Test Report

Test Report Number	EOTEL107
Applied Standard(s)	FCC Part15 Subpart C 15.205 15.207 15.209 15.247,ANSI C63.10-2013
Date of Issue	20th, August 2015
Testing Laboratory Address	e-OHTAMA,LTD. Tokyo Laboratory 2-8-20 Kurigi, Asao-ku Kawasaki-shi, Kanagawa, 215-0033 Japan
Test Date(s)	29th May, 2015 - 30th May, 2015, 20th August, 2015
Product Name	Equipment built-in 2.4GHz band transceiver module
Model Number	HRF-2401
Serial Number	-
Applicant (Client) Address	62-1, Toyooka-Cho, Kita-ku, Hamamatsu-city Shizuoka, 433-8103, Japan HERUTU ELECTRONICS CORPORATION
Manufacturer Address	62-1, Toyooka-Cho, Kita-ku, Hamamatsu-city Shizuoka, 433-8103, Japan HERUTU ELECTRONICS CORPORATION
FCC ID	FCC ID : T82HRF-2401

Test Result

The test result for the electromagnetic compatibility tests as described in the section 1 to 2 and in this page was:

Pass

Tested by: Katsutoshi Hatanaka
Katsutoshi Hatanaka
Test Enginner

Approved by: Koji Imai
Koji Imai
Testing Group Leader

Checked box (☒) indicates that the listed condition, standard or equipment is applicable for this Report.
Blank box (☐) indicates that the listed condition, standard or equipment is not applicable for this Report.

Test results of this report refer only to the EUT tested here.

Page

1. Summary

1.1 Terms and definitions

AV
Average

DoC
Declaration of Conformity

EUT
Equipment Under Test

PK
Peak

QP
Quasi-peak

1.2 Standard(s) and Result

Applied Standard(s)	Normative Reference(s)	Classification	Result	Note
FCC Part15 Subpart C	6dB Bandwidth	15.247(a)(2)	Pass	
	Maximum Peak Output Power	15.247(b)(3)	Pass	
	Band Edge of Compliance of RF Conducted Emissions	15.247(d)	Pass	
	Peak Power Spectral Density	15.247(e)	Pass	
	Line Conducted Measurement	15.207	Pass	
	Radiated emissions	15.209 15.205	Pass	

1.3 Test Methodology

All mesurements contained in this report were conducted with ANSI C63.10-2003,American National Standard for Methods of Mesurement of Radio-Niose Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9kHz to 40GHz.
The KDB558074 for Revision to Compliance Measurement Guidance shall be performed also.

2. Equipment Under Test (EUT)

2.1 General Descriptions

Equipment built-in 2.4GHz band transceiver module.

2.2 Detailed Descriptions

Product Name	Equipment built-in 2.4GHz band transceiver module
Model Number	HRF-2401
Serial Number	-
Power Supply	5.0Vdc
Dimension	20 mm × 30 mm × 3 mm
Operating Frequency	2403.000MHz – 2478.000MHz
Normal Placement	outdoor
Condition of the EUT	Prototype

2.3 WORST-CASE CONFIGURATION AND MODE

(a) EUT axes

The fundamental was measured in three different orientations X, Y and Z to find worst-case orientation, and it was found that Y orientation is worst-case; therefore final testing for radiated emissions was performed with EUT in X orientation with Cable.

2.4 Operation Mode(s) of the EUT for EMC during the Test(s)

Operation Mode Name	Description
GFSK	Normal operationTx mode

2.5 Peripheral Devices

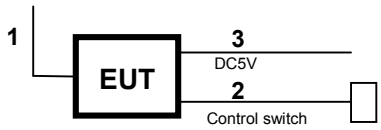
Mark	Description	Model Number	Serial Number	FCC ID Code or DoC status	Manufacturer
1	Personal Computer	S-10-3	QB02052841	DoC	lenovo

2.6 Interconnecting Cables

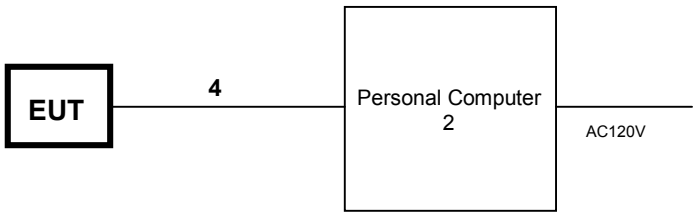
Mark	Description	Length (m)	Shielded		Tested Port(s) (Note:1)	
			Cable	Connector	Applicable	Interface
1	Antenna cable	0.10	Yes	Yes	No	RF cable
2	Control switch cable	0.30	No	Yes	No	I/O signal
3	Power cable	0.30	No	Yes	No	DC power

2.7 System Configuration

Unless otherwise specified in the following sections, the test configuration described here is applied for the tests. The configuration was choice by the applicant.



Conducted1(RF TEST)



Conducted2(15.207)

Radiated(15.209)

2.8 Labeling Requirements

Per 15.19; Docket 95-19

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphlet supplied to the user and be readily visible to the purchaser at the time of purchase. However, when the device is so small wherein placement of the label with specified statement is not practical, only the trade name and FCC ID must be displayed on the device per Section 15.19(b)(2).
Please see attachment for FCC ID label and label location

2.9 Antenna Requirements

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 t to comply with the provisions of this section."

The antennas of the HERUTU ELECTRONICS CORPORATION are permanently attached or uses a unique coupling to the intentional radiator.

Conclusion:
HERUTU ELECTRONICS CORPORATION unit complies with the requirement of §15.203.

< Type of use antenna >

1 . Internal antenna

①1/4λDipole chip antenna	Antenna Gain : -2.13dBi

2 . External antenna

①1/4λDipole antenna(Flying Lead and U-FL connector)	Antenna Gain : +2.0dBi
②1/2λDipole antenna(SMB Male connector)	Antenna Gain : +2.0dBi
③1/2λDipole antenna(SMB Male connector)	Antenna Gain : +2.0dBi
Magnet Base Cable :RG174-1.5m	(Cable Loss : 2.1 d B)

2.10 Modular transmitter Requirements

Excerpt from §15.212 of the FCC Rules/Regulations:

"Single modular transmitters must meet the following requirements to obtain a modular transmitter approval."

(i) The radio elements of the modular transmitter must have their own shielding. The physical crystal and tuning capacitors may be located external to the shielded radio elements.

(ii) The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with Part 15 requirements under conditions of excessive data rates or over-modulation.

(iii) The modular transmitter must have its own power supply regulation.

(iv) The modular transmitter must comply with the antenna and transmission system requirements of Sections 15.203, 15.204(b) and 15.204(c). The antenna must either be permanently attached or employ a "unique" antenna coupler (at all connections between the module and the antenna, including the cable). The "professional installation" provision of Section 15.203 is not applicable to modules but can apply to limited modular approvals under paragraph (b) of this section.

(v) The modular transmitter must be tested in a stand-alone configuration, i.e., the module must not be inside another device during testing for compliance with Part 15 requirements. Unless the transmitter module will be battery powered, it must comply with the AC line conducted requirements found in Section 15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will be marketed with the module (see Section 15.27(a)). The length of these lines shall be the length typical of actual use or, if that length is unknown, at least 10 centimeters to insure that there is no coupling between the case of the module and supporting equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified and commercially available (see Section 15.31(i)).

(vi) The modular transmitter must be equipped with either a permanently affixed label or must be capable of electronically displaying its FCC identification number.

(vii) The modular transmitter must comply with any specific rules or operating requirements that ordinarily apply to a complete transmitter and the manufacturer must provide adequate instructions along with the module to explain any such requirements. A copy of these instructions must be included in the application for equipment authorization.

(viii) The modular transmitter must comply with any applicable RF exposure requirements in its final configuration.

3. Test Data

3.1 Test specification

Standard	FCC Part15 Subpart C 15.205 15.207 15.209 15.247, ANSI C63.10-2013
Frequency Range	2403.000 MHz to 2478.000MHz
Test Date	29th May, 2015 - 30th May, 2015 , 20th August, 2015
Test Location	e-OHTAMA,LTD. Tokyo Laboratory 2-8-20 Kurigi, Asao-ku Kawasaki-shi, Kanagawa, 215-0033 Japan
Test Engineer	Katsutoshi Hatanaka
Temperature	22.5 °C – 23.5℃
Humidity	56.0%RH – 62.9% RH
Pressure	1005 hPa
Power Supply	5.0V dc
Modulation Type	GFSK
Tested channel	Lower ch 2403.000MHz Middle ch 2441.000MHz Higher ch 2478.000MHz
FCC ID	T82HRF-2401

Remark: *1 : Equivalent isotropic radiated power and Frequency Range only.

3.2 6dB Bandwidth

3.2.1 Test Result

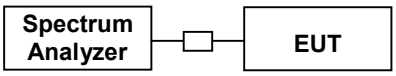
Cannel	Center Frequency (MHz)	6dB Bandwidth (kHz)	Limit (kHz)
Center	2441	569.138	>500
Lower	2403	521.042	>500
Higher	2478	657.315	>500

Table1 6dB Bandwidth

Result : Pass

3.2.2 Test Detail

1.The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator.
The path loss was compensated to the results for each measurement.
2.Set to the maximum power setting and enable the EUT transmit continuously.
3.Use the following spectrum analyzer setting for 6dB Bandwidth measurement.
Span:spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
Frequency: The nominal EUT channel center frequency_2441MHz
and reference data.(Lower ch 2403MHz and Higher ch 2478MHz)
RBW: The nominal IF filter bandwidth (3 dB RBW) shall be in the range of
1% to 5% of the OBW,
VBW: VBW shall be approximately three times the RBW
Sweep:auto Detector function:peak Trace:max hold
4.Measure and record the results in the test report.



3.2.3 Test data

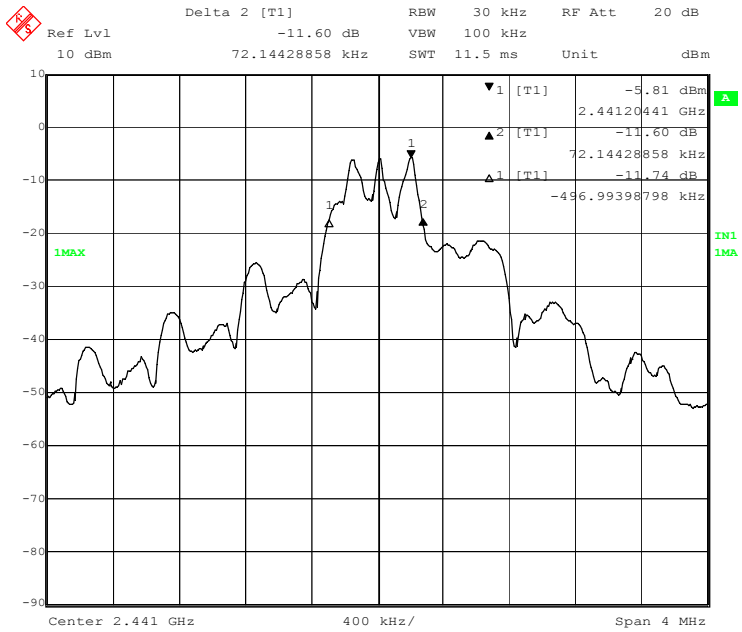


Figure 1 6dB Bandwidth(Center ch_2441.000MHz)

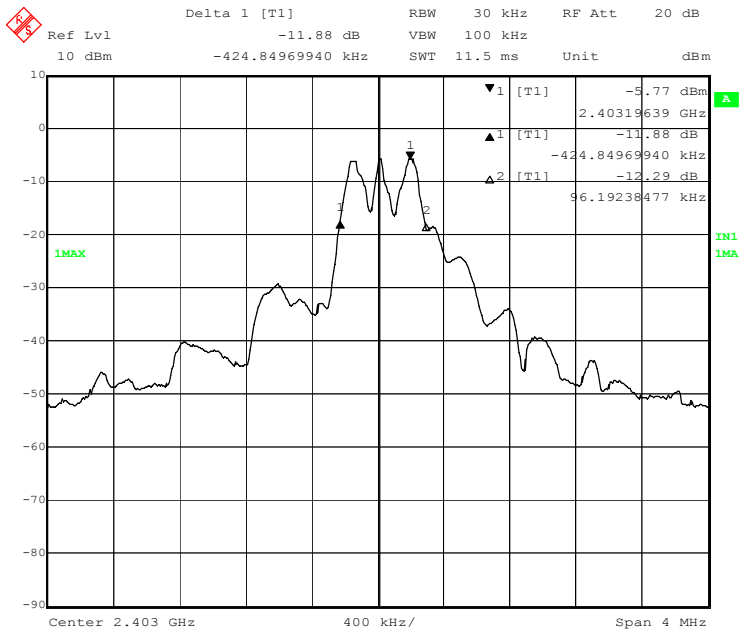


Figure 2 6dB Bandwidth(Lower ch_2403.000MHz)

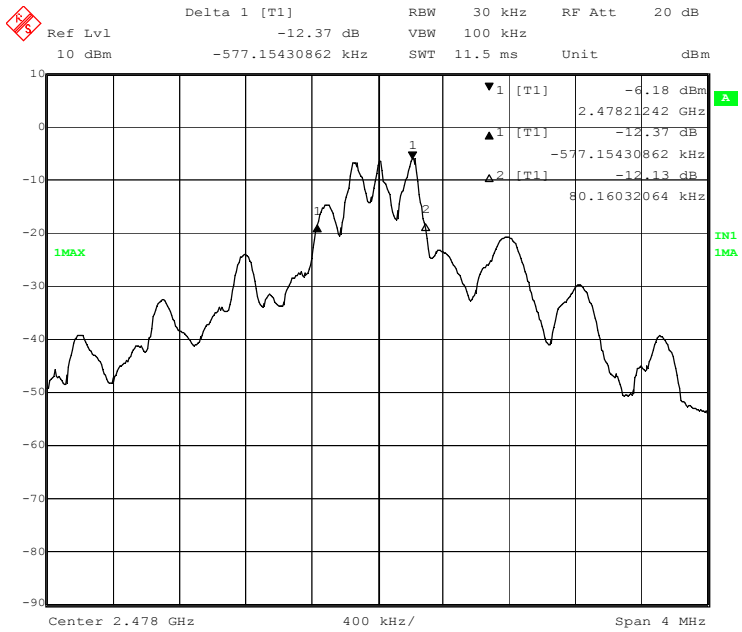


Figure 3 6dB Bandwidth(Higher ch_2478.000MHz)

3.3 Maximum Peak Output Power

3.3.1 Test Result

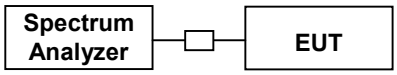
Channel	Frequency (MHz)	S/A Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
Lower	2403	0.32	1.0	1.32	30	28.68
Middle	2441	0.29	1.0	1.29	30	28.71
Higher	2478	0.07	1.0	1.07	30	28.93

Table3　Maximum Peak Output Power

Result：Pass

3.3.2　Test Detail

1.The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
2.Set to the maximum power setting and enable the EUT transmit continuously.
3.Enable the EUT hopping function.
4.Measure the conducted output power with cable loss and record the result in the test report.
5.Measure and record the results in the test report.



3.3.3 Test data

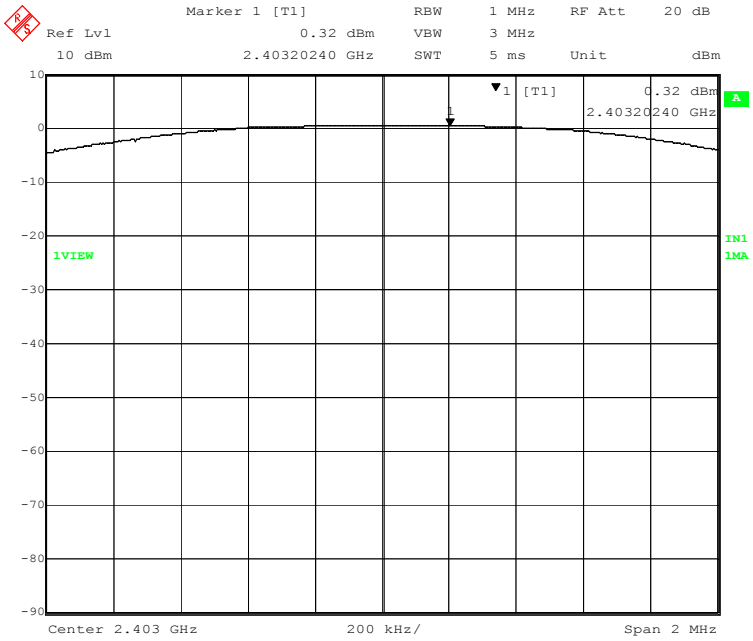


Figure 7 Maximum Peak Output Power(Lower ch_2403.000MHz)

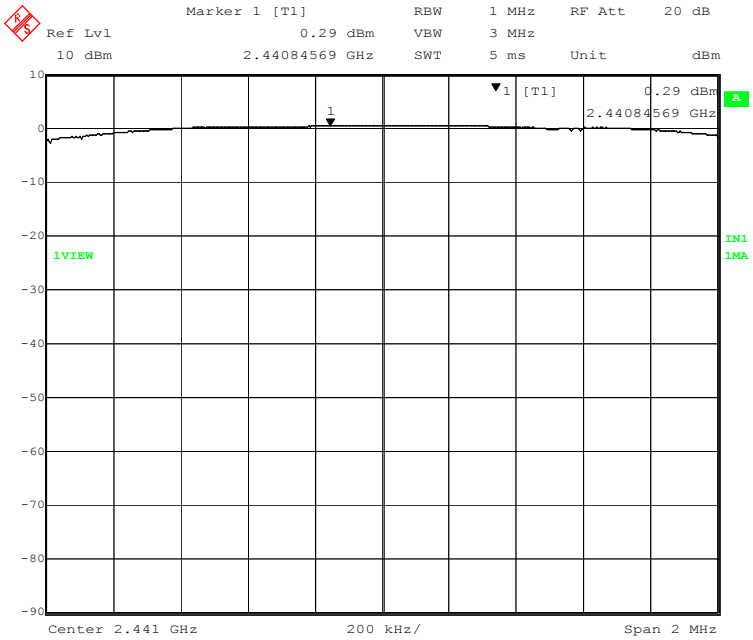


Figure 8 Maximum Peak Output Power(Middle ch_2441.000MHz)

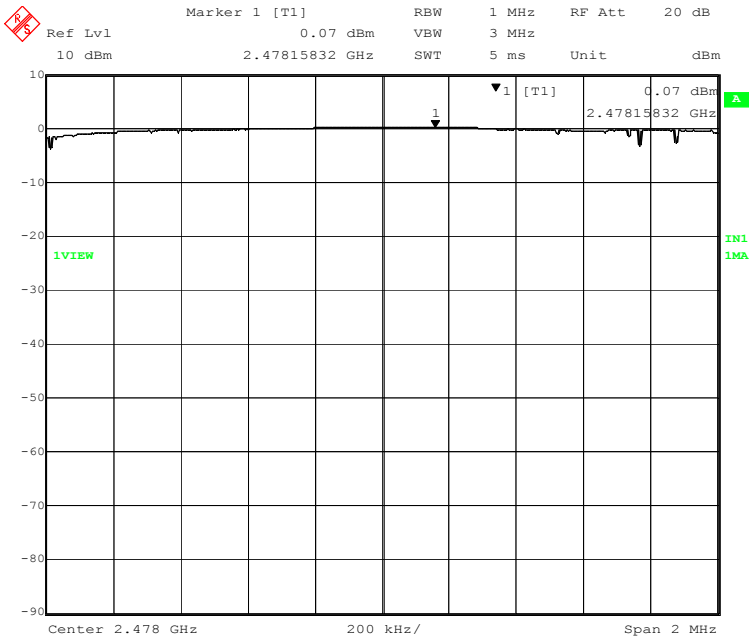


Figure 9 Maximum Peak Output Power(Higher ch_2478.000MHz)

3.4 Band Edge of Compliance of RF Conducted Emissions

3.4.1 Test Result

Edge	Deference (dB)	Limit (dB)	Margin (dB)
Lower	40.63	20	20.63
Higher	46.38	20	26.38

Table4 Band Edge of Compliance of RF Conducted Emissions

Result：Pass

3.4.2 Test Detail

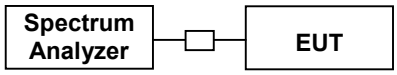
1.Set to the maximum power setting and enable the EUT transmit continuously.

2.Set RBW=300kHz(≧1% Span=30MHz) VBW = 300kHz(≧RBW)

Bandefge emissions must be at least 20dB down from the highest emission level within the authorize Band as measure with a 300kHz RBW.The attenuation shall be 30dB instead of 20dB when RMS conducted output power procedure is used.

4.Enable hopping function of the EUT and then repeat step 2. And 3.

5.Measure and record the results in the test report.



3.4.3 Test data

3.4.3.1 Conducted Band Edges

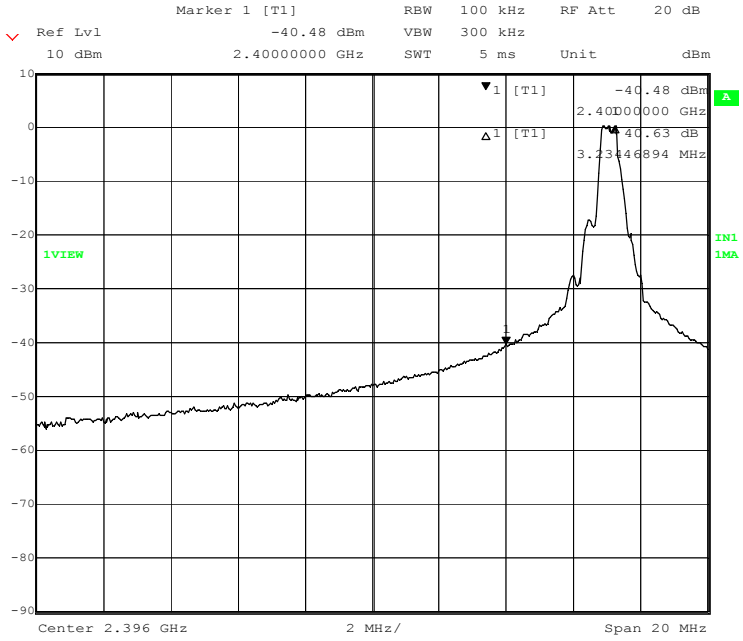


Figure 10 Low Band Edge Plot on _2402.000MHz

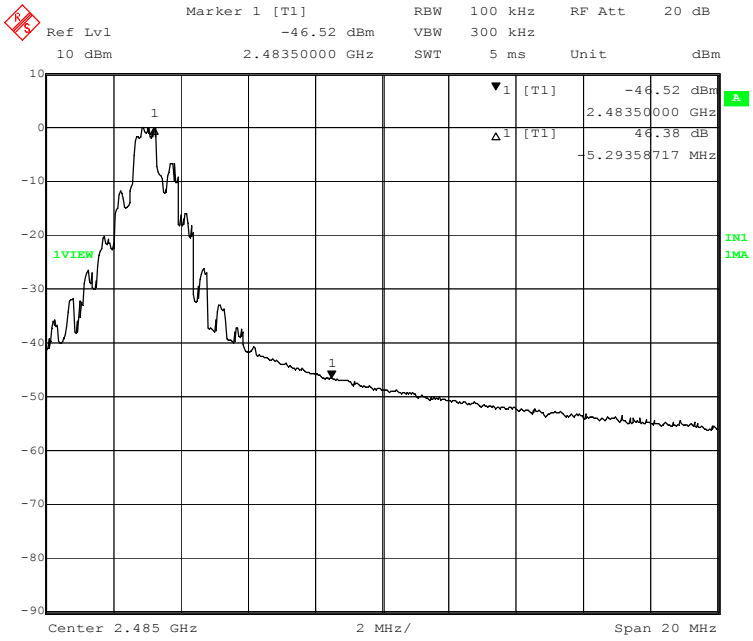


Figure 11 High Band Edge Plot on _2478.000MHz

3.5 Peak Power Spectral Density

3.5.1 Test Result

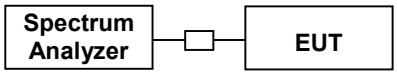
Channel	Frequency (MHz)	S/A Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)
Lower	2403	-8.41	1.0	-7.41	8.0	15.41
Middle	2441	-8.59	1.0	-7.59	8.0	15.59
Higher	2478	-8.52	1.0	-7.52	8.0	15.52

Table5 Peak Power Spectral Density

Result：Pass

3.5.2 Test Detail

1.The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator.
The path loss was compensated to the results for each measurement.
2.Set RBW of spectrum analyzer to 3kHz and VBW 30kHz.Set Detector to Peak,Trace to Max Hold.
3.Mark the frequency with maximum peak power as the center of the display of spectrum.
4.Set the span 1.5MHz and the sweep time to 500s and record the maximum peak value.



3.5.3 Test data

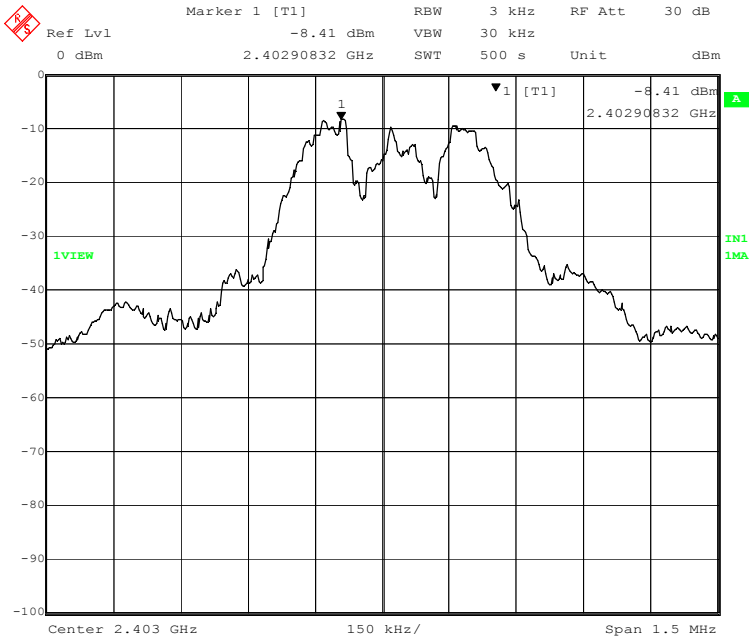


Figure12 Peak Power Spectral Density(Lower ch_2403.000MHz)

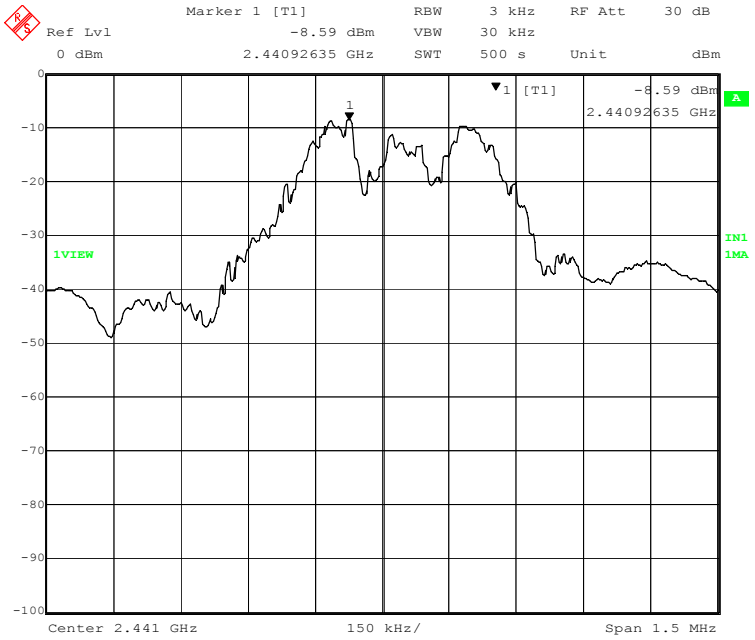


Figure 13 Peak Power Spectral Density(Middle ch_2441.000MHz)

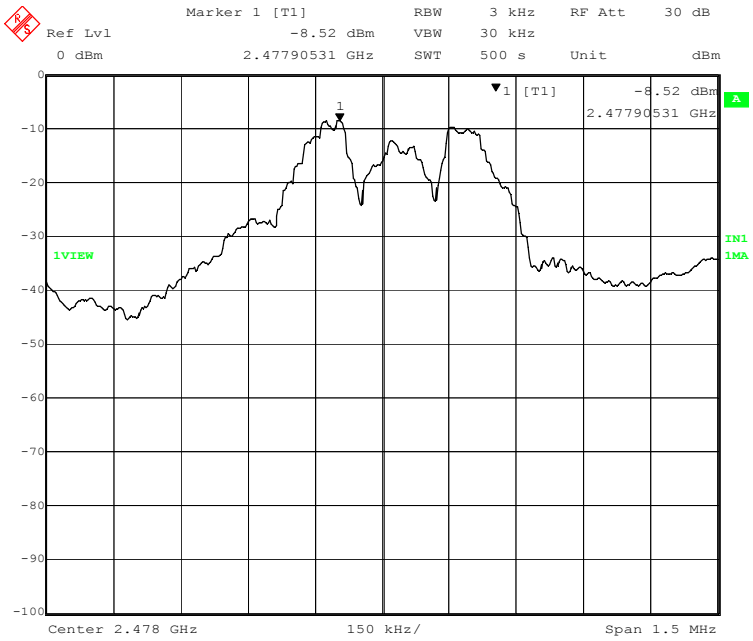


Figure 14 Peak Power Spectral Density(Higher ch_2478.000MHz)

3.6 Line Conducted Measurement

3.6.1 Test Result

Frequency [MHz]	Line [A/B]	Level[dBμV] QP	[dB]	Factor [dB]	Result[dBμV] QP	AV	Limit[dBμV] QP	AV	Margin[dB] QP	AV
0.15520	A	36.5	21.7	9.9	46.4	31.6	65.7	55.7	19.3	24.1
0.15108	A	40.0	25.0	9.8	49.8	34.8	65.9	55.9	16.1	21.1
0.23084	A	25.4	15.3	9.9	35.3	25.2	62.4	52.4	27.1	27.2
0.23092	A	25.5	15.3	9.9	35.4	25.2	62.4	52.4	27.0	27.2
0.50628	A	31.3	28.4	10.2	41.5	38.6	56.0	46.0	14.5	7.4
16.05285	A	29.6	23.5	10.3	39.9	33.8	60.0	50.0	20.1	16.2
0.15370	B	39.1	22.4	9.9	49.0	32.3	65.8	55.8	16.8	23.5
0.18026	B	32.3	17.7	10.1	42.4	27.8	64.5	54.5	22.1	26.7
0.22554	B	28.1	18.2	9.9	38.0	28.1	62.6	52.6	24.6	24.5
0.50491	B	31.9	29.2	10.2	42.1	39.4	56.0	46.0	13.9	6.6
15.94884	B	28.9	22.7	10.4	39.3	33.1	60.0	50.0	20.7	16.9

Table6 Line Conducted Measurement

Result : Pass

3.6.2 Test Detail

Onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN).

3.6.3 Test data

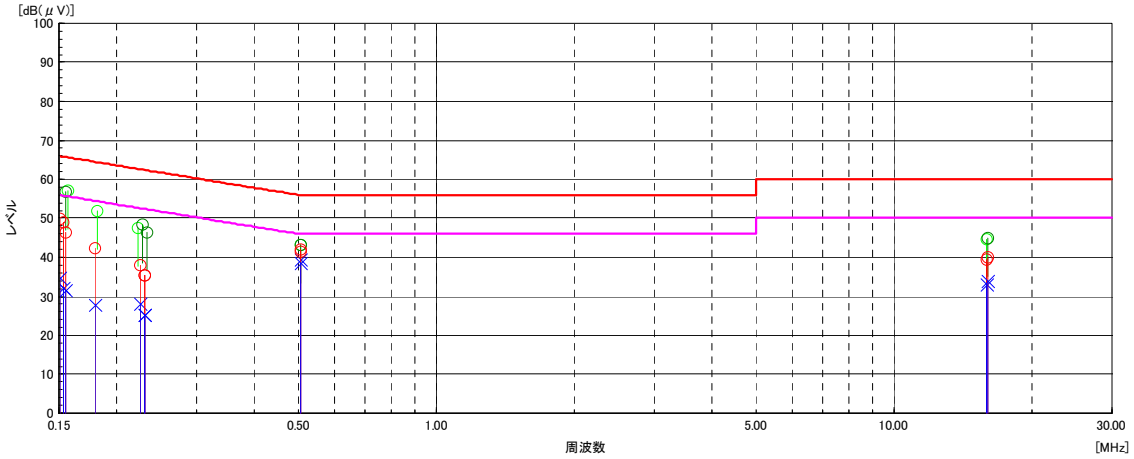


Figure 13 Line Conducted Measurement

3.7 Radiated emission

3.7.1 Test Result

3.7.1.1 1/4λ Dipole chip antenna

3.7.1.1.1 9kHz to 1000MHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading (dBμV)	Correction factor (dB/m)	Noise level (dBμV/m)	Ant height (m)	Ant Pol (H/V)	Turn table angle (digree)	Limit (dBμV/m)	Margin (dB)
2403.000	9.109	20.6	-3.6	17.0	358	H	102	29.5	12.5
	18.188	19.8	-3.8	16.0	278	V	110	29.5	13.5
	34.229	18.2	-3.9	14.3	195	V	96	40.0	25.7
	131.065	19.5	-6.6	12.9	211	V	324	43.5	30.6
	290.555	16.2	-0.9	15.3	173	H	306	46.0	30.7
	768.629	19.8	1.5	21.3	333	H	206	46.0	24.7
	896.966	16.1	3.1	19.2	256	H	90	46.0	26.8
2478.000	8.886	21.5	-3.6	17.9	278	V	86	29.5	11.6
	12.339	20.5	-3.5	17.0	238	H	186	29.5	12.5
	34.557	19.1	-4.1	15.0	182	V	56	40.0	25.0
	292.118	16.8	-0.8	16.0	162	V	226	46.0	30.0
	335.428	21.5	-4.0	17.5	155	H	178	46.0	28.5
	685.025	18.9	0.8	19.7	203	V	320	46.0	26.3
	987.592	17.3	4.0	21.3	171	H	320	54.0	32.7

Table7 Radiated Emission (9kHz-1000MHz)

Result : Pass

3.7.1.1.2 1GHz to 25GHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading PK (dBμV)	Reading AV (dBμV)	Correction factor (dB/m)	Noise level PK (dBμV/m)	Noise level AV (dBμV/m)	Ant height (cm)	Ant Pol (H/V)	Turn table angle (digree)	Limit PK (dBμV/m)	Limit AV (dBμV/m)	Margin PK (dB)	Margin AV (dB)
2403.000	1108.252	62.9	53.8	-26.5	36.4	27.3	156	H	158	74.0	54.0	37.6	26.7
	2402.876	103.5	91.6	-17.6	85.9	74.0	162	V	320	94.0	94.0	8.1	20.0
	4853.668	61.6	41.8	-10.3	51.3	31.5	168	V	106	74.0	54.0	22.7	22.5
	7188.032	53.5	46.8	-4.8	48.7	42.0	155	H	228	74.0	54.0	25.3	12.0
	10263.226	51.5	44.9	-0.6	50.9	44.3	163	V	96	74.0	54.0	23.1	9.7
	15036.066	41.5	40.5	8.2	49.7	48.7	148	H	265	74.0	54.0	24.3	5.3
2478.000	1266.293	61.8	60.2	-24.4	37.4	35.8	165	H	186	74.0	54.0	36.6	18.2
	2478.011	106.5	105.8	-17.4	89.1	88.4	159	V	270	94.0	94.0	4.9	5.6
	4955.703	57.3	56.9	-10.0	47.3	46.9	182	V	60	74.0	54.0	26.7	7.1
	7213.567	51.8	50.0	-4.7	47.1	45.3	177	H	350	74.0	54.0	26.9	8.7
	10160.256	48.0	45.8	-0.8	47.2	45.0	182	V	126	74.0	54.0	26.8	9.0
	14986.890	41.8	40.3	8.5	50.3	48.8	159	V	350	74.0	54.0	23.7	5.2

Table 8 Radiated Emission (1GHz-25GHz)

Result : Pass

3.7.1.2 1/4λ Dipole antenna(Flying Lead and U-FL connector)

3.7.1.2.1 9kHz to 1000MHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading (dBµV)	Correction factor (dB/m)	Noise level (dBµV/m)	Ant height (cm)	Ant Pol (H/V)	Turn table angle (digree)	Limit (dBµV/m)	Margin (dB)
2403.000	3.554	23.5	-3.7	19.8	220	H	335	29.5	9.7
	28.997	3.2	10.7	13.9	221	H	356	29.5	15.6
	36.055	19.0	-4.6	14.4	164	H	355	40.0	25.6
	296.395	17.8	-0.6	17.2	193	H	180	46.0	28.8
	320.851	30.2	-4.1	26.1	154	V	88	46.0	19.9
	658.847	18.0	0.7	18.7	163	H	318	46.0	27.3
	982.059	18.4	3.8	22.2	163	H	342	54.0	31.8
2478.000	4.056	24.8	-3.6	21.2	172	H	308	29.5	8.3
	29.443	3.9	14.3	18.2	223	H	145	29.5	11.3
	37.408	18.1	-5.1	13.0	178	H	157	40.0	27.0
	192.229	32.8	-3.8	29.0	165	V	136	43.5	14.5
	295.858	28.5	-0.6	27.9	177	V	120	46.0	18.1
	343.086	21.3	-4.0	17.3	186	H	236	46.0	28.7
	733.804	20.7	1.1	21.8	196	H	308	46.0	24.2
	990.341	18.6	4.0	22.6	161	H	188	54.0	31.4

Table9 Radiated Emission (9kHz-1000MHz)

Result : Pass

3.7.1.2.2 1GHz to 25GHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading PK (dBµV)	Reading AV (dBµV)	Correction factor (dB/m)	Noise level PK (dBµV/m)	Noise level AV (dBµV/m)	Ant height (cm)	Ant Pol (H/V)	Turn table angle (digree)	Limit PK (dBµV/m)	Limit AV (dBµV/m)	Margin PK (dB)	Margin AV (dB)
2403.000	1118.308	52.0	49.6	-26.4	25.6	23.2	153	H	166	74.0	54.0	48.4	30.8
	2402.386	108.2	107.2	-17.6	90.6	89.6	151	V	359	94.0	94.0	3.4	4.4
	4782.056	57.5	55.9	-10.4	47.1	45.5	166	V	226	74.0	54.0	26.9	8.5
	7385.183	52.2	50.9	-4.7	47.5	46.2	169	V	286	74.0	54.0	26.5	7.8
	12253.000	46.3	45.2	4.7	51.0	49.9	162	H	192	74.0	54.0	23.0	4.1
	14568.822	46.5	42.8	7.1	53.6	49.9	180	H	286	74.0	54.0	20.4	4.1
2478.000	1236.944	61.8	60.1	-24.8	37.0	35.3	171	H	286	74.0	54.0	37.0	18.7
	2478.137	108.3	107.5	-17.4	90.9	90.1	153	V	118	94.0	94.0	3.1	3.9
	4702.551	54.5	52.9	-10.5	44.0	42.4	160	V	247	74.0	54.0	30.0	11.6
	7387.482	50.7	49.7	-4.7	46.0	45.0	166	V	360	74.0	54.0	28.0	9.0
	12553.413	48.0	45.1	4.3	52.3	49.4	206	H	30	74.0	54.0	21.7	4.6
	14771.772	47.4	43.7	8.2	53.6	51.9	229	H	210	74.0	54.0	20.4	2.1

Table10 Radiated Emission (1GHz-25GHz)

Result : Pass

3.7.1.3 1/2λ Dipole antenna(SMB Male connector)

3.7.1.3.1 9kHz to 1000MHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading (dBµV)	Correction factor (dB/m)	Noise level (dBµV/m)	Ant height (cm)	Ant Pol (H/V)	Turn table angle (digree)	Limit (dBµV/m)	Margin (dB)
2403.000	3.118	23.3	-3.7	19.6	218	H	344	29.5	9.9
	29.564	3.1	15.0	18.1	183	H	310	29.5	11.4
	36.757	19.7	-4.9	14.8	156	H	346	40.0	25.2
	292.558	18.2	-0.8	17.4	155	H	248	46.0	28.6
	310.857	31.2	-3.9	27.3	146	V	116	46.0	18.7
	677.162	18.4	0.7	19.1	206	H	300	46.0	26.9
	975.255	18.1	3.7	21.8	182	H	310	54.0	32.2
2478.000	3.526	23.0	-3.7	19.3	260	H	316	29.5	10.2
	29.003	3.5	10.7	14.2	233	H	6	29.5	15.3
	31.449	18.0	-2.8	15.2	238	H	5	40.0	24.8
	200.238	16.0	-3.5	12.5	174	V	108	43.5	31.0
	270.263	28.5	-1.9	26.6	186	V	128	46.0	19.4
	311.200	26.5	-4.0	22.5	152	H	240	46.0	23.5
	656.926	18.6	0.7	19.3	278	H	339	46.0	26.7

Table11 Radiated Emission (9kHz-1000MHz)

Result : Pass

3.7.1.3.2 1GHz to 25GHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading PK (dBµV)	Reading AV (dBµV)	Correction factor (dB/m)	Noise level PK (dBµV/m)	Noise level AV (dBµV/m)	Ant height (cm)	Ant Pol (H/V)	Turn table angle (digree)	Limit PK (dBµV/m)	Limit AV (dBµV/m)	Margin PK (dB)	Margin AV (dB)
2403.000	1225.769	62.6	60.9	-24.9	37.7	36.0	165	V	165	74.0	54.0	36.3	18.0
	2401.825	109.0	108.3	-17.8	91.2	90.5	152	V	276	94.0	94.0	2.8	3.5
	4821.950	58.6	56.6	-10.4	48.2	46.2	153	V	128	74.0	54.0	25.8	7.8
	7248.052	53.5	51.9	-4.6	48.9	47.3	170	V	245	74.0	54.0	25.1	6.7
	10773.070	48.3	44.9	1.8	50.1	46.7	171	H	100	74.0	54.0	23.9	7.3
	15108.625	43.7	42.2	8.1	51.8	50.3	169	H	98	74.0	54.0	22.2	3.7
2478.000	1252.455	60.8	58.2	-24.6	36.2	33.6	159	V	200	74.0	54.0	37.8	20.4
	2477.015	108.8	108.2	-17.5	91.3	90.7	152	V	177	94.0	94.0	2.7	3.3
	4968.063	57.8	56.9	-10.0	47.8	46.9	155	V	256	74.0	54.0	26.2	7.1
	7428.320	55.5	54.3	-4.7	50.8	49.6	159	V	222	74.0	54.0	23.2	4.4
	12113.700	47.5	45.2	3.5	51.0	48.7	171	H	293	74.0	54.0	23.0	5.3
	14638.533	45.8	43.8	7.5	53.3	51.3	251	H	18	74.0	54.0	20.7	2.7

Table12 Radiated Emission (1GHz-25GHz)

Result : Pass

3.7.1.4 1/2λ Dipole antenna(SMB Male connector) Magnet Base

3.7.1.4.1 9kHz to 1000MHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading (dBµV)	Correction factor (dB/m)	Noise level (dBµV/m)	Ant height (cm)	Ant Pol (H/V)	Turn table angle (digree)	Limit (dBµV/m)	Margin (dB)
2403.000	4.115	19.1	-3.6	15.5	211	H	346	29.5	14.0
	29.854	3.6	16.1	19.7	203	H	56	29.5	9.8
	31.516	17.2	-2.8	14.4	176	V	196	40.0	25.6
	237.322	16.3	-2.9	13.4	302	H	120	46.0	32.6
	311.524	32.8	-4.0	28.8	156	H	111	46.0	17.2
	530.362	19.5	-1.7	17.8	210	H	176	46.0	28.2
	984.229	18.2	3.8	22.0	244	H	87	54.0	32.0
2478.000	4.035	17.9	-3.6	14.3	232	V	188	29.5	15.2
	32.336	19.1	-3.2	15.9	161	H	128	40.0	24.1
	272.155	29.0	-1.8	27.2	155	V	186	46.0	18.8
	288.045	29.8	-1.0	28.8	161	V	218	46.0	17.2
	304.005	28.4	-3.9	24.5	124	H	123	46.0	21.5
	320.053	25.9	-4.1	21.8	104	H	97	46.0	24.2
	970.548	17.5	3.6	21.1	161	V	230	54.0	32.9

Table13 Radiated Emission (9kHz-1000MHz)

Result : Pass

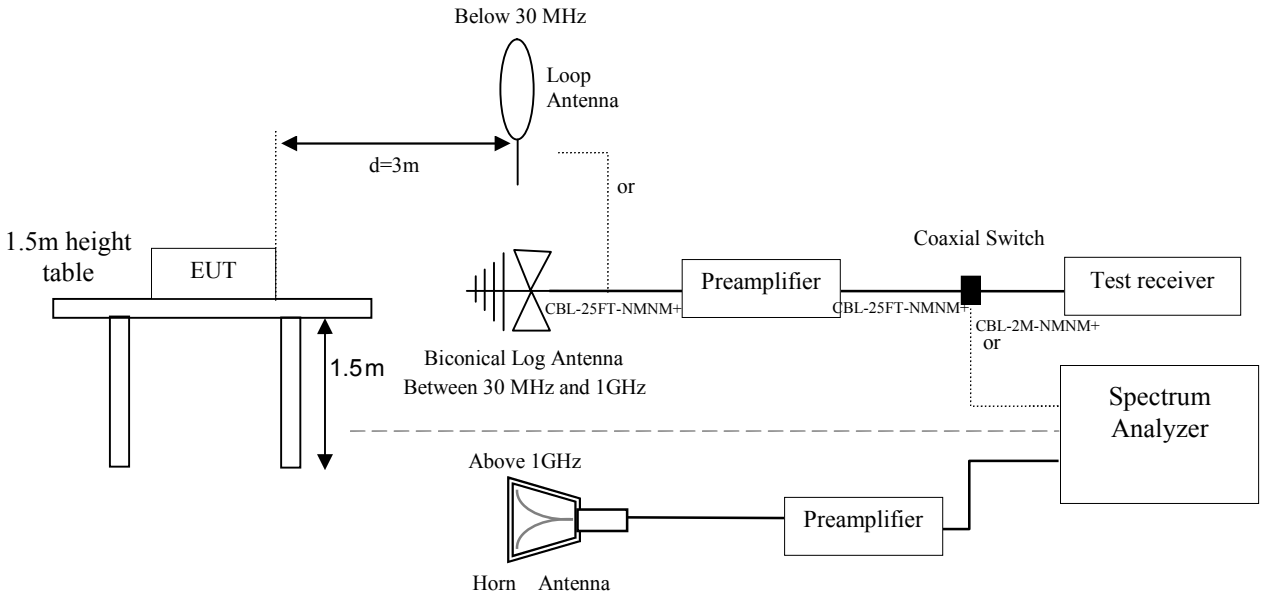
3.7.1.4.2 1GHz to 25GHz

Setting Frequency (MHz)	Measurement Frequency (MHz)	Reading PK (dBµV)	Reading AV (dBµV)	Correction factor (dB/m)	Noise level PK (dBµV/m)	Noise level AV (dBµV/m)	Ant height (cm)	Ant Pol (H/V)	Turn table angle (digree)	Limit PK (dBµV/m)	Limit AV (dBµV/m)	Margin PK (dB)	Margin AV (dB)
2403.000	1215.632	69.5	67.8	-25.0	44.5	42.8	166	V	186	74.0	54.0	29.5	11.2
	2402.386	108.9	108.5	-17.6	91.3	90.9	148	V	52	94.0	94.0	2.7	3.1
	4812.365	56.0	54.6	-10.4	45.6	44.2	166	V	207	74.0	54.0	28.4	9.8
	7189.72	52.8	49.5	-4.8	48.0	44.7	151	V	3	74.0	54.0	26.0	9.3
	10602.869	48.5	45.0	1.8	50.3	46.8	238	H	226	74.0	54.0	23.7	7.2
	14603.842	46.9	46.1	7.3	53.4	51.4	211	H	52	74.0	54.0	20.6	2.6
2478.000	1245.266	70.7	70.1	-24.7	46.0	45.4	158	V	178	74.0	54.0	28.0	8.6
	2478.136	108.6	107.9	-17.4	91.2	90.5	155	V	57	94.0	94.0	2.8	3.5
	4968.429	53.7	52.8	-10.0	43.7	42.8	163	V	74	74.0	54.0	30.3	11.2
	8688.227	48.4	46.5	-1.5	46.9	45.0	170	H	66	74.0	54.0	27.1	9.0
	12286.108	47.8	48.0	4.8	52.6	52.8	167	H	235	74.0	54.0	21.4	1.2
	14818.953	44.8	42.3	8.5	53.3	50.8	212	H	145	74.0	54.0	20.7	3.2

Table14 Radiated Emission (1GHz-25GHz)

Result : Pass

3.7.2 Test Detail



1. The EUT is placed on a non-conducting table 1.5m above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10:2013. The EUT is set to transmit in a continuous mode.
2. For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.
3. For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.
4. The spectrum from 30 MHz to 25 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.
5. The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

3.7.3 Test data

3.7.3.1 1/4λ Dipole chip antenna

3.7.3.1.1 9kHz to1000MHz

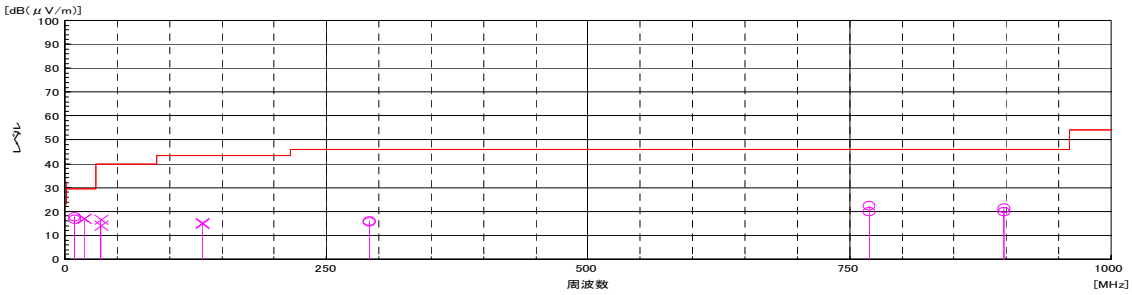


Figure 14 Radiated Emission (Lower ch_2403.000MHz)

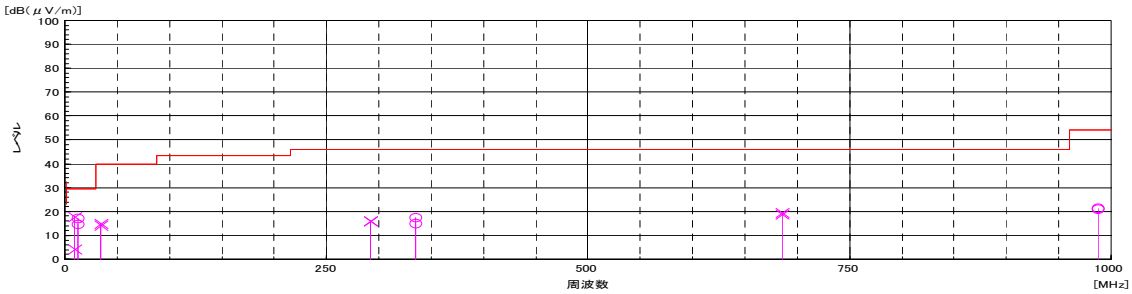


Figure 15 Radiated Emission (Higher ch_2478.000MHz)

3.7.3.1.2 1GHz to 25GHz

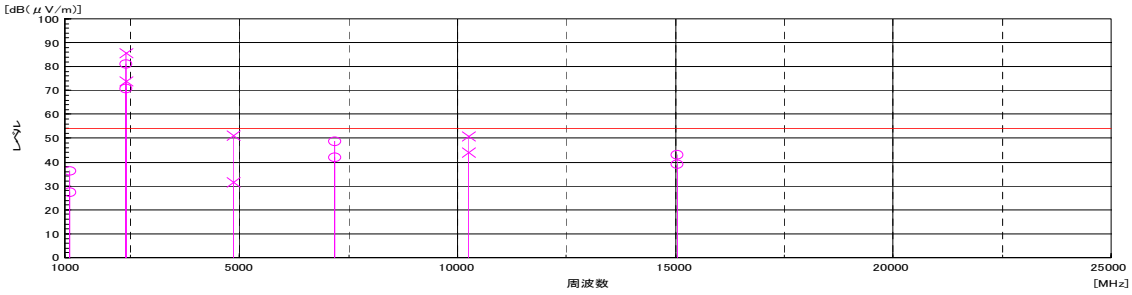


Figure 16 Radiated Emission (Lower ch_2403.000MHz)

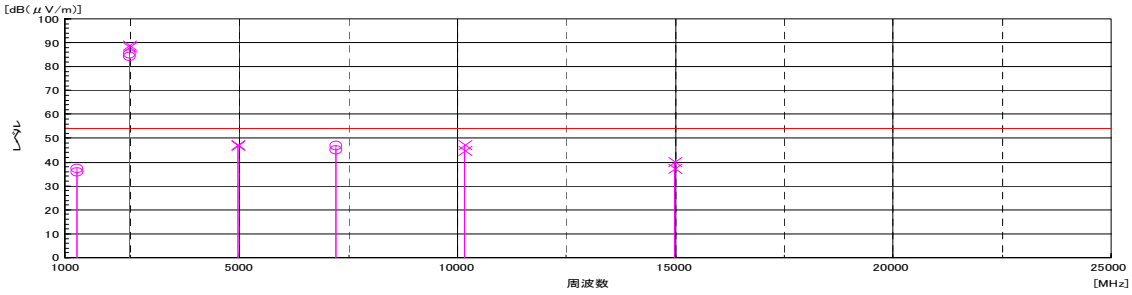


Figure 17 Radiated Emission (Higher ch_2478.000MHz)

3.7.3.2 1/4λ Dipole antenna(Flying Lead and U-FL connector)

3.7.3.2.1 9kHz to 1000MHz

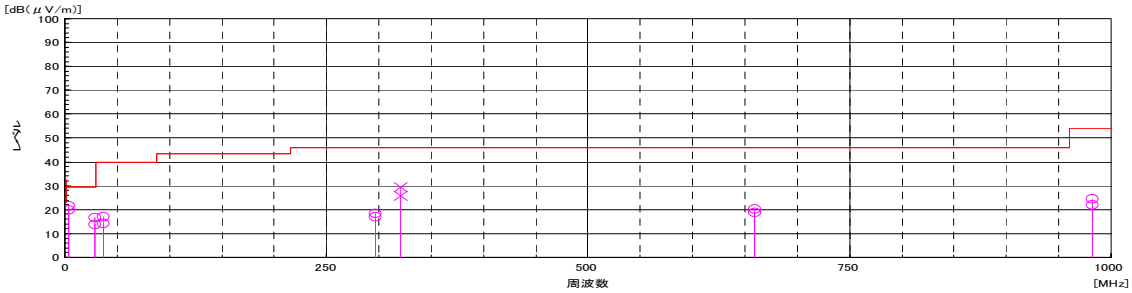


Figure 18 Radiated Emission (Lower ch_2403.000MHz)

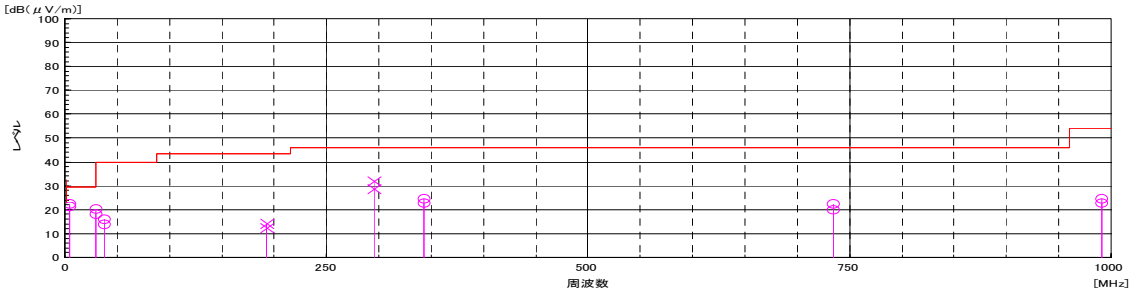


Figure 19 Radiated Emission (Higher ch_2478.000MHz)

3.7.3.2.2 1GHz to 25GHz

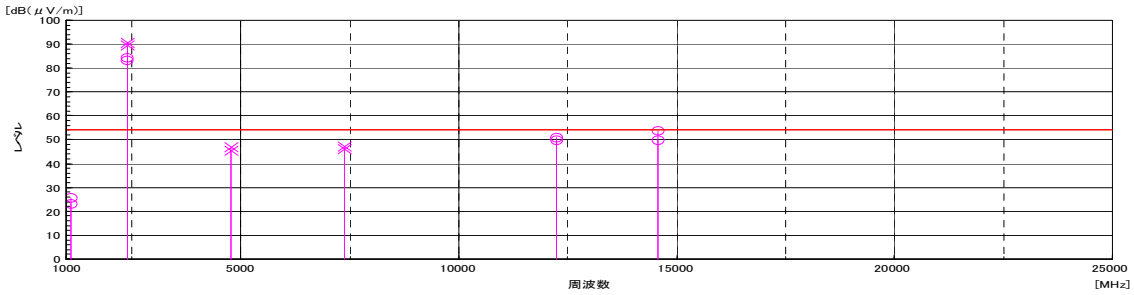


Figure 20 Radiated Emission (Lower ch_2403.000MHz)

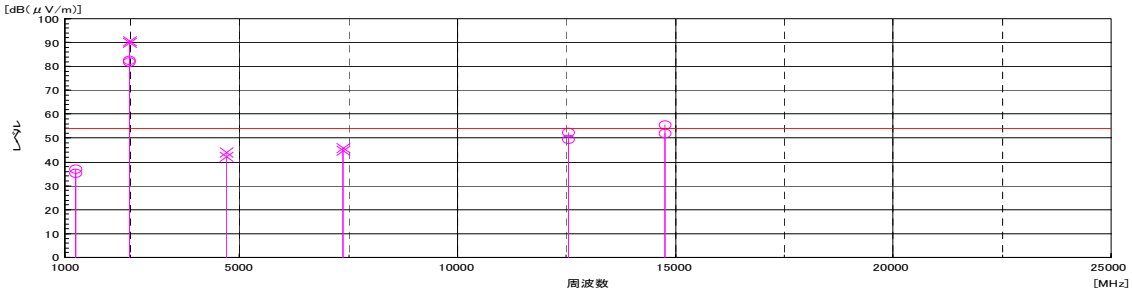


Figure 21 Radiated Emission (Higher ch_2478.000MHz)

3.7.3.3 1/2λ Dipole antenna(SMB Male connector)

3.7.3.3.1 9kHz to 1000MHz

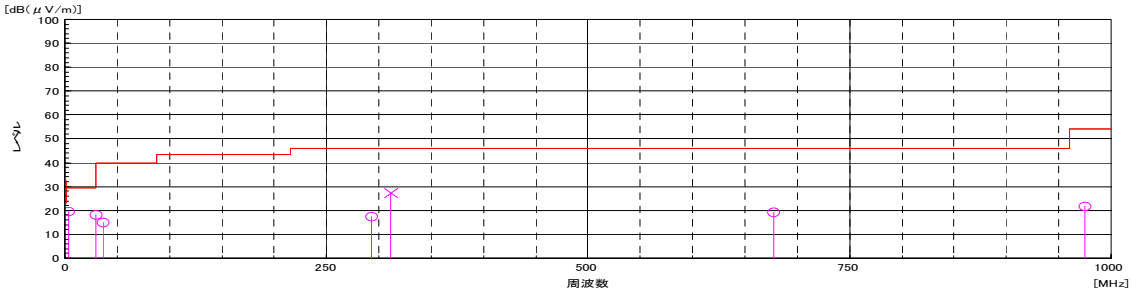


Figure 22 Radiated Emission (Lower ch_2403.000MHz)

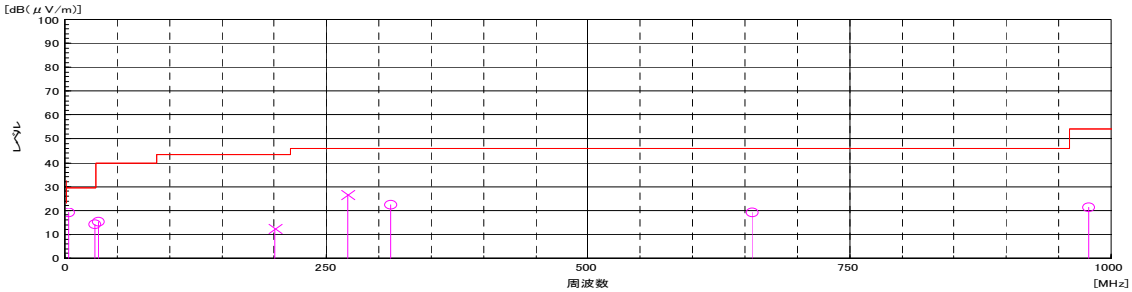


Figure23 Radiated Emission (Higher ch_2478.000MHz)

3.7.3.3.2 1GHz to 25GHz

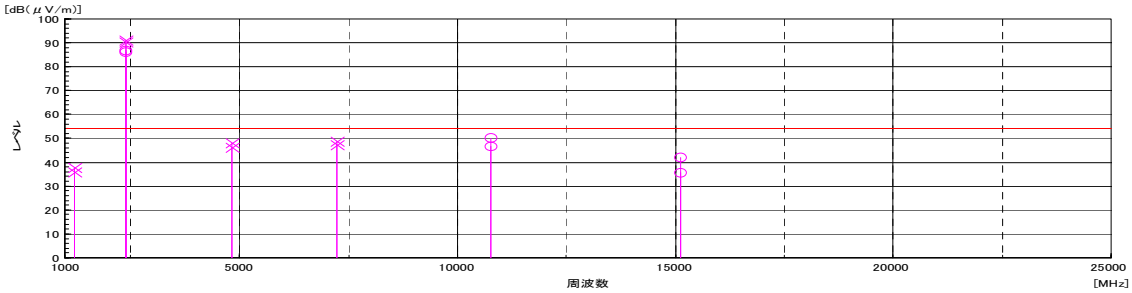


Figure 24 Radiated Emission (Lower ch_2403.000MHz)

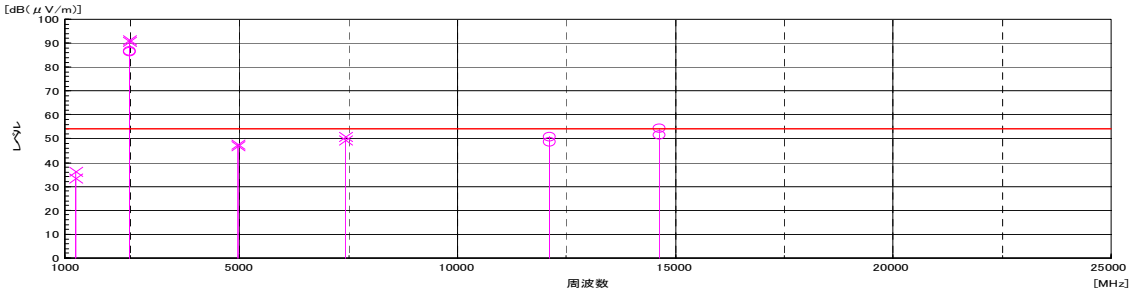


Figure 25 Radiated Emission (Higher ch_2478.000MHz)

3.7.3.4 1/2λ Dipole antenna(SMB Male connector) Magnet Base

3.7.3.4.1 9kHz to 1000MHz

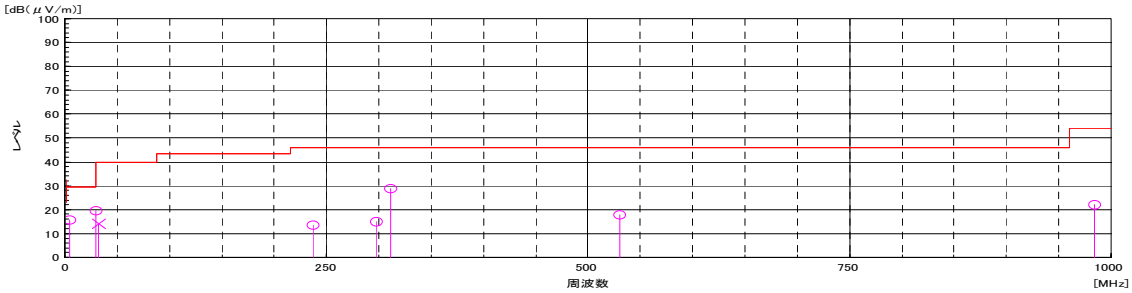


Figure 26 Radiated Emission (Lower ch_2403.000MHz)

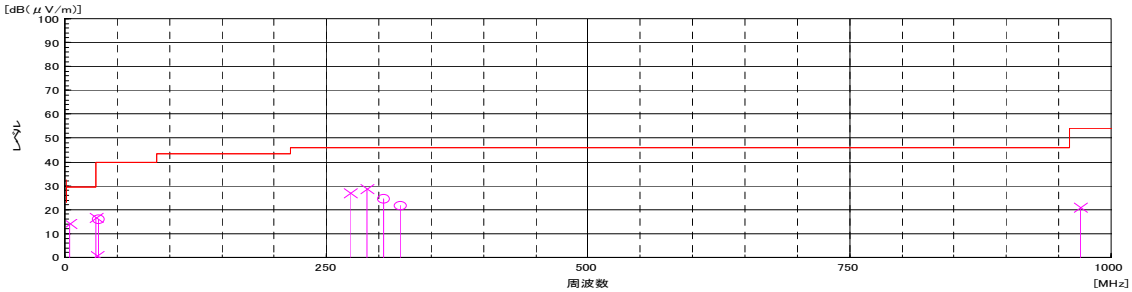


Figure 27 Radiated Emission (Higher ch_2478.000MHz)

3.7.3.4.2 1GHz to 25GHz

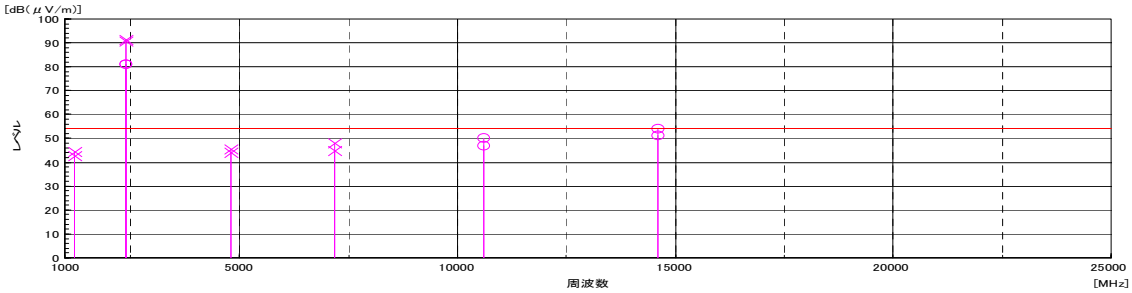


Figure 28 Radiated Emission (Lower ch_2403.000MHz)

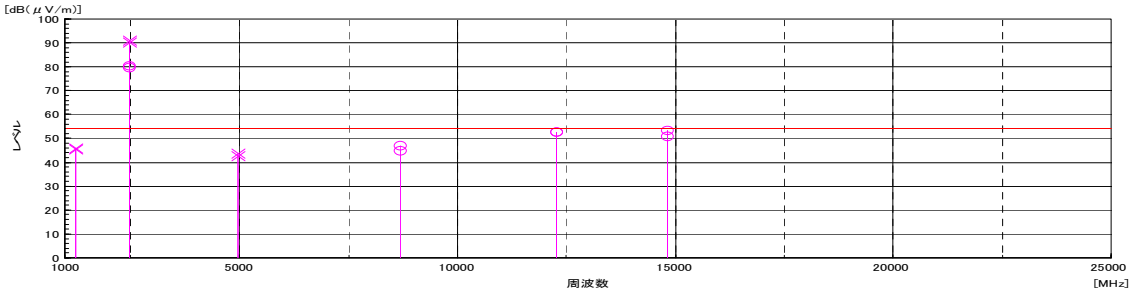


Figure 29 Radiated Emission (Higher ch_2478.000MHz)

3.7.4 Remarks

1. All measurements were performed using a loop antenna. The antenna was positioned in three orthogonal positions
   (X front, Y side, Z top) and the position with the highest emission level was recorded.
2. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
3. Measurements were performed at 3m and the data was extrapolated to the specified measurement distance of 10m. to 300m.
4. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector.
5. Field Strength Level $_{[dB\mu V/m]}$= Analyzer Level $_{[dB\mu V]}$ + AFCL $_{[dB/m]}$.
6. AFCL $_{[dB/m]}$ = Antenna Factor $_{[dBm]}$ + Cable Loss $_{[dB]}$
   Margin $_{[dB]}$= Field Strength Level $_{[dB\mu V/m]}$ - Limit $_{[dB\mu V/m]}$

4.Test facility

4.1Test Instruments

4.1.1Conducted Emissions

Product Name	Manufacturer	Model Number	Serial Number	Calibration Date	Due Date
EMI Test Receiver	Rohde & Schwarz	ESIB40	100263	2014/10/16	2015/10/31
Cable	Pasternack	PE315-24	-	2014/06/25	2015/06/30
LISN	Rohde & Schwarz	ENV216	100466	2014/07/22	2015/07/31

4.1.2 Radiated Electric-Field Emissions

Product Name	Manufacturer	Model Number	Serial Number	Calibration Date	Due Date
EMI Test Receiver	Rohde & Schwarz	ESI26	100263	2015/01/16	2016/01/31
Pre amplifier	Hewlett Packard	8447D	2727A05948	2014/03/14	2015/03/31
Pre amplifier	Hewlett Packard	8449B	3085A00790	2014/07/24	2015/07/31
Cable	Mini-Circuits	CBL-25FT-NMNM+	83148	2014/12/20	2015/12/31
Cable	Mini-Circuits	CBL-25FT-NMNM+	83145	2014/12/20	2015/12/31
Cable	Mini-Circuits	CBL-2M-NMNM+	71548	2014/12/20	2015/12/31
Cable	Mini-Circuits	CBL-1M-NMNM+	104547/4	2014/12/20	2015/12/31
Loop Antenna	EMCO	6507	9108-1268	2014/10/07	2015/10/31
Biconical Antenna	Schwarzbeck	VHA9103	91032512	2015/02/14	2016/02/28
Logperidic antenna	Schwarzbeck	UHALP9107	1614	2014/08/21	2015/08/31
Horn Antenna	ETS-LINDGREN	3117	00146463	2014/05/26	2015/05/31

4.2 Test equipment

Dimension	Material	Measurement
1.5m(W) X 0.8m(H) X 1.0m(D)	Polystyrene	Radiated Emissions
0.4m(W) X 0.7m(H) X 0.4m(D)	Polystyrene	Conducted Emissions

Annex A (Miscellaneous Information)

A.1 Test Locations

Unless otherwise described in this report, the tests were carried out at the following locations:

e-OHTAMA,LTD. Tokyo Laboratory
2-8-20 Kurigi, Asao-ku Kawasaki-shi, Kanagawa, 215-0033 Japan
TEL: +81-44-980-2091
FAX: +81-44-980-2052

A.2 Uncertainty

The following Uncertainty of measurement values have been estimated for tests performed.

Parameter	Uncertainty
Radio frequency	±1.3×10^{-7}
Total RF power, conducted	±0.6dB
RF power density, conducted	±1.9dB
Spurious emissions, conducted	±3.0dB
All emissions, radiated	±6.0dB(0.009MHz to 25GHz)
Temperature	±0.5℃
Humidity	±4.7 %
DC and low frequency voltages	±1.4％

Annex B (Description of Test Method)

Unless otherwise described in this report, tests are carried out using the methods which are described in the applied standards and summarized in this section.

Specifically for 47 CFR 15 Subpart B, section 6 of ANSI C63.10-2013 is to be used for EUT arrangements and operations, and section 8 of the standard is to be used for radiated emissions measurement procedures.

B.1 Conducted Emissions (AC Main and Other Terminals)

Table-top EUT is placed on a wooden table so that one side (rear or bottom) of the EUT is separated 0.4 m from the reference plane (metallic wall or ground plane), and floor-standing EUT is placed on the ground plane.
Mains to the EUT is supplied through a LISN, and mains to non-EUT components, if any, are supplied through yet another LISN(s).
If LISN is not applicable, mains would be supplied directly and a voltage probe would be used instead for the measurement.
For each current-carrying conductors or terminals to be measured, a spectrum analyzer is used to pre-scan the emissions.
For each of the significant emissions detected, the maximum signal level is read using a measuring receiver having CISPR 16 quasi-peak (QP) and average (AV) detector function and 9 kHz nominal bandwidth.
Then, appropriate correction factor —consists of transducer (LISN or voltage probe) factor and transmission loss (due to the attenuator, filter and/or transient suppressor, if any, and the cable) in the system— is applied to the receiver reading to calculate the corresponding emission level.
For example, if reading on the receiver is 33.0 dBµV, the transducer factor is 0.5 dB, and transmission loss (attenuation) in the coaxial cable and the attenuator is 10.5 dB, the emission level is calculated as:
33.0 dBµV + 0.5 dB + 10.5 dB = 44.0 dBµV.
Finally, the calculated emission level is compared with the upper limit specified in the standard.
Actual measurement will be carried out according to the appropriate edition of CISPR 16-2-1, CISPR 22, and ANSI C63.10 and/or other standards whichever applicable.
Specifically for 47 CFR 15 Subpart B, section 6 of ANSI C63.10-2013 is to be used for EUT arrangements and operations, and section 8 of the standard is to be used for radiated emissions measurement procedures.

B.2 Radiated Electric-Field Emissions (30 MHz to 1000MHz)

EUT is placed on a turn-table in a test site, on a table (styrene form) 1.5 m height or on the floor unless otherwise specified in the standard.
Receiving antenna ---usually biconical, log-periodic or biconical/log-periodic hybrid---is positioned at the specified distance from the EUT.
For each polarization (horizontal and vertical), a spectrum analyzer is used to pre-scan the emissions while rotating the turn-table.
For each of the significant electromagnetic field detected, the test personnel discriminates EUT's emissions from the ambient noises.
For each of the significant emissions, maximum level of the emission is searched while rotating the turn-table and varying the antenna height between 1 m and 4 m, and the maximum signal level is read using a measuring receiver having CISPR 16 quasi-peak (QP) detector function and 120 kHz nominal bandwidth.
Then, appropriate correction factor —consists of antenna factor, amplifier gain and transmission loss (due to the attenuator and the cable loss) in the system— is applied to the receiver reading to calculate the corresponding field strength.
For example, if reading on the receiver is 33.0 dBµV, the antenna factor is 9.4 dB (1/m), the amplifier gain is 25.6 dB, and transmission loss (attenuation) in the coaxial cable and the attenuator is 6.5 dB, the field strength is calculated as: 33.0 dBµV + 9.4 dB (1/m) - 25.6 dB + 6.5 dB = 23.3 dBµV/m.
Finally, the calculated field strength is compared with the upper limit specified in the standard.
Actual measurement will be carried out according to the appropriate edition of CISPR 16-2-3, CISPR 22, and ANSI C63.10 and/or other standards whichever applicable.
Specifically for 47 CFR 15 Subpart B, section 6 of ANSI C63.10-2013 is to be used for EUT arrangements and operations, and section 8 of the standard is to be used for radiated emissions measurement procedures.

B.3 Radiated Electric-Field Emissions above 1000MHz

EUT is placed on a turn-table in a test site, on a table (styrene foam) 1.5 m height or on the floor unless otherwise specified in the standard.
Receiving antenna ---usually double ridge waveguide horn or standard horn--- is positioned at the specified distance from the EUT.
For each polarization (horizontal and vertical), a spectrum analyzer is used to pre-scan the emissions while rotating the turn-table.
For each of the significant electromagnetic field detected, the test personnel discriminates EUT's emissions from the ambient noises.
For each of the significant emissions, maximum level of the emission is searched while rotating the turn-table and varying the antenna height if it is required, and the maximum signal level is read using a spectrum analyzer or a measuring receiver having peak detector function and 1 MHz nominal bandwidth, unless otherwise specified in the standard. To obtain average readings with spectrum analyzers, video averaging (usually with VBW = 10 Hz) may be used.
As specified in the applicable standard, the antenna height would be (1) varied between 1 m and 4 m, or (2) varied so that the whole height of the EUT is covered by the main lobe of the receiving antenna, or (3) fixed to the approximate radiation center of the EUT.
Then, appropriate correction factor ---consists of antenna factor, amplifier gain and transmission loss (due to the attenuator and the cable loss) in the system--- is applied to the spectrum analyzer/receiver reading to calculate the corresponding field strength, and the result is compared with the upper limit specified in the standard.
Actual measurement will be carried out according to the appropriate edition of CISPR 16-2-3, CISPR 22, ANSI C63.10 and/or other standards whichever applicable.
Specifically for 47 CFR 15 Subpart B, section 6 of ANSI C63.10-2013 is to be used for EUT arrangements and operations, and section 8 of the standard is to be used for radiated emissions measurement procedures.

B.4 Radiated Magnetic-Field Emissions

EUT is placed on a turn-table in a test site, on a (styrene foam) table 1.5 m height or on the floor unless otherwise specified in the standard.
Receiving antenna ---loop antenna (active or passive) --- is positioned at the specified distance from the EUT.
A spectrum analyzer is used to pre-scan the emissions while rotating the turn-table.
For each of the significant electromagnetic field detected, the test personnel discriminates EUT's emissions from the ambient noises.
For each of the significant emissions, maximum level of the emission is searched while rotating the turn-table and rotating the receiving antenna about its center, and the maximum signal level is read using a measuring receiver having CISPR 16 quasi-peak (QP) detector function and 120 kHz nominal bandwidth.
Then, appropriate correction factor ---consists of antenna factor, and transmission loss (cable loss) in the system--- is applied to the receiver reading to calculate the corresponding field strength, and the result is compared with the upper limit specified in the standard.
In general, it is assumed that magnetic field strength can be converted to electric field strength by applying the free space impedance of approximately 377 ohms, and vice versa.
Actual measurement will be carried out according to the appropriate edition of CISPR 16-2-3, ANSI C63.10 and/or other standards whichever applicable.