TEST REPORT

Applicant Name :	YEALINK(XIAMEN) NETWORK TECHNOLOGY CO.,LTD.
Address :	FCC: 309, 3rd Floor, No.16, Yun Ding North Road, Huli District, Xiamen City, Fujian, China ISEDC: 309, 3rd Floor, No.16, Yun Ding North Road, Huli District Xiamen City Fujian 361008 China (Peoples Republic Of)
Report Number :	SZNS220511-19727E-RFA
FCC ID:	T2C-YL43752
IC:	10741A-YL43752

Test Standard (s)

FCC PART 15.247; RSS-GEN ISSUE 5, FEBRUARY 2021 AMENDMENT 2; RSS-247, ISSUE 2, FEBRUARY 2017

Sample Description

Product Type:	Wireless LAN &Bluetooth Stamp Module
Model No.:	YL43752
Multiple Model(s) No.:	N/A
Trade Mark:	Yealink
Date Received:	2022/05/11
Report Date:	2022/09/23
Test Result:	Pass*

* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Audy Yu
EMC Engineer

Approved By:

Candy Li
EMC Engineer

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

HVIN	YL43752
FVIN	270.352.252.205
Frequency Range	Bluetooth: 2402~2480MHz
Transmit Peak Power	7.90dBm
Modulation Technique	Bluetooth: GFSK, π/4-DQPSK, 8DPSK
Antenna Specification*	FPC antenna : 3.30dBi ; Iron antenna: 3.32dBi; PCB antenna: 2.61dBi (It is provided by the applicant)
Voltage Range	DC 3.3V
Sample serial number	SZNS220511-19727E-RF-S1for Conducted and Radiated Emissions SZNS220511-19727E-RF-S2 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition

Note: Three types of antenna was used for EUT test, detail please refer to EUT photo.

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules and RSS-247, Issue 2, February 2017, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada 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 and RSS-247, Issue 2, February 2017, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada rules.

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.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		$0.082*10^{-7}$
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz- 40GHz	4.72dB
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 4297.01

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. The Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

"AuthenticTool"* exercise software was made to the EUT tested and the power level is Default*.The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

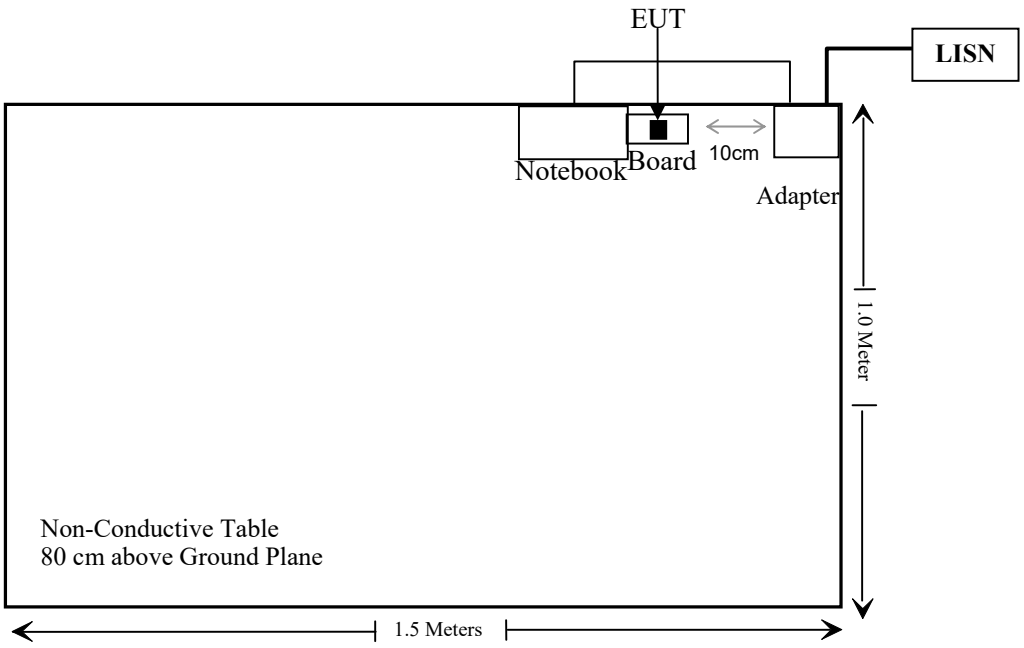
Manufacturer	Description	Model	Serial Number
DELL	Note Book	Latitude E4710	PC201911252059
DELL	Adapter	42T4416	11S42T4416Z 1Z
YEALINK	Board	Unknown	Unknown

External I/O Cable

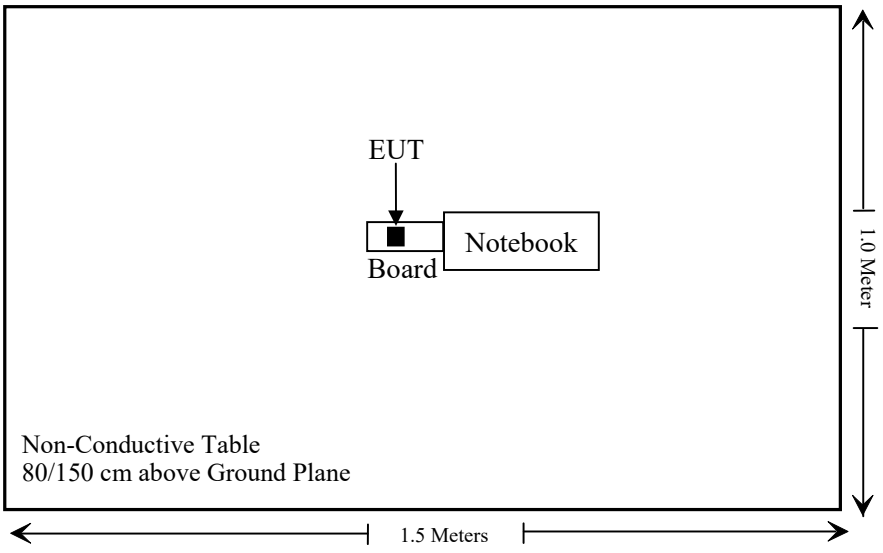
Cable Description	Length (m)	From Port	To
Un-shielded detachable AC cable	1.5	Adapter	LISN
Un-shielded Un-detachable DC cable	2.5	Adapter	NoteBook

Block Diagram of Test Setup

For conducted emission:



For Radiated Emissions:



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (3) & §2.1093	Maximum Permissible Exposure (MPE)	Compliant
RSS-102 § 4	RF Exposure Limit	Compliant
FCC §15.203 RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207(a) RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §15.205, §15.209, §15.247(d) RSS-247 § 5.5, RSS-GEN § 8.10	Radiated Emissions	Compliant
FCC §15.247(a)(1) RSS-247 § 5.1(a), RSS-GEN § 6.7	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliant
FCC §15.247(a)(1) RSS-247 § 5.1 (b)	Channel Separation Test	Compliant
FCC §15.247(a)(1)(iii) RSS-247 § 5.1 (d)	Time of Occupancy (Dwell Time)	Compliant
FCC §15.247(a)(1)(iii) RSS-247 § 5.1 (d)	Quantity of hopping channel Test	Compliant
FCC §15.247(b)(1) RSS-247 § 5.1(b) &§ 5.4(b)	Peak Output Power Measurement	Compliant
FCC §15.247(d) RSS-247 § 5.5	Band edges	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	EMI Test Receiver	ESCI	100784	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.11	N1000	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.15	N600	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.16	N650	2021/12/14	2022/12/13
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101590	2022/01/19	2023/01/18
Tonscend	RF Control Unit	JS0806-2	19G8060182	2021/10/26	2022/10/25
Unknown	RF Coaxial Cable	Unknown	1	Each time	/

*** 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) (3) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

According to KDB 447498 D04 Interim General RF Exposure Guidance

MPE-Based Exemption:

General frequency and separation-distance dependent MPE-based effective radiated power(ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemptionfrom further evaluation from 300 kHz through 100 GHz.

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 R^2f.
1,500-100,000	19.2R^2.

Ris the minimum separation distance in meters
f = frequency in MHz

For multiple RF sources: Multiple RF sources are exempt if:

in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation:

$$\sum_{i=1}^{a}\frac{P_i}{P_{th,i}}+\sum_{j=1}^{b}\frac{ERP_j}{ERP_{th,j}}+\sum_{k=1}^{c}\frac{Evaluated_k}{Exposure\ Limit_k}\leq 1$$

Result

For worst case：

Mode	Frequency (MHz)	Tune up conducted power	Antenna Gain		ERP		Evaluation Distance (m)	ERP Limit (W)
		(dBm)	(dBi)	(dBd)	(dBm)	(W)		
BT	2402-2480	8.5	3.32	1.17	9.67	0.009	0.2	0.768
BLE	2402-2480	8.0	3.32	1.17	9.17	0.008	0.2	0.768
2.4G Wi-Fi	2412-2462	18.5	3.32	1.17	19.67	0.093	0.2	0.768
5G Wi-Fi	5180-5240	12.0	4.18	2.03	14.03	0.025	0.2	0.768
	5260-5280	13.0	4.18	2.03	15.03	0.032	0.2	0.768
	5500-5700	12.0	4.18	2.03	14.03	0.025	0.2	0.768
	5745-5825	14.5	4.18	2.03	16.53	0.045	0.2	0.768

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
2. The BT can transmit at the same time with the Wi-Fi, the 2.4G Wi-Fi and 5G Wi-Fi cannot Simultaneous transmitting

Simultaneous transmitting consideration (worst case):

The ratio=ERP_{BT}/limit+ERP_{Wi-Fi}/limit=0.009/0.768+0.093/0.768=0.133＜1.0, so simultaneous exposure is compliant.

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliant.

RSS-102 § 4 –EXPOSURE LIMITS

Applicable Standard

According to RSS-102 §4:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ $f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ $f^{0.25}$	0.1540/ $f^{0.25}$	8.944/ $f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/$f^{1.2}$

Note: f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \le 1$$

Mode	Frequency (MHz)	Antenna Gain		Max Tune Up Conducted Power		Evaluation Distance (m)	Power Density (W/m^2)	MPE Limit (W/m^2)
		(dBi)	(numeric)	(dBm)	(W)			
BT	2402-2480	3.32	2.15	8.5	0.007	0.2	0.030	5.351
BLE	2402-2480	3.32	2.15	8.0	0.006	0.2	0.026	5.351
2.4G Wi-Fi	2412-2462	3.32	2.15	18.5	0.071	0.2	0.304	5.366
5G Wi-Fi	5150-5250	4.18	2.62	12.0	0.016	0.2	0.083	9.011
5G Wi-Fi	5250-5350	4.18	2.62	13.0	0.020	0.2	0.104	9.130
5G Wi-Fi	5470-5725	4.18	2.62	12.0	0.016	0.2	0.083	9.390
5G Wi-Fi	5725-5850	4.18	2.62	14.5	0.028	0.2	0.146	9.687

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
2. The BT can transmit at the same time with the Wi-Fi, the 2.4G Wi-Fi and 5G Wi-Fi cannot Simultaneous transmitting

Simultaneous transmitting consideration (worst case):

The ratio=MPE_{BT}/limit+$MPE_{Wi\text{-}Fi}$/limit=0.030/5.351+0.304/5.366=0.062＜1.0

To maintain Compliant with the ISEDC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Pass

FCC §15.203 & RSS-GEN §6.8 – 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.

According to FCC § 15.203, the applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.
Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

Antenna Connector Construction

The EUT has been test using three types of antenna, please refer to the EUT photos.

No.	Antenna Type	Antenna Gain	Impedance	Frequency Range
1	FPC	3.30dBi	50 Ω	2.4~2.5GHz
2	Iron	3.32dBi	50 Ω	2.4~2.5GHz
3	PCB	2.61dBi	50 Ω	2.4~2.5GHz

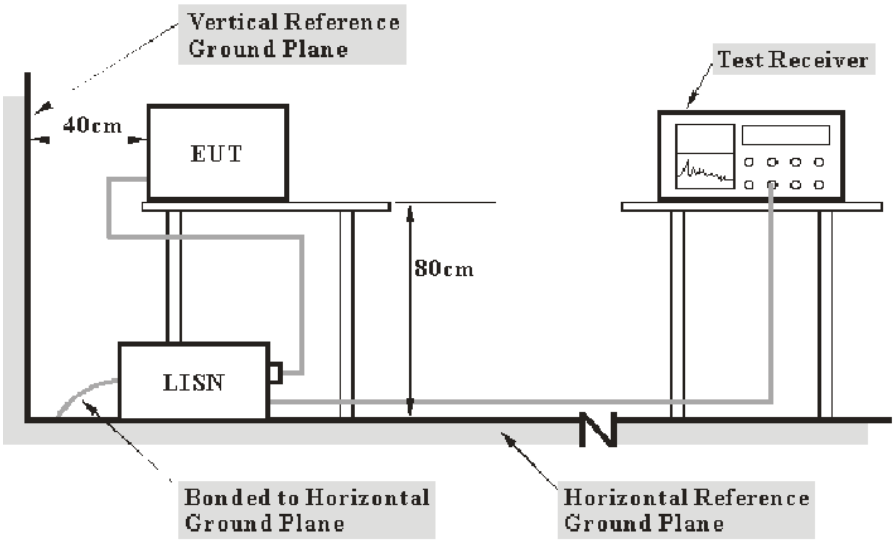
Result: Compliance

FCC §15.207 (a) & RSS-GEN § 8.8 – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a), RSS-GEN § 8.8

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 & RSS-Gen.

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

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) and Cable Loss. The basic equation is as follows:

Transd Factor = LISN VDF + Cable Loss

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

Over limit = Level - Limit
Level= Reading level+ Transd Factor

Test Data

Environmental Conditions

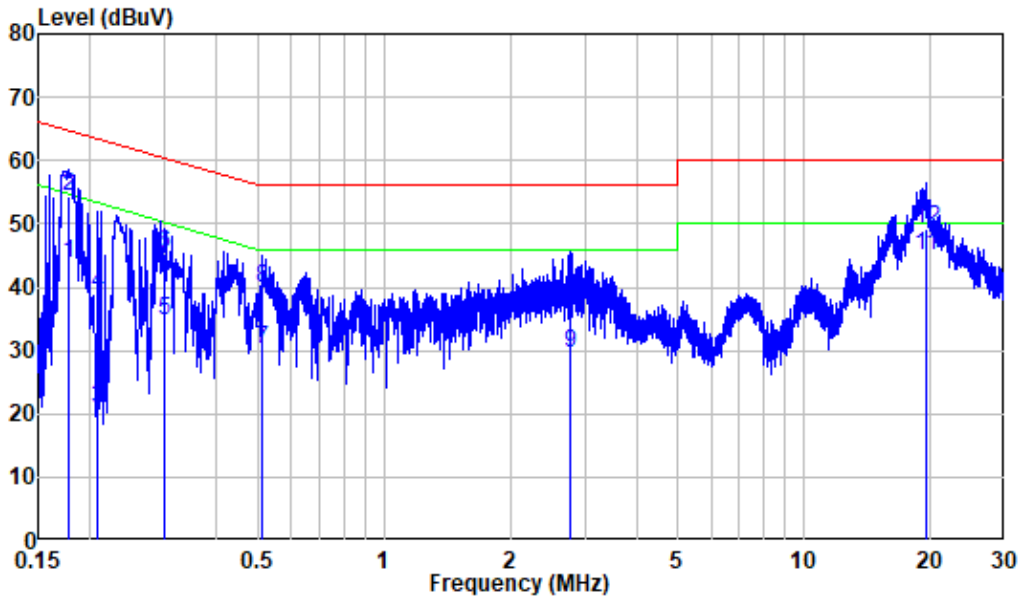
Temperature:	25 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Jason liu on 2022-08-08.

EUT operation mode: Transmitting (worst case is 8DPSK, low channel)

For FPC Antenna:

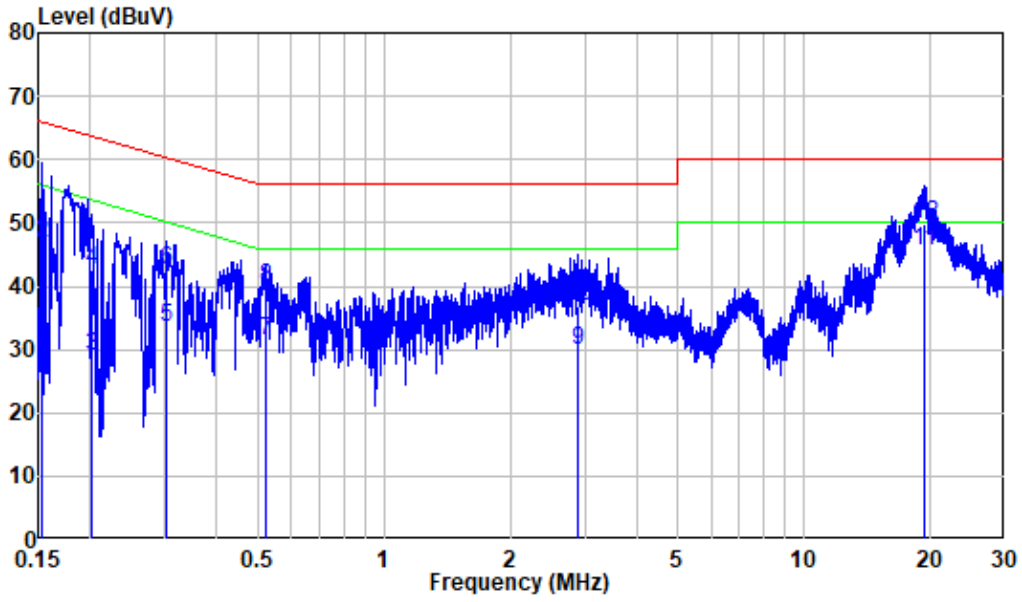
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Mode : BT
Model : YL43752
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.178	9.80	33.98	43.78	54.60	-10.82	Average
2	0.178	9.80	44.61	54.41	64.60	-10.19	QP
3	0.209	9.80	11.06	20.86	53.26	-32.40	Average
4	0.209	9.80	29.23	39.03	63.26	-24.23	QP
5	0.300	9.80	25.04	34.84	50.24	-15.40	Average
6	0.300	9.80	35.37	45.17	60.24	-15.07	QP
7	0.513	9.81	20.47	30.28	46.00	-15.72	Average
8	0.513	9.81	29.98	39.79	56.00	-16.21	QP
9	2.759	9.83	19.72	29.55	46.00	-16.45	Average
10	2.759	9.83	26.82	36.65	56.00	-19.35	QP
11	19.519	10.00	35.05	45.05	50.00	-4.95	Average
12	19.519	10.00	39.18	49.18	60.00	-10.82	QP

AC 120V/60 Hz, Neutral

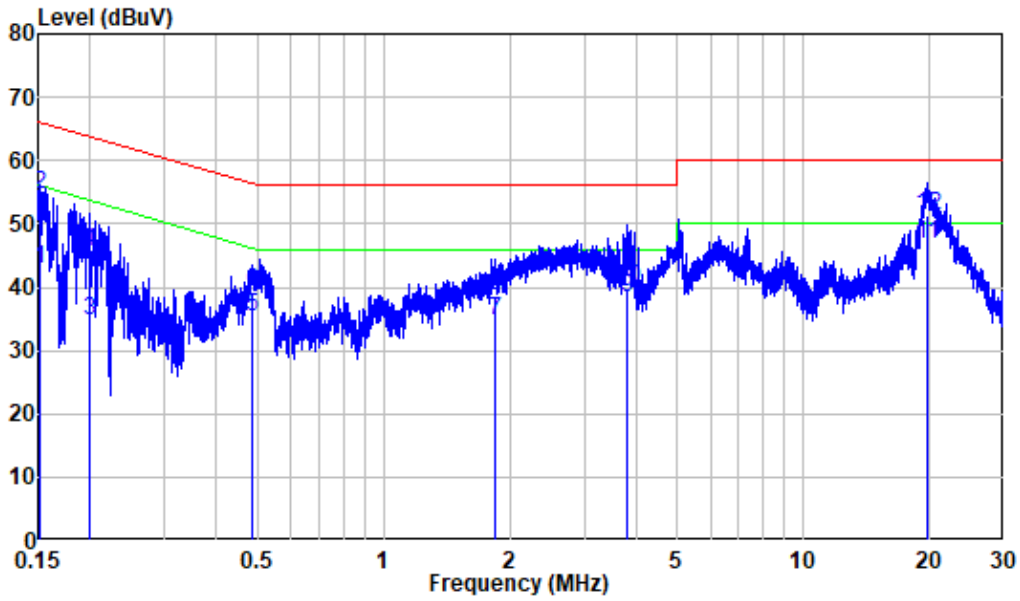


Site : Shielding Room
Condition: Neutral
Mode : BT
Model : YL43752
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.153	9.80	15.32	25.12	55.86	-30.74	Average
2	0.153	9.80	37.14	46.94	65.86	-18.92	QP
3	0.202	9.80	19.12	28.92	53.52	-24.60	Average
4	0.202	9.80	32.77	42.57	63.52	-20.95	QP
5	0.304	9.80	23.79	33.59	50.13	-16.54	Average
6	0.304	9.80	32.89	42.69	60.13	-17.44	QP
7	0.523	9.81	21.67	31.48	46.00	-14.52	Average
8	0.523	9.81	29.98	39.79	56.00	-16.21	QP
9	2.890	9.83	20.18	30.01	46.00	-15.99	Average
10	2.890	9.83	26.89	36.72	56.00	-19.28	QP
11	19.326	10.09	35.63	45.72	50.00	-4.28	Average
12	19.326	10.09	39.70	49.79	60.00	-10.21	QP

For iron Antenna:

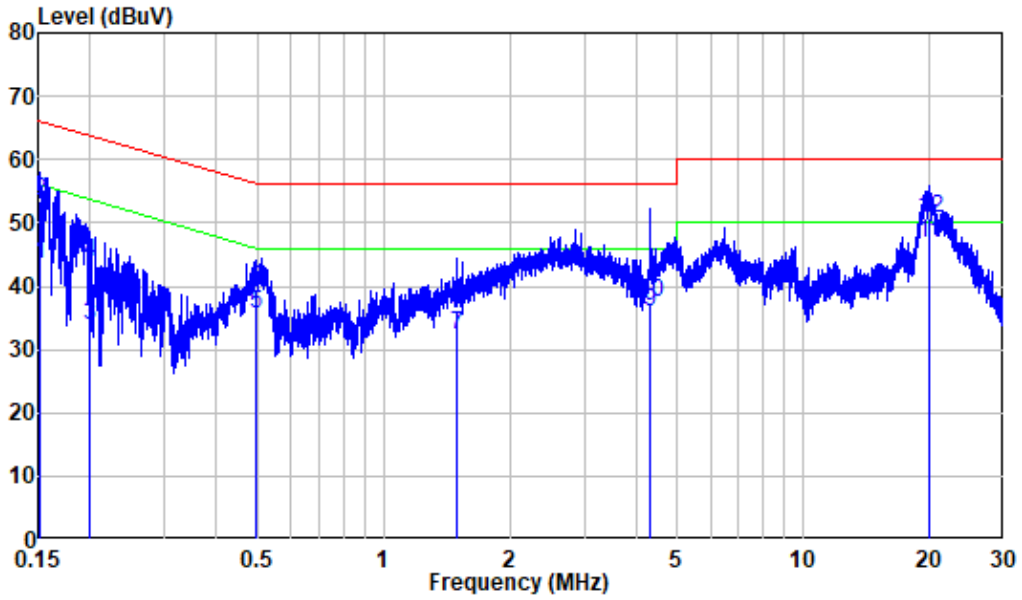
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Mode : BT
Model : YL43752
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.152	9.80	33.10	42.90	55.91	-13.01	Average
2	0.152	9.80	44.88	54.68	65.91	-11.23	QP
3	0.200	9.80	24.84	34.64	53.62	-18.98	Average
4	0.200	9.80	35.76	45.56	63.62	-18.06	QP
5	0.484	9.80	25.47	35.27	46.27	-11.00	Average
6	0.484	9.80	29.38	39.18	56.27	-17.09	QP
7	1.835	9.82	24.93	34.75	46.00	-11.25	Average
8	1.835	9.82	28.77	38.59	56.00	-17.41	QP
9	3.784	9.84	28.63	38.47	46.00	-7.53	Average
10	3.784	9.84	30.07	39.91	56.00	-16.09	QP
11	19.700	10.00	36.84	46.84	50.00	-3.16	Average
12	19.700	10.00	41.27	51.27	60.00	-8.73	QP

AC 120V/60 Hz, Neutral

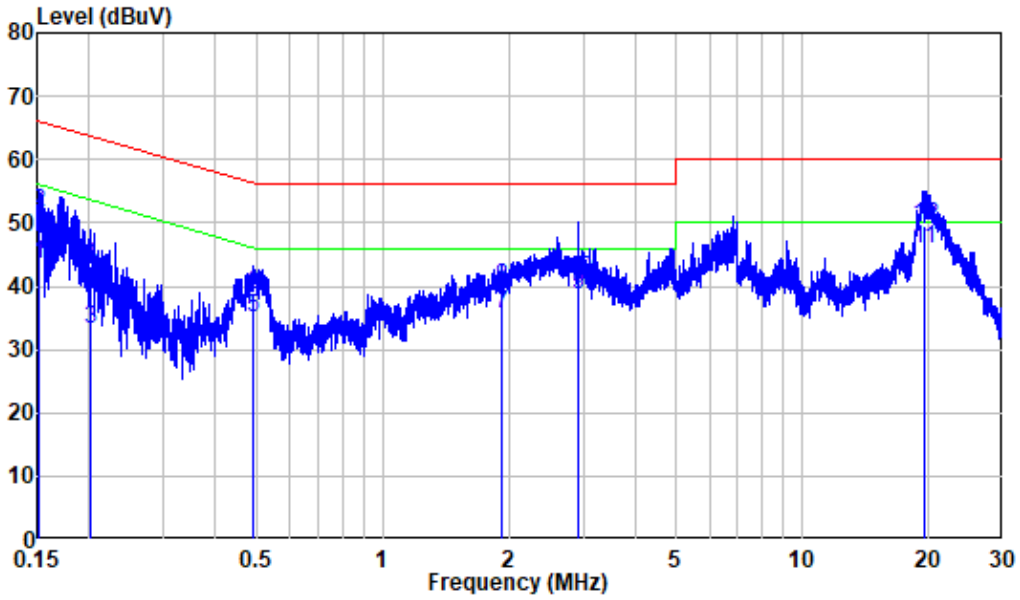


Site : Shielding Room
Condition: Neutral
Mode : BT
Model : YL43752
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.152	9.80	33.79	43.59	55.90	-12.31	Average
2	0.152	9.80	43.71	53.51	65.90	-12.39	QP
3	0.200	9.80	24.06	33.86	53.61	-19.75	Average
4	0.200	9.80	33.93	43.73	63.61	-19.88	QP
5	0.495	9.80	25.75	35.55	46.08	-10.53	Average
6	0.495	9.80	29.64	39.44	56.08	-16.64	QP
7	1.498	9.81	22.48	32.29	46.00	-13.71	Average
8	1.498	9.81	26.57	36.38	56.00	-19.62	QP
9	4.320	9.85	26.10	35.95	46.00	-10.05	Average
10	4.320	9.85	27.62	37.47	56.00	-18.53	QP
11	19.937	10.10	36.61	46.71	50.00	-3.29	Average
12	19.937	10.10	40.60	50.70	60.00	-9.30	QP

For PCB Antenna:

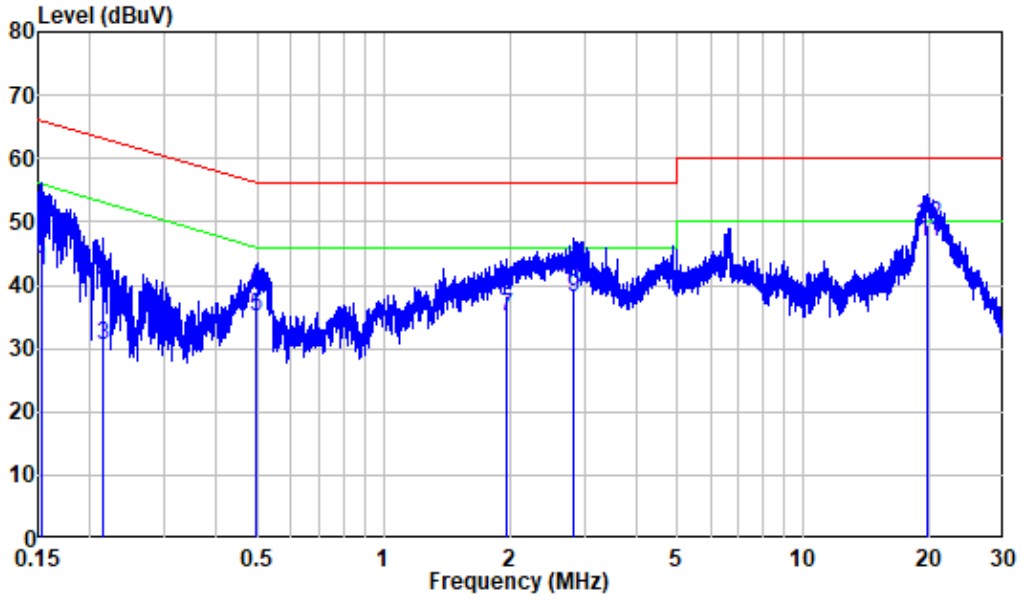
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Mode : BT
Model : YL43752
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.151	9.80	33.77	43.57	55.93	-12.36	Average
2	0.151	9.80	41.85	51.65	65.93	-14.28	QP
3	0.202	9.80	23.26	33.06	53.55	-20.49	Average
4	0.202	9.80	33.24	43.04	63.55	-20.51	QP
5	0.491	9.80	25.26	35.06	46.15	-11.09	Average
6	0.491	9.80	28.97	38.77	56.15	-17.38	QP
7	1.922	9.82	25.95	35.77	46.00	-10.23	Average
8	1.922	9.82	30.12	39.94	56.00	-16.06	QP
9	2.933	9.83	28.94	38.77	46.00	-7.23	Average
10	2.933	9.83	31.12	40.95	56.00	-15.05	QP
11	19.493	9.99	35.76	45.75	50.00	-4.25	Average
12	19.493	9.99	39.50	49.49	60.00	-10.51	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Mode : BT
Model : YL43752
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.154	9.80	32.57	42.37	55.81	-13.44	Average
2	0.154	9.80	40.68	50.48	65.81	-15.33	QP
3	0.215	9.80	20.81	30.61	53.02	-22.41	Average
4	0.215	9.80	30.37	40.17	63.02	-22.85	QP
5	0.498	9.80	25.27	35.07	46.03	-10.96	Average
6	0.498	9.80	28.88	38.68	56.03	-17.35	QP
7	1.971	9.82	25.16	34.98	46.00	-11.02	Average
8	1.971	9.82	28.65	38.47	56.00	-17.53	QP
9	2.843	9.83	28.26	38.09	46.00	-7.91	Average
10	2.843	9.83	29.58	39.41	56.00	-16.59	QP
11	19.792	10.10	36.71	46.81	50.00	-3.19	Average
12	19.792	10.10	39.30	49.40	60.00	-10.60	QP

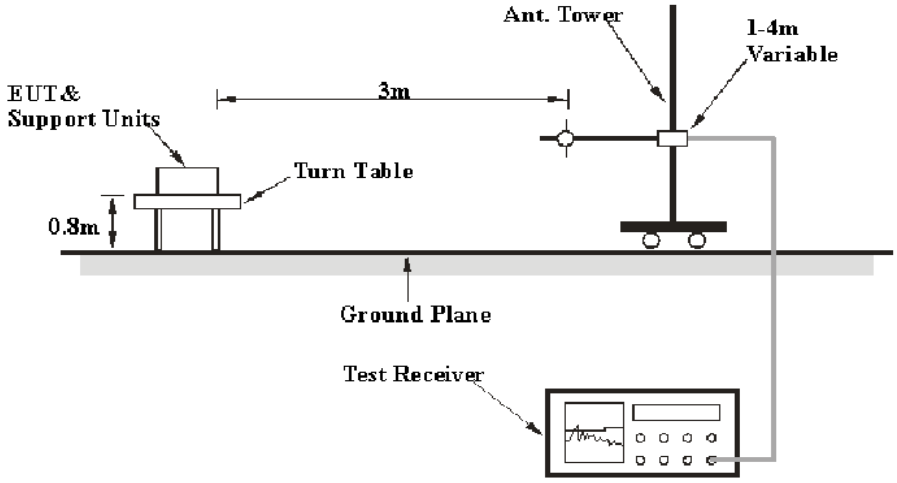
FCC §15.209, §15.205 & §15.247(d) & RSS-247§ 5.5 - Spurious Emissions

Applicable Standard

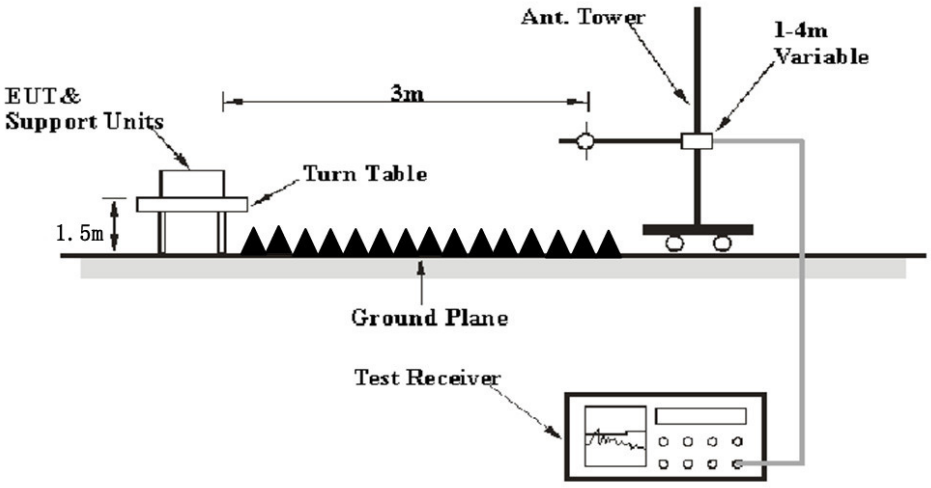
FCC §15.205; §15.209; §15.247(d); RSS-247§ 5.5; RSS-GEN § 8.10

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, RSS-247, RSS-Gen limits.

EMI Test Receiver & Spectrum Analyzer Setup

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

Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

Over Limit/Margin = Level / Corrected Amplitude – Limit
Level / Corrected Amplitude = Read Level + Factor

Test Data

Environmental Conditions

Temperature:	26.8~27.8℃
Relative Humidity:	50~58%
ATM Pressure:	101.0 kPa

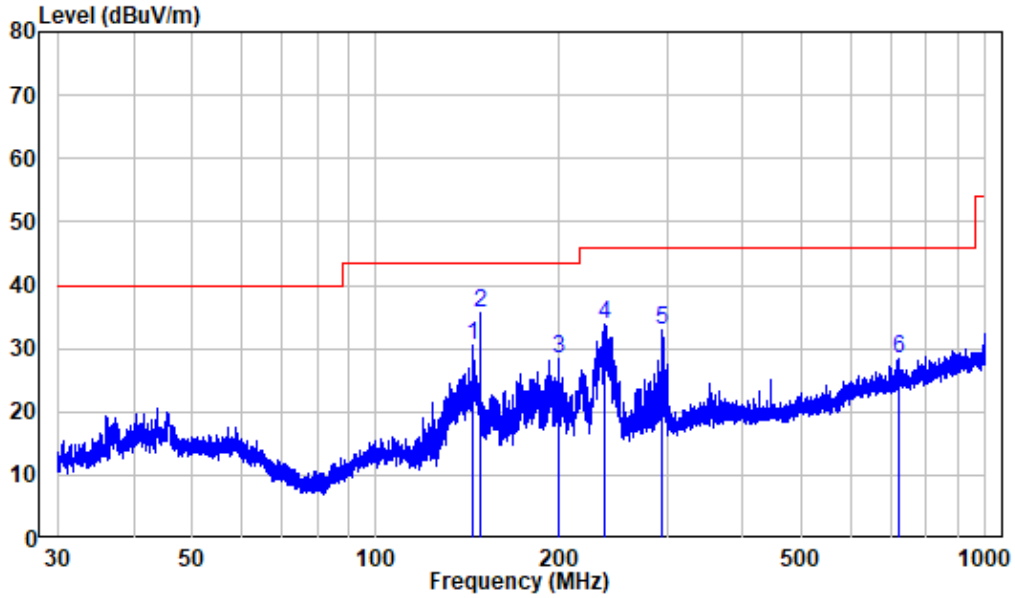
The testing was performed by Level Li on 2022-08-08 for below 1GHz, and on 2022-07-03 and 2022-09-21 for above 1GHz.

EUT operation mode: Transmitting(Pre-scan in the X, Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

For FPC Antenna:
Below 1GHz: *(Worst case for 8DPSK Mode, High channel)*

Note: When the test result of Peak was less than the limit of QP more than 6dB, just the peak level was recorded

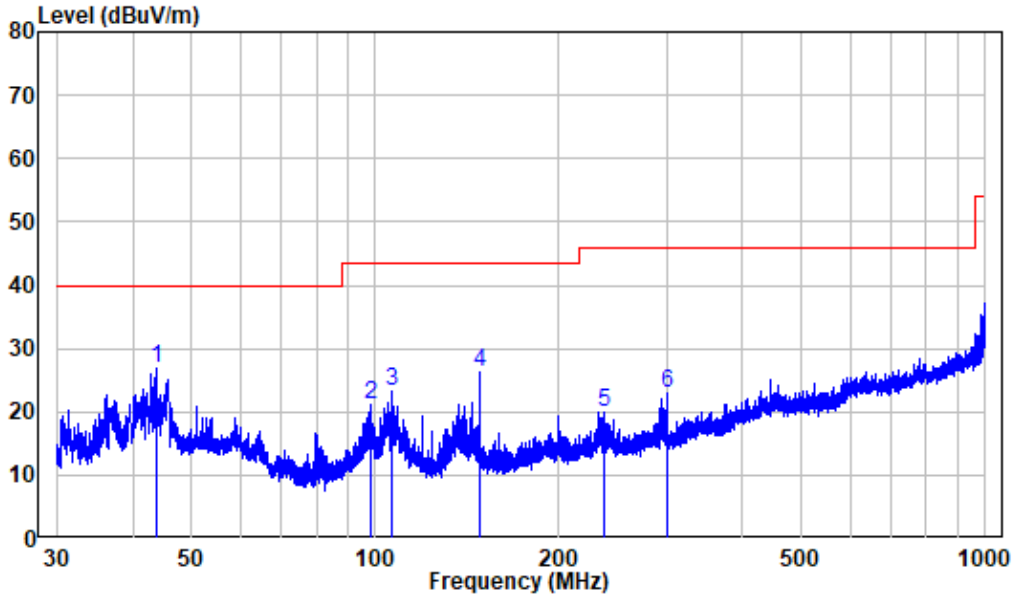
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220511-19727E-RF
Test Mode: BT

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	144.019	-15.52	45.96	30.44	43.50	-13.06	Peak
2	148.506	-15.35	51.04	35.69	43.50	-7.81	Peak
3	199.548	-11.43	39.85	28.42	43.50	-15.08	Peak
4	236.749	-10.94	44.68	33.74	46.00	-12.26	Peak
5	294.372	-9.27	42.28	33.01	46.00	-12.99	Peak
6	722.042	-1.32	29.72	28.40	46.00	-17.60	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220511-19727E-RF
Test Mode: BT

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	43.812	-9.91	36.92	27.01	40.00	-12.99	Peak
2	98.400	-12.16	33.17	21.01	43.50	-22.49	Peak
3	106.712	-11.95	35.30	23.35	43.50	-20.15	Peak
4	148.506	-15.35	41.51	26.16	43.50	-17.34	Peak
5	236.541	-10.95	30.99	20.04	46.00	-25.96	Peak
6	299.973	-9.23	32.29	23.06	46.00	-22.94	Peak

Above 1GHz: (worst case for 8DPSK)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel									
2310	68.57	PK	357	1.2	H	-7.24	61.33	74	-12.67
2310	53.45	AV	357	1.2	H	-7.24	46.21	54	-7.79
2310	68.46	PK	197	2.1	V	-7.24	61.22	74	-12.78
2310	53.34	AV	197	2.1	V	-7.24	46.10	54	-7.90
2390	70.63	PK	177	1.6	H	-7.22	63.41	74	-10.59
2390	54.12	AV	177	1.6	H	-7.22	46.90	54	-7.10
2390	69.51	PK	339	2.5	V	-7.22	62.29	74	-11.71
2390	54.04	AV	339	2.5	V	-7.22	46.82	54	-7.18
4804	58.83	PK	26	2.3	H	-3.51	55.32	74	-18.68
4804	48.86	AV	26	2.3	H	-3.51	45.35	54	-8.65
4804	56.90	PK	283	2.4	V	-3.51	53.39	74	-20.61
Middle Channel									
4882	58.84	PK	306	1.2	H	-3.37	55.47	74	-18.53
4882	48.79	AV	306	1.2	H	-3.37	45.42	54	-8.58
4882	58.02	PK	33	1.4	V	-3.37	54.65	74	-19.35
4882	46.99	AV	244	1.4	V	-3.37	43.62	54	-10.38
High Channel									
2483.5	70.11	PK	49	2.3	H	-7.2	62.91	74	-11.09
2483.5	54.90	AV	49	2.3	H	-7.2	47.7	54	-6.3
2483.5	70.02	PK	234	1.9	V	-7.2	62.82	74	-11.18
2483.5	54.81	AV	234	1.9	V	-7.2	47.61	54	-6.39
2500	69.34	PK	234	2.2	H	-7.18	62.16	74	-11.84
2500	54.63	AV	234	2.2	H	-7.18	47.45	54	-6.55
2500	69.22	PK	285	1.4	V	-7.18	62.04	74	-11.96
2500	54.55	AV	285	1.4	V	-7.18	47.37	54	-6.63
4960	58.36	PK	279	2.4	H	-3.01	55.35	74	-18.65
4960	48.08	AV	279	2.4	H	-3.01	45.07	54	-8.93
4960	57.94	PK	163	2.3	V	-3.01	54.93	74	-19.07
4960	47.23	AV	163	2.3	V	-3.01	44.22	54	-9.78

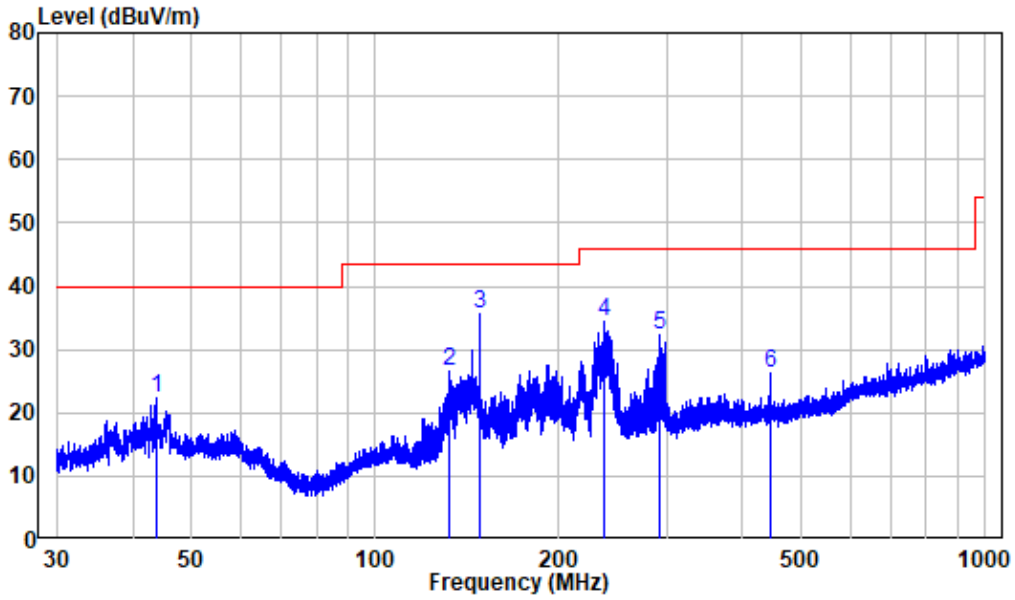
Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Absolute Level (Corrected Amplitude) = Factor + Reading
Margin = Absolute Level (Corrected Amplitude) – Limit
The other spurious emission which is in the noise floor level was not recorded.
The test result of peak was less than the limit of average, so just peak value were recorded.

For iron Antenna:

Below 1GHz: *(Worst case for 8DPSK Mode, High channel)*

Note: When the test result of Peak was less than the limit of QP more than 6dB, just the peak level was recorded

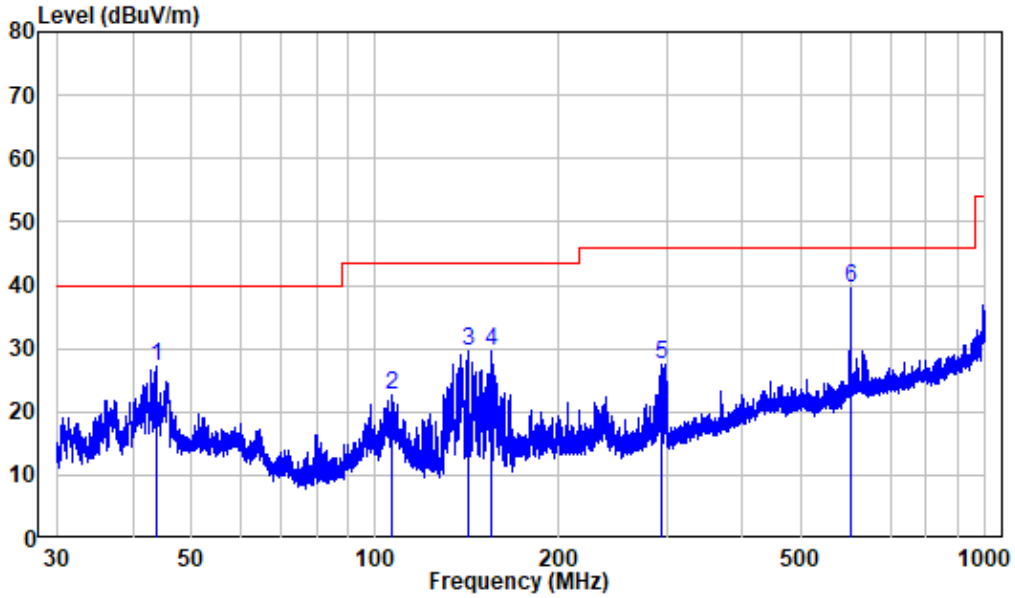
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220511-19727E-RF
Test Mode: BT

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	43.793	-9.91	32.36	22.45	40.00	-17.55	Peak
2	131.931	-14.98	41.45	26.47	43.50	-17.03	Peak
3	148.506	-15.35	50.87	35.52	43.50	-7.98	Peak
4	237.476	-10.93	45.40	34.47	46.00	-11.53	Peak
5	293.213	-9.28	41.45	32.17	46.00	-13.83	Peak
6	445.632	-5.63	31.82	26.19	46.00	-19.81	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220511-19727E-RF
Test Mode: BT

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	43.774	-9.91	37.05	27.14	40.00	-12.86	Peak
2	106.712	-11.95	34.64	22.69	43.50	-20.81	Peak
3	141.764	-15.53	45.16	29.63	43.50	-13.87	Peak
4	154.617	-14.97	44.70	29.73	43.50	-13.77	Peak
5	294.243	-9.27	36.76	27.49	46.00	-18.51	Peak
6	600.110	-2.43	41.97	39.54	46.00	-6.46	Peak

Above 1GHz: (worst case for 8DPSK)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel									
2310	68.33	PK	62	2.5	H	-7.24	61.09	74	-12.91
2310	53.42	AV	62	2.5	H	-7.24	46.18	54	-7.82
2310	68.25	PK	203	2.2	V	-7.24	61.01	74	-12.99
2310	53.34	AV	203	2.2	V	-7.24	46.10	54	-7.90
2390	69.45	PK	322	1.7	H	-7.22	62.23	74	-11.77
2390	54.07	AV	322	1.7	H	-7.22	46.85	54	-7.15
2390	69.34	PK	3	1.9	V	-7.22	62.12	74	-11.88
2390	53.98	AV	3	1.9	V	-7.22	46.76	54	-7.24
4804	57.34	PK	68	1.2	H	-3.51	53.83	74	-20.17
4804	55.16	PK	183	1.3	V	-3.51	51.65	74	-22.35
Middle Channel									
4882	57.86	PK	168	2.1	H	-3.37	54.49	74	-19.51
4882	46.38	AV	168	2.1	H	-3.37	43.01	54	-10.99
4882	55.18	PK	201	2.5	V	-3.37	51.81	74	-22.19
High Channel									
2483.5	70.02	PK	39	1	H	-7.2	62.82	74	-11.18
2483.5	54.81	AV	39	1	H	-7.2	47.61	54	-6.39
2483.5	69.89	PK	74	2.4	V	-7.2	62.69	74	-11.31
2483.5	54.72	AV	74	2.4	V	-7.2	47.52	54	-6.48
2500	69.18	PK	16	1.4	H	-7.18	62	74	-12
2500	54.52	AV	16	1.4	H	-7.18	47.34	54	-6.66
2500	69.09	PK	358	2.3	V	-7.18	61.91	74	-12.09
2500	54.44	AV	358	2.3	V	-7.18	47.26	54	-6.74
4960	58.35	PK	144	2.5	H	-3.01	55.34	74	-18.66
4960	46.57	AV	144	2.5	H	-3.01	43.56	54	-10.44
4960	54.26	PK	207	1.9	V	-3.01	51.25	74	-22.75

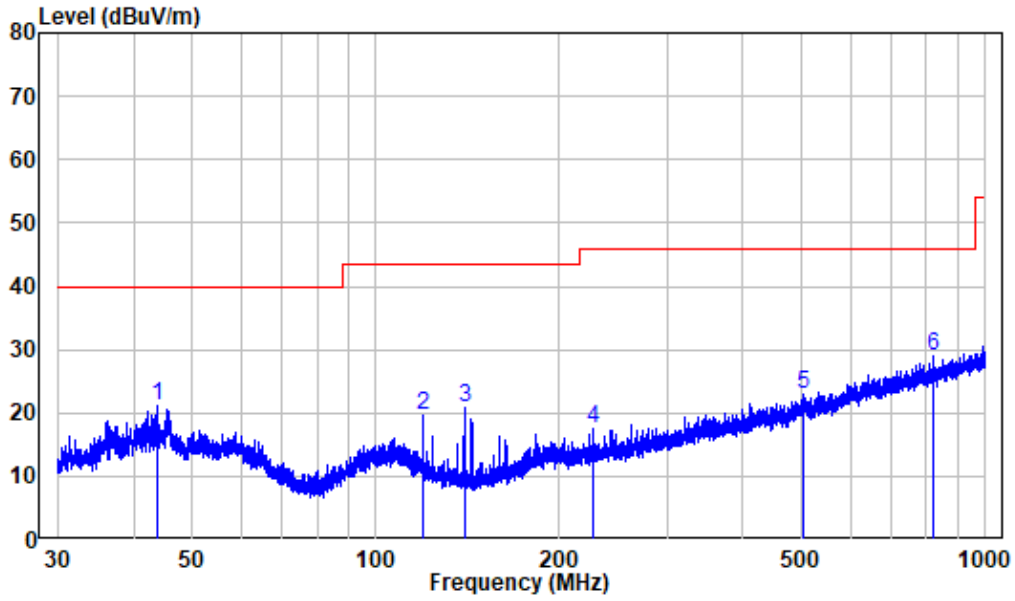
Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Absolute Level (Corrected Amplitude) = Factor + Reading
Margin = Absolute Level (Corrected Amplitude) – Limit
The other spurious emission which is in the noise floor level was not recorded.
The test result of peak was less than the limit of average, so just peak value were recorded.

For PCB Antenna:

Below 1GHz: *(Worst case for 8DPSK Mode, High channel)*

Note: When the test result of Peak was less than the limit of QP more than 6dB, just the peak level was recorded

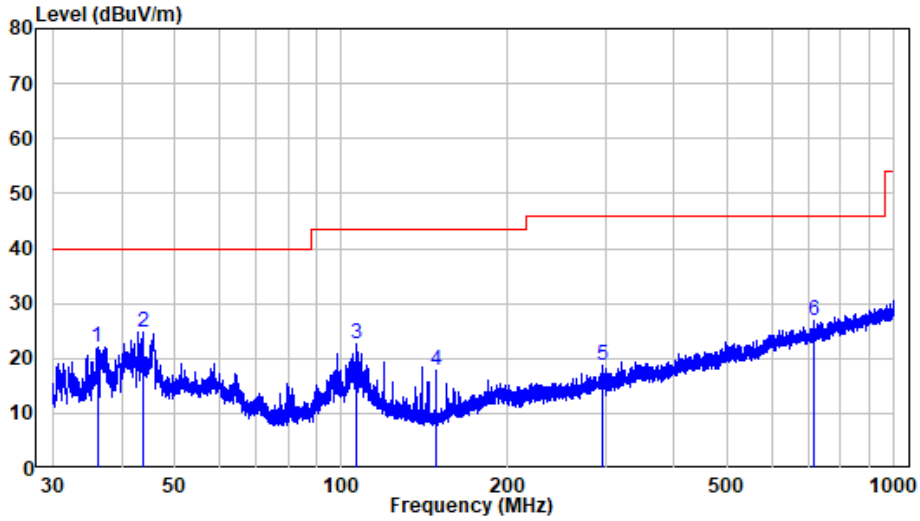
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220511-19727E-RF
Test Mode: BT

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	43.812	-9.91	30.90	20.99	40.00	-19.01	Peak
2	119.593	-13.46	33.16	19.70	43.50	-23.80	Peak
3	139.545	-15.43	36.38	20.95	43.50	-22.55	Peak
4	227.391	-11.19	28.84	17.65	46.00	-28.35	Peak
5	503.381	-4.26	27.34	23.08	46.00	-22.92	Peak
6	820.631	0.01	28.87	28.88	46.00	-17.12	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220511-19727E-RF
Test Mode: BT

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	36.143	-11.17	33.21	22.04	40.00	-17.96	Peak
2	43.774	-9.91	34.81	24.90	40.00	-15.10	Peak
3	106.712	-11.95	34.72	22.77	43.50	-20.73	Peak
4	148.376	-15.36	33.21	17.85	43.50	-25.65	Peak
5	295.665	-9.27	27.88	18.61	46.00	-27.39	Peak
6	713.548	-1.37	28.34	26.97	46.00	-19.03	Peak

Above 1GHz: (worst case for 8DPSK)

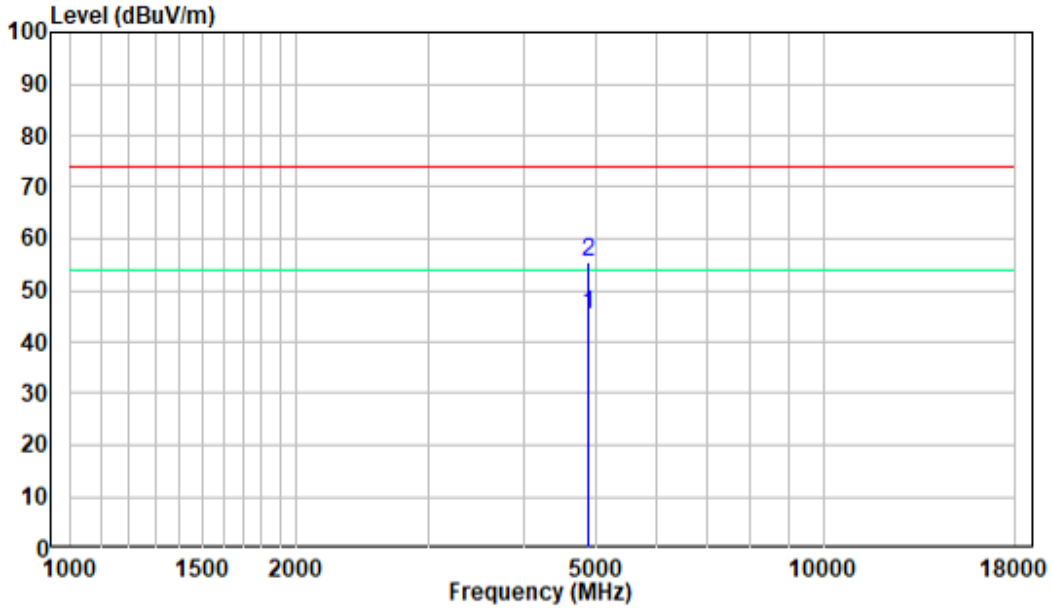
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel									
2310	68.56	PK	214	2.3	H	-7.24	61.32	74	-12.68
2310	53.21	AV	214	2.3	H	-7.24	45.97	54	-8.03
2310	68.06	PK	272	1.4	V	-7.24	60.82	74	-13.18
2310	53.29	AV	272	1.4	V	-7.24	46.05	54	-7.95
2390	69.39	PK	149	1.9	H	-7.22	62.17	74	-11.83
2390	53.83	AV	149	1.9	H	-7.22	46.61	54	-7.39
2390	69.72	PK	82	1.4	V	-7.22	62.50	74	-11.50
2390	53.87	AV	82	1.4	V	-7.22	46.65	54	-7.35
4804	58.55	PK	184	1.8	H	-3.51	55.04	74	-18.96
4804	48.27	AV	184	1.8	H	-3.51	44.76	54	-9.24
4804	55.17	PK	57	2.3	V	-3.51	51.66	74	-22.34
Middle Channel									
4882	57.36	PK	66	1.7	H	-3.37	53.99	74	-20.01
4882	54.8	PK	32	1.7	V	-3.37	51.43	74	-22.57
High Channel									
2483.5	71.05	PK	276	1.8	H	-7.2	63.85	74	-10.15
2483.5	55.19	AV	276	1.8	H	-7.2	47.99	54	-6.01
2483.5	70.61	PK	164	2.4	V	-7.2	63.41	74	-10.59
2483.5	55.26	AV	164	2.4	V	-7.2	48.06	54	-5.94
2500	69.13	PK	298	2.3	H	-7.18	61.95	74	-12.05
2500	55.23	AV	298	2.3	H	-7.18	48.05	54	-5.95
2500	69.20	PK	97	1.6	V	-7.18	62.02	74	-11.98
2500	55.07	AV	97	1.6	V	-7.18	47.89	54	-6.11
4960	54.85	PK	166	1.5	H	-3.01	51.84	74	-22.16
4960	54.28	PK	189	2.4	V	-3.01	51.27	74	-22.73

Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Absolute Level (Corrected Amplitude) = Factor + Reading
Margin = Absolute Level (Corrected Amplitude) – Limit
The other spurious emission which is in the noise floor level was not recorded.
The test result of peak was less than the limit of average, so just peak value were recorded.

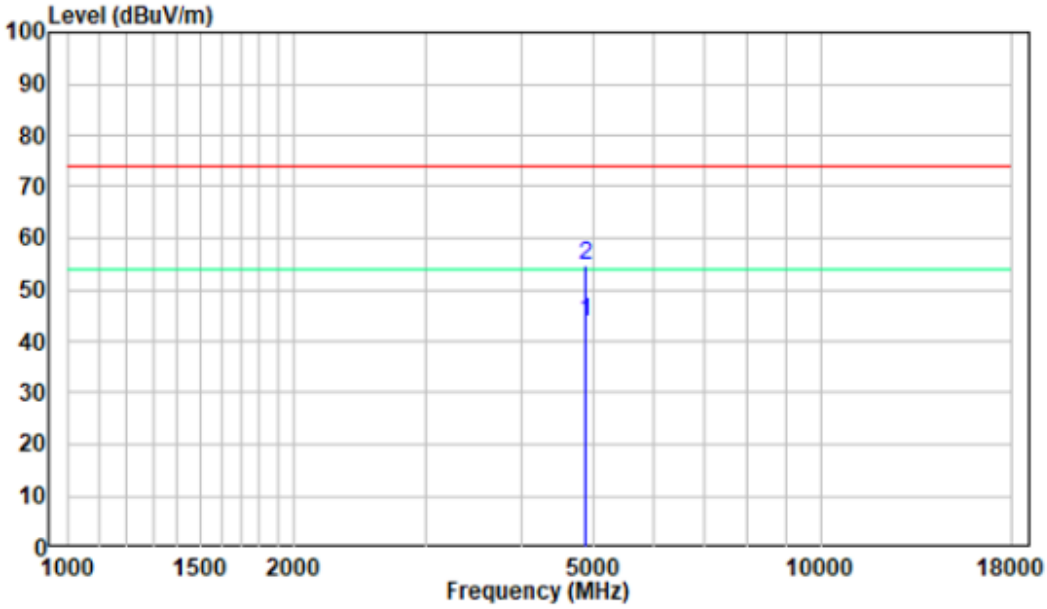
1 GHz - 18 GHz: (Pre-Scan plots)

FPC ANT Middle channel

Horizontal



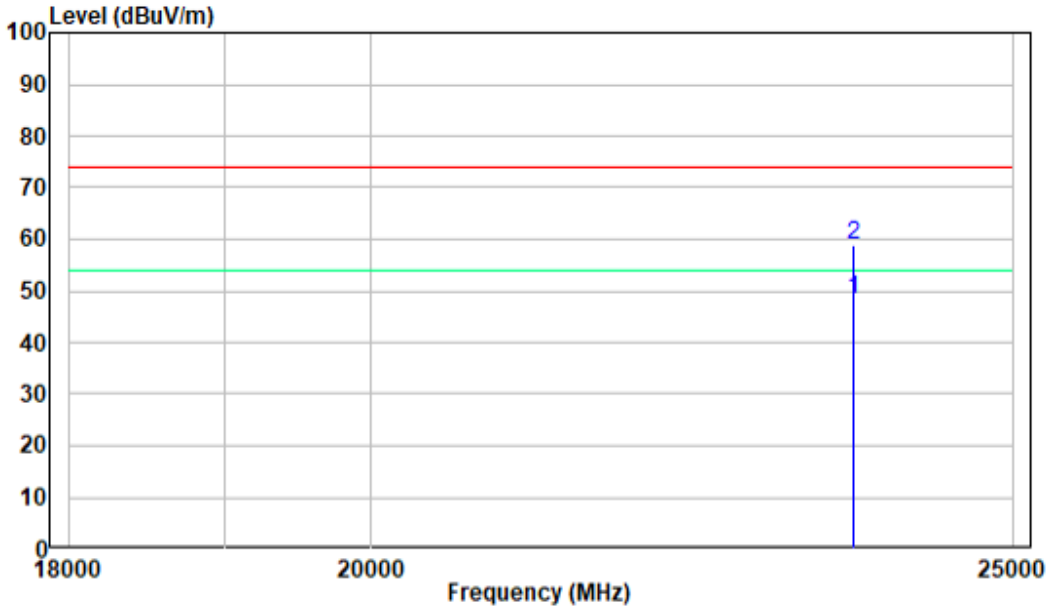
Vertical



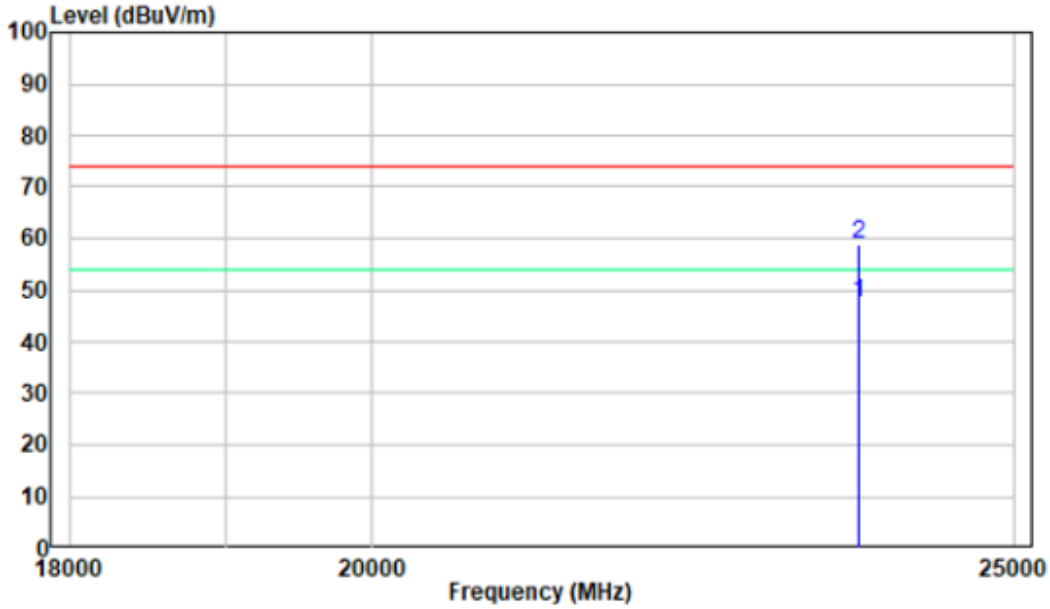
18-25GHz: (Pre-Scan plots)

Middle channel

Horizontal



Vertical



FCC §15.247(a) (1) & RSS-247 § 5.1 (b) -CHANNEL SEPARATION TEST

Applicable Standard

According to FCC §15.247(a) (1):

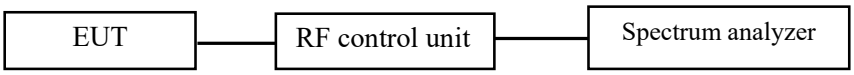
Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that 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.

According to RSS-247 § 5.1 (b):

Frequency hopping systems (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.

Test Procedure

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



Test Data

Environmental Conditions

Temperature:	22℃
Relative Humidity:	57%
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-08-23.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) & RSS-247 § 5.1 (a), RSS-GEN § 6.7 – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

According to FCC §15.247(a) (1):

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.

According to RSS-247 § 5.1 (a), RSS-GEN § 6.7:

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "20 dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated 20 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

Test Procedure

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

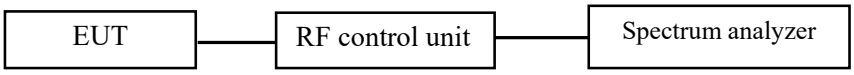
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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:	22℃
Relative Humidity:	57%
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-08-23.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) (iii) & RSS-247 § 5.1 (d) - QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

According to FCC §15.247(a) (1) (iii):

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.

According to RSS-247 § 5.1 (d):

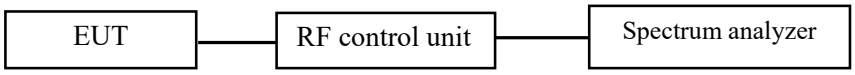
Frequency hopping systems (FHSS) operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping 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:	22℃
Relative Humidity:	57%
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-08-23.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) (iii) & RSS-247 § 5.1 (d) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

According to FCC §15.247(a) (1) (iii):

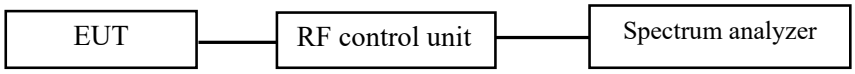
Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

According to RSS-247 § 5.1 (d):

Frequency hopping systems (FHSs) operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping 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:	22℃
Relative Humidity:	57%
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-08-23.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(b) (1) & RSS-247§ 5.1(b) &§ 5.4(b) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to FCC §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.

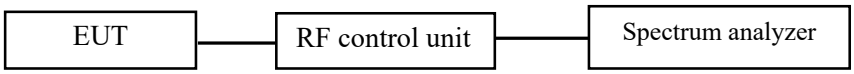
According to RSS-247§ 5.1(b) &§ 5.4(b):

For frequency hopping systems (FHSs) operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W (see Section 5.4(e) for exceptions).

Frequency hopping systems (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.

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:	22℃
Relative Humidity:	57%
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-08-23.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(d) & RSS-247 § 5.5 - BAND EDGES TESTING

Applicable Standard

According to FCC §15.247(d).

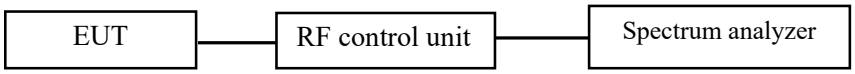
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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)).

According to RSS-247 § 5.5.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(e), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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:	22℃
Relative Humidity:	57%
ATM Pressure:	101.0 kPa

The testing was performed by Roger Ling on 2022-08-23.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

APPENDIX

Appendix A: 20dB Emission Bandwidth

Test Result

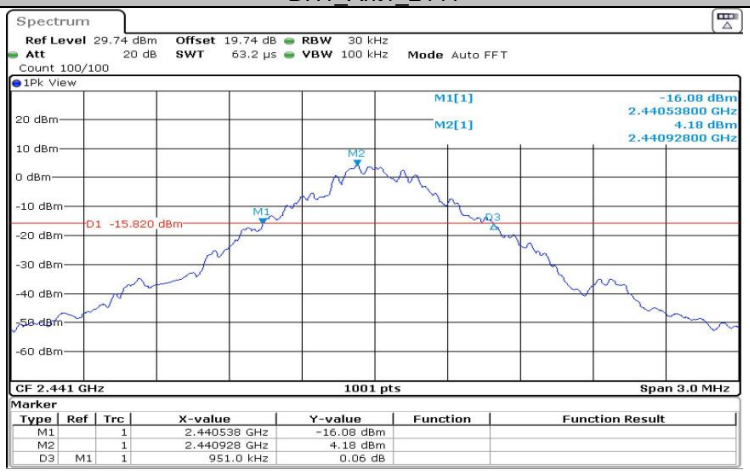
Test Mode	Antenna	Channel	20db EBW[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.95	---	---
		2441	0.95	---	---
		2480	0.95	---	---
2DH1	Ant1	2402	1.35	---	---
		2441	1.35	---	---
		2480	1.35	---	---
3DH1	Ant1	2402	1.27	---	---
		2441	1.29	---	---
		2480	1.29	---	---

Test Graphs

DH1_Ant1_2402

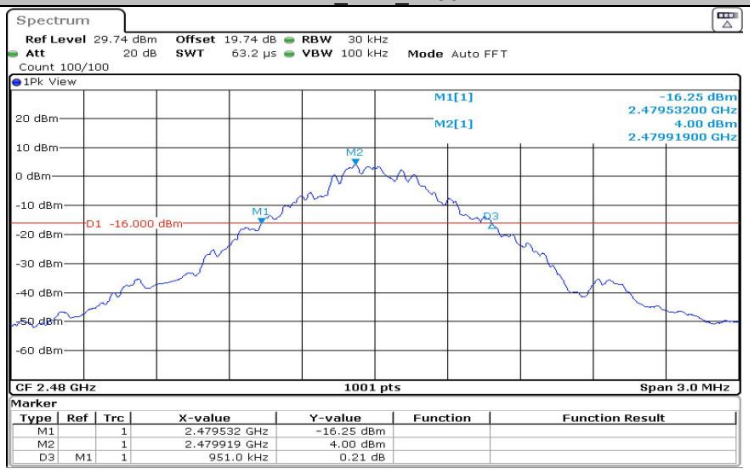
Date: 23.AUG.2022 22:24:23

DH1_Ant1_2441



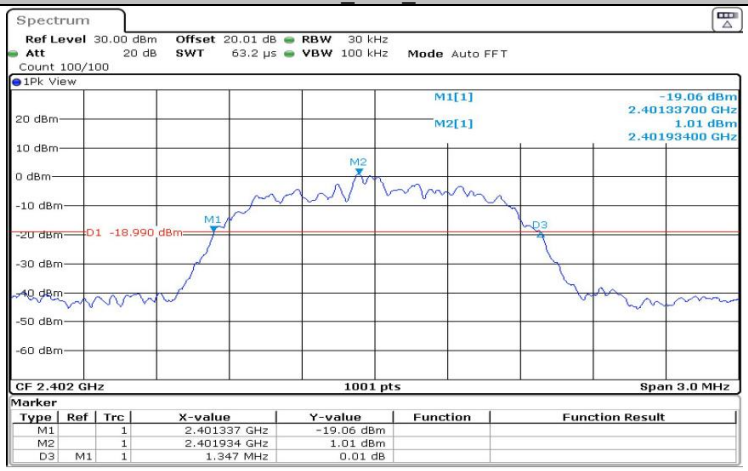
Date: 23.AUG.2022 22:27:29

DH1_Ant1_2480



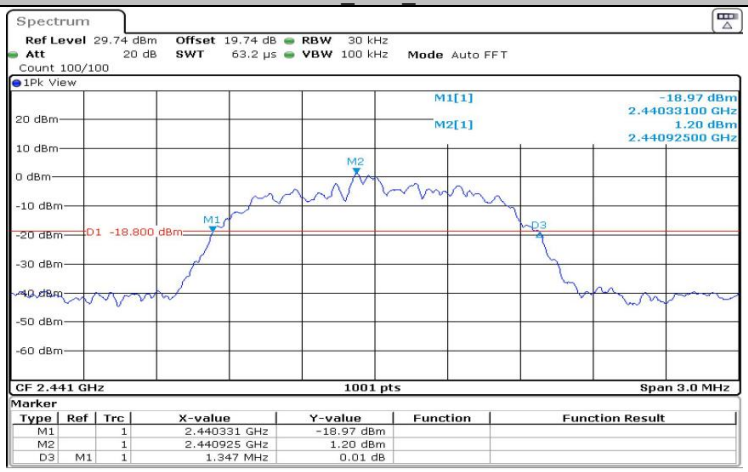
Date: 23.AUG.2022 22:30:56

2DH1_Ant1_2402



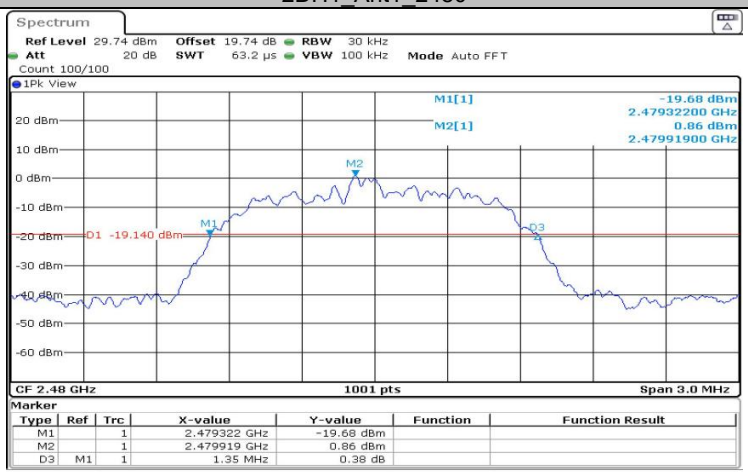
Date: 23.AUG.2022 22:07:43

2DH1_Ant1_2441



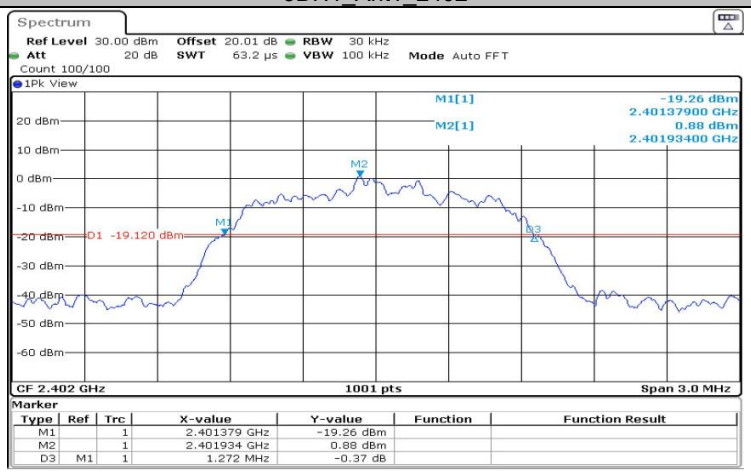
Date: 23.AUG.2022 22:11:40

2DH1_Ant1_2480

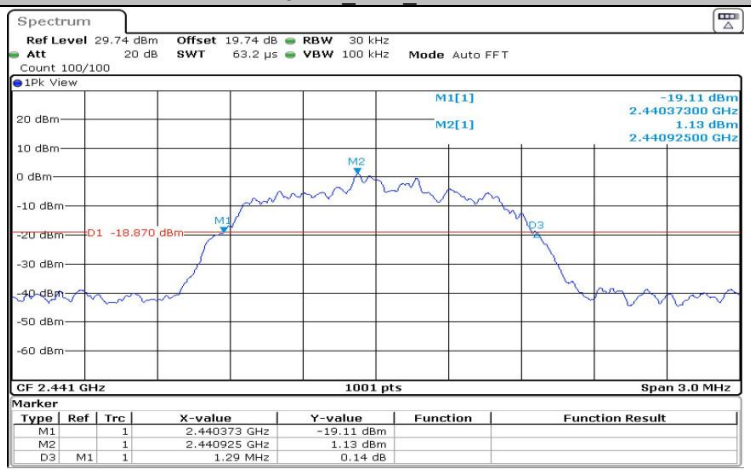


Date: 23.AUG.2022 22:13:06

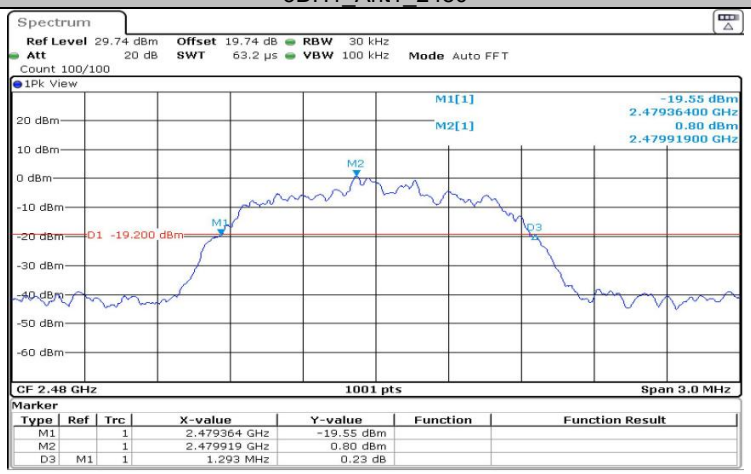
3DH1_Ant1_2402



3DH1_Ant1_2441



3DH1_Ant1_2480



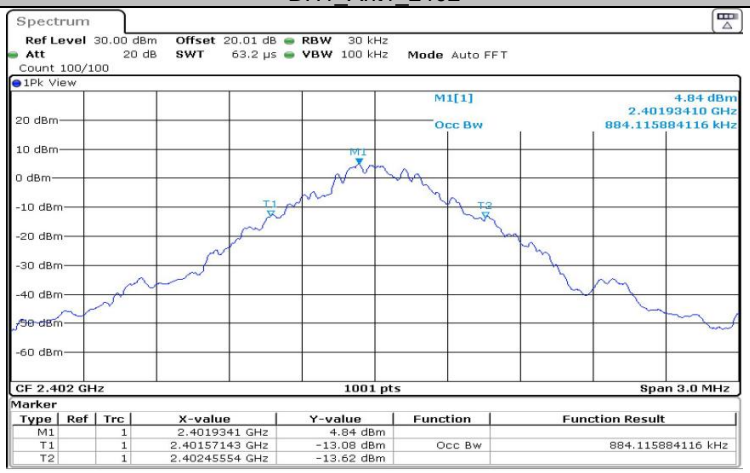
Appendix B: Occupied Channel Bandwidth

Test Result

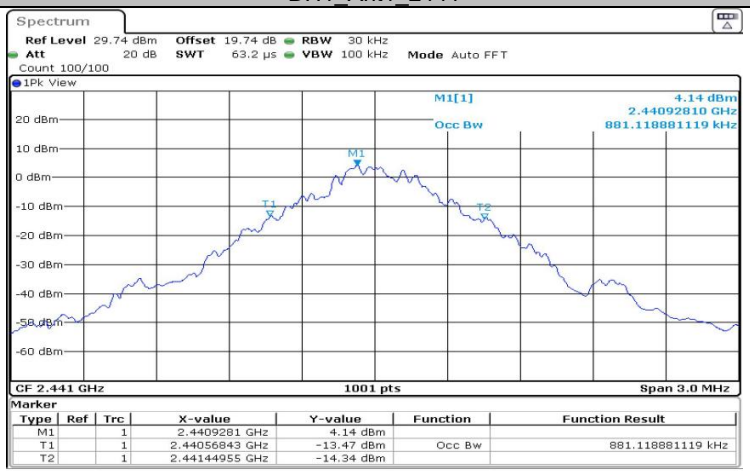
Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.884	---	---
		2441	0.881	---	---
		2480	0.908	---	---
2DH1	Ant1	2402	1.193	---	---
		2441	1.196	---	---
		2480	1.220	---	---
3DH1	Ant1	2402	1.178	---	---
		2441	1.178	---	---
		2480	1.187	---	---

Test Graphs

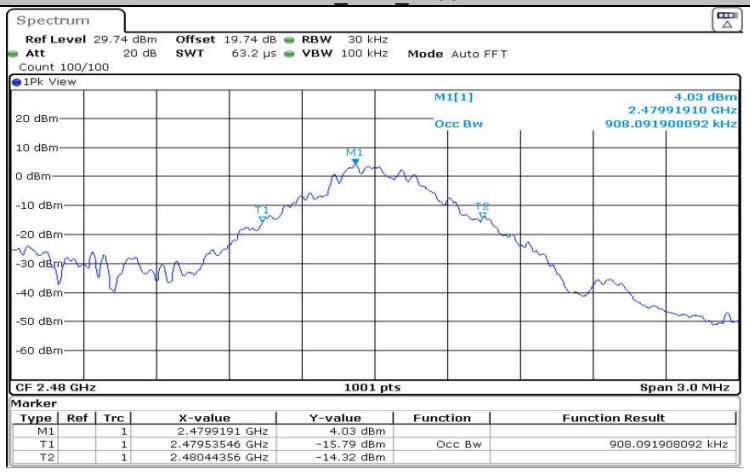
DH1_Ant1_2402



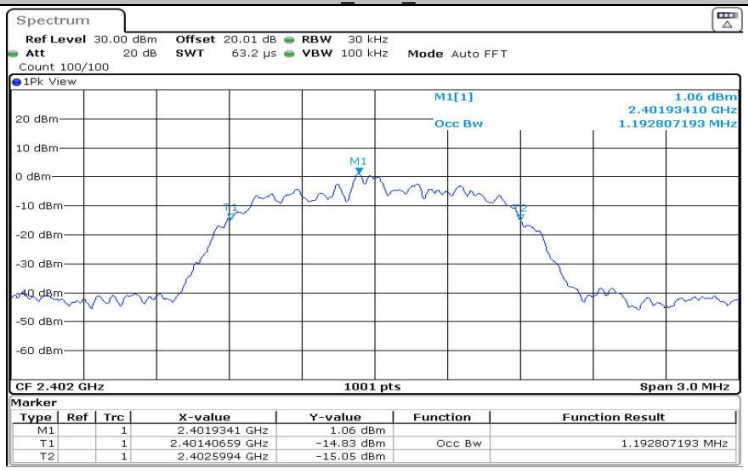
DH1_Ant1_2441



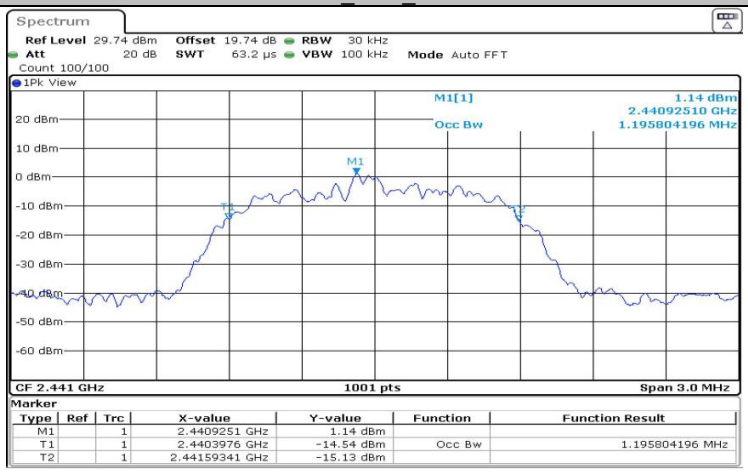
DH1_Ant1_2480



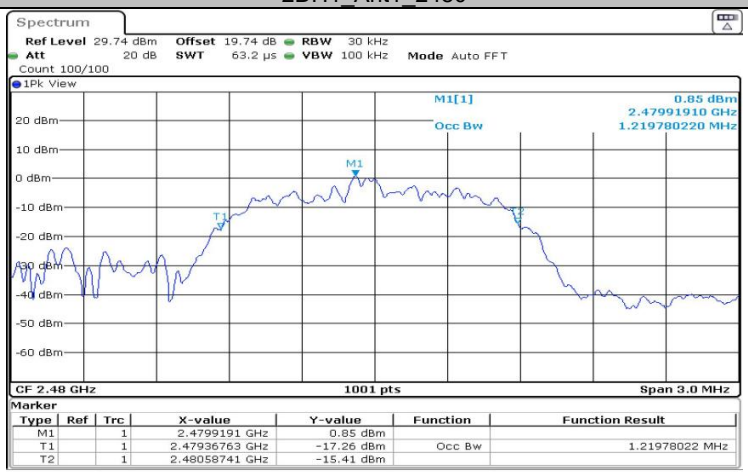
2DH1_Ant1_2402



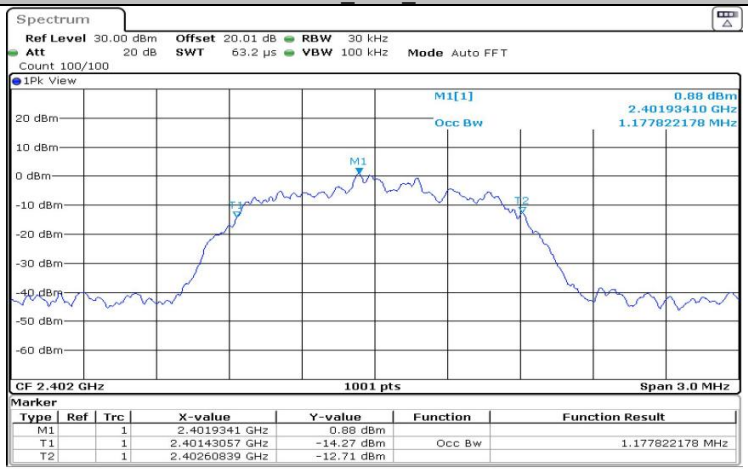
2DH1_Ant1_2441



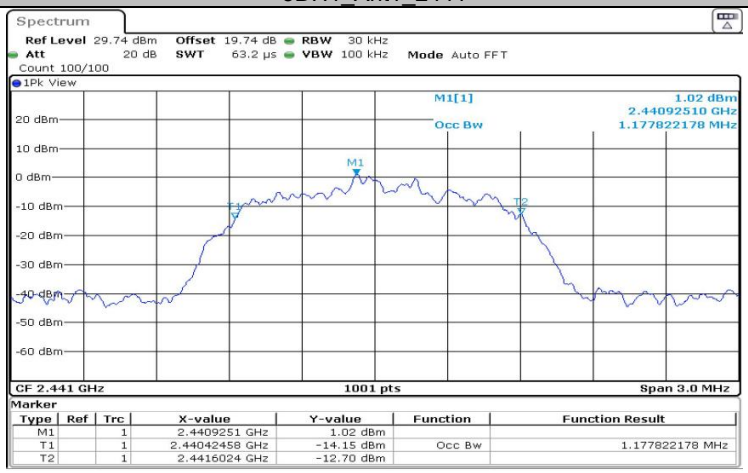
2DH1_Ant1_2480



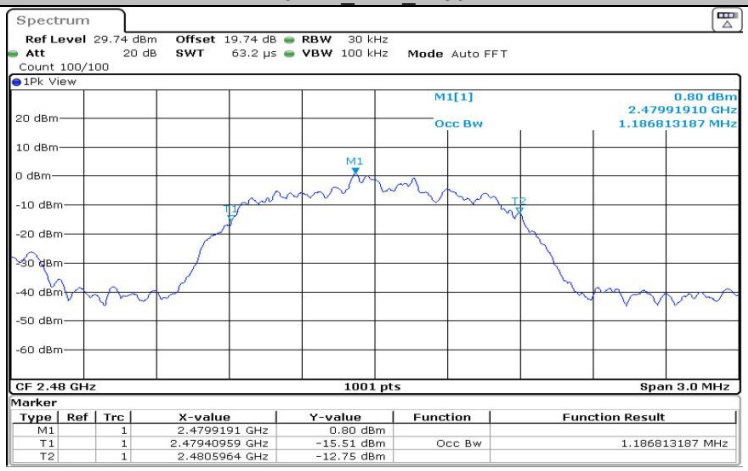
3DH1_Ant1_2402



3DH1_Ant1_2441



3DH1_Ant1_2480



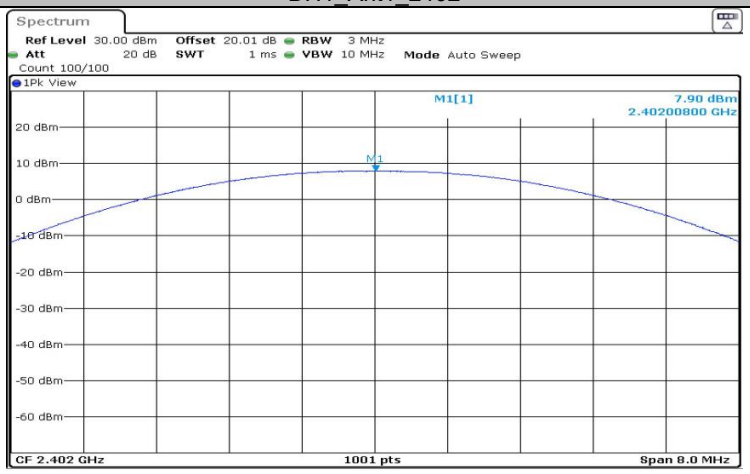
Appendix C: Maximum conducted Peak output power

Test Result

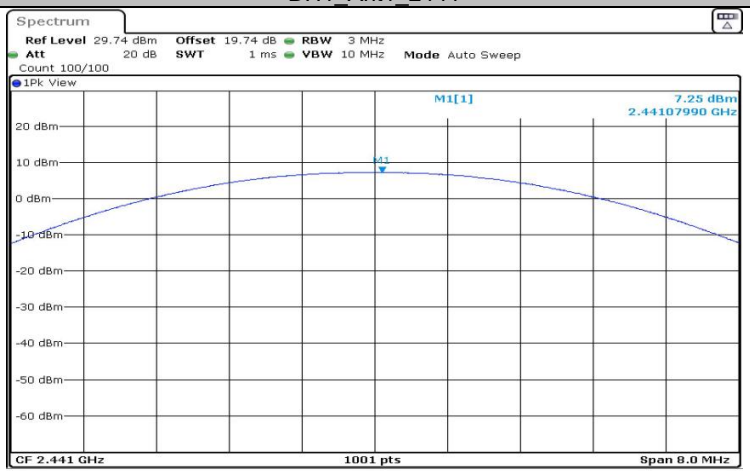
Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH1	Ant1	2402	7.90	≤20.97	PASS
		2441	7.25	≤20.97	PASS
		2480	7.08	≤20.97	PASS
2DH1	Ant1	2402	6.01	≤20.97	PASS
		2441	6.02	≤20.97	PASS
		2480	5.83	≤20.97	PASS
3DH1	Ant1	2402	6.28	≤20.97	PASS
		2441	6.51	≤20.97	PASS
		2480	6.20	≤20.97	PASS
Note: the maximum antenna gain among the three antenna is 3.32dBi, the maximum EIRP=11.22dBm<36dBm					

Test Graphs

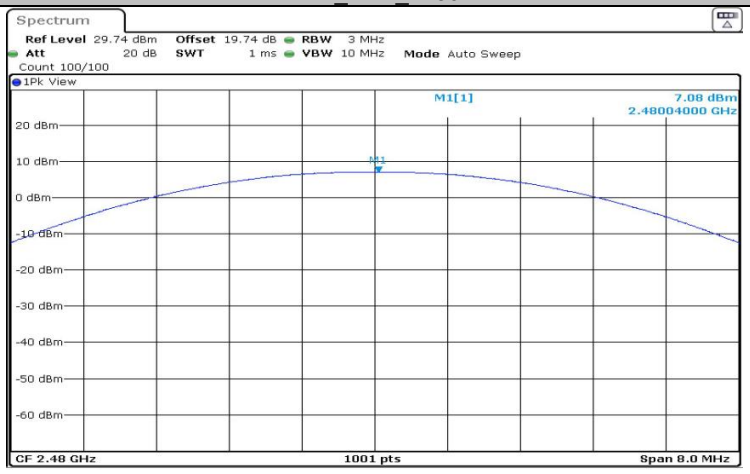
DH1_Ant1_2402



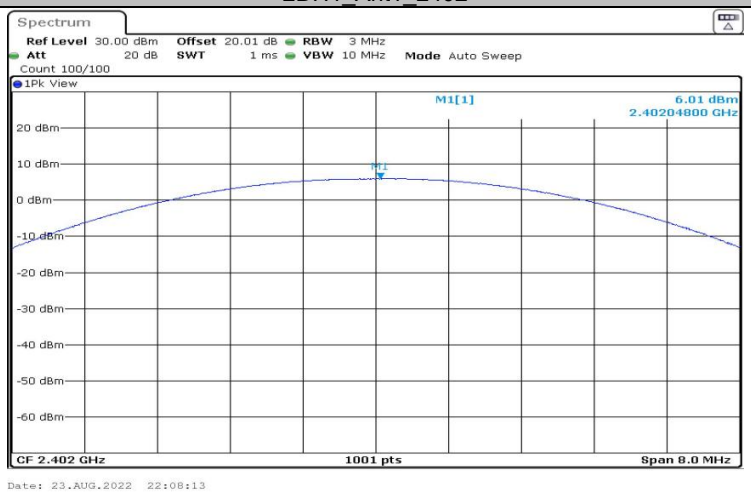
DH1_Ant1_2441



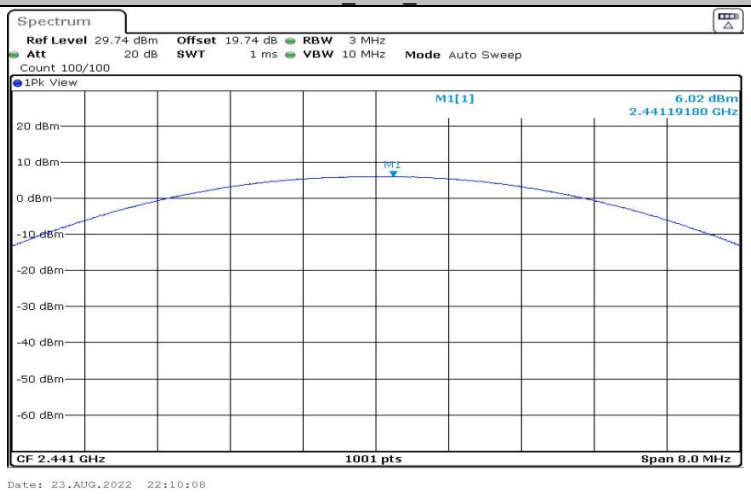
DH1_Ant1_2480



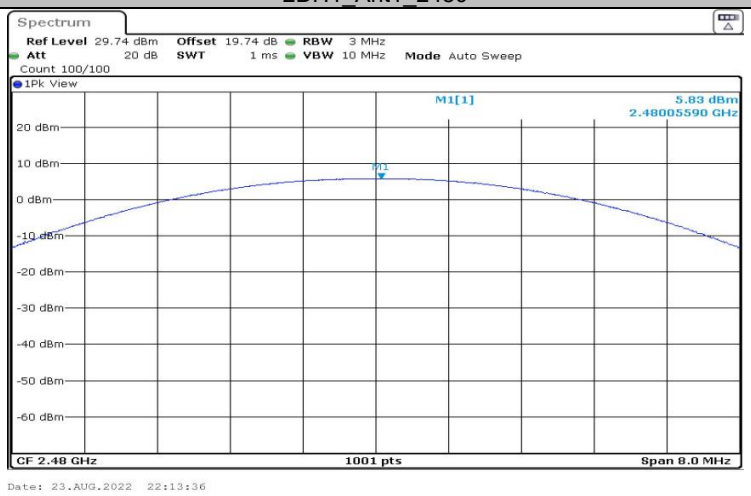
2DH1_Ant1_2402



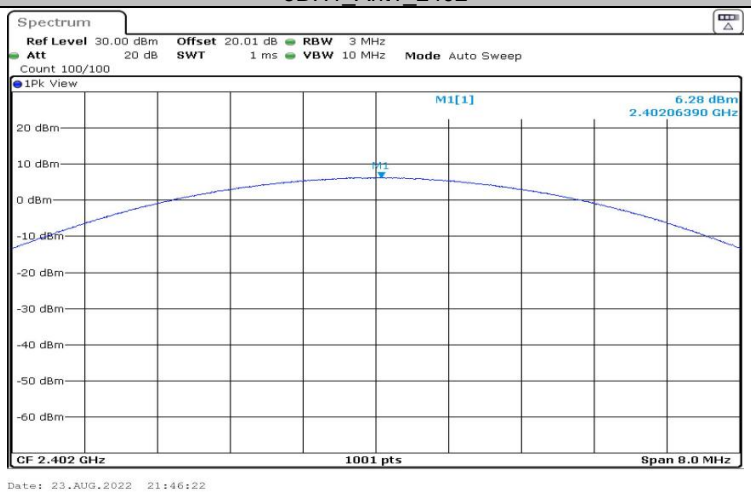
2DH1_Ant1_2441



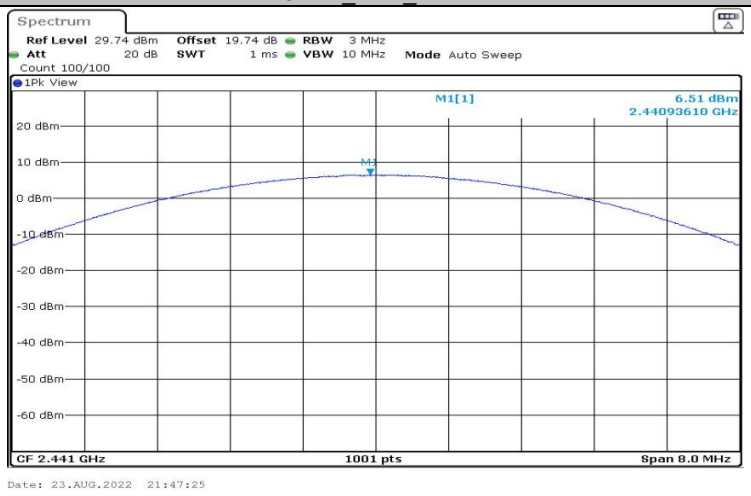
2DH1_Ant1_2480



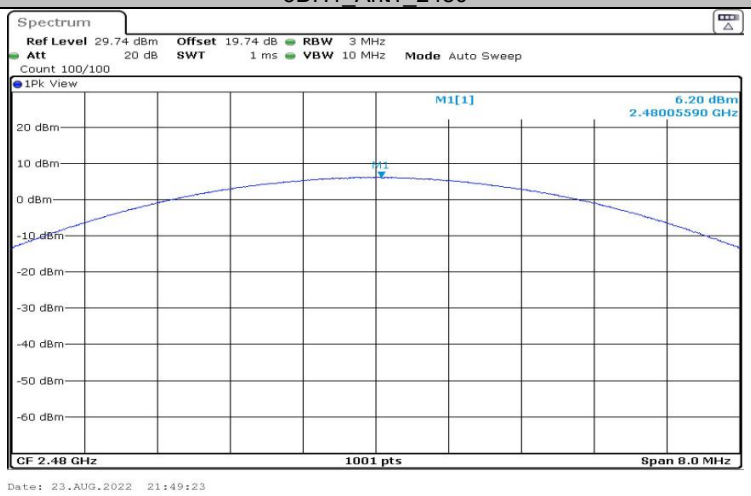
3DH1_Ant1_2402



3DH1_Ant1_2441



3DH1_Ant1_2480



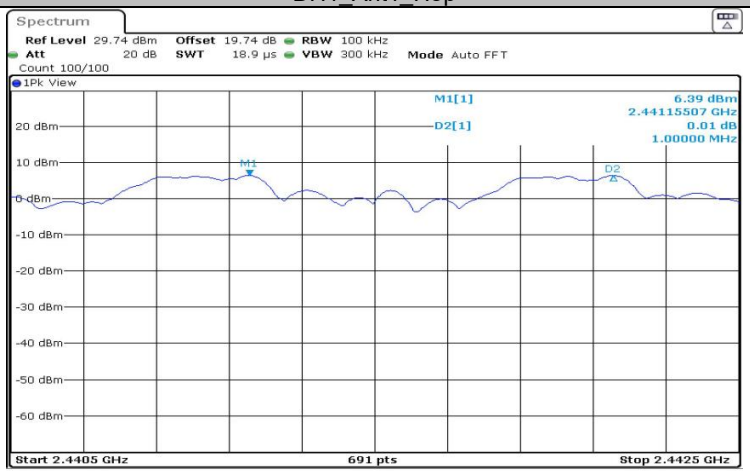
Appendix D: Carrier frequency separation

Test Result

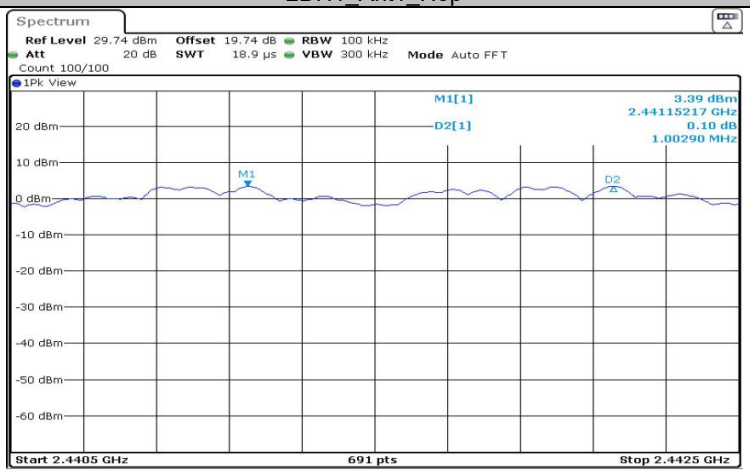
Test Mode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1.000	≥0.633	PASS
2DH1	Ant1	Hop	1.003	≥0.900	PASS
3DH1	Ant1	Hop	1.000	≥0.860	PASS

Test Graphs

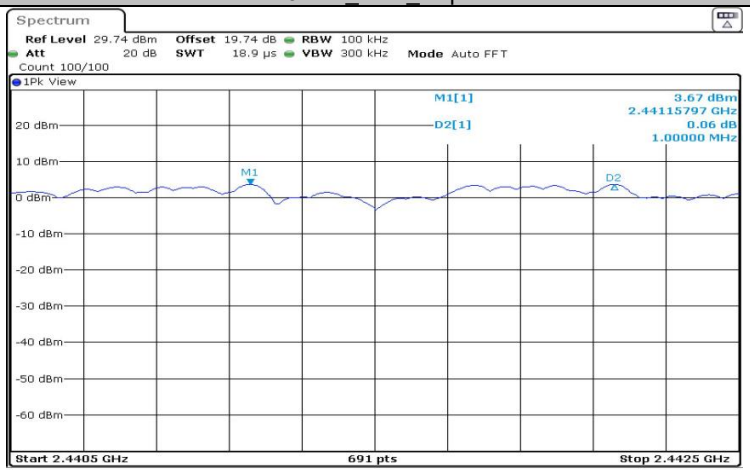
DH1_Ant1_Hop



2DH1_Ant1_Hop



3DH1_Ant1_Hop



Appendix E: Time of occupancy

Test Result

Test Mode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.36	330	0.119	≤0.4	PASS
DH3	Ant1	Hop	1.61	150	0.242	≤0.4	PASS
DH5	Ant1	Hop	2.85	120	0.342	≤0.4	PASS
2DH1	Ant1	Hop	0.37	390	0.144	≤0.4	PASS
2DH3	Ant1	Hop	1.62	180	0.292	≤0.4	PASS
2DH5	Ant1	Hop	2.86	120	0.343	≤0.4	PASS
3DH1	Ant1	Hop	0.37	330	0.122	≤0.4	PASS
3DH3	Ant1	Hop	1.61	150	0.242	≤0.4	PASS
3DH5	Ant1	Hop	2.86	120	0.343	≤0.4	PASS

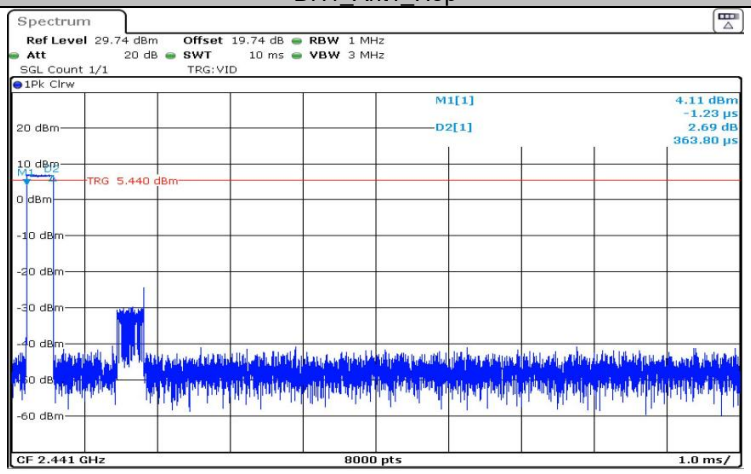
Note 1: A period time=0.4*79=31.6(S), Result=BurstWidth*Totalhops

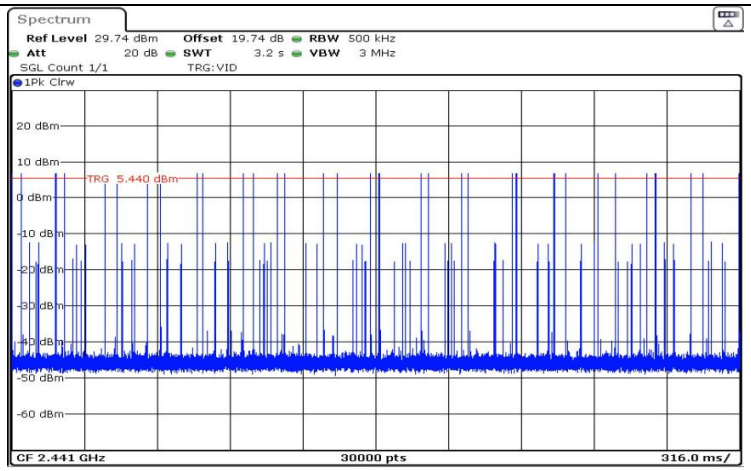
Note 2: Totalhops=Hopping Number in 3.16s*10

Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s(Second high signals were other channel)

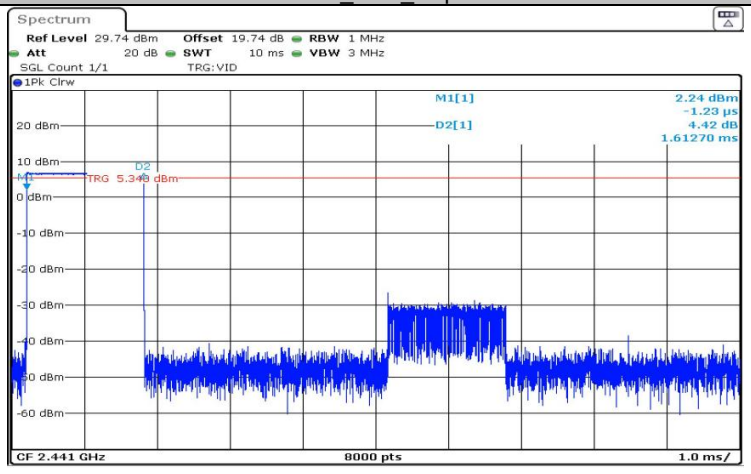
Test Graphs

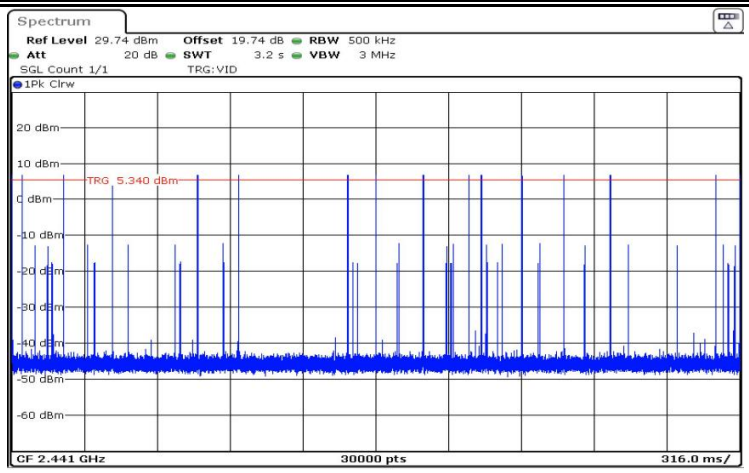
DH1_Ant1_Hop



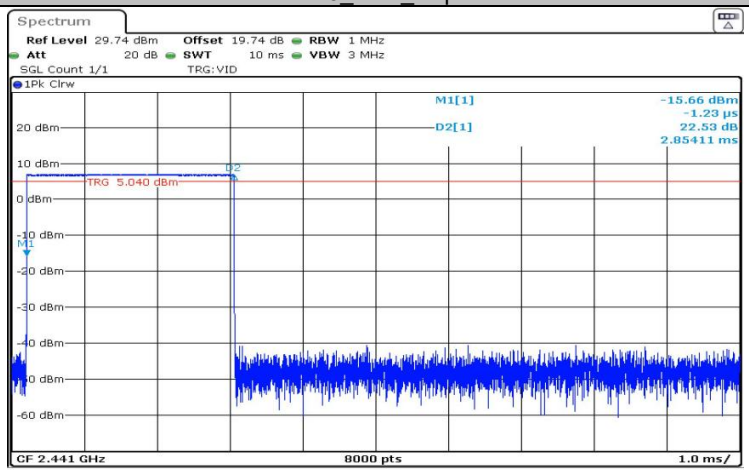


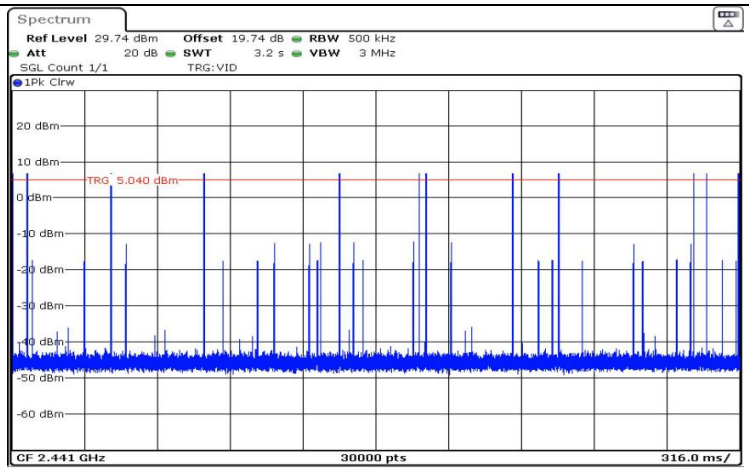
DH3_Ant1_Hop



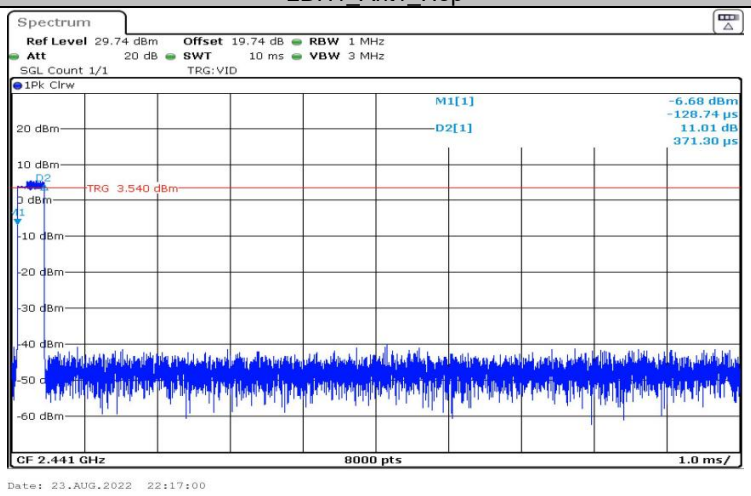

Spectrum
Ref Level 29.74 dBm Offset 19.74 dB RBW 500 kHz
Att 20 dB SWT 3.2 s VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
TRG 5.340 dBm
CF 2.441 GHz 30000 pts 316.0 ms/
Date: 23.AUG.2022 22:41:39

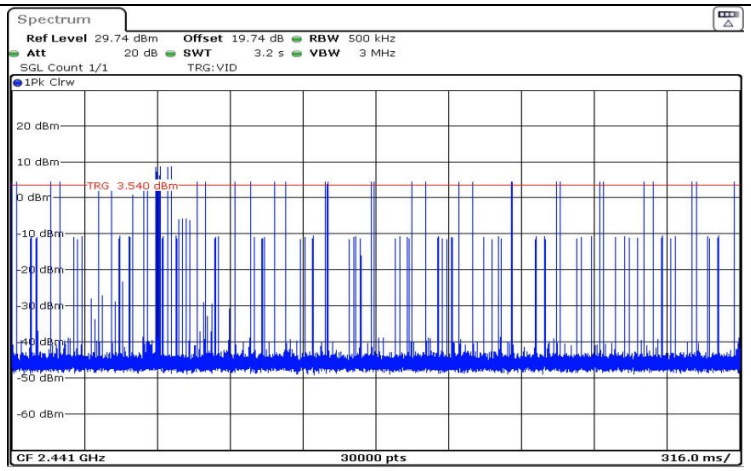
DH5_Ant1_Hop


Spectrum
Ref Level 29.74 dBm Offset 19.74 dB RBW 1 MHz
Att 20 dB SWT 10 ms VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
M1[1] -15.66 dBm
-1.23 µs
D2[1] 22.53 dB
2.85411 ms
TRG 5.040 dBm
CF 2.441 GHz 8000 pts 1.0 ms/
Date: 23.AUG.2022 22:42:32

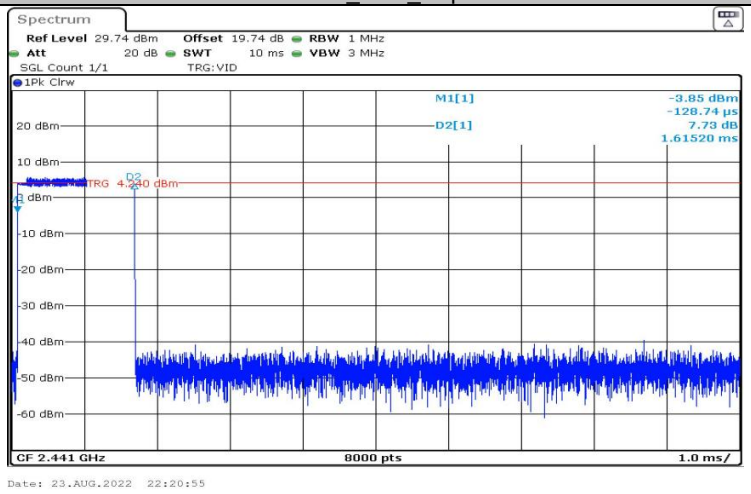

Spectrum
Ref Level 29.74 dBm Offset 19.74 dB RBW 500 kHz
Att 20 dB SWT 3.2 s VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
TRG 5.040 dBm
CF 2.441 GHz 30000 pts 316.0 ms/
Date: 23.AUG.2022 22:42:37

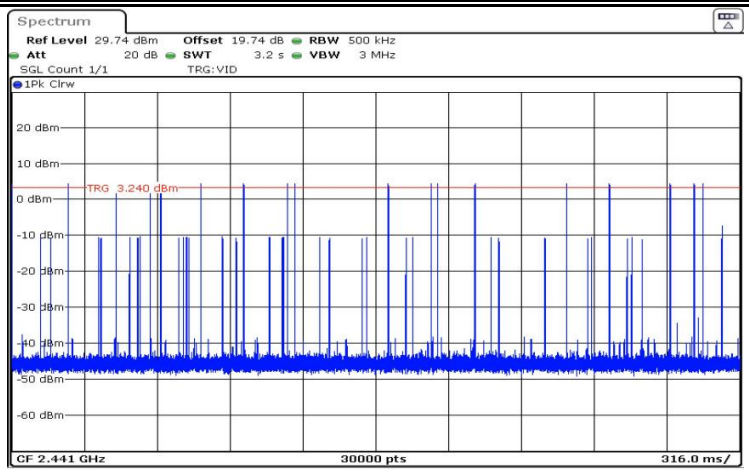
2DH1_Ant1_Hop



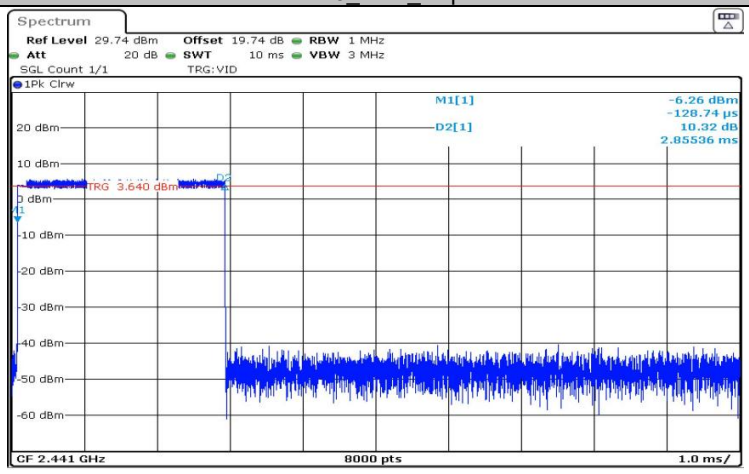


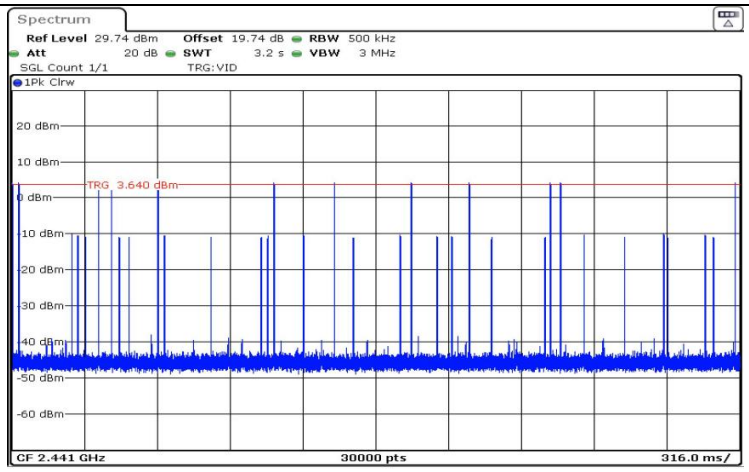
2DH3_Ant1_Hop

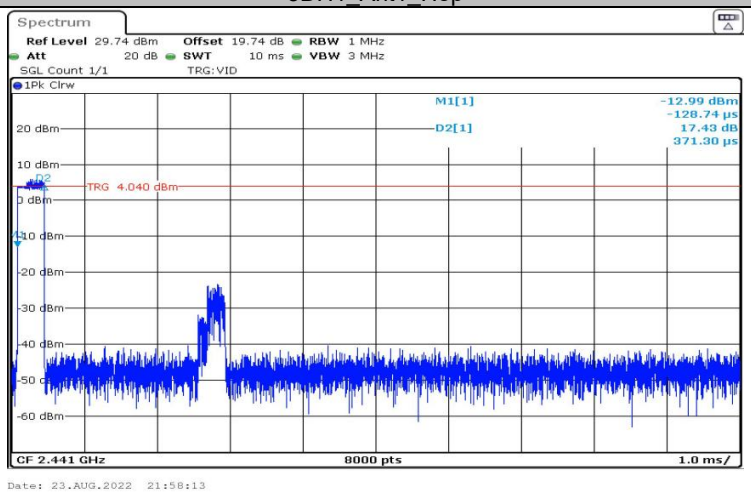
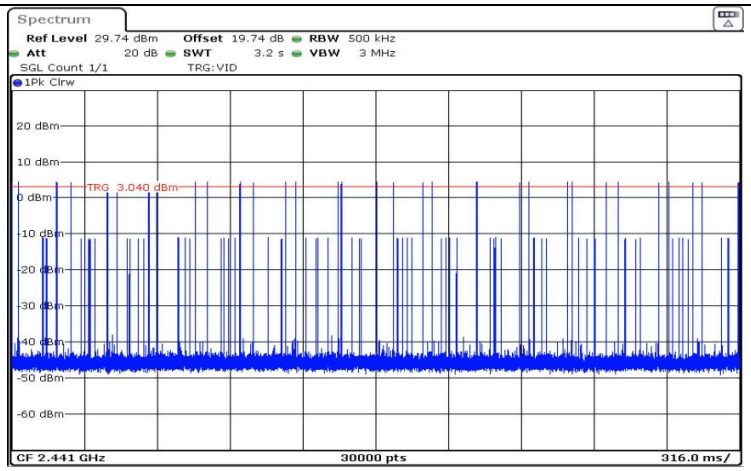
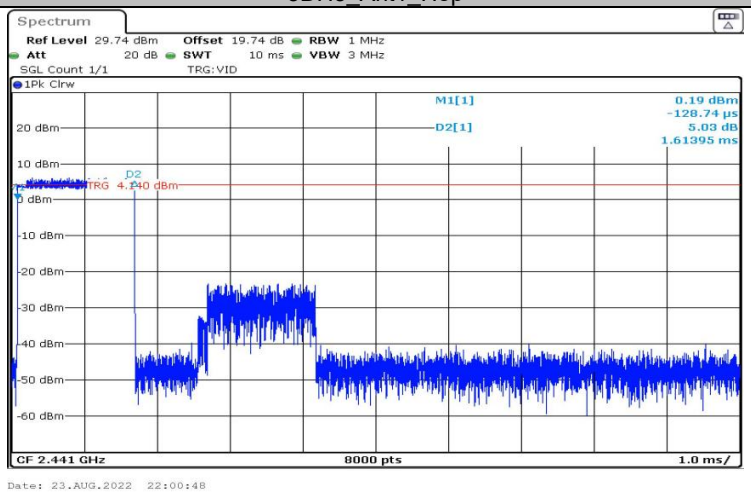


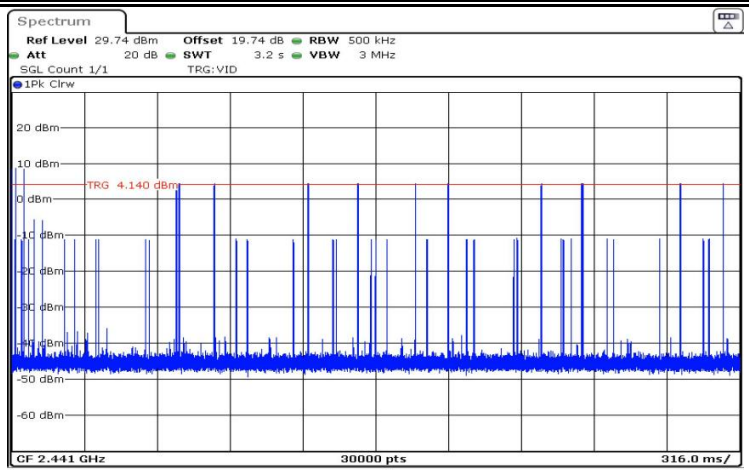


2DH5_Ant1_Hop



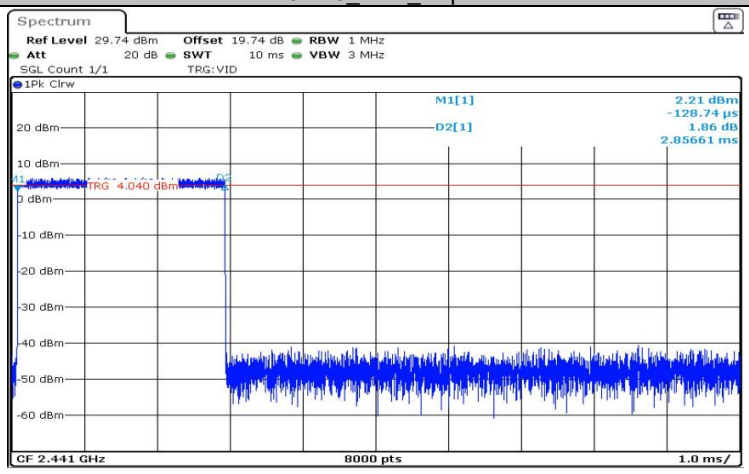


3DH1_Ant1_Hop


3DH3_Ant1_Hop


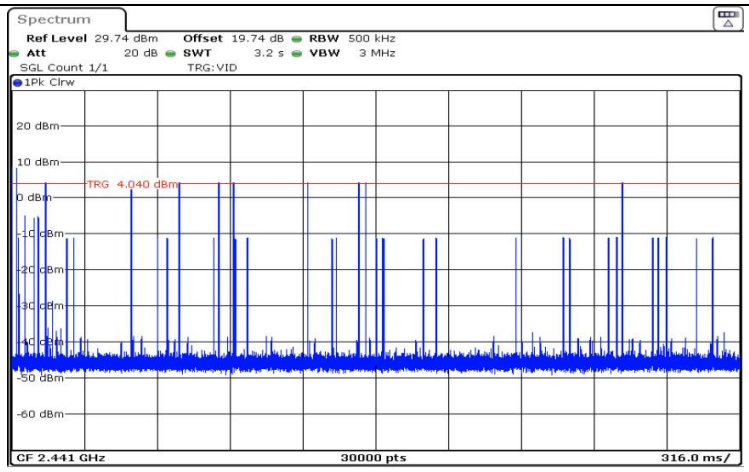


Date: 23.AUG.2022 22:00:54

3DH5_Ant1_Hop



Date: 23.AUG.2022 22:06:04



Date: 23.AUG.2022 22:06:40

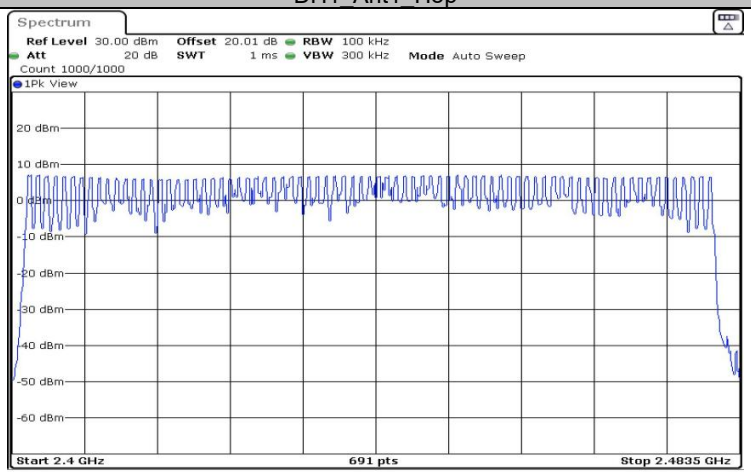
Appendix F: Number of hopping channels

Test Result

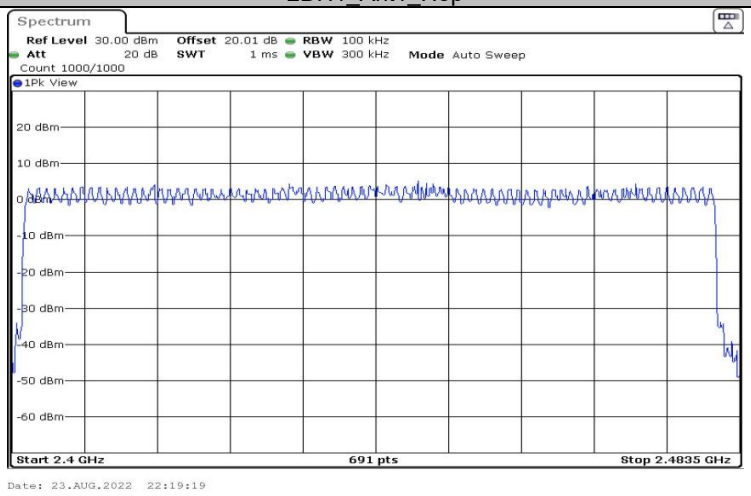
Test Mode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	≥15	PASS
2DH1	Ant1	Hop	79	≥15	PASS
3DH1	Ant1	Hop	79	≥15	PASS

Test Graphs

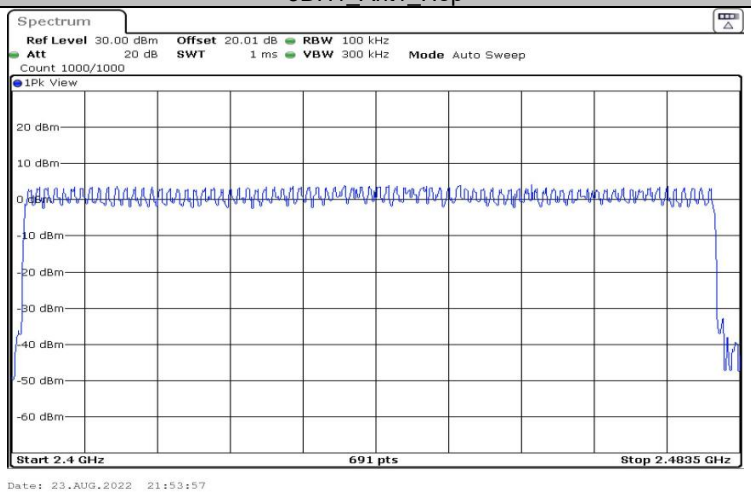
DH1_Ant1_Hop



2DH1_Ant1_Hop



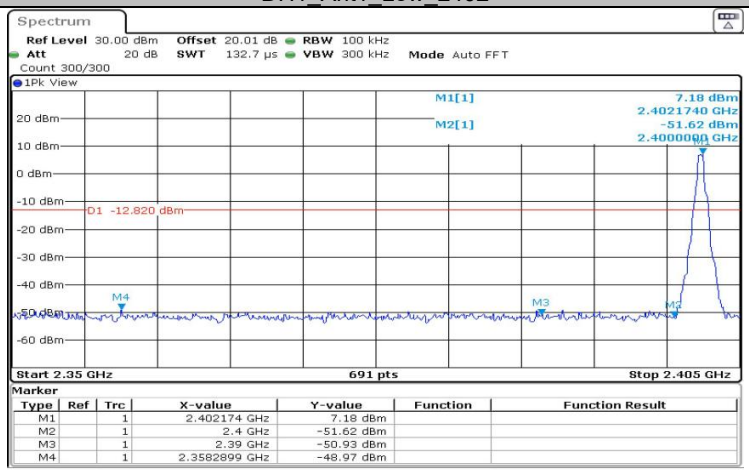
3DH1_Ant1_Hop



Appendix G: Band edge measurements

Test Graphs

DH1_Ant1_Low_2402

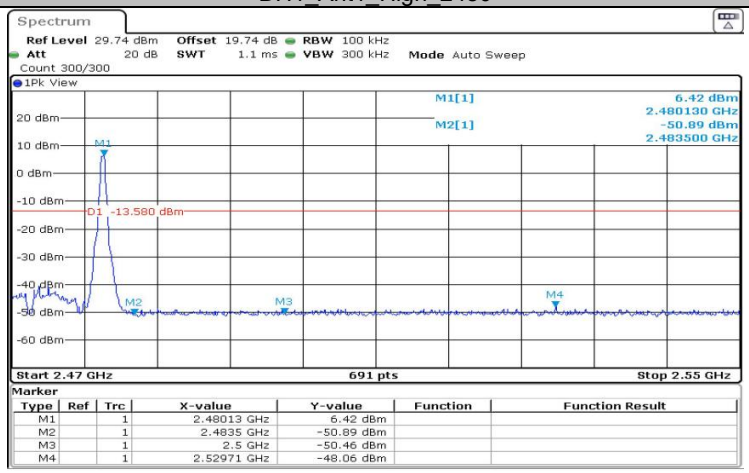


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402174 GHz	7.18 dBm		
M2		1	2.4 GHz	-51.62 dBm		
M3		1	2.39 GHz	-50.93 dBm		
M4		1	2.3582899 GHz	-48.97 dBm		

Date: 23.AUG.2022 22:24:45

DH1_Ant1_High_2480



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48013 GHz	6.42 dBm		
M2		1	2.4835 GHz	-50.89 dBm		
M3		1	2.5 GHz	-50.46 dBm		
M4		1	2.52971 GHz	-48.06 dBm		

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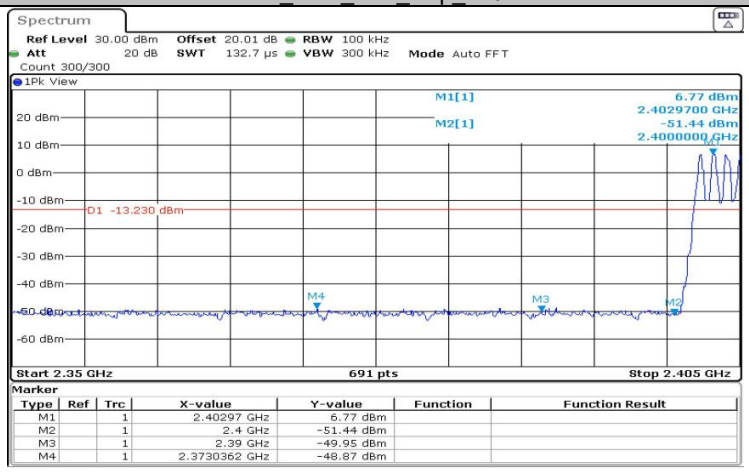
DH1_Ant1_Low_Hop_2402



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40297 GHz	6.77 dBm		
M2		1	2.4 GHz	-51.44 dBm		
M3		1	2.39 GHz	-49.95 dBm		
M4		1	2.3730362 GHz	-48.87 dBm		

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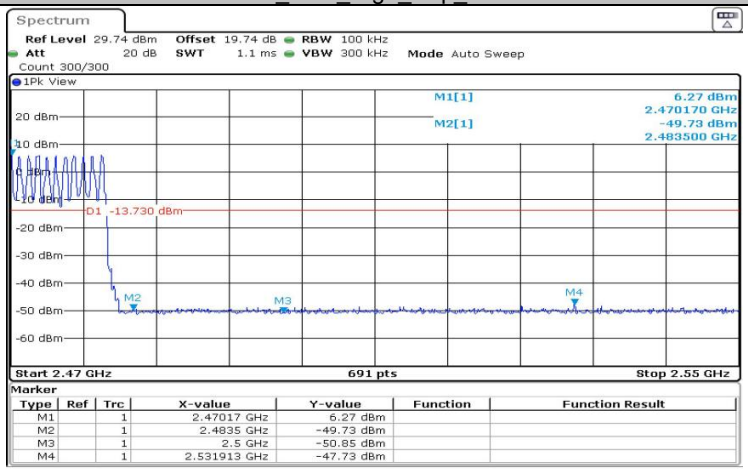
DH1_Ant1_High_Hop_2480



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47017 GHz	6.27 dBm		
M2		1	2.4835 GHz	-49.73 dBm		
M3		1	2.5 GHz	-50.85 dBm		
M4		1	2.531913 GHz	-47.73 dBm		

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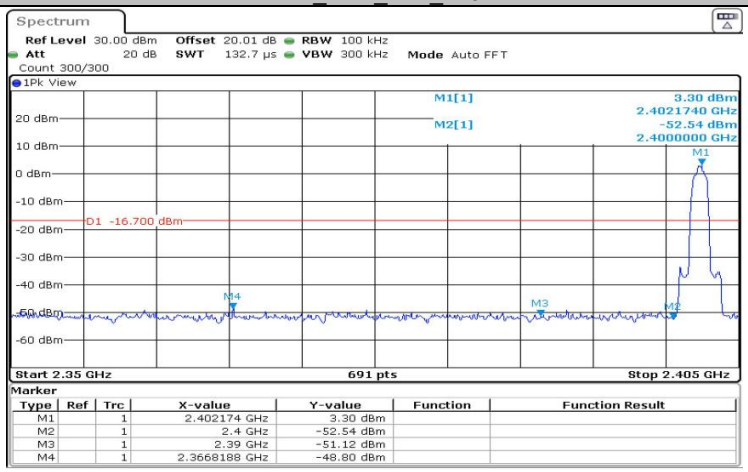
2DH1_Ant1_Low_2402



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402174 GHz	3.30 dBm		
M2		1	2.4 GHz	-52.54 dBm		
M3		1	2.39 GHz	-51.12 dBm		
M4		1	2.3668188 GHz	-48.80 dBm		

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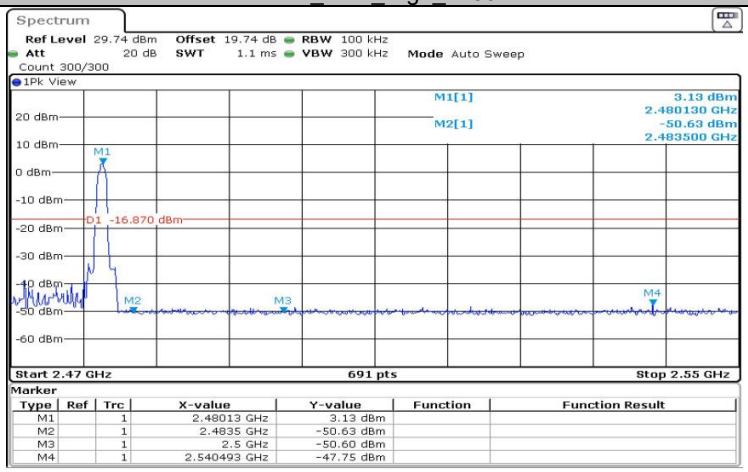
2DH1_Ant1_High_2480



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48013 GHz	3.13 dBm		
M2		1	2.4835 GHz	-50.63 dBm		
M3		1	2.5 GHz	-50.60 dBm		
M4		1	2.540493 GHz	-47.75 dBm		

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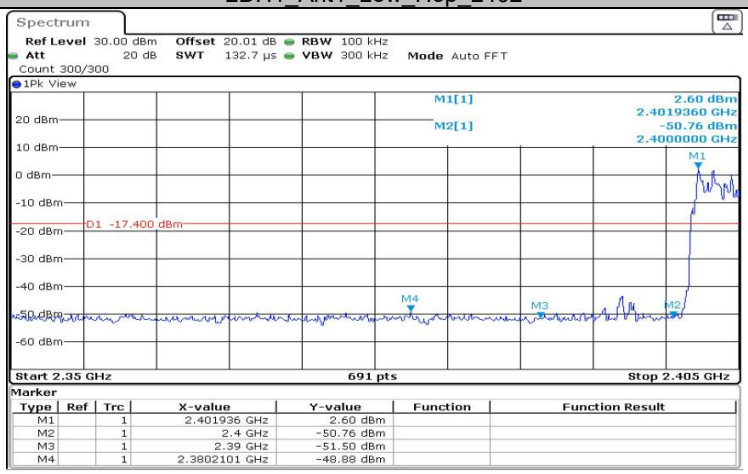
2DH1_Ant1_Low_Hop_2402



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401936 GHz	2.60 dBm		
M2		1	2.4 GHz	-50.76 dBm		
M3		1	2.39 GHz	-51.50 dBm		
M4		1	2.3802101 GHz	-48.88 dBm		

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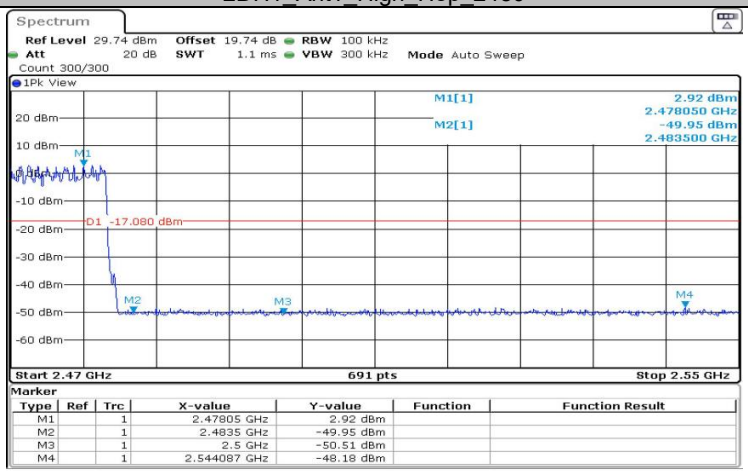
2DH1_Ant1_High_Hop_2480



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47805 GHz	2.92 dBm		
M2		1	2.4835 GHz	-49.95 dBm		
M3		1	2.5 GHz	-50.51 dBm		
M4		1	2.544087 GHz	-48.18 dBm		

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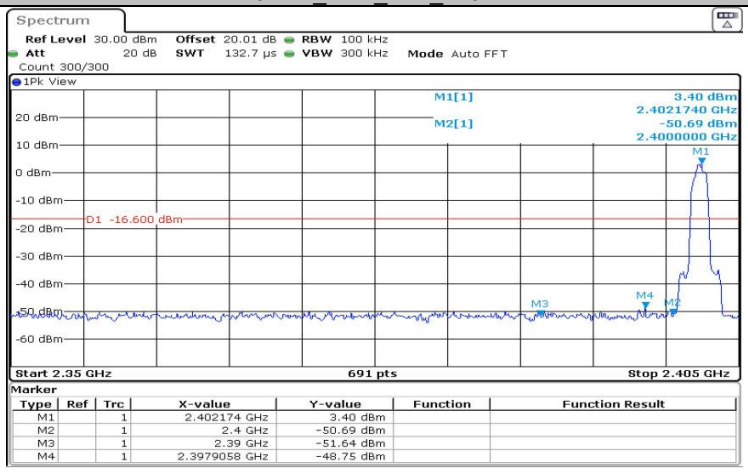
3DH1_Ant1_Low_2402



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402174 GHz	3.40 dBm		
M2		1	2.4 GHz	-50.69 dBm		
M3		1	2.39 GHz	-51.64 dBm		
M4		1	2.3979058 GHz	-48.75 dBm		

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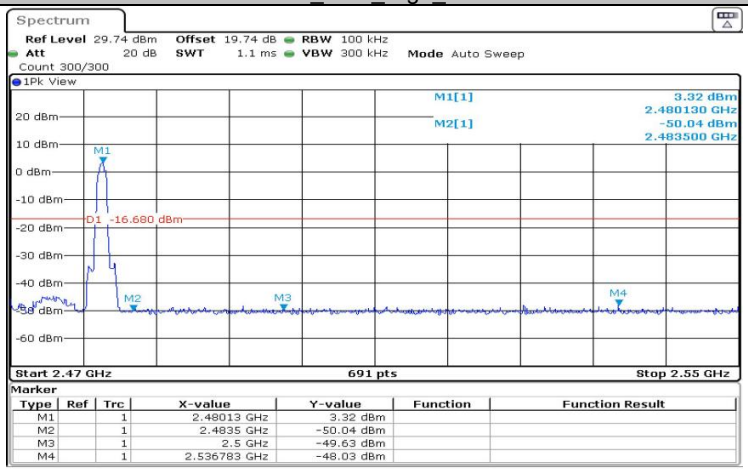
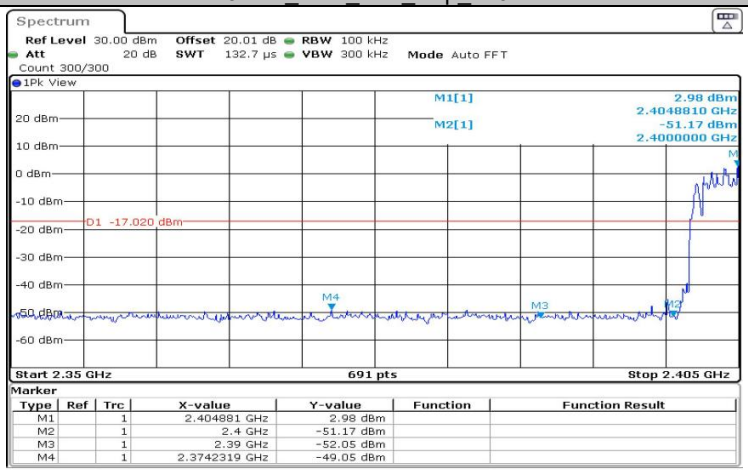
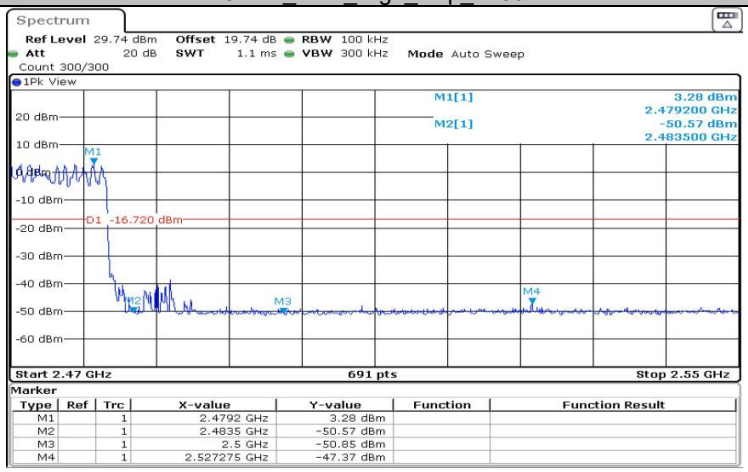
3DH1_Ant1_High_2480



3DH1_Ant1_Low_Hop_2402



3DH1_Ant1_High_Hop_2480



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