Generator	Agilent	N5181A	EC 5338-2	2018-03-03
☐	Mobile Test System	Litepoint	Iqxel	EC 5176	2018-01-11
☑	Test Receiver	R&S	ESCI 7	EC 4501	2018-02-23
Additional instrument					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3323	2018-06-14
☑	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3324	2018-04-09
☑	Therom-Hygrograph	ZJ1-2A	S.M.I.F.	EC 3325	2018-03-23
☑	Pressure meter	YM3	Shanghai Mengde	EC 3320	2018-06-28
Conducted Emission					
Used	Equipment	Manufacturer	Type	Internal no.	Due date
☑	Test Receiver	R&S	ESCS 30	EC 2107	2018-10-19
☑	A.M.N.	R&S	ESH2-Z5	EC 3119	2018-12-01
☐	I.S.N.	FCC	FCC-TLISN -T8-02	EC 3756	2018-02-08

2.6 Test Summary

This report applies to tested sample only. This report shall not be reproduced in part without written approval of Intertek Testing Service Shanghai Limited.

TEST ITEM	FCC REFERANCE	IC REFERANCE	RESULT
20 dB Bandwidth	15.247(a)(1)	RSS-247 Issue 1 Annex 5.1	Tested
Carrier Frequency Separation	15.247(a)(1)	RSS-247 Issue 1 Annex 5.1	Pass
Output power	15.247(b)(1)	RSS-247 Issue 1 Annex 5.4	Pass
Radiated Spurious Emissions	15.205 & 15.209	RSS-Gen Issue 4 Clause 8.10	Pass
Band Edge Emission	15.247(d)	RSS-247 Issue 1 Annex 5.5	Pass
Power line conducted emission	15.207	RSS-Gen Issue 4 Clause 8.8	Pass
Number of Hopping Frequencies	15.247(a)(1)(iii)	RSS-247 Issue 1 Annex 5.1	Pass
Dwell time	15.247(a)(1)(iii)	RSS-247 Issue 1 Annex 5.1	Pass
Occupied bandwidth	-	RSS-Gen Issue 4 Clause 6.6	Tested

Note: “NA” means “not applied”.

2.7 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT

Item No.	Test Items	Expanded Uncertainty (k=2) (±)
1	Radio frequency	**0.84×10^{-7}**
2	RF power, conducted	**0.74 dB**
3	RF power, radiated	**5.92 dB**
5	Power Spectral Density, conducted	**2.99 dB**
6	Occupied Channel Bandwidth	**0.88 %**
7	Conducted emission at mains ports	**3.19 dB**
8	Radiated Emissions up to 1 GHz	**4.90 dB**
9	Radiated Emissions 1-6GHz	**5.02 dB**
19	Radiated Emissions 6-18GHz	**5.28 dB**

3. 20 dB Bandwidth

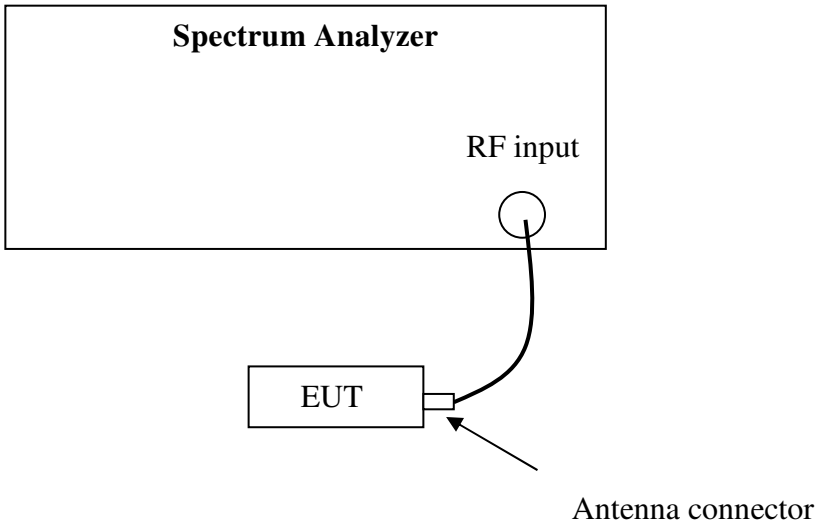
Test result: Tested

3.1 Limit

☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

☒ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

3.2 Test Configuration



3.3 Test Procedure and test setup

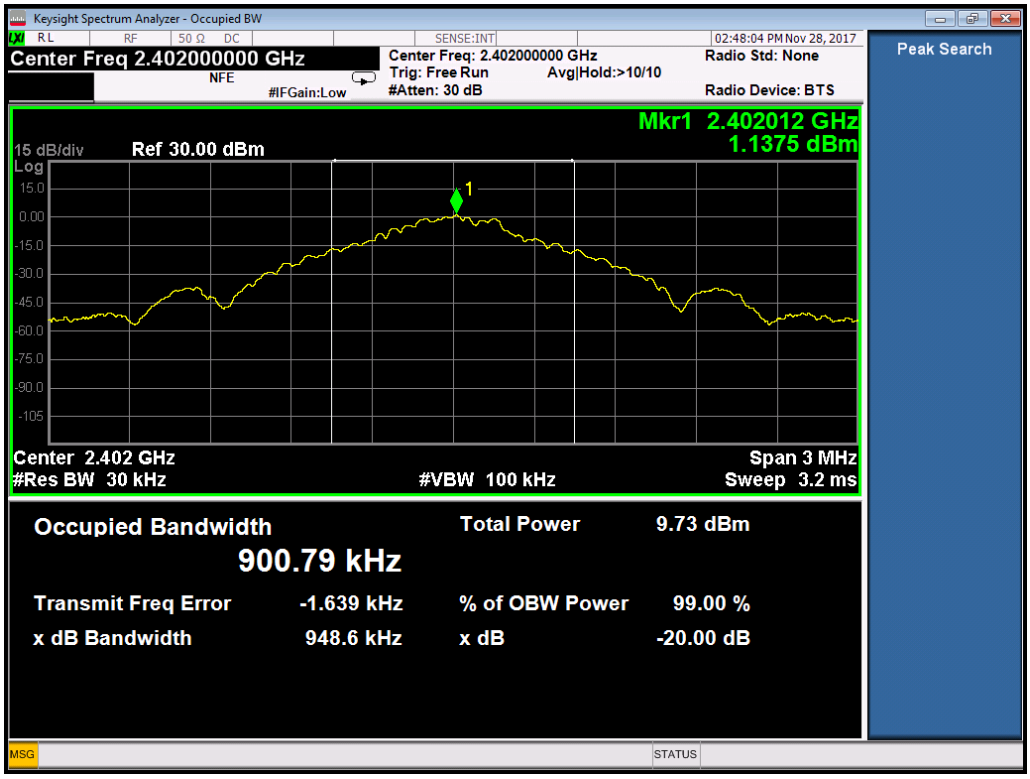
The 20 bandwidth per FCC § 15.247(a)(1) is measured using the Spectrum Analyzer with Span = approximately 2 to 3 times the 20 dB bandwidth, RBW≥1% of the 20 dB bandwidth, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

3.4 Test Protocol

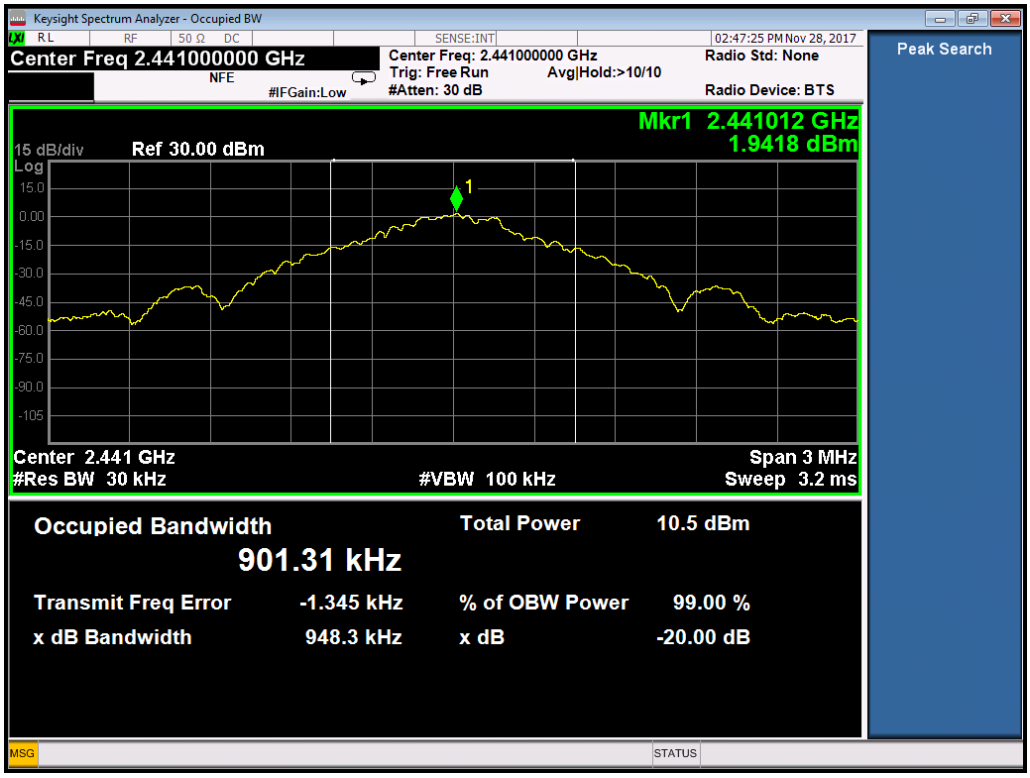
Temperature : 25°C
Relative Humidity : 55 %

Mode	CH	Bandwidth (kHz)	Two-thirds of Bandwidth (kHz)
1	L	949	633
	M	948	632
	H	949	633

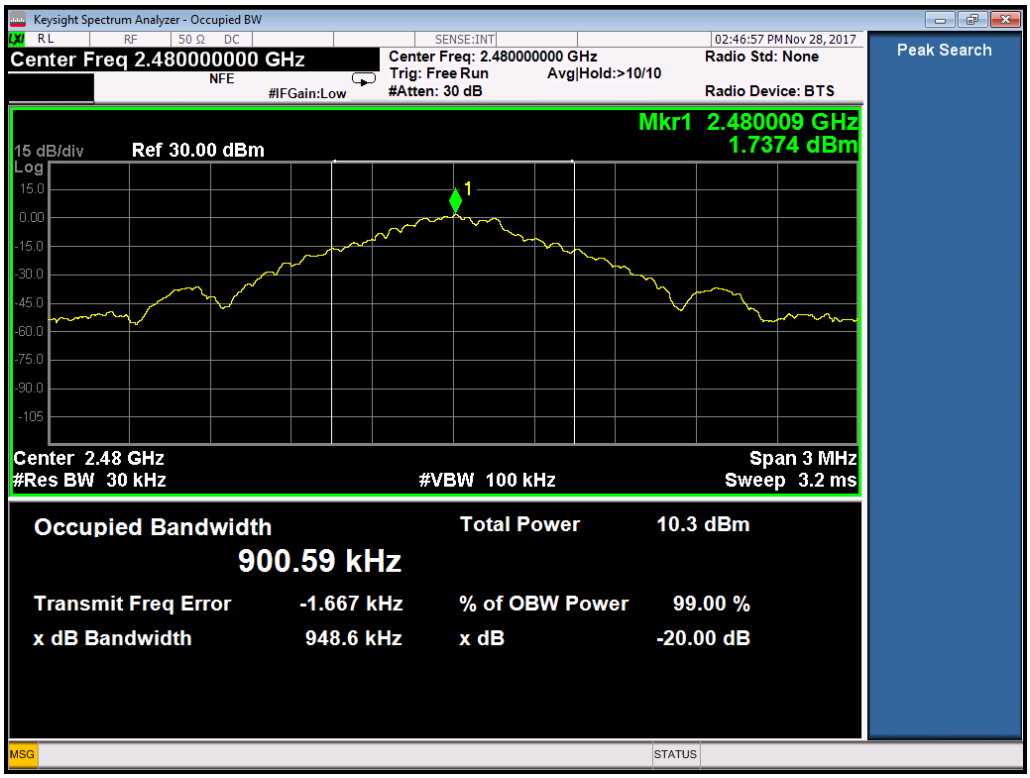
L



M

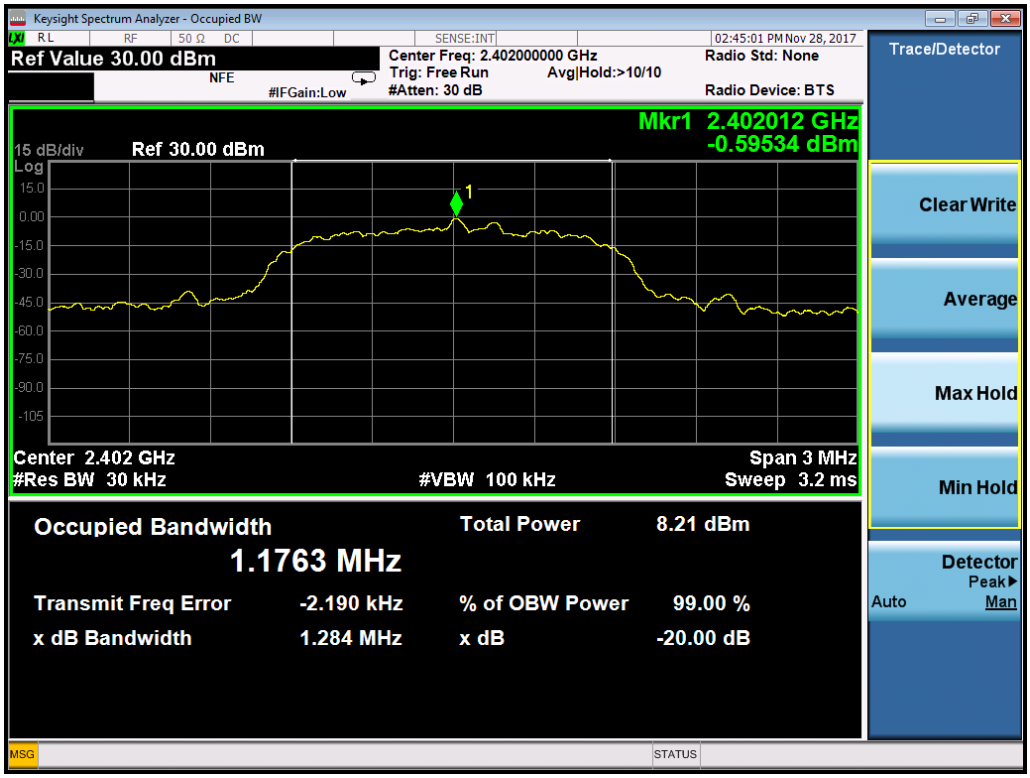

Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω DC
SENSE:INT
02:47:25 PM Nov 28, 2017
Center Freq 2.441000000 GHz
NFE
#IFGain:Low
Center Freq: 2.441000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.441012 GHz
1.9418 dBm
15 dB/div
Ref 30.00 dBm
Log
15.0
0.00
-15.0
-30.0
-45.0
-60.0
-75.0
-90.0
-105
Center 2.441 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
901.31 kHz
Total Power
10.5 dBm
Transmit Freq Error
-1.345 kHz
% of OBW Power
99.00 %
x dB Bandwidth
948.3 kHz
x dB
-20.00 dB
MSG
STATUS

H

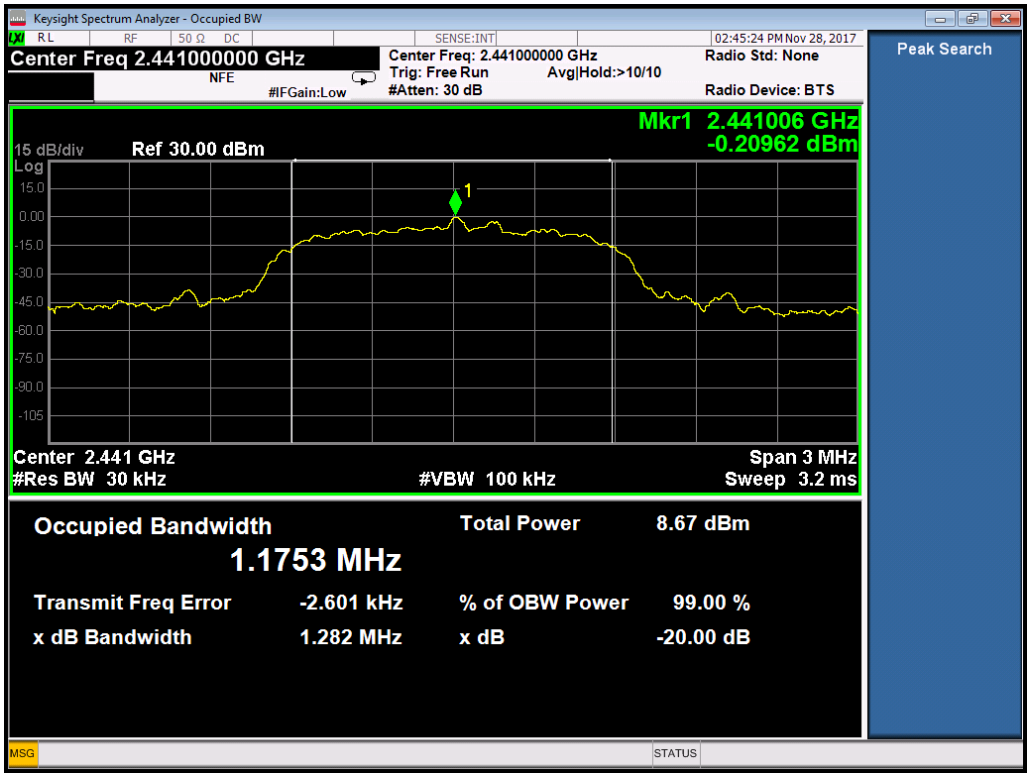

Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω DC
SENSE:INT
02:46:57 PM Nov 28, 2017
Center Freq 2.480000000 GHz
NFE
#IFGain:Low
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.480009 GHz
1.7374 dBm
15 dB/div
Ref 30.00 dBm
Log
15.0
0.00
-15.0
-30.0
-45.0
-60.0
-75.0
-90.0
-105
Center 2.48 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
900.59 kHz
Total Power
10.3 dBm
Transmit Freq Error
-1.667 kHz
% of OBW Power
99.00 %
x dB Bandwidth
948.6 kHz
x dB
-20.00 dB
MSG
STATUS

Mode	CH	Bandwidth (kHz)	Two-thirds of Bandwidth (kHz)
3	L	1284	856
	M	1282	855
	H	1283	855

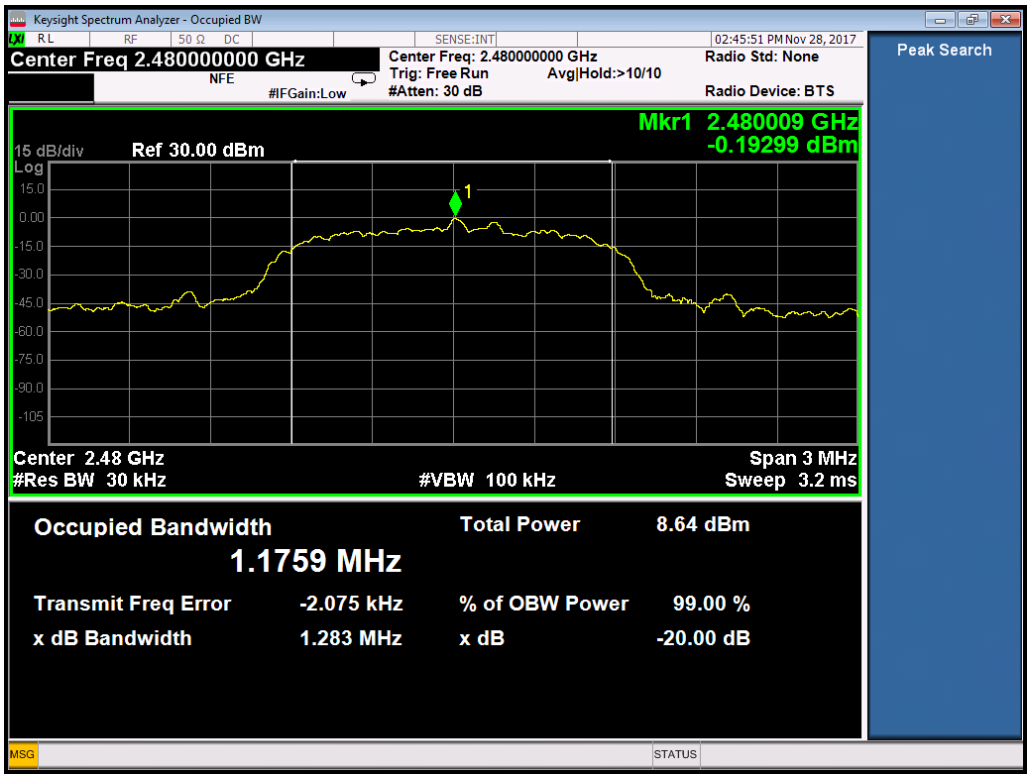
L



M


Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω DC
SENSE:INT
02:45:24 PM Nov 28, 2017
Center Freq 2.441000000 GHz
NFE
#IFGain:Low
Center Freq: 2.441000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.441006 GHz
-0.20962 dBm
15 dB/div
Ref 30.00 dBm
Log
15.0
0.00
-15.0
-30.0
-45.0
-60.0
-75.0
-90.0
-105
Center 2.441 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
1.1753 MHz
Total Power
8.67 dBm
Transmit Freq Error
-2.601 kHz
% of OBW Power
99.00 %
x dB Bandwidth
1.282 MHz
x dB
-20.00 dB
MSG
STATUS

H


Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω DC
SENSE:INT
02:45:51 PM Nov 28, 2017
Center Freq 2.480000000 GHz
NFE
#IFGain:Low
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.480009 GHz
-0.19299 dBm
15 dB/div
Ref 30.00 dBm
Log
15.0
0.00
-15.0
-30.0
-45.0
-60.0
-75.0
-90.0
-105
Center 2.48 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
1.1759 MHz
Total Power
8.64 dBm
Transmit Freq Error
-2.075 kHz
% of OBW Power
99.00 %
x dB Bandwidth
1.283 MHz
x dB
-20.00 dB
MSG
STATUS

4. Carrier Frequency Separation

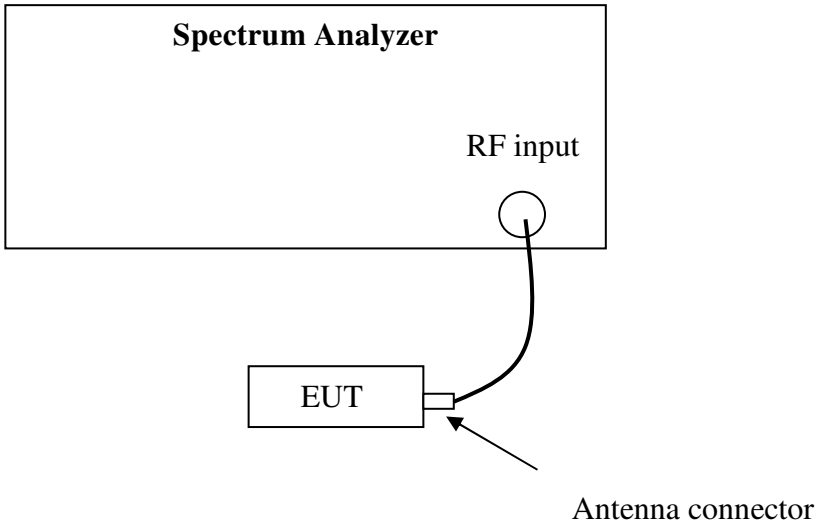
Test result: Pass

4.1 Limit

☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

☒ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

4.2 Test Configuration



4.3 Test Procedure and test setup

The Carrier Frequency Separation per FCC § 15.247(a)(1) is measured using the Spectrum Analyzer with Span can capture two adjacent channels, RBW≥1% of the span, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

4.4 Test Protocol

Temperature : 25°C
Relative Humidity : 55 %

Mode	CH	Frequency Separation (kHz)	Limit (kHz)
1	L	1000	≥ 2/3 of 20dB BW
	M	997	≥ 2/3 of 20dB BW
	H	1004	≥ 2/3 of 20dB BW

L

M


Keysight Spectrum Analyzer - Swept SA
Marker 1 Δ 996.599660 kHz
NFE
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:51:01 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Log
Ref 20.00 dBm
ΔMkr1 996.60 kHz
-1.096 dB
Center 2.441000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 2.500 MHz
Sweep 1.333 ms (10000 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

H


Keysight Spectrum Analyzer - Swept SA
Marker 1 Δ -1.003600360 MHz
NFE
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:51:43 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Log
Ref 20.00 dBm
ΔMkr1 -1.003 60 MHz
0.065 dB
Center 2.479000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 2.500 MHz
Sweep 1.333 ms (10000 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Mode	CH	Frequency Separation (kHz)	Limit (kHz)
3	L	995	≥ 2/3 of 20dB BW
	M	1001	≥ 2/3 of 20dB BW
	H	1001	≥ 2/3 of 20dB BW

L

M


Keysight Spectrum Analyzer - Swept SA
Marker 1 Δ 1.001100110 MHz
NFE
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:53:32 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
ΔMkr1 1.001 10 MHz
-0.121 dB
Center 2.441000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 2.500 MHz
Sweep 1.333 ms (10000 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

H


Keysight Spectrum Analyzer - Swept SA
Marker 1 Δ -1.000850085 MHz
NFE
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:52:55 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
ΔMkr1 -1.000 85 MHz
-0.003 dB
Center 2.479000 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 2.500 MHz
Sweep 1.333 ms (10000 pts)
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

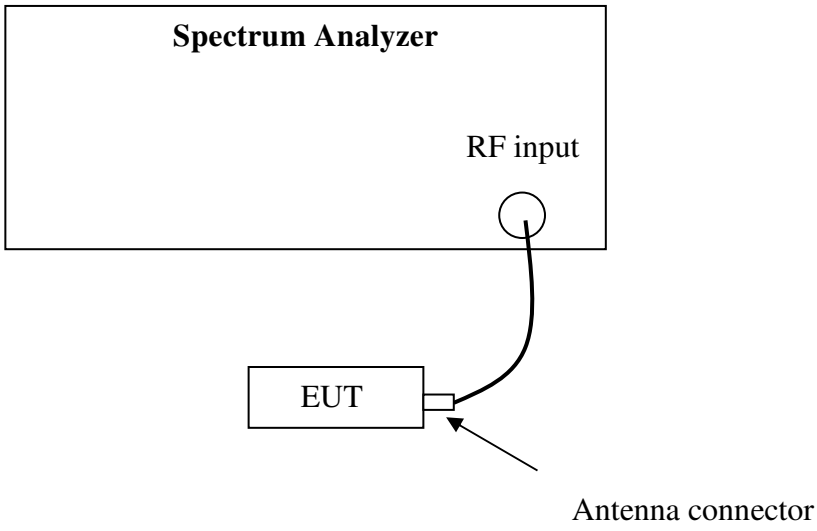
5. Maximum peak output power

Test result: Pass

5.1 Test limit

☐ For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt
☒ For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts
If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.
☐ For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

5.2 Test Configuration



5.3 Test procedure and test setup

The power output per FCC § 15.247(b) is measured by setting the Spectrum Analyzer as RBW = 1MHz, VBW = 3MHz, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The test method is following DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

5.4 Test protocol

Temperature : 22 °C
Relative Humidity : 43 %

Mode	CH	Cable loss (dB)	Conducted Power (dBm)	Limit (dBm)
1	L	1.00	3.51	21
	M	1.00	3.93	21
	H	1.00	4.05	21

Mode	CH	Cable loss (dB)	Conducted Power (dBm)	Limit (dBm)
3	L	1.00	4.26	21
	M	1.00	5.00	21
	H	1.00	4.71	21

Conclusion: The maximum EIRP = 5.00dBm + 2.6dBi = 7.60dBm = 5.75mW < IC EIRP limit of 4W

6. Radiated Emissions in restricted frequency bands

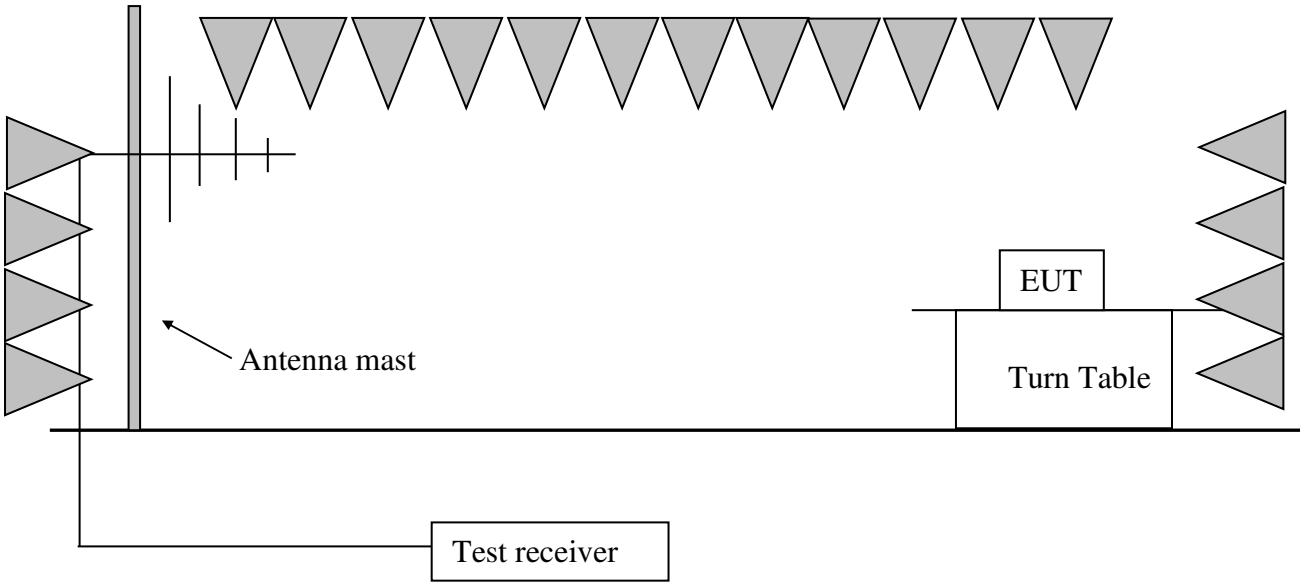
Test result: PASS

6.1 Test limit

The 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) showed as below:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
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

6.2 Test Configuration



6.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, if applied, the pre-amplifier would be equipped just at the output terminal of the antenna.

Tabletop devices shall be placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m.

The turntable rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.

The EUT was tested according to DTS test procedure of KDB558074 D01 DTS “Meas Guidance” for compliance to FCC 47CFR 15.247 requirements.

The radiated emission was measured using the Spectrum Analyzer with the resolutions bandwidth set as:

RBW = 300 Hz, VBW = 1 kHz (9 kHz~150 kHz);
RBW = 10 kHz, VBW = 30 kHz (150 kHz~30MHz);
RBW = 100 kHz, VBW = 300 kHz (30MHz~1GHz for PK)
RBW = 1MHz, VBW = 3MHz (>1GHz for PK);
RBW = 1MHz, VBW = 10Hz (>1GHz for AV);

Remark:
1. Factor= Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Measured level= Original Receiver Reading + Factor
3. Margin = Limit – Measured level
4. If the PK measured level is lower than AV limit, the AV test can be elided.

Example:

Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m;
Measured level = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m,
Measured level = 10.20dBuV/m, then Margin = 54 - 10.20 = 43.80dBuV/m.

6.4 Test protocol

Mode 1

Channel	Frequency (MHz)	Measured level (dBμV/m)	Factor (dB)	Limits (dBμV/m)	Margin (dB)	Detector	Polarization
L	2402.54	90.20	34.50	Fundamental	/	PK	V
	344.90	41.80	15.90	46.00	4.20	PK	H
	698.69	41.10	20.90	46.00	4.90	PK	V
	2390.00	51.40	37.30	54.00	2.60	PK	V
	4804.17	51.70	-1.50	54.00	2.30	PK	V
	7203.96	41.80	2.60	54.00	12.20	PK	V
M	2440.90	90.60	34.60	Fundamental	/	PK	V
	344.90	41.80	15.90	46.00	4.20	PK	H
	698.69	41.10	20.90	46.00	4.90	PK	V
	2390.00	50.20	37.30	54.00	3.80	PK	V
	4880.65	51.50	-1.10	54.00	2.50	PK	V
	7320.08	42.10	3.10	54.00	11.90	PK	V
H	2480.37	90.50	34.70	Fundamental	/	PK	V
	344.90	41.80	15.90	46.00	4.20	PK	H
	698.69	41.10	20.90	46.00	4.90	PK	V
	2390.00	50.20	37.30	54.00	3.80	PK	V
	4962.55	50.60	-0.80	54.00	3.40	PK	V
	7442.41	41.90	3.50	54.00	12.10	PK	V

Mode 3

Channel	Frequency (MHz)	Measured level (dBμV/m)	Factor (dB)	Limits (dBμV/m)	Margin (dB)	Detector	Polarization
L	2402.54	90.70	34.50	Fundamental	/	PK	V
	344.90	41.80	15.90	46.00	4.20	PK	H
	698.69	41.10	20.90	46.00	4.90	PK	V
	2390.00	51.80	37.30	54.00	2.20	PK	V
	4804.17	51.90	-1.50	54.00	2.10	PK	V
	7203.96	42.60	2.60	54.00	11.40	PK	V
M	2440.90	91.10	34.60	Fundamental	/	PK	V
	344.90	41.80	15.90	46.00	4.20	PK	H
	698.69	41.10	20.90	46.00	4.90	PK	V
	2390.00	50.30	37.30	54.00	3.70	PK	V
	4880.65	52.20	-1.10	54.00	1.80	PK	V
	7320.08	42.20	3.10	54.00	11.80	PK	V
H	2480.37	90.90	34.70	Fundamental	/	PK	V
	344.90	41.80	15.90	46.00	4.20	PK	H
	698.69	41.10	20.90	46.00	4.90	PK	V
	2390.00	50.30	37.30	54.00	3.70	PK	V
	4962.55	50.90	-0.80	54.00	3.10	PK	V
	7442.41	41.80	3.50	54.00	12.20	PK	V

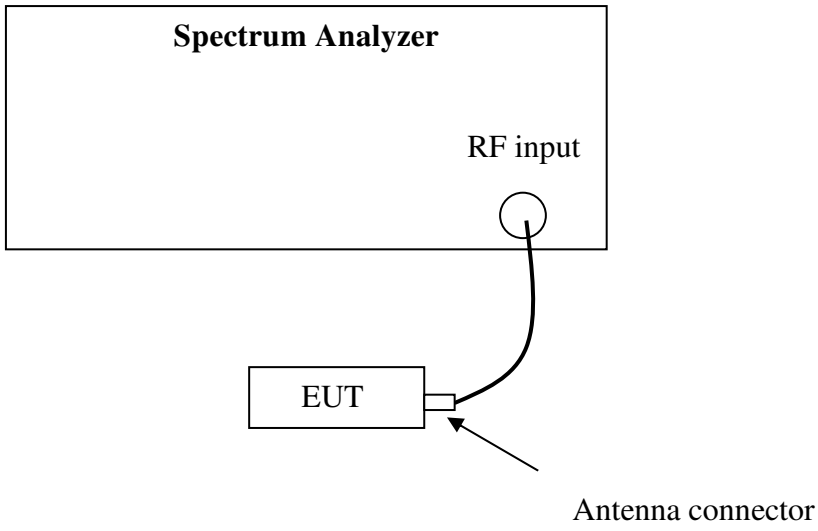
7. Band Edge Emission

Test result: **PASS**

7.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

7.2 Test Configuration

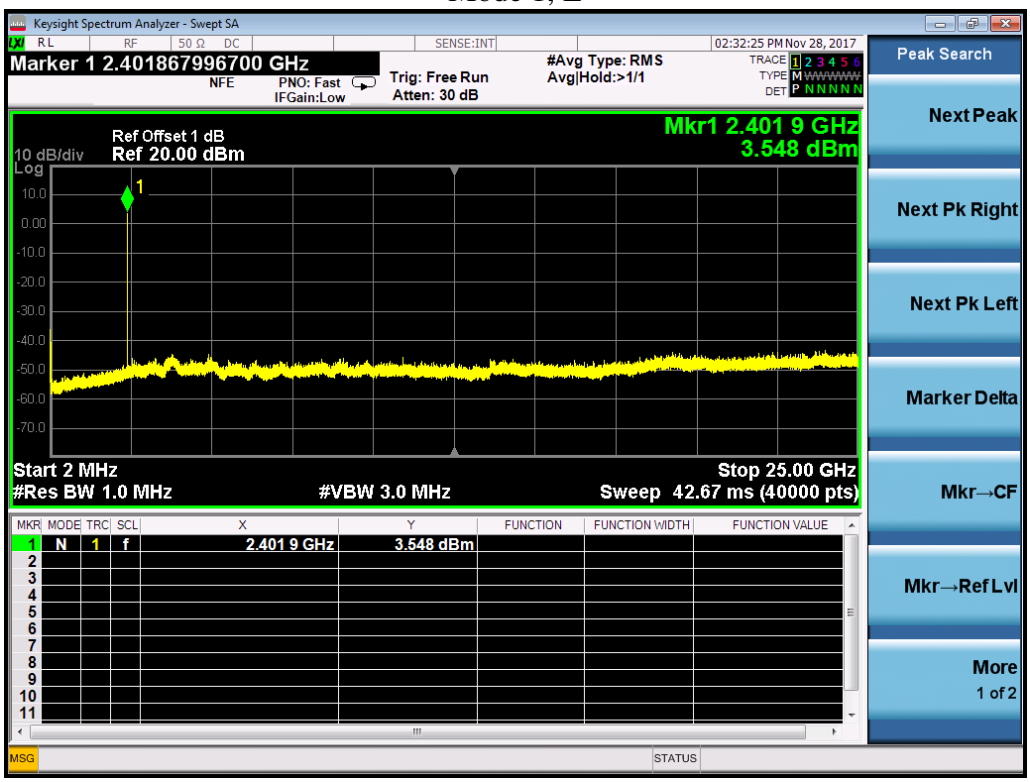


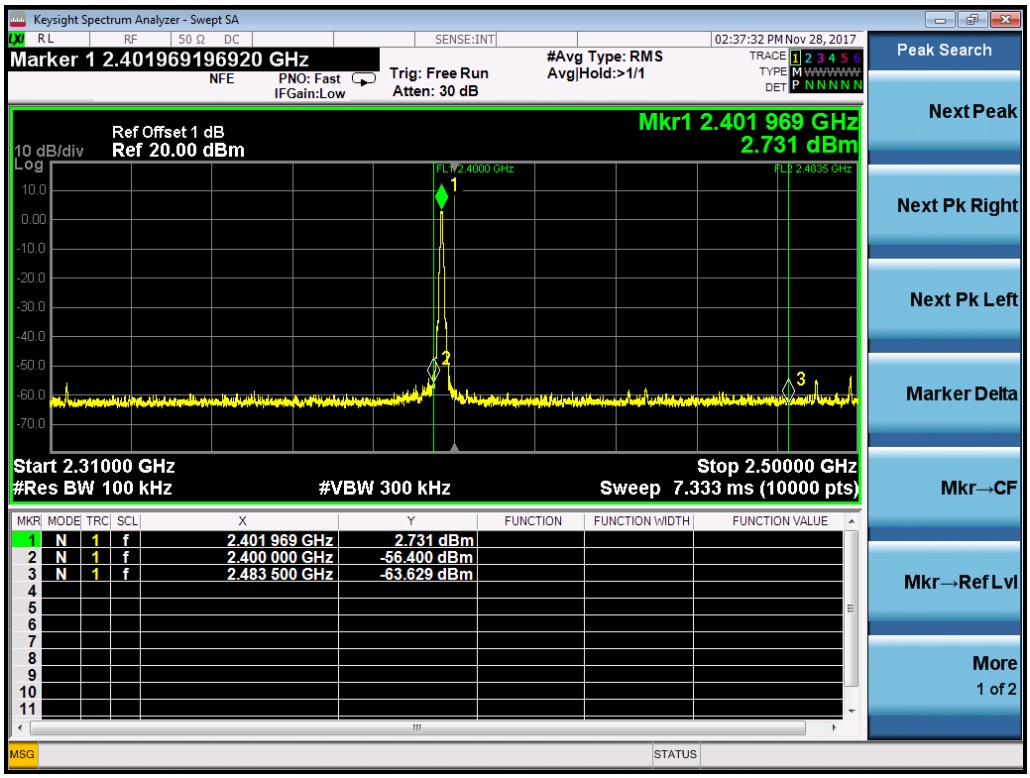
7.3 Test procedure and test setup

The Band Edge Emissions per FCC § 15.247(d) is measured using the Spectrum Analyzer with Span wide enough capturing all spurious from the lowest emission frequency of the EUT up to 10th harmonics, RBW = 100kHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

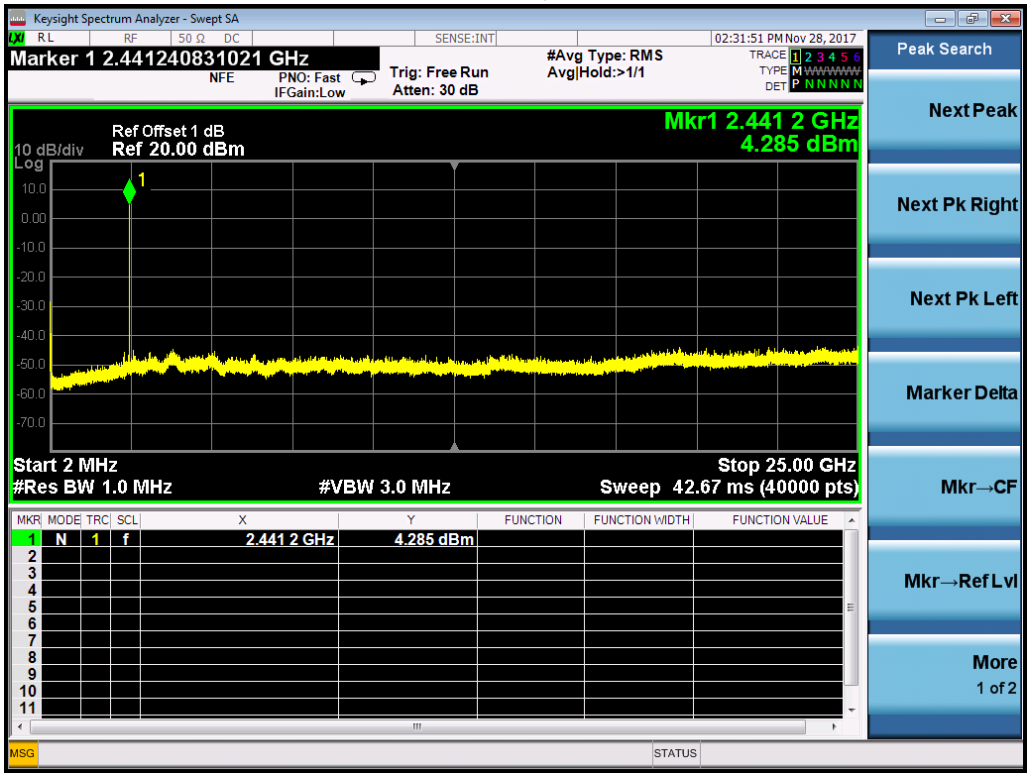
7.4 Test protocol

Mode 1, L

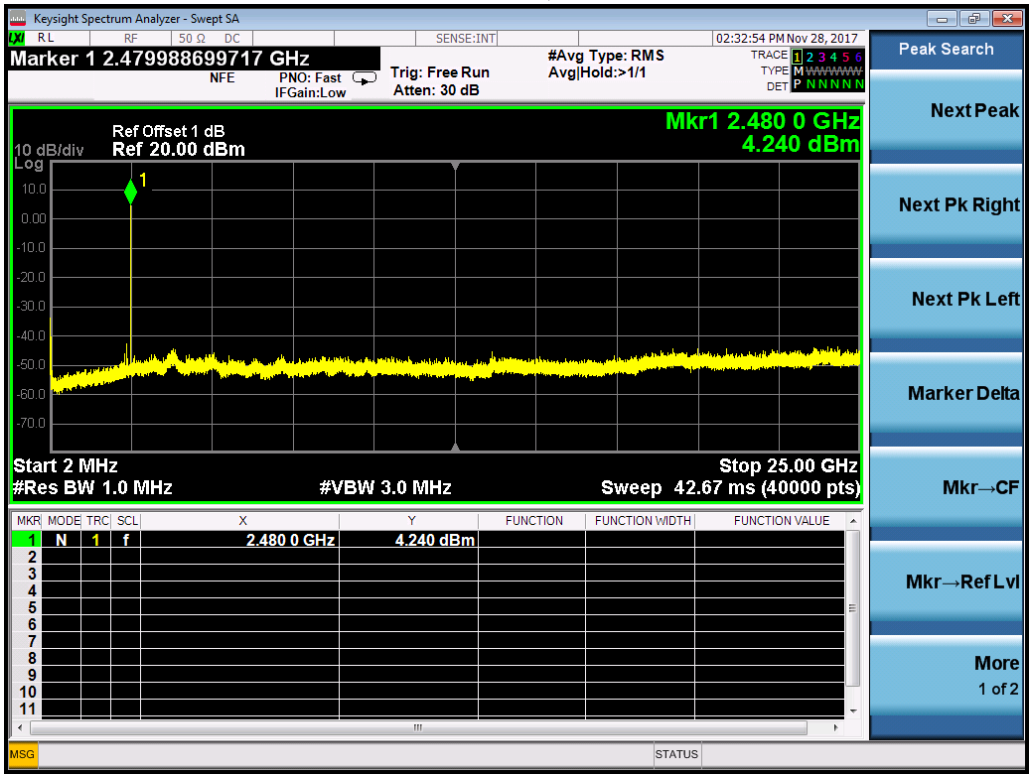


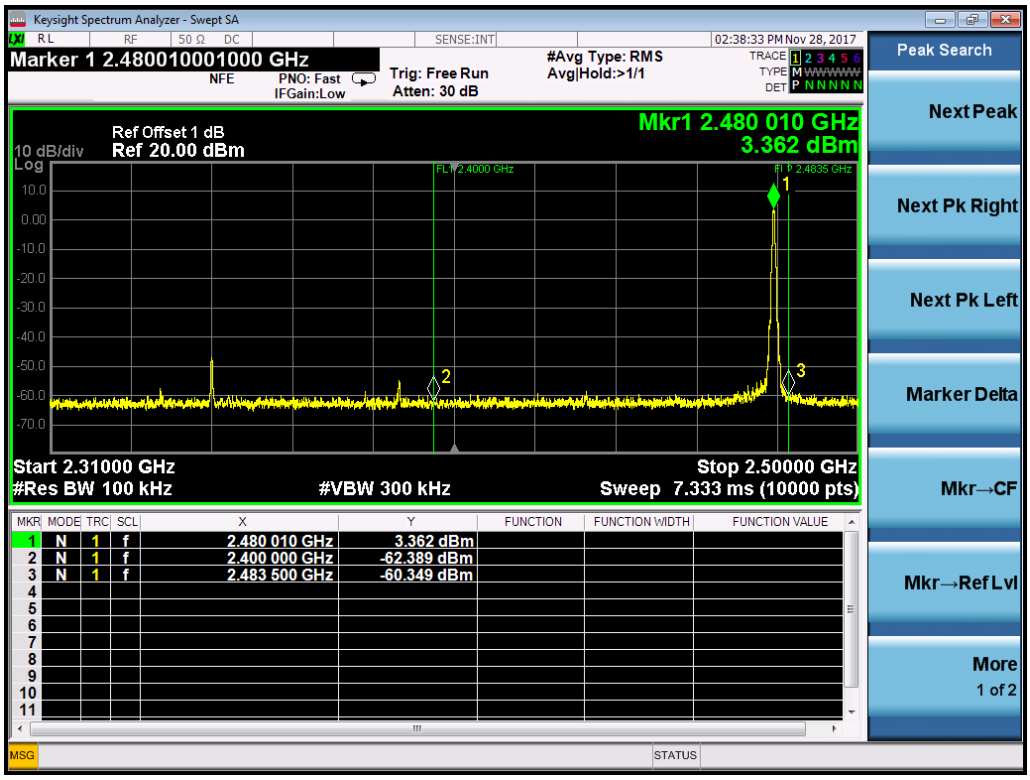


Mode 1, M

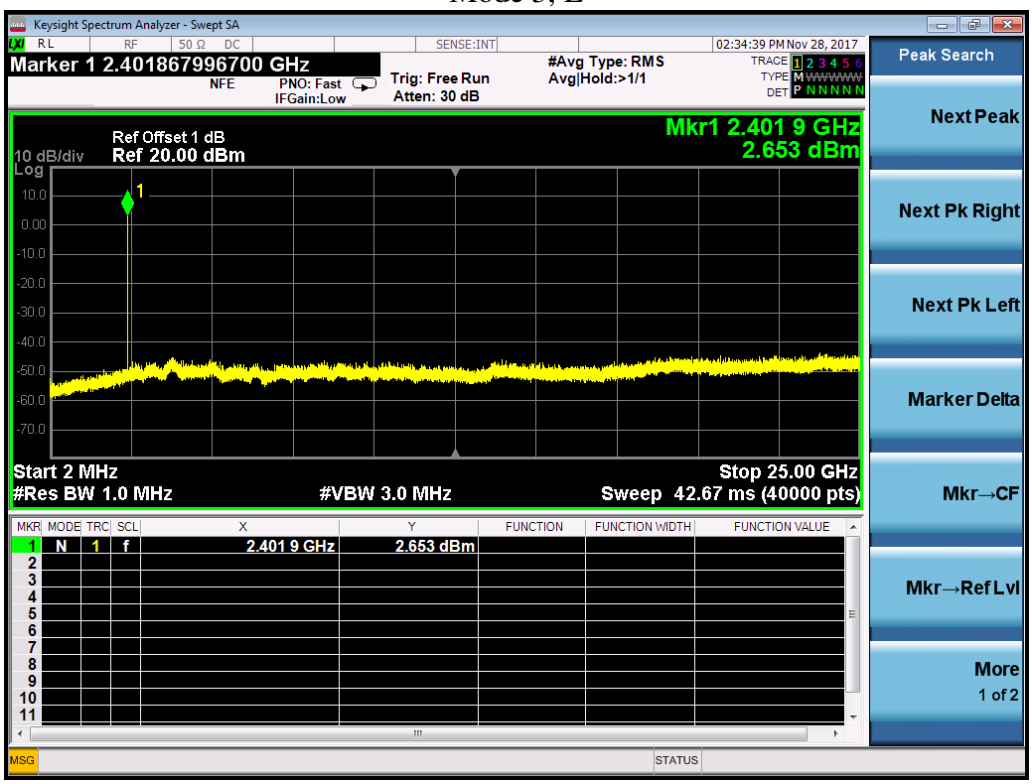


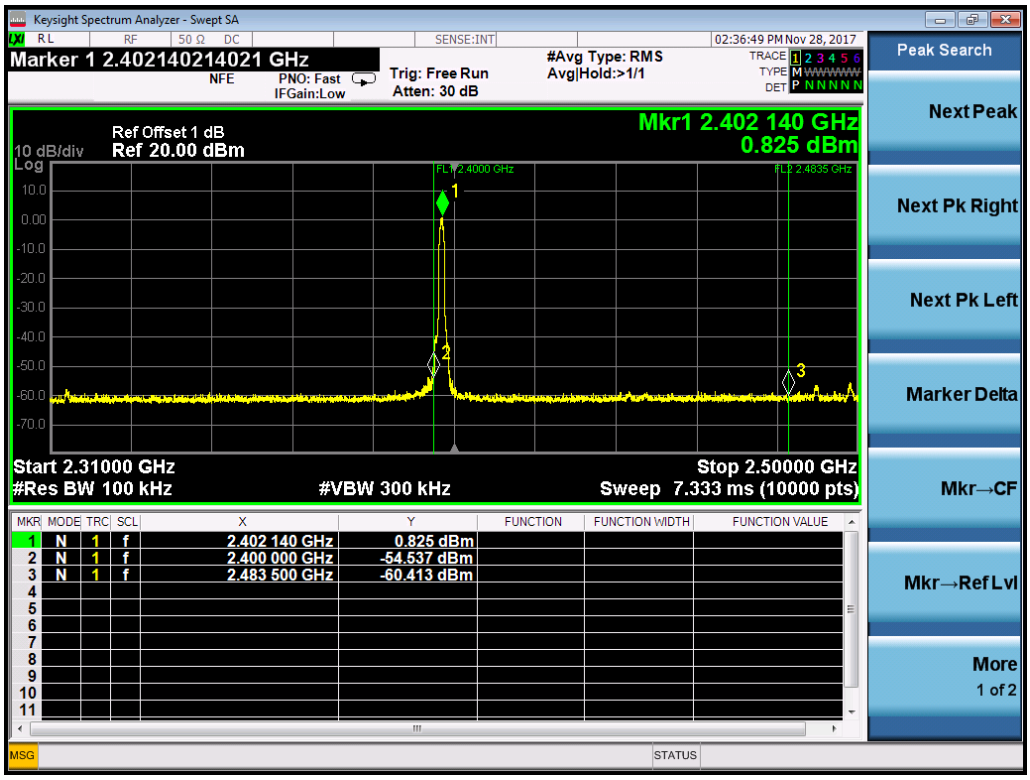
Mode 1, H



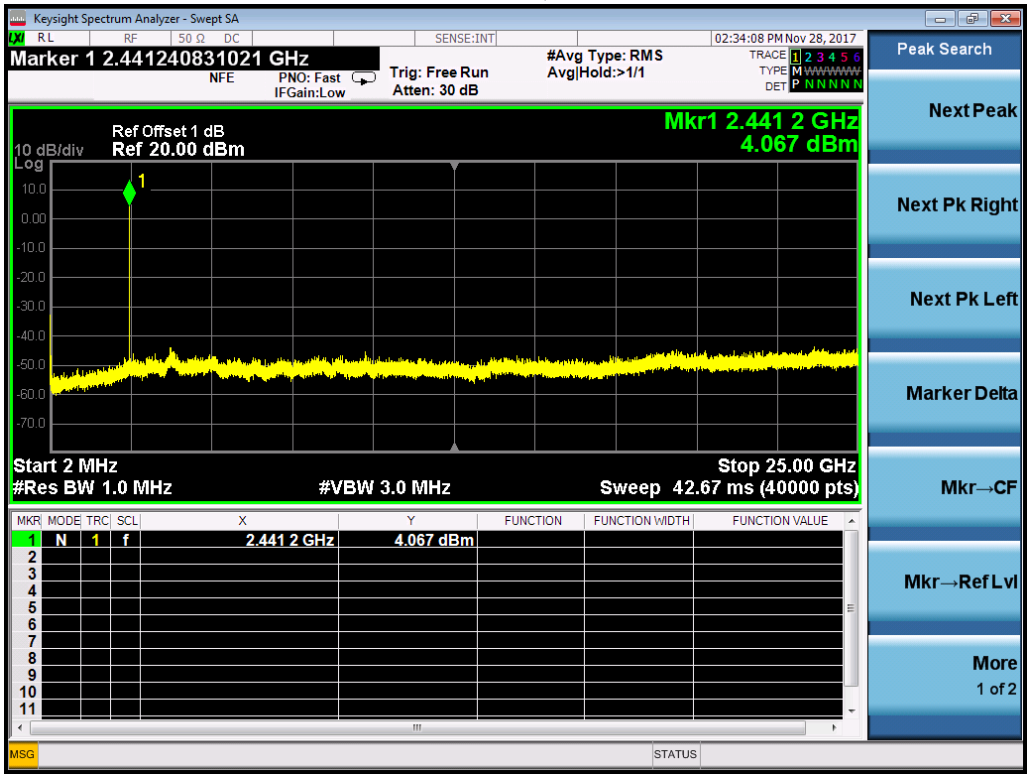

Keysight Spectrum Analyzer - Swept SA
Marker 1 2.480010001000 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:38:33 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 2.480 010 GHz
3.362 dBm
Start 2.31000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 7.333 ms (10000 pts)
1 N 1 f 2.480 010 GHz 3.362 dBm
2 N 1 f 2.400 000 GHz -62.389 dBm
3 N 1 f 2.483 500 GHz -60.349 dBm
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Mode 3, L

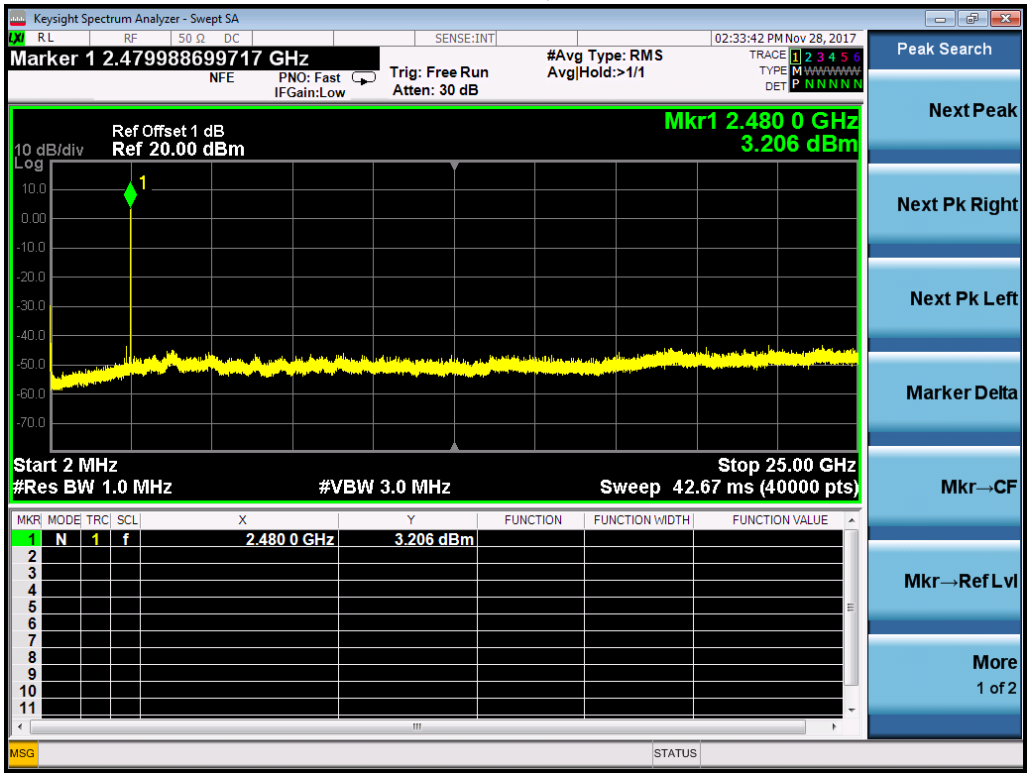

Keysight Spectrum Analyzer - Swept SA
Marker 1 2.401867996700 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:34:39 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 2.401 9 GHz
2.653 dBm
Start 2 MHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 25.00 GHz
Sweep 42.67 ms (40000 pts)
1 N 1 f 2.401 9 GHz 2.653 dBm
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

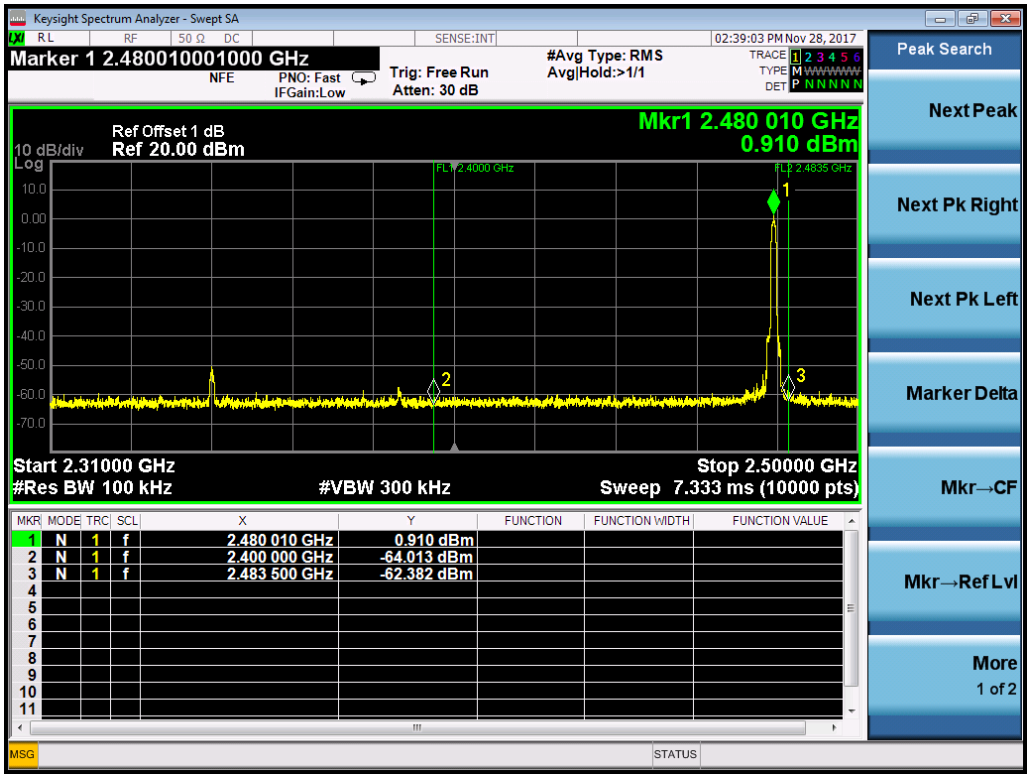

Keysight Spectrum Analyzer - Swept SA
Marker 1 2.402140214021 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:36:49 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 2.402 140 GHz
0.825 dBm
Start 2.31000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 7.333 ms (10000 pts)
1 N 1 f 2.402 140 GHz 0.825 dBm
2 N 1 f 2.400 000 GHz -54.537 dBm
3 N 1 f 2.483 500 GHz -60.413 dBm
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Mode 3, M

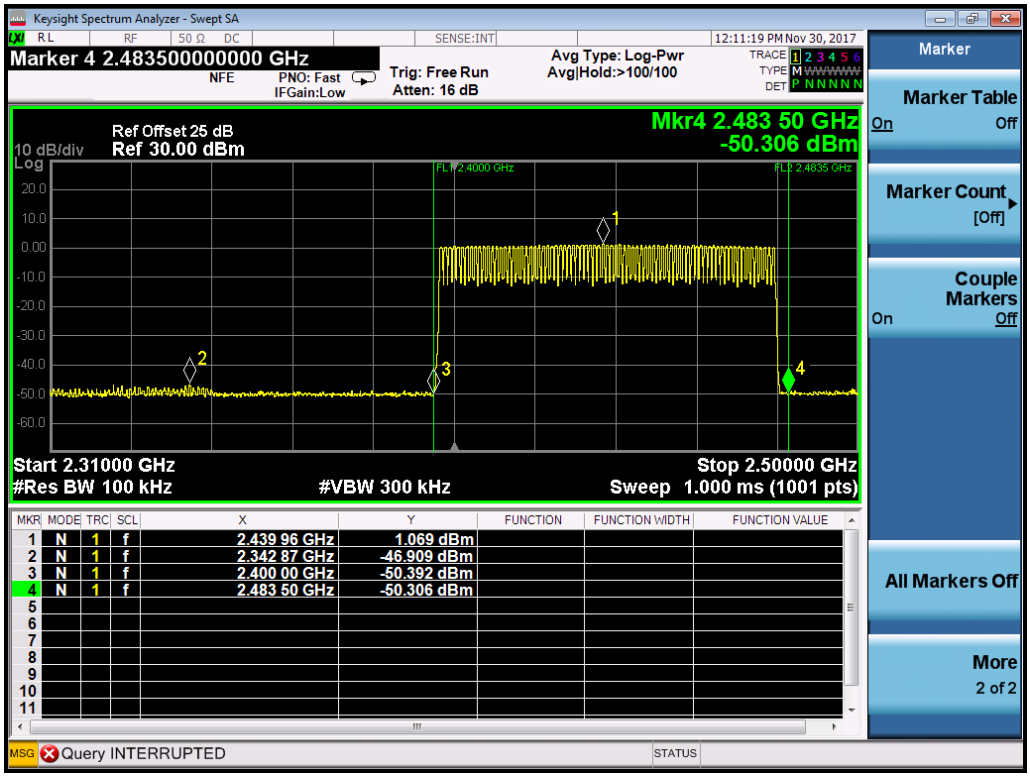

Keysight Spectrum Analyzer - Swept SA
Marker 1 2.441240831021 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:34:08 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 2.441 2 GHz
4.067 dBm
Start 2 MHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 25.00 GHz
Sweep 42.67 ms (40000 pts)
1 N 1 f 2.441 2 GHz 4.067 dBm
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

Mode 3, H

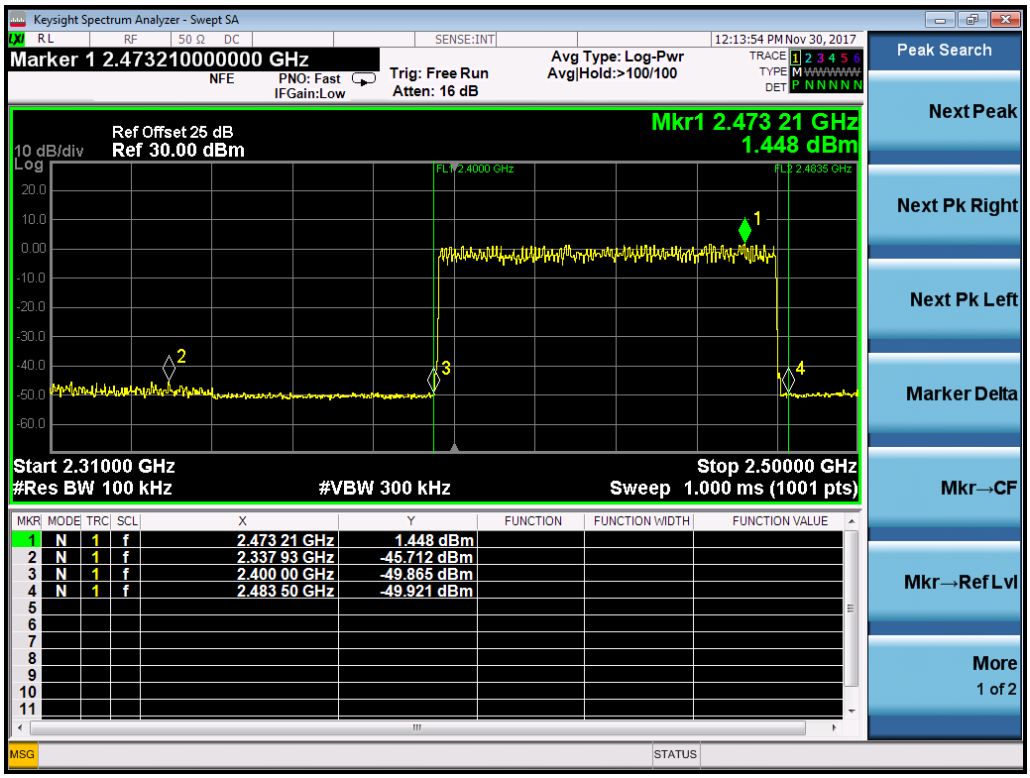

Keysight Spectrum Analyzer - Swept SA
Marker 1 2.479988699717 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:33:42 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 2.480 0 GHz
3.206 dBm
Start 2 MHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 25.00 GHz
Sweep 42.67 ms (40000 pts)
1 N 1 f 2.480 0 GHz 3.206 dBm
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2
MSG
STATUS


Keysight Spectrum Analyzer - Swept SA
Marker 1 2.480010001000 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
#Avg Type: RMS
Avg|Hold:>1/1
02:39:03 PM Nov 28, 2017
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 2.480 010 GHz
0.910 dBm
Start 2.31000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 7.333 ms (10000 pts)
1 N 1 f 2.480 010 GHz 0.910 dBm
2 N 1 f 2.400 000 GHz -64.013 dBm
3 N 1 f 2.483 500 GHz -62.382 dBm
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2
MSG
STATUS

Mode 4


Keysight Spectrum Analyzer - Swept SA
Marker 4 2.483500000000 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 16 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
12:11:19 PM Nov 30, 2017
Ref Offset 25 dB
10 dB/div
Ref 30.00 dBm
Mkr4 2.483 50 GHz
-50.306 dBm
Start 2.31000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 1.000 ms (1001 pts)
1 N 1 f 2.439 96 GHz 1.069 dBm
2 N 1 f 2.342 87 GHz -46.909 dBm
3 N 1 f 2.400 00 GHz -50.392 dBm
4 N 1 f 2.483 50 GHz -50.306 dBm
Marker
Marker Table
Marker Count
[Off]
Couple Markers
All Markers Off
More
2 of 2
Query INTERRUPTED

Mode 6


Keysight Spectrum Analyzer - Swept SA
Marker 1 2.473210000000 GHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 16 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
12:13:54 PM Nov 30, 2017
Ref Offset 25 dB
10 dB/div
Ref 30.00 dBm
Mkr1 2.473 21 GHz
1.448 dBm
Start 2.31000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 1.000 ms (1001 pts)
1 N 1 f 2.473 21 GHz 1.448 dBm
2 N 1 f 2.337 93 GHz -45.712 dBm
3 N 1 f 2.400 00 GHz -49.865 dBm
4 N 1 f 2.483 50 GHz -49.921 dBm
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Marker Delta
Mkr→CF
Mkr→Ref Lvl
More
1 of 2

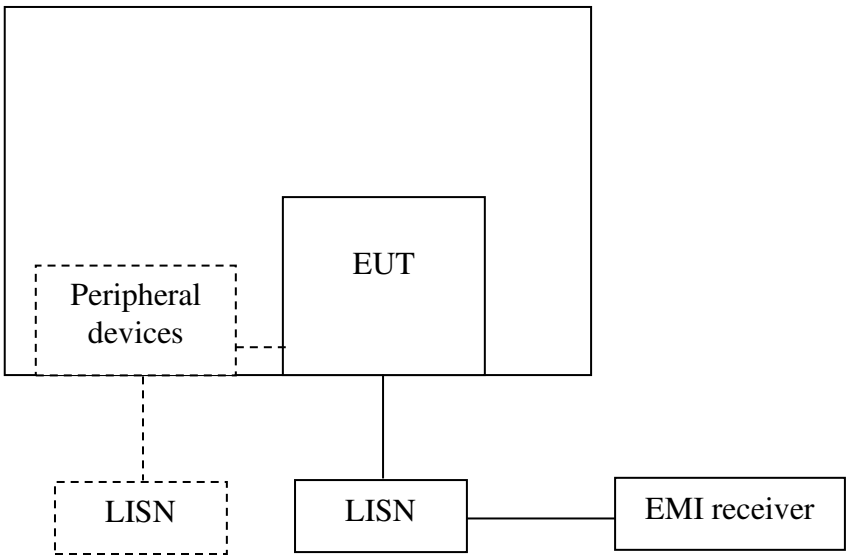
8. Power line conducted emission

Test result: **Pass**

8.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
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.		

8.2 Test configuration



☒ For table top equipment, wooden support is 0.8m height table

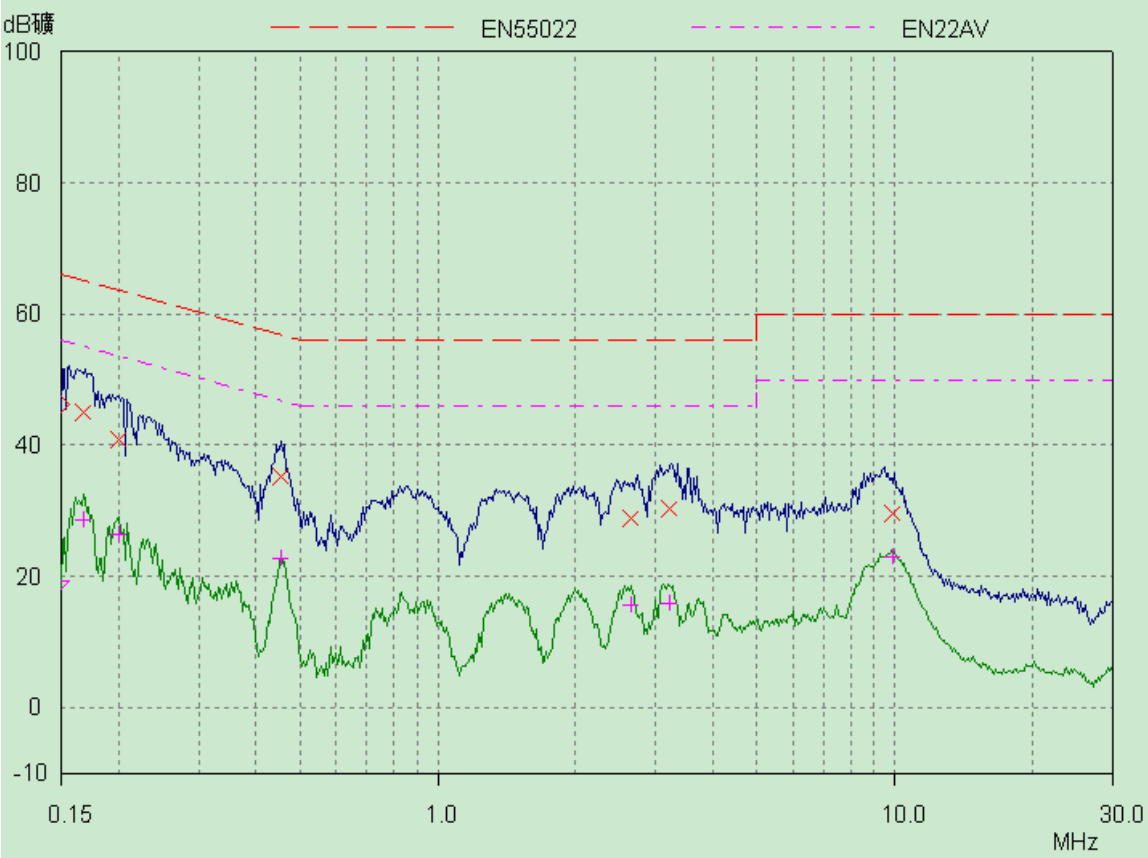
☐ For floor standing equipment, wooden support is 0.1m height rack.

8.3 Test procedure and test set up

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50Ω/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50Ω/50uH coupling impedance with 50Ω termination.
Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4 on conducted measurement.
The bandwidth of the test receiver is set at 9 kHz.

8.4 Test protocol

Temperature: 24 °C
Relative Humidity: 44 %



Frequency	Correct Factor (dB)	Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
		QP	AV	QP	AV	QP	AV
0.17 (L)	3.00	45.11	28.70	65.10	55.10	19.99	26.40
0.20 (L)	3.00	40.84	26.39	63.58	53.58	22.74	27.19
0.46 (N)	3.00	35.48	22.60	56.78	46.78	21.30	24.18
2.63 (N)	3.00	29.51	17.91	56.00	46.00	26.49	28.09
3.21 (N)	3.00	31.02	18.23	56.00	46.00	24.98	27.77
9.88 (N)	3.00	29.85	23.21	60.00	50.00	30.15	26.79
Remark: 1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB). 2. Margin (dB) = Limit - Corrected Reading.							

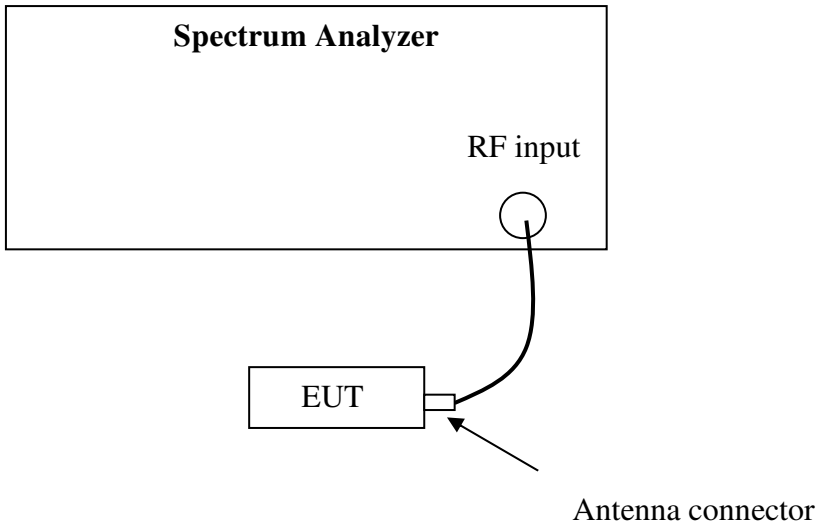
9. Number of Hopping Frequencies

Test result: **Pass**

9.1 Limit

Number of Hopping Frequencies in the 2400-2483.5 MHz band shall use at least 15 channels.

9.2 Test Configuration



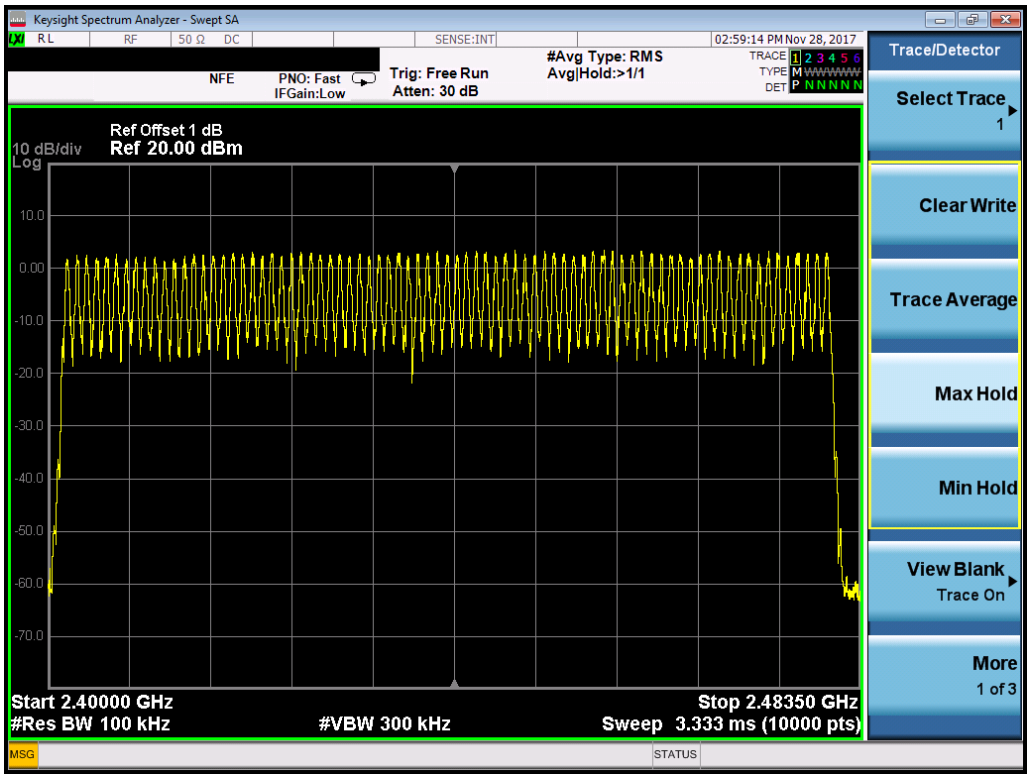
9.3 Test procedure and test setup

The channel number per FCC §15.247(a)(1)(iii) is measured using the Spectrum Analyzer with RBW=1MHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

9.4 Test protocol

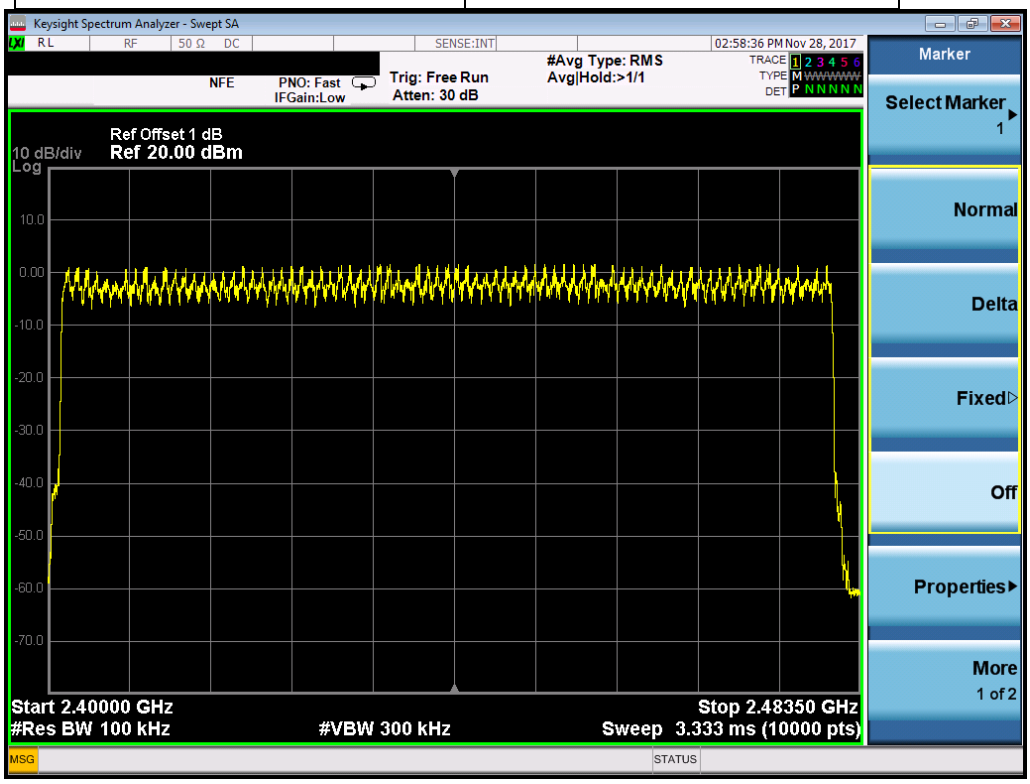
Mode 4

Channel Number	Limit
79	≥15



Mode 6

Channel Number	Limit
79	≥15



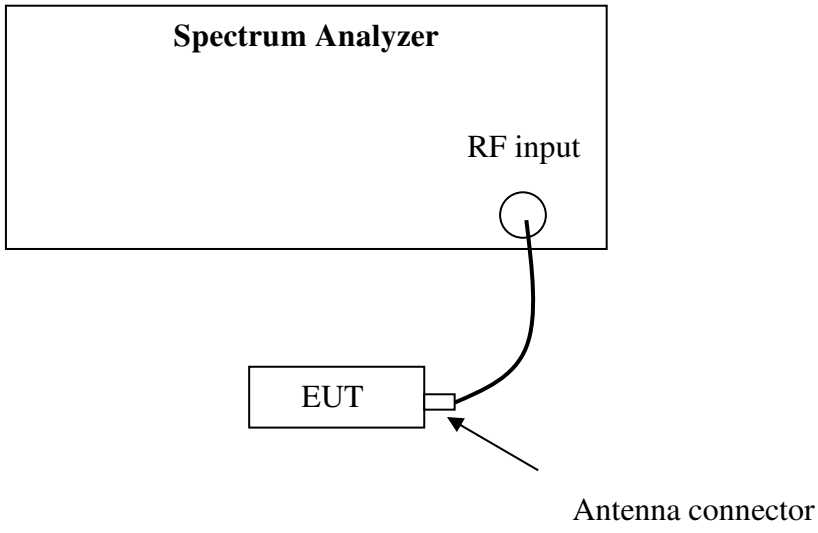
10. Dwell Time

Test result: **Pass**

10.1 Limit

The dwell time on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

10.2 Test Configuration



10.3 Test procedure and test setup

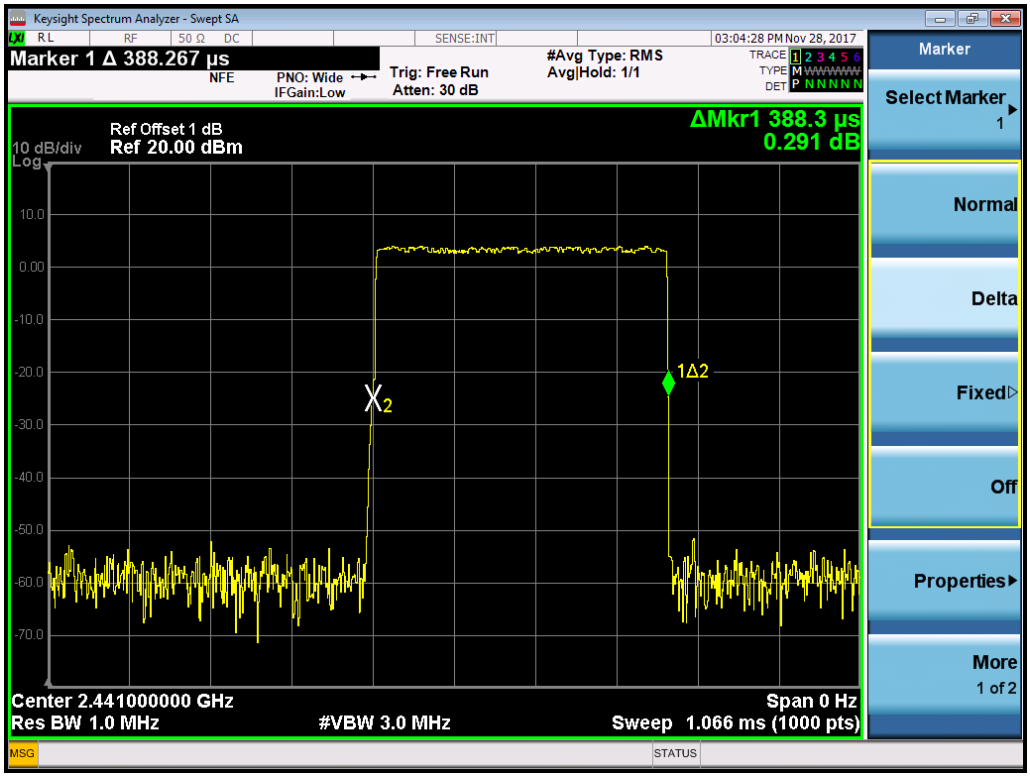
Dwell time per FCC § 15.247(a)(1)(iii) is measured using the Spectrum Analyzer with Span = 0, RBW=1MHz, VBW≥RBW, Sweep can capture the entire dwell time, Detector = peak, Trace = max hold.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

10.4 Test protocol

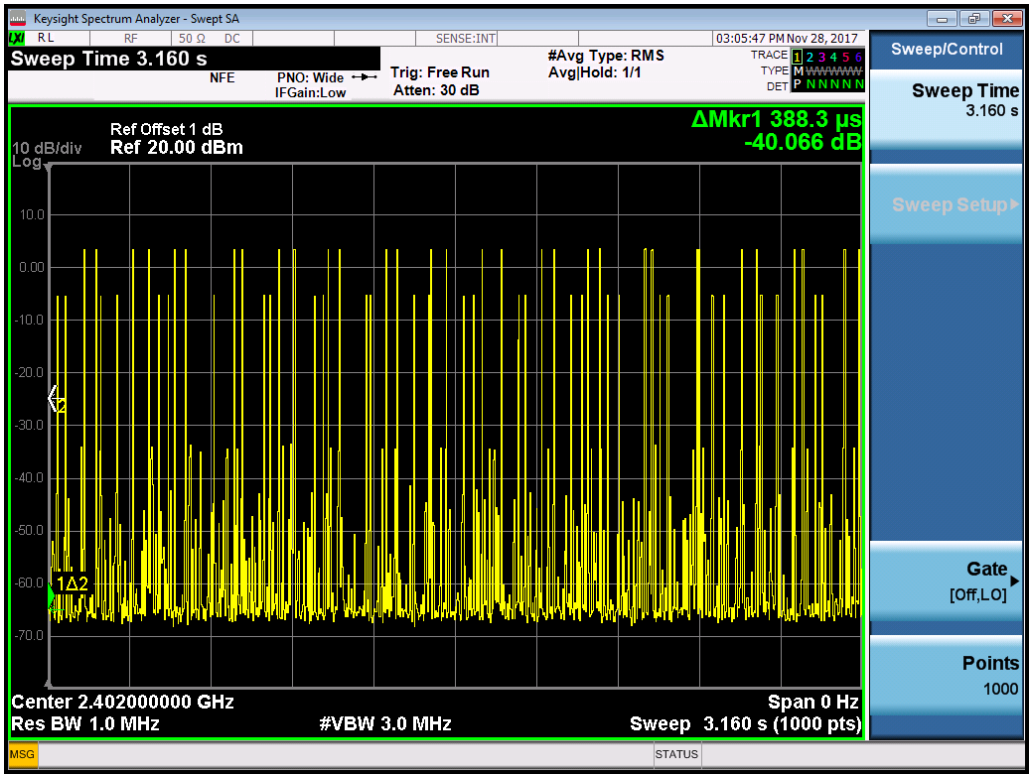
Packet	Occupancy time for single hop (ms) **O**	CH	Real observed period (s) **P**	Hops among Observed period **I**	Dwell time (s) **T**	Limit (s)
3DH1	0.388	L	3.16	32	0.124	≤0.4
		M	3.16	32	0.124	
		H	3.16	32	0.124	
3DH3	1.650	L	3.16	16	0.264	
		M	3.16	16	0.264	
		H	3.16	15	0.248	
3DH5	2.894	L	3.16	6	0.174	
		M	3.16	13	0.376	
		H	3.16	12	0.347	

Remark: 1. There are 79 channels in all. So the complete observed period P = 0.4 * 79 = 31.6 s.
2. Average time of occupancy **T = O *I * 31.6 / P**

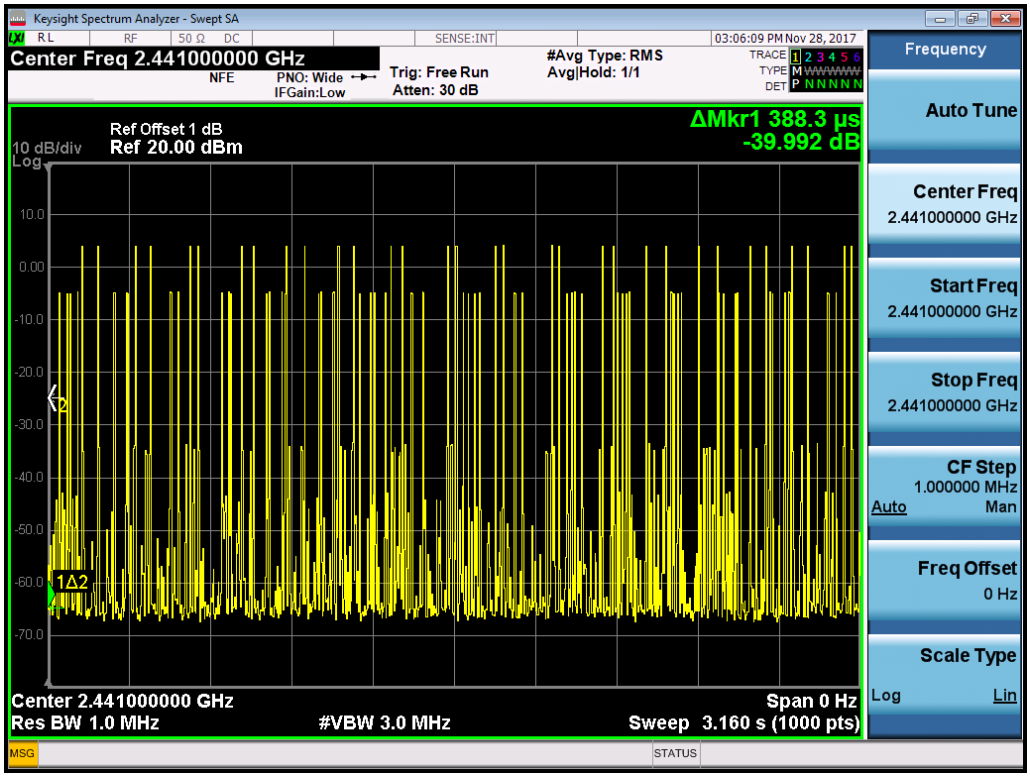
3DH1



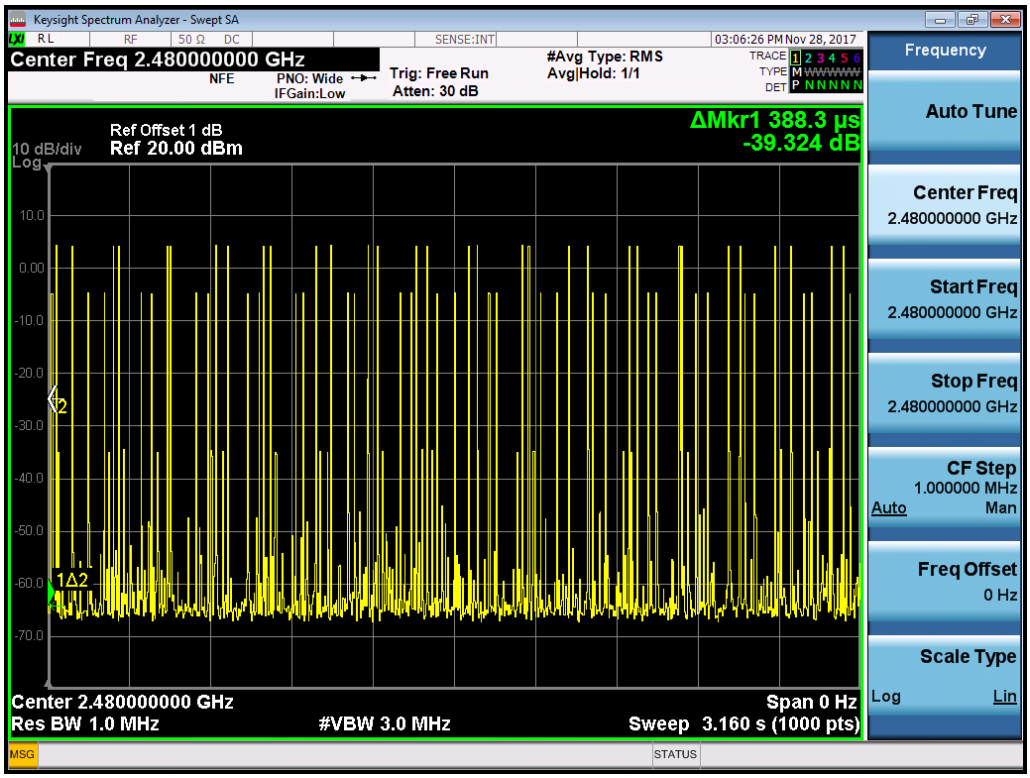
Channel L



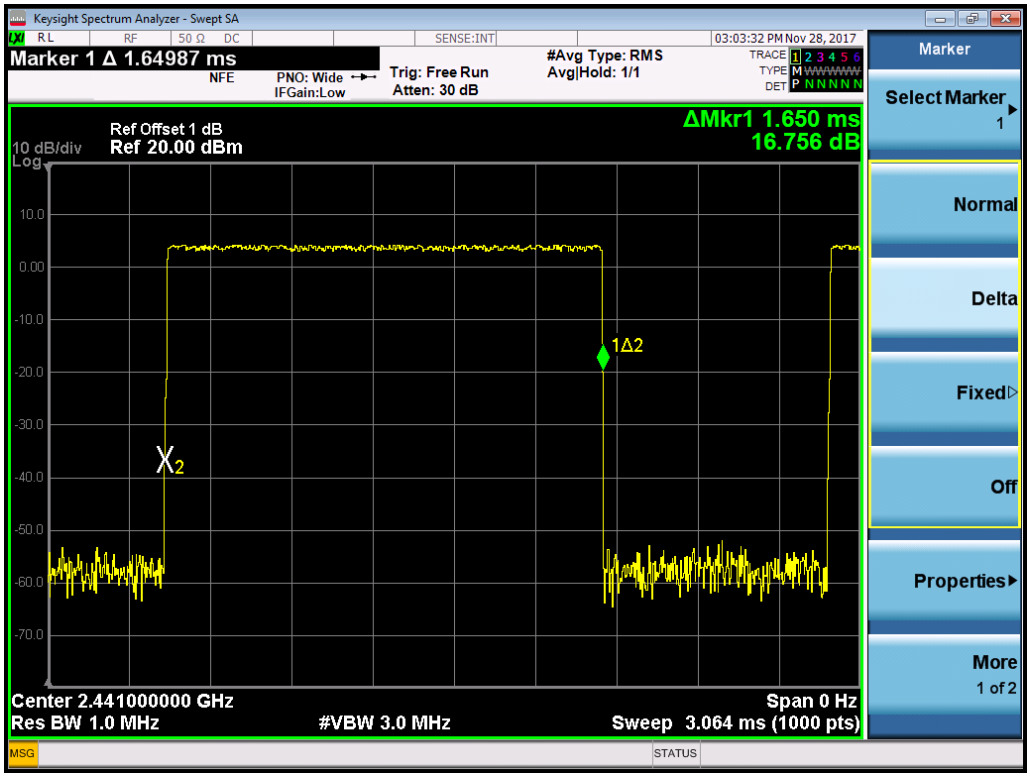
Channel M



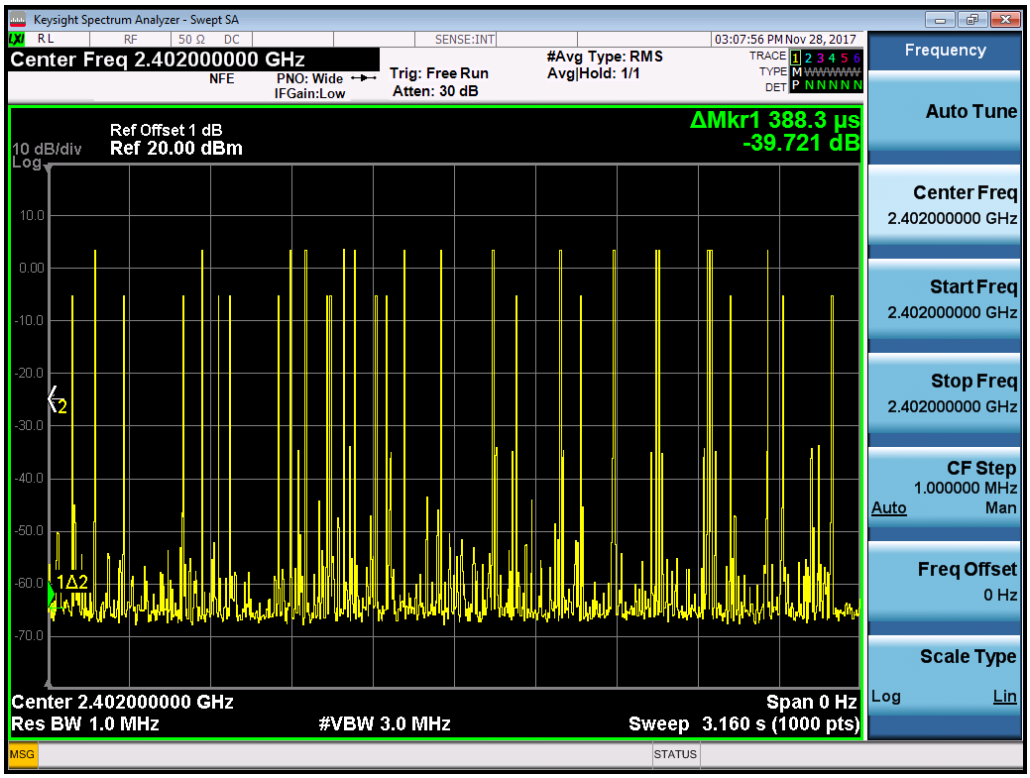
Channel H



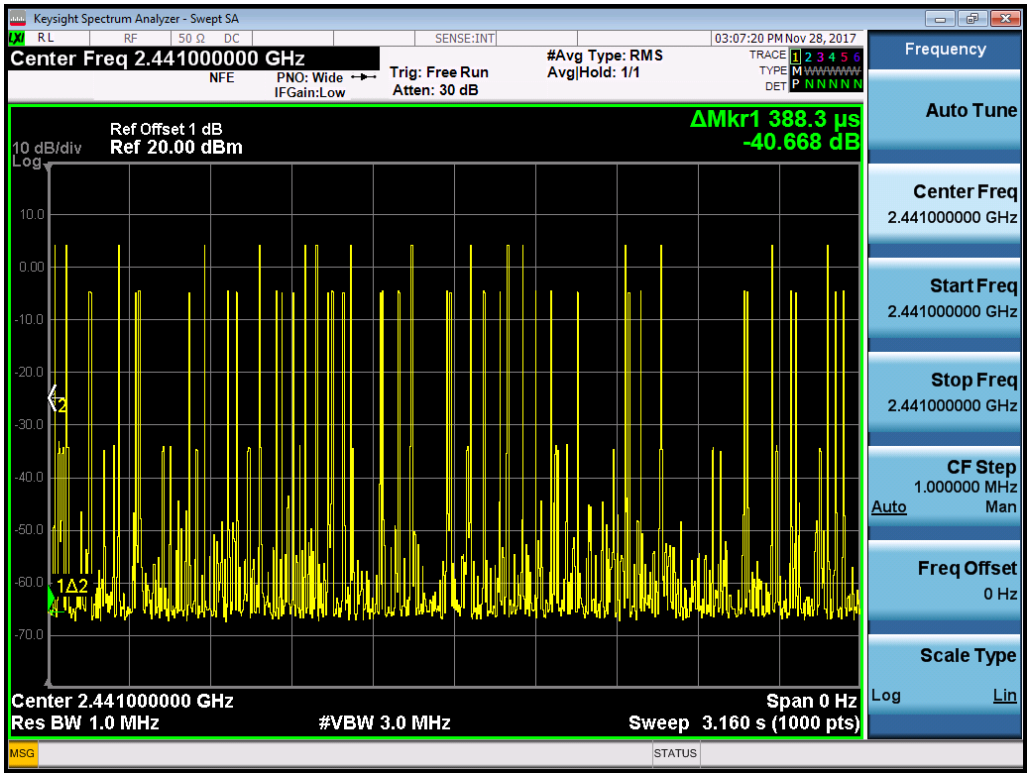
3DH3



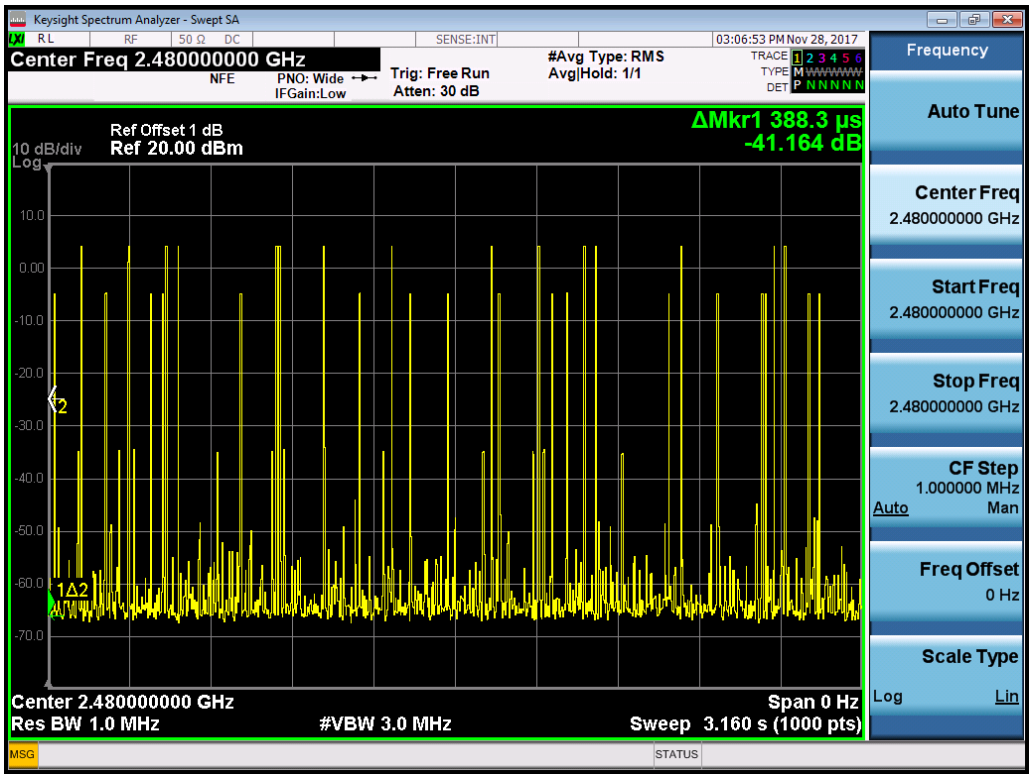
Channel L



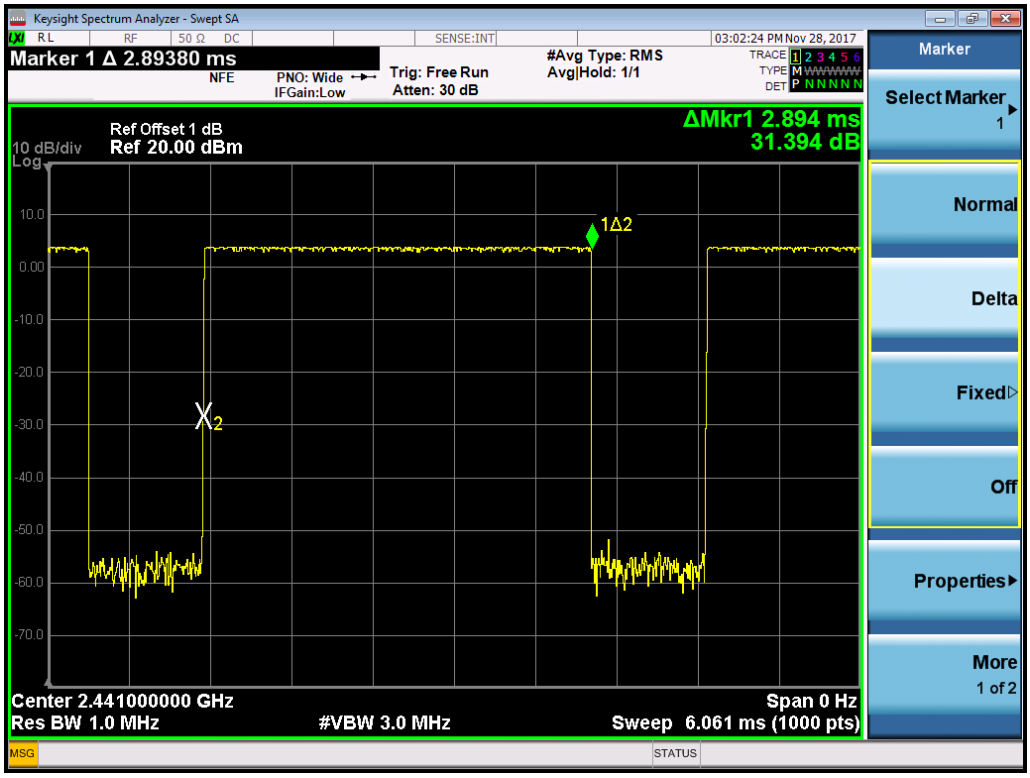
Channel M



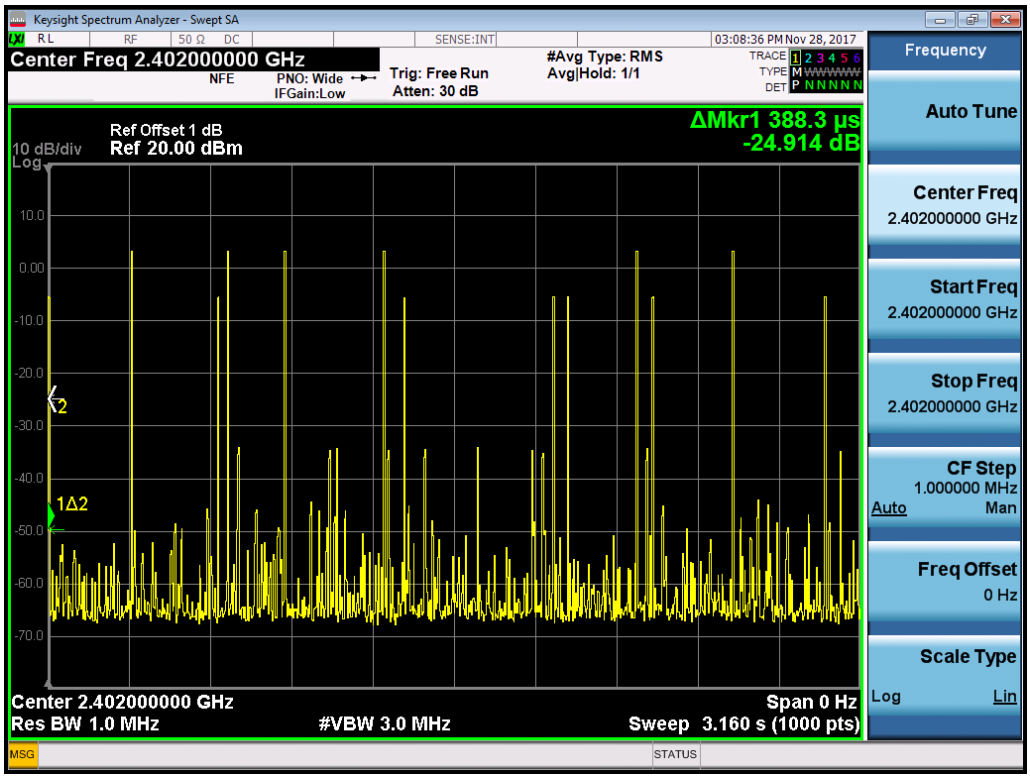
Channel H



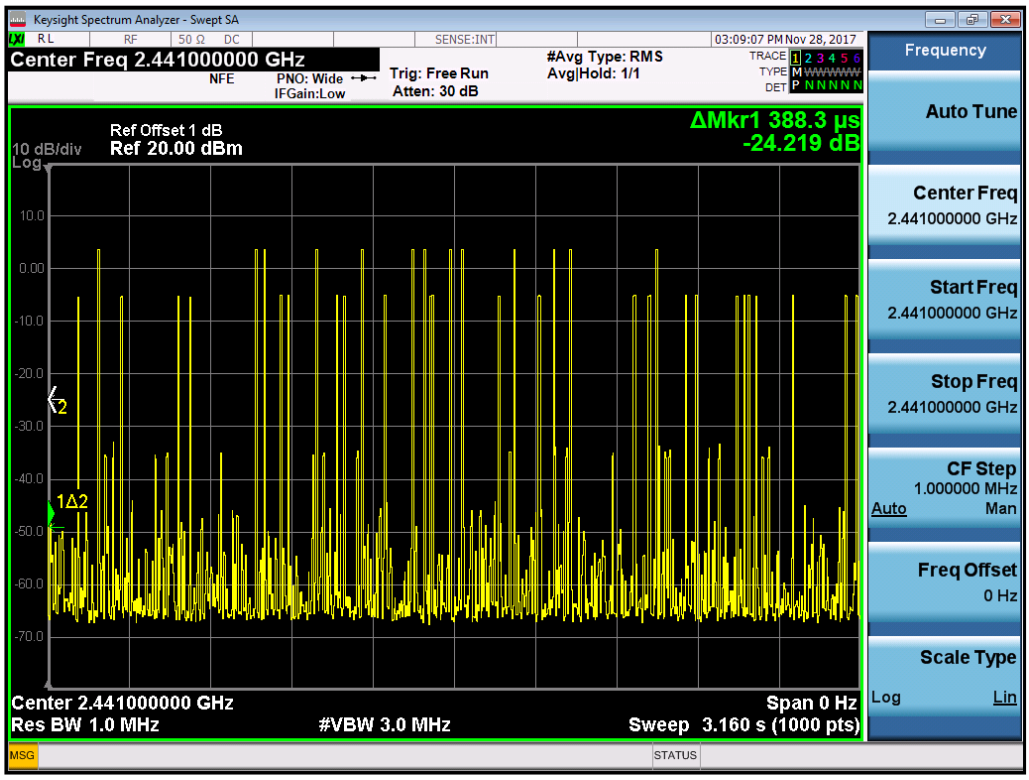
3DH5



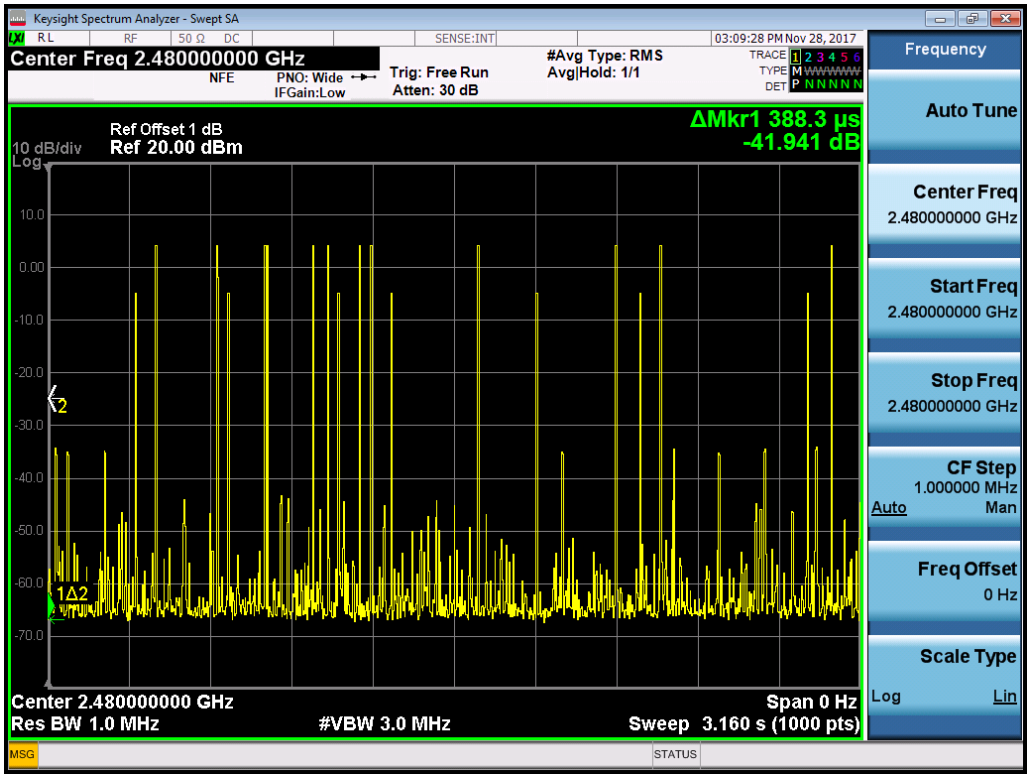
Channel L



Channel M



Channel H



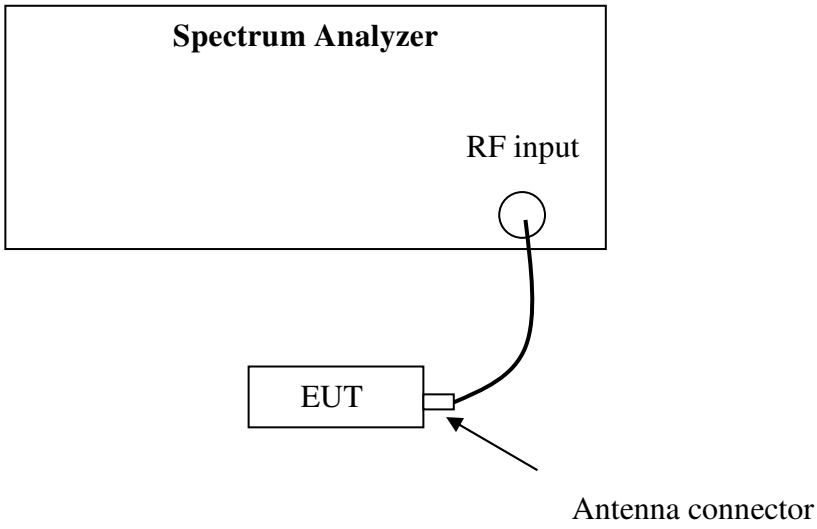
11. Occupied Bandwidth

Test Status: Pass

11.1 Test limit

None

11.2 Test Configuration



11.3 Test procedure and test setup

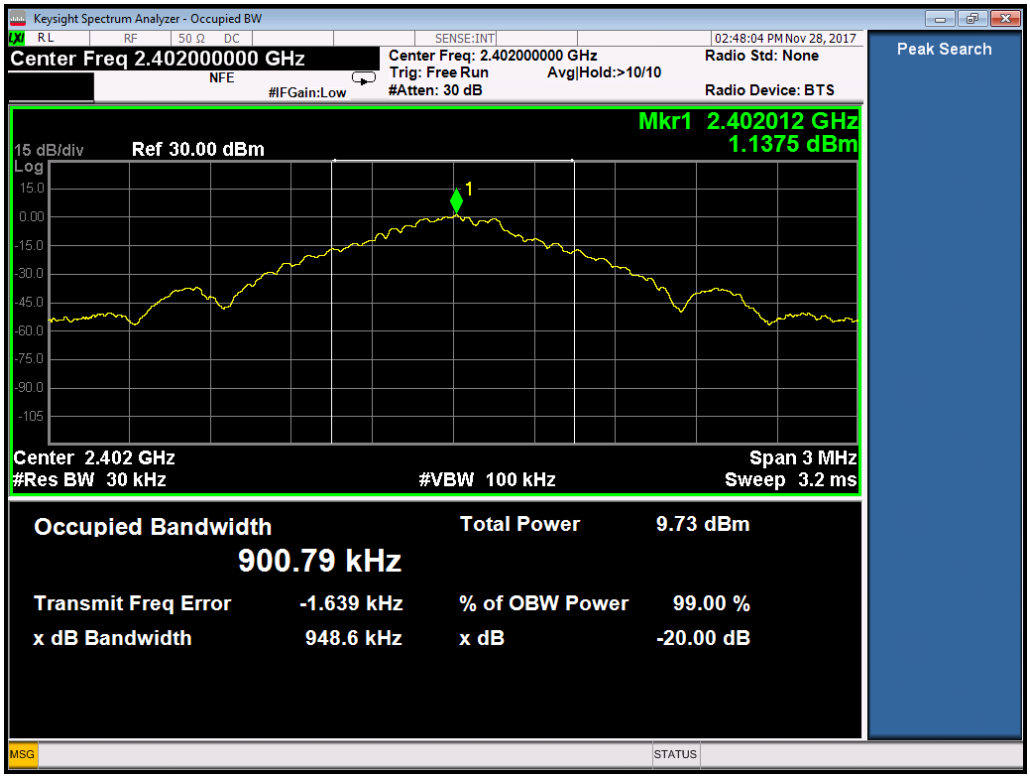
The occupied bandwidth per RSS-Gen Issue 4 Clause 6.6 was measured using the Spectrum Analyzer with the RBW close to 1% of the selected span, VBW = 3 * RBW
Detector = Sample, Sweep = Auto.

11.4 Test protocol

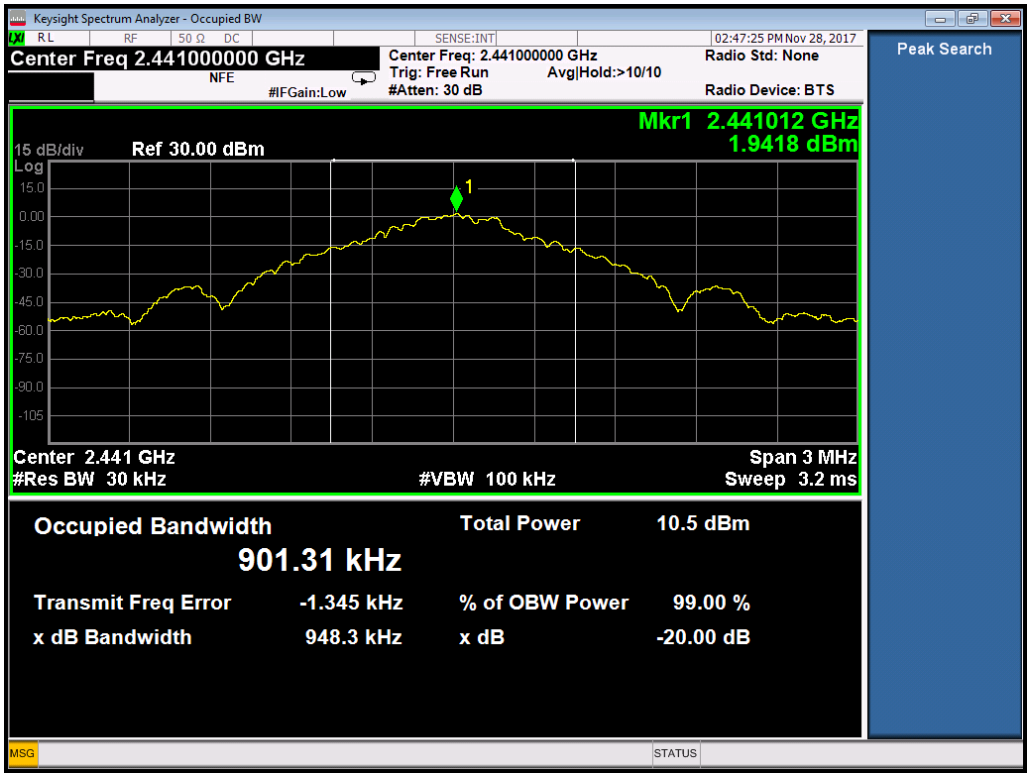
Temperature : 22 °C
Relative Humidity : 43%

Mode	Channel	Occupied Bandwidth (kHz)
1	L	901
	M	901
	H	901

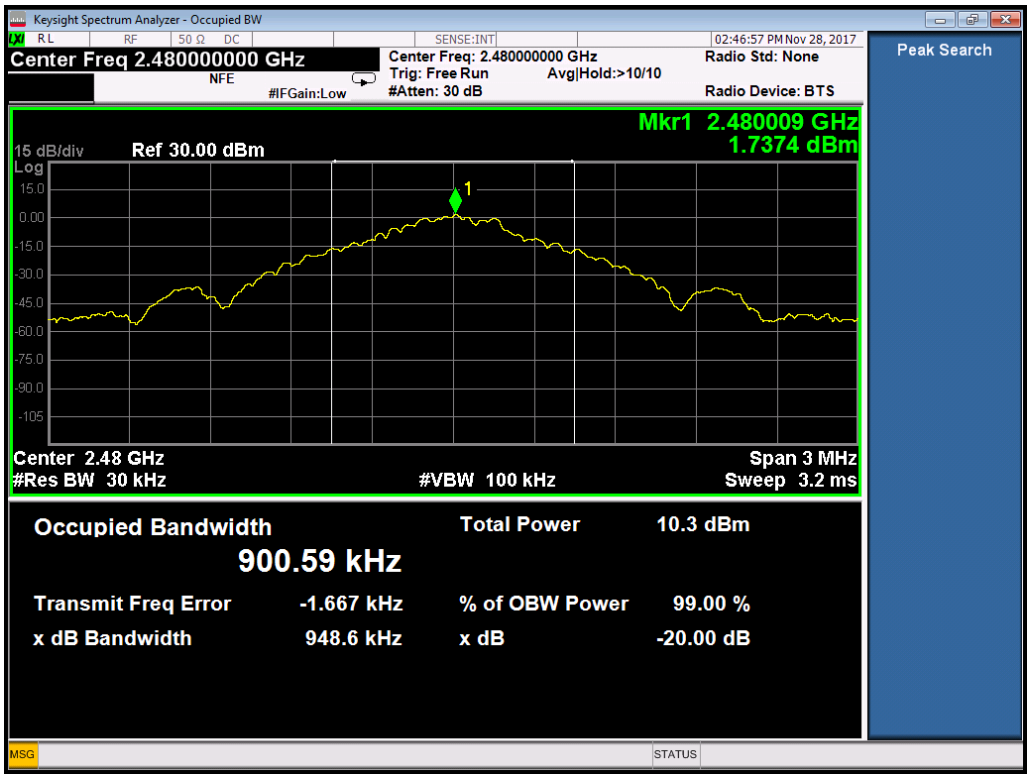
L



M

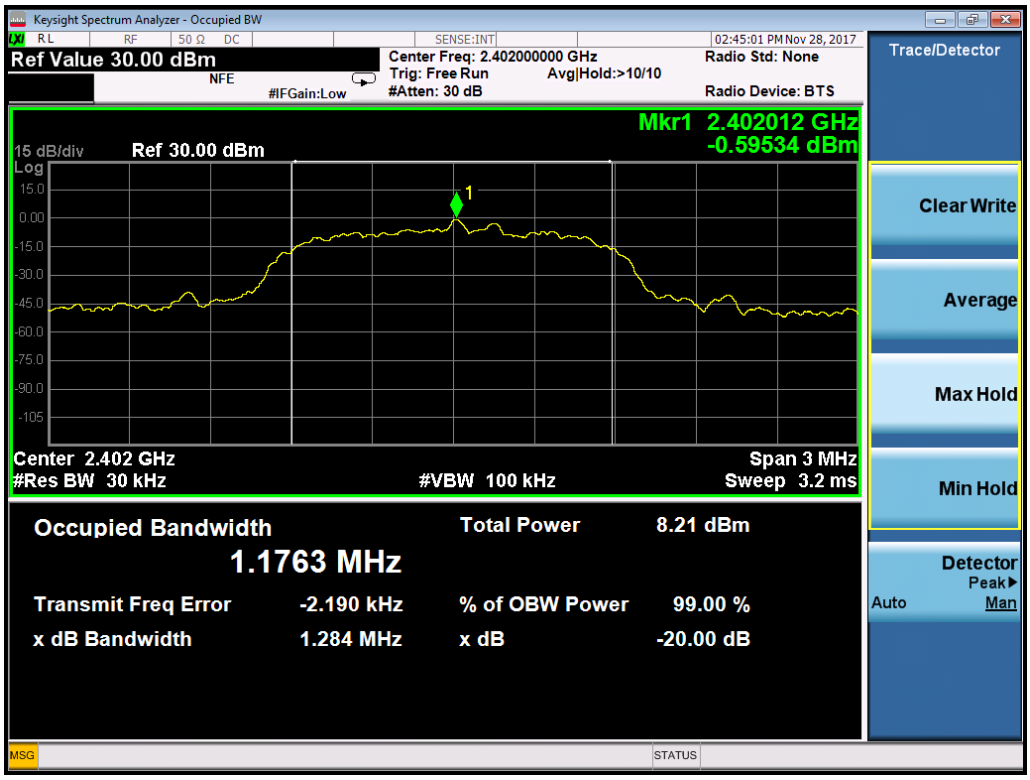

Keysight Spectrum Analyzer - Occupied BW
Center Freq 2.441000000 GHz
Center Freq: 2.441000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.441012 GHz
1.9418 dBm
15 dB/div
Ref 30.00 dBm
Center 2.441 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
901.31 kHz
Total Power
10.5 dBm
Transmit Freq Error
-1.345 kHz
% of OBW Power
99.00 %
x dB Bandwidth
948.3 kHz
x dB
-20.00 dB

H

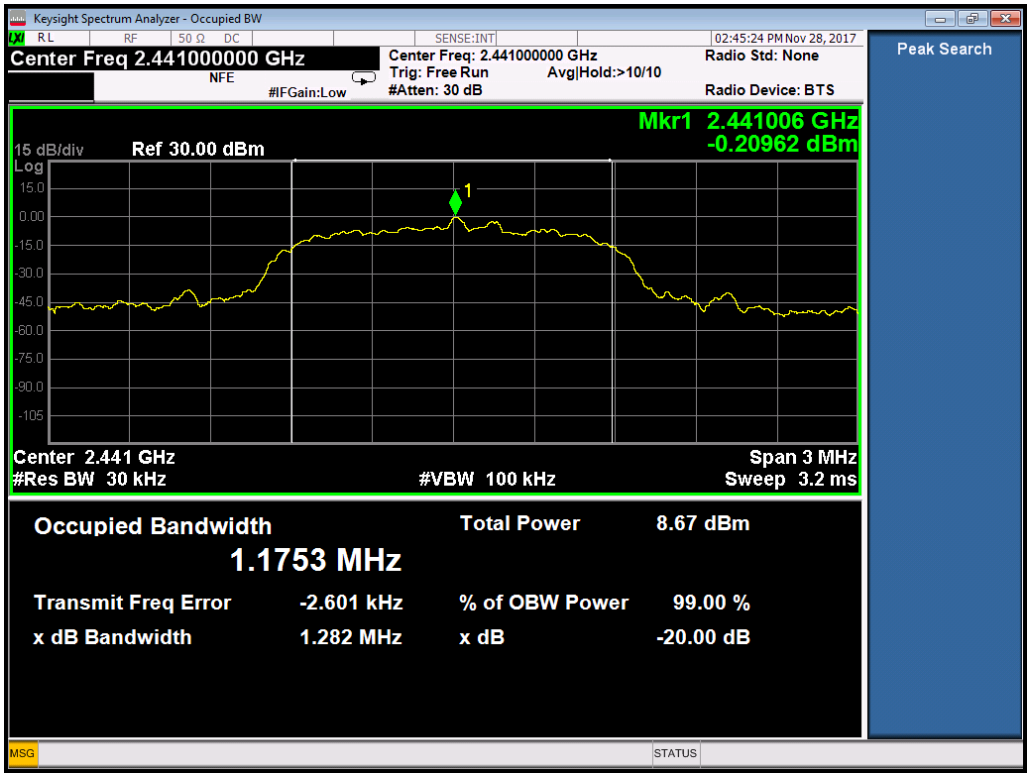

Keysight Spectrum Analyzer - Occupied BW
Center Freq 2.480000000 GHz
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.480009 GHz
1.7374 dBm
15 dB/div
Ref 30.00 dBm
Center 2.48 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
900.59 kHz
Total Power
10.3 dBm
Transmit Freq Error
-1.667 kHz
% of OBW Power
99.00 %
x dB Bandwidth
948.6 kHz
x dB
-20.00 dB

Mode	Channel	Occupied Bandwidth (kHz)
3	L	1176
	M	1175
	H	1176

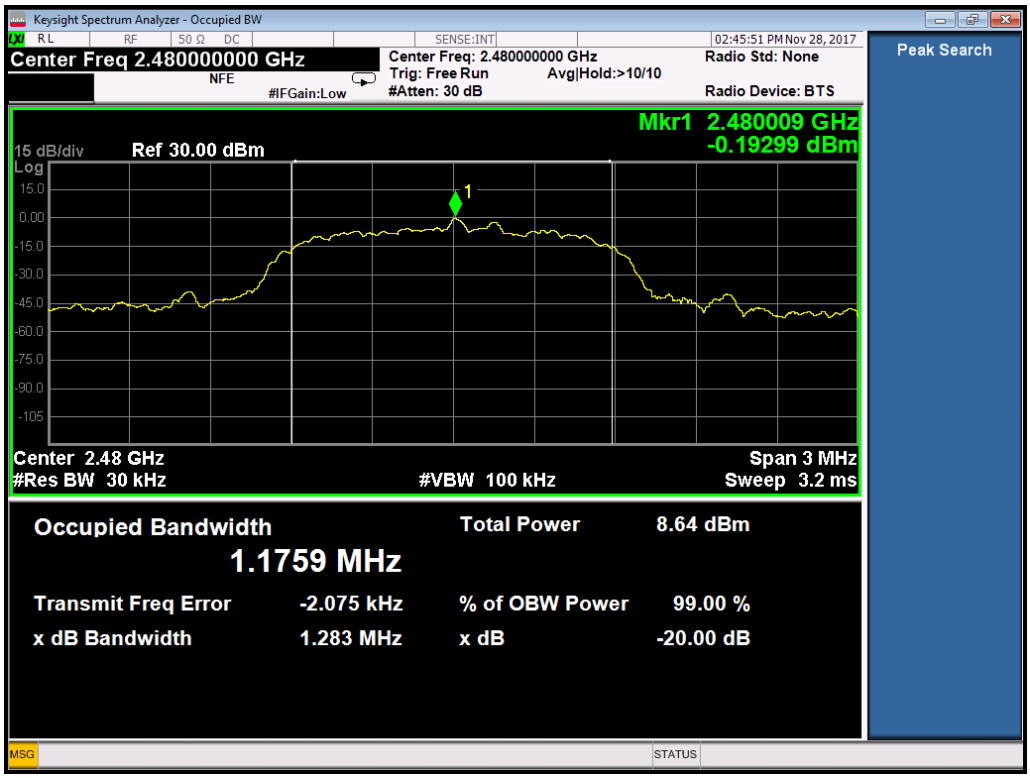
L



M


Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω DC
SENSE:INT
02:45:24 PM Nov 28, 2017
Center Freq 2.441000000 GHz
NFE
#IFGain:Low
Center Freq: 2.441000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.441006 GHz
-0.20962 dBm
15 dB/div
Ref 30.00 dBm
Log
15.0
0.00
-15.0
-30.0
-45.0
-60.0
-75.0
-90.0
-105
Center 2.441 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
1.1753 MHz
Total Power
8.67 dBm
Transmit Freq Error
-2.601 kHz
% of OBW Power
99.00 %
x dB Bandwidth
1.282 MHz
x dB
-20.00 dB
MSG
STATUS

H


Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω DC
SENSE:INT
02:45:51 PM Nov 28, 2017
Center Freq 2.480000000 GHz
NFE
#IFGain:Low
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 30 dB
Radio Std: None
Radio Device: BTS
Peak Search
Mkr1 2.480009 GHz
-0.19299 dBm
15 dB/div
Ref 30.00 dBm
Log
15.0
0.00
-15.0
-30.0
-45.0
-60.0
-75.0
-90.0
-105
Center 2.48 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
1.1759 MHz
Total Power
8.64 dBm
Transmit Freq Error
-2.075 kHz
% of OBW Power
99.00 %
x dB Bandwidth
1.283 MHz
x dB
-20.00 dB
MSG
STATUS