

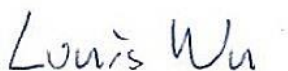


FCC CO-LOCATION RADIO TEST REPORT

FCC ID : 2AEUPBHASC0111
Equipment : Security Camera
Brand Name : ring
Model Name : 5CCEA2
Applicant : Ring LLC
12515 Cerise Ave, Hawthorne, CA 90250, USA
Manufacturer : Ring LLC
12515 Cerise Ave, Hawthorne, CA 90250, USA
Standard : FCC Part 15 Subpart C §15.247
FCC Part 15 Subpart C §15.249
FCC Part 15 Subpart E §15.407

The product was received on May 29, 2025 and testing was performed from Jun. 06, 2025 to Jun. 10, 2025. We, Sporton International Inc. Wensan Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

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



Approved by: Louis Wu

Sporton International Inc. Wensan Laboratory

No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)



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History of this test report

Report No.	Version	Description	Issue Date
FR4O1404-01H	01	Initial issue of report	Jun. 23, 2025

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(d) 15.407(b)	Unwanted Emissions	Pass	-
3.2	15.203	Antenna Requirement	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/manufacture 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 section "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: Keven Cheng

Report Producer: Jessie Ho

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
General Specs Bluetooth-LE, LoRa, Wi-Fi 2.4GHz 802.11b/g/n/ac/ax, Wi-Fi 5GHz 802.11a/n/ac/ax, and 24GHz Radar.	
Antenna Type Bluetooth-LE: Stamped metal Antenna WLAN: Stamped metal Antenna 24GHz Radar: Patch antenna	

Antenna information		
2400 MHz ~ 2483.5 MHz	Peak Gain (dBi)	Bluetooth-LE: 2.0 WLAN: 2.8
5150 MHz ~ 5250 MHz	Peak Gain (dBi)	2.0
24.05 GHz ~ 24.25 GHz	Peak Gain (dBi)	2.0

Remark: The EUT's information above is declared by manufacturer. Please refer to Disclaimer in report summary.

1.2 Modification of EUT

No modifications made to the EUT during the testing.

1.3 Testing Location

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No. 03CH13-HY, 03CH18-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW3786

1.4 Applicable Standards

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

- ♦ FCC Part 15 Subpart E
- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC Part 15 Subpart C §15.249
- ♦ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- ♦ FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01.
- ♦ ANSI C63.10-2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.

2 Test Configuration of Equipment Under Test

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst case emissions were reported in this report.

2.1 Carrier Frequency and Channel

2400-2483.5 MHz			
Bluetooth – LE 2Mbps		802.11g	
Channel	Channel	Channel	Channel
39	2480	11	2462

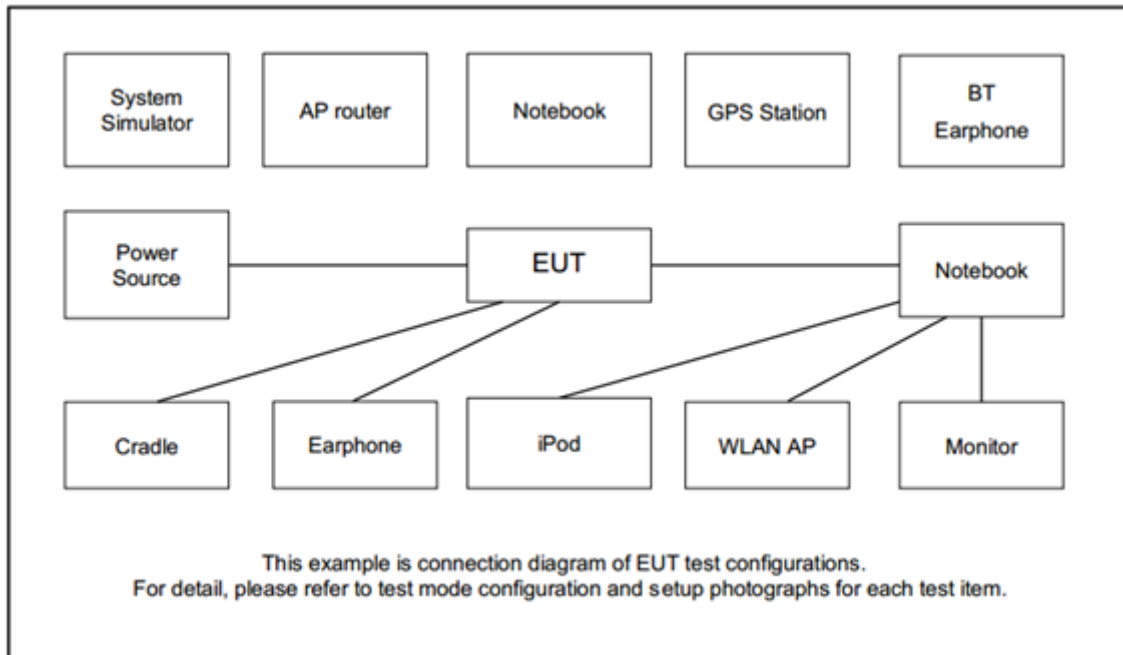
902-928 MHz	24050-24250 MHz
LoRa	24G Radar
Freq. (MHz)	Freq. (MHz)
902.4	24240

5150-5250 MHz	
802.11a	
Channel	Freq. (MHz)
36	5180

<Co-Location>

Modulation	Data Rate	Worst Plane
Bluetooth – LE + WLAN 2.4G 802.11g + LoRa + 24G Radar	2 Mbps + 6Mbps	Y Plane
Bluetooth – LE + WLAN 5G 802.11a + LoRa + 24G Radar	2 Mbps + MCS0	Y Plane

2.2 Connection Diagram of Test System



2.3 EUT Operation Test Setup

The RF test items, utility “Tera tern” and “Compliance Tool” were installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

3 Test Result

3.1 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

3.1.1 Limit of Unwanted Emissions

<For 24.05 GHz ~ 24.25 GHz>

The field strength measured at 3 meters shall not exceed the limits in the following table:

Rules and specifications	FCC CFR 47 Part 15 section 15.249	
Description	Field strength of fundamental	
24.0~24.25 (GHz)	Fundamental emissions (millivolts/meter) at 3m	Fundamental emissions (dBμV/m) at 3m
Average limits	250	107.95
Peak limits	-	127.95
Description	Field strength of harmonics	
24.0~24.25 (GHz)	Fundamental emissions (microvolts/meter) at 3m	Harmonic emissions (dBμV/m) at 3m
Average limits	2500	67.95
Peak limits	-	87.95
Note: Above 18GHz, the distance correction factor is used, 18GHz to 90GHz : $20\log(1\text{m}/3\text{m}) = -9.54\text{dB}$; 90GHz – 100GHz: $20\log(0.5\text{m}/3\text{m}) = -15.56\text{dB}$.		

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, whichever is the lesser attenuation

Frequency (MHz)	Field Strength (microvolts/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 2402 MHz ~ 2480 MHz>

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device is measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB.

<For 5150 MHz ~ 5250 MHz>

- (1) For transmitters operating in the 5150-5250 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of -27dBm/MHz.
- (2) Unwanted spurious emissions falls in restricted bands shall comply with the general field strength limits as below table:

Frequency (MHz)	Field Strength (microvolts/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

Note: The following formula is used to convert the EIRP to field strength.

$$E = \frac{1000000\sqrt{30P}}{3} \text{ } \mu\text{V/m, where P is the eirp (Watts)}$$

EIRP (dBm)	Field Strength at 3m (dBμV/m)
- 27	68.3

- (2) KDB789033 D02 v02r01 G)2)c)

(i) Sections 15.407(b)(1-3) specifies the unwanted emissions limit for the U-NII-1 and U-NII-2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz.

(ii) Section 15.407(b)(4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are based on the use of a peak detector.

3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.



3.1.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
Section G) Unwanted emissions measurement.
 - (1) Procedure for Unwanted Emissions Measurements Below 1000 MHz
 - RBW = 120 kHz
 - VBW = 300 kHz
 - Detector = Peak
 - Trace mode = max hold
 - (2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz
 - RBW = 1 MHz
 - VBW $\geq$ 3 MHz
 - Detector = Peak
 - Sweep time = auto
 - Trace mode = max hold
 - (3) Procedures for Average Unwanted Emissions Measurements Above 1000 MHz
 - RBW = 1 MHz
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW $\geq$ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
2. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
3. The EUT is set 3 meters away from the receiving antenna which is mounted on the top of a variable height antenna tower.
4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT is arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as “-”.

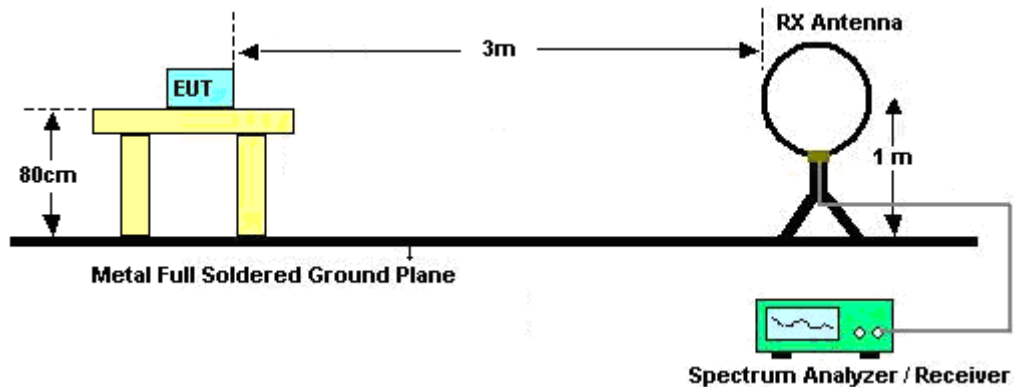
7. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as “-”.

<For 24.05 GHz ~ 24.25 GHz>

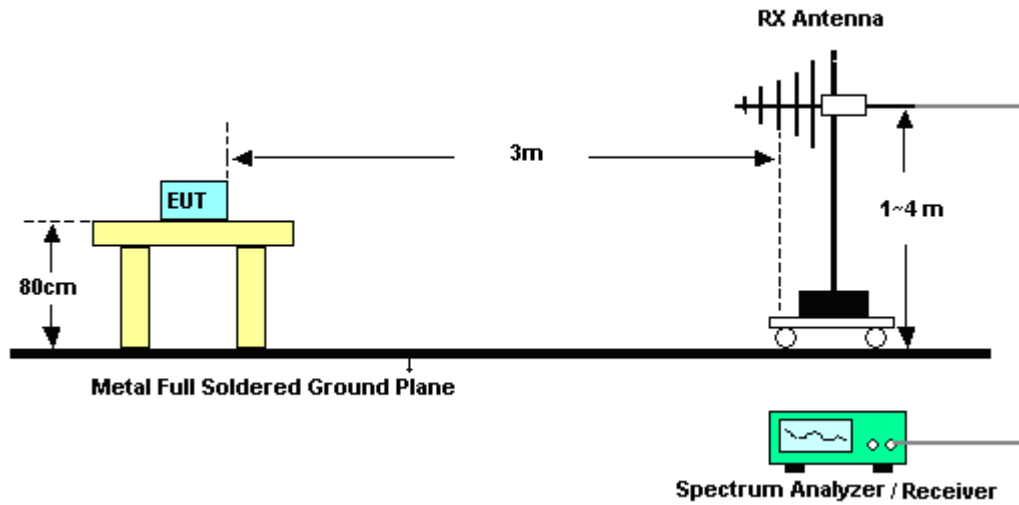
For emissions 9KHz to 40GHz, ANSI C63.10 Section 6.3 Radiated emissions testing follows, and for emissions 40GHz to 100GHz, ANSI C63.10 Section 9.8 and 9.9 radiated measurements follows. The EUT was placed on a turntable with 0.8 meter height for frequency below 1GHz and with 1.5 meter height for frequency above 1GHz, and was arranged test distance as shown in Section 3.4 Test Setup, respectively. For emissions, test results are attenuated more than 20 dB below the permissible value need not be reported in accordance with FCC Part 15.31(O).

3.1.4 Test Setup

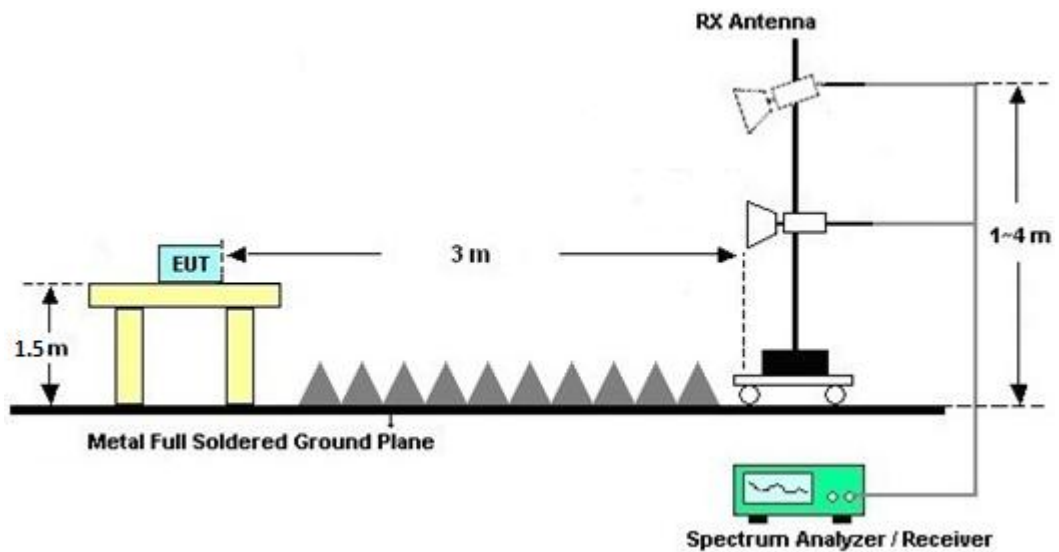
For radiated emissions below 30MHz



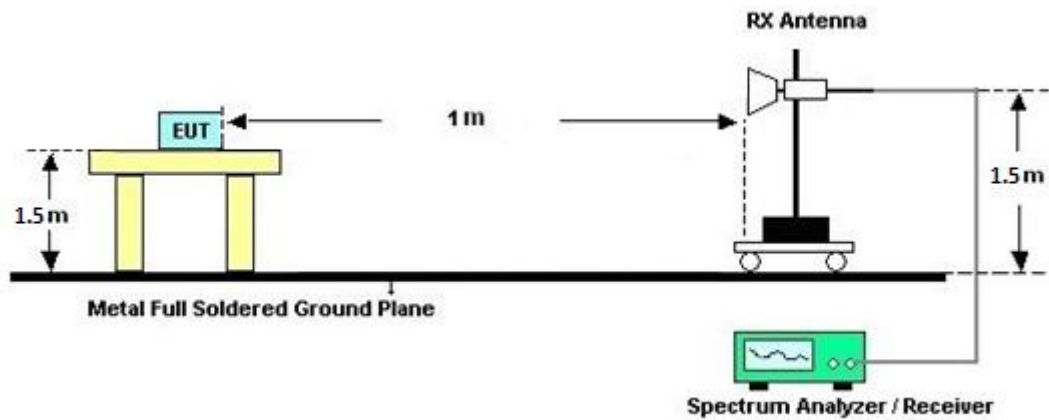
For radiated emissions from 30MHz to 1GHz



For radiated test from 1GHz to 18GHz

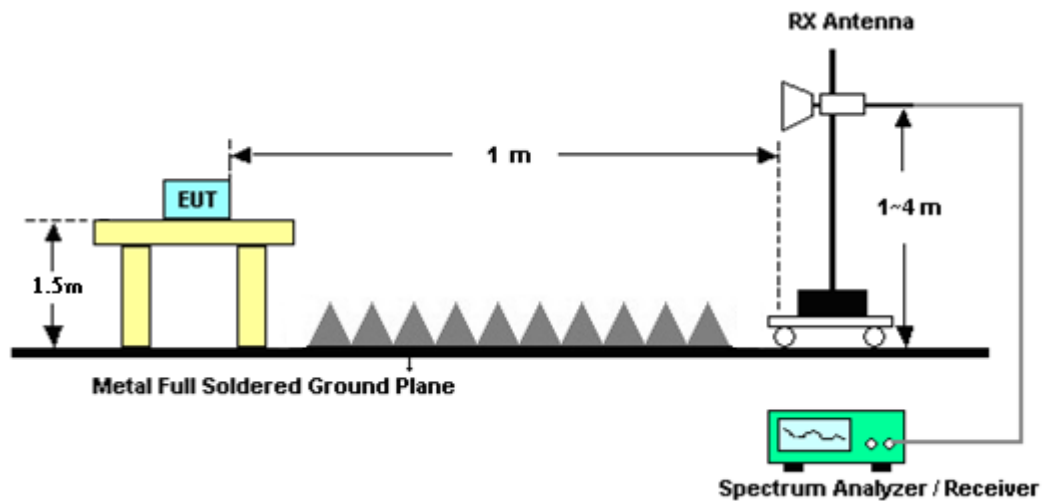


For radiated test above 18GHz



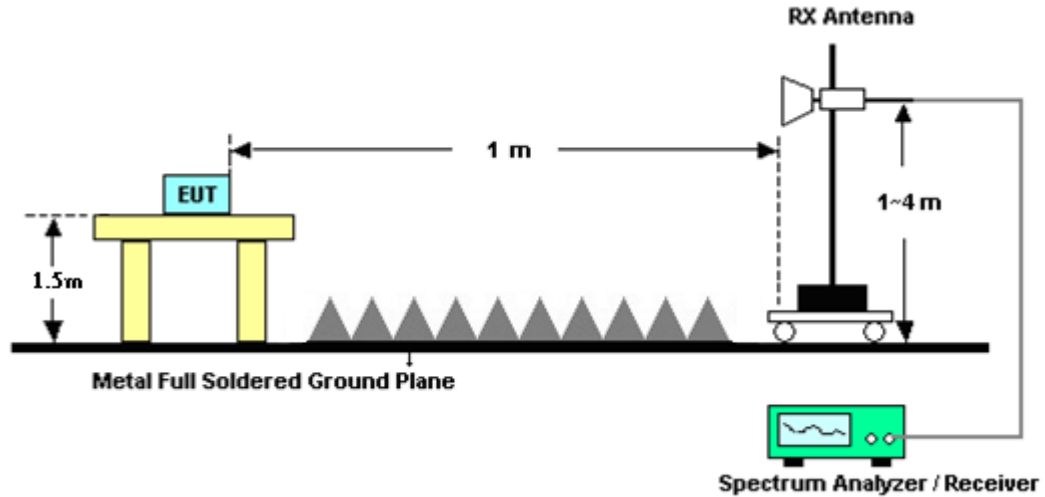
<For radiated emissions from 18 ~ 40GHz>

<For 24.05 GHz ~ 24.25 GHz>



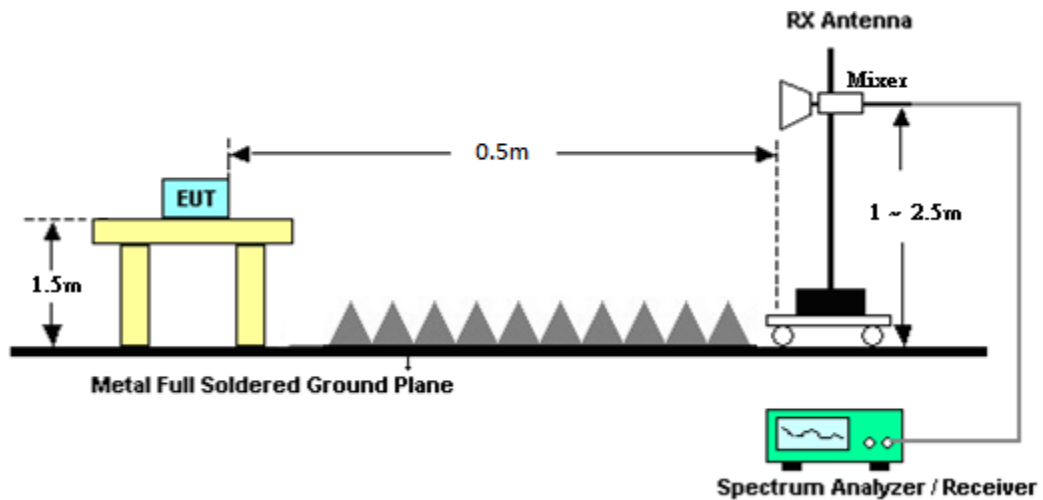
<For radiated emissions above 40 ~ 90GHz>

<For 24.05 GHz ~ 24.25 GHz>



<For radiated emissions above 90 ~ 100GHz>

<For 24.05 GHz ~ 24.25 GHz>



3.1.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which starts from 9 kHz to 30 MHz, is pre-scanned and the result which is 20 dB lower than the limit line is not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.



3.1.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.1.7 Duty Cycle

Please refer to Appendix C.

3.1.8 Test Result of Radiated Spurious Emissions (30MHz ~ 10th Harmonic)

Please refer to Appendix A and B.



3.2 Antenna Requirements

3.2.1 Standard Applicable

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

3.2.2 Antenna Anti-Replacement Construction

Antenna permanently attached.

3.2.3 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.

3.2.4 Antenna Connector Construction

Embedded in Antenna.



4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Aug. 29, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Aug. 28, 2025	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	803951/2	9K~30M	Mar. 05, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Mar. 04, 2026	Radiation (03CH13-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	1224	18GHz~40GHz	Jun. 24, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Jun. 23, 2025	Radiation (03CH13-HY)
Preamplifier	EMEC	EM18G40G	060801	18GHz~40GHz	May.26, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	May.25, 2026	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	804011/2,804012/2	18GHz~40GHz	Dec. 31, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Dec. 30, 2025	Radiation (03CH13-HY)
Amplifier	SONOMA	310N	187282	9kHz~1GHz	Dec. 12, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Dec. 11, 2025	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N-06	40103 & 07	30MHz~1GHz	Apr. 13, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Apr. 12, 2026	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1326	1GHz~18GHz	Aug. 15, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Aug. 14, 2025	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-00101 800-30-10P	1590074	1GHz~18GHz	May. 14, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	May. 13, 2026	Radiation (03CH13-HY)
Preamplifier	EM Electronics	EM01G18G	060803	1GHz~18GHz	Jan. 08, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Jan. 07, 2026	Radiation (03CH13-HY)
Spectrum Analyzer	Keysight	N9010A	MY55370526	10Hz~44GHz	Jan. 11, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Jan. 10, 2026	Radiation (03CH13-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY57290111	3Hz~26.5GHz	Nov. 22, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Nov. 21, 2025	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0030/126E	30MHz~18GHz	Feb. 06, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Feb. 05, 2026	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	804616/2	30MHz~40GHz	Feb. 06, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Feb. 05, 2026	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24961/4	30MHz~18GHz	Feb. 06, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Feb. 05, 2026	Radiation (03CH13-HY)
Notch Filter	Wainwright	WLK4-1000-15 30-8000-40SS	SN12	1.53GHz Low Pass Filter	Sep. 11, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Sep. 10, 2025	Radiation (03CH13-HY)
Notch Filter	Wainwright	WHKX12-900-1 000-15000-60S S	SN11	1GHz High Pass Filter	Mar. 12, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Mar. 11, 2026	Radiation (03CH13-HY)
Notch Filter	Wainwright	WHKX12-2700-3000-18000-60 SS	SN2	3GHz High Pass Filter	Jul. 09, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Jul. 08, 2025	Radiation (03CH13-HY)
Notch Filter	Wainwright	WHKX8-5872.5 -6750-18000-40 ST	SN5	6.75GHz High Pass Filter	Mar. 07, 2025	Jun. 09, 2025 ~ Jun. 10, 2025	Mar. 06, 2026	Radiation (03CH13-HY)
Hygrometer	TECPEL	DTM-303A	TP215159	N/A	Sep. 10, 2024	Jun. 09, 2025 ~ Jun. 10, 2025	Sep. 09, 2025	Radiation (03CH13-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	Jun. 09, 2025 ~ Jun. 10, 2025	N/A	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Jun. 09, 2025 ~ Jun. 10, 2025	N/A	Radiation (03CH13-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Jun. 09, 2025 ~ Jun. 10, 2025	N/A	Radiation (03CH13-HY)
Software	Audix	N/A	RK-001124	N/A	N/A	Jun. 09, 2025 ~ Jun. 10, 2025	N/A	Radiation (03CH13-HY)



Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170584	18GHz-40GHz	Dec. 06, 2024	Jun. 06, 2025~ Jun. 09, 2025	Dec .05, 2025	Radiation (03CH18-HY)
Spectrum Analyzer	Rohde & Schwarz	FSV3044	101009	10Hz~44GHz	Nov. 22, 2024	Jun. 06, 2025~ Jun. 09, 2025	Nov. 21, 2025	Radiation (03CH18-HY)
Preamplifier	EMEC	EM18G40G	060873	18GHz~40GHz	Sep. 02, 2024	Jun. 06, 2025~ Jun. 09, 2025	Sep. 01, 2025	Radiation (03CH18-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	804011/2,804012/2	18GHz-40GHz	Dec. 31, 2024	Jun. 06, 2025~ Jun. 09, 2025	Dec. 30, 2025	Radiation (03CH18-HY)
Turn Table	EMEC	N/A	N/A	Phi/Theta 0~360 Degree	N/A	Jun. 06, 2025~ Jun. 09, 2025	N/A	Radiation (03CH18-HY)
Controller	EMEC	EM 1000	N/A	Control Turn table	N/A	Jun. 06, 2025~ Jun. 09, 2025	N/A	Radiation (03CH18-HY)
Spectrum Analyzer	Rohde & Schwarz	FSW43	101456	2Hz to 43.5GHz	Feb. 20, 2025	Jun. 09, 2025	Feb. 19, 2026	Radiation (03CH18-HY)
Harmonic Mixer*	Rohde & Schwarz	RPG FS-Z60	101033	40GHz to 60GHz	Jun. 27, 2024	Jun. 09, 2025	Jun. 26, 2025	Radiation (03CH18-HY)
Harmonic Mixer*	Rohde & Schwarz	FSZ-90	101867	60GHz to 90GHz	Jun. 27, 2024	Jun. 09, 2025	Jun. 26, 2025	Radiation (03CH18-HY)
Harmonic Mixer*	Rohde & Schwarz	RPG FS-Z140	101130	90GHz to 140GHz	Jun. 27, 2024	Jun. 09, 2025	Jun. 26, 2025	Radiation (03CH18-HY)
Antenna	Quinstar	QWH-UPRR00	1410300003	40-60 GHz	Jun. 27, 2024	Jun. 09, 2025	Jun. 26, 2025	Radiation (03CH18-HY)
Antenna	Quinstar	QWH-EPRR00	1372000000	60-90 GHz	Jun. 27, 2024	Jun. 09, 2025	Jun. 26, 2025	Radiation (03CH18-HY)
Antenna	Quinstar	QWH-FPRR00	1011500008	90-140 GHz	Jun. 27, 2024	Jun. 09, 2025	Jun. 26, 2025	Radiation (03CH18-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	801607/2	N/A	Dec. 25, 2024	Jun. 09, 2025	Dec. 24, 2025	Radiation (03CH18-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	519231/2	N/A	Dec. 25, 2024	Jun. 09, 2025	Dec. 24, 2025	Radiation (03CH18-HY)
AC Power Source	AC POWER	AFC-500W	F104070011	50Hz~60Hz	N/A	Jun. 09, 2025	N/A	Radiation (03CH18-HY)

5 Measurement Uncertainty

<03CH13-HY >

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.30 dB
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.50 dB
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Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.80 dB
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.10 dB
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<03CH18-HY >

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.50 dB
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.20 dB
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Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.70 dB
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.40 dB
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Appendix A. Radiated Spurious Emission

Bluetooth-LE_GSFK(2M) CH39 +802.11g CH11 +LoRa FHSS 150KHz 902.4MHz + 24G Radar

24GHz 24000~24250MHz

(Field strength of fundamental @ 3m)

24GHz	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
24.24GHz		23500	38.84	-35.16	74	65.24	39	6.04	61.9			P	H
		23507.05	24.67	-29.33	54	51.07	39	6.04	61.9			A	H
	*	24238	93.05	-34.9	127.95	119.23	39	6.16	61.8			P	H
	*	24237.9	92.58	-15.42	108	118.76	39	6.16	61.8			A	H
		24250	60.12	-13.88	74	86.3	39	6.16	61.8			P	H
		24250	50.16	-3.84	54	76.34	39	6.16	61.8			A	H
		23996	37.71	-36.29	74	63.95	38.9	6.1	61.7			P	V
		23500	24.95	-29.05	54	51.35	39	6.04	61.9			A	V
	*	24238	92.11	-35.84	127.95	118.29	39	6.16	61.8			P	V
	*	24238	91.61	-16.39	108	117.79	39	6.16	61.8			A	V
		24250	58.33	-15.67	74	84.51	39	6.16	61.8			P	V
		24250	47.49	-6.51	54	73.67	39	6.16	61.8			A	V
Remark	- No other spurious found. - All results are Pass against Peak and Average limit line. - The general radiated emission limits in §15.209 is lesser attenuation as limit. - The maximized peak level complies with the average limit, unnecessary to perform an average measurement												



24GHz 24000~24250MHz
(Radiated Spurious Emission @ 3m)

24GHz	Note	Frequency (MHz)	Level (dB μ V/m)	Over Limit (dB)	Limit Line (dB μ V/m)	Read Level (dB μ V)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
24.24GHz		22298	39.12	-34.88	74	66.51	38.72	5.87	62.44			P	H
		23500	27.15	-26.85	54	53.55	39	6.04	61.9			A	H
		39347	43.52	-30.48	74	62.78	44.28	8.72	62.72			P	H
		38158	31.98	-22.02	54	51.01	43.53	8.24	61.26			A	H
		22146	40.1	-33.9	74	67.61	38.66	5.84	62.47			P	V
		22186	27.07	-26.93	54	54.55	38.67	5.85	62.46			A	V
		38121	45.37	-28.63	74	64.41	43.5	8.25	61.25			P	V
		38202	31.69	-22.31	54	50.73	43.56	8.22	61.28			A	V
Remark	1. No other spurious found. 2. All results are Pass against Peak and Average limit line. 3. The general radiated emission limits in §15.209 is lesser attenuation as limit. 4. The maximized peak level complies with the average limit, unnecessary to perform an average measurement												

24GHz 24000~24250MHz
(Radiated Spurious Emission & Harmonic @ 3m)

24GHz	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
24.24GHz		48.48	58.45	-29.5	87.95	100	0	P	H
		48.48	51.09	-16.86	67.95	100	0	A	H
		48.8231	58.36	-15.64	74	100	0	P	H
		51.1109	49.03	-4.97	54	100	0	A	H
		60.1585	62.68	-11.32	74	100	0	P	H
		60.0035	50.67	-3.33	54	100	0	A	H
		72.72	56.56	-31.39	87.95	100	0	P	H
		72.72	47.57	-20.38	67.95	100	0	A	H
		91.4494	62.99	-11.01	74	100	0	P	H
		90.0045	50.77	-3.23	54	100	0	A	H
		96.96	49.68	-38.27	87.95	100	0	P	H
		96.96	39.82	-28.13	67.95	100	0	A	H
		48.48	57.19	-30.76	87.95	100	0	P	V
		48.48	48.48	-19.47	67.95	100	0	A	V
		48.5011	58.3	-15.7	74	100	0	P	V
		48.7551	46.65	-7.35	54	100	0	A	V
		60.1375	61.89	-12.11	74	100	0	P	V
		60.0145	50.65	-3.35	54	100	0	A	V
		72.72	46.94	-41.01	87.95	100	0	P	V
		72.72	46.94	-21.01	67.95	100	0	A	V
		90.7174	63	-12.11	74	100	0	P	V
		90.7804	50.48	-3.52	54	100	0	A	V
		96.96	48.91	-39.04	87.95	100	0	P	V
		96.96	39.69	-28.26	67.95	100	0	A	V
Remark	1. Except above, no other spurious found. 2. All results are Pass against Peak and Average limit line. 3. Test plots shown in the Annex B use closer distance and above final results are extrapolated to the distance specified by the limit, 3m, by offset with distance correction factor.								



Bluetooth-LE_GSKF(2M) CH39 +802.11a CH36 +LoRa FHSS 150KHz 902.4MHz + 24G Radar

24GHz 24000~24250MHz

(Field strength of fundamental @ 3m)

24GHz	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	Limit (dB)	Line (dBμV/m)	Level (dBμV)	Factor (dB/m)	Loss (dB)	Factor (dB)	Pos (cm)	Pos (deg)	Avg. (P/A)	(H/V)
24.24GHz		23500	38.68	-35.32	74	65.08	39	6.04	61.9			P	H
		23530.55	24.55	-29.45	54	50.95	38.99	6.04	61.89			A	H
	*	24238	93.03	-34.92	127.95	119.21	39	6.16	61.8			P	H
	*	24237.9	92.5	-15.5	108	118.68	39	6.16	61.8			A	H
		24250	59.87	-14.13	74	86.05	39	6.16	61.8			P	H
		24250	49.81	-4.19	54	75.99	39	6.16	61.8			A	H
		23867	37.52	-36.48	74	63.8	38.93	6.08	61.75			P	V
		23502	24.79	-29.21	54	51.19	39	6.04	61.9			A	V
	*	24238	92.14	-35.81	127.95	118.32	39	6.16	61.8			P	V
	*	24238	91.49	-16.51	108	117.67	39	6.16	61.8			A	V
		24250	58.29	-15.71	74	84.47	39	6.16	61.8			P	V
		24250	47.62	-6.38	54	73.8	39	6.16	61.8			A	V
Remark		1. No other spurious found. 2. All results are Pass against Peak and Average limit line. 3. The general radiated emission limits in §15.209 is lesser attenuation as limit. 4. The maximized peak level complies with the average limit, unnecessary to perform an average measurement											



24GHz 24000~24250MHz
(Radiated Spurious Emission @ 3m)

24GHz	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
24.24GHz		22314	39.25	-34.75	74	66.63	38.73	5.87	62.44			P	H
		22172	27.03	-26.97	54	54.52	38.67	5.85	62.47			A	H
		39411	43.76	-30.24	74	62.91	44.33	8.85	62.79			P	H
		38166	31.58	-22.42	54	50.63	43.53	8.23	61.27			A	H
		22143	40.06	-33.94	74	67.57	38.66	5.84	62.47			P	V
		22236	27.07	-26.93	54	54.51	38.69	5.86	62.45			A	V
		38186	45.37	-28.63	74	64.4	43.55	8.23	61.27			P	V
		38204	31.71	-22.29	54	50.75	43.56	8.22	61.28			A	V
Remark	1. No other spurious found. 2. All results are Pass against Peak and Average limit line. 3. The general radiated emission limits in §15.209 is lesser attenuation as limit. 4. The maximized peak level complies with the average limit, unnecessary to perform an average measurement												

24GHz 24000~24250MHz
(Radiated Spurious Emission & Harmonic @ 3m)

24GHz	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
24.24GHz		48.48	58.86	-29.09	87.95	100	0	P	H
		48.48	51.36	-16.59	67.95	100	0	A	H
		48.8731	57.5	-16.5	74	100	0	P	H
		51.1109	49.16	-4.84	54	100	0	A	H
		60.0315	62.31	-11.69	74	100	0	P	H
		60.0795	50.74	-3.26	54	100	0	A	H
		72.72	56.49	-31.46	87.95	100	0	P	H
		72.72	47.99	-19.96	67.95	100	0	A	H
		91.7683	62.47	-11.53	74	100	0	P	H
		90.0065	50.77	-3.23	54	100	0	A	H
		96.96	49.32	-38.63	87.95	100	0	P	H
		96.96	39.71	-28.24	67.95	100	0	A	H
		48.48	55.27	-32.68	87.95	100	0	P	V
		48.48	48.37	-19.58	67.95	100	0	A	V
		48.7161	59.08	-14.92	74	100	0	P	V
		48.7771	46.53	-7.47	54	100	0	A	V
		60.1085	62.08	-11.92	74	100	0	P	V
		60.0125	50.7	-3.3	54	100	0	A	V
		72.72	55.02	-32.93	87.95	100	0	P	V
		72.72	46.76	-21.19	67.95	100	0	A	V
		90.7934	63.31	-11.92	74	100	0	P	V
		91.7133	50.55	-3.45	54	100	0	A	V
		96.96	49.46	-38.49	87.95	100	0	P	V
		96.96	39.66	-28.29	67.95	100	0	A	V
Remark	1.	Except above, no other spurious found.							
	2.	All results are Pass against Peak and Average limit line.							
	3.	Test plots shown in the Annex B use closer distance and above final results are extrapolated to the distance specified by the limit, 3m, by offset with distance correction factor.							

**Note symbol**

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is over limit line.
P/A	P eak or A verage
H/V	H orizontal or V ertical

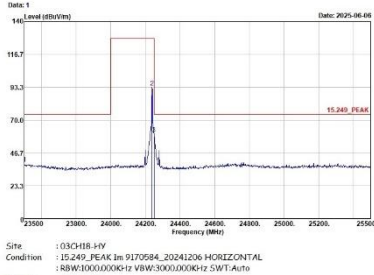
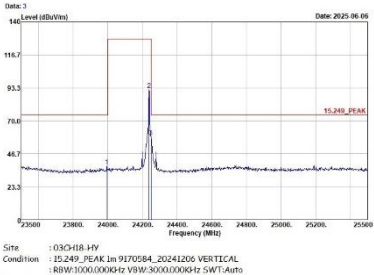
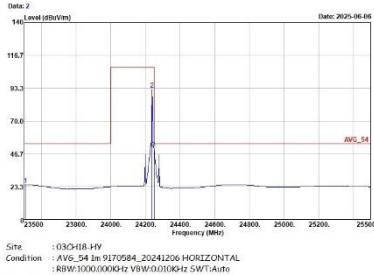
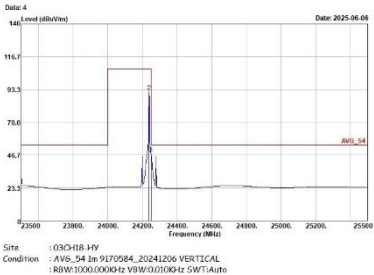


Appendix B. Radiated Spurious Emission Plots

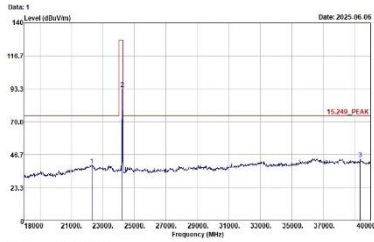
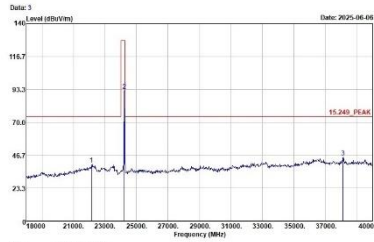
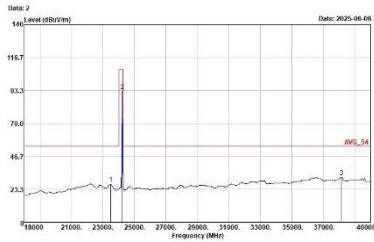
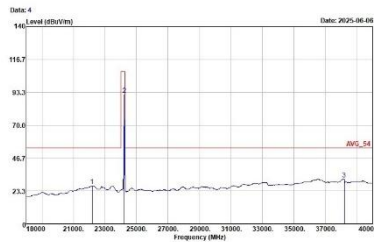
Bluetooth-LE_GSKF(2M) CH39 +802.11g CH11 +LoRa FHSS 150KHz 902.4MHz + 24G Radar

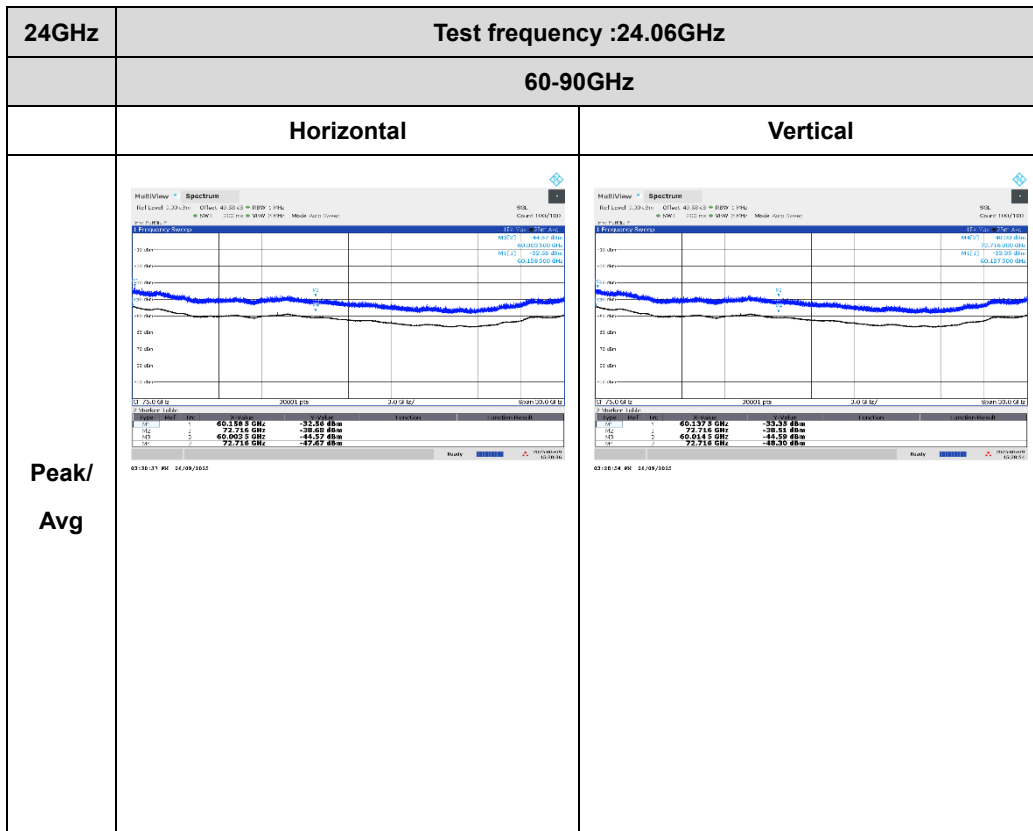
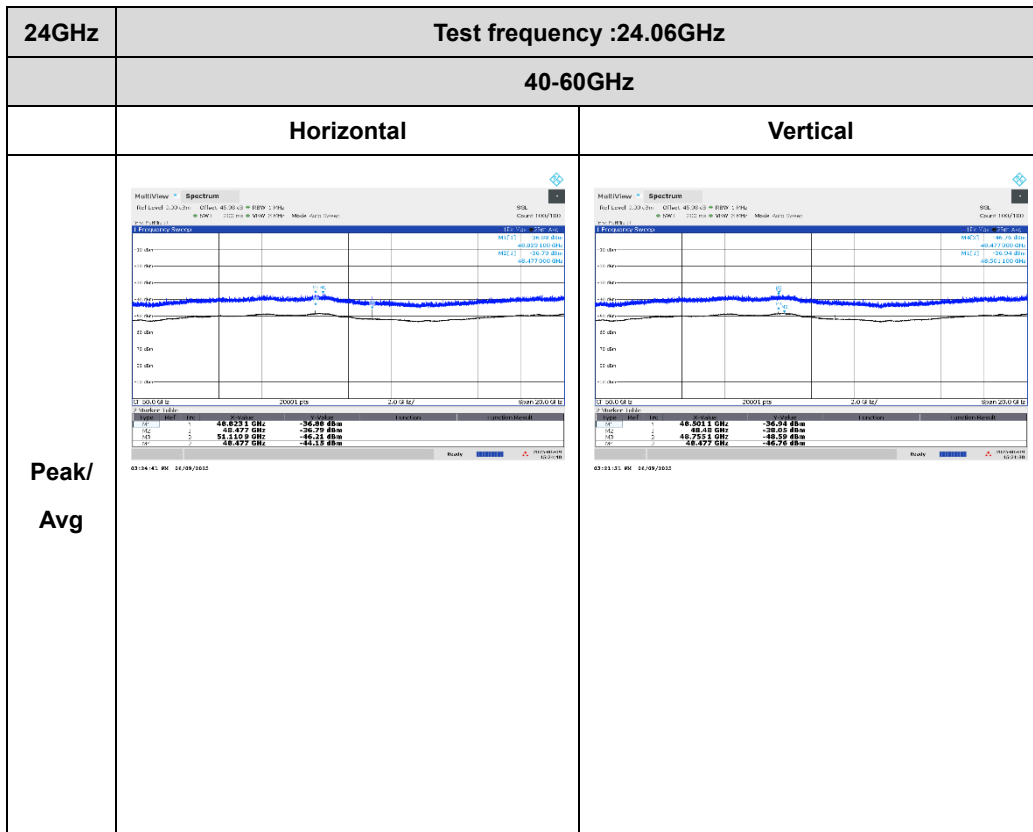
24GHz 24000~24250MHz

Field strength of fundamental@ 3m

24GHz	Field strength of fundamental	
	Test frequency:24.24GHz	
	Horizontal	Vertical
Peak		
Avg.		

24GHz 24000~24250MHz
(Radiated Spurious Emission& Harmonic @ 3m)

24GHz	Test frequency :24.06GHz	
	18-40GHz	
	Horizontal	Vertical
Peak	 Site : 03CH8-HY Condition : 15.249_PEAk In 9170584_20241206 HORIZONTAL RBW:1000.0000Hz VBW:3000.0000Hz SWT:Auto	 Site : 03CH8-HY Condition : 15.249_PEAk In 9170584_20241206 VERTICAL RBW:1000.0000Hz VBW:3000.0000Hz SWT:Auto
Avg	 Site : 03CH8-HY Condition : AVG_54 In 9170584_20241206 HORIZONTAL RBW:1000.0000Hz VBW:0.0100Hz SWT:Auto	 Site : 03CH8-HY Condition : AVG_54 In 9170584_20241206 VERTICAL RBW:1000.0000Hz VBW:0.0100Hz SWT:Auto





24GHz

Test frequency :24.06GHz

90-100GHz

Horizontal

Horizontal Spectrum

Ref Level: -20.00 dBm, Offset: 40.26 dB, BW: 500 Hz, Span: 20.00 GHz, Center: 90.100 GHz

Frequency (GHz)	Power (dBm)
90.145	-32.25
90.146	-32.25
90.147	-32.25
90.148	-32.25
90.149	-32.25
90.150	-32.25
90.151	-32.25
90.152	-32.25
90.153	-32.25
90.154	-32.25
90.155	-32.25
90.156	-32.25
90.157	-32.25
90.158	-32.25
90.159	-32.25
90.160	-32.25
90.161	-32.25
90.162	-32.25
90.163	-32.25
90.164	-32.25
90.165	-32.25
90.166	-32.25
90.167	-32.25
90.168	-32.25
90.169	-32.25
90.170	-32.25
90.171	-32.25
90.172	-32.25
90.173	-32.25
90.174	-32.25
90.175	-32.25
90.176	-32.25
90.177	-32.25
90.178	-32.25
90.179	-32.25
90.180	-32.25
90.181	-32.25
90.182	-32.25
90.183	-32.25
90.184	-32.25
90.185	-32.25
90.186	-32.25
90.187	-32.25
90.188	-32.25
90.189	-32.25
90.190	-32.25
90.191	-32.25
90.192	-32.25
90.193	-32.25
90.194	-32.25
90.195	-32.25
90.196	-32.25
90.197	-32.25
90.198	-32.25
90.199	-32.25
90.200	-32.25

43.15:44.90 14/09/2022

Vertical

Vertical Spectrum

Ref Level: -20.00 dBm, Offset: 40.26 dB, BW: 500 Hz, Span: 20.00 GHz, Center: 90.100 GHz

Frequency (GHz)	Power (dBm)
90.174	-32.37
90.175	-32.37
90.176	-32.37
90.177	-32.37
90.178	-32.37
90.179	-32.37
90.180	-32.37
90.181	-32.37
90.182	-32.37
90.183	-32.37
90.184	-32.37
90.185	-32.37
90.186	-32.37
90.187	-32.37
90.188	-32.37
90.189	-32.37
90.190	-32.37
90.191	-32.37
90.192	-32.37
90.193	-32.37
90.194	-32.37
90.195	-32.37
90.196	-32.37
90.197	-32.37
90.198	-32.37
90.199	-32.37
90.200	-32.37

43.14:14.90 14/09/2022



24GHz

Test frequency :24.24GHz

30MHz-18GHz

Horizontal

Vertical

Peak/
Avg.

Level (dBmV/m)

140.0
122.5
105.0
87.5
70.0
52.5
35.0
17.5

50 3624 7216 10812 14406 18000

Frequency (MHz)

Date: 2025-06-10

PEAK_74

Avg_54

Site : 88043-HV
Condition: PEAK_74 3m HORN_31280_1326 HORIZONTAL

Peak	Freq	Level	Limit	Line	Margin	Read	Ant	Cable	Preamp	Aux	Apos	Tpos	Remark
						Level	Factor	Loss	Factor	Factor			
1	36.79	38.38	46.00	-9.58	29.99	31.24	8.89	31.99	0.00	0.00	0.00	0.00	PEAK
2	122.15	28.00	43.50	-15.50	38.81	17.59	1.40	31.91	0.00	0.00	0.00	0.00	PEAK
3	156.18	29.34	43.50	-14.16	32.85	16.61	1.82	31.90	0.00	0.00	0.00	0.00	PEAK
4	489.27	33.24	46.00	-12.76	38.89	22.81	2.89	31.68	0.00	0.00	0.00	0.00	PEAK
5	612.00	38.38	46.00	-7.61	38.79	25.90	1.58	31.81	0.00	0.00	0.00	0.00	PEAK
6	982.28	118.89	186.61	29.82	4.21	31.87	0.19	0.00	0.00	0.00	0.00	0.00	PEAK
7	982.19	45.82	56.00	-10.18	38.85	26.97	4.16	38.49	0.00	0.00	0.00	0.00	PEAK
8	2462.00	189.65	186.61	3.04	181.89	27.78	6.89	36.97	9.93	0.00	0.00	0.00	Peak
9	2468.00	182.97	186.61	-3.64	195.88	27.88	6.92	36.97	9.93	0.00	0.00	0.00	Peak
10	1515.00	42.82	74.00	-31.18	55.82	33.13	18.79	57.66	0.74	0.00	0.00	0.00	Peak
11	2325.00	46.89	74.00	-27.11	53.12	37.80	12.74	57.53	0.44	0.00	0.00	0.00	Peak
12	1185.00	47.51	74.00	-26.49	51.43	37.93	14.28	56.74	0.63	0.00	0.00	0.00	Peak
13	12395.00	47.83	74.00	-26.17	47.52	37.21	16.55	56.32	0.49	0.00	0.00	0.00	Peak
14	11619.00	46.83	74.00	-27.17	45.38	38.82	18.84	56.14	0.73	0.00	0.00	0.00	Peak
15	17819.00	47.74	74.00	-26.26	44.66	38.34	19.78	55.84	0.82	0.00	0.00	0.00	Peak

Level (dBmV/m)

140.0
122.5
105.0
87.5
70.0
52.5
35.0
17.5

50 3624 7216 10812 14406 18000

Frequency (MHz)

Date: 2025-06-10

PEAK_74

Avg_54

Site : 88043-HV
Condition: PEAK_74 3m HORN_31280_1326 VERTICAL

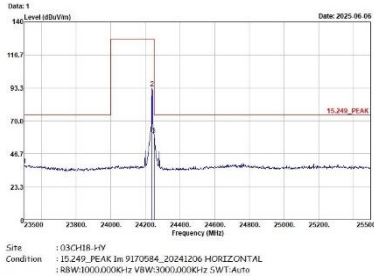
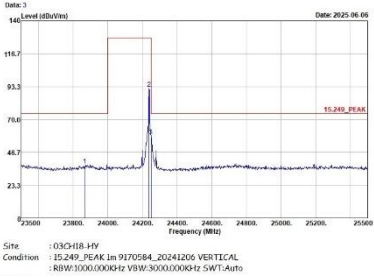
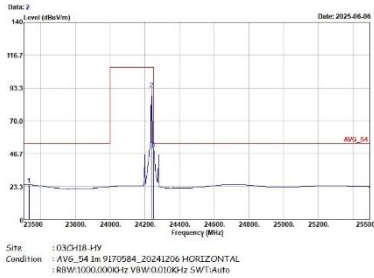
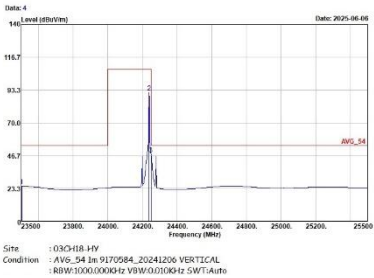
Peak	Freq	Level	Limit	Line	Margin	Read	Ant	Cable	Preamp	Aux	Apos	Tpos	Remark
						Level	Factor	Loss	Factor	Factor			
1	36.79	38.77	46.00	-7.23	38.66	31.24	8.89	31.99	0.00	0.00	0.00	0.00	PEAK
2	72.68	31.97	46.00	-14.03	39.89	12.79	1.25	31.91	0.00	0.00	0.00	0.00	PEAK
3	71.65	38.13	46.00	-7.87	37.00	12.93	1.26	31.91	0.00	0.00	0.00	0.00	PEAK
4	438.24	34.82	46.00	-11.18	31.58	22.86	2.89	31.68	0.00	0.00	0.00	0.00	PEAK
5	688.12	36.48	46.00	-9.52	38.83	25.97	1.49	31.81	0.00	0.00	0.00	0.00	PEAK
6	982.28	122.24	186.61	34.03	189.96	29.82	4.21	31.87	0.19	0.00	0.00	0.00	Peak
7	981.20	48.77	54.00	-5.23	25.95	38.98	4.19	38.56	0.21	100	100	100	Peak
8	2462.00	183.63	186.61	3.08	95.86	27.78	6.89	36.97	9.93	0.00	0.00	0.00	Peak
9	2468.00	188.18	186.61	1.57	188.29	27.88	6.92	36.97	9.93	0.00	0.00	0.00	Peak
10	1878.00	41.47	74.00	-32.53	59.21	38.98	9.38	59.81	0.93	0.00	0.00	0.00	Peak
11	3016.00	43.28	74.00	-30.72	52.44	34.58	11.63	56.11	0.74	0.00	0.00	0.00	Peak
12	1888.00	47.13	74.00	-26.87	51.83	37.98	14.22	56.74	0.64	0.00	0.00	0.00	Peak
13	11679.00	47.22	74.00	-26.78	47.88	38.54	16.14	56.82	0.66	0.00	0.00	0.00	Peak
14	13248.00	46.53	74.00	-27.47	44.35	39.84	18.63	56.28	0.71	0.00	0.00	0.00	Peak
15	16935.00	47.52	74.00	-26.48	44.48	38.62	19.36	55.44	0.78	0.00	0.00	0.00	Peak



Bluetooth-LE_GSKF(2M) CH39 +802.11a CH36 +LoRa FHSS 150KHz 902.4MHz + 24G Radar

24GHz 24000~24250MHz

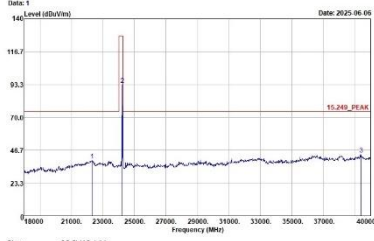
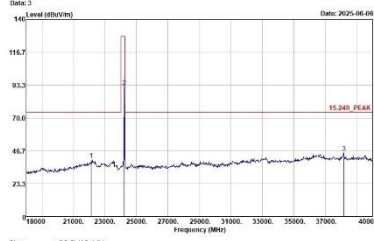
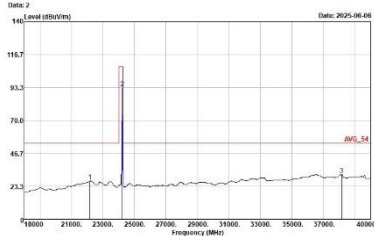
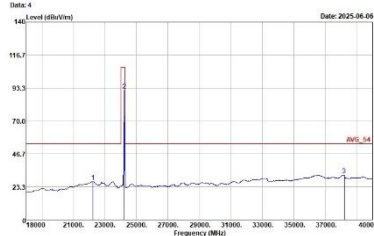
Field strength of fundamental@ 3m

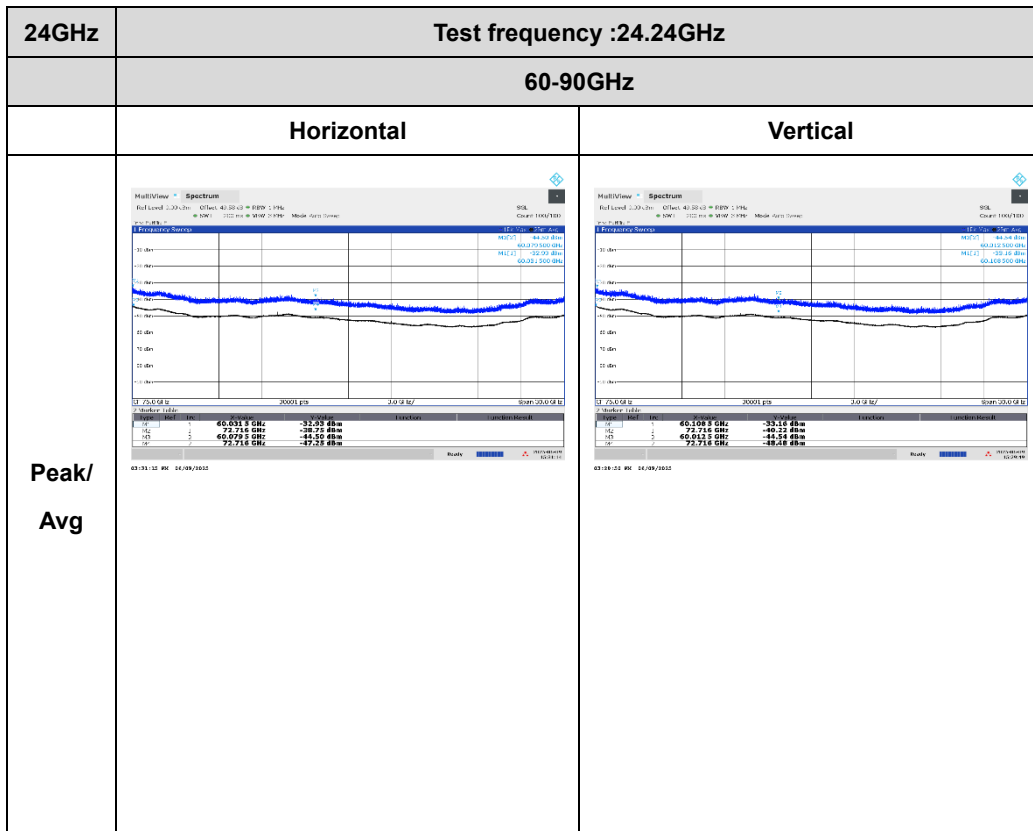
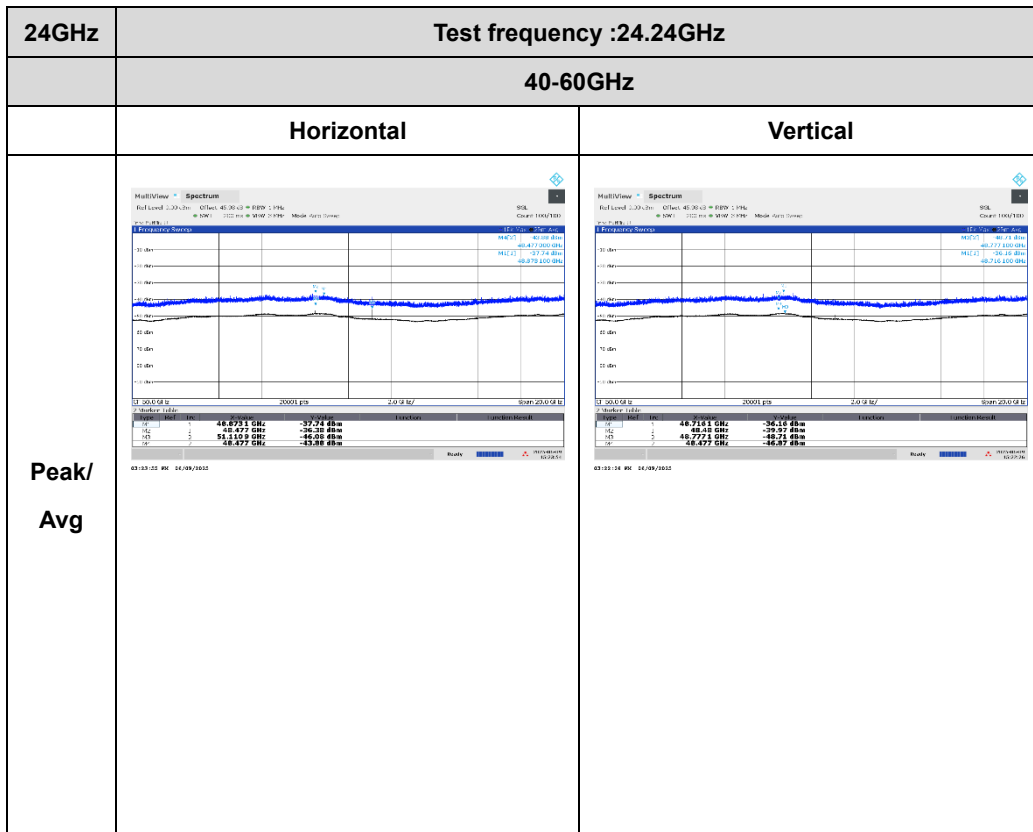
24GHz	Field strength of fundamental	
	Test frequency:24.24GHz	
	Horizontal	Vertical
Peak	 Site : 03CHB-HY Condition : 15.249_Peak In 9170584_20241206 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto	 Site : 03CHB-HY Condition : 15.249_Peak In 9170584_20241206 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto
Avg.	 Site : 03CHB-HY Condition : AVG_54 In 9170584_20241206 HORIZONTAL : RBW:1000.000kHz VBW:0.010kHz SWT:Auto	 Site : 03CHB-HY Condition : AVG_54 In 9170584_20241206 VERTICAL : RBW:1000.000kHz VBW:0.010kHz SWT:Auto

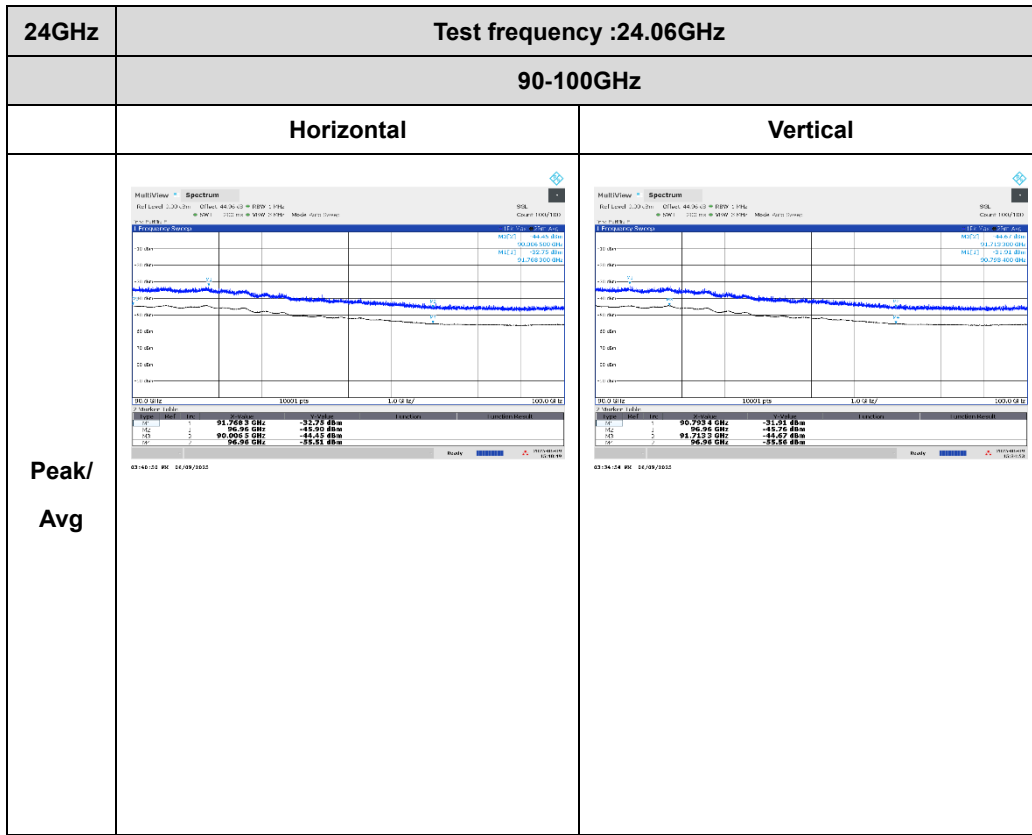


24GHz 24000~24250MHz

(Radiated Spurious Emission& Harmonic @ 3m)

24GHz	Test frequency :24.06GHz	
	18-40GHz	
	Horizontal	Vertical
Peak	 Site : 03CH8-HY Condition : 15.249_Peak In 9170584_20241206 HORIZONTAL : RBW:1000.0000Hz VBW:3000.0000Hz SWT:Auto	 Site : 03CH8-HY Condition : 15.249_Peak In 9170584_20241206 VERTICAL : RBW:1000.0000Hz VBW:3000.0000Hz SWT:Auto
Avg	 Site : 03CH8-HY Condition : AVG_54 In 9170584_20241206 HORIZONTAL : RBW:1000.0000Hz VBW:0.0100Hz SWT:Auto	 Site : 03CH8-HY Condition : AVG_54 In 9170584_20241206 VERTICAL : RBW:1000.0000Hz VBW:0.0100Hz SWT:Auto







24GHz

Test frequency :24.24GHz

30MHz-18GHz

Horizontal

Vertical

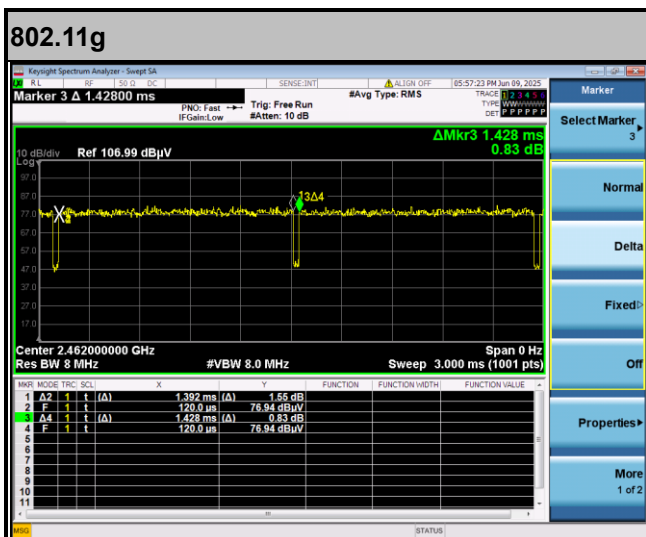
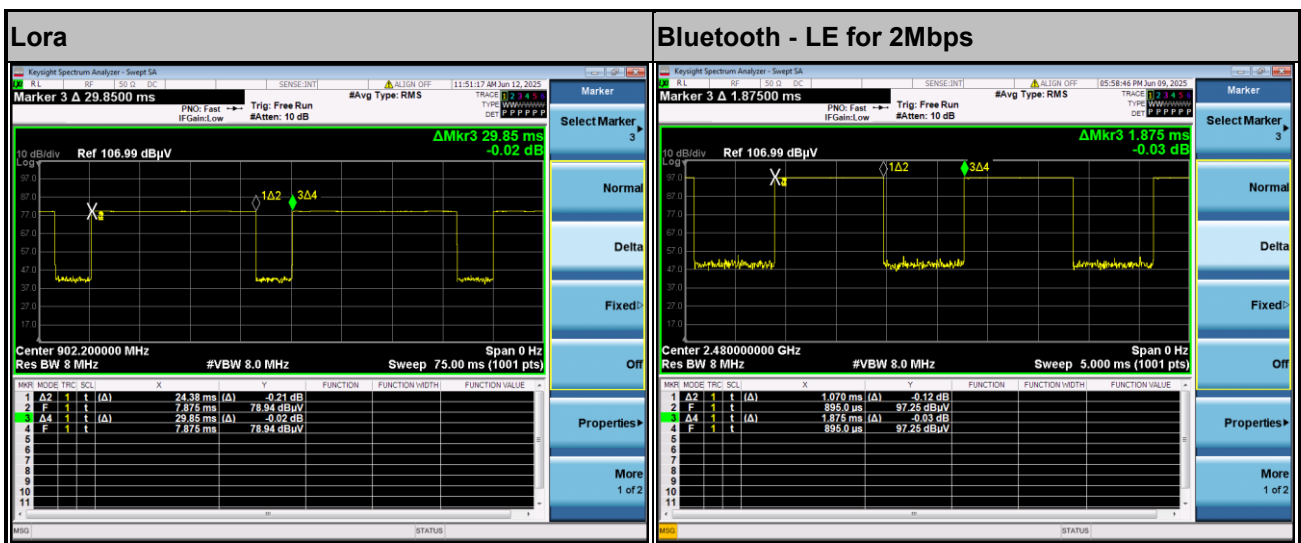
Peak/
Avg.



Appendix B. Duty Cycle Plots

<Mode 7>

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Lora	81.68	24380	0.04	100Hz
Bluetooth - LE for 2Mbps	57.07	1070	0.93	1kHz
802.11g	97.48	1392	0.72	1kHz





<Mode 8>

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Lora	81.68	24380	0.04	100Hz
Bluetooth - LE for 2Mbps	57.22	1070	0.93	1kHz
802.11a	97.20	1390	0.72	1kHz

