FCC RADIO TEST REPORT

FCC 47 CFR PART 15 SUBPART C

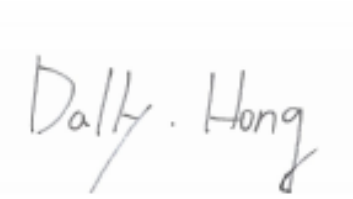
INDUSTRY CANADA RSS-310

Test Standard	**FCC Part 15.249** **IC RSS-310 issue 4 and IC RSS-GEN issue 5**
Trade name	**KOHLER**
Product name	**New Microwave Sensor**
Model No.	**1384310, 1384311, 1384312, 1384313, 1384314, 1386373, 1386374, 1386375, 1386376**
Test Result	**Pass**

The test Result was tested by Compliance Certification Services Inc. The test data, data evaluation, test procedures, and equipment configurations shown in this report were given in ANSI C63.10: 2013 and compliance standards.

The test results of this report relate only to the tested sample (EUT) identified in this report.
The test Report of full or partial shall not copy. Without written approval of Compliance Certification Services Inc. (Wugu Laboratory)

Approved by: *Tested by:*



Kevin Tsai
Deputy Manager

Dally Hong
Engineer

Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	March 20, 2019	Initial Issue	ALL	May Lin
01	April 03, 2019	1. Revised the EUT information、measurement uncertainty、test procedure、test plot and test results.	P.4, P.6, P.13-14, P.17, P.20-21, P.23, P.26-31	May Lin
02	April 11, 2019	1. Revised the EUT information and test procedure.	P.4, P.18	May Lin

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1. GENERAL INFORMATION

1.1 EUT INFORMATION

Applicant	Kohler Co. 444 Highland Drive Kohler, WI 53044 United States
Manufacturer	Shanghai Kohler Electronics., Ltd. No. 1955, Fengxiang Road, Baoshan Area, Shanghai, PRC Post code: 200444
Equipment	New Microwave Sensor
Model Name	1384310, 1384311, 1384312, 1384313, 1384314, 1386373, 1386374, 1386375, 1386376
Model Discrepancy	See the following Note 1
EUT Functions	24G Radar
Received Date	February 20, 2019
Date of Test	March 06 ~ April 03, 2019
Output Power	Peak : 79.83dBuV/m Average : 64.65dBuV/m
Power Operation	☐ AC ☒ DC Type: ☐ Battery ☒ DC Power Supply: 5V ☐ External DC adapter

Note:

1. Difference of the five samples (list on this report) please see as below:

No.	*New Microwave Sensor*	*Part No./ Material No.*	*Difference*	*Cable Length (mm)*
1	*Right-angle*	*1384310*	*Main Model*	*800+*
		1384311	*Cable Length & Order*	*500 - 600*
		1384312	*Cable Length*	*250 - 300*
		1384313	*Cable Length & Connector Type*	*800+*
		1386373	*Cable Length & Connector Type*	*500+*
		1386374	*Cable Length & Connector Type*	*500+*
		1386375	*Cable Length & Connector Type*	*500+*
		1386376	*Cable Length & Connector Type*	*500+*
2	*Chamfer-angle*	*1384314*	*Main Model*	*700+*

1.2 EUT CHANNEL INFORMATION

Center Frequency Frequency Range	24.125GHz(24GHz-24.25GHz)
Modulation Type	FMCW
Number of channel	1

1.3 ANTENNA INFORMATION

Antenna Type	☐ PIFA ☒ PCB ☐ Dipole ☐ Printed ☐ Coils
Antenna Gain	0 dBi
Antenna Connector	N/A

1.4 MEASUREMENT UNCERTAINTY

PARAMETER	UNCERTAINTY
AC Powerline Conducted Emission	N/A
Emission bandwidth, 20dB bandwidth	+/- 0.0014
RF output power, conducted	+/- 1.14
Power density, conducted	+/- 1.40
3M Semi Anechoic Chamber / 30M~200M	+/- 4.12
3M Semi Anechoic Chamber / 200M~1000M	+/- 4.68
3M Semi Anechoic Chamber / 1G~8G	+/- 5.18
3M Semi Anechoic Chamber / 8G~18G	+/- 5.47
3M Semi Anechoic Chamber / 18G~26G	+/- 3.81
3M Semi Anechoic Chamber / 26G~40G	+/- 3.87
3M Semi Anechoic Chamber / 40G~60G	+/- 1.8509
3M Semi Anechoic Chamber / 60G~90G	+/- 3.43
3M Semi Anechoic Chamber / 90G~140G	+/- 3.52

***Remark**:*
1.This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2
2. ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report.

1.5 FACILITIES AND TEST LOCATION

All measurement facilities used to collect the measurement data are located at *No.11, Wugong 6th Rd., Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.)*

Test site	Test Engineer	Remark
AC Conduction Room	-	-
Radiation	Dally Hong	-
RF Conducted	Dally Hong	-

Remark: *The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.*

1.6 INSTRUMENT CALIBRATION

3M 966A Chamber Test Site					
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Cal Date**	**Cal Due**
Band Reject Filters	MICRO TRONICS	BRM 50702	120	05/14/2018	05/13/2019
Bilog Antenna	Sunol Sciences	JB3	A030105	07/13/2018	07/12/2019
Cable	HUBER SUHNER	SUCOFLEX 104PEA	25157	06/29/2018	06/28/2019
Cable	HUBER SUHNER	SUCOFLEX 104PEA	20995	06/29/2018	06/28/2019
Digital Thermo-Hygro Meter	WISEWIND	1206	D07	01/30/2019	01/29/2020
double Ridged Guide Horn Antenna	ETC	MCTD 1209	DRH13M02003	08/20/2018	08/19/2019
Loop Ant	COM-POWER	AL-130	121051	03/21/2018	03/20/2019
Pre-Amplifier	EMEC	EM330	060609	06/29/2018	06/28/2019
Pre-Amplifier	HP	8449B	3008A00965	06/29/2018	06/28/2019
PSA Series Spectrum Analyzer	Agilent	E4446A	MY46180323	05/31/2018	05/30/2019
Antenna Tower	CCS	CC-A-1F	N/A	N.C.R	N.C.R
Controller	CCS	CC-C-1F	N/A	N.C.R	N.C.R
Turn Table	CCS	CC-T-1F	N/A	N.C.R	N.C.R
Mixer	Keysight	11974VE01	MY30012006	09/01/2016	08/31/2019
Mixer	Keysight	11974VE01	MY30012006	08/19/2016	08/18/2019
Mixer	Keysight	N9029AV08	US53250002	08/19/2016	08/18/2019
Mixer	Keysight	N9029AV05	US53250003	08/24/2016	08/23/2019
Horn Antenna	CMI	WR15	WR15-01	08/29/2016	08/28/2019
Horn Antenna	CMI	WR12	WR12-01	08/19/2016	09/18/2019
Horn Antenna	CMI	WR8.0	WR8-01	05/30/2016	05/29/2019
Horn Antenna	CMI	WR8.0	WR8-02	08/24/2016	08/23/2019
Horn Antenna	CMI	WR5.1	WR5.1-01	08/29/2016	08/28/2019
PXA Spectrum Analyzer	Agilent	N9030A	MY53120760	04/09/2018	04/08/2019

Remark: *Each piece of equipment is scheduled for calibration once a year.*

1.7 SUPPORT AND EUT ACCESSORIES EQUIPMENT

EUT Accessories Equipment					
No.	**Equipment**	**Brand**	**Model**	**Series No.**	**FCC ID**
	N/A				

Support Equipment					
No.	**Equipment**	**Brand**	**Model**	**Series No.**	**FCC ID**
1.	NB	Lenovo	Thinkpad L460	N/A	N/A
2.	USB Test Board	N/A	test plate 2	N/A	N/A

1.8 TEST METHODOLOGY AND APPLIED STANDARDS

The test methodology, setups and results comply with all requirements in accordance with ANSI C63.10:2013, FCC Part 15.249, RSS-310 Issue 4 and RSS-GEN Issue 5.

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2. TEST SUMMERY

FCC Standard Section	IC Standard Section	Report Section	Test Item	Result
15.203	-	1.3	Antenna Requirement	Pass
15.207(a)	RSS-GEN 8.8	4.1	AC Conducted Emission	N/A
15.215	RSS-210	4.2	20dB Bandwidth and Occupied Bandwidth (99%)	Pass
15.249(a)	RSS-310 3.10	4.3	Filed strength of fundamental	Pass
15.249(a)	RSS-GEN 8.9, 8.10	4.3	Radiation Spurious Emission	Pass

3. DESCRIPTION OF TEST MODES

3.1 THE WORST MODE OF MEASUREMENT

Radiated Emission Measurement Above 1G	
Test Condition	**Band edge, Emission for Unwanted and Fundamental**
Power supply Mode	**Mode 1: EUT power by host system (DC 5V)**
Worst Mode	**☒ Mode 1 ☐ Mode 2 ☐ Mode 3 ☐ Mode 4**
Worst Position	**☐ Placed in fixed position.** **☒ Placed in fixed position at X-Plane (E2-Plane)** **☐ Placed in fixed position at Y-Plane (E1-Plane)** **☐ Placed in fixed position at Z-Plane (H-Plane)**
Worst Polarity	**☒ Horizontal ☐ Vertical**

Radiated Emission Measurement Below 1G	
Test Condition	**Radiated Emission Below 1G**
Power supply Mode	**Mode 1: EUT power by host system (DC 5V)**
Worst Mode	**☒ Mode 1 ☐ Mode 2 ☐ Mode 3 ☐ Mode 4**

Remark:
1. The worst mode was record in this test report.
2. EUT pre-scanned in three axis, X, Y, Z and two polarity, Horizontal and Vertical for radiated measurement. The worst case (X-Plane and Horizontal) were recorded in this report

4. TEST RESULT

4.1 AC POWER LINE CONDUCTED EMISSION

4.1.1 Test Limit

According to §15.207(a) and RSS-GEN section 8.8,

Frequency Range (MHz)	Limits(dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

* Decreases with the logarithm of the frequency.

4.1.2 Test Procedure

1. The EUT was placed on a non-conducted table, which is 0.8m above horizontal ground plane and 0.4m above vertical ground plane.

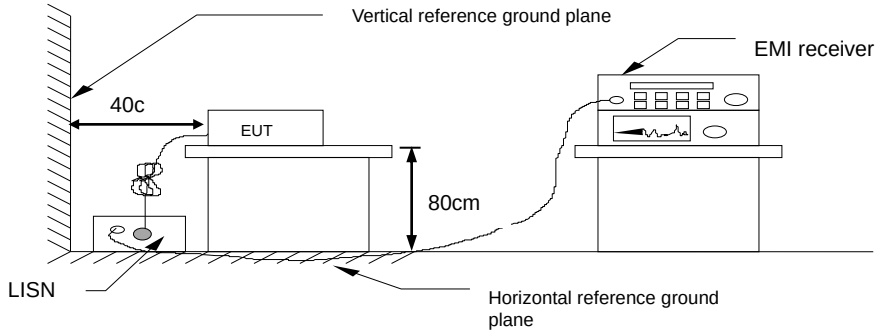
2. EUT connected to the line impedance stabilization network (LISN)

3. Receiver set RBW of 9kHz and Detector Peak, and note as quasi-peak and average.

4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.

5. Recorded Line for Neutral and Line.

4.1.3 Test Setup

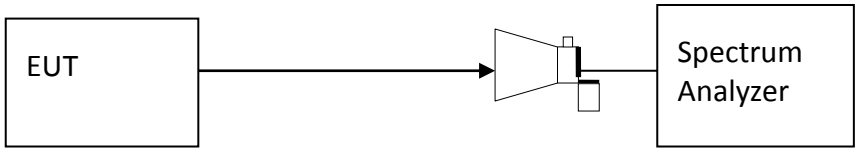


4.1.4 Test Result

Not applicable, because EUT not connect to AC Main Source direct.

4.2 20dB BANDWIDTH AND OCCUPIED BANDWIDTH (99%)

TEST CONFIGURATION



TEST PROCEDURE

1. Place the EUT on the table and set it in the transmitting mode.
2. SA set RBW = 1% ~ 5% OBW, VBW = three times the RBW and Detector = Peak, to measurement 99% Bandwidth and 20dB Bandwidth
3. Measure and record the result of 20 dB Bandwidth and 99% Bandwidth. in the test report.

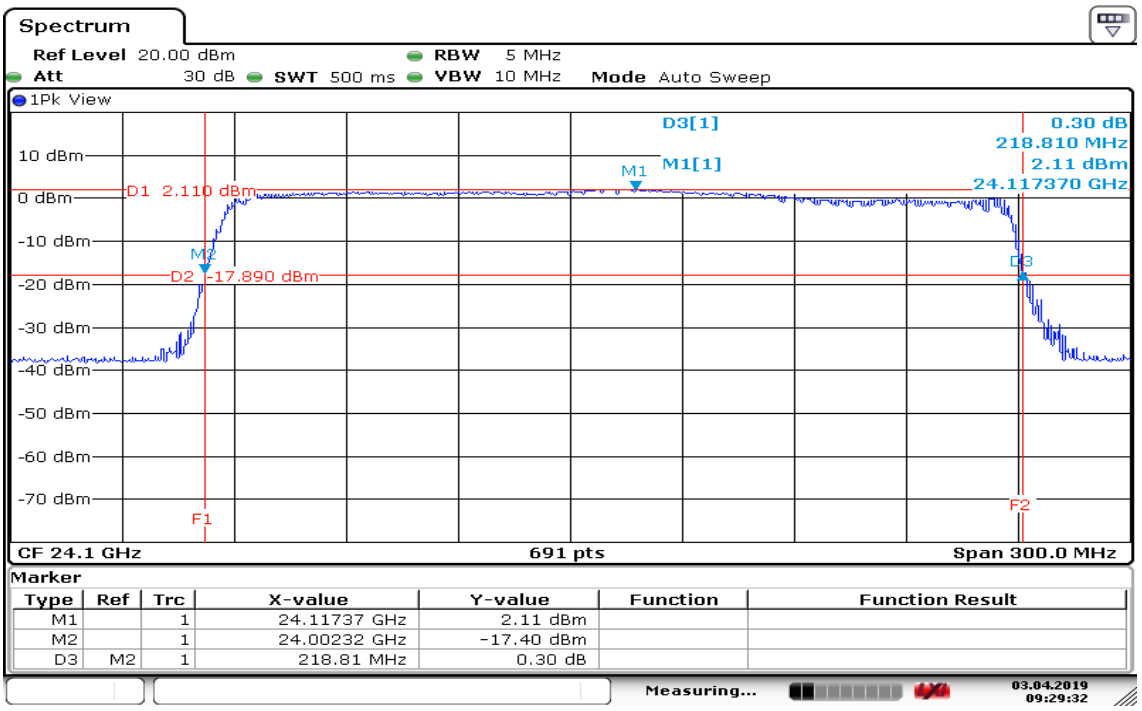
TEST RESULTS

No non-compliance noted

Test Condition	Frequency(Hz)	Occupied Bandwidth 99% (MHz)	20 dB Bandwidth (MHz)
24G Radar	24G	211.866	218.81

Test Plot

20dB Bandwidth



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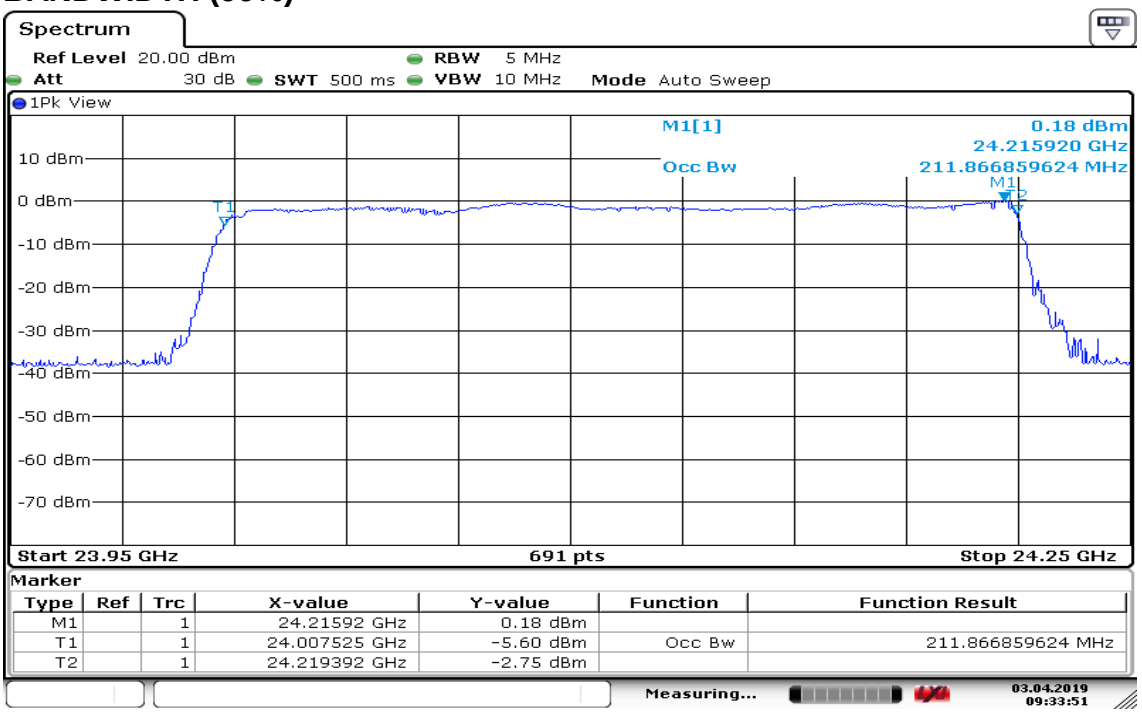
BANDWIDTH (99%)



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4.3 FIELD STRENGTH OF FUNDAMENTAL AND RADIATION SPURIOUS EMISSION

4.3.1 Test Limit

FCC according to §15.249(a).

(1) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
2400-2483.5	50	500
5725-5875	50	500
24000-24250	250	2500

* Field strength limits are specified at a distance of 3 meters

Fundamental Limit Conversion			
Average (mV/m) at 3M	Average (dBuV/m) at 3M	Average (dBuV/m) at 1M	Peak (dBuV/m) at 1M
250	107.9588	117.50	137.50

*(Limit=107.9588+20LOG(3/1)=117.50 dBuV/m)

Harmonic Limit Conversion			
Average (uV/m) at 3M	Average (dBuV/m) at 3M	Average (dBuV/m) at 1M	Peak (dBuV/m) at 1M
2500	67.9588	77.50	97.50

*(Limit=67.9588+20LOG(3/1)=77.50 dBuV/m)

(2) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209(follow the table), whichever is the lesser attenuation

Below 30 MHz

Frequency	Field Strength (μA/m)	Magnetic field strength (H-Field) (μA/m)	Measurement Distance (metres)
9-490 kHz	2,400/F (F in kHz)	2,400/F (F in kHz)	300
490-1,705 kHz	24,000/F (F in kHz)	24,000/F (F in kHz)	30
1.705-30 MHz	30	N/A	30

Above 30 MHz

Frequency (MHz)	Field Strength microvolts/m at 3 metres (watts, e.i.r.p.)	
	Transmitters	Receivers
30-88	100 (3 nW)	100 (3 nW)
88-216	150 (6.8 nW)	150 (6.8 nW)
216-960	200 (12 nW)	200 (12 nW)
Above 960	500 (75 nW)	500 (75 nW)

IC according to RSS-Gen, Section 8.9 and 8.10.

RSS-Gen Table 3 and Table 5 – General Field Strength Limits for Transmitters and Receivers at Frequencies Above 30 MHz (Note)

Frequency (MHz)	Field Strength microvolts/m at 3 metres (watts, e.i.r.p.)	
	Transmitters	Receivers
30-88	100 (3 nW)	100 (3 nW)
88-216	150 (6.8 nW)	150 (6.8 nW)
216-960	200 (12 nW)	200 (12 nW)
Above 960	500 (75 nW)	500 (75 nW)

Note: Measurements for compliance with the limits in table 3 may be performed at distances other than 3 metres, in accordance with Section 6.6.

RSS-Gen Table 6: General Field Strength Limits for Transmitters at Frequencies Below 30 MHz (Transmit)

Frequency	Magnetic field strength (H-Field) (μA/m)	Measurement Distance (m)
9-490 kHz Note	6.37/F (F in kHz)	300
490-1,705 kHz	63.7/F (F in kHz)	30
1.705-30 MHz	0.08	30

Note: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector..

4.3.2 Test Procedure

1. The EUT is placed on a turntable, Above 1 GHz is 1.5m, below 1 GHz and above 40G is 0.8m above ground plane. The EUT Configured un accordance with ANSI C63.10: 2013, and the EUT set in a continuous mode.

2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. And EUT is set 3m away from the receiving antenna, which is scanned from 1m to 4m above the ground plane to find out the highest emissions. Measurement are made polarized in both the vertical and the horizontal positions with antenna.

3. The measurement distance above 40 GHz is set 1m away from the receiving antenna.

4. The SA setting following：

(1) Below 1G：RBW = 100kHz, VBW ≥ 3 RBW, Sweep = Auto, Detector = Peak,

(2) Above 1G：

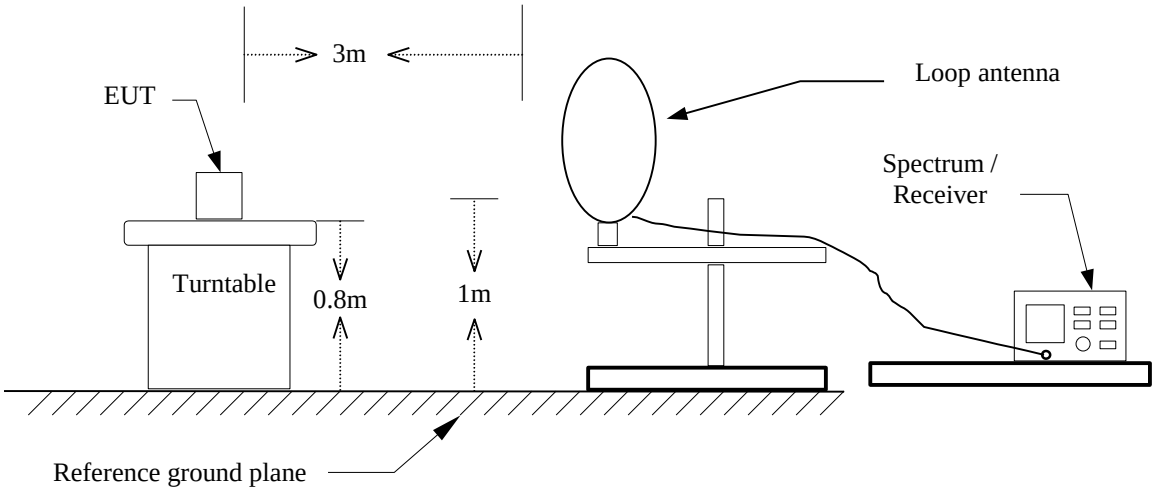
(2.1) For Peak measurement：RBW = 1MHz, VBW ≥ 3 RBW.

(2.2) For Average measurement：RBW = 1MHz, VBW = 10Hz.

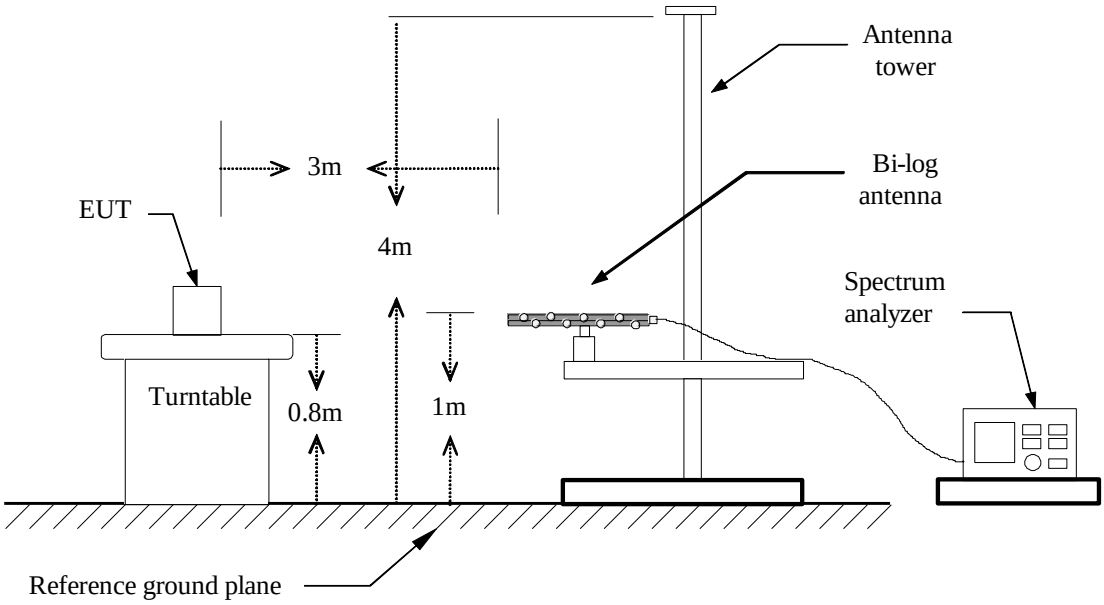
For measurements above 40 GHz, every attempt shall be made to reduce contributions from reflections to a minimum. Measurements in the frequency range above 40 GHz are typically made at a closer distance because the instrumentation noise floor is typically close to the radiated emission limit. Use of waveguide and flexible waveguide might be necessary at frequencies above 40 GHz to achieve usable signal-to-noise ratios at required measurement distances.The corrected system noise floor level is 6 dB or more below the limit, then the validated maximum measurement distance is the distance specified by the limit.
This devices that cause emissions above 10 GHz are physically small compared with the beamwidths of typical horn antennas used for EMC measurements. For such EUTs and frequencies above 40 GHz,, it might be preferable to vary the height and polarization of the EUT, instead of the receiving antenna, to maximize the measured emissions.

4.3.3 Test Setup

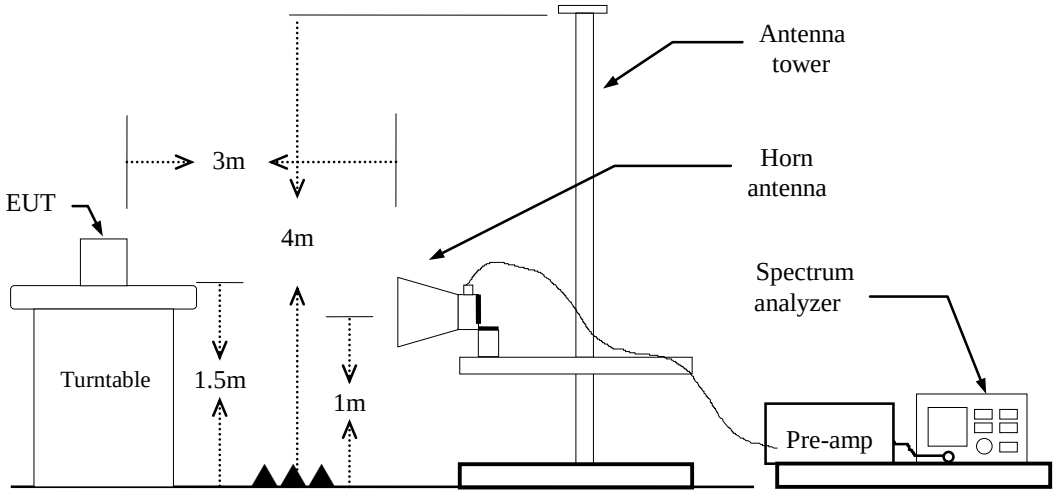
9kHz ~ 30MHz



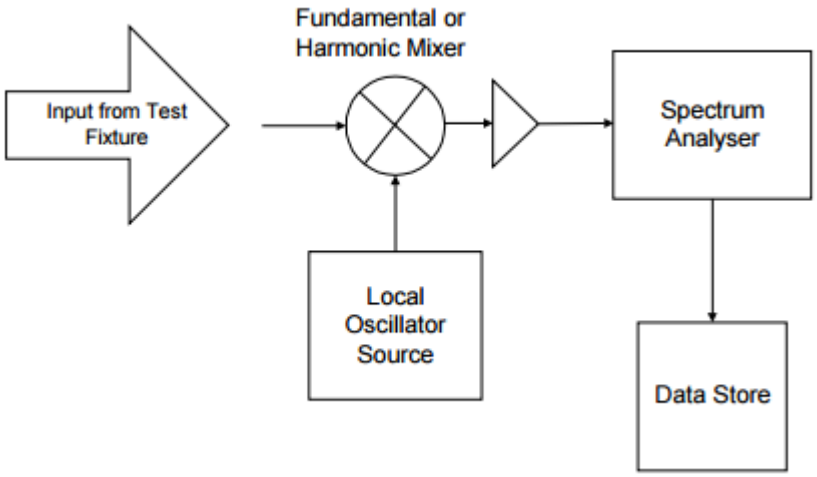
30MHz ~ 1GHz



Above 1 GHz



Above 40 GHz



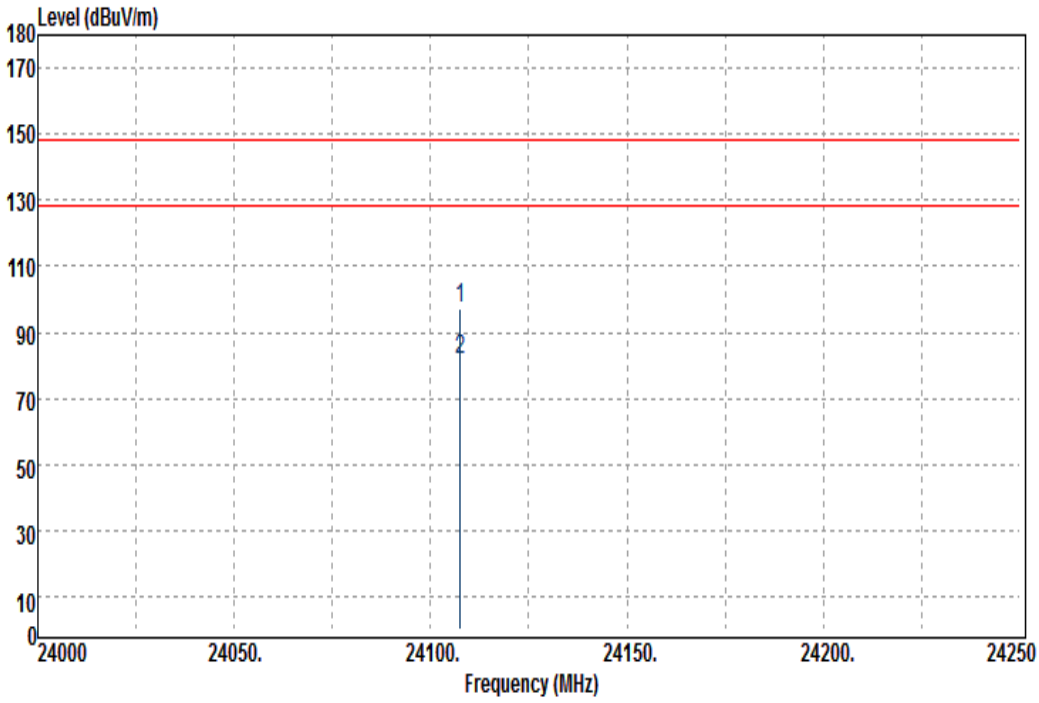
4.3.4 Test Result

Freq. (GHz)	Peak Value (dBuV/m)	Average Value (dBuV/m)	Peak Limit (dBuV/m)	Average Limit (dBuV/m)	Result	Antenna Polarization (V/H)
24107.50	96.87	81.69	128.00	108.00	Pass	H
24195.00	94.78	69.78	128.00	108.00	Pass	V

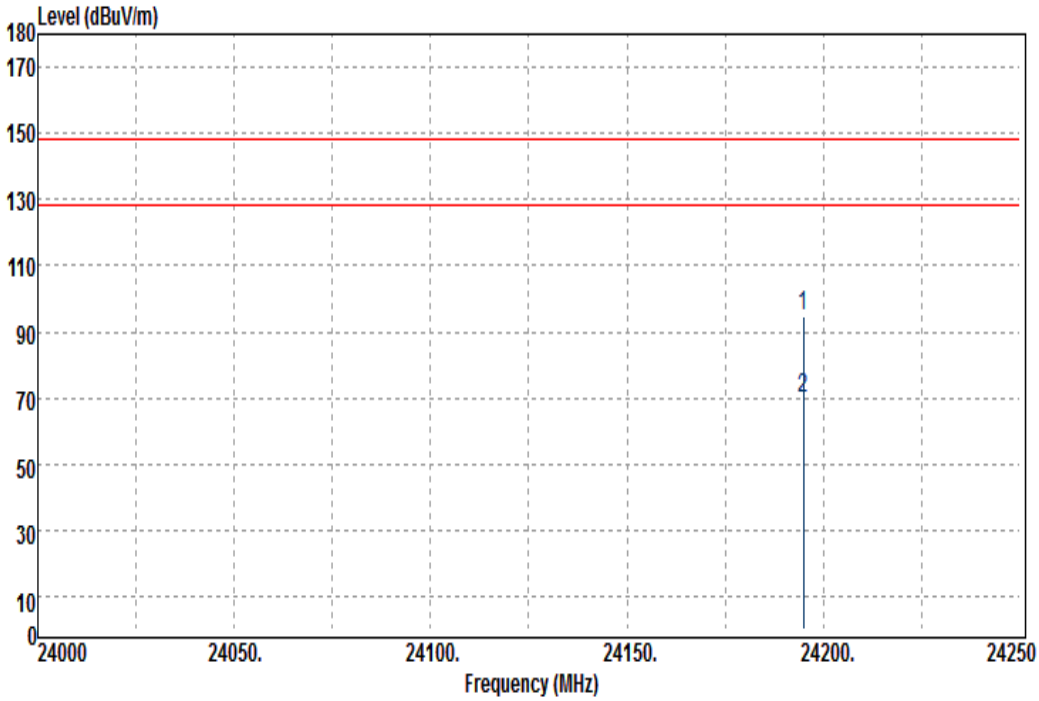
Test Data

(1) Filed strength of fundamental :

Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	Fundamental	Test Date	March 06, 2019
Axis	X-Plane	Test Engineer	Dally Hong
Detector	Peak & Average	Horizontal	

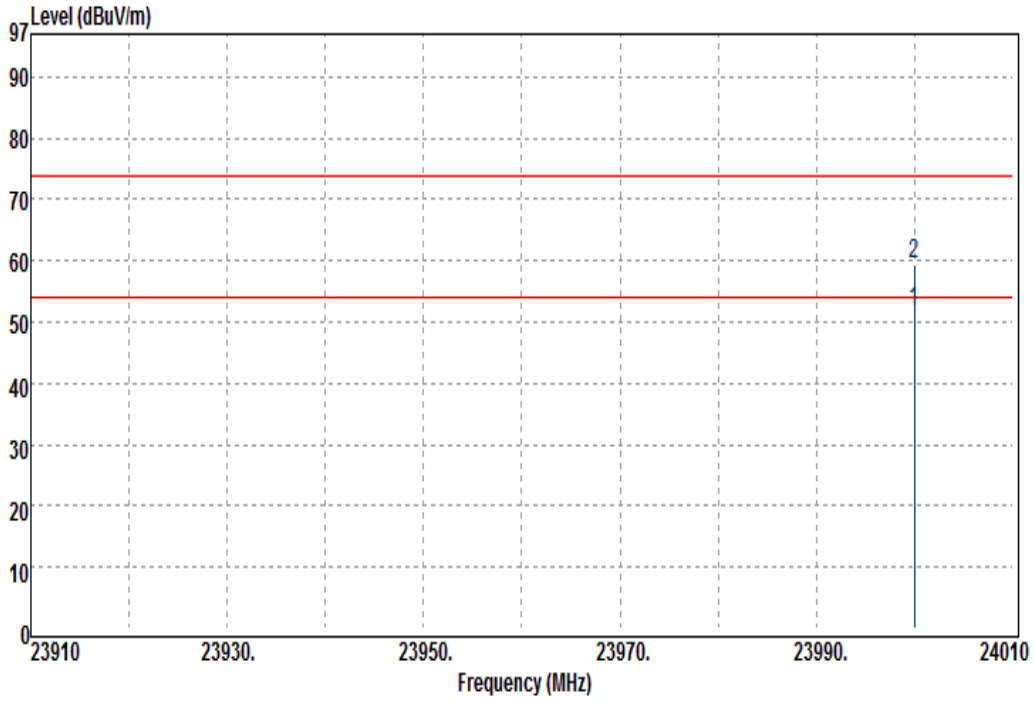


Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	Fundamental	Test Date	March 06, 2019
Polarize	Vertical	Test Engineer	Dally Hong
Detector	Peak & Average	Vertical	



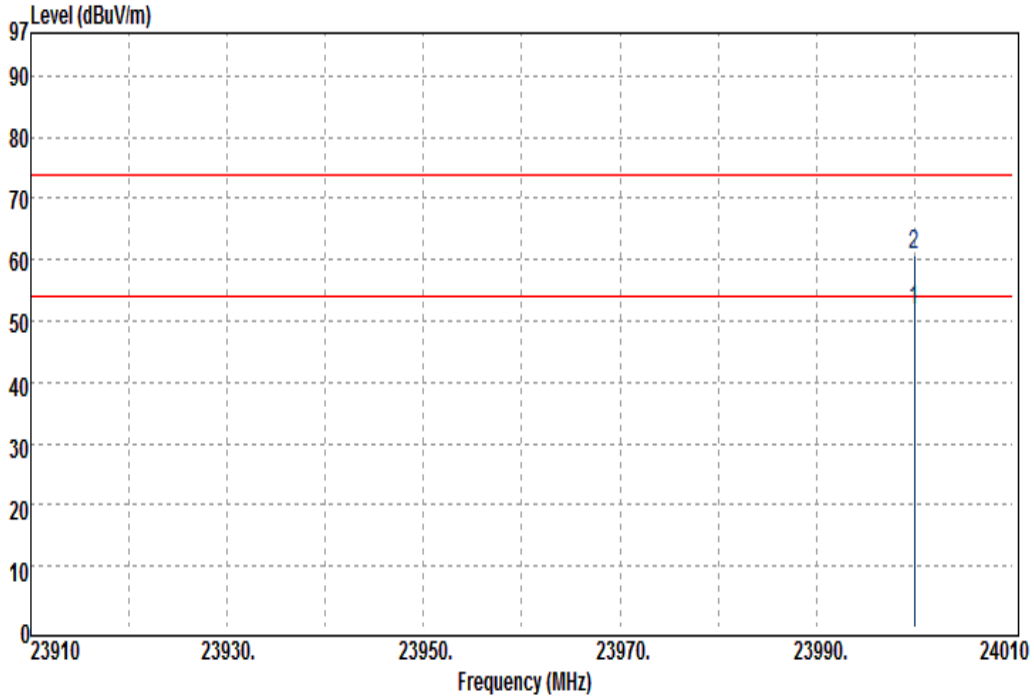
(2) Band Edge Test Data

Test Mode:	24 GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	Band Edge	Test Date	March 06, 2019
Polarize	Vertical	Test Engineer	Dally Hong



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	Factor(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
1	24000.00	34.65	17.09	51.74	54.00	-2.26	Average
2	24000.00	42.37	17.09	59.46	74.00	-14.54	Peak

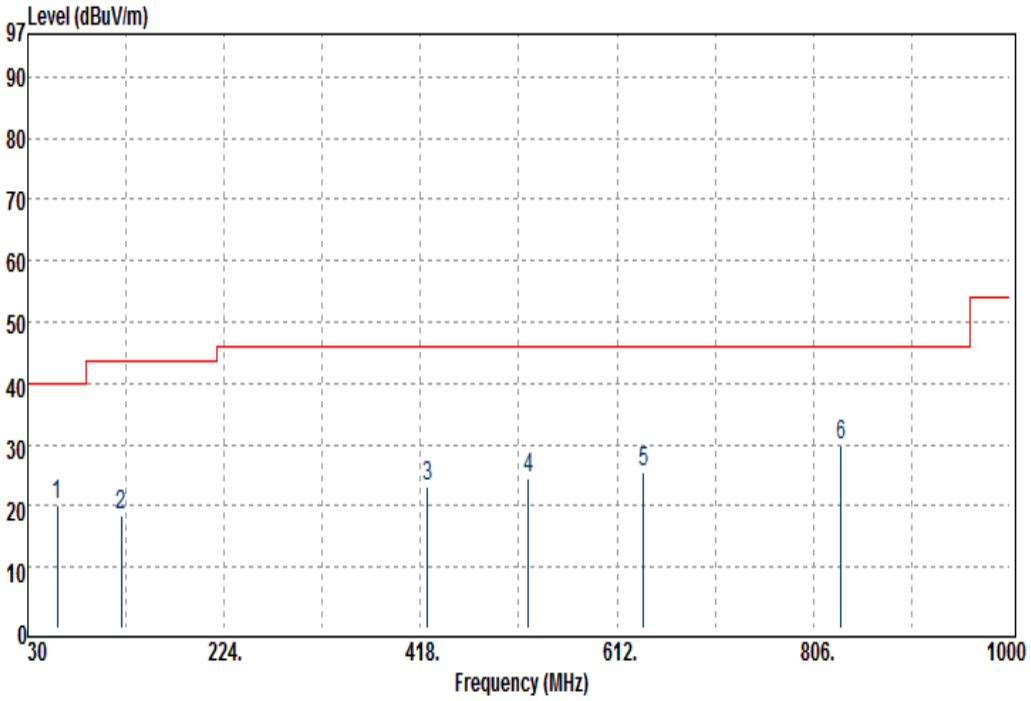
Test Mode:	24 GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	Band Edge	Test Date	March 06, 2019
Polarize	Horizontal	Test Engineer	Dally Hong



No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	Factor(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
1	24000.00	34.62	17.09	51.71	54.00	-2.29	Average
2	24000.00	43.80	17.09	60.89	74.00	-13.11	Peak

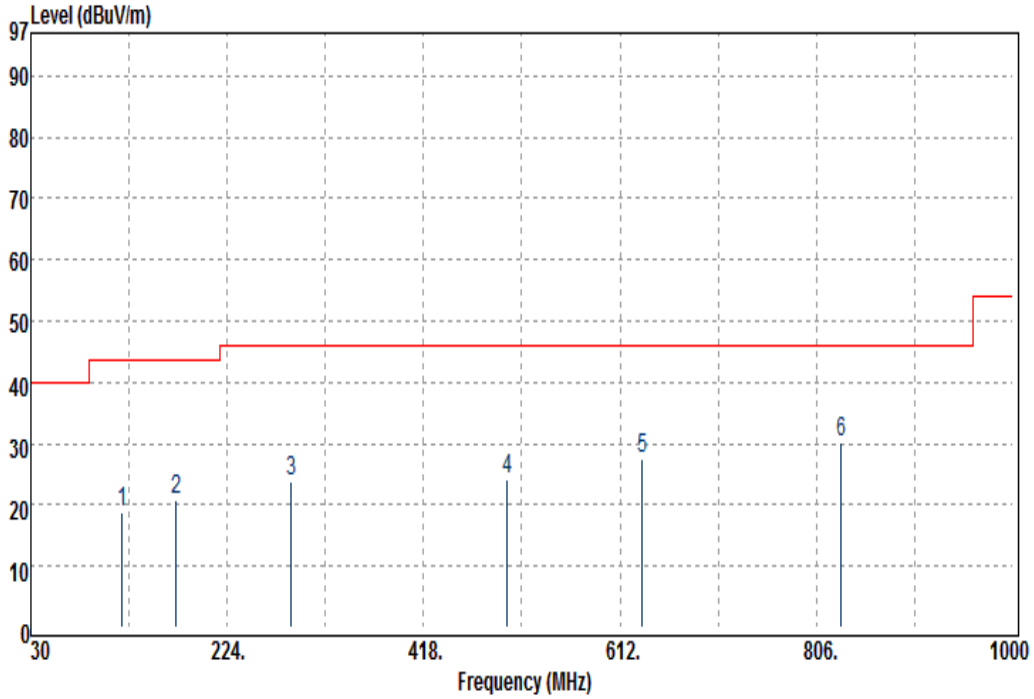
(3) Below 1G:

Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	30MHz-1GHz	Test Date	March 06, 2019
Polarize	Vertical	Test Engineer	Dally Hong
Detector	Peak and Qusi-peak		



Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
59.10	35.34	-15.36	19.98	40.00	-20.02	Peak
122.15	26.65	-8.25	18.40	43.50	-25.10	Peak
424.79	27.19	-4.09	23.10	46.00	-22.90	Peak
524.70	25.81	-1.31	24.50	46.00	-21.50	Peak
638.19	24.75	0.86	25.61	46.00	-20.39	Peak
833.16	25.38	4.45	29.83	46.00	-16.17	Peak

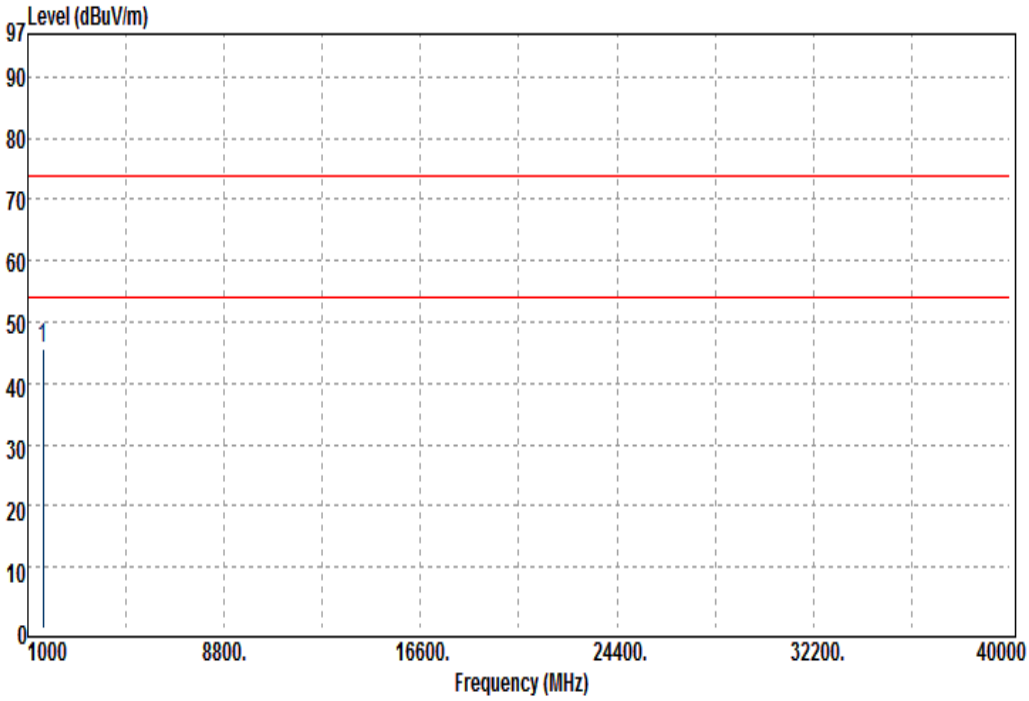
Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	30MHz-1GHz	Test Date	March 06, 2019
Polarize	Horizontal	Test Engineer	Dally Hong
Detector	Peak and Qusi-peak		



Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
120.21	27.18	-8.33	18.85	43.50	-24.65	Peak
173.56	31.09	-10.36	20.73	43.50	-22.77	Peak
287.05	31.58	-7.70	23.88	46.00	-22.12	Peak
500.45	26.36	-2.10	24.26	46.00	-21.74	Peak
634.31	26.67	0.92	27.59	46.00	-18.41	Peak
830.25	25.78	4.32	30.10	46.00	-15.90	Peak

(4) Above 1G :

Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	1GHz-40GHz	Test Date	March 06, 2019
Polarize	Vertical	Test Engineer	Dally Hong
Detector	Peak and Average		

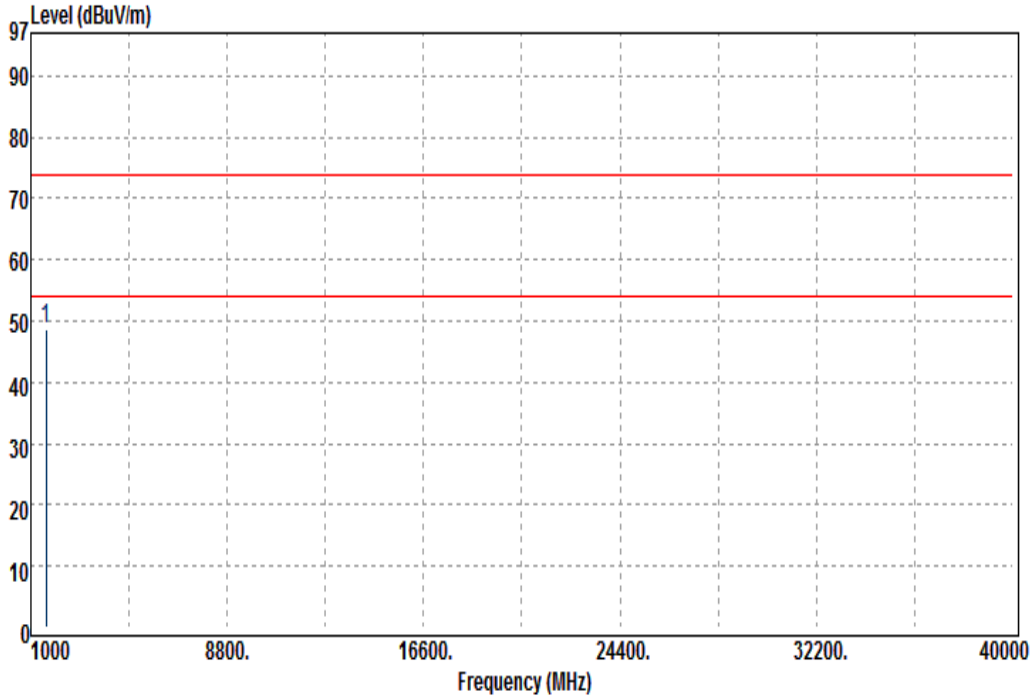


Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1595.00	52.94	-7.18	45.76	74.00	-28.24	Peak
N/A						

Remark:

1. *For above 1GHz, the EUT peak value was under average limit, therefore the Average value compliance with the average limit*

Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	1GHz-40GHz	Test Date	March 06, 2019
Polarize	Horizontal	Test Engineer	Dally Hong
Detector	Peak and Average		

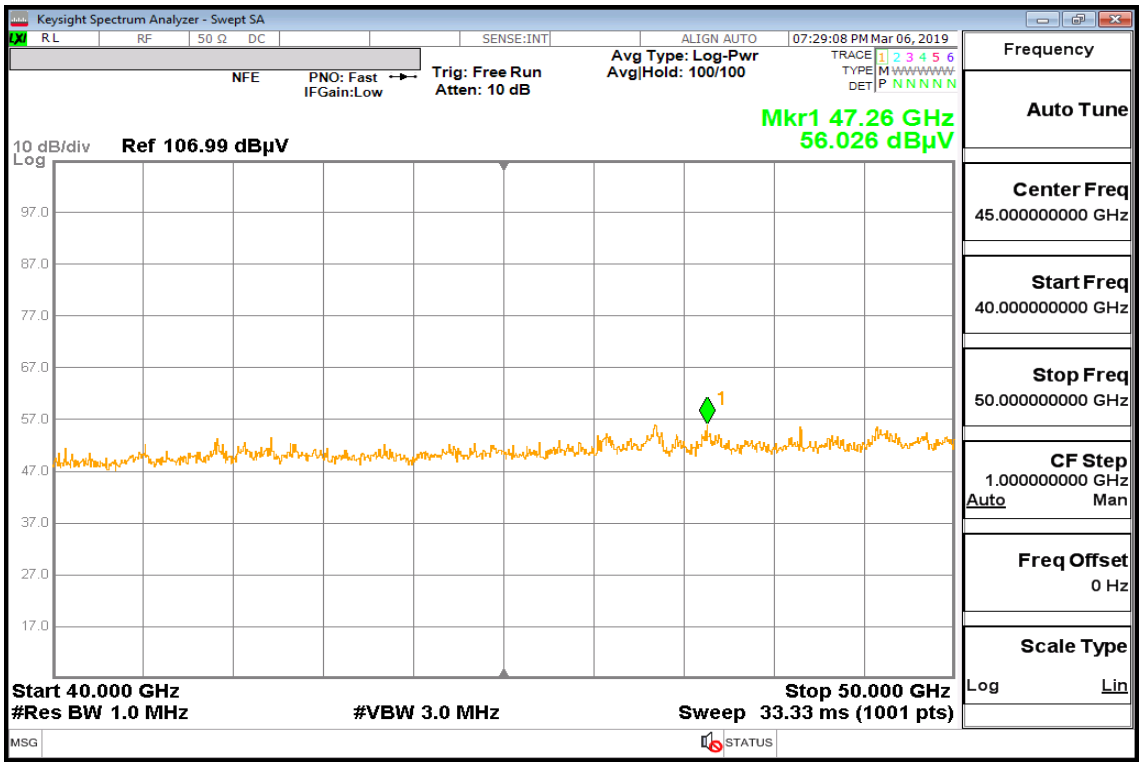


Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1595.00	55.98	-7.18	48.80	74.00	-25.20	Peak
N/A						

Remark:

1. *For above 1GHz, the EUT peak value was under average limit, therefore the Average value compliance with the average limit*

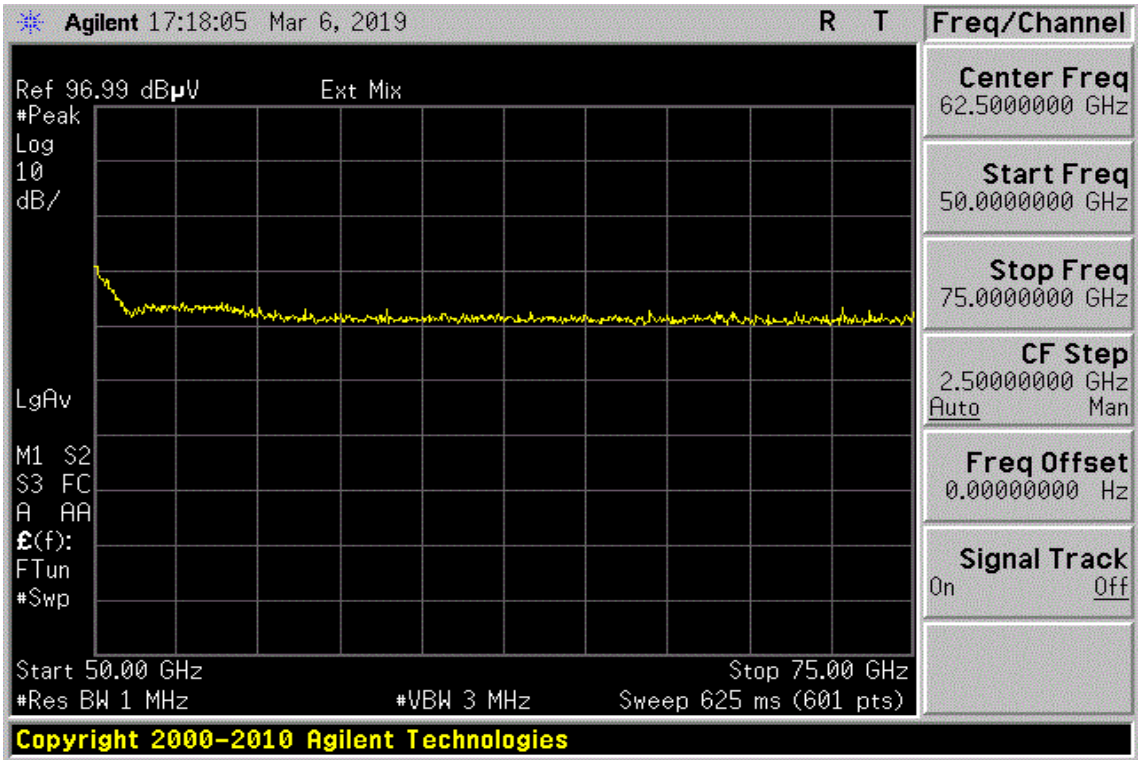
Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	40GHz-50GHz	Test Date	March 06, 2019
Polarize	Vertical/Horizontal	Test Engineer	Dally Hong
Detector	Peak and Average		



Remark:

1. *For above 1GHz, the EUT peak value was under average limit, therefore the Average value compliance with the average limit*

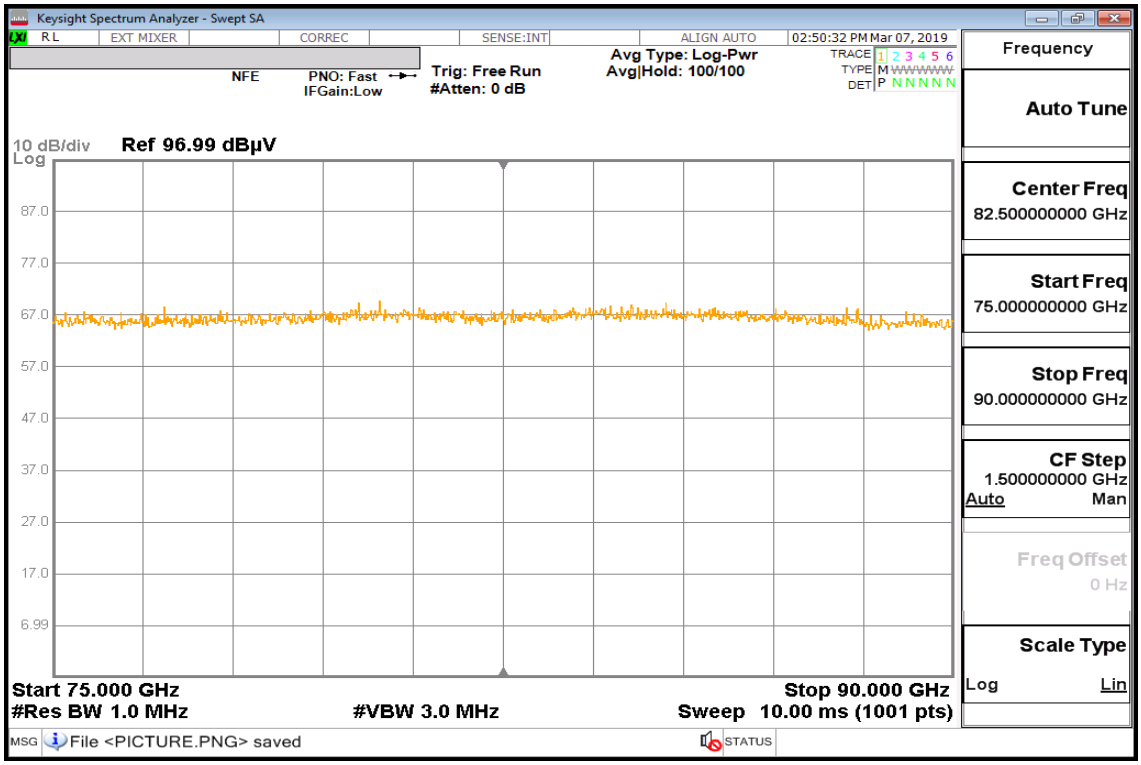
Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	50GHz-75GHz	Test Date	March 06, 2019
Polarize	Vertical/Horizontal	Test Engineer	Dally Hong
Detector	Peak and Average		



Remark:

1. *For above 1GHz, the EUT peak value was under average limit, therefore the Average value compliance with the average limit*

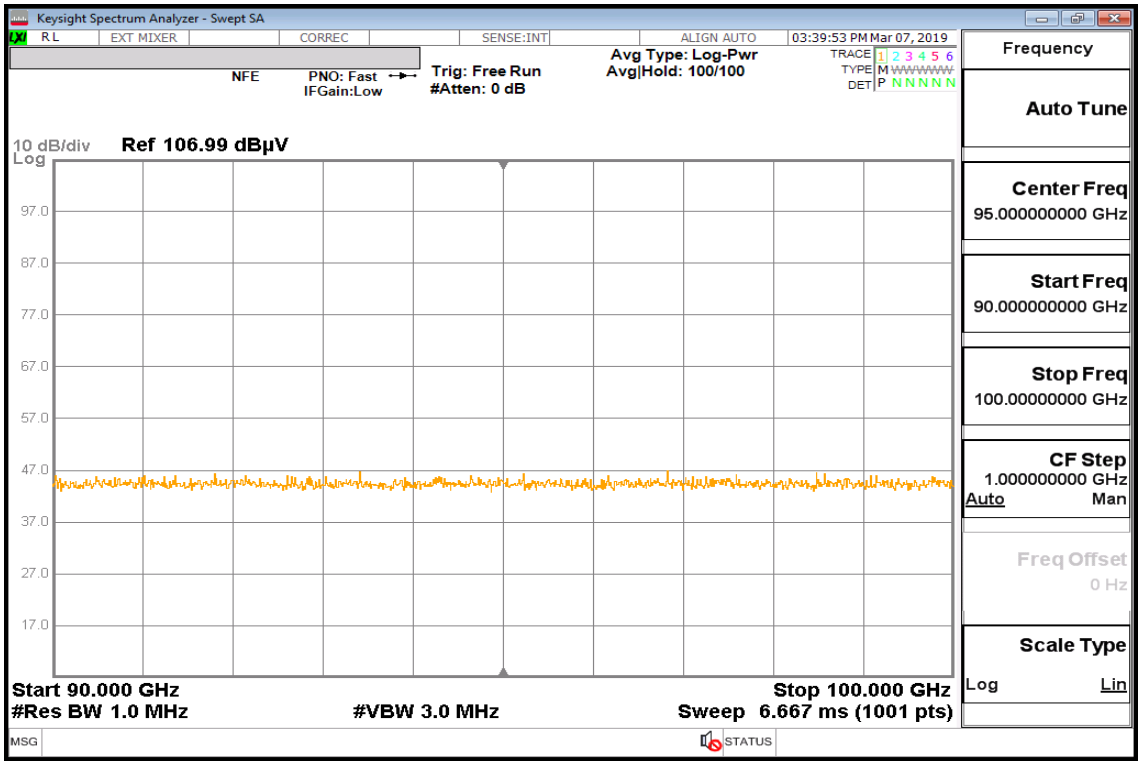
Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	75GHz-90GHz	Test Date	March 07, 2019
Polarize	Vertical/Horizontal	Test Engineer	Dally Hong
Detector	Peak and Average		



Remark:

1. *For above 1GHz, the EUT peak value was under average limit, therefore the Average value compliance with the average limit*

Test Mode:	TX-24GHz	Temp/Hum	23(℃)/ 66%RH
Test Item	90GHz-100GHz	Test Date	March 07, 2019
Polarize	Vertical/Horizontal	Test Engineer	Dally Hong
Detector	Peak and Average		



Remark:

1. *For above 1GHz, the EUT peak value was under average limit, therefore the Average value compliance with the average limit*

--End of Report--