FCC Part 15.247

TEST REPORT

For

Chengdu Vantron Technology, Ltd.

No.5 GaoPeng Road, Hi-Tech Zone, Chengdu, SiChuan, P.R. China

FCC ID: 2AAGE-VTDONGLE

Report Type	**Original Report**
Product Name:	**Gateway**
Model Name:	**VT-IoT-Dongle**
Series Model Name:	**VT-IoT-Dongle-CATM**
Report Number :	**RLK190919004-00B**
Report Date :	**2019/10/05**
Reviewed By :	**Zeus Chen** Zeus Chen
Prepared By: **Bay Area Compliance Laboratories Corp.(Linkou Laboratory)** **No. 6, Wende 2Rd., Guishan Dist., Taoyuan City 33382, Taiwan (R.O.C.)** **Tel: +886 (3)3961072; Fax: +886 (3) 3961027** **www.bacl.com.tw**	

Revision History

Revision	Report Number	Issue Date	Description
1.0	RLK190919004-00B	2019/10/05	Original Report

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	**Chengdu Vantron Technology, Ltd.** No.5 GaoPeng Road, Hi-Tech Zone, Chengdu, SiChuan, P.R. China
Manufacturer	**Chengdu Vantron Technology, Ltd.** No.5 GaoPeng Road, Hi-Tech Zone, Chengdu, SiChuan, P.R. China
Product (Equipment)	**Gateway**
Model Name	**VT-IoT-Dongle**
Series Model Name	**VT-IoT-Dongle-CATM**
Model Discrepancy	Please refer below Model Discrepancy Table
EUT Function	BT- BR/EDR
Frequency Range	2402 - 2480 MHz
Number of Channels	79 Channels
Output Power	BR-1Mbps: 8.91 dBm (0.0078 W) EDR-2Mbps: 7.44 dBm (0.0055 W) EDR-3Mbps:: 7.62 dBm (0.0058 W)
Modulation Type	BR-1Mbps: GFSK EDR-2Mbps: π/4-DQPSK EDR-3Mbps: 8-DPSK
Related Submittal(s)/Grant(s)	**FCC Part 15.247 DTS with FCC ID : 2AAGE-VTDONGLE** **FCC Part 15.407 NII with FCC ID : 2AAGE-VTDONGLE**
Received Date	Sep. 23, 2019
Date of Test	Sep. 24, 2019 - Oct 03, 2019

**All measurement and test data in this report was gathered from production sample serial number: 190919004 (Assigned by BACL, LinKou).*

**Model Discrepancy: Difference was LTE module use and contain FCC ID (Card Plug-in)*

Model Name	Discrepancy
VT-IoT-Dongle	**Contain LTE module FCC ID RI7LE910NAV2** Note 1
VT-IoT-Dongle-CATM	**Contain LTE module FCC ID 2AJYU-SIM7000A** Note 1

Note 1: LTE Module have already get FCC Grants

The major electrical and mechanical constructions of series models are identical to the basic model, except different Market segmentation. The model, VT-IoT-Dongle is the testing sample, and the final test data are shown on this test report.

1.2 Operation Condition of EUT

Power Operation (Voltage Range)	☒ AC 120 V/60 Hz ☒ Adapter (Not for Sale) via power Cable to connector port ☐ By Power Cord.
	☒ DC Type ☒ DC Power Supply: 5Vdc to connector port ☐ Battery ☐ External from USB Cable 5Vdc ☐ External DC Adapter
	☐ Host System

1.3 Objective and Test Methodology

The Objective of this Test Report was to document the compliance of the Chengdu Vantron Technology, Ltd. Appliance (Model: VT-IoT-Dongle, Series Model: VT-IoT-Dongle-CATM) 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.

-KDB 558074 D01 15.247 Meas Guidance v05r02.

1.4 Measurement Uncertainty

Parameter	Expanded Measurement uncertainty
RF output power with Power Meter	± 0.55 dB
Occupied Channel Bandwidth	± 4.54 Hz
RF Conducted test with Spectrum	± 1.45 dB
AC Power Line Conducted Emission	± 2.66 dB
Radiated Below 1G	± 3.57 dB
Radiated Above 1G-18G	± 4.29 dB
Radiated Above 18G-40G	± 4.67 dB

1.5 Test Facility

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

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

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.

Radiated below 1G were tested worst output power mode.

VT-IoT-Dongle and VT-IoT-Dongle-CATM all have two mode Wlan + WWan or BT + WWan for Co-location.

AC Line put the worst case co-location mode in the report. Radiation co-location we put the worst case co-location mode (Wlan +WWan $_{(FCC\ ID:\ RI7LE910NAV2)}$) and please refer to RLK190919004-00C Report.

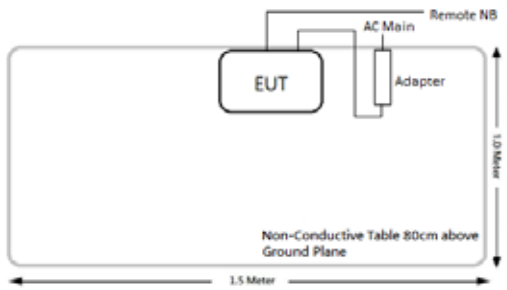
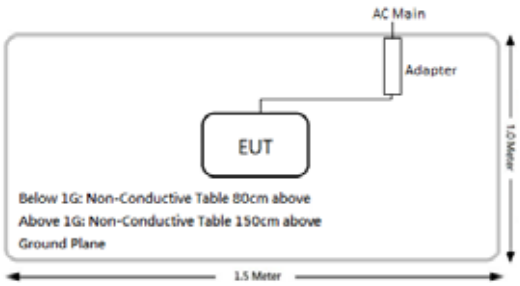
Worst Case of Power Setting				
EUT Exercise Software		Command via Putty		
Configuration	**NTX**	**Low CH**	**Mid CH**	**High CH**
BR-1Mbps (GFSK) mode	1	Default	Default	Default
EDR-2Mbps (π/4-DQPSK) mode	1	Default	Default	Default
EDR-3Mbps (8DPSK) mode	1	Default	Default	Default

2.2 Support Equipment List and Details

No.	Description	Manufacturer	Model Number
A	Notebook PC	DELL	Latitude E6410
B	Notebook PC	Lenovo	Y520-151KBN
C	Notebook PC	APPLE	A1706
D	Adapter	FLEX	A1718 (Apple)
E	Adapter	Chicony Power	ADL135NCC3A (Lenovo)
F	Adapter	MYCELL	AC-B04
G	DC Power Source	GW Instek	SPS-2415

No.	Cable Description	Shielding Type	Length (m)	From	To
1	Connector Cable	Non-Shielded	1	EUT	Power Apply

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/cm2);

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:

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

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)			
Wi-Fi 2.4G	2412-2462	3.00	1.995	25.00	316.2278	20	0.1256	1.0
BLE	2402-2480	3.00	1.995	4.00	2.5119	20	0.0010	1.0
BR+EDR	2402-2480	3.00	1.995	9.00	7.9433	20	0.0032	1.0
Wi-Fi 5G UNII-1	5150-5250	3.00	1.995	20.00	100.0000	20	0.0397	1.0
Wi-Fi 5G UNII-3	5745-5850	3.00	1.995	21.00	125.8925	20	0.0500	1.0

LTE module FCC ID: 2AJYU-SIM7000A

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)			
LTE B2	1850-1910	0.48	1.117	25.70	371.54	20	0.0826	1.0
LTE B4	1710-1755	-0.73	0.845	25.70	371.54	20	0.0625	1.0
LTE B12	699-716	2.11	1.626	25.70	371.54	20	0.1202	0.466
LTE B13	777-787	2.11	1.626	25.70	371.54	20	0.1202	0.518

LTE module FCC ID: RI7LE910NAV2

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)			
LTE B2	1850-1910	0.48	1.117	24.00	251.189	20	0.0558	1.0
LTE B4	1710-1755	-0.73	0.845	24.00	251.189	20	0.0422	1.0
LTE B5	824-849	2.65	1.841	24.00	251.189	20	0.0920	0.550
LTE B12	699-716	2.11	0.845	24.00	251.189	20	0.0812	0.466
LTE B13	777-787	2.11	1.626	24.00	251.189	20	0.0812	0.518
LTE B17	704-716	2.11	0.845	24.00	251.189	20	0.0812	0.469

MPE evaluation for simultaneous transmission:

Note:

1. **Wi-Fi (2.4G) or Wi-Fi 5G and BT can't transmit simultaneously.**
2. **Wi-Fi (2.4G) and Wi-Fi 5G can't transmit simultaneously**

Wi-Fi or BT & WWAN can transmit simultaneously, MPE evaluation is as below formula:

PD1/Limit1+PD2/Limit2+……＜1, PD (Power Density)

The worst case is as below:

Max MPE of Wi-Fi + Max MPE of LTE
= 0.1256/1.0+0.1202/0.466 =0.3835＜1.0

Result: MPE evaluation of single and simultaneous 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
Jinchang	JCW425	PIFA	3.00 dBi	Compliance

The EUT has an internal antenna arrangement, which was permanently attached, fulfill the requirement of this section.

6 FCC §15.207 - AC Line Conducted Emissions

6.1 Applicable Standard

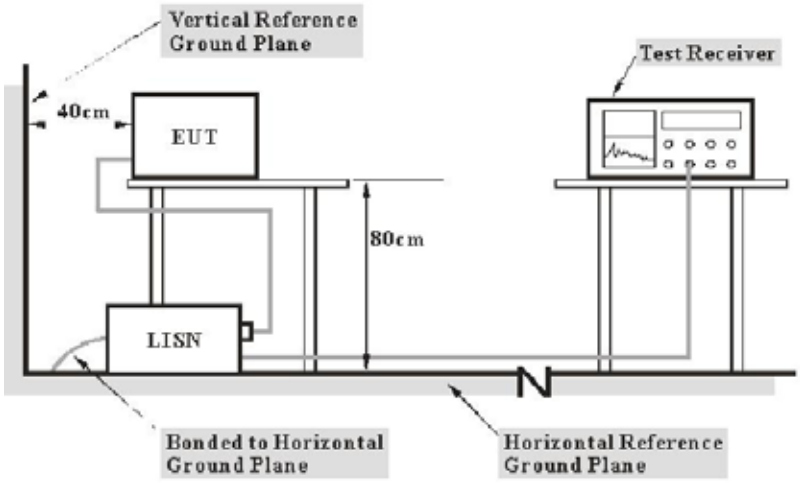
According to FCC §15.207,

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.
Conduction Room					
LISN	Rohde & Schwarz	ENV216	100010	2019/09/02	2020/09/01
EMI Test Receiver	Rohde & Schwarz	ESR3	102430	2019/03/27	2020/03/26
Pulse Limiter	SCHWARZBECK	VSTD 9561-F	00432	2019/08/28	2020/08/27
RF Cable	EMCI	EMCCFD300-BM-BM-8000	180526	2019/08/08	2020/08/07
Software	Audix	e3 v9	E3LK-03	N.C.R	N.C.R

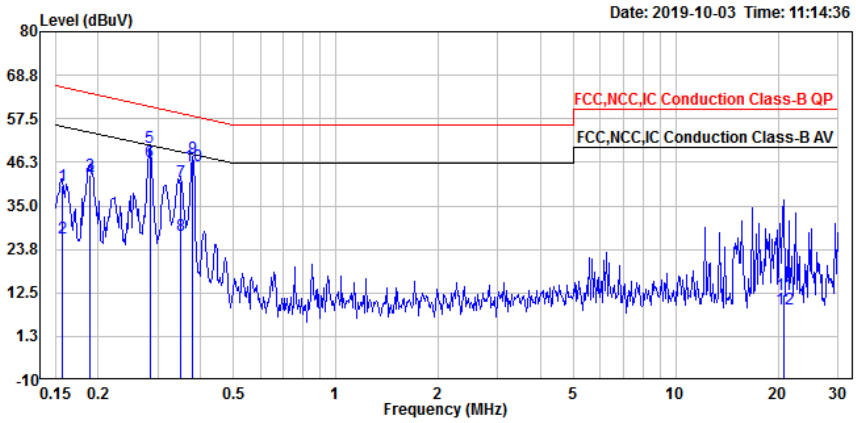
***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units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

6.4 Test Environmental Conditions

Temperature:	25 ℃	**Relative Humidity:**	62 %
ATM Pressure:	1010 hPa	**Test Engineer:**	Ray Huang
Test Date:	2019-10-03		

6.5 Test Data and Test Plot

Mode: Co-location mode (BT + WWan$_{(FCC\ ID:\ RI7LE910NAV2)}$), Line



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.157	20.37	40.31	19.94	65.60	-25.29	QP
2	0.157	6.81	26.75	19.94	55.60	-28.85	Average
3	0.189	22.93	42.87	19.94	64.08	-21.21	QP
4	0.189	22.00	41.94	19.94	54.08	-12.14	Average
5	0.284	30.25	50.18	19.93	60.71	-10.53	QP
6	0.284	26.42	46.35	19.93	50.71	-4.36	Average
7	0.349	21.43	41.38	19.95	58.99	-17.61	QP
8	0.349	7.46	27.41	19.95	48.99	-21.58	Average
9	0.378	27.43	47.39	19.96	58.32	-10.93	QP
10	0.378	25.23	45.19	19.96	48.32	-3.13	Average
11	20.795	-8.19	11.98	20.17	60.00	-48.02	QP
12	20.795	-11.69	8.48	20.17	50.00	-41.52	Average

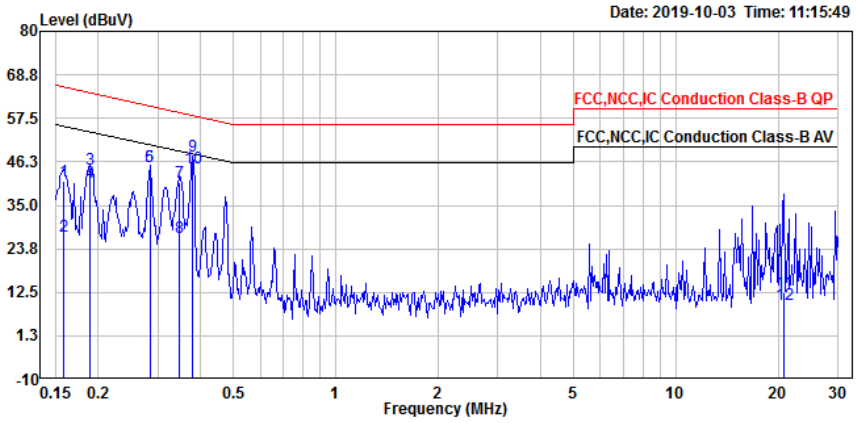
Note:

Level = Read Level + Factor

Over Limit (Margin) = Level – Limit Line

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

Mode: AC 120V/60 Hz, Co-location mode (BT + WWan$_{(FCC\ ID:\ RI7LE910NAV2)}$), Neutral



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.159	21.37	41.32	19.95	65.54	-24.22	QP
2	0.159	7.16	27.11	19.95	55.54	-28.43	Average
3	0.189	24.24	44.18	19.94	64.08	-19.90	QP
4	0.189	20.92	40.86	19.94	54.08	-13.22	Average
5	0.284	25.21	45.15	19.94	60.71	-15.56	QP
6	0.284	25.06	45.00	19.94	50.71	-5.71	Average
7	0.346	20.91	40.87	19.96	59.05	-18.18	QP
8	0.346	6.81	26.77	19.96	49.05	-22.28	Average
9	0.378	27.61	47.58	19.97	58.32	-10.74	QP
10	0.378	24.58	44.55	19.97	48.32	-3.77	Average
11	20.795	-7.95	12.37	20.32	60.00	-47.63	QP
12	20.795	-11.10	9.22	20.32	50.00	-40.78	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

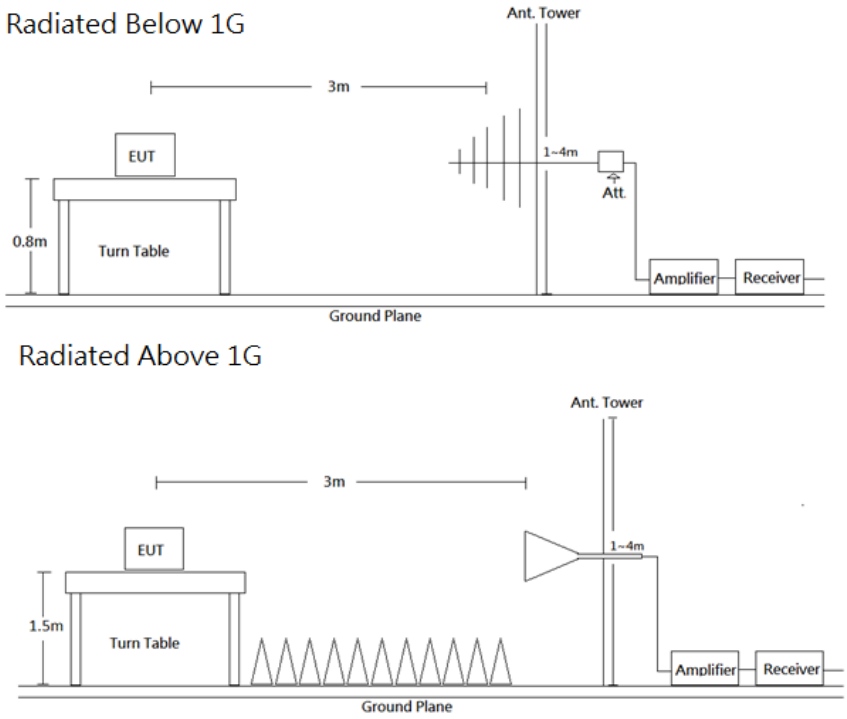
As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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 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	Duty cycle	Measurement method
30-1000 MHz	120 kHz	/	QP	-	QP
Above 1 GHz	1 MHz	3 MHz	PK	-	PK
	1 MHz	3 MHz	RMS	>98%	Ave
	1 MHz	1/T	PK	<98%	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.
966A Room					
Bilog Antenna/6 dB Attenuator	SUNOL SCIENCES & EMEC /EMCI	JB3/N-6-06	A111513/AT-N0668	2019/03/29	2020/03/28
Horn Antenna	ETS-Lindgren	3115	00109141	2019/07/05	2020/07/04
Horn Antenna	ETS-Lindgren	3160-09	00123852	2019/07/11	2020/07/10
Preamplifier	A.H. Systems	PAM-0118P	478	2019/03/28	2020/03/27
Preamplifier	A.H. Systems	PAM-1840VH	174	2019/02/18	2020/02/17
Signal and Spectrum Analyzer	Rohde & Schwarzr	FSV40	101434	2019/04/17	2020/04/16
Microflex Cable (1m)	EMCI	EMC106-SM-SM-2000	93D0127	2019/05/05	2020/05/04
Microflex Cable (2m)	MTJ	H0919	MFR64639 226389-002	2019/05/05	2020/05/04
Microflex Cable (8m)	UTIFLEX	UFA210A-1-3149-300300	160309-1	2019/05/05	2020/05/04
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					
Signal Analyzer	Rohde & Schwarz	FSU26	100406	2019/03/19	2020/03/18
Cable	MTJ	MT40S	620620-MT40S-100	2018/12/28	2019/12/27

***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).*

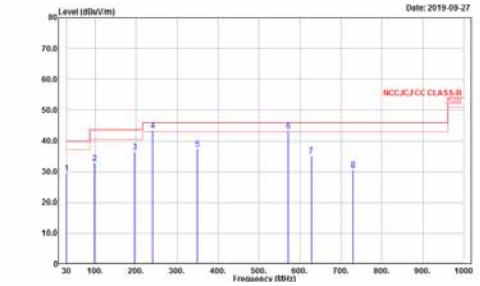
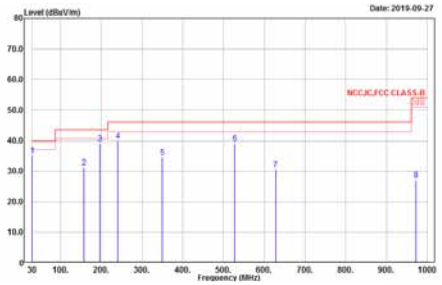
7.4 Test Environmental Conditions

Temperature:	25/22.9 ℃	**Relative Humidity:**	45/57 %
ATM Pressure:	1015hPa	**Test Engineer:**	Leo Chang / Ian Tu
Radiated Test Date:	2019-09-24 to 2019-09-27	**Conducted Test Date:**	2019-09-27

7.5 Radiated Emission Test Plot and Data

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

Below 1G (30 MHz-1 GHz) test the output power worst mode

Horizontal	Vertical
	

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1	30.000	29.57	40.00	-10.43	35.40	-5.83	Peak	horizontal
2	98.870	32.68	43.50	-10.82	53.46	-20.78	Peak	horizontal
3	196.840	36.46	43.50	-7.04	55.33	-18.87	Peak	horizontal
4	240.490	43.43	46.00	-2.57	62.81	-19.38	QP	horizontal
5	349.130	37.30	46.00	-8.70	54.01	-16.71	Peak	horizontal
6	571.260	43.10	46.00	-2.90	55.55	-12.45	QP	horizontal
7	627.520	35.14	46.00	-10.86	46.59	-11.45	Peak	horizontal
8	729.370	30.49	46.00	-15.51	40.58	-10.09	Peak	horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1	30.970	35.10	40.00	-4.90	41.66	-6.56	Peak	vertical
2	157.070	31.15	43.50	-12.35	49.51	-18.36	Peak	vertical
3	195.870	38.92	43.50	-4.58	57.94	-19.02	Peak	vertical
4	240.490	39.92	46.00	-6.08	59.30	-19.38	QP	vertical
5	349.130	34.51	46.00	-11.49	51.22	-16.71	Peak	vertical
6	527.610	39.09	46.00	-6.91	52.26	-13.17	QP	vertical
7	627.520	30.55	46.00	-15.45	42.00	-11.45	Peak	vertical
8	971.870	27.14	54.00	-26.86	34.33	-7.19	Peak	vertical

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 (GFSK):

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2350.800	36.62	54.00	-17.38	44.36	-7.74	Average
2350.800	45.61	74.00	-28.39	53.35	-7.74	Peak
2402.200	92.57			100.19	-7.62	Average
2402.200	93.84			101.46	-7.62	Peak
4804.000	38.72	54.00	-15.28	38.10	0.62	Average
4804.000	44.32	74.00	-29.68	43.70	0.62	Peak
7206.000	33.37	54.00	-20.63	28.11	5.26	Average
7206.000	44.45	74.00	-29.55	39.20	5.25	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2376.500	36.09	54.00	-17.91	43.75	-7.66	Average
2376.500	45.82	74.00	-28.18	53.48	-7.66	Peak
2401.900	96.45			104.07	-7.62	Average
2401.900	96.89			104.51	-7.62	Peak
4804.000	39.08	54.00	-14.92	38.46	0.62	Average
4804.000	41.80	74.00	-32.20	41.18	0.62	Peak
7206.000	32.70	54.00	-21.30	27.45	5.25	Average
7206.000	44.37	74.00	-29.63	39.12	5.25	Peak

Middle CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2350.280	36.62	54.00	-17.38	44.36	-7.74	Average
2350.280	50.31	74.00	-23.69	58.05	-7.74	Peak
2441.290	95.25			102.77	-7.52	Average
2441.290	95.99			103.51	-7.52	Peak
2490.500	36.59	54.00	-17.41	43.92	-7.33	Average
2490.500	50.91	74.00	-23.09	58.24	-7.33	Peak
4882.000	37.95	54.00	-16.05	37.15	0.80	Average
4882.000	43.54	74.00	-30.46	42.74	0.80	Peak
7323.000	34.65	54.00	-19.35	28.95	5.70	Average
7323.000	46.23	74.00	-27.77	40.53	5.70	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2384.480	36.81	54.00	-17.19	44.45	-7.64	Average
2384.480	51.03	74.00	-22.97	58.67	-7.64	Peak
2441.290	96.42			103.94	-7.52	Average
2441.290	97.22			104.74	-7.52	Peak
2488.790	36.58	54.00	-17.42	43.91	-7.33	Average
2488.790	50.77	74.00	-23.23	58.10	-7.33	Peak
4882.000	40.49	54.00	-13.51	39.68	0.81	Average
4882.000	43.76	74.00	-30.24	42.95	0.81	Peak
7323.000	35.02	54.00	-18.98	29.32	5.70	Average
7323.000	45.22	74.00	-28.78	39.52	5.70	Peak

High CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.170	100.22			107.57	-7.35	Average
2480.170	100.89			108.24	-7.35	Peak
2484.340	38.20	54.00	-15.80	45.54	-7.34	Average
2484.340	52.46	74.00	-21.54	59.80	-7.34	Peak
4960.000	42.04	54.00	-11.96	41.22	0.82	Average
4960.000	45.84	74.00	-28.16	45.02	0.82	Peak
7440.000	33.80	54.00	-20.20	27.74	6.06	Average
7440.000	45.74	74.00	-28.26	39.68	6.06	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.170	99.14			106.49	-7.35	Average
2480.170	100.50			107.85	-7.35	Peak
2491.300	37.69	54.00	-16.31	45.02	-7.33	Average
2491.300	51.61	74.00	-22.39	58.94	-7.33	Peak
4960.000	38.35	54.00	-15.65	37.53	0.82	Average
4960.000	43.40	74.00	-30.60	42.58	0.82	Peak
7440.000	33.50	54.00	-20.50	27.44	6.06	Average
7440.000	44.47	74.00	-29.53	38.41	6.06	Peak

EDR-2Mbps mode (π/4-DQPSK):

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2361.800	36.62	54.00	-17.38	44.32	-7.70	Average
2361.800	51.11	74.00	-22.89	58.81	-7.70	Peak
2401.900	89.72			97.34	-7.62	Average
2401.900	92.78			100.40	-7.62	Peak
4804.600	31.20	54.00	-22.80	30.58	0.62	Average
4804.600	41.47	74.00	-32.53	40.85	0.62	Peak
7206.000	32.86	54.00	-21.14	27.61	5.25	Average
7206.000	43.33	74.00	-30.67	38.08	5.25	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2365.000	36.88	54.00	-17.12	44.58	-7.70	Average
2365.000	50.96	74.00	-23.04	58.66	-7.70	Peak
2401.900	91.82			99.44	-7.62	Average
2401.900	94.95			102.57	-7.62	Peak
4804.600	32.05	54.00	-21.95	31.43	0.62	Average
4804.600	41.55	74.00	-32.45	40.93	0.62	Peak
7206.000	32.57	54.00	-21.43	27.32	5.25	Average
7206.000	44.50	74.00	-29.50	39.25	5.25	Peak

Middle CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2353.700	36.90	54.00	-17.10	44.63	-7.73	Average
2353.700	51.13	74.00	-22.87	58.86	-7.73	Peak
2440.910	91.41			98.93	-7.52	Average
2440.910	94.35			101.87	-7.52	Peak
2486.130	37.66	54.00	-16.34	45.00	-7.34	Average
2486.130	51.38	74.00	-22.62	58.72	-7.34	Peak
4882.800	33.47	54.00	-20.53	32.65	0.82	Average
4882.800	42.96	74.00	-31.04	42.14	0.82	Peak
7323.000	33.11	54.00	-20.89	27.39	5.72	Average
7323.000	44.57	74.00	-29.43	38.85	5.72	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2371.750	36.86	54.00	-17.14	44.53	-7.67	Average
2371.750	50.43	74.00	-23.57	58.10	-7.67	Peak
2440.910	92.29			99.81	-7.52	Average
2440.910	95.26			102.78	-7.52	Peak
2499.810	37.63	54.00	-16.37	44.95	-7.32	Average
2499.810	50.86	74.00	-23.14	58.18	-7.32	Peak
4882.800	32.56	54.00	-21.44	31.74	0.82	Average
4882.800	42.18	74.00	-31.82	41.36	0.82	Peak
7323.000	33.24	54.00	-20.76	27.52	5.72	Average
7323.000	44.88	74.00	-29.12	39.16	5.72	Peak

High CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.140	95.37			102.72	-7.35	Average
2480.140	99.29			106.64	-7.35	Peak
2483.740	38.12	54.00	-15.88	45.46	-7.34	Average
2483.740	51.80	74.00	-22.20	59.14	-7.34	Peak
4960.000	32.91	54.00	-21.09	32.09	0.82	Average
4960.000	42.80	74.00	-31.20	41.98	0.82	Peak
7440.000	33.48	54.00	-20.52	27.42	6.06	Average
7440.000	44.64	74.00	-29.36	38.58	6.06	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.900	94.53			101.88	-7.35	Average
2479.900	97.67			105.02	-7.35	Peak
2483.920	37.82	54.00	-16.18	45.16	-7.34	Average
2483.920	53.01	74.00	-20.99	60.35	-7.34	Peak
4960.000	32.41	54.00	-21.59	31.60	0.81	Average
4960.000	41.39	74.00	-32.61	40.58	0.81	Peak
7440.000	33.56	54.00	-20.44	27.50	6.06	Average
7440.000	44.91	74.00	-29.09	38.85	6.06	Peak

EDR-3Mbps mode (8-DPSK):

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2385.000	36.82	54.00	-17.18	44.46	-7.64	Average
2385.000	51.04	74.00	-22.96	58.68	-7.64	Peak
2402.100	89.19			96.81	-7.62	Average
2402.100	92.58			100.20	-7.62	Peak
4804.600	31.97	54.00	-22.03	31.35	0.62	Average
4804.600	40.07	74.00	-33.93	39.45	0.62	Peak
7206.000	32.44	54.00	-21.56	27.19	5.25	Average
7206.000	45.07	74.00	-28.93	39.82	5.25	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2349.000	36.97	54.00	-17.03	44.71	-7.74	Average
2349.000	50.77	74.00	-23.23	58.51	-7.74	Peak
2402.100	91.56			99.18	-7.62	Average
2402.100	95.02			102.64	-7.62	Peak
4804.600	31.67	54.00	-22.33	31.05	0.62	Average
4804.600	41.78	74.00	-32.22	41.16	0.62	Peak
7206.000	32.61	54.00	-21.39	27.36	5.25	Average
7206.000	43.98	74.00	-30.02	38.73	5.25	Peak

Middle CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2314.180	36.74	54.00	-17.26	44.56	-7.82	Average
2314.180	51.20	74.00	-22.80	59.02	-7.82	Peak
2441.100	91.53			99.05	-7.52	Average
2441.100	94.89			102.41	-7.52	Peak
2494.110	37.64	54.00	-16.36	44.97	-7.33	Average
2494.110	52.09	74.00	-21.91	59.42	-7.33	Peak
4882.000	32.86	54.00	-21.14	32.04	0.82	Average
4882.000	41.82	74.00	-32.18	41.00	0.82	Peak
7323.000	33.26	54.00	-20.74	27.54	5.72	Average
7323.000	43.26	74.00	-30.74	37.54	5.72	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2382.960	36.95	54.00	-17.05	44.59	-7.64	Average
2382.960	50.79	74.00	-23.21	58.43	-7.64	Peak
2441.100	91.94			99.46	-7.52	Average
2441.100	95.12			102.64	-7.52	Peak
2499.620	37.67	54.00	-16.33	44.99	-7.32	Average
2499.620	51.00	74.00	-23.00	58.32	-7.32	Peak
4882.000	32.92	54.00	-21.08	32.10	0.82	Average
4882.000	42.65	74.00	-31.35	41.83	0.82	Peak
7323.000	33.11	54.00	-20.89	27.39	5.72	Average
7323.000	45.54	74.00	-28.46	39.82	5.72	Peak

High CH

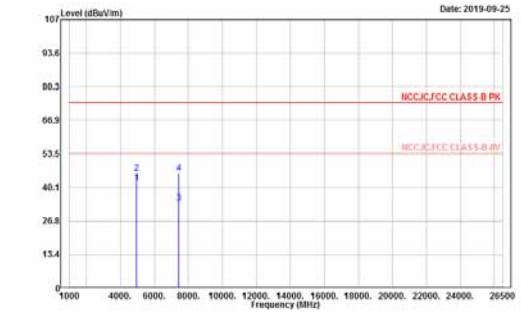
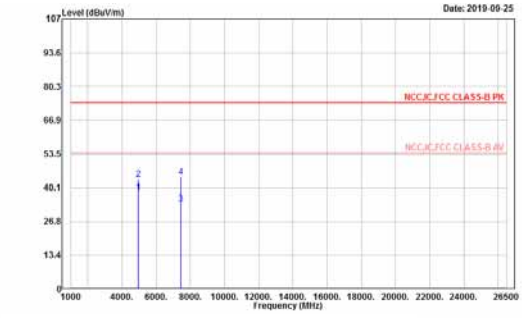
Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.990	95.76			103.11	-7.35	Average
2479.990	99.15			106.50	-7.35	Peak
2499.790	37.97	54.00	-16.03	45.29	-7.32	Average
2499.790	52.18	74.00	-21.82	59.50	-7.32	Peak
4960.000	34.18	54.00	-19.82	33.37	0.81	Average
4960.000	41.65	74.00	-32.35	40.84	0.81	Peak
7440.000	33.75	54.00	-20.25	27.69	6.06	Average
7440.000	46.09	74.00	-27.91	40.03	6.06	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.990	94.82			102.17	-7.35	Average
2479.990	97.26			104.61	-7.35	Peak
2493.250	37.70	54.00	-16.30	45.03	-7.33	Average
2493.250	51.38	74.00	-22.62	58.71	-7.33	Peak
4960.000	33.18	54.00	-20.82	32.36	0.82	Average
4960.000	41.29	74.00	-32.71	40.47	0.82	Peak
7440.000	33.36	54.00	-20.64	27.30	6.06	Average
7440.000	44.42	74.00	-29.58	38.36	6.06	Peak

Above 1G (1 GHz-26.5 GHz): The worst mode

Horizontal	Vertical
	

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1 !	4960.000	42.04	54.00	-11.96	41.22	0.82	Average	horizontal
2	4960.000	45.84	74.00	-28.16	45.02	0.82	Peak	horizontal
3	7440.000	33.80	54.00	-20.20	27.74	6.06	Average	horizontal
4	7440.000	45.74	74.00	-28.26	39.68	6.06	Peak	horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1 !	4960.000	38.35	54.00	-15.65	37.53	0.82	Average	vertical
2	4960.000	43.40	74.00	-30.60	42.58	0.82	Peak	vertical
3	7440.000	33.50	54.00	-20.50	27.44	6.06	Average	vertical
4	7440.000	44.47	74.00	-29.53	38.41	6.06	Peak	vertical

Level = Read Level + Factor

Over Limit = Level – Limit

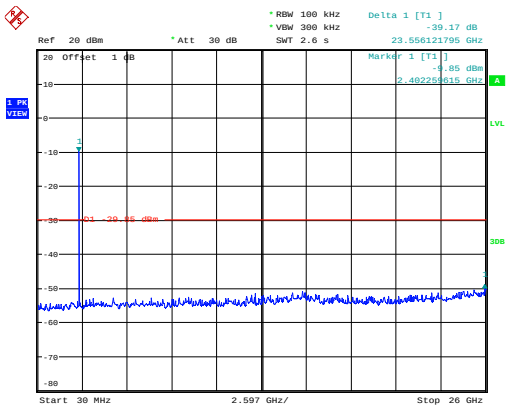
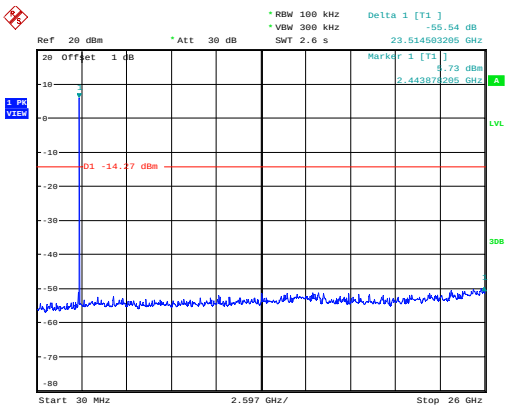
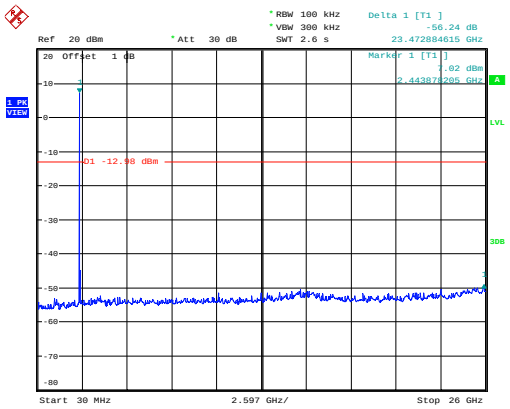
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

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

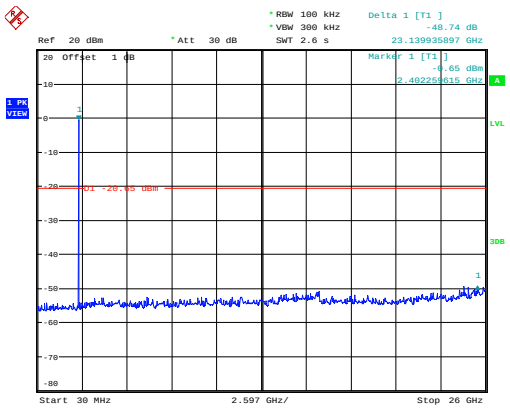
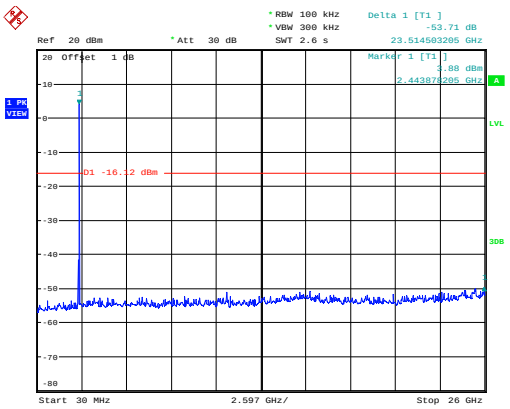
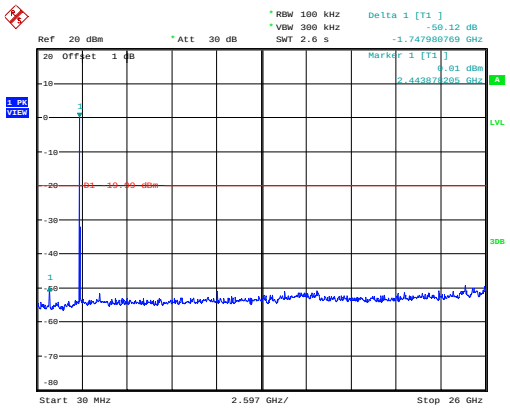
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BR-1Mbps mode (GFSK)				
Low	2402	39.17	≥ 20	Compliance
Mid	2441	55.54	≥ 20	Compliance
High	2480	56.24	≥ 20	Compliance
EDR-2Mbps mode (π/4-DQPSK)				
Low	2402	48.74	≥ 20	Compliance
Mid	2441	53.71	≥ 20	Compliance
High	2480	50.12	≥ 20	Compliance
EDR-3Mbps mode (8DPSK)				
Low	2402	52.16	≥ 20	Compliance
Mid	2441	51.70	≥ 20	Compliance
High	2480	52.10	≥ 20	Compliance

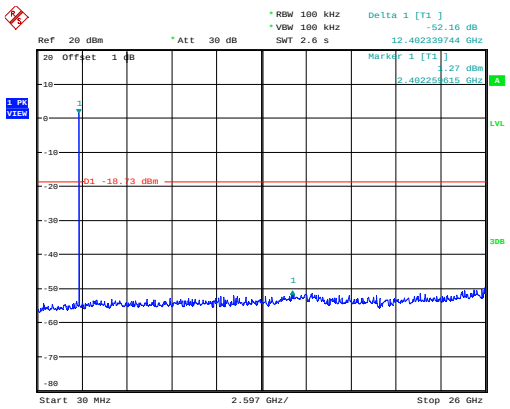
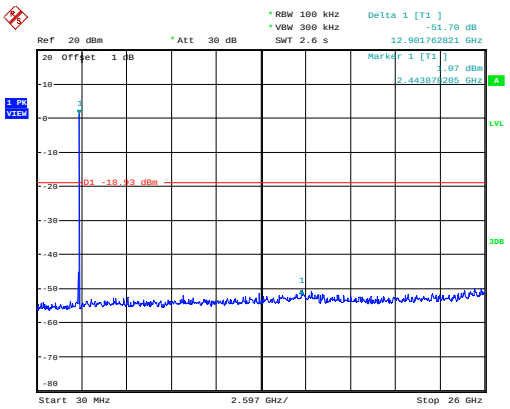
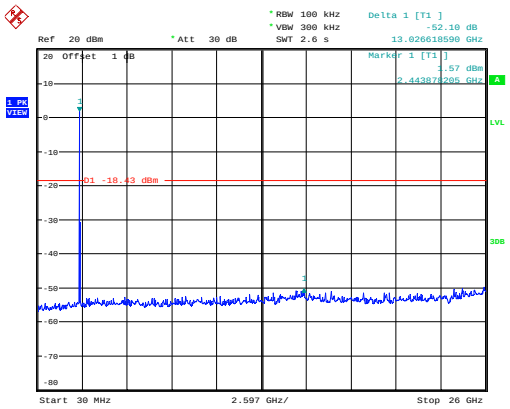
BR-1Mbps mode (GFSK):

Low CH	Middle CH
	
High CH	**-**
	-

EDR-2Mbps mode (π/4-DQPSK):

Low CH	Middle CH
 Date: 27.SEP.2019 19:37:24	 Date: 27.SEP.2019 19:42:28
High CH	**-**
 Date: 27.SEP.2019 19:47:36	-

EDR-3Mbps mode (8DPSK):

Low CH	Middle CH
 Date: 27.SEP.2019 20:21:44	 Date: 27.SEP.2019 20:29:53
High CH	**-**
 Date: 27.SEP.2019 20:34:41	-

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					
Signal Analyzer	Rohde & Schwarz	FSU26	100406	2019/03/19	2020/03/18
Cable	MTJ	MT40S	620620-MT40S-100	2018/12/28	2019/12/27

***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).*

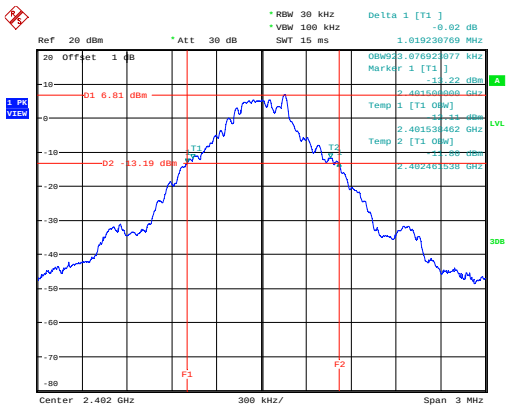
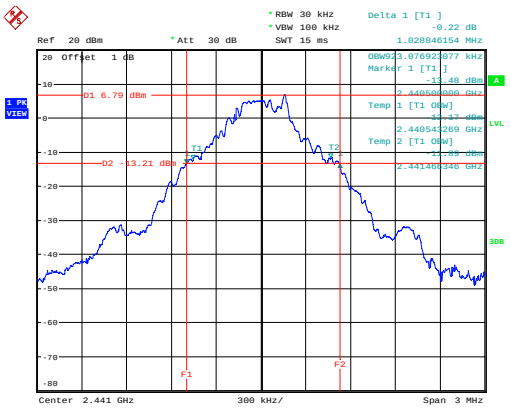
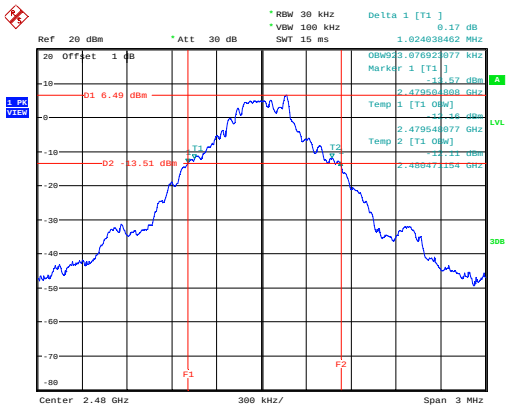
8.4 Test Environmental Conditions

Temperature:	22.9 ℃	**Relative Humidity:**	57 %
ATM Pressure:	1015hPa	**Test Engineer:**	Ian Tu
Conducted Test Date:	2019-09-27	-	-

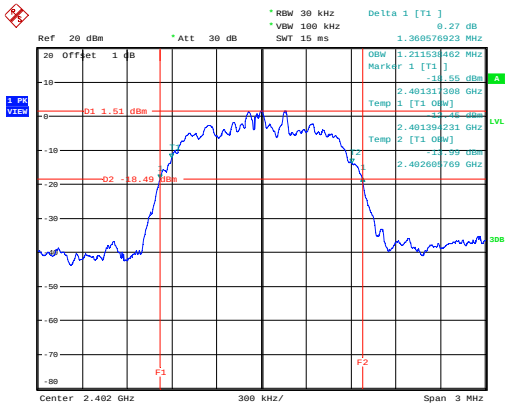
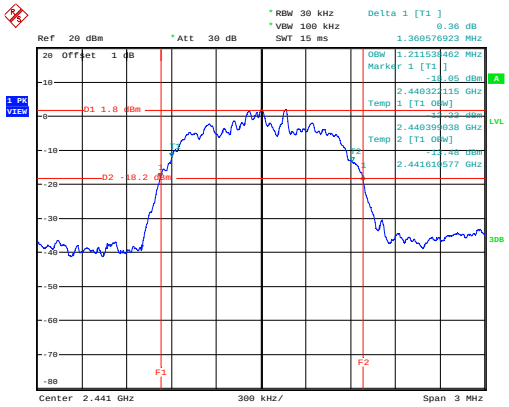
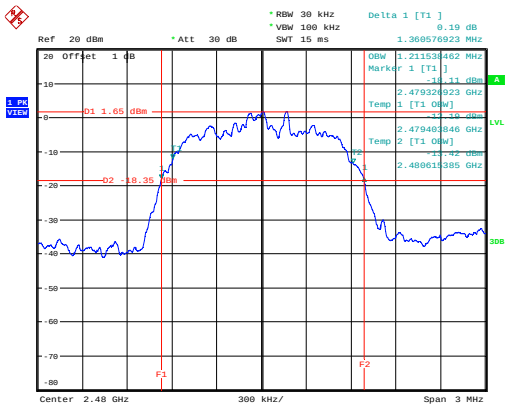
8.5 Test Results

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
BR-1Mbps Mode (GFSK)			
Low	2402	1.0192	0.9231
Middle	2441	1.0288	0.9231
High	2480	1.0240	0.9231
EDR-2Mbps Mode (π/4-DQPSK)			
Low	2402	1.3606	1.2115
Middle	2441	1.3606	1.2115
High	2480	1.3606	1.2115
EDR-3Mbps Mode (8DPSK)			
Low	2402	1.3173	1.2115
Middle	2441	1.3221	1.2115
High	2480	1.3221	1.2115

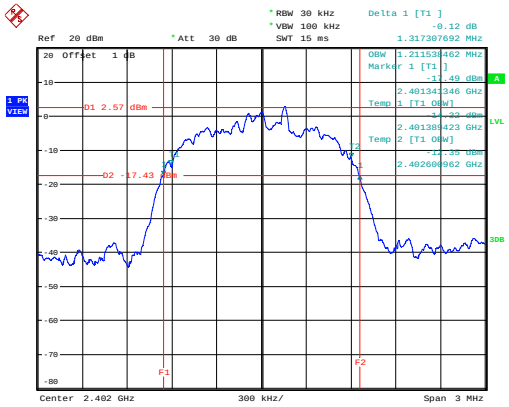
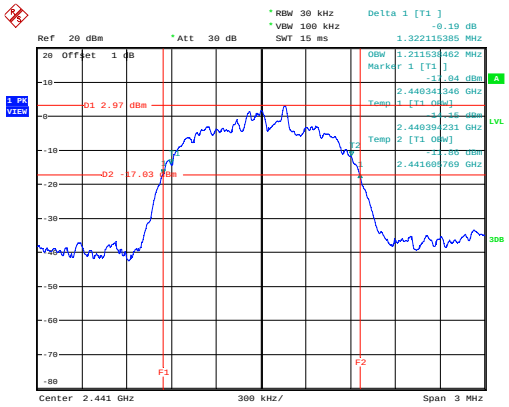
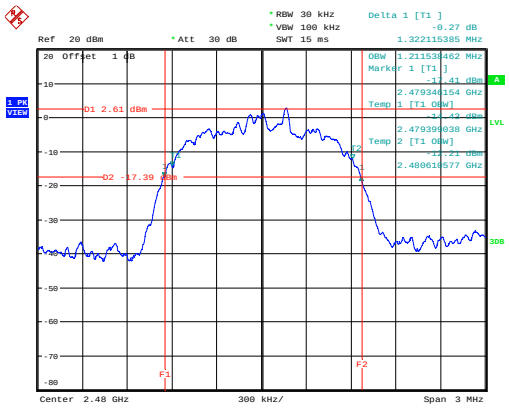
BR-1Mbps mode (GFSK):

Low CH	Middle CH
 Date: 27.SEP.2019 18:42:14	 Date: 27.SEP.2019 18:57:12
High CH	**-**
 Date: 27.SEP.2019 19:03:14	-

EDR-2Mbps Mode (π/4-DQPSK):

Low CH	Middle CH
	
Date: 27.SEP.2019 19:35:44	Date: 27.SEP.2019 19:41:44
High CH	**-**
	-
Date: 27.SEP.2019 19:45:57	

EDR-3Mbps Mode (8DPSK):

Low CH	Middle CH
	
Date: 27.SEP.2019 20:17:39	Date: 27.SEP.2019 20:29:06
High CH	**-**
	-
Date: 27.SEP.2019 20:33:18	

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					
Signal Analyzer	Rohde & Schwarz	FSU26	100406	2019/03/19	2020/03/18
Cable	MTJ	MT40S	620620-MT40S-100	2018/12/28	2019/12/27

***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).*

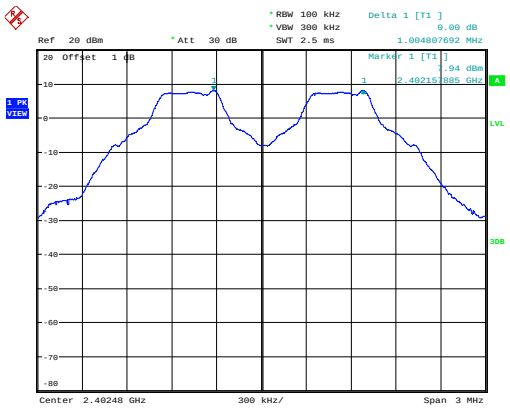
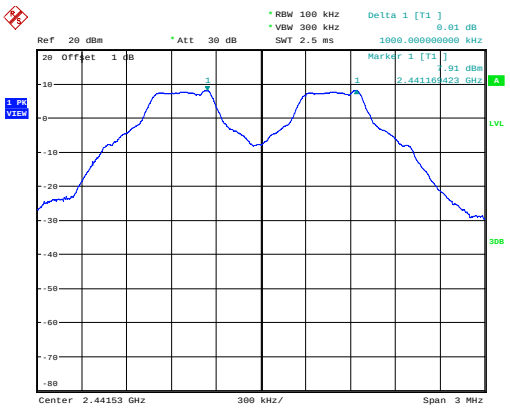
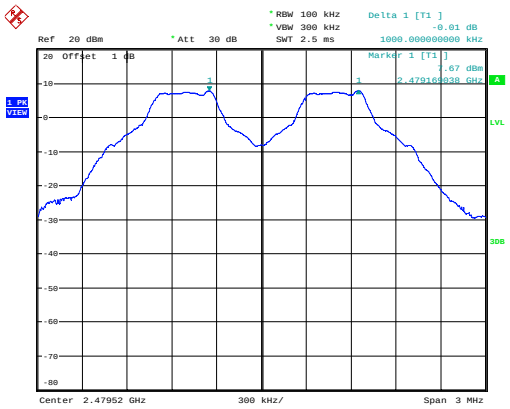
9.4 Test Environmental Conditions

Temperature:	22.9°C	**Relative Humidity:**	57 %
ATM Pressure:	1015hPa	**Test Engineer:**	Ian Tu
Conducted Test Date:	2019-09-27	-	-

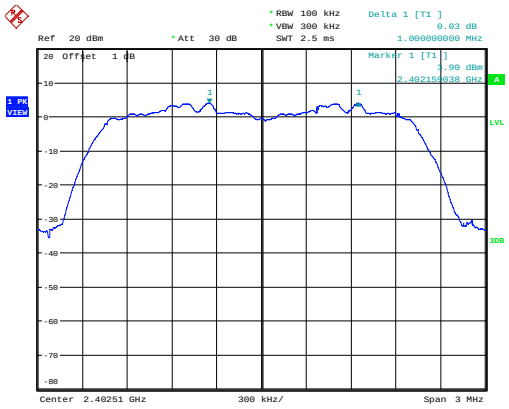
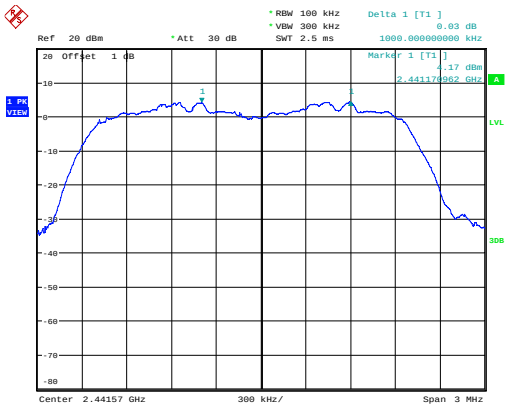
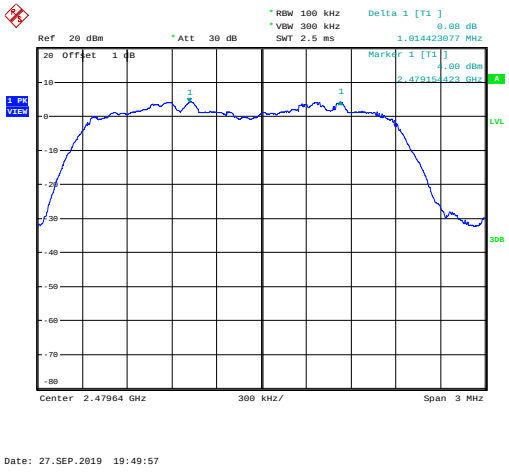
9.5 Test Results

Channel	Frequency (MHz)	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Limit (dBm)	Result
BR-1Mbps mode (GFSK)						
Low	2402	1.0048	1.0192	0.679	>two-thirds of the 20 dB bandwidth	Compliance
Middle	2441	1.0000	1.0288	0.686		Compliance
High	2480	1.0000	1.0240	0.683		Compliance
EDR-2Mbps mode (π/4-DQPSK)						
Low	2402	1.0000	1.3606	0.907	>two-thirds of the 20 dB bandwidth	Compliance
Middle	2441	1.0000	1.3606	0.907		Compliance
High	2480	1.0144	1.3606	0.907		Compliance
EDR-3Mbps mode (8DPSK)						
Low	2402	1.0000	1.3173	0.878	>two-thirds of the 20 dB bandwidth	Compliance
Middle	2441	1.0000	1.3221	0.881		Compliance
High	2480	1.0048	1.3221	0.881		Compliance

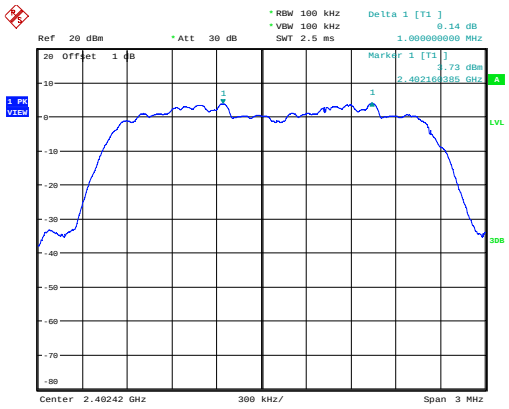
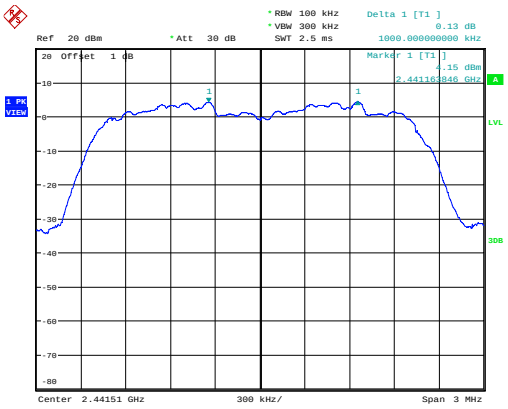
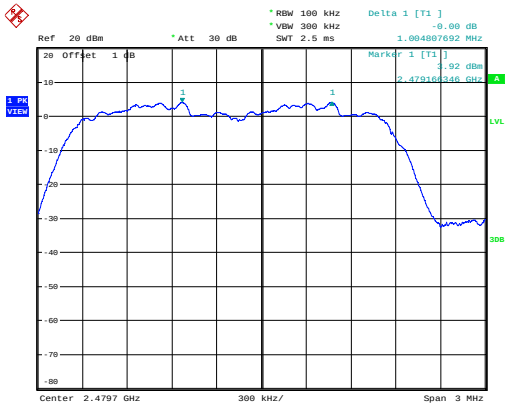
BR-1Mbps mode (GFSK):

Low CH	Middle CH
 Date: 27.SEP.2019 18:55:23	 Date: 27.SEP.2019 19:01:19
High CH	**-**
 Date: 27.SEP.2019 19:09:15	-

EDR-2Mbps mode (π/4-DQPSK):

Low CH	Middle CH
	
High CH	**-**
	-

EDR-3Mbps mode (8-DPSK):

Low CH	Middle CH
	
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					
Signal Analyzer	Rohde & Schwarz	FSU26	100406	2019/03/19	2020/03/18
Cable	MTJ	MT40S	620620-MT40S-100	2018/12/28	2019/12/27

***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 Environmental Conditions

Temperature:	22.9°C	**Relative Humidity:**	57 %
ATM Pressure:	1015hPa	**Test Engineer:**	Ian Tu
Conducted Test Date:	2019-09-27	-	-

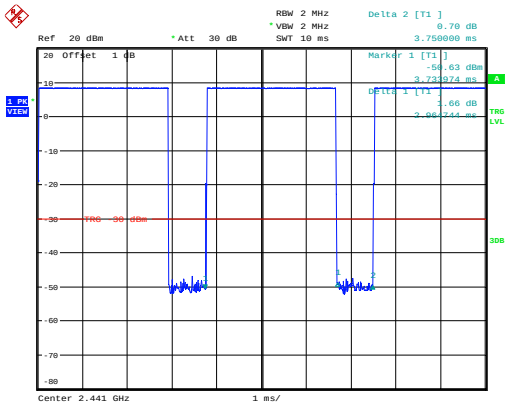
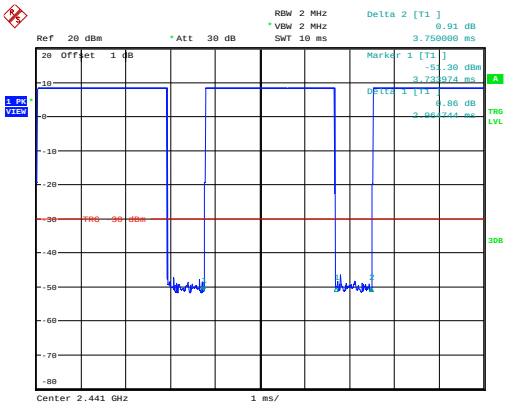
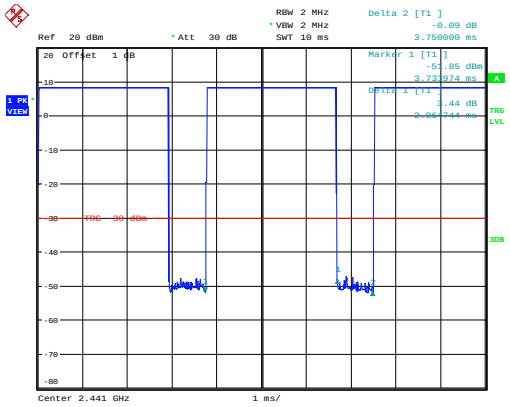
10.5 Test Results

Time of Occupancy (Dwell Time) Result				
Modulation Mode	**Pulse Time per Hop (ms)**	**Number of Pulse in [0.4 x N sec] (s)**	**Dwell Time in [0.4 x N sec] (s)**	**Dwell Time Limits (s)**
BR-1Mbps mode (GFSK)	2.96	106.7	0.316	0.4
EDR-2Mbps mode (π/4-DQPSK)	2.96	106.7	0.316	0.4
EDR-3Mbps mode (8DPSK)	2.96	106.7	0.316	0.4

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

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

** 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
 Date: 27.SEP.2019 19:14:28	 Date: 27.SEP.2019 19:33:59
3-DH5	**-**
 Date: 27.SEP.2019 20:11:24	-

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					
Signal Analyzer	Rohde & Schwarz	FSU26	100406	2019/03/19	2020/03/18
Cable	MTJ	MT40S	620620-MT40S-100	2018/12/28	2019/12/27

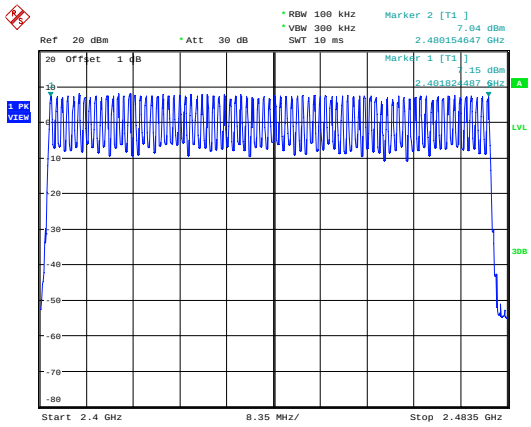
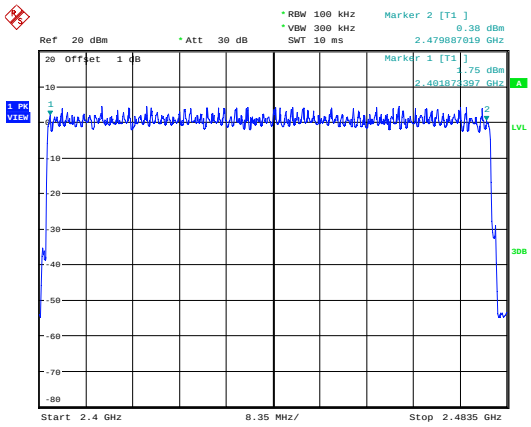
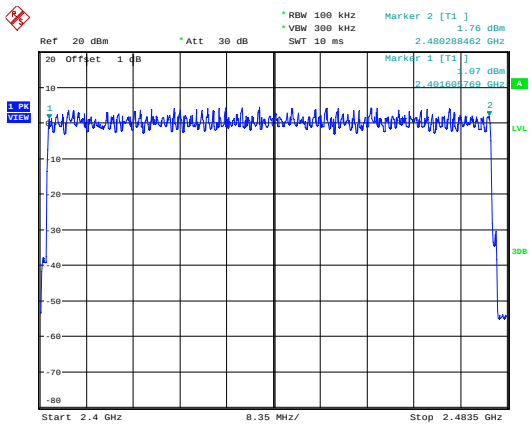
***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units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

11.4 Test Environmental Conditions

Temperature:	22.9°C	**Relative Humidity:**	57 %
ATM Pressure:	1015hPa	**Test Engineer:**	Ian Tu
Conducted Test Date:	2019-09-27	-	-

11.5 Test Results

Mode	Frequency Range (MHz)	Number of Hopping Channel	Limit (CH)	Result
BR-1Mbps mode (GFSK)	2402-2480	79	>15	Compliance
EDR-2Mbps mode (π/4-DQPSK)	2402-2480	79	>15	Compliance
EDR-3Mbps mode (8DPSK)	2402-2480	79	>15	Compliance

BR-1Mbps mode (GFSK)	EDR-2Mbps mode (π/4-DQPSK)
	
EDR-3Mbps mode (8DPSK)	**-**
	-

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					
Power Sensor	Agilent	U2021XA	MY54250014	2018/11/12	2019/11/11
Cable	MTJ	MT40S	620620-MT40S-100	2018/12/28	2019/12/27

***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 Environmental Conditions

Temperature:	22.9°C	**Relative Humidity:**	57 %
ATM Pressure:	1015hPa	**Test Engineer:**	Ian Tu
Conducted Test Date:	2019-09-27	-	-

12.5 Test Results

Channel	Frequency (MHz)	Maximum Peak Output Power (dBm)	Maximum Peak Output Power (W)	Limit (dBm)	Result
BR-1Mbps mode (GFSK)					
Low	2402	8.89	0.0077	21	Compliance
Middle	2441	**8.91**	**0.0078**	21	Compliance
High	2480	8.58	0.0072	21	Compliance
EDR-2Mbps mode (π/4-DQPSK)					
Low	2402	7.25	0.0053	21	Compliance
Middle	2441	**7.44**	**0.0055**	21	Compliance
High	2480	7.02	0.0050	21	Compliance
EDR-3Mbps mode (8DPSK)					
Low	2402	7.39	0.0055	21	Compliance
Middle	2441	**7.62**	**0.0058**	21	Compliance
High	2480	7.24	0.0053	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					
Signal Analyzer	Rohde & Schwarz	FSU26	100406	2019/03/19	2020/03/18
Cable	MTJ	MT40S	620620-MT40S-100	2018/12/28	2019/12/27

***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).*

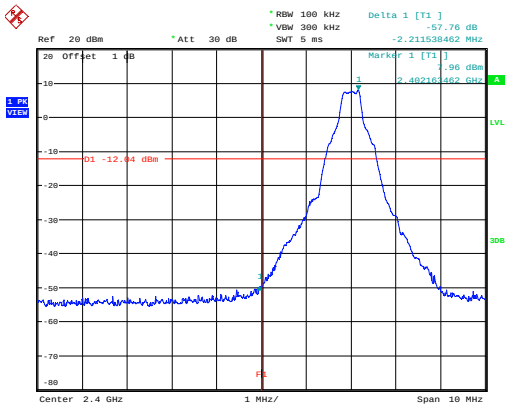
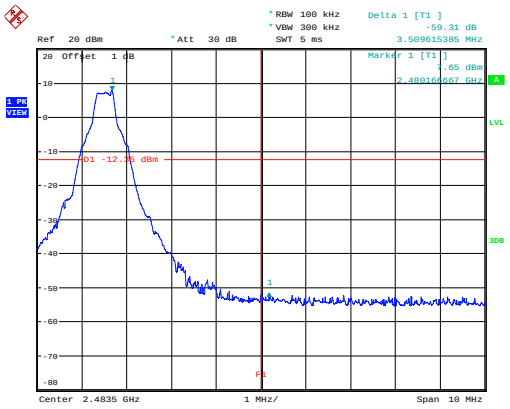
13.4 Test Environmental Conditions

Temperature:	22.9°C	**Relative Humidity:**	57 %
ATM Pressure:	1015hPa	**Test Engineer:**	Ian Tu
Conducted Test Date:	2019-09-27 to 2019-10-01	-	-

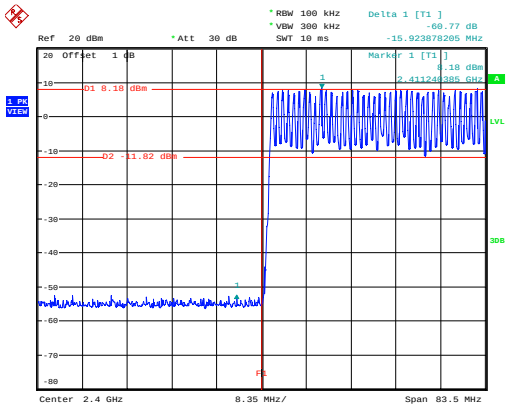
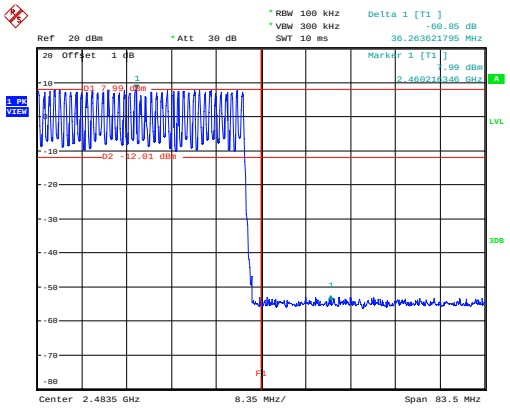
13.5 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BR-1Mbps mode (GFSK)				
Low	2402	57.76	≥ 20	Compliance
High	2480	59.31	≥ 20	Compliance
BR-1Mbps Hopping mode (GFSK)				
Low	2402	60.77	≥ 20	Compliance
High	2480	60.85	≥ 20	Compliance
EDR-2Mbps mode (π/4-DQPSK)				
Low	2402	55.99	≥ 20	Compliance
High	2480	55.94	≥ 20	Compliance
EDR-2Mbps Hopping mode (π/4-DQPSK)				
Low	2402	56.76	≥ 20	Compliance
High	2480	56.95	≥ 20	Compliance
EDR-3Mbps mode (8DPSK)				
Low	2402	55.84	≥ 20	Compliance
High	2480	56.40	≥ 20	Compliance
EDR-3Mbps Hopping mode (8DPSK)				
Low	2402	57.64	≥ 20	Compliance
High	2480	56.32	≥ 20	Compliance

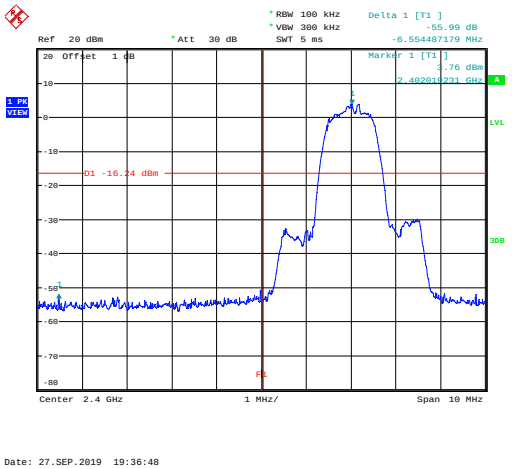
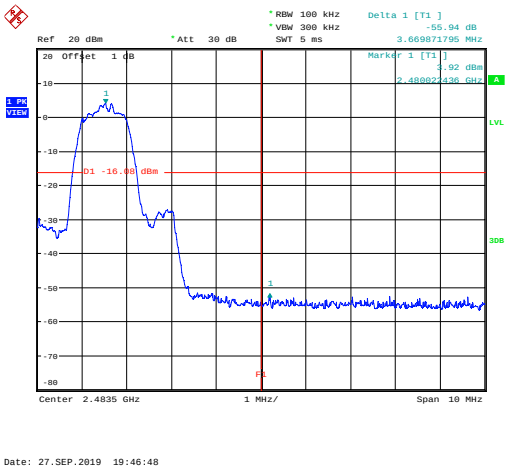
BR-1Mpbs mode (GFSK):

Left Side	Right Side
	

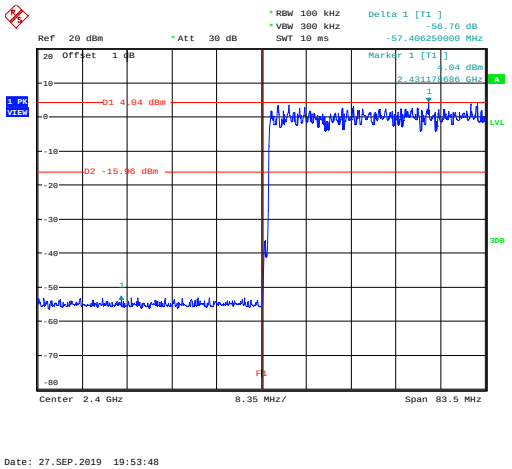
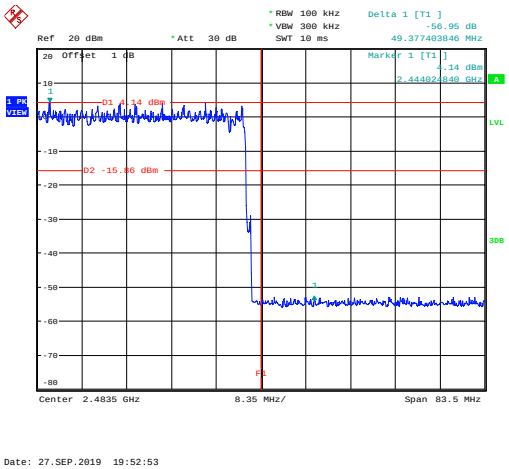
BR-1Mpbs Hopping mode (GFSK):

Left Side	Right Side
	

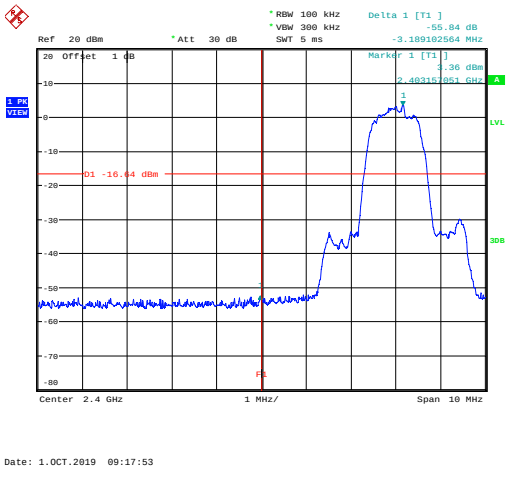
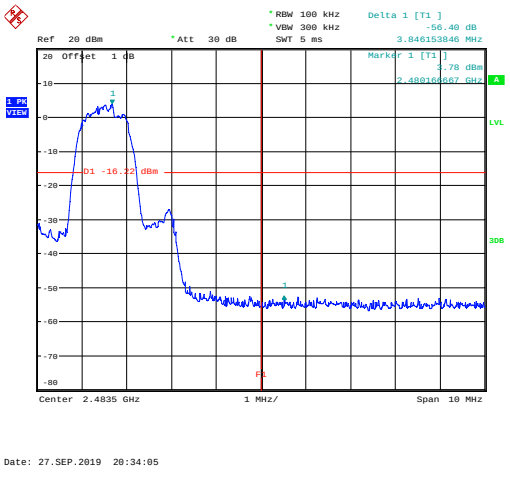
EDR-2Mbps mode (π/4-DQPSK):

Left Side	Right Side
	

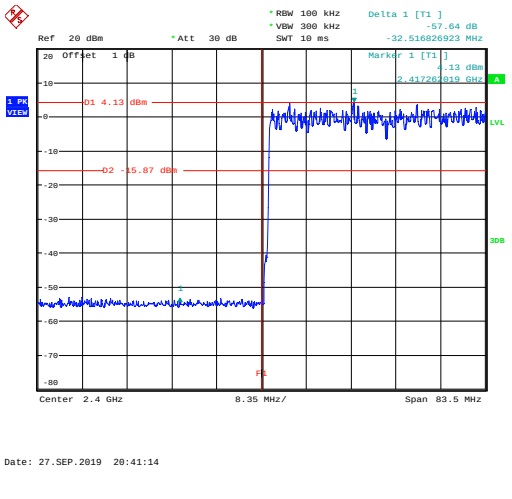
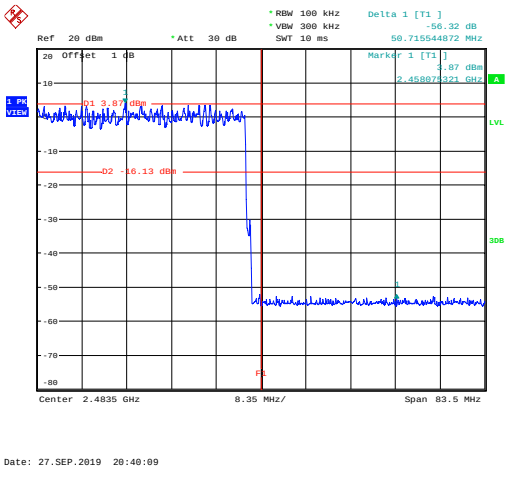
EDR-2Mbps Hopping mode (π/4-DQPSK):

Left Side	Right Side
	

EDR-3Mbps mode (8DPSK):

Left Side	Right Side
	

EDR-3Mbps Hopping mode (8DPSK):

Left Side	Right Side
	

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