



# TEST REPORT

Product Name: LED Controller  
FCC ID: 2AJWW-FUT037S  
Trademark: N/A  
Model Number: FUT037S+, FUT035S+, FUT035W+, FUT037W+, FUT035Z+, FUT037Z+, E2-RF, E3-RF, E2-WR, E3-WR, E2-ZR, E3-ZR, FUT043+  
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Sample Received Date: Mar. 29, 2024  
Sample tested Date: Mar. 29, 2024 to Apr. 10, 2024  
Issue Date: Apr. 10, 2024  
Report No.: CTB240410066RFX  
Test Standards: FCC Part15.247  
ANSI C63.10:2013  
Test Results: PASS  
Remark: This is 2.4GHz radio test report.

Compiled by:

Reviewed by:

Approved by:

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Arron Liu



Zhou Kui

Arron Liu

Bin Mei / Director

Note: If there is any objection to the inspection results in this report, please submit a written report to the company within 15 days from the date of receiving the report. The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen CTB Testing Technology Co., Ltd. this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client. "\*" indicates the testing items were fulfilled by subcontracted lab. "#" indicates the items are not in CNAS accreditation scope.

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*(Note: N/A means not applicable)*

**1. VERSION**

Report No.	Issue Date	Description	Approved
CTB240410066RFX	Apr. 10, 2024	Original	Valid

## 2. TEST SUMMARY

The Product has been tested according to the following specifications:

Test Item	Test Requirement	Test method	Result
<b>AC Power Line Conducted Emission</b>	47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	N/A
<b>Radiated Spurious emissions</b>	47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS
<b>Band edge and RF Conducted Spurious Emissions</b>	47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a)	ANSI C63.10-2013	PASS
<b>Conducted Peak Output Power</b>	47 CFR Part 15 Subpart C Section 15.247 (b)(3)	ANSI C63.10-2013	PASS
<b>Bandwidth</b>	47 CFR Part 15 Subpart C Section 15.247 (a)(2)	ANSI C63.10-2013	PASS
<b>Power Spectral Density</b>	47 CFR Part 15 Subpart C Section 15.247 (e)	ANSI C63.10-2013/ KDB 558074 D01v05r02	PASS
<b>Antenna Requirement</b>	47 CFR Part 15 Subpart C Section 15.203/15.247 (b)	/	PASS

Remark:

Test according to ANSI C63.10-2013.

### 3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Item	Uncertainty
Occupancy bandwidth	54.3kHz
Conducted output power Above 1G	0.9dB
Conducted output power below 1G	0.9dB
Power Spectral Density , Conduction	0.9dB
Conduction spurious emissions	2.0dB
Out of band emission	2.0dB
3m chamber Radiated spurious emission(9K-30MHz)	4.8dB
3m chamber Radiated spurious emission(30MHz-1GHz)	4.6dB
3m chamber Radiated spurious emission(1GHz-18GHz)	5.1dB
3m chamber Radiated spurious emission(18GHz-40GHz)	3.4dB
humidity uncertainty	5.5%
Temperature uncertainty	0.63°C
frequency	1×10 <sup>-7</sup>
Conducted Emission (150KHz-30MHz)	3.2 dB
Radiated Emission(30MHz ~ 1000MHz)	4.8 dB
Radiated Emission(1GHz ~6GHz)	4.9 dB

#### 4. PRODUCT INFORMATION AND TEST SETUP

##### 4.1 Product Information

Model(s):	FUT037S+, FUT035S+, FUT035W+, FUT037W+, FUT035Z+, FUT037Z+, E2-RF, E3-RF, E2-WR, E3-WR, E2-ZR, E3-ZR, FUT043+
Model Description:	All the model are the same circuit and RF module, only different for model name. Test sample model: FUT037S+
Hardware Version:	V3.0
Software Version:	V2.0
Operation Frequency:	2410-2472MHz
Max. RF output power:	2.38dBm
Type of Modulation:	GFSK
Antenna installation:	Internal Antenna
Antenna Gain:	4.45dBi
Ratings:	DC 3V by 1.5V*2 AAA battery

##### 4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

##### 4.3 Support Equipment

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
/	/	/	/	/	/

**Notes:**

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

#### 4.4 Channel List

CH No.	Frequency (MHz)	CH No.	Frequency (MHz)	CH No.	Frequency (MHz)
1	2410	2	2441	3	2472

#### 4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting (GFSK)	2410MHz	2441MHz	2472MHz

#### 4.6 Test Environment

Humidity(%):	54
Atmospheric Pressure(kPa):	101
Normal Voltage(DC):	3V
Normal Temperature(°C)	23
Low Temperature(°C)	0
High Temperature(°C)	40

## 5. TEST FACILITY AND TEST INSTRUMENT USED

### 5.1 Test Facility

All measurement facilities used to collect the measurement data are located at 1&2F., Building A, No. 26, Xinh Road, Xinqiao, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

### 5.2 Test Instrument Used

Item	Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	Agilent	N9020A	MY52090073	2024.07.05
2	Power Sensor	Agilent	U2021XA	MY56120032	2024.07.05
3	Power Sensor	Agilent	U2021XA	MY56120034	2024.07.05
4	Communication test set	R&S	CMW500	108058	2024.07.05
5	Spectrum Analyzer	KEYSIGHT	N9020A	MY51289897	2024.07.05
6	Signal Generator	Agilent	N5181A	MY50140365	2024.07.05
7	Vector signal generator	Agilent	N5182A	MY47420195	2024.07.05
8	Communication test set	Agilent	E5515C	MY50102567	2024.07.06
9	2.4 GHz Filter	Shenxiang	MSF2400-2483.5MS-1154	20181015001	2024.07.05
10	5 GHz Filter	Shenxiang	MSF5150-5850 MS-1155	20181015001	2024.07.06
11	Filter	Xingbo	XBLBQ-DZA120	190821-1-1	2024.07.06
12	BT&WI-FI Automatic test software	Microwave	MTS8000	Ver. 2.0.0.0	/
13	Rohde & Schwarz SFU Broadcast Test System	R&S	SFU	101017	2024.10.30
14	Temperature humidity chamber	Hongjing	TH-80CH	DG-15174	2024.07.05
15	234G Automatic test software	Microwave	MTS8200	Ver. 2.0.0.0	/
16	966 chamber	C.R.T.	966	/	2024.08.11
17	Receiver	R&S	ESPI	100362	2024.07.05
18	Amplifier	HP	8447E	2945A02747	2024.07.05
19	Amplifier	Agilent	8449B	3008A01838	2024.07.05
20	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	00869	2024.07.08

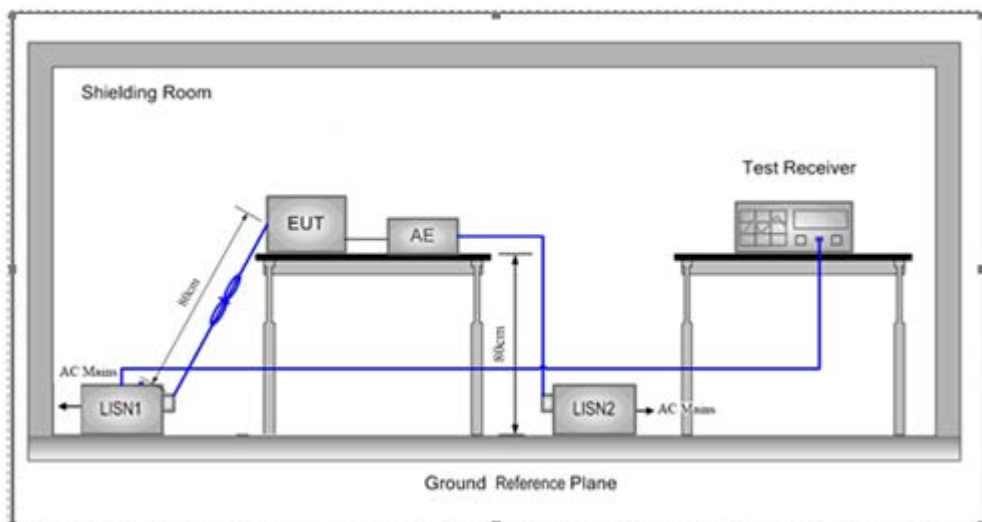


21	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA9120D	01911	2024.07.08
22	EMI test software	Fala	EZ-EMC	FA-03A2 RE	/
23	Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-224	2024.07.08
24	loop antenna	ZHINAN	ZN30900A	GTS534	/
25	40G Horn antenna	A/H/System	SAS-574	588	2024.10.30
26	Amplifier	AEROFLEX	Aeroflex	097	2024.07.05

Radiated emission					
No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA 9120 D	01911	2024.07.08
2	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	00869	2024.07.08
3	Amplifier	Agilent	8449B	3008A01838	2024.07.05
4	Amplifier	HP	8447E	2945A02747	2024.07.05
5	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI	100428/003	2024.07.05
6	Coaxial cable	ETS	RFC-SNS-100-NMS-80 NI	/	2024.07.05
7	Coaxial cable	ETS	RFC-SNS-100-NMS-20 NI	/	2024.07.05
8	Coaxial cable	ETS	RFC-SNS-100-SMS-20 NI	/	2024.07.05
9	Coaxial cable	ETS	RFC-NNS-100-NMS-300 NI	/	2024.07.05
10	Communication test set	Agilent	E5515C	MY50102567	2024.07.05
11	Communication test set	R&S	CMW500	108058	2024.07.05
12	EZ-EMC	Frad	EMC-con3A1.1	/	/

## 6. AC POWER LINE CONDUCTED EMISSION

### 6.1 Block Diagram Of Test Setup



### 6.2 Limit

**Table 4 – AC power-line conducted emissions limits**

Frequency (MHz)	Conducted limit (dB $\mu$ V)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 <sup>Note 1</sup>	56 to 46 <sup>Note 1</sup>
0.5 - 5	56	46
5 - 30	60	50

**Note 1:** The level decreases linearly with the logarithm of the frequency.

\* Decreasing linearly with the logarithm of the frequency

### 6.3 Test procedure

- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50 $\Omega$ /50 $\mu$ H + 5 $\Omega$  linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under

test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement.
- 6) All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.
- 7) If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

#### 6.4 Test Result

N/A

NOTE: This EUT is powered by DC power only, this test item is not applicable.

## 7. RADIATED SPURIOUS EMISSION

### 7.1 Block Diagram Of Test Setup

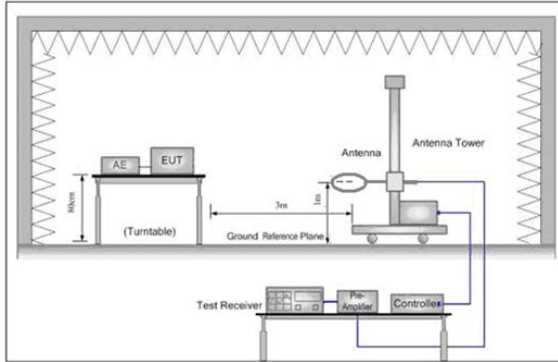


Figure 1. Below 30MHz

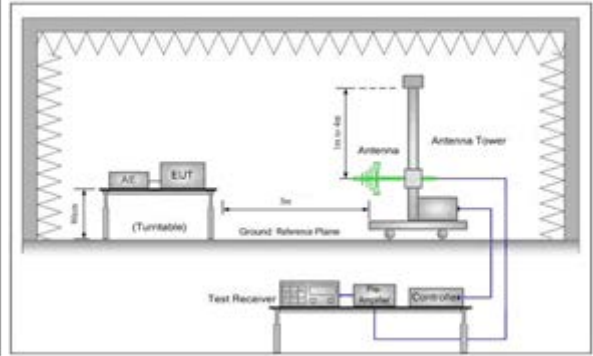
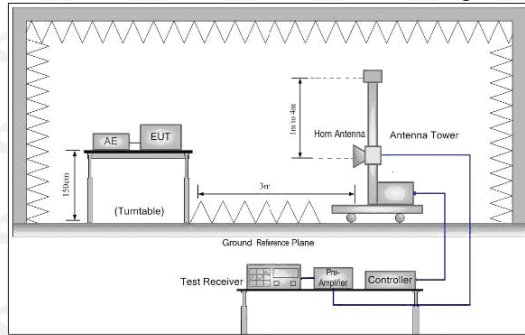


Figure 2. 30MHz to 1GHz



### 7.2 Limit

Spurious Emissions:

Frequency	Field strength (microvolt/meter)	Limit (dB $\mu$ V/m )	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

7.3 Test procedure

**Below 1GHz test procedure as below:**

- a.The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b.The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c.The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d.For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e.The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f.If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

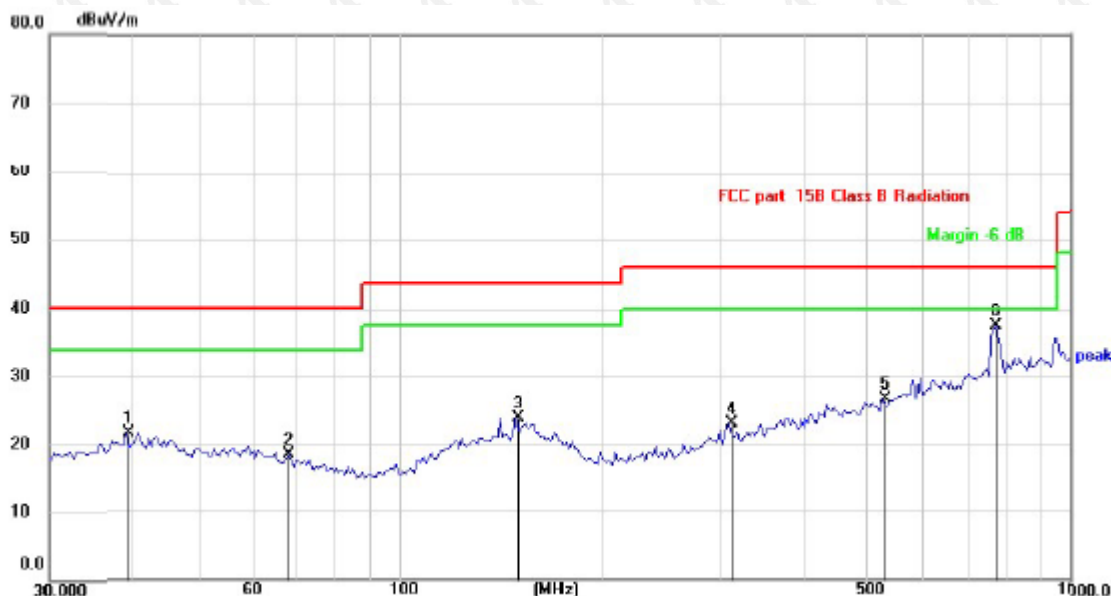
**Above 1GHz test procedure as below:**

- g.Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter( Above 18GHz the distance is 1 meter and table is 1.5 meter).
  - h.Test the EUT in the lowest channel ,the middle channel ,the Highest channel
  - i.Repeat above procedures until all frequencies measured was complete.
  - j. Full battery is used during test
- Receiver set:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30KHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30KHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30KHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30KHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30KHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	120 kHz	300KHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

### 7.4 Test Result

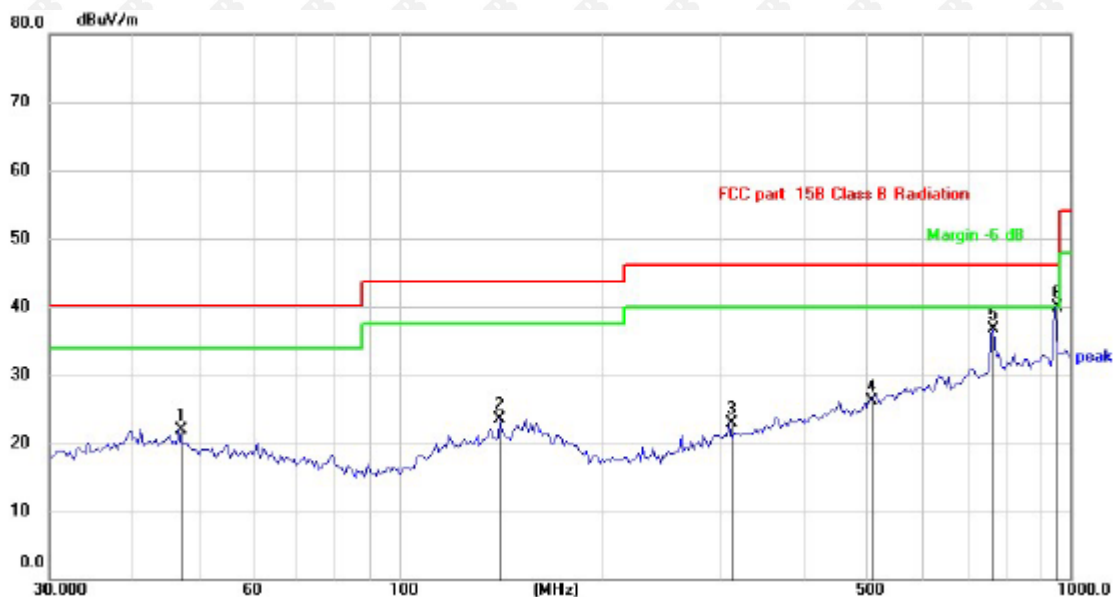
Below 1GHz Test Results:  
 Antenna polarity: H  
 Worst case-GFSK(low channel)



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dB/m	Over dB	Detector
1		39.0245	26.80	-5.03	21.77	40.00	-18.23	QP
2		68.3908	26.39	-7.84	18.55	40.00	-21.45	QP
3		149.2239	27.25	-3.26	23.99	43.50	-19.51	QP
4		311.6326	27.57	-4.44	23.13	46.00	-22.87	QP
5		527.3205	25.88	0.75	26.63	46.00	-19.37	QP
6	*	775.5169	31.56	5.96	37.52	46.00	-8.48	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit

Antenna polarity: V  
 Worst case-GFSK(low channel)



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dB/m	Over dB	Detector
1		46.9125	27.96	-6.06	21.90	40.00	-18.10	QP
2		141.5777	27.76	-4.20	23.56	43.50	-19.94	QP
3		311.6326	27.32	-4.44	22.88	46.00	-23.12	QP
4		509.1501	25.92	0.28	26.20	46.00	-19.80	QP
5		768.7481	30.95	5.84	36.79	46.00	-9.21	QP
6	*	948.7610	32.50	7.36	39.86	46.00	-6.14	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit



## Above 1 GHz Test Results:

CH Low (2410MHz)

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dB $\mu$ V)	(dB)	(dB $\mu$ V/m)	(dB $\mu$ V/m)	(dB)	
2410	102.02	-5.84	96.18	N/A	N/A	peak
2410	94.49	-5.84	88.65	N/A	N/A	AVG
4820	59.15	-3.64	55.51	74	-18.49	peak
4820	48.11	-3.64	44.47	54	-9.53	AVG
7230	60.13	-0.95	59.18	74	-14.82	peak
7230	49.72	-0.95	48.77	54	-5.23	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dB $\mu$ V)	(dB)	(dB $\mu$ V/m)	(dB $\mu$ V/m)	(dB)	
2410	101.92	-5.84	96.08	N/A	N/A	peak
2410	92.72	-5.84	86.88	N/A	N/A	AVG
4820	56.87	-3.64	53.23	74	-20.77	peak
4820	48.40	-3.64	44.76	54	-9.24	AVG
7230	58.29	-0.95	57.34	74	-16.66	peak
7230	50.30	-0.95	49.35	54	-4.65	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

CH Middle (2441MHz)

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dB $\mu$ V)	(dB)	(dB $\mu$ V/m)	(dB $\mu$ V/m)	(dB)	
2441	98.70	-5.71	92.99	N/A	N/A	peak
2441	91.65	-5.71	85.94	N/A	N/A	AVG
4882	54.68	-3.51	51.17	74	-22.83	peak
4882	46.97	-3.51	43.46	54	-10.54	AVG
7323	56.82	-0.82	56.00	74	-18.00	peak
7323	47.10	-0.82	46.28	54	-7.72	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dB $\mu$ V)	(dB)	(dB $\mu$ V/m)	(dB $\mu$ V/m)	(dB)	
2441	97.62	-5.71	91.91	N/A	N/A	peak
2441	91.35	-5.71	85.64	N/A	N/A	AVG
4882	55.44	-3.51	51.93	74	-22.07	peak
4882	45.21	-3.51	41.70	54	-12.30	AVG
7323	57.71	-0.82	56.89	74	-17.11	peak
7323	47.74	-0.82	46.92	54	-7.08	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

CH High (2472MHz)  
Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dB $\mu$ V)	(dB)	(dB $\mu$ V/m)	(dB $\mu$ V/m)	(dB)	
2472	99.18	-5.65	93.53	N/A	N/A	peak
2472	91.66	-5.65	86.01	N/A	N/A	AVG
4944	54.85	-3.43	51.42	74	-22.58	peak
4944	45.94	-3.43	42.51	54	-11.49	AVG
7416	57.01	-0.75	56.26	74	-17.74	peak
7416	47.01	-0.75	46.26	54	-7.74	AVG

Remark: Factor = Antenna Factor + Cable Loss - Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dB $\mu$ V)	(dB)	(dB $\mu$ V/m)	(dB $\mu$ V/m)	(dB)	
2472	105.38	-5.65	99.73	N/A	N/A	peak
2472	92.66	-5.65	87.01	N/A	N/A	AVG
4944	54.19	-3.43	50.76	74	-23.24	peak
4944	47.39	-3.43	43.96	54	-10.04	AVG
7416	56.80	-0.75	56.05	74	-17.95	peak
7416	46.21	-0.75	45.46	54	-8.54	AVG

Remark: Factor = Antenna Factor + Cable Loss - Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Remark:

- (1) Measuring frequencies from 9KHz to the 25 GHz, The test range is 9K ~10 times the main wave, and other spurious below the limit of 20dB will not be reflected in the report.
- (2). All modes of GFSK were test at Low, Middle, and High channel, only the worst result of GFSK Low Channel was reported for below 1GHz test.
- (3). For GFSK above 1GHz test all modes of GFSK were test at Low, Middle, and High channel, only the worst result of GFSK Low Channel was reported.
- (4). By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that "Z axis" position was the worst, and test data recorded in this report.
- (5). Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

**Restricted bands around fundamental frequency (Radiated)**

Operation Mode: TX CH Low (2410MHz)  
Horizontal (Worst case)

Frequency (MHz)	Meter Reading (dB $\mu$ V)	Factor (dB)	Emission Level (dB $\mu$ V/m)	Limits (dB $\mu$ V/m)	Margin (dB)	Detector Type
2310	55.30	-5.81	49.49	74	-24.51	peak
2310	/	-5.81	/	54	/	AVG
2390	54.42	-5.84	48.58	74	-25.42	peak
2390	/	-5.84	/	54	/	AVG
2400	53.68	-5.84	47.84	74	-26.16	peak
2400	/	-5.84	/	54	/	AVG

Vertical:

Frequency (MHz)	Meter Reading (dB $\mu$ V)	Factor (dB)	Emission Level (dB $\mu$ V/m)	Limits (dB $\mu$ V/m)	Margin (dB)	Detector Type
2310	56.91	-5.81	51.10	74	-22.90	peak
2310	/	-5.81	/	54	/	AVG
2390	55.61	-5.84	49.77	74	-24.23	peak
2390	/	-5.84	/	54	/	AVG
2400	57.17	-5.84	51.33	74	-22.67	peak
2400	/	-5.84	/	54	/	AVG

When the peak value is smaller than the AVG limit, AVG is not reflected.

Operation Mode: TX CH High (2472MHz)  
Horizontal (Worst case)

Frequency (MHz)	Reading Result (dB $\mu$ V)	Factor (dB)	Emission Level (dB $\mu$ V/m)	Limits (dB $\mu$ V/m)	Margin (dB)	Detector Type
2483.50	54.10	-5.65	48.45	74	-25.55	peak
2483.50	/	-5.65	/	54	/	AVG
2500.00	54.82	-5.65	49.17	74	-24.83	peak
2500.00	/	-5.65	/	54	/	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency (MHz)	Reading Result (dB $\mu$ V)	Factor (dB)	Emission Level (dB $\mu$ V/m)	Limits (dB $\mu$ V/m)	Margin (dB)	Detector Type
2483.50	54.27	-5.65	48.62	74	-25.38	peak
2483.50	/	-5.65	/	54	/	AVG
2500.00	55.33	-5.65	49.68	74	-24.32	peak
2500.00	/	-5.65	/	54	/	AVG

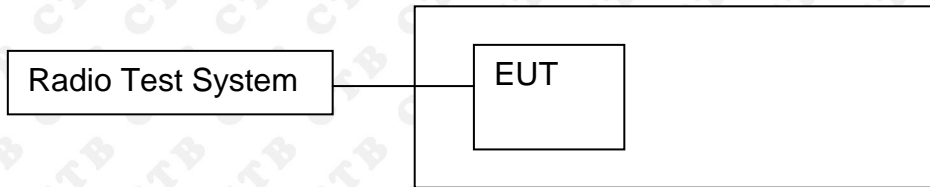
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Remark: All the other emissions not reported were too low to read and deemed to comply with FCC limit.

When the peak value is smaller than the AVG limit, AVG is not reflected.

## 8. BAND EDGE AND RF CONDUCTED SPURIOUS EMISSIONS

### 8.1 Block Diagram Of Test Setup



### 8.2 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### 8.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:

Below 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

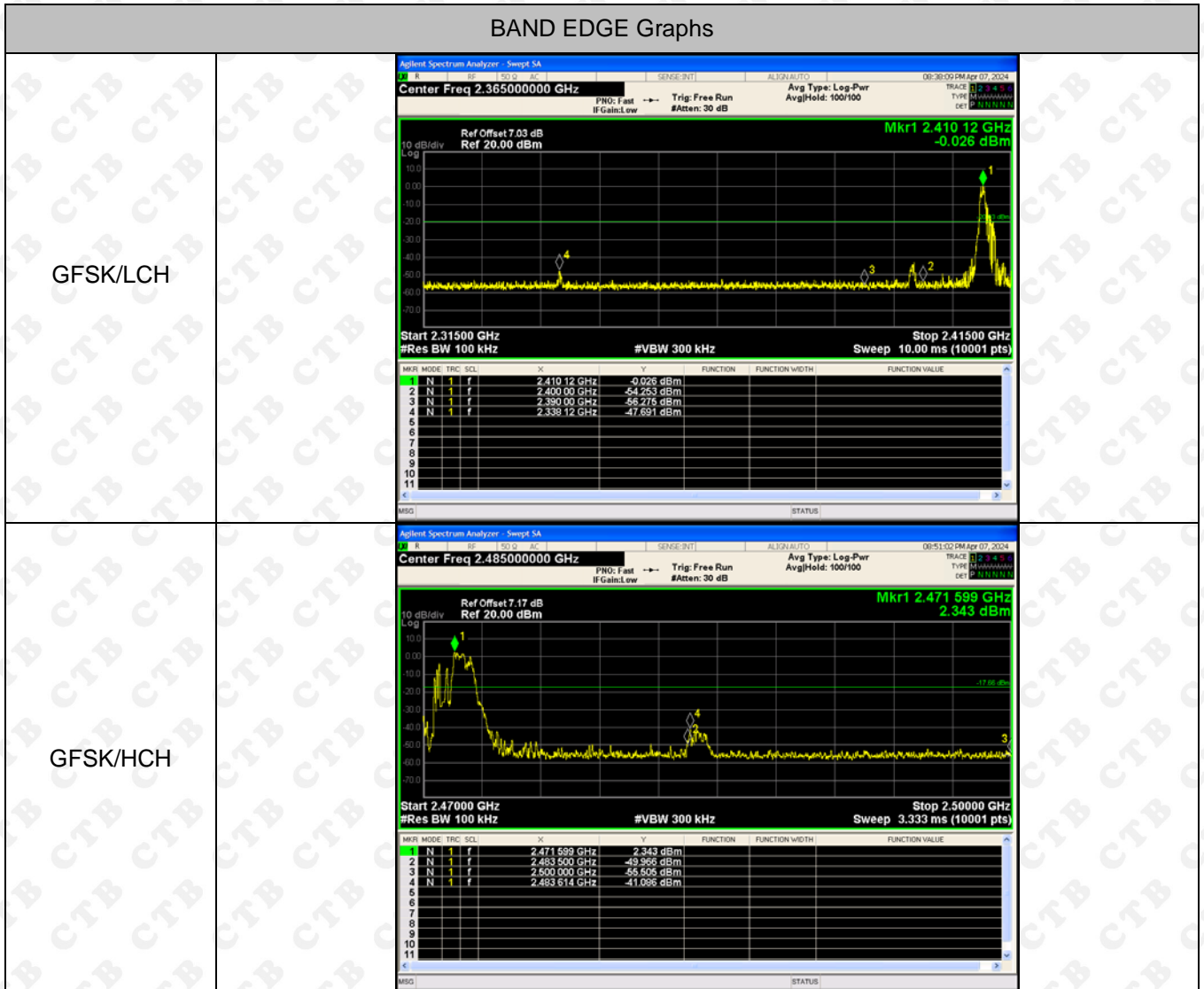
Detector function = peak, Trace = max hold

Above 30MHz:

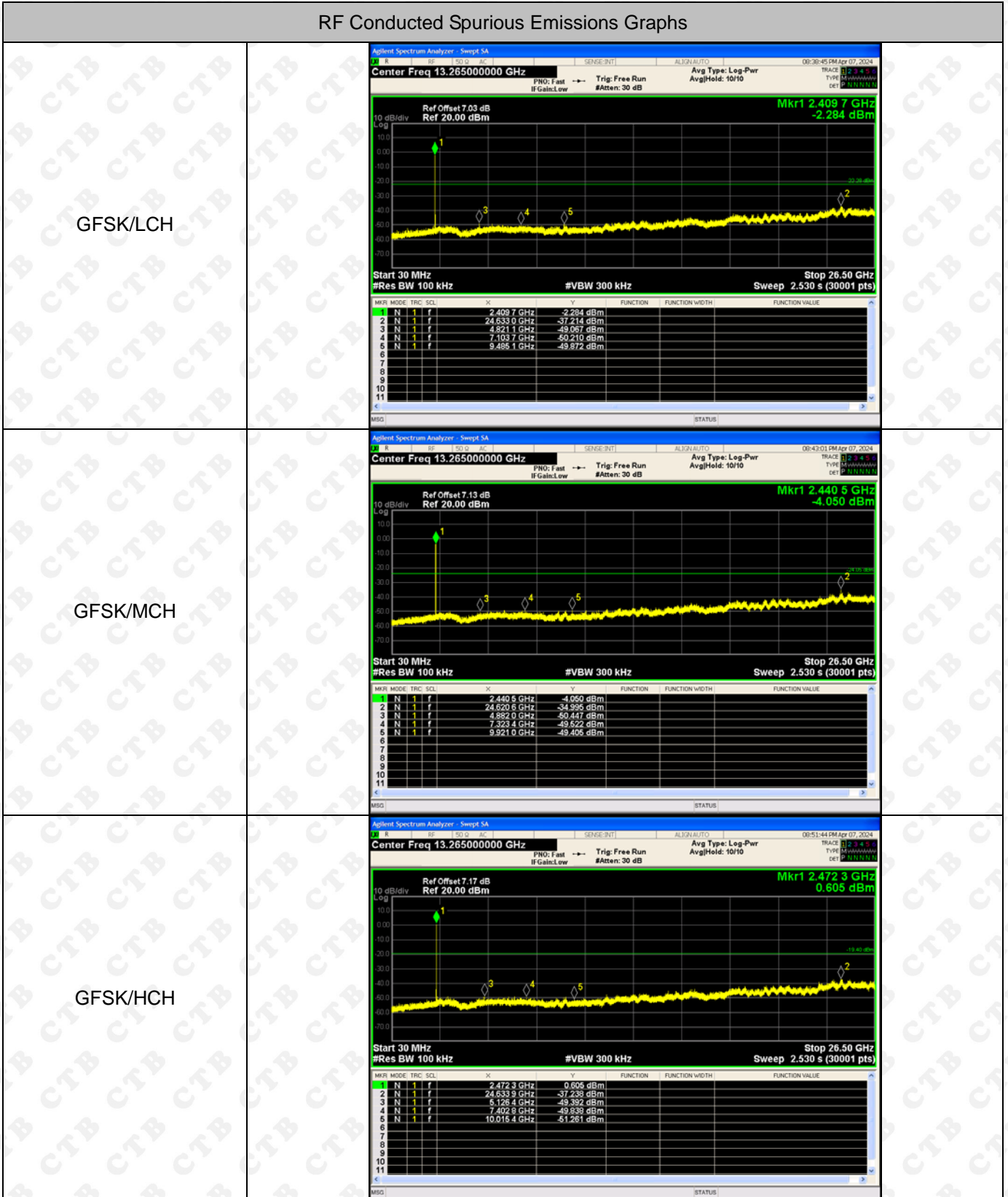
RBW = 100KHz, VBW = 300KHz, Sweep = auto

Detector function = peak, Trace = max hold

8.4 Test Result



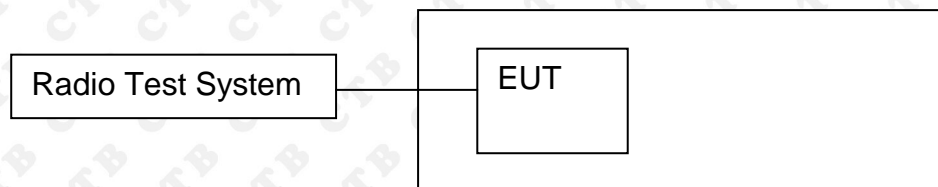
RF Conducted Spurious Emissions Graphs





## 9. COUDUCTED OUTPUT POWER

### 9.1 Block Diagram Of Test Setup



### 9.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(3)	Output Power	1 watt or 30dBm	2400-2483.5	PASS

### 9.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 2MHz. VBW = 6MHz. Channel power measurement. Sweep = auto; Detector Function = peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

## 9.4 Test Result

Mode	Channel.	Maximum Output Power [dBm]	Limit[dBm]	Verdict
GFSK	LCH	1.540	30	PASS
	MCH	1.623	30	PASS
	HCH	2.380	30	PASS

## Duty Cycle

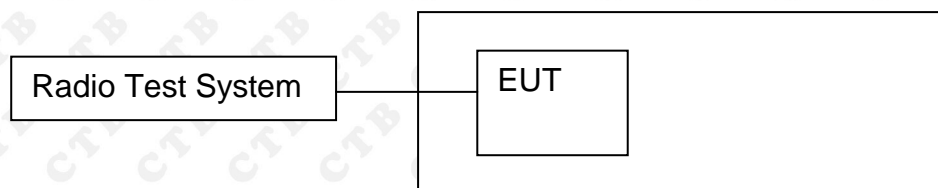
Mode	Channel.	Duty Cycle(%)	Correction Factor (dB)
GFSK	LCH	100	0
	MCH	100	0
	HCH	100	0

**Test Graph:**

<p>GFSK Low channel</p>	<p>Agilent Spectrum Analyzer - Swept SA Center Freq 2.41000000 GHz Ref Offset 7.03 dB Ref 20.00 dBm Mkr1 2.410 38 GHz 1.540 dBm Center 2.410000 GHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)</p>	
<p>GFSK Mid channel</p>	<p>Agilent Spectrum Analyzer - Swept SA Center Freq 2.41000000 GHz Ref Offset 7.03 dB Ref 20.00 dBm Mkr1 2.410 38 GHz 1.540 dBm Center 2.410000 GHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)</p>	
<p>GFSK High channel</p>	<p>Agilent Spectrum Analyzer - Swept SA Center Freq 2.47200000 GHz Ref Offset 7.17 dB Ref 20.00 dBm Mkr1 2.471 44 GHz 2.380 dBm Center 2.472000 GHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)</p>	

### 10. 6DB OCCUPIED BANDWIDTH

#### 10.1 Block Diagram Of Test Setup



#### 10.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(2)	Bandwidth	>= 500KHz (6dB bandwidth)	2400-2483.5	PASS

#### 10.3 Test procedure

1. Rem1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

#### 10.4 Test Result

Test Mode	Frequency	6dB Bandwidth (MHz)	Limit (KHz)	Result
GFSK	Low channel	0.921	>= 500	PASS
	Mid channel	1.232	>= 500	PASS
	High channel	1.669	>= 500	PASS

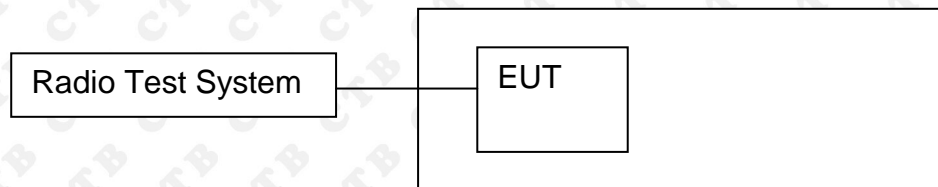
Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

Test Graph:

<p>GFSK Low channel</p>	<p>Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.41000000 GHz Center Freq: 2.41000000 GHz Trig: Free Run #Gain: Low #Atten: 30 dB Avg/Hold: 100/100 Radio Std: None Radio Device: BTS</p> <p>Ref Offset: 7.03 dB Ref: 27.03 dBm Mkr3: 2.410987 GHz -12.132 dBm</p> <p>Center: 2.41 GHz #Res BW: 100 kHz #VBW: 300 kHz Span: 5 MHz Sweep: 1 ms</p> <p>Occupied Bandwidth: 2.0863 MHz Total Power: 9.85 dBm Transmit Freq Error: 579.12 kHz OBW Power: 99.00 % x dB Bandwidth: 958.6 kHz x dB: -6.00 dB</p>
<p>GFSK Mid channel</p>	<p>Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.44100000 GHz Center Freq: 2.44100000 GHz Trig: Free Run #Gain: Low #Atten: 30 dB Avg/Hold: 100/100 Radio Std: None Radio Device: BTS</p> <p>Ref Offset: 7.15 dB Ref: 27.13 dBm Mkr3: 2.441518 GHz -7.0821 dBm</p> <p>Center: 2.441 GHz #Res BW: 100 kHz #VBW: 300 kHz Span: 5 MHz Sweep: 1 ms</p> <p>Occupied Bandwidth: 1.6199 MHz Total Power: 10.6 dBm Transmit Freq Error: -210.83 kHz OBW Power: 99.00 % x dB Bandwidth: 1.332 MHz x dB: -6.00 dB</p>
<p>GFSK High channel</p>	<p>Agilent Spectrum Analyzer - Occupied BW Center Freq: 2.47200000 GHz Center Freq: 2.47200000 GHz Trig: Free Run #Gain: Low #Atten: 30 dB Avg/Hold: 100/100 Radio Std: None Radio Device: BTS</p> <p>Ref Offset: 7.17 dB Ref: 27.17 dBm Mkr3: 2.472533 GHz -5.9082 dBm</p> <p>Center: 2.472 GHz #Res BW: 100 kHz #VBW: 300 kHz Span: 5 MHz Sweep: 1 ms</p> <p>Occupied Bandwidth: 2.1393 MHz Total Power: 11.7 dBm Transmit Freq Error: -366.34 kHz OBW Power: 99.00 % x dB Bandwidth: 1.701 MHz x dB: -6.00 dB</p>

## 11. POWER SPECTRAL DENSITY

### 11.1 Block Diagram Of Test Setup



### 11.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247	Power Spectral Density	8 dBm (in any 3KHz)	2400-2483.5	PASS

### 11.3 Test procedure

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS bandwidth.
3. Set the RBW to:  $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$ .
4. Set the VBW  $\geq 3 \times \text{RBW}$ .
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 11.4 Test Result

Mode	Channel.	Power Spectral Density (dBm/3KHz)	Limit(dBm/3KHz)	Verdict
GFSK	LCH	-14.592	8	PASS
GFSK	MCH	-12.439	8	PASS
GFSK	HCH	-15.24	8	PASS

## Test Graph

Graphs	
GFSK/LCH	<p>Agilent Spectrum Analyzer - Swept SA          Center Freq 2.41000000 GHz          Ref Offset 7.03 dB          Ref 20.00 dBm          Mkr1 2.410165 GHz          -14.592 dBm          Center 2.410000 GHz          #Res BW 3.0 kHz          #VBW 10 kHz          Span 5.000 MHz          Sweep 527.2 ms (1001 pts)</p>
GFSK/MCH	<p>Agilent Spectrum Analyzer - Swept SA          Center Freq 2.44100000 GHz          Ref Offset 7.13 dB          Ref 20.00 dBm          Mkr1 2.440946 GHz          -12.439 dBm          Center 2.441000 GHz          #Res BW 3.0 kHz          #VBW 10 kHz          Span 3.000 MHz          Sweep 316.3 ms (1001 pts)</p>
GFSK/HCH	<p>Agilent Spectrum Analyzer - Swept SA          Center Freq 2.47200000 GHz          Ref Offset 7.17 dB          Ref 20.00 dBm          Mkr1 2.472380 GHz          -15.240 dBm          Center 2.472000 GHz          #Res BW 3.0 kHz          #VBW 10 kHz          Span 5.000 MHz          Sweep 527.2 ms (1001 pts)</p>

## 12. ANTENNA REQUIREMENT

### 15.203 requirement:

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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

### 15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

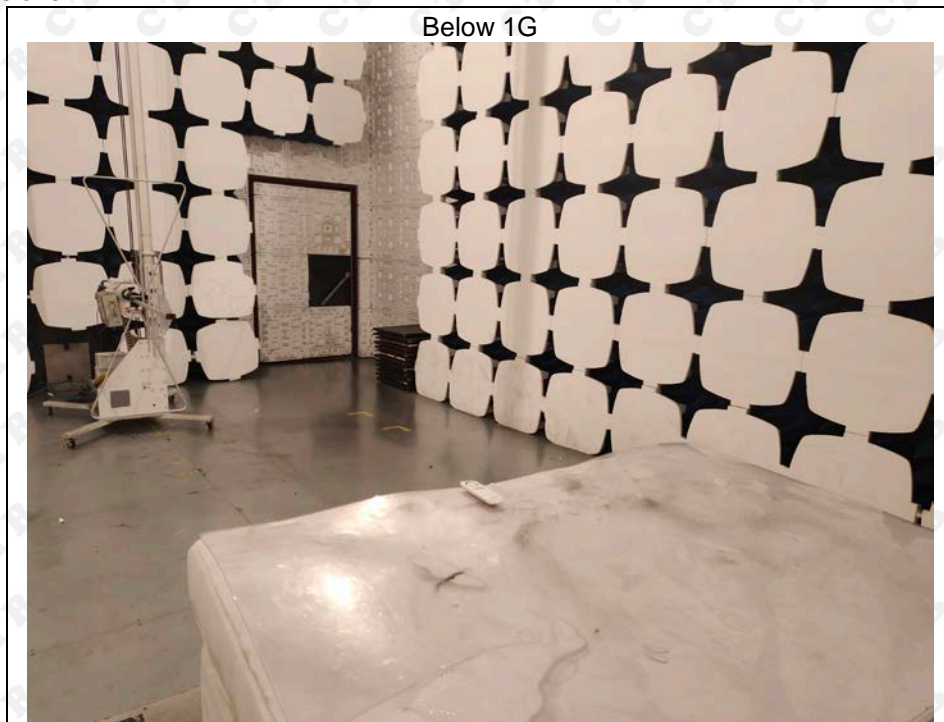
### EUT Antenna:

The EUT antenna is internal antenna. The best case gain of the antenna is 4.45dBi.



### 13. EUT TEST SETUP PHOTOGRAPHS

#### Radiated Emissions



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