Test Report of FCC CFR 47 Part 15 Subpart C

On Behalf of

Graupner CO., Ltd

8th F,202 Dong,Chunui Techno-Park2,18, Bucheon-ro 198beon-gil,Wonmi-gu,, Bucheon-Shi, Kyungki-Do, South Korea

Product Name:	**2.4GHz Radio Controller**
Model/Type No.:	**X-8E**
Trade Name:	**HoTT**
FCC ID:	**SNL-16006500**
Prepared By:	**Shenzhen Hongcai Testing Technology Co., Ltd.** 1st-3rd Floor, Building C, Shuanghuan Xin Yi Dai Hi-Tech Industrial Park, No.8 Baoqing Road, Baolong Industrial Zone, Longgang District, Shenzhen, Guangdong, China Tel: +86-755-86337020 Fax:+86-755-86337028
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1. GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

Client Information

Applicant:	**Graupner CO.,Ltd**
Address of applicant:	8th F,202 Dong,Chunui Techno-Park2,18, Bucheon-ro 198beon-gil, Wonmi-gu,,Bucheon-Shi, Kyungki-Do, South Korea
Manufacturer :	**Graupner CO.,Ltd**
Address of applicant:	8th F,202 Dong,Chunui Techno-Park2,18, Bucheon-ro 198beon-gil, Wonmi-gu,,Bucheon-Shi, Kyungki-Do, South Korea
Manufacturer :	**SJ Technology(Shenzhen)Co.,Ltd**
Address of manufacturer:	F6, 1 Bldg, A Area, Yintianxifa Industrial Area, Xixiang Town, Baoan District Shenzhen, Guangdong Province, China

General Description of E.U.T

Items	Description
EUT Description:	2.4GHz Radio Controller
Model No.:	X-8E
Trade Name:	HoTT
Frequency Band:	2404.056~2479.095MHz
Channel Spacing:	1.014MHz
Number of Channels:	75
Type of Modulation:	MSK and FHSS
Antenna Gain	0.5dBi
Antenna Type:	2.4GHz Ceramic Patch Antenna
Rated Voltage:	DC 4.2V from battery

Remark: ** The test data gathered are from the production sample provided by the manufacturer.*

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Hopping Channels:

Number	Channel	Frequency
[0]	52	2456.786
[1]	70	2475.039
[2]	5	2409.126
[3]	25	2429.407
[4]	42	2446.646
[5]	47	2451.716
[6]	63	2467.940
[7]	9	2413.182
[8]	17	2421.295
[9]	44	2448.674
[10]	56	2460.842
[11]	61	2465.912
[12]	14	2418.253
[13]	24	2428.393
[14]	35	2439.547
[15]	48	2452.730
[16]	60	2464.898
[17]	10	2414.197
[18]	28	2432.449
[19]	34	2438.533
[20]	45	2449.688
[21]	62	2466.927
[22]	11	2415.210
[23]	20	2424.337
[24]	38	2442.590
[25]	46	2450.702
[26]	65	2469.969
[27]	0	2404.056
[28]	27	2431.435
[29]	30	2434.477
[30]	57	2461.856
[31]	64	2468.955
[32]	2	2406.084
[33]	21	2425.351
[34]	39	2443.604
[35]	51	2455.772
[36]	73	2478.081
[37]	6	2410.140

Number	Channel	Frequency
[38]	29	2433.463
[39]	32	2436.505
[40]	49	2453.744
[41]	72	2477.067
[42]	4	2408.112
[43]	19	2423.323
[44]	33	2437.519
[45]	53	2457.800
[46]	67	2471.997
[47]	12	2416.225
[48]	22	2426.365
[49]	43	2447.660
[50]	59	2463.884
[51]	74	2479.095
[52]	8	2412.169
[53]	26	2430.421
[54]	31	2435.491
[55]	58	2462.870
[56]	71	2476.053
[57]	3	2407.098
[58]	18	2422.309
[59]	41	2445.632
[60]	50	2454.758
[61]	69	2474.025
[62]	13	2417.239
[63]	23	2427.379
[64]	36	2440.561
[65]	55	2459.828
[66]	66	2470.983
[67]	7	2411.154
[68]	16	2420.281
[69]	37	2441.575
[70]	54	2458.814
[71]	68	2473.011
[72]	1	2405.070
[73]	15	2419.267
[74]	40	2444.618

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1.2 Related Submittal(s) / Grant (s) and Test Methodology

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.

DA 00-705: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

1.3 Test Facility

All measurement required was performed at laboratory of Shenzhen CTL Testing Technology Co., Ltd. Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4 and CISPR 22/EN 55022 requirements.

FCC – Registration No.: 970318
Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 970318, December, 2013.

IC Registration No.: 9618B
The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 9618B on November 13, 2013.

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2. SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

The calibrated antennas used to sample the radiated field strength are mounted on a non-conductive, motorized antenna mast 3 or 10 meters from the leading edge of the turntable.

2.3 General Test Procedures

Conducted Emissions: The EUT is placed on the table, which is 0.8 m above ground plane According to the requirements in ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-Peak detector mode.

Radiated Emissions: The EUT is a placed on as turntable, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in ANSI C63.10-2013.

2.4 Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the Shenzhen CTL Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty
Transmitter power conducted	+/- 0.57 dB
Transmitter power Radiated	+/- 2.20 dB
Conducted spurious emission 9KHz-40 GHz	+/- 2.20 dB
Power Line Conducted Emission	+/- 3.20 dB
Radiated Emission	+/- 4.32 dB

Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

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2.5 Measure Results Explanation Example

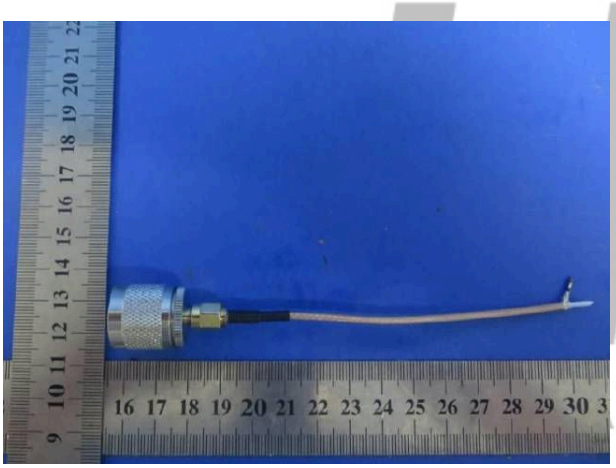
For all conducted test items:

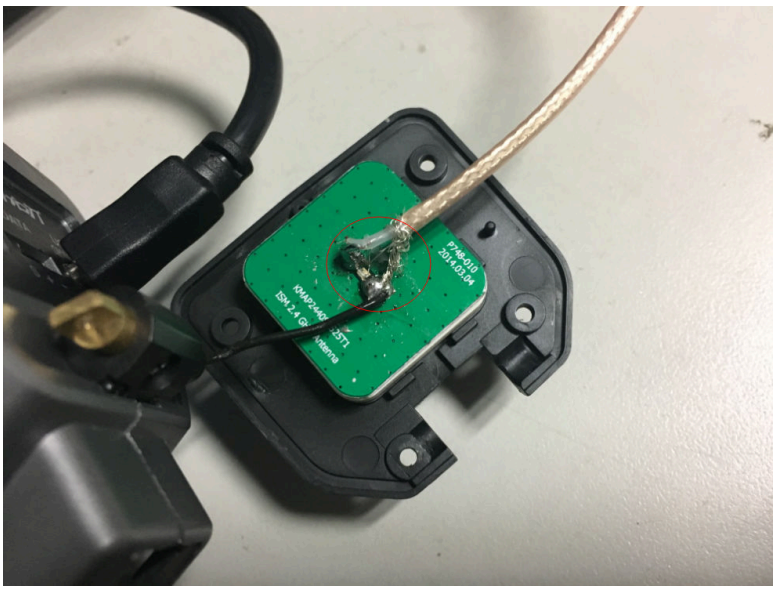
The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

The spectrum analyzer offset is derived from RF cable less and attenuator factor.
Offset= RF cable less+ attenuator factor.

Note: Using a temporary antenna connector for the EUT when the conducted measurements are performed.

Equipment	Manufacturer	Model No.	Frequency range(GHz)	Attenuation values(dBm)
Line	Zhenjiang south electronic	RG316	1-12	0.08
Connector	Zhenjiang south electronic	SMA-K/N-J	1-12	0.01





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2.6 List of Measuring Equipments Used

No.	Instrument no.	Equipment	Manufacturer	Model No.	S/N	Last Calibration	Due Calibration
1	BCT-EMC001	EMI Test Receiver	R&S	ESCI	100687	2016-4-25	2017-4-24
2	BCT-EMC002	EMI Test Receiver	R&S	ES PI	100097	2016-10-1	2017-10-31
3	BCT-EMC003	Amplifier	HP	8447D	1937A02492	2016-4-25	2017-4-24
4	BCT-EMC018	TRILOGBroadband Test-Antenna	SCHWARZBECK	VULB9163	9163-324	2016-4-25	2017-4-24
5	BCT-EMC021	Triple-Loop Antenna	EVERFINE	LLA-2	711002	2016-10-1	2017-10-31
6	BCT-EMC026	RF POWER AMPLIFIER	FRANKONIA	FLL-75	1020A1109	2016-4-25	2017-4-24
7	BCT-EMC029	6DB Attenuator	FRANKONIA	N/A	1001698	2016-4-25	2017-4-24
8	BCT-EMC032	10dB attenuator	ELECTRO-METRICS	EM-7600	836	2016-4-25	2017-4-24
9	BCT-EMC036	Spectrum Analyzer	R&S	FSP	100397	2016-10-1	2017-10-31
10	BCT-EMC037	Broadband preamplifier	SCH WARZBECK	BBV9718	9718-182	2016-4-25	2017-4-24
11	BCT-EMC039	Horn Antenna	SCHWARZBECK	BBHA 9120D	0437	2016-4-25	2017-4-24
12	BCT-EMC038	Horn Antenna	SCHWARZBECK	BBHA9170	0483	2016-4-25	2017-4-24
13	BCT-EMC050	Pulse power sensor	Anritsu	MA2411B	110553	2016-10-1	2017-10-31
14	BCT-EMC050	Power Meter	Anritsu	ML2487B	100345	2016-10-1	2017-10-31

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3. SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC §15.207	AC Power Line Conducted Emission	Pass
FCC §15.247(a)(1)	Hopping Channel Bandwidth	Pass
FCC §15.247(a)(1)	Hopping Channel Separation	Pass
FCC §15.247(a)(1)	Number of Hopping Frequency Used	Pass
FCC §15.247(a)(1)(iii)	Dwell Time of Each Frequency	Pass
FCC §15.247(b)(1)	Maximum Peak Output Power	Pass
FCC §15.247(d)	Band Edges Emission	Pass
FCC §15.247(d)	Spurious Radiated Emission	Pass
FCC §15.203/15.247(b)/(c)	Antenna Requirement	Pass

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4. TEST OF AC POWER LINE CONDUCTED EMISSION

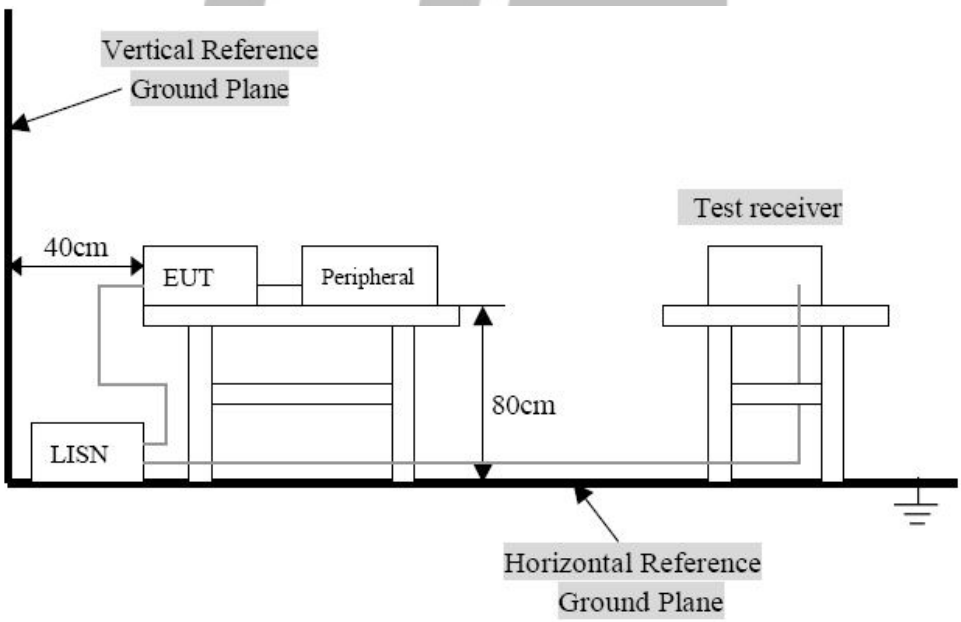
4.1 Applicable Standard

Refer to FCC §15.207.

For a Low-power Radio-frequency Device is designed to be connected to the AC power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed below limits table.

Frequency Range (MHz)	Limits (dBuV)	
	Quasi-Peak	Average
0.150～0.500	66～56	56～46
0.500～5.000	56	46
5.000～30.00	60	50

4.2 Test Setup Diagram



Remark: The EUT was connected to a 120VAC/ 60Hz power source.

4.3 Test Result

Not applicable.

The EUT is powered by battery

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5. Test of Hopping Channel Bandwidth

5.1 Applicable Standard

Section 15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

5.2 EUT Setup

Spectrum Analyzer

5.3 Test Equipment List and Details

See section 2.5.

5.4 Test Procedure

1. Use the following spectrum analyzer settings:

   Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

   RBW ⩾ 1% of the 20 dB bandwidth

   VBW ⩾ RBW

   Sweep = Auto

   Detector function = peak

   Trace = max hold

2. The spectrum width with level higher than 20dB below the peak level.

3. Repeat above 1~3 points for the middle and highest channel of the EUT.

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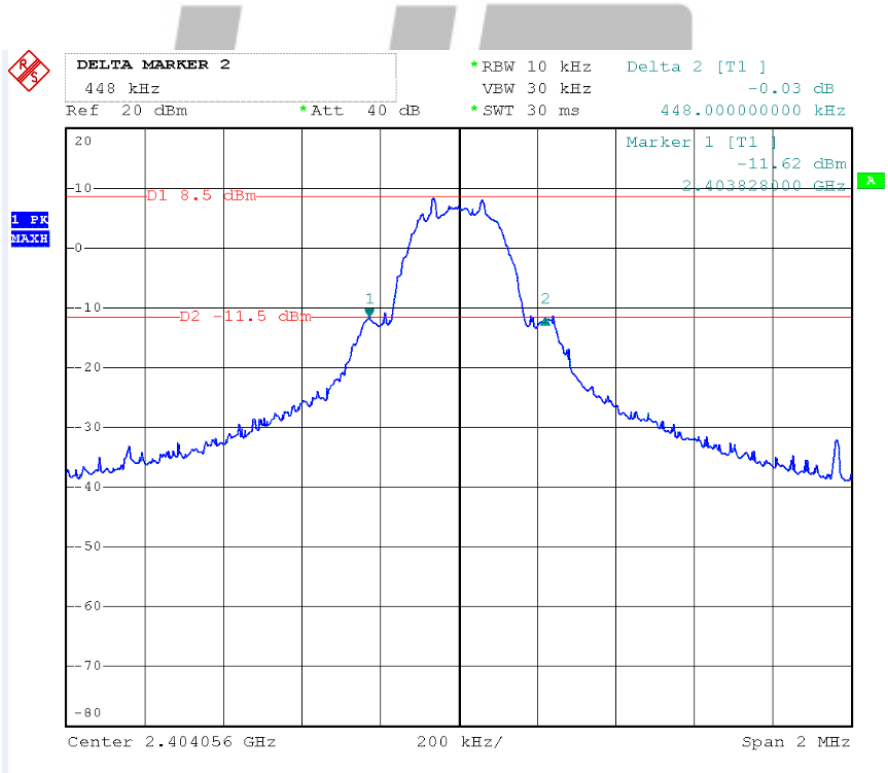
5.5 Test Result

Temperature (℃) : 22~23	EUT: 2.4GHz Radio Controller
Humidity (%RH): 50~54	M/N: X-8E
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

Modulation Type	Channel No.	Frequency (MHz)	20dB Bandwidth (kHz)	Min. Limit (kHz)
FHSS	Low	2404.056	448	>25
FHSS	Middle	2440.561	460	>25
FHSS	High	2479.095	468	>25

Channel Low:



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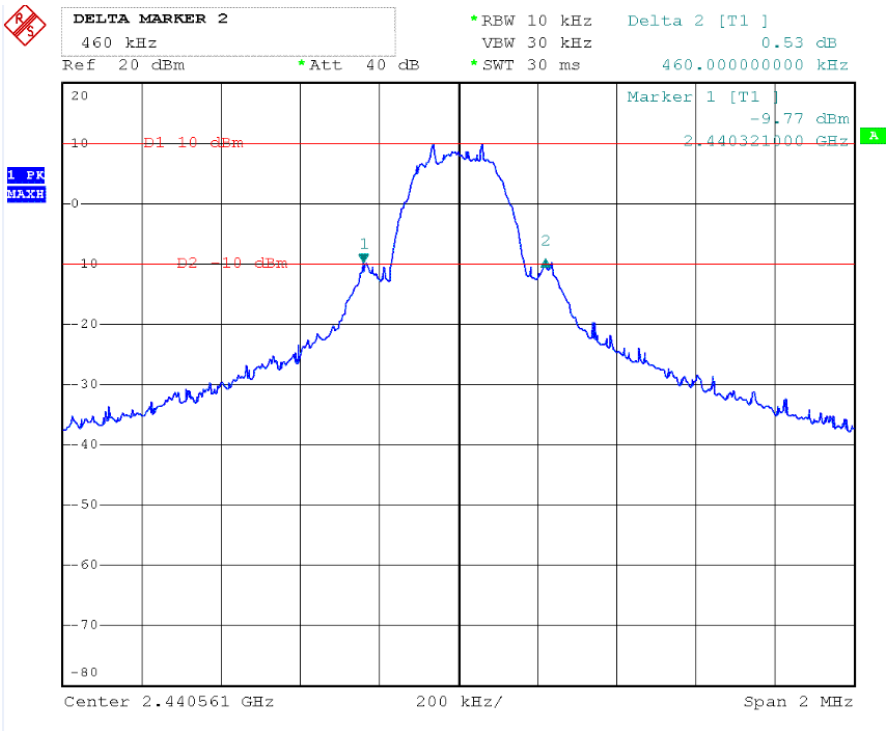
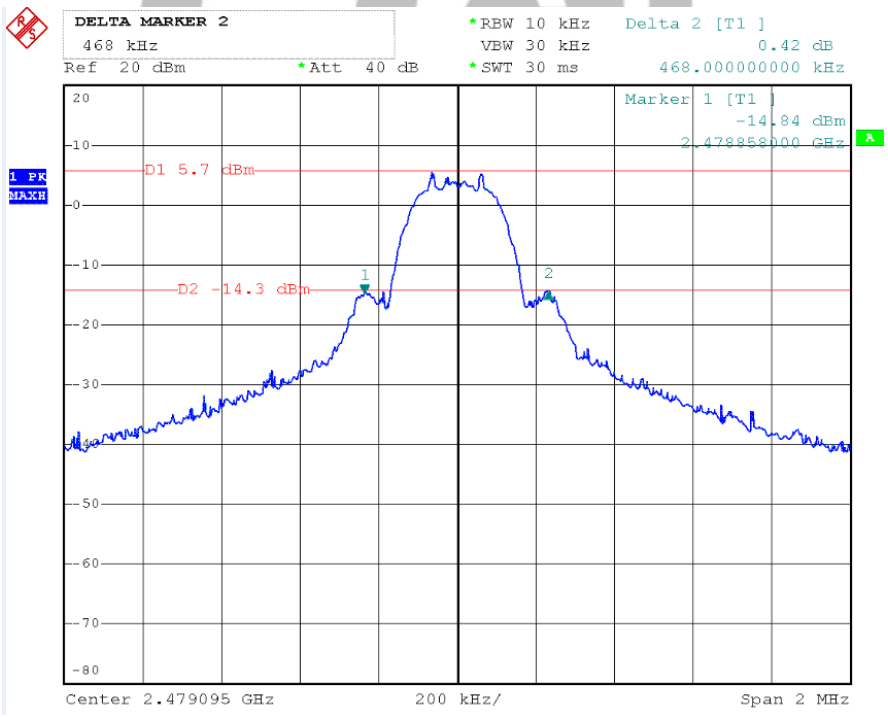
Channel Middle：



Channel High：



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6. Test of Hopping Channel Separation

6.1 Applicable Standard

Section 15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

6.2 EUT Setup

Spectrum Analyzer

6.3 Test Equipment List and Details

See section 2.5.

6.4 Test Procedure

1. The EUT must have its hopping function enabled.

2. Use the following spectrum analyzer settings:

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

Resolution (or IF) Bandwidth (RBW) ⩾ 1% of the span

Video (or Average) Bandwidth (VBW) ⩾ RBW

Sweep = auto

Detector function = peak

Trace = max hold

4. The Hopping Channel Separation is defined as the separation between 2 neighboring hopping frequencies.

5. Repeat above 1~3 points for the middle and highest channel of the EUT.

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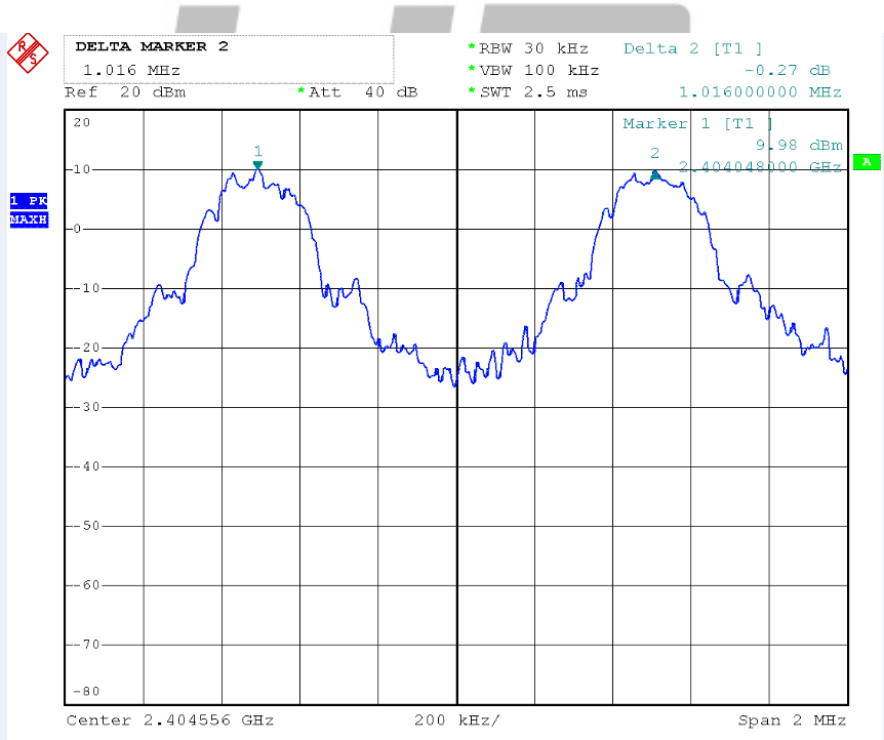
6.5 Test Result

Temperature (℃) : 22~23	EUT: 2.4GHz Radio Controller
Humidity (%RH): 50~54	M/N: X-8E
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

Modulation Type	Frequency (MHz)	Channel Separation (MHz)	Min. Limit (kHz)
FHSS	2404.056~2405.056	1.016	>25
FHSS	2440.561~2441.061	1.012	>25
FHSS	2478.595~2479.095	0.960	>25

Channel Low:



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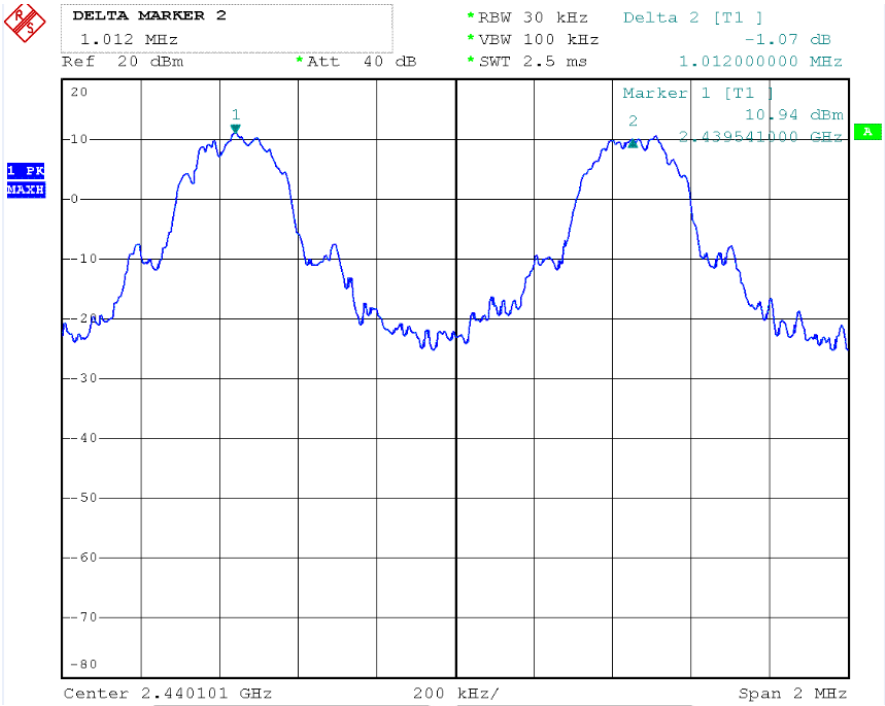
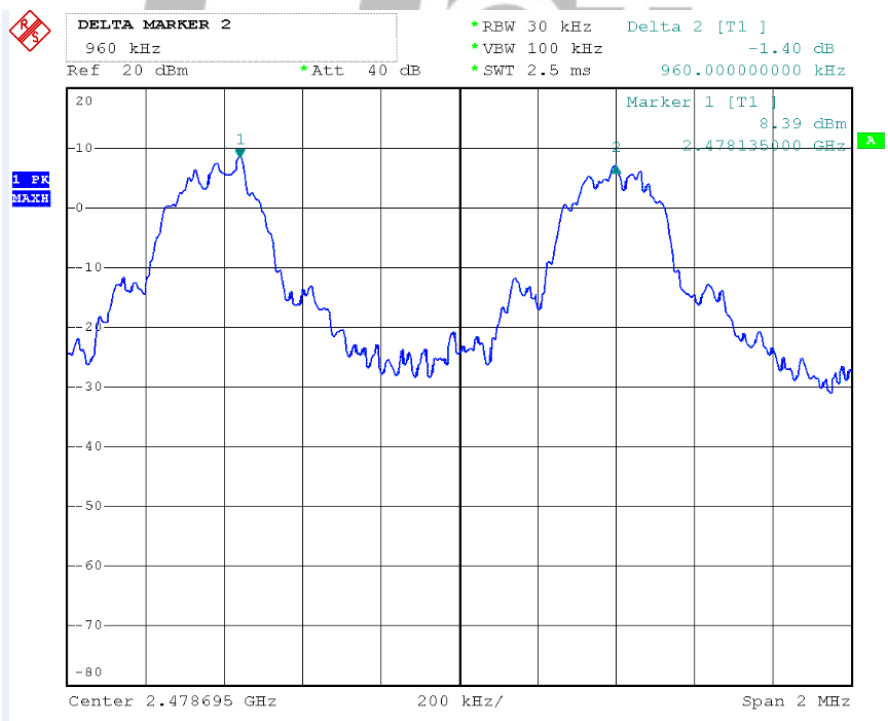
Channel Middle:



Channel High:



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7. Test of Number of Hopping Frequency

7.1 Applicable Standard

Section 15.247(a)(1)(iii): For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 15 non-overlapping hopping channels. Frequency hopping system which use fewer than 75 hopping frequencies may employ intelligent hopping techniques to avoid interference to other transmissions. Frequency hopping system may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

7.2 EUT Setup

Spectrum Analyzer

7.3 Test Equipment List and Details

See section 2.5.

7.4 Test Procedure

1. The EUT must have its hopping function enabled.
2. Use the following spectrum analyzer settings:

   Span = the frequency band of operation

   RBW ⩾ 1% of the span

   VBW ⩾ RBW

   Sweep = Auto

   Detector function = peak

   Trace = max hold
3. Observe frequency hopping in 2400MHz~2483.5MHz, there are at least 32 non-overlapping channels.
4. Repeat above 1~3 points for the middle and highest channel of the EUT.

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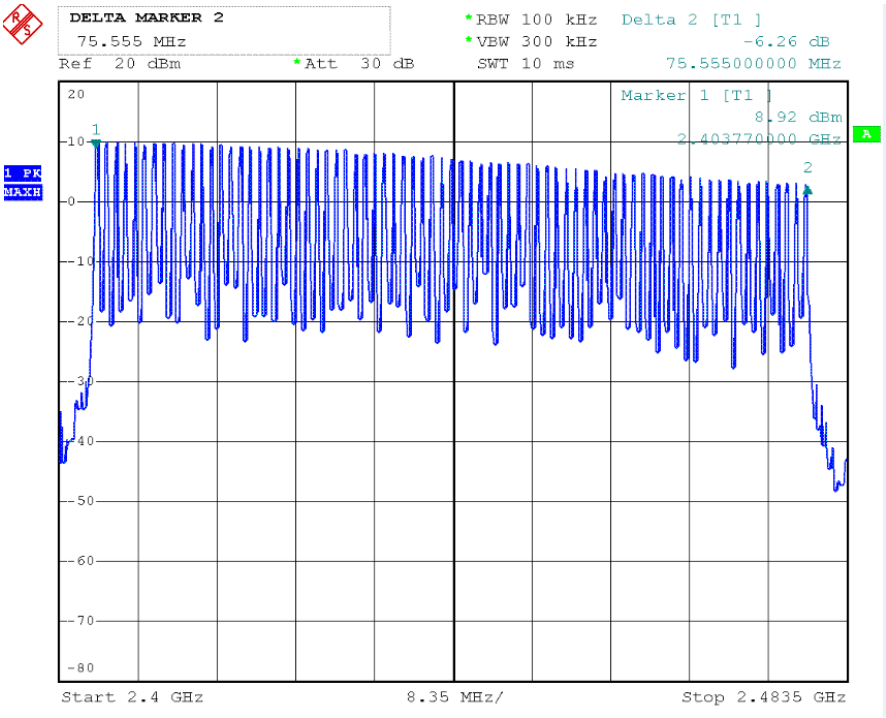
7.5 Test Result

Temperature (℃) : 22~23	EUT: 2.4GHz Radio Controller
Humidity (%RH): 50~54	M/N: X-8E
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

Modulation Type	Frequency (MHz)	Number of Hopping Channels	Min. Limit
FHSS	2404.056~2479.095	75	⩾15



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8. Test of Dwell Time of Each Frequency

8.1 Applicable Standard

Section 15.247(a)(1)(iii): For frequency hopping systems operating in the 2400-2483.5 MHz band The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4seconds multiplied by the number of hopping channels employed.

8.2 EUT Setup

Spectrum Analyzer

8.3 Test Equipment List and Details

See section 2.5.

8.4 Test Procedure

1. The EUT must have its hopping function enabled.
2. Use the following spectrum analyzer settings:

   Span = zero span, centered on a hopping channel

   RBW = 1 MHz

   VBW ⩾ RBW

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

   Detector function = peak

   Trace = max hold

3. Measure the maximum time duration of one single pulse.

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8.5 Test Result

Temperature (℃) : 22~23	EUT: 2.4GHz Radio Controller
Humidity (%RH): 50~54	M/N: X-8E
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

Test Result: PASS

Modulation Type	Channel No.	Frequency (MHz)	Dwell Time (ms)	Limit (ms)
FHSS	Low	2404.056	207.360	400
FHSS	Middle	2440.056	204.288	400
FHSS	High	2479.095	207.360	400

A period time = 0.4 (s) * 75= 30 (s)

CH Low:
N=135

Time slot =1.536
Dwell time=N*T= 135*1.536=207.36 (ms)

CH Mid:
N=133

Time slot =1.536(ms)
Dwell time=N*T= 133*1.536=204.288(ms)

CH High:
N=135

Time slot =1.92(ms)
Dwell time=N*T= 135*1.536=207.36(ms)

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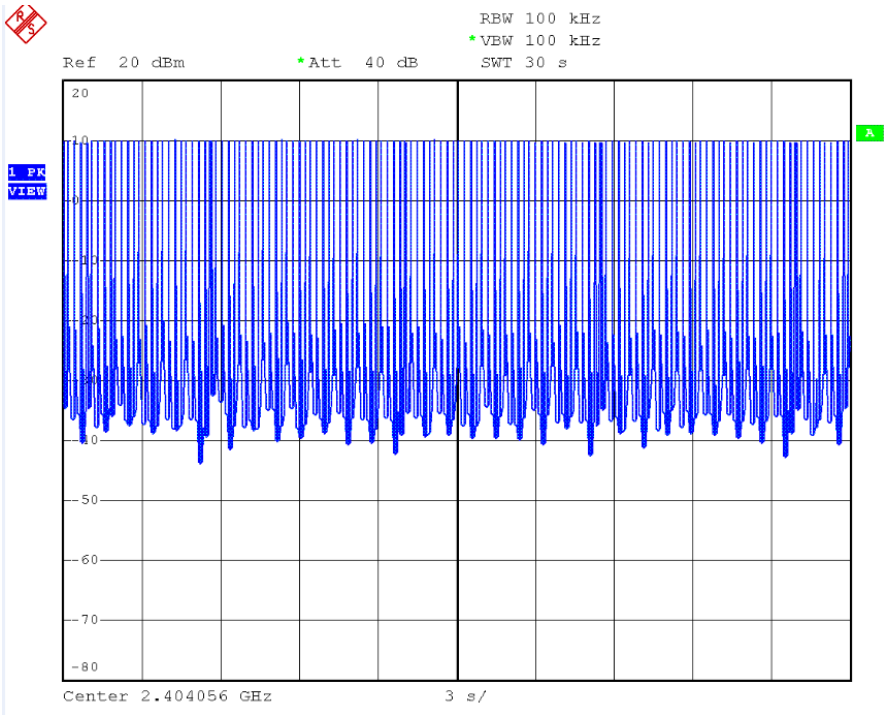
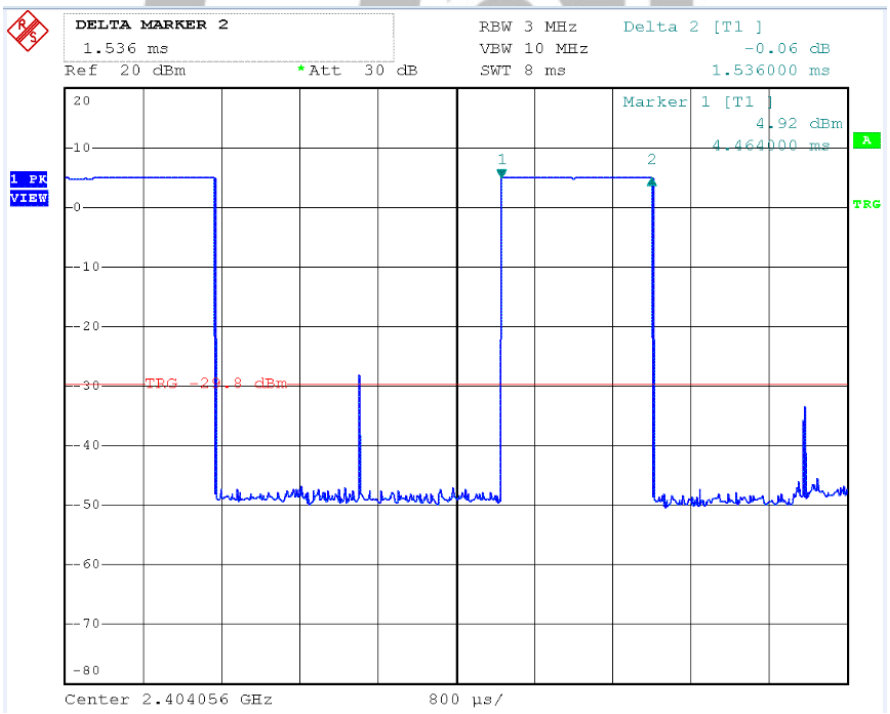
Channel Low：





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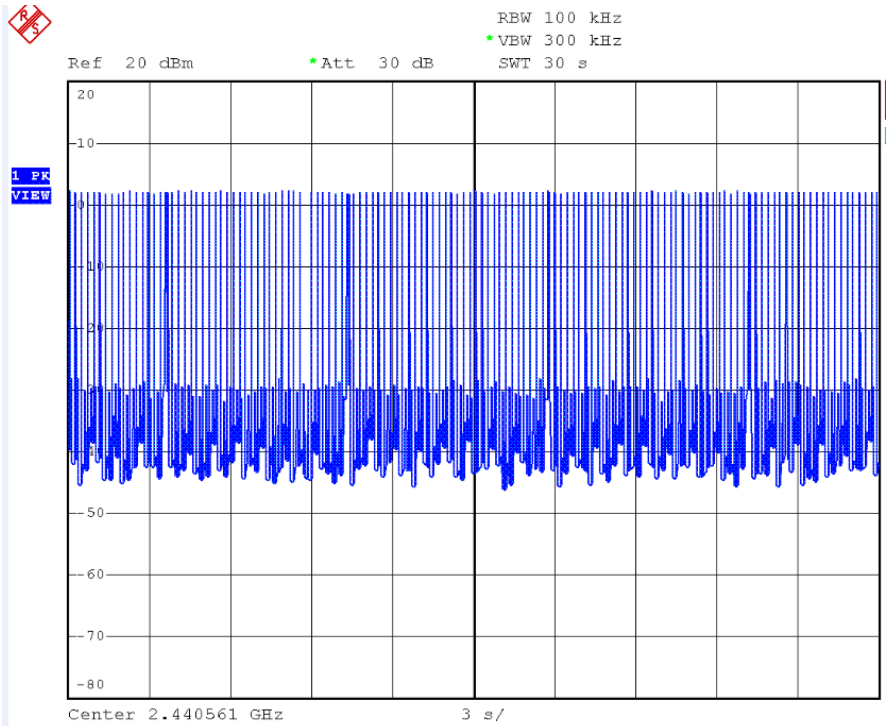
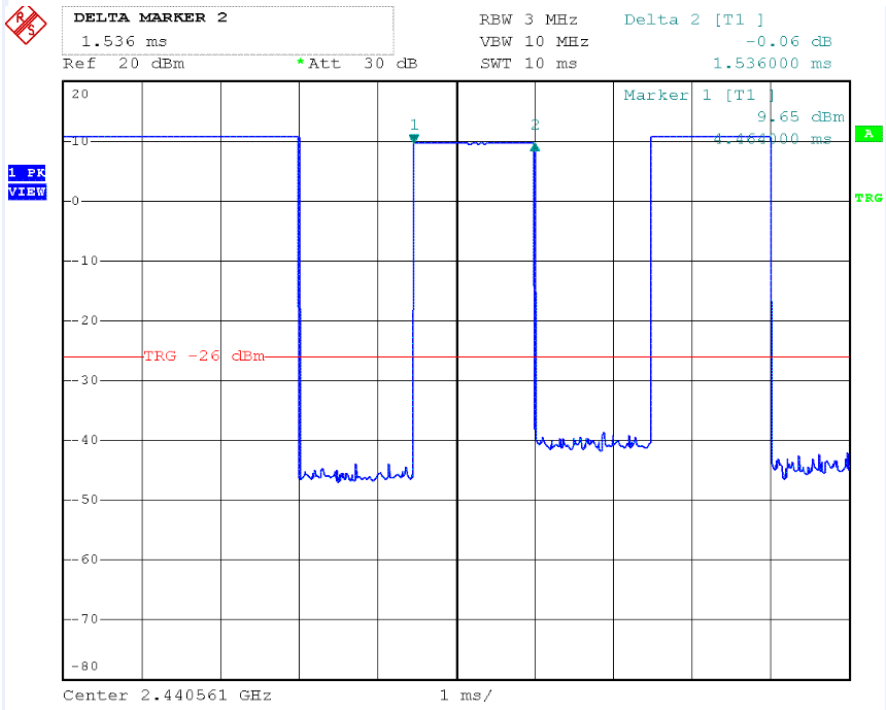
Channel Middle：





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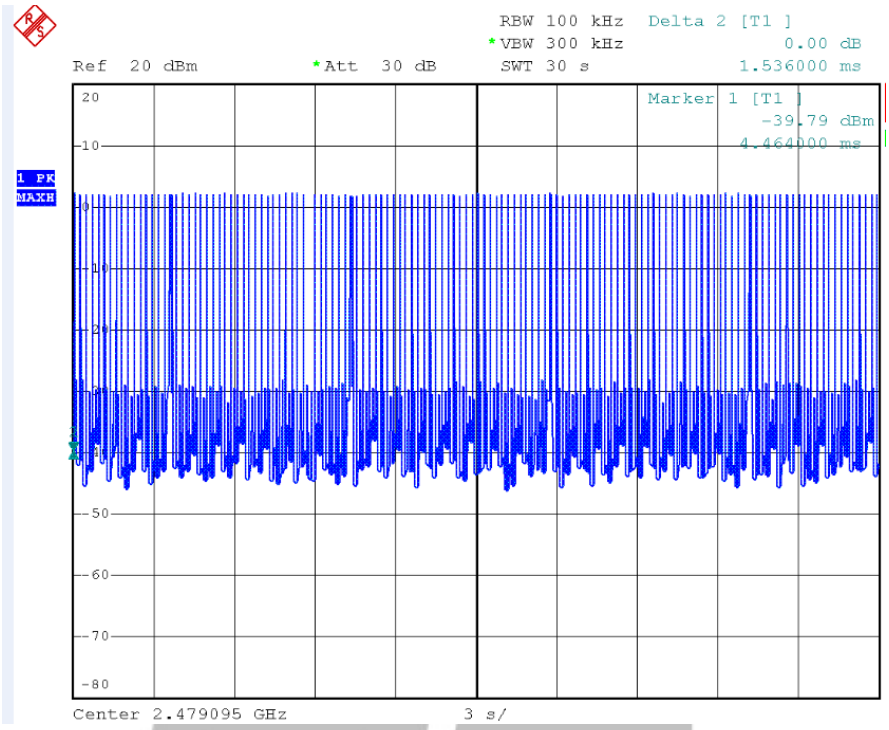
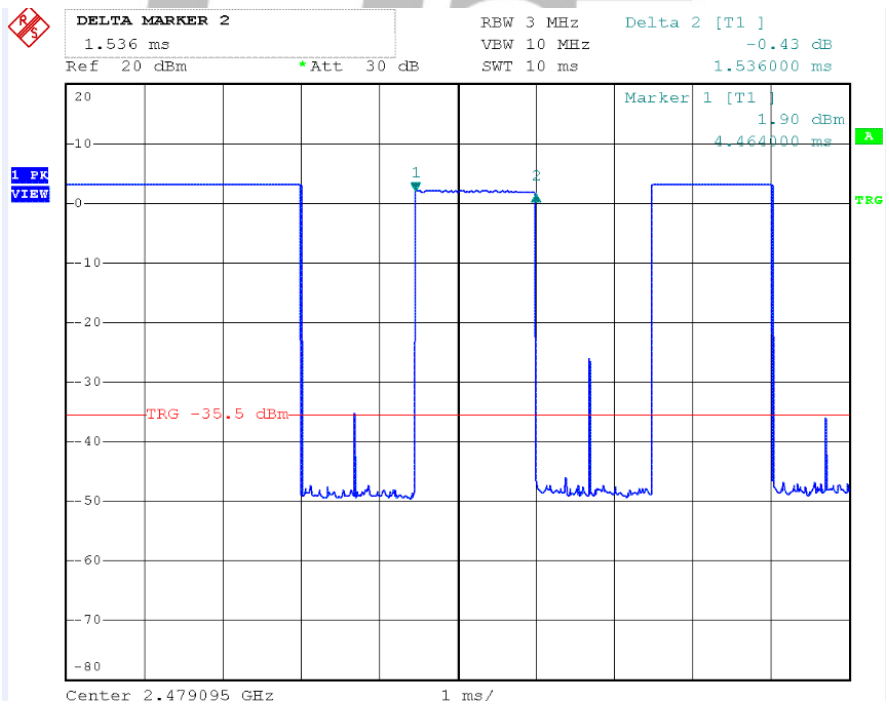
Channel High：





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9. Test of Maximum Peak Output Power

9.1 Applicable Standard

Section 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 The maximum peak output power shall not exceed 1 watt. For all other frequency hopping systems in this frequency band, The maximum peak output power shall not exceed 0.125 watt.

9.2 EUT Setup

Spectrum Analyzer

9.3 Test Equipment List and Details

See section 2.5.

9.4 Test Procedure

1. The transmitter output was connected to the peak power meter and recorded the peak value.
2. Peak power meter parameter set to auto attenuator and filter is the same as.
3. Repeated the 1 for the middle and highest channel of the EUT.

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9.5 Test Result

Temperature (℃) : 22~23	EUT: 2.4GHz Radio Controller
Humidity (%RH): 50~54	M/N: X-8E
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

Modulation Type	Channel No.	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Result
FHSS	Low	2404.056	9.35	21	Pass
FHSS	Middle	2440.561	6.53	21	Pass
FHSS	High	2479.095	2.55	21	Pass

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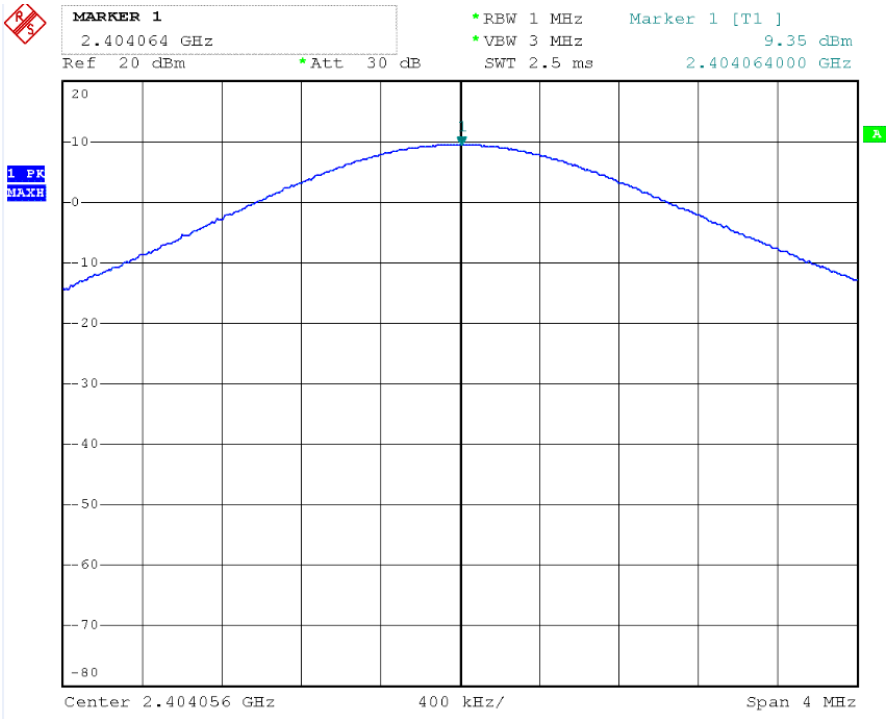
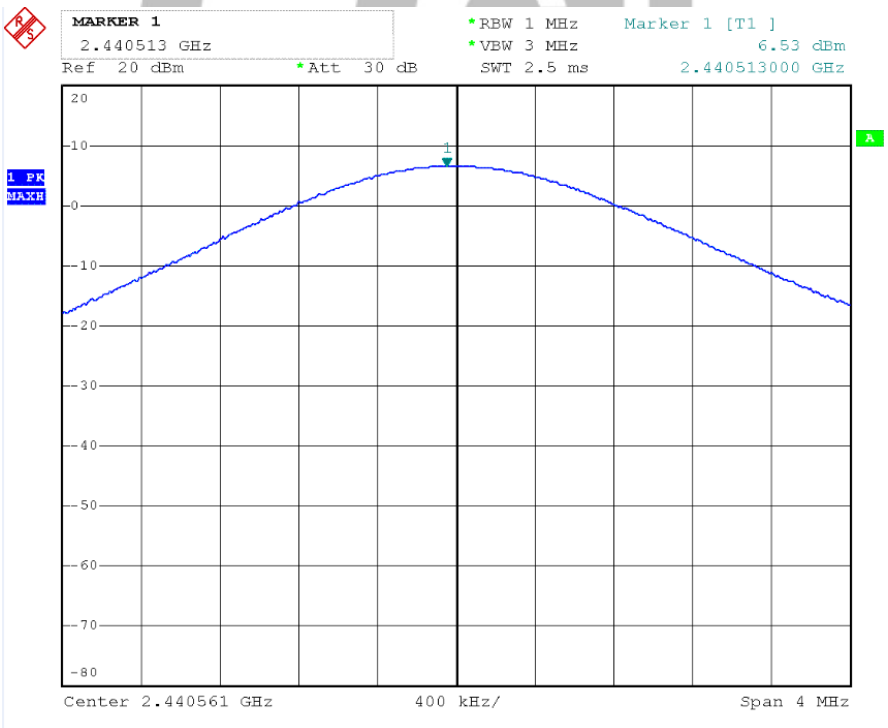
Channel Low：



Channel Middle：



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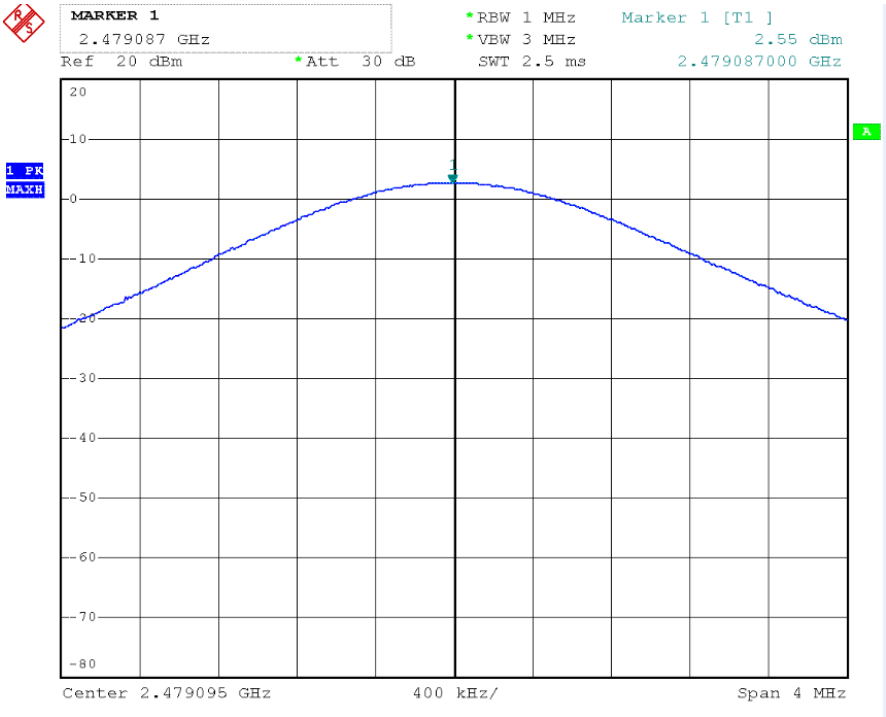
Channel High：



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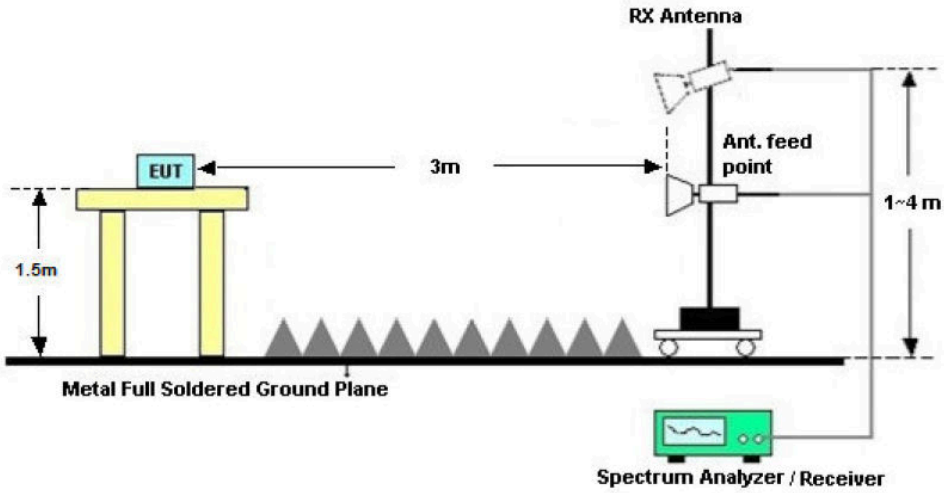
10. Test of Band Edges Emission

10.1 Applicable Standard

Section 15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions that fall in the restricted bands, as defined in Section 15.205, must also comply with the radiated emission limits specified in Section 15.209.

10.2 EUT Setup

Radiated Measurement Setup



HONGCAI TESTING

Conducted Measurement Setup

Spectrum Analyzer

10.3 Test Equipment List and Details

See section 2.5.

10.4 Test Procedure

Conducted Measurement

1. Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation.
2. Set the RBW⩾ 1% of the span
3. Set the VBW ≥ RBW.
4. Detector = peak.

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5. Sweep time = auto
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level.

Radiated Measurement

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest

2. Set RBW = 1 MHz for f ⩾ 1 GHz, 100 kHz for f < 1 GHz

3. Set VBW ⩾ RBW

4. Detector = Peak

5. Trace Mode = max hold.

6. Sweep = auto couple.

7. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest

2. Set RBW = 1 MHz for f ⩾ 1 GHz, 100 kHz for f < 1 GHz

3. Set VBW ⩾ RBW

4. Detector = power average (RMS)

5. Sweep = auto couple.

6. Trace (RMS) averaging was performed over at least 100 traces

NOTE :

1. Configure the EUT according to ANSI C63.10-2013

2. The turntable was rotated by 360 degrees to determine the position of the highest radiation.

3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of both horizontal and vertical polarization.

4. For band edge emission, the antenna tower was scan (from 1 M to 4 M) and then the turn table was rotated (from 0 degree to 360 degrees) to find the maximum reading.

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10.5 Test Result

Temperature (℃) : 22~23	EUT: 2.4GHz Radio Controller
Humidity (%RH): 50~54	M/N: X-8E
Barometric Pressure (mbar): 950~1000	Operation Condition: Tx Mode

Radiated Test Result

Frequency (MHz)	Antenna Polarization	Emission Read Value (dBμV/m)	Limits (dBμV/m)
2389.00	H	39.23	54
2389.00	V	40.95	54
2486.00	H	39.68	54
2486.00	V	40.12	54

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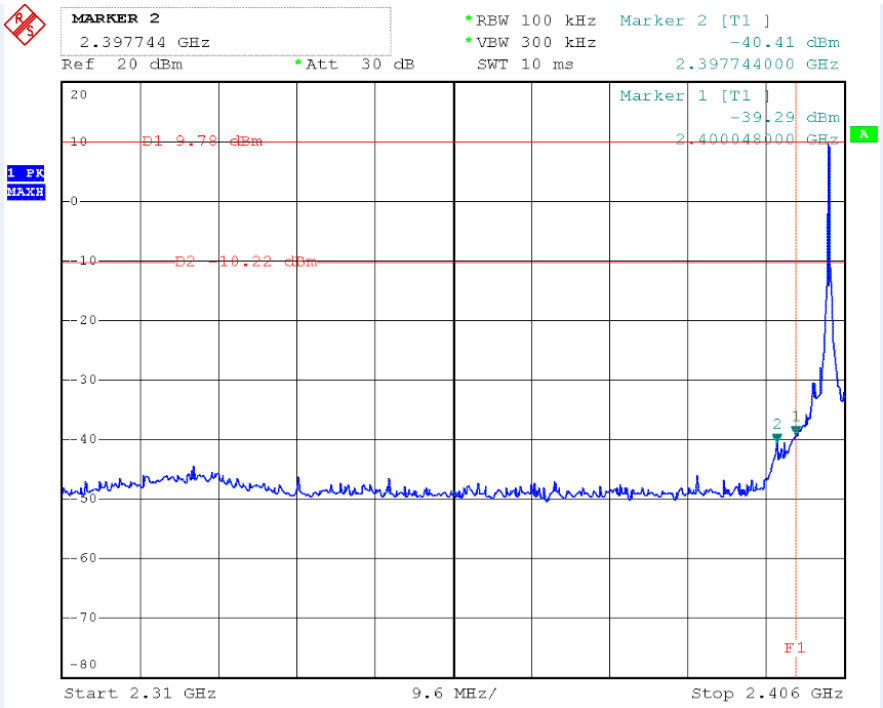
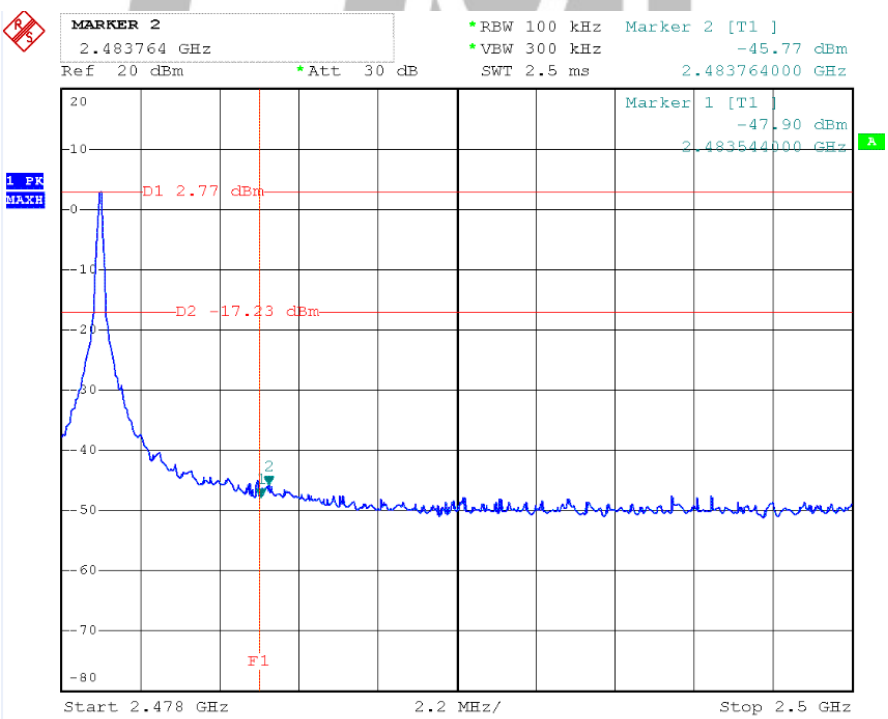
Conducted Test Result
Low Channel



High Channel



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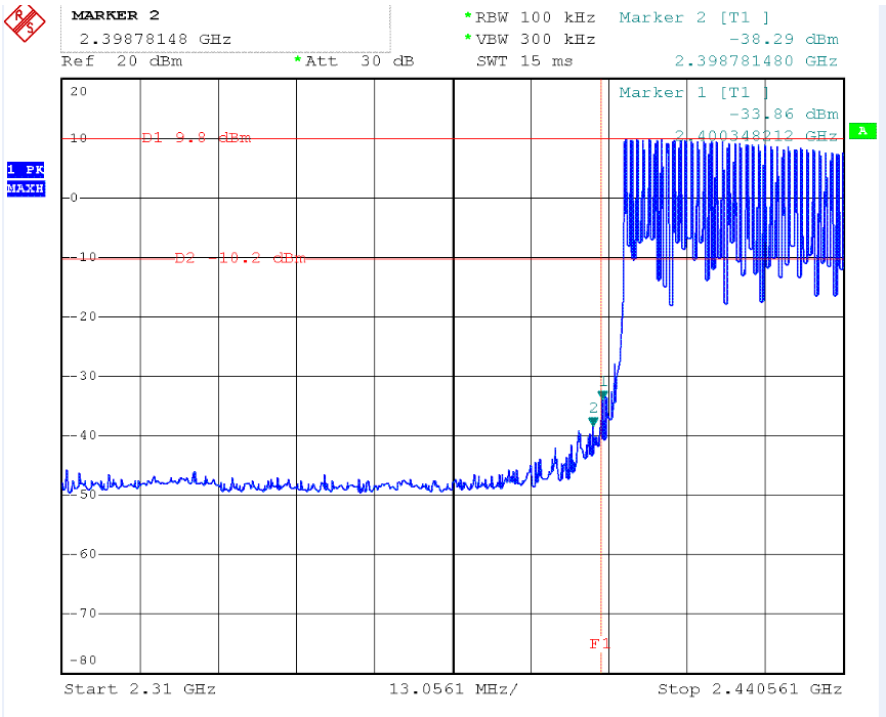
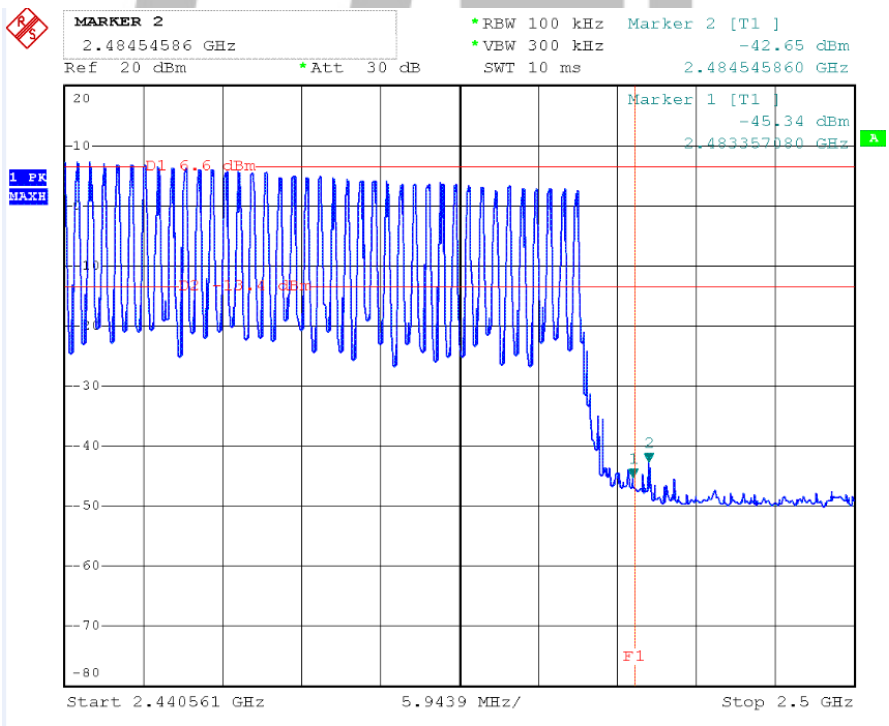
Hopping Conducted Test Result
Low Channel



High Channel



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11. Test of Spurious Radiated Emission

11.1 Applicable Standard

Refer to FCC §15.205 and §15.209.

11.1.2 Limits

Section 15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions that fall in the restricted bands, as defined in Section 15.205, must also comply with the radiated emission limits specified in Section 15.209.

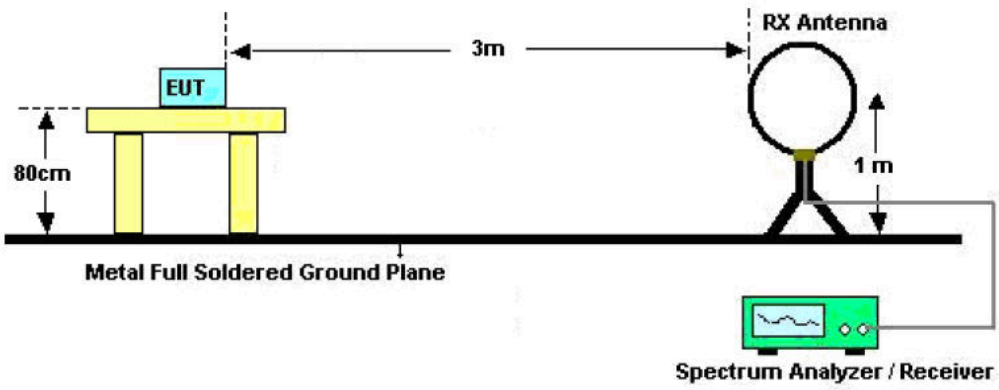
All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table per Section 15.209.

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

11.2 EUT Setup

Radiated Measurement Setup

For radiated emission below 30MHz



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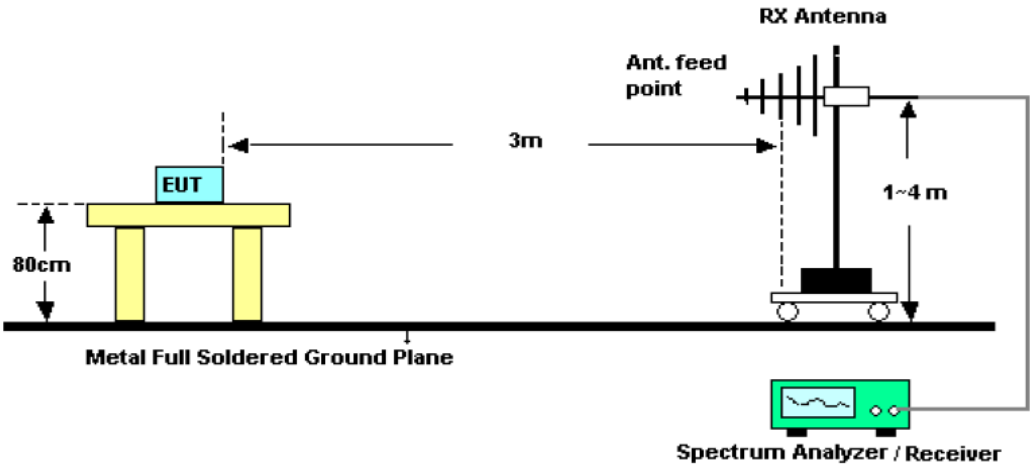
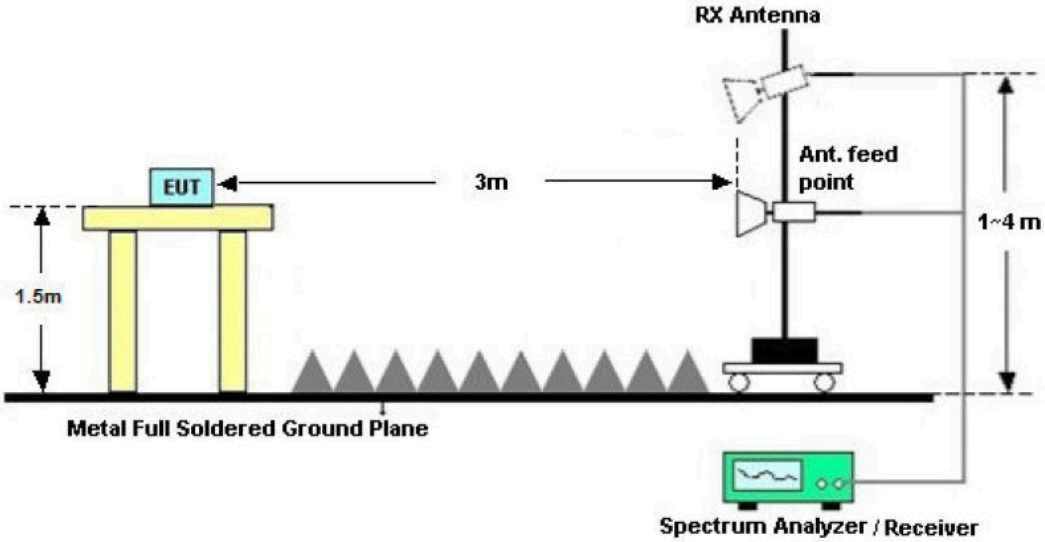
For radiated emission from 30MHz to1GHz



For radiated emission from above1GHz



Conducted Measurement Setup

Spectrum Analyzer

11.3 Test Equipment List and Details

See section 2.5.

11.4 Test Procedure

Conducted Measurement

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = 100 kHz.
3. Set the VBW ≥ RBW.

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4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level.

Radiated Measurement

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest

2. Set RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz

3. Set VBW ≥ RBW

4. Detector = Peak

5. Trace Mode = max hold.

6. Sweep = auto couple.

7. Trace was allowed to stabilize

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest

2. Set RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz

3. Set VBW ≥ RBW

4. Detector = power average (RMS)

5. Sweep = auto couple.

6. Trace (RMS) averaging was performed over at least 100 traces

NOTE: 1. Configure the EUT according to ANSI C63.10-2013

2. The turntable was rotated by 360 degrees to determine the position of the highest radiation.

3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of both horizontal and vertical polarization.

4. For band edge emission, the antenna tower was scan (from 1 M to 4 M) and then the turn table was rotated (from 0 degree to 360 degrees) to find the maximum reading.

11.5 Test Result

Temperature (℃) : 22~23	EUT: 2.4GHz Radio Controller
Humidity (%RH): 50~54	M/N: X-8E
Barometric Pressure (mbar): 950~1000	Operation Condition: TX Mode

Test Result: PASS

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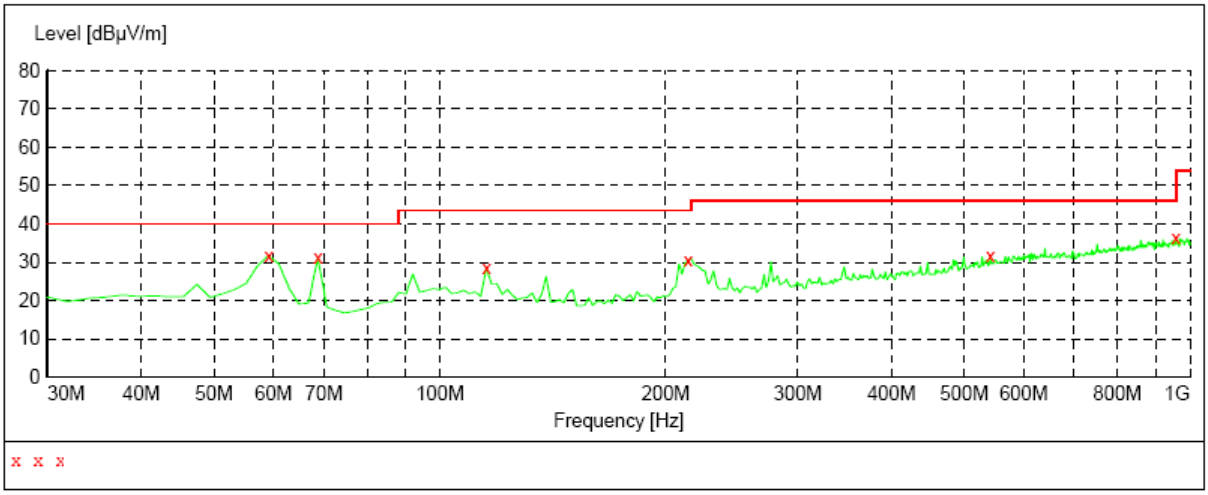
Radiated Spurious Emission Data Below 1GHz Channel Low:

EUT:	2.4GHz Radio Controller
M/N:	X-8E
Operating Condition:	TX Mode
Test Site:	3m CHAMBER
Operator:	Chen
Test Specification:	DC 4.2V from battery
Comment:	Polarization: Horizontal

SWEEP TABLE: "test (30M-1G)"

Short Description:			Field Strength		
Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
59.100000	31.70	14.6	40.0	8.3	QP	100.0	0.00	HORIZONTAL
68.800000	31.20	12.7	40.0	8.8	QP	100.0	0.00	HORIZONTAL
115.360000	28.40	15.5	43.5	15.1	QP	100.0	0.00	HORIZONTAL
214.300000	30.50	15.2	43.5	13.0	QP	100.0	0.00	HORIZONTAL
542.160000	31.60	24.8	46.0	14.4	QP	100.0	0.00	HORIZONTAL
957.320000	36.30	29.6	46.0	9.7	QP	100.0	0.00	HORIZONTAL

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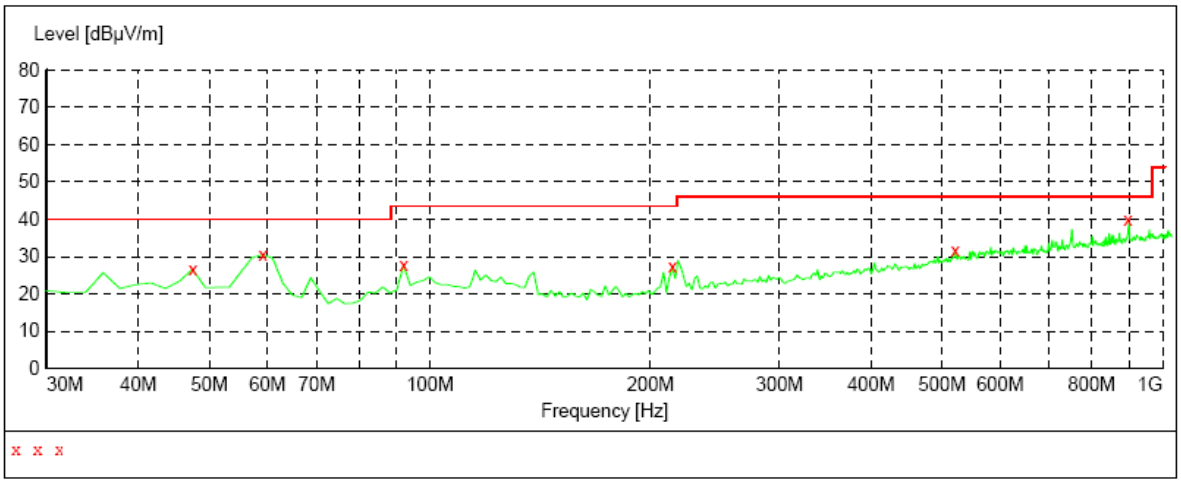
Radiated Spurious Emission Data Below 1GHz Channel Low:

EUT:	2.4GHz Radio Controller
M/N:	X-8E
Operating Condition:	TX Mode
Test Site:	3m CHAMBER
Operator:	Chen
Test Specification:	DC 4.2V from battery
Comment:	Polarization: Vertical

SWEEP TABLE: "test (30M-1G)"

Short Description: Field Strength

Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
47.460000	26.60	15.8	40.0	13.4	QP	100.0	0.00	VERTICAL
59.100000	30.50	14.6	40.0	9.5	QP	100.0	0.00	VERTICAL
92.080000	27.70	16.5	43.5	15.8	QP	100.0	0.00	VERTICAL
214.300000	27.30	15.2	43.5	16.2	QP	100.0	0.00	VERTICAL
520.820000	31.70	24.3	46.0	14.3	QP	100.0	0.00	VERTICAL
895.240000	40.60	29.1	46.0	5.4	QP	100.0	0.00	VERTICAL

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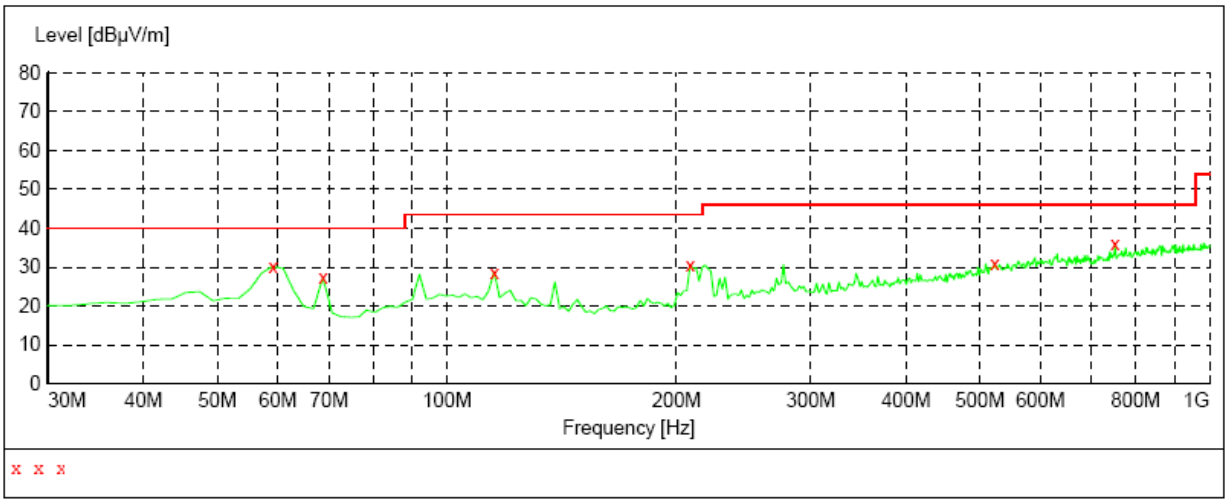
Radiated Spurious Emission Data Below 1GHz Channel Middle:

EUT:	2.4GHz Radio Controller
M/N:	X-8E
Operating Condition:	TX Mode
Test Site:	3m CHAMBER
Operator:	Chen
Test Specification:	DC 4.2V from battery
Comment:	Polarization: Horizontal

SWEEP TABLE: "test (30M-1G)"

Short Description:			Field Strength		
Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
59.100000	30.20	14.6	40.0	9.8	QP	100.0	0.00	HORIZONTAL
68.800000	27.30	12.7	40.0	12.7	QP	100.0	0.00	HORIZONTAL
115.360000	28.80	15.5	43.5	14.7	QP	100.0	0.00	HORIZONTAL
208.480000	30.70	15.1	43.5	12.8	QP	100.0	0.00	HORIZONTAL
522.760000	31.10	24.4	46.0	14.9	QP	100.0	0.00	HORIZONTAL
751.680000	35.90	27.3	46.0	10.1	QP	100.0	0.00	HORIZONTAL

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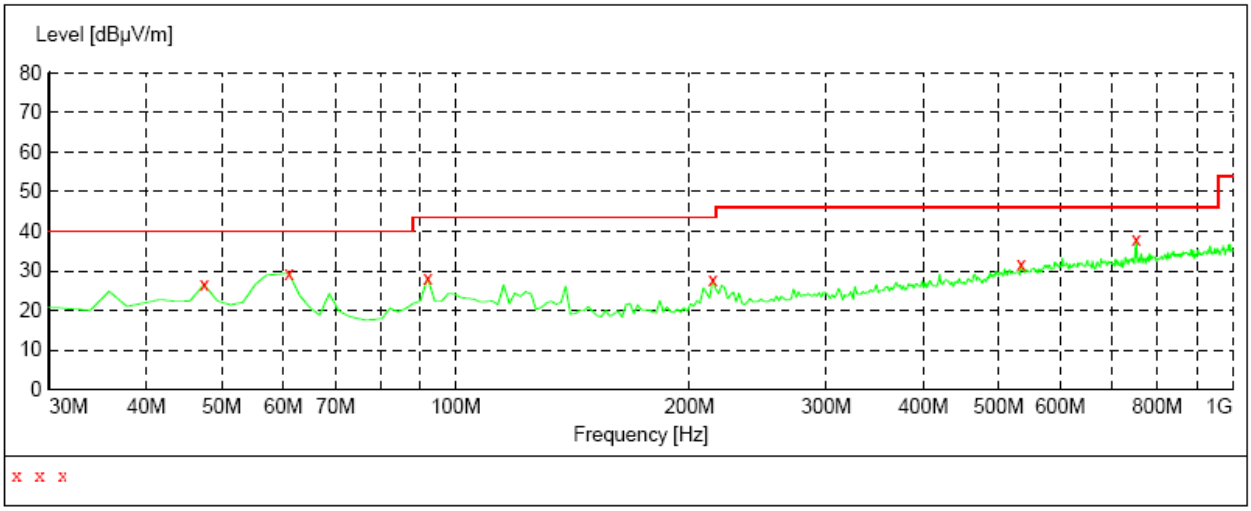
Radiated Spurious Emission Data Below 1GHz Channel Middle:

EUT:	2.4GHz Radio Controller
M/N:	X-8E
Operating Condition:	TX Mode
Test Site:	3m CHAMBER
Operator:	Chen
Test Specification:	DC 4.2V from battery
Comment:	Polarization: Vertical

SWEEP TABLE: "test (30M-1G)"

Short Description: Field Strength

Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
47.460000	26.50	15.8	40.0	13.5	QP	100.0	0.00	VERTICAL
61.040000	29.40	14.2	40.0	10.6	QP	100.0	0.00	VERTICAL
92.080000	28.30	16.5	43.5	15.2	QP	100.0	0.00	VERTICAL
214.300000	27.60	15.2	43.5	15.9	QP	100.0	0.00	VERTICAL
534.400000	31.70	24.6	46.0	14.3	QP	100.0	0.00	VERTICAL
751.680000	38.10	27.3	46.0	7.9	QP	100.0	0.00	VERTICAL

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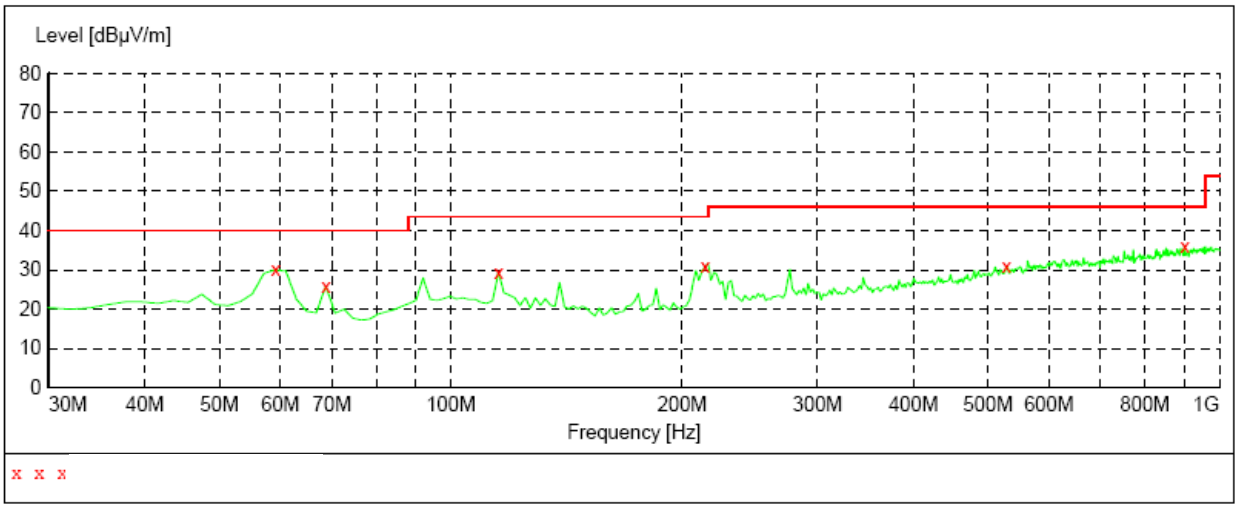
Radiated Spurious Emission Data Below 1GHz Channel High:

EUT:	2.4GHz Radio Controller
M/N:	X-8E
Operating Condition:	TX Mode
Test Site:	3m CHAMBER
Operator:	Chen
Test Specification:	DC 4.2V from battery
Comment:	Polarization: Horizontal

SWEEP TABLE: "test (30M-1G)"

Short Description: Field Strength

Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
59.100000	30.00	14.6	40.0	10.0	QP	100.0	0.00	HORIZONTAL
68.800000	25.90	12.7	40.0	14.1	QP	100.0	0.00	HORIZONTAL
115.360000	29.40	15.5	43.5	14.1	QP	100.0	0.00	HORIZONTAL
214.300000	30.80	15.2	43.5	12.7	QP	100.0	0.00	HORIZONTAL
528.580000	30.90	24.5	46.0	15.1	QP	100.0	0.00	HORIZONTAL
901.060000	36.20	29.2	46.0	9.8	QP	100.0	0.00	HORIZONTAL

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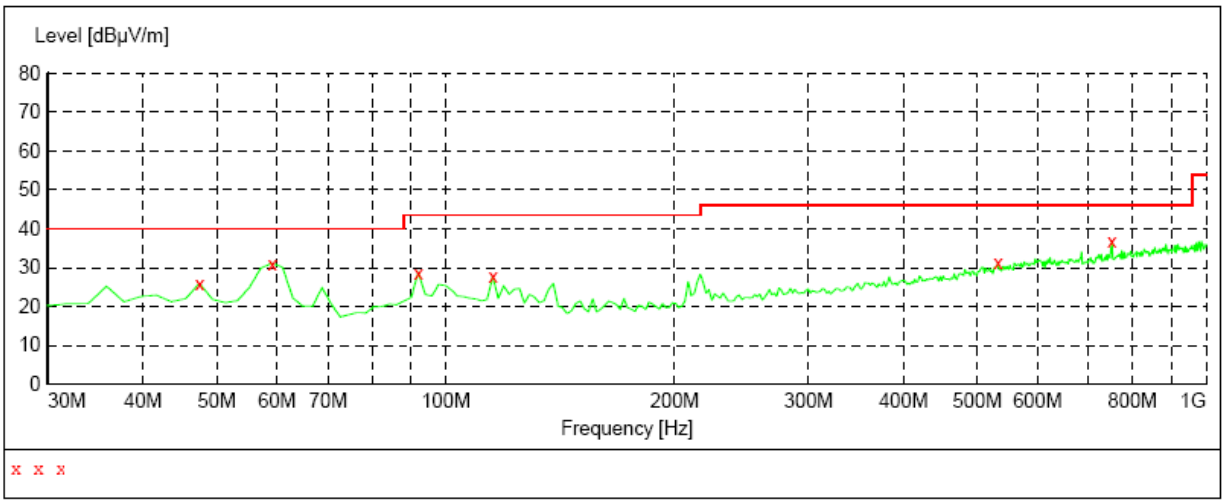
Radiated Spurious Emission Data Below 1GHz Channel High:

EUT:	2.4GHz Radio Controller
M/N:	X-8E
Operating Condition:	TX Mode
Test Site:	3m CHAMBER
Operator:	Chen
Test Specification:	DC 4.2V from battery
Comment:	Polarization: Vertical

SWEEP TABLE: "test (30M-1G)"

Short Description: Field Strength

Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	100 kHz	VULB9163 NEW



MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
47.460000	25.90	15.8	40.0	14.1	QP	100.0	0.00	VERTICAL
59.100000	31.10	14.6	40.0	8.9	QP	100.0	0.00	VERTICAL
92.080000	28.80	16.5	43.5	14.7	QP	100.0	0.00	VERTICAL
115.360000	27.80	15.5	43.5	15.7	QP	100.0	0.00	VERTICAL
532.460000	31.30	24.6	46.0	14.7	QP	100.0	0.00	VERTICAL
751.680000	36.70	27.3	46.0	9.3	QP	100.0	0.00	VERTICAL

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Radiated Spurious Emission Test Data Above 1GHz

Channel Low

Channel Low（2404.056MHz）								
Maximum Frequency (MHz)	Polarity and Level					Limit (dBμV/m)	Margin (dBμV/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dBμV	Transd	Result dBμV/m			
2404.056	H	1	96.09	-7.15	88.94	N/A	N/A	P
			90.01	-7.15	82.86	N/A	N/A	A
2404.056	V	1	97.56	-7.15	90.41	N/A	N/A	P
			91.35	-7.15	84.2	N/A	N/A	A
4808.112	H	1	43.35	1.07	44.42	74	-29.58	P
			34.03	1.07	35.1	54	-18.9	A
4808.112	V	1	45.64	1.07	46.71	74	-27.29	P
			34.75	1.07	35.82	54	-18.18	A
7205	H	1	43.02	7.38	50.4	74	-23.6	P
			33.15	7.38	40.53	54	-13.47	A
7205	V	1	46.15	7.38	53.53	74	-20.47	P
			34.53	7.38	41.91	54	-12.09	A
9613.33	H	1	44.31	10.29	54.6	74	-19.4	P
			33.62	10.29	43.91	54	-10.09	A
9613.33	V	1	45.34	7.38	52.72	74	-21.28	P
			33.95	7.38	41.33	54	-12.67	A
12021.67	H	1	44.75	14.01	58.76	74	-15.24	P
			34.34	14.01	48.35	54	-5.65	A
12021.67	V	1	45.62	14.01	59.63	74	-14.37	P
			34.19	14.01	48.2	54	-5.8	A
2404.056	H	1	96.09	-7.15	88.94	N/A	N/A	P

Remark: 1. Transd.=Antenna Factor+Cable Loss-Pre-amplifier
Margin = Level-Limit
Mark: P means Peak Value, Q means Quasi Peak Value, A means Average Value
2. Data of measurement within this frequency range shown " -" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
3. Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz, A(Average): RBW=1MHz, VBW=3MHz.
4. The test limit distance is 3m limit

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Channel Mid

Channel Mid（2440.561MHz）								
Maximum Frequency (MHz)	Polarity and Level					Limit (dBμV/m)	Margin (dBμV/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dBμV	Transd	Result dBμV/m			
2438.533	H	1	95.35	-6.37	88.98	N/A	N/A	P
			90.15	-6.37	83.78	N/A	N/A	A
2438.533	V	1	97.56	-6.37	91.19	N/A	N/A	P
			91.2	-6.37	84.83	N/A	N/A	A
4877.066	H	1	41.16	1.07	42.23	74	-31.77	P
			33.15	1.07	34.22	54	-19.78	A
4877.066	V	1	41.02	1.07	42.09	74	-31.91	P
			33.09	1.07	34.16	54	-19.84	A
7318.33	H	1	42.56	7.49	50.05	74	-23.95	P
			33.65	7.49	41.14	54	-12.86	A
7318.33	V	1	43.54	7.49	51.03	74	-22.97	P
			33.64	7.49	41.13	54	-12.87	A
9755	H	1	44.16	10.47	54.63	74	-19.37	P
			33.45	10.47	43.92	54	-10.08	A
9755	V	1	45.5	10.47	55.97	74	-18.03	P
			33.89	10.47	44.36	54	-9.64	A
12191.67	H	1	46.159	14.1	60.259	74	-13.741	P
			32.98	14.1	47.08	54	-6.92	A
12191.67	V	1	46.12	14.1	60.22	74	-13.78	P
			33.4	14.1	47.5	54	-6.5	A
25380.37	----	----	----	----	----	----	----	----

Remark: 1. Transd.=Antenna Factor+Cable Loss-Pre-amplifier
Margin = Level-Limit
Mark: P means Peak Value, Q means Quasi Peak Value, A means Average Value
2. Data of measurement within this frequency range shown " -" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
3. Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz, A(Average): RBW=1MHz, VBW=3MHz.
4. The test limit distance is 3m limit

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Channel High

Channel High（2479.095MHz）								
Maximum Frequency (MHz)	Polarity and Level					Limit (dBμV/m)	Margin (dBμV/m)	Mark (P/Q/A)
	Polarity	Height (m)	Reading dBμV	Transd	Result dBμV/m			
2474.025	H	1	94.55	-6.05	88.5	N/A	N/A	P
			89.12	-6.05	83.07	N/A	N/A	A
2474.025	V	1	96.11	-6.05	90.06	N/A	N/A	P
			90.02	-6.05	83.97	N/A	N/A	A
4948.05	H	1	42.08	1.07	43.15	74	-30.85	P
			33.72	1.07	34.79	54	-19.21	A
4948.5	V	1	43.14	1.07	44.21	74	-29.79	P
			33.36	1.07	34.43	54	-19.57	A
7431.67	H	1	43.98	7.61	51.59	74	-22.41	P
			33.02	7.61	40.63	54	-13.37	A
7431.67	V	1	45.15	7.61	52.76	74	-21.24	P
			33.78	7.61	41.39	54	-12.61	A
9896.67	H	1	43.12	10.65	53.77	74	-20.23	P
			34.39	10.65	45.04	54	-8.96	A
9896.67	V	1	46.01	10.65	56.66	74	-17.34	P
			34.12	10.65	44.77	54	-9.23	A
12361.67	H	1	44.14	14.19	58.33	74	-15.67	P
			33.31	14.19	47.5	54	-6.5	A
12361.67	V	1	45.29	14.19	59.48	74	-14.52	P
			33.05	14.19	47.24	54	-6.76	A
25380.37	----	----	----	----	----	----	----	----

Remark: 1. Transd.=Antenna Factor+Cable Loss-Pre-amplifier
Margin = Level-Limit
Mark: P means Peak Value, Q means Quasi Peak Value, A means Average Value
2. Data of measurement within this frequency range shown " -" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
3. Spectrum analyzer setting P(Peak): RBW=1MHz, VBW=3MHz, A(Average): RBW=1MHz, VBW=3MHz.
4. The test limit distance is 3m limit

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Radiated Emission Below 30 MHz TX (CH Low)

Frequency (MHz)	Read Level (dBuV)	Antenna Factor (dB/m)	Cable Loss (dB)	Emission Levels (dBuV/m)	Limit (dBμV/m)	Margin (dB)	Detector Mode
0.566	25.51	8.22	-1.01	32.72	72.5	-39.78	QP
18.99	24.54	8.17	-1.2	31.51	69.5	-37.99	QP
23.62	24.58	8.03	-1.05	31.56	69.5	-37.94	QP
24.66	25.55	7.48	-1.69	31.34	69.5	-38.16	QP

Note:

1. The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos. The worst case data is recorded in the report.
2. Emission level (dBuV/m) =Raw Value (dBuV) + Correction Factor (dB/m)
3. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
4. The other emission levels were very low against the limit.
5. Margin value = Emission level.- Limit value

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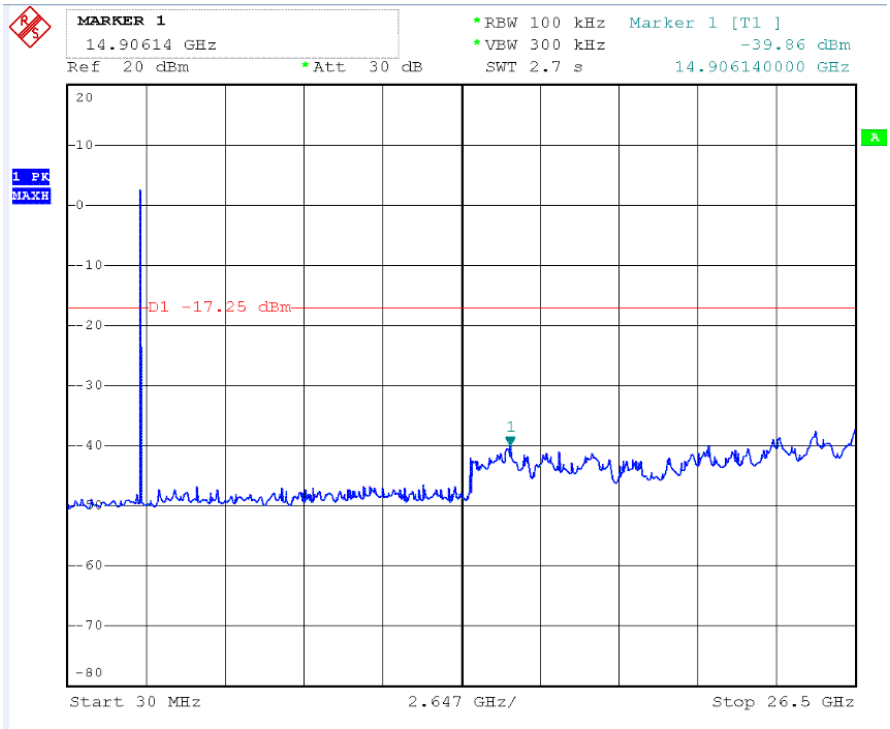
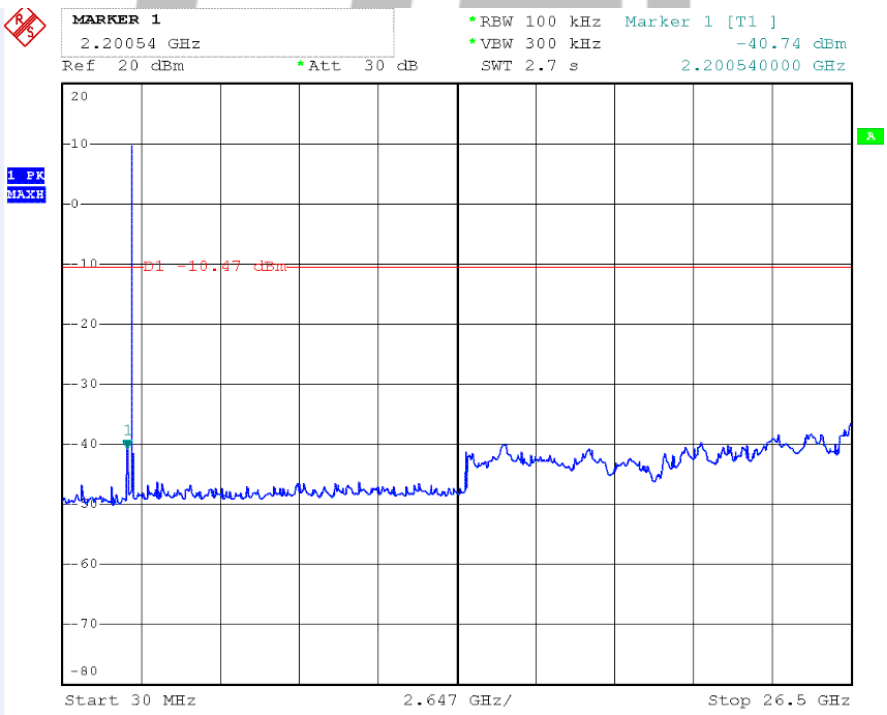
Conducted Spurious Emission Test Data 30MHz-26.5GHz
Channel Low



Channel Mid



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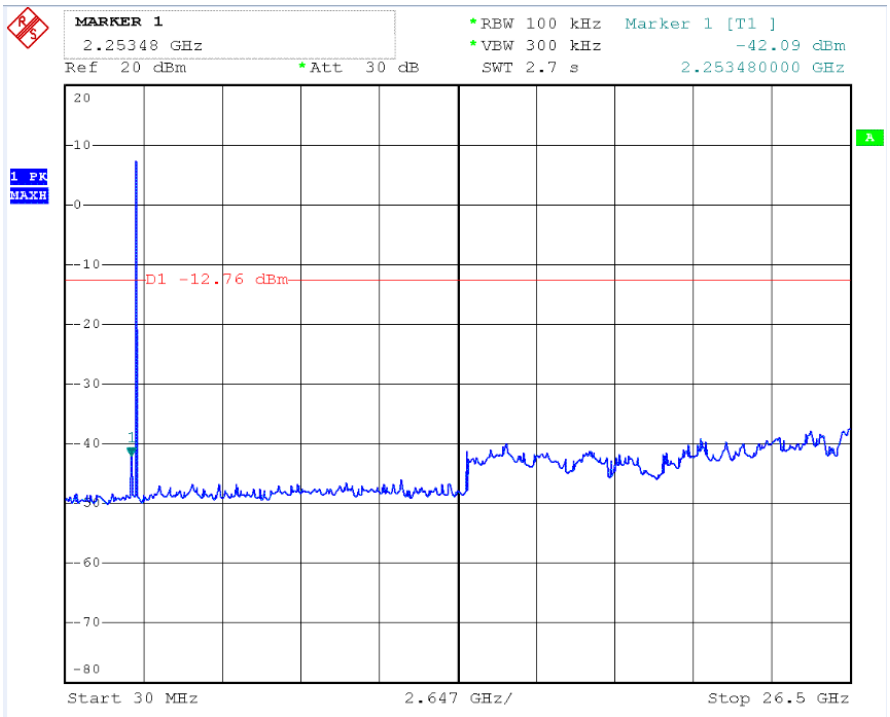
Channel High



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12. ANTENNA REQUIREMENT

12.1 Standard Applicable

Section 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.

Section 15.247(b)/(c):

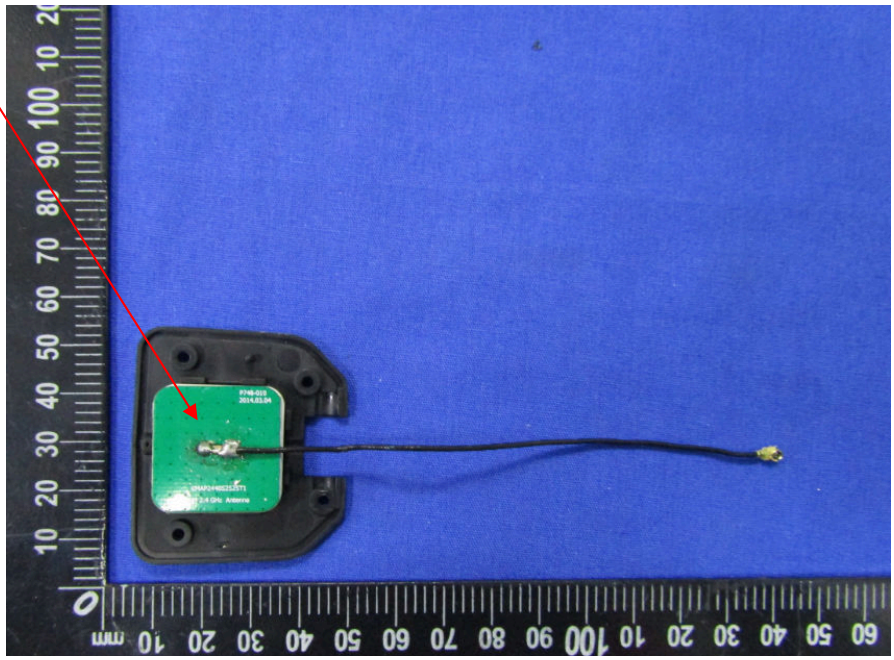
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

If the intentional radiator is used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

12.2 Antenna Connected Construction

The antenna connector is designed with permanent attachment and no consideration of replacement. The antenna used in this product is complied with Standard. The maximum Gain of the antenna lower than 6.0dBi and have the definite antenna Specification.

Antenna



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13 .Radio Frequency Exposure

13.1 Applicable Standard

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to §RSS-102, Devices that have a radiating element normally operating at separation distances greater than 20 cm between the user and the device shall undergo an RF exposure evaluation. SAR evaluation may be performed in lieu of an RF exposure evaluation for devices operating below 6 GHz with a separation distance of greater than 20 cm between the user and the device.

According to §1.1310, KDB447498 and §2.1093 RF exposure is required.

OET Bulletin 65 Supplement C [June 2001]: Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields

KDB447498 D01 General RF Exposure Guidance v06: RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices

13.2 Limit

According to KDB447498 D01 General RF Exposure Guidance v06 Section 4.3.1 Standalone SAR test exclusion considerations:"Unless specifically required by the *published RF exposure KDB procedures*, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding *SAR Test Exclusion Threshold* condition(s), listed below, is (are) satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum *test separation distance* required for the exposure conditions.28 The minimum *test separation distance* defined in 4.1 f) is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To qualify for SAR test exclusion, the *test separation distances* applied must be fully explained and justified, typically in the SAR measurement or SAR analysis report, by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, according to the required *published RF exposure KDB procedures*. When no other RF exposure testing or reporting are required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exclusion. When required, the device specific conditions described in the other *published RF exposure KDB procedures* must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops and tablets, etc.29 "

1) 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:

[(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,30 where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation31
- The result is rounded to one decimal place for comparison
- The values 3.0 and 7.5 are referred to as numeric thresholds in step b) 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.
According to KDB447498 D01 General RF Exposure Guidance v06 Appendix A: SAR Test Exclusion Thresholds for 100 MHz-6 GHz and ≤ 50 mm, Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table.

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MHz	5	10	15	20	25	mm
150	39	77	116	155	194	*SAR Test Exclusion Threshold* (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

13.3 RF Exposure

TEST RESULTS

Test Frequency (MHz)	Output Power (dBm)	Output Power including Power Drift (dBm)	Output Power including Power Drift (mW)	Separation Distance (mm)	Evaluated SAR test exclusion	SAR test exclusion thresholds	Verdict
2404.056	9.35	9.70	9.33	5	2.89	3	PASS
2440.561	6.53	6.88	4.88	5	1.52	3	PASS
2479.095	2.55	2.90	1.95	5	0.61	3	PASS

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13.4 Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1093 for the uncontrolled RF Exposure and SAR Exclusion Threshold per KDB447498 D01 General RF Exposure Guidance v06.

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