FCC/IC TEST REPORT

Test report No.:	EMC- FCC- R0173
FCC ID:	IFHLYNX4S
IC:	3420A-LYNX4S
Type of equipment:	2.4GHz Radio Control System
Basic Model Name:	LYNX 4S
Applicant:	Hitec RCD Inc.
Max.RF Output Power:	14.65 dBm
FCC Rule Part(s):	FCC Part 15 Subpart C 15.247
IC Rule:	RSS-210, RSS-GEN
Frequency Range:	2 409.2 MHz ~ 2 474.0 MHz
Test result:	Complied

The above equipment was tested by EMC compliance Testing Laboratory for compliance with the requirements of FCC Rules and Regulations.
The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Date of receipt: 2014. 06. 18

Date of test: 2014. 06. 30 ~ 07.02

Issued date: 2014. 07. 16

Tested by: AHN, BYUNG WOO

Approved by: YU, SANG HOON

65, Sinwon-ro, Yeongtong-gu, Suwon- si, Gyeonggi-do, 443-390, Korea
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[Contents]

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82-31-336-9919 (Main) 82-505-299-8311 (Fax)
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1. Client information

Applicant:	Hitec RCD Inc.
Address:	12115 Paine Street, Poway, California, 92064 USA
Telephone number:	858-748-6948
Facsimile number:	858-748-1767
Contact person:	Tony Ohm / tonyo@hitecrcd.com

Manufacturer:	Hitec RCD PHILIPPINES, INC.
Address:	Lot 6 and 8 Blk. 24, Phase 4 CEPZ, Rosario, Cavite, Philippines

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2. Laboratory information

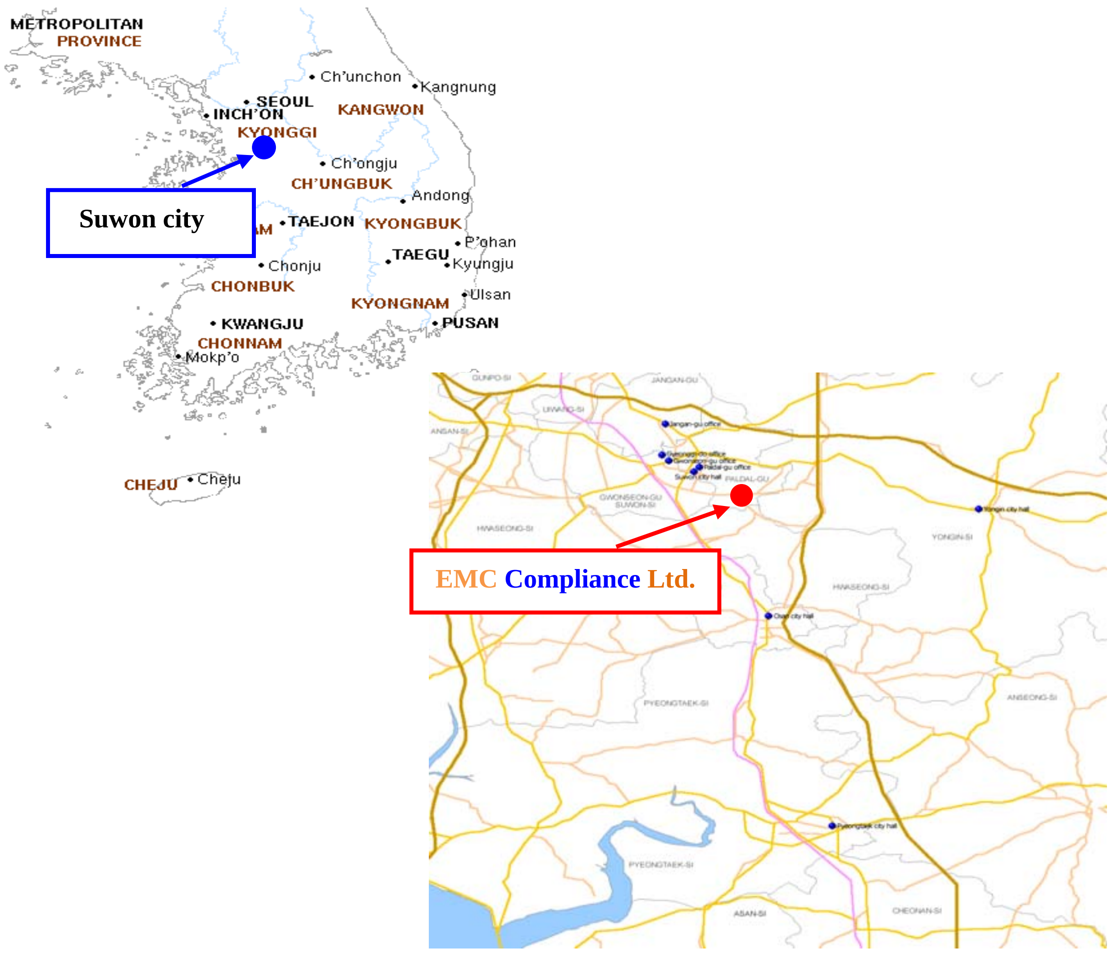
Address

EMC compliance Ltd.
65, Sinwon-ro, Yeongtong-gu, Suwon- si, Gyeonggi-do, 443-390, Korea
Telephone Number: 82-31-336-9919   Facsimile Number: 82-505-299-8311

Certificate

KOLAS No.: 231
FCC Site Registration No.: 687132
VCCI Site Registration No.: R-3327, G-198, C-3706, T-1849
IC Site Registration No.:8035A-2

SITE MAP



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3. Description of E.U.T.

3.1 Basic description

Applicant:	Hitec RCD Inc.
Address of Applicant	12115 Paine Street, Poway, California, 92064 USA
Manufacturer	Hitec RCD PHILIPPINES, INC.
Address of Manufacturer	Lot 6 and 8 Blk. 24, Phase 4 CEPZ, Rosario, Cavite, Philippines
Type of equipment	2.4GHz Radio Control System
Basic Model	LYNX 4S
Serial number	Proto Type

3.2 General description

Frequency Range	2 409.2 ㎒ ~ 2 474.0 ㎒
Type of Modulation	Modulation technologies : FHSS Modulation : GFSK
Number of Channels	21 channels
Type of Antenna	Dipole
Antenna Gain	2.39 dBi
Transmit Power	14.65 dBm
Power supply	DC 4.8 V*

* Declared by the applicant.

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3.3 Test frequency

* PROTON / AXION

	Frequency
Low frequency	2 409.2 ㎒
Middle frequency	2 441.6 ㎒
High frequency	2 474.0 ㎒

3.4 Test Voltage

mode	Voltage
Norminal voltage	DC 4.8 V

※ 15.247 Requirements for Frequency Hopping System transmitter

- This Frequency Hopping System has been tested by a Frequency Hopping System Qualification Lab, and we confirm with the following:
  1) This system is hopping pseudo-randomly.
  2) Each frequency is used equally on the average by each transmitter.
  3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
  4) The receiver shifts frequencies in synchronization with the transmitted signals.

- 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
- 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

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4. Summary of test results

4.1 Standards & results

FCC Rule	IC Rule	Parameter	Report Section	Test Result
15.203, 15.247(b)(4)	RSS-GEN, 7.1.2	Antenna Requirement	5.1	C
15.247(b)(1), (4)	RSS-210, A8.4(2)	Maximum Peak Output Power	5.2	C
15.247(a)(1)	RSS-210, A8.1(b)	Carrier Frequency Separation	5.3	C
15.247(a)(1)	RSS-210, A8.1(a)	20dB Channel Bandwidth	5.4	C
-	RSS-210, A1.1	Occupied Bandwidth	5.4	C
15.247(a)(iii) 15.247(b)(1)	RSS-210, A8.1(d)	Number of Hopping Channel	5.5	C
15.247(a) (iii)	RSS-210, A8.1(d)	Time of Occupancy(Dwell Time)	5.6	C
15.247(d), 15.205(a), 15.209(a)	RSS-210, A8.5 RSS-210, A2.9 RSS-GEN, 7.2.3	Spurious Emission, BandEdge, Restricted Band	5.7	C
15.207(a)	RSS-GEN, 7.2.4	Conducted Emissions	5.8	C

Note: C=complies
NC= Not complies
NT=Not tested
NA=Not Applicable

* The method of measurement used to test on this DSS device is FCC Public Notice DA 00-705
* The general test methods used to test on this device is ANSI C63.4 2003 (or 2009, or ANSI C63.10 2009)

4.2 Uncertainty

Measurement Item	Expanded Uncertainty U = KUc (K = 2)	
Conducted RF power	± 1.36 dB	
Occupied Bandwidth	± 2.54 kHz	
Conducted Spurious Emissions	± 1.52 dB	
Radiated Spurious Emissions	30 MHz ~ 300 MHz:	+ 4.86 dB, - 4.88 dB
	300 MHz ~ 1 000 MHz:	+ 4.98 dB, - 4.99 dB
	1 GHz ~ 6 GHz:	+ 6.19 dB, - 6.20 dB
	6 GHz ~ 25 GHz:	+ 6.41 dB, - 6.53 dB

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5. Test results

5.1 Antenna Requirement

5.1.1 Regulation

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

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.2 Result

-Complied

The transmitter has a dipole antenna. The directional gain of the antenna is 2.39 dBi.

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5.2 Maximum Peak Output Power

5.2.1 Regulation

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

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

5.2.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument (spectrum analyzer) using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 5 times the 20 ㏈ bandwidth, centered on a hopping channel RBW > the 20 ㏈ bandwidth of the emission being measured VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Measure the highest amplitude appearing on spectral display and record the level to calculate results.
6. Repeat above procedures until all frequencies measured were complete.

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5.2.3 Test Result

- Complied

* PROTON

Channel	Frequency (㎒)	Result (dBm)	Limit (dBm)	Margin (dB)
Low	2 409.2	14.65	30.00	15.35
Middle	2 441.6	13.27	30.00	16.73
High	2 474.0	11.07	30.00	18.93

* AXION

Channel	Frequency (㎒)	Result (dBm)	Limit (dBm)	Margin (dB)
Low	2 409.2	14.55	30.00	15.45
Middle	2 441.6	12.79	30.00	17.21
High	2 474.0	11.06	30.00	18.94

NOTE:
1. Since the directional gain of the integral antenna declared by the manufacturer (G_{ANT} = 2.39 dBi) does not exceed 6.0 dBi, there was no need to reduce the output power.
2. We took the insertion loss of the cable loss into consideration within the measuring instrument.

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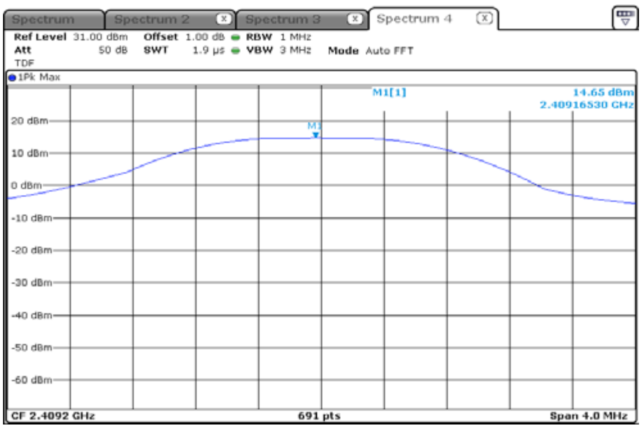
5.2.4 Test Plot

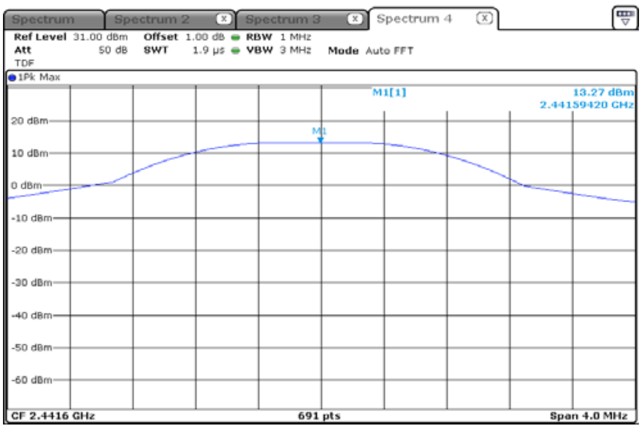
Figure 1. Plot of the Maximum Peak Output Power (Conducted)

* PROTON

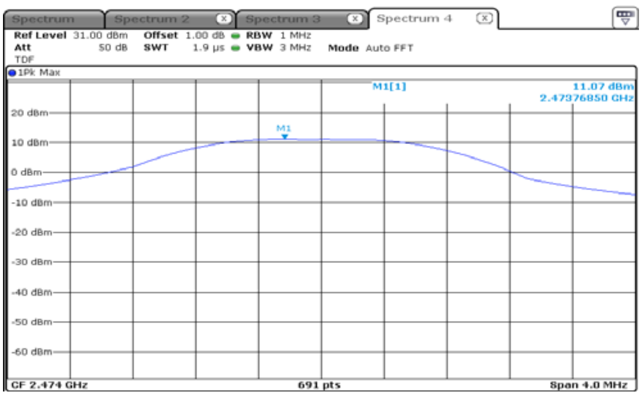
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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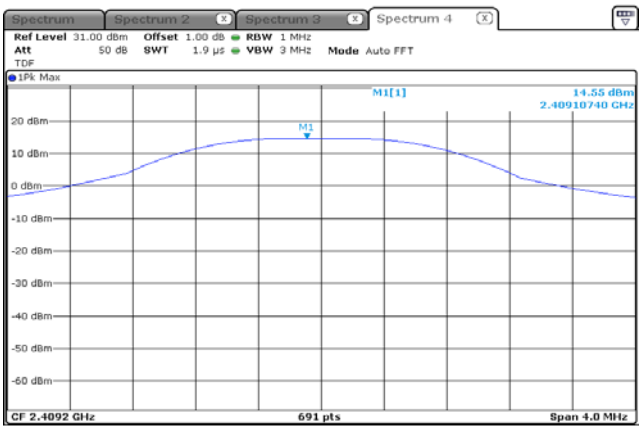
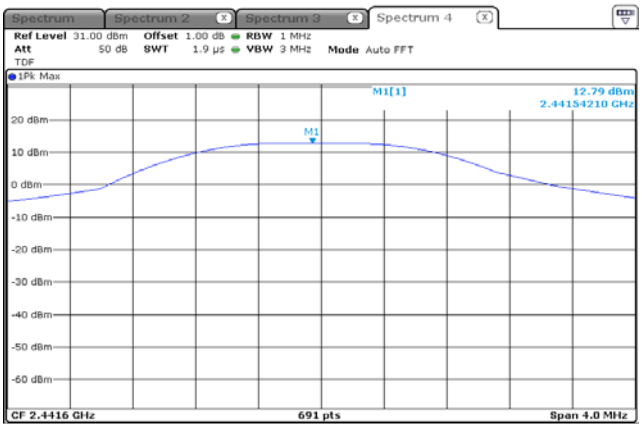
*** AXION**

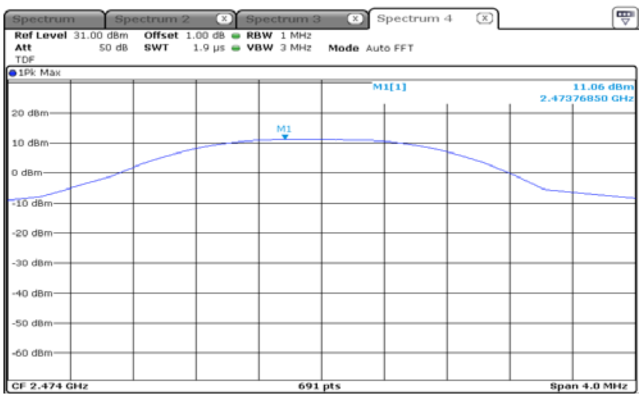
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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5.3 Carrier Frequency Separation

5.3.1 Regulation

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽

5.3.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: 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
5. Measure the separation between the peaks of the adjacent channels using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.

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5.3.3 Test Result

- Complied

* PROTON

Channel	Carrier frequency separation (㎒)	Limit
Low	1.198	≥25 kHz or two-thirds of the 20 ㏈ bandwidth
Middle	1.812	≥25 kHz or two-thirds of the 20 ㏈ bandwidth
High	5.398	≥25 kHz or two-thirds of the 20 ㏈ bandwidth

* AXION

Channel	Carrier frequency separation (㎒)	Limit
Low	1.203	≥25 kHz or two-thirds of the 20 ㏈ bandwidth
Middle	1.802	≥25 kHz or two-thirds of the 20 ㏈ bandwidth
High	5.412	≥25 kHz or two-thirds of the 20 ㏈ bandwidth

NOTE1: We took the insertion loss of the cable loss into consideration within the measuring instrument.
NOTE2: It is all separation difference due to choosing 21 channels randomly.
The min channel separation from 109 channel is 600 ㎑, and 2/3 20 ㏈ BW is less than 600 ㎑, so the selected 21 channels will always greater than 2/3 of 20 ㏈ BW.

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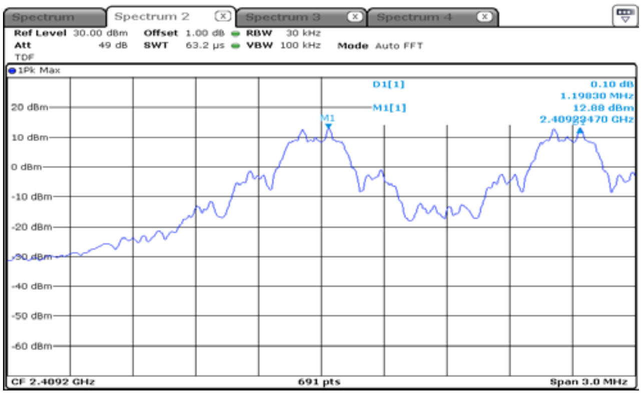
5.3.4 Test Plot

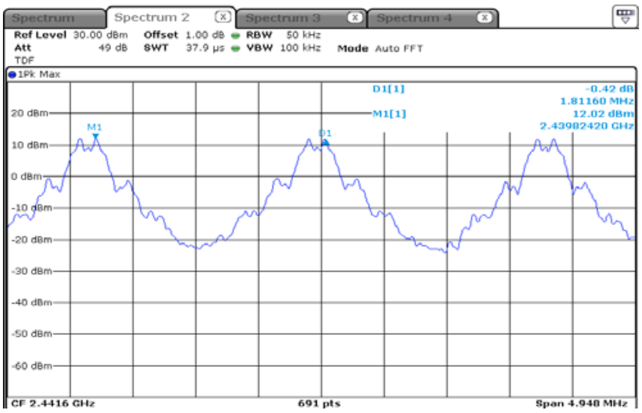
Figure 2.Plot of the Carrier Frequency Separation (Conducted)

*** PROTON**

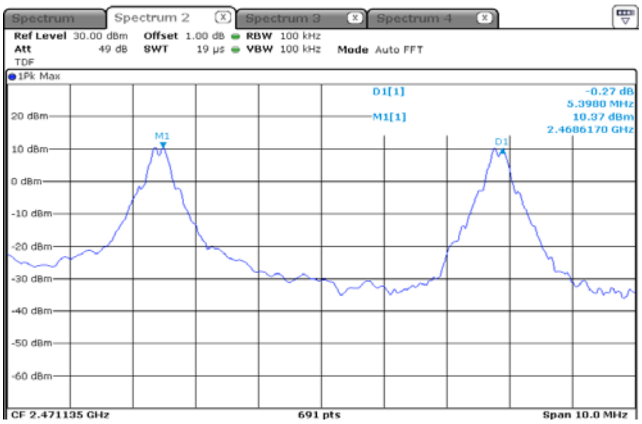
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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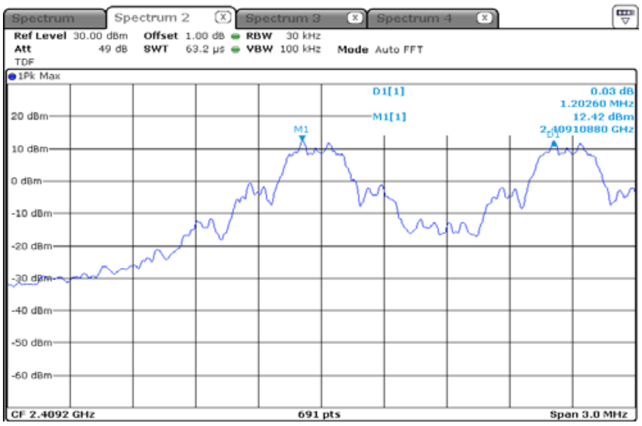
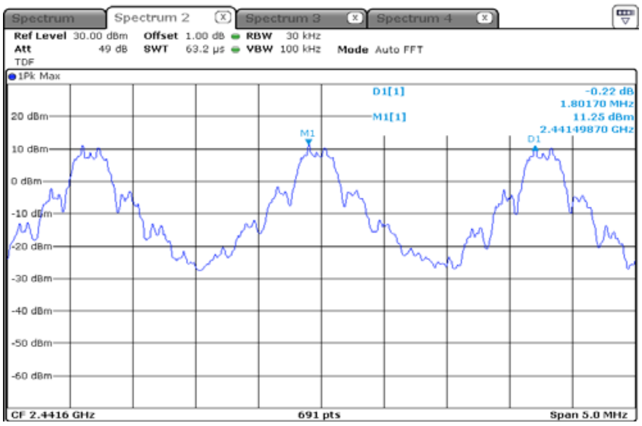
*** AXION**

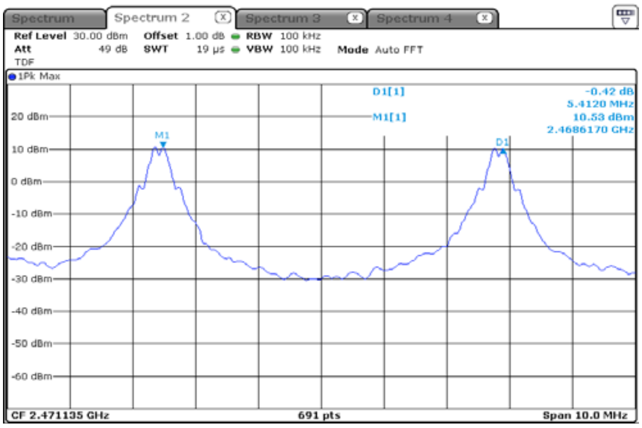
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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5.4 20 dB Channel Bandwidth

5.4.1 Regulation

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽

5.4.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 2 to 3 times the 20 ㏈ bandwidth, centered on a hopping channel RBW ≥ 1% of the 20 ㏈ bandwidth VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Set a reference level on it equal to the highest peak value.
6. Measure the frequency difference of two frequencies that were attenuated 20 ㏈ from the reference level. Record the frequency difference as the emission bandwidth.
7. Repeat above procedures until all frequencies measured were complete..

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5.4.3 Test Result

- Complied

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Channel	20 ㏈ Channel Bandwidth(㎒)	Occupied Bandwidth (99 % BW)(㎒)
Low	0.777	0.755
Middle	0.773	0.760
High	0.786	0.768

* AXION

Channel	20 ㏈ Channel Bandwidth(㎒)	Occupied Bandwidth (99 % BW)(㎒)
Low	0.777	0.755
Middle	0.777	0.747
High	0.773	0.786

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

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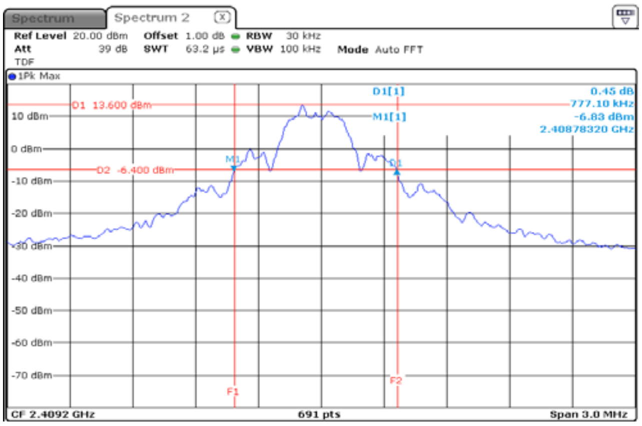
5.4.4 Test Plot

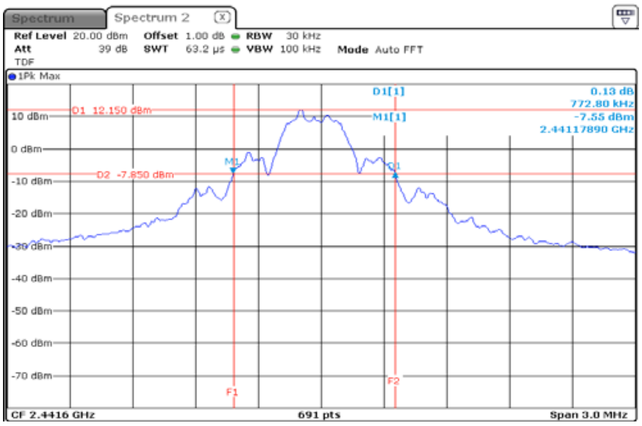
Figure 3.Plot of the 20 ㏈ Channel Bandwidth / Occupied Bandwidth (Conducted)

*** PROTON (** 20 ㏈ Channel Bandwidth)

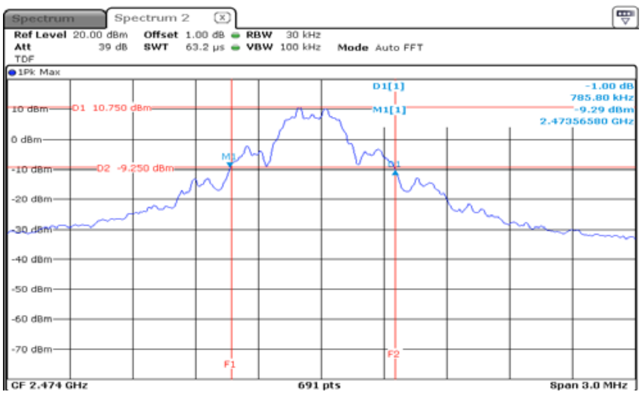
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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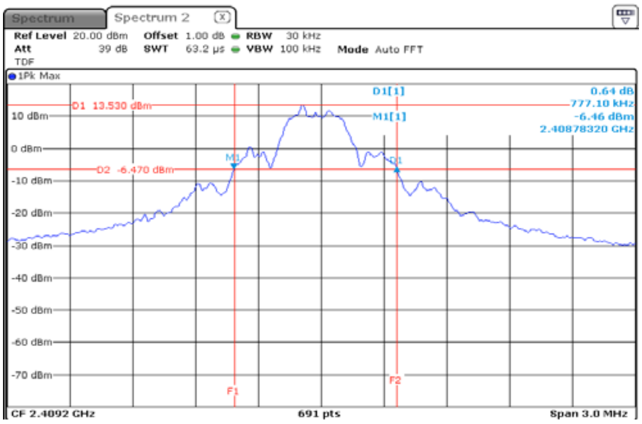
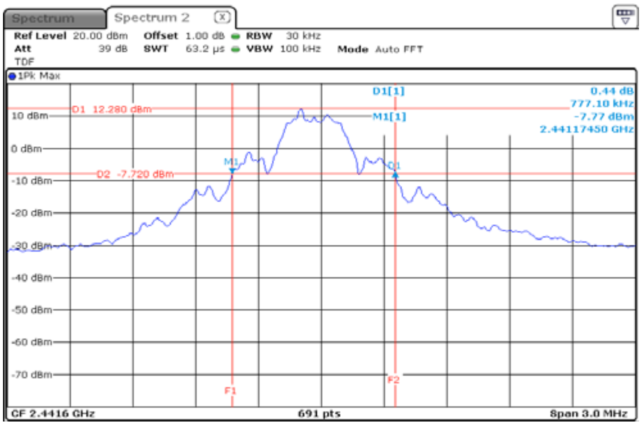
*** AXION (20 ㏈ Channel Bandwidth)**

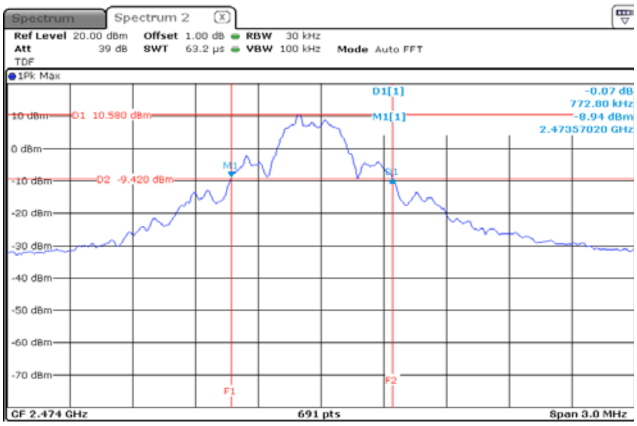
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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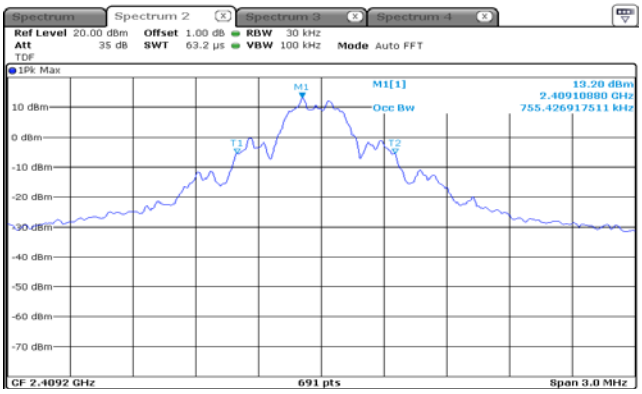
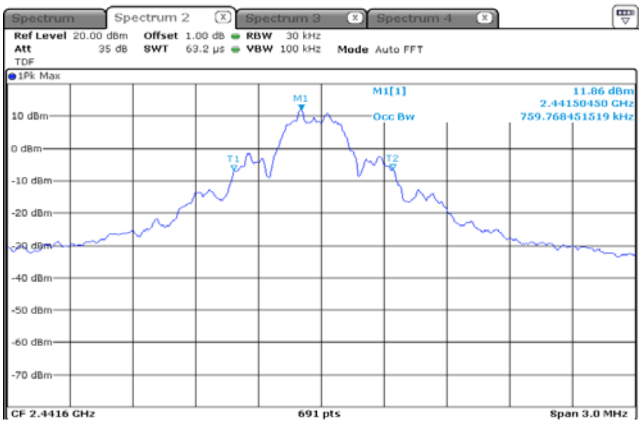
*** PROTON (Occupied Bandwidth)**

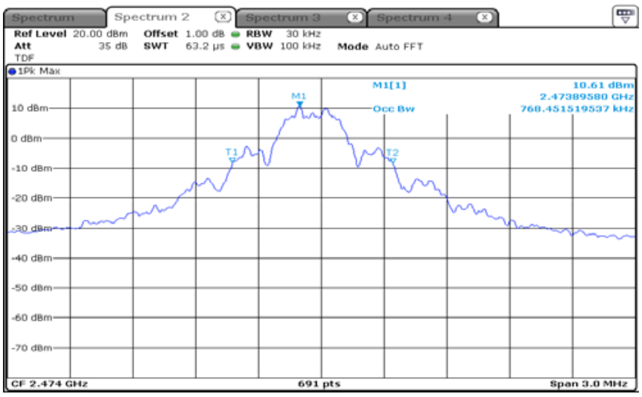
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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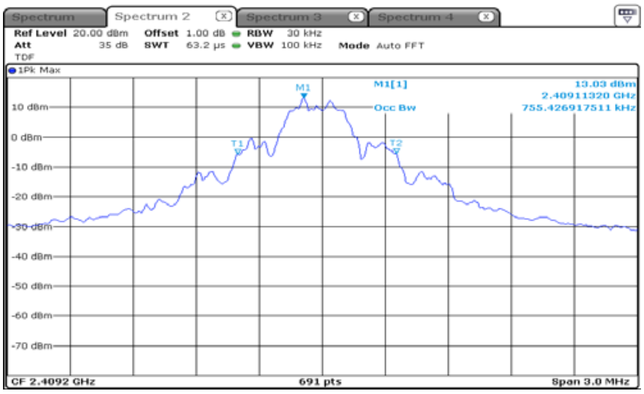
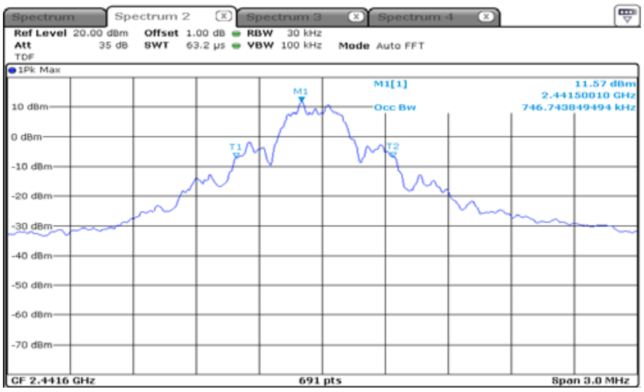
*** AXION (Occupied Bandwidth)**

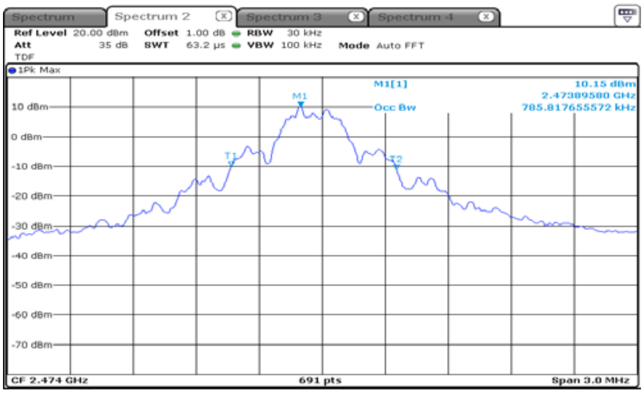
Lowest Channel
(2 409.2 ㎒)



Middle Channel
(2 441.6 ㎒)



Highest Channel
(2 474.0 ㎒)



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5.5 Number of Hopping Channels

5.5.1 Regulation

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

5.5.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set the hopping function enabled by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = the frequency band of operation RBW ≥ 1% of the span VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold
5. Record the number of hopping channels.

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5.5.3 Test Result

- Complied

* PROTON

Frequency	Number of hopping channel	Limit
2 409.2 – 2 474.0 MHz	21	≥15

* AXION

Frequency	Number of hopping channel	Limit
2 409.2 – 2 474.0 MHz	21	≥15

NOTE1: We took the insertion loss of the cable loss into consideration within the measuring instrument.

NOTE2: It can use 109 channels. In that case of TX and RX, it can choose 21 channels randomly on the most clean condition.

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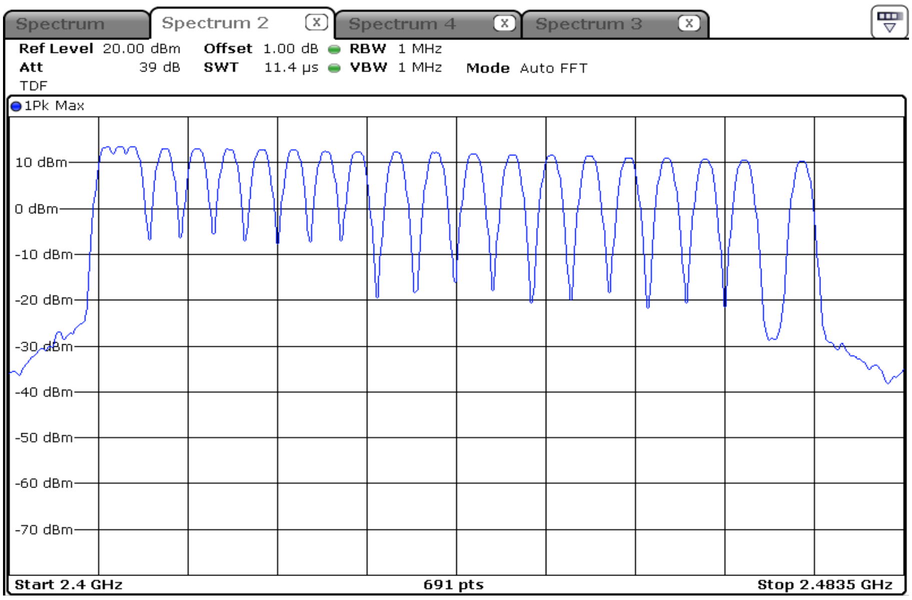
5.5.4 Test Plot

Figure 4. Plot of the Number of Hopping Channels (Conducted)

*** PROTON**



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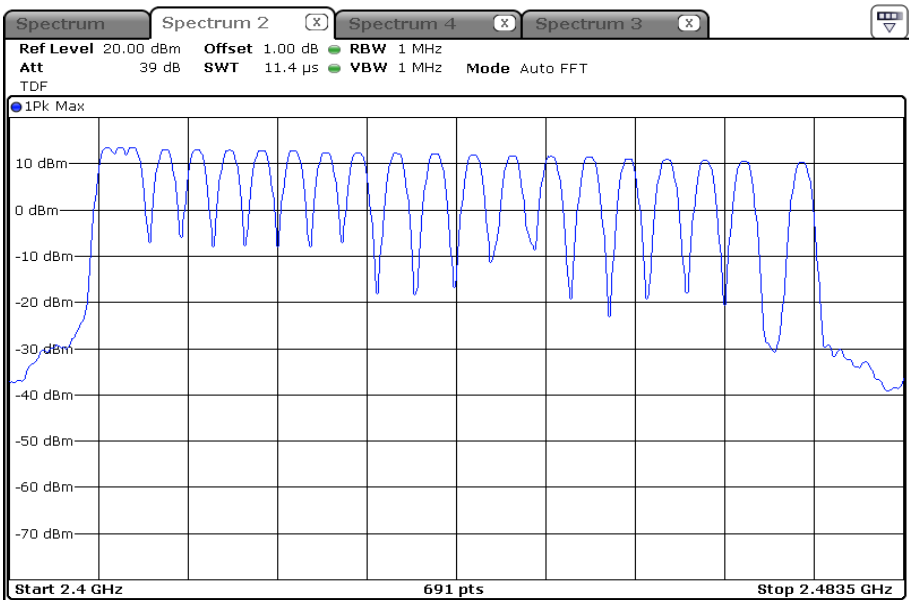
*** AXION**



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5.6 Time of Occupancy(Dwell Time)

5.6.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 ㎒ 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.

5.6.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface or Bluetooth tester.
4. Set the spectrum analyzer as follows: Span = zero span, centered on a hopping channel RBW = 1 ㎒ VBW ≥ RBW Sweep = as necessary to capture the entire dwell time per hopping channel Detector function = peak Trace = max hold
5. Measure the dwell time using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.
7. Repeat this test for different modes of operation (e.g., data rate, modulation format, etc.), if applicable.

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5.6.3 Test Result

- Complied

* PROTON

Channel	Reading[ms]	Hopping rate [hop/s]	Number of Channels	Actual[s]	Limit[s]
high	1.827	130.000	21	0.095	0.40

* AXION

Channel	Reading[ms]	Hopping rate [hop/s]	Number of Channels	Actual[s]	Limit[s]
high	1.827	280.000	21	0.205	0.40

Actual = Reading × (Hopping rate / Number of channels) × Test period
Test period = 0.4 [seconds / channel] × 21 [channel] = 8.4 [seconds]
Hopping rate : 26.000 (number of hopping during 200 ms)× 5 = 130.000 (PROTON)
28.000 (number of hopping during 100 ms)× 10 = 280.000 (AXION)

NOTE:
1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

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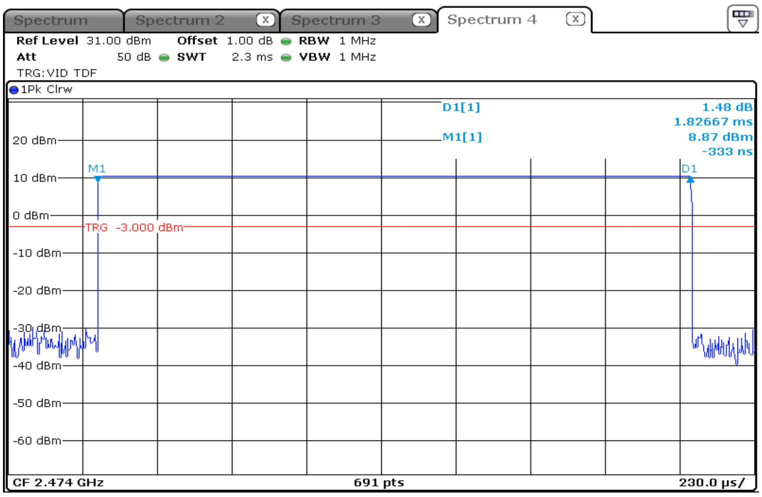
5.6.4 Test Plot

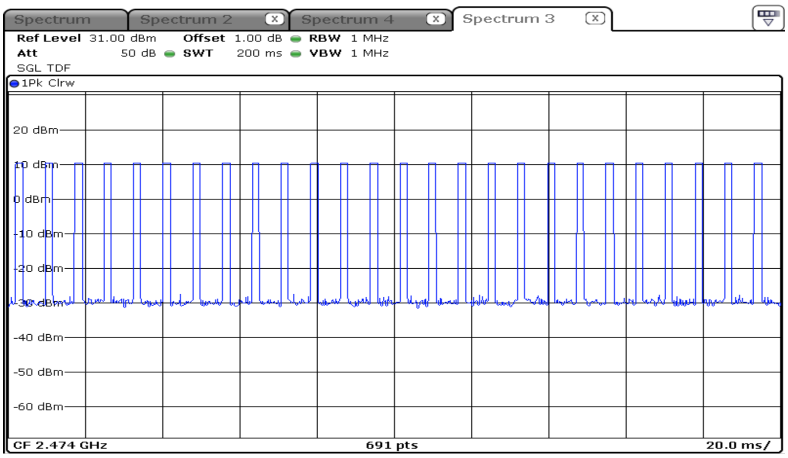
Figure 5. Plot of the Time of Occupancy (Conducted)

*** PROTON**

Highest Channel
(2 474.0 ㎒)



Hopping rate



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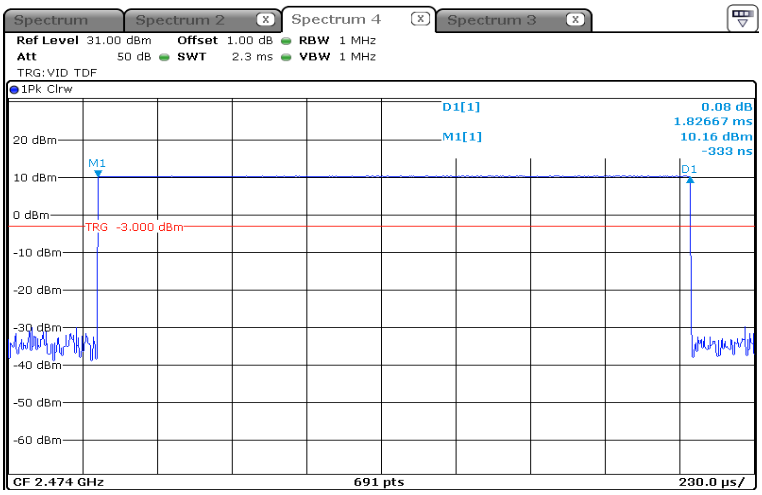
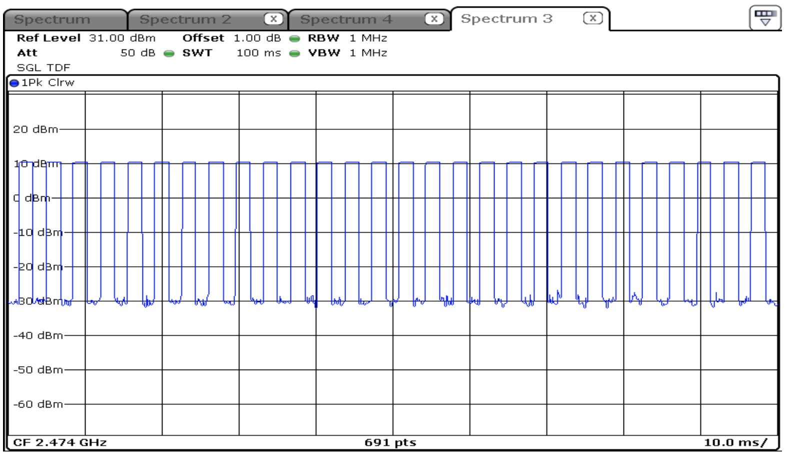
*** AXION**

Highest Channel
(2 474.0 ㎒)



Hopping rate



5.7 Spurious Emission, Band edge, and Restricted bands

5.7.1 Regulation

According to §15.247(d), in any 100 ㎑ 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 ㏈ below that in the 100 ㎑ 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 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to §15.209(a), Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall notexceed the field strength levels specified in the following table:

Frequency (㎒)	Field strength (㎶/m)	Measurement distance (m)
0.009 - 0.490	2400/F(㎑)	300
0.490 -1.705	24000/F(㎑)	30
1.705 – 30	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 ㎒, 76–88 ㎒, 174–216 ㎒ or 470–806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

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According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	Above 38.6
13.36 - 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

5.7.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1) <u>Band-edge Compliance of RF Conducted Emissions</u>

1. Set the spectrum analyzer as follows:
   Span = wide enough to capture the peak level of the emission operating on the closest channel to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
   RBW ≥ 1% of the span
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. 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.
3. Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

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2) Spurious RF Conducted Emissions:

1. Set the spectrum analyzer as follows:
   Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
   RBW = 100 ㎑
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
   a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
3. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

3) Spurious Radiated Emissions:

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360˚.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 ㎑ to 30 ㎒ using the loop antenna, and from 30 to 1000 ㎒ using the TRILOG broadband antenna, and from 1000 ㎒ to 26500 ㎒ using the horn antenna.
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

Note
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1 ㎓.

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5.7.3 Test Result

- Complied

1. Band edge compliance of RF Conducted Emissions was shown in figure 6.
2. Band edge compliance of RF Radiated Emissions was shown in figure 7.
3. Spurious RF conducted Emissions were shown in the Figure 8.
   Note: We took the insertion loss of the cable into consideration within the measuring instrument.
4. Measured value of the Field strength of spurious Emissions (Radiated)

※ Noise was not measured. (Margin was more than 20dB)
Worst value of noise floor was recorded.

*** Below 1 ㎓ data (Worst-case: PROTON_Low channel)**

Low channel (2 409.2 ㎒)

Frequency [㎒]	Receiver Bandwidth [㎑]	Pol. [V/H]	Reading [dB(㎶)]	Factor [dB]	Result [dB(㎶/m)]	Limit [dB(㎶/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 ㎒							
Below 30.00	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 ㎓							
160.71	120	V	47.2	-13.6	33.6	54.0	20.4
Above 200.00	Not Detected	-	-	-	-	-	-

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*** Above 1 ㎓ data**

PROTON_Low channel (2 409.2 ㎒)

Frequency [㎒]	Receiver Bandwidth [㎑]	Pol. [V/H]	Reading [dB(㎶)]	Factor [dB]	Result [dB(㎶/m)]	Limit [dB(㎶/m)]	Margin [dB]
Peak DATA. Emissions above 1 ㎓							
2 296.75	1 000	H	55.4	-2.5	52.9	74.0	21.1
4 818.38	1 000	V	46.8	6.80	53.6	74.0	20.4
Above 5 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 ㎓							
2 296.75	1 000	H	34.2	-2.5	31.7	54.0	22.3
4 818.4	1 000	V	26.3	6.8	33.1	54.0	20.9
Above 5 000.00	Not Detected	-	-	-	-	-	-

PROTON_Middle channel (2 441.6 ㎒)

Frequency [㎒]	Receiver Bandwidth [㎑]	Pol. [V/H]	Reading [dB(㎶)]	Factor [dB]	Result [dB(㎶/m)]	Limit [dB(㎶/m)]	Margin [dB]
Peak DATA. Emissions above 1 ㎓							
2 286.25	1 000	V	54.5	-2.6	51.9	74.0	22.1
4 882.97	1 000	H	47.3	7.0	54.3	74.0	19.7
Above 5 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 ㎓							
2 286.25	1 000	V	34.1	-2.6	31.5	54.0	22.5
4 882.97	1 000	H	27.3	7.0	34.3	54.0	19.7
Above 5 000.00	Not Detected	-	-	-	-	-	-

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PROTON _High channel (2 474.0 ㎒)

Frequency [㎒]	Receiver Bandwidth [㎑]	Pol. [V/H]	Reading [dB(㎶)]	Factor [dB]	Result [dB(㎶/m)]	Limit [dB(㎶/m)]	Margin [dB]
Peak DATA. Emissions above 1 ㎓							
2 300.50	1 000	V	50.3	-2.5	47.8	74.0	26.2
4 947.56	1 000	V	48.6	7.3	55.9	74.0	18.1
Above 5 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 ㎓							
2 300.50	1 000	V	30.8	-2.5	28.3	54.0	25.7
4 947.56	1 000	V	27.5	7.3	34.8	54.0	19.2
Above 5 000.00	Not Detected	-	-	-	-	-	-

AXION_Low channel (2 409.2 ㎒)

Frequency [㎒]	Receiver Bandwidth [㎑]	Pol. [V/H]	Reading [dB(㎶)]	Factor [dB]	Result [dB(㎶/m)]	Limit [dB(㎶/m)]	Margin [dB]
Peak DATA. Emissions above 1 ㎓							
2 265.00	1 000	H	59.3	-2.7	56.6	74.0	17.4
4 818.37	1 000	H	48.5	6.8	55.3	74.0	18.7
Above 5 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 ㎓							
2 265.00	1 000	H	41.2	-2.7	38.5	54.0	15.5
4 818.38	1 000	H	28.0	6.8	34.8	54.0	19.2
Above 5 000.00	Not Detected	-	-	-	-	-	-

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AXION_Middle channel (2 441.6 ㎒)

Frequency [㎒]	Receiver Bandwidth [㎑]	Pol. [V/H]	Reading [dB(㎶)]	Factor [dB]	Result [dB(㎶/m)]	Limit [dB(㎶/m)]	Margin [dB]
Peak DATA. Emissions above 1 ㎓							
2 285.75	1 000	V	55.1	-2.6	52.5	74.0	21.5
4 882.97	1 000	H	48.4	7.0	55.4	74.0	18.6
Above 5 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 ㎓							
2 285.75	1 000	V	34.5	-2.6	31.9	54.0	22.1
4 882.97	1 000	H	28.6	7.0	35.6	54.0	18.4
Above 5 000.00	Not Detected	-	-	-	-	-	-

AXION_High channel (2 474.0 ㎒)

Frequency [㎒]	Receiver Bandwidth [㎑]	Pol. [V/H]	Reading [dB(㎶)]	Factor [dB]	Result [dB(㎶/m)]	Limit [dB(㎶/m)]	Margin [dB]
Peak DATA. Emissions above 1 ㎓							
2 295.75	1 000	V	50	-2.5	47.5	74.0	26.5
4 947.56	1 000	H	49.3	7.3	56.6	74.0	17.4
Above 5 000.00	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 ㎓							
2 295.75	1 000	V	30.7	-2.5	28.2	54.0	25.8
4 947.56	1 000	H	29.6	7.3	36.9	54.0	17.1
Above 5 000.00	Not Detected	-	-	-	-	-	-

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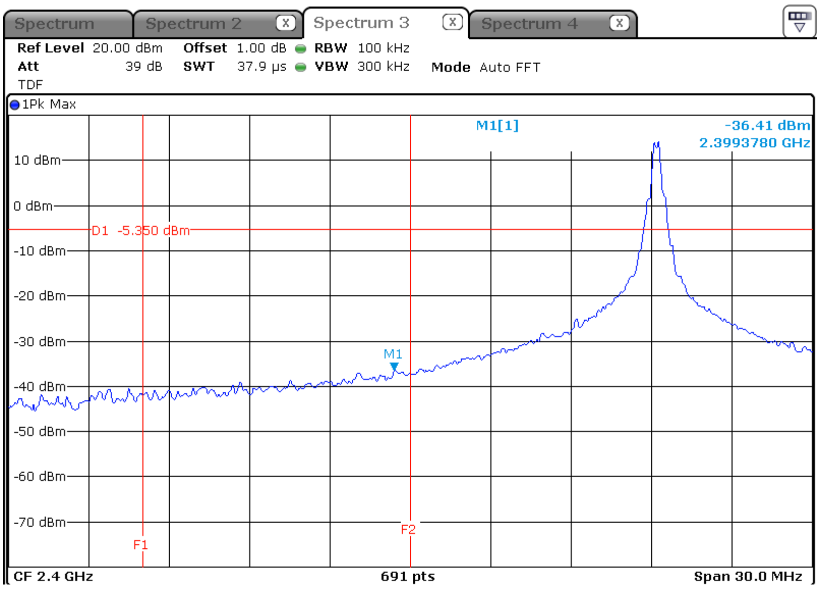
5.7.4 Test Plot

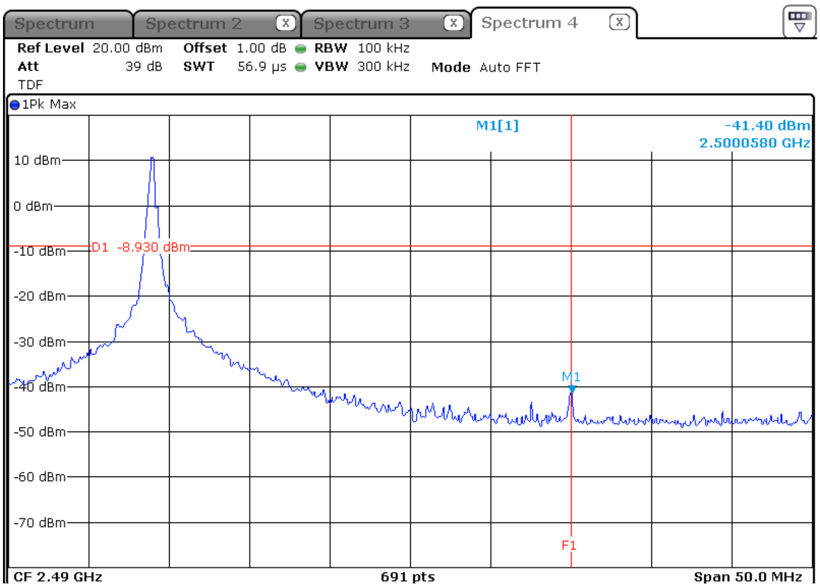
Figure 6. Plot of the Band Edge (Conducted)

*** PROTON (Without hopping)**

Lowest Channel
(2 409.2 ㎒)



Highest Channel
(2 474.0 ㎒)



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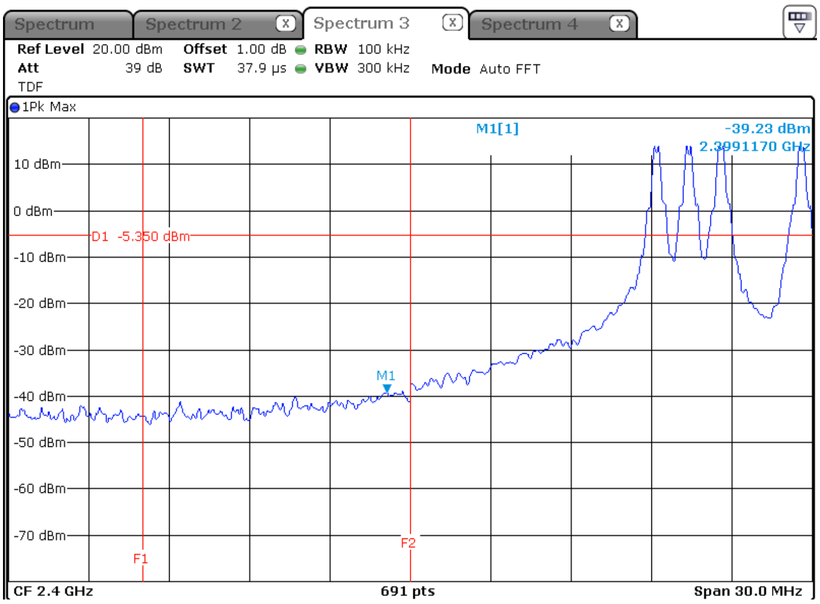
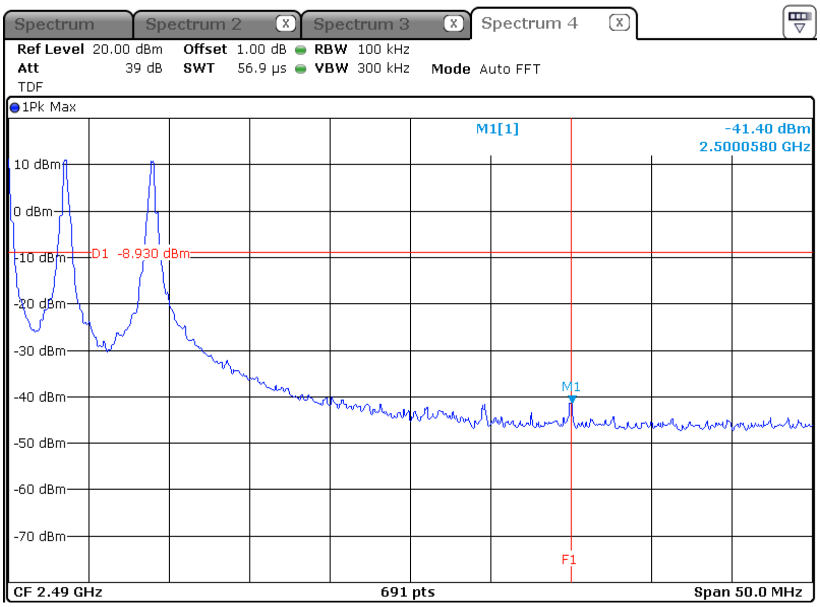
*** PROTON (With hopping)**

Lowest Channel
(2 409.2 ㎒)



Highest Channel
(2 474.0 ㎒)



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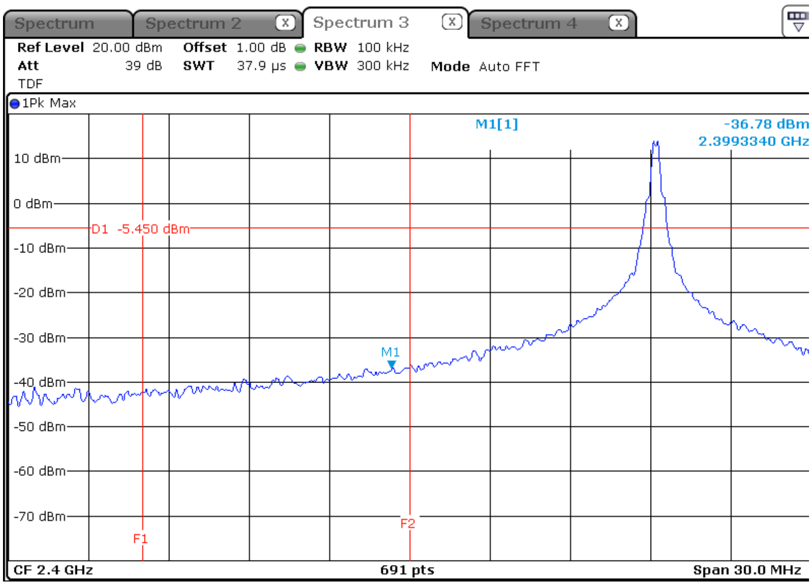
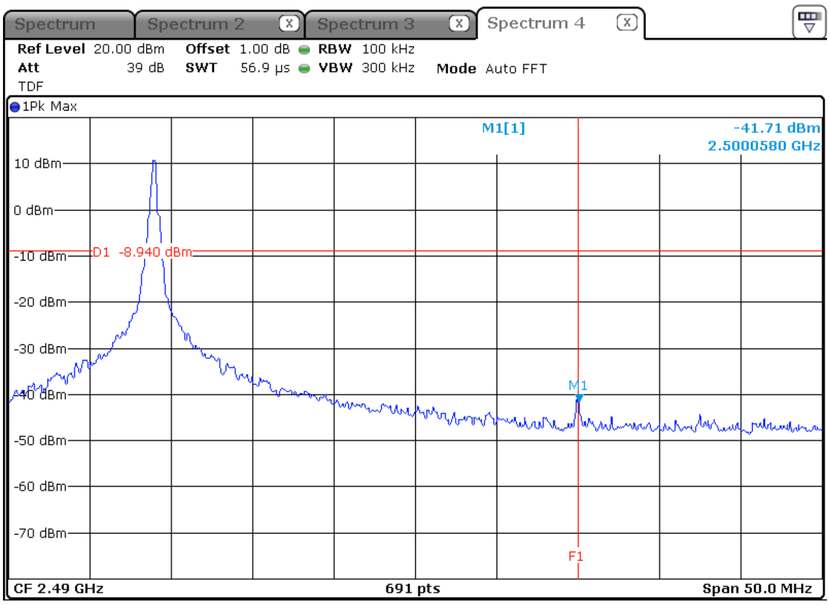
*** AXION (Without hopping)**

Lowest Channel
(2 409.2 ㎒)



Highest Channel
(2 474.0 ㎒)



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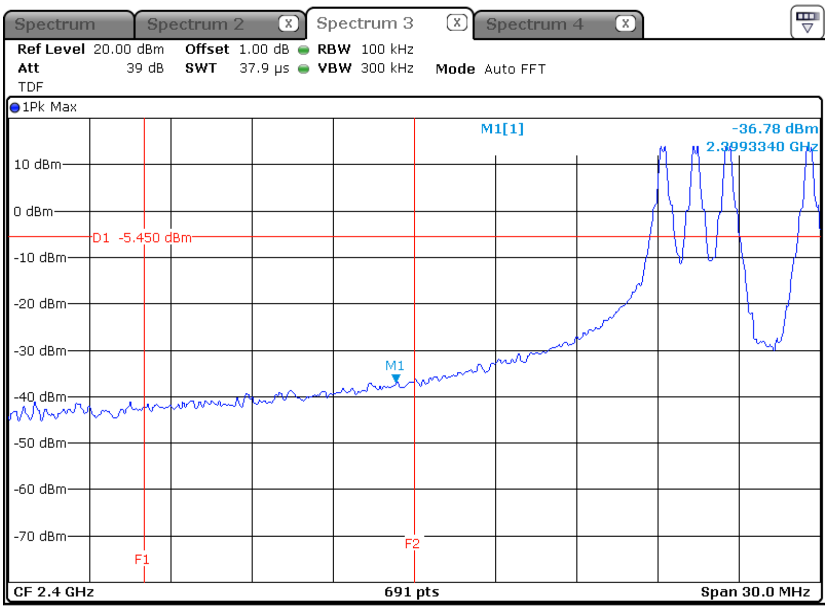
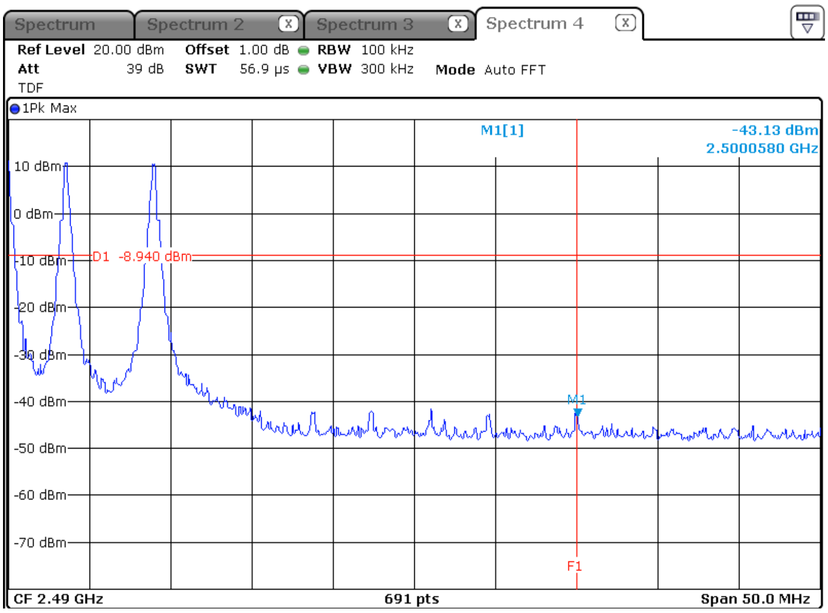
*** AXION (With hopping)**

Lowest Channel
(2 409.2 ㎒)



Highest Channel
(2 474.0 ㎒)



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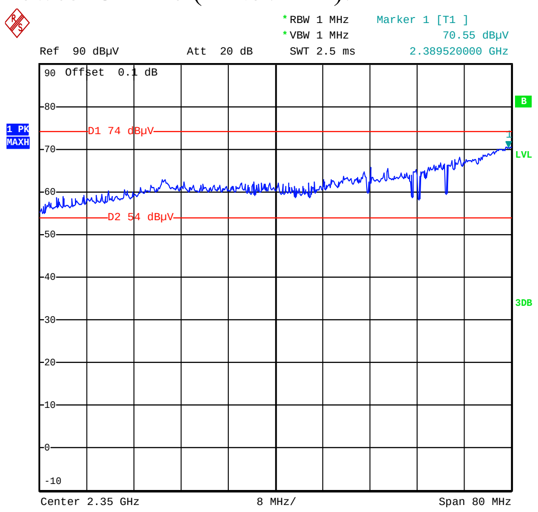
5.7.4 Test Plot (Continue)

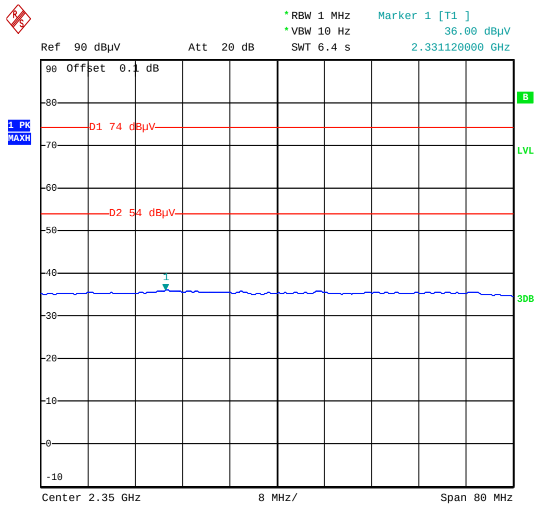
Figure 7. Plot of the Band Edge (Radiated)

*** PROTON**

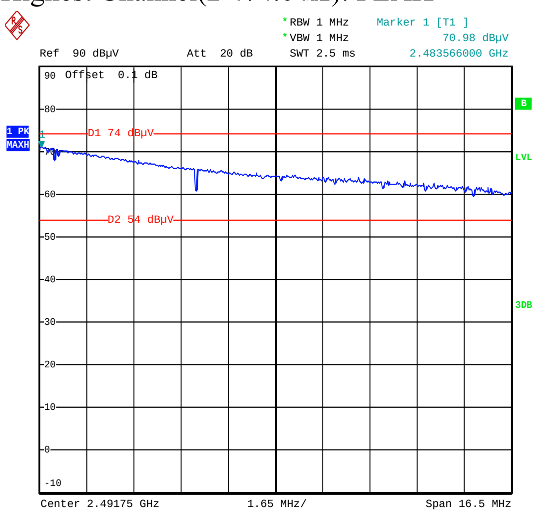
Lowest Channel(2 409.2 ㎒): PEAK



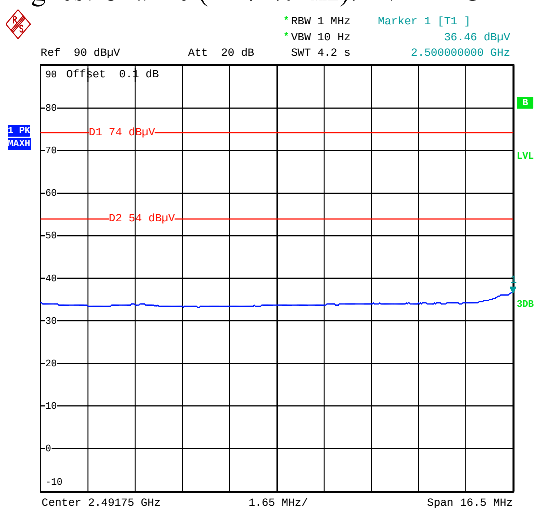
Lowest Channel(2 409.2 ㎒): AVERAGE



Highest Channel(2 474.0 ㎒): PEAK



Highest Channel(2 474.0 ㎒): AVERAGE



Note.
Peak offset(dB) = ANT Factor- Amp Gain + Cable Loss
Average offset (dB) = ANT Factor- Amp Gain + Cable Loss

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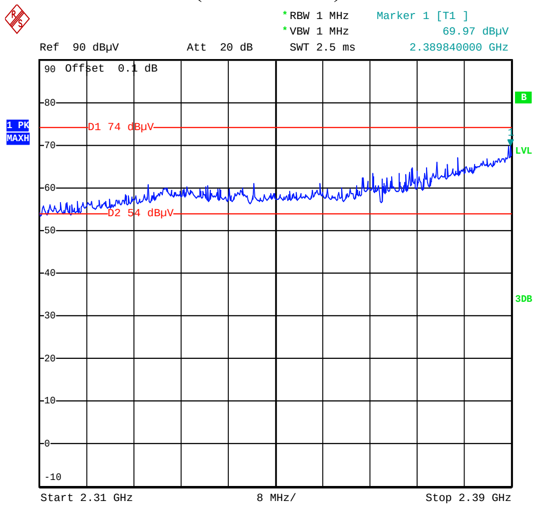
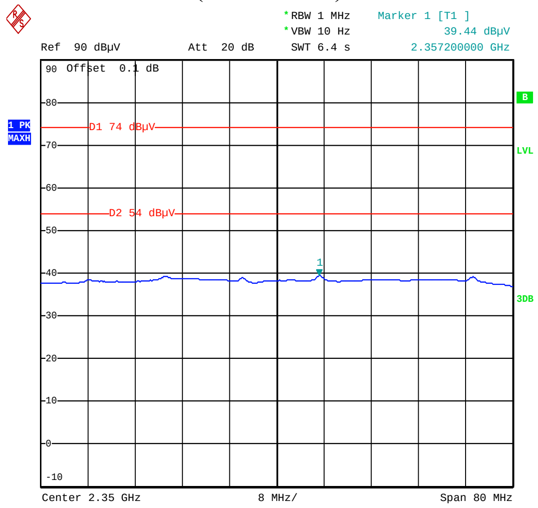
*** AXION**

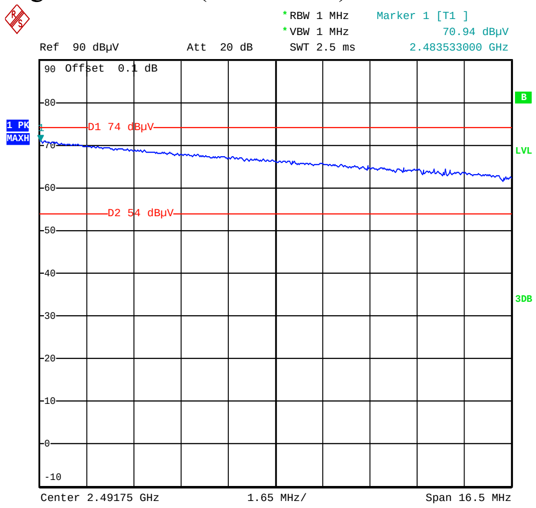
Lowest Channel(2 409.2 ㎒): PEAK



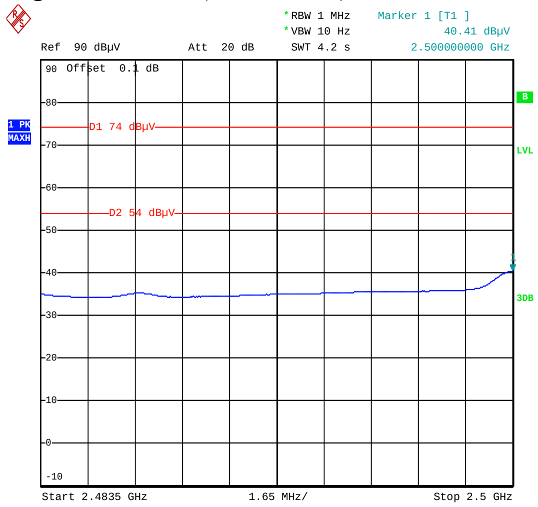
Lowest Channel(2 409.2 ㎒): AVERAGE



Highest Channel(2 474.0 ㎒): PEAK



Highest Channel(2 474.0 ㎒): AVERAGE



Note.
Peak offset(dB) = ANT Factor- Amp Gain + Cable Loss
Average offset (dB) = ANT Factor- Amp Gain + Cable Loss

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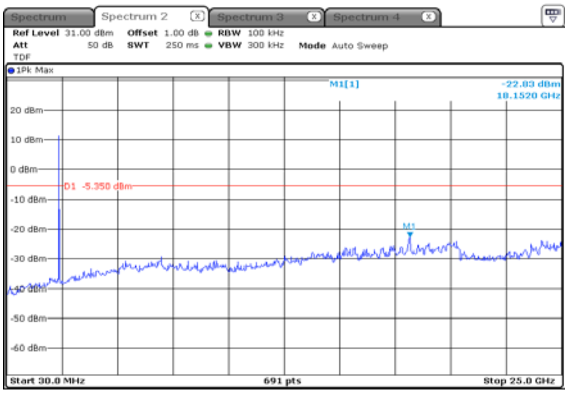
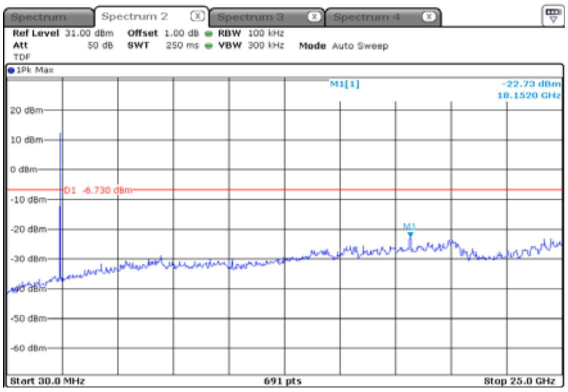
Figure 8. Plot of the Spurious RF conducted emissions

*** PROTON**

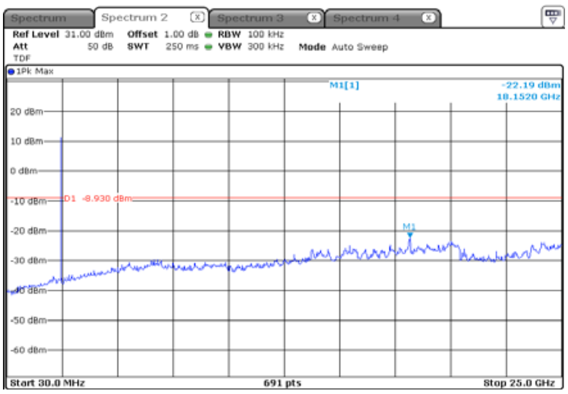
Lowest Channel(2 409.2 ㎒):30 ㎒ ~ 25㎓



Middle Channel(2 441.6 ㎒): 30 ㎒ ~ 25 ㎓



Highest Channel(2 474.0 ㎒): 30 ㎒ ~ 25 ㎓



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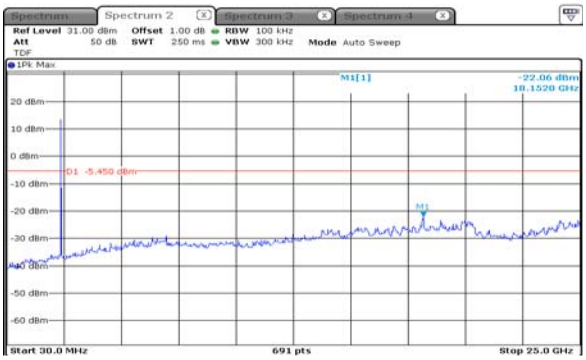
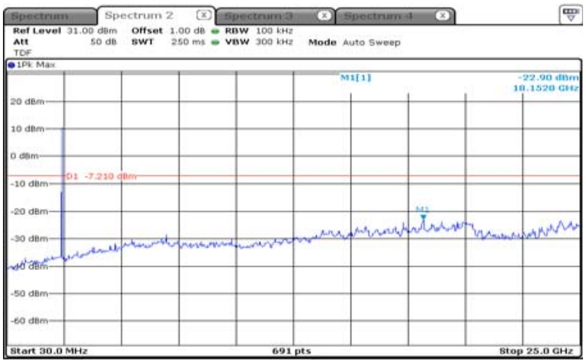
*** AXION**

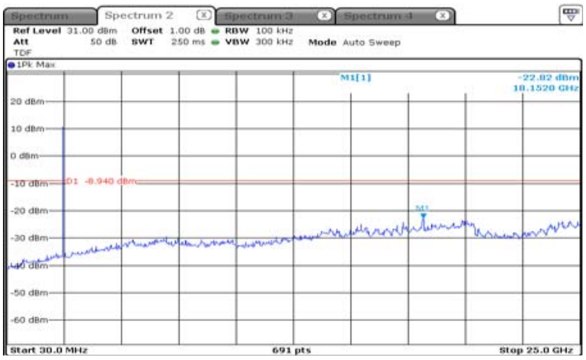
Lowest Channel(2 409.2 ㎒):30 ㎒ ~ 25㎓



Middle Channel(2 441.6 ㎒): 30 ㎒ ~ 25 ㎓



Highest Channel(2 474.0 ㎒): 30 ㎒ ~ 25 ㎓



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5.8 Conducted Emission

5.8.1 Regulation

According to §15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (㎒)	Conducted limit (dB㎶)	
	Qausi-peak	Average
0.15 – 0.5	66 to 56 *	56 to 46 *
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

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5.8.2 Measurement Procedure

1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 ㎝ in which is located 40 ㎝ away from the vertical wall and 1.5m away from the side wall of the shielded room.
2) Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 ㎒ to 30 ㎒.
5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 ㎑ or to QUASI-PEAK and AVERAGE within a bandwidth of 9 ㎑. The EUT was in transmitting mode during the measurements.

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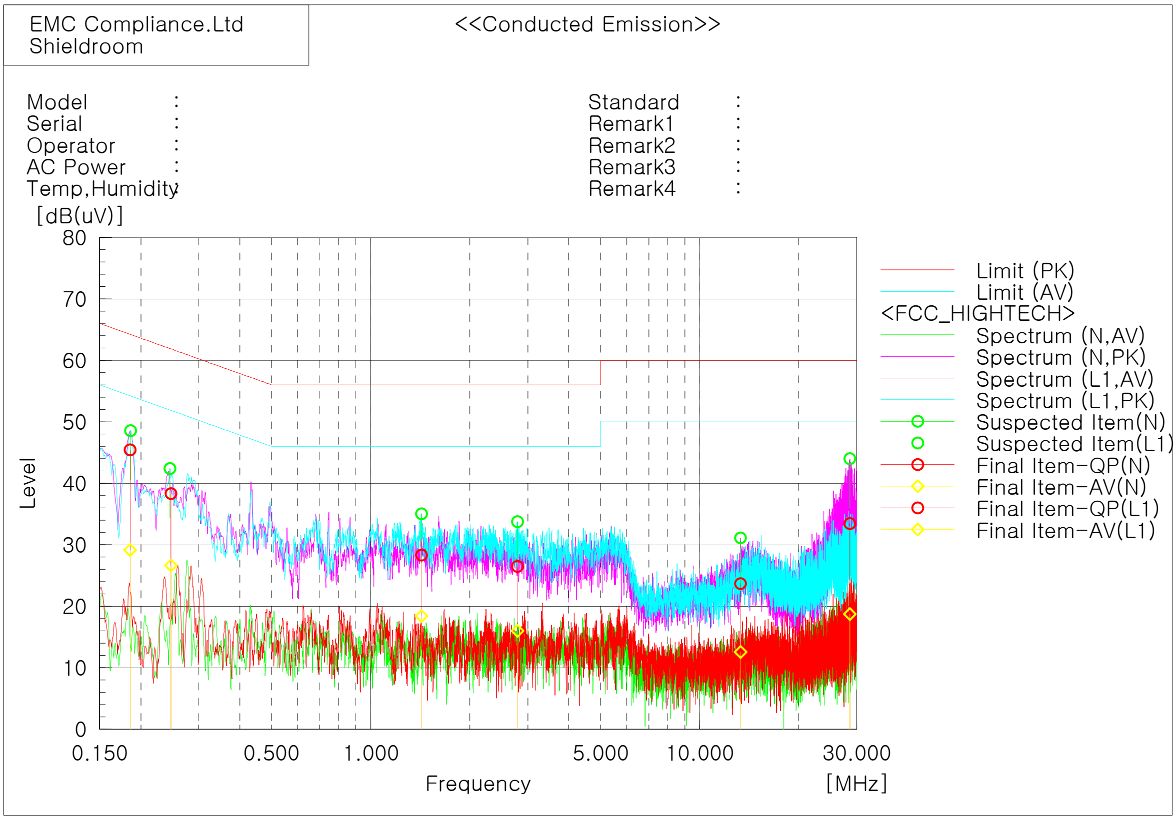
5.8.3 Test Result

- Complied

***Conducted emission worst-case data : chrarging mode**



Final Result

--- N Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	13.28562	13.8	2.7	9.9	23.7	12.6	60.0	50.0	36.3	37.4
2	28.5938	23.5	8.8	9.9	33.4	18.7	60.0	50.0	26.6	31.3

--- L1 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.18593	35.3	19.1	10.1	45.4	29.2	64.2	54.2	18.8	25.0
2	0.24691	28.5	16.9	9.8	38.3	26.7	61.9	51.9	23.6	25.2
3	1.42586	18.5	8.6	9.8	28.3	18.4	56.0	46.0	27.7	27.6
4	2.79132	16.8	6.3	9.7	26.5	16.0	56.0	46.0	29.5	30.0

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6. Test equipment used for test

	Description	Manufacture	Model No.	Serial No.	Next Cal Date.
■	Spectrum Analyzer	R&S	FSV30	100914	14.08.19
■	DC Power Supply	Agilent	E3632A	MY51220373	14.12.24
■	Vector Signal Generator	R & S	SMBV100A	257566	15.01.07
■	Amplifier	Sonoma Instrument	310N	293004	14.10.31
■	Broadband Preamplifier	Schwarzbeck	BBV9718	233	15.03.21
■	Broadband Preamplifier	Schwarzbeck	BBV9721	2	15.05.09
■	Loop Antenna	R&S	HFH2-Z2	100355	15.06.19
■	Bi-Log Antenna	Schwarzbeck	VULB9163	552	14.07.18
■	Horn Antenna	ETS-Lindgren	3115	62589	14.11.11
■	Horn Antenna	ETS - Lindgren	3116	86635	15.02.26
■	Attenuator	HP	8491A	16861	15.05.08
■	Highpass Filter	Wainwright Instruments GmbH	WHKX3.0/ 18G-12SS	44	15.02.05
■	Antenna Mast	Innco Systems	MA4000-EP	303	-
■	Turn Table	Innco Systems	DT2000S-1t	79	-

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