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: XYFX10CSP

Report Type:	Product Type:
Original Report	Digital Telemetry Radio System

Test Engineer:	Chris Wang
Report Number:	RKS170504001-00B
Report Date:	2017-08-23
Reviewed By:	Oscar Ye RF Leader
Prepared By:	Bay Area Compliance Laboratories Corp. (Kunshan) No.248 Chenghu Road,Kunshan,Jiangsu province,China Tel: +86-0512-86175000 Fax: +86-0512-88934268 www.baclcorp.com.cn

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	FrSky Electronic Co., Ltd.
Tested Model	HORUS X10
Series Model	HORUS X10C,HORUS X10S,HORUS X10 PLUS
Product Type	Digital Telemetry Radio System
Dimension	2000mm(L)×1800mm(W)×900 mm(H)
Power Supply	DC 7.2Vsupplied by battery or DC 15V from adapter

Adapter Information:
Model: YNQX18T150100UL
Input: AC100-240 V 50/60Hz 1.0A
Output:15V, 1.0A

Note: The difference between tested model and series model was explained in the declaration letter.

**All measurement and test data in this report was gathered from production sample serial number: 20170504001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2017-05-04)*

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, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

FCC Part15.247 DTS submission with FCC ID: XYFX10CSP.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013.

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		3.19 dB
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	4.88dB
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.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 815570 and ISED Registration No.: 3062E. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel list for GFSK Modulation:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2405.50	25	2441.00
2	2406.46	26	2442.48
3	2407.91	27	2444.53
4	2409.49	28	2445.38
5	2410.94	29	2446.95
6	2412.39	30	2448.40
7	2413.96	31	2449.97
8	2415.41	32	2451.42
9	2416.98	33	2452.87
10	2418.43	34	2454.44
11	2419.88	35	2455.89
12	2421.45	36	2457.46
13	2422.90	37	2458.91
14	2424.47	38	2460.48
15	2425.92	39	2461.93
16	2427.49	40	2463.38
17	2428.94	41	2464.95
18	2430.39	42	2466.40
19	2432.08	43	2467.97
20	2433.41	44	2469.42
21	2434.98	45	2470.87
22	2436.43	46	2472.44
23	2437.88	47	2474.00
24	2439.45	/	/

EUT was tested with Channel 1, 25 and 47.

EUT Exercise Software

EUT was tested in engineering mode.

Power Level: 17

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

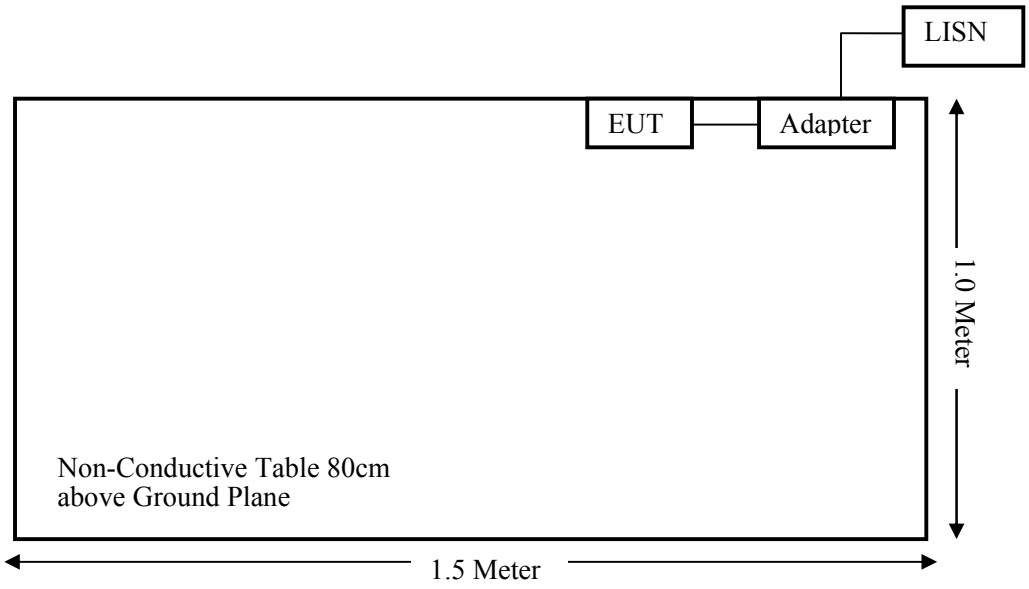
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

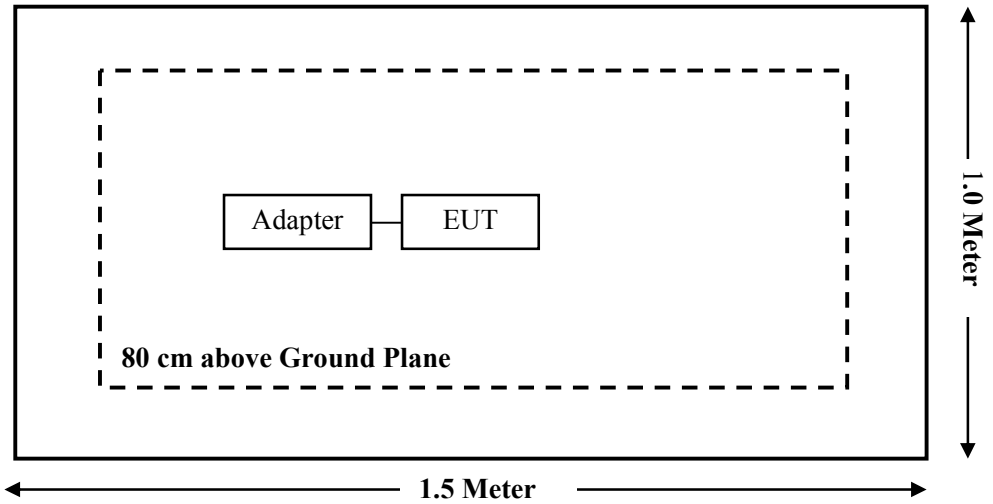
Cable Description	Shielding Type	Length (m)	From Port	To
/	/	/	/	/

Block Diagram of Test Setup

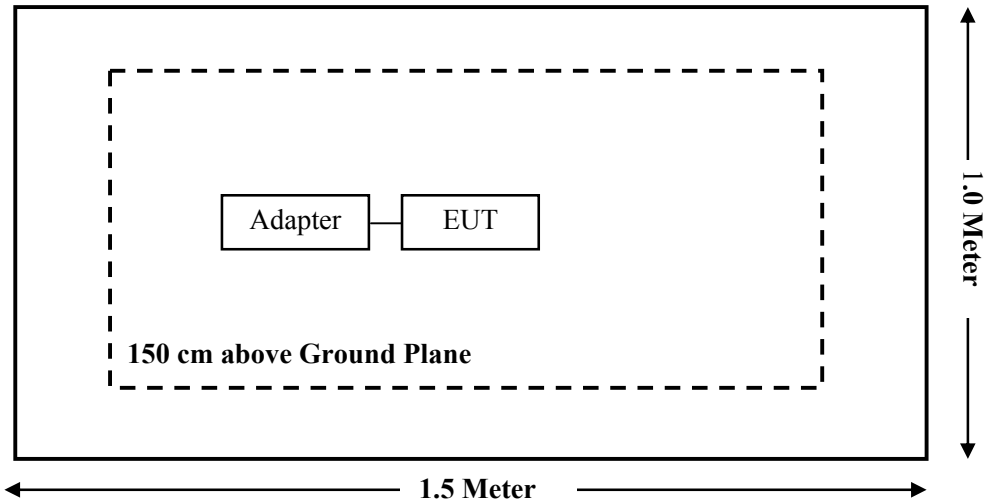
For Conducted Emissions:



For Radiated Emissions (Below 1GHz):



For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i)§1.1307(b)(1) & §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§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

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	Signal Analyzer	FSIQ26	100048	2016-11-25	2017-11-24
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2016-01-09	2019-01-08
ETS	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Sonoma Instrunent	Pre-amplifier	330	171377	2016-12-12	2017-12-11
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-12-12	2017-12-11
Heatsink Required	Amplifier	QLW-18405536-J0	15964001009	2016-12-12	2017-12-11
R&S	Auto test Software	EMC32	100361	/	/
Haojintech	Coaxial Cable	Cable-1	001	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-2	002	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-3	003	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-4	004	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-5	005	2016-12-12	2017-12-11
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSV40	101116	2016-07-04	2017-07-03
FrSky	RF Cable	/	/	2017-06-10	2018-06-09
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2016-10-10	2017-10-09
Rohde & Schwarz	LISN	ENV216	3560655016	2016-11-25	2017-11-24
Rohde & Schwarz	CE Test software	EMC32	100357	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2016-09-08	2017-09-07

*** 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§2.1093and §1.1307(b)(1), 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:

For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:
[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR

·f(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
·When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

Measurement Result

Frequency Range	Conducted Output Power		Minimum Test Separation Distances
(MHz)	(dBm)	(mW)	(mm)
2405.50-2474.00	17.50	56.23	18

Note:

1. Minimum test separation distance is 18 mm, as following photo:

2. Turn up power 17±0.5dBm, which is declared by the manufacturer.

3. This is a handheld device.

Result: [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [√f(GHz)]=56.23/18*√2.474= **4.9<7.5**. So no SAR test is needed.

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 a RP-SMA connector to attach an external antenna arrangement for SRD, which the antenna gain is 2.0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

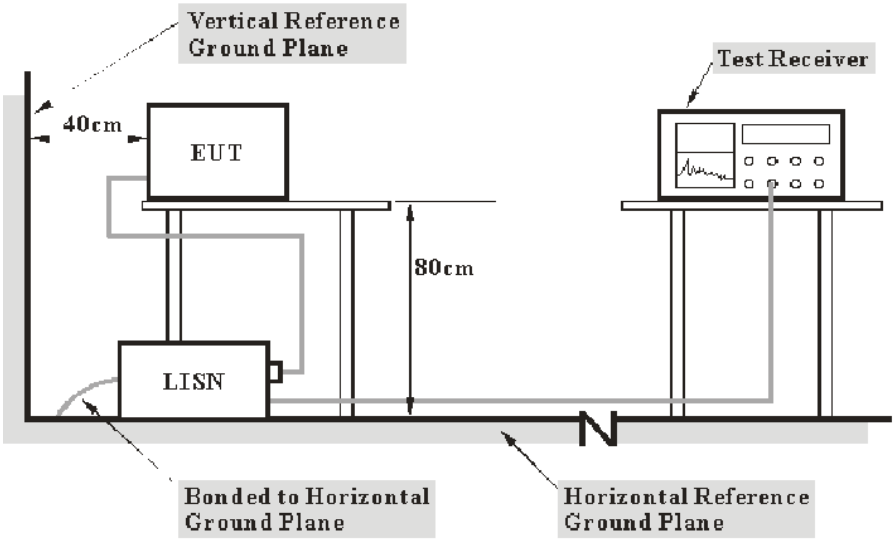
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

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

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

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

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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

Margin = Limit – Corrected Amplitude

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

Test Data

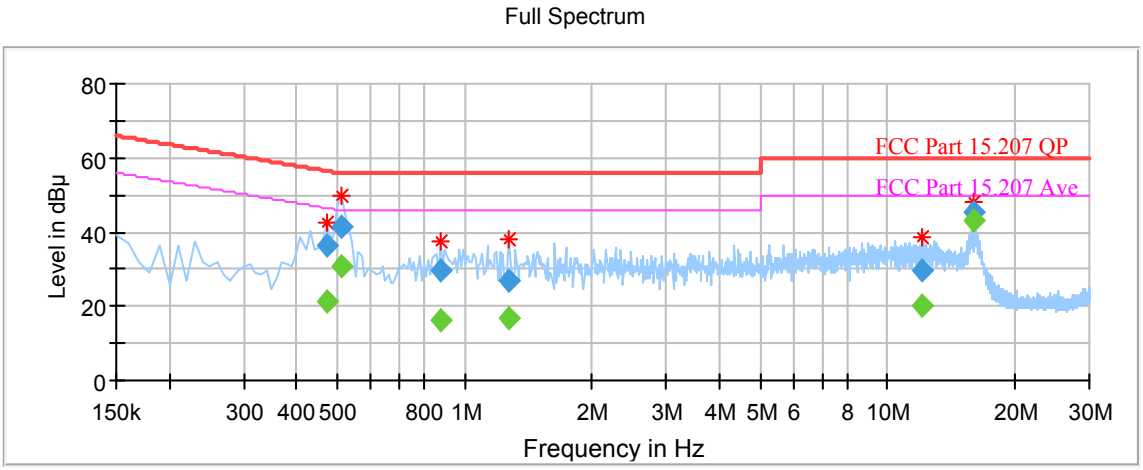
Environmental Conditions

Temperature:	24.1 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Chris Wang on 2017-06-12.

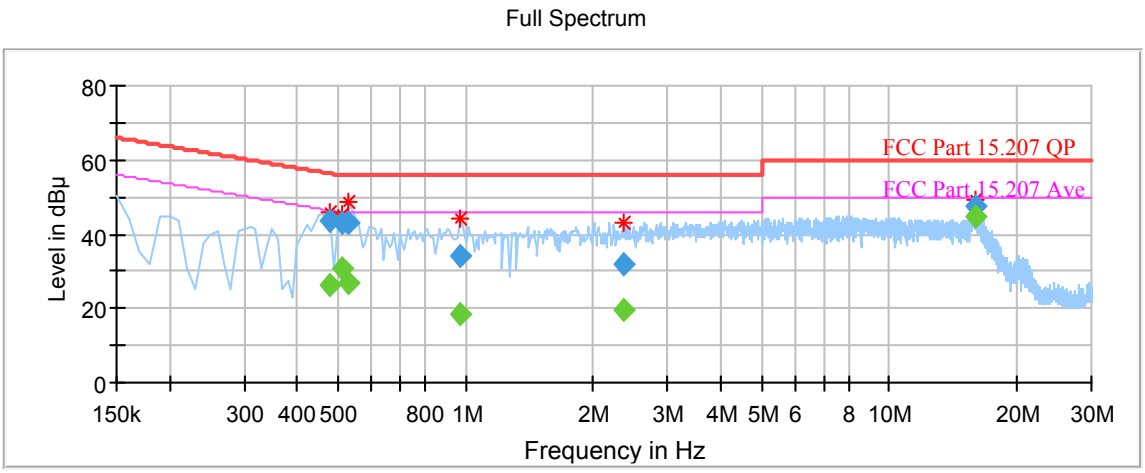
EUT operation mode: Transmitting in low channel (Worst case)

AC 120V/60 Hz, Line



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.470000	---	21.14	9.000	L1	10.1	25.37	46.51	Compliance
0.470000	36.56	---	9.000	L1	10.1	19.95	56.51	Compliance
0.510000	---	30.62	9.000	L1	10.1	15.38	46.00	Compliance
0.510000	41.12	---	9.000	L1	10.1	14.88	56.00	Compliance
0.880000	---	16.41	9.000	L1	9.9	29.59	46.00	Compliance
0.880000	29.76	---	9.000	L1	9.9	26.24	56.00	Compliance
1.270000	---	16.75	9.000	L1	9.9	29.25	46.00	Compliance
1.270000	27.03	---	9.000	L1	9.9	28.97	56.00	Compliance
12.120000	---	20.01	9.000	L1	10.0	29.99	50.00	Compliance
12.120000	29.45	---	9.000	L1	10.0	30.55	60.00	Compliance
16.000000	---	43.11	9.000	L1	10.0	6.89	50.00	Compliance
16.000000	45.13	---	9.000	L1	10.0	14.87	60.00	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.480000	---	26.52	9.000	N	10.1	19.82	46.34	Compliance
0.480000	43.80	---	9.000	N	10.1	12.54	56.34	Compliance
0.510000	---	30.60	9.000	N	10.1	15.40	46.00	Compliance
0.510000	43.18	---	9.000	N	10.1	12.82	56.00	Compliance
0.530000	---	26.86	9.000	N	10.1	19.14	46.00	Compliance
0.530000	43.27	---	9.000	N	10.1	12.73	56.00	Compliance
0.970000	---	18.49	9.000	N	9.9	27.51	46.00	Compliance
0.970000	33.94	---	9.000	N	9.9	22.06	56.00	Compliance
2.370000	---	19.59	9.000	N	9.9	26.41	46.00	Compliance
2.370000	31.72	---	9.000	N	9.9	24.28	56.00	Compliance
16.000000	---	44.78	9.000	N	10.0	5.22	50.00	Compliance
16.000000	47.55	---	9.000	N	10.0	12.45	60.00	Compliance

Note:
1) Corr.=LISN VDF (Voltage Division Factor) + Cable Loss
2) Corrected Amplitude = Reading + Corr.
3) Margin = Limit –Corrected Amplitude

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

Applicable Standard

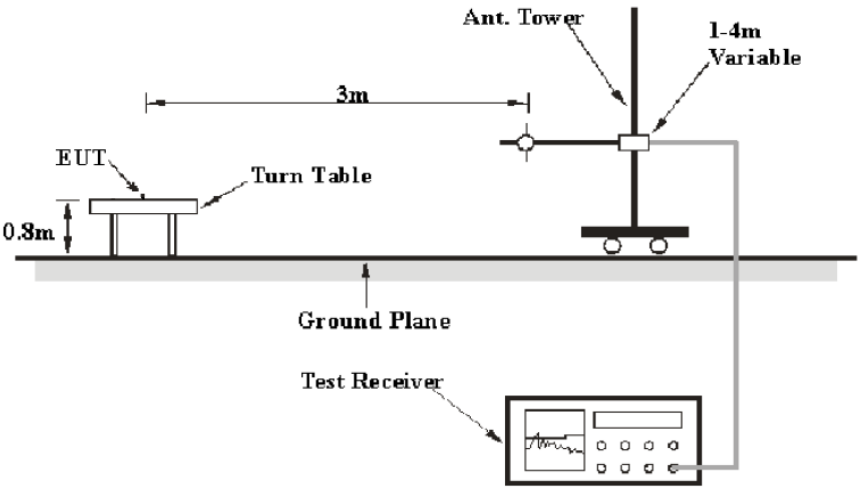
FCC §15.205; §15.209; §15.247(d)

Measurement Uncertainty

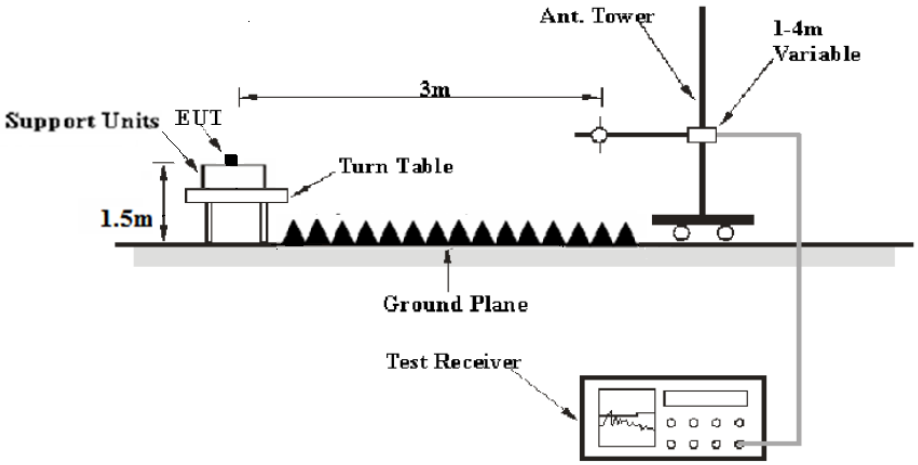
All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

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 & Spectrum Analyzer Setup were 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

Frequency Range	RBW	Video B/W	Detector
1GHz – 25GHz	1MHz	3 MHz	PK
	1MHz	10 Hz	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:

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - 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:

Margin = Limit – 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:	24.1 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Chris Wang on 2017-06-12.

EUT operation mode: Transmitting(Scan with X-Axis, Y-Axis and Z-Axis position, the worst case was recorded)

30MH -25 GHz:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (cm)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2405.50 MHz)									
498.20	31.66	QP	18	225	V	5.7	37.36	46	8.64
2405.50	117.56	PK	233	103	V	-6.18	111.38	/	/
2405.50	94.65	Ave	233	103	V	-6.18	88.47	/	/
2405.50	117.40	PK	82	130	H	-6.18	111.22	/	/
2405.50	91.63	Ave	82	130	H	-6.18	85.45	/	/
2390.00	51.74	PK	313	235	V	-6.22	45.52	74.00	28.48
2390.00	31.66	Ave	313	235	V	-6.22	25.44	54.00	28.56
2400.00	63.92	PK	282	129	V	-6.19	57.73	74.00	16.27
2400.00	41.36	Ave	282	129	V	-6.19	35.17	54.00	18.83
1302.60	57.08	PK	160	162	H	-10.64	46.44	74.00	27.56
1302.60	34.84	Ave	160	162	H	-10.64	24.20	54.00	29.80
4811.00	57.55	PK	92	113	V	1.63	59.18	74.00	14.82
4811.00	44.44	Ave	92	113	V	1.63	46.07	54.00	7.93
7216.50	59.75	PK	352	168	V	7.56	67.31	74.00	6.69
7216.50	41.67	Ave	352	168	V	7.56	49.23	54.00	4.77
Middle Channel (2441.00 MHz)									
498.20	31.26	QP	207	117	V	5.7	36.96	46	9.04
2441.00	117.69	PK	67	138	V	-6.10	111.59	/	/
2441.00	87.62	Ave	67	138	V	-6.10	81.52	/	/
2441.00	117.32	PK	327	247	H	-6.10	111.22	/	/
2441.00	84.85	Ave	327	247	H	-6.10	78.75	/	/
1302.60	56.84	PK	352	206	V	-10.64	46.20	74.00	27.80
1302.60	34.76	Ave	352	206	V	-10.64	24.12	54.00	29.88
3062.66	42.67	PK	102	122	H	-3.08	39.59	74.00	34.41
3062.66	30.03	Ave	102	122	H	-3.08	26.95	54.00	27.05
4882.00	58.76	PK	248	188	V	1.79	60.55	74.00	13.45
4882.00	46.56	Ave	248	188	V	1.79	48.35	54.00	5.65
6032.06	41.93	PK	55	196	H	4.19	46.12	74.00	27.88
6032.06	27.54	Ave	55	196	H	4.19	31.73	54.00	22.27
7323.00	57.87	PK	105	133	V	7.67	65.54	74.00	8.46
7323.00	40.68	Ave	105	133	V	7.67	48.35	54.00	5.65

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (cm)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
High Channel (2474.00 MHz)									
498.20	31.38	QP	54	149	V	5.7	37.08	46	8.92
2474.00	117.61	PK	193	232	V	-6.03	111.58	/	/
2474.00	87.40	Ave	193	232	V	-6.03	81.37	/	/
2474.00	117.53	PK	186	241	H	-6.03	111.50	/	/
2474.00	84.73	Ave	186	241	H	-6.03	78.70	/	/
2483.50	56.47	PK	93	205	V	-6.01	50.46	74.00	23.54
2483.50	41.43	Ave	93	205	V	-6.01	35.42	54.00	18.58
1302.60	56.25	PK	79	159	H	-10.64	45.61	74.00	28.39
1302.60	34.96	Ave	79	159	H	-10.64	24.32	54.00	29.68
4948.00	59.42	PK	22	199	V	1.94	61.36	74.00	12.64
4948.00	47.61	Ave	22	199	V	1.94	49.55	54.00	4.45
6032.06	42.05	PK	284	124	H	4.19	46.24	74.00	27.76
6032.06	27.56	Ave	284	124	H	4.19	31.75	54.00	22.25
7422.00	55.09	PK	160	231	V	7.77	62.86	74.00	11.14
7422.00	40.03	Ave	160	231	V	7.77	47.80	54.00	6.20

Note: The fundamental test is without Amplifier

FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

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

Test Procedure

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

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

Test Data

Environmental Conditions

Temperature:	24.3 ℃
Relative Humidity:	49%
ATM Pressure:	101.3 kPa

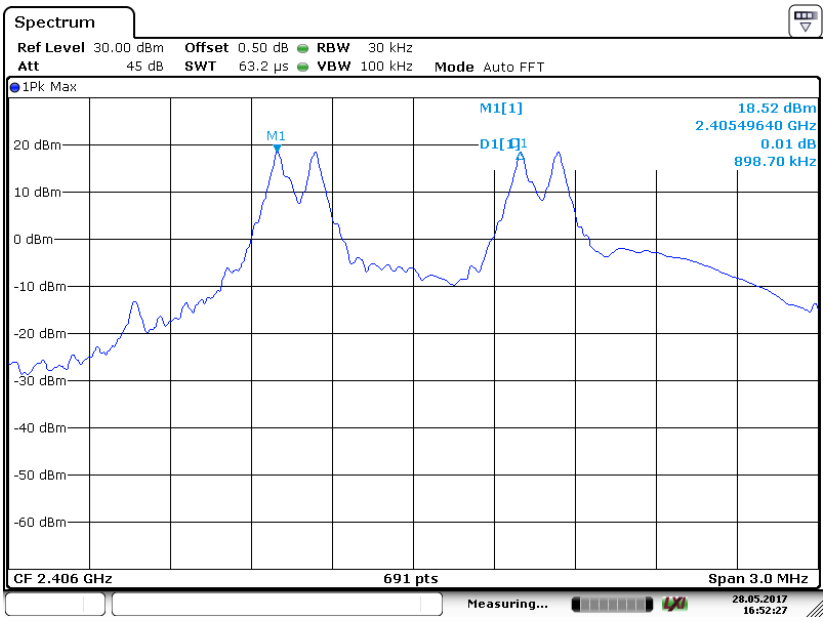
The testing was performed by Chris Wang on 2017-05-28.

EUT operation mode: Hopping

Modulation	Channel	Frequency (MHz)	Channel Separation (kHz)	Limit (kHz)	Result
GFSK	Low	2405.50	898.70	142.80	Pass
	Adjacent	2406.46			
	Middle	2441.00	1497.80	144.73	Pass
	Adjacent	2442.48			
	Adjacent	2472.44	1497.80	144.73	Pass
	High	2474.00			

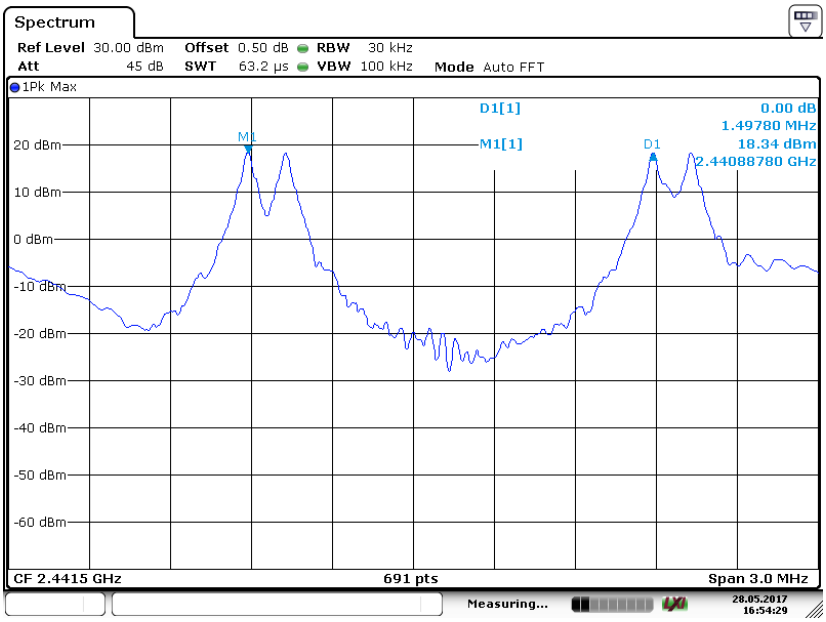
The limit =20dB Bandwidth*2/3

Low Channel



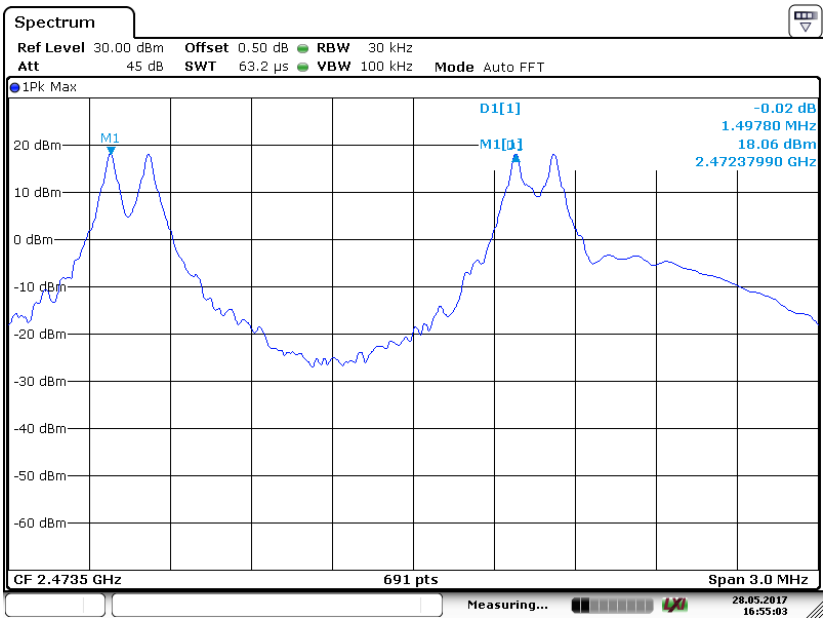
Date: 28.MAY.2017 16:52:28

Middle Channel



Date: 28.MAY.2017 16:54:29

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

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level.
d) Steps a) through c) might require iteration to adjust within the specified tolerances.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target "−20 dB down" requirement;
f) Set detection mode to peak and trace mode to max hold.
g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
h) Determine the "−20 dB down amplitude" using [(reference value) −20dB]. Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display; such that each marker is at or slightly below the "−20dB down amplitude" determined in step h). If a marker is below this "−20 dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "−20 dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

Test Data

Environmental Conditions

Temperature:	24.1 ℃
Relative Humidity:	49%
ATM Pressure:	101.3 kPa

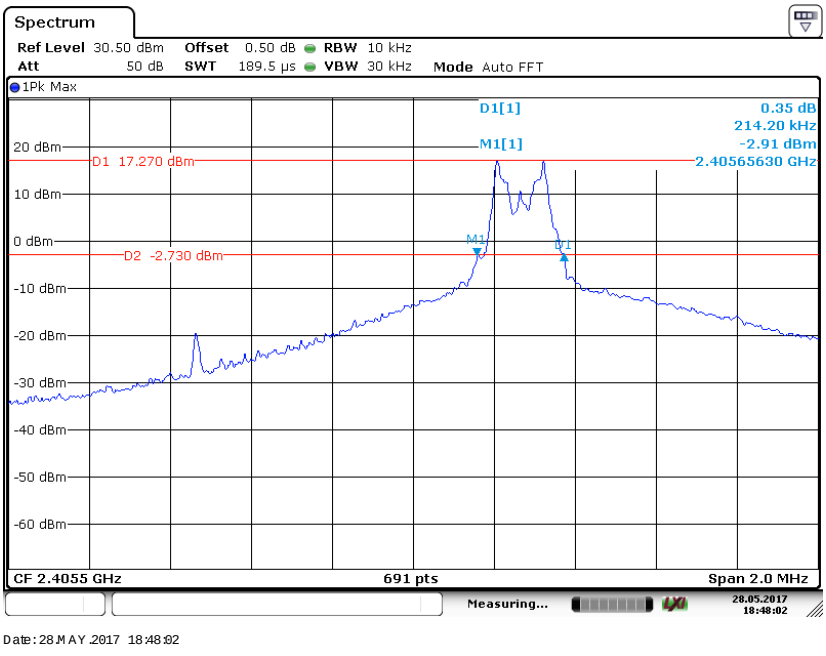
The testing was performed by Chris Wang on 2017-05-28.

EUT operation mode: Transmitting

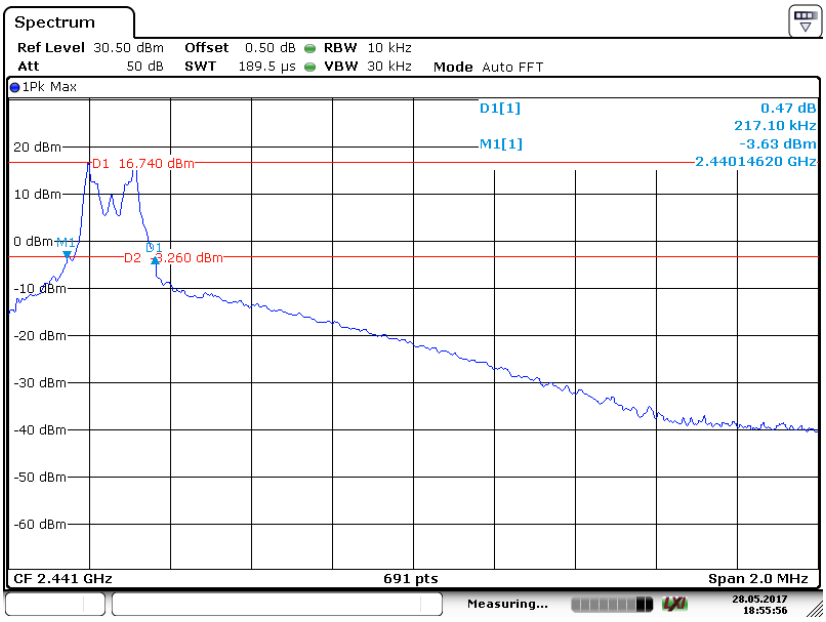
Test Result: Compliance

Modulation	Channel	Frequency (MHz)	20 dB Emission Bandwidth (kHz)
GFSK	Low	2405.5	214.20
	Middle	2441.0	217.10
	High	2474.0	217.10

Low Channel

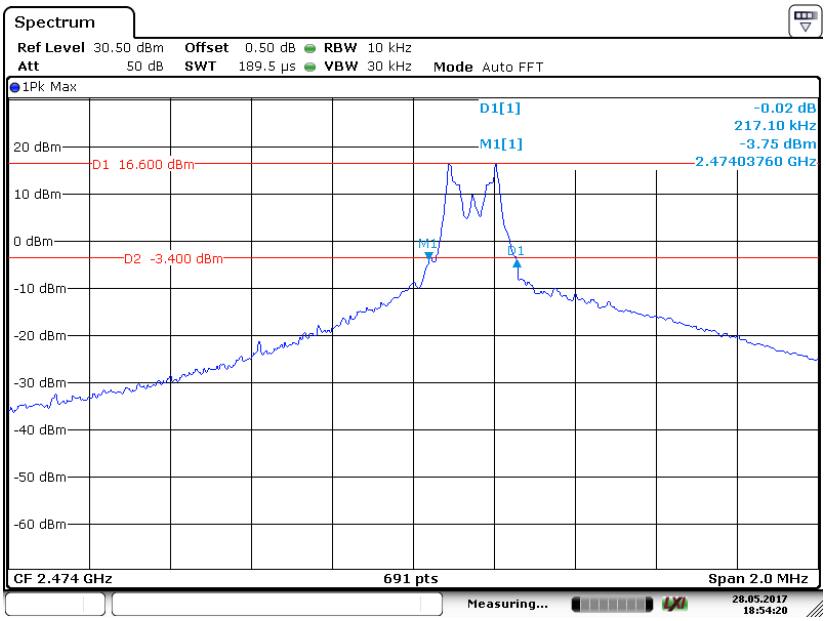


Middle Channel



Date: 28.MAY.2017 18:55:56

High Channel



Date: 28.MAY.2017 18:54:20

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

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

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c) VBW ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

Test Data

Environmental Conditions

Temperature:	24.3 ℃
Relative Humidity:	49%
ATM Pressure:	101.3 kPa

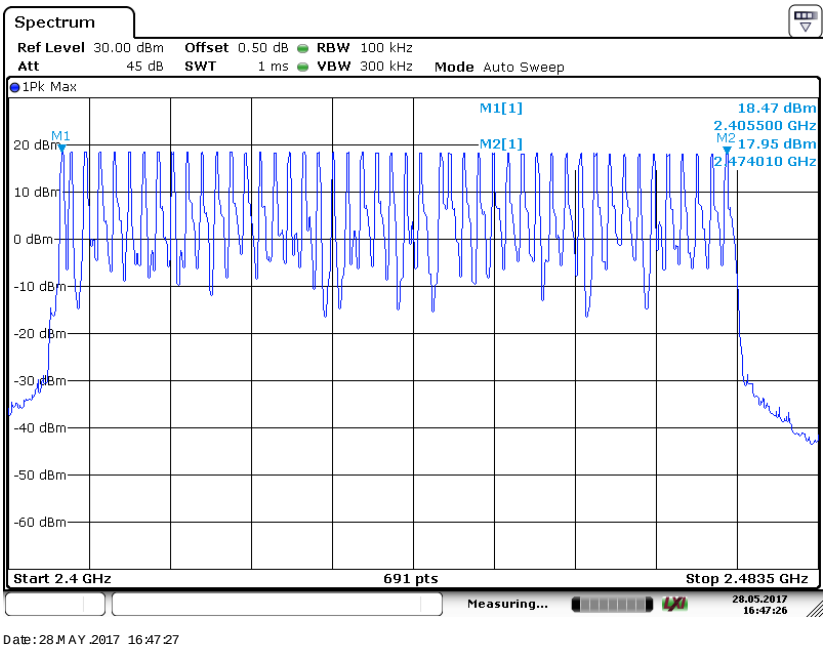
The testing was performed by Chris Wang on 2017-05-28.

EUT operation mode: Hopping

Test Result: Compliance

Modulation	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
GFSK	2405.5-2474.0	47	≥15

Number of Hopping Channels



Date: 28.MAY.2017 16:47:27

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 ≤ channel spacing and where possible RBW should be set >> 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.

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) *(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 in the requirements. 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.

Test Data

Environmental Conditions

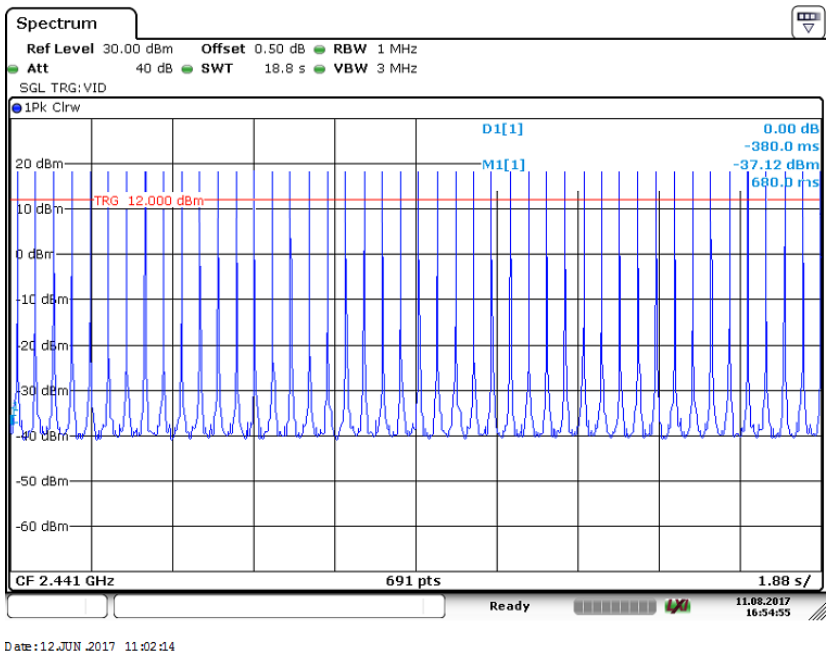
Temperature:	24.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

The testing was performed by Chris Wang on 2017-05-28 to 2017-06-12.

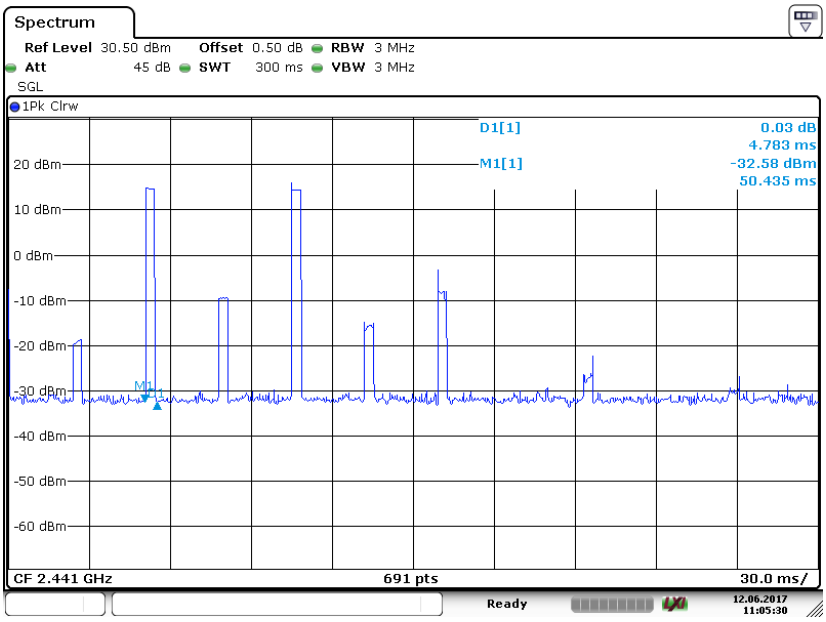
EUT operation mode: Hopping

Modulation	Channel	Pulse Width (ms)	Pulse Number	Dwell Time (s)	Limit (s)	Result
GFSK	Middle	3.65	45	0.164	≤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



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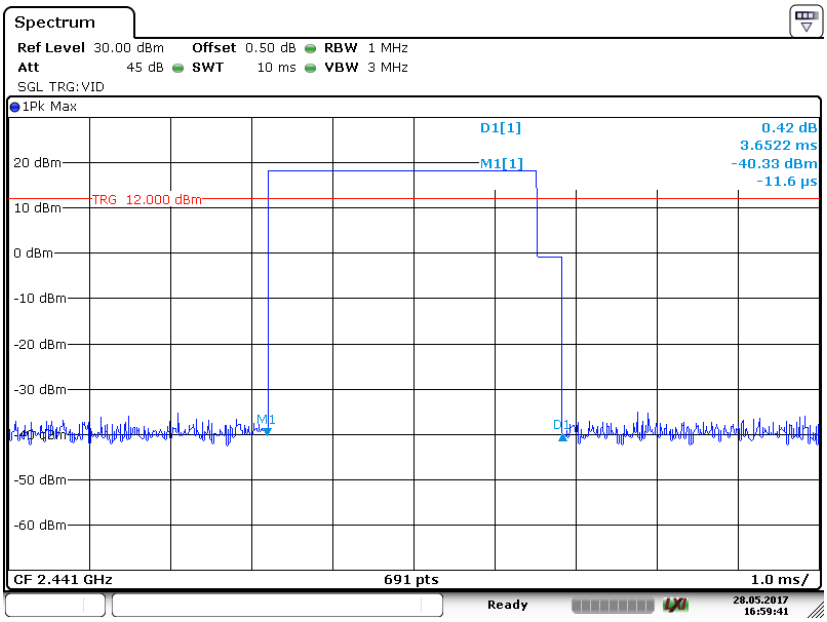
Single Pulse



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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

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.

Test Data

Environmental Conditions

Temperature:	24.3 ℃
Relative Humidity:	49%
ATM Pressure:	101.3 kPa

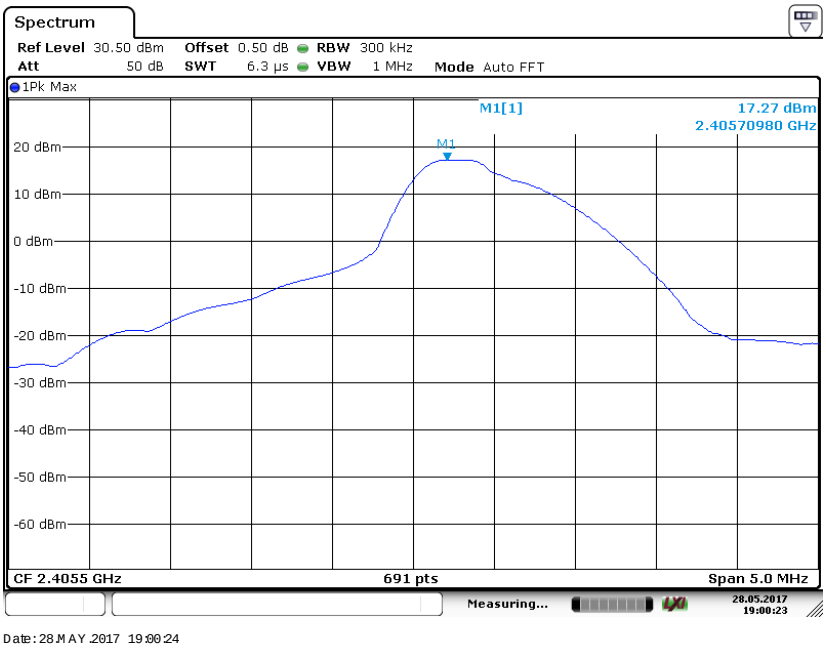
The testing was performed by Chris Wang on 2017-05-28.

EUT operation mode: Transmitting

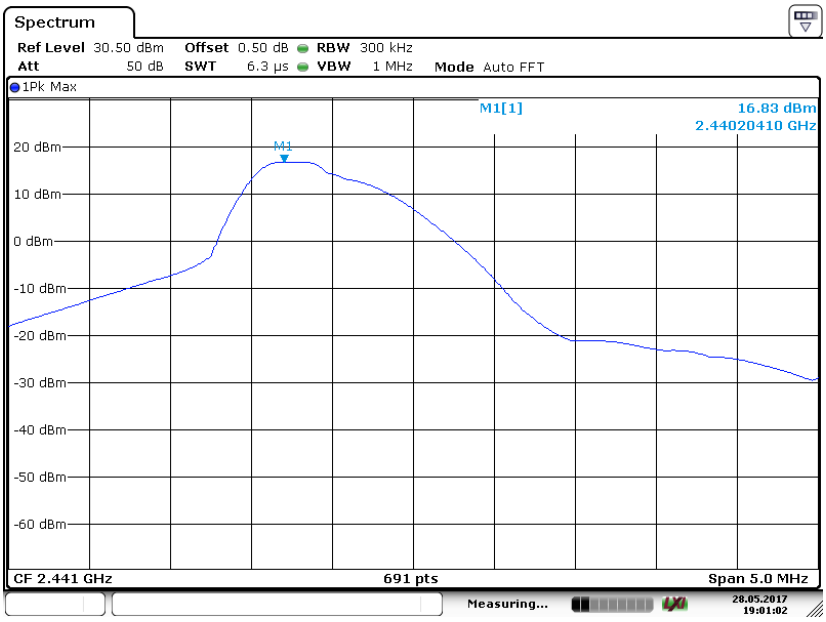
Test Result: Compliance

Modulation	Channel	Frequency (MHz)	Output Power		Limit (mW)
			(dBm)	(mW)	
GFSK	Low	2405.5	17.27	53.33	125
	Middle	2441.0	16.83	48.19	125
	High	2474.0	16.69	46.67	125

Low Channel

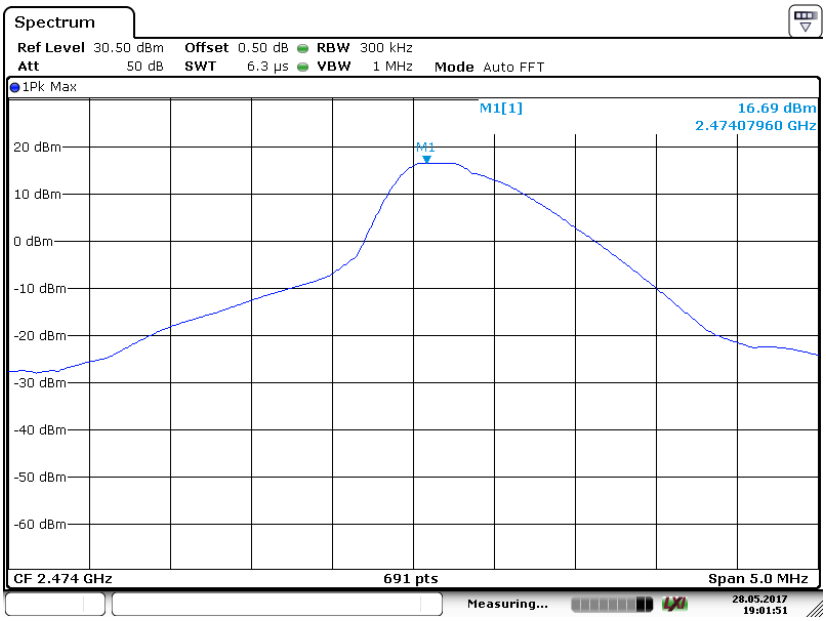


Middle Channel



Date: 28.MAY.2017 19:01:02

High Channel



Date: 28.MAY.2017 19:01:50

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

a) Connect the EMI receiver or spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).
b) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).
c) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent “normal mode of operation” as specified in 6.10.3.
d) If using the radiated method, then use the applicable procedure(s) of 6.4, 6.5, or 6.6, and orient the EUT and measurement antenna positions to produce the highest emission level.
e) Perform the test as follows:
1) 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 that fall outside of the authorized band of operation.
2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
3) Attenuation: Auto (at least 10 dB preferred).
4) Sweep time: Coupled.
5) Resolution bandwidth: 100 kHz.
6) Video bandwidth: 300 kHz.
7) Detector: Peak.
8) Trace: Max hold.
f) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator overshoot.
g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
h) Repeat step c) through step e) for every applicable modulation.
i) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel) and repeat step c) through step d).
j) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Test Data

Environmental Conditions

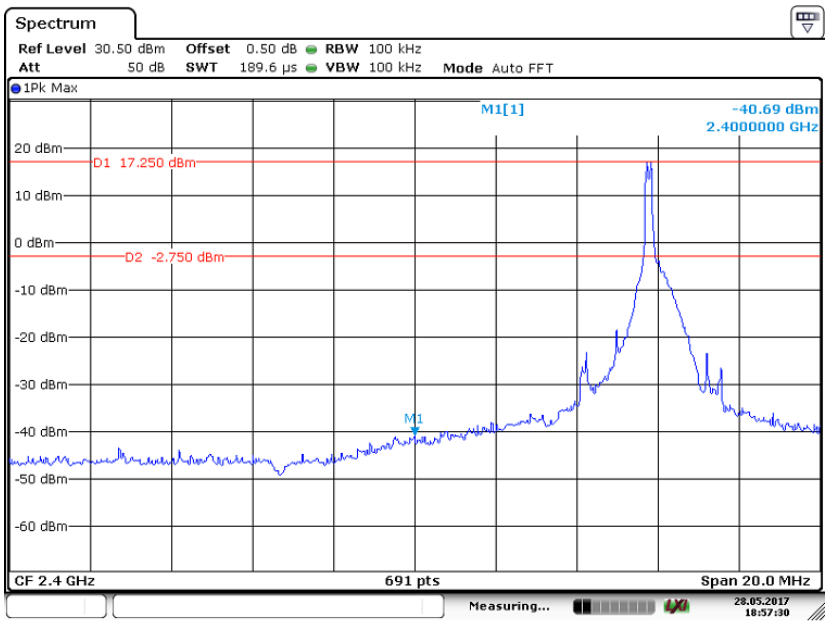
Temperature:	24.3 ℃
Relative Humidity:	49%
ATM Pressure:	101.3 kPa

The testing was performed by Chris Wang on 2017-08-23 .

EUT operation mode: Transmitting

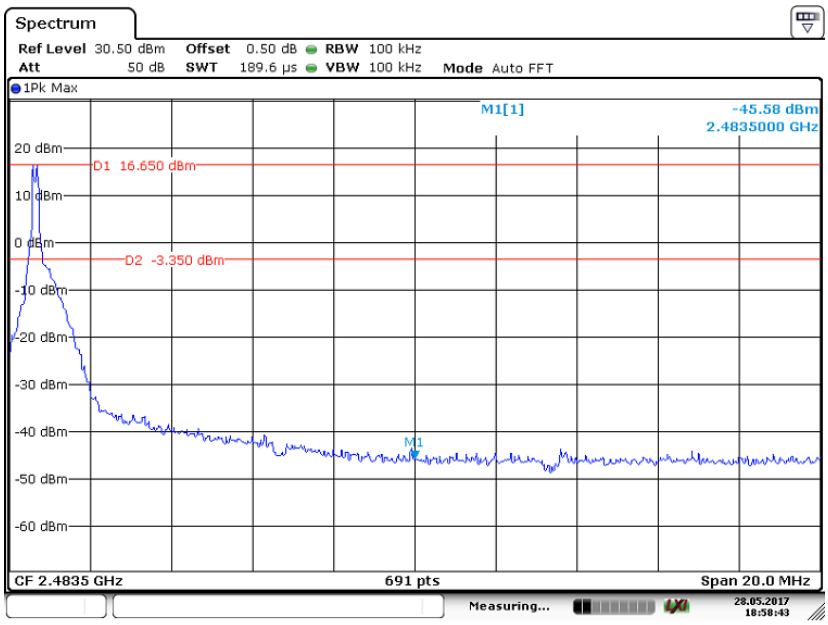
Test Result: Compliance

Band Edge-Left Side



Date:23.AUG.2017 11:57:30

Band Edge-Right Side



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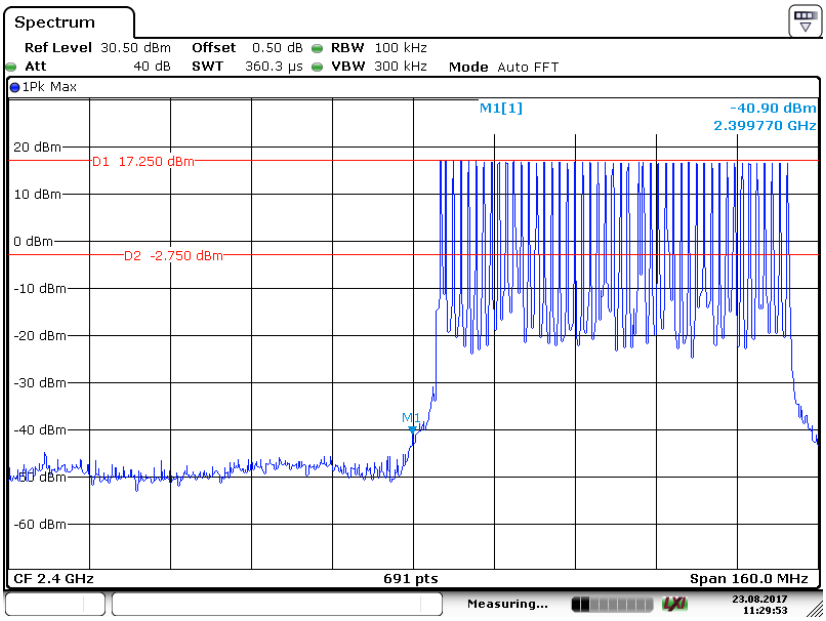
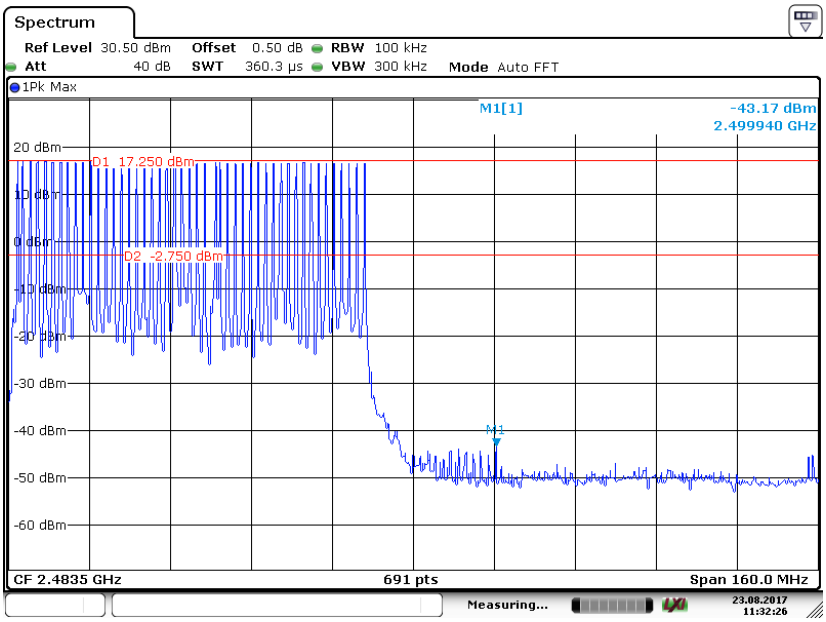
Band Edge-Left Side_Hopping



Date: 23.AUG.2017 11:29:53

Band Edge-Right Side_Hopping



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