RADIO TEST REPORT

Test Report No. 15116661S-A-R1

Customer	**Nintendo Co., Ltd.**
Description of EUT	**Game controller**
Model Number of EUT	**BEE-012**
FCC ID	**BKEBEE012**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**December 19, 2024**
Remarks	**Bluetooth Low Energy part**

Representative Test Engineer	**Approved By**
Kazuya Noda Leader	Akio Hayashi Manager

CERTIFICATE 1266.03

☐ The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan, Inc.

☒ There is no testing item of "Non-accreditation".

Report Cover Page - Form-ULID-003532 (DCS:13-EM-F0429) Issue# 23.0

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REVISION HISTORY

Original Test Report No.: 15116661S-A

This report is a revised version of 15116661S-A. 15116661S-A is replaced with this report.

<table>
<tr><th>Revision</th><th>Test Report No.</th><th>Date</th><th>Page Revised Contents</th></tr>
<tr><td>- (Original)</td><td>15116661S-A</td><td>August 8, 2024</td><td>-</td></tr>
<tr><td>1</td><td>15116661S-A-R1</td><td>December 19, 2024</td><td>Page 32
The following note has been added:

Before
Average measurement value with duty factor
<table>
<tr><th>Polarity</th><th>Frequency [MHz]</th><th>Detector</th><th>Reading [dBuV]</th><th>Ant.Fac. [dB/m]</th><th>Loss [dB]</th><th>Gain [dB]</th><th>Duty Factor [dB]</th><th>Distance Factor [dB]</th><th>Result [dBuV/m]</th><th>Limit [dBuV/m]</th><th>Margin [dB]</th><th>Remark</th></tr>
<tr><td>Hori.</td><td>2483.500</td><td>AV</td><td>37.72</td><td>27.80</td><td>-28.21</td><td>-</td><td>4.63</td><td>2.46</td><td>44.40</td><td>53.9</td><td>9.5</td><td>*1)</td></tr>
<tr><td>Hori.</td><td>4960.000</td><td>AV</td><td>40.99</td><td>32.23</td><td>-35.97</td><td>-</td><td>4.63</td><td>2.46</td><td>44.34</td><td>53.9</td><td>9.5</td><td>-</td></tr>
<tr><td>Vert.</td><td>2483.500</td><td>AV</td><td>38.25</td><td>27.80</td><td>-28.21</td><td>-</td><td>4.63</td><td>2.46</td><td>44.93</td><td>53.9</td><td>8.9</td><td>*1)</td></tr>
<tr><td>Vert.</td><td>2483.644</td><td>AV</td><td>36.78</td><td>27.80</td><td>-28.21</td><td>-</td><td>4.63</td><td>2.46</td><td>43.46</td><td>53.9</td><td>10.4</td><td>-</td></tr>
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Reference: Abbreviations (Including words undescribed in this report)

A2LA	The American Association for Laboratory Accreditation	ICES	Interference-Causing Equipment Standard
AC	Alternating Current	IEC	International Electrotechnical Commission
AFH	Adaptive Frequency Hopping	IEEE	Institute of Electrical and Electronics Engineers
AM	Amplitude Modulation	IF	Intermediate Frequency
Amp, AMP	Amplifier	ILAC	International Laboratory Accreditation Conference
ANSI	American National Standards Institute	ISED	Innovation, Science and Economic Development Canada
Ant, ANT	Antenna	ISO	International Organization for Standardization
AP	Access Point	JAB	Japan Accreditation Board
ASK	Amplitude Shift Keying	LAN	Local Area Network
Atten., ATT	Attenuator	LIMS	Laboratory Information Management System
AV	Average	MCS	Modulation and Coding Scheme
BPSK	Binary Phase-Shift Keying	MRA	Mutual Recognition Arrangement
BR	Bluetooth Basic Rate	N/A	Not Applicable
BT	Bluetooth	NIST	National Institute of Standards and Technology
BT LE	Bluetooth Low Energy	NS	No signal detect.
BW	BandWidth	NSA	Normalized Site Attenuation
Cal Int	Calibration Interval	NVLAP	National Voluntary Laboratory Accreditation Program
CCK	Complementary Code Keying	OBW	Occupied Band Width
Ch., CH	Channel	OFDM	Orthogonal Frequency Division Multiplexing
CISPR	Comite International Special des Perturbations Radioelectriques	P/M	Power meter
CW	Continuous Wave	PCB	Printed Circuit Board
DBPSK	Differential BPSK	PER	Packet Error Rate
DC	Direct Current	PHY	Physical Layer
D-factor	Distance factor	PK	Peak
DFS	Dynamic Frequency Selection	PN	Pseudo random Noise
DQPSK	Differential QPSK	PRBS	Pseudo-Random Bit Sequence
DSSS	Direct Sequence Spread Spectrum	PSD	Power Spectral Density
EDR	Enhanced Data Rate	QAM	Quadrature Amplitude Modulation
EIRP, e.i.r.p.	Equivalent Isotropically Radiated Power	QP	Quasi-Peak
EMC	ElectroMagnetic Compatibility	QPSK	Quadri-Phase Shift Keying
EMI	ElectroMagnetic Interference	RBW	Resolution Band Width
EN	European Norm	RDS	Radio Data System
ERP, e.r.p.	Effective Radiated Power	RE	Radio Equipment
EU	European Union	RF	Radio Frequency
EUT	Equipment Under Test	RMS	Root Mean Square
Fac.	Factor	RSS	Radio Standards Specifications
FCC	Federal Communications Commission	Rx	Receiving
FHSS	Frequency Hopping Spread Spectrum	SA, S/A	Spectrum Analyzer
FM	Frequency Modulation	SG	Signal Generator
Freq.	Frequency	SVSWR	Site-Voltage Standing Wave Ratio
FSK	Frequency Shift Keying	TR	Test Receiver
GFSK	Gaussian Frequency-Shift Keying	Tx	Transmitting
GNSS	Global Navigation Satellite System	VBW	Video BandWidth
GPS	Global Positioning System	Vert.	Vertical
Hori.	Horizontal	WLAN	Wireless LAN

CONTENTS PAGE

SECTION 1: Customer Information 5
SECTION 2: Equipment Under Test (EUT) 5
SECTION 3: Test Specification, Procedures & Results 6
SECTION 4: Operation of EUT during testing 9
SECTION 5: Conducted Emission 12
SECTION 6: Radiated Spurious Emission 13
SECTION 7: Antenna Terminal Conducted Tests 15
APPENDIX 1: Test Data 16
Conducted Emission 16
99 % Occupied Bandwidth and 6 dB Bandwidth 19
Maximum Peak Output Power 22
Radiated Spurious Emission 24
Conducted Spurious Emission 35
Power Density 36
APPENDIX 2: Test Instruments 38
APPENDIX 3: Photographs of Test Setup 39
Conducted Emission 39
Radiated Spurious Emission 40
Pre-Check of Worst Case Position 41
Antenna Terminal Conducted Tests 42

SECTION 1: Customer Information

Company Name	Nintendo Co., Ltd.
Address	11-1 Hokotate-cho, Kamitoba, Minami-ku, Kyoto 601-8501, Japan
Telephone Number	+81-75-662-9600
Contact Person	Yosuke Ishikawa

The information provided by the customer is as follows;
- Customer, Description of EUT, Model Number of EUT, FCC ID on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer Information
- SECTION 2: Equipment Under Test (EUT) other than the Receipt Date and Test Date
- SECTION 4: Operation of EUT during testing

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	Game controller
Model Number	BEE-012
Serial Number	Refer to SECTION 4.2
Condition	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab.
Receipt Date	January 16, 2024
Test Date	June 18 to 25, 2024

2.2 Product Description

General Specification

Rating	DC 5 V (*.Supply voltage from connector) (*. DC 3.89 V from Rechargeable Li-ion battery for the internal circuit)
Operating temperature	5 deg. C to 35 deg. C

Radio Specification

This report contains data provided by the customer which can impact the validity of results. UL Japan, Inc. is only responsible for the validity of results after the integration of the data provided by the customer.
The data provided by the customer is marked “a)” in the table below.

Bluetooth (Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	GFSK
Antenna Gain a)	0.69 dBi

Bluetooth (BR / EDR)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	FHSS (GFSK, π/4 DQPSK, 8 DPSK)
Antenna Gain a)	0.69 dBi

SECTION 3: Test Specification, Procedures & Results

3.1 Test Specification

Test Specification	FCC Part 15 Subpart C The latest version on the first day of the testing period
Title	FCC 47 CFR Part 15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

* Also the EUT complies with FCC Part 15 Subpart B.

3.2 Procedures and Results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Conducted Emission	**FCC:** ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.207	26.4 dB, 0.15000 MHz, N. QP	Complied	-
	ISED: RSS-Gen 8.8	**ISED:** RSS-Gen 8.8			
6 dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(a)(2)	See data.	Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.2(a)			
Maximum Peak Output Power	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(b)(3)		Complied	Conducted
	ISED: RSS-Gen 6.12	**ISED:** RSS-247 5.4(d)			
Power Density	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section 15.247(e)		Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.2(b)			
Spurious Emission Restricted Band Edges	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(d)	6.3 dB 4804.000 MHz, AV, Vertical, Mode: Tx BT LE 2M-PHY 2402 MHz	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *1)
	ISED: RSS-Gen 6.13	**ISED:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10			

Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593.
* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

*1) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 15.247 Meas Guidance v05r02 8.5 and 8.6.

FCC Part 15.31 (e)
This EUT provides the stable voltage constantly to RF Module regardless of input voltage.
Therefore, this EUT complies with the requirement.

FCC Part 15.203 Antenna requirement
It is impossible for end users to replace the antenna, because the antenna is mounted inside of the EUT.
Therefore, the equipment complies with the antenna requirement of Section 15.203.

3.3 Addition to Standard

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
99% Occupied Bandwidth	**ISED:** RSS-Gen 6.7	**ISED:** -	N/A	-	Conducted

Other than above, no addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

Measurement uncertainty is not taken into account when stating conformity with a specified requirement.
Note: When margins obtained from test results are less than the measurement uncertainty, the test results may exceed the limit.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor *k* = 2.

Item	Frequency range	Uncertainty (+/-)
Conducted Emission (AC Mains) LISN	150 kHz to 30 MHz	3.2 dB
Radiated Emission (Measurement distance: 3 m)	9 kHz to 30 MHz	3.3 dB
	30 MHz to 200 MHz	4.9 dB
	200 MHz to 1 GHz	6.2 dB
	1 GHz to 6 GHz	4.7 dB
	6 GHz to 18 GHz	5.3 dB
	18 GHz to 40 GHz	5.5 dB
Radiated Emission (Measurement distance: 1 m)	1 GHz to 18 GHz	5.6 dB
	18 GHz to 40 GHz	5.8 dB

Antenna terminal test	Uncertainty (+/-)
Power Measurement above 1 GHz (Average Detector)	1.3 dB
Power Measurement above 1 GHz (Peak Detector)	1.8 dB
Spurious Emission (Conducted) below 1 GHz	0.91 dB
Conducted Emissions Power Density Measurement 1 GHz to 3 GHz	1.3 dB
Conducted Emissions Power Density Measurement 3 GHz to 18 GHz	2.5 dB
Spurious Emission (Conducted) 18 GHz to 26.5 GHz	2.8 dB
Spurious Emission (Conducted) 26.5 GHz to 40 GHz	2.6 dB
Bandwidth Measurement	0.012 %
Duty Cycle and Time Measurement	0.27 %
Temperature	2.2 deg.C.
Humidity	4.0 %
Voltage	0.74 %

3.5 Test Location

UL Japan, Inc. Shonan EMC Lab.
1-22-3, Megumigaoka, Hiratsuka-shi, Kanagawa-ken 259-1220 Japan
Telephone: +81-463-50-6400
A2LA Certificate Number: 1266.03
(FCC test firm registration number: 626366, ISED lab company number: 2973D / CAB identifier: JP0001)

Test room	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber (SAC1)	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.2 Semi-anechoic chamber (SAC2)	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber (SAC3)	12.7 x 7.7 x 5.35	12.7 x 7.7	5 m
No.4 Semi-anechoic chamber (SAC4)	8.1 x 5.1 x 3.55	8.1 x 5.1	-
Wireless anechoic chamber 1 (WAC1)	9.5 x 6.0 x 5.4	9.5 x 6.0	3 m
Wireless anechoic chamber 2 (WAC2)	9.5 x 6.0 x 5.4	9.5 x 6.0	3 m
No.1 Shielded room	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.2 Shielded room	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.3 Shielded room	6.3 x 4.7 x 2.7	6.3 x 4.7	-
No.4 Shielded room	4.4 x 4.7 x 2.7	4.4 x 4.7	-
No.5 Shielded room	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.6 Shielded room	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.8 Shielded room	3.45 x 5.5 x 2.4	3.45 x 5.5	-
No.1 Measurement room	2.55 x 4.1 x 2.5	-	-
No.2 Measurement room	4.5 x 3.5 x 2.5	-	-
Wireless shielded room 1	3.0 x 4.5 x 2.7	3.0 x 4.5	-
Wireless shielded room 2	3.0 x 4.5 x 2.7	3.0 x 4.5	-

3.6 Test Data, Test Instruments, and Test Set Up

Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1 Operating Mode(s)

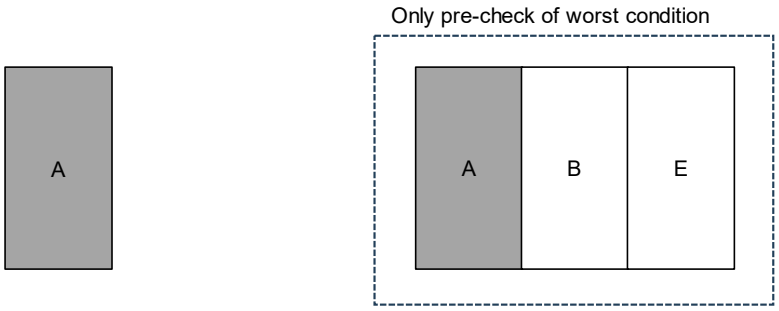
Mode	Remarks*
Bluetooth Low Energy (BT LE)	1M-PHY Uncoded PHY (1M-PHY), Maximum Packet Size, PRBS9
Bluetooth Low Energy (BT LE)	2M-PHY Uncoded PHY (2M-PHY), Maximum Packet Size, PRBS9
*Power of the EUT was set by the software as follows; Power Setting: 5 dBm Software: InspectionFwPackage Version: V0.15.0 (Date: 2024.01 16, Storage location: EUT memory) *This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.	

*The Details of Operating Mode(s)

Test Item	Operating Mode	Tested Frequency
Conducted Emission, Radiated Spurious Emission (Below 1 GHz), Conducted Spurious Emission	Tx BT LE, 1M-PHY *1)	2402 MHz
Radiated Spurious Emission (Above 1 GHz), Maximum Peak Output Power, Power Density, 6 dB Bandwidth, 99 % Occupied Bandwidth	Tx BT LE, 1M-PHY Tx BT LE, 2M-PHY	2402 MHz 2440 MHz 2480 MHz
*1) Conducted emissions, Spurious emissions and Conducted Spurious Emission for frequencies below 1 GHz were limited to the channel that had the highest power during the antenna terminal test, as preliminary testing indicated that changing the operating frequency had no significant impact on the emissions in those frequency bands.		

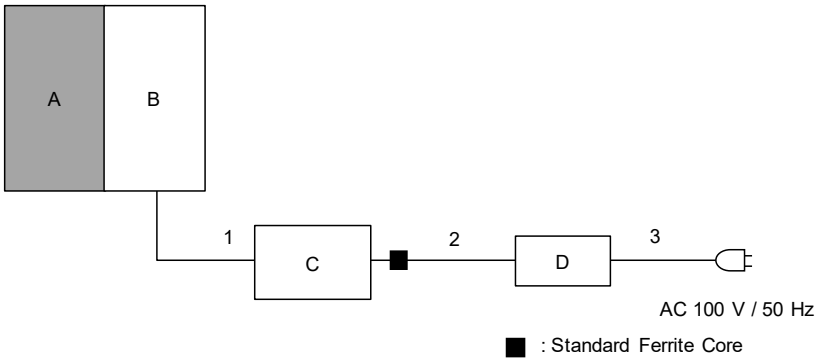
4.2 Configuration and Peripherals

Radiated Emission test

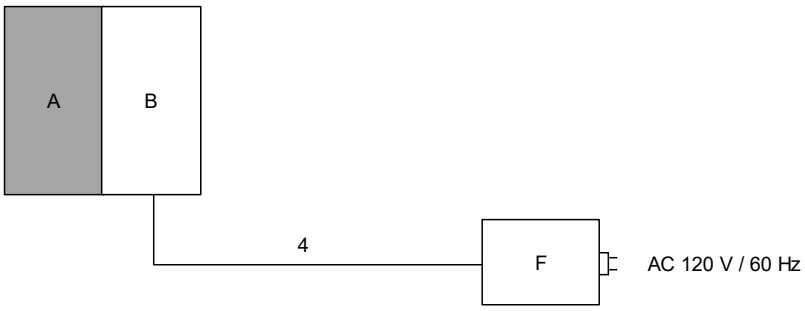


* The carrier level and noise levels were confirmed at each condition of standalone and connected by support equipment, and the test was made at the condition that has the maximum noise.

Antenna Terminal Conducted test



Conducted Emission test



* Cabling and setup(s) were taken into consideration and test data was taken under worse case conditions.
* As a result of comparing AC 120 V and AC 240 V at pre-check, conducted emission test was performed with AC 120 V of the worst voltage as representative.

Description of EUT and Support Equipment

No.	Item	Model Number	Serial Number	Manufacturer	Remarks
A	Controller	BEE-012	HBL01000089217 *1) HBL01000051689 *2)	Nintendo Co., Ltd.	EUT
B	Charging Grip	BEE-010	HDL04000004020 *1) B-0047 *2)	Nintendo Co., Ltd.	-
C	Laptop PC	CF-SZ6RDYVS	8KKSC50259	Panasonic	-
D	AC Adaptor	CF-AA64L2C M1	64L2CM118906341A	Panasonic	-
E	Controller	BEE-014	HCL01000090015	Nintendo Co., Ltd.	-
F	AC Adaptor	NGN-01	0A0000030	Nintendo Co., Ltd.	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	USB	1.5	Shielded	Shielded	-
2	DC	1.0	Unshielded	Unshielded	-
3	AC	0.8	Unshielded	Unshielded	-
4	DC	1.5	Shielded	Shielded	-

*1) Used for Radiated Emission test and Conducted emission test.
*2) Used for Antenna Terminal Conducted test.

SECTION 5: Conducted Emission

Test Procedure and Conditions

EUT was placed on a urethane platform of nominal size, 1.0 m by 2.0 m, raised 0.8 m above the conducting ground plane.
The rear of tabletop was located 40 cm to the vertical conducting plane. The rear of EUT, including peripherals was aligned and flushed with rear of tabletop. All other surfaces of tabletop were at least 80cm from any other grounded conducting surface. EUT was located 80 cm from a Line Impedance Stabilization Network (LISN) / Artificial mains Network (AMN) and excess AC cable was bundled in center.

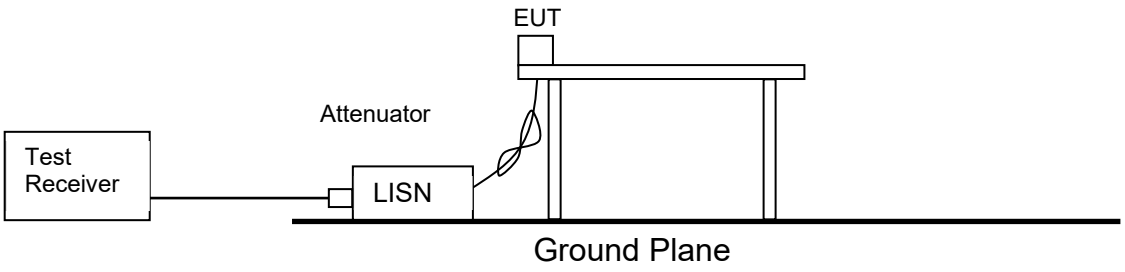
For the tests on EUT with other peripherals (as a whole system)
I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane.

The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Shielded Room.
The EUT was connected to a LISN (AMN).
An overview sweep with peak detection has been performed.

Test results are rounded off and limit are rounded down, so some differences might be observed.

Detector : QP and CISPR AV
Measurement Range : 0.15 MHz to 30 MHz
Test Data : APPENDIX
Test Result : Pass

Figure 1: Test Setup



SECTION 6: Radiated Spurious Emission

Test Procedure

It was measured based on "8.5 and 8.6 of KDB 558074 D01 15.247 Meas Guidance v05r02".

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 1.0 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane. Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.

The height of the measuring antenna varied between 1 m and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

Frequency	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Biconical	Logperiodic	Horn

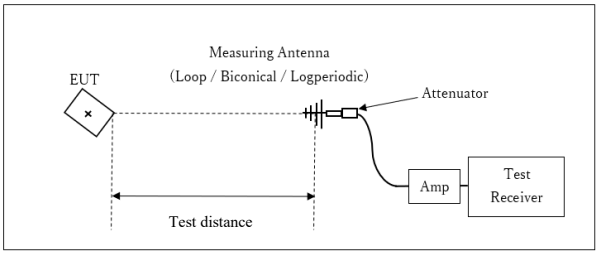
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.

20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument Used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	11.12.2.5.2 RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (Linear voltage) Trace: 100 traces Duty factor was added to the results.	RBW: 100 kHz VBW: 300 kHz

Figure 2: Test Setup

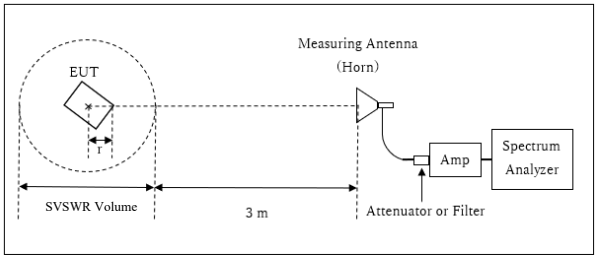
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

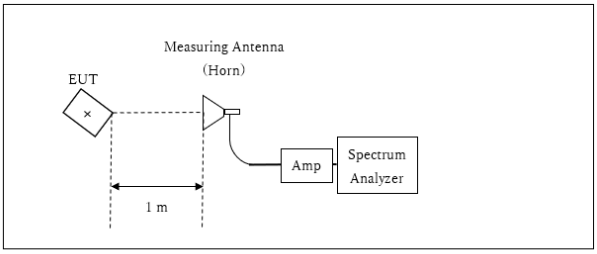


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.98 m / 3.0 m) = 2.46 dB
* Test Distance: (3 + SVSWR Volume /2) - r = 3.98 m

SVSWR Volume : 2.0 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.02 m

10 GHz to 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.54 dB
*Test Distance: 1 m

The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.

	Below 1 GHz	1 GHz to 2.8 GHz	2.8 GHz to 10 GHz	Above 10 GHz
Horizontal	Axis-X	Axis-X	Axis-Z	Axis-X
Vertical	Axis-X	Axis-Y	Axis-Y	Axis-X

Test results are rounded off and limit are rounded down, so some differences might be observed.

Measurement Range : 30 MHz to 26.5 GHz
Test Data : APPENDIX
Test Result : Pass

SECTION 7: Antenna Terminal Conducted Tests

Test Procedure

The tests were made with below setting connected to the antenna port.

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument Used
6 dB Bandwidth	Enough width to display emission skirts	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak	-	Power Meter (Sensor: 160 MHz BW)
Peak Power Density	1.5 times the 6 dB Bandwidth	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *2)
Conducted Spurious Emission *3) *4)	9 kHz to 150 kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150 kHz to 30 MHz	10 kHz	30 kHz				

*1) Peak hold was applied as Worst-case measurement.
*2) Section 11.10.2 Method PKPSD (peak PSD) of "ANSI C63.10-2013".
*3) In the frequency range below 30MHz, RBW was narrowed to separate the noise contents.
Then, wide-band noise near the limit was checked separately, however the noise was not detected as shown in the chart.
(9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 10 kHz)
*4) The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohmes. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to 45.5 - 51.5 = -6.0 dBuA/m, which has the same margin, 3 dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

Test results are rounded off and limit are rounded down, so some differences might be observed.
The equipment and cables were not used for factor 0 dB of the data sheets.

Test Data : APPENDIX
Test Result : Pass

APPENDIX 1: Test Data

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

UL Japan,Inc. Shonan EMC Lab. No.1 Shielded Room
Date : 2024/06/25

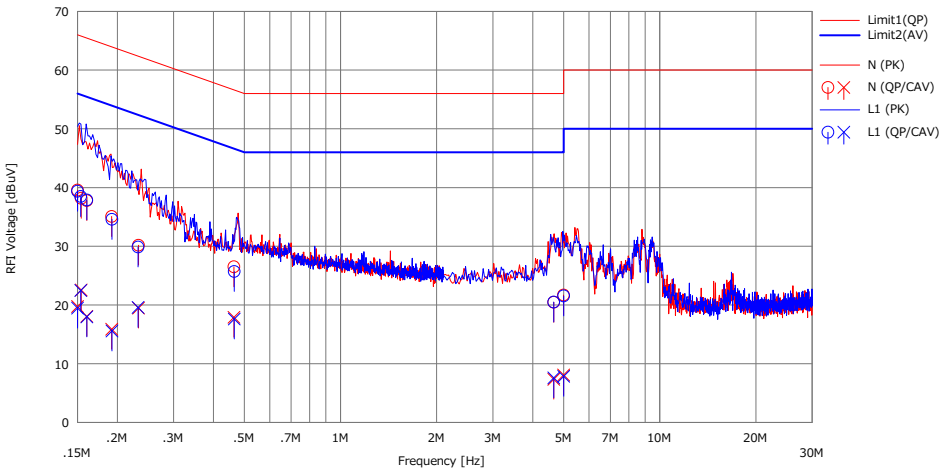
Mode : Tx, BTLE 1M, 2402 MHz

Power : AC 120 V / 60 Hz (AC Adapter)
Temp./Humi. : 23 deg.C / 53 %RH

Remarks : -

Limit : FCC_Part 15 Subpart C(15.207)

Engineer : Yusuke Tanikawara



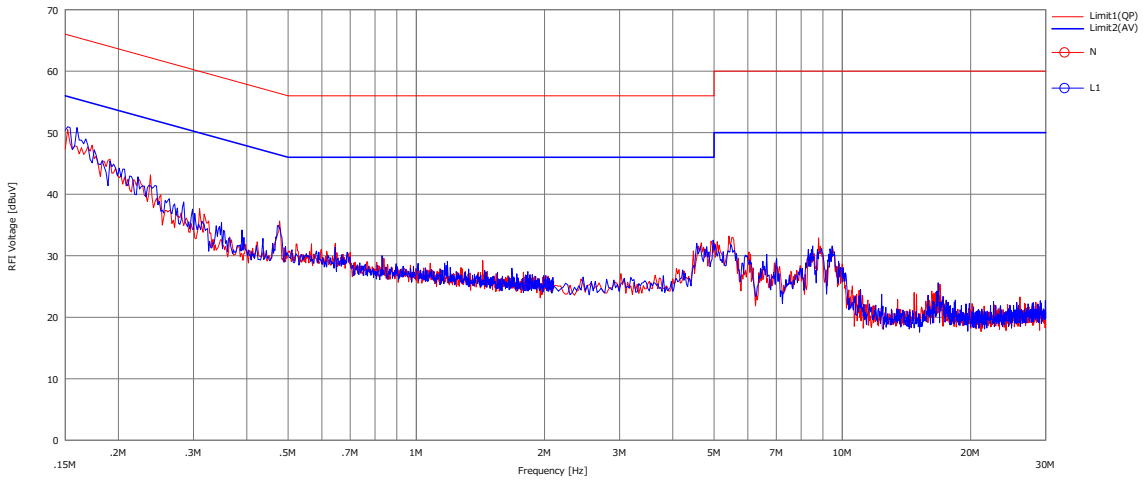
No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		(QP)	(CAV)		(QP)	(CAV)	(QP)	(AV)	(QP)	(AV)		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15000	27.00	7.20	12.55	39.55	19.75	66.00	56.00	26.4	36.2	N	
2	0.15416	25.60	10.00	12.56	38.16	22.56	65.77	55.77	27.6	33.2	N	
3	0.16047	25.20	5.50	12.57	37.77	18.07	65.44	55.44	27.6	37.3	N	
4	0.19208	22.50	3.30	12.57	35.07	15.87	63.95	53.95	28.8	38.0	N	
5	0.23304	17.60	6.90	12.57	30.17	19.47	62.34	52.34	32.1	32.8	N	
6	0.46372	13.90	5.30	12.61	26.51	17.91	56.63	46.63	30.1	28.7	N	
7	4.65201	7.40	-5.70	13.05	20.45	7.35	56.00	46.00	35.5	38.6	N	
8	4.99785	8.60	-5.00	13.09	21.69	8.09	56.00	46.00	34.3	37.9	N	
9	0.15000	26.80	6.90	12.57	39.37	19.47	66.00	56.00	26.6	36.5	L1	
10	0.15359	25.90	9.90	12.57	38.47	22.47	65.80	55.80	27.3	33.3	L1	
11	0.16054	25.30	5.40	12.57	37.87	17.97	65.44	55.44	27.5	37.4	L1	
12	0.19231	22.00	3.00	12.58	34.58	15.58	63.94	53.94	29.3	38.3	L1	
13	0.23239	17.30	7.00	12.57	29.87	19.57	62.36	52.36	32.4	32.7	L1	
14	0.46478	13.10	5.00	12.61	25.71	17.61	56.61	46.61	30.9	29.0	L1	
15	4.65455	7.50	-5.40	13.00	20.50	7.60	56.00	46.00	35.5	38.4	L1	
16	4.99889	8.50	-5.20	13.04	21.54	7.84	56.00	46.00	34.4	38.1	L1	

Calculation:Result[dBuV]=Reading[dBuV]+C.Fac(LISN(AMN)+Cable+ATT)[dB]
LISN(AMN):145539

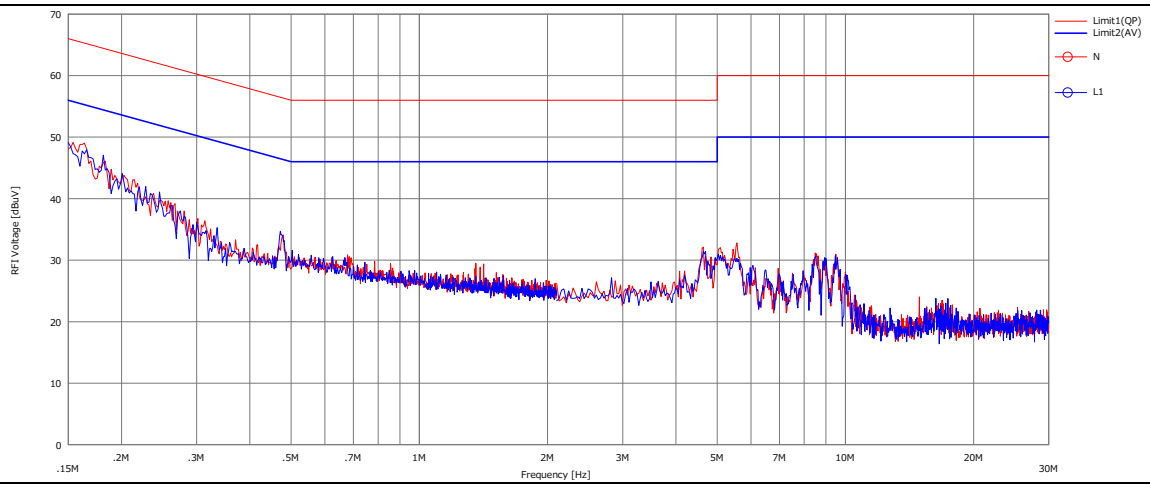
Conducted Emission

Test place	Shonan EMC Lab. No.1 Shielded Room
Date	June 25, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yusuke Tanikawara
Mode	Tx BT LE, 1M-PHY

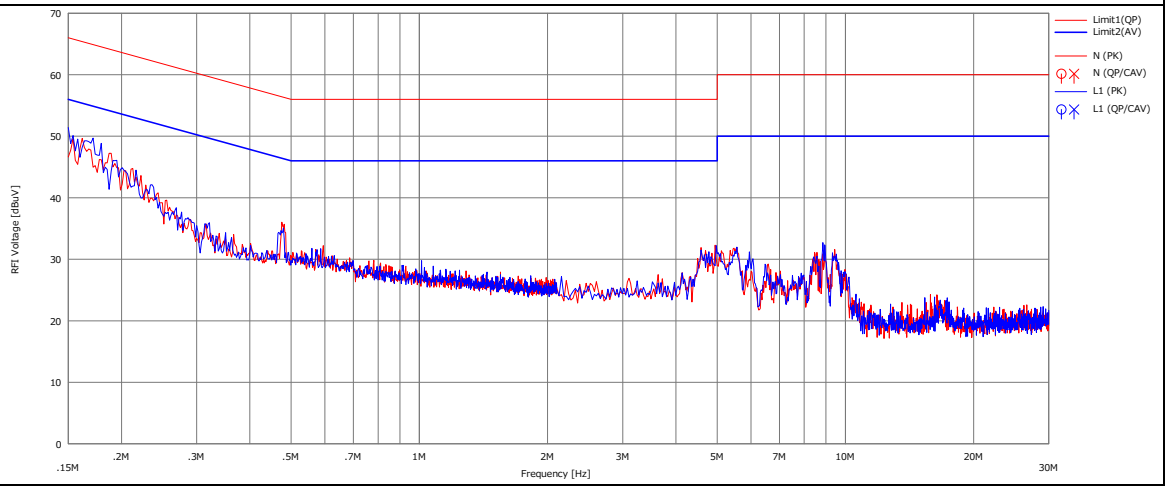
2402 MHz



2440 MHz



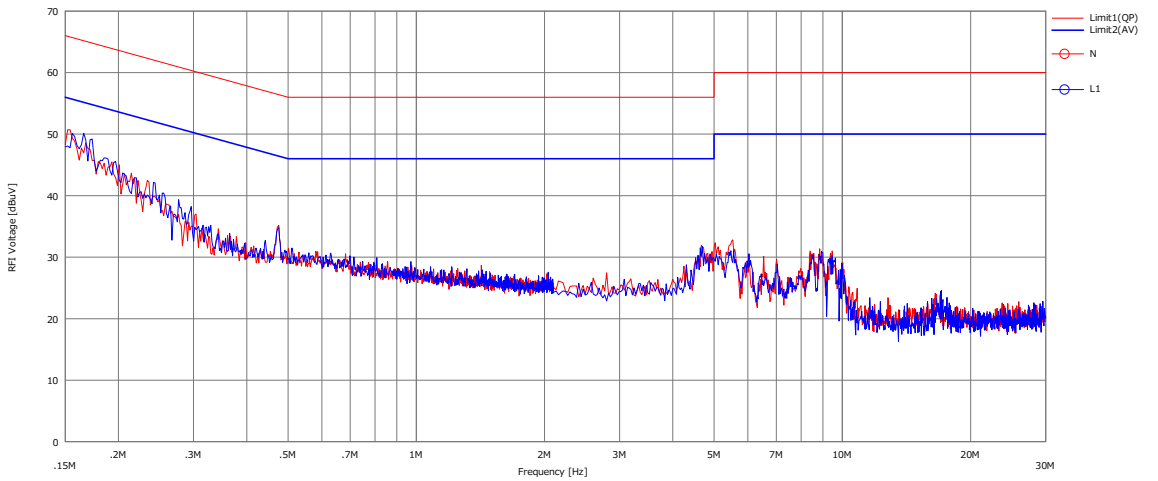
2480 MHz



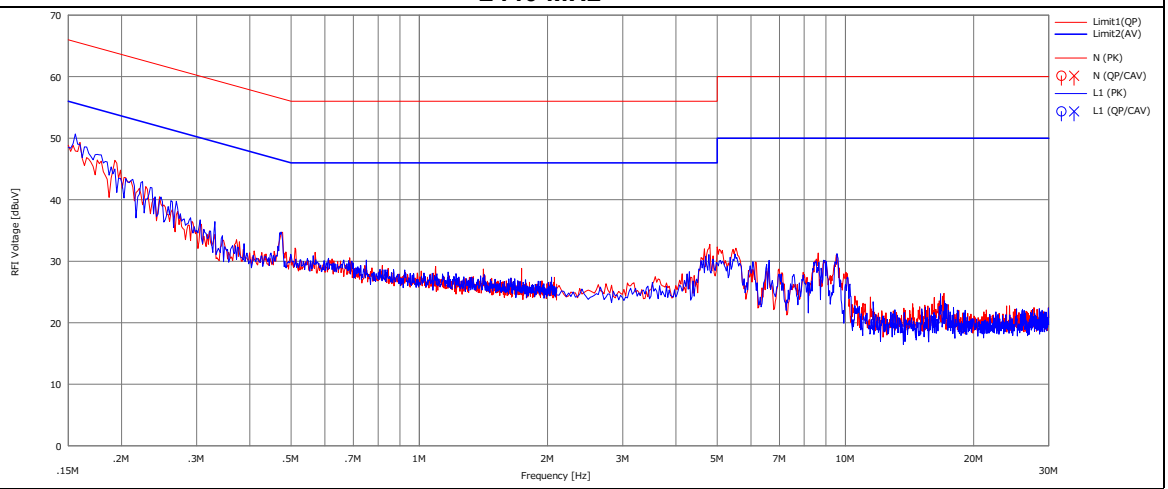
Conducted Emission

Test place	Shonan EMC Lab. No.1 Shielded Room
Date	June 25, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yusuke Tanikawara
Mode	Tx BT LE, 2M-PHY

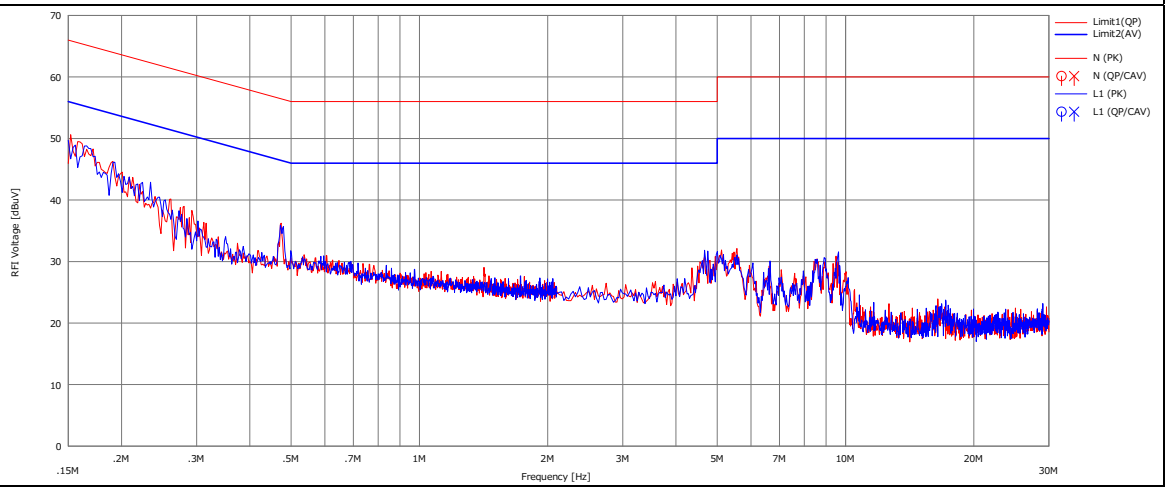
2402 MHz



2440 MHz



2480 MHz



99 % Occupied Bandwidth and 6 dB Bandwidth

Test place	Shonan EMC Lab. No.1 Measurement Room
Date	June 18, 2024
Temperature / Humidity	24 deg. C / 47 % RH
Engineer	Kazuya Noda
Mode	Tx BT LE

BT LE 1M-PHY

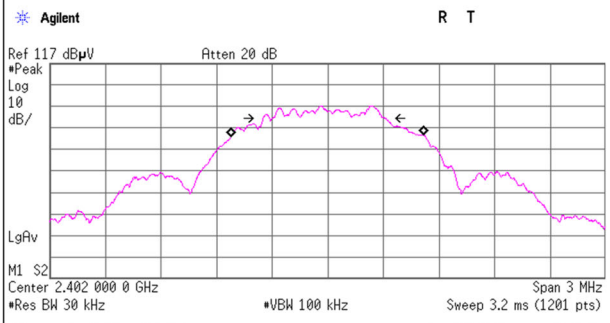
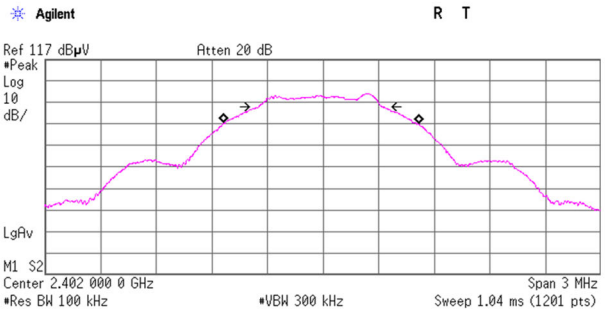
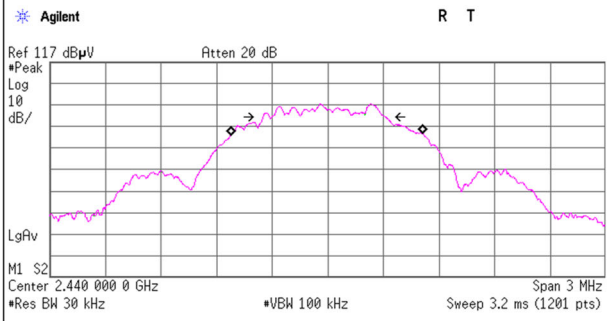
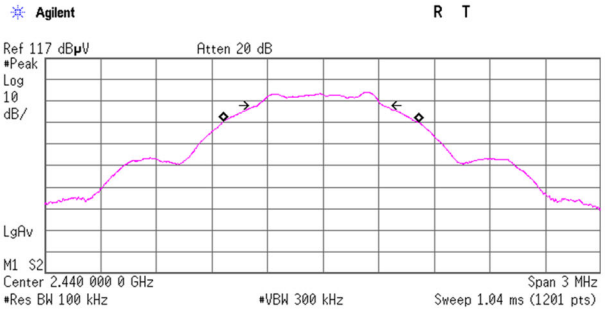
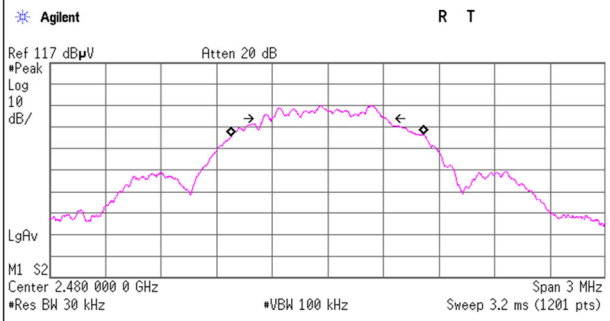
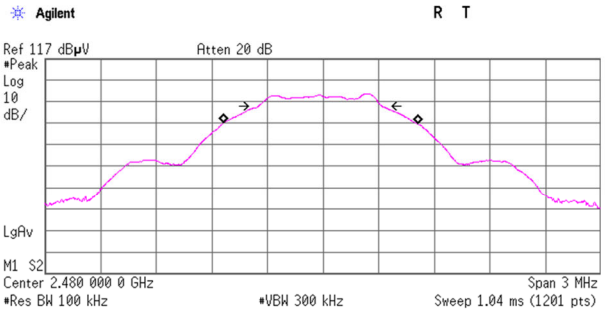
Frequency [MHz]	99 % Occupied Bandwidth [kHz]	6 dB Bandwidth [MHz]	Limit for 6 dB Bandwidth [MHz]
2402	1036.1	0.669	> 0.5000
2440	1033.4	0.674	> 0.5000
2480	1036.5	0.672	> 0.5000

BT LE 2M-PHY

Frequency [MHz]	99 % Occupied Bandwidth [kHz]	6 dB Bandwidth [MHz]	Limit for 6 dB Bandwidth [MHz]
2402	2063.4	1.204	> 0.5000
2440	2061.7	1.199	> 0.5000
2480	2062.9	1.198	> 0.5000

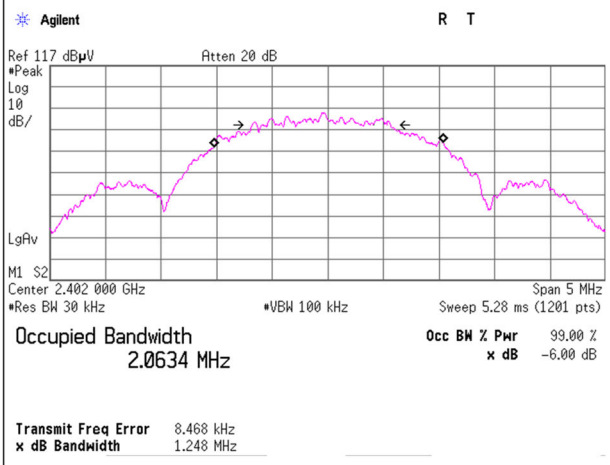
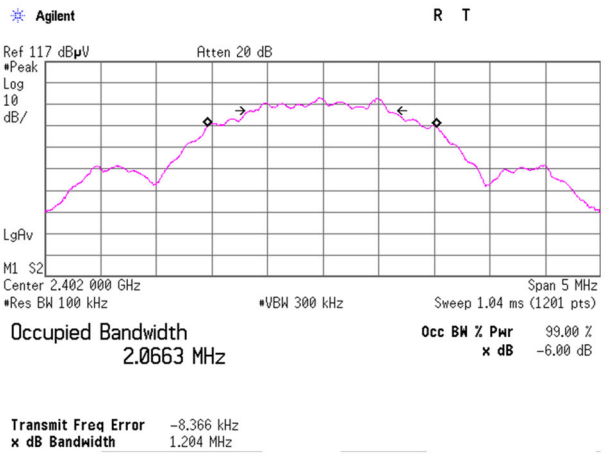
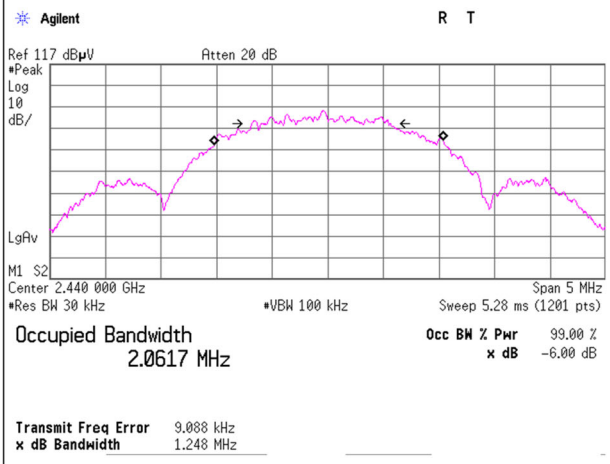
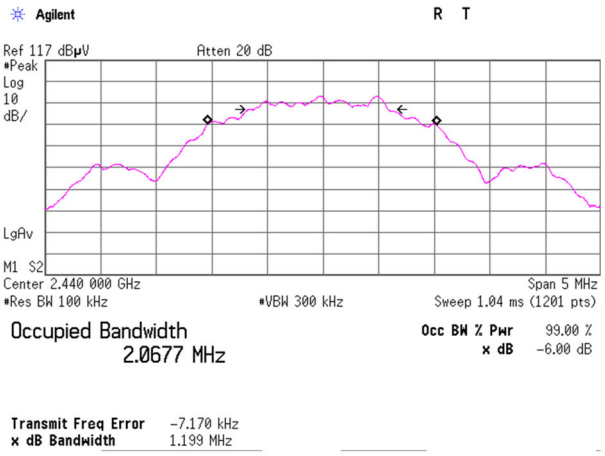
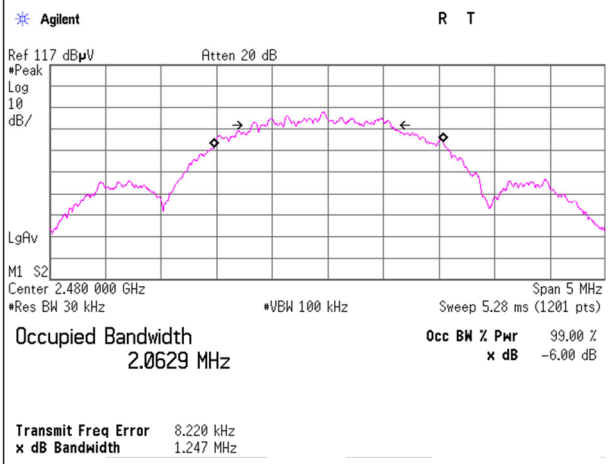
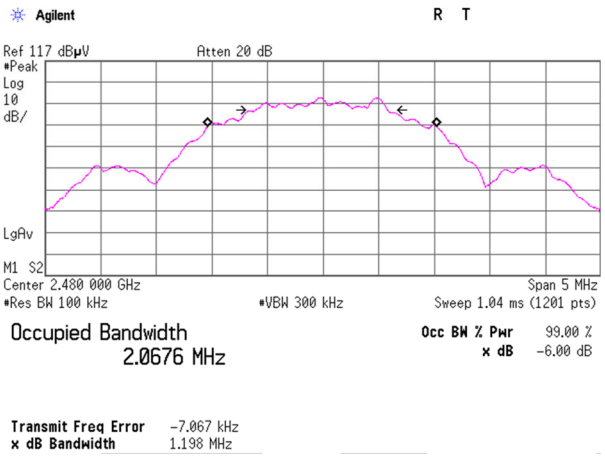
99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE 1M-PHY,

99 % Occupied Bandwidth	6 dB Bandwidth
2402 MHz	**2402 MHz**
 Occupied Bandwidth 1.0361 MHz Occ BW % Pwr 99.00 % x dB -6.00 dB Transmit Freq Error -1.553 kHz x dB Bandwidth 665.847 kHz	 Occupied Bandwidth 1.0508 MHz Occ BW % Pwr 99.00 % x dB -6.00 dB Transmit Freq Error -11.619 kHz x dB Bandwidth 668.785 kHz
2440 MHz	**2440 MHz**
 Occupied Bandwidth 1.0334 MHz Occ BW % Pwr 99.00 % x dB -6.00 dB Transmit Freq Error -3.048 kHz x dB Bandwidth 665.591 kHz	 Occupied Bandwidth 1.0523 MHz Occ BW % Pwr 99.00 % x dB -6.00 dB Transmit Freq Error -11.559 kHz x dB Bandwidth 673.944 kHz
2480 MHz	**2480 MHz**
 Occupied Bandwidth 1.0365 MHz Occ BW % Pwr 99.00 % x dB -6.00 dB Transmit Freq Error -2.548 kHz x dB Bandwidth 665.547 kHz	 Occupied Bandwidth 1.0519 MHz Occ BW % Pwr 99.00 % x dB -6.00 dB Transmit Freq Error -12.641 kHz x dB Bandwidth 672.374 kHz

99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE 2M-PHY,

99 % Occupied Bandwidth	6 dB Bandwidth
2402 MHz	**2402 MHz**
	
2440 MHz	**2440 MHz**
	
2480 MHz	**2480 MHz**
	

Maximum Peak Output Power

Test place	Shonan EMC Lab. No.1 Measurement Room
Date	June 19, 2024
Temperature / Humidity	25 deg. C / 50 % RH
Engineer	Kazuya Noda
Mode	Tx BT LE

BT LE 1M-PHY

Maximum peak output power

				Conducted Power					e.i.r.p. for RSS-247					
Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin	Antenna Gain	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]	[dBi]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-5.67	1.62	9.94	5.89	3.88	30.00	1000	24.11	0.69	6.58	4.55	36.02	4000	29.44
2440	-5.73	1.63	9.94	5.84	3.84	30.00	1000	24.16	0.69	6.53	4.50	36.02	4000	29.49
2480	-6.09	1.63	9.94	5.48	3.53	30.00	1000	24.52	0.69	6.17	4.14	36.02	4000	29.85

BT LE 2M-PHY

Maximum peak output power

				Conducted Power					e.i.r.p. for RSS-247					
Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin	Antenna Gain	Result		Limit		Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]	[dBi]	[dBm]	[mW]	[dBm]	[mW]	[dB]
2402	-5.69	1.62	9.94	5.87	3.86	30.00	1000	24.13	0.69	6.56	4.53	36.02	4000	29.46
2440	-5.75	1.63	9.94	5.82	3.82	30.00	1000	24.18	0.69	6.51	4.48	36.02	4000	29.51
2480	-6.11	1.63	9.94	5.46	3.52	30.00	1000	24.54	0.69	6.15	4.12	36.02	4000	29.87

Sample Calculation:

Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

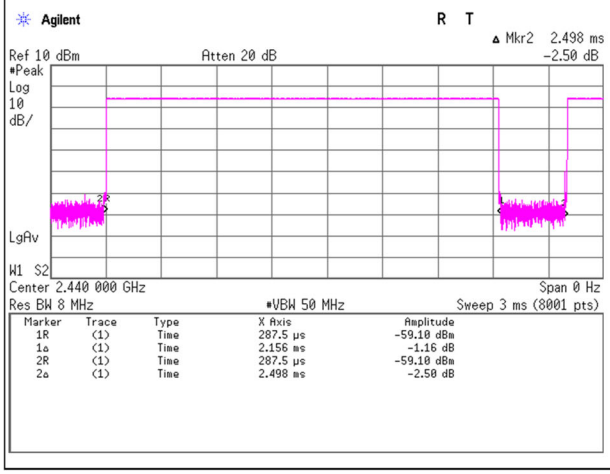
e.i.r.p. Result = Conducted Power Result + Antenna Gain

Burst rate confirmation

Test place	Shonan EMC Lab. No.1 Measurement Room
Date	June 18, 2024
Temperature / Humidity	24 deg. C / 47 % RH
Engineer	Kazuya Noda
Mode	Tx BT LE

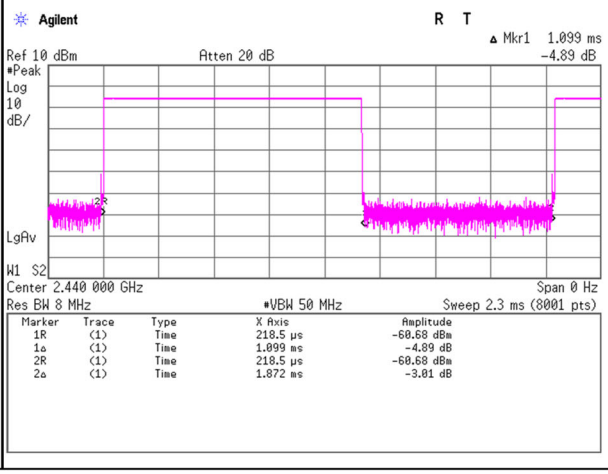
BT LE 1M-PHY (for Radiated emission) *1)

Tx on / (Tx on + Tx off) =	0.863
Tx on / (Tx on + Tx off) * 100 =	86.3 %
Duty factor = 20 * log (2.498 / 2.156) =	1.28 dB *1)



BT LE 2M-PHY (for Radiated emission) *2)

Tx on / (Tx on + Tx off) =	0.587
Tx on / (Tx on + Tx off) * 100 =	58.7 %
Duty factor = 20 * log (1.872 / 1.099) =	4.63 dB *2)



* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Radiated Spurious Emission

Test place	Shonan EMC Lab.			
Semi Anechoic Chamber	WAC2	WAC2	WAC2	WAC2
Date	June 24, 2024	June 19, 2024	June 20, 2024	June 21, 2024
Temperature / Humidity	24 deg. C / 59 % RH	21 deg. C / 59 % RH	25 deg. C / 61 % RH	24 deg. C / 61 % RH
Engineer	Kouki Yamada (Below 1 GHz)	Kouki Yamada (1 GHz to 10 GHz)	Hiromasa Sato (10 GHz to 18 GHz)	Yusuke Tanikawara (18 GHz to 26.5 GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz			

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	34.423	QP	22.50	12.62	6.30	32.79	0.00	8.63	40.0	31.3	100	311	-
Hori.	43.323	QP	22.50	10.95	6.41	32.97	0.00	6.89	40.0	33.1	100	221	-
Hori.	58.634	QP	22.30	9.59	6.43	33.13	0.00	5.19	40.0	34.8	100	104	-
Hori.	950.697	QP	19.60	22.08	8.98	30.07	0.00	20.59	46.0	25.4	100	31	-
Hori.	2390.000	PK	47.38	27.75	-28.27	-	2.46	49.32	73.9	24.5	115	204	-
Hori.	4804.000	PK	51.25	31.56	-36.04	-	2.46	49.23	73.9	24.6	397	195	-
Hori.	7206.000	PK	45.81	36.21	-34.48	-	2.46	50.00	73.9	23.9	150	0	-
Hori.	9608.000	PK	45.76	38.14	-31.55	-	2.46	54.81	73.9	19.0	150	0	-
Hori.	7206.000	AV	35.24	36.21	-34.48	-	2.46	39.43	53.9	14.4	150	0	Floor noise
Hori.	9608.000	AV	34.43	38.14	-31.55	-	2.46	43.48	53.9	10.4	150	0	Floor noise
Vert.	30.371	QP	22.60	13.59	6.23	32.66	0.00	9.77	40.0	30.2	100	281	-
Vert.	40.735	QP	22.30	11.37	6.38	32.93	0.00	7.12	40.0	32.8	100	129	-
Vert.	65.413	QP	22.50	9.39	6.43	33.16	0.00	5.16	40.0	34.8	100	172	-
Vert.	75.508	QP	26.20	9.11	6.64	33.19	0.00	8.77	40.0	31.2	100	21	-
Vert.	886.323	QP	20.20	22.15	8.87	30.48	0.00	20.74	46.0	25.2	100	101	-
Vert.	2390.000	PK	47.21	27.75	-28.27	-	2.46	49.15	73.9	24.7	298	95	-
Vert.	4804.000	PK	52.33	31.56	-36.04	-	2.46	50.31	73.9	23.5	215	138	-
Vert.	7206.000	PK	46.17	36.21	-34.48	-	2.46	50.36	73.9	23.5	150	0	-
Vert.	9608.000	PK	45.88	38.14	-31.55	-	2.46	54.93	73.9	18.9	150	0	-
Vert.	7206.000	AV	35.18	36.21	-34.48	-	2.46	39.37	53.9	14.5	150	0	Floor noise
Vert.	9608.000	AV	34.46	38.14	-31.55	-	2.46	43.51	53.9	10.3	150	0	Floor noise

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Other bands : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2390.000	AV	35.89	27.75	-28.27	-	1.28	2.46	39.11	53.9	14.7	*1)
Hori.	4804.000	AV	44.80	31.56	-36.04	-	1.28	2.46	44.06	53.9	9.8	-
Vert.	2390.000	AV	35.58	27.75	-28.27	-	1.28	2.46	38.80	53.9	15.1	*1)
Vert.	4804.000	AV	45.21	31.56	-36.04	-	1.28	2.46	44.47	53.9	**9.4**	-

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.
*1) Not out of band emission (Leakage Power)

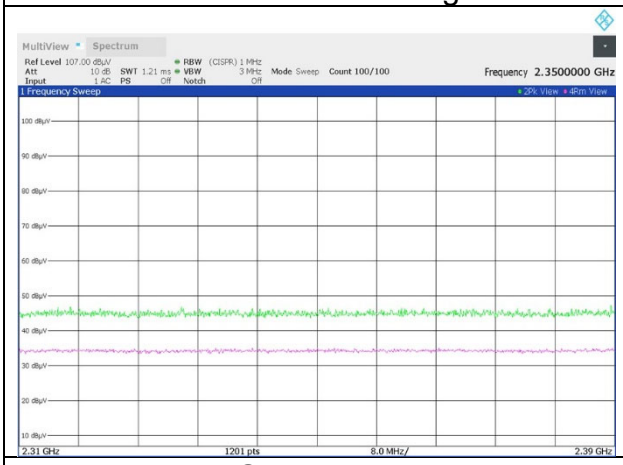
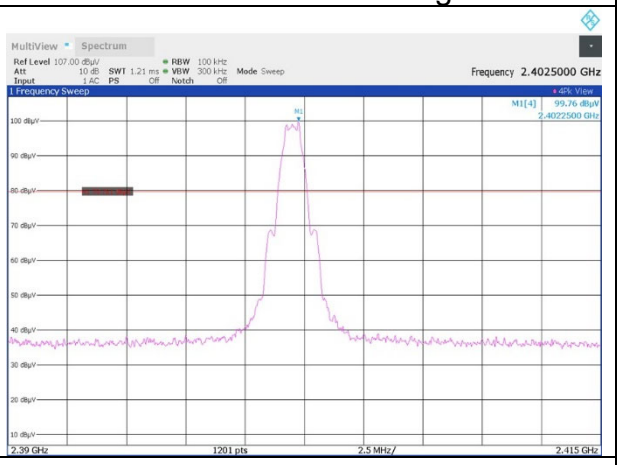
20 dBc Data Sheet **(RBW 100 kHz, VBW 300 kHz)**

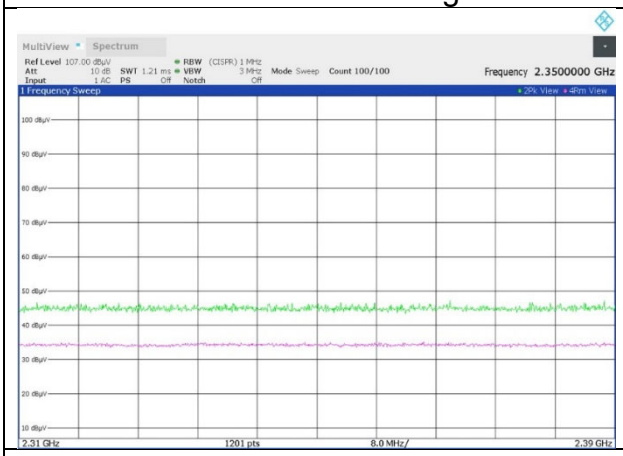
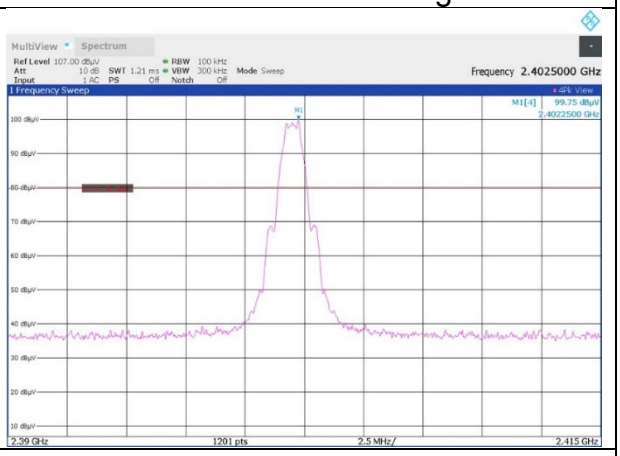
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	99.76	27.77	-28.26	-	2.46	101.73	-	-	Carrier
Hori.	2400.000	PK	43.31	27.77	-28.26	-	2.46	45.28	81.7	36.4	-
Vert.	2402.000	PK	99.75	27.77	-28.26	-	2.46	101.72	-	-	Carrier
Vert.	2400.000	PK	43.60	27.77	-28.26	-	2.46	45.57	81.7	36.1	-

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	WAC2
Date	June 19, 2024
Temperature / Humidity	21 deg. C / 59 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz

Horizontal	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

Vertical	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge and authorized band edge were shown in tabular data.

Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	WAC2	WAC2
Date	June 19, 2024	June 21, 2024
Temperature / Humidity	21 deg. C / 59 % RH	24 deg. C / 61 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)	Yusuke Tanikawara (10 GHz to 26.5 GHz)
Mode	Tx BT LE 1M-PHY 2440 MHz	

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	4880.000	PK	50.88	31.95	-36.01	-	2.46	49.28	73.9	24.6	109	1	-
Hori.	7320.000	PK	46.25	36.66	-34.24	-	2.46	51.13	73.9	22.7	150	0	Floor noise
Hori.	9760.000	PK	45.83	38.10	-31.33	-	2.46	55.06	73.9	18.8	150	0	Floor noise
Hori.	7320.000	AV	35.41	36.66	-34.24	-	2.46	40.29	53.9	13.6	150	0	Floor noise
Hori.	9760.000	AV	34.32	38.10	-31.33	-	2.46	43.55	53.9	10.3	150	0	Floor noise
Vert.	4880.000	PK	50.66	31.95	-36.01	-	2.46	49.06	73.9	24.8	198	144	-
Vert.	7320.000	PK	46.10	36.66	-34.24	-	2.46	50.98	73.9	22.9	150	0	Floor noise
Vert.	9760.000	PK	45.71	38.10	-31.33	-	2.46	54.94	73.9	18.9	150	0	Floor noise
Vert.	7320.000	AV	34.33	36.66	-34.24	-	2.46	39.21	53.9	14.6	150	0	Floor noise
Vert.	9760.000	AV	34.28	38.10	-31.33	-	2.46	43.51	53.9	10.3	150	0	Floor noise

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	4880.000	AV	43.07	31.95	-36.01	-	1.28	2.46	42.75	53.9	11.1	-
Vert.	4880.000	AV	44.21	31.95	-36.01	-	1.28	2.46	43.89	53.9	**10.0**	-

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.

Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	WAC2	WAC2
Date	June 19, 2024	June 21, 2024
Temperature / Humidity	21 deg. C / 59 % RH	24 deg. C / 61 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)	Yusuke Tanikawara (10 GHz to 26.5 GHz)
Mode	Tx BT LE 1M-PHY 2480 MHz	

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2483.500	PK	48.38	27.80	-28.21	-	2.46	50.43	73.9	23.4	186	210	-
Hori.	4960.000	PK	50.87	32.23	-35.97	-	2.46	49.59	73.9	24.3	105	3	-
Hori.	7440.000	PK	46.19	36.81	-33.99	-	2.46	51.47	73.9	22.4	150	0	Floor noise
Hori.	9920.000	PK	45.47	38.04	-31.10	-	2.46	54.87	73.9	19.0	150	0	Floor noise
Hori.	7440.000	AV	35.52	36.81	-33.99	-	2.46	40.80	53.9	13.1	150	0	Floor noise
Hori.	9920.000	AV	34.11	38.04	-31.10	-	2.46	43.51	53.9	10.3	150	0	Floor noise
Vert.	2483.500	PK	48.42	27.80	-28.21	-	2.46	50.47	73.9	23.4	318	113	-
Vert.	4960.000	PK	52.12	32.23	-35.97	-	2.46	50.84	73.9	23.0	154	141	-
Vert.	7440.000	PK	46.33	36.81	-33.99	-	2.46	51.61	73.9	22.2	150	0	Floor noise
Vert.	9920.000	PK	45.74	38.04	-31.10	-	2.46	55.14	73.9	18.7	150	0	Floor noise
Vert.	7440.000	AV	35.29	36.81	-33.99	-	2.46	40.57	53.9	13.3	150	0	Floor noise
Vert.	9920.000	AV	34.37	38.04	-31.10	-	2.46	43.77	53.9	10.1	150	0	Floor noise

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2483.500	AV	35.68	27.80	-28.21	-	1.28	2.46	39.01	53.9	14.8	*1)
Hori.	4960.000	AV	42.08	32.23	-35.97	-	1.28	2.46	42.08	53.9	11.8	-
Vert.	2483.500	AV	35.44	27.80	-28.21	-	1.28	2.46	38.77	53.9	15.1	*1)
Vert.	4960.000	AV	44.40	32.23	-35.97	-	1.28	2.46	44.40	53.9	**9.5**	-

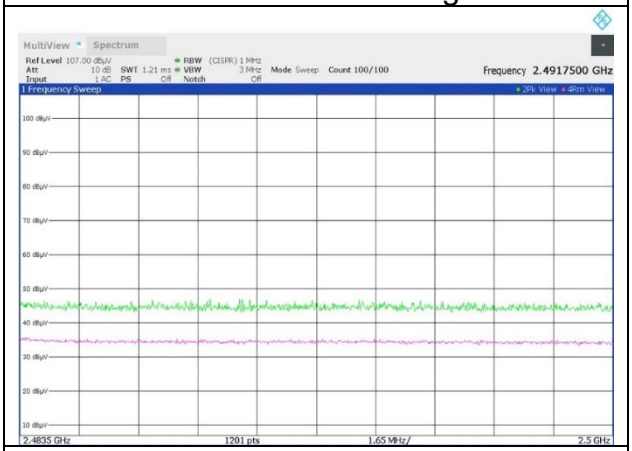
1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.
*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	WAC2
Date	June 19, 2024
Temperature / Humidity	21 deg. C / 59 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)
Mode	Tx BT LE 1M-PHY 2480 MHz

Horizontal

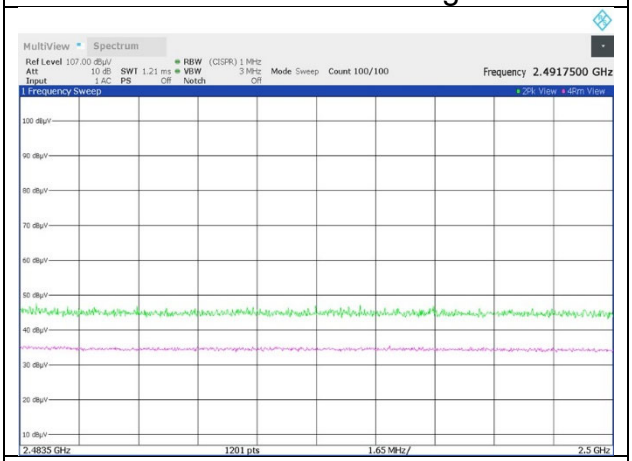
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	WAC2	WAC2
Date	June 19, 2024	June 21, 2024
Temperature / Humidity	21 deg. C / 59 % RH	24 deg. C / 61 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)	Yusuke Tanikawara (10 GHz to 26.5 GHz)
Mode	Tx BT LE 2M-PHY 2402 MHz	

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2390.000	PK	47.23	27.75	-28.27	-	2.46	49.17	73.9	24.7	146	202	-
Hori.	4804.000	PK	51.74	31.56	-36.04	-	2.46	49.72	73.9	24.1	327	193	-
Hori.	7206.000	PK	46.37	36.21	-34.48	-	2.46	50.56	73.9	23.3	150	0	Floor noise
Hori.	9608.000	PK	45.85	38.14	-31.55	-	2.46	54.90	73.9	19.0	150	0	Floor noise
Hori.	7206.000	AV	35.22	36.21	-34.48	-	2.46	39.41	53.9	14.4	150	0	Floor noise
Hori.	9608.000	AV	34.27	38.14	-31.55	-	2.46	43.32	53.9	10.5	150	0	Floor noise
Vert.	2390.000	PK	47.47	27.75	-28.27	-	2.46	49.41	73.9	24.4	338	100	-
Vert.	4804.000	PK	52.78	31.56	-36.04	-	2.46	50.76	73.9	23.1	112	135	-
Vert.	7206.000	PK	46.27	36.21	-34.48	-	2.46	50.46	73.9	23.4	150	0	Floor noise
Vert.	9608.000	PK	45.66	38.14	-31.55	-	2.46	54.71	73.9	19.1	150	0	Floor noise
Vert.	7206.000	AV	35.42	36.21	-34.48	-	2.46	39.61	53.9	14.2	150	0	Floor noise
Vert.	9608.000	AV	34.63	38.14	-31.55	-	2.46	43.68	53.9	10.2	150	0	Floor noise

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2390.000	AV	34.56	27.75	-28.27	-	4.63	2.46	41.13	53.9	12.7	*1)
Hori.	4804.000	AV	42.89	31.56	-36.04	-	4.63	2.46	45.50	53.9	8.4	-
Vert.	2390.000	AV	34.59	27.75	-28.27	-	4.63	2.46	41.16	53.9	12.7	*1)
Vert.	4804.000	AV	44.99	31.56	-36.04	-	4.63	2.46	47.60	53.9	**6.3**	-

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.
*1) Not out of band emission (Leakage Power)

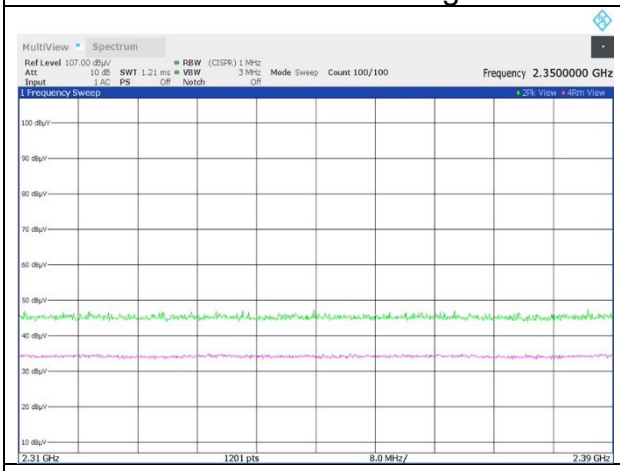
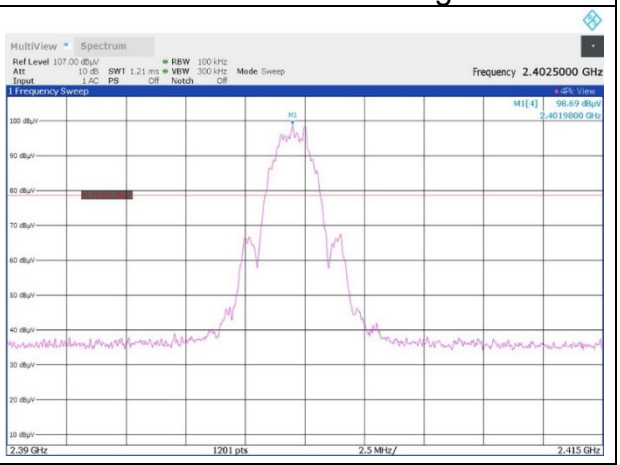
20 dBc Data Sheet **(RBW 100 kHz, VBW 300 kHz)**

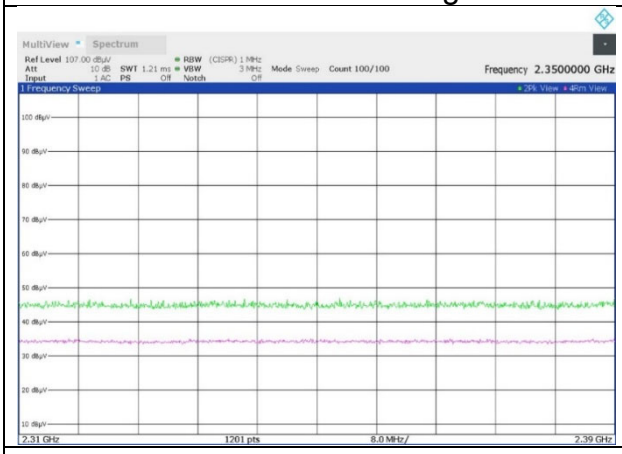
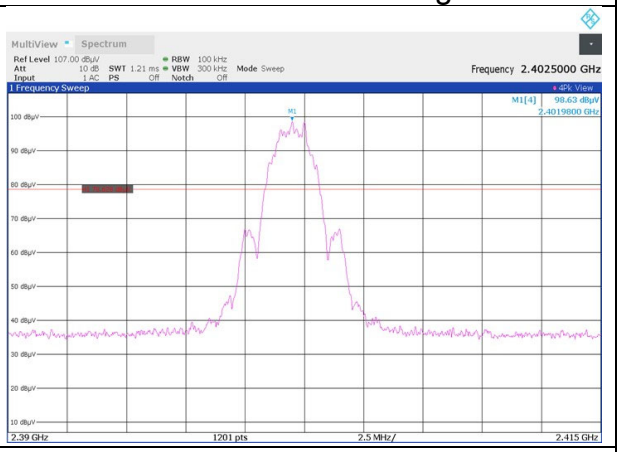
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	98.69	27.77	-28.26	-	2.46	100.66	-	-	Carrier
Hori.	2400.000	PK	67.28	27.77	-28.26	-	2.46	69.25	80.6	11.3	-
Vert.	2402.000	PK	98.63	27.77	-28.26	-	2.46	100.60	-	-	Carrier
Vert.	2400.000	PK	67.12	27.77	-28.26	-	2.46	69.09	80.6	11.5	-

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	WAC2
Date	June 19, 2024
Temperature / Humidity	21 deg. C / 59 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)
Mode	Tx BT LE 2M-PHY 2402 MHz

Horizontal	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

Vertical	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge and authorized band edge were shown in tabular data.

Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	WAC2	WAC2
Date	June 19, 2024	June 21, 2024
Temperature / Humidity	21 deg. C / 59 % RH	24 deg. C / 61 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)	Yusuke Tanikawara (10 GHz to 26.5 GHz)
Mode	Tx BT LE 2M-PHY 2440 MHz	

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	4880.000	PK	50.89	31.95	-36.01	-	2.46	49.29	73.9	24.6	109	348	-
Hori.	7320.000	PK	46.31	36.66	-34.24	-	2.46	51.19	73.9	22.7	150	0	Floor noise
Hori.	9760.000	PK	45.52	38.10	-31.33	-	2.46	54.75	73.9	19.1	150	0	Floor noise
Hori.	7320.000	AV	35.70	36.66	-34.24	-	2.46	40.58	53.9	13.3	150	0	Floor noise
Hori.	9760.000	AV	34.41	38.10	-31.33	-	2.46	43.64	53.9	10.2	150	0	Floor noise
Vert.	4880.000	PK	51.54	31.95	-36.01	-	2.46	49.94	73.9	23.9	198	139	-
Vert.	7320.000	PK	46.24	36.66	-34.24	-	2.46	51.12	73.9	22.7	150	0	Floor noise
Vert.	9760.000	PK	45.30	38.10	-31.33	-	2.46	54.53	73.9	19.3	150	0	Floor noise
Vert.	7320.000	AV	35.43	36.66	-34.24	-	2.46	40.31	53.9	13.5	150	0	Floor noise
Vert.	9760.000	AV	34.37	38.10	-31.33	-	2.46	43.60	53.9	10.3	150	0	Floor noise

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	4880.000	AV	40.85	31.95	-36.01	-	4.63	2.46	43.88	53.9	10.0	-
Vert.	4880.000	AV	42.35	31.95	-36.01	-	4.63	2.46	45.38	53.9	**8.5**	-

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.

Radiated Spurious Emission

Test place	Shonan EMC Lab.	
Semi Anechoic Chamber	WAC2	WAC2
Date	June 19, 2024	June 21, 2024
Temperature / Humidity	21 deg. C / 59 % RH	24 deg. C / 61 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)	Yusuke Tanikawara (10 GHz to 26.5 GHz)
Mode	Tx BT LE 2M-PHY 2480 MHz	

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	2483.500	PK	55.76	27.80	-28.21	-	2.46	57.81	73.9	16.0	138	202	-
Hori.	4960.000	PK	50.48	32.23	-35.97	-	2.46	49.20	73.9	24.7	149	347	-
Hori.	7440.000	PK	46.55	36.81	-33.99	-	2.46	51.83	73.9	22.0	150	0	Floor noise
Hori.	9920.000	PK	45.60	38.04	-31.10	-	2.46	55.00	73.9	18.9	150	0	Floor noise
Hori.	7440.000	AV	35.50	36.81	-33.99	-	2.46	40.78	53.9	13.1	150	0	Floor noise
Hori.	9920.000	AV	34.36	38.04	-31.10	-	2.46	43.76	53.9	10.1	150	0	Floor noise
Vert.	2483.500	PK	54.64	27.80	-28.21	-	2.46	56.69	73.9	17.2	319	94	-
Vert.	2483.644	PK	53.11	27.80	-28.21	-	2.46	55.16	73.9	18.7	319	94	-
Vert.	4960.000	PK	51.36	32.23	-35.97	-	2.46	50.08	73.9	23.8	153	138	-
Vert.	7440.000	PK	46.39	36.81	-33.99	-	2.46	51.67	73.9	22.2	150	0	Floor noise
Vert.	9920.000	PK	45.56	38.04	-31.10	-	2.46	54.96	73.9	18.9	150	0	Floor noise
Vert.	7440.000	AV	35.28	36.81	-33.99	-	2.46	40.56	53.9	13.3	150	0	Floor noise
Vert.	9920.000	AV	34.62	38.04	-31.10	-	2.46	44.02	53.9	9.8	150	0	Floor noise

1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2483.500	AV	37.72	27.80	-28.21	-	4.63	2.46	44.40	53.9	9.5	*1)
Hori.	4960.000	AV	40.99	32.23	-35.97	-	4.63	2.46	44.34	53.9	9.5	-
Vert.	2483.500	AV	38.25	27.80	-28.21	-	4.63	2.46	44.93	53.9	8.9	*1)
Vert.	2483.644	AV	36.78	27.80	-28.21	-	4.63	2.46	43.46	53.9	10.4	*1)
Vert.	4960.000	AV	41.97	32.23	-35.97	-	4.63	2.46	45.32	53.9	**8.5**	-

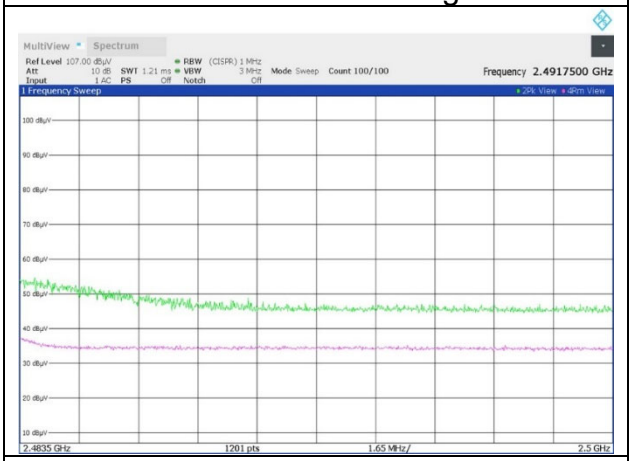
1 GHz to 18 GHz : Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter) - Gain(Amplifier)) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.98 m / 3.0 m) = 2.46 dB
10 GHz - 40 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Burst rate confirmation" sheet.
*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Shonan EMC Lab.
Semi Anechoic Chamber	WAC2
Date	June 19, 2024
Temperature / Humidity	21 deg. C / 59 % RH
Engineer	Kouki Yamada (1 GHz to 10 GHz)
Mode	Tx BT LE 2M-PHY 2480 MHz

Horizontal

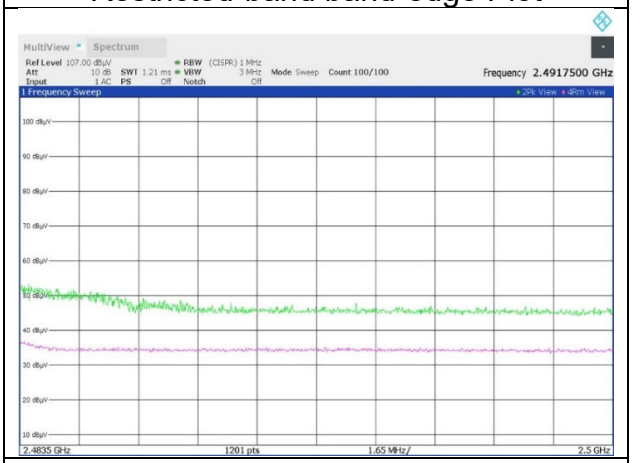
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

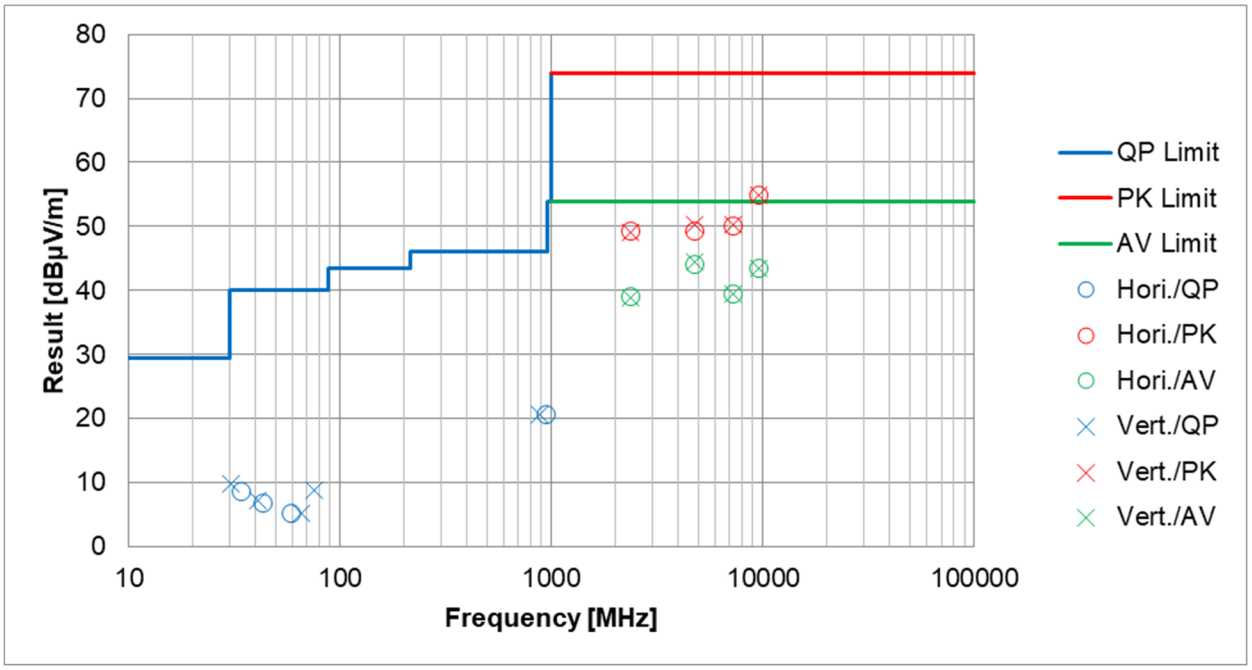


Trace Green : Peak Plot
Trace Purple : Average Plot

* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission
(Plot data, Worst case mode for Maximum Peak Output Power)

Test place	Shonan EMC Lab.			
Semi Anechoic Chamber	WAC2	WAC2	WAC2	WAC2
Date	June 24, 2024	June 19, 2024	June 20, 2024	June 21, 2024
Temperature / Humidity	24 deg. C / 59 % RH	21 deg. C / 59 % RH	25 deg. C / 61 % RH	24 deg. C / 61 % RH
Engineer	Kouki Yamada (Below 1 GHz)	Kouki Yamada (1 GHz to 10 GHz)	Hiromasa Sato (10 GHz to 18 GHz)	Yusuke Tanikawara (18 GHz to 26.5 GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz			

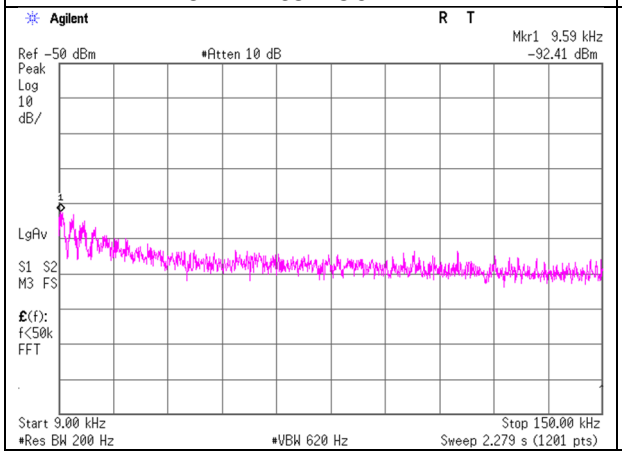


*These plots data contain sufficient number to show the trend of characteristic features for EUT.

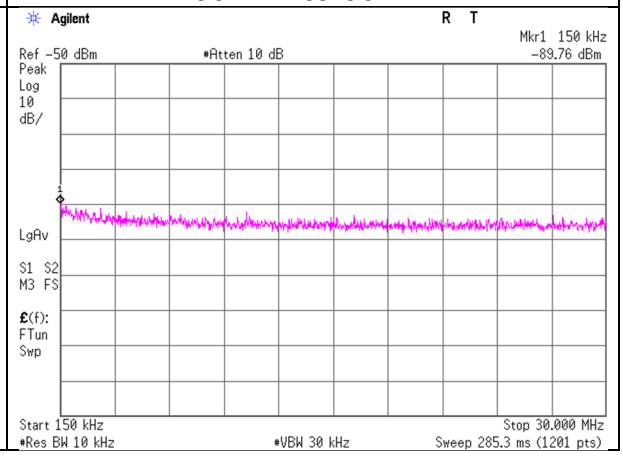
Conducted Spurious Emission

Test place	Shonan EMC Lab. No.1 Measurement Room
Date	June 18, 2024
Temperature / Humidity	24 deg. C / 47 % RH
Engineer	Kazuya Noda
Mode	Tx BT LE 1M-PHY 2402 MHz

9 kHz to 150 kHz



150 kHz to 30 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain* [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
9.59	-92.4	1.00	9.9	2.0	1	-79.5	300	6.0	-18.3	47.9	66.2	-
150.00	-89.8	1.00	9.9	2.0	1	-76.9	300	6.0	-15.6	24.0	39.6	-

E [dBuV/m] = EIRP [dBm] - 20 log (Distance [m]) + Ground bounce [dB] + 104.8 [dBuV/m]

EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

N: Number of output

*2.0 dBi was applied to the test result based on ANSI C63.10 since antenna gain was less than 2.0 dBi.

Power Density

Test place	Shonan EMC Lab. No.1 Measurement Room
Date	June 18, 2024
Temperature / Humidity	24 deg. C / 47 % RH
Engineer	Kazuya Noda
Mode	Tx BT LE

BT LE 1M-PHY

Frequency [MHz]	Measured Frequency [MHz]	Reading [dBm/3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm/3 kHz]	Limit [dBm/3 kHz]	Margin [dB]
2402	2402.011	-22.04	1.62	9.94	-10.48	8.00	18.48
2440	2440.012	-22.02	1.63	9.94	-10.45	8.00	18.45
2480	2480.011	-22.47	1.63	9.94	-10.90	8.00	18.90

BT LE 2M-PHY

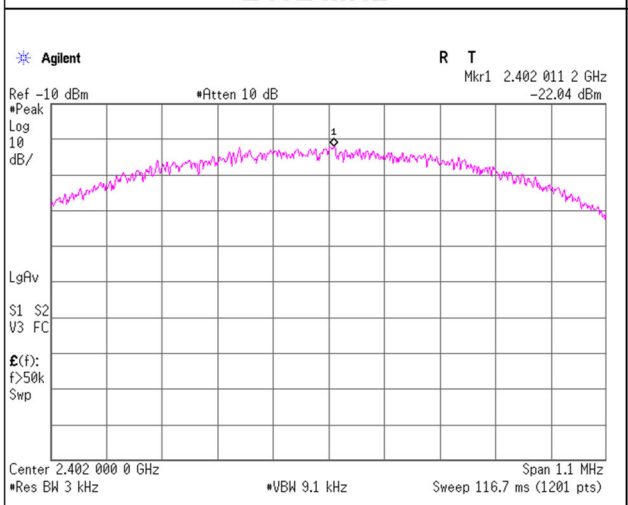
Frequency [MHz]	Measured Frequency [MHz]	Reading [dBm/3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm/3 kHz]	Limit [dBm/3 kHz]	Margin [dB]
2402	2401.958	-24.50	1.62	9.94	-12.94	8.00	20.94
2440	2439.958	-24.41	1.63	9.94	-12.84	8.00	20.84
2480	2479.958	-24.87	1.63	9.94	-13.30	8.00	21.30

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

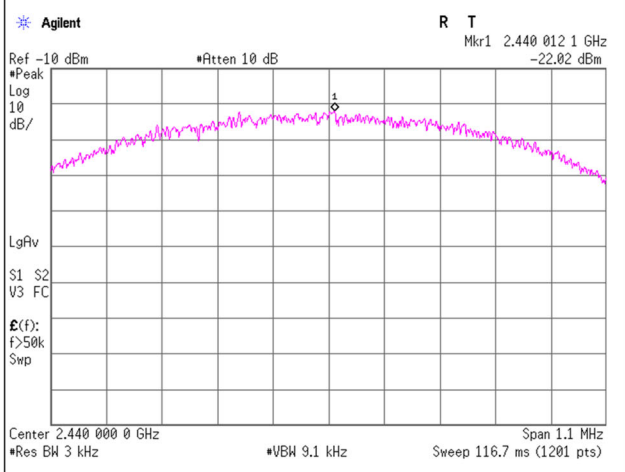
Power Density

BT LE 1M-PHY

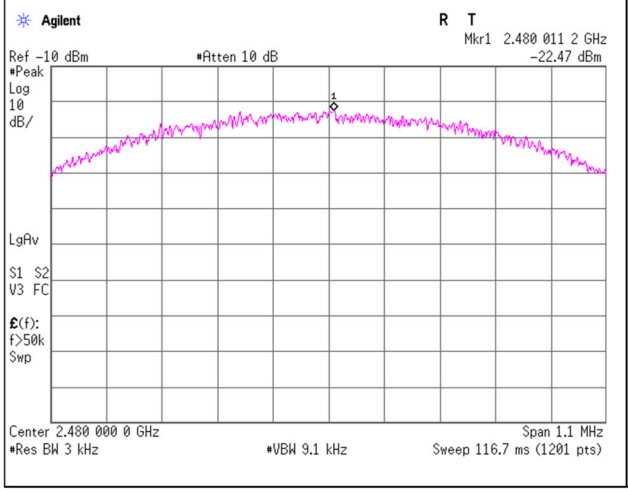
2402 MHz



2440 MHz

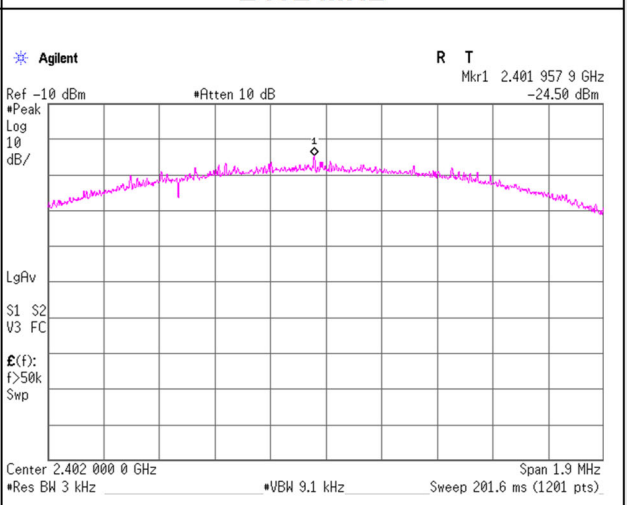


2480 MHz

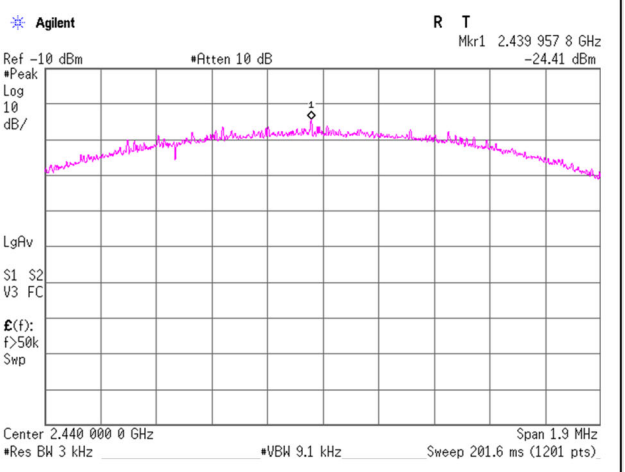


BT LE 2M-PHY

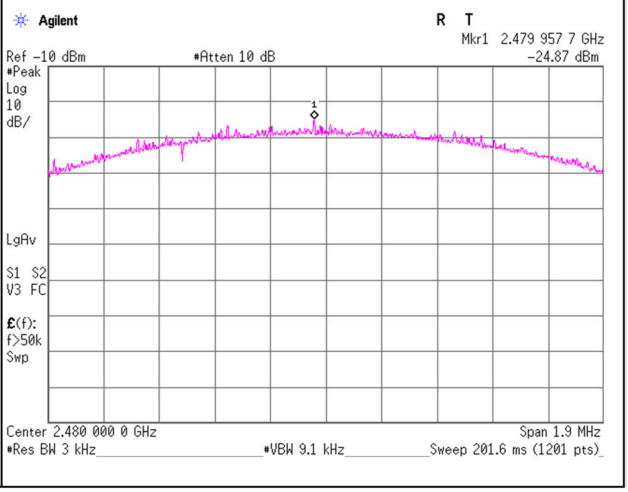
2402 MHz



2440 MHz



2480 MHz



APPENDIX 2: Test Instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
AT	145801	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY48250152	2024/02/27	12
AT	146247	Power Meter	Keysight Technologies Inc	8990B	MY51000272	2024/05/14	12
AT	146310	Power sensor	Keysight Technologies Inc	N1923A	MY5326009	2024/05/14	12
AT	191846	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2023/08/07	12
AT	196942	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	803416/2	2024/03/07	12
AT	204928	Attenuator	Weinschel Corp.	54A-10	109973	2024/02/09	12
CE	144966	Coaxial Cable&RF Selector	Suhner/Suhner/TOYO	RG223U/141PE/NS 4906	-/0901-269(RF Selector)	2024/04/01	12
CE	145539	LISN	Rohde & Schwarz	ENV216	100512	2024/02/06	12
CE	145790	Test Receiver	Rohde & Schwarz	ESU40	100093	2024/04/19	12
CE	145792	Digital Hitester	HIOKI E.E. CORPORATION	3805-50	80997812	2023/09/25	12
CE	150923	Attenuator	JFW	50HF-003N	-	2024/02/13	12
CE	167990	Thermo-Hygrometer	CUSTOM. Inc	CTH-202	708Q08R	2023/08/01	12
CE	207279	Tape Measure	ASKUL	-	-	-	-
CE,RE	170932	EMI Software	TSJ (Techno Science Japan)	TEPTO-DV3(RE,CE,ME,PE)	Ver 3.1.0546	-	-
RE	145127	Pre Amplifier	Toyo Corporation	TPA0118-36	2072554	2024/05/08	12
RE	145528	Logperiodic Antenna	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	195	2024/04/10	12
RE	146351	Horn Antenna	EMCO	3160-09	1278	2024/05/23	12
RE	199783	Attenuator	JFW	50HF-006N	-	2024/06/14	12
RE	207281	Tape Measure	ASKUL	-	-	-	-
RE	235267	Test Receiver	Rohde & Schwarz	ESW44	103018	2024/03/05	12
RE	235738	Thermo-Hygrometer	CUSTOM. Inc	CTH-230	-	2024/04/28	12
RE	236584	Horn Antenna	AINFO Inc.	LB-8180-NF	2030013000112	2024/04/04	12
RE	236615	Semi-Anechoic Chamber	TDK	SWAC-02(NSA)	2	2024/05/10	12
RE	236617	Semi-Anechoic Chamber	TDK	SWAC-02(SVSWR)	2	2024/06/06	12
RE	236687	Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	788	2024/04/04	12
RE	236709	Coaxial Cable	Hayashi-Repic co., Ltd.	NMS079B-GL310C-SMS117B-2m	47256-02-04	2024/05/09	12
RE	236711	Coaxial Cable	Hayashi-Repic co., Ltd.	KMS020B-GL140sE-KMS020B-7.0m	47256-03-02	2024/05/09	12
RE	236720	Coaxial Cable	Huber+Suhner	SF106/SF106/SF106	2001167/2001168/2001161	2024/05/10	12
RE	236724	Coaxial Cable	Hayashi-Repic co., Ltd.	SF106(HUBER+SUHNER)/LMR400UF/GL310C/GL310C	2000430/47753-2/47256-01-04/47256-01-02	2024/05/10	12
RE	236967	Pre Amplifier	TSJ (Techno Science Japan)	MLA-9K01-L01	23050010	2024/06/14	12
RE	237786	RF RELAY MATRIX	TSJ (Techno Science Japan)	RFM-E221261R	07796	2023/11/01	12
RE	239644	Coaxial Cable	Junkosha	MWX221-01000NFSNMS/B	2306S022	2023/08/22	12
RE	239647	Coaxial Cable	To-Conne Co., Ltd.	TC-048-2.92P-2.92J-1000	-	2023/08/22	12
RE	239787	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHBB 9124+BBA9106	01908	2023/09/21	12

***Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.**
The expiration date of the calibration is the end of the expired month.
As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

Test item:

AT: Antenna Terminal Conducted test
CE: Conducted Emission
RE: Radiated Emission