FCC PART 15.247
TEST REPORT

For

Guangzhou Modeng Intelligent Technology Co., Ltd

A1-23, Dabancang1904innovation Industry park, No.36, Xinmin eight Street, Gexin Road, Haizhou District, Guangzhou City, Guangdong Province, China

FCC ID: 2AZ9BSPK-RKZ1

Report Type:	Product Type:
Original Report	ROKR Z1

Report Number: SZXX1210611-22963E-RF

Report Date: 2021-06-23

Reviewed By: Candy Li, RF Engineer

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	ROKR Z1
Tested Model No.	SPK-RKZ1
Multiple Model No.	SPK-RKZ1-BLK, SPK-RKZ1-BL, SPK-RKZ1-RD
Model Differences	Only the appearance and color are different.
Frequency Range	2402~2480MHz
Maximum conducted Peak output power	-1.38dBm
Modulation Technique	GFSK, π/4-DQPSK, 8DPSK
Antenna Specification*	Internal Antenna: 1.08443dBi(provided by the applicant)
Voltage Range	DC 3.7V from internal battery or DC 5V from USB port.
Date of Test	2021-06-18 to 2021-06-22
Sample number	SZXX1210611-22963E-RF-S_9QS(Assigned by ATC)
Received date	2021-06-11
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF output power, conducted		±0.73dB
Unwanted Emission, conducted		±1.6dB
RF Frequency		$\pm 0.082*10^{-7}$
Emissions, Radiated	30MHz - 1GHz	±4.28dB
	1GHz- 18GHz	±4.98dB
	18GHz- 26.5GHz	±5.06dB
Temperature		±1℃
Humidity		±6%
Supply voltages		±0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A-2.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

Software “bt_ tool_v1.1.0” was used during testing and the power level was 7*.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

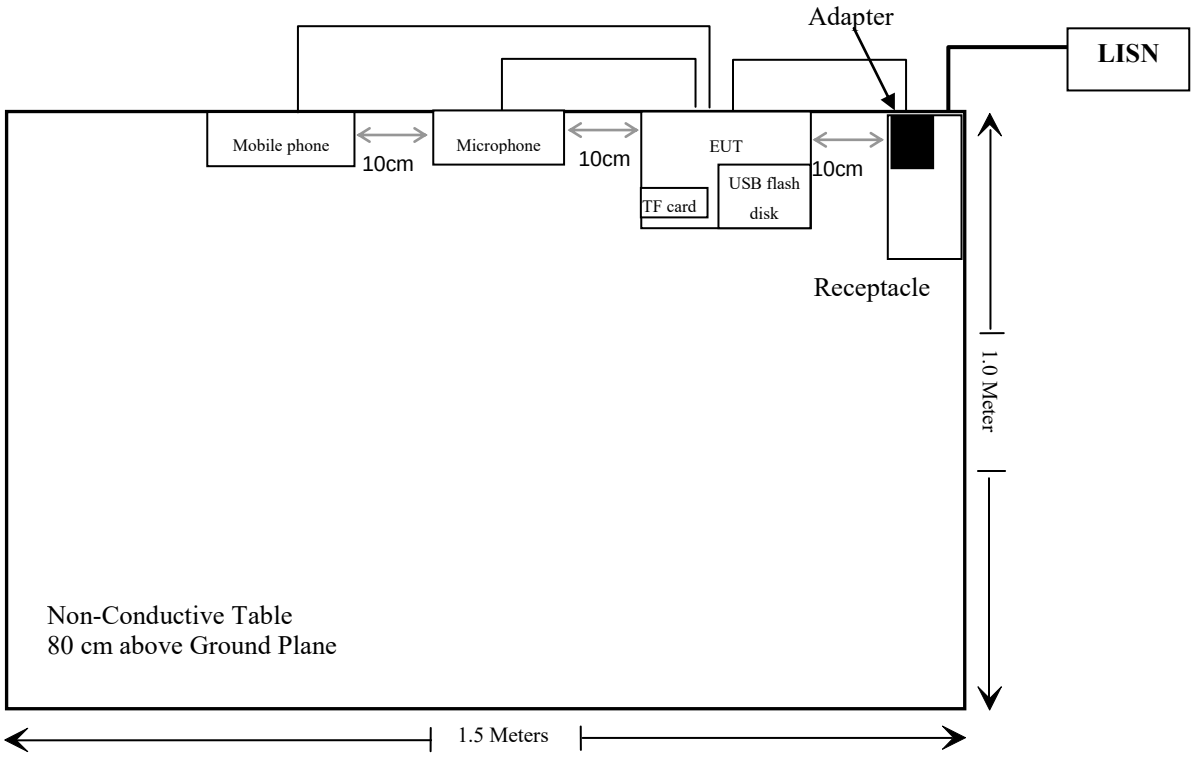
Manufacturer	Description	Model	Serial Number
HUAWEI	Mobile Phone	MATE 30	SJE0218125006255
HUAWEI	Adapter	HW-050100C01	H779K8K6V19398
KINGSTON	TF card	SDC10/32GB	31694-002_A00LF
KINGSTON	USB flash disk	Datatraveler G3	USJ620014258E
Shure	Microphone	SM58S	SM5684231J8751S

External I/O Cable

Cable Description	Length (m)	From Port	To
Unshielded Detachable USB cable	0.8	EUT	Adapter
Unshielded Detachable MIC cable	2.9	EUT	Microphone
Unshielded Detachable Audio Cable	1.2	Mobile Phone	EUT

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC§15.247 (i), §1.1307 (b) (1) &§2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliance
§15.247(a)(1)	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliance
§15.247(a)(1)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	Test Receiver	ESPI3	100396	2020/12/24	2021/12/23
R & S	L.I.S.N.	ENV216	101314	2020/12/25	2021/12/24
Anritsu Corp	50Ω Coaxial Switch	MP59B	6200506474	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-2m	No.2	2020/12/25	2021/12/24
Radiated Emissions Test					
Rohde&Schwarz	Test Receiver	ESR	101817	2020/12/24	2021/12/23
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
A.H. Systems, inc.	Preamplifier	PAM-0118P	531	2020/07/08	2021/07/07
SONOMA INSTRUMENT	Amplifier	310 N	186131	2020/12/25	2021/12/24
Quinstar	Amplifier	QLW-184055 36-J0	15964001002	2020/11/28	2021/11/27
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2020/01/04	2023/01/03
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Unknown	RF Coaxial Cable	N-5m	No.3	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-5m	No.4	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.5	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.6	2020/12/25	2021/12/24
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV40	101495	2020/12/24	2021/12/23
Rohde & Schwarz	Open Switch and Control Unit	OSP120 +OSP -B157	101244 + 100866	2020/12/24	2021/12/23

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Test Result:

For worst case:

Mode	Frequency (MHz)	Maximum Tune-up power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
		(dBm)	(mW)				
Bluetooth	2480	-1	0.79	5	0.3	3.0	Yes

Result: No Standalone SAR test is required

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Antenna Connector Construction

The EUT has one internal Antenna arrangement, which was permanently attached and the antenna gain is 1.08443 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

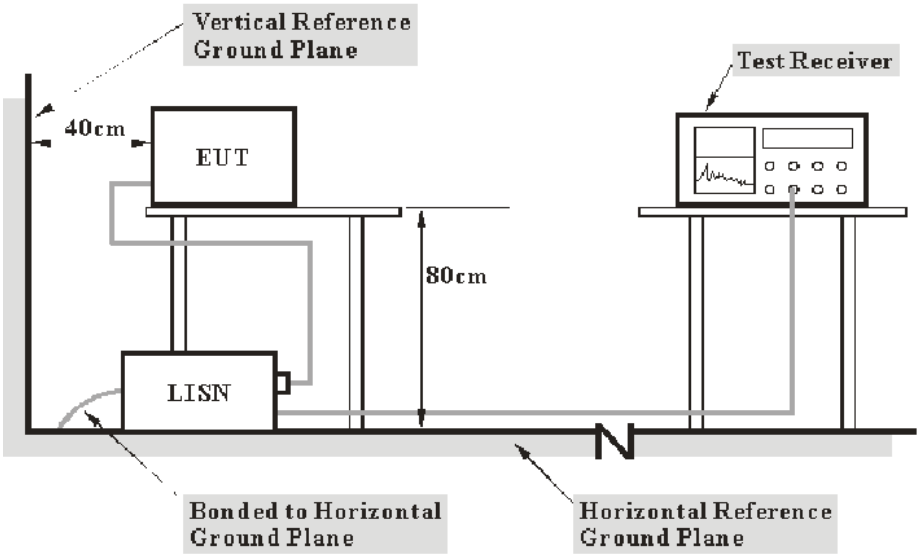
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Transd Factor & Margin Calculation

The Transd factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Transd Factor = LISN VDF + Cable Loss

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Limit – level
Level= reading level+ Transd Factor

Test Data

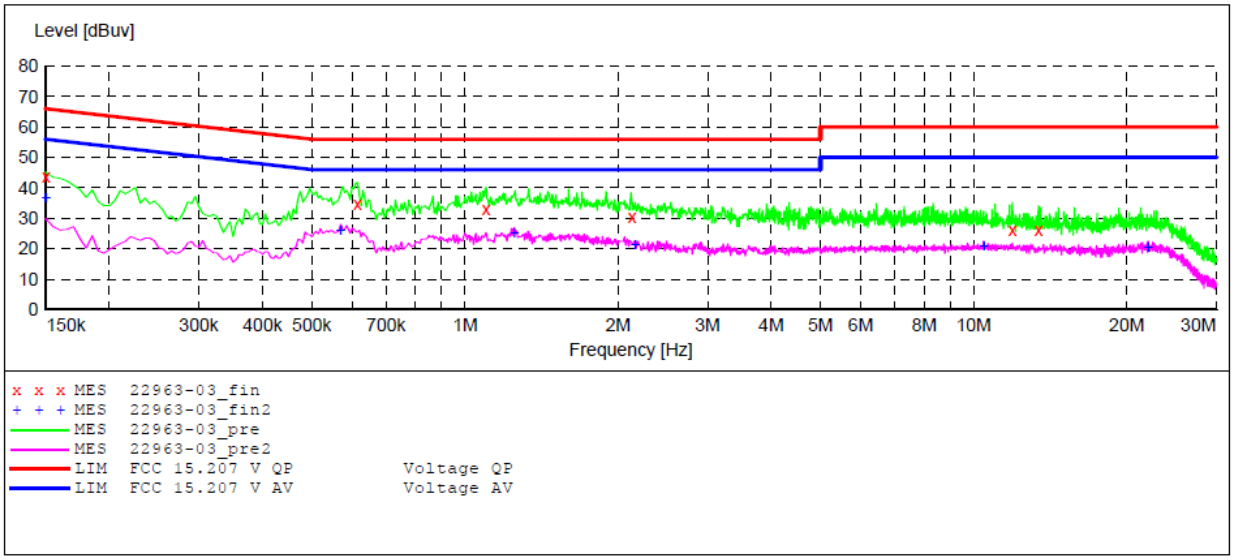
Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting on 2021-06-22.

EUT operation mode: Transmitting (the worst case is 8DPSK Mode, Low channel)

AC 120V/60 Hz, Line



MEASUREMENT RESULT: "22963-03_fin"

2021-6-22 11:17

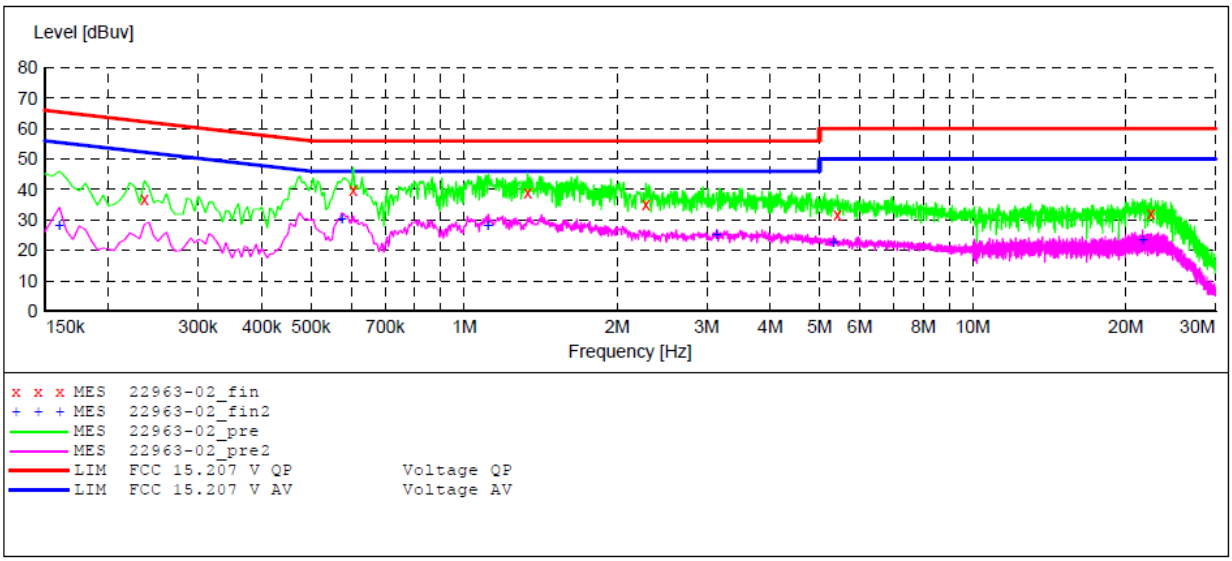
Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.150000	43.60	10.8	66	22.4	QP	L1	GND
0.615000	34.80	11.0	56	21.2	QP	L1	GND
1.100000	32.90	11.1	56	23.1	QP	L1	GND
2.130000	30.70	11.3	56	25.3	QP	L1	GND
11.925000	26.20	11.6	60	33.8	QP	L1	GND
13.425000	26.10	11.6	60	33.9	QP	L1	GND

MEASUREMENT RESULT: "22963-03_fin2"

2021-6-22 11:17

Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.150000	37.10	10.8	56	18.9	AV	L1	GND
0.570000	26.30	11.0	46	19.7	AV	L1	GND
1.250000	25.30	11.2	46	20.7	AV	L1	GND
2.160000	21.60	11.3	46	24.4	AV	L1	GND
10.475000	20.90	11.6	50	29.1	AV	L1	GND
22.050000	20.60	11.7	50	29.4	AV	L1	GND

AC 120V/60 Hz, Neutral



MEASUREMENT RESULT: "22963-02_fin"

2021-6-22 11:15

Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.235000	37.10	10.9	62	24.9	QP	N	GND
0.605000	39.80	11.0	56	16.2	QP	N	GND
1.335000	39.20	11.2	56	16.8	QP	N	GND
2.280000	35.20	11.3	56	20.8	QP	N	GND
5.420000	31.60	11.5	60	28.4	QP	N	GND
22.450000	32.40	11.7	60	27.6	QP	N	GND

MEASUREMENT RESULT: "22963-02_fin2"

2021-6-22 11:15

Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.160000	28.20	10.8	56	27.8	AV	N	GND
0.575000	30.70	11.0	46	15.3	AV	N	GND
1.115000	28.50	11.2	46	17.5	AV	N	GND
3.140000	25.30	11.3	46	20.7	AV	N	GND
5.330000	22.90	11.4	50	27.1	AV	N	GND
21.625000	23.60	11.7	50	26.4	AV	N	GND

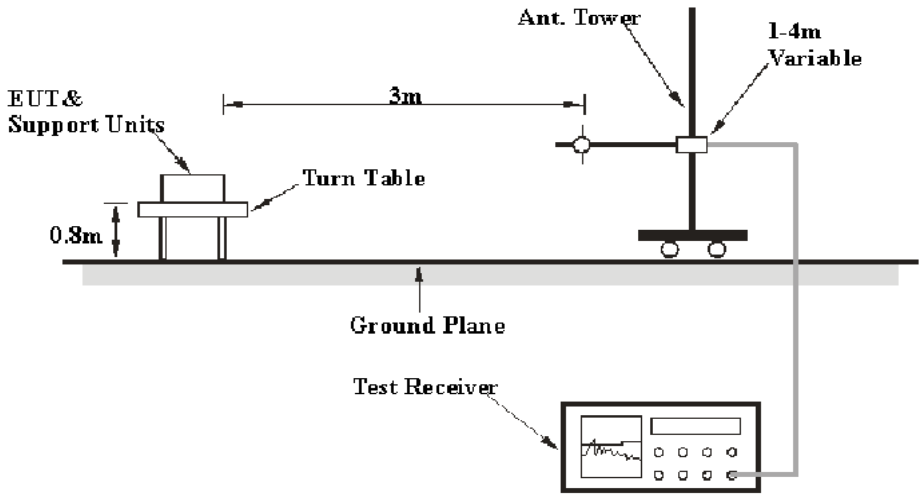
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

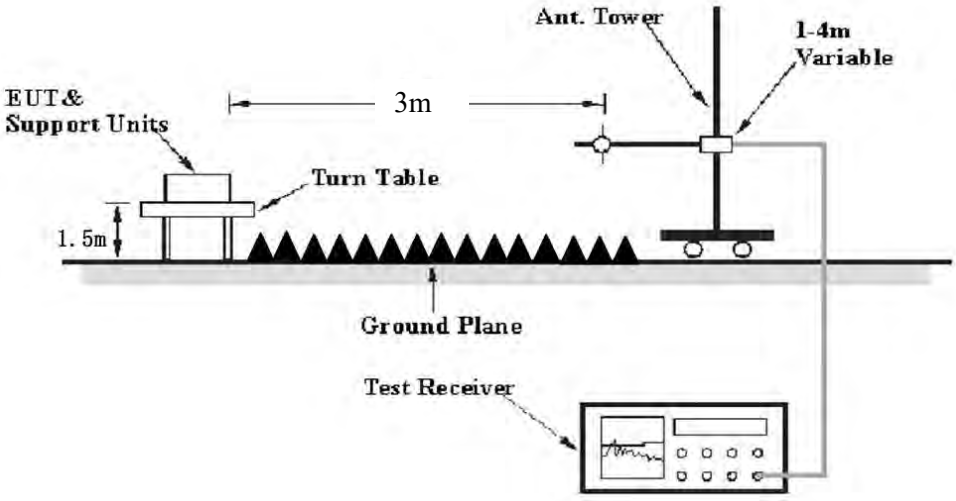
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

During the radiated emission test, according to the DA 00-705 Released March 30, 2000, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

Factor & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin = Result - Limit

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

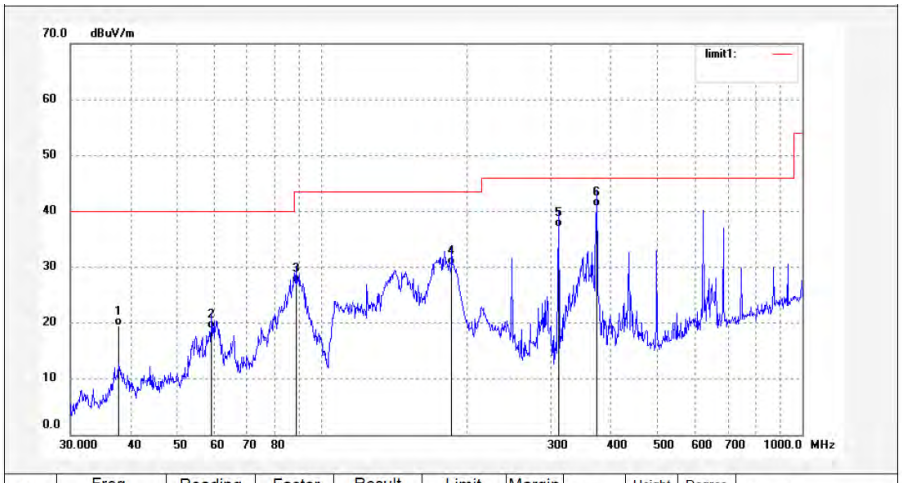
The testing was performed by Ting on 2021-06-18

EUT operation mode: Transmitting

(Scan with GFSK, π/4-DQPSK, 8DPSK mode, the worst case is 8DPSK Mode)

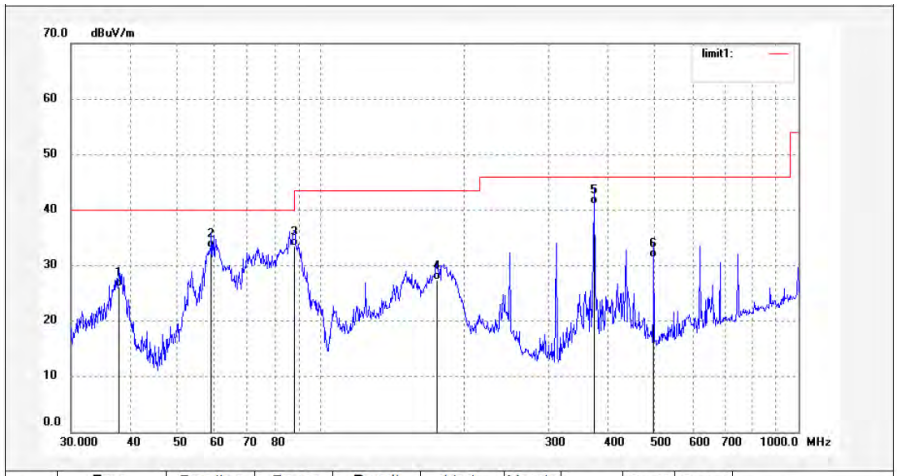
Below 1GHz: 8DPSK Mode, Low channel

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	37.8121	38.40	-18.96	19.44	40.00	-20.56	QP			
2	59.0251	37.40	-18.36	19.04	40.00	-20.96	QP			
3	88.3421	48.21	-20.99	27.22	43.50	-16.28	QP			
4	186.4409	48.25	-17.80	30.45	43.50	-13.05	QP			
5	311.0867	51.45	-14.30	37.15	46.00	-8.85	QP			
6	373.3110	53.88	-13.04	40.84	46.00	-5.16	QP			

Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	37.8121	41.88	-15.70	26.18	40.00	-13.82	QP			
2	59.0251	51.59	-18.48	33.11	40.00	-6.89	QP			
3	88.0329	53.63	-20.10	33.53	43.50	-9.97	QP			
4	175.0365	46.12	-18.67	27.45	43.50	-16.05	QP			
5	373.3110	54.00	-13.04	40.96	46.00	-5.04	QP			
6	497.6764	41.98	-10.62	31.36	46.00	-14.64	QP			

Above 1GHz (worst case):

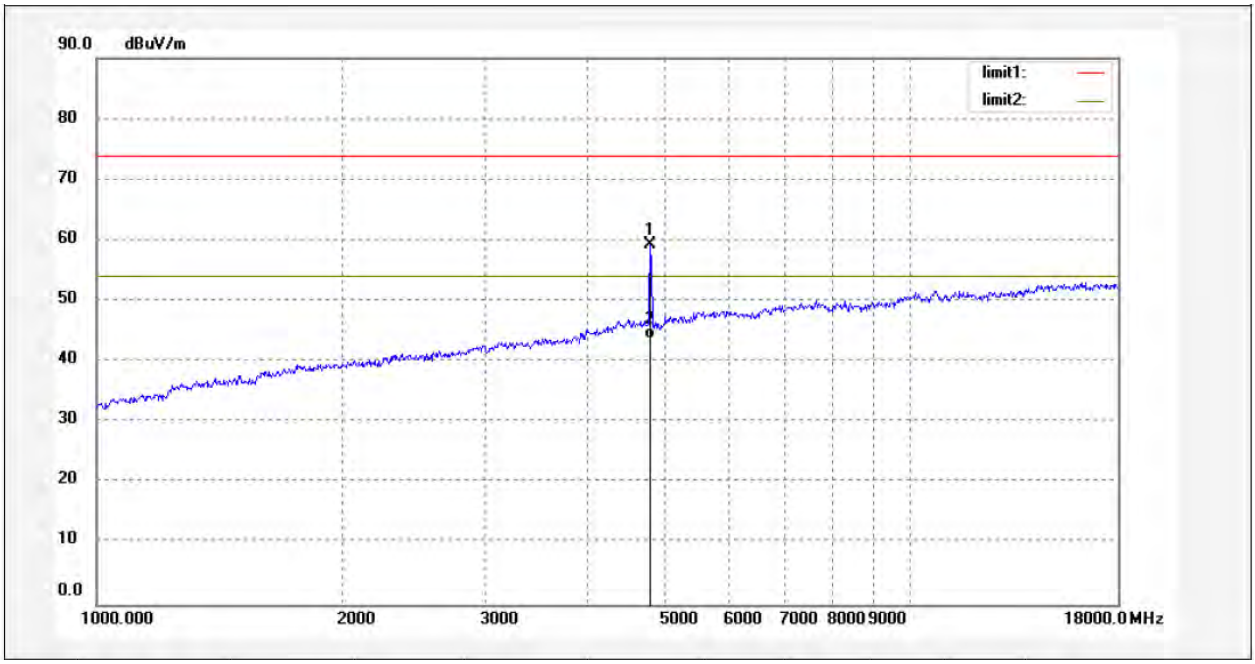
Frequency (MHz)	Receiver		Turntable Angle	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/Ave	Degree	Height (m)	Polar (H/V)				
Low Channel									
2310	44.58	PK	320	1.2	H	-6.84	37.74	74	36.26
2310	45.66	PK	21	2.6	V	-6.84	38.82	74	35.18
2390	46.72	PK	320	1.2	H	-6.44	40.28	74	33.72
2390	46.05	PK	320	1.3	V	-6.44	39.61	74	34.39
4804.11	56.42	PK	52	2.2	H	2.81	59.23	74	14.77
4804.11	41.06	AV	52	2.2	H	2.81	43.87	54	10.13
4804.11	57.64	PK	85	1.7	V	2.81	60.45	74	13.55
4804.11	41.65	AV	85	1.7	V	2.81	44.46	54	9.54
7206.309	53.84	PK	45	1.6	V	7.46	61.30	74	12.70
7206.309	40.15	AV	45	1.6	V	7.46	47.61	54	6.39
Middle Channel									
4882	54.45	PK	140	1.2	H	3.04	57.49	74	16.51
4882	42.85	AV	140	1.2	H	3.04	45.89	54	8.11
4882	53.58	PK	101	2.5	V	3.04	56.62	74	17.38
4882	41.39	AV	101	2.5	V	3.04	44.43	54	9.57
High Channel									
2483.5	47.89	PK	230	1.7	H	-5.96	41.93	74	32.07
2483.5	48.24	PK	46	2.1	V	-5.96	42.28	74	31.72
2500	48.83	PK	67	1.3	H	-5.88	42.95	74	31.05
2500	48.74	PK	101	1	V	-5.88	42.86	74	31.14
4960.662	55.78	PK	346	2.2	V	3.32	59.10	74	14.90
4960.662	42.36	AV	346	2.2	V	3.32	45.68	54	8.32

Note:
Absolute Level = Factor + Reading
Margin = Limit - Absolute Level
The other spurious emission which is 20dB to the limit was not recorded.
The test result of peak was less than the limit of average, so just peak value were recorded.

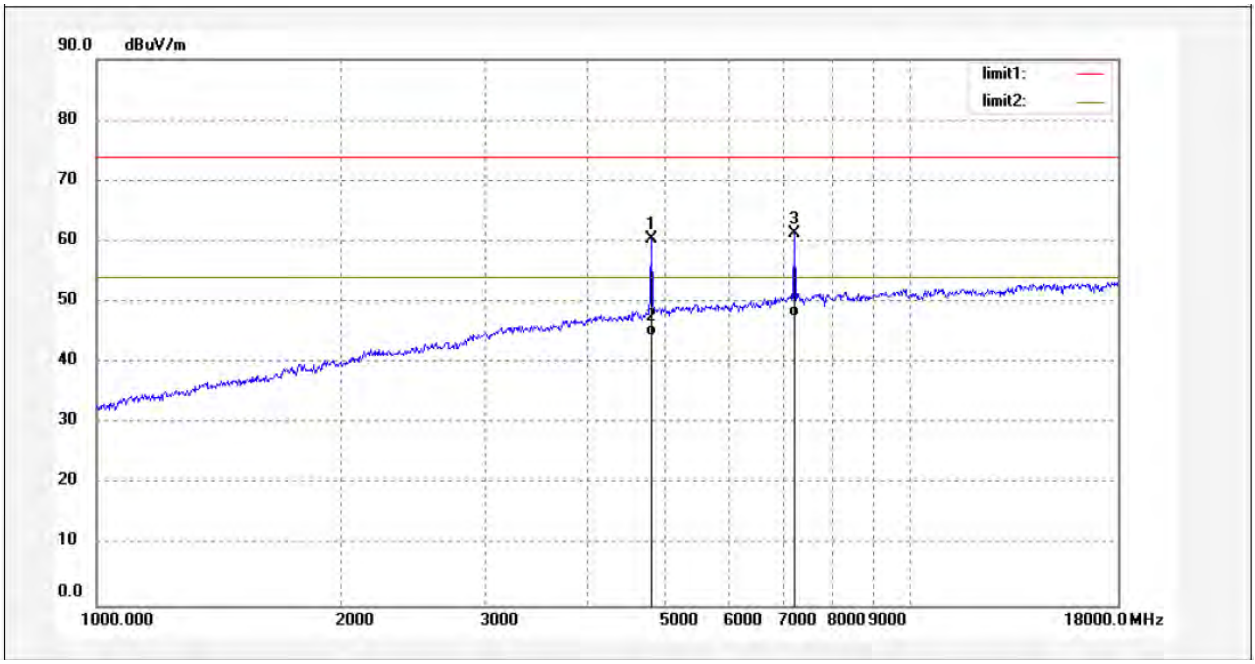
1 GHz - 18 GHz: (Pre-Scan plots)

Low Channel

Horizontal



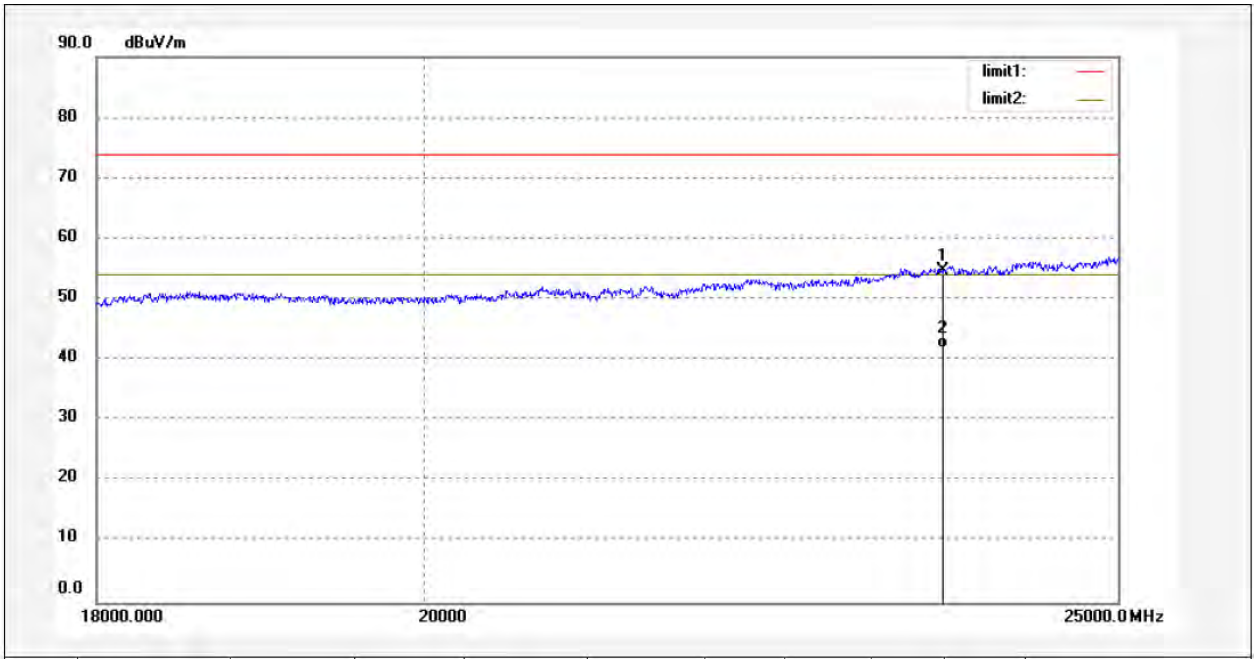
Vertical



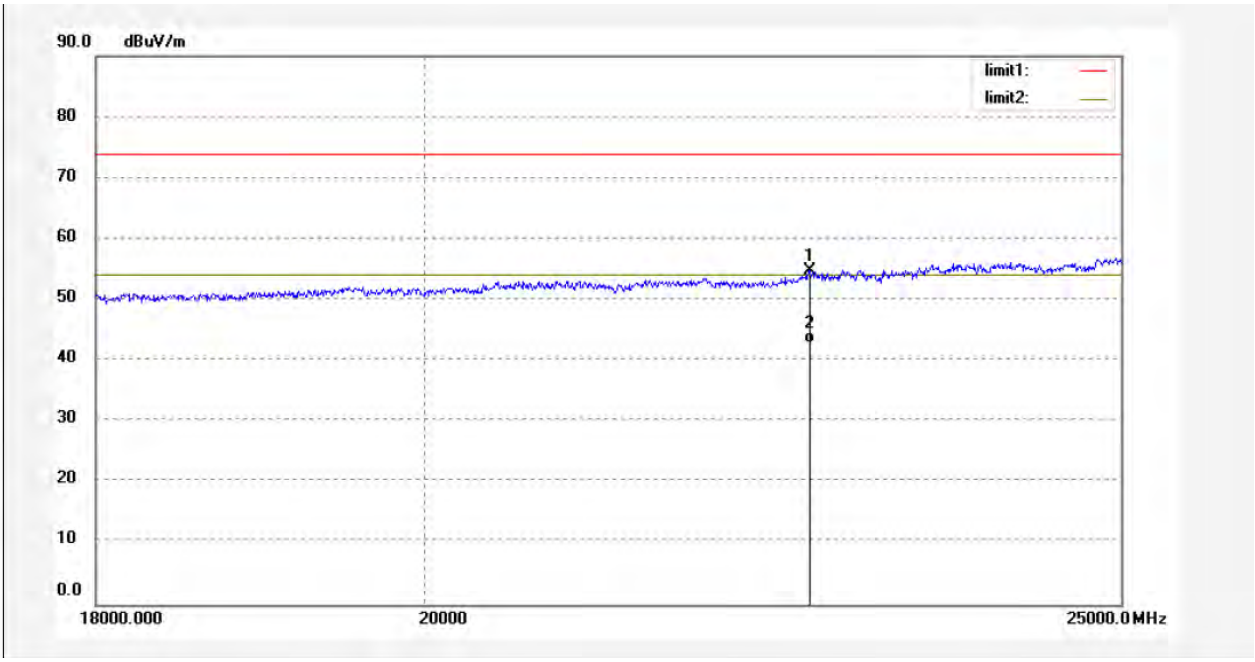
18-25GHz: (Pre-Scan plots)

Low Channel

Horizontal



Vertical



FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, 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 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly 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.

Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting on 2021-06-18.

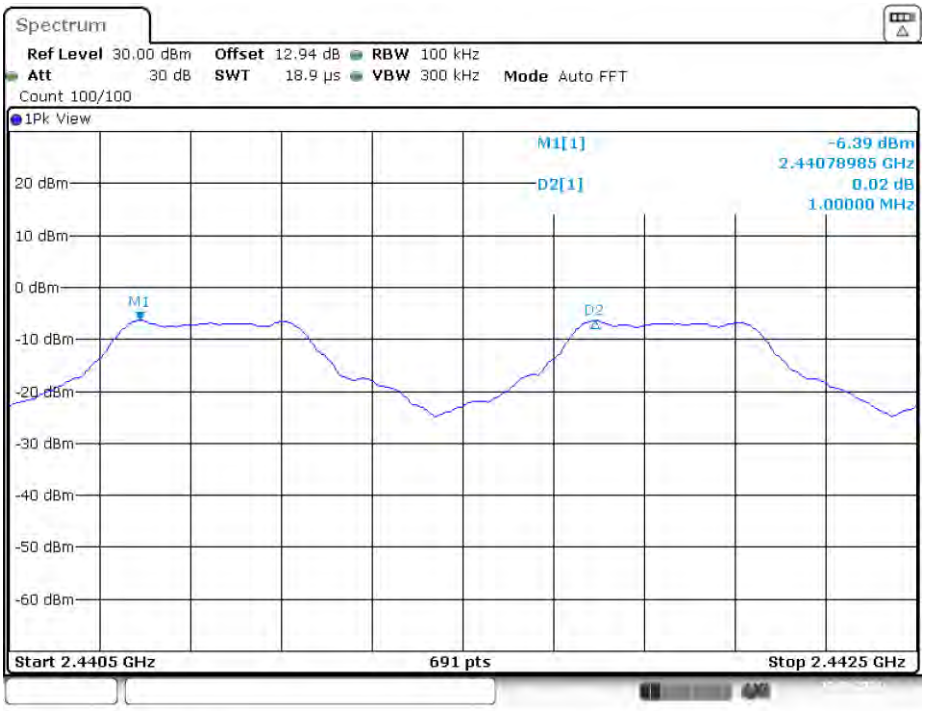
EUT operation mode: Transmitting

Test Result: Compliant.

Test Mode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1	>=0.588	PASS
2DH1	Ant1	Hop	1	>=0.848	PASS
3DH1	Ant1	Hop	1	>=0.838	PASS

Please refer to the below plots:

DH1_Ant1_Hop



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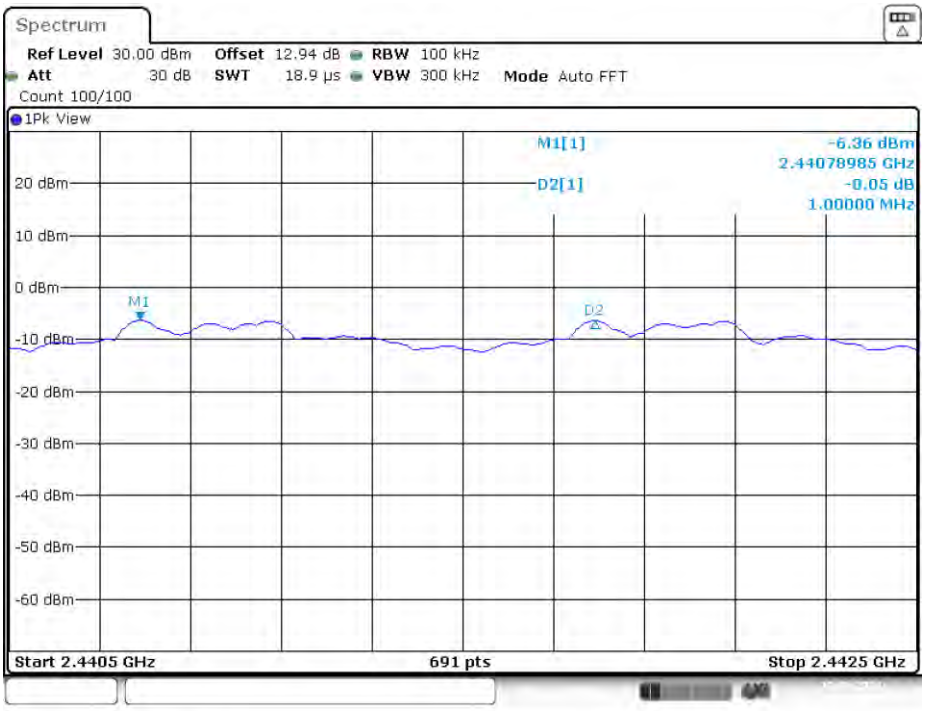
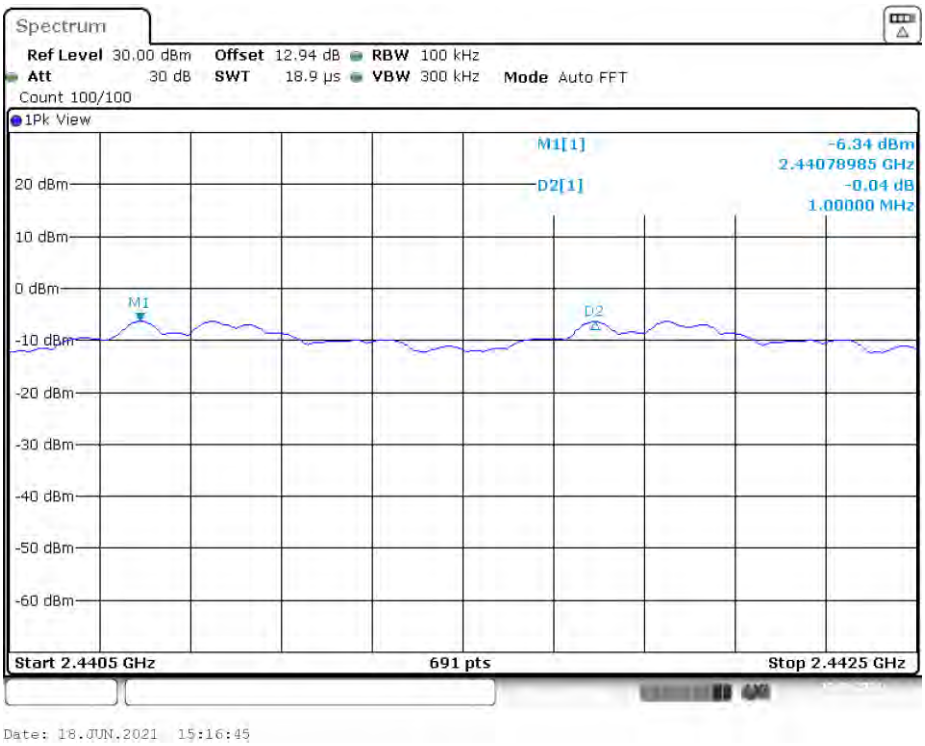
2DH1_Ant1_Hop



Date: 18.JUN.2021 15:06:29

3DH1_Ant1_Hop



FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

Alternatively, 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 125 mW.

Test Procedure

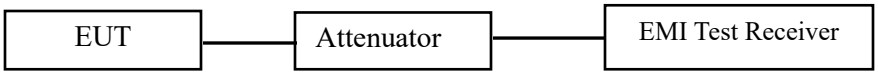
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

• The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.

• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting on 2021-06-18.

EUT operation mode: Transmitting

Test Result: Compliant.

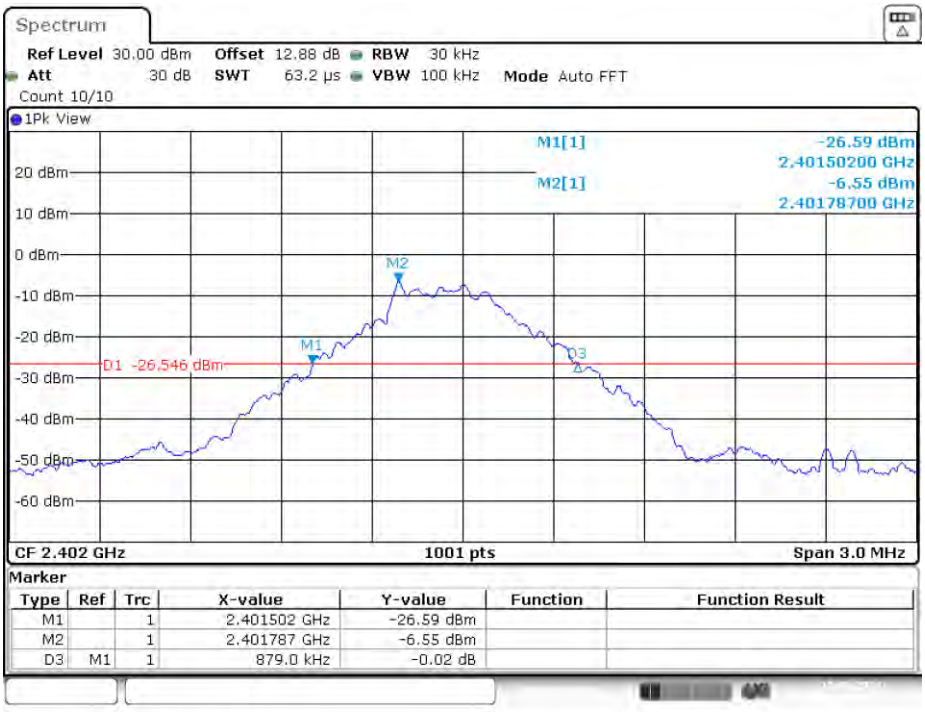
Test Mode	Antenna	Channel	20db EBW[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.879	---	PASS
		2441	0.882	---	PASS
		2480	0.882	---	PASS
2DH1	Ant1	2402	1.272	---	PASS
		2441	1.269	---	PASS
		2480	1.263	---	PASS
3DH1	Ant1	2402	1.257	---	PASS
		2441	1.257	---	PASS
		2480	1.254	---	PASS

Test Mode	Antenna	Channel	99% Occupied Bandwidth [MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.818	---	PASS
		2441	0.821	---	PASS
		2480	0.824	---	PASS
2DH1	Ant1	2402	1.163	---	PASS
		2441	1.166	---	PASS
		2480	1.163	---	PASS
3DH1	Ant1	2402	1.157	---	PASS
		2441	1.154	---	PASS
		2480	1.157	---	PASS

Please refer to the below plots:

20 dB EMISSION BANDWIDTH

DH1_Ant1_2402MHz



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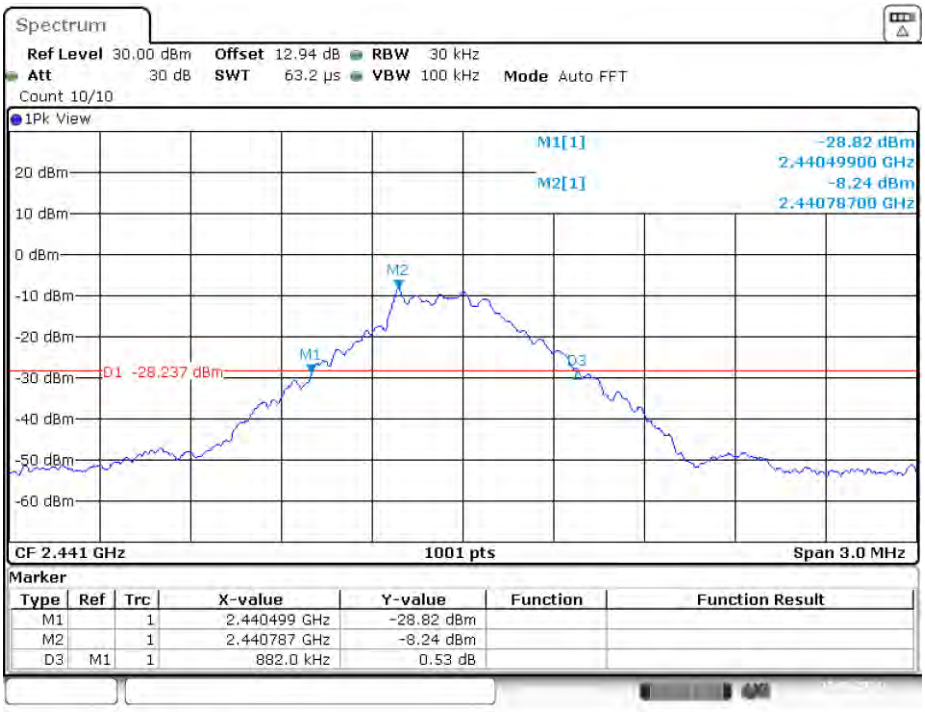
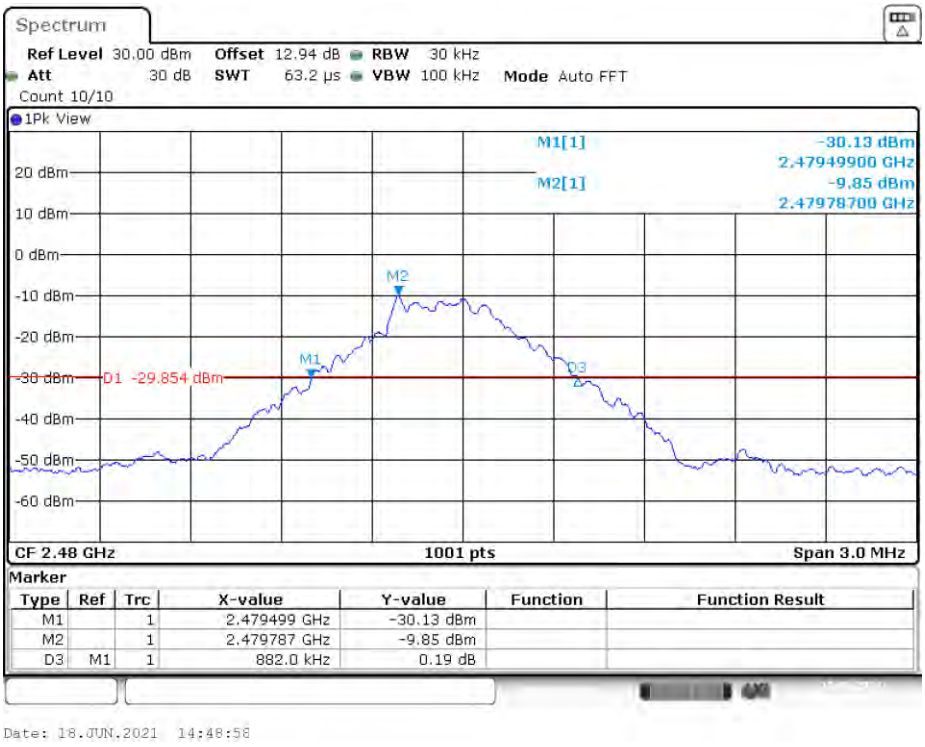
DH1_Ant1_2441MHz



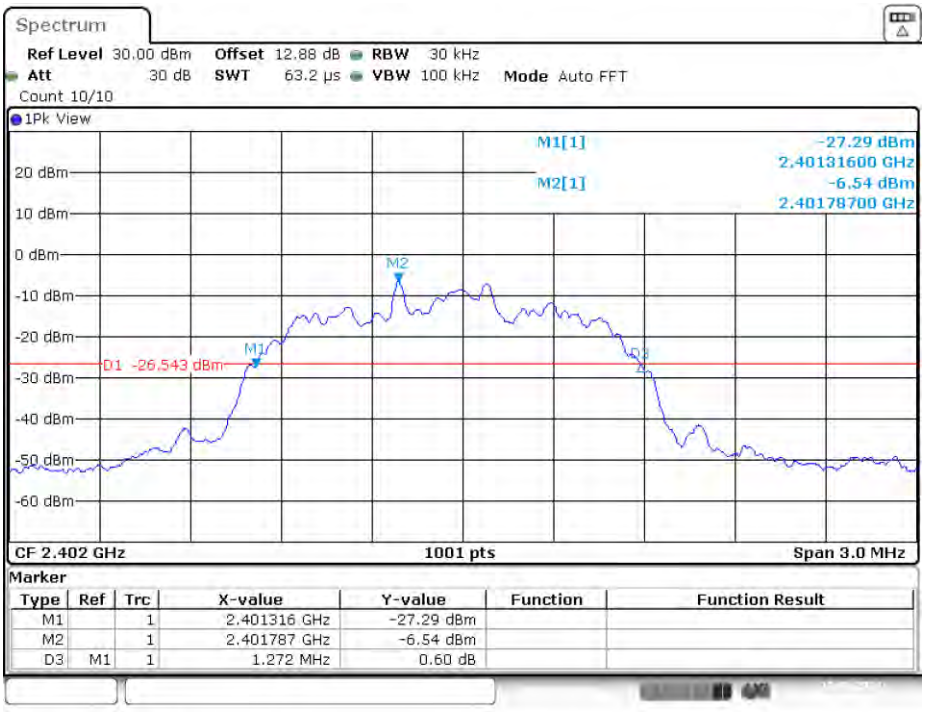
Date: 18.JUN.2021 14:47:34

DH1_Ant1_2480MHz



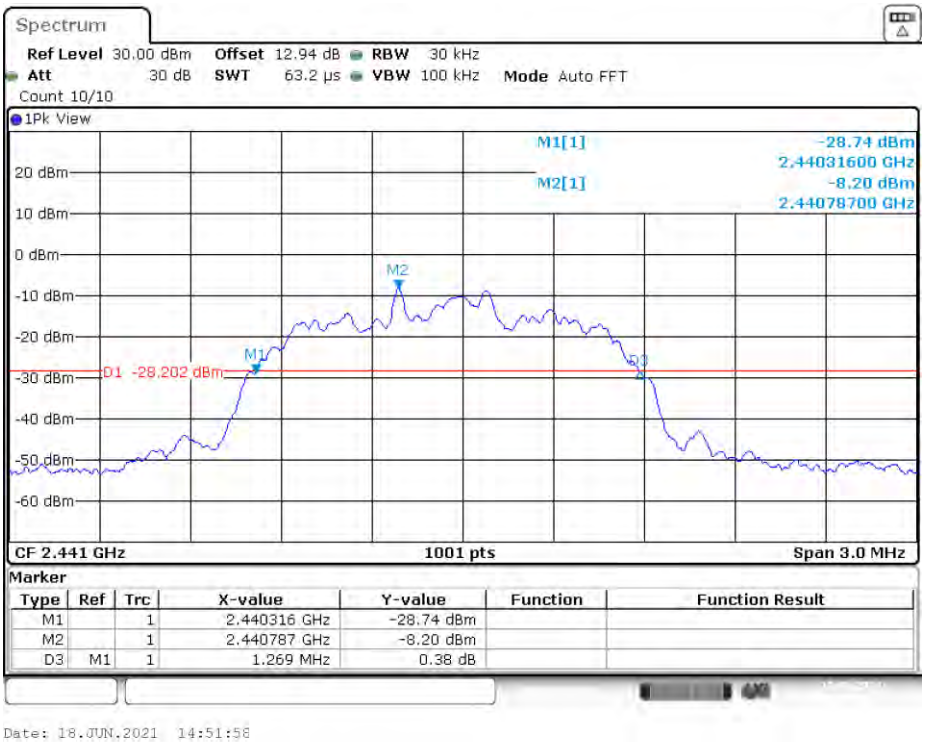
Date: 18.JUN.2021 14:48:58

2DH1_Ant1_2402MHz

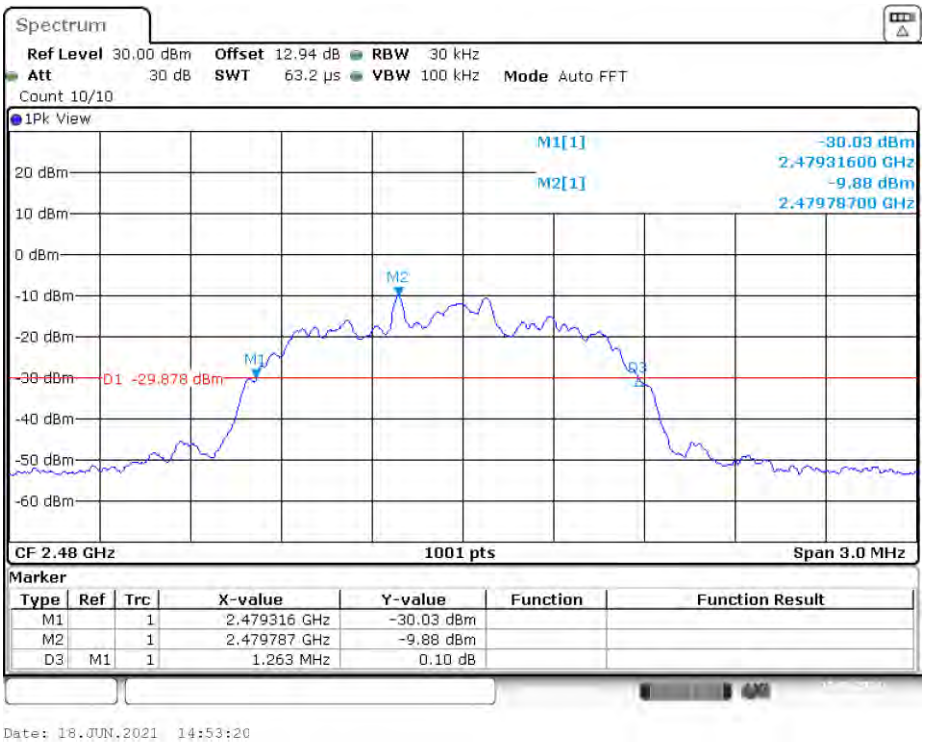


Date: 18.JUN.2021 14:50:45

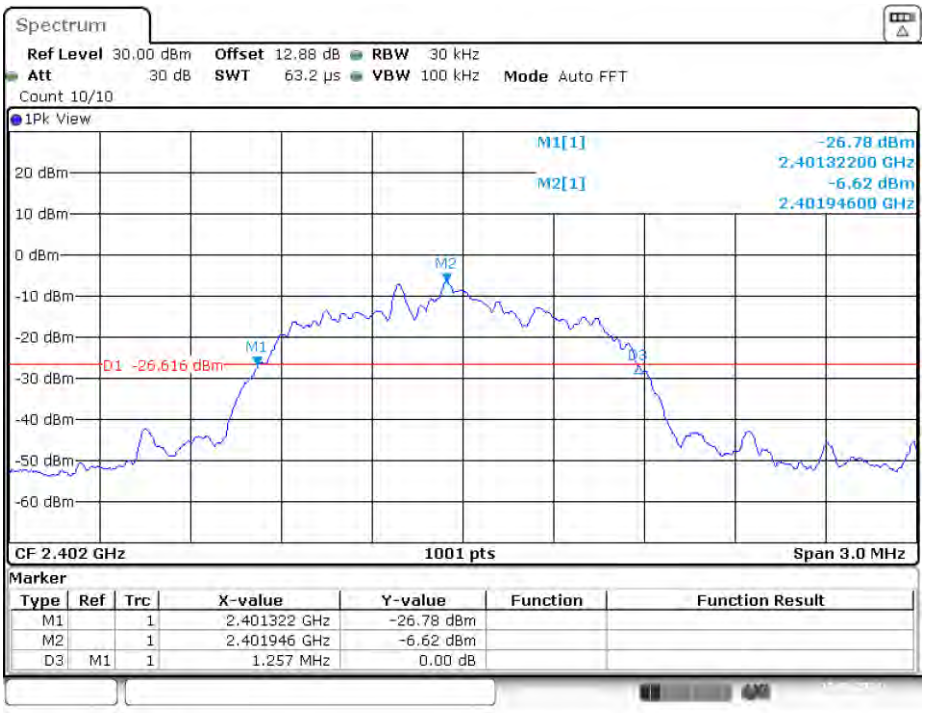
2DH1_Ant1_2441MHz



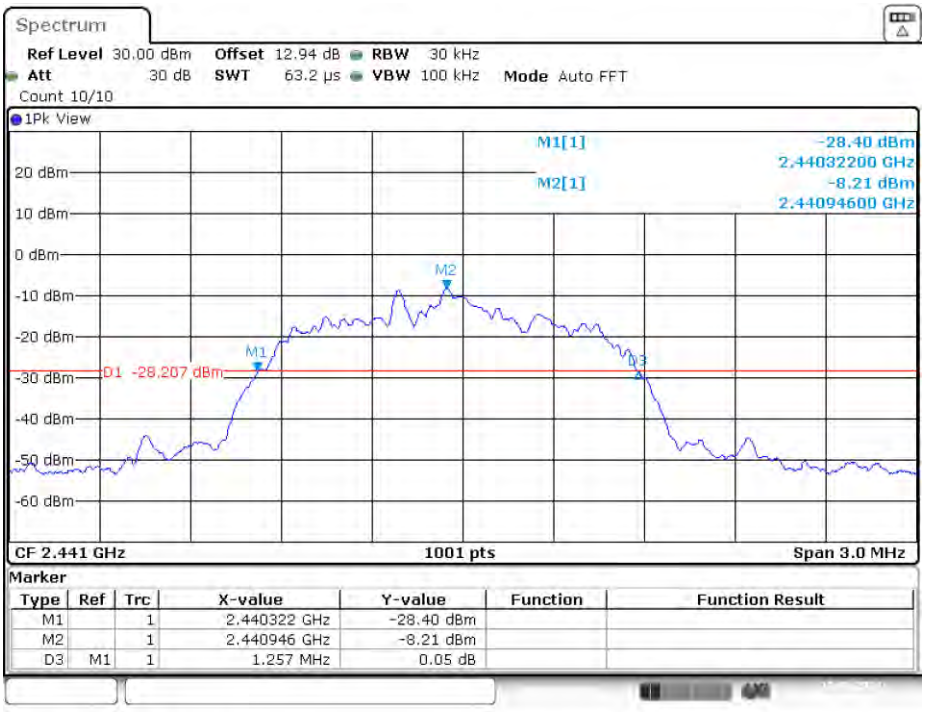
2DH1_Ant1_2480MHz



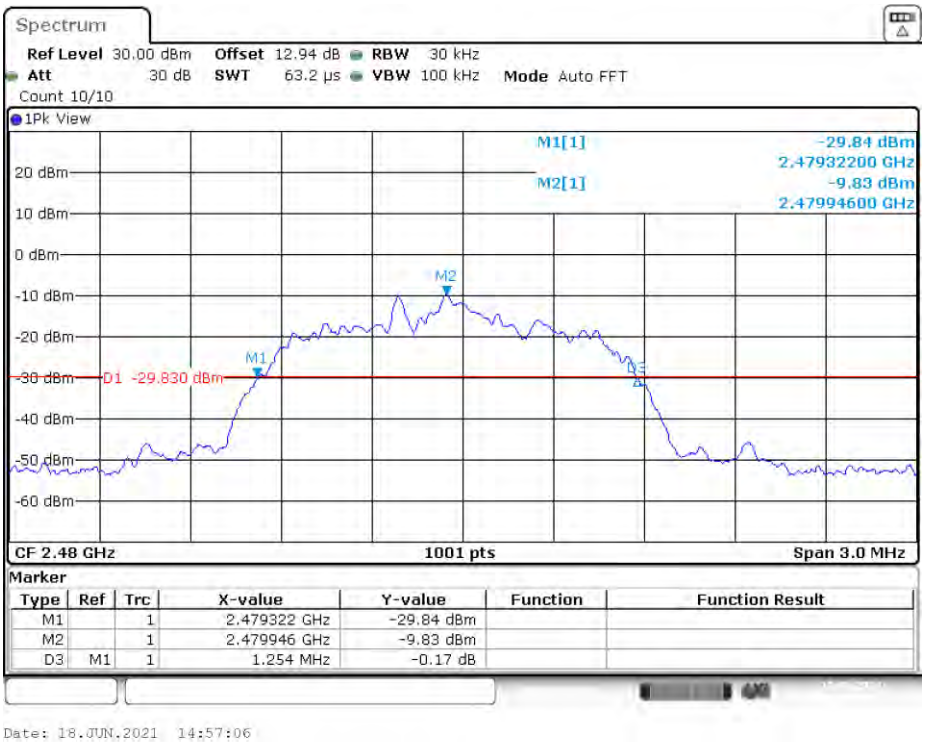
3DH1_Ant1_2402MHz



3DH1_Ant1_2441MHz



3DH1_Ant1_2480MHz



99% OCCUPIED BANDWIDTH

DH1_Ant1_2402MHz

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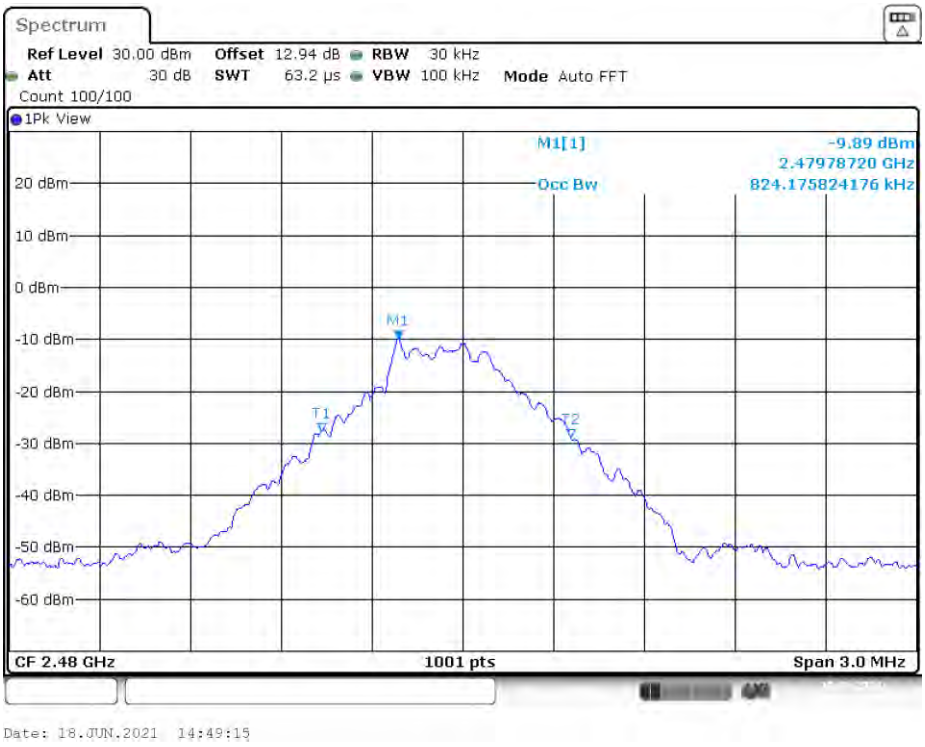
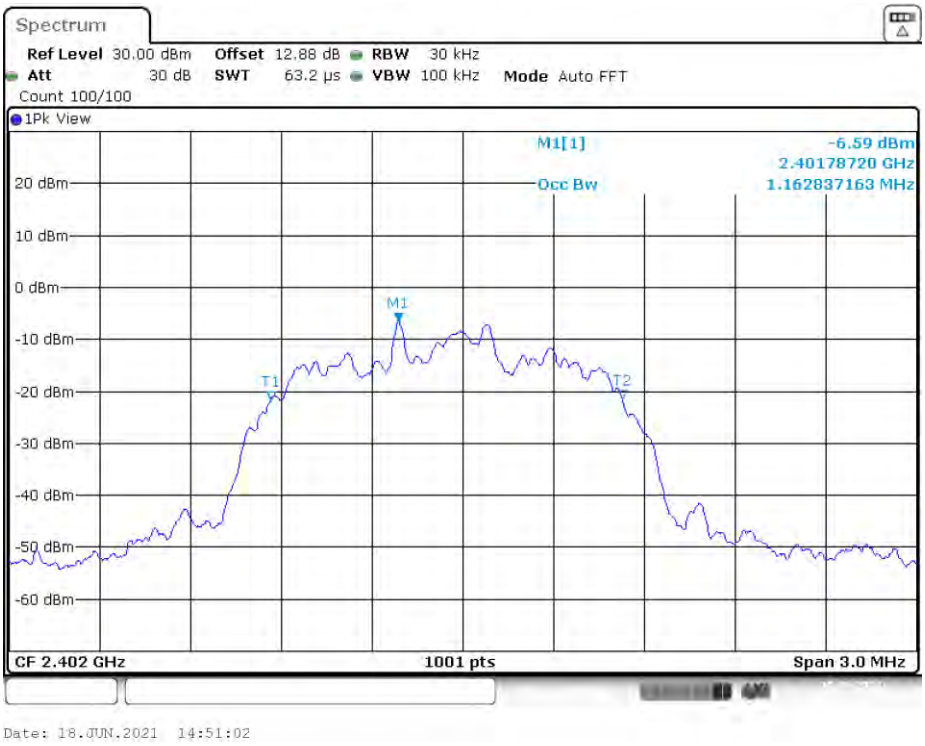
DH1_Ant1_2441MHz

Date: 18.JUN.2021 14:47:51

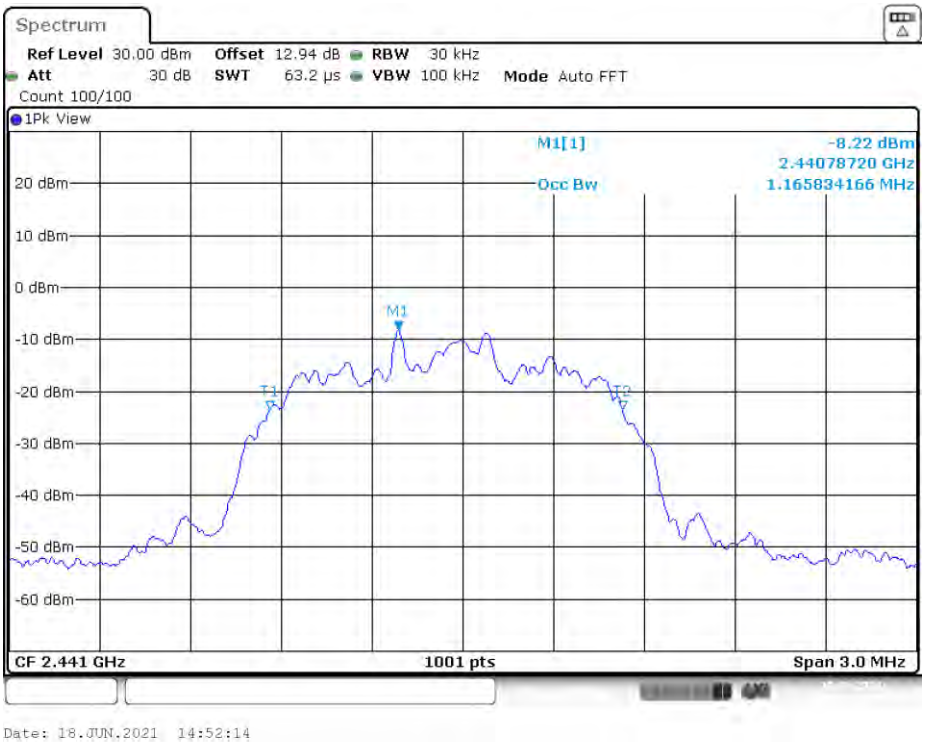
DH1_Ant1_2480MHz



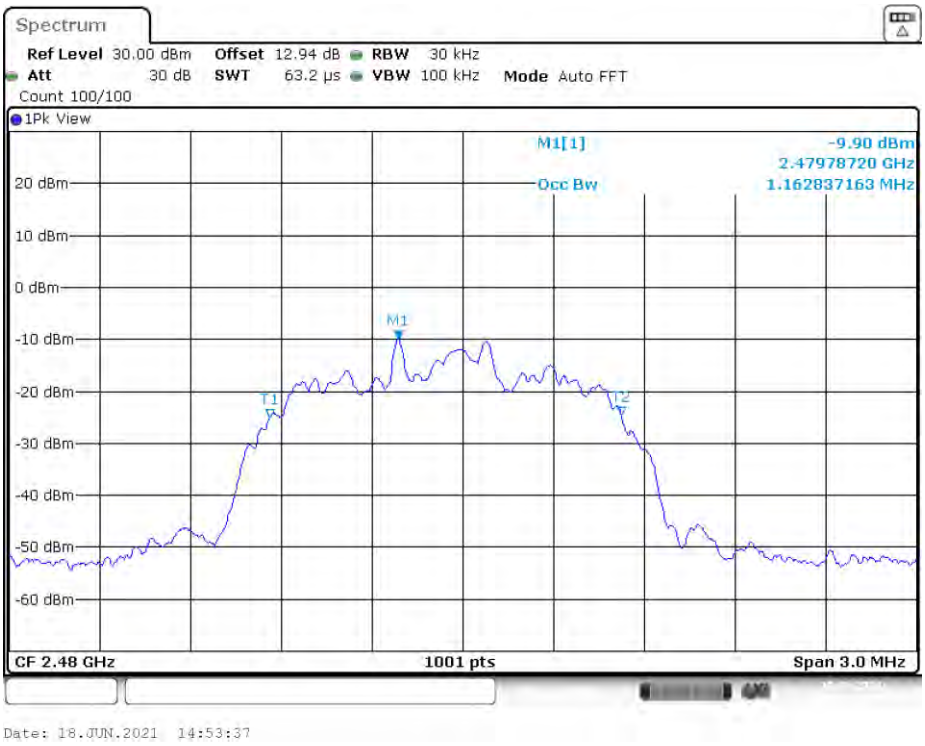
2DH1_Ant1_2402MHz



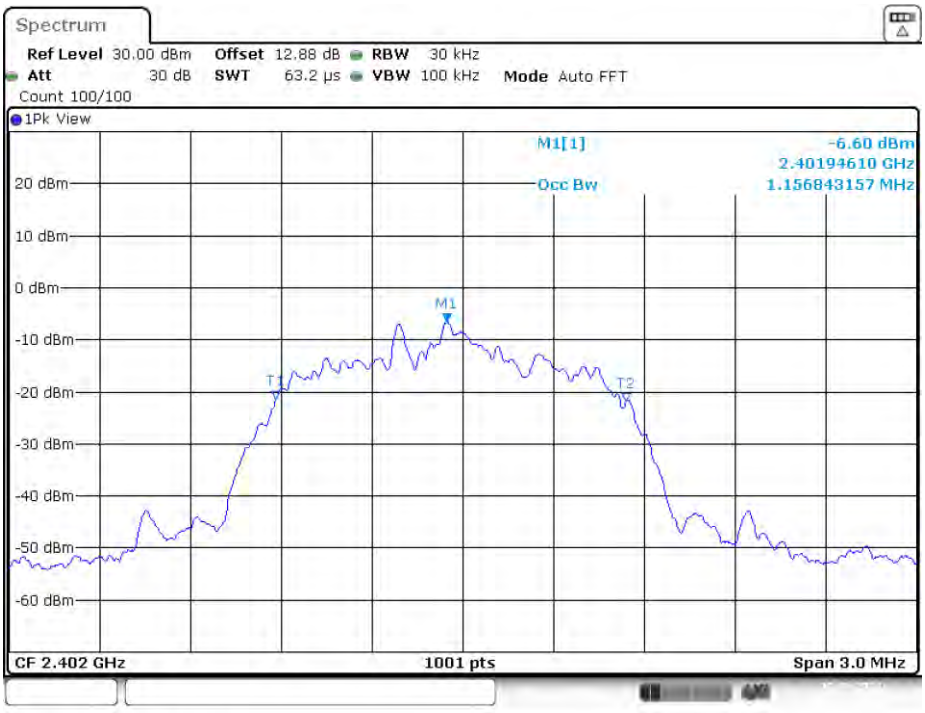
2DH1_Ant1_2441MHz



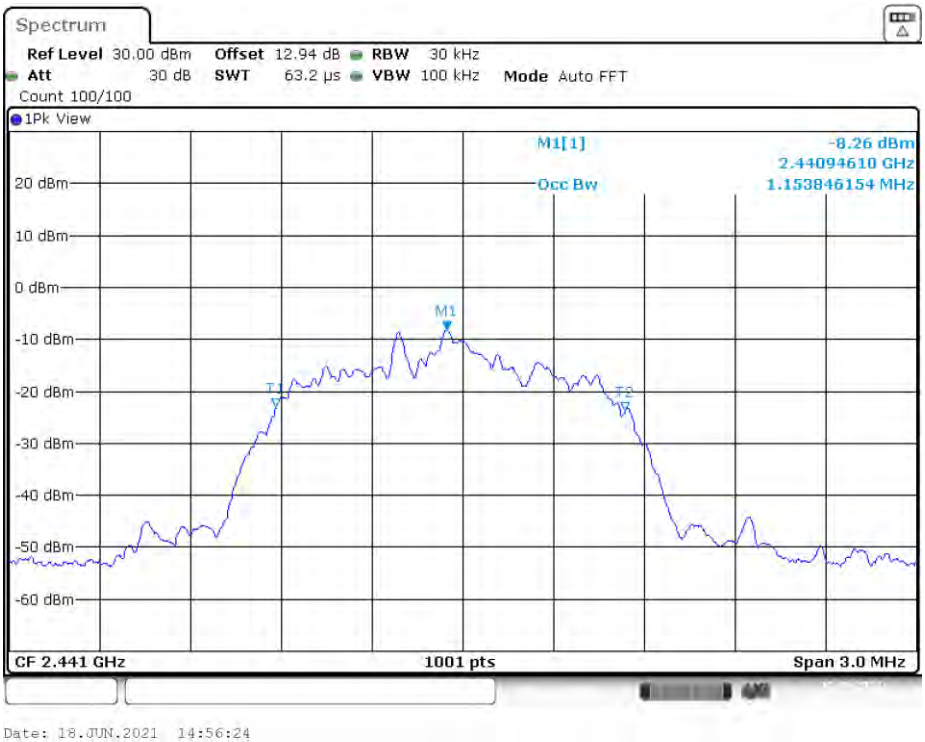
2DH1_Ant1_2480MHz



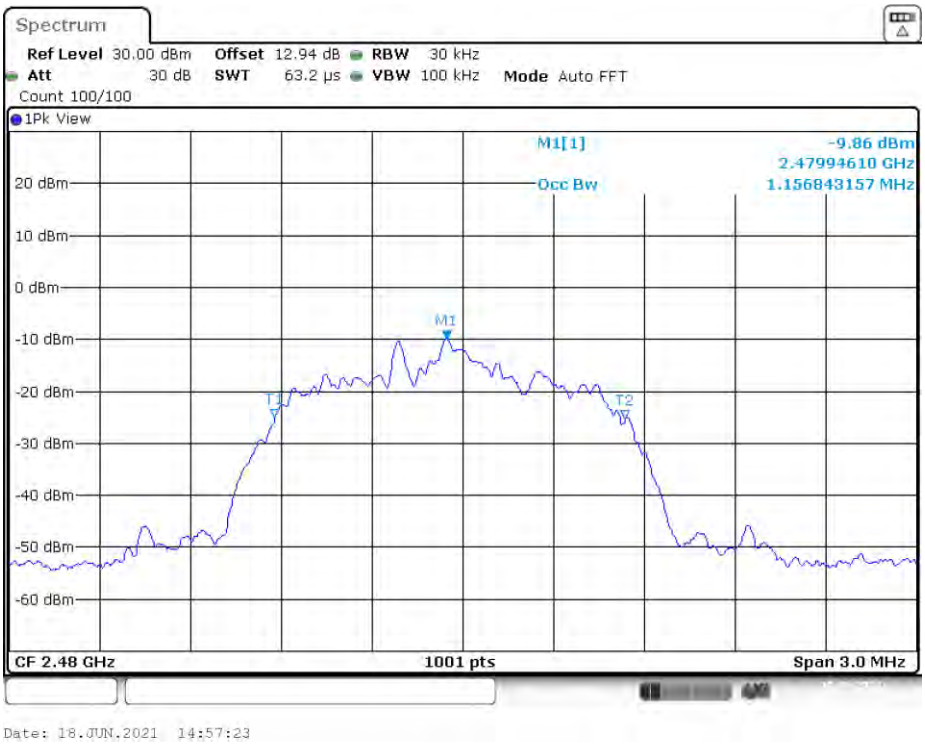
3DH1_Ant1_2402MHz



3DH1_Ant1_2441MHz



3DH1_Ant1_2480MHz



FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy 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.

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

2. Set the EUT in hopping mode from first channel to last.

3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

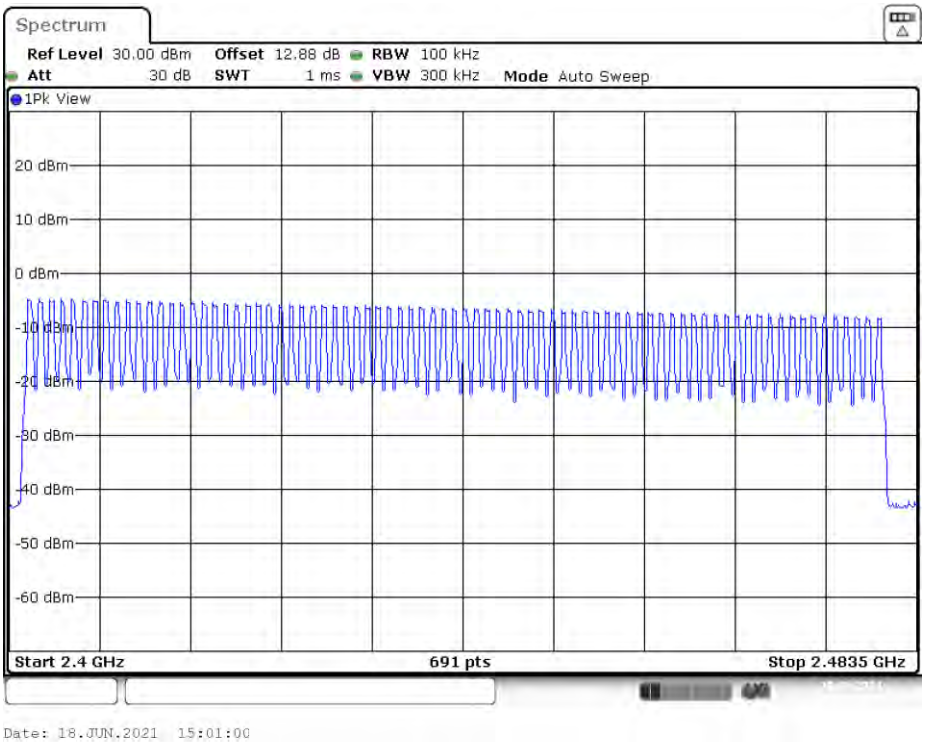
The testing was performed by Ting on 2021-06-18.

EUT operation mode: Transmitting

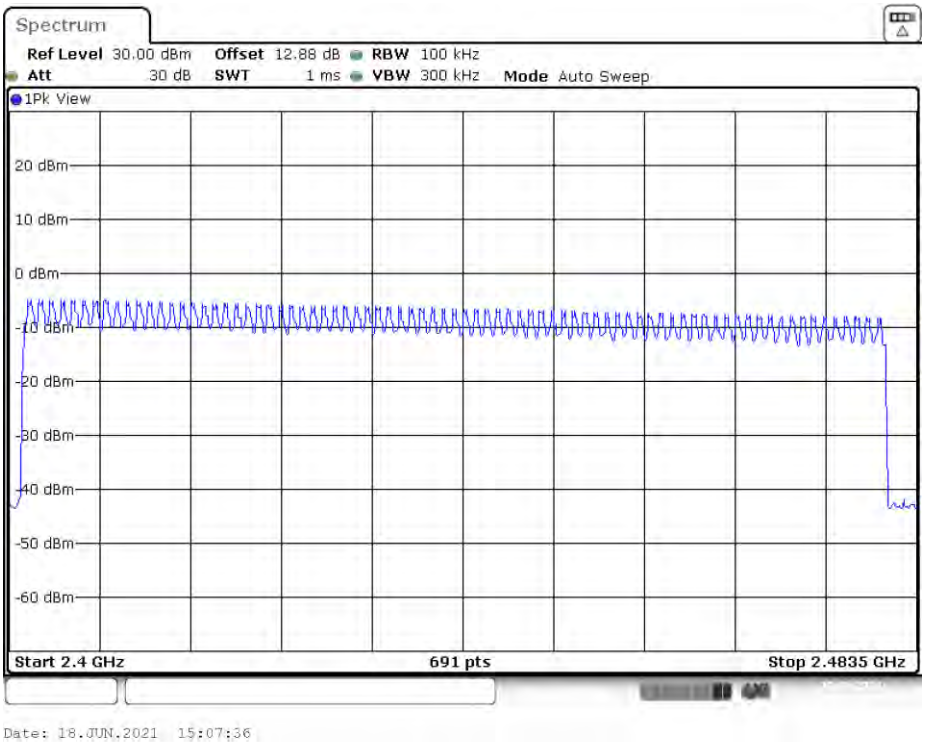
Test Result: Compliant.

TestMode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	>=15	PASS
2DH1	Ant1	Hop	79	>=15	PASS
3DH1	Ant1	Hop	79	>=15	PASS

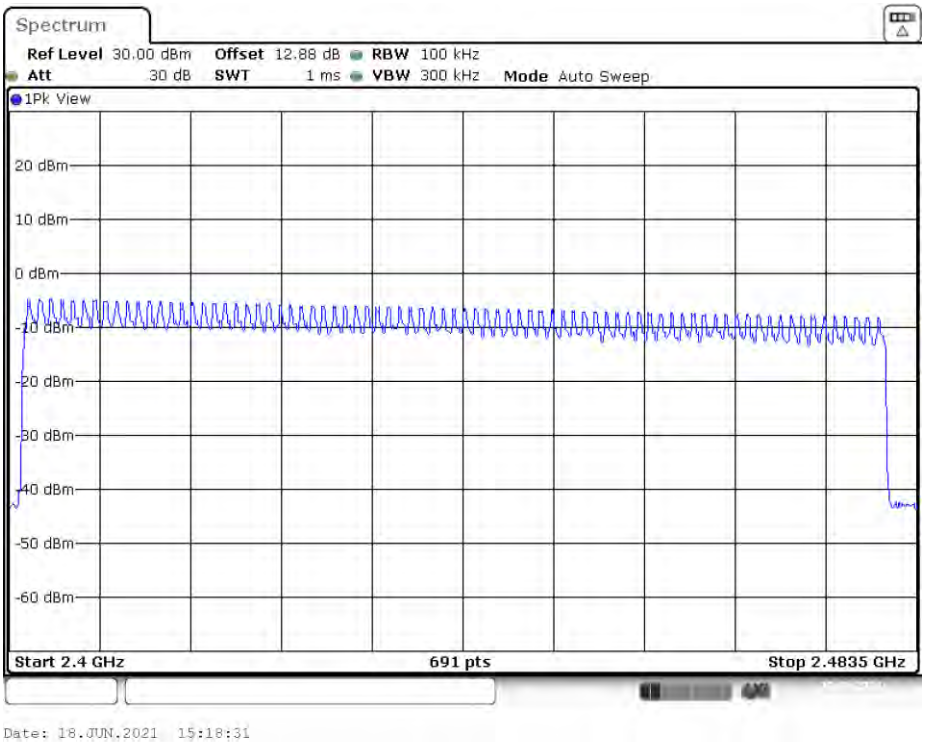
DH1_Ant1_Hop



2DH1_Ant1_Hop



3DH1_Ant1_Hop



FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy 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.

Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting on 2021-06-18.

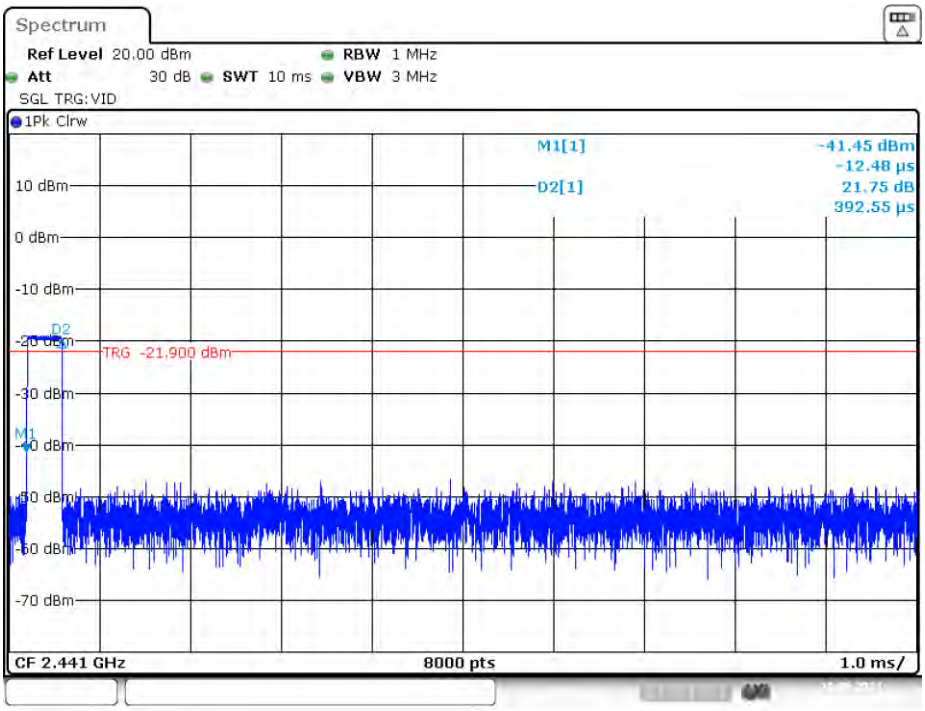
EUT operation mode: Transmitting

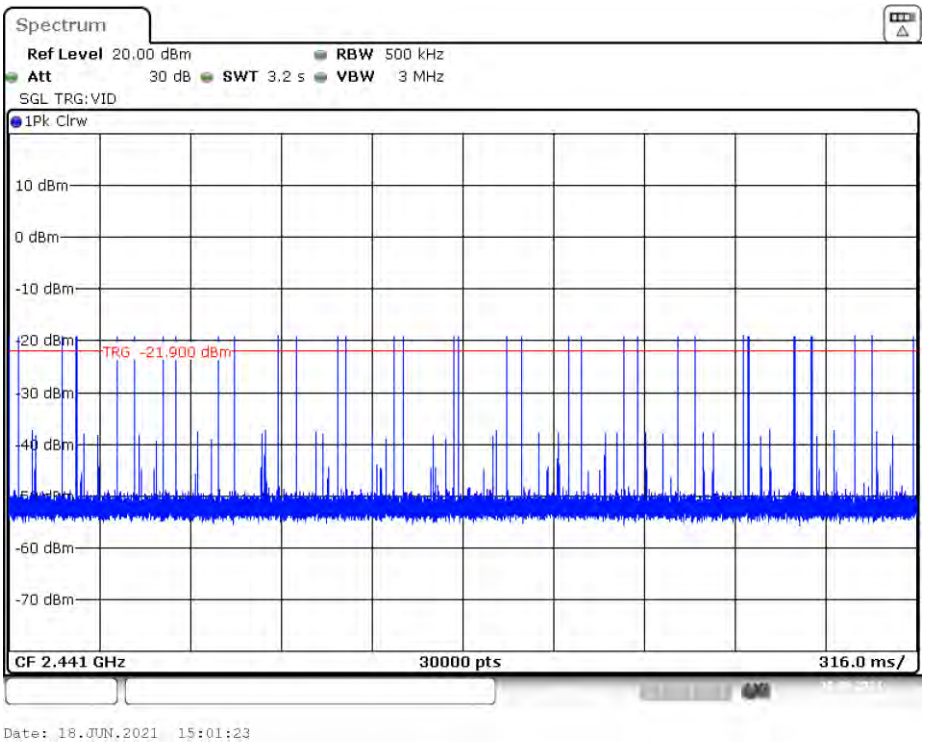
Test Result: Compliant.

Test Mode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.39	330	0.13	<=0.4	PASS
DH3	Ant1	Hop	1.64	180	0.295	<=0.4	PASS
DH5	Ant1	Hop	2.88	100	0.288	<=0.4	PASS
2DH1	Ant1	Hop	0.40	320	0.129	<=0.4	PASS
2DH3	Ant1	Hop	1.65	140	0.231	<=0.4	PASS
2DH5	Ant1	Hop	2.89	80	0.231	<=0.4	PASS
3DH1	Ant1	Hop	0.41	320	0.13	<=0.4	PASS
3DH3	Ant1	Hop	1.65	170	0.28	<=0.4	PASS
3DH5	Ant1	Hop	2.89	90	0.26	<=0.4	PASS

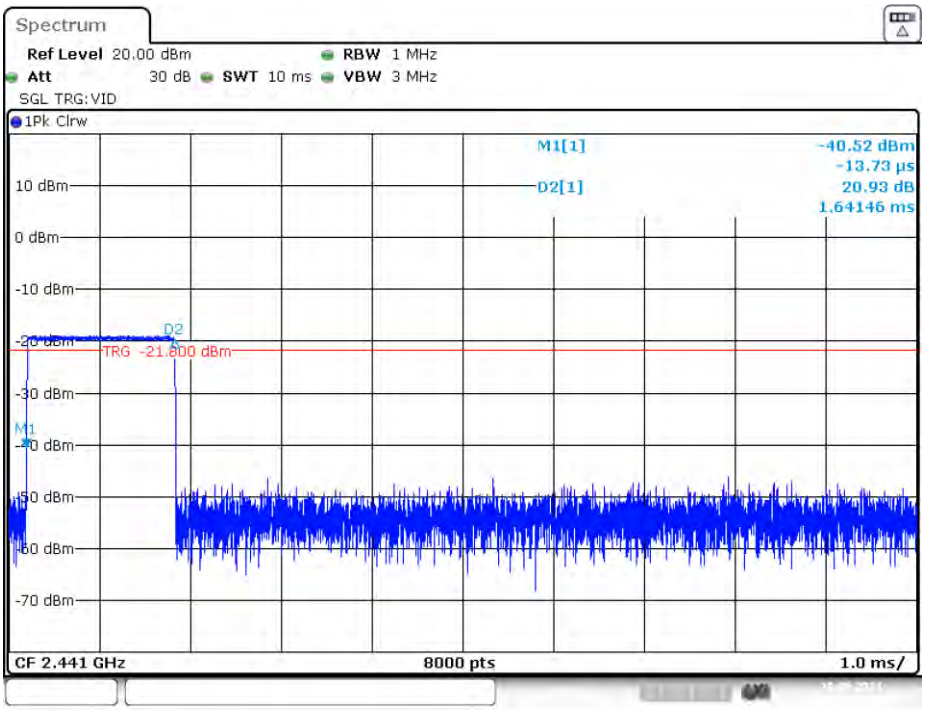
Note 1: A period time=0.4*79=31.6(S), Result=Burst Width*Total Hops
Note 2: Total Hops =Hopping Number in 3.16s*10
Note 3: Hoping Number in 3.16s=Total of highest signals in 3.16s (Second high signals were other channel)

DH1_Ant1_Hop

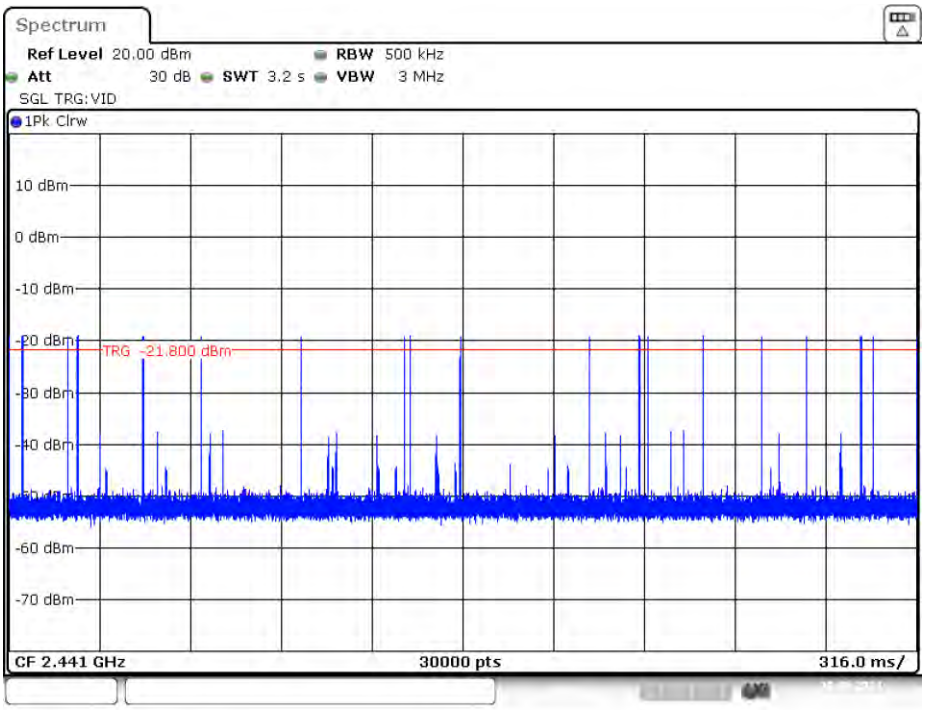

Spectrum
Ref Level 20.00 dBm
RBW 1 MHz
Att 30 dB SWT 10 ms VBW 3 MHz
SGL TRG:VID
1Pk Clrw
M1[1] -41.45 dBm
-12.48 µs
D2[1] 21.75 dB
392.55 µs
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D2
TRG -21.900 dBm
M1
CF 2.441 GHz
8000 pts
1.0 ms/
Date: 18.JUN.2021 15:01:16


Spectrum
Ref Level 20.00 dBm
RBW 500 kHz
Att 30 dB SWT 3.2 s VBW 3 MHz
SGL TRG:VID
1Pk Clrw
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-60 dBm
-70 dBm
TRG -21.900 dBm
CF 2.441 GHz
30000 pts
316.0 ms/
Date: 18.JUN.2021 15:01:23

DH3_Ant1_Hop

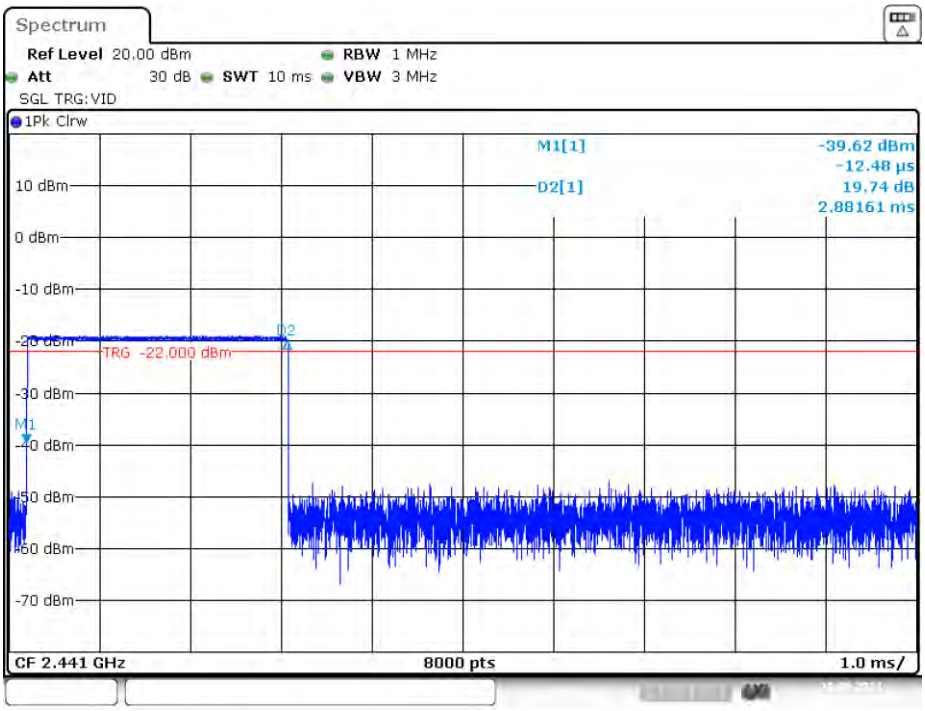


Date: 18.JUN.2021 15:02:27

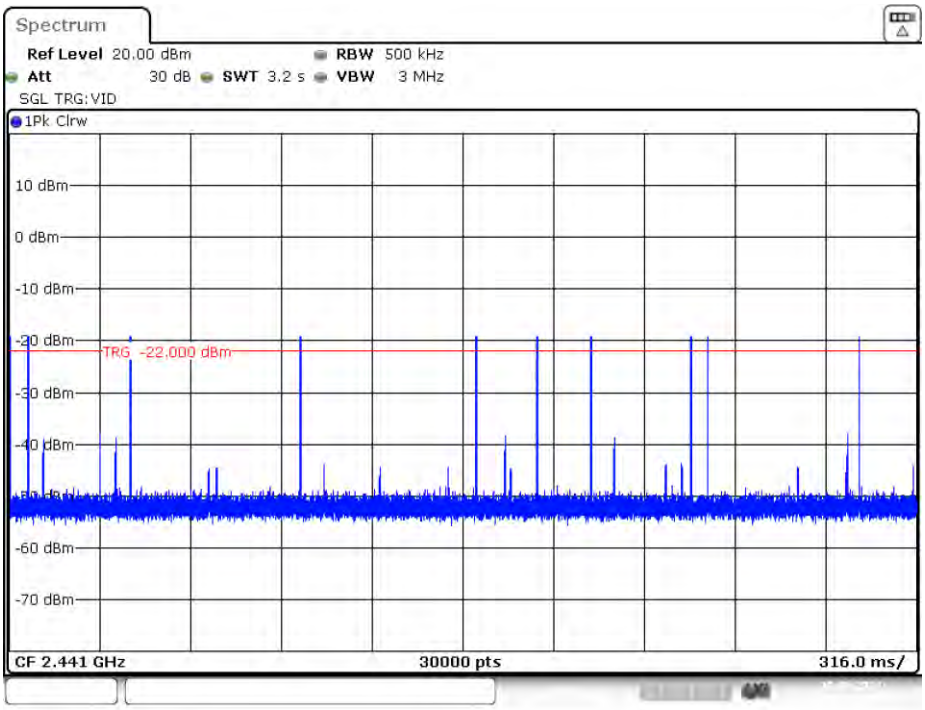


Date: 18.JUN.2021 15:02:33

DH5_Ant1_Hop

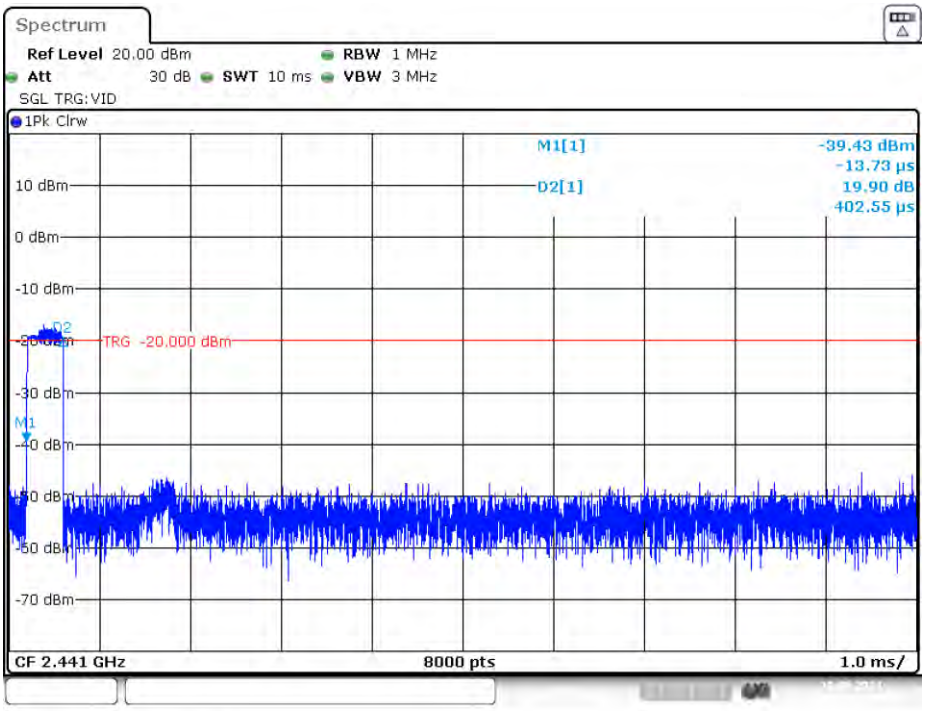


Date: 18.JUN.2021 15:03:10

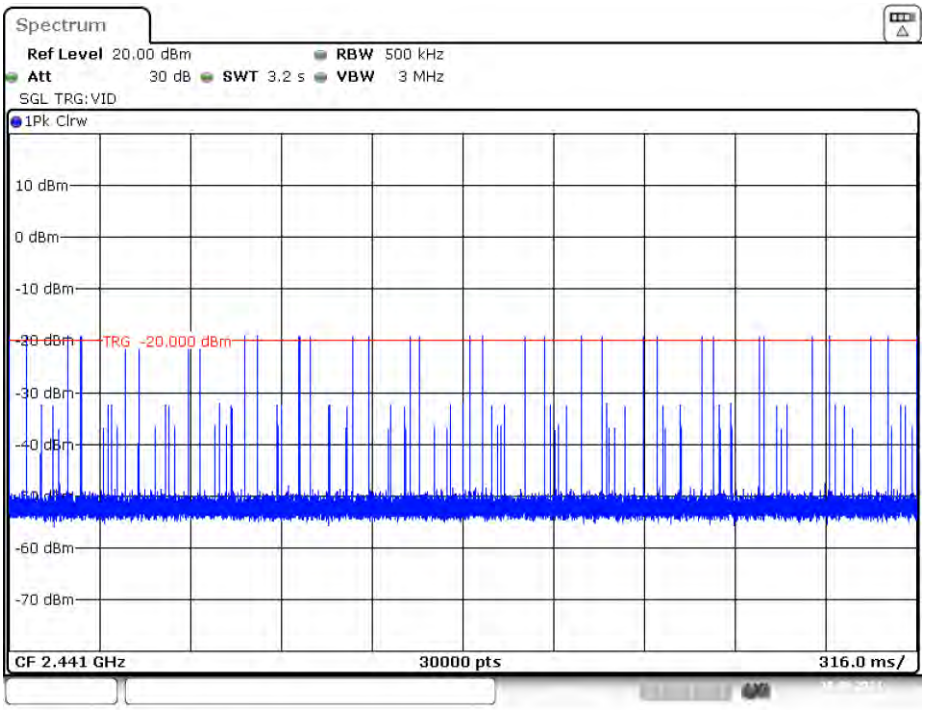


Date: 18.JUN.2021 15:03:15

2DH1_Ant1_Hop

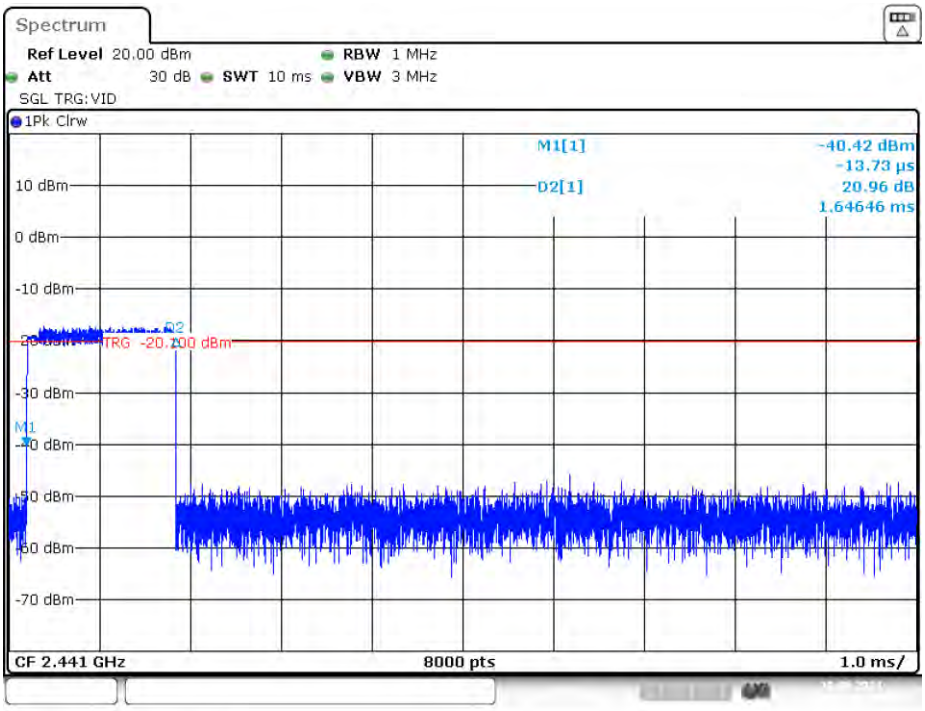


Date: 18.JUN.2021 15:07:54

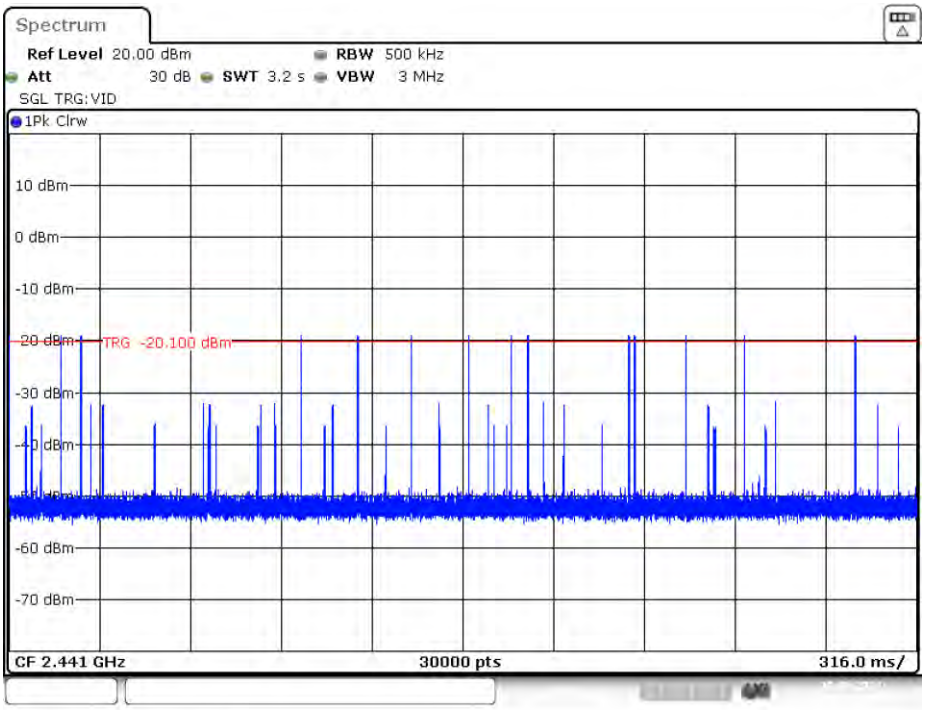


Date: 18.JUN.2021 15:07:59

2DH3_Ant1_Hop

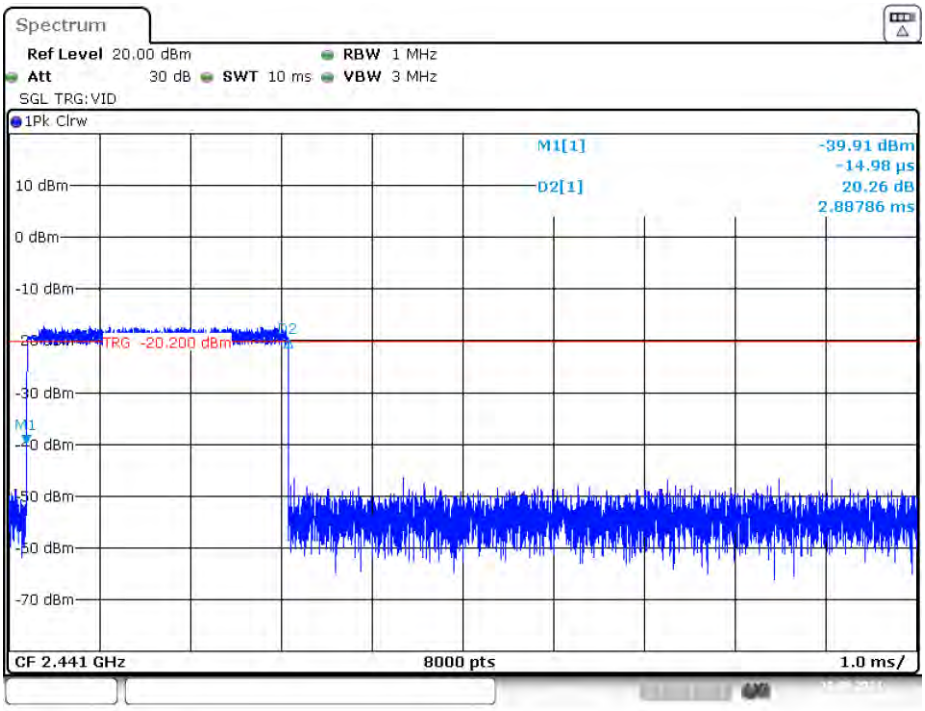


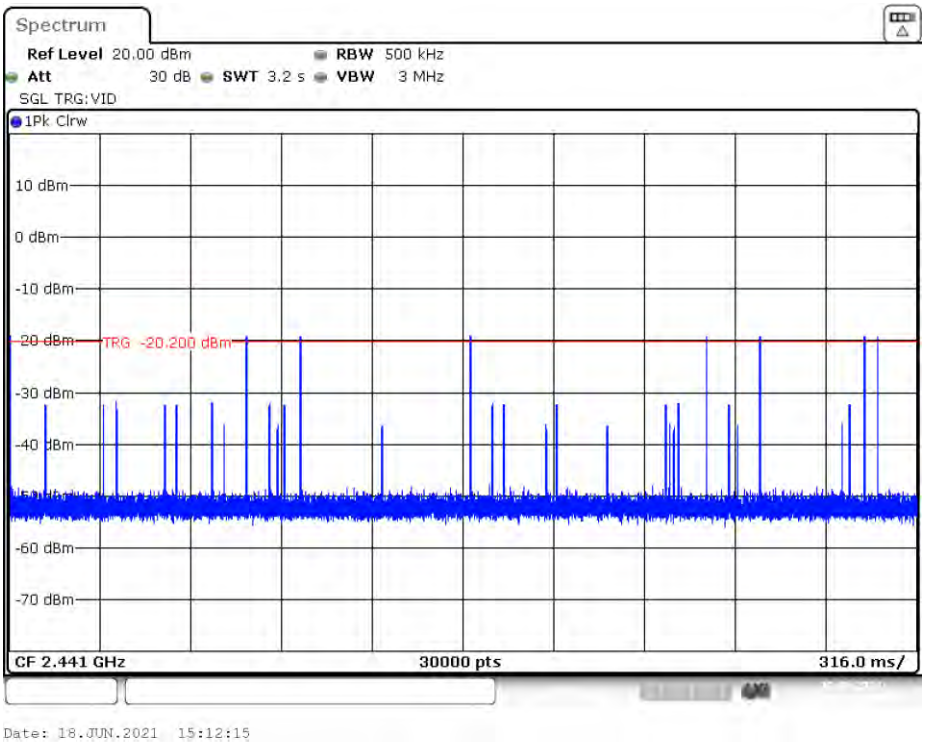
Date: 18.JUN.2021 15:08:50



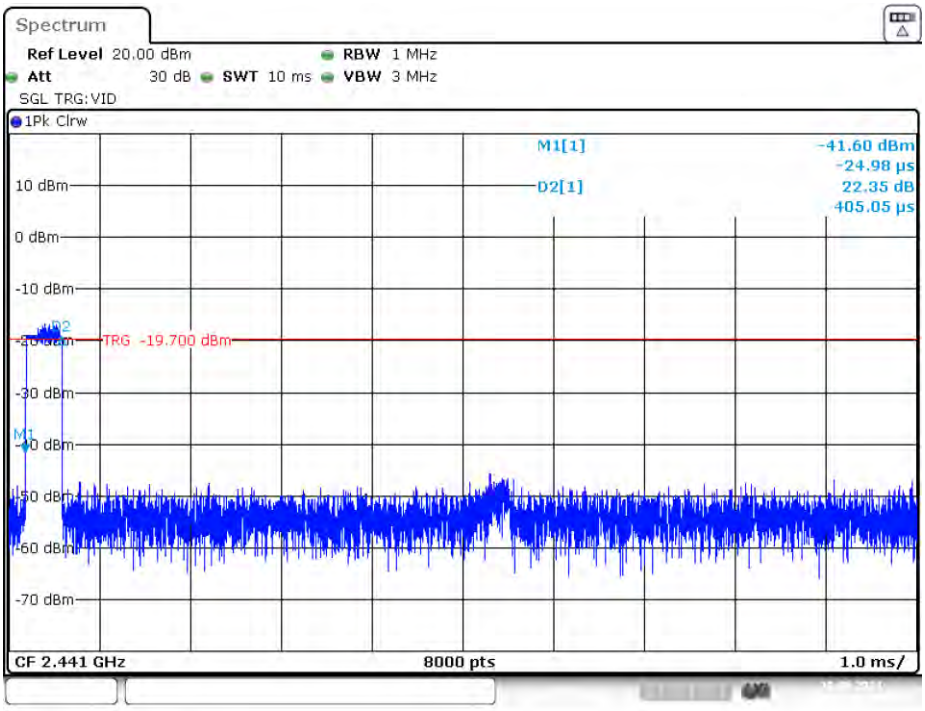
Date: 18.JUN.2021 15:08:55

2DH5_Ant1_Hop

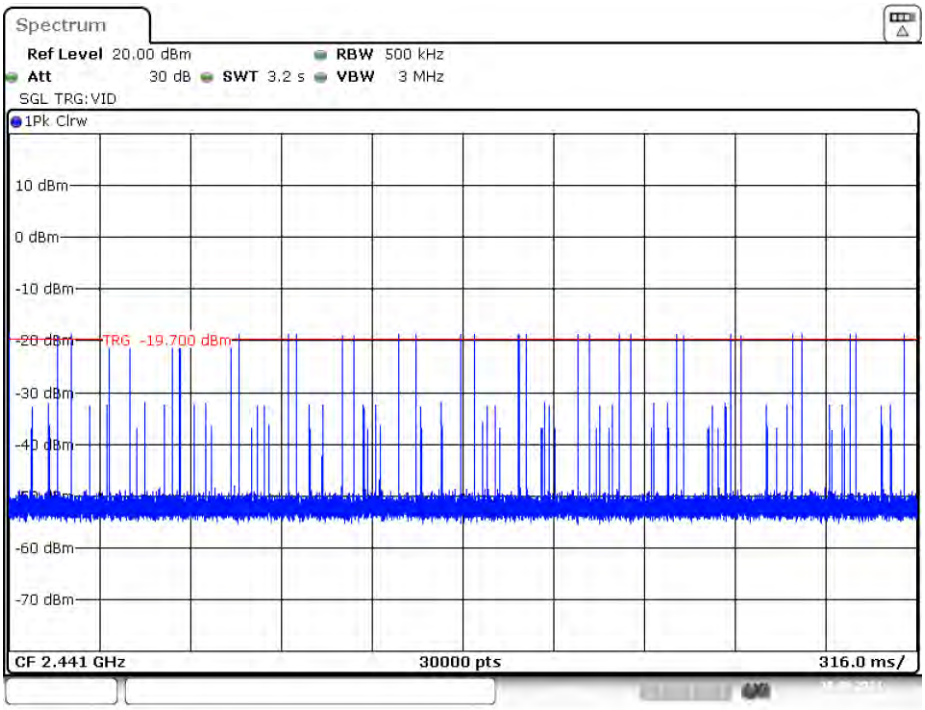




3DH1_Ant1_Hop

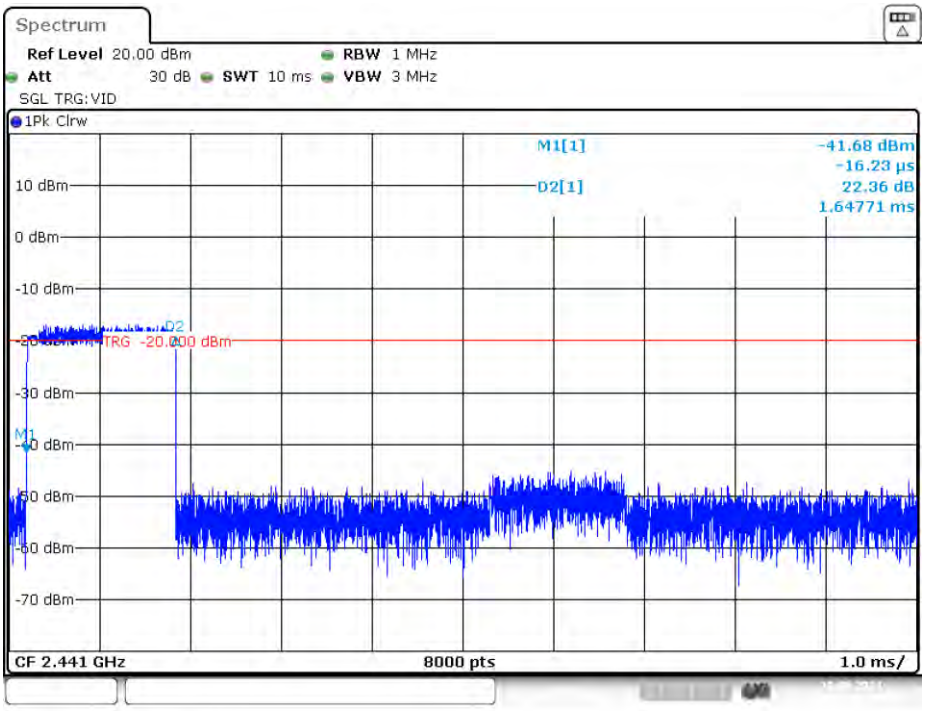


Date: 18.JUN.2021 15:18:49



Date: 18.JUN.2021 15:18:54

3DH3_Ant1_Hop



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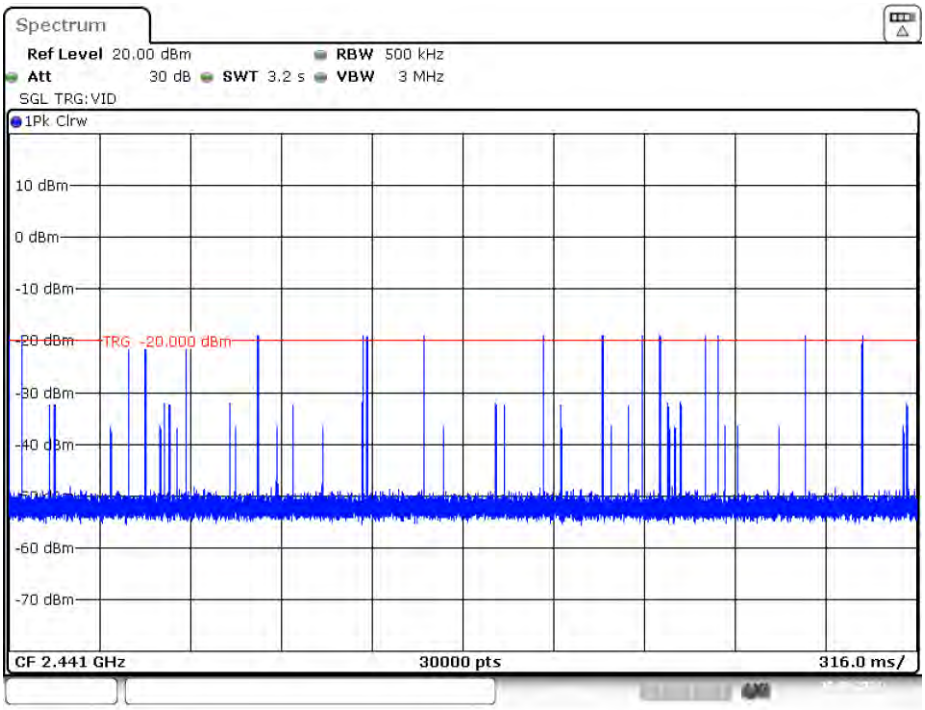
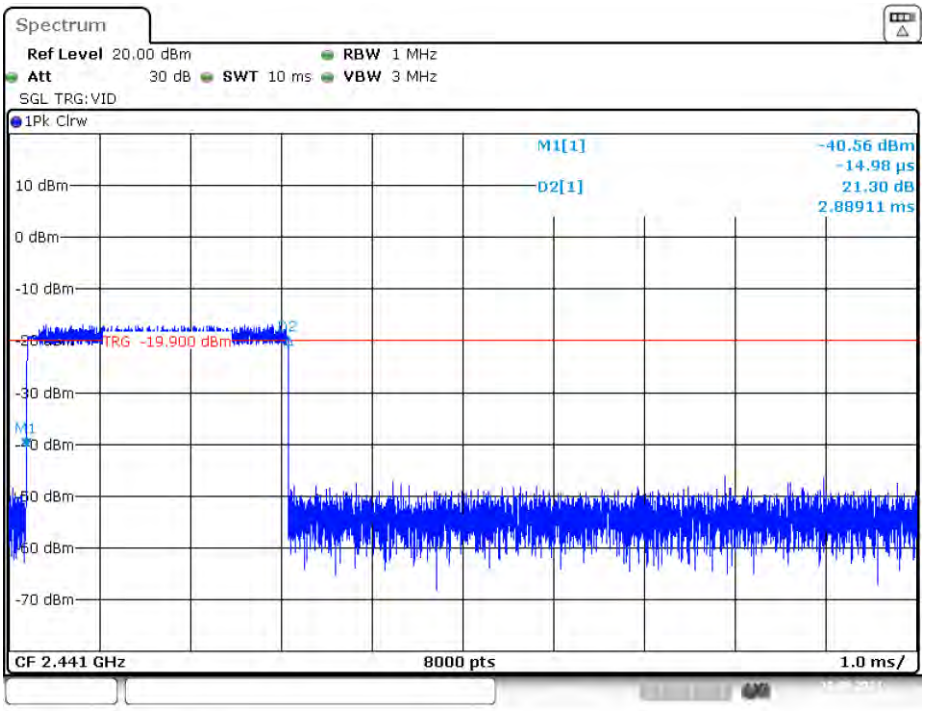


Date: 18.JUN.2021 15:20:33

3DH5_Ant1_Hop



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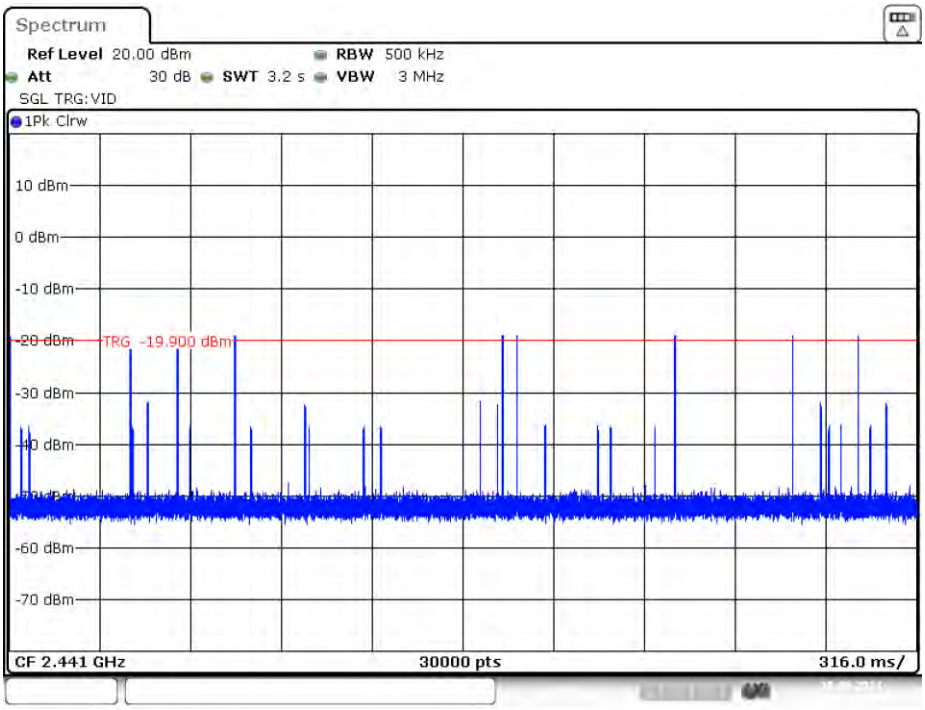

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FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to §15.247(b) (1), 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. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

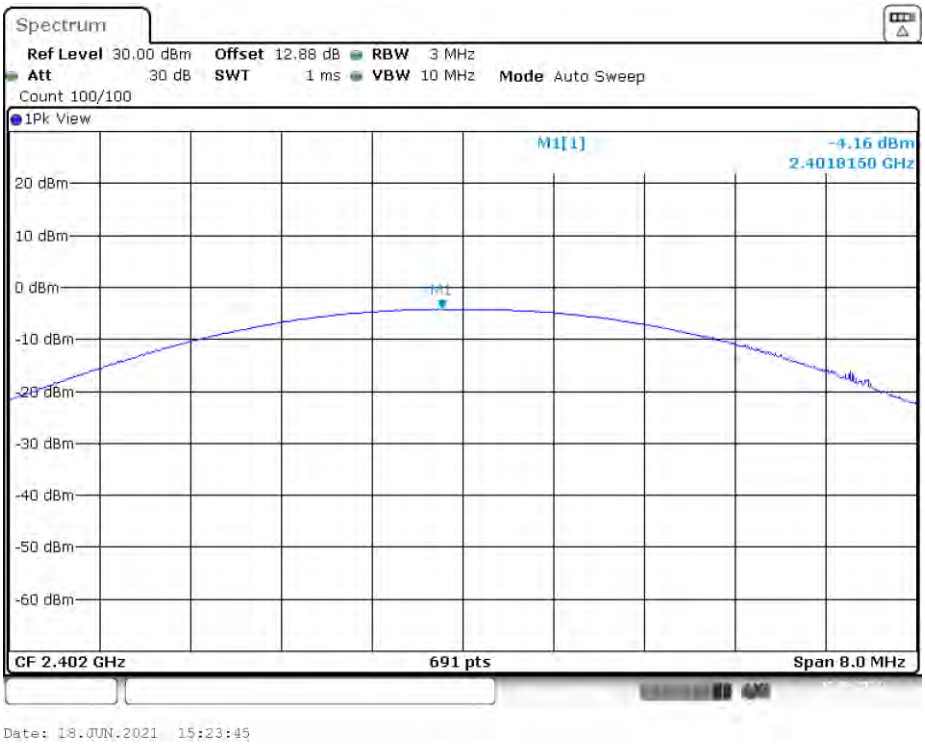
The testing was performed by Ting on 2021-06-18.

EUT operation mode: Transmitting

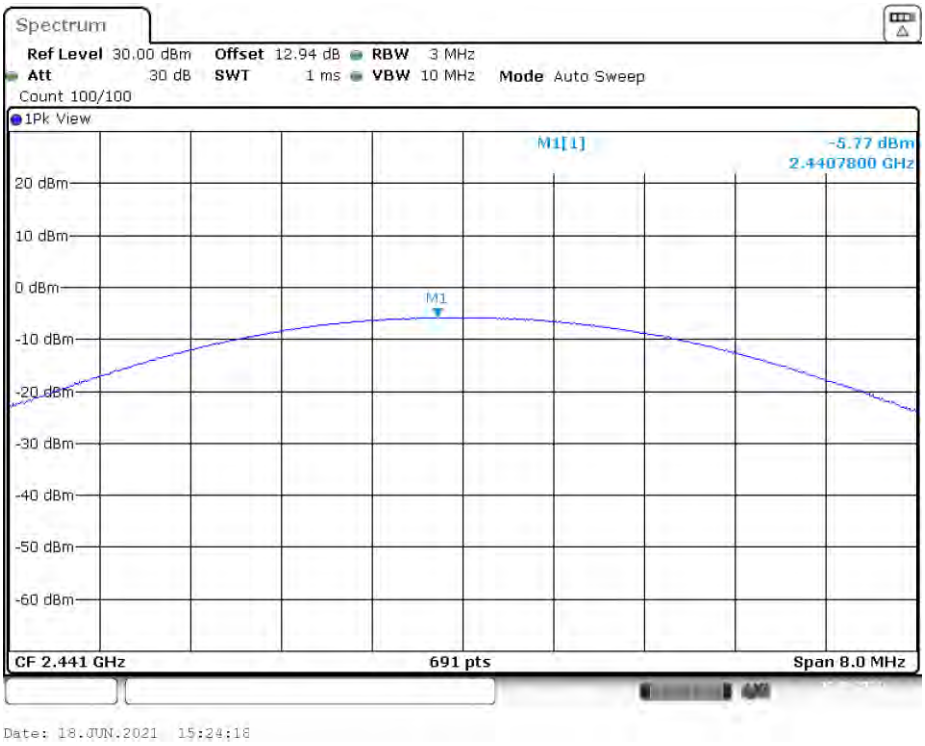
Test Result: Compliant.

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH1	Ant1	2402	-4.16	<=20.97	PASS
		2441	-5.77	<=20.97	PASS
		2480	-7.45	<=20.97	PASS
2DH1	Ant1	2402	-1.89	<=20.97	PASS
		2441	-3.62	<=20.97	PASS
		2480	-5.29	<=20.97	PASS
3DH1	Ant1	2402	-1.38	<=20.97	PASS
		2441	-3.07	<=20.97	PASS
		2480	-4.76	<=20.97	PASS

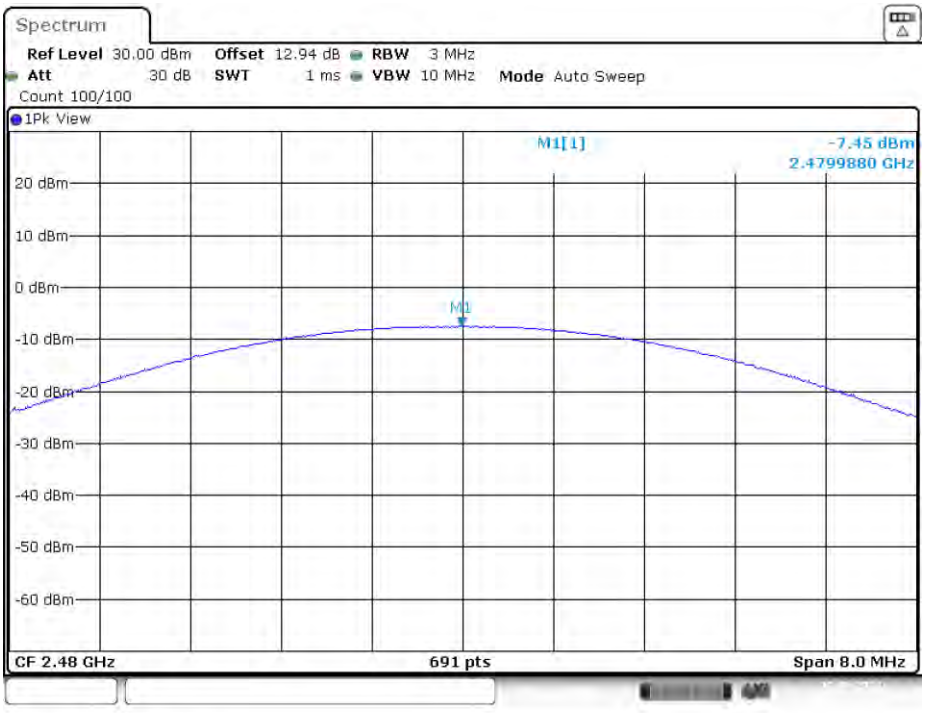
DH1_Ant1_2402MHz



DH1_Ant1_2441MHz



DH1_Ant1_2480MHz



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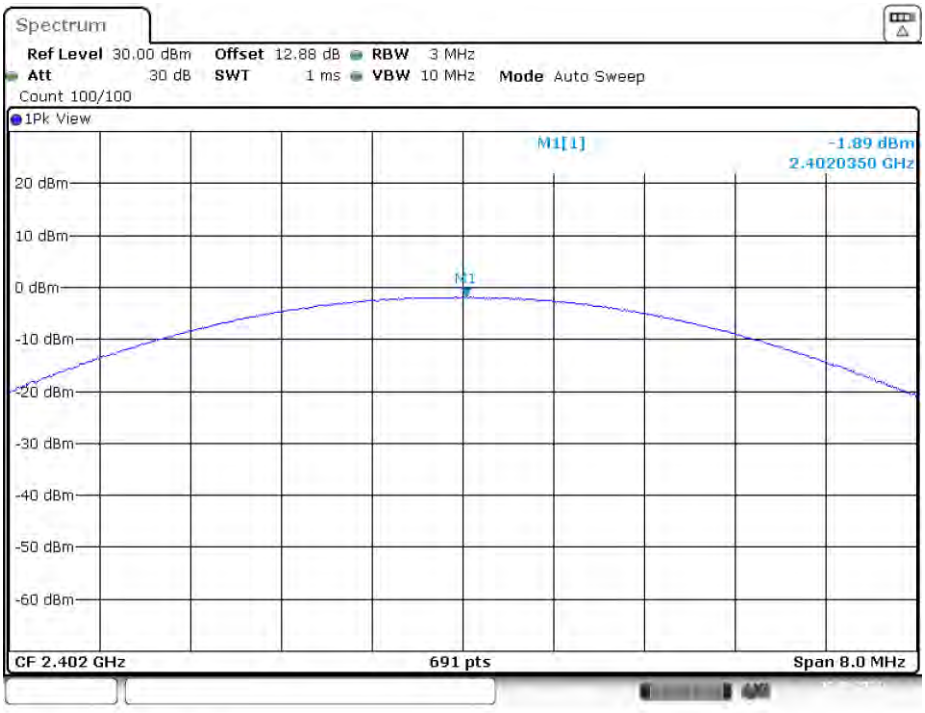
2DH1_Ant1_2402MHz



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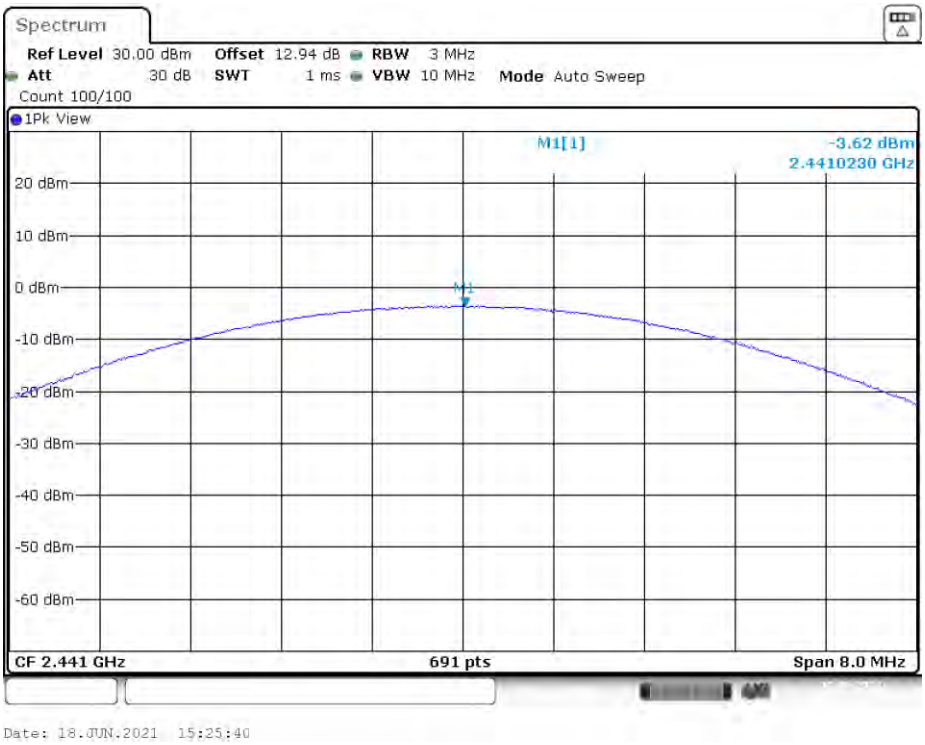
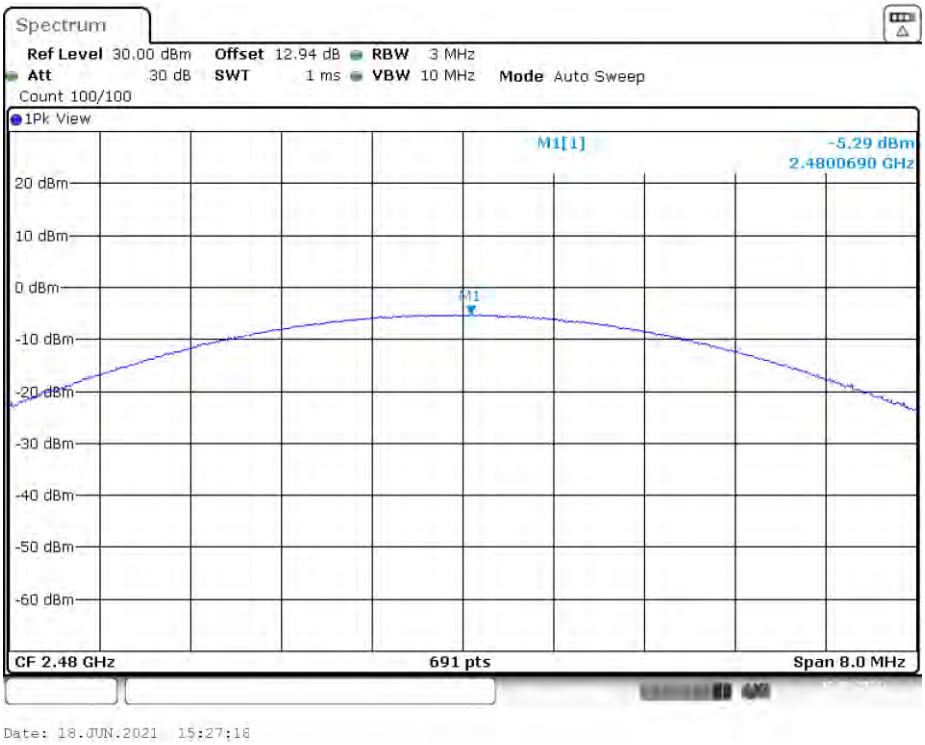
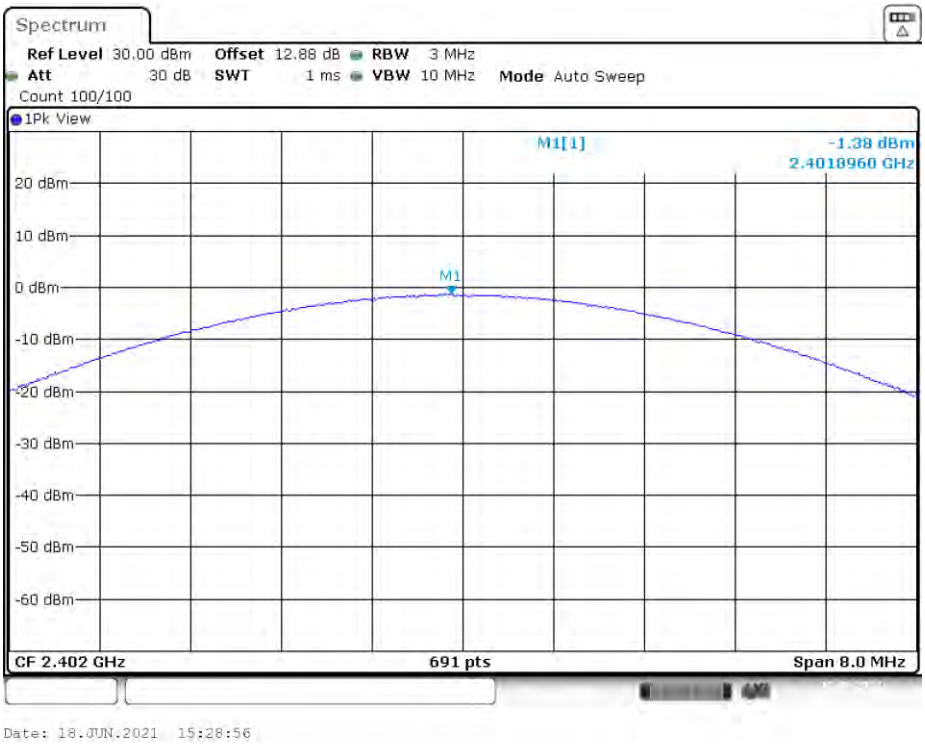
2DH1_Ant1_2441MHz



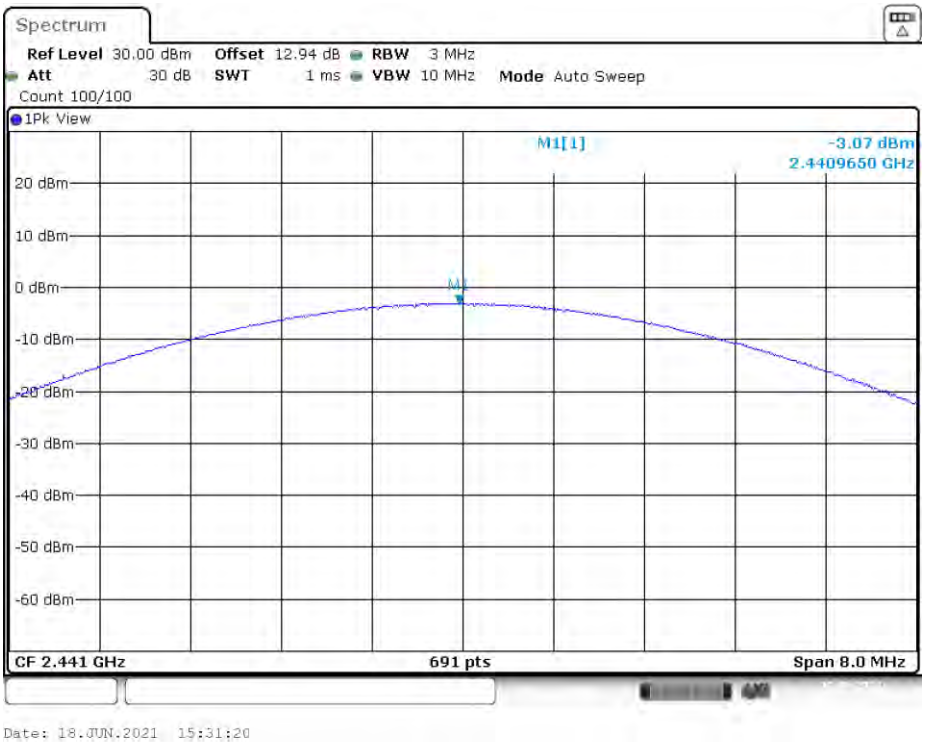
2DH1_Ant1_2480MHz



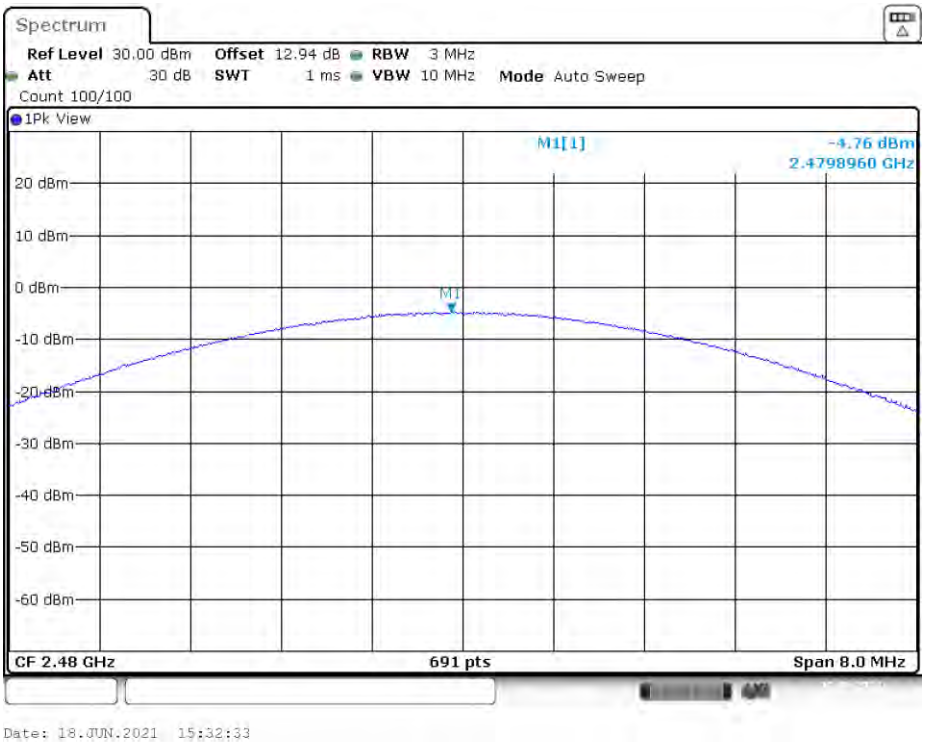
3DH1_Ant1_2402MHz



3DH1_Ant1_2441MHz



3DH1_Ant1_2480MHz



FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

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)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

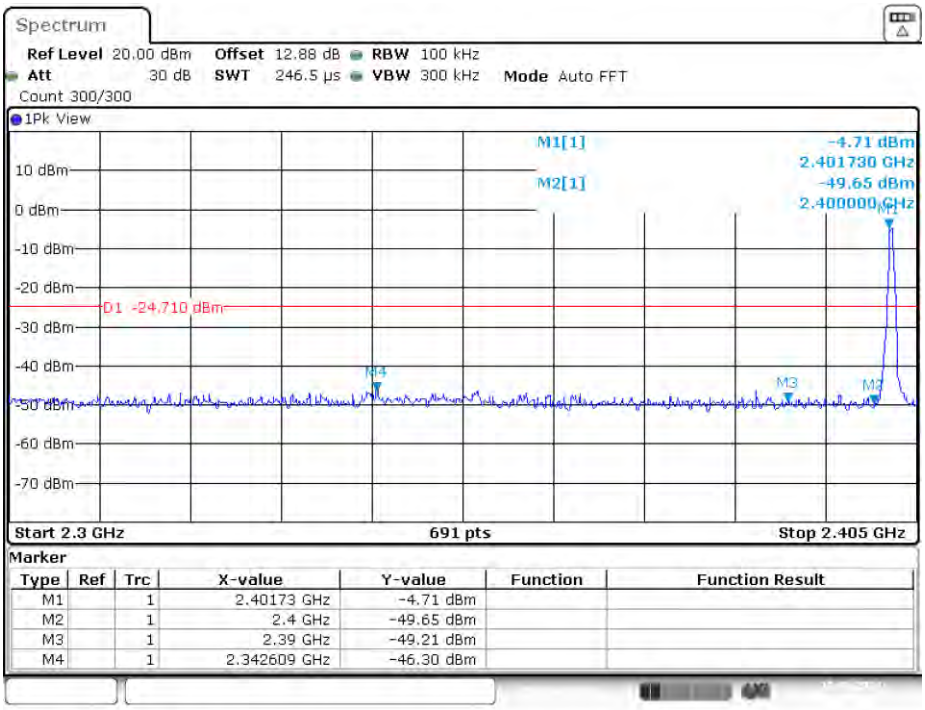
The testing was performed by Ting on 2021-06-18.

EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

DH1_Ant1_Low_2402MHz



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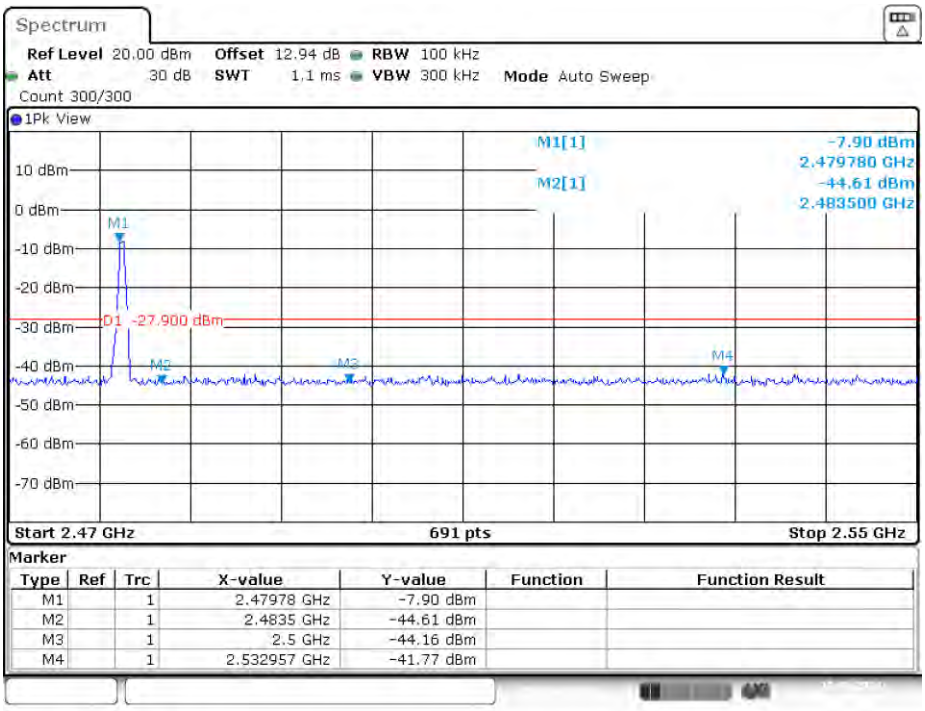
DH1_Ant1_High_2480MHz



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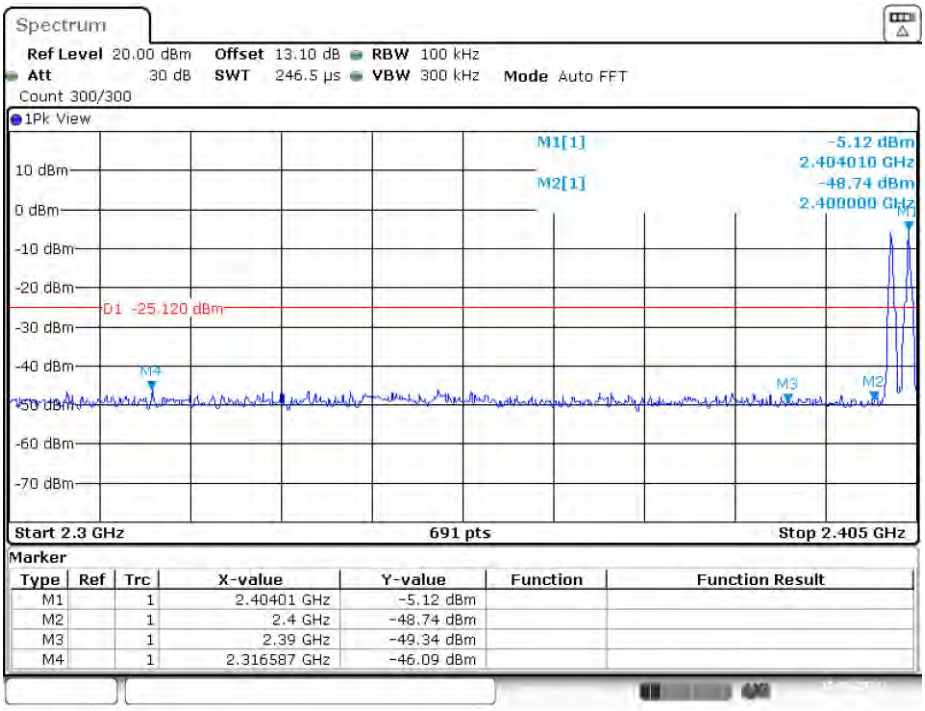
DH1_Ant1_Low_Hop_2402MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40401 GHz	-5.12 dBm		
M2		1	2.4 GHz	-48.74 dBm		
M3		1	2.39 GHz	-49.34 dBm		
M4		1	2.316587 GHz	-46.09 dBm		

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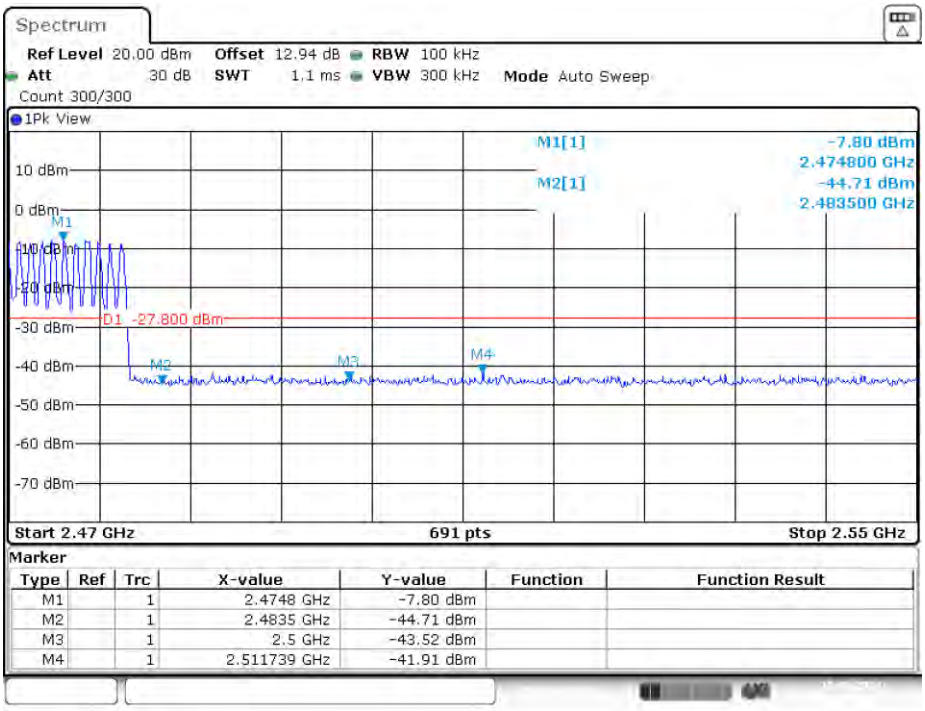
DH1_Ant1_High_Hop_2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4748 GHz	-7.80 dBm		
M2		1	2.4835 GHz	-44.71 dBm		
M3		1	2.5 GHz	-43.52 dBm		
M4		1	2.511739 GHz	-41.91 dBm		

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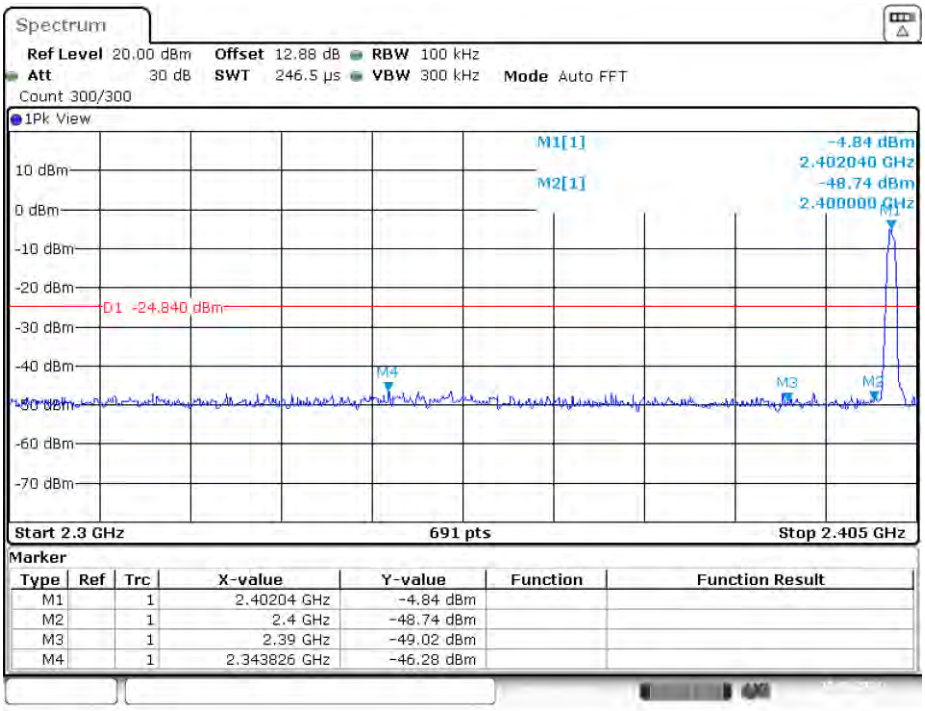
2DH1_Ant1_Low_2402MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40204 GHz	-4.84 dBm		
M2		1	2.4 GHz	-48.74 dBm		
M3		1	2.39 GHz	-49.02 dBm		
M4		1	2.343826 GHz	-46.28 dBm		

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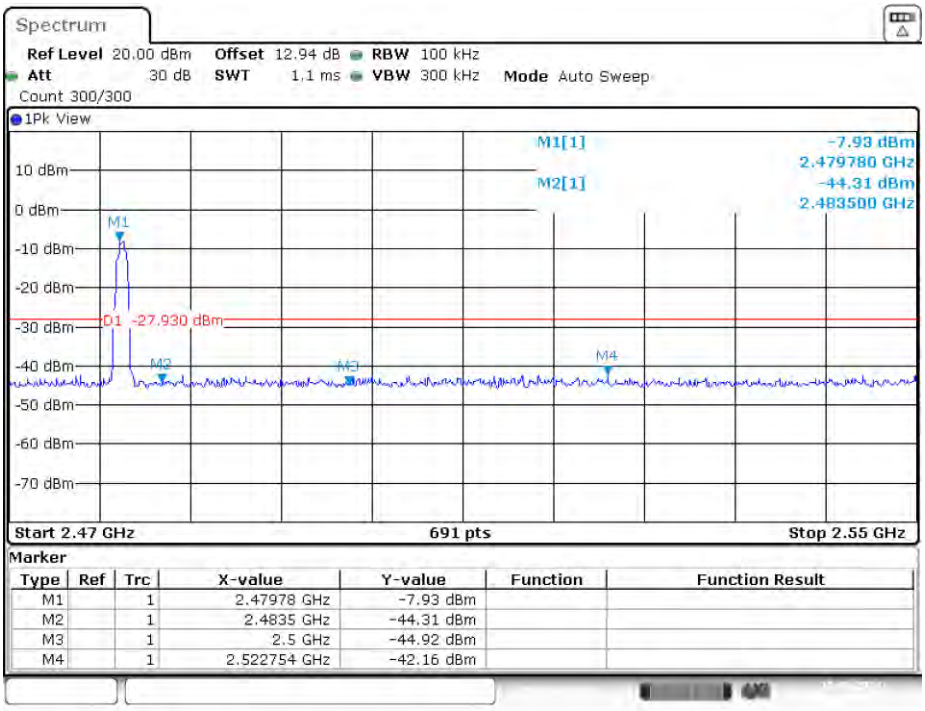
2DH1_Ant1_High_2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47978 GHz	-7.93 dBm		
M2		1	2.4835 GHz	-44.31 dBm		
M3		1	2.5 GHz	-44.92 dBm		
M4		1	2.522754 GHz	-42.16 dBm		

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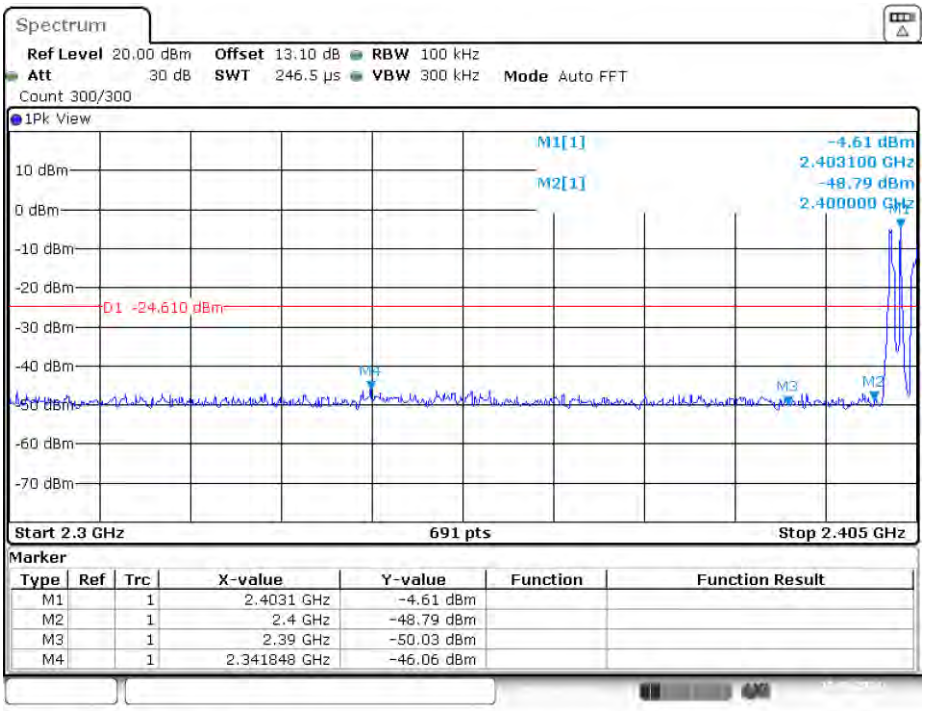
2DH1_Ant1_Low_Hop_2402MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4031 GHz	-4.61 dBm		
M2		1	2.4 GHz	-48.79 dBm		
M3		1	2.39 GHz	-50.03 dBm		
M4		1	2.341848 GHz	-46.06 dBm		

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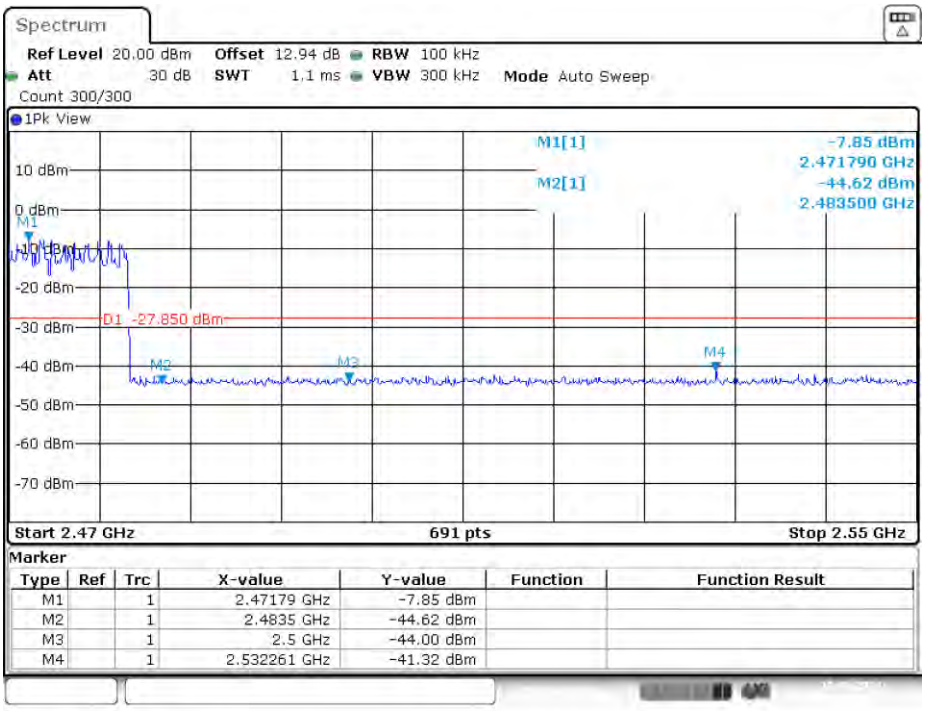
2DH1_Ant1_High_Hop_2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47179 GHz	-7.85 dBm		
M2		1	2.4835 GHz	-44.62 dBm		
M3		1	2.5 GHz	-44.00 dBm		
M4		1	2.532261 GHz	-41.32 dBm		

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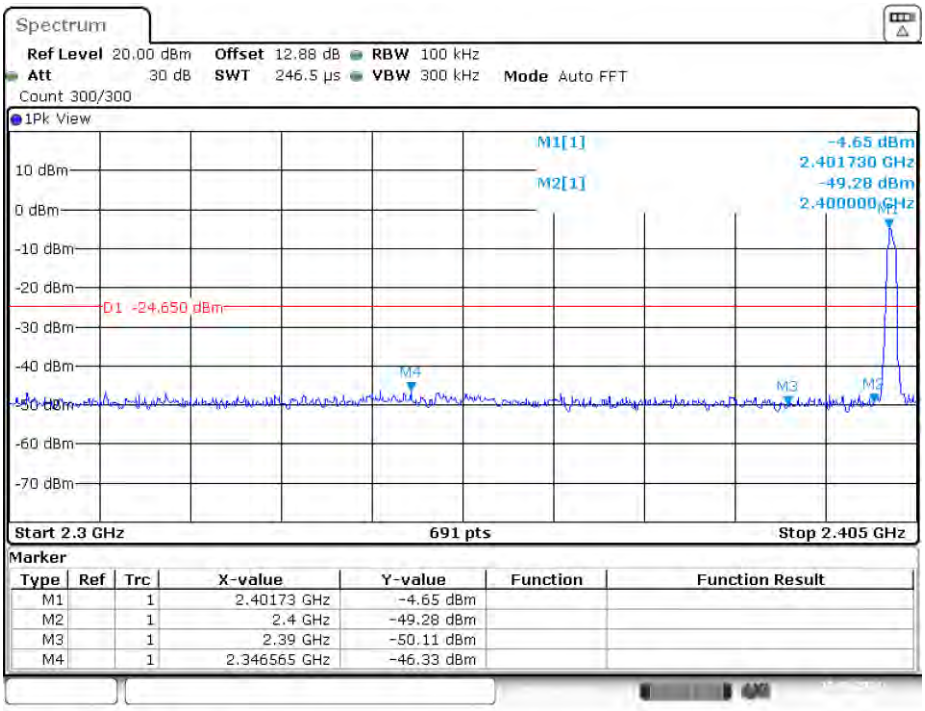
3DH1_Ant1_Low_2402MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40173 GHz	-4.65 dBm		
M2		1	2.4 GHz	-49.28 dBm		
M3		1	2.39 GHz	-50.11 dBm		
M4		1	2.346565 GHz	-46.33 dBm		

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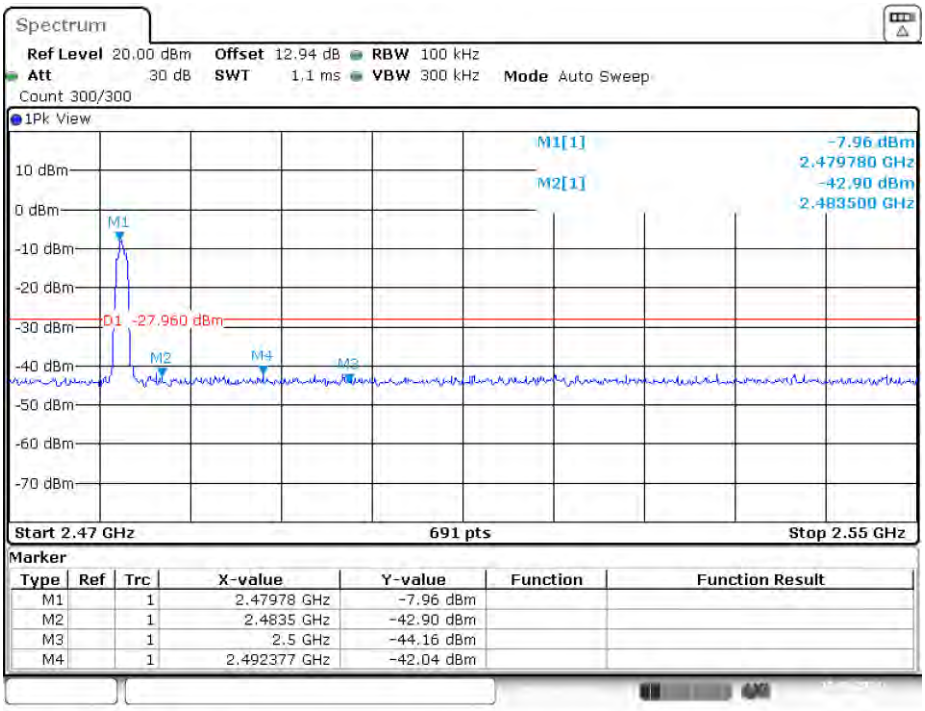
3DH1_Ant1_High_2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47978 GHz	-7.96 dBm		
M2		1	2.4835 GHz	-42.90 dBm		
M3		1	2.5 GHz	-44.16 dBm		
M4		1	2.492377 GHz	-42.04 dBm		

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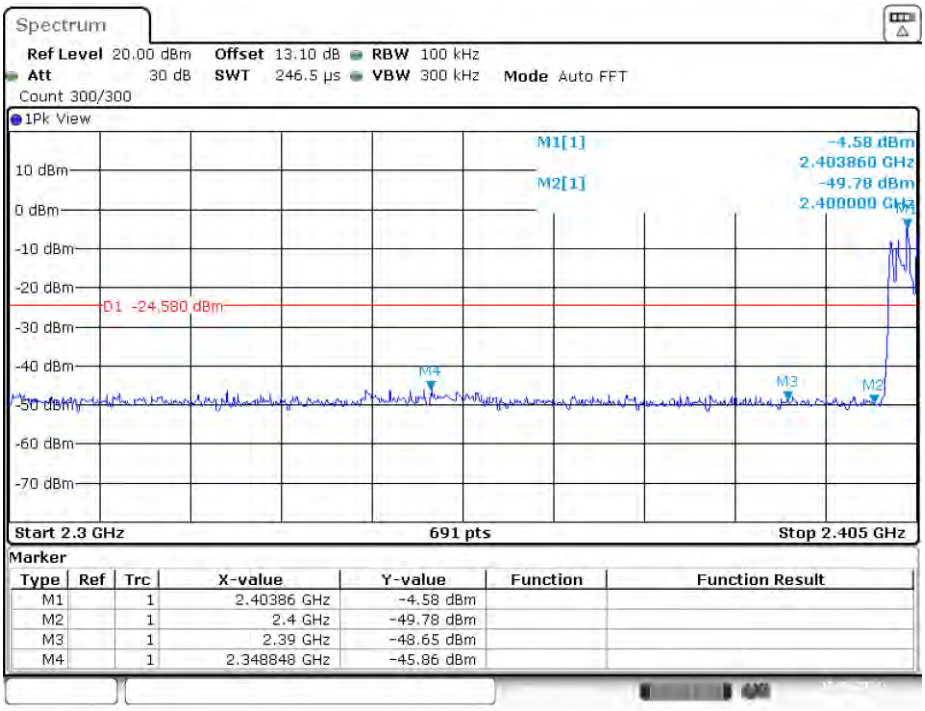
3DH1_Ant1_Low_Hop_2402MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40386 GHz	-4.58 dBm		
M2		1	2.4 GHz	-49.78 dBm		
M3		1	2.39 GHz	-48.65 dBm		
M4		1	2.348848 GHz	-45.86 dBm		

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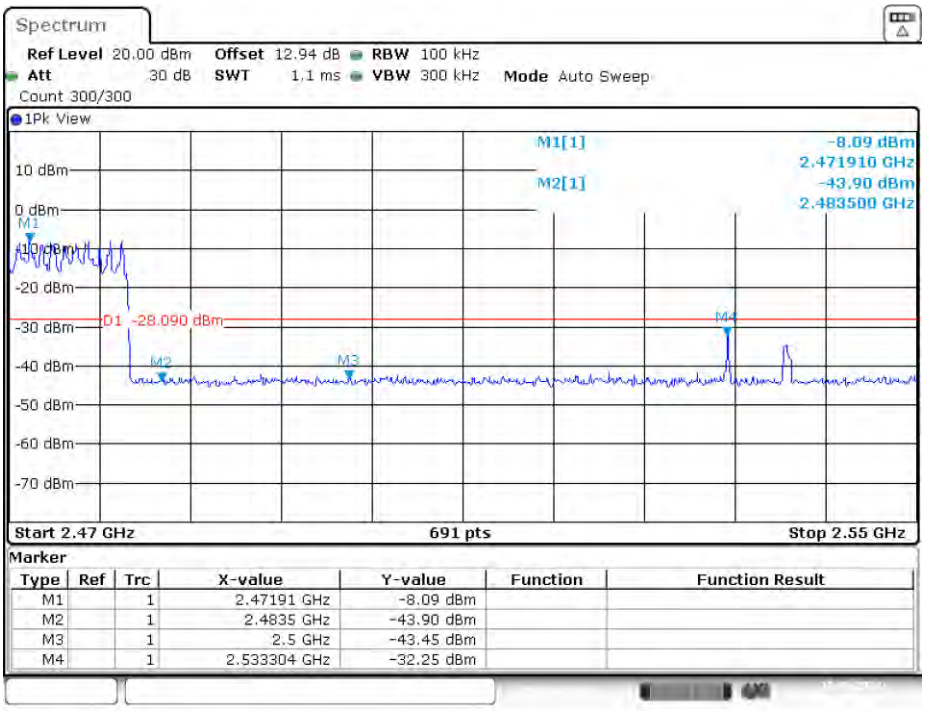
3DH1_Ant1_High_Hop_2480MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47191 GHz	-8.09 dBm		
M2		1	2.4835 GHz	-43.90 dBm		
M3		1	2.5 GHz	-43.45 dBm		
M4		1	2.533304 GHz	-32.25 dBm		

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******* END OF REPORT *******