

FCC PART 15.247 TEST REPORT

For

FrSky Electronic Co., Ltd.

F-4, Building C, Zhongxiu Technology Park, No.3 Yuanxi Road, Wuxi, 214125, Jiangsu, China

FCC ID: XYFXELITET

Report Type: Original Report	Product Type: Digital Telemetry Radio System
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Report Number: RSHA180330003-00B	
Report Date: 2018-05-03	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	FrSky Electronic Co., Ltd.
Tested Model	Taranis X-Lite
Series Model	Taranis Elite, Taranis X-Lite S, Taranis X-Lite PRO, Taranis Elite S, Taranis Elite PRO
Model Difference	Model name
Product Type	Digital Telemetry Radio System
Dimension	177.3mm(L)*127mm(W)*53.4mm(H)
Power Supply	DC 7.4V from batteries

**All measurement and test data in this report was gathered from production sample serial number: 20180330003. (Assigned by BACL, Kunshan). The EUT supplied by the applicant was received on 2018-03-30.*

Objective

This test report is prepared on behalf of FrSky Electronic Co., Ltd. in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

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

Related Submittal(s)/Grant(s)

FCC Part 15.247 DTS submission with FCC ID: XYFXELITET.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and DA 00-705 March 30, 2000.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
	18GHz~40GHz	5.65dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road,Kunshan,Jiangsu province,China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel list:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2404.57	25	2440.88
2	2406.25	26	2442.32
3	2407.85	27	2444.40
4	2409.30	28	2445.37
5	2410.91	29	2446.81
6	2412.18	30	2448.26
7	2413.79	31	2449.86
8	2415.23	32	2451.30
9	2416.83	33	2452.91
10	2418.28	34	2454.35
11	2419.72	35	2455.79
12	2421.32	36	2457.39
13	2422.77	37	2458.84
14	2424.37	38	2460.28
15	2425.81	39	2461.88
16	2427.25	40	2463.32
17	2428.86	41	2464.93
18	2430.30	42	2466.37
19	2431.75	43	2467.82
20	2433.35	44	2469.42
21	2434.79	45	2470.87
22	2436.23	46	2472.30
23	2437.84	47	2473.55
24	2439.06	/	/

EUT was tested with Channel 1, 24 and 47.

EUT Exercise Software

RF test tool: channel changer

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

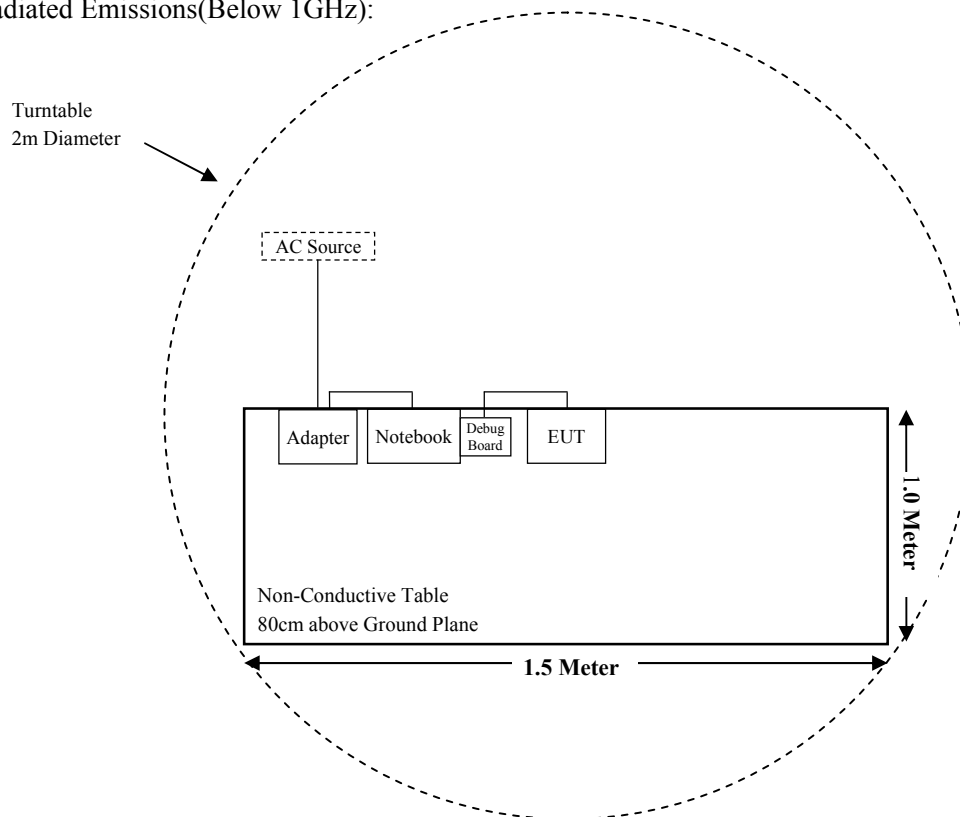
Manufacturer	Description	Model	Serial Number
FrSky Electronic	Debug Board	/	/
DELL	Notebook	GX620	D65874152
DELL	Adapter	LA65NS0-00	DF263

External I/O Cable

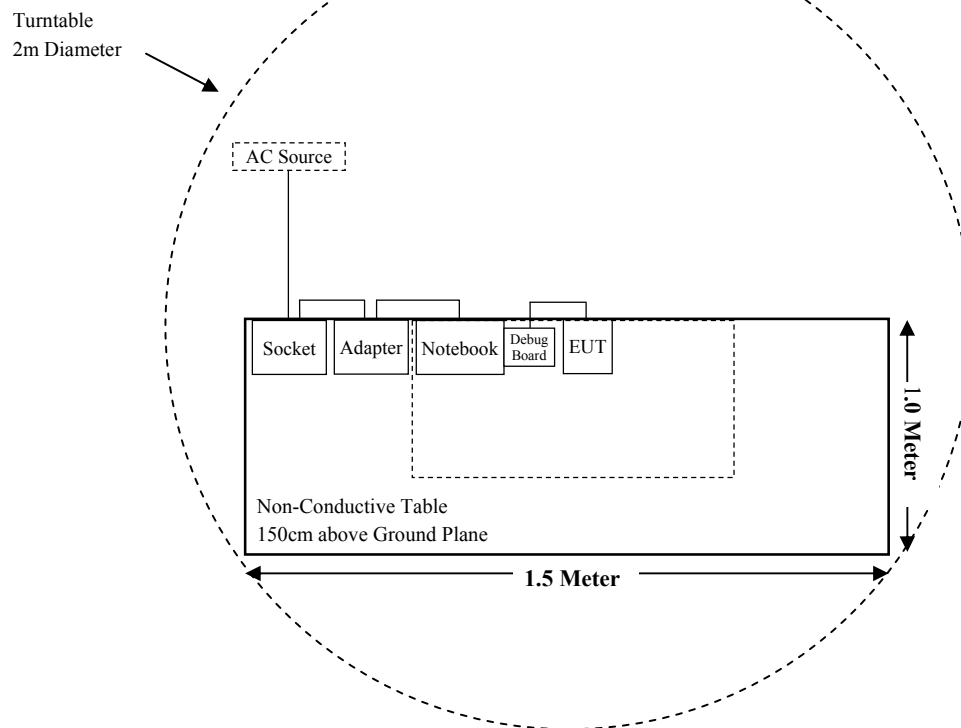
Cable Description	Shielding Type	Length (m)	From Port	To
Serial Port Cable	Un-shielding	0.5	Debug Board	EUT

Block Diagram of Test Setup

For Radiated Emissions(Below 1GHz):



For Radiated Emissions(Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i)§1.1310 & §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Not Applicable (See Note)
§15.205, §15.209 & §15.247(d)	Radiated 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)(1)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance

Note: The EUT is powered by batteries.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test (Chamber 1#)					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2017-11-12	2018-11-11
Sunol Sciences	Broadband Antenna	JB3	A040914-2	2016-01-09	2019-01-08
Sonoma Instrument	Pre-amplifier	310N	171205	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-8	008	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2017-08-15	2018-08-14
Radiated Emission Test (Chamber 2#)					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2017-08-27	2018-08-26
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Narda	Pre-amplifier	AFS42-00101800	2001270	2017-12-12	2018-12-11
EM Electronics Corporation	Amplifier	EM18G40G	060726	2018-03-22	2019-03-21
MICRO-TRONICS	Band Reject Filter	BRM50702	/	2017-08-05	2018-08-04
Narda	Attenuator/10dB	10dB	/	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2017-08-15	2018-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Rohde & Schwarz	FSV40 Signal Analyzer	FSV40	101116	2017-07-22	2018-07-21
Narda	Attenuator/2dB	2dB	/	2017-08-15	2018-08-14
FrSky Electronic	RF Cable	/	/	Each Time	/

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i), §1.1310 & §2.1093 – RF EXPOSURE

Applicable Standard

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

According to KDB447498 D01 General RF Exposure Guidance v06:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

Measurement Result

Frequency Range	Target Average Output Power		Minimum test separation distance required for the exposure conditions
	(dBm)	(mW)	
(MHz)			(mm)
2404.57-2473.55	4.00	2.51	5.00

Note:

1. The target average output power was declared by the manufacturer.
2. This is a handheld device

Result: $[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] = 2.51/5 \cdot \sqrt{2.47355} = 0.8 < 7.5$

So the stand-alone SAR evaluation is not necessary.

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

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

Antenna Information

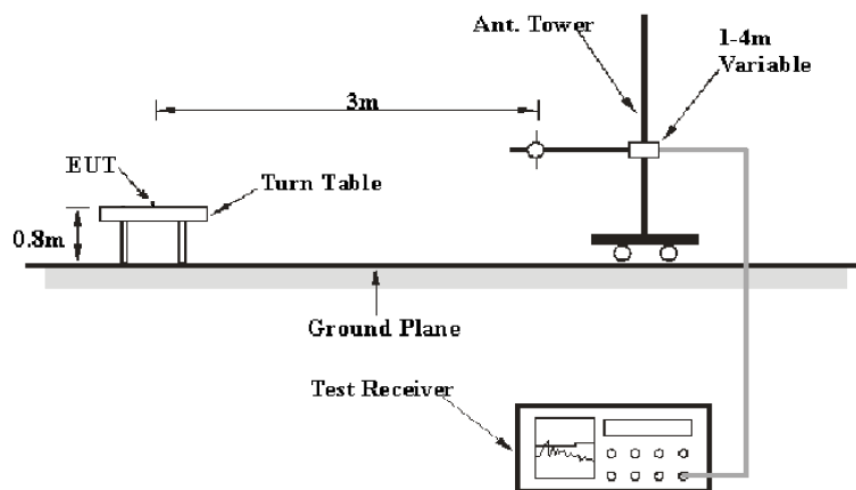
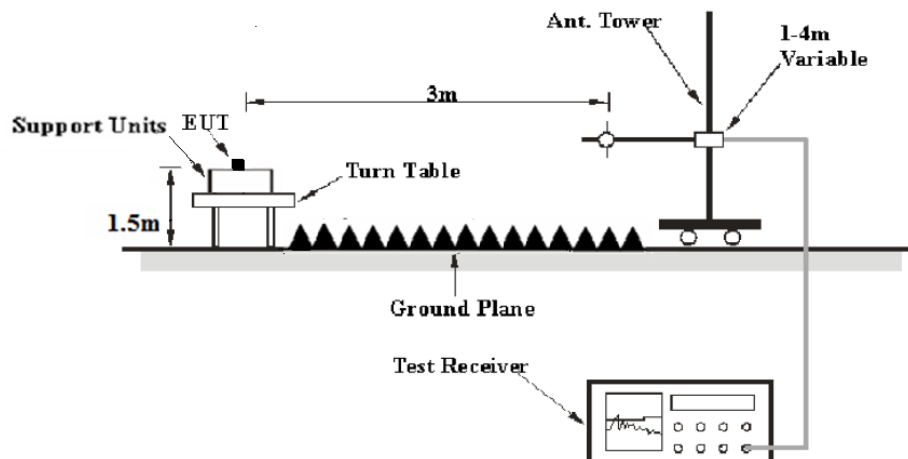
The EUT has two type of antennas as below, which use the unique coupling to the intentional radiator, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	Antenna Gain
PIFA antenna	2dBi
External antenna	2dBi

Result: Compliance.

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

FCC §15.205; §15.209; §15.247(d)

EUT Setup**Below 1 GHz:****Above 1GHz:**

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

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

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

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP
Above 1GHz	1MHz	3 MHz	/	PK
	1MHz	3 MHz	/	Ave.

Test Procedure

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

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

Corrected Amplitude & Margin Calculation

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

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data**Environmental Conditions**

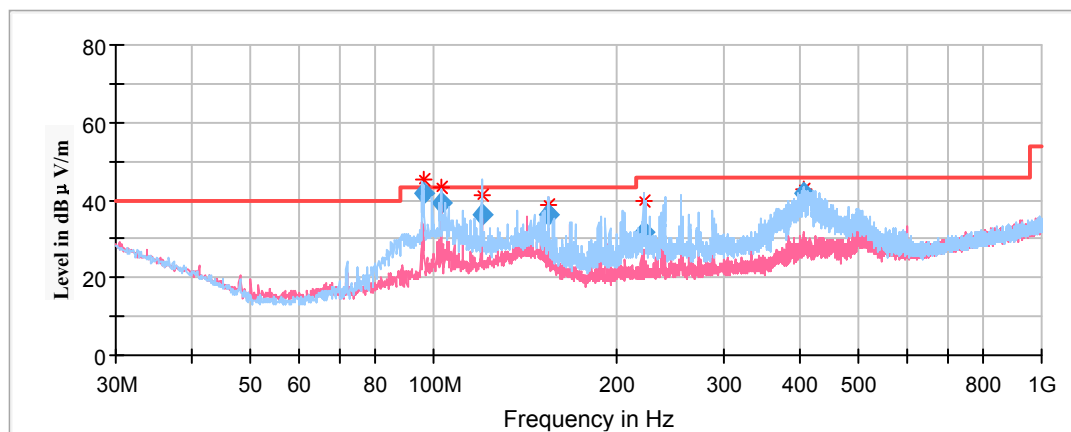
Temperature:	24.2 °C
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

The testing was performed by Mark Yu on 2018-04-23& 2018-05-03.

EUT operation mode: Transmitting

Test data for PIFA antenna:**Spurious Emission Test:****30MHz-1GHz:**

Pre-Scan with low, middle and high channels in the X,Y and Z axes of orientation, the worst case **low channel in X-axis of orientation** was recorded



Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	QuasiPeak (dBμV/m)	Height (cm)	Polar (H/V)				
96.070950	41.80	199.0	H	2.0	-16.4	43.50	1.70
102.838500	39.01	199.0	H	62.0	-14.8	43.50	4.49
119.894900	36.22	199.0	H	0.0	-11.6	43.50	7.28
154.246200	36.16	101.0	H	331.0	-13.0	43.50	7.34
221.152200	31.70	199.0	H	220.0	-12.7	46.00	14.30
406.244800	41.78	101.0	H	153.0	-8.5	46.00	4.22

1GHz-18GHz:

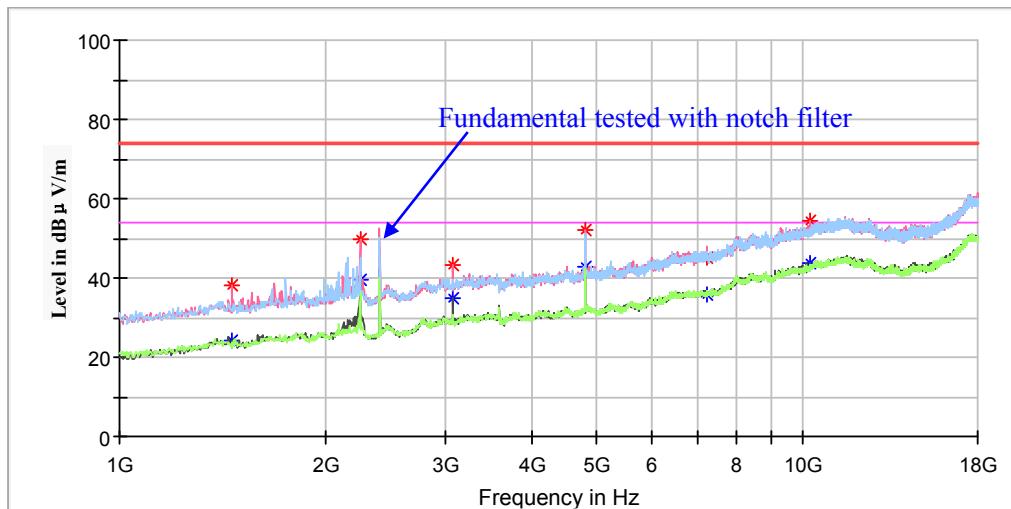
Pre-Scan in the X,Y and Z axes of orientation, the worst case **in X-axis of orientation** was recorded

Note:

1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude

Low Channel: 2404.57MHz

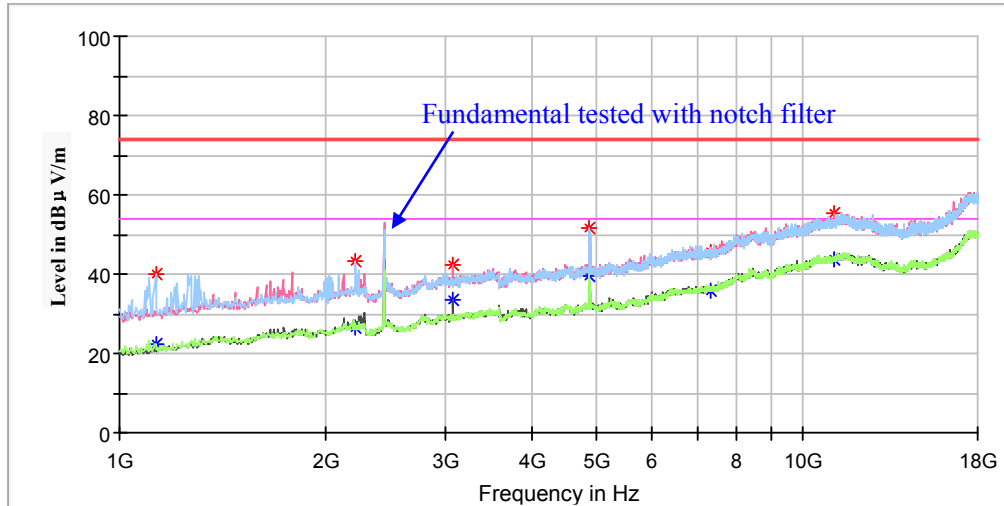
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1459.000000	38.11	---	150.0	V	7.0	-8.3	74.00	35.89
1462.400000	---	24.24	150.0	V	7.0	-8.3	54.00	29.76
2247.800000	---	39.55	150.0	V	247.0	-5.3	54.00	14.45
2247.800000	49.78	---	150.0	V	247.0	-5.3	74.00	24.22
3070.600000	---	34.72	250.0	V	160.0	-1.9	54.00	19.28
3070.600000	43.37	---	250.0	V	160.0	-1.9	74.00	30.63
4809.140000	---	42.56	100.0	V	201.0	2.5	54.00	11.44
4809.140000	52.00	---	100.0	V	201.0	2.5	74.00	22.00
7213.710000	---	36.03	250.0	V	139.0	9.8	54.00	17.97
7213.710000	45.29	---	250.0	V	139.0	9.8	74.00	28.71
10210.600000	---	43.93	100.0	V	91.0	15.8	54.00	10.07
10214.000000	54.39	---	100.0	V	91.0	15.8	74.00	19.61

Middle Channel: 2439.06MHz

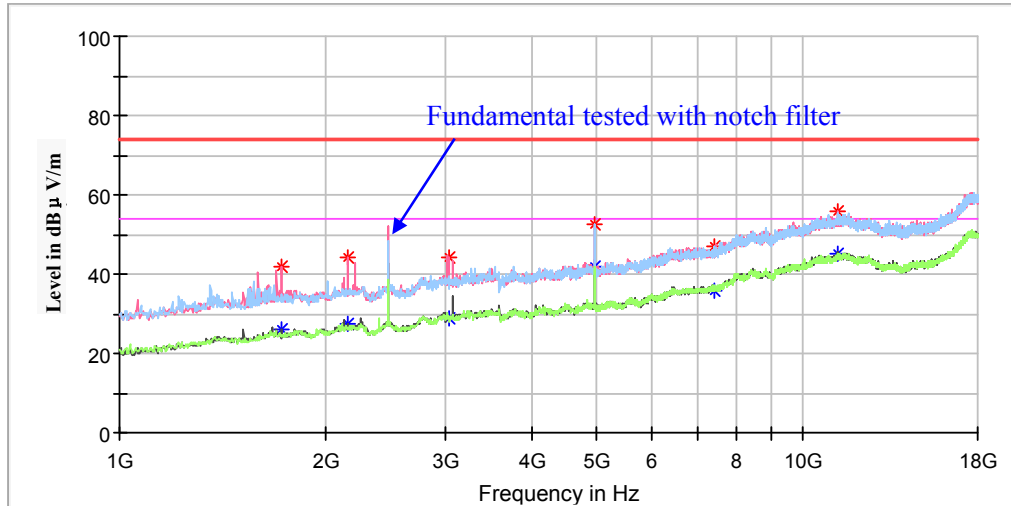
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1129.200000	---	22.10	200.0	H	53.0	-11.0	54.00	31.90
1129.200000	39.86	---	200.0	H	53.0	-11.0	74.00	34.14
2217.200000	---	26.35	100.0	H	350.0	-5.4	54.00	27.65
2217.200000	43.48	---	100.0	H	350.0	-5.4	74.00	30.52
3070.600000	---	33.65	100.0	V	60.0	-1.9	54.00	20.35
3070.600000	42.49	---	100.0	V	60.0	-1.9	74.00	31.51
4878.120000	---	39.46	250.0	V	335.0	2.6	54.00	14.54
4878.120000	51.52	---	250.0	V	335.0	2.6	74.00	22.48
7317.180000	---	36.04	100.0	V	45.0	10.0	54.00	17.96
7317.180000	45.79	---	100.0	V	45.0	10.0	74.00	28.21
11128.600000	---	43.67	250.0	V	54.0	17.5	54.00	10.33
11128.600000	55.22	---	250.0	V	54.0	17.5	74.00	18.78

High Channel: 2473.55MHz

Full Spectrum

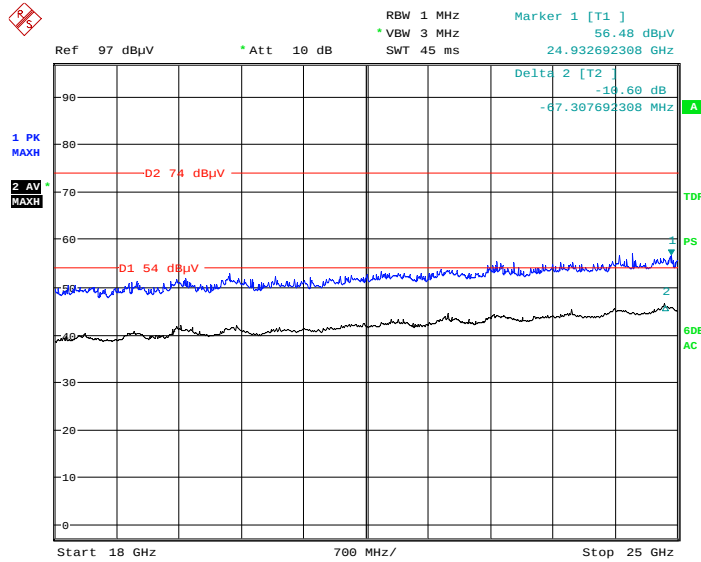


Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1724.200000	---	25.87	200.0	H	150.0	-7.1	54.00	28.13
1724.200000	41.80	---	200.0	H	150.0	-7.1	74.00	32.20
2156.000000	---	27.63	100.0	V	272.0	-5.6	54.00	26.37
2156.000000	44.00	---	100.0	V	272.0	-5.6	74.00	30.00
3036.600000	---	28.87	150.0	V	341.0	-2.0	54.00	25.13
3036.600000	44.26	---	150.0	V	341.0	-2.0	74.00	29.74
4947.100000	---	41.79	200.0	V	18.0	2.8	54.00	12.21
4947.100000	52.39	---	200.0	V	18.0	2.8	74.00	21.61
7420.650000	---	35.92	100.0	V	176.0	10.1	54.00	18.08
7420.650000	46.81	---	100.0	V	176.0	10.1	74.00	27.19
11234.000000	---	44.90	200.0	V	221.0	17.7	54.00	9.10
11234.000000	55.61	---	200.0	V	221.0	17.7	74.00	18.39

18GHz-25GHz:

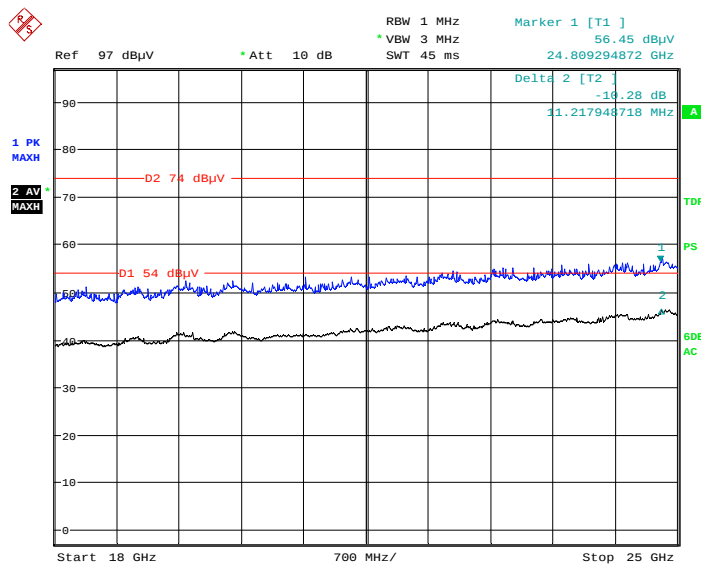
Pre-Scan with low, middle and high channels in the X,Y and Z axes of orientation, the worst case **low channel in X-axis of orientation** was recorded

Horizontal



Date: 23.APR.2018 10:19:19

Vertical



Date: 23.APR.2018 10:29:20

Fundamental Test & Restricted Bands Emissions:

Pre-Scan in the X,Y and Z axes of orientation, the worst case **in X-axis of orientation** was recorded

Note:

1. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

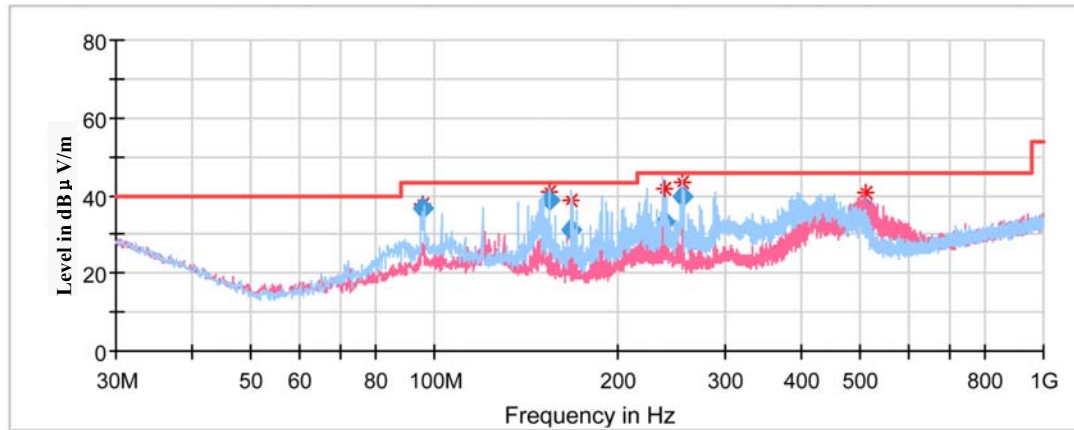
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2404.57MHz								
2404.570000	---	106.31	100.0	V	125.0	5.1	/	/
2404.570000	106.33	---	100.0	V	125.0	5.1	/	/
2404.570000	---	104.00	200.0	H	111.0	5.1	/	/
2404.570000	104.05	---	200.0	H	111.0	5.1	/	/
2400.000000	---	39.80	150.0	V	124.0	5.1	54.00	14.20
2400.000000	52.28	---	150.0	V	124.0	5.1	74.00	21.72
Middle Channel: 2439.06MHz								
2439.060000	---	106.04	100.0	V	245.0	5.2	/	/
2439.060000	106.11	---	100.0	V	245.0	5.2	/	/
2439.060000	---	103.69	150.0	H	148.0	5.2	/	/
2439.060000	103.78	---	150.0	H	148.0	5.2	/	/
High Channel: 2473.55MHz								
2473.550000	---	105.35	250.0	V	6.0	5.3	/	/
2473.550000	105.39	---	250.0	V	6.0	5.3	/	/
2473.550000	---	103.06	200.0	H	18.0	5.3	/	/
2473.550000	103.10	---	200.0	H	18.0	5.3	/	/
2483.500000	---	42.15	150.0	V	211.0	5.3	54.00	11.85
2483.500000	50.10	---	150.0	V	211.0	5.3	74.00	23.90

Test data for external antenna:**Spurious Emission Test:****30MHz-1GHz:**

Pre-Scan with low, middle and high channels in the X,Y and Z axes of orientation, the worst case **low channel in X-axis of orientation** was recorded.



Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	QuasiPeak (dBµV/m)	Height (cm)	Polar (H/V)				
95.941850	37.61	200.0	H	18.0	-16.3	43.50	5.89
154.304950	41.02	200.0	H	235.0	-13.0	43.50	2.48
168.096850	38.70	100.0	H	255.0	-13.6	43.50	4.80
238.181350	41.87	100.0	H	44.0	-12.6	46.00	4.13
255.572550	42.99	100.0	H	219.0	-12.4	46.00	3.01
509.186900	40.96	100.0	V	67.0	-6.1	46.00	5.04

1GHz-18GHz:

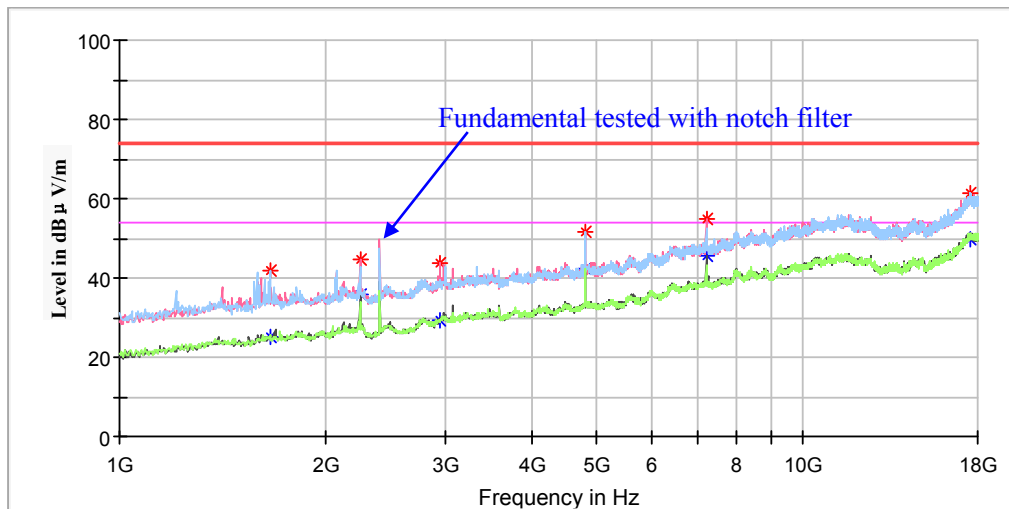
Pre-Scan in the X,Y and Z axes of orientation, the worst case **in X-axis of orientation** was recorded

Note:

1. This test was performed with the 2.4-2.5GHz notch filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude

Low Channel: 2404.57MHz

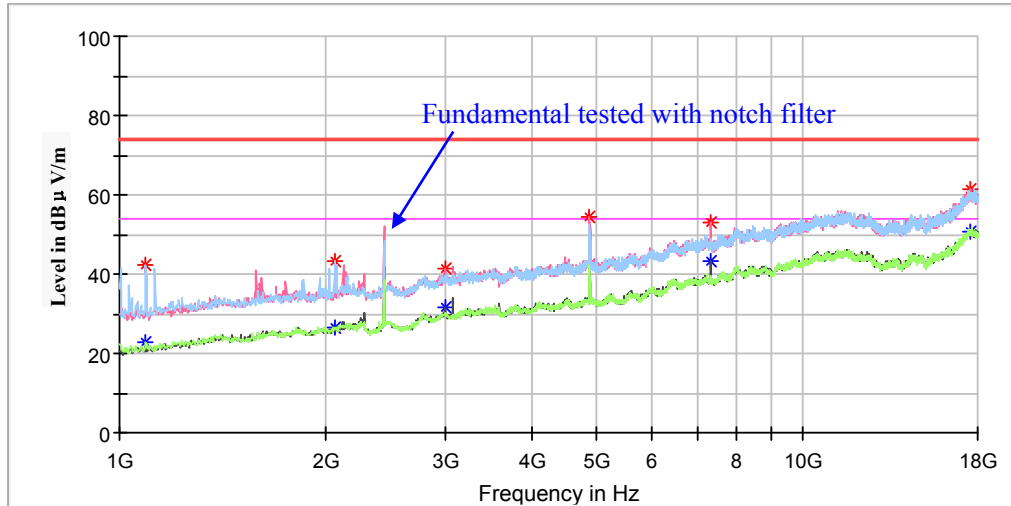
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1659.600000	---	25.18	100.0	H	203.0	-7.3	54.00	28.82
1659.600000	41.67	---	100.0	H	203.0	-7.3	74.00	32.33
2247.800000	---	35.88	150.0	V	278.0	-5.3	54.00	18.12
2247.800000	44.84	---	150.0	V	278.0	-5.3	74.00	29.16
2941.400000	---	29.44	200.0	V	200.0	-2.3	54.00	24.56
2941.400000	43.93	---	200.0	V	200.0	-2.3	74.00	30.07
4809.140000	---	42.54	100.0	V	50.0	2.5	54.00	11.46
4809.140000	51.84	---	100.0	V	50.0	2.5	74.00	22.16
7213.710000	---	45.74	200.0	V	137.0	9.8	54.00	8.26
7213.710000	54.93	---	200.0	V	137.0	9.8	74.00	19.07
17547.800000	---	49.99	100.0	H	8.0	23.7	54.00	4.01
17547.800000	61.58	---	100.0	H	8.0	23.7	74.00	12.42

Middle Channel: 2439.06MHz

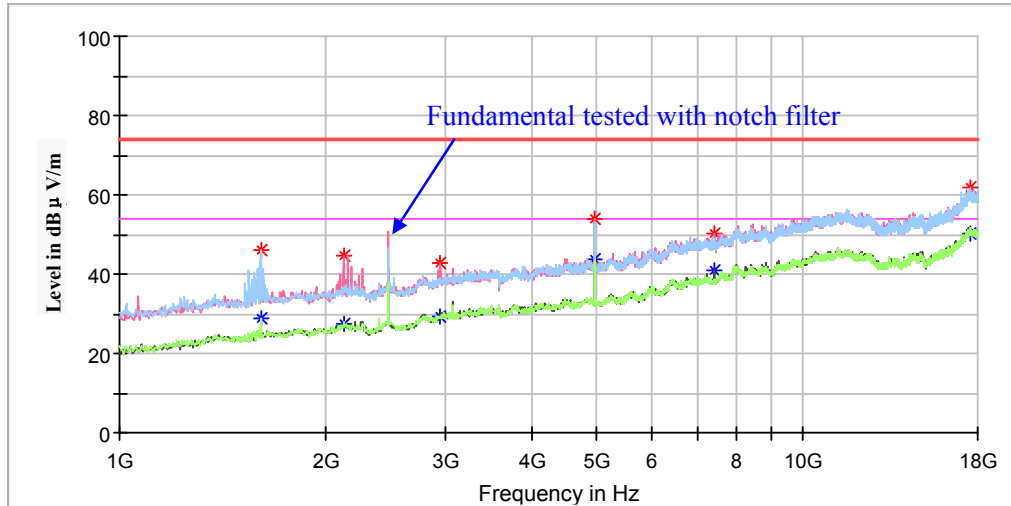
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dB μ V/m)	Margin (dB)
	MaxPeak (dB μ V /m)	Average (dB μ V /m)	Height (cm)	Polar (H/V)				
1091.800000	---	23.01	100.0	H	95.0	-11.3	54.00	30.99
1091.800000	42.39	---	100.0	H	95.0	-11.3	74.00	31.61
2064.200000	---	26.32	100.0	H	344.0	-5.8	54.00	27.68
2064.200000	43.08	---	100.0	H	344.0	-5.8	74.00	30.92
2989.000000	---	31.48	250.0	V	272.0	-2.1	54.00	22.52
2989.000000	41.57	---	250.0	V	272.0	-2.1	74.00	32.43
4878.120000	---	42.42	150.0	V	134.0	2.6	54.00	11.58
4878.120000	54.23	---	150.0	V	134.0	2.6	74.00	19.77
7317.180000	---	43.36	250.0	V	273.0	10.0	54.00	10.64
7317.180000	52.81	---	250.0	V	273.0	10.0	74.00	21.19
17588.600000	---	50.66	100.0	V	108.0	23.7	54.00	3.34
17588.600000	61.37	---	100.0	V	108.0	23.7	74.00	12.63

High Channel: 2473.55MHz

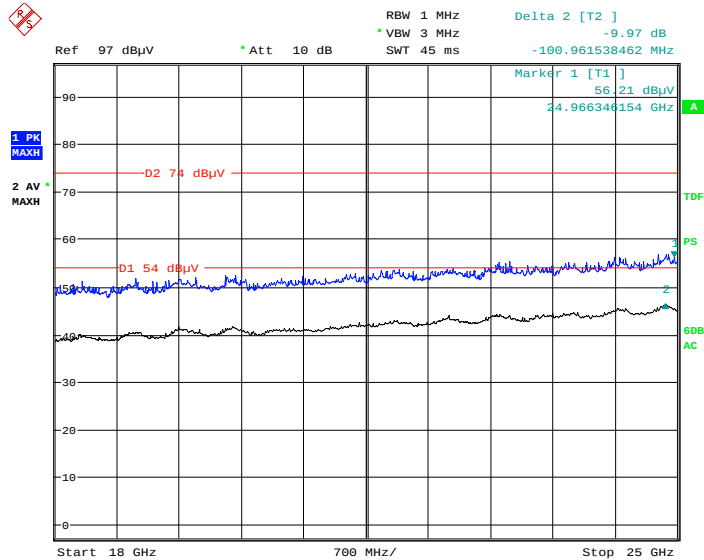
Full Spectrum



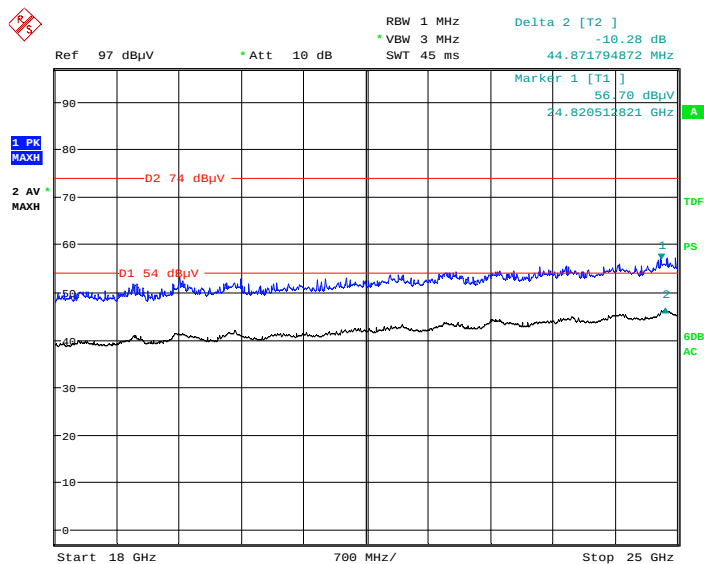
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1608.600000	---	28.68	150.0	H	11.0	-7.6	54.00	25.32
1608.600000	45.91	---	150.0	H	11.0	-7.6	74.00	28.09
2125.400000	---	27.36	150.0	V	58.0	-5.7	54.00	26.64
2125.400000	44.65	---	150.0	V	58.0	-5.7	74.00	29.35
2948.200000	---	29.07	250.0	V	41.0	-2.3	54.00	24.93
2948.200000	42.90	---	250.0	V	41.0	-2.3	74.00	31.10
4947.100000	---	43.50	150.0	V	260.0	2.8	54.00	10.50
4947.100000	53.80	---	150.0	V	260.0	2.8	74.00	20.20
7420.650000	---	41.03	200.0	V	119.0	10.1	54.00	12.97
7420.650000	50.06	---	200.0	V	119.0	10.1	74.00	23.94
17585.200000	---	50.35	100.0	V	312.0	23.7	54.00	3.65
17585.200000	61.64	---	100.0	V	312.0	23.7	74.00	12.36

18GHz-25GHz:

Pre-Scan with low, middle and high channels in the X,Y and Z axes of orientation, the worst case **low channel in X-axis of orientation** was recorded

Horizontal

Date: 23.APR.2018 10:39:17

Vertical

Date: 23.APR.2018 10:42:48

Fundamental Test & Restricted Bands Emissions:

Pre-Scan in the X,Y and Z axes of orientation, the worst case in X-axis of orientation was recorded

Note:

1. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

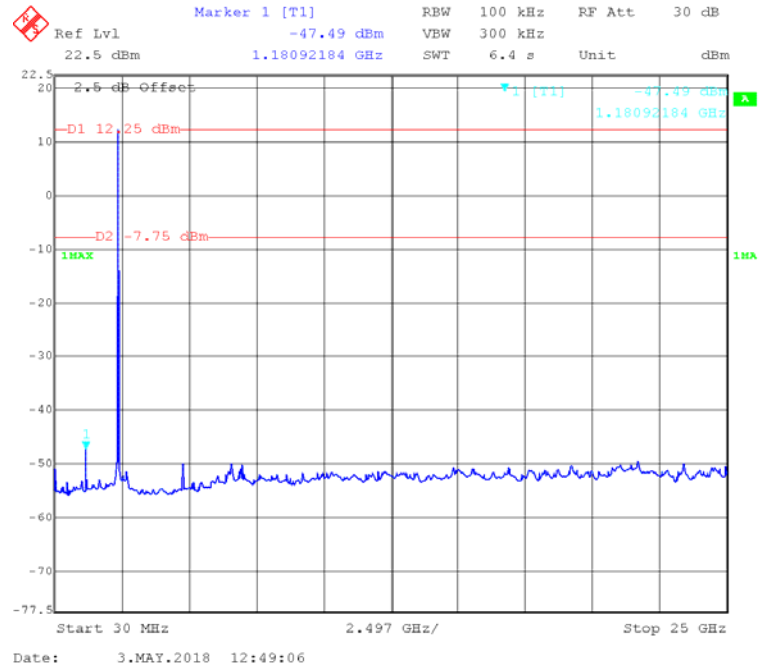
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

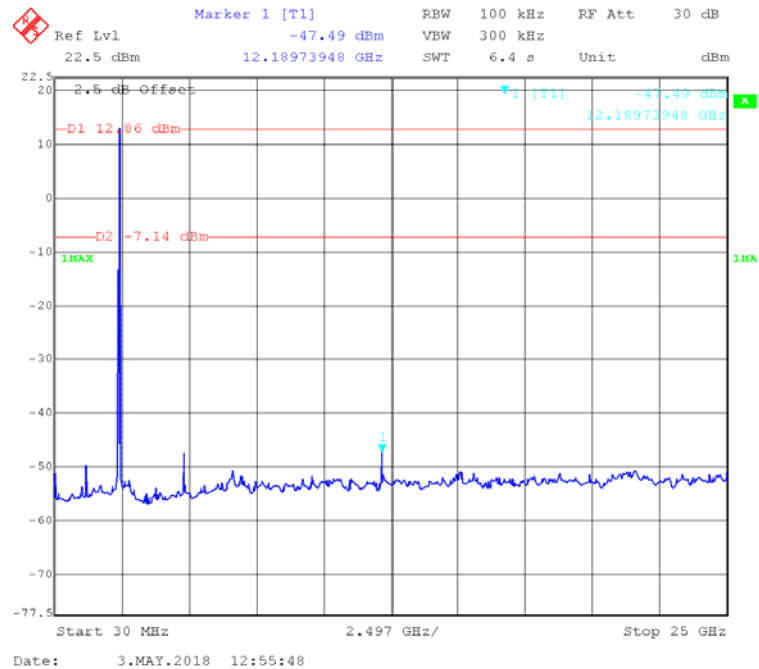
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2404.57MHz								
2404.570000	---	110.88	200.0	V	174.0	5.1	/	/
2404.570000	110.96	---	200.0	V	174.0	5.1	/	/
2404.570000	---	108.63	100.0	H	155.0	5.1	/	/
2404.570000	108.75	---	100.0	H	155.0	5.1	/	/
2400.000000	---	39.95	100.0	V	199.0	5.1	54.00	14.05
2400.000000	47.81	---	100.0	V	199.0	5.1	74.00	26.19
Middle Channel: 2439.06MHz								
2439.060000	---	109.47	150.0	V	214.0	5.2	/	/
2439.060000	109.49	---	150.0	V	214.0	5.2	/	/
2439.060000	---	107.25	200.0	H	114.0	5.2	/	/
2439.060000	107.26	---	200.0	H	114.0	5.2	/	/
High Channel: 2473.55MHz								
2473.550000	---	108.82	250.0	V	56.0	5.3	/	/
2473.550000	108.83	---	250.0	V	56.0	5.3	/	/
2473.550000	---	106.62	100.0	H	15.0	5.3	/	/
2473.550000	106.64	---	100.0	H	15.0	5.3	/	/
2483.500000	---	43.81	150.0	V	125.0	5.3	54.00	10.19
2483.500000	52.66	---	150.0	V	125.0	5.3	74.00	21.34

Conducted Spurious Emissions at Antenna Port:

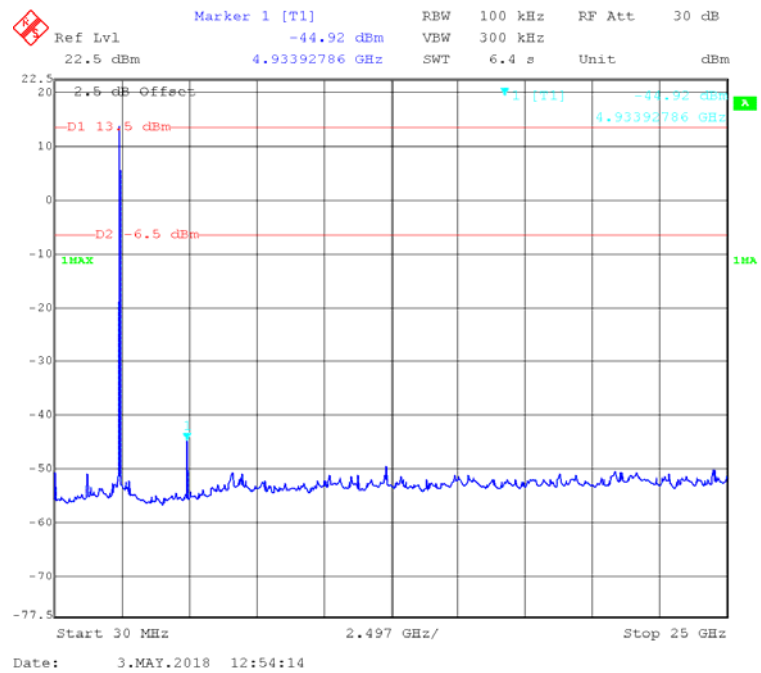
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1)-CHANNEL SEPARATION TEST**Applicable Standard**

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.

Test Procedure

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

Test Data**Environmental Conditions**

Temperature:	24.2 °C
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

The testing was performed by Mark Yu on 2018-03-27.

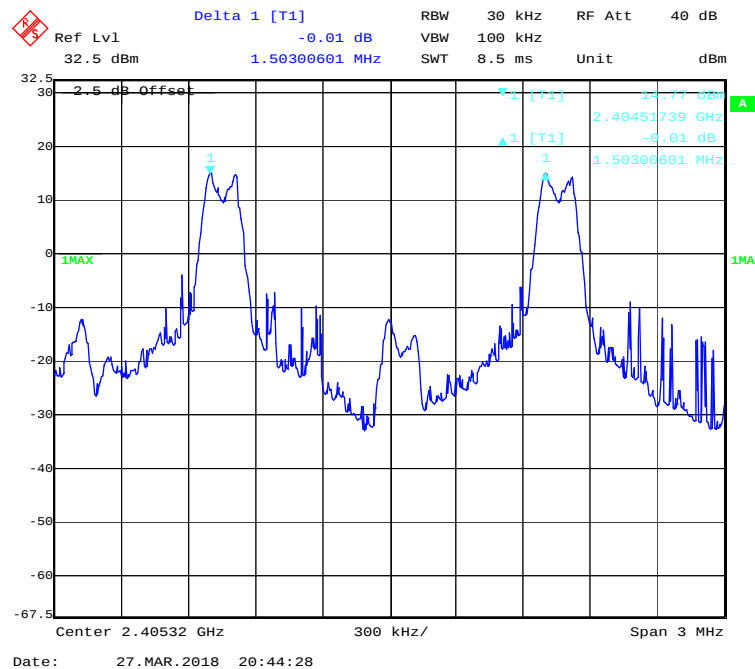
EUT operation mode: Hopping

Test Result: Compliance.

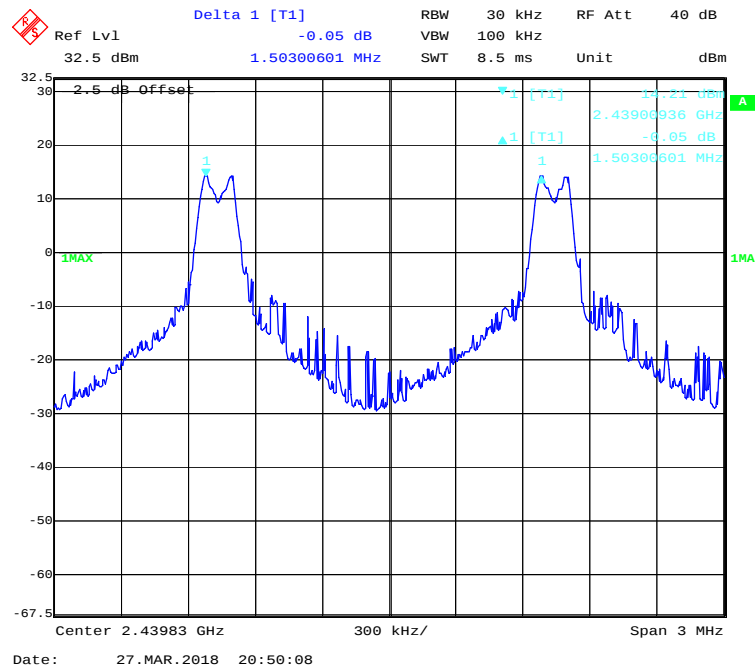
Modulation	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)	Result
FSK	Low	2404.57	1.503	0.104	Pass
	Adjacent	2406.25			
	Middle	2439.06	1.503	0.104	Pass
	Adjacent	2440.88			
	Adjacent	2472.30	1.503	0.104	Pass
	High	2473.55			

The limit = 20dB Bandwidth*2/3

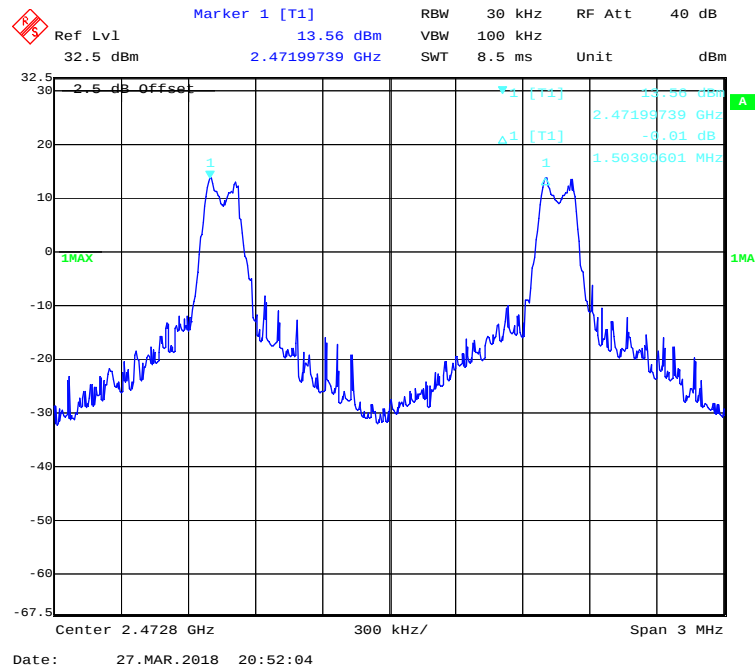
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH**Applicable Standard**

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Procedure

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.

Test Data**Environmental Conditions**

Temperature:	24.2 °C
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

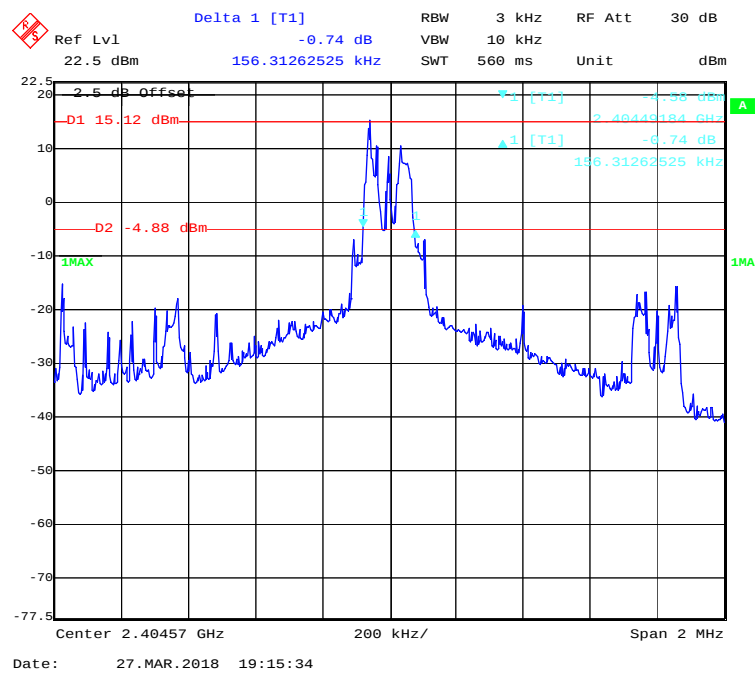
The testing was performed by Mark Yu on 2018-03-27.

EUT operation mode: Transmitting

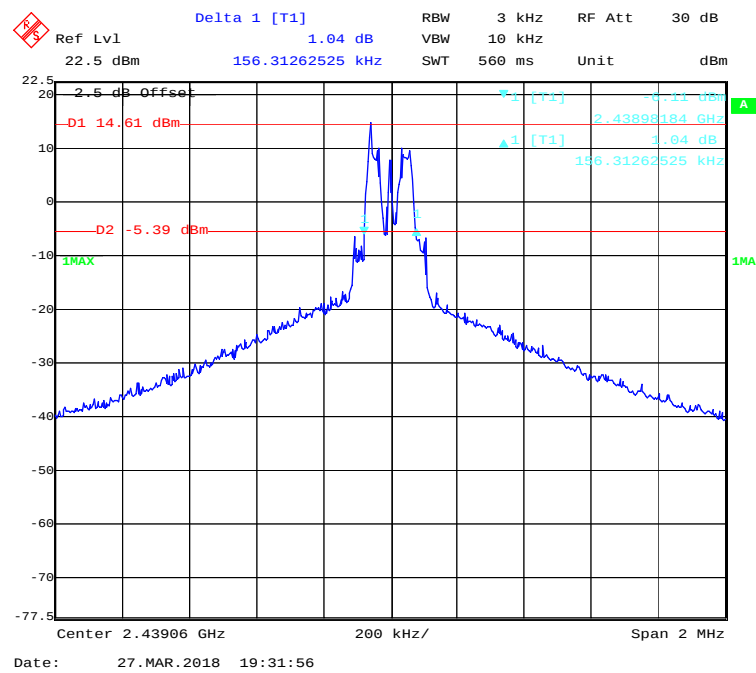
Test Result: Compliance.

Modulation	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
FSK	Low	2404.57	0.156
	Middle	2439.06	0.156
	High	2473.55	0.156

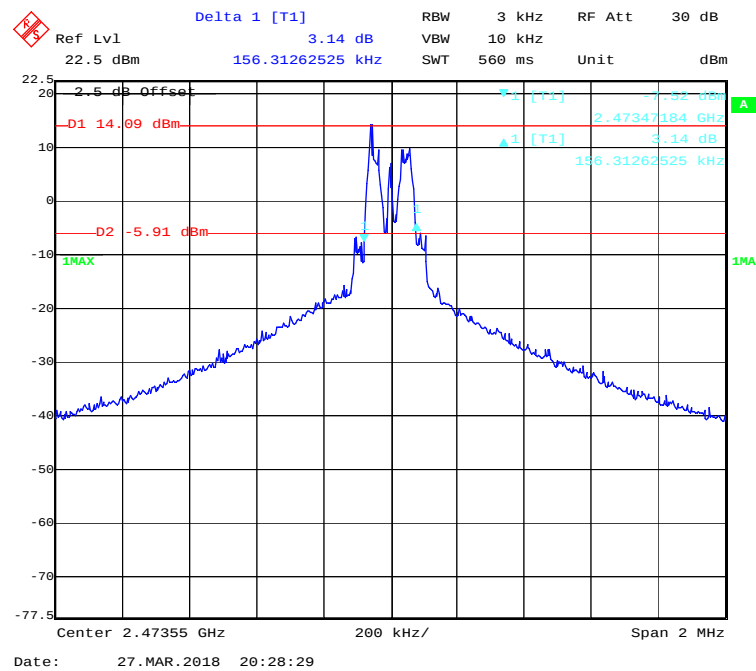
Low Channel



Middle Channel



High Channel



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

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

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

Test Data**Environmental Conditions**

Temperature:	24.2 °C
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

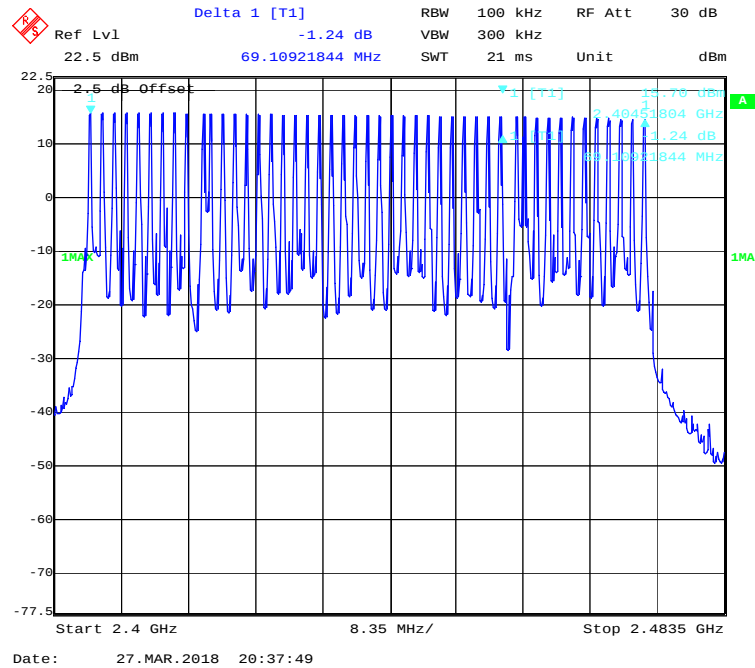
The testing was performed by Mark Yu on 2018-03-27.

EUT operation mode: Hopping

Test Result: Compliance.

Modulation	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
FSK	2404.57-2473.55	47	≥ 15

Number of Hopping Channels



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

Applicable Standard

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

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- a Span: Zero span, centered on a hopping channel.
- b RBW shall be $\leq$ channel spacing and where possible RBW should be set $\geq 1 / T$, where T is the expected dwell time per channel.
- c Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- d Detector function: Peak.
- e Trace: Max hold.

Test Data

Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

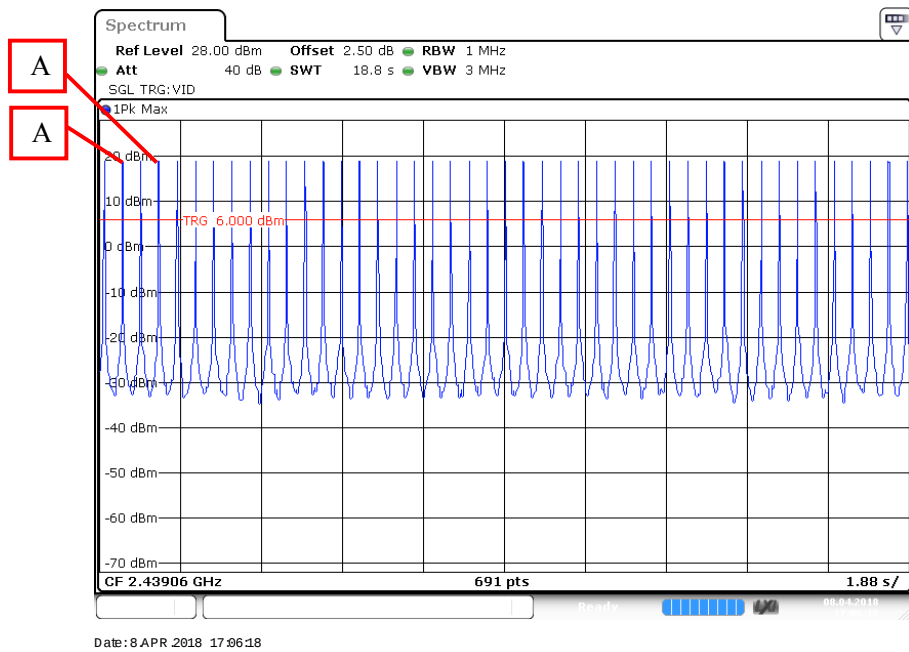
The testing was performed by Mark Yu on 2018-04-08.

EUT operation mode: Hopping

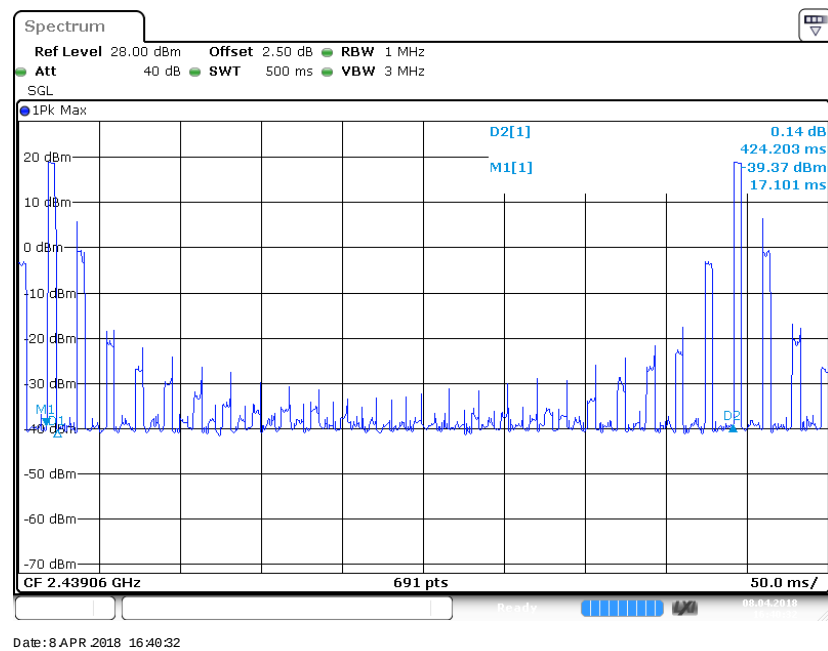
Test Result: Compliance.

Modulation	Channel	Pulse Width	Pulse Number	Dwell Time	Limit	Result
		(ms)		(s)	(s)	
FSK	Middle	4.957	45	0.223	≤ 0.4	Pass
	Note: Dwell time = Pulse time * N Observed time = 0.4s * hopping number = 0.4s * 47 = 18.8s					

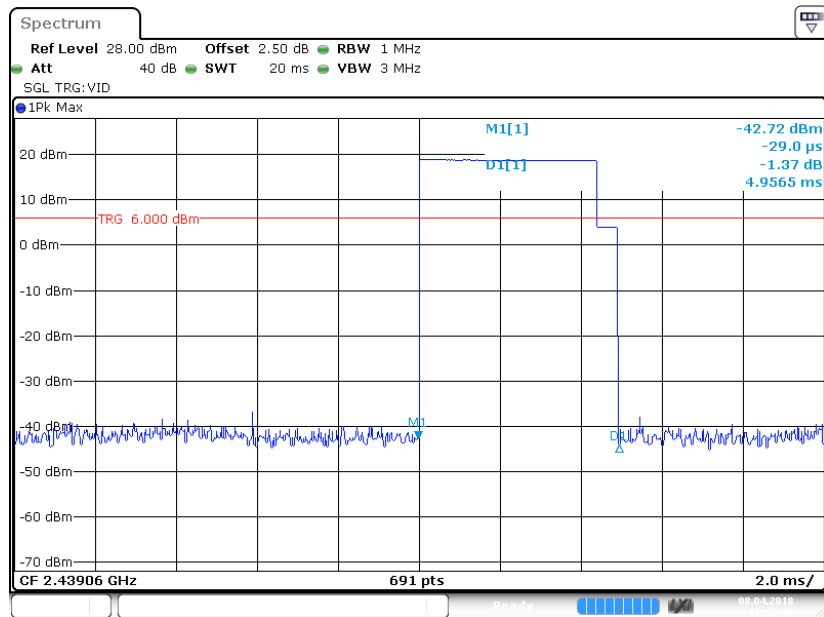
Number of Pulses



Zoom in A



Single Pulse



Date: 8 APR 2018 16:52:31

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

Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

The testing was performed by Mark Yu on 2018-03-27.

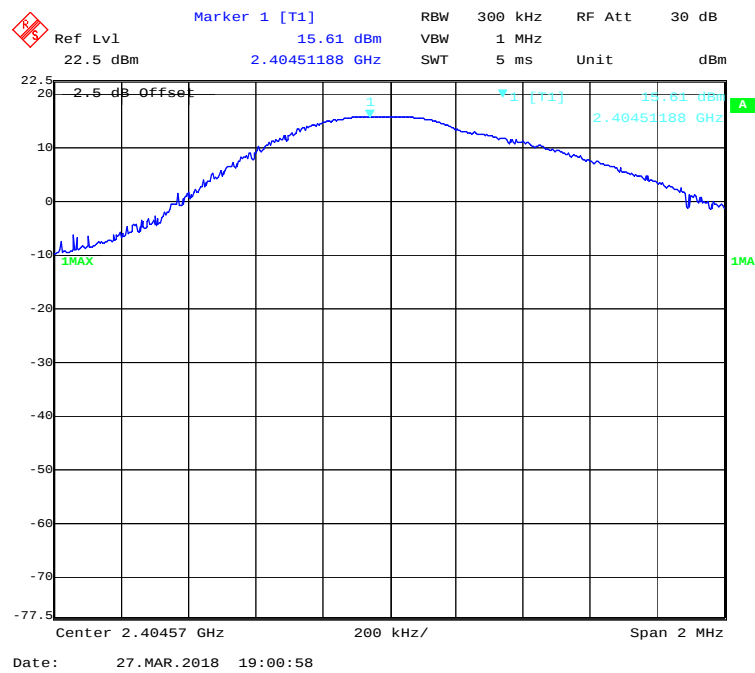
EUT operation mode: Transmitting

Test Result: Compliance.

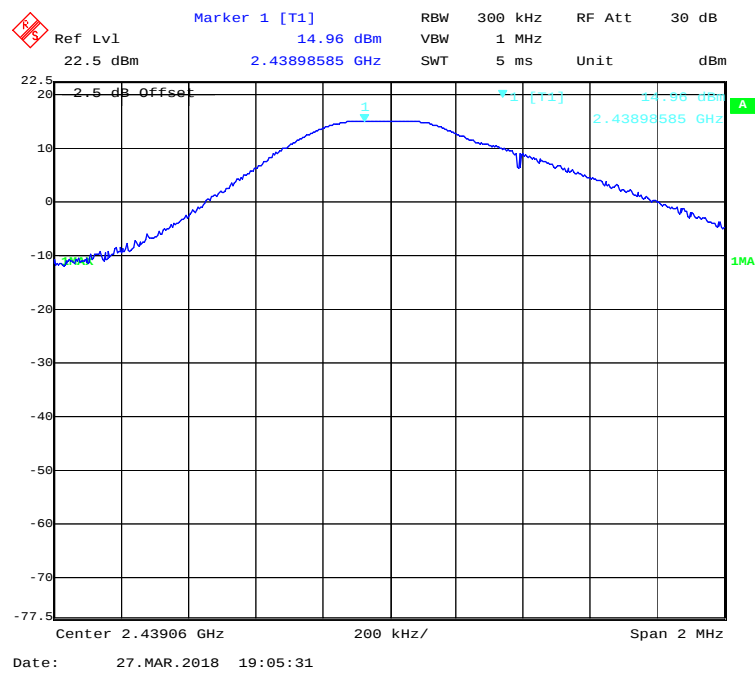
Modulation	Channel	Frequency (MHz)	Peak Output Power		Average Output Power		Limit (mW)
			(dBm)	(mW)	(dBm)	(mW)	
FSK	Low	2404.57	15.61	36.39	3.78	2.39	125
	Middle	2439.06	14.96	31.33	3.02	2.00	125
	High	2473.55	14.30	26.92	2.56	1.80	125

Note: The average output power was used for SAR evaluation.

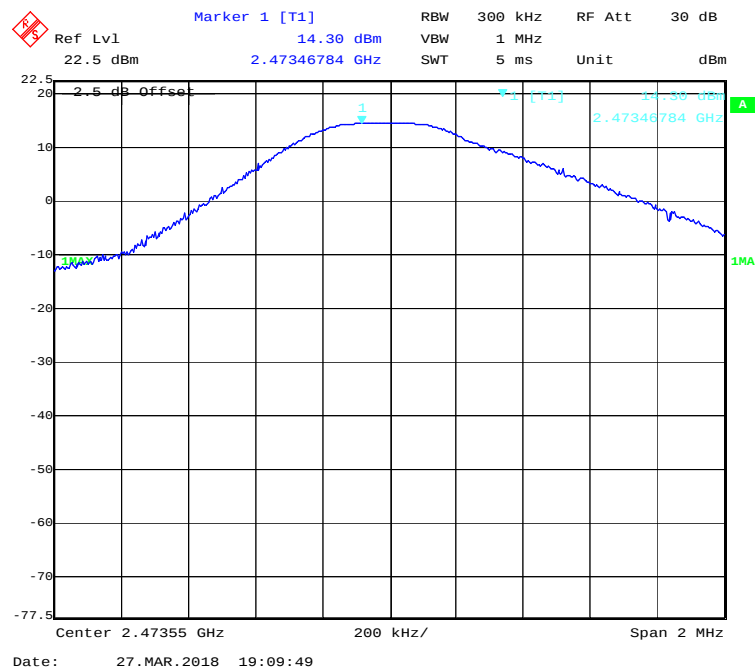
Low Channel



Middle Channel



High Channel



FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

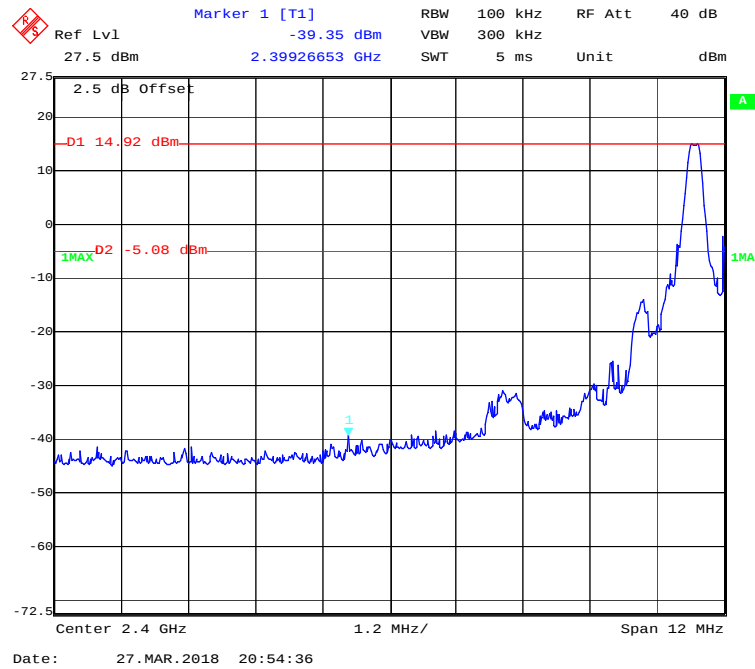
The testing was performed by Mark Yu on 2018-03-27.

EUT operation mode: Transmitting & Hopping

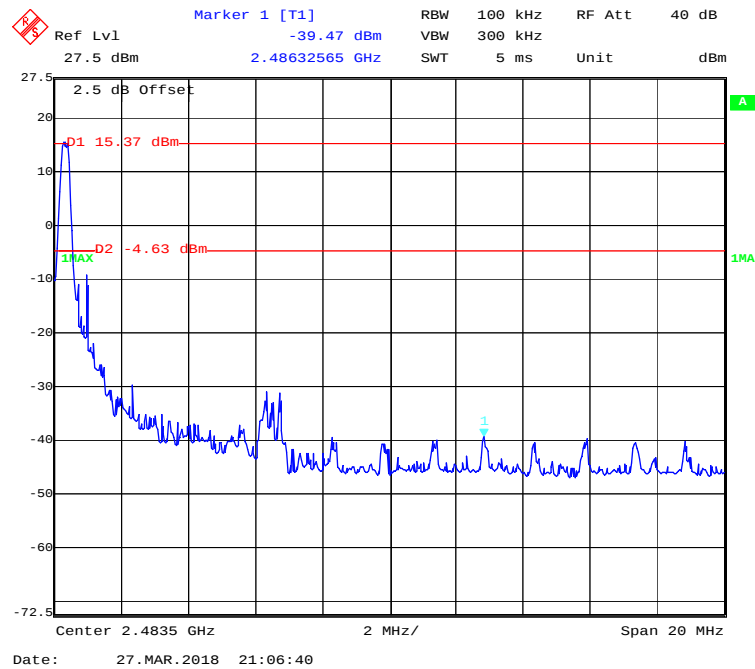
Test Result: Compliance.

Band Edge

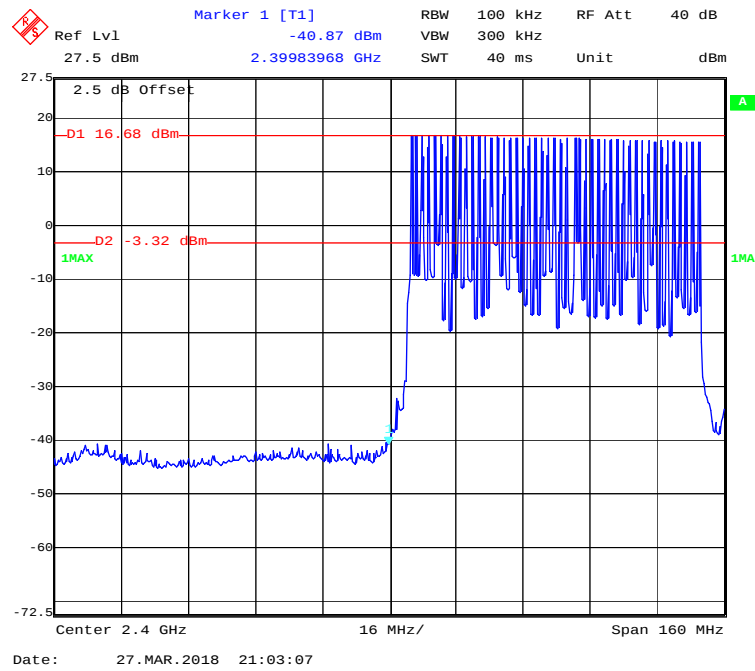
Left Side



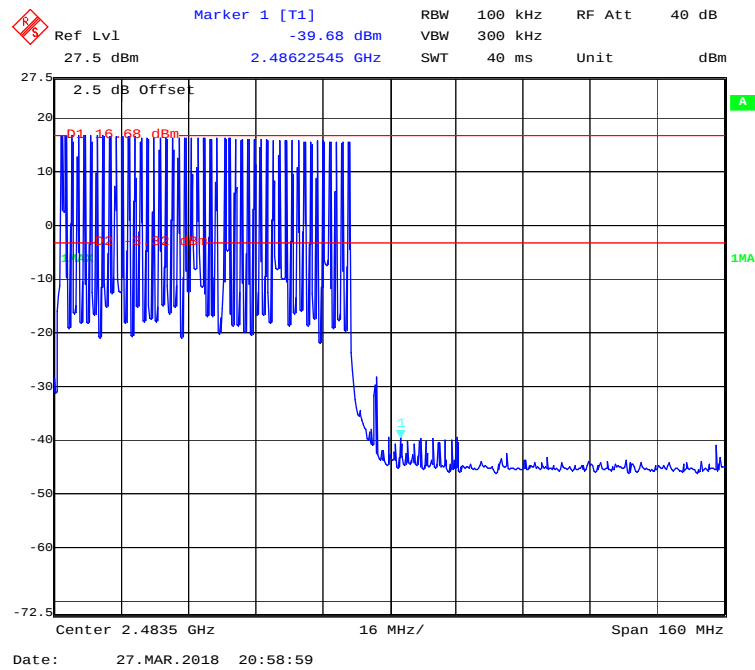
Right Side



Left Side-Hopping



Right Side-Hopping



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