

FCC Test Report

Product Name	ThinkPad TrackPoint Keyboard II
Machine Type / Model No.	KC-1957
FCC ID.	A5MKC-1957

Applicant	Lenovo (Beijing) Limited
Address	201-H2-6, Floor 2, Building 2, No.6 Shangdi West Road, Haidian District, Beijing, China 100085

Date of Receipt	Dec. 26, 2019
Issued Date	Jan. 21, 2020
Report No.	19C0439R-RFUSP01V00
Report Version	V1.0



The test results relate only to the samples tested.

The test results shown in the test report are traceable to the national/international standard through the calibration report of the equipment and evaluated measurement uncertainty herein.

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Test Report

Issued Date: Jan. 21, 2020

Report No.: 19C0439R-RFUSP01V00



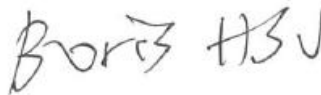
Product Name	ThinkPad TrackPoint Keyboard II
Applicant	Lenovo (Beijing) Limited
Address	201-H2-6, Floor 2, Building 2, No.6 Shangdi West Road, Haidian District, Beijing, China 100085
Manufacturer	Chicony Electronics Co., Ltd.
Machine Type / Model No.	KC-1957
FCC ID.	A5MKC-1957
EUT Rated Voltage	DC 3.7V by Battery, DC 5V by USB
EUT Test Voltage	DC 5V by USB
Trade Name	Lenovo
Applicable Standard	FCC CFR Title 47 Part 15 Subpart C ANSI C63.4: 2014, ANSI C63.10: 2013
Test Result	Complied

Documented By :



(Senior Adm. Specialist / Leven Huang)

Tested By :



(Engineer / Boris Hsu)

Approved By :



(Director / Vincent Lin)

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Attachment 1: EUT Test Photographs

Attachment 2: EUT Detailed Photographs

1. GENERAL INFORMATION

1.1. EUT Description

Product Name	ThinkPad TrackPoint Keyboard II
Trade Name	Lenovo
Machine Type / Model No.	KC-1957
FCC ID.	A5MKC-1957
Frequency Range	2402 – 2480MHz
Channel Number	V5.0: 40CH
Type of Modulation	V5.0: GFSK
Antenna Type	Chip Antenna
Channel Control	Auto
Antenna Gain	Refer to the table “Antenna List”
USB Type C Cable	Shielded, 1.1m

Antenna List

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	MAGIC	MTCA321608002G4E	Chip Antenna	2dBi for 2.4 GHz

Note: The antenna of EUT is conforming to FCC 15.203.

Center Frequency of Each Channel: (For V5.0)

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
Channel 00:	2402 MHz	Channel 01:	2404 MHz	Channel 02:	2406 MHz	Channel 03:	2408 MHz
Channel 04:	2410 MHz	Channel 05:	2412 MHz	Channel 06:	2414 MHz	Channel 07:	2416 MHz
Channel 08:	2418 MHz	Channel 09:	2420 MHz	Channel 10:	2422 MHz	Channel 11:	2424 MHz
Channel 12:	2426 MHz	Channel 13:	2428 MHz	Channel 14:	2430 MHz	Channel 15:	2432 MHz
Channel 16:	2434 MHz	Channel 17:	2436 MHz	Channel 18:	2438 MHz	Channel 19:	2440 MHz
Channel 20:	2442 MHz	Channel 21:	2444 MHz	Channel 22:	2446 MHz	Channel 23:	2448 MHz
Channel 24:	2450 MHz	Channel 25:	2452 MHz	Channel 26:	2454 MHz	Channel 27:	2456 MHz
Channel 28:	2458 MHz	Channel 29:	2460 MHz	Channel 30:	2462 MHz	Channel 31:	2464 MHz
Channel 32:	2466 MHz	Channel 33:	2468 MHz	Channel 34:	2470 MHz	Channel 35:	2472 MHz
Channel 36:	2474 MHz	Channel 37:	2476 MHz	Channel 38:	2478 MHz	Channel 39:	2480 MHz

Note:

1. The EUT is a ThinkPad TrackPoint Keyboard II with a built-in Bluetooth V5.0 transceiver.
2. These tests were conducted on a sample for the purpose of demonstrating compliance of Bluetooth transmitter with Part 15 Subpart C Paragraph 15.247 for spread spectrum devices.
3. Regarding to the operation frequency, the lowest, middle and highest frequency are selected to perform the test.
4. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case is shown in the report.

Test Mode	Mode 1: Transmit - BLE (GFSK)
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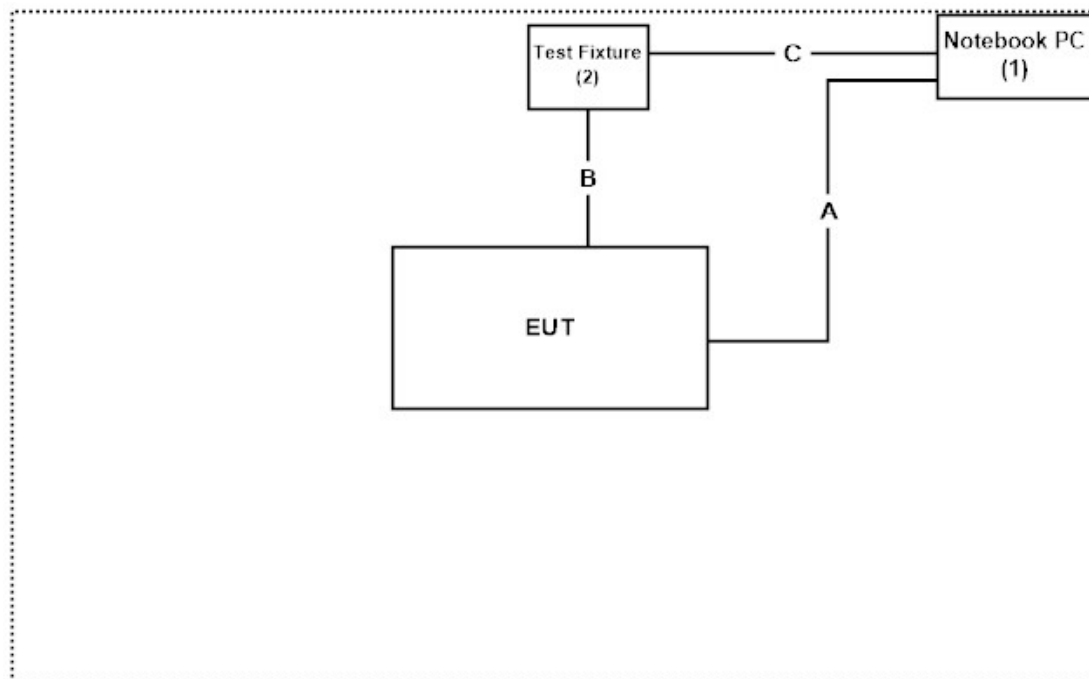
1.3. Tested System Details

The types for all equipment, plus descriptions of all cables used in the tested system (including inserted cards) are:

Product	Brand Name	Model No.	Serial No.	Power Cord
1. Notebook PC	DELL	Latitude 5580	2HRD7H2	Non-Shielded, 0.8m
2. Test Fixture	Lenovo	N/A	N/A	N/A

Signal Cable Type	Signal cable Description
A USB Type C Cable	Shielded, 1.1m
B Signal Cable	Non-Shielded, 0.1m, four PCS.
C RS-232 to USB Cable	Non-Shielded, 1.7m

1.4. Configuration of Tested System



1.5. EUT Exercise Software

1. Setup the EUT as shown in Section 1.4.
2. Execute software “nRFgo Studio V.1.21.2.10” on the EUT.
3. Configure the test mode, the test channel, and the data rate.
4. Press “OK” to start the continuous transmit.
5. Verify that the EUT works properly.

1.6. Test Facility

Ambient conditions in the laboratory:

Performed Item	Items	Required	Actual
Conducted Emission	Temperature (°C)	10~40 °C	24.1 °C
	Humidity (%RH)	10~90 %	50 %
Radiated Emission	Temperature (°C)	10~40 °C	20 °C
	Humidity (%RH)	10~90 %	74 %
Conductive	Temperature (°C)	10~40 °C	22.3 °C
	Humidity (%RH)	10~90 %	64.7 %

USA : FCC Registration Number: TW3023

Canada : IC Registration Number: 4075A

Site Description: Accredited by TAF
Accredited Number: 3023

Test Laboratory: DEKRA Testing and Certification Co., Ltd
Address: No.5-22, Ruishukeng, Linkou Dist., New Taipei City 24451,
Taiwan.
Phone number: 886-2-8601-3788
Fax number: 886-2-8601-3789
Email address: info.tw@dekra.com
Website: <http://www.dekra.com.tw>

1.7. List of Test Equipment

For Conducted measurements /CB3/SR8

	Equipment	Manufacturer	Model No.	Serial No.	Cali. Date	Due. Date
	Temperature Chamber	WIT GROUP	TH-1S-B	EQ-201-00146	2019/02/26	2020/02/25
X	Spectrum Analyzer	Agilent	N9010A	MY53470892	2019/09/25	2020/09/24
X	Peak Power Analyzer	Keysight	8990B	MY51000410	2019/07/30	2020/07/29
X	Wideband Power Sensor	Keysight	N1923A	MY56080003	2019/07/30	2020/07/29
X	Wideband Power Sensor	Keysight	N1923A	MY56080004	2019/07/30	2020/07/29
X	EMI Test Receiver	R&S	ESCS 30	100369	2019/11/19	2020/11/18
X	LISN	R&S	ENV216	101105	2019/04/10	2020/04/09
X	LISN	R&S	ESH3-Z5	836679/014	2019/04/10	2020/04/09
X	Coaxial Cable	DEKRA	RG 400	LC018-RG	2019/06/20	2020/06/19

Note:

1. All equipments are calibrated every one year.
2. The test instruments marked with “X” are used to measure the final test results.
3. Test Software version : DEKRA Conduction Test SystemV9.0.5.

For Radiated measurements /Site3/CB8

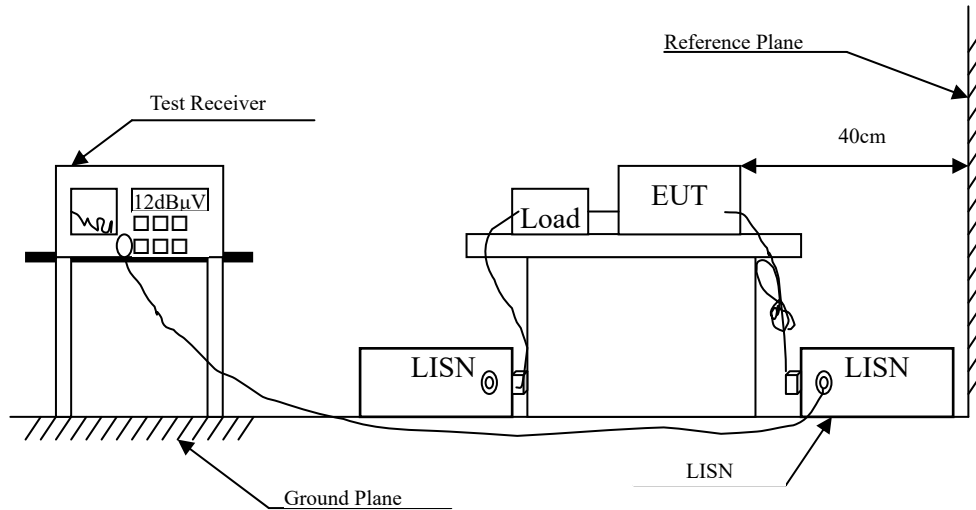
	Equipment	Manufacturer	Model No.	Serial No.	Cali. Date	Due. Date
X	Spectrum Analyzer	R&S	FSP40	100170	2019/03/11	2020/03/10
X	Loop Antenna	Teseq	HLA6121	37133	2019/10/15	2021/10/14
X	Bilog Antenna	Schaffner Chase	CBL6112B	2794	2019/06/23	2020/06/22
X	Coaxial Cable	DEKRA	L1907-001C	280280.F141.1000D	2019/07/10	2020/07/09
X	Amplifier	EMCI	EMC001330	980254	2019/08/22	2020/08/21
X	Horn Antenna	ETS-LINDGREN	3117	00228113	2019/05/02	2020/05/01
X	Coaxial Cable	DEKRA	L1907-002C	280280.F141.1000D	2019/07/10	2020/07/09
X	Amplifier	EMCI	EMC05820SE	980362	2019/06/26	2020/06/25
X	Amplifier	EMCI	EMC051845SE	SN980632	2019/08/08	2020/08/07
	Horn Antenna	Com-Power	AH-1840	101101	2019/10/31	2020/10/30
	Amplifier + Cable	EMCI	EMC184045SE	980369	2019/04/16	2020/04/15
	Bilog Antenna	Schaffner Chase	CBL6112B	2916	2019/06/23	2020/06/22
	Coaxial Cable	DEKRA	L1907-003C	00100A1B3A120M	2019/07/10	2020/07/09
	Amplifier	EMCI	EMC001330	980255	2019/06/28	2020/06/27
X	Filter	MICRO-TRONICS	BRM50702	G270	2019/08/08	2020/08/07
	Filter	MICRO-TRONICS	BRM50716	G196	2019/08/08	2020/08/07

Note:

1. Loop Antenna is calibrated every two years, the other equipments are calibrated every one year.
2. The test instruments marked with “X” are used to measure the final test results.
3. Test Software version : DEKRA Test SystemV1.1.

2. Conducted Emission

2.1. Test Setup



2.2. Limits

FCC Part 15 Subpart C Paragraph 15.207 (dBμV) Limit		
Frequency MHz	Limits	
	QP	AV
0.15 - 0.50	66-56	56-46
0.50-5.0	56	46
5.0 - 30	60	50

Remarks: In the above table, the tighter limit applies at the band edges.

2.3. Test Procedure

The EUT and Peripherals are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50 ohm /50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm /50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs.)

Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all the interface cables must be changed according to ANSI C63.4: 2014 on conducted measurement.

Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz.

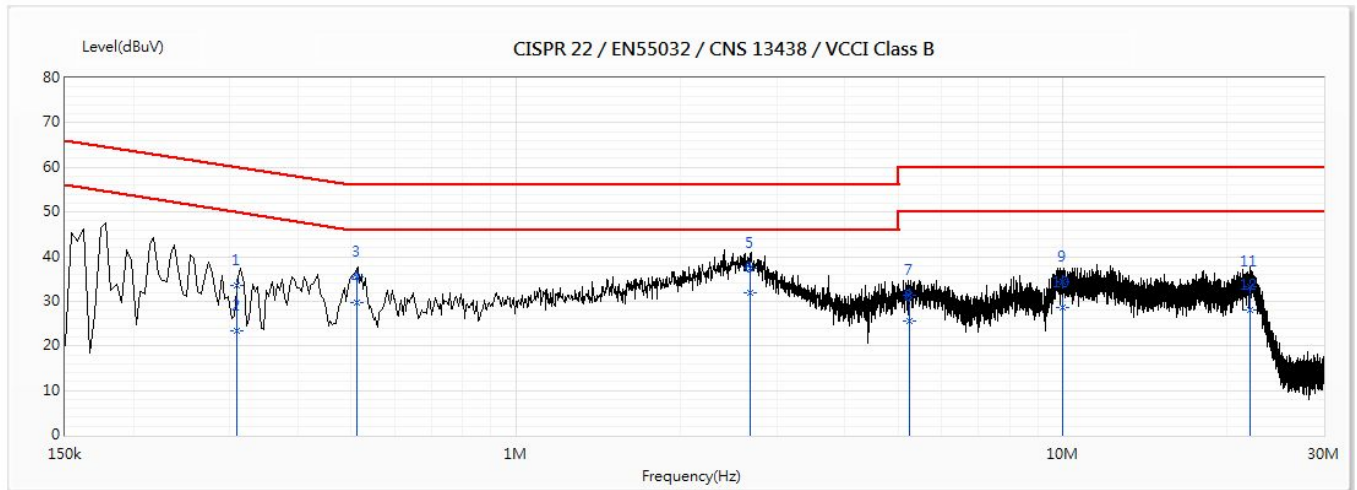
2.4. Uncertainty

± 2.26 dB

2.5. Test Result of Conducted Emission

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Conducted Emission Test
 Test date : 2020/01/16
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

L1



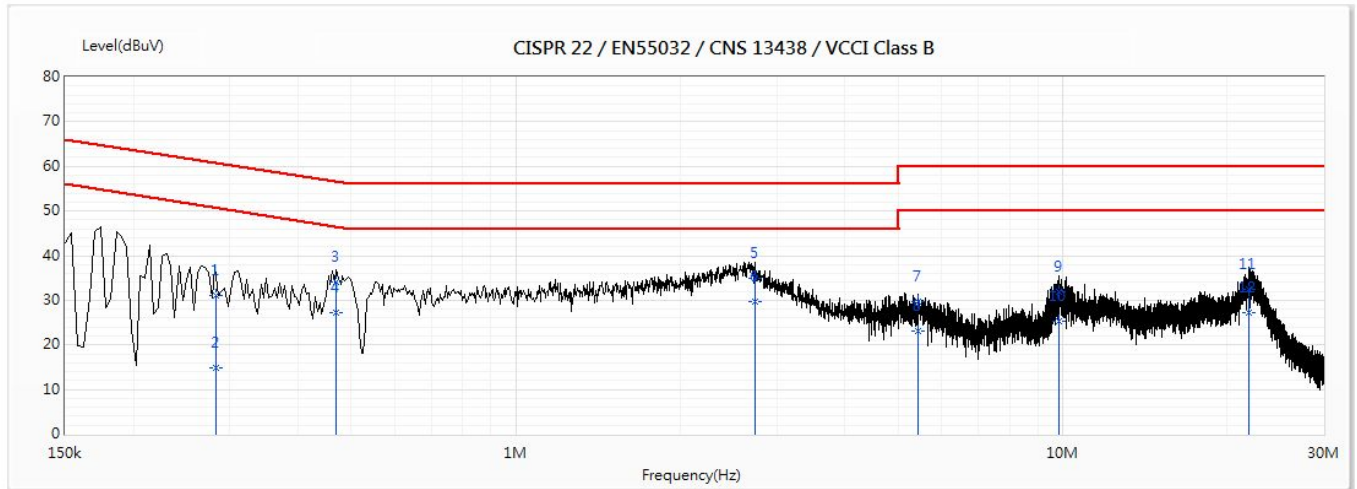
No	Frequency (MHz)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	0.31	33.41	59.98	-26.57	23.71	9.69	QP
2	0.31	23.30	49.98	-26.68	13.61	9.69	AV
3	0.512	35.43	56.00	-20.57	25.73	9.70	QP
4	0.512	29.82	46.00	-16.18	20.12	9.70	AV
5	2.689	37.32	56.00	-18.68	27.51	9.80	QP
*6	2.689	31.97	46.00	-14.03	22.17	9.80	AV
7	5.258	31.25	60.00	-28.75	21.36	9.89	QP
8	5.258	25.66	50.00	-24.34	15.78	9.89	AV
9	10.019	34.27	60.00	-25.73	24.25	10.02	QP
10	10.019	28.65	50.00	-21.35	18.63	10.02	AV
11	22	33.31	60.00	-26.69	23.12	10.19	QP
12	22	27.96	50.00	-22.04	17.77	10.19	AV

Note:

1. All Reading Levels are Quasi-Peak and average value.
2. " * ", means this data is the worst emission level.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Conducted Emission Test
 Test date : 2020/01/16
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

N



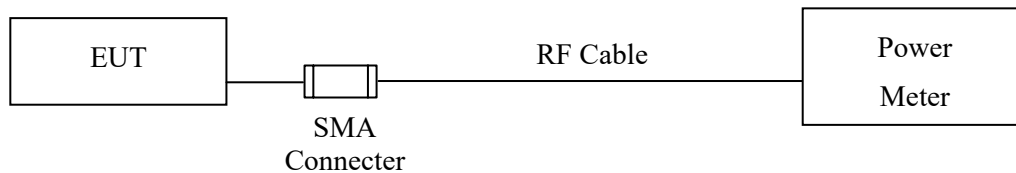
No	Frequency (MHz)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	0.282	31.16	60.75	-29.59	21.44	9.72	QP
2	0.282	14.89	50.75	-35.86	5.17	9.72	AV
3	0.47	34.18	56.52	-22.33	24.45	9.73	QP
4	0.47	27.26	46.52	-19.26	17.52	9.73	AV
5	2.732	34.86	56.00	-21.14	25.02	9.84	QP
*6	2.732	29.71	46.00	-16.29	19.86	9.84	AV
7	5.434	29.82	60.00	-30.18	19.88	9.94	QP
8	5.434	23.10	50.00	-26.90	13.16	9.94	AV
9	9.86	31.87	60.00	-28.13	21.79	10.09	QP
10	9.86	25.24	50.00	-24.76	15.16	10.09	AV
11	21.863	32.44	60.00	-27.56	22.05	10.39	QP
12	21.863	27.14	50.00	-22.86	16.75	10.39	AV

Note:

1. All Reading Levels are Quasi-Peak and average value.
2. " * ", means this data is the worst emission level.

3. Peak Power Output

3.1. Test Setup



3.2. Limit

The maximum peak power shall be less 1Watt.

3.3. Test Procedure

The EUT was tested according to C63.10:2013 for compliance to FCC 47CFR 15.247 requirements. The maximum peak conducted output power using C63.10:2013 Section 11.9.1.3 PKPM1 Peak power meter method.

3.4. Uncertainty

± 1.19 dB

3.5. Test Result of Peak Power Output

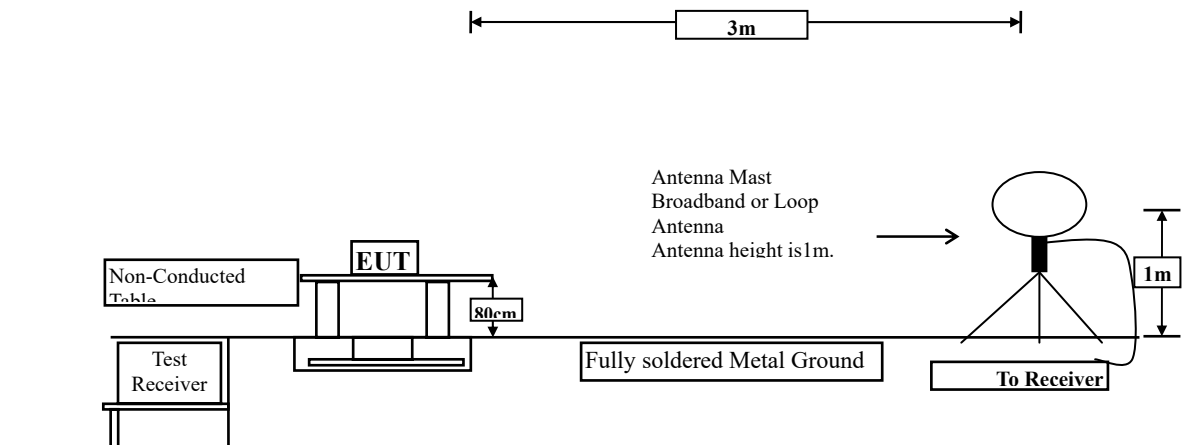
Product : ThinkPad TrackPoint Keyboard II
Test Item : Peak Power Output
Test date : 2020/01/03
Test Mode : Mode 1: Transmit - BLE (GFSK)

Channel No.	Frequency (MHz)	Peak Measurement (dBm)	Required Limit	Result
Channel 00	2402.00	1.42	1 Watt= 30 dBm	Pass
Channel 19	2440.00	1.20	1 Watt= 30 dBm	Pass
Channel 39	2480.00	0.95	1 Watt= 30 dBm	Pass

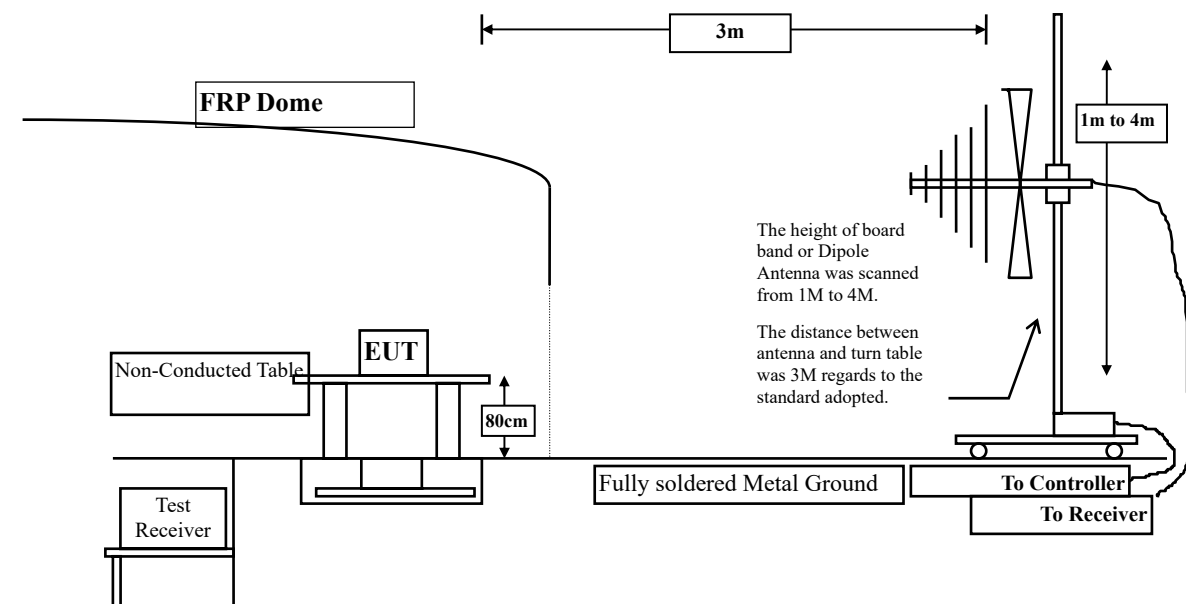
4. Radiated Emission

4.1. Test Setup

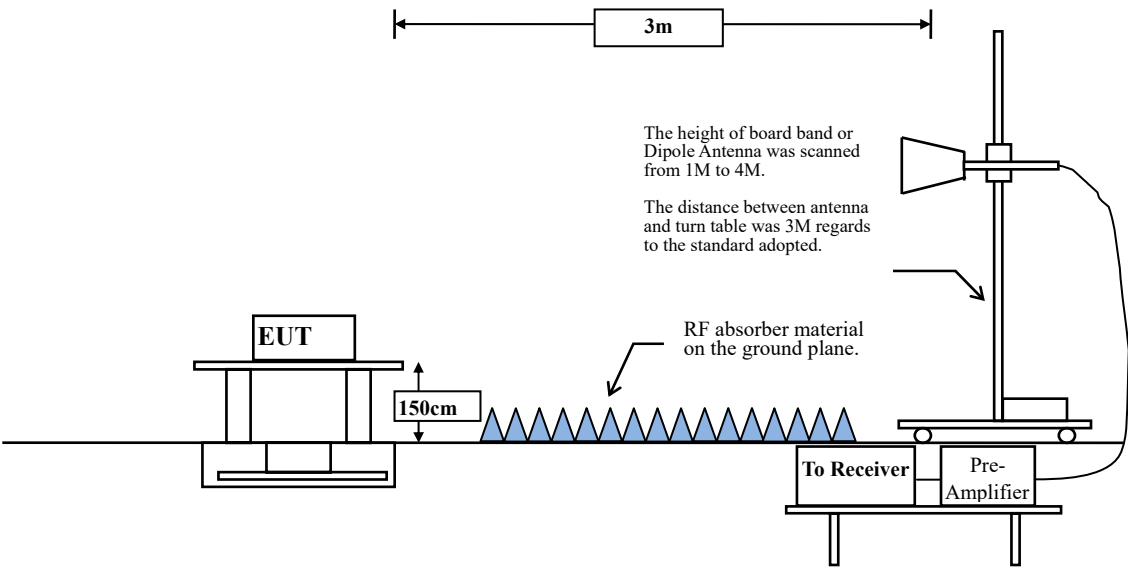
Under 30MHz



Below 1GHz



Above 1GHz



4.2. Limits

➤ General Radiated Emission Limits

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 20dB below the level of the fundamental or to the general radiated emission limits in paragraph 15.209, whichever is the lesser attenuation.

FCC Part 15 Subpart C Paragraph 15.209 Limits		
Frequency MHz	Field strength (microvolts/meter)	Measurement distance (meter)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

- Remarks:
1. RF Voltage (dBμV) = 20 log RF Voltage (uV)
 2. In the Above Table, the tighter limit applies at the band edges.
 3. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

4.3. Test Procedure

The EUT was setup according to ANSI C63.10: 2013 and tested according to C63.10:2013 Section 11.12.1 for compliance to FCC 47CFR 15.247 requirements.

Measuring the frequency range below 1GHz, the EUT is placed on a turn table which is 0.8 meter above ground, when measuring the frequency range above 1GHz, the EUT is placed on a turn table which is 1.5 meter above ground.

The turn table is rotated 360 degrees to determine the position of the maximum emission level.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned between 1 meter and 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10: 2013 on radiated measurement.

The resolution bandwidth below 30MHz setting on the field strength meter is 9kHz and 30MHz~1GHz is 120kHz and above 1GHz is 1MHz.

Radiated emission measurements below 30MHz are made using Loop Antenna and 30MHz~1GHz are made using broadband Bilog antenna and above 1GHz are made using Horn Antennas.

The measurement is divided into the Preliminary Measurement and the Final Measurement.

The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna.

The worst radiated emission is measured in the Open Area Test Site on the Final Measurement.

The measurement frequency range from 9kHz - 10th Harmonic of fundamental was investigated.

RBW and VBW Parameter setting:

According to C63.10 Section 11.12.2.4 Peak measurement procedure

RBW = as specified in Table 1.

$VBW \geq 3 \times RBW$.

Table 1 —RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

According to C63.10 Section 11.12.2.5 Average measurement procedure

RBW = 1MHz.

VBW = 10Hz, when duty cycle $\geq 98 \%$

$VBW \geq 1/T$, when duty cycle $< 98 \%$

(T refers to the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.)

2.4GHz band	Duty Cycle (%)	T (ms)	1/T (Hz)	VBW (Hz)
BLE	62.59	0.3919	2552	3000

Note: Duty Cycle Refer to Section 9

4.4. Uncertainty

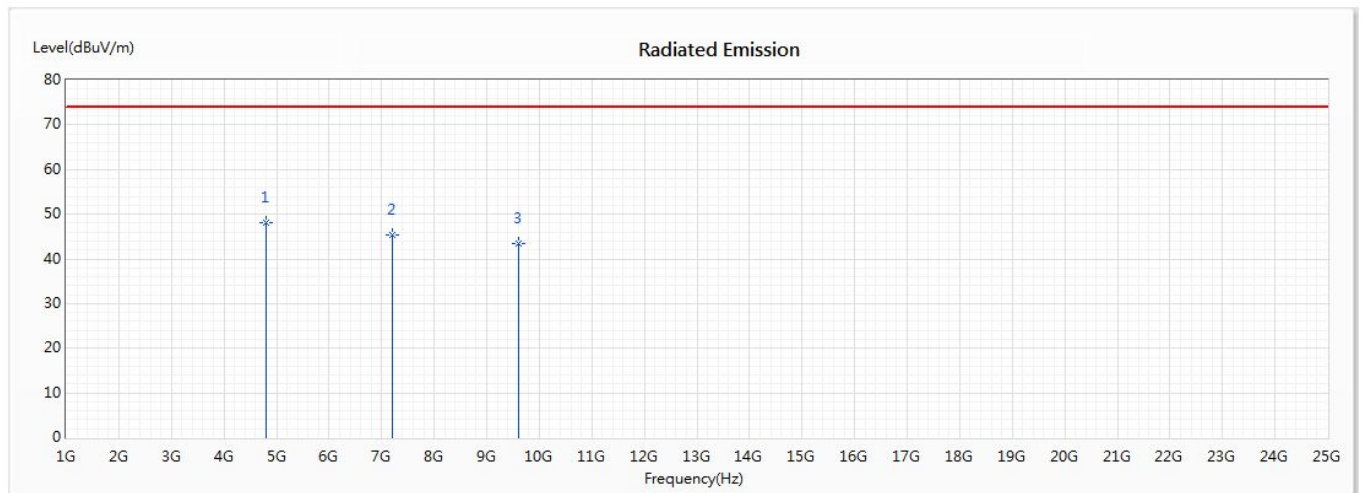
± 4.08 dB above 1GHz

± 4.22 dB below 1GHz

4.5. Test Result of Radiated Emission

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Harmonic Radiated Emission
 Test date : 2020/01/07
 Test Mode : Mode 1: Transmit - BLE (GFSK)(2402MHz)

Horizontal



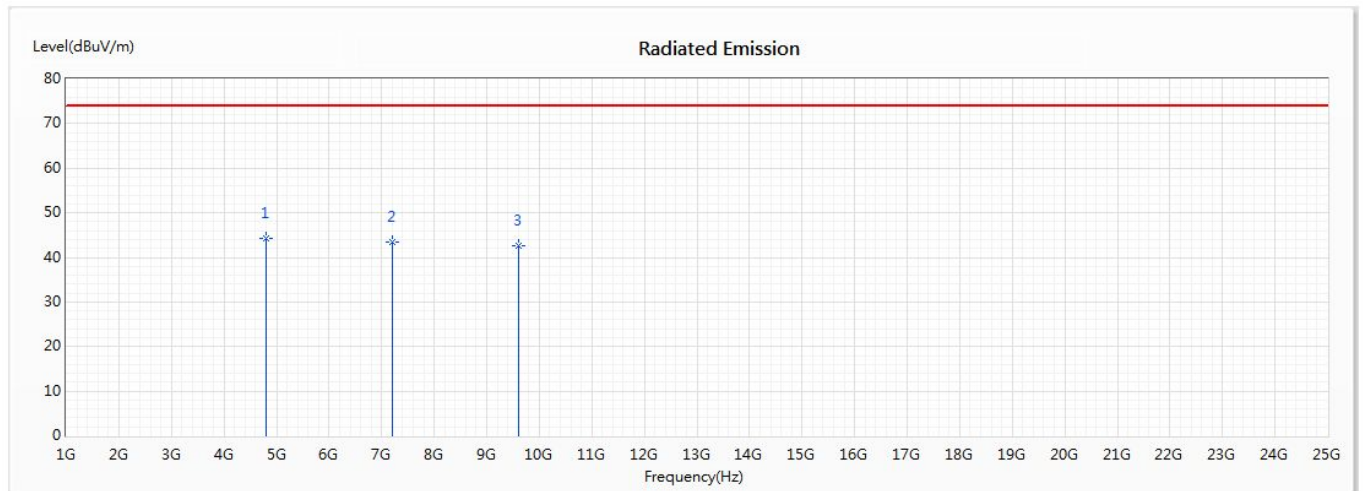
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
* 1	4804	47.99	74.00	-26.01	60.14	-12.15	PK
2	7206	45.48	74.00	-28.52	58.62	-13.14	PK
3	9608	43.39	74.00	-30.61	56.81	-13.42	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Harmonic Radiated Emission
 Test date : 2020/01/07
 Test Mode : Mode 1: Transmit - BLE (GFSK)(2402MHz)

Vertical



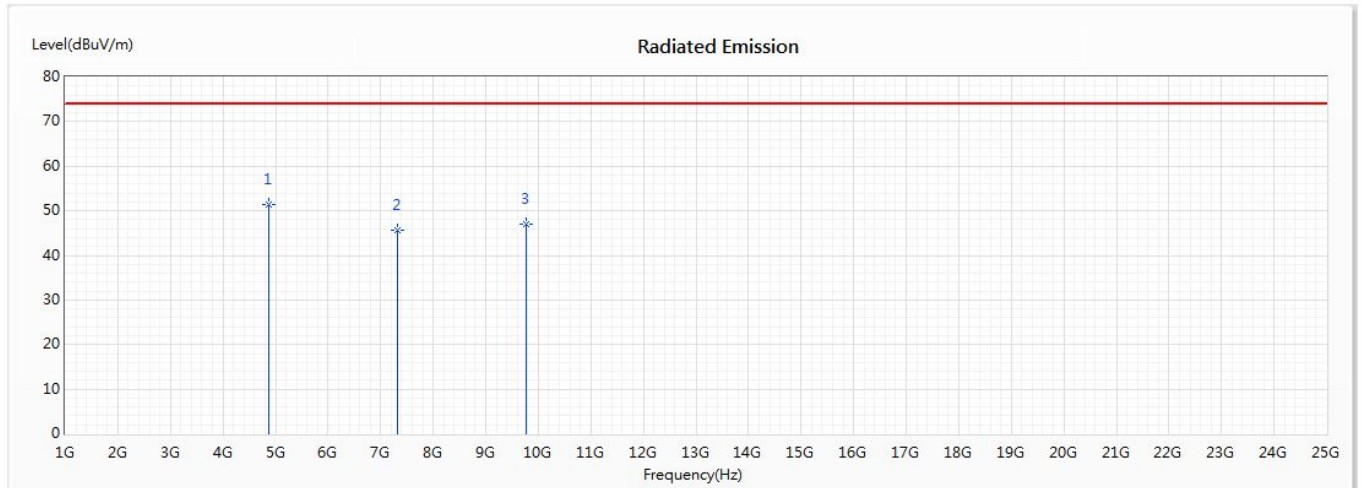
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
* 1	4804	44.19	74.00	-29.81	56.34	-12.15	PK
2	7206	43.43	74.00	-30.57	56.57	-13.14	PK
3	9608	42.69	74.00	-31.31	56.11	-13.42	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Harmonic Radiated Emission
 Test date : 2020/01/07
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

Horizontal



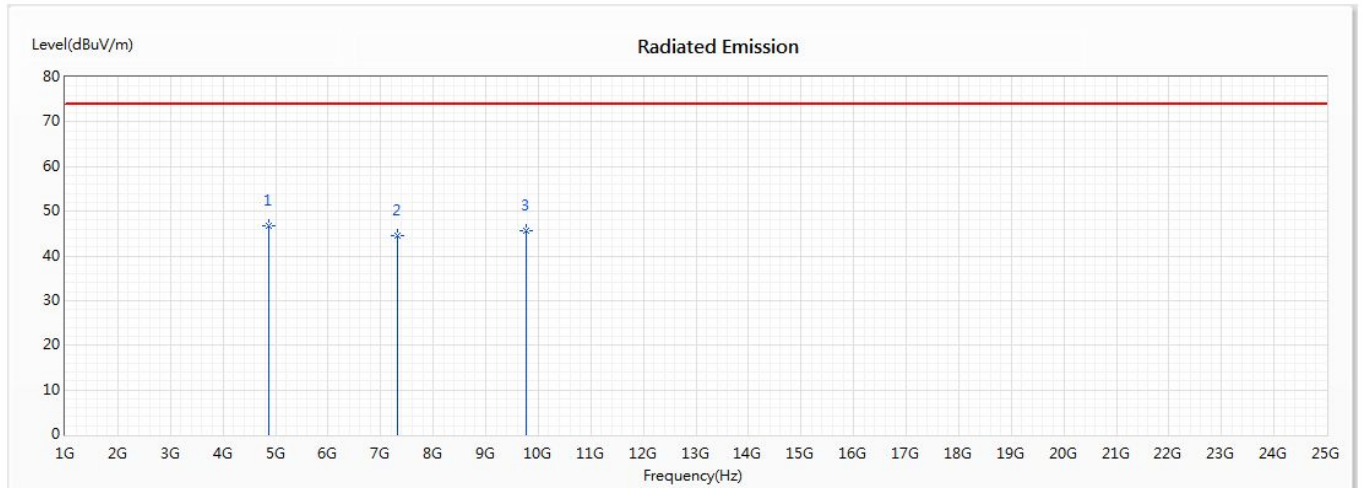
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
* 1	4880	51.31	74.00	-22.69	62.91	-11.60	PK
2	7320	45.66	74.00	-28.34	59.21	-13.55	PK
3	9760	46.88	74.00	-27.12	59.36	-12.48	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Harmonic Radiated Emission
 Test date : 2020/01/09
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

Vertical



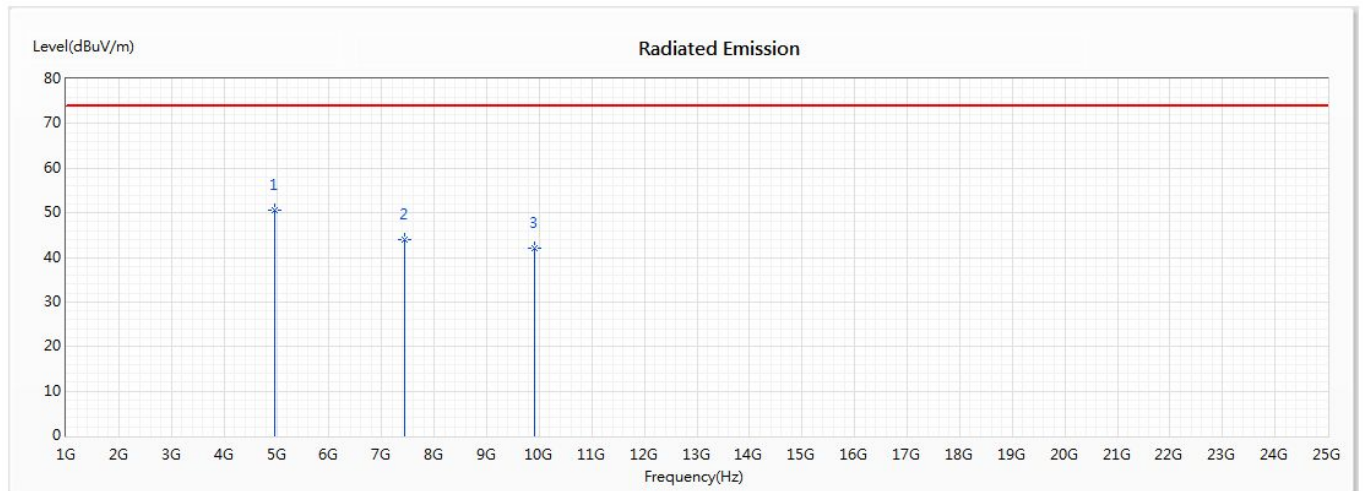
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
* 1	4880	46.87	74.00	-27.13	58.47	-11.60	PK
2	7320	44.50	74.00	-29.50	58.05	-13.55	PK
3	9760	45.68	74.00	-28.32	58.16	-12.48	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Harmonic Radiated Emission
 Test date : 2020/01/09
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

Horizontal



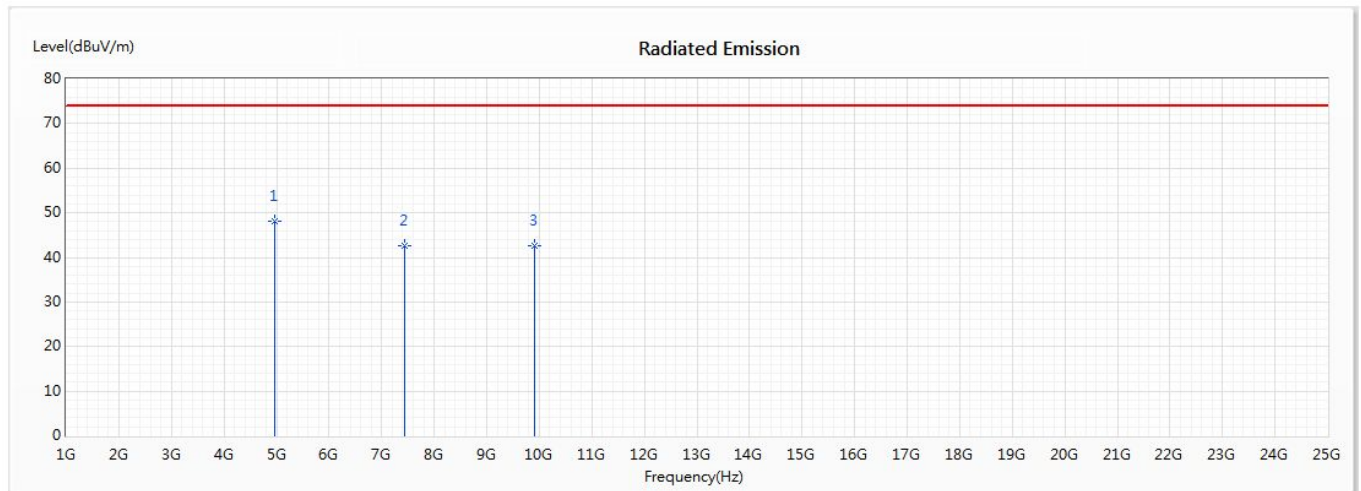
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
* 1	4960	50.69	74.00	-23.31	61.58	-10.89	PK
2	7440	43.85	74.00	-30.15	58.47	-14.62	PK
3	9920	42.14	74.00	-31.86	56.37	-14.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Harmonic Radiated Emission
 Test date : 2020/01/09
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

Vertical



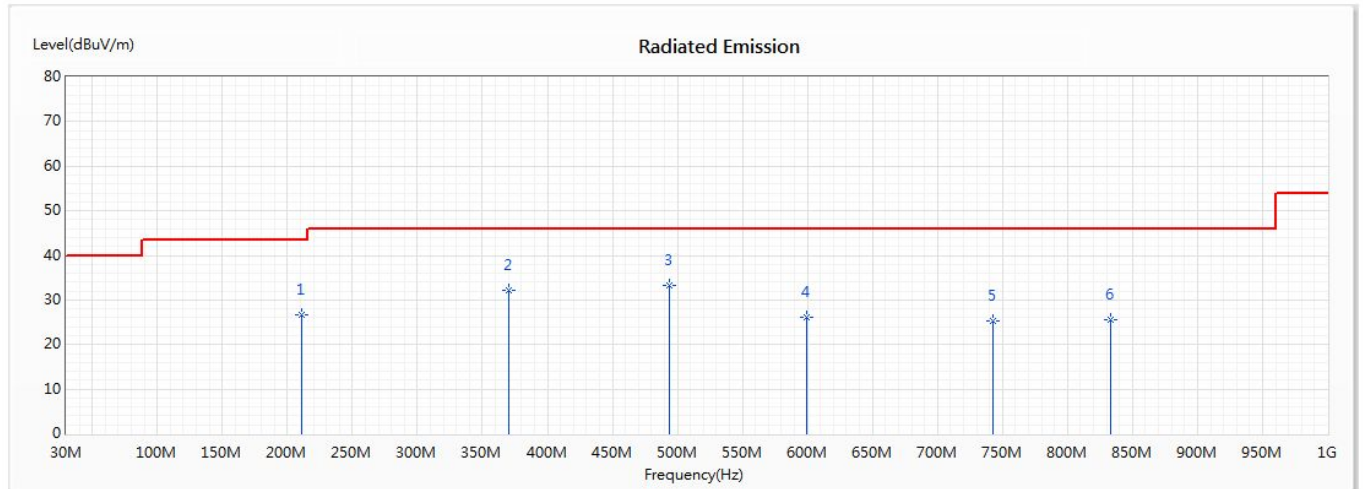
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
* 1	4960	48.11	74.00	-25.89	59.00	-10.89	PK
2	7440	42.60	74.00	-31.40	57.22	-14.62	PK
3	9920	42.51	74.00	-31.49	56.74	-14.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The average measurement was not performed when the peak measured data under the limit of average detection.
5. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : General Radiated Emission
 Test date : 2020/01/10
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

Horizontal



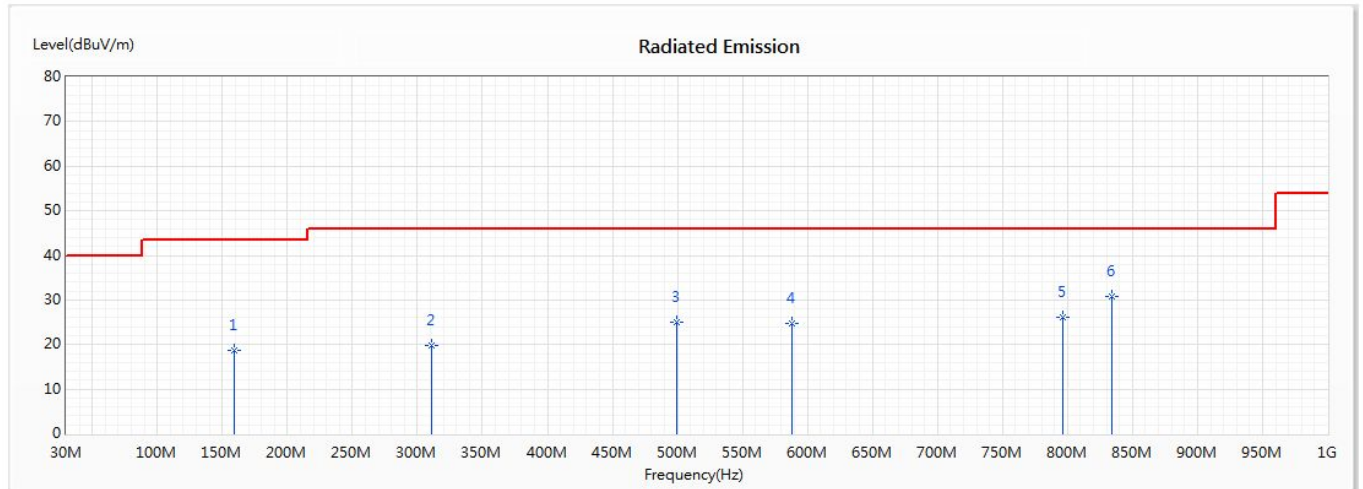
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
1	211.348	26.63	43.50	-16.87	44.83	-18.20	QP
2	370.203	32.26	46.00	-13.74	44.62	-12.36	QP
* 3	493.913	33.35	46.00	-12.65	44.60	-11.25	QP
4	599.348	26.11	46.00	-19.89	32.74	-6.63	QP
5	742.739	25.25	46.00	-20.75	31.07	-5.82	QP
6	832.71	25.50	46.00	-20.50	34.13	-8.63	QP

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The emission levels of other frequencies are very lower than the limit and not show in test report.
5. No emission found between lowest internal used/generated frequency to 30MHz.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : General Radiated Emission
 Test date : 2020/01/10
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

Vertical



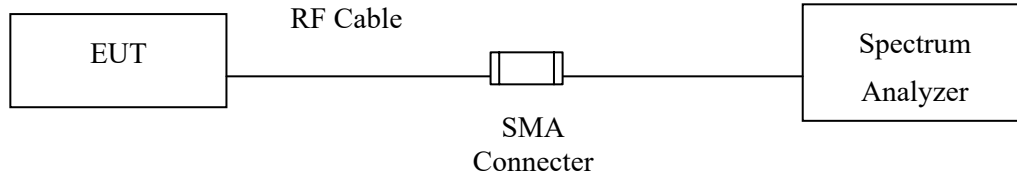
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
1	159.333	18.56	43.50	-24.94	39.27	-20.71	QP
2	311.159	19.87	46.00	-26.13	34.20	-14.33	QP
3	499.536	24.89	46.00	-21.11	35.75	-10.86	QP
4	588.101	24.77	46.00	-21.23	31.91	-7.14	QP
5	796.159	26.06	46.00	-19.94	34.92	-8.86	QP
* 6	834.116	30.75	46.00	-15.25	39.34	-8.59	QP

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The emission levels of other frequencies are very lower than the limit and not show in test report.
5. No emission found between lowest internal used/generated frequency to 30MHz.

5. RF Antenna Conducted Test

5.1. Test Setup



5.2. Limits

According to FCC 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 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

5.3. Test Procedure

The EUT was tested according to C63.10:2013 Section 11.11 for compliance to FCC 47CFR 15.247 requirements.

Set RBW = 100 kHz, Set VBW > RBW, scan up through 10th harmonic.

5.4. Uncertainty

$\pm 1.20\text{dB}$

5.5. Test Result of RF Antenna Conducted Test

Product : ThinkPad TrackPoint Keyboard II
Test Item : RF Antenna Conducted Test
Test date : 2020/01/03
Test Mode : Mode 1: Transmit - BLE (GFSK)

Figure Channel 00:

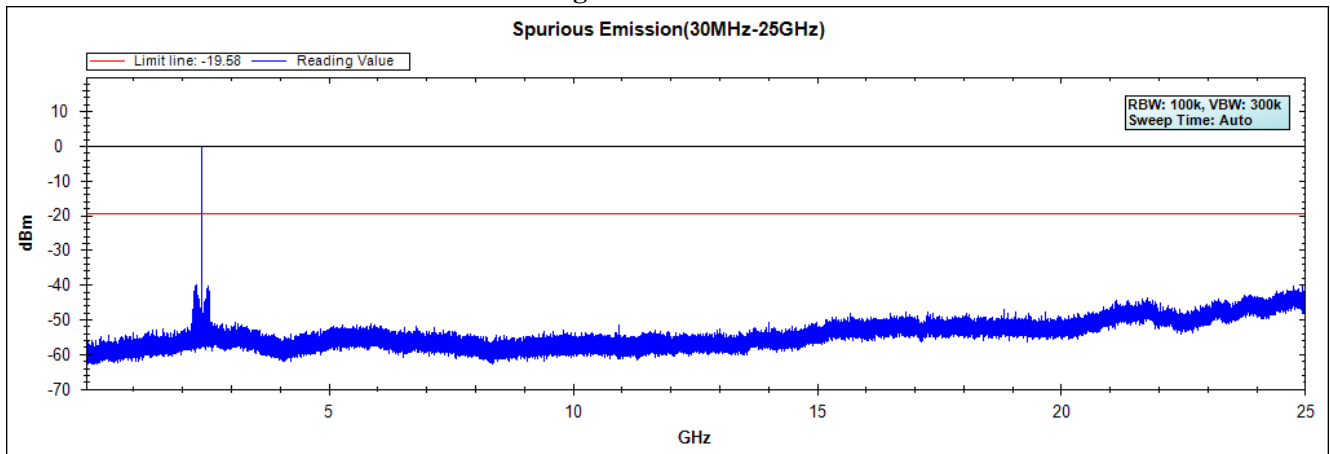


Figure Channel 19:

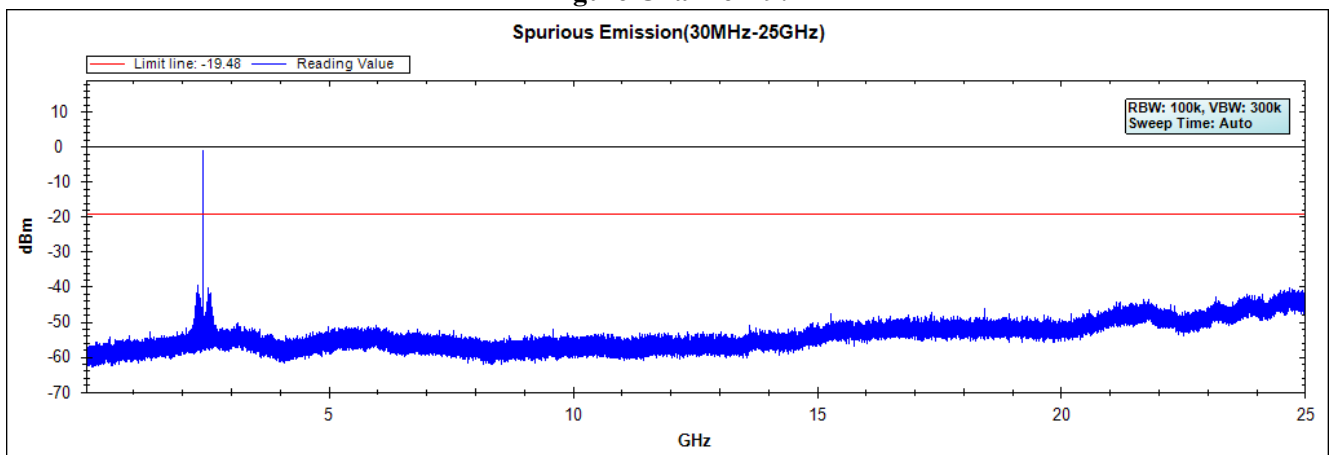
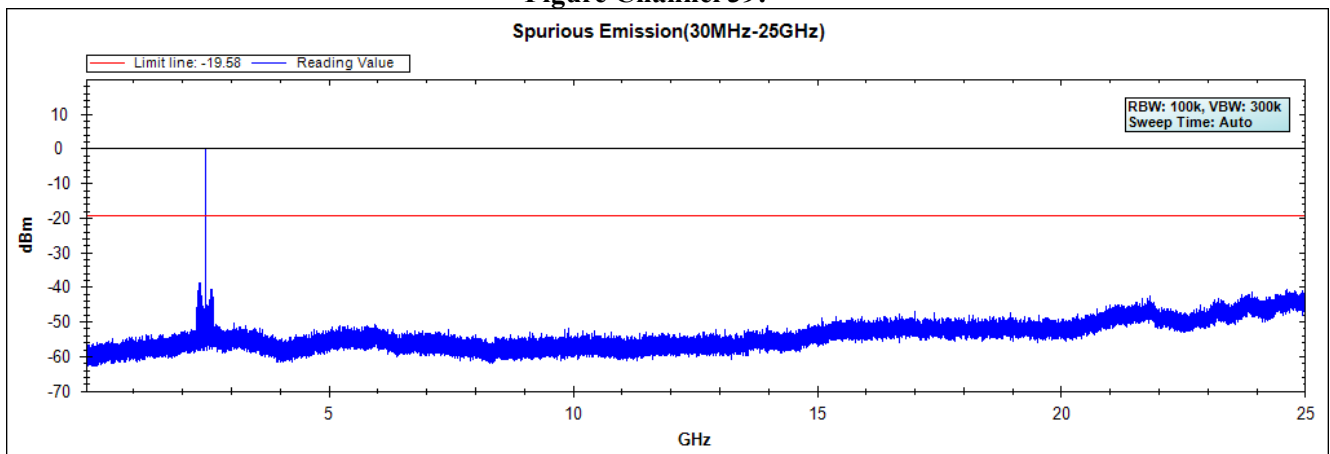


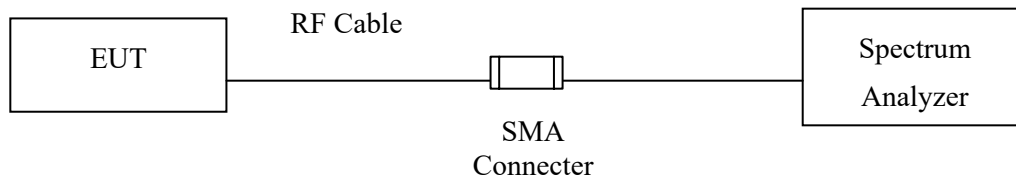
Figure Channel 39:



6. Band Edge

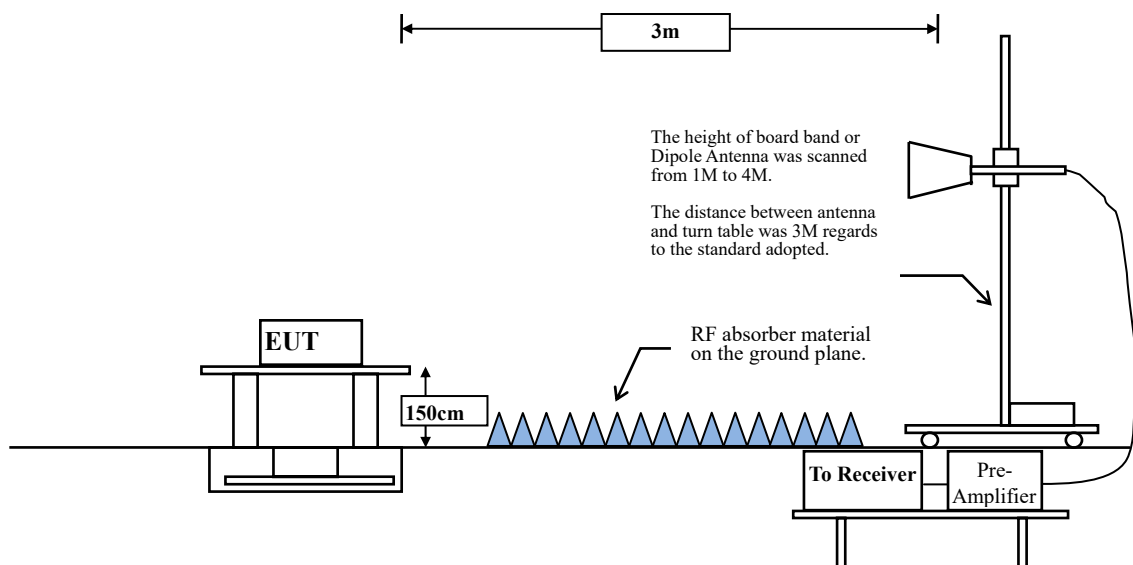
6.1. Test Setup

RF Conducted Measurement



RF Radiated Measurement:

Above 1GHz



6.2. Limit

According to FCC 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 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. 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)).

6.3. Test Procedure

The EUT was setup according to ANSI C63.10, 2013 and tested according to C63.10:2013 Section 11.12.1 for compliance to FCC 47CFR 15.247 requirements.

The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10:2013 on radiated measurement.

RBW and VBW Parameter setting:

According to C63.10 Section 11.12.2.4 Peak measurement procedure

RBW = as specified in Table 1.

$VBW \geq 3 \times RBW$.

Table 1 —RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

According to C63.10 Section 11.12.2.5 Average measurement procedure

RBW = 1MHz.

VBW = 10Hz, when duty cycle $\geq 98 \%$

$VBW \geq 1/T$, when duty cycle $< 98 \%$

(T refers to the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.)

2.4GHz band	Duty Cycle (%)	T (ms)	1/T (Hz)	VBW (Hz)
BLE	62.59	0.3919	2552	3000

Note: Duty Cycle Refer to Section 9

6.4. Uncertainty

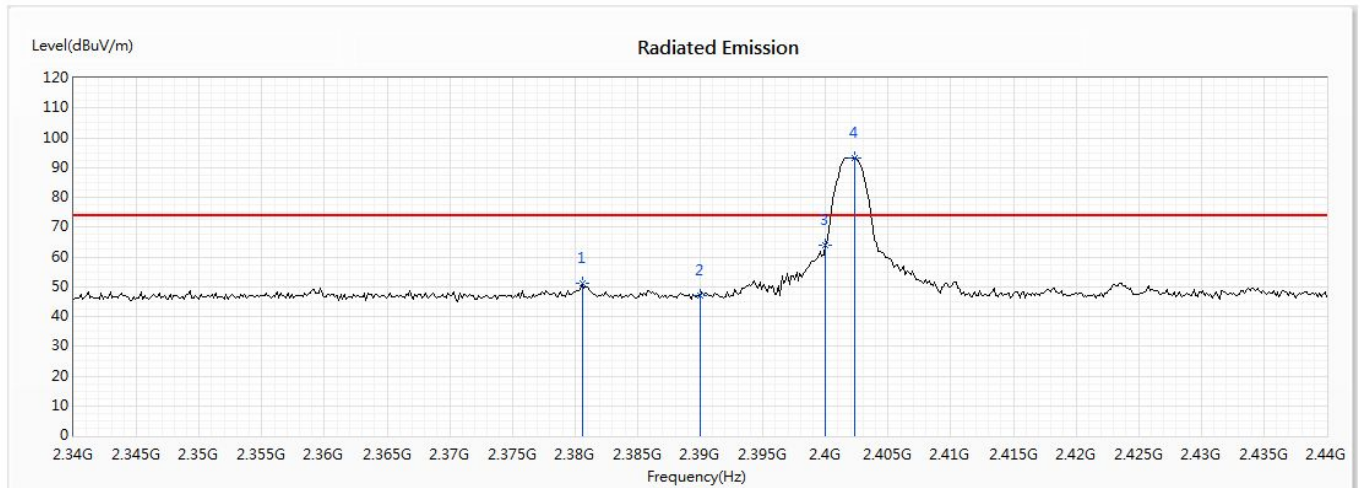
± 4.08 dB above 1GHz

± 4.22 dB below 1GHz

6.5. Test Result of Band Edge

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2402MHz)

Horizontal



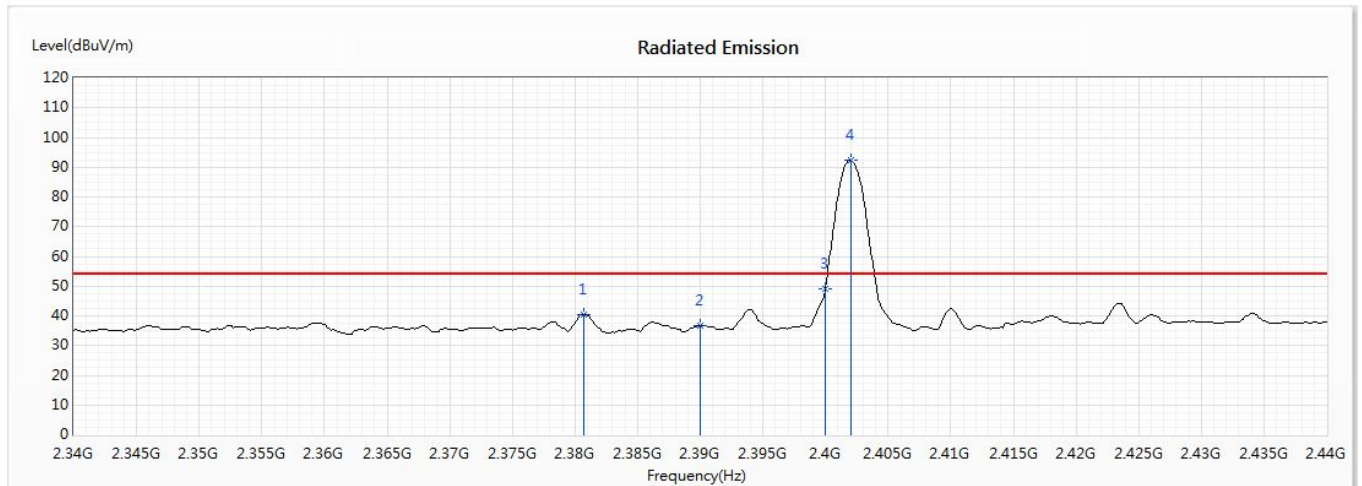
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
1	2380.58	51.03	74.00	-22.97	38.18	12.85	PK
2	2390	47.11	74.00	-26.89	34.22	12.89	PK
3	2400	63.74	--	--	50.78	12.96	PK
! 4	2402.319	93.28	--	--	80.31	12.97	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2402MHz)

Horizontal



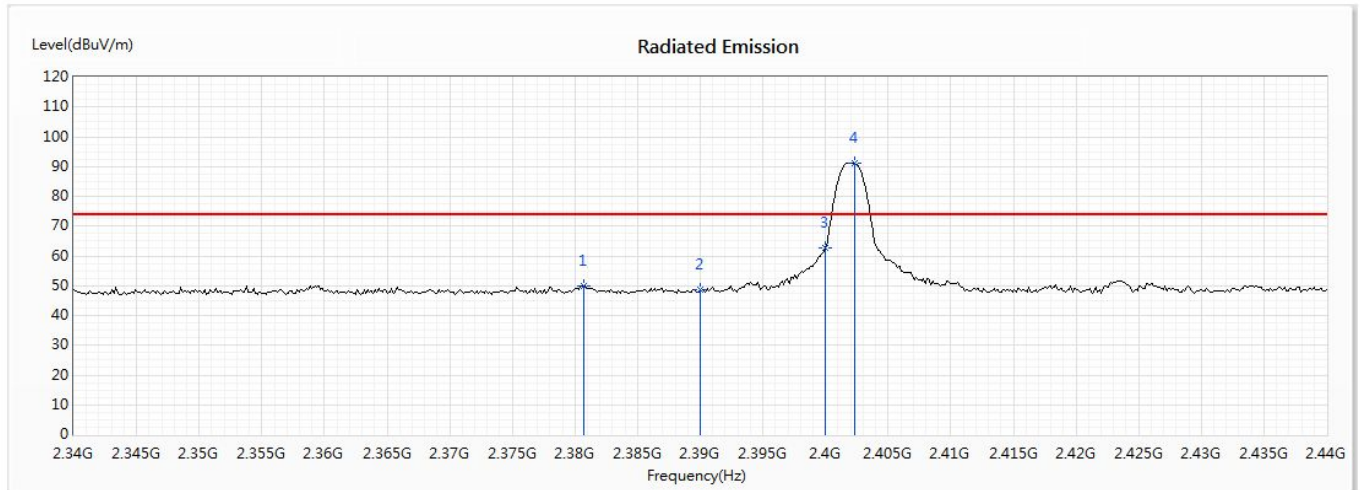
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
1	2380.725	40.58	54.00	-13.42	27.73	12.85	AV
2	2390	36.69	54.00	-17.31	23.80	12.89	AV
3	2400	49.25	--	--	36.29	12.96	AV
! 4	2402.029	92.22	--	--	79.25	12.97	AV

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2402MHz)

Vertical



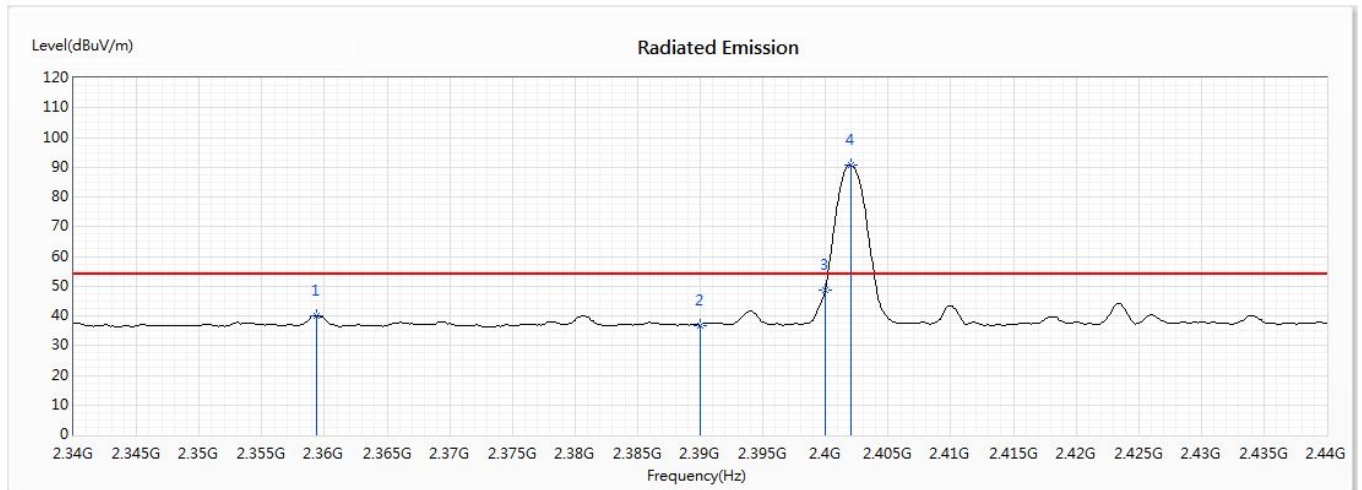
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
1	2380.725	49.75	74.00	-24.25	36.90	12.85	PK
2	2390	48.46	74.00	-25.54	35.57	12.89	PK
3	2400	62.79	--	--	49.83	12.96	PK
! 4	2402.319	91.04	--	--	78.07	12.97	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2402MHz)

Vertical



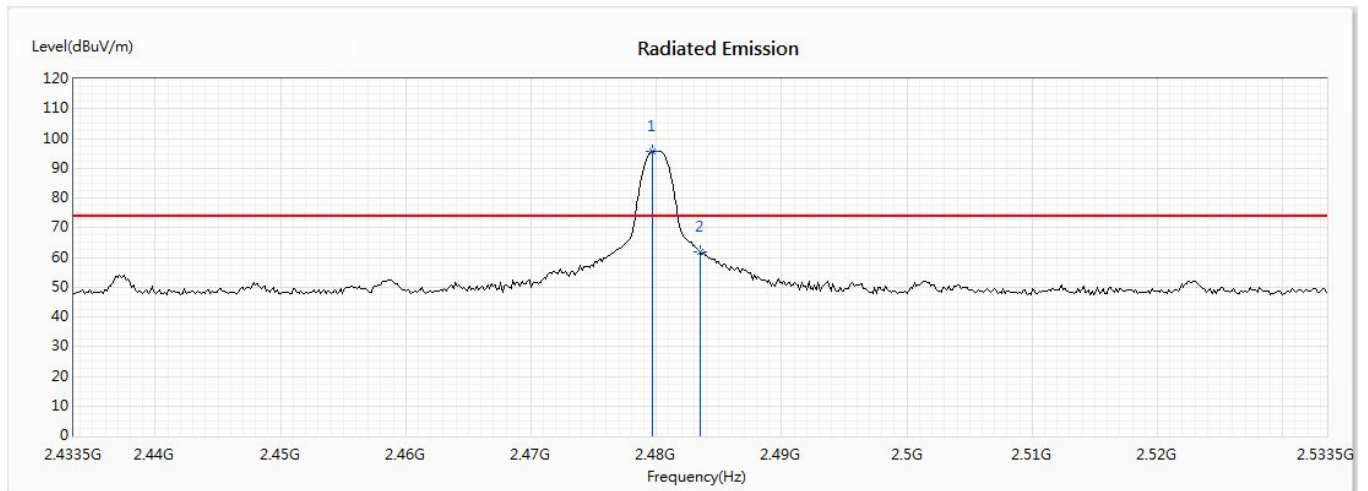
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
1	2359.42	40.10	54.00	-13.90	27.37	12.73	AV
2	2390	36.90	54.00	-17.10	24.01	12.89	AV
3	2400	48.78	--	--	35.82	12.96	AV
! 4	2402.029	90.62	--	--	77.65	12.97	AV

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

Horizontal



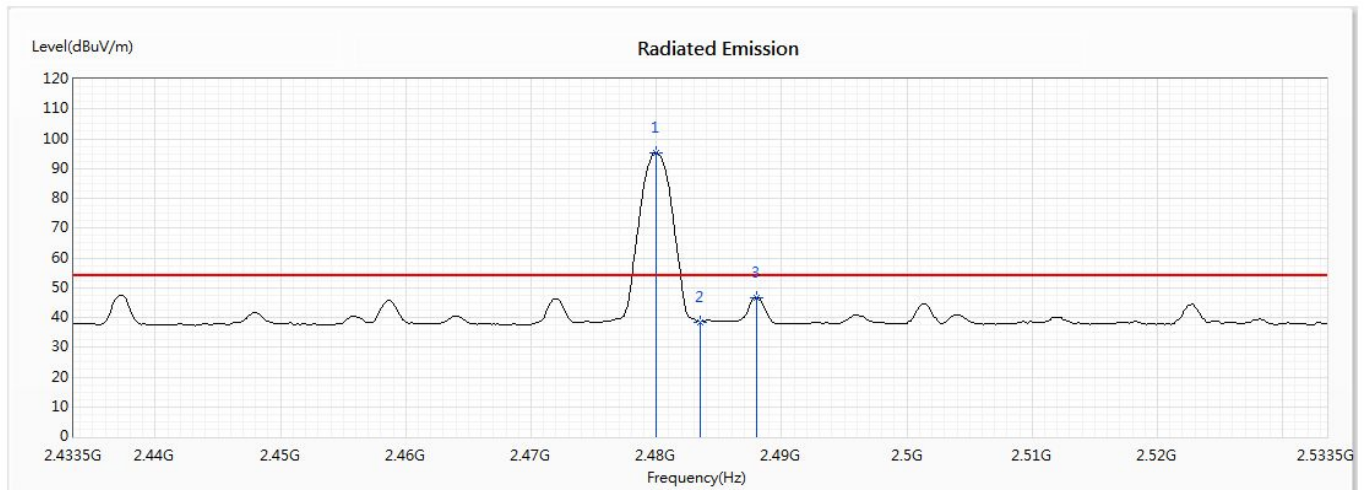
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
! 1	2479.732	95.65	--	--	82.28	13.37	PK
2	2483.5	61.66	74.00	-12.34	48.28	13.38	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

Horizontal



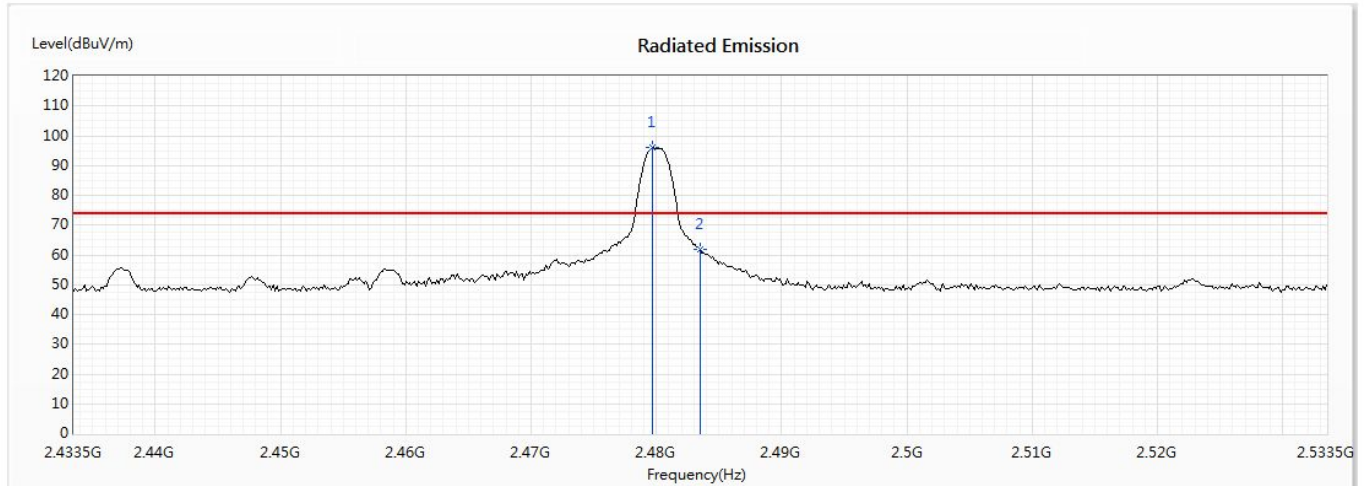
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
! 1	2480.022	95.10	--	--	81.73	13.37	AV
2	2483.5	38.50	54.00	-15.50	25.12	13.38	AV
3	2487.993	46.65	54.00	-7.35	33.26	13.39	AV

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

Vertical



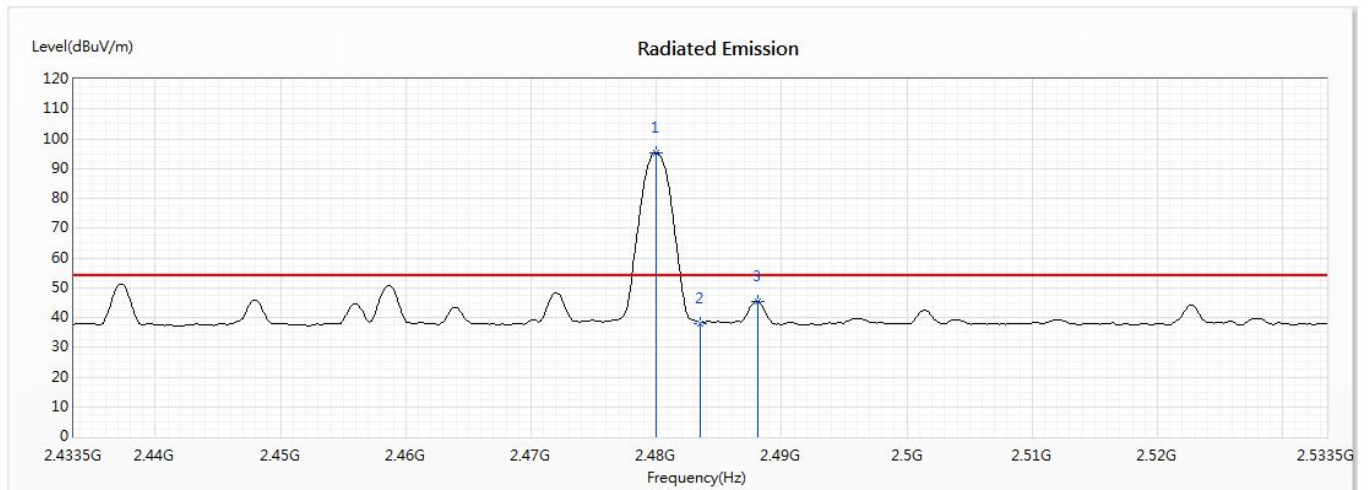
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
! 1	2479.732	95.91	--	--	82.54	13.37	PK
2	2483.5	61.78	74.00	-12.22	48.40	13.38	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Band Edge
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

Vertical



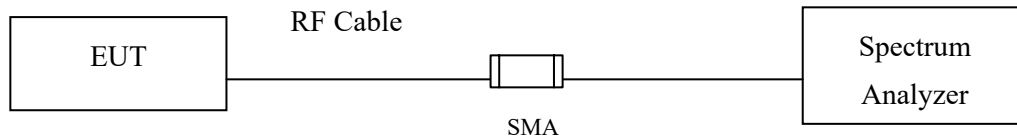
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB/m)	Detector Type
! 1	2480.022	95.35	--	--	81.98	13.37	AV
2	2483.5	38.13	54.00	-15.87	24.75	13.38	AV
3	2488.138	45.25	54.00	-8.75	31.86	13.39	AV

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Emission Level = Reading Level + Correct Factor.

7. 6dB Bandwidth

7.1. Test Setup



7.2. Limits

The minimum bandwidth shall be at least 500 kHz.

7.3. Test Procedure

The EUT was setup according to ANSI C63.10, 2013; tested according to ANSI C63.10 Section 11.8 for compliance to FCC 47CFR 15.247 requirements.

Set RBW = 1-5% of the emission bandwidth, $VBW \geq 3 * RBW$

7.4. Uncertainty

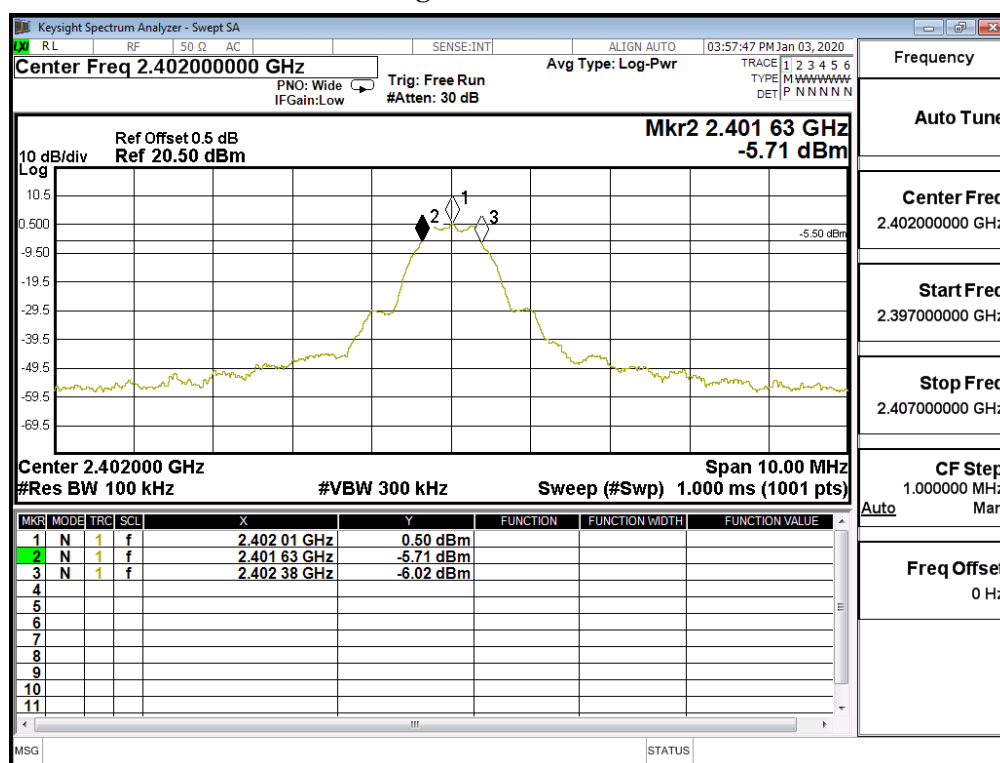
$\pm 283\text{Hz}$

7.5. Test Result of 6dB Bandwidth

Product : ThinkPad TrackPoint Keyboard II
 Test Item : 6dB Bandwidth Data
 Test date : 2020/01/03
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2402MHz)

Channel No.	Frequency (MHz)	Measurement Level (kHz)	Required Limit (kHz)	Result
00	2402	750	>500	Pass

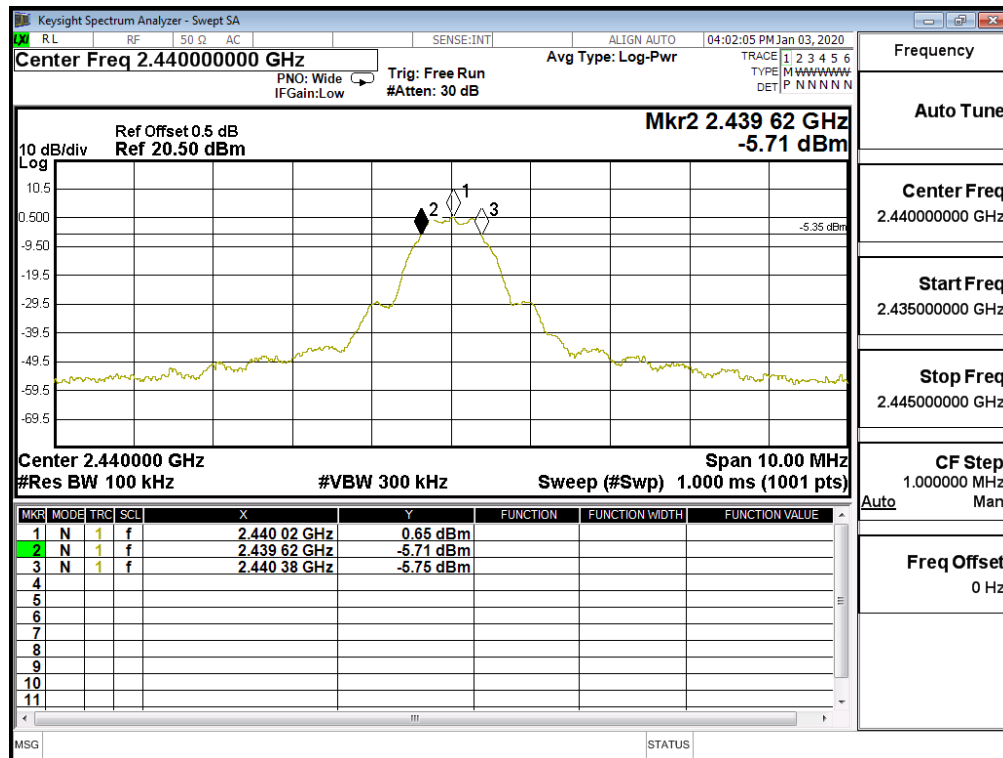
Figure Channel 00:



Product : ThinkPad TrackPoint Keyboard II
 Test Item : 6dB Bandwidth Data
 Test date : 2020/01/03
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

Channel No.	Frequency (MHz)	Measurement Level (kHz)	Required Limit (kHz)	Result
19	2440	760	>500	Pass

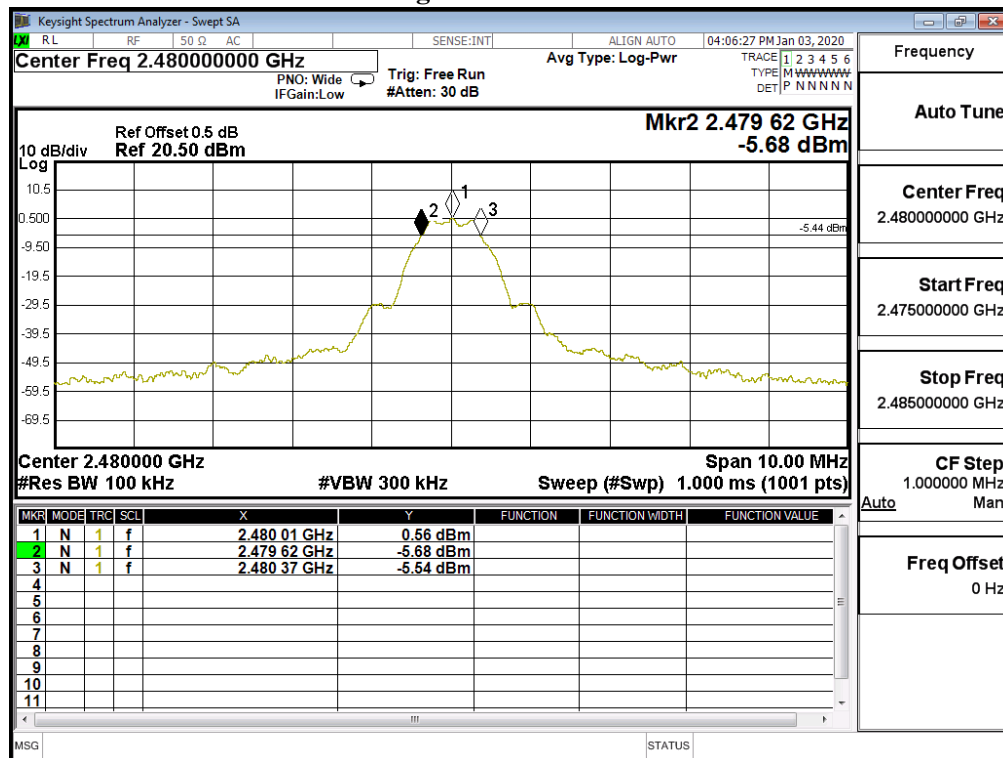
Figure Channel 19:



Product : ThinkPad TrackPoint Keyboard II
 Test Item : 6dB Bandwidth Data
 Test date : 2020/01/03
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

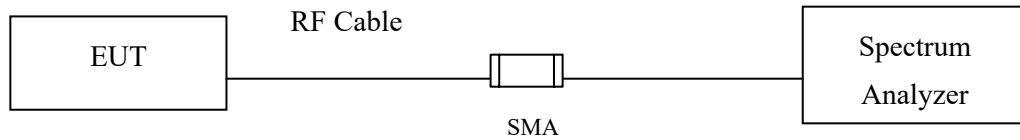
Channel No.	Frequency (MHz)	Measurement Level (kHz)	Required Limit (kHz)	Result
39	2480	750	>500	Pass

Figure Channel 39:



8. Power Density

8.1. Test Setup



8.2. Limits

The transmitted power density averaged over any 1 second interval shall not be greater +8dBm in any 3kHz bandwidth.

8.3. Test Procedure

The EUT was setup according to ANSI C63.10, 2013; tested according to DTS test procedure of C63.10 Section 11.10.2 for compliance to FCC 47CFR 15.247 requirements.

The maximum power spectral density using C63.10 Section 11.10.2 Method PKPSD (peak PSD).

8.4. Uncertainty

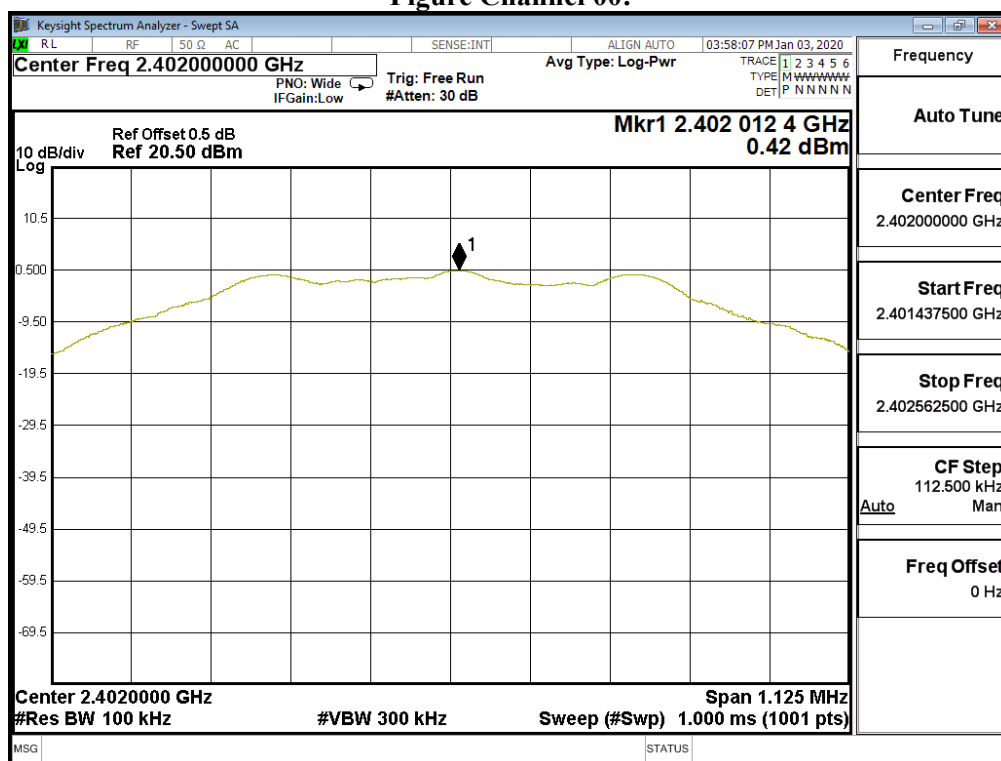
± 1.20 dB

8.5. Test Result of Power Density

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Power Density Data
 Test date : 2020/01/03
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2402MHz)

Channel No.	Frequency (MHz)	Measure Level (dBm)	Limit (dBm)	Result
00	2402	0.42	$\leq 8\text{dBm}$	Pass

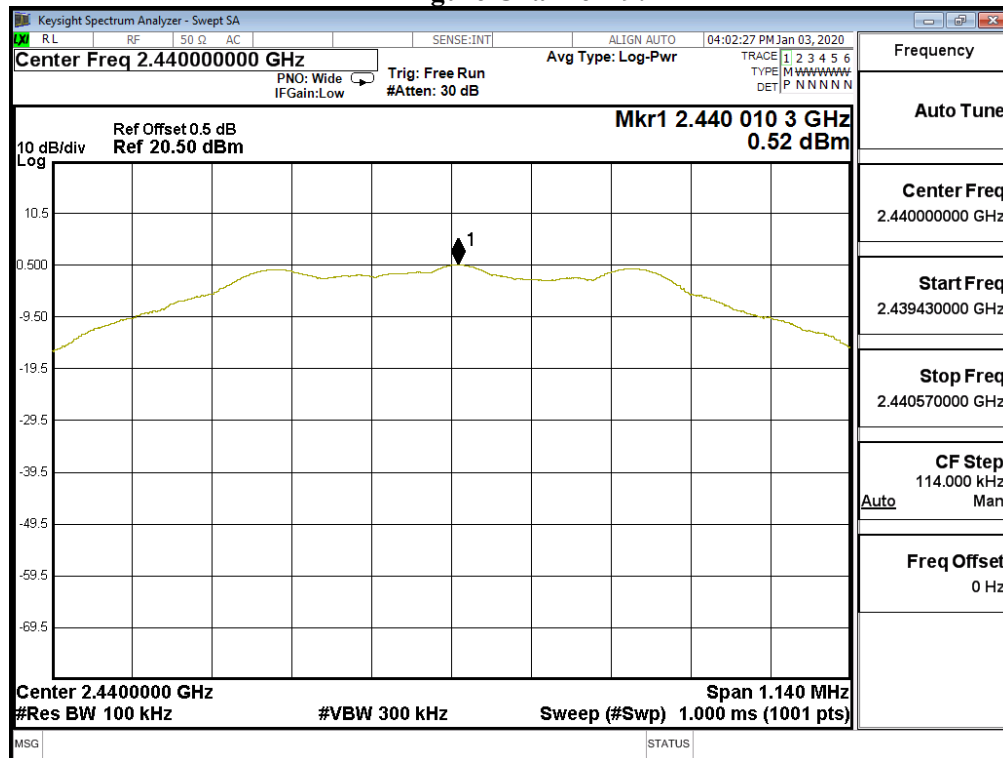
Figure Channel 00:



Product : ThinkPad TrackPoint Keyboard II
 Test Item : Power Density Data
 Test date : 2020/01/03
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2440MHz)

Channel No.	Frequency (MHz)	Measurement Level (dBm)	Required Limit (dBm)	Result
19	2440	0.52	$\leq 8\text{dBm}$	Pass

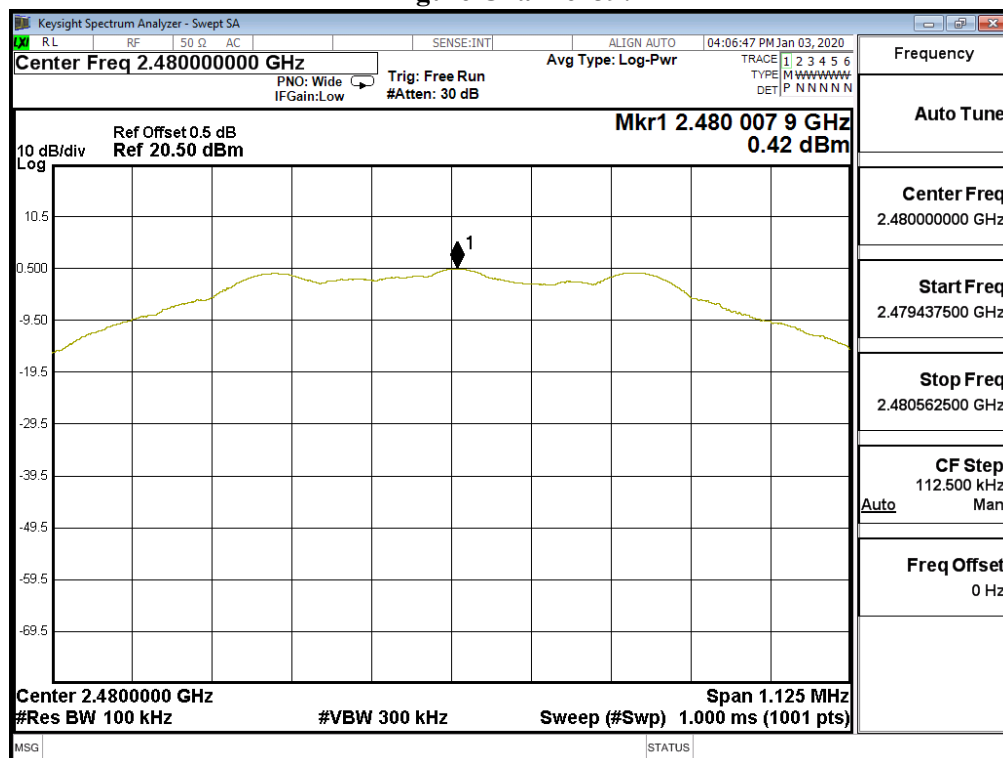
Figure Channel 19:



Product : ThinkPad TrackPoint Keyboard II
 Test Item : Power Density Data
 Test date : 2020/01/03
 Test Mode : Mode 1: Transmit - BLE (GFSK) (2480MHz)

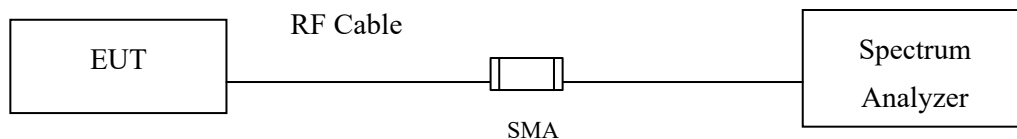
Channel No.	Frequency (MHz)	Measurement Level (dBm)	Required Limit (dBm)	Result
39	2480	0.42	$\leq 8\text{dBm}$	Pass

Figure Channel 39:



9. Duty Cycle

9.1. Test Setup



9.2. Test Procedure

The EUT was setup according to ANSI C63.10 2013; tested according to ANSI C63.10 2013 for compliance to FCC 47CFR 15.247 requirements.

9.3. Uncertainty

$\pm 2.31\text{msec}$

9.4. Test Result of Duty Cycle

Product : ThinkPad TrackPoint Keyboard II
 Test Item : Duty Cycle
 Test date : 2020/01/06
 Test Mode : Mode 1: Transmit - BLE (GFSK)

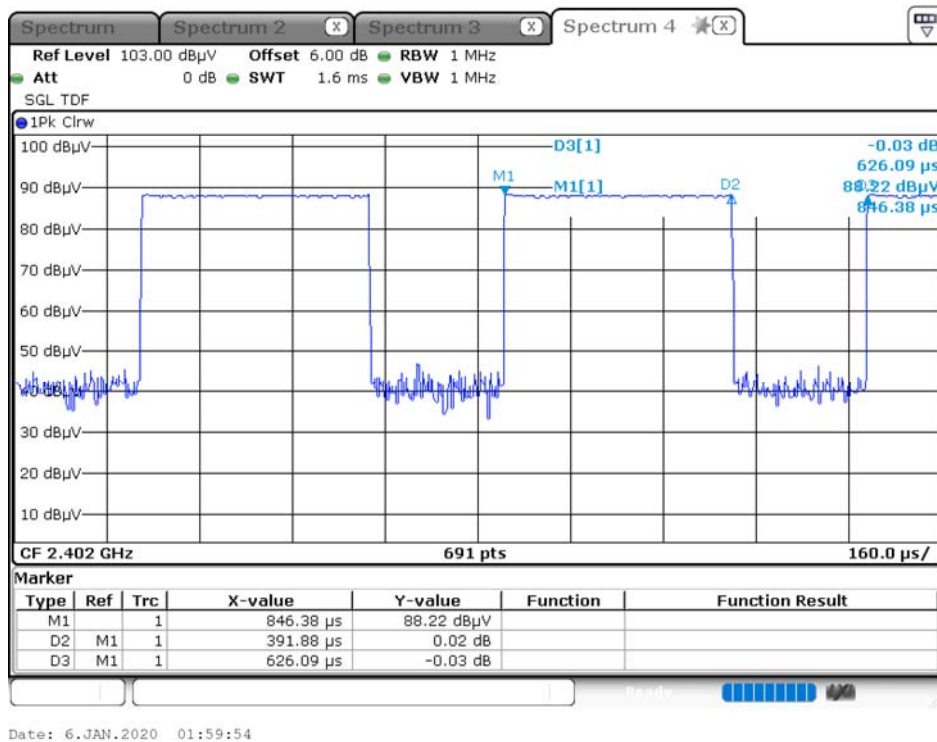
Duty Cycle Formula:

Duty Cycle = Ton / (Ton + Toff)

Duty Factor = 10 Log (1/Duty Cycle)

Results:

2.4GHz band	Ton (ms)	Ton + Toff (ms)	Duty Cycle (%)	Duty Factor (dB)
BLE	0.3919	0.6261	62.59	2.03



10. EMI Reduction Method During Compliance Testing

No modification was made during testing.