

TEST REPORT

of

FCC Part 15 Subpart C

Full Module report

☒ New Application; ☐ Class I PC; ☐ Class II PC

Product : BT Module
Brand: Sunrise
Model: BM2020
Model Difference: N/A
FCC ID: 2AMPPBM2020
FCC Rule Part: §15.247, Cat: DSS
Applicant: Sunrise Technology Co., Ltd
Address: No.28, Longshan St., Xitun Dist.,
Taichung City 407, Taiwan (R.O.C.)

Test Performed by:
International Standards Laboratory

<Lung-Tan LAB>

*Site Registration No.

BSMI: SL2-IN-E-0013; MRA TW1036; TAF: 0997; IC: IC4067B-3;

*Address:

No. 120, Lane 180, Hsin Ho Rd.

Lung-Tan Dist., Tao Yuan City 325, Taiwan

*Tel : 886-3-407-1718; Fax: 886-3-407-1738

Report No.: **ISL-17LR184FCDSS**

Issue Date :**2017/07/11**



Test results given in this report apply only to the specific sample(s) tested and are traceable to national or international standard through calibration of the equipment and evaluating measurement uncertainty herein.

This report MUST not be used to claim product endorsement by TAF, NVLAP or any agency of the Government.

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VERIFICATION OF COMPLIANCE

Applicant: Sunrise Technology Co., Ltd
Product Description: BT Module
Brand Name: Sunrise
Model No.: BM2020
Model Difference: N/A
FCC ID: 2AMPPBM2020
Date of test: 2017/06/28 ~ 2017/07/10
Date of EUT Received: 2017/06/28

We hereby certify that:

All the tests in this report have been performed and recorded in accordance with the standards described above and performed by an independent electromagnetic compatibility consultant, International Standards Laboratory.

The test results contained in this report accurately represent the measurements of the characteristics and the energy generated by sample equipment under test at the time of the test. The sample equipment tested as described in this report is in compliance with the limits of above standards.

Test By:	 _____ Dion Chang / Engineer	Date:	2017/07/11 _____
Prepared By:	 _____ Gigi Yeh / Specialist	Date:	2017/07/11 _____
Approved By:	 _____ Vincent Su / Technical Manager	Date:	2017/07/11 _____

Version

Version No.	Date	Description
00	2017/07/11	Initial creation of document

Uncertainty of Measurement

Description Of Test	Uncertainty
Conducted Emission (AC power line)	2.586 dB
Field Strength of Spurious Radiation	<=30MHz: 2.96dB 30-1GHz: 4.22 dB 1-40 GHz: 4.08 dB
Conducted Power	2.412 GHz: 1.30 dB 5.805 GHz: 1.55 dB
Power Density	2.412 GHz: 1.30 dB 5.805 GHz: 1.67 dB
Frequency	0.0032%
Time	0.01%
DC Voltage	1%

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1. GENERAL INFORMATION

1.1. Product Description

General:

Product Name	BT Module
Brand Name	Sunrise
Model Name	BM2020
Model Difference	N/A
Power Supply	3.3Vdc

Bluetooth: 1TX/1RX

Frequency Range:	2402– 2480MHz
Bluetooth Version:	BT3.0
Channel number:	79 channels
Modulation type	GFSK + $\pi/4$ DQPSK + 8DPSK
Transmit Power:	1.98 dBm Peak
Tune up power	+/- 1 dB
Dwell Time:	$\leq 0.4s$
Antenna Designation:	PCB Antenna 2.5dBi

The EUT is compliance with BT3.0 Standard.

This test report applies for Bluetooth EDR 3.0 transmitter.

Remark: The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.2. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: 2AMPPBM2020** filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

1.3. Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4: 2014, ANSI C63.10: 2013. Radiated testing was performed at an antenna to EUT distance 3 meters.

Tested in accordance with FCC Public Notice DA 00-705

1.4. Test Facility

The measurement facilities used to collect the 3m Radiated Emission and AC power line conducted data are located on the address of International Standards Laboratory <Lung-Tan LAB> No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist., Tao Yuan City 325, Taiwan which are constructed and calibrated to meet the FCC requirements in documents . FCC Registration Number is: 872200; Designation Number is: TW1036, Canada Registration Number: 4067B-4.

1.5. Special Accessories

Not available for this EUT intended for grant.

1.6. Equipment Modifications

Not available for this EUT intended for grant.

2. SYSTEM TEST CONFIGURATION

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT (Transmitter) was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements.

2.3. Test Procedure

2.3.1 Conducted Emissions

The EUT is placed on a turn table which is 0.8 m above ground plane. According to the requirements in Section 5 and 7 of ANSI C63.10: 2013. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR 16-1-1 Quasi-Peak and Average detector mode.

2.3.2 Radiated Emissions

The EUT is placed on a turn table which is 0.8 m/1.5m(Frequency above 1GHz) above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter(EUT) was rotated through three orthogonal axes according to the requirements in Section 6 and 11 of ANSI C63.10: 2013.

2.4. Configuration of Tested System

Fig. 2-1 Configuration of Tested System (Fixed channel)

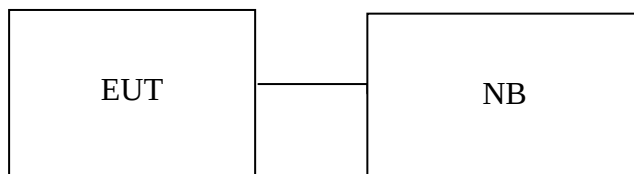


Table 1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/ Type No.	Series No.	Data Cable	Power Cord
1	NB	Dell	PP42L	N/A	No- Shielding	No- Shielding

3. SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power line Conducted Emission	Compliant
§15.247(b)(1)	Peak Output Power/EIRP	Compliant
§15.247(d)	100 KHz Bandwidth Of Frequency Band Edges	Compliant
§15.247(c)	TX Spurious Emission	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency	Compliant
§15.247(a)(1)(ii)	Time of Occupancy	Compliant
§15.247(a)(1)	20dB Bandwidth & 99% Power Bandwidth	Compliant
§15.203, §15.247(c)/	Antenna Requirement	Compliant

4. DESCRIPTION OF TEST MODES

Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Channel low (2402MHz)、 mid (2441MHz) and high (2480MHz) with each modulation were chosen for full testing.

The worst case EDR 3M mode was reported for Radiated Emission.

5. AC POWER LINE CONDUCTED EMISSION TEST

5.1. Standard Applicable:

According to §15.207, frequency range within 150KHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note 1.The lower limit shall apply at the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

5.2. Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Conduction 04-3 Cable	WOKEN	CFD 300-NL	Conduction 04 -3	09/12/2016	09/11/2017
EMI Receiver 16	Rohde & Schwarz	ESCI	101221	10/24/2016	10/23/2017
LISN 18	ROHDE & SCHWARZ	ENV216	101424	02/05/2017	02/04/2018
LISN 19	ROHDE & SCHWARZ	ENV216	101425	03/07/2017	03/06/2018
Test Software	Farad	EZEMC Ver:ISL-03A2	N/A	N/A	N/A

5.3. EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.4-2009.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

5.4. Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

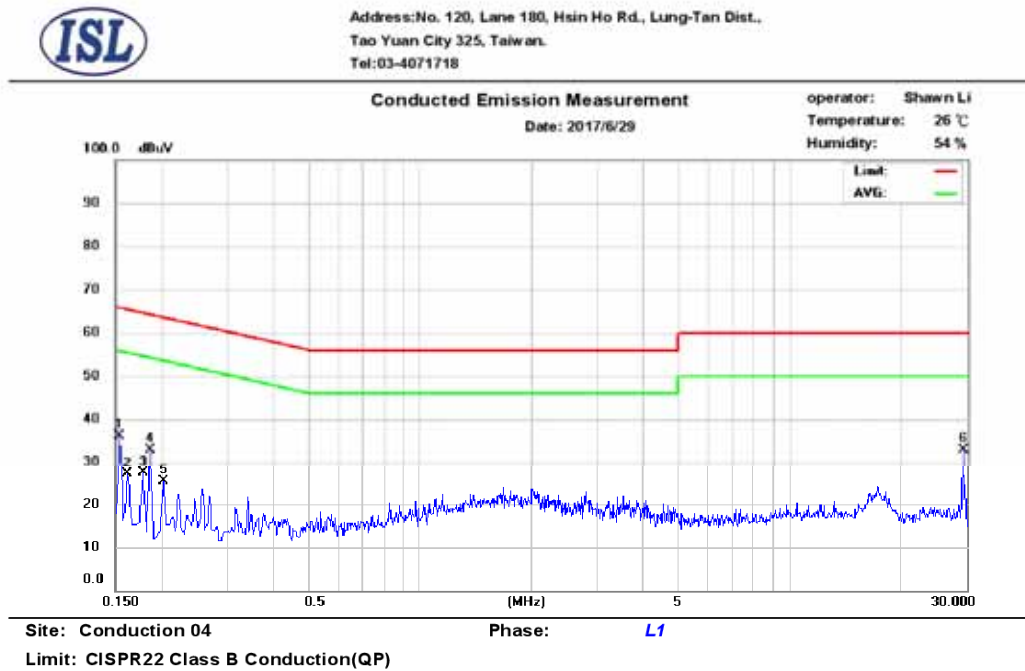
5.5. Measurement Result:

The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. Significant peaks are then marked as shown on the following data page, and these signals are then quasi-peaked.

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

AC POWER LINE CONDUCTED EMISSION TEST DATA

Operation Mode:	Operation Mode	Test Date:	2017/06/29
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No.	Frequency (MHz)	QP_R (dBuV)	AVG_R (dBuV)	Correct Factor (dB)	QP Emission (dBuV)	QP Limit (dBuV)	QP Margin (dB)	AVG Emission (dBuV)	AVG Limit (dBuV)	AVG Margin (dB)
1	0.154	22.61	-0.74	9.65	32.26	65.78	-33.52	8.91	55.78	-46.87
2	0.162	17.16	-0.74	9.65	26.81	65.36	-38.55	8.91	55.36	-46.45
3	0.178	14.88	-1.40	9.66	24.54	64.58	-40.04	8.26	54.58	-46.32
4	0.186	14.24	-2.12	9.66	23.90	64.21	-40.31	7.54	54.21	-46.67
5	0.202	12.10	-1.26	9.66	21.76	63.53	-41.77	8.40	53.53	-45.13
6	29.278	18.17	0.67	10.05	28.22	60.00	-31.78	10.72	50.00	-39.28

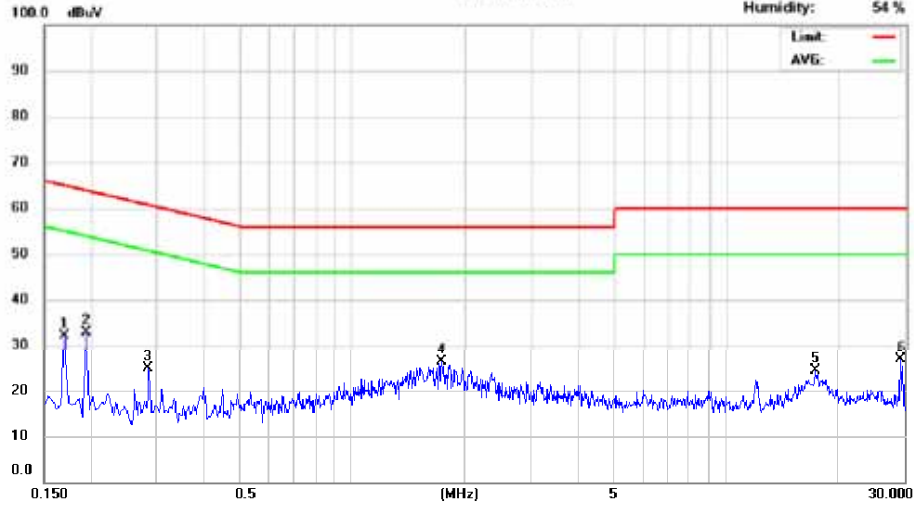


Address: No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist.,
Tao Yuan City 325, Taiwan.
Tel: 03-4071718

Conducted Emission Measurement

operator: Shawn Li
Temperature: 26 °C
Humidity: 54 %

Date: 2017/6/29



Site: Conduction 04

Phase: **N**

Limit: CISPR22 Class B Conduction(QP)

No.	Frequency (MHz)	QP_R (dBuV)	AVG_R (dBuV)	Correct Factor (dB)	QP Emission (dBuV)	QP Limit (dBuV)	QP Margin (dB)	AVG Emission (dBuV)	AVG Limit (dBuV)	AVG Margin (dB)
1	0.170	19.97	1.89	9.64	29.61	64.96	-35.35	11.53	54.96	-43.43
2	0.194	12.56	0.53	9.65	22.21	63.86	-41.65	10.18	53.86	-43.68
3	0.286	4.97	-0.33	9.66	14.63	60.64	-46.01	9.33	50.64	-41.31
4	1.738	13.12	7.90	9.70	22.82	56.00	-33.18	17.60	46.00	-28.40
5	17.378	8.56	3.64	10.12	18.68	60.00	-41.32	13.76	50.00	-36.24
6	29.266	17.47	0.28	10.21	27.68	60.00	-32.32	10.49	50.00	-39.51

6. PEAK OUTPUT POWER MEASUREMENT

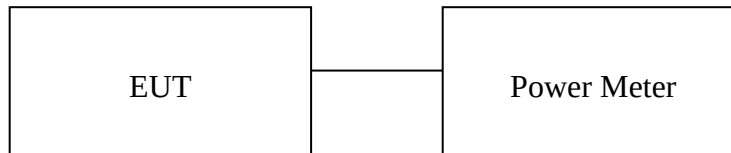
6.1. Standard Applicable:

According to §15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850MHz band: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: 0.125 Watts.

6.2. Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter 05	Anritsu	ML2495A	1116010	07/28/2016	07/27/2017
Power Sensor 05	Anritsu	MA2411B	34NKF50	07/28/2016	07/27/2017
Power Sensor 06	DARE	RPR3006W	13I00030SNO3 3	11/03/2016	11/02/2017
Power Sensor 07	DARE	RPR3006W	13I00030SNO3 4	11/03/2016	11/02/2017
Temperature Chamber	KSON	THS-B4H100	2287	06/28/2017	06/27/2018
DC Power supply	ABM	8185D	N/A	10/06/2016	10/05/2017
AC Power supply	EXTECH	CFC105W	NA	12/25/2016	12/24/2017
Attenuator	Woken	Watt-65m3502	11051601	NA	NA
Splitter	MCLI	PS4-199	12465	12/26/2015	12/25/2017
Spectrum analyzer	keysight	N9010A	MY56070257	05/31/2017	05/30/2018
Spectrum analyzer	R&S	FSP40	100143	08/07/2016	08/06/2017
Test Software	DARE	Radimation Ver:2013.1.23	NA	NA	NA

6.3. .Test Set-up:



6.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum.
3. Record the max. reading.
4. Repeat above procedures until all frequency measured were complete.

6.5. Measurement Result:

BDR Mode

Frequency (MHz)	Peak Reading Power (dBm)	Cable Loss	Output Power (dBm)	Output Power (W)	Limit (W)
Low	1.11	0.00	1.11	0.00129	1
Mid	0.74	0.00	0.74	0.00118	1
High	0.87	0.00	0.87	0.00122	1

EDR 2M Mode

Frequency (MHz)	Peak Reading Power (dBm)	Cable Loss	Output Power (dBm)	Output Power (W)	Limit (W)
Low	1.68	0.00	1.68	0.00147	0.125
Mid	1.36	0.00	1.36	0.00137	0.125
High	1.46	0.00	1.46	0.00140	0.125

EDR 3M Mode

Frequency (MHz)	Peak Reading Power (dBm)	Cable Loss	Output Power (dBm)	Output Power (W)	Limit (W)
Low	1.98	0.00	1.98	0.00158	0.125
Mid	1.69	0.00	1.69	0.00148	0.125
High	1.78	0.00	1.78	0.00151	0.125

Offset: 1dB

7. 100KHz BANDWIDTH OF BAND EDGES MEASUREMENT

7.1. Standard Applicable:

According to §15.247(d), in any 100 KHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, 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).

7.2. Measurement Equipment Used:

7.2.1. Conducted Emission at antenna port:

Refer to section 6.2 for details.

7.2.2. Radiated emission:

Chamber 19(966)					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer 21(3Hz-44GHz)	Agilent	N9030A	MY51360021	11/14/2016	11/13/2017
EMI Receiver	SCHWARZBECK	FCVU1534	1534149	11/30/2016	11/29/2017
Loop Antenna(9K-30M)	EM	EM-6879	271	11/01/2016	10/31/2018
Bilog Antenna (30M-1G)	SCHWARZBECK	VULB9168 w 5dB Att	736	07/22/2016	07/21/2017
Horn antenna (1G-18G)	SCHWARZBECK	9120D	9120D-1627	07/22/2016	07/21/2017
Horn antenna (18G-26G)	Com-power	AH-826	081001	07/24/2015	07/23/2017
Horn antenna (26G-40G)	Com-power	AH-640	100A	02/22/2017	02/21/2019
Preamplifier (9k-1000M)	HP	8447F	3113A06362	11/13/2016	11/12/2017
Preamplifier(1G-26G)	Agilent	8449B	3008A02471	08/25/2016	08/24/2017
Preamplifier (26G-40G)	MITEQ	JS4-26004000-27-5A	818471	07/23/2015	07/22/2017
RF Cable (9k-18G)	HUBER SUHNER	SUCOFLEX 104A	MY1397/4A	08/25/2016	08/24/2017
RF cable (18G~40G)	HUBER SUHNER	Sucoflex 102	27963/2&3742 1/2	11/03/2015	11/02/2017
Turn Table	MF	Turn Table-19	Turn Table-19	N/A	N/A
Mast Tower	MF	JSDES-15A	1308283	N/A	N/A
Controller	MF	MF-7802BS	MF780208460	N/A	N/A
AC power source	T-Power	TFC-1005	40006471	N/A	N/A
Signal Generator	R&S	SMU200A	102330	03/15/2017	03/14/2018
Signal Generator	Anritsu	MG3692A	20311	11/04/2016	11/03/2017
2.4G Filter	Micro-Tronics	Brm50702	76	12/25/2016	12/24/2017
Test Software	Audix	E3 Ver:6.12023	N/A	N/A	N/A

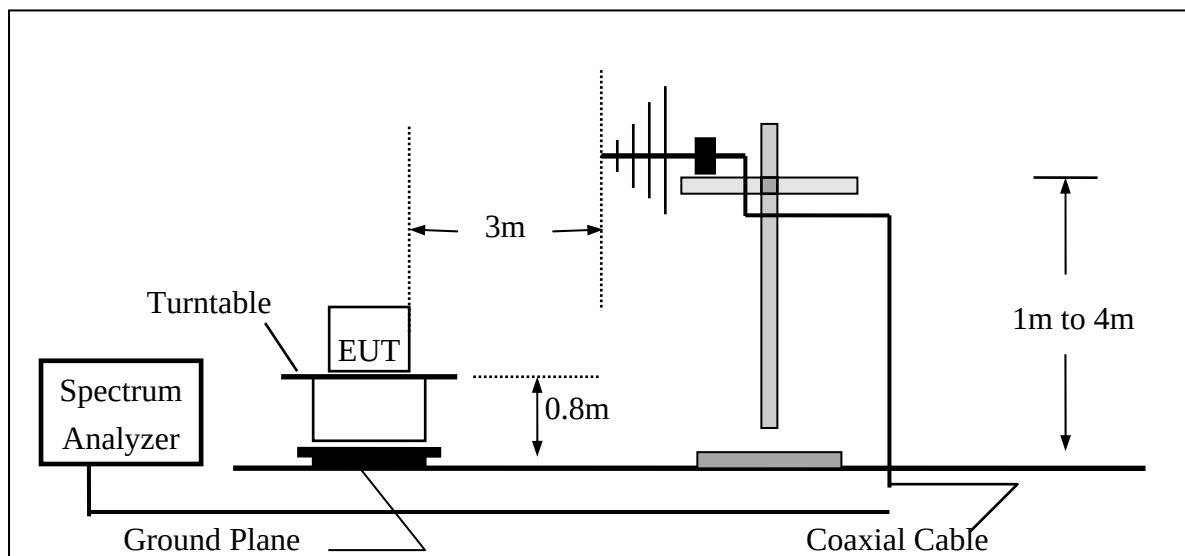
7.3. Test SET-UP:

7.3.1. Conducted Emission at antenna port:

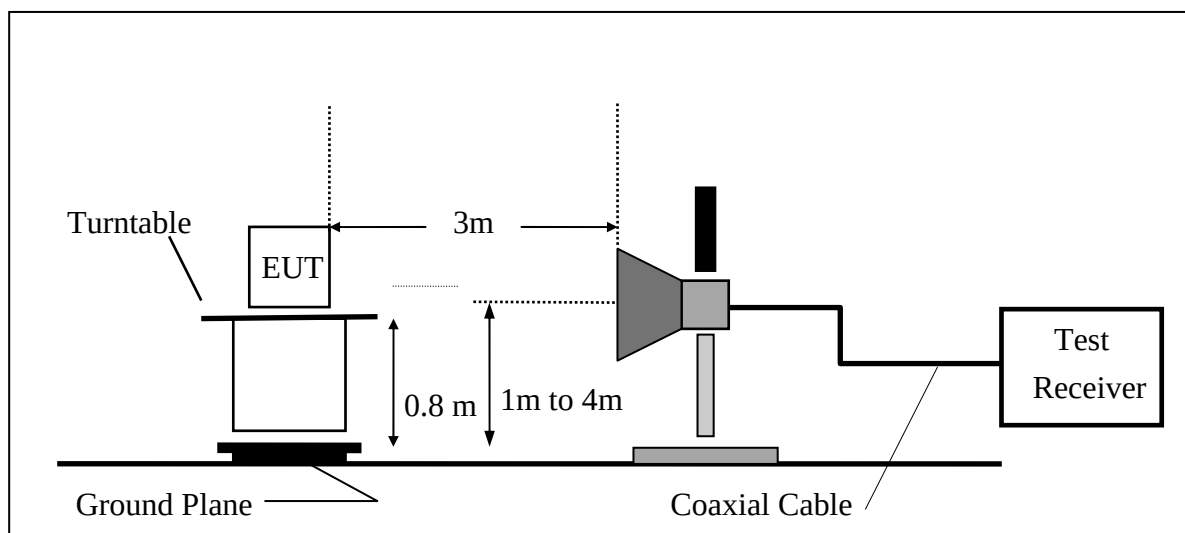
Refer to section 6.3 for details.

7.3.2. Radiated emission:

(A) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(B) Radiated Emission Test Set-UP Frequency Over 1 GHz



7.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW, VBW=100KHz, Span=25MHz, Sweep = auto
5. Mark Peak, 2.390GHz and 2.4835GHz and record the max. level.
6. Repeat above procedures until all frequency measured were complete.

7.5. Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

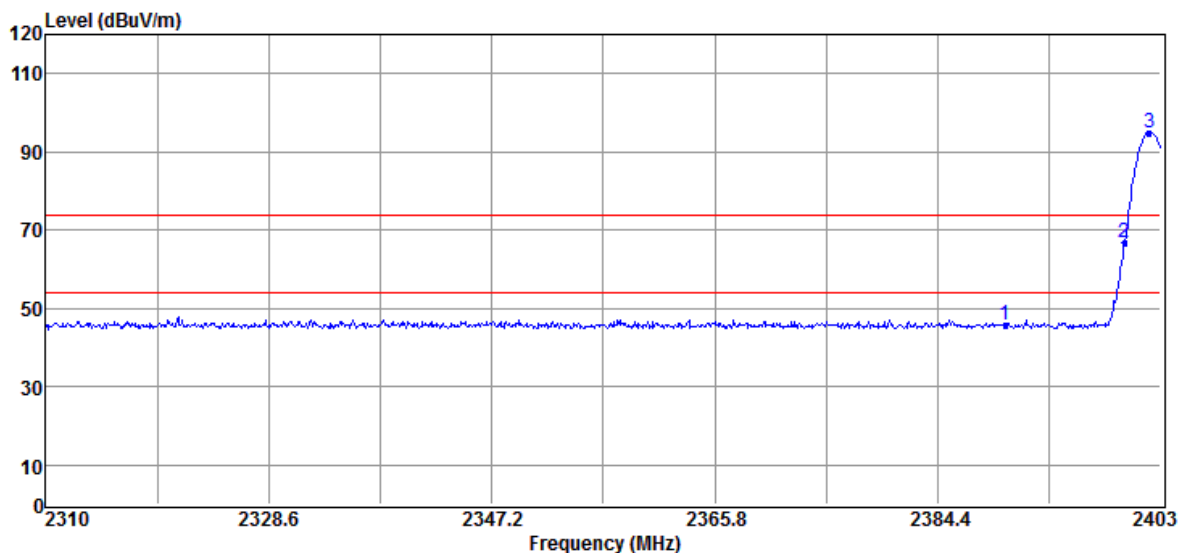
7.6. Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

Radiated Emission: (The worst data :EDR 3M mode)

Operation Mode TX CH Low
Fundamental Frequency 2402 MHz
Temperature 25 °C

Test Date 2017/07/05
Test By Dino
Humidity 60 %

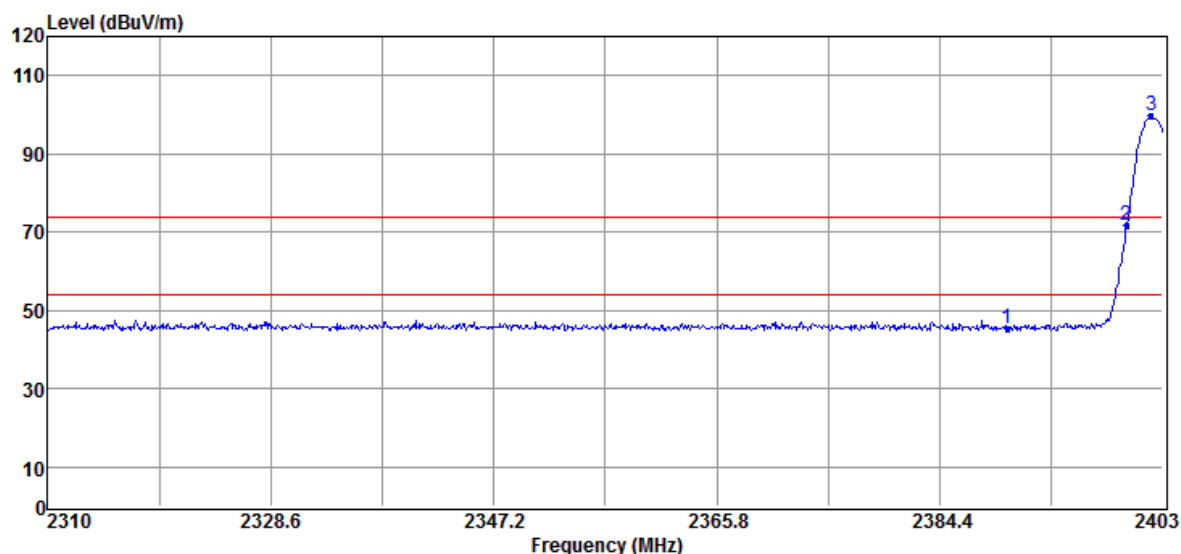


No	Freq MHz	Reading dBuV	Factor dB/m	Level dBuV/m	Limit dBuV/m	Over Li mit dB	Remark	Pol V/H
1	2390.00	48.78	-3.15	45.63	74.00	-28.37	Peak	VERTICAL
2	2400.00	70.05	-3.16	66.89	75.04	-8.15	Peak	VERTICAL
3	2402.07	98.20	-3.16	95.04	F	---	Peak	VERTICAL

Remark:

- 1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency
- 2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.
- 3 “F” denotes fundamental frequency; “H” denotes harmonics frequency. “S” denotes spurious frequency.
- 4 Measurement of data within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 Spectrum Peak mode IF bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, Sweep time= 200 ms., the VBW setting was 3 MHz.
- 6 Spectrum AV mode if bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, VBW= 10Hz, Sweep time= 200 ms.

Note: “F” denotes fundamental frequency



No	Freq MHz	Reading dBuV	Factor dB/m	Level dBuV/m	Limit dBuV/m	Over L imit dB	Remark	Pol V/H
1	2390.00	48.40	-3.15	45.25	74.00	-28.75	Peak	VERTICAL
2	2400.00	74.87	-3.16	71.71	79.82	-8.11	Peak	VERTICAL
3	2402.07	102.98	-3.16	99.82	F	---	Peak	VERTICAL

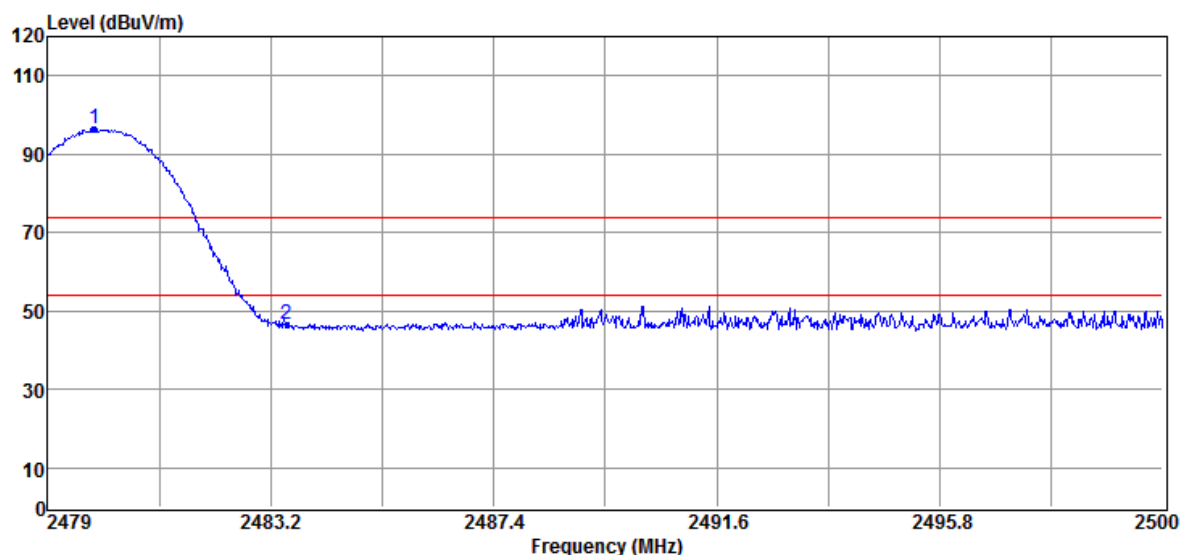
Remark:

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- 5 Spectrum Peak mode IF bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, Sweep time= 200 ms., the VBW setting was 3 MHz.
- 6 Spectrum AV mode if bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, VBW= 10Hz, Sweep time= 200 ms.

Note: “F” denotes fundamental frequency

Operation Mode TX CH High
Fundamental Frequency 2480 MHz
Temperature 25 °C

Test Date 2017/07/05
Test By Dino
Humidity 60 %

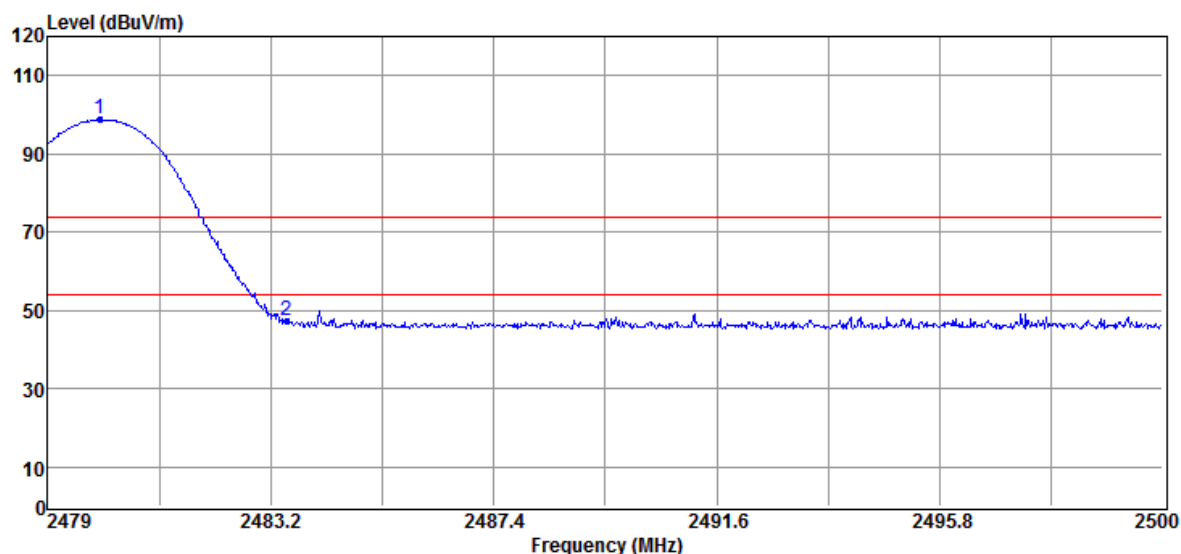


No	Freq MHz	Reading dBuV	Factor dB/m	Level dBuV/m	Limit dBuV/m	Over Li mit dB	Remark	Pol V/H
1	2479.88	99.51	-3.11	96.40	F	---	Peak	VERTICAL
2	2483.50	49.66	-3.11	46.55	74.00	-27.45	Peak	VERTICAL

Remark:

- 1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency
- 2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.
- 3 “F” denotes fundamental frequency; “H” denotes harmonics frequency. “S” denotes spurious frequency.
- 4 Measurement of data within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 Spectrum Peak mode IF bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, Sweep time= 200 ms., the VBW setting was 3 MHz.
- 6 Spectrum AV mode if bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, VBW= 10Hz, Sweep time= 200 ms.

Note: “F” denotes fundamental frequency



No	Freq MHz	Reading dBuV	Factor dB/m	Level dBuV/m	Limit dBuV/m	Over L imit dB	Remark	Pol V/H
1	2479.99	101.96	-3.11	98.85	F	---	Peak	HORIZONTAL
2	2483.50	50.39	-3.11	47.28	74.00	-26.72	Peak	HORIZONTAL

Remark:

- 1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency
- 2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.
- 3 “F” denotes fundamental frequency; “H” denotes harmonics frequency. “S” denotes spurious frequency.
- 4 Measurement of data within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 Spectrum Peak mode IF bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, Sweep time= 200 ms., the VBW setting was 3 MHz.
- 6 Spectrum AV mode if bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, VBW= 10Hz, Sweep time= 200 ms.

Note: “F” denotes fundamental frequency

8. SPURIOUS EMISSION TEST

8.1. Standard Applicable:

According to §15.247(d), all other emissions outside these bands shall not exceed the general radiated emission limits specified in §15.209(a). And according to §15.33(a)(1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

8.2. Measurement Equipment Used:

8.2.1. Conducted Emission at antenna port:

Refer to section 6.2 for details.

8.2.2. Radiated emission:

Refer to section 7.2 for details.

8.3. Test SET-UP:

8.3.1. Conducted Emission at antenna port:

Refer to section 6.3 for details.

8.3.2. Radiated emission:

Refer to section 7.3 for details.

8.4. Measurement Procedure:

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
4. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Repeat above procedures until all frequency measured were complete.

8.5. Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

8.6. Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

Radiated Spurious Emission Measurement Result: (below 1GHz)(Worst case: EDR 3M Mode)

Operation Mode	TX CH Low	Test Date	2017/07/05
Fundamental Frequency	2402MHz	Test By	Dino
Temperature	25 °C	Humidity	60 %

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark	Pol V/H
1	106.63	47.20	-8.78	38.42	43.50	-5.08	Peak	VERTICAL
2	191.99	46.86	-7.82	39.04	43.50	-4.46	Peak	VERTICAL
3	480.08	38.20	-0.84	37.36	46.00	-8.64	Peak	VERTICAL
4	576.11	38.44	0.66	39.10	46.00	-6.90	Peak	VERTICAL
5	719.67	29.49	3.23	32.72	46.00	-13.28	Peak	VERTICAL
6	951.50	30.51	6.83	37.34	46.00	-8.66	Peak	VERTICAL
1	216.24	46.75	-7.14	39.61	46.00	-6.39	Peak	HORIZONTAL
2	468.44	41.65	-1.03	40.62	46.00	-5.38	Peak	HORIZONTAL
3	576.11	42.64	0.66	43.30	46.00	-2.70	Peak	HORIZONTAL
4	719.67	32.85	3.23	36.08	46.00	-9.92	Peak	HORIZONTAL
5	815.70	29.94	4.54	34.48	46.00	-11.52	Peak	HORIZONTAL
6	951.50	30.28	6.83	37.11	46.00	-8.89	Peak	HORIZONTAL

Remark:

- 1 Emission is 20dB lower, so that emission as measured between 9kHz to 30MHz is not reported
- 2 Measuring frequencies from the lowest internal frequency to the 1GHz.
- 3 Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using Peak / QP detector mode.
- 4 Measurement result within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 The IF bandwidth of SPA between 30MHz to 1GHz was 100KHz, VBW=300KHz.

Radiated Spurious Emission Measurement Result (below 1GHz)

Operation Mode	TX CH Mid	Test Date	2017/07/05
Fundamental Frequency	2441MHz	Test By	Dino
Temperature	25 °C	Humidity	60 %

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark	Pol V/H
1	106.63	46.87	-8.78	38.09	43.50	-5.41	Peak	VERTICAL
2	191.99	46.70	-7.82	38.88	43.50	-4.62	Peak	VERTICAL
3	480.08	40.18	-0.84	39.34	46.00	-6.66	Peak	VERTICAL
4	576.11	37.62	0.66	38.28	46.00	-7.72	Peak	VERTICAL
5	719.67	29.85	3.23	33.08	46.00	-12.92	Peak	VERTICAL
6	951.50	29.95	6.83	36.78	46.00	-9.22	Peak	VERTICAL
1	204.60	48.06	-7.70	40.36	43.50	-3.14	Peak	HORIZONTAL
2	240.49	44.90	-6.10	38.80	46.00	-7.20	Peak	HORIZONTAL
3	480.08	45.50	-0.84	44.66	46.00	-1.34	Peak	HORIZONTAL
4	576.11	41.80	0.66	42.46	46.00	-3.54	Peak	HORIZONTAL
5	719.67	32.09	3.23	35.32	46.00	-10.68	Peak	HORIZONTAL
6	950.53	29.47	6.83	36.30	46.00	-9.70	Peak	HORIZONTAL

Remark:

- 1 Emission is 20dB lower, so that emission as measured between 9kHz to 30MHz is not reported
- 2 Measuring frequencies from the lowest internal frequency to the 1GHz.
- 3 Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using Peak / QP detector mode.
- 4 Measurement result within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 The IF bandwidth of SPA between 30MHz to 1GHz was 100KHz, VBW=300KHz.

Radiated Spurious Emission Measurement Result (below 1GHz)

Operation Mode TX CH High
Fundamental Frequency 2480MHz
Temperature 25 °C

Test Date 2017/07/05
Test By Dino
Humidity 60 %

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark	Pol V/H
1	106.63	47.10	-8.78	38.32	43.50	-5.18	Peak	VERTICAL
2	191.99	46.62	-7.82	38.80	43.50	-4.70	Peak	VERTICAL
3	480.08	39.98	-0.84	39.14	46.00	-6.86	Peak	VERTICAL
4	576.11	38.03	0.66	38.69	46.00	-7.31	Peak	VERTICAL
5	719.67	30.99	3.23	34.22	46.00	-11.78	Peak	VERTICAL
6	951.50	30.09	6.83	36.92	46.00	-9.08	Peak	VERTICAL
1	191.99	47.80	-7.82	39.98	43.50	-3.52	Peak	HORIZONTAL
2	468.44	43.70	-1.03	42.67	46.00	-3.33	Peak	HORIZONTAL
3	576.11	43.09	0.66	43.75	46.00	-2.25	Peak	HORIZONTAL
4	719.67	32.39	3.23	35.62	46.00	-10.38	Peak	HORIZONTAL
5	864.20	30.49	5.34	35.83	46.00	-10.17	Peak	HORIZONTAL
6	951.50	29.89	6.83	36.72	46.00	-9.28	Peak	HORIZONTAL

Remark:

- 1 Emission is 20dB lower, so that emission as measured between 9kHz to 30MHz is not reported
- 2 Measuring frequencies from the lowest internal frequency to the 1GHz.
- 3 Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using Peak / QP detector mode.
- 4 Measurement result within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 The IF bandwidth of SPA between 30MHz to 1GHz was 100KHz, VBW=300KHz.

Radiated Spurious Emission Measurement Result (above 1GHz)

Operation Mode	TX CH Low	Test Date	2017/07/05
Fundamental Frequency	2402 MHz	Test By	Dino
Temperature	25 °C	Humidity	60 %

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark	Pol V/H
1	4804.00	40.36	3.23	43.59	74.00	-30.41	Peak	VERTICAL
2	7615.00	41.08	10.10	51.18	74.00	-22.82	Peak	VERTICAL
1	4804.00	43.52	3.23	46.75	74.00	-27.25	Peak	HORIZONTAL
2	7566.00	40.93	10.09	51.02	74.00	-22.98	Peak	HORIZONTAL

Remark:

- 1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency
- 2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.
- 3 “F” denotes fundamental frequency; “H” denotes harmonics frequency. “S” denotes spurious frequency.
- 4 Measurement of data within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 Spectrum Peak mode IF bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, Sweep time= 200 ms., the VBW setting was 3 MHz.
- 6 Spectrum AV mode if bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, VBW= 10Hz, Sweep time= 200 ms.

Radiated Spurious Emission Measurement Result (above 1GHz)

Operation Mode	TX CH Mid	Test Date	2017/07/05
Fundamental Frequency	2441 MHz	Test By	Dino
Temperature	25 °C	Humidity	60 %

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark	Pol V/H
1	4882.00	39.77	3.41	43.18	74.00	-30.82	Peak	VERTICAL
2	7293.00	41.19	10.08	51.27	74.00	-22.73	Peak	VERTICAL
1	4882.00	42.95	3.41	46.36	74.00	-27.64	Peak	HORIZONTAL
2	7279.00	40.56	10.06	50.62	74.00	-23.38	Peak	HORIZONTAL

Remark:

- 1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency
- 2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.
- 3 “F” denotes fundamental frequency; “H” denotes harmonics frequency. “S” denotes spurious frequency.
- 4 Measurement of data within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 Spectrum Peak mode IF bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, Sweep time= 200 ms., the VBW setting was 3 MHz.
- 6 Spectrum AV mode if bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, VBW= 10Hz, Sweep time= 200 ms.

Radiated Spurious Emission Measurement Result (above 1GHz)

Operation Mode	TX CH High	Test Date	2017/07/05
Fundamental Frequency	2480 MHz	Test By	Dino
Temperature	25 °C	Humidity	60 %

No	Freq MHz	Reading dBuV	Factor dB	Level dBuV/m	Limit dBuV/m	Over Limit dB	Remark	Pol V/H
1	4960.00	38.72	3.60	42.32	74.00	-31.68	Peak	VERTICAL
2	7300.00	41.43	10.08	51.51	74.00	-22.49	Peak	VERTICAL
1	4960.00	41.24	3.60	44.84	74.00	-29.16	Peak	HORIZONTAL
2	7223.00	40.93	10.02	50.95	74.00	-23.05	Peak	HORIZONTAL

Remark:

- 1 Measuring frequencies from the lowest internal frequency to the 10th of fundamental frequency
- 2 Field strength limits for frequency above 1000MHz are based on average limits. However, Peak mode field strength shall not exceed the average limits specified plus 20dB.
- 3 “F” denotes fundamental frequency; “H” denotes harmonics frequency. “S” denotes spurious frequency.
- 4 Measurement of data within this frequency range shown “ - ” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 5 Spectrum Peak mode IF bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, Sweep time= 200 ms., the VBW setting was 3 MHz.
- 6 Spectrum AV mode if bandwidth Setting : 1GHz- 26GHz, RBW= 1MHz, VBW= 10Hz, Sweep time= 200 ms.

9. FREQUENCY SEPARATION

9.1. Standard Applicable:

According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the 20dB bandwidth of the hopping channel, whichever is greater.

9.2. Measurement Equipment Used:

Refer to section 6.2 for details.

9.3. Test Set-up:

Refer to section 6.3 for details.

9.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = middle of hopping channel .
4. Set the spectrum analyzer as RBW =100KHz, Adjust Span to 3.0 MHz, Sweep = auto.
5. Max hold. Mark 3 Peaks of hopping channel and record the 3 peaks frequency.

9.5. Measurement Result:

Channel separation (MHz)	Limit	Result
1	$\geq 25\text{KHz}$ or 2/3 times 20dB bandwidth	PASS

Note: Refer to next page for plots.

Frequency Separation Test Data

Low



Mid



High



10. NUMBER OF HOPPING FREQUENCY

10.1. Standard Applicable:

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

10.2. Measurement Equipment Used:

Refer to section 6.2 for details.

10.3. Test Set-up:

Refer to section 6.3 for details.

10.4. Measurement Procedure:

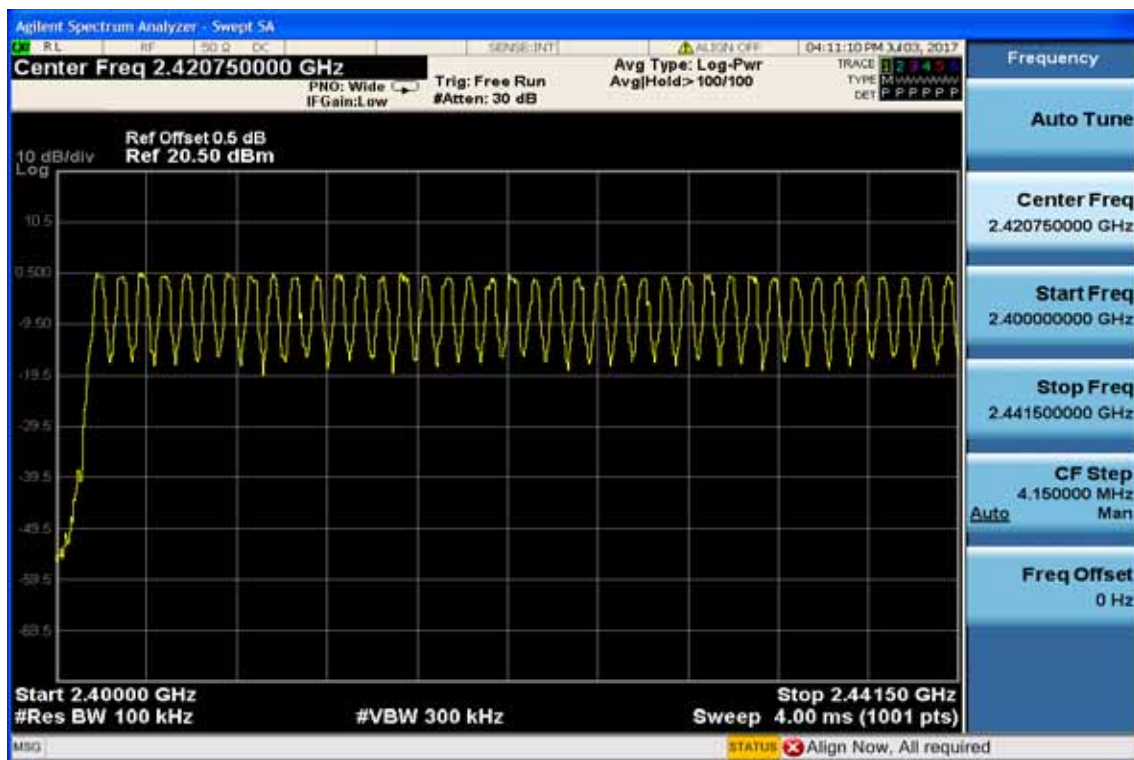
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set spectrum analyzer Start=2400MHz, Stop = 2441.5MHz and Start=2441.5MHz, Stop = 2483.5MHz, Sweep = auto.
4. Set the spectrum analyzer as RBW=100KHz, VBW=300KHz
5. Max hold, view and count how many channel in the band.

10.5. Measurement Result:

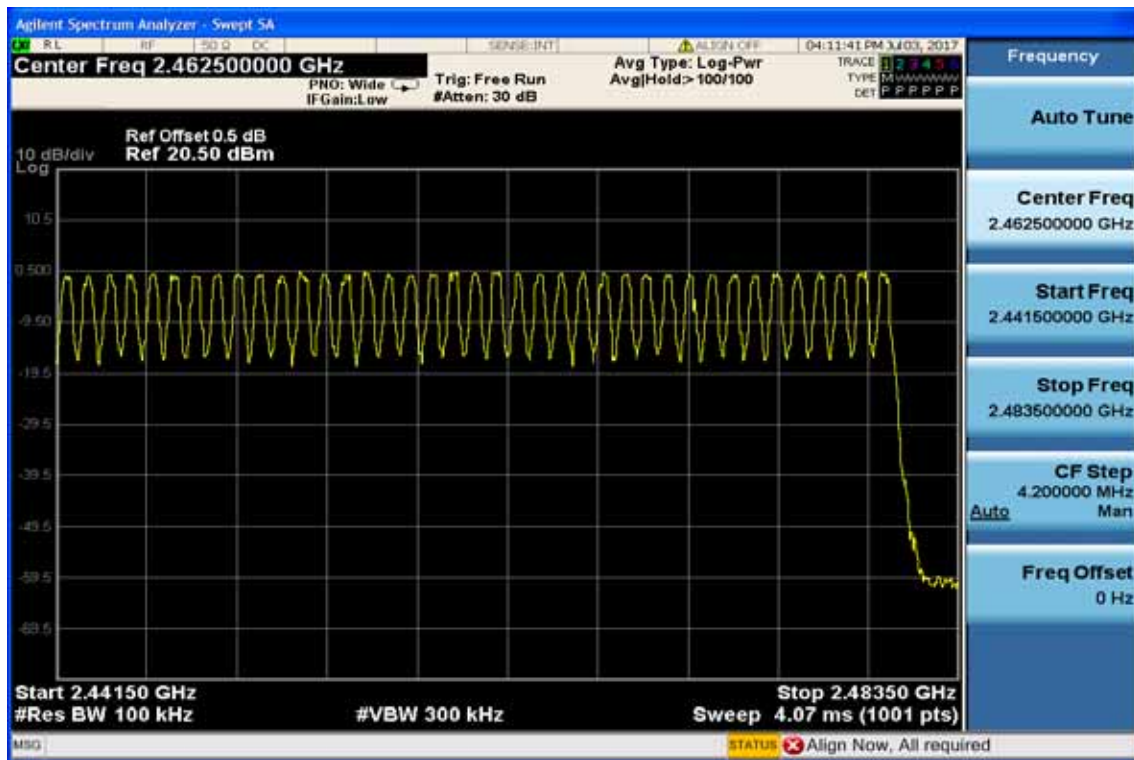
Test Result : 79 Channel > 15 Channel

Note: Refer to next page for plots.

Channel Number 2.4 GHz – 2.441.5GHz



2.441 GHz – 2.4835GHz



11. TIME OF OCCUPANCY (DWELL TIME)

11.1. Standard Applicable:

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 seconds multiplied by the number of hopping channel employed.

11.2. Measurement Equipment Used:

Refer to section 6.2 for details.

11.3. Test Set-up:

Refer to section 6.3 for details.

11.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW / VBW = 1MHz, Span = 0Hz , Adjust Sweep = 2.5ms.
5. Repeat above procedures until all frequency measured were complete.

11.5. Measurement Result:

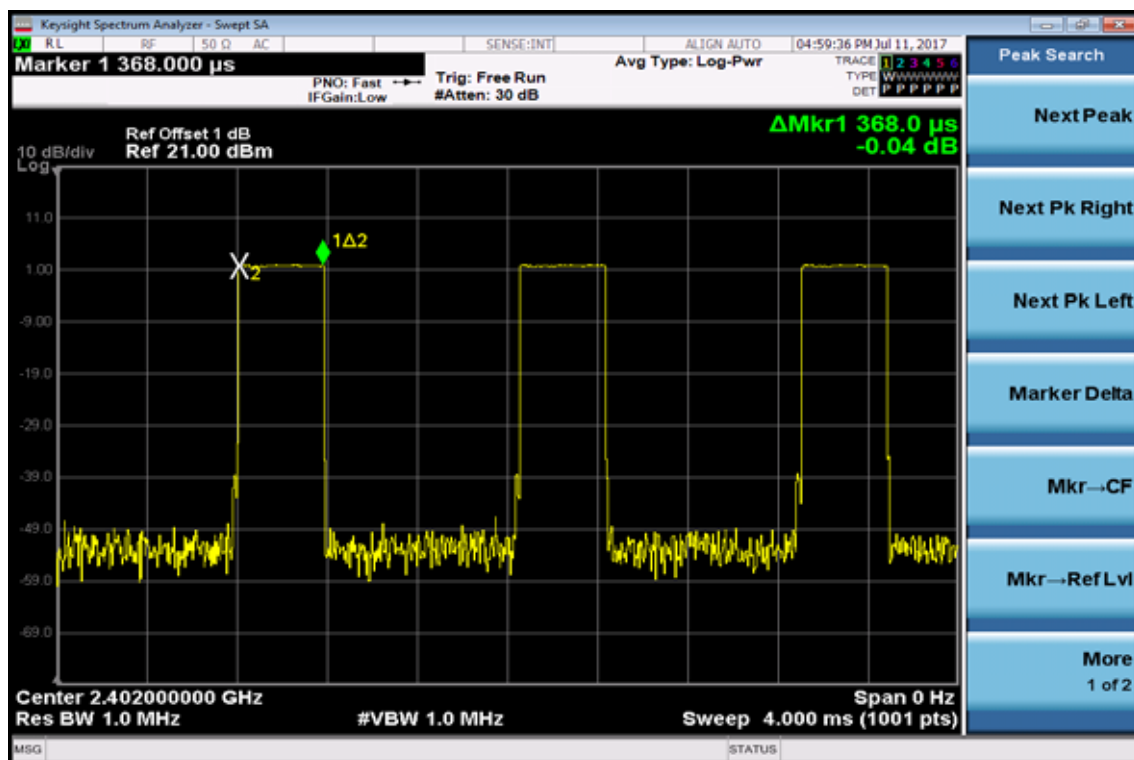
A period time = 0.4 (ms) * 79 = 31.6 (s)

CH Low	DH1 time slot	=	0.368 (ms)	*	(1600/2/79)	*	31.6 =	117.76	(ms)
	DH3 time slot	=	1.620 (ms)	*	(1600/4/79)	*	31.6 =	259.20	(ms)
	DH5 time slot	=	2.880 (ms)	*	(1600/6/79)	*	31.6 =	307.20	(ms)
CH Mid	DH1 time slot	=	0.368 (ms)	*	(1600/2/79)	*	31.6 =	117.76	(ms)
	DH3 time slot	=	1.610 (ms)	*	(1600/4/79)	*	31.6 =	257.60	(ms)
	DH5 time slot	=	2.880 (ms)	*	(1600/6/79)	*	31.6 =	307.20	(ms)
CH High	DH1 time slot	=	0.372 (ms)	*	(1600/2/79)	*	31.6 =	119.04	(ms)
	DH3 time slot	=	1.620 (ms)	*	(1600/4/79)	*	31.6 =	259.20	(ms)
	DH5 time slot	=	2.880 (ms)	*	(1600/6/79)	*	31.6 =	307.20	(ms)

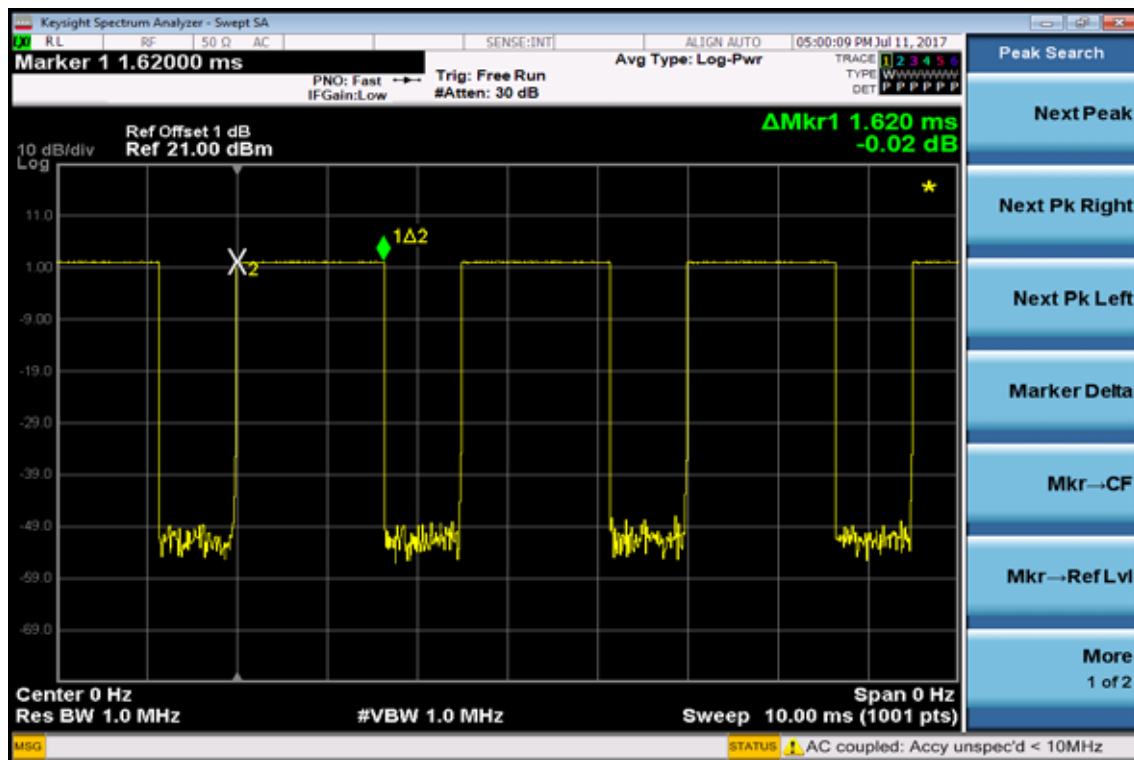
Note: Refer to next page for plots.

Low Channel

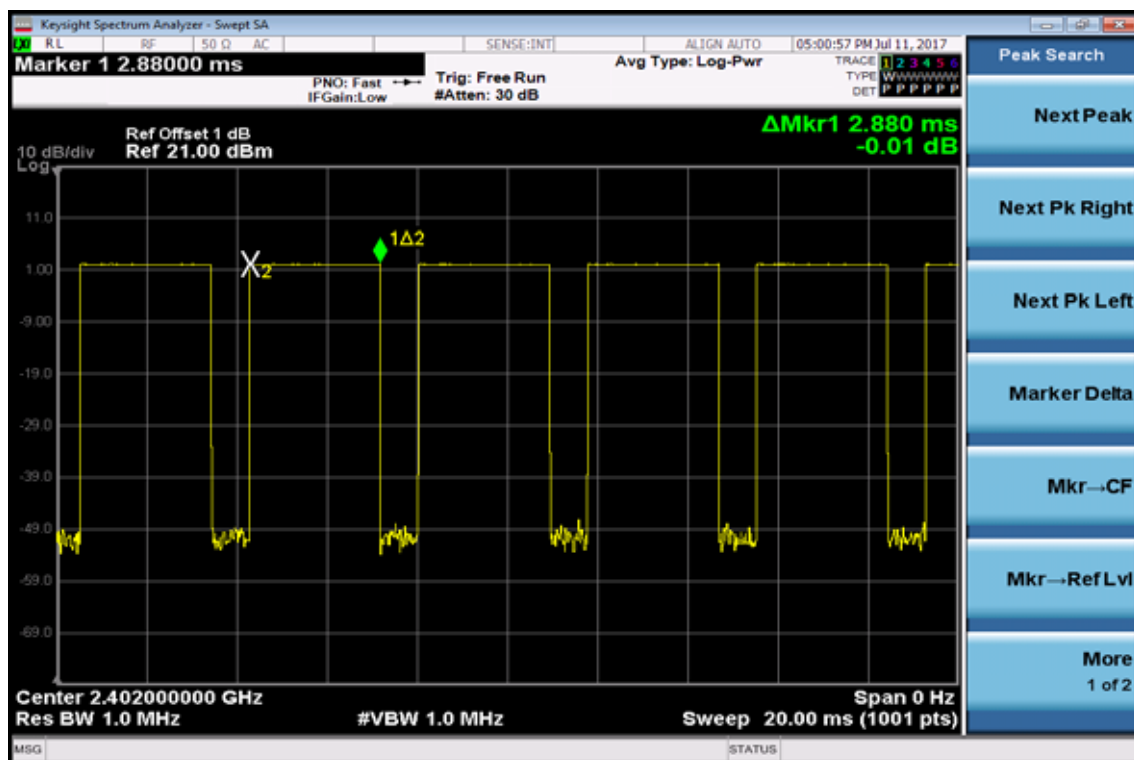
DH1



DH3

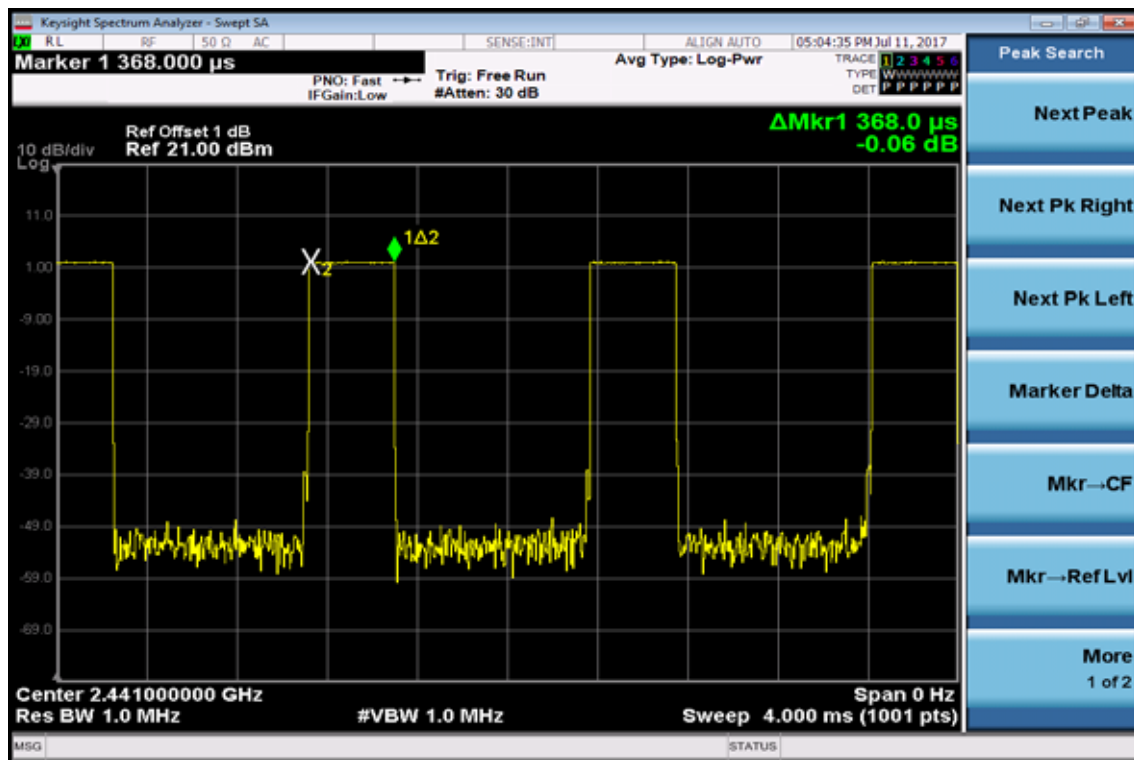


DH5

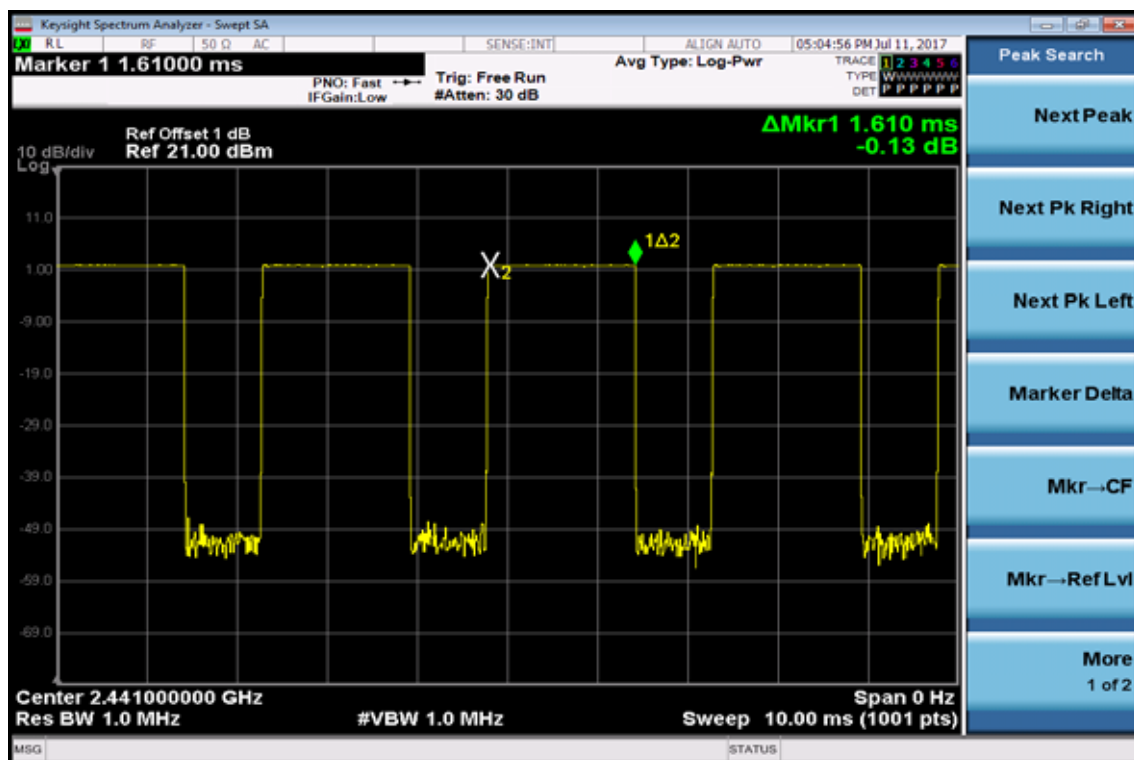


Mid Channel

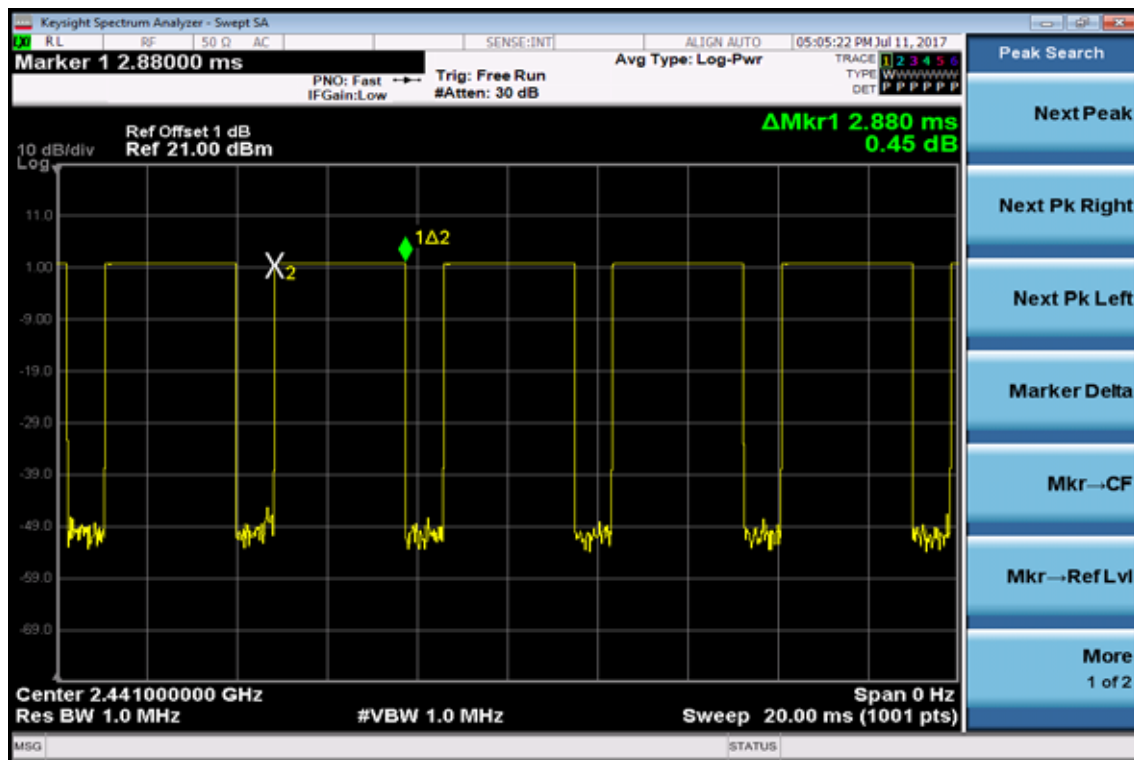
DH1



DH3

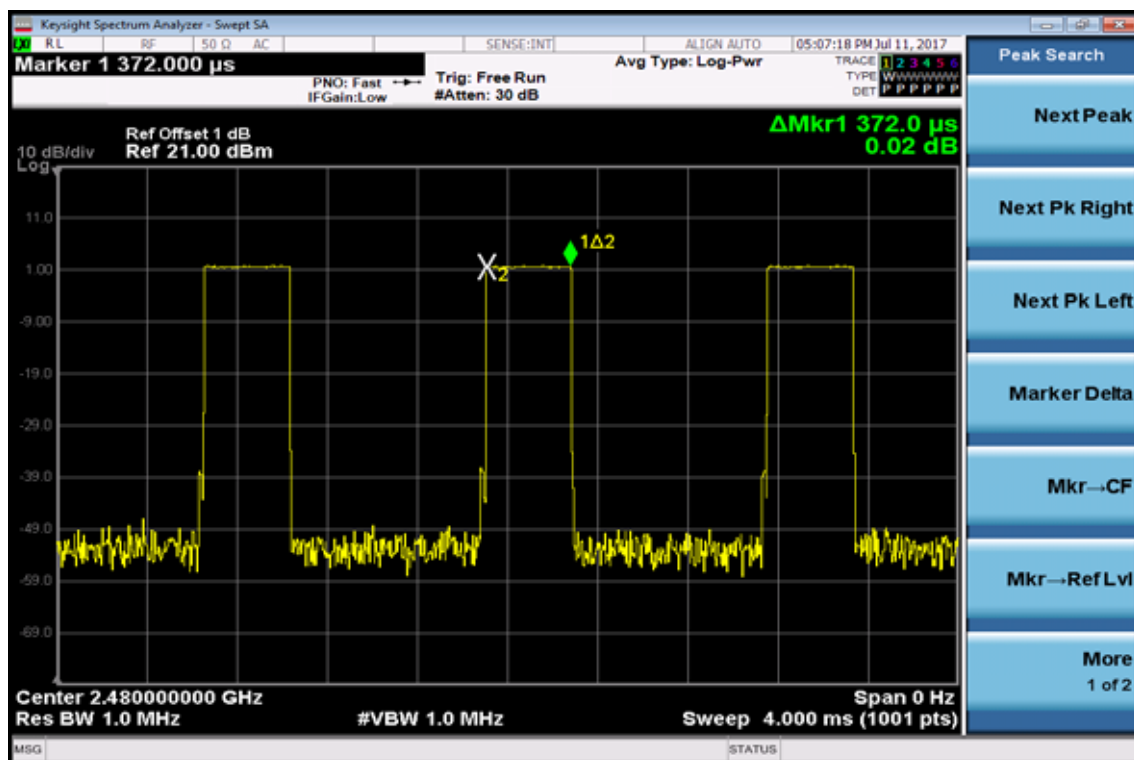


DH5

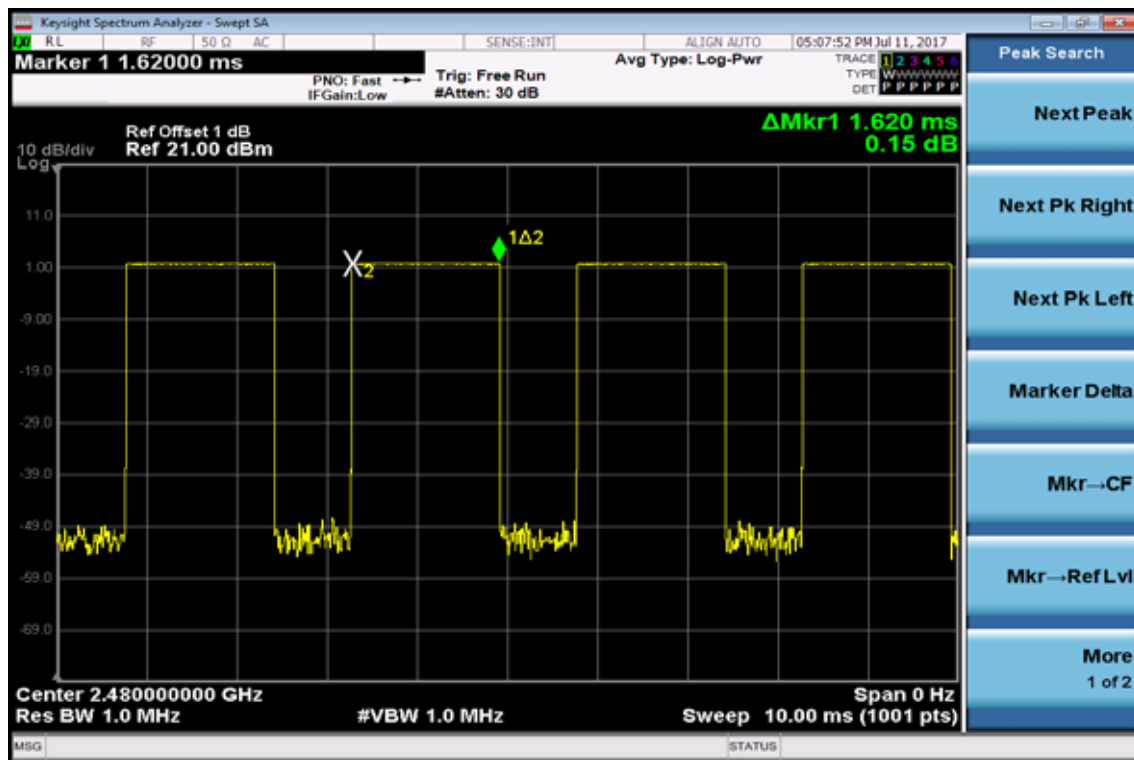


High Channel

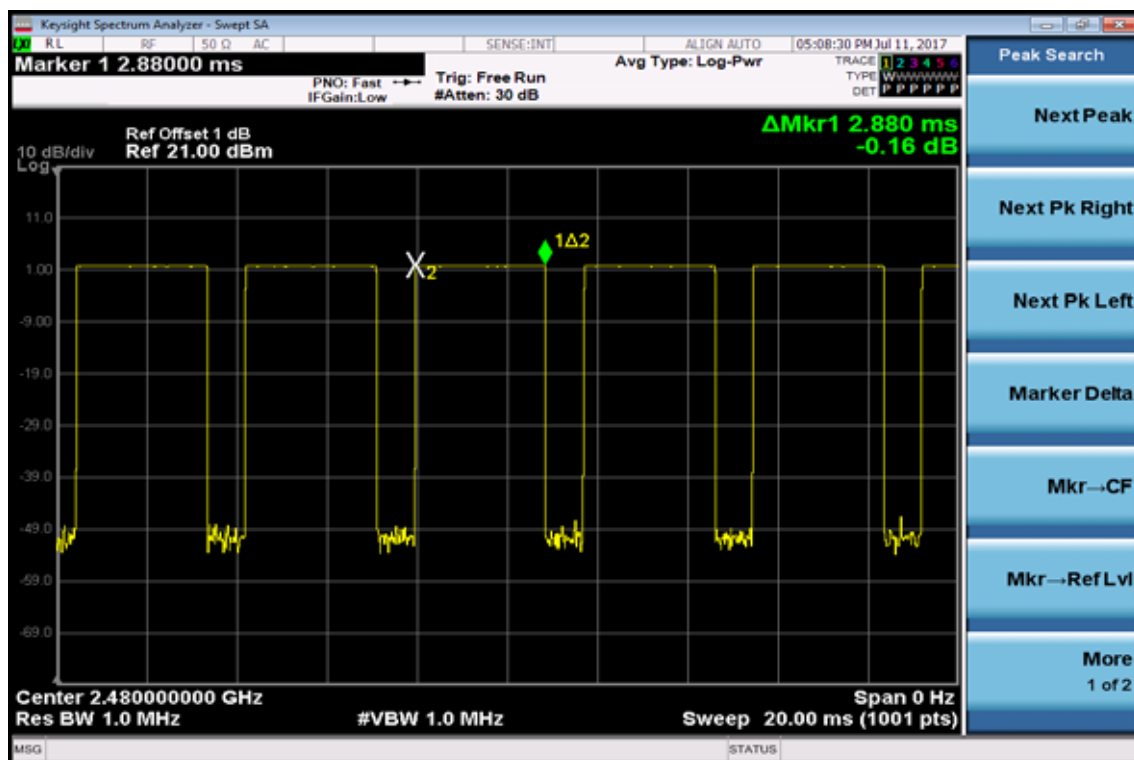
DH1



DH3



DH5



12. 20dB Bandwidth Bandwidth

12.1. Standard Applicable:

According to §15.247(a)(1)

(2) FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W. 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.

12.2. Measurement Equipment Used:

Refer to section 6.2 for details.

12.3. Test Set-up:

Refer to section 6.3 for details.

12.4. Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as RBW= (1 -5 % of Bandwidth.), Span= 3MHz, Sweep=auto
4. Mark the peak frequency and -20dB (upper and lower) frequency.
5. Repeat above procedures until all frequency measured were complete.

12.5. Measurement Result:

BDR Mode

CH	20dB Bandwidth (MHz)
Low	0.919
Mid	0.884
High	0.887

EDR 2M Mode

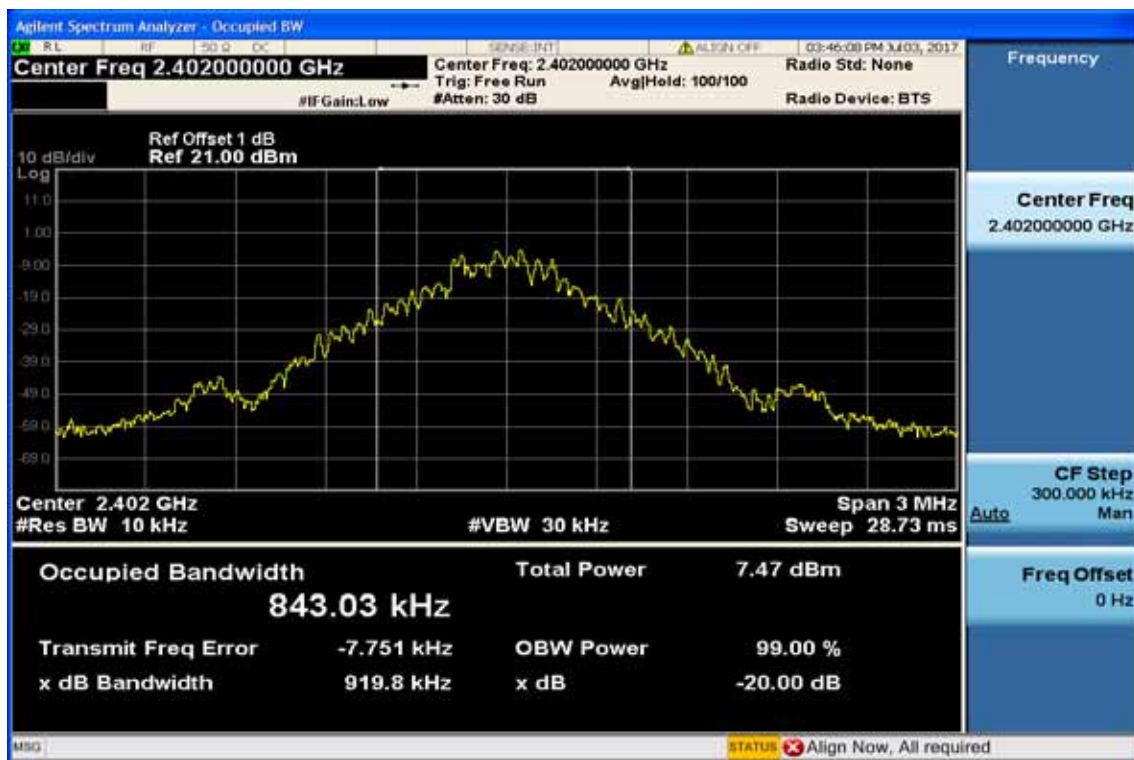
CH	20dB Bandwidth (MHz)	2/3* 20dB Bandwidth (MHz)
Lower	1.261	0.841
Mid	1.330	0.887
Higher	1.315	0.877

EDR 3M Mode

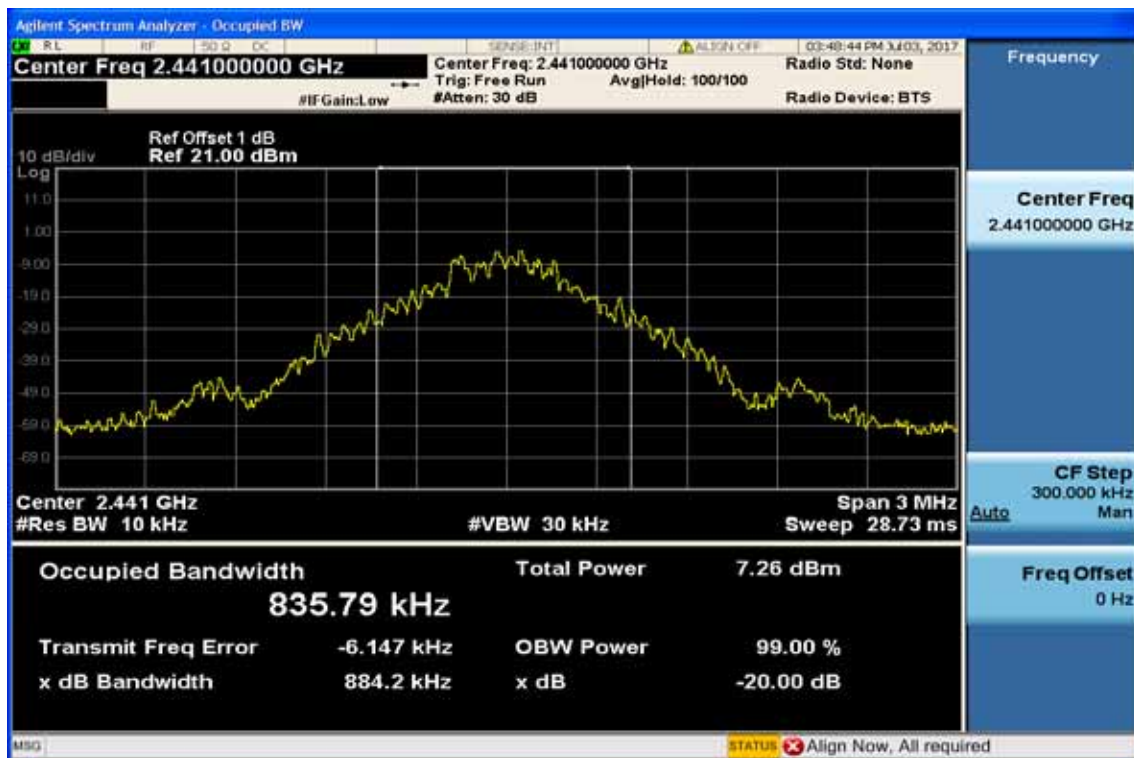
CH	20dB Bandwidth (MHz)	2/3* 20dB Bandwidth (MHz)
Lower	1.322	0.881
Mid	1.301	0.867
Higher	1.317	0.878

Note: Refer to next page for plots.

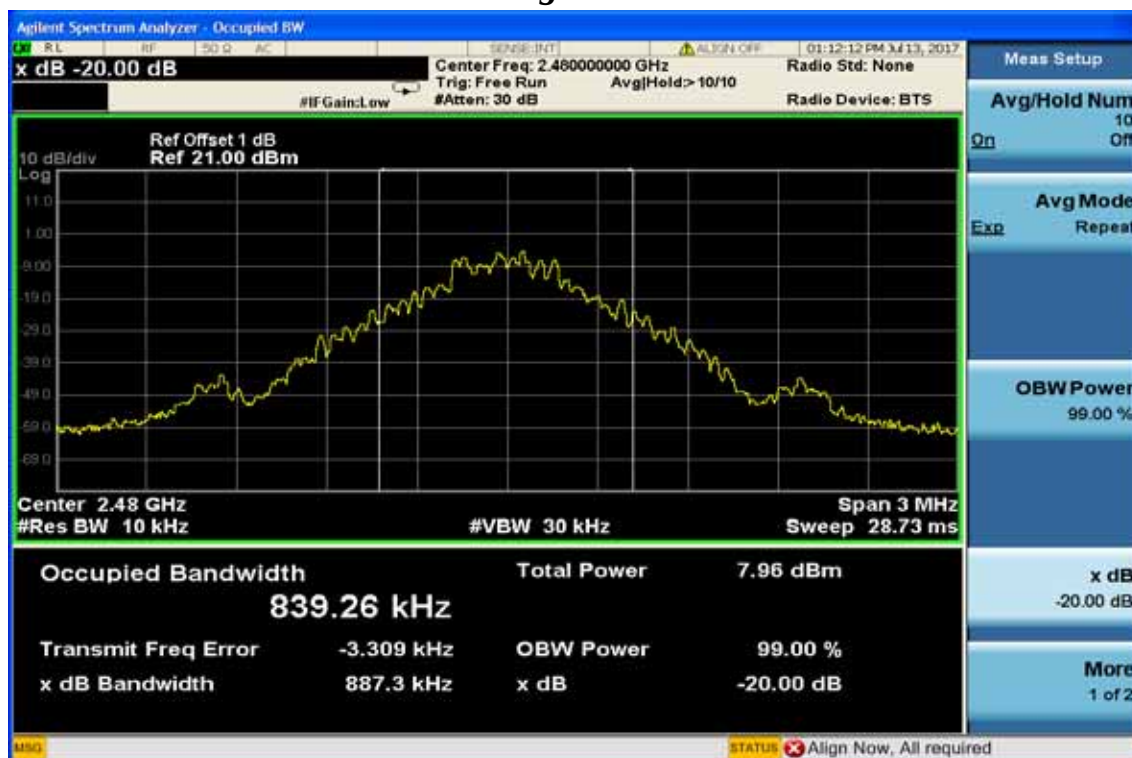
BDR Mode **20dB Bandwidth Test Data CH-Low**



20dB Bandwidth Test Data CH-Mid

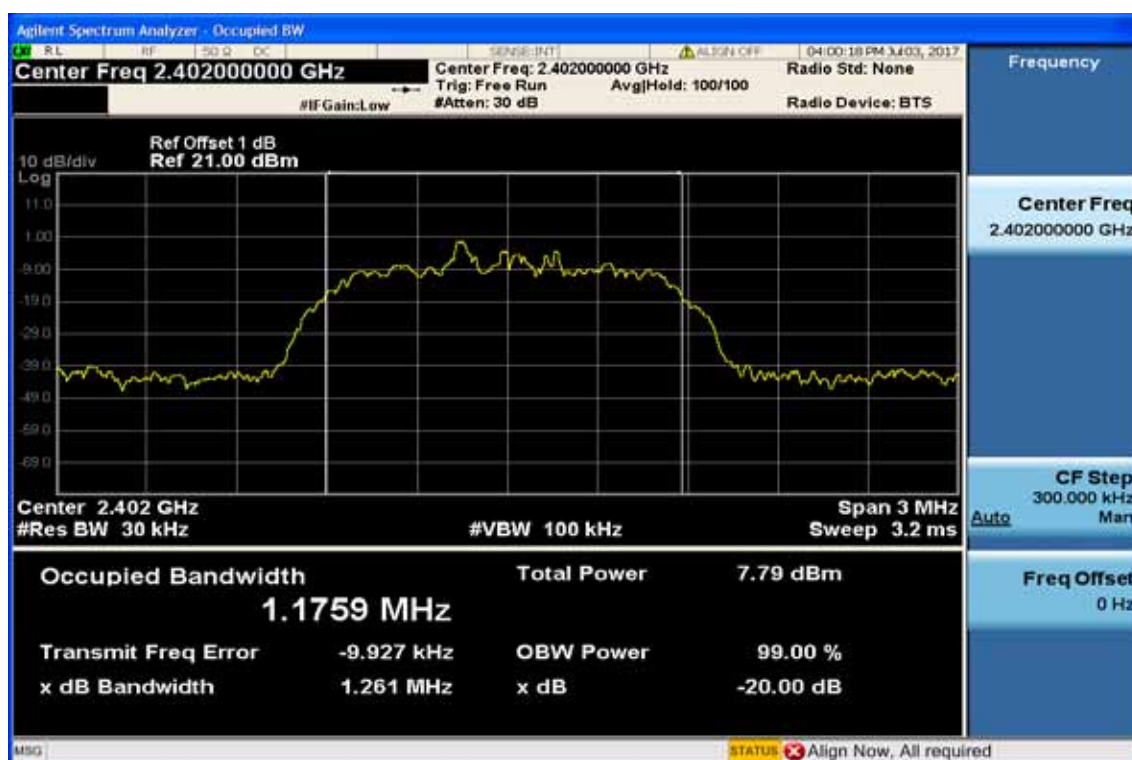


20dB Bandwidth Test Data CH-High

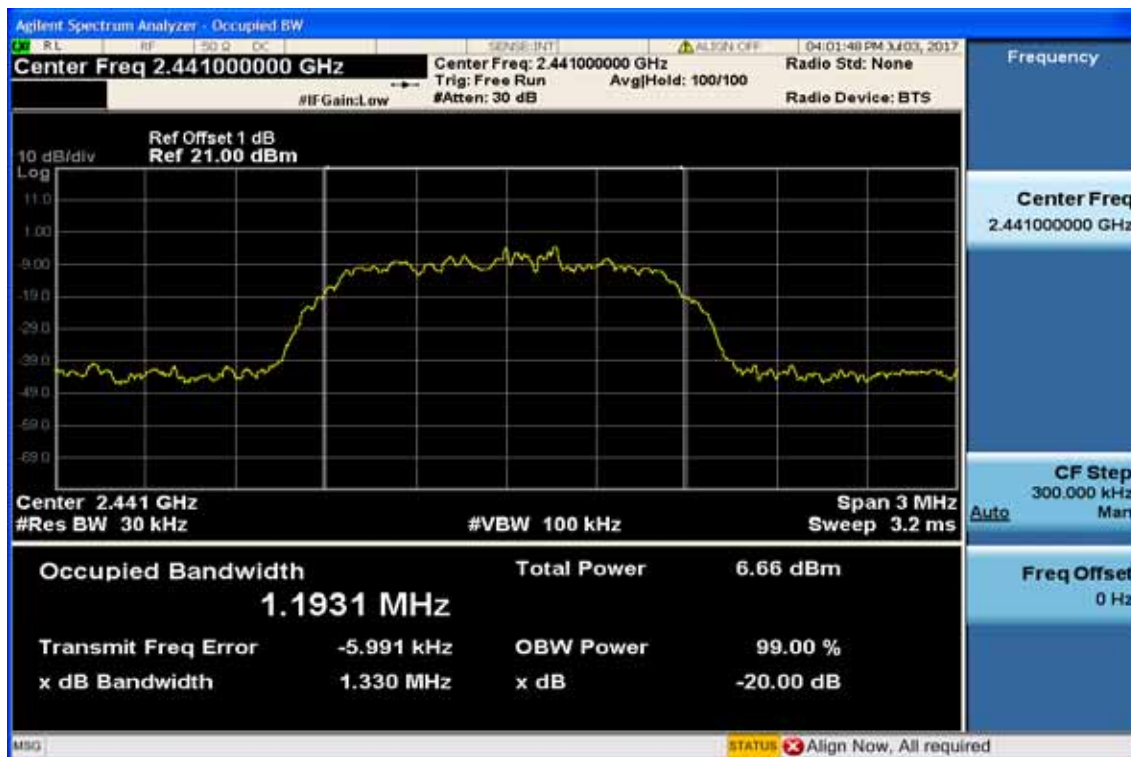


EDR 2M Mode

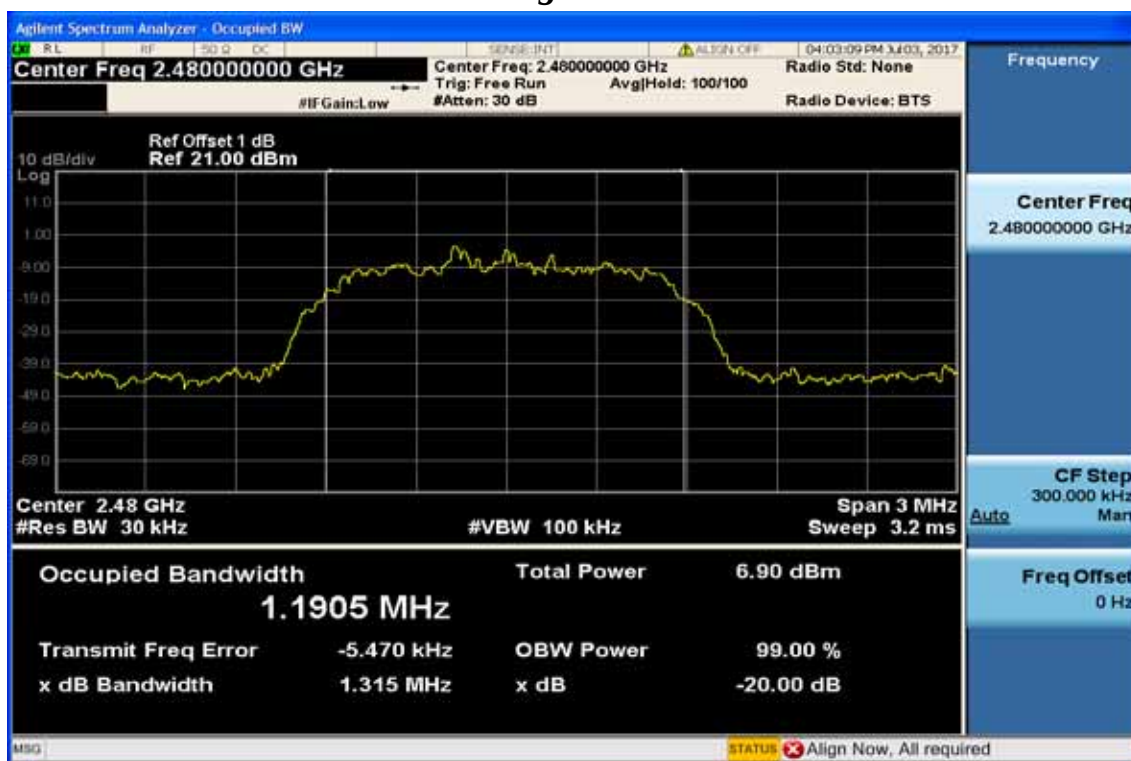
20dB Bandwidth Test Data CH-Low



20dB Bandwidth Test Data CH-Mid

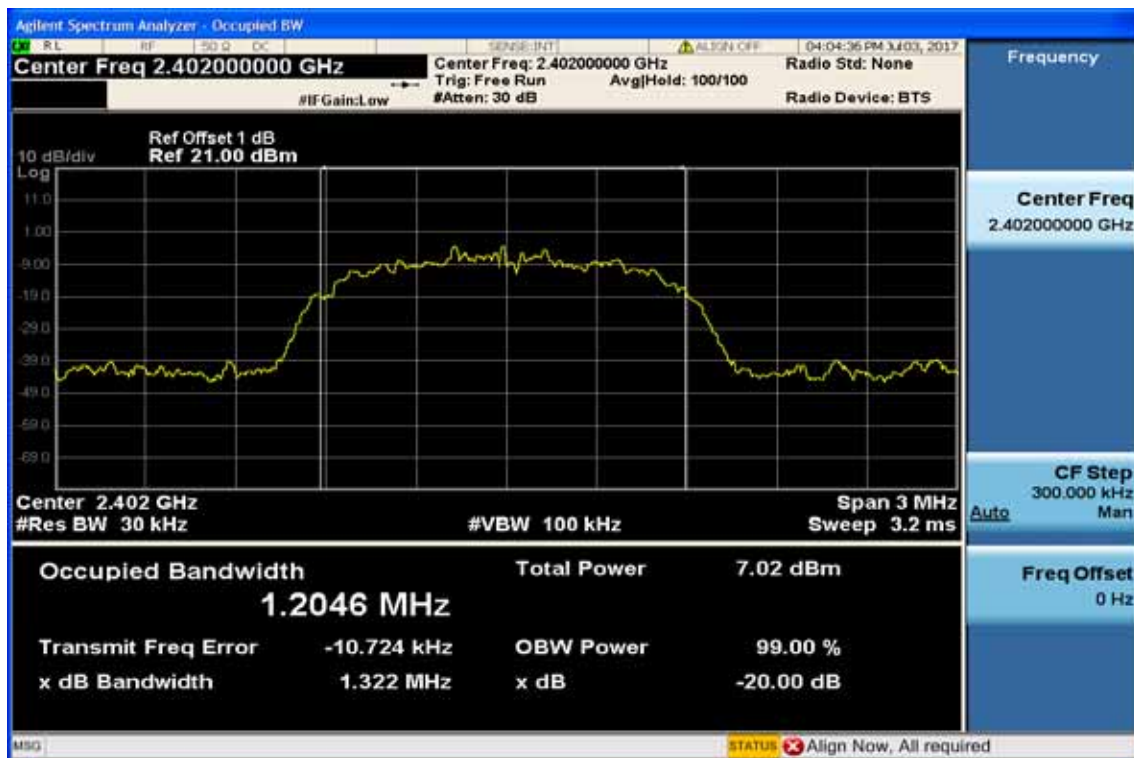


20dB Bandwidth Test Data CH-High



EDR 3M Mode

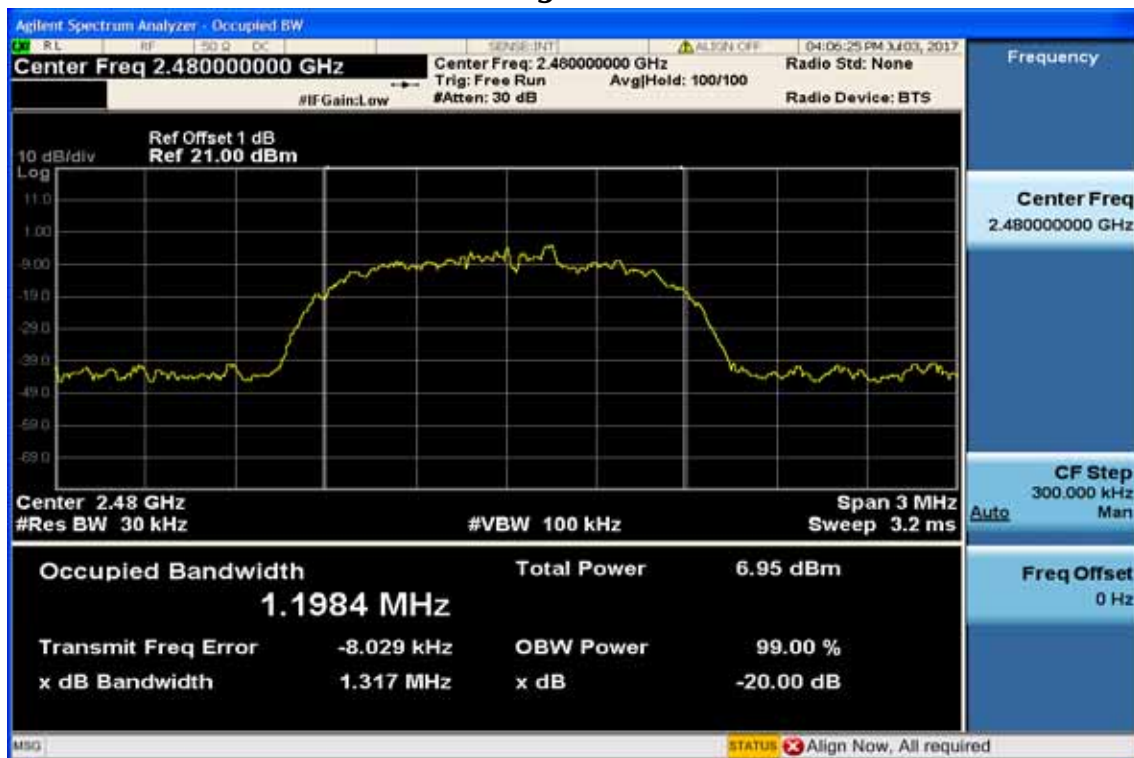
20dB Bandwidth Test Data CH-Low



20dB Bandwidth Test Data CH-Mid



20dB Bandwidth Test Data CH-High



13. ANTENNA REQUIREMENT

13.1. Standard Applicable:

According to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

And according to §15.247(c), if transmitting antennas of directional gain greater than 6dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level.⁹ When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

13.2. Antenna Connected Construction:

The directional gains of antenna used for transmitting is 2.5dBi, and the antenna type is PCB antenna which is designed no consideration of replacement. Please see EUT photo for details.