Testing Laboratory
3787

RADIO TEST REPORT

FCC ID	:	**WR932181716523**
Equipment	:	**Video doorbell**
Brand Name	:	**ecobee**
Model Name	:	**EB-CAMSDB-01**
Applicant	:	**Ecobee Incorporated** **25, Dockside Drive Suite 700, Toronto, Canada, M5A0B5**
Standard	:	**47 CFR FCC Part 15 Subpart C § 15.249**

The product was received on Jul. 10, 2023, and testing was started from Jul. 21, 2023 and completed on Aug. 07, 2023. We, Sporton International Inc. Hsinchu Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in ANSI C63.10-2013 and shown compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. Hsinchu Laboratory, the test report shall not be reproduced except in full.

Approved by: Sam Chen

Sporton International Inc. Hsinchu Laboratory
No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)

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History of this test report

Report No.	Version	Description	Issued Date
FR361614AE	01	Initial issue of report	Aug. 31, 2023

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
2.1	15.207	AC Power Line Conducted Emissions	PASS	-
2.2	15.249(a)	Field Strength of Fundamental Emissions	PASS	-
2.3	15.215(c)	20dB Spectrum Bandwidth	PASS	-
2.4	15.249(a)/(d)	Radiated Emissions	PASS	-
2.5	15.249(d)	Band Edge Emissions	PASS	-
2.6	15.203	Antenna Requirements	PASS	-

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the chapter "Measurement Uncertainty".

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Sam Chen

Report Producer: Sophia Shiung

1 General Information

1.1 Product Details

Items	Description
Power Type	From host system (16~24 Vac)
Modulation	FMCW
Frequency Range	24000 ~ 24250 MHz
Operation Frequency Range	24.05 ~ 24.24 GHz
Test Frequency	24145 MHz
Channel Bandwidth (99%)	184.82 MHz
Max. Field Strength	65.64 dBuV/m at 3m (Average) / 75.18 dBuV/m at 1m (Average) 99.79 dBuV/m at 3m (Peak) / 109.33 dBuV/m at 1m (Peak)

Note: The above information was declared by manufacturer.

1.2 Antenna Information

Ant.	Port			Brand	Model Name	Antenna Type	Connector	Gain (dBi)
	WLAN / Bluetooth	Thread	Sub-G					
1	1	-	-	PSA	RFMTA160900NNLB001	PIFA	N/A	Note 1
2	-	1	-	PSA	RFPCA361205IMAB401	PIFA	I-PEX	
3	-	-	1	PSA	RFMTA341100NNUB001	PIFA	N/A	

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)
4	Socionext	SC1233AR3	Chip	N/A	2

Note 1:

Ant.	Antenna Gain (dBi)				
	WLAN		Bluetooth	Thread	Sub-G
	2.4GHz	5GHz			
1	2.81	4.99	2.81	-	-
2	-	-	-	3.00	-
3	-	-	-	-	1.66

Note 2: The above information was declared by manufacturer.

Note 3: **For 2.4GHz function:**

For IEEE 802.11 b/g/n (TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For 5GHz function:

For IEEE 802.11a/n/ac (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For bluetooth function (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For Thread function (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For Sub-G function (1TX/1RX):

Only Port 1 can be used as transmitting/receiving antenna.

For 24GHz function (1TX/2RX):

Only Ant. 4 can be used as transmitting/receiving antenna.

1.3 Accessories

Accessories
CHIME adapter*1: Non-shielded, 0.2m
Backplate*1

1.4 Table for Test Modes

The following table is a list of the test modes shown in this test report.

Test Items	Mode	Frequency
AC Power Line Conducted Emissions Test Voltage: 120Vac / 60Hz	Normal link	Random
Field Strength of Fundamental Emissions	CTX	24145 MHz
20dB Spectrum Bandwidth	CTX	24145 MHz
Radiated Emissions 30MHz~1GHz	Normal link	Random
Radiated Emissions 1GHz~40GHz	CTX	24145 MHz
Radiated Emissions 40GHz~100GHz	CTX	24145 MHz
Band Edge Emissions	CTX	24145 MHz

Note: CTX=continuously transmitting

For AC Power Line Conducted Emissions

Test mode: 1. EUT_WLAN 2.4GHz + Thread + 24GHz radar

2. EUT_WLAN 5GHz + Thread + 24GHz radar

3. EUT_Bluetooth + Thread + 24GHz radar

Mode 3 has been evaluated to be the worst case among Mode 1~3, thus measurement for Mode 4~5 will follow this same test mode.

4. EUT_Bluetooth + Sub-G (Hopping mode) + 24GHz radar

5. EUT_Bluetooth + Sub-G (Hybrid mode) + 24GHz radar

For operating, mode 3 is the worst case and it was record in this test report.

For Radiated Emissions 30MHz~1GHz

After evaluating, EUT in Y axis was the worst case, so the measurement will follow this same test configuration.

Test mode: 1. EUT in Y axis_WLAN 2.4GHz + Thread + 24GHz radar

2. EUT in Y axis_WLAN 5GHz + Thread + 24GHz radar

3. EUT in Y axis_Bluetooth + Thread + 24GHz radar

Mode 3 has been evaluated to be the worst case among Mode 1~3, thus measurement for Mode 4~5 will follow this same test mode.

4. EUT in Y axis_Bluetooth + Sub-G (Hopping mode) + 24GHz radar

5. EUT in Y axis_Bluetooth + Sub-G (Hybrid mode) + 24GHz radar

For operating, mode 3 is the worst case and it was record in this test report.

For Other Test Items

After evaluating, EUT in Y axis was the worst case, so the measurement will follow this same test configuration.

For Simultaneous Transmission Analysis - Co-location RF Exposure Evaluation

Test mode: 1. WLAN 2.4GHz + Thread + 24GHz radar

2. WLAN 2.4GHz + Sub-G (Hopping mode) + 24GHz radar
3. WLAN 2.4GHz + Sub-G (Hybrid mode) + 24GHz radar
4. WLAN 5GHz + Thread + 24GHz radar
5. WLAN 5GHz + Sub-G (Hopping mode) + 24GHz radar
6. WLAN 5GHz + Sub-G (Hybrid mode) + 24GHz radar
7. Bluetooth + Thread + 24GHz radar
8. Bluetooth + Sub-G (Hopping mode) + 24GHz radar
9. Bluetooth + Sub-G (Hybrid mode) + 24GHz radar

Refer to Sporton Test Report No.: FA361614 for Co-location RF Exposure Evaluation.

1.5 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ANSI C63.10-2013
- 47 CFR FCC Part 15 Subpart C § 15.249

The following reference test guidance is not within the scope of accreditation of TAF.

- FCC KDB 414788 D01 v01r01

1.6 Table for Testing Locations

Testing Location Information	
Test Lab.：Sporton International Inc. Hsinchu Laboratory	
Hsinchu (TAF: 3787)	ADD: No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.) TEL: 886-3-656-9065 FAX: 886-3-656-9085 Test site Designation No. TW3787 with FCC. Conformity Assessment Body Identifier (CABID) TW3787 with ISED.

Test Condition	Test Site No.	Test Engineer	Test Environment (°C / %)	Test Date
Radiated < 1GHz	03CH05-CB	George Fan	22.9~23.6 / 60~63	Jul. 31, 2023~ Aug. 03, 2023
Radiated > 1GHz	03CH05-CB	George Fan	20~21 / 55~58	Jul. 21, 2023~ Jul. 26, 2023
AC Conduction	CO01-CB	Ryan Huang	22~23 / 56~57	Aug. 07, 2023

1.7 Table for Supporting Units

For AC Conduction

No.	Support Unit	Brand	Model	FCC ID
A	Power adapter	AMIGO	CT-5723-03	N/A
B	Test fixture	NEWHOUSE	CHM1	N/A
C	NB	DELL	PP13S	N/A

For Radiated < 1GHz

No.	Support Unit	Brand	Model	FCC ID
A	Power adapter	AMIGO	CT-5723-03	N/A
B	Test fixture	NEWHOUSE	CHM1	N/A
C	NB	DELL	PP13S	N/A

For Radiated > 1GHz

No.	Support Unit	Brand	Model	FCC ID
A	NB	DELL	E4300	N/A
B	Fixture	ALPHA	1EBRC21T..A2G	N/A
C	Power adapter	AMIGO	CT-5723-03	N/A

1.8 Duty Cycle

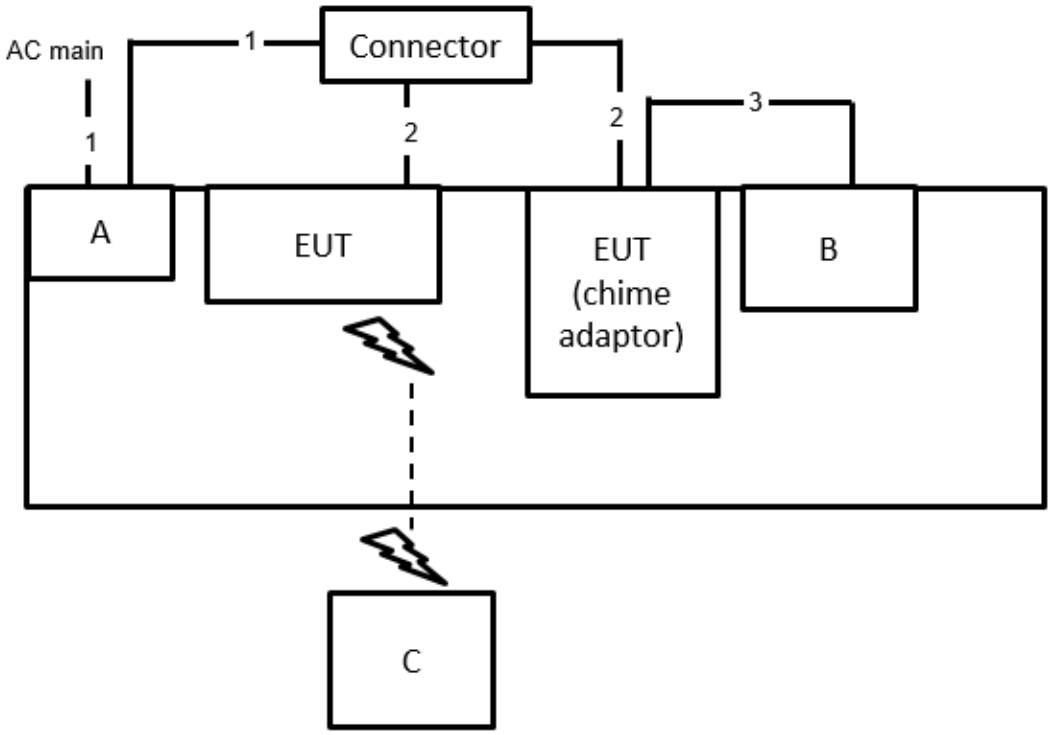
On Time (ms)	On+Off Time (ms)	Duty Cycle (%)	Correction Factor (dB)
0.16	8.16	1.960784314	-34.15

1.9 Table for Parameters of Test Software Setting

Test Software Version	0.00.042
Frequency	24145 MHz
Software Setting	Default

1.10 Test Configurations

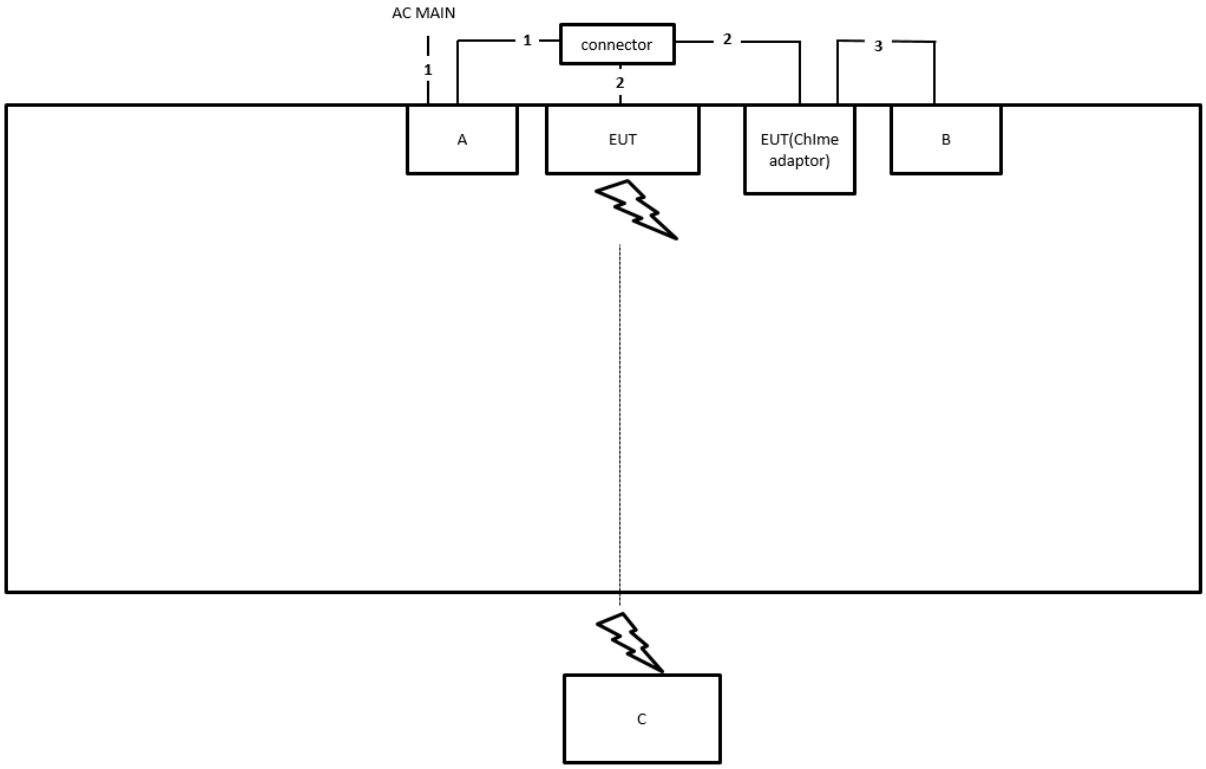
1.10.1 AC Power Line Conduction Emissions Test Configuration



Item	Connection	Shielded	Length
1	Power cable	No	2.6m
2	Power cable	No	1.4m
3	Power cable	No	0.2m

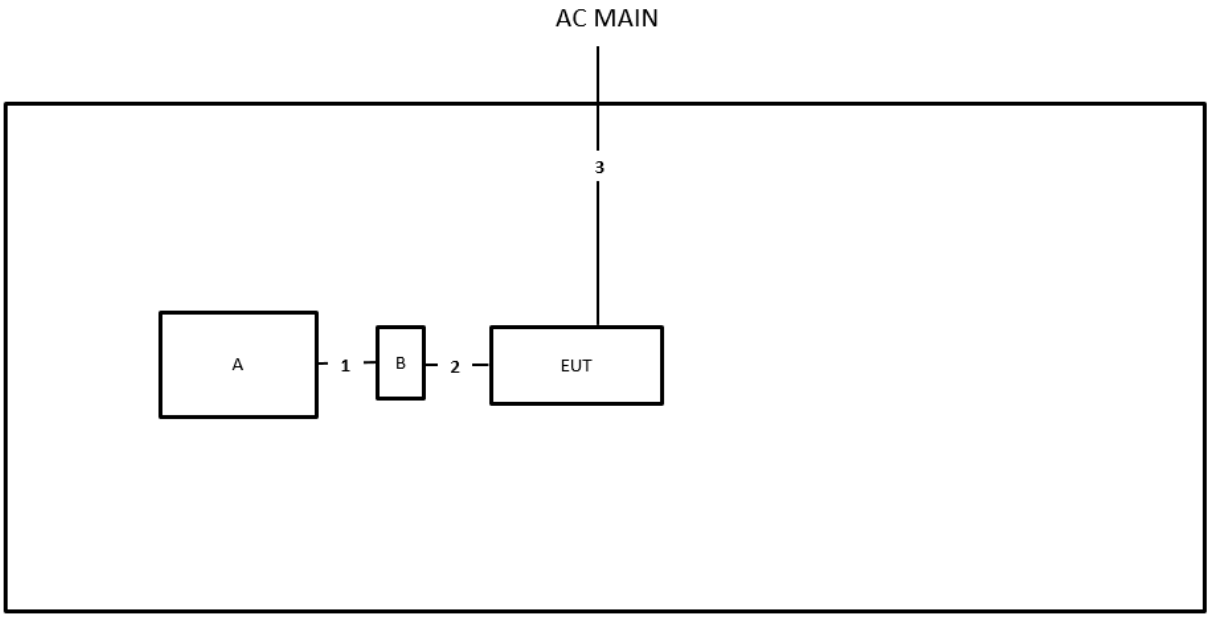
1.10.2 Radiation Emissions Test Configuration

Test Configuration: 30MHz~1GHz



Item	Connection	Shielded	Length
1	Power cable	No	2.6m
2	Power cable	No	1.4m
3	Power cable	No	0.2m

Test Configuration: Above 1GHz



Item	Connection	Shielded	Length
1	USB cable	No	0.5m
2	PIN cable	No	0.15m
3	Power cable	No	2.6m

2 Test Result

2.1 AC Power Line Conducted Emissions Measurement

2.1.1 Limit

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

Frequency (MHz)	QP Limit (dBuV)	AV Limit (dBuV)
0.15~0.5	66~56	56~46
0.5~5	56	46
5~30	60	50

2.1.2 Measuring Instruments and Setting

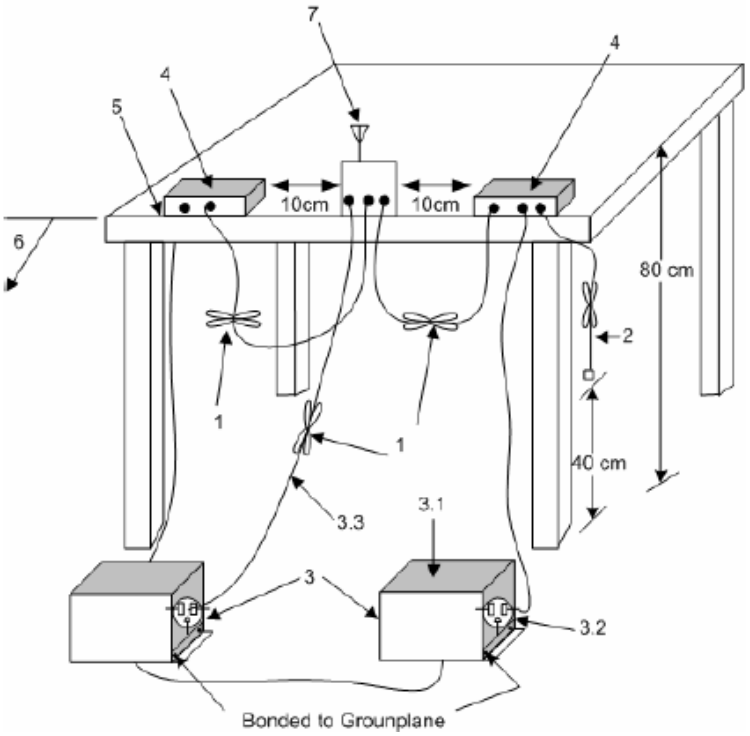
Refer a test equipment and calibration data table in this test report. The following table is the setting of the receiver.

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

2.1.3 Test Procedures

1. Configure the EUT according to ANSI C63.10. The EUT or host of EUT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT or host of EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connected to the other LISNs. The LISN should provide 50uH/50ohms coupling impedance.
4. The frequency range from 150 kHz to 30 MHz was searched.
5. Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. The measurement has to be done between each power line and ground at the power terminal.

2.1.4 Test Setup Layout



1—Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 cm to 40 cm long.
2—The I/O cables that are not connected to an accessory shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
3—EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω loads. LISN may be placed on top of, or immediately beneath, reference ground plane.
3.1—All other equipment powered from additional LISN(s).
3.2—A multiple-outlet strip may be used for multiple power cords of non-EUT equipment.
3.3—LISN at least 80 cm from nearest part of EUT chassis.
4—Non-EUT components of EUT system being tested.
5—Rear of EUT, including peripherals, shall all be aligned and flush with edge of tabletop.
6—Edge of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane.
7—Antenna can be integral or detachable. If detachable, then the antenna shall be attached for this test.

2.1.5 Test Deviation

There is no deviation with the original standard.

2.1.6 EUT Operation during Test

The EUT was placed on the test table and programmed in normal function.

2.1.7 Measurement Results Calculation

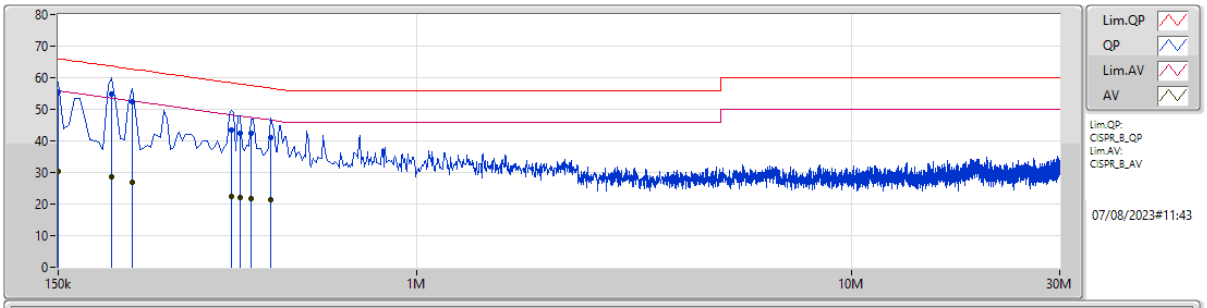
The measured Level is calculated using:

a. Corrected Reading: LISN Factor (LISN) + Attenuator (AT/AUX) + Cable Loss (CL) + Read Level (Raw) = Level

b. Margin = -Limit + Level

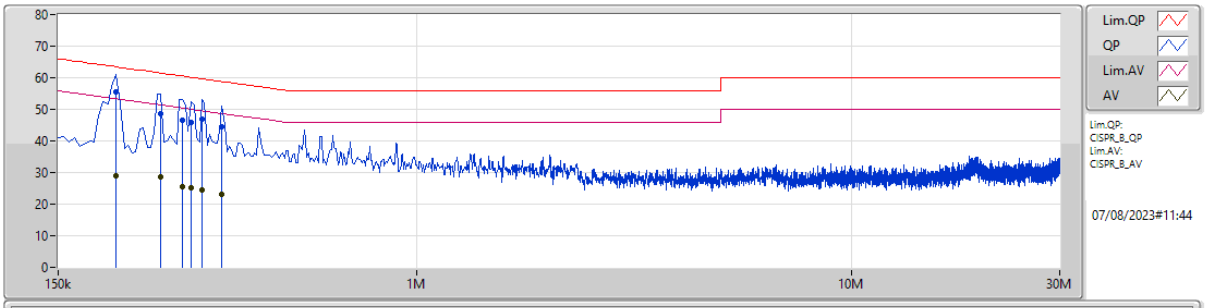
2.1.8 Results of AC Power Line Conducted Emissions Measurement

Mode 3



Type	Freq	Level	Limit	Margin	Factor	Condition	Comment	Raw	LISN	CL	AT
	(Hz)	(dBuV)	(dBuV)	(dB)	(dB)			(dBuV)	(dB)	(dB)	(dB)
QP	150k	55.50	66.00	-10.50	10.00	Line	-	45.50	0.09	0.04	9.87
AV	150k	30.50	56.00	-25.50	10.00	Line	-	20.50	0.09	0.04	9.87
QP	199.5k	54.88	63.63	-8.75	9.98	Line	"Worst"	44.90	0.08	0.04	9.86
AV	199.5k	28.72	53.63	-24.91	9.98	Line	-	18.74	0.08	0.04	9.86
QP	222k	52.57	62.75	-10.18	9.99	Line	-	42.58	0.08	0.04	9.87
AV	222k	27.05	52.75	-25.70	9.99	Line	-	17.06	0.08	0.04	9.87
QP	375k	43.56	58.39	-14.83	10.05	Line	-	33.51	0.09	0.06	9.90
AV	375k	22.51	48.39	-25.88	10.05	Line	-	12.46	0.09	0.06	9.90
QP	393k	42.37	58.01	-15.64	10.05	Line	-	32.32	0.09	0.06	9.90
AV	393k	22.10	48.01	-25.91	10.05	Line	-	12.05	0.09	0.06	9.90
QP	415.5k	42.57	57.53	-14.96	10.05	Line	-	32.52	0.09	0.06	9.90
AV	415.5k	21.79	47.53	-25.74	10.05	Line	-	11.74	0.09	0.06	9.90
QP	460.5k	40.87	56.69	-15.82	10.05	Line	-	30.82	0.09	0.06	9.90
AV	460.5k	21.27	46.69	-25.42	10.05	Line	-	11.22	0.09	0.06	9.90

Mode 3



Type	Freq	Level	Limit	Margin	Factor	Condition	Comment	Raw	LISN	CL	AT
	(Hz)	(dBuV)	(dBuV)	(dB)	(dB)			(dBuV)	(dB)	(dB)	(dB)
QP	204k	55.40	63.44	-8.04	9.97	Neutral	"Worst"	45.43	0.07	0.04	9.86
AV	204k	28.84	53.44	-24.60	9.97	Neutral	-	18.87	0.07	0.04	9.86
QP	258k	48.66	61.49	-12.83	9.99	Neutral	-	38.67	0.07	0.05	9.87
AV	258k	28.65	51.49	-22.84	9.99	Neutral	-	18.66	0.07	0.05	9.87
QP	289.5k	46.55	60.53	-13.98	10.00	Neutral	-	36.55	0.07	0.05	9.88
AV	289.5k	25.63	50.53	-24.90	10.00	Neutral	-	15.63	0.07	0.05	9.88
QP	303k	46.02	60.17	-14.15	10.00	Neutral	-	36.02	0.07	0.05	9.88
AV	303k	25.29	50.17	-24.88	10.00	Neutral	-	15.29	0.07	0.05	9.88
QP	321k	47.03	59.67	-12.64	10.01	Neutral	-	37.02	0.07	0.05	9.89
AV	321k	24.59	49.67	-25.08	10.01	Neutral	-	14.58	0.07	0.05	9.89
QP	357k	44.47	58.79	-14.32	10.02	Neutral	-	34.45	0.07	0.06	9.89
AV	357k	22.95	48.79	-25.84	10.02	Neutral	-	12.93	0.07	0.06	9.89

2.2 Field Strength of Fundamental Emissions Measurement

2.2.1 Limit

The field strength of fundamental emissions within these bands specified at a distance of 3 meters (measurement instrumentation employing an average detector) shall comply with the following table.

Frequency Band	Fundamental Emissions Limit Average/Peak (dBuV/m) at 3m
24000 ~ 24250 MHz	107.96/127.96

Note 1: 107.96 dBuV/m rounding to 108dBuV/m and 127.96 dBuV/m rounding to 128dBuV/m

Note 2: Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade from 3m to 1m.

Distance extrapolation factor = 20 log (specific distance [3m] / test distance [1m]) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor [9.54 dB].

Average limit = 108dBuV/m + distance extrapolation factor (9.54 dB) =117.54dBuV/m.

Peak limit = 128dBuV/m + distance extrapolation factor (9.54 dB) =137.54dBuV/m.

2.2.2 Measuring Instruments and Setting

Refer a test equipment and calibration data table in this test report. The following table is the setting of the spectrum analyzer.

Power Meter Parameter	Setting
RBW	1 MHz
VBW	3 MHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

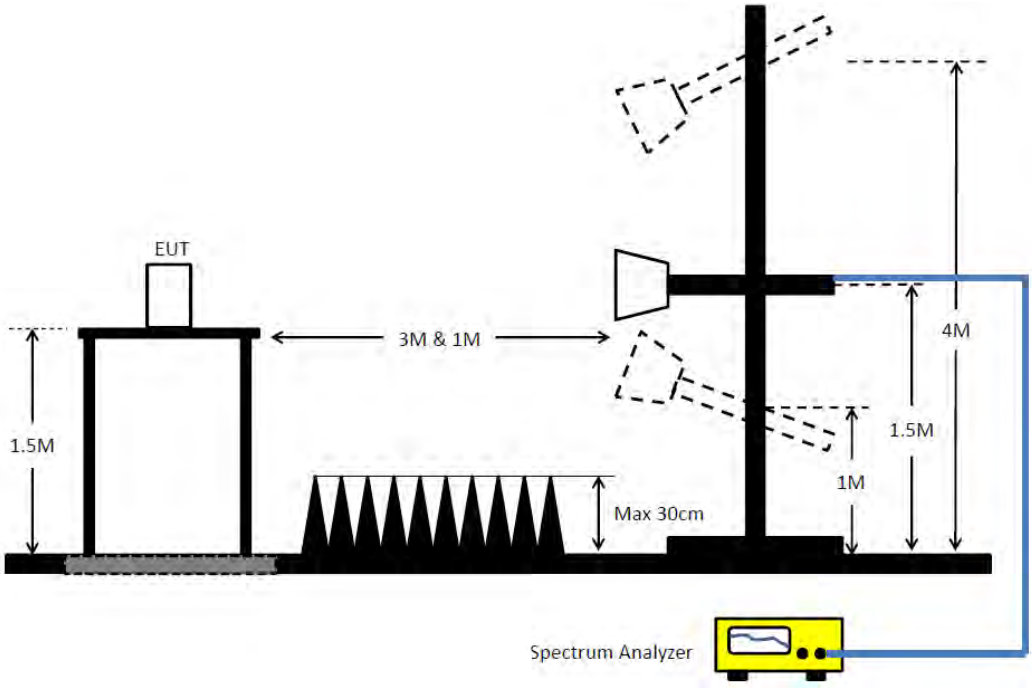
2.2.3 Test Procedures

1. Configure the EUT according to ANSI C63.10. The EUT was placed on the top of the turntable 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. For Fundamental emissions, use 1MHz RBW and 3MHz VBW for peak reading. The average is used

peak level + correction factor.

6. When the radiated emissions limits are expressed in terms of the average value of the emissions, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.

2.2.4 Test Setup Layout



2.2.5 Test Deviation

There is no deviation with the original standard.

2.2.6 EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

2.2.7 Measurement Results Calculation

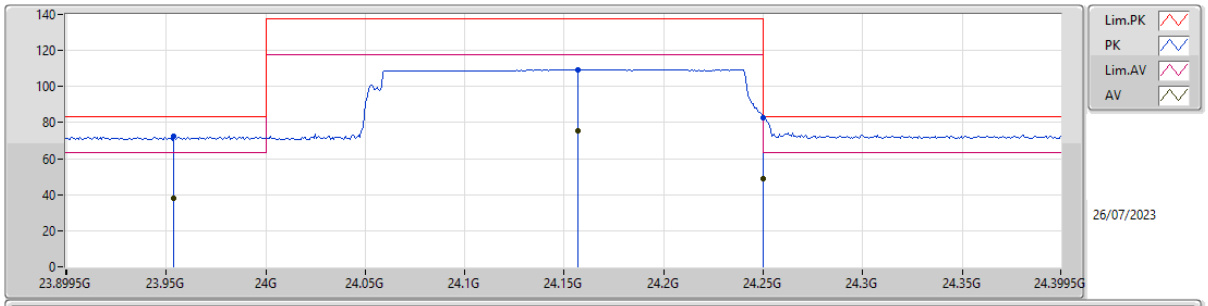
The measured Level is calculated using:

Corrected Reading: Antenna factor (AF) + Cable loss (CL) + Read level (Raw) - Preamp factor (PA)(if applicable) = Level.

2.2.8 Test Result of Field Strength of Fundamental Emissions

Horizontal

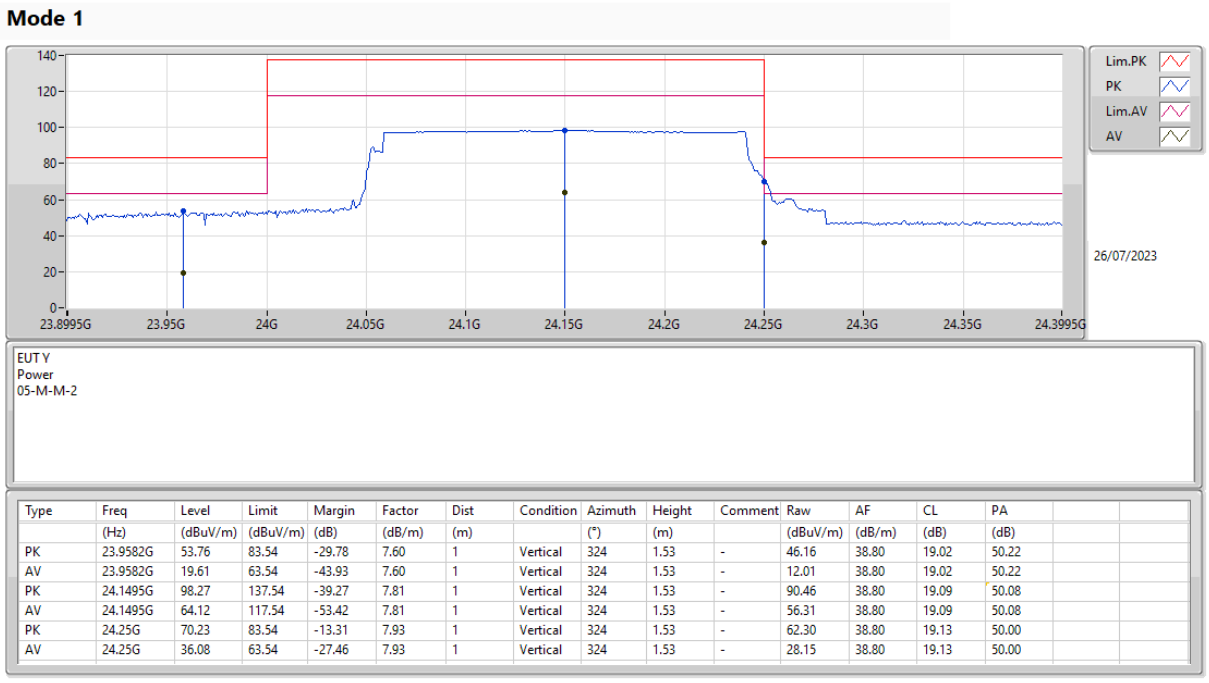
Mode 1



EUT Y
Power
05-M-M-2

Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	23.95385G	72.46	83.54	-11.08	7.60	1	Horizontal	20	1.63	-	64.86	38.80	19.02	50.22
AV	23.95385G	38.31	83.54	-11.08	7.60	1	Horizontal	20	1.63	-	64.86	38.80	19.02	50.22
PK	24.157G	109.33	137.54	-28.21	7.83	1	Horizontal	20	1.63	-	101.50	38.80	19.10	50.07
AV	24.157G	75.18	117.54	-42.36	7.83	1	Horizontal	20	1.63	-	67.35	38.80	19.10	50.07
PK	24.25G	82.95	83.54	-0.59	7.93	1	Horizontal	20	1.63	-	75.02	38.80	19.13	50.00
AV	24.25G	48.80	63.54	-14.74	7.93	1	Horizontal	20	1.63	-	40.87	38.80	19.13	50.00

Vertical



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	23.9582G	53.76	83.54	-29.78	7.60	1	Vertical	324	1.53	-	46.16	38.80	19.02	50.22
AV	23.9582G	19.61	63.54	-43.93	7.60	1	Vertical	324	1.53	-	12.01	38.80	19.02	50.22
PK	24.1495G	98.27	137.54	-39.27	7.81	1	Vertical	324	1.53	-	90.46	38.80	19.09	50.08
AV	24.1495G	64.12	117.54	-53.42	7.81	1	Vertical	324	1.53	-	56.31	38.80	19.09	50.08
PK	24.25G	70.23	83.54	-13.31	7.93	1	Vertical	324	1.53	-	62.30	38.80	19.13	50.00
AV	24.25G	36.08	63.54	-27.46	7.93	1	Vertical	324	1.53	-	28.15	38.80	19.13	50.00

Note:

Emission level (dBuV/m) = 20 log Emission level (uV/m).

2.3 20dB Spectrum Bandwidth Measurement

2.3.1 Limit

Intentional radiators must be designed to ensure that the 20 dB bandwidth of the emissions in the specific band (24000 ~ 24250 MHz).

2.3.2 Measuring Instruments and Setting

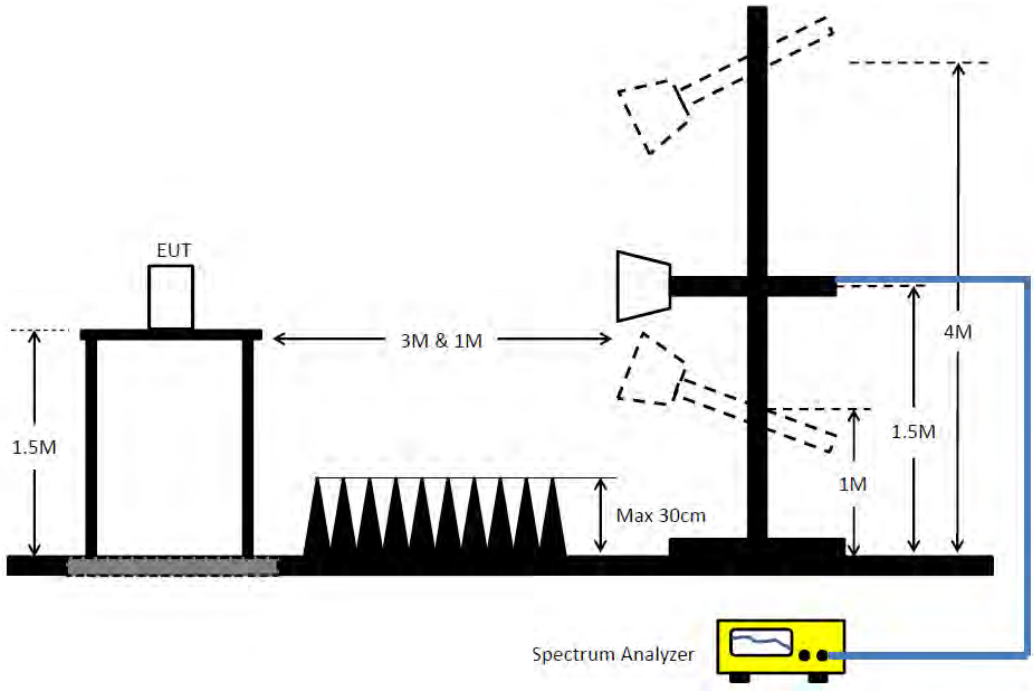
Refer a test equipment and calibration data table in this test report. The following table is the setting of the spectrum analyzer.

Spectrum Parameters	Setting
Attenuation	Auto
Span Frequency	> 20dB Bandwidth
RBW	20 dB Bandwidth 1%~5%
VBW	3 time RBW
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

2.3.3 Test Procedures

1. The test procedure is the same as section 2.4.3.
2. The resolution bandwidth (20 dB Bandwidth 1%~5%) and the video bandwidth (3 time RBW) were used.
3. Measured the spectrum width with power higher than 20dB below carrier.

2.3.4 Test Setup Layout



2.3.5 Test Deviation

There is no deviation with the original standard.

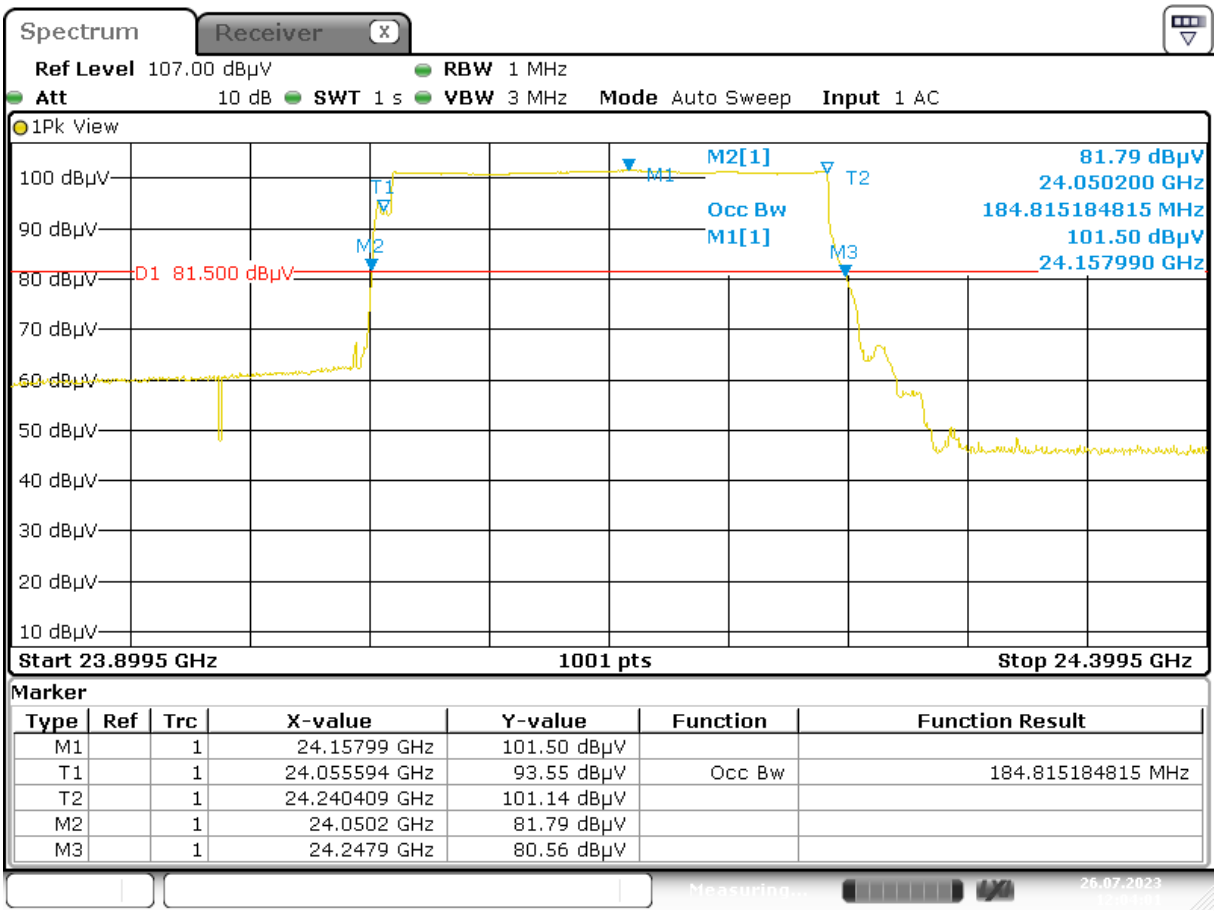
2.3.6 EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

2.3.7 Test Result of 20dB Spectrum Bandwidth

Frequency	20dB BW (MHz)	99% OBW (MHz)	Frequency range (MHz) f_L > 24000MHz	Frequency range (MHz) f_H < 24250MHz	Test Result
24145 MHz	197.70	184.82	24050.20	24247.90	**PASS**

20 dB and 99% Bandwidth Plot on 24145 MHz



Date: 26.JUL.2023 12:04:01

2.4 Radiated Emissions Measurement

2.4.1 Limit

For 9kHz~40GHz

Harmonic emissions limits comply with below 54 dBuV/m at 3m. Other 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 comply with the radiated emissions limits specified in section 15.209(a) limit in the table below has to be followed.

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

For 40GHz~100GHz

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 47 CFR Part 15.249, whichever is the lesser attenuation.

Operating Frequencies	Harmonics Strength (micorvolts/meter)	Harmonics Strength (dBuV/m) at 3m
24000 ~ 24250 MHz	2500 at 3m	68 (Average)
24000 ~ 24250 MHz	2500 at 3m	88 (Peak)

2.4.2 Measuring Instruments and Setting

Refer a test equipment and calibration data table in this test report. The following table is the setting of the spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RBW / VBW	1MHz / 3MHz for Peak

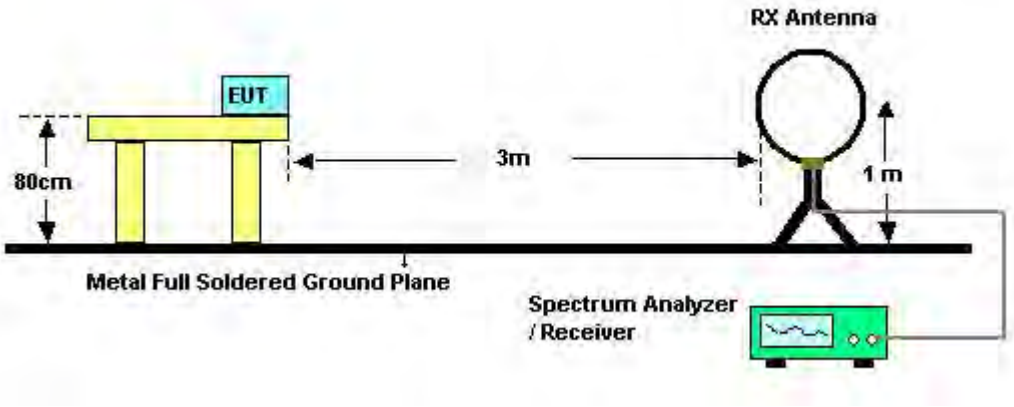
Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RBW 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RBW 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RBW 120kHz for QP

2.4.3 Test Procedures

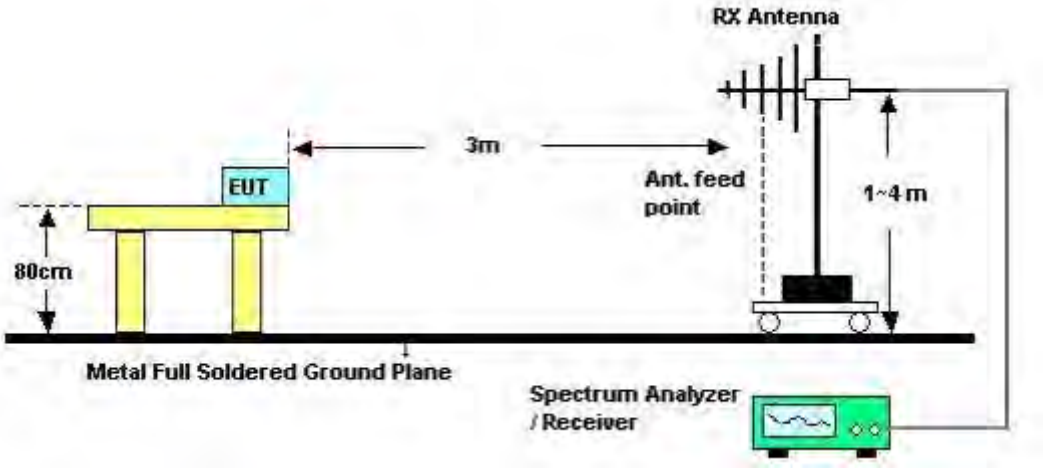
1. Configure the EUT according to ANSI C63.4. The EUT was placed on the top of the turntable 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
6. For emissions above 1GHz, use 1MHz RBW and 3MHz VBW for peak reading. The average is used peak level + correction factor.
7. When the radiated emissions limits are expressed in terms of the average value of the emissions, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.
8. If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
9. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
10. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High – Low scan is not required in this case.

2.4.4 Test Setup Layout

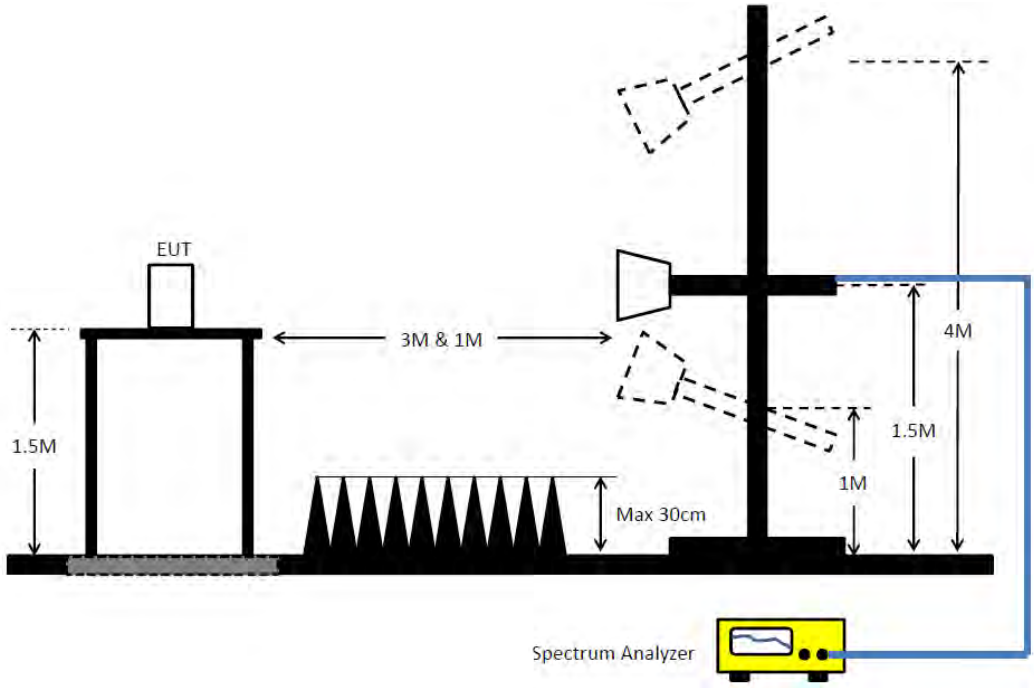
For Radiated Emissions: 9kHz ~30MHz



For Radiated Emissions: 30MHz~1GHz



For radiated emissions: 1GHz~40GHz

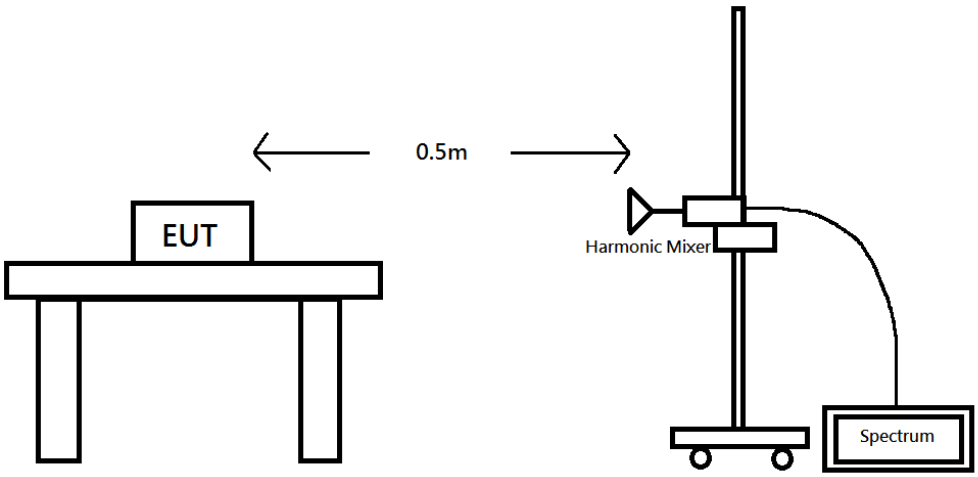


Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade from 3m to 1m.

Distance extrapolation factor = 20 log (specific distance [3m] / test distance [1m]) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor [9.54 dB].

For radiated emissions: 40GHz~100GHz



2.4.5 Test Deviation

There is no deviation with the original standard.

2.4.6 EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

2.4.7 Measurement Results Calculation

The measured Level is calculated using:

For below 40GHz

Corrected Reading: Antenna factor (AF) + Cable loss (CL) + Read level (Raw) - Preamp factor (PA)(if applicable) = Level.

For above 40GHz

EIRP = Meas. Level - RX Antenna Gain + 20*log(4*Pi(3.14159)*D/(300/(Frequency*1000)))

2.4.8 Results of Radiated Emissions (9kHz~30MHz)

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Limit Line (dBuV)	Remark
-	-	-	-	See Note

Note:

There is a comparison data of both open-field test site and alternative test site - semi-Anechoic chamber according to KDB414788 Radiated Test Site, and the result came out very similar.

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

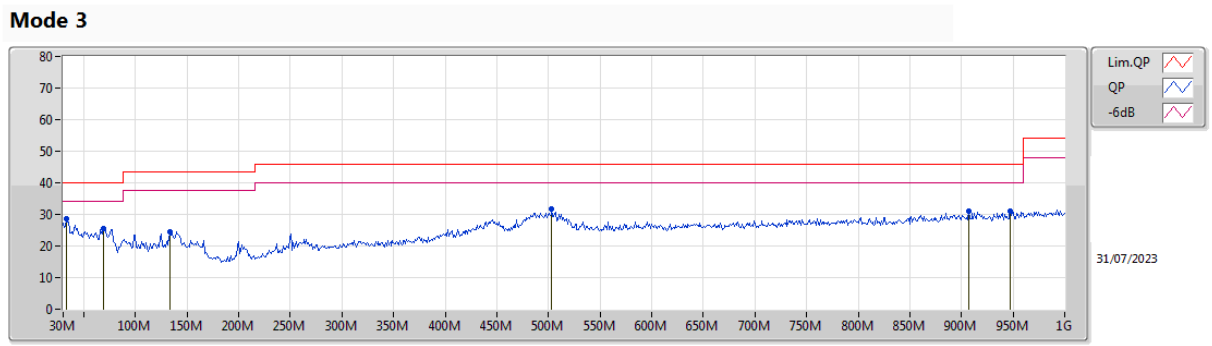
The radiated emissions were investigated from 9 kHz or the lowest frequency generated within the device, up to the 10 harmonic or 40 GHz, whichever is appropriate.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor.

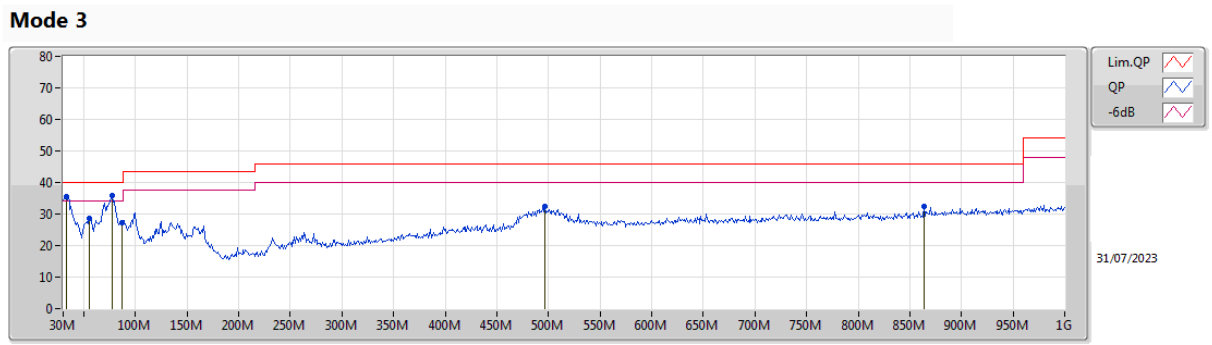
2.4.9 Results of Radiated Emissions (30MHz~1GHz)

Horizontal



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	32.91M	28.45	40.00	-11.55	-8.02	3	Horizontal	146	1.00	"Worst"	36.47	22.55	1.05	31.62
PK	68.8M	25.37	40.00	-14.63	-18.11	3	Horizontal	248	1.50	-	43.48	12.35	1.44	31.90
PK	133.79M	24.54	43.50	-18.96	-12.25	3	Horizontal	0	1.50	-	36.79	17.76	1.96	31.97
PK	503.36M	31.74	46.00	-14.26	-4.97	3	Horizontal	203	1.00	-	36.71	23.31	4.00	32.28
PK	906.88M	31.12	46.00	-14.88	-0.41	3	Horizontal	83	1.50	-	31.53	26.38	5.67	32.46
PK	947.62M	31.16	46.00	-14.84	-0.17	3	Horizontal	137	1.00	-	31.33	26.69	5.69	32.55

Vertical



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	32.91M	35.62	40.00	-4.38	-8.02	3	Vertical	6	1.00	-	43.64	22.55	1.05	31.62
PK	55.22M	28.61	40.00	-11.39	-17.72	3	Vertical	240	1.00	-	46.33	12.85	1.31	31.88
PK	77.53M	35.77	40.00	-4.23	-17.80	3	Vertical	56	1.00	"Worst"	53.57	12.63	1.53	31.96
PK	87.23M	27.37	40.00	-12.63	-16.09	3	Vertical	39	1.00	-	43.46	14.24	1.60	31.93
PK	496.57M	32.42	46.00	-13.58	-5.06	3	Vertical	217	1.00	-	37.48	23.24	3.97	32.27
PK	864.2M	32.25	46.00	-13.75	-1.07	3	Vertical	294	1.50	-	33.32	26.03	5.48	32.58

Note:

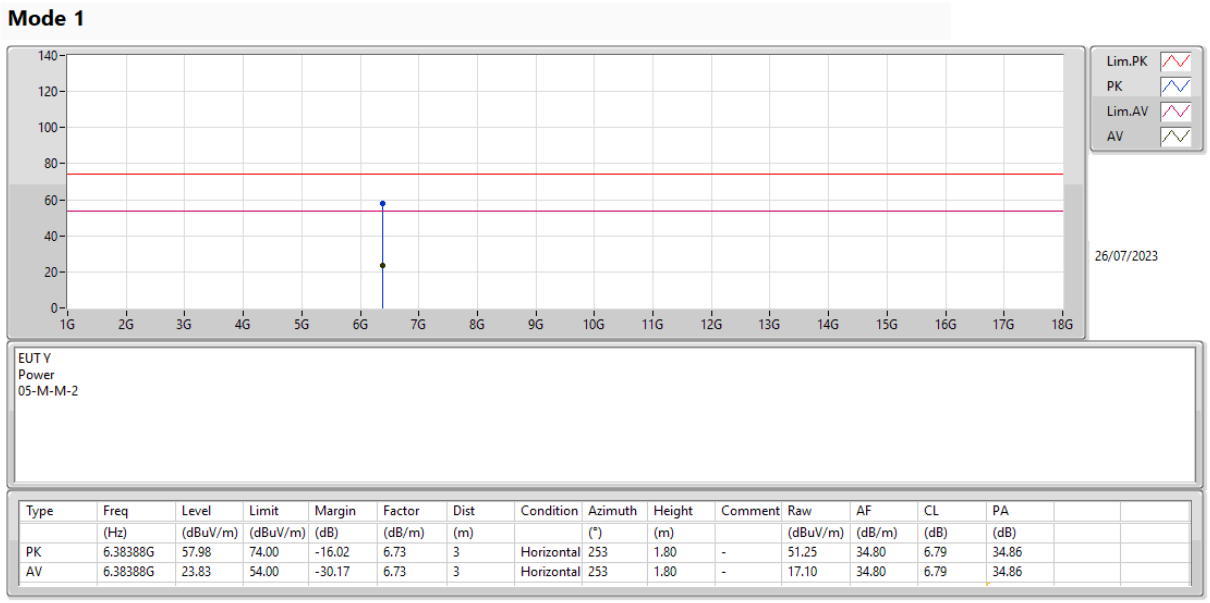
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Emission level (dBuV/m) = 20 log Emission level (uV/m).

2.4.10 Results for Radiated Emissions (1GHz~40GHz)

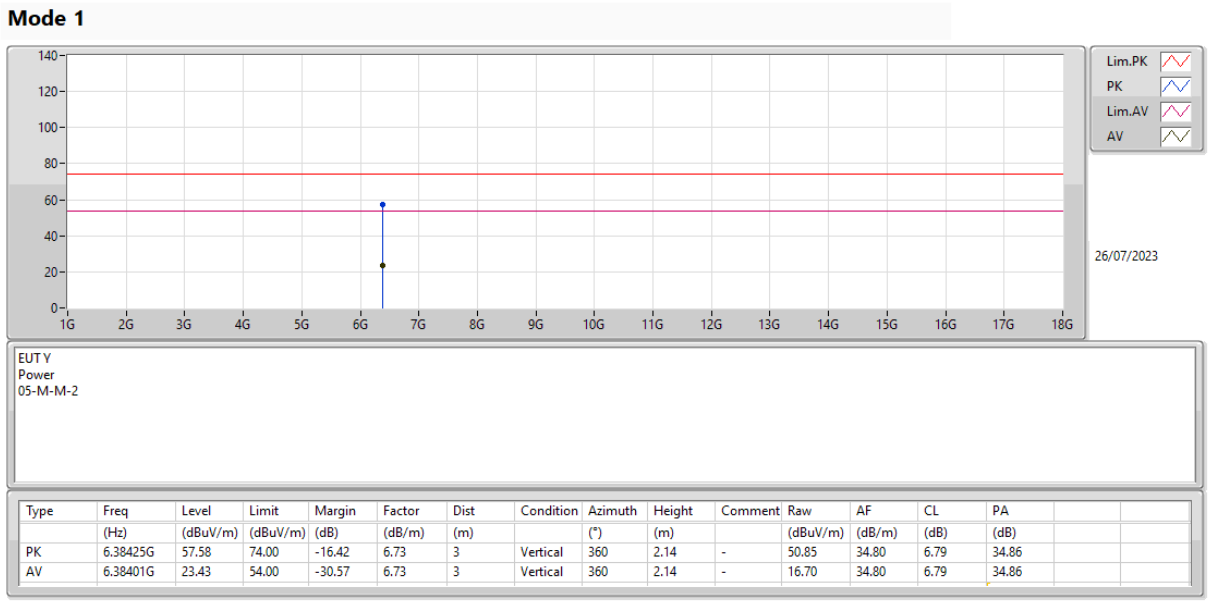
Test Range	1 GHz ~ 18 GHz

Horizontal



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	6.38388G	57.98	74.00	-16.02	6.73	3	Horizontal	253	1.80	-	51.25	34.80	6.79	34.86
AV	6.38388G	23.83	54.00	-30.17	6.73	3	Horizontal	253	1.80	-	17.10	34.80	6.79	34.86

Vertical

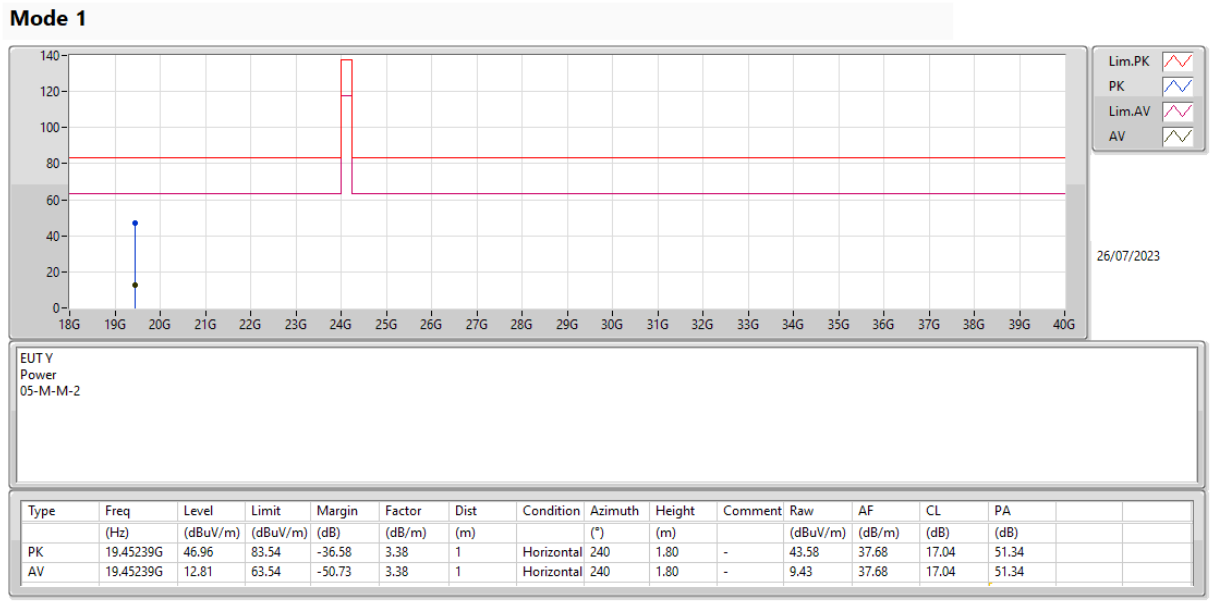


Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	6.38425G	57.58	74.00	-16.42	6.73	3	Vertical	360	2.14	-	50.85	34.80	6.79	34.86
AV	6.38401G	23.43	54.00	-30.57	6.73	3	Vertical	360	2.14	-	16.70	34.80	6.79	34.86

Note:
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Emission level (dBuV/m) = 20 log Emission level (uV/m).

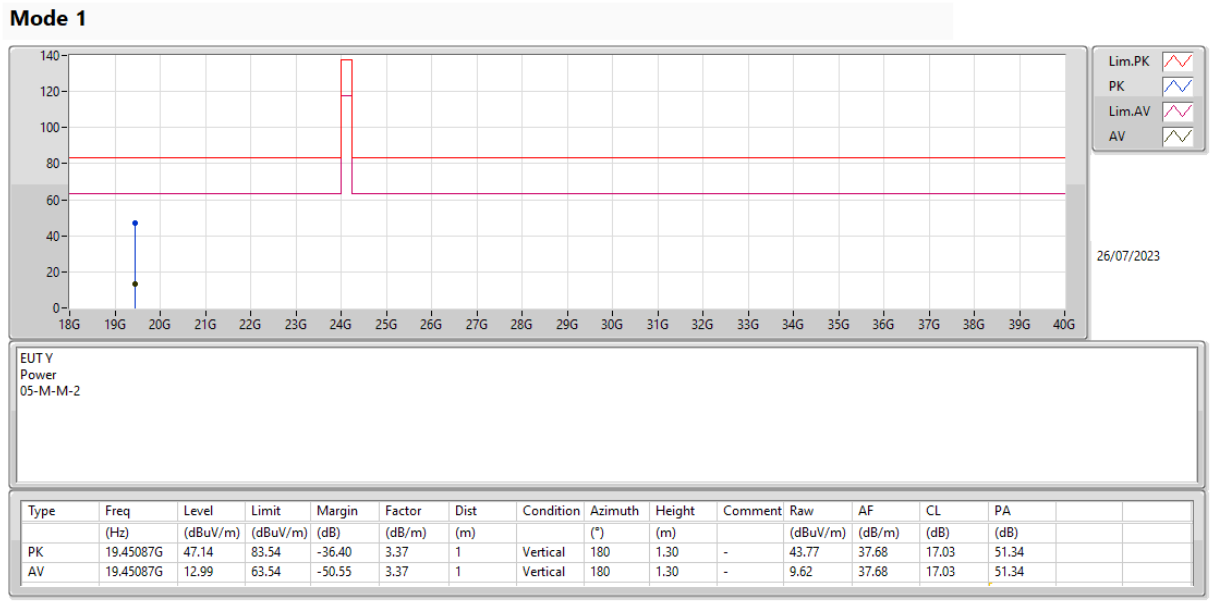
Test Range	18 GHz ~ 40 GHz

Horizontal



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	19.45239G	46.96	83.54	-36.58	3.38	1	Horizontal	240	1.80	-	43.58	37.68	17.04	51.34
AV	19.45239G	12.81	63.54	-50.73	3.38	1	Horizontal	240	1.80	-	9.43	37.68	17.04	51.34

Vertical



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	19.45087G	47.14	83.54	-36.40	3.37	1	Vertical	180	1.30	-	43.77	37.68	17.03	51.34
AV	19.45087G	12.99	63.54	-50.55	3.37	1	Vertical	180	1.30	-	9.62	37.68	17.03	51.34

Note:
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Emission level (dBuV/m) = 20 log Emission level (uV/m).

2.4.11 Results for Radiated Emissions (40GHz~100GHz)

Test Range	40~60G

Frequency (MHz)	Emission Freq. (GHz)	Measurement Distance (m)	Read Level (dBm)	Rx Antenna Gain (dBi)	Measurement Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Result
24145	48.320	1	-80.36	23.9	66.68	97.50	-30.82	Peak	Pass
	48.306	1	-83.11	23.9	63.93	77.50	-13.57	Average	Pass

Test Range	60~90G

Frequency (MHz)	Emission Freq. (GHz)	Measurement Distance (m)	Read Level (dBm)	Rx Antenna Gain (dBi)	Measurement Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Result
24145	72.408	1	-82.76	23.8	67.89	97.50	-29.61	Peak	Pass
	72.403	1	-84.64	23.8	66.01	77.50	-11.49	Average	Pass

Test Range	90~100G

Frequency (MHz)	Emission Freq. (GHz)	Measurement Distance (m)	Read Level (dBm)	Rx Antenna Gain (dBi)	Measurement Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Result
24145	92.335	1	-79.10	23.6	73.86	97.50	-23.64	Peak	Pass
	92.390	1	-80.91	23.6	72.06	77.50	-5.44	Average	Pass

Distance extrapolation factor = 20 log (specific distance [3m] / test distance [0.5m]) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor [15.56 dB].

EIRP = PT * GT = (PR / GR) * (4 * Pi * D / λ)^2

2.5 Band Edge Emissions Measurement

2.5.1 Limit

Band edge emissions radiated outside of the specified frequency bands shall be attenuated by at least 50 dB below the level of the fundamental or comply with the radiated emissions limits specified in section 15.209(a) limit in the table below has to be followed.

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

2.5.2 Measuring Instruments and Setting

Refer a test equipment and calibration data table in this test report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	100 MHz
RBW / VBW	1MHz / 3MHz for Peak, The average is used peak level + correction factor

2.5.3 Test Procedures

The test procedure is the same as section 2.4.3.

2.5.4 Test Setup Layout

This test setup layout is the same as that shown in section 2.4.4

2.5.5 Test Deviation

There is no deviation with the original standard.

2.5.6 EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

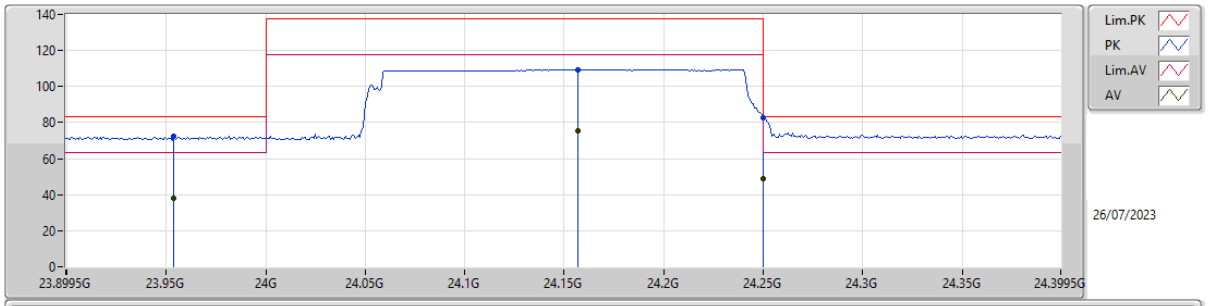
2.5.7 Measurement Results Calculation

The measured Level is calculated using:
Corrected Reading: Antenna factor (AF) + Cable loss (CL) + Read level (Raw) - Preamp factor (PA)(if applicable) = Level.

2.5.8 Test Result of Band Edge and Fundamental Emissions

Horizontal

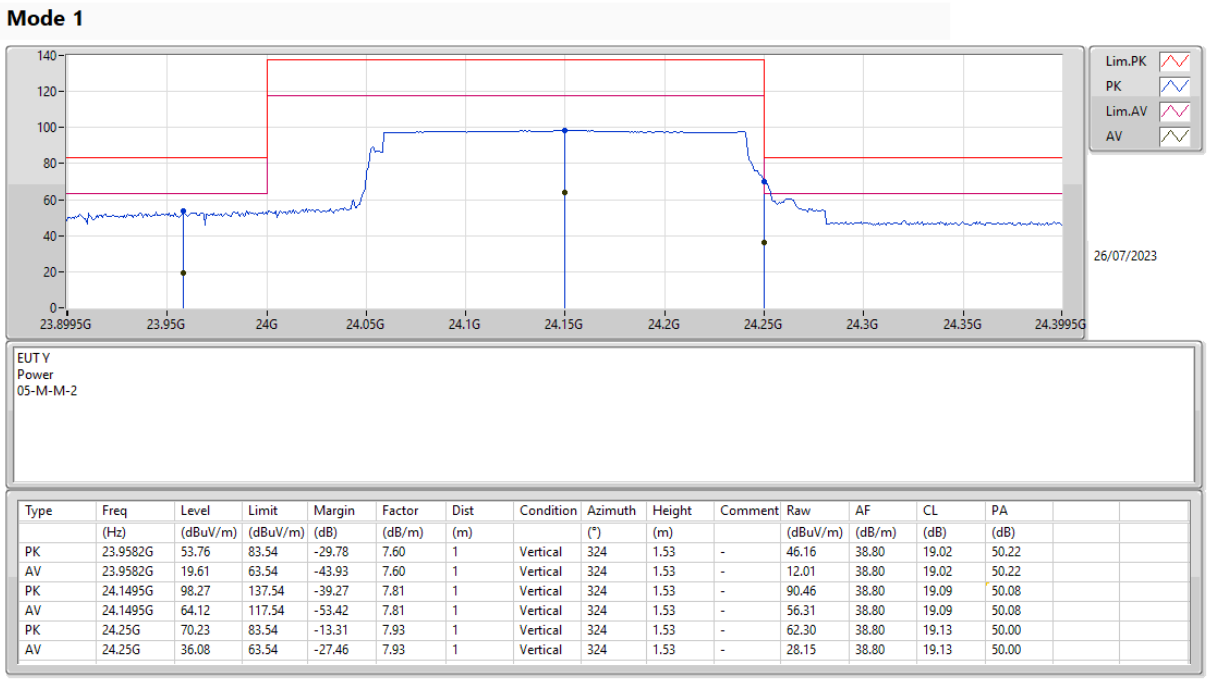
Mode 1



EUT Y
Power
05-M-M-2

Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	23.95385G	72.46	83.54	-11.08	7.60	1	Horizontal	20	1.63	-	64.86	38.80	19.02	50.22
AV	23.95385G	38.31	83.54	-11.08	7.60	1	Horizontal	20	1.63	-	64.86	38.80	19.02	50.22
PK	24.157G	109.33	137.54	-28.21	7.83	1	Horizontal	20	1.63	-	101.50	38.80	19.10	50.07
AV	24.157G	75.18	117.54	-42.36	7.83	1	Horizontal	20	1.63	-	67.35	38.80	19.10	50.07
PK	24.25G	82.95	83.54	-0.59	7.93	1	Horizontal	20	1.63	-	75.02	38.80	19.13	50.00
AV	24.25G	48.80	63.54	-14.74	7.93	1	Horizontal	20	1.63	-	40.87	38.80	19.13	50.00

Vertical



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comment	Raw	AF	CL	PA
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB/m)	(m)		(°)	(m)		(dBuV/m)	(dB/m)	(dB)	(dB)
PK	23.9582G	53.76	83.54	-29.78	7.60	1	Vertical	324	1.53	-	46.16	38.80	19.02	50.22
AV	23.9582G	19.61	63.54	-43.93	7.60	1	Vertical	324	1.53	-	12.01	38.80	19.02	50.22
PK	24.1495G	98.27	137.54	-39.27	7.81	1	Vertical	324	1.53	-	90.46	38.80	19.09	50.08
AV	24.1495G	64.12	117.54	-53.42	7.81	1	Vertical	324	1.53	-	56.31	38.80	19.09	50.08
PK	24.25G	70.23	83.54	-13.31	7.93	1	Vertical	324	1.53	-	62.30	38.80	19.13	50.00
AV	24.25G	36.08	63.54	-27.46	7.93	1	Vertical	324	1.53	-	28.15	38.80	19.13	50.00

Note:

Emission level (dBuV/m) = 20 log Emission level (uV/m).

2.6 Antenna Requirements

2.6.1 Limit

Except for special regulations, the Low-power Radio-frequency Devices must not be equipped with any jacket for installing an antenna with extension cable. An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited.

2.6.2 Antenna Connector Construction

The antenna connector complied with the requirements.

3 List of Measuring Equipments

Instrument	Brand	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date	Remark
EMI Receiver	Agilent	N9038A	My52260123	9kHz ~ 8.4GHz	Feb. 20, 2023	Feb. 19, 2024	Conduction (CO01-CB)
LISN	F.C.C.	FCC-LISN-50-16-2	04083	150kHz ~ 100MHz	Feb. 16, 2023	Feb. 15, 2024	Conduction (CO01-CB)
LISN	Schwarzbeck	NSLK 8127	8127647	9kHz ~ 30MHz	Apr. 27, 2023	Apr. 26, 2024	Conduction (CO01-CB)
Pulse Limiter	Rohde& Schwarz	ESH3-Z2	100430	9kHz ~ 30MHz	Feb. 09, 2023	Feb. 08, 2024	Conduction (CO01-CB)
COND Cable	Woken	Cable	Low cable-CO01	9kHz ~ 30MHz	Oct. 18, 2022	Oct. 17, 2023	Conduction (CO01-CB)
Software	SPORTON	SENSE	V5.10	-	N.C.R.	N.C.R.	Conduction (CO01-CB)
Loop Antenna	Teseq	HLA 6120	31244	9kHz - 30 MHz	Mar. 23, 2023	Mar. 22, 2024	Radiation (03CH05-CB)
3m Semi Anechoic Chamber NSA	TDK	SAC-3M	03CH05-CB	30 MHz ~ 1 GHz	Aug. 03, 2022	Aug. 02, 2023	Radiation (03CH05-CB)
3m Semi Anechoic Chamber NSA	TDK	SAC-3M	03CH05-CB	30 MHz ~ 1 GHz	Aug. 02, 2023	Aug. 01, 2024	Radiation (03CH05-CB)
3m Semi Anechoic Chamber VSWR	TDK	SAC-3M	03CH05-CB	1GHz ~18GHz 3m	Nov. 06, 2022	Nov. 05, 2023	Radiation (03CH05-CB)
Bilog Antenna with 6dB Attenuator	TESEQ & EMCI	CBL 6112D & N-6-06	35236 & AT-N0610	30MHz ~ 2GHz	Mar. 24, 2023	Mar. 23, 2024	Radiation (03CH05-CB)
Horn Antenna	SCHWARZBECK	BBHA9120D	BBHA 9120 D-1291	1GHz~18GHz	Jun. 08, 2023	Jun. 07, 2024	Radiation (03CH05-CB)
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170252	15GHz ~ 40GHz	Aug. 22, 2022	Aug. 21, 2023	Radiation (03CH05-CB)
Amplifier	EMCI	EMC330N	980331	20MHz ~ 3GHz	May 03, 2023	May 02, 2024	Radiation (03CH05-CB)
Pre-Amplifier	EMCI	EMC12630SE	980287	1GHz – 26.5GHz	Jun. 30, 2023	Jun. 29, 2024	Radiation (03CH05-CB)
Pre-Amplifier	SGH	SGH184	20221107-3	18GHz ~ 40GHz	Nov. 16, 2022	Nov. 15, 2023	Radiation (03CH05-CB)
Spectrum Analyzer	R&S	FSP40	100304	9kHz ~ 40GHz	Apr. 18, 2023	Apr. 17, 2024	Radiation (03CH05-CB)
EMI Test Receiver	R&S	ESCS	826547/017	9kHz ~ 2.75GHz	Jun. 13, 2023	Jun. 12, 2024	Radiation (03CH05-CB)
RF Cable-low	Woken	RG402	Low Cable-04+23	30MHz~1GHz	Oct. 03, 2022	Oct. 02, 2023	Radiation (03CH05-CB)
RF Cable-high	Woken	RG402	High Cable-28	1GHz~18GHz	Oct. 03, 2022	Oct. 02, 2023	Radiation (03CH05-CB)
RF Cable-high	Woken	RG402	High Cable-04+28	1GHz~18GHz	Oct. 03, 2022	Oct. 02, 2023	Radiation (03CH05-CB)

Instrument	Brand	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date	Remark
High Cable	Woken	WCA0929M	40G#5+6	1GHz ~ 40 GHz	Dec. 07, 2022	Dec. 06, 2023	Radiation (03CH05-CB)
High Cable	Woken	WCA0929M	40G#5	1GHz ~ 40 GHz	Dec. 07, 2022	Dec. 06, 2023	Radiation (03CH05-CB)
High Cable	Woken	WCA0929M	40G#6	1GHz ~ 40 GHz	Dec. 07, 2022	Dec. 06, 2023	Radiation (03CH05-CB)
Test Software	SPORTON	SENSE	V5.10	-	N.C.R.	N.C.R.	Radiation (03CH05-CB)
*Mixer	OML	M19HWA	U91113-1	40 ~ 60 GHz	Mar. 10, 2022	Mar. 09, 2024	Radiation (03CH05-CB)
*Mixer	OML	M12HWA	E91113-1	60 ~ 90 GHz	Oct. 22, 2022	Oct. 21, 2024	Radiation (03CH05-CB)
*Mixer	OML	M08HWA	F91113-1	90 ~ 140 GHz	Mar. 10, 2022	Mar. 09, 2024	Radiation (03CH05-CB)
Standard Horn Antenna	Custom Microwave	M12RH	E91113-A	60 ~ 90 GHz	N.C.R	N.C.R	Radiation (03CH05-CB)
Standard Horn Antenna	Custom Microwave	M08RH	F91113-A	90 ~ 140 GHz	N.C.R	N.C.R	Radiation (03CH05-CB)

Note: Calibration Interval of instruments listed above is one year.

* Calibration Interval of instruments listed above is two year.

N.C.R. means Non-Calibration required.

4 Measurement Uncertainty

Test Items	Uncertainty	Remark
Conducted Emission (150kHz ~ 30MHz)	3.4 dB	Confidence levels of 95%
Radiated Emission (9kHz ~ 30MHz)	3.7 dB	Confidence levels of 95%
Radiated Emission (30MHz ~ 1,000MHz)	5.1 dB	Confidence levels of 95%
Radiated Emission (1GHz ~ 18GHz)	4.1 dB	Confidence levels of 95%
Radiated Emission (18GHz ~ 40GHz)	4.2 dB	Confidence levels of 95%
Radiated Emission (40GHz ~ 60GHz)	3.0 dB	Confidence levels of 95%
Radiated Emission (60GHz ~ 90GHz)	3.0 dB	Confidence levels of 95%
Radiated Emission (90GHz ~ 200GHz)	4.3 dB	Confidence levels of 95%