FCC Part 15.247

TEST REPORT

For

Shanghai Zenchant Electronic CO.,LTD.

Room 1203,Building A,Noble International Center,No.908 xiuwen Road,Minghang District,Shanghai,China

Report Type	**Original Report**
FCC Identity:	**FCC ID: 2AOC9-ZENBDM10A**
Product Name	**Dual-mode Bluetooth module**
Model Name	**ZEN-BDM10-A**
Report Number	**RSHD201120004-00B**
Report Date	**2020/12/23**
Reviewed By	**Flight Hsieh** Flight.Hsieh
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Revision History

Revision	Report Number	Issue Date	Description
1.0	RSHD201120004-00B	2020/12/23	Original Report

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	**Shanghai Zenchant Electronic CO.,LTD.** Room 1203,Building A,Noble International Center,No.908 xiuwen Road,Minghang District,Shanghai,China
Manufacturer	**Shanghai Zenchant Electronic CO.,LTD.** Room 1203,Building A,Noble International Center,No.908 xiuwen Road,Minghang District,Shanghai,China
Product (Equipment)	Dual-mode Bluetooth module
Model Name	ZEN-BDM10-A
Frequency Range	2402 - 2480 MHz
Number of Channels	79 Channels
Output Power	BR-1Mbps: 3.63 dBm (0.0023 W) EDR-2Mbps: 3.59 dBm (0.0023 W)
Modulation Type	BR-1Mbps: GFSK EDR-2Mbps: π/4-DQPSK
Related Submittal(s)/Grant(s)	**FCC Part 15.247 DTS with FCC ID: 2AOC9-ZENBDM10A**
Received Date	2020/11/25
Date of Test	2020/11/26 - 2020/12/04

*All measurement and test data in this report was gathered from production sample serial number: 201120004 (Assigned by BACL, Linkou Laboratory).

1.2 Operation Condition of EUT

Power Operation (Voltage Range)	☐ AC 120 V/60 Hz ☐ Adapter ☐ By Power Cord.
	☒ DC Type ☐ DC Power ☐ Battery ☒ From Host: 3.7Vdc ☐ External DC Adapter

1.3 Objective and Test Methodology

The Objective of this Test Report was to document the compliance of the Shanghai Zenchant Electronic CO.,LTD..

Appliance (Model: ZEN-BDM10-A) to the requirements of the following Standards:

- Part 2, Subpart J, Part 15, Subparts A and C, section 15.247 of the Federal Communication Commission's rules.
- ANSI C63.10-2013 of t American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.4 Measurement Uncertainty

Parameter	Expanded Measurement uncertainty
RF output power with Power Meter	± 1.488 dB
Occupied Channel Bandwidth	± 453.927 Hz
RF Conducted test with Spectrum	± 2.77 dB
AC Power Line Conducted Emission	± 2.66 dB
Radiated Below 1G	± 3.57 dB
Radiated Above 1G	± 5.32 dB

The test results with statement of conformity, the decision rules are based on the specifications and standards. The test results will not take the measurement uncertainty into account.

1.5 Environmental Conditions and Test Date

Test Site	Test Date	Temperature (°C)	Relative Humidity (% RH)	Test Engineer
Conduction (Con-01)	2020/11/26	20.9	57	Brian Chang
Radiated (966B)	2020/12/04	22.0	56	Brian Chang
Conducted (TH-02)	2020/12/01	22.5	60	Rui Zhan

1.6 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Linkou Laboratory) to collect test data is located on

☒ No.6, Wende 2Rd., Guishan Dist., Taoyuan City 33382, Taiwan (R.O.C.).

Bay Area Compliance Laboratories Corp. (Linkou Laboratory) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3546) by Mutual Recognition Agreement (MRA). 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. The FCC Registration No.: 0027578244. Designation No.: TW3546. The Test Firm Registration No.: 181430.

2 System Test Configuration

2.1 Description of Test Configuration

The system was configured for testing in testing mode which was provided by manufacturer. No special accessory, No modification was made to the EUT and No special equipment used during test.

For BT (BR/EDR), there are totally 79 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	**2402**	**39**	**2441**
1	2403	--	--
2	2404	--	--
3	2405	76	2478
--	--	77	2479
38	2440	**78**	**2480**

For BLE: Channel **0**, **39** and **78** were tested.

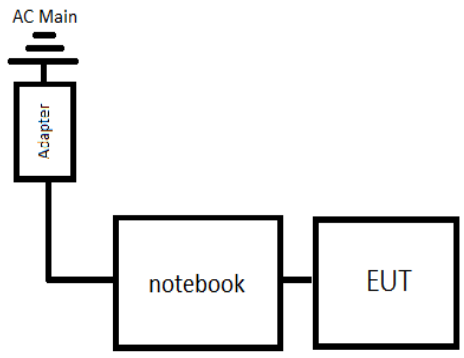
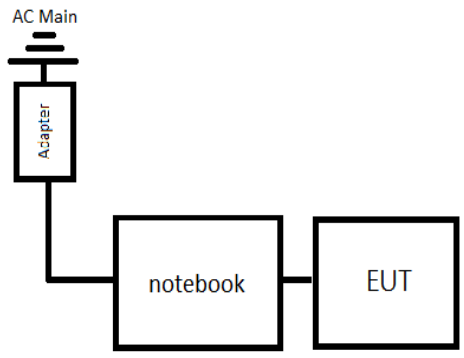
The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the peak power across all date rates bandwidths, and modulations. Radiated below 1G were tested worst output power.

Worst Case of Power Setting				
EUT Exercise Software		FCC Assist 1.0.0.2		
Configuration	**N_{TX}**	**Low CH**	**Mid CH**	**High CH**
BR-1Mbps mode	1	10	10	10
EDR-2Mbps mode	1	10	10	06

2.2 Support Equipment List and Details

No.	Description	Manufacturer	Model Number	Serial Number
A	NoteBook	DELL	Latitude E6410	NoteBook

2.3 Block Diagram of Test Setup

Conduction	Radiation
	

3 Summary of Test Results

FCC Rules	Description of Test	Result
§15.247(i), §1.1310, §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247(a)(1)	20 dB Emission 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)(3)	Maximum Peak Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance

4 FCC§15.247(i), §1.1310, § 2.1091 –Maximum Permissible Exposure (MPE)

4.1 Applicable Standard

According to subpart 15.247(i)and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30
30–300	27.5	0.073	0.2	30
300–1500	/	/	f/1500	30
1500–100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary: Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = 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);

4.2 RF Exposure Evaluation Result

MPE Evaluation:

Mode	Frequency Range (MHz)	Antenna Gain		Target Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
BR/EDR	2402-2480	-1.39	0.7261	4.00	2.5119	20	0.0004	1.0
BLE	2402-2480	-1.39	0.7261	4.00	2.5119	20	0.0004	1.0

Result: MPE evaluation of single transmission meet the requirement of standard.

5 FCC §15.203 – Antenna Requirements

5.1 Applicable Standard

According to § 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 user of a standard antenna jack or electrical connector is prohibited.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna does not exceed 6dBi

5.2 Antenna List and Details

Brand	Model	Antenna Type	Antenna Gain	Result
ZenChant	ZEN-BDM10	PCB	-1.39 dBi	Compliance

The EUT has an internal antennas arrangement and fulfill the requirement of this section.

6 FCC §15.207 - AC Line Conducted Emissions

6.1 Applicable Standard

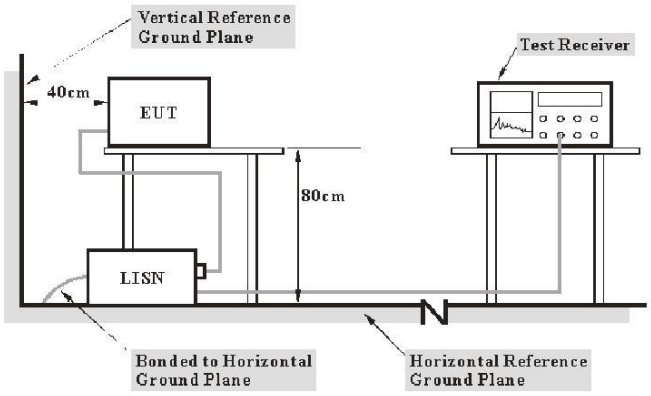
According to FCC §15.207,

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency. Note 2: A linear average detector is required

6.2 EUT Setup and Test Procedure



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 setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits

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	Receiver RBW
150 kHz - 30 MHz	9 kHz

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

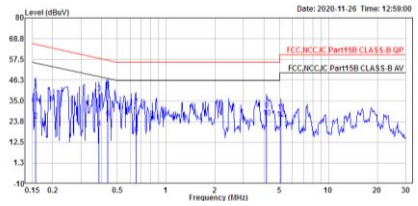
6.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
AC Line Conduction Room (CON-01)					
Two-Line V-Network	Rohde & Schwarz	ENV216	100010	2020/09/14	2021/09/13
Pulse Limiter	SCHWARZBECK	VSTD 9561-F	00432	2020/09/11	2021/09/10
ESR EMI Test Receiver	Rohde & Schwarz	ESR3	102430	2020/05/07	2021/05/06
RF Cable	EMCI	EMCCFD300-BM-BM-8000	180526	2020/08/18	2021/08/17
Software	Audix	e3 v9	E3LK-03	N.C.R	N.C.R

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

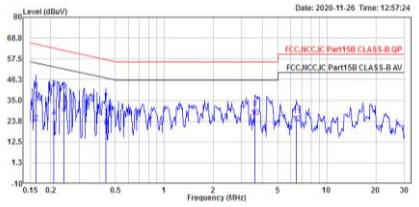
6.4 Test Data and Test Plot

Line



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.157	20.05	39.91	19.86	65.60	-25.69	QP
2	0.157	4.46	24.32	19.86	55.60	-31.28	Average
3	0.387	19.47	39.34	19.87	58.13	-18.79	QP
4	0.387	0.28	20.15	19.87	48.13	-27.98	Average
5	0.436	21.07	40.95	19.88	57.13	-16.18	QP
6	0.436	5.90	25.78	19.88	47.13	-21.35	Average
7	0.655	12.34	32.25	19.91	56.00	-23.75	QP
8	0.655	-3.08	16.83	19.91	46.00	-29.17	Average
9	4.159	10.03	30.09	20.06	56.00	-25.91	QP
10	4.159	6.07	26.13	20.06	46.00	-19.87	Average
11	5.076	8.84	28.92	20.08	60.00	-31.08	QP
12	5.076	5.17	25.25	20.08	50.00	-24.75	Average

Neutral



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.162	20.53	40.40	19.87	65.34	-24.94	QP
2	0.162	3.09	22.96	19.87	55.34	-32.38	Average
3	0.208	21.66	41.54	19.88	63.29	-21.75	QP
4	0.208	6.22	26.10	19.88	53.29	-27.19	Average
5	0.240	20.67	40.55	19.88	62.10	-21.55	QP
6	0.240	7.37	27.25	19.88	52.10	-24.85	Average
7	0.436	14.66	34.55	19.89	57.13	-22.58	QP
8	0.436	0.75	20.64	19.89	47.13	-26.49	Average
9	3.603	10.84	30.90	20.06	56.00	-25.10	QP
10	3.603	5.98	26.04	20.06	46.00	-19.96	Average
11	6.498	6.48	26.64	20.16	60.00	-33.36	QP
12	6.498	2.44	22.60	20.16	50.00	-27.40	Average

Note:

Level = Read Level + Factor

Over Limit (Margin) = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

7 FCC §15.209, §15.205, §15.247(d) – Spurious Emissions

7.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1MHz.

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	13.36-13.41	399.9-410	4.5-5.15
0.495-0.505	16.42-16.423	608-614	5.35-5.46
2.1735-2.1905	16.69475-16.69525	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

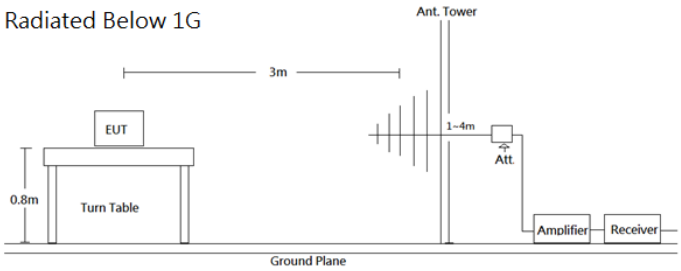
Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

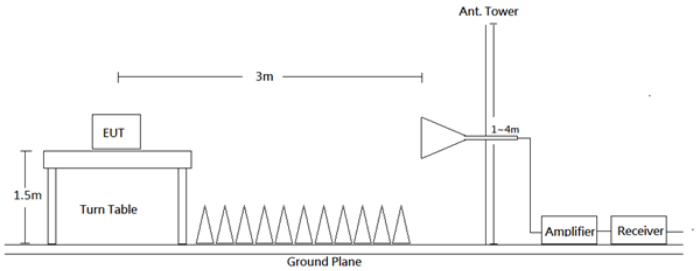
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the 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 20dB. 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).

7.2 EUT Setup and Test Procedure

Radiated Below 1G



Radiated Above 1G



Radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC Part 15.209 and FCC 15.247 Limits.

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	Detector	Measurement method
30-1000 MHz	120 kHz	/	QP	QP
Above 1 GHz	1 MHz	3 MHz	PK	PK
	1 MHz	10 Hz	RMS	Ave

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations. All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

7.3 Test Equipment List and Details

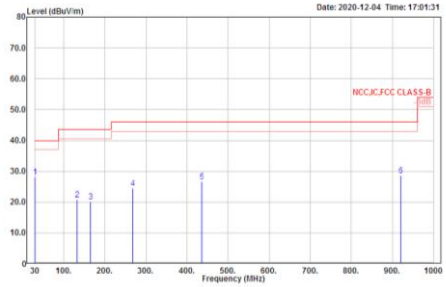
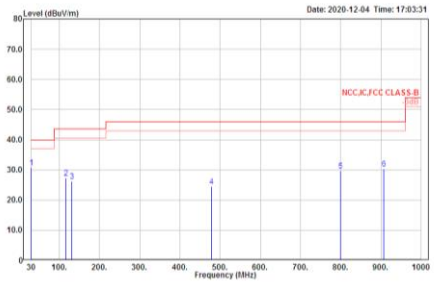
Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Radiation 3M Room (966B)					
Active Loop	EMCO	6502	0001-3322	2020/03/16	2021/03/15
Bilog Antenna/6 dB Attenuator	SUNOL SCIENCES & EMEC /EMCI	JB3/N-6-06	A111513/AT-N0668	2020/03/19	2021/03/18
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
Horn Antenna	ETS-Lindgren	3115	00109141	2020/07/15	2021/07/14
Horn Antenna	ETS-Lindgren	3160-09	00123852	2020/07/07	2021/07/06
Preamplifier	A.H. Systems	PAM-1840VH	174	2020/03/25	2021/03/24
Preamplifier	A.H. Systems	PAM-0118	478	2020/05/05	2021/05/04
Microflex Cable (1m)	EMCI	EMC102-KM-KM-1000	180524	2020/08/06	2021/08/05
Microflex Cable (2m)	EMCI	EMC106-SM-SM-2000	180516	2020/08/06	2021/08/05
Microflex Cable (8m)	UTIFLEX	UFA210A-1-3149-300300	MFR 64639 232490-002	2020/08/06	2021/08/05
Turn Table	Chaintek	T-200-S-1	003501	N.C.R	N.C.R
Antenna Tower	Chaintek	MBD-400-1	003504	N.C.R	N.C.R
Controller	Chaintek	3000-1	003507	N.C.R	N.C.R
Software	Audix	e3 v9	E3LK-01	N.C.R	N.C.R
Conducted Room(TH-02)					
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
SMA 10dB Fixed Attenuator	MVE	2W 6GHz	N/A	Each use	-
Cable	MTJ	MT40S	620620-MT40S-100	Each Use	-

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

7.4 Radiated Emission Test Plot and Data

Transmitting mode (Pre-scan with three orthogonal axis, and worse case as X axis)

Below 1G (30 MHz-1 GHz)

Horizontal	Vertical
	

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	30.970	35.39	-7.25	28.14	40.00	-11.86	Peak
2	132.820	37.49	-16.74	20.75	43.50	-22.75	Peak
3	165.880	38.58	-18.50	20.08	43.50	-23.42	Peak
4	268.620	41.87	-17.48	24.39	46.00	-21.61	Peak
5	436.430	40.82	-14.13	26.69	46.00	-19.31	Peak
6	920.460	35.10	-6.43	28.67	46.00	-17.33	Peak

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	30.000	36.88	-6.13	30.75	40.00	-9.25	Peak
2	116.330	44.26	-16.99	27.27	43.50	-16.23	Peak
3	131.850	42.88	-16.74	26.14	43.50	-17.36	Peak
4	479.110	37.54	-12.95	24.59	46.00	-21.41	Peak
5	799.210	37.41	-7.79	29.62	46.00	-16.38	Peak
6	906.880	36.81	-6.52	30.29	46.00	-15.71	Peak

Note:

Level = Read Level + Factor, Over Limit = Level – Limit,

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported

Above 1G (1 GHz-26.5 GHz)

BR-1Mbps mode:

Low CH

Horizontal

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2336.500	55.05	-6.75	48.30	74.00	-25.70	Peak
2336.500	43.27	-6.75	36.52	54.00	-17.48	Average
2402.000	101.43	-6.61	94.82			Peak
2402.000	100.68	-6.61	94.07			Average
4804.000	42.69	0.67	43.36	74.00	-30.64	Peak
4804.000	32.73	0.67	33.40	54.00	-20.60	Average
7206.000	42.56	7.41	49.97	74.00	-24.03	Peak
7206.000	34.17	7.41	41.58	54.00	-12.42	Average

Vertical

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2389.700	54.96	-6.66	48.30	74.00	-25.70	Peak
2389.700	41.91	-6.66	35.25	54.00	-18.75	Average
2402.000	89.59	-6.61	82.98			Peak
2402.000	88.86	-6.61	82.25			Average
4804.000	42.43	0.67	43.10	74.00	-30.90	Peak
4804.000	31.33	0.67	32.00	54.00	-22.00	Average
7206.000	41.37	7.41	48.78	74.00	-25.22	Peak
7206.000	31.30	7.41	38.71	54.00	-15.29	Average

Middle CH

Horizontal

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2321.858	54.34	-6.69	47.65	74.00	-26.35	Peak
2321.858	42.01	-6.69	35.32	54.00	-18.68	Average
2441.164	101.92	-6.23	95.69			Peak
2441.164	101.14	-6.23	94.91			Average
2489.806	54.49	-5.90	48.59	74.00	-25.41	Peak
2489.806	46.18	-5.90	40.28	54.00	-13.72	Average
4882.000	42.46	1.10	43.56	74.00	-30.44	Peak
4882.000	33.11	1.10	34.21	54.00	-19.79	Average
7323.000	44.71	7.80	52.51	74.00	-21.49	Peak
7323.000	36.55	7.80	44.35	54.00	-9.65	Average

Vertical

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2390.000	54.05	-6.66	47.39	74.00	-26.61	Peak
2390.000	41.90	-6.66	35.24	54.00	-18.76	Average
2441.164	91.24	-6.23	85.01			Peak
2441.164	90.47	-6.23	84.24			Average
2539.900	53.87	-5.70	48.17	74.00	-25.83	Peak
2539.900	42.16	-5.70	36.46	54.00	-17.54	Average
4882.000	42.97	1.10	44.07	74.00	-29.93	Peak
4882.000	31.54	1.10	32.64	54.00	-21.36	Average
7323.000	42.57	7.80	50.37	74.00	-23.63	Peak
7323.000	32.85	7.80	40.65	54.00	-13.35	Average

High CH

Horizontal

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2479.922	101.70	-5.96	95.74			Peak
2479.922	100.97	-5.96	95.01			Average
2483.500	56.84	-5.94	50.90	74.00	-23.10	Peak
2483.500	46.98	-5.94	41.04	54.00	-12.96	Average
4960.000	42.92	1.25	44.17	74.00	-29.83	Peak
4960.000	33.34	1.25	34.59	54.00	-19.41	Average
7440.000	45.34	8.07	53.41	74.00	-20.59	Peak
7440.000	34.48	8.07	42.55	54.00	-11.45	Average

Vertical

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2479.922	90.75	-5.96	84.79			Peak
2479.922	90.02	-5.96	84.06			Average
2503.784	54.78	-5.82	48.96	74.00	-25.04	Peak
2503.784	42.12	-5.82	36.30	54.00	-17.70	Average
4960.000	43.09	1.25	44.34	74.00	-29.66	Peak
4960.000	31.79	1.25	33.04	54.00	-20.96	Average
7440.000	44.97	8.07	53.04	74.00	-20.96	Peak
7440.000	33.98	8.07	42.05	54.00	-11.95	Average

EDR-2Mbps mode:

Low CH

Horizontal

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2373.200	54.75	-6.72	48.03	74.00	-25.97	Peak
2373.200	43.08	-6.72	36.36	54.00	-17.64	Average
2402.000	101.60	-6.61	94.99			Peak
2402.000	97.53	-6.61	90.92			Average
4804.000	42.05	0.67	42.72	74.00	-31.28	Peak
4804.000	32.56	0.67	33.23	54.00	-20.77	Average
7206.000	42.10	7.41	49.51	74.00	-24.49	Peak
7206.000	32.93	7.41	40.34	54.00	-13.66	Average

Vertical

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2390.000	54.54	-6.66	47.88	74.00	-26.12	Peak
2390.000	41.93	-6.66	35.27	54.00	-18.73	Average
2402.000	90.26	-6.61	83.65			Peak
2402.000	86.22	-6.61	79.61			Average
4804.000	42.14	0.67	42.81	74.00	-31.19	Peak
4804.000	31.56	0.67	32.23	54.00	-21.77	Average
7206.000	42.52	7.41	49.93	74.00	-24.07	Peak
7206.000	30.96	7.41	38.37	54.00	-15.63	Average

Middle CH

Horizontal

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2348.962	53.93	-6.80	47.13	74.00	-26.87	Peak
2348.962	42.06	-6.80	35.26	54.00	-18.74	Average
2440.922	102.15	-6.23	95.92			Peak
2440.922	98.09	-6.23	91.86			Average
2488.838	54.44	-5.91	48.53	74.00	-25.47	Peak
2488.838	45.45	-5.91	39.54	54.00	-14.46	Average
4882.000	41.98	1.10	43.08	74.00	-30.92	Peak
4882.000	32.66	1.10	33.76	54.00	-20.24	Average
7323.000	42.58	7.80	50.38	74.00	-23.62	Peak
7323.000	32.35	7.80	40.15	54.00	-13.85	Average

Vertical

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2339.282	54.49	-6.76	47.73	74.00	-26.27	Peak
2339.282	42.10	-6.76	35.34	54.00	-18.66	Average
2440.922	90.42	-6.23	84.19			Peak
2440.922	86.45	-6.23	80.22			Average
2541.836	54.64	-5.69	48.95	74.00	-25.05	Peak
2541.836	42.09	-5.69	36.40	54.00	-17.60	Average
4882.000	43.27	1.10	44.37	74.00	-29.63	Peak
4882.000	31.31	1.10	32.41	54.00	-21.59	Average
7323.000	42.61	7.80	50.41	74.00	-23.59	Peak
7323.000	31.96	7.80	39.76	54.00	-14.24	Average

High CH

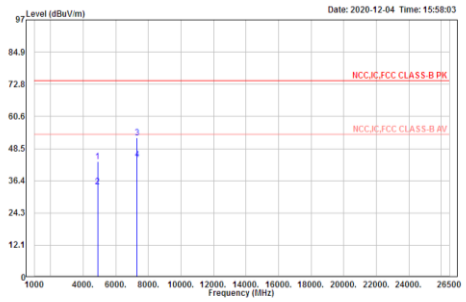
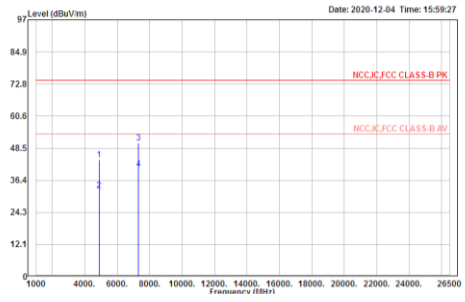
Horizontal

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2479.922	100.79	-5.96	94.83			Peak
2479.922	96.82	-5.96	90.86			Average
2483.500	55.11	-5.94	49.17	74.00	-24.83	Peak
2483.500	44.50	-5.94	38.56	54.00	-15.44	Average
4960.000	42.24	1.25	43.49	74.00	-30.51	Peak
4960.000	32.90	1.25	34.15	54.00	-19.85	Average
7440.000	40.60	8.07	48.67	74.00	-25.33	Peak
7440.000	31.42	8.07	39.49	54.00	-14.51	Average

Vertical

Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
2479.922	88.52	-5.96	82.56			Peak
2479.922	84.56	-5.96	78.60			Average
2493.370	54.08	-5.88	48.20	74.00	-25.80	Peak
2493.370	42.10	-5.88	36.22	54.00	-17.78	Average
4960.000	43.34	1.25	44.59	74.00	-29.41	Peak
4960.000	31.67	1.25	32.92	54.00	-21.08	Average
7440.000	41.10	8.07	49.17	74.00	-24.83	Peak
7440.000	32.39	8.07	40.46	54.00	-13.54	Average

Above 1G (1 GHz-26.5 GHz): The worst mode is BR-1Mbps Middle CH.

Horizontal	Vertical
	

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4882.000	42.46	1.10	43.56	74.00	-30.44	Peak
2 !	4882.000	33.11	1.10	34.21	54.00	-19.79	Average
3	7323.000	44.71	7.80	52.51	74.00	-21.49	Peak
4 !	7323.000	36.55	7.80	44.35	54.00	-9.65	Average

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4882.000	42.97	1.10	44.07	74.00	-29.93	Peak
2	4882.000	31.54	1.10	32.64	54.00	-21.36	Average
3	7323.000	42.57	7.80	50.37	74.00	-23.63	Peak
4 !	7323.000	32.85	7.80	40.65	54.00	-13.35	Average

Level = Read Level + Factor

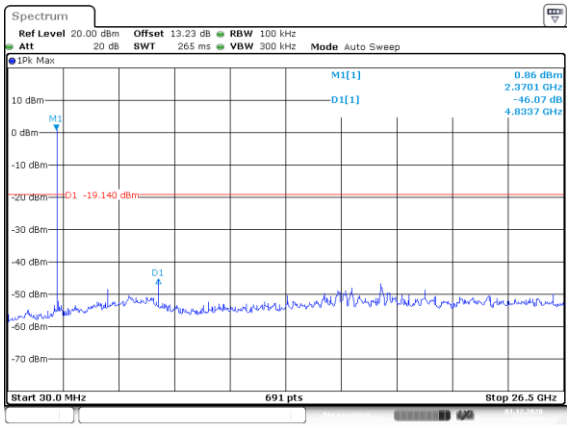
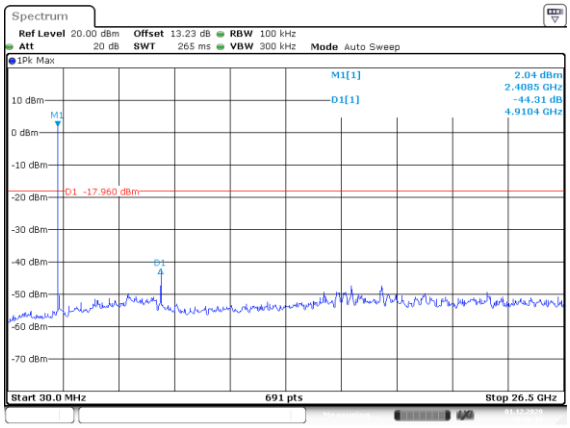
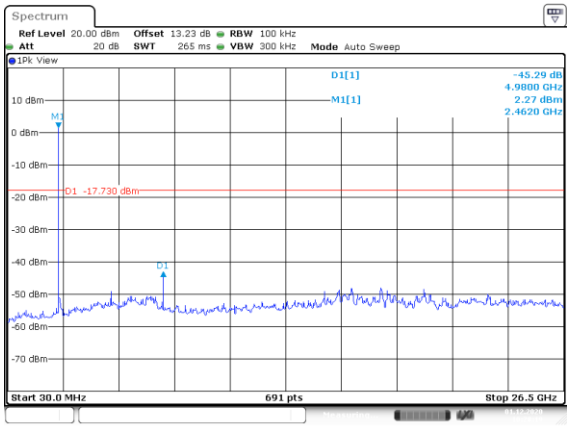
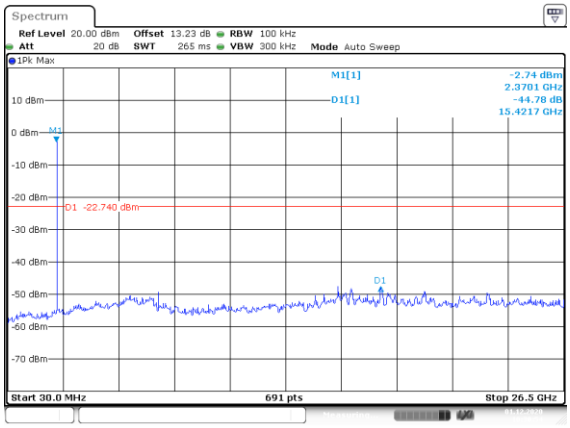
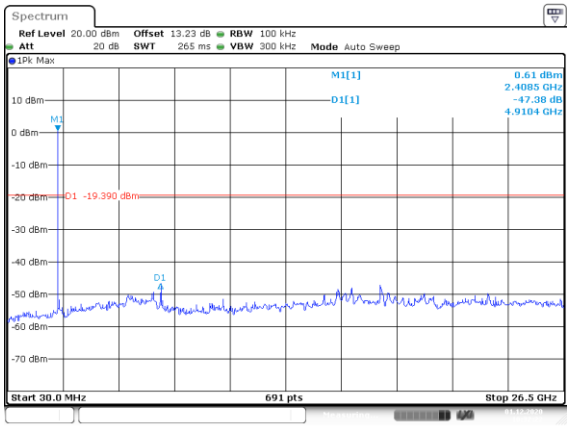
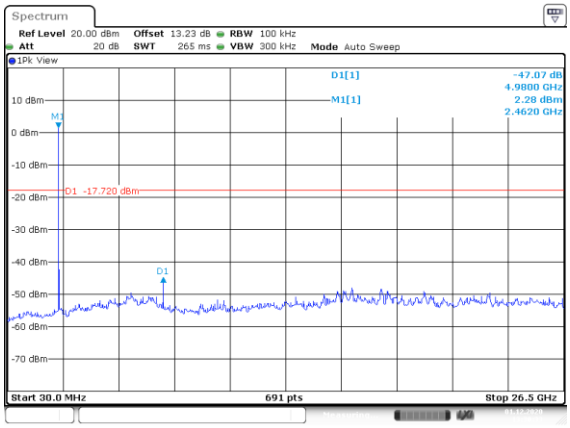
Over Limit = Level – Limit

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported

Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BR-1Mbps				
Low	2402	46.07	≥ 20	Compliance
Mid	2441	44.31	≥ 20	Compliance
High	2480	45.29	≥ 20	Compliance
EDR-2Mbps				
Low	2402	44.78	≥ 20	Compliance
Mid	2441	47.38	≥ 20	Compliance
High	2480	47.07	≥ 20	Compliance

BR-1Mbps Low CH	BR-1Mbps Middle CH
	
BR-1Mbps High CH	**EDR-2Mbps Low CH**
	
EDR-2Mbps Middle CH	**EDR-2Mbps High CH**
	

8 FCC §15.247(a)(1) – 20 dB Emission Bandwidth

8.1 Applicable Standard

According to FCC §15.247(a) (1) the maximum 20 dB bandwidth of the hopping channel shall be presented.

8.2 Test Procedure

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

(2) Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.

(3) Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.

(4) Repeat above procedures until all frequencies measured were complete.

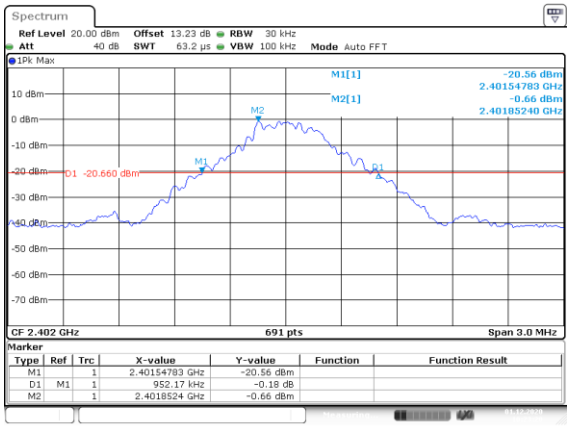
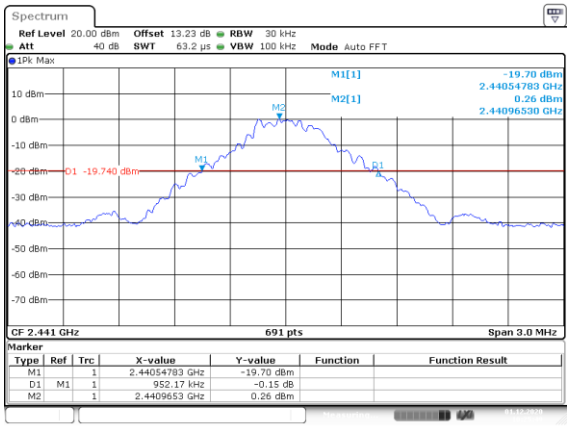
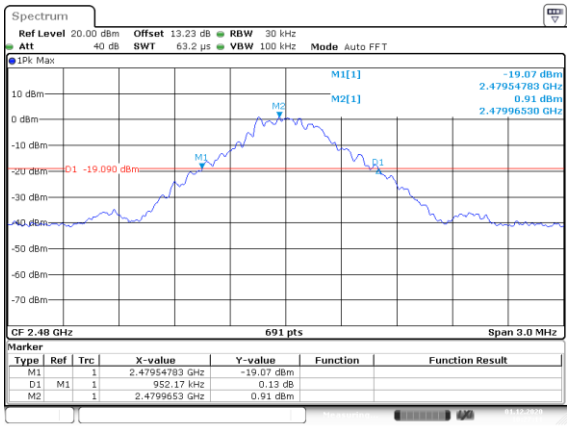
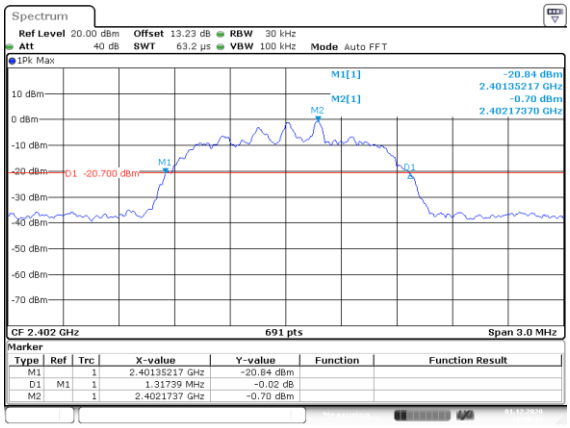
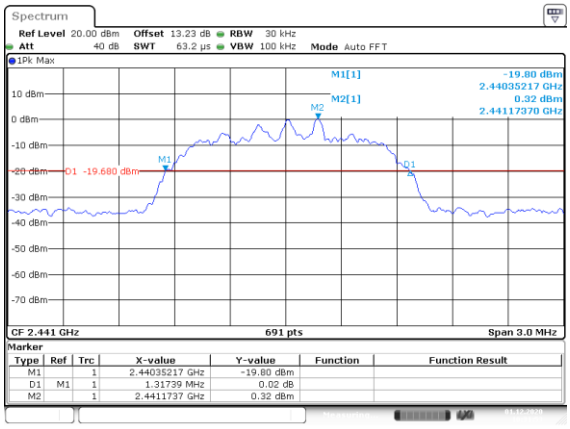
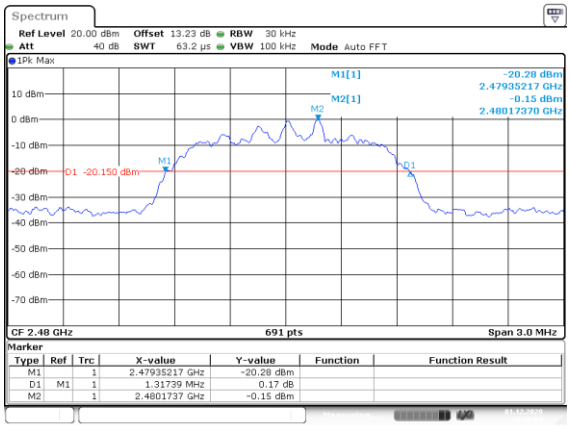
8.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
Cable	MTJ	MT40S	620620-MT40S-100	Each use	-
SMA 10dB Fixed Attenuator	MVE	2W 6GHz	N/A	Each use	-

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

8.4 Test Results

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
BR-1Mbps		
Low	2402	0.95
Middle	2441	0.95
High	2480	0.95
EDR-2Mbps		
Low	2402	1.32
Middle	2441	1.32
High	2480	1.32

BR-1Mbps Low CH	BR-1Mbps Middle CH
	
BR-1Mbps High CH	**EDR-2Mbps Low CH**
	
EDR-2Mbps Middle CH	**EDR-2Mbps High CH**
	

9 FCC §15.247(a)(1) – Channel Separation Test

9.1 Applicable Standard

According to FCC §15.247(a) (1): Frequency hopping systems 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, 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.

9.2 Test Procedure

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) ≈ 30% of the channel spacing, adjust as necessary to best identify the center of each individual channel. Video (or Average) Bandwidth (VBW) ≥RBW. Sweep = auto

Detector function = peak Trace = max hold

9.3 Test Equipment List and Details

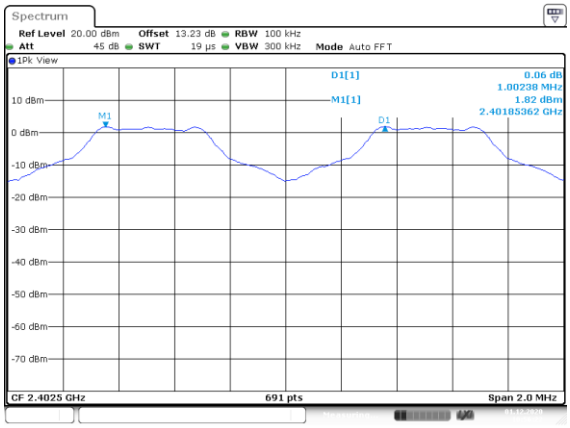
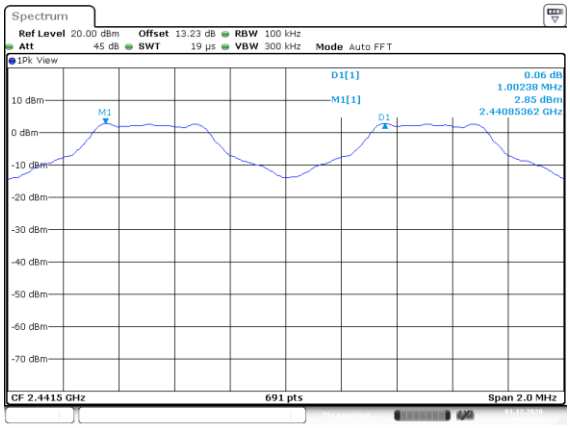
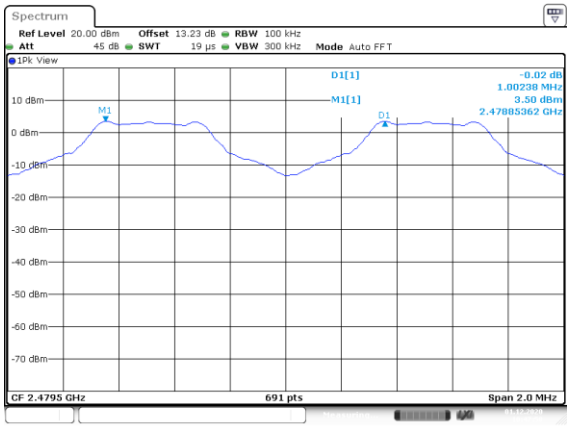
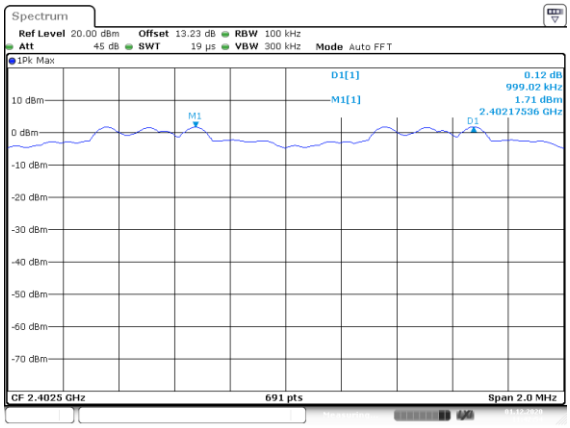
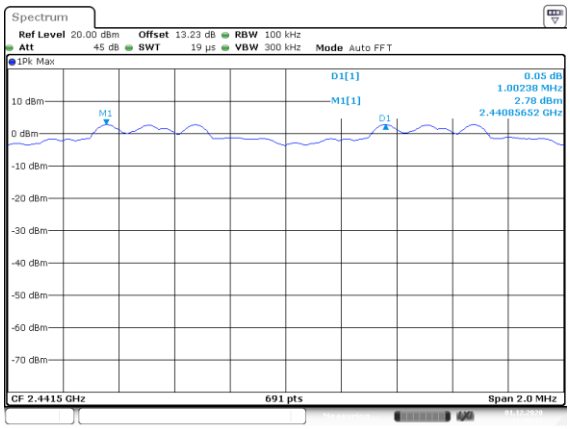
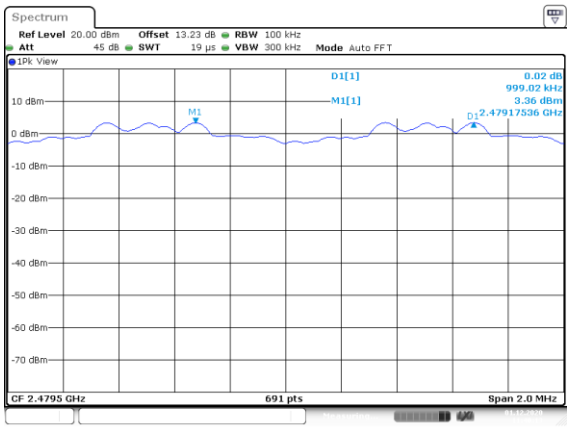
Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
Cable	MTJ	MT40S	620620-MT40S-100	Each use	-
SMA 10dB Fixed Attenuator	MVE	2W 6GHz	N/A	Each use	-

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

9.4 Test Results

Channel	Frequency (MHz)	20 dBc BW (MHz)	Channel Separation (MHz)	Limit (MHz)	Result
BR-1Mbps					
Low	2402	0.95	1.00	0.635	Compliance
Middle	2441	0.95	1.00	0.635	Compliance
High	2480	0.95	1.00	0.635	Compliance
EDR-2Mbps					
Low	2402	1.32	1.00	0.878	Compliance
Middle	2441	1.32	1.00	0.878	Compliance
High	2480	1.32	1.00	0.878	Compliance

Note: Limit is >two-thirds of the 20 dB bandwidth

BR-1Mbps Low CH	BR-1Mbps Middle CH
	
BR-1Mbps High CH	**EDR-2Mbps Low CH**
	
EDR-2Mbps Middle CH	**EDR-2Mbps High CH**
	

10 FCC §15.247(a)(1)(iii) – Time of Occupancy (Dwell Time)

10.1 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.

10.2 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel

RBW ≤ channel spacing and where possible RBW should be set >> 1/T, where T is the expected dwell time per channel

Sweep = as necessary to capture the entire dwell time per hopping channel Detector function = peak

Trace = max hold

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements.

Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) x (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

10.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
Cable	MTJ	MT40S	620620-MT40S-100	Each use	-
SMA 10dB Fixed Attenuator	MVE	2W 6GHz	N/A	Each use	-

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

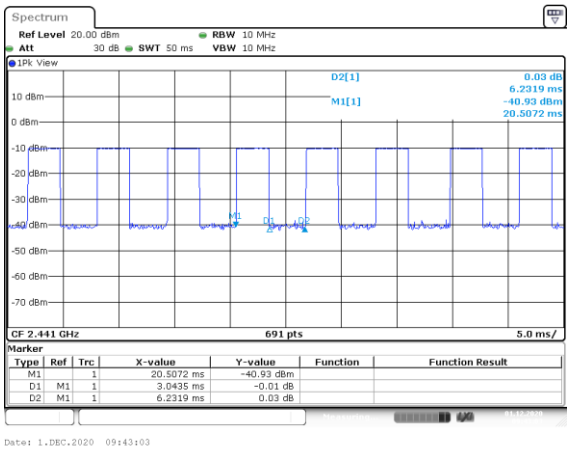
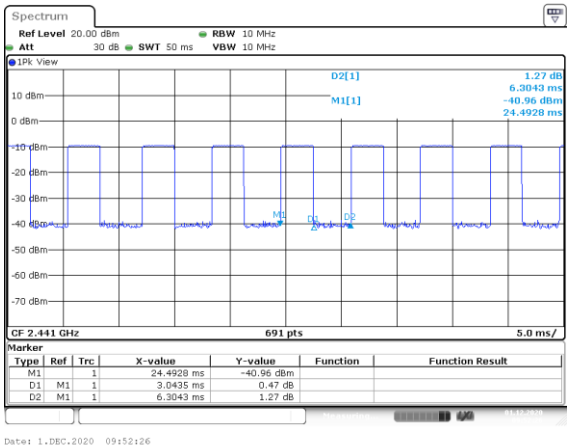
10.4 Test Results

Modulation Mode	Pulse Time per Hop (ms)	Number of Pulse in [0.4 x N sec]	Dwell Time in [0.4 x N sec] (s)	Dwell Time Limits (s)
BR-1Mbps mode	3.04	106.7	0.325	0.4
EDR-2Mbps mode	3.04	106.7	0.325	0.4

Note1: Number of Pulse in [0.4 x N sec] = 1600/79/6*(0.4*79)

Note2: Dwell Time in [0.4 x N sec] = (Pulse Time * Number of Pulse in [0.4 x N sec])/1000

Note3: Bluetooth ACL packets can be 1, 3, or 5 time slots. The DH1 packet can cover a single time slot. The DH3 packet can cover up to 3 time slots. The DH5 packet can cover up to 5 time slots. Operate DH5 at maximum dwell time and maximum duty cycle. A maximum length packet has duration of 5 time slots. The hopping rate is 1600 hops/second so the maximum dwell time is 5/1600 seconds, or 3.125ms.

DH5	2-DH5
	

11 FCC §15.247(a)(1)(iii) –Quantity of hopping channel Test

11.1 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.

11.2 Test Procedure

Span = the frequency band of operation.

RBW < 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller VBW ≥ RBW.

Sweep = auto. Detector function = peak Trace = max hold.

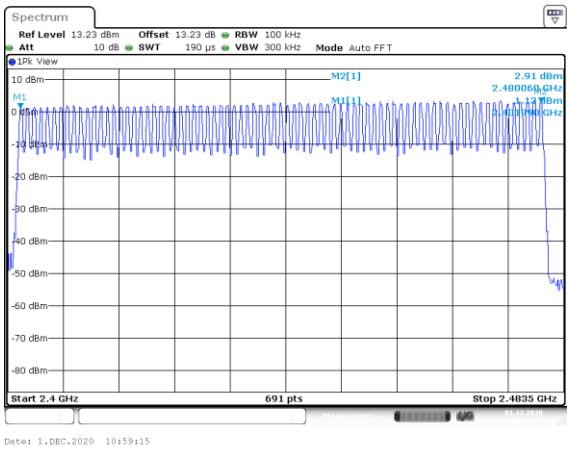
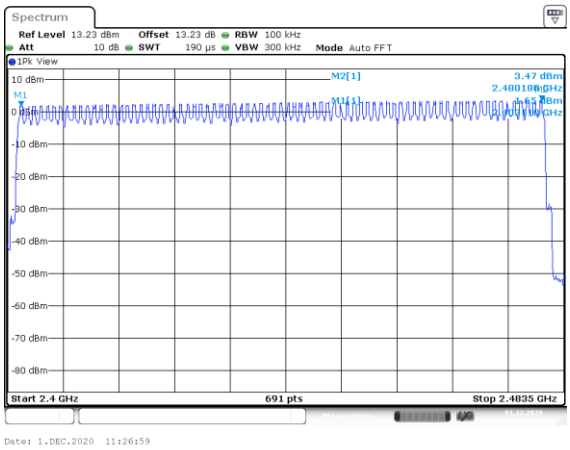
11.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
Cable	MTJ	MT40S	620620-MT40S-100	Each use	-
SMA 10dB Fixed Attenuator	MVE	2W 6GHz	N/A	Each use	-

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

11.4 Test Results

Mode	Frequency Range (MHz)	Number of Hopping Channel	Limit (CH)	Result
BR-1Mbps	2402-2480	79	>15	Compliance
EDR-2Mbps	2402-2480	79	>15	Compliance

BR-1Mbps mode	EDR-2Mbps mode
	

12 FCC §15.247(b)(1) – Maximum Output Power

12.1 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. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

12.2 Test Procedure

Place the EUT on a bench and set it in transmitting mode.

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to Power sensor.

12.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
USB Wideband Power Sensor	Agilent	U2021XA	MY56120026	2020/09/14	2021/09/13
Cable	MTJ	MT40S	620620-MT40S-100	Each use	-

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

12.4 Test Results

Configuration	Channel	Frequency (MHz)	Maximum Peak Output Power (dBm)	Maximum Peak Output Power (W)	Limit (dBm)	Result
BR-1Mbps	Low	2402	1.95	0.0016	21	Compliance
	Middle	2441	2.91	0.0020	21	Compliance
	High	2480	3.63	0.0023	21	Compliance
EDR-2Mbps	Low	2402	2.64	0.0018	21	Compliance
	Middle	2441	3.59	0.0023	21	Compliance
	High	2480	3.24	0.0021	21	Compliance

13 FCC §15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

13.1 Applicable Standard

According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c)

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13.2 Test Procedure

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

RBW = 100 kHz VBW = 300 kHz.

Sweep = coupled. Detector function = peak Trace = max hold.

13.3 Test Equipment List and Details

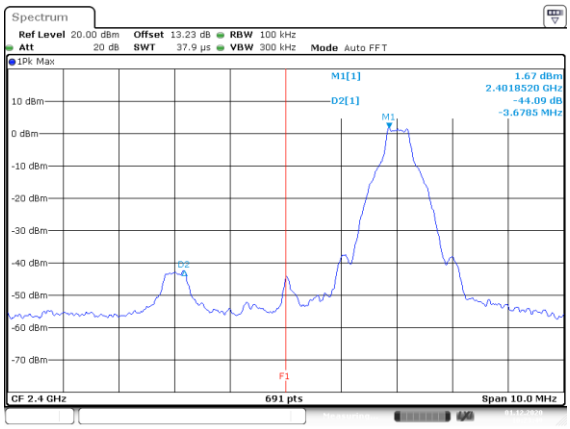
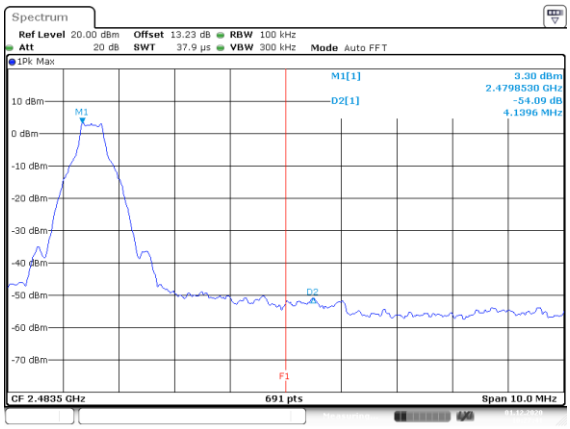
Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101434	2020/05/07	2021/05/06
Cable	MTJ	MT40S	620620-MT40S-100	Each use	-
SMA 10dB Fixed Attenuator	MVE	2W 6GHz	N/A	Each use	-

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).

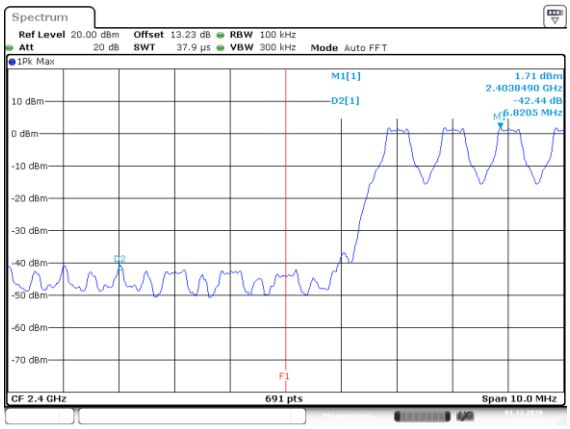
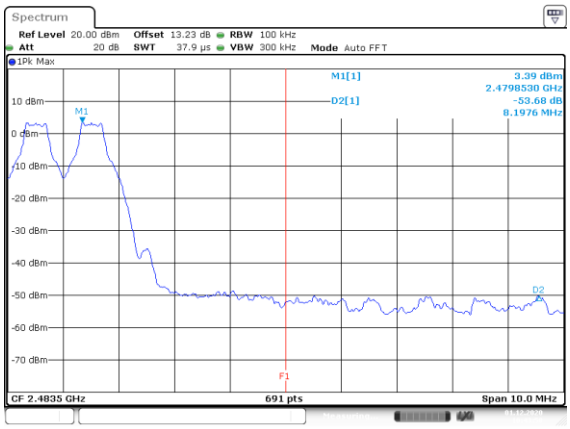
13.4 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BR-1Mbps				
Low	2402	44.09	≥ 20	Compliance
High	2480	54.09	≥ 20	Compliance
BR-1Mbps Hopping				
Low	2402	42.44	≥ 20	Compliance
High	2480	53.68	≥ 20	Compliance
EDR-2Mbps				
Low	2402	43.51	≥ 20	Compliance
High	2480	55.05	≥ 20	Compliance
EDR-2Mbps Hopping				
Low	2402	42.55	≥ 20	Compliance
High	2480	54.46	≥ 20	Compliance

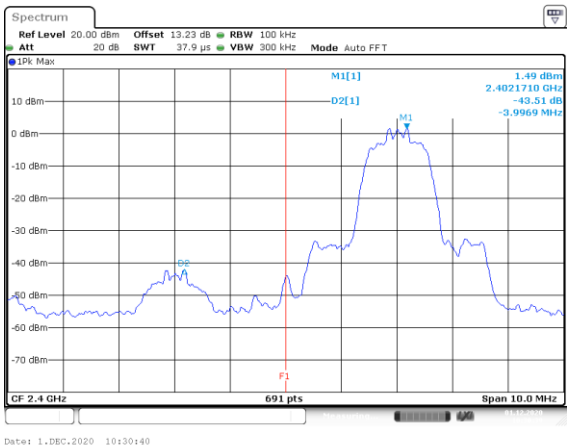
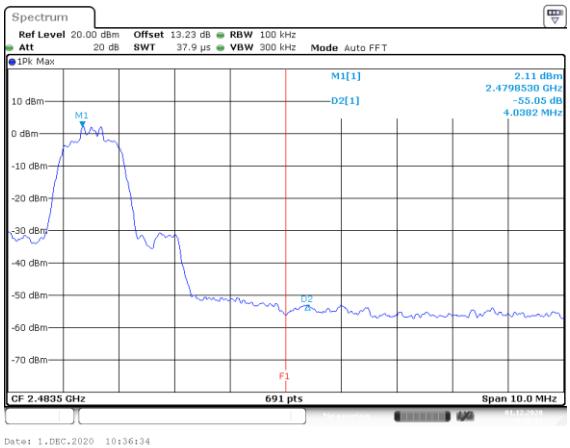
BR-1Mpbs:

Left Side	Right Side
	

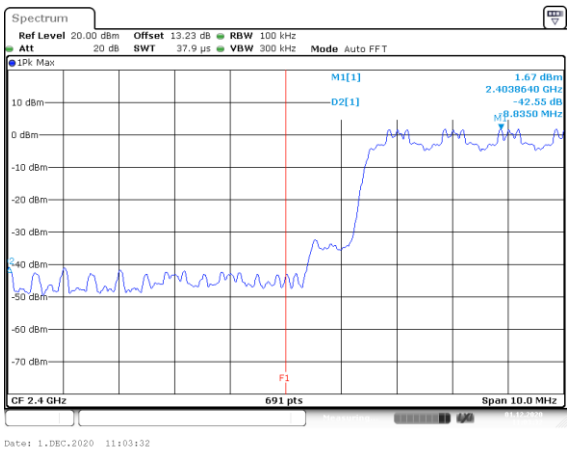
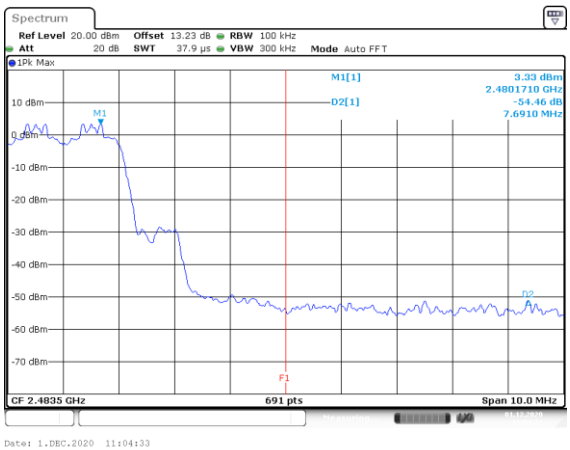
BR-1Mpbs Hopping:

Left Side	Right Side
	

EDR-2Mbps:

Left Side	Right Side
	

EDR-2Mbps Hopping:

Left Side	Right Side
	

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