

RADIO TEST REPORT

Test Report No. 15179368H-A

Customer	Murata Manufacturing Co., Ltd.
Description of EUT	Communication Module
Model Number of EUT	2JV
FCC ID	VPYLBCA1ZZ2DV
Test Regulation	FCC Part 15 Subpart C
Test Result	Complied
Issue Date	April 3, 2024
Remarks	*Radiated Spurious Emission only *For Permissive Change

Representative Test Engineer



Hiroki Numata
Engineer

Approved By



Takumi Shimada
Engineer



CERTIFICATE 5107.02

- ☐ 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

ANNOUNCEMENT

- This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
- The results in this report apply only to the sample tested. (Laboratory was not involved in sampling.)
- This sample tested is in compliance with the limits of the above regulation.
- The test results in this test report are traceable to the national or international standards.
- This test report must not be used by the customer to claim product certification, approval, or endorsement by the A2LA accreditation body.
- This test report covers Radio technical requirements.
It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
- The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
- The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan, Inc. has been accredited.
- The information provided by the customer for this report is identified in SECTION 1.
- The laboratory is not responsible for information provided by the customer which can impact the validity of the results.
- For test report(s) referred in this report, the latest version (including any revisions) is always referred.

REVISION HISTORY

Original Test Report No.: 15179368H-A

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15179368H-A	April 3, 2024	-

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: Radiated Spurious Emission.....	12
APPENDIX 1: Test Data.....	14
Radiated Spurious Emission.....	15
APPENDIX 2: Test Instruments	37
APPENDIX 3: Photographs of Test Setup	38
Radiated Spurious Emission.....	38
Worst Case Position	40

SECTION 1: Customer Information

Company Name	Murata Manufacturing Co., Ltd.
Address	1-10-1 Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan
Telephone Number	+81-50-1737-2801
Contact Person	Kenji Hayashikoshi

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	Communication Module
Model Number	2JV
Serial Number	Refer to SECTION 4.2
Condition	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	March 19, 2024
Test Date	March 21 and 22, 2024

2.2 Product Description

General Specification

Rating	Typ. DC 3.3 V / Min. DC 2.4 V / Max. DC 4.75 V
--------	--

Radio Specification

Bluetooth (Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	GFSK
Antenna Type	Monopole
Antenna Gain	1.0 dBi (Model 1) 0.0 dBi (Model 2)

2.3 Variant Models

This model has variant models: 2DV

Although they have following difference, there was no degradation of electrical performance.

The difference between 2JV and variant models: 2DV is the model flash memory and its wiring pattern.

Therefore the test was performed with 2JV as a representative according to the customer's request.

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

3.2 Procedures and Results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: RSS-Gen 6.13	FCC: Section15.247(d) ISED: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	0.3 dB 7320.0 MHz, AV, Horizontal	Complied	Radiated (above 30 MHz) *1)
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

The antenna is not removable from the EUT.
Therefore, the equipment complies with the antenna requirement of Section 15.203

3.3 Addition to Standard

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 $k = 2$.

Radiated emission

Measurement distance	Frequency range		Unit	Calculated Uncertainty (+/-)
3 m	9 kHz to 30 MHz		dB	3.3
10 m			dB	3.1
3 m	30 MHz to 200 MHz	Horizontal	dB	4.7
		Vertical	dB	4.7
	200 MHz to 1000 MHz	Horizontal	dB	4.8
		Vertical	dB	6.0
10 m	30 MHz to 200 MHz	Horizontal	dB	5.2
		Vertical	dB	5.1
	200 MHz to 1000 MHz	Horizontal	dB	5.2
		Vertical	dB	5.2
3 m	1 GHz to 6 GHz		dB	5.0
	6 GHz to 18 GHz		dB	5.2
1 m	10 GHz to 18 GHz		dB	5.3
	18 GHz to 26.5 GHz		dB	5.2
	26.5 GHz to 40 GHz		dB	4.7
0.5 m	26.5 GHz to 40 GHz		dB	4.8

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.

4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan

Telephone: +81-596-24-8999

A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 884919

ISED Lab Company Number: 2973C / CAB identifier: JP0002

Test site	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms	Maximum measurement distance
No.1 semi-anechoic chamber	19.2 x 11.2 x 7.7	7.0 x 6.0	No.1 Power source room	10 m
No.2 semi-anechoic chamber	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.3 Preparation room	3 m
No.3 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.4 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.4 Preparation room	3 m
No.4 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.5 semi-anechoic chamber	6.0 x 6.0 x 3.9	6.0 x 6.0	-	-
No.5 measurement room	6.4 x 6.4 x 3.0	6.4 x 6.4	-	-
No.6 shielded room	4.0 x 4.5 x 2.7	4.0 x 4.5	-	-
No.6 measurement room	4.75 x 5.4 x 3.0	4.75 x 4.15	-	-
No.7 shielded room	4.7 x 7.5 x 2.7	4.7 x 7.5	-	-
No.8 measurement room	3.1 x 5.0 x 2.7	3.1 x 5.0	-	-
No.9 measurement room	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.10 shielded room	3.8 x 2.8 x 2.8	3.8 x 2.8	-	-
No.11 measurement room	4.0 x 3.4 x 2.5	N/A	-	-
No.12 measurement room	2.6 x 3.4 x 2.5	N/A	-	-
Large Chamber	16.9 x 22.1 x 10.17	16.9 x 22.1	-	10 m
Small Chamber	5.3 x 6.69 x 3.59	5.3 x 6.69	-	-

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)

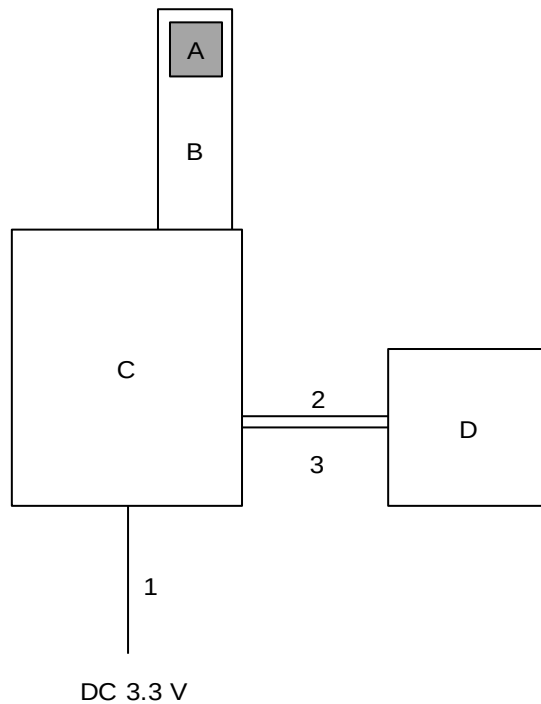
Mode	Remarks*
Bluetooth Low Energy (BT LE)	1M-PHY Uncoded PHY (1M-PHY), Maximum Packet Size, PRBS9
Bluetooth Low Energy (BT LE)	2M-PHY Uncoded PHY (2M-PHY), Maximum Packet Size, PRBS9
*Power of the EUT was set by the software as follows; Power Setting: 5 dBm Software: SDK146 (Date: March 21, 2024, Storage 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 Antenna	Tested Frequency
Radiated Spurious Emission (Below 1 GHz)	Tx BT LE, 1M-PHY *1)	Model 1 Model 2	2402 MHz
Radiated Spurious Emission (Above 1 GHz)	Tx BT LE, 1M-PHY Tx BT LE, 2M-PHY	Model 1 Model 2	2402 MHz 2440 MHz 2480 MHz
*1) Spurious emissions 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

Antenna: Model 1



* Cabling and setup(s) were taken into consideration and test data was taken under worse case conditions.

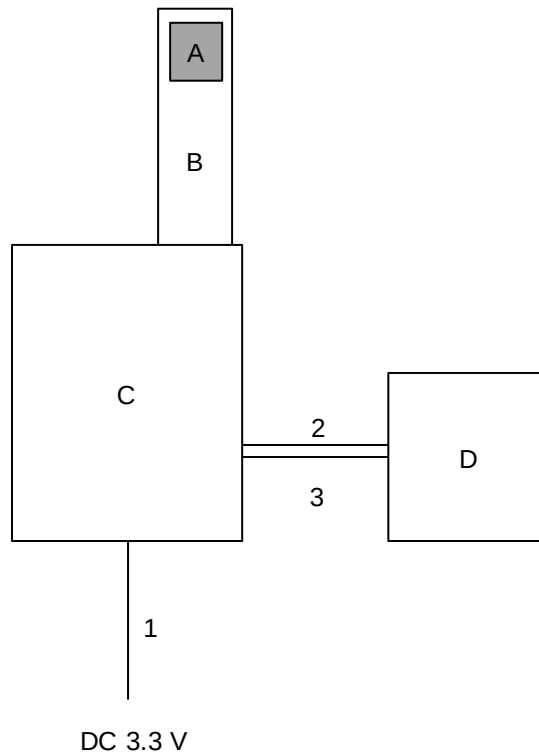
Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	Communication Module	2JV	#2	Murata Manufacturing Co., Ltd.	EUT
B	Jig Board	P2ML10527	-	Murata Manufacturing Co., Ltd.	-
C	Jig Board	P2ML7727	-	Murata Manufacturing Co., Ltd.	-
D	Jig Board	P2ML3656	-	Murata Manufacturing Co., Ltd.	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.6	Unshielded	Unshielded	-
2	Signal Cable	0.1	Unshielded	Unshielded	-
3	Signal Cable	0.1	Unshielded	Unshielded	-

Antenna: Model 2



* Cabling and setup(s) were taken into consideration and test data was taken under worse case conditions.

Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	Communication Module	2JV	#1	Murata Manufacturing Co., Ltd.	EUT
B	Jig Board	P2ML11429	-	Murata Manufacturing Co., Ltd.	-
C	Jig Board	P2ML7727	-	Murata Manufacturing Co., Ltd.	-
D	Jig Board	P2ML3656	-	Murata Manufacturing Co., Ltd.	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.6	Unshielded	Unshielded	-
2	Signal Cable	0.1	Unshielded	Unshielded	-
3	Signal Cable	0.1	Unshielded	Unshielded	-

SECTION 5: 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, 1.0 m by 1.5 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

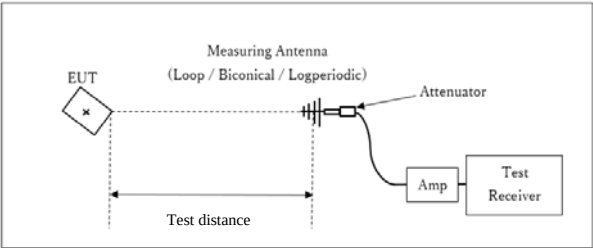
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired 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	<u>11.12.2.5.1</u> RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces <u>11.12.2.5.2</u> The duty cycle was less than 98% for detected noise, a duty factor was added to the 11.12.2.5.1 results.	RBW: 100 kHz VBW: 300 kHz

Figure 2: Test Setup

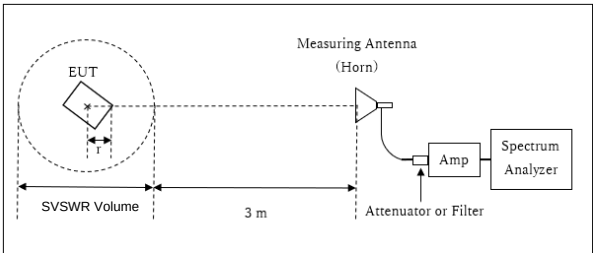
Below 1 GHz



x : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

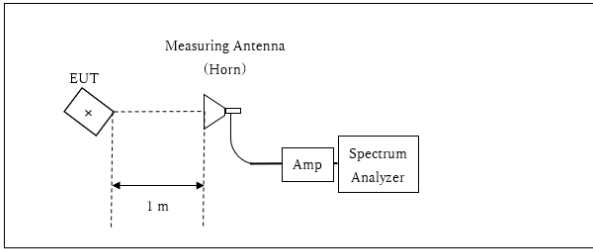


r : Radius of an outer periphery of EUT
x : Center of turn table

Distance Factor: $20 \times \log (3.7 \text{ m} / 3.0 \text{ m}) = 1.83 \text{ dB}$
* Test Distance: $(3 + \text{SVSWR Volume} / 2) - r = 3.7 \text{ m}$

SVSWR Volume : 1.5 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
 $r = 0.05 \text{ m}$

10 GHz to 26.5 GHz



x : Center of turn table

Distance Factor: $20 \times \log (1.0 \text{ m} / 3.0 \text{ m}) = -9.5 \text{ dB}$
*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.

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

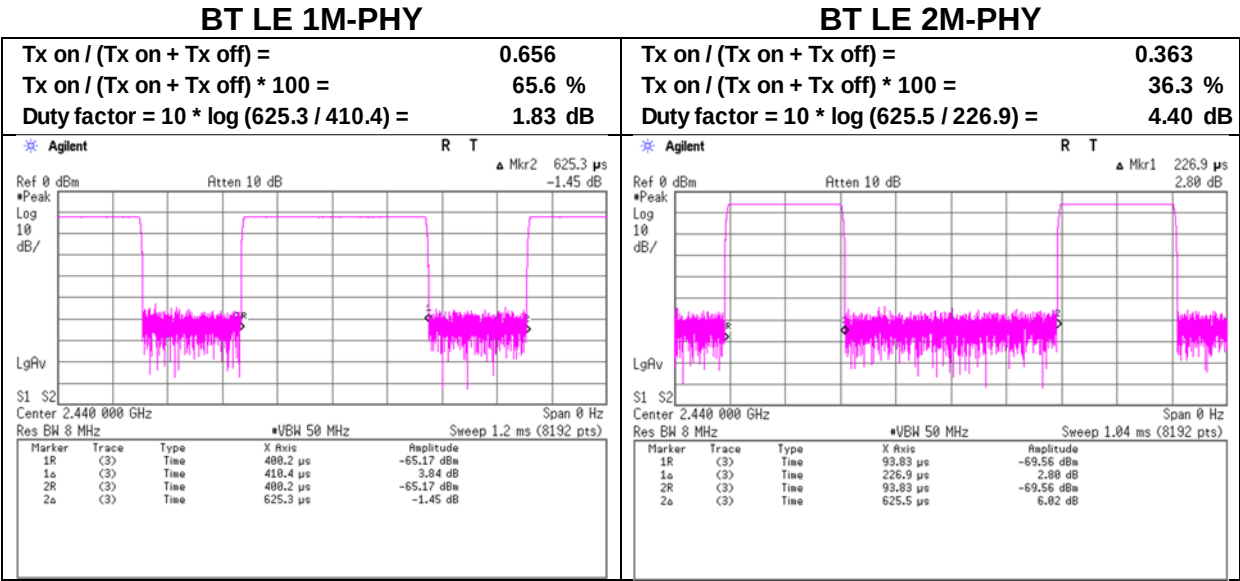
Measurement Range	: 30 MHz to 26.5 GHz
Test Data	: APPENDIX
Test Result	: Pass

APPENDIX 1: Test Data

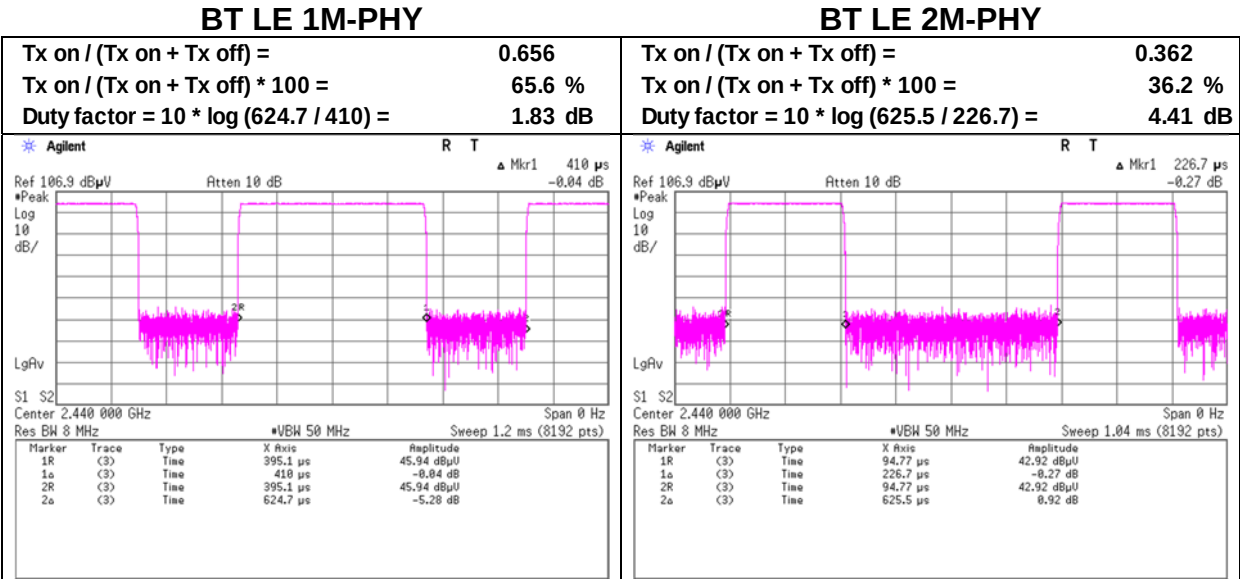
Burst rate confirmation

Test place	Ise EMC Lab. No.2 Semi Anechoic Chamber	
Date	March 21, 2024	March 21, 2024
Temperature / Humidity	22 deg. C / 50 % RH	23 deg. C / 53 % RH
Engineer	Nachi Konegawa	Yuichiro Yamazaki
Mode	Tx	

Antenna: Model 1



Antenna: Model 2



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

Radiated Spurious Emission

Antenna: Model 1

Test place	Ise EMC Lab.	No.2
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	22 deg. C / 50 % RH	19 deg. C / 47 % RH
Engineer	Nachi Konegawa	Hiroki Numata
	(1 GHz to 10 GHz)	(Above 10 GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz	

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	65.3	21.7	-	6.7	7.1	28.5	-	7.0	-	40.0	-	33.0	-	
Hori.	79.3	21.7	-	6.9	7.2	28.5	-	7.3	-	40.0	-	32.7	-	
Hori.	92.2	21.6	-	9.1	7.3	28.4	-	9.5	-	43.5	-	34.0	-	
Hori.	98.9	21.8	-	10.2	7.4	28.4	-	11.0	-	43.5	-	32.5	-	
Hori.	399.4	21.1	-	15.9	9.4	28.5	-	17.9	-	46.0	-	28.1	-	
Hori.	503.4	21.2	-	17.9	9.8	29.1	-	19.8	-	46.0	-	26.2	-	
Hori.	2390.0	50.3	38.2	27.7	4.8	34.4	1.8	48.4	38.1	73.9	53.9	25.5	15.8	*1)
Hori.	4804.0	42.8	34.1	31.6	7.0	33.6	-	47.8	39.1	73.9	53.9	26.1	14.8	Floor noise
Hori.	7206.0	43.9	34.9	35.6	8.1	33.4	-	54.2	45.1	73.9	53.9	19.7	8.8	Floor noise
Hori.	9608.0	43.2	34.5	35.7	9.0	34.0	-	53.8	45.2	73.9	53.9	20.1	8.7	Floor noise
Vert.	65.3	26.7	-	6.7	7.1	28.5	-	12.0	-	40.0	-	28.0	-	
Vert.	79.3	27.4	-	6.9	7.2	28.5	-	13.0	-	40.0	-	27.0	-	
Vert.	92.2	21.6	-	9.1	7.3	28.4	-	9.5	-	43.5	-	34.0	-	
Vert.	98.9	23.4	-	10.2	7.4	28.4	-	12.6	-	43.5	-	30.9	-	
Vert.	399.4	21.0	-	15.9	9.4	28.5	-	17.8	-	46.0	-	28.2	-	
Vert.	503.4	21.2	-	17.9	9.8	29.1	-	19.8	-	46.0	-	26.2	-	
Vert.	2390.0	47.2	36.4	27.7	4.8	34.4	1.8	45.3	36.4	73.9	53.9	28.6	17.6	*1)
Vert.	4804.0	42.4	33.5	31.6	7.0	33.6	-	47.4	38.5	73.9	53.9	26.5	15.4	Floor noise
Vert.	7206.0	42.9	34.7	35.6	8.1	33.4	-	53.2	44.9	73.9	53.9	20.7	9.0	Floor noise
Vert.	9608.0	42.9	34.4	35.7	9.0	34.0	-	53.5	45.0	73.9	53.9	20.4	8.9	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)

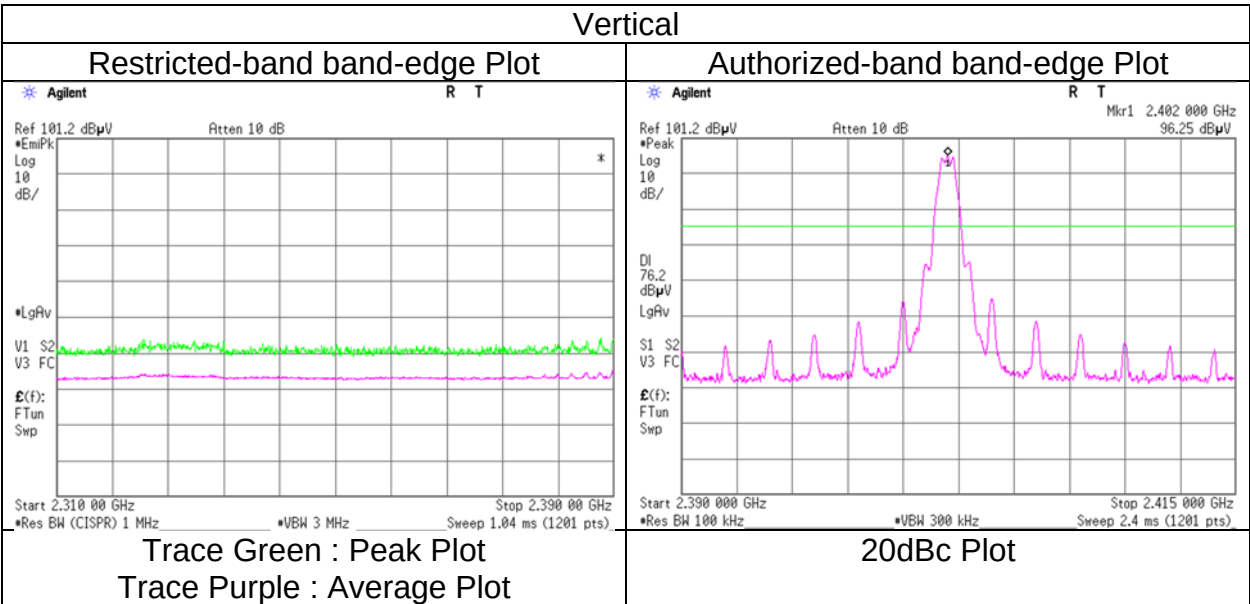
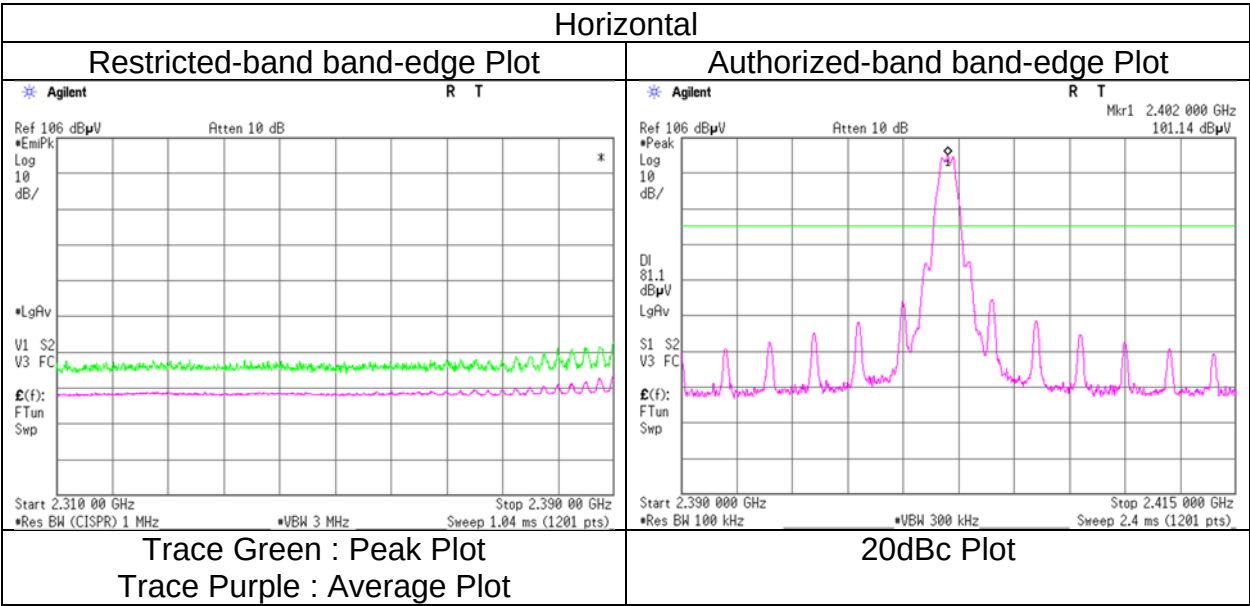
20dBc Data Sheet

Polarity	Frequency	Reading (PK)	Ant Factor	Loss	Gain	Result	Limit	Margin	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
Hori.	2402.0	101.1	27.6	4.9	34.4	99.3	-	-	Carrier
Hori.	2400.0	59.9	27.6	4.9	34.4	58.0	79.3	21.2	
Vert.	2402.0	96.3	27.6	4.9	34.4	94.4	-	-	Carrier
Vert.	2400.0	55.0	27.6	4.9	34.4	53.1	74.4	21.3	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Distance factor:
1 GHz - 6 GHz 20log (3.7 m / 3.0 m) = 1.83 dB
6 GHz - 10 GHz 20log (3.7 m / 3.0 m) = 1.83 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 1

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	22 deg. C / 50 % RH
Engineer	Nachi Konegawa
	(1 GHz to 10 GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz



* 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 Antenna: Model 1

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	22 deg. C / 50 % RH	19 deg. C / 47 % RH
Engineer	Nachi Konegawa	Hiroki Numata
	(1 GHz to 10 GHz)	(Above 10 GHz)
Mode	Tx BT LE 1M-PHY 2440 MHz	

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	4880.0	42.3	33.7	31.6	7.0	33.6	-	47.3	38.8	73.9	53.9	26.6	15.2	Floor noise
Hori.	7320.0	46.3	39.4	35.6	8.2	33.5	1.8	56.6	51.6	73.9	53.9	17.3	2.3	
Hori.	9760.0	43.6	34.4	36.0	9.0	34.1	-	54.6	45.4	73.9	53.9	19.3	8.5	Floor noise
Vert.	4880.0	42.9	33.7	31.6	7.0	33.6	-	47.9	38.8	73.9	53.9	26.0	15.2	Floor noise
Vert.	7320.0	46.4	38.6	35.6	8.2	33.5	1.8	56.7	50.7	73.9	53.9	17.2	3.2	
Vert.	9760.0	43.2	34.5	36.0	9.0	34.1	-	54.2	45.5	73.9	53.9	19.8	8.4	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

Result (AV)= Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*QP detector was used up to 1GHz.

Distance factor:	1 GHz - 6 GHz	20log (3.7 m / 3.0 m) = 1.83 dB
	6 GHz - 10 GHz	20log (3.7 m / 3.0 m) = 1.83 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Antenna: Model 1

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 10 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 1M-PHY 2480 MHz	

Polarity	Frequency	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dBm]	Loss	Gain	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
[Hori/Vert]	[MHz]				[dB]	[dB]								
Hori.	2483.5	56.6	46.3	27.5	4.9	34.3	1.8	54.7	46.2	73.9	53.9	19.2	7.7	*1)
Hori.	2484.0	60.0	47.3	27.5	4.9	34.3	1.8	58.1	47.2	73.9	53.9	15.8	6.7	
Hori.	4960.0	40.7	33.6	31.7	7.0	33.6	-	45.9	38.8	73.9	53.9	28.0	15.1	Floor noise
Hori.	7440.0	46.6	38.1	35.5	8.3	33.5	1.8	56.8	50.1	73.9	53.9	17.1	3.8	
Hori.	9920.0	43.4	34.6	36.2	9.1	34.1	-	54.6	45.8	73.9	53.9	19.3	8.1	Floor noise
Vert.	2483.5	55.5	45.5	27.5	4.9	34.3	1.8	53.6	45.4	73.9	53.9	20.3	8.5	*1)
Vert.	2484.0	58.9	46.5	27.5	4.9	34.3	1.8	56.9	46.4	73.9	53.9	17.0	7.5	
Vert.	4960.0	41.0	33.6	31.7	7.0	33.6	-	46.2	38.8	73.9	53.9	27.8	15.2	Floor noise
Vert.	7440.0	46.3	37.2	35.5	8.3	33.5	1.8	56.5	49.3	73.9	53.9	17.4	4.6	
Vert.	9920.0	43.5	34.6	36.2	9.1	34.1	-	54.7	45.8	73.9	53.9	19.2	8.1	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

$$\text{Result (AV)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz))} - \text{Gain(Amplifier)} + \text{Duty factor}$$

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

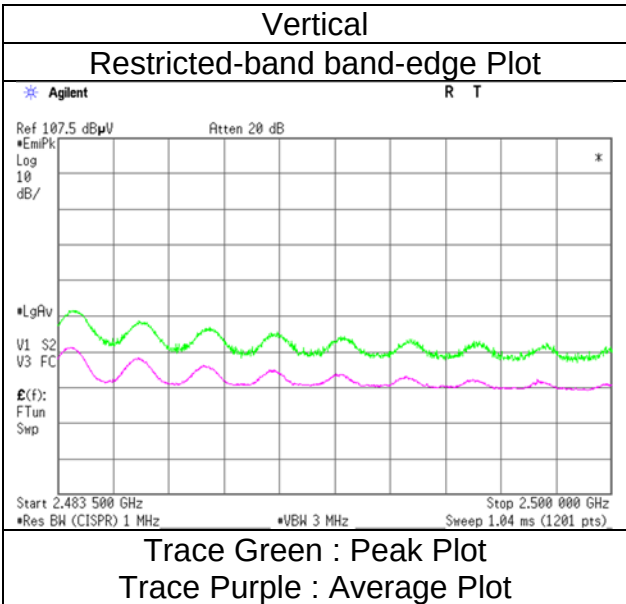
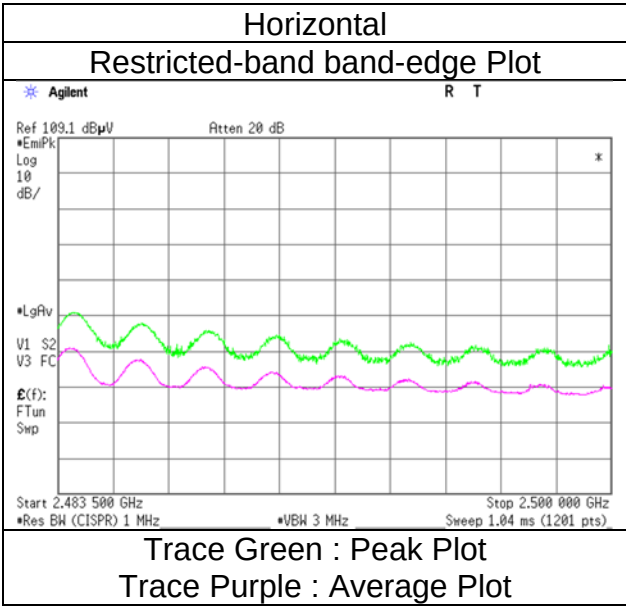
*OP detector was used up to 1GHz.

*1) Not Out of Band emission(Leakage Power)

Distance factor:	1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 1

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 10 GHz)
Mode	Tx BT LE 1M-PHY 2480 MHz



* 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
Antenna: Model 1

Test place Ise EMC Lab.
Semi Anechoic Chamber No.2
Date March 21, 2024 No.2
Temperature / Humidity March 22, 2024
Engineer 23 deg. C / 53 % RH 19 deg. C / 47 % RH
 Yuichiro Yamazaki Hiroki Numata
 (1 GHz to 10 GHz) (Above 10 GHz)
Mode Tx BT LE 2M-PHY 2402 MHz

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	2390.0	50.2	37.9	27.7	4.8	34.4	4.4	48.3	40.4	73.9	53.9	25.6	13.5	*1)
Hori.	4804.0	42.5	33.6	31.6	7.0	33.6	-	47.5	38.6	73.9	53.9	26.4	15.3	Floor noise
Hori.	7206.0	47.4	37.5	35.6	8.1	33.4	4.4	57.7	52.2	73.9	53.9	16.2	1.7	
Hori.	9608.0	43.0	34.2	35.7	9.0	34.0	-	53.6	44.8	73.9	53.9	20.3	9.1	Floor noise
Vert.	2390.0	49.4	37.1	27.7	4.8	34.4	4.4	47.5	39.6	73.9	53.9	26.4	14.3	*1)
Vert.	4804.0	42.3	33.8	31.6	7.0	33.6	-	47.2	38.8	73.9	53.9	26.7	15.1	Floor noise
Vert.	7206.0	47.1	36.9	35.6	8.1	33.4	4.4	57.4	51.6	73.9	53.9	16.5	2.3	
Vert.	9608.0	42.6	34.1	35.7	9.0	34.0	-	53.2	44.7	73.9	53.9	20.7	9.2	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)

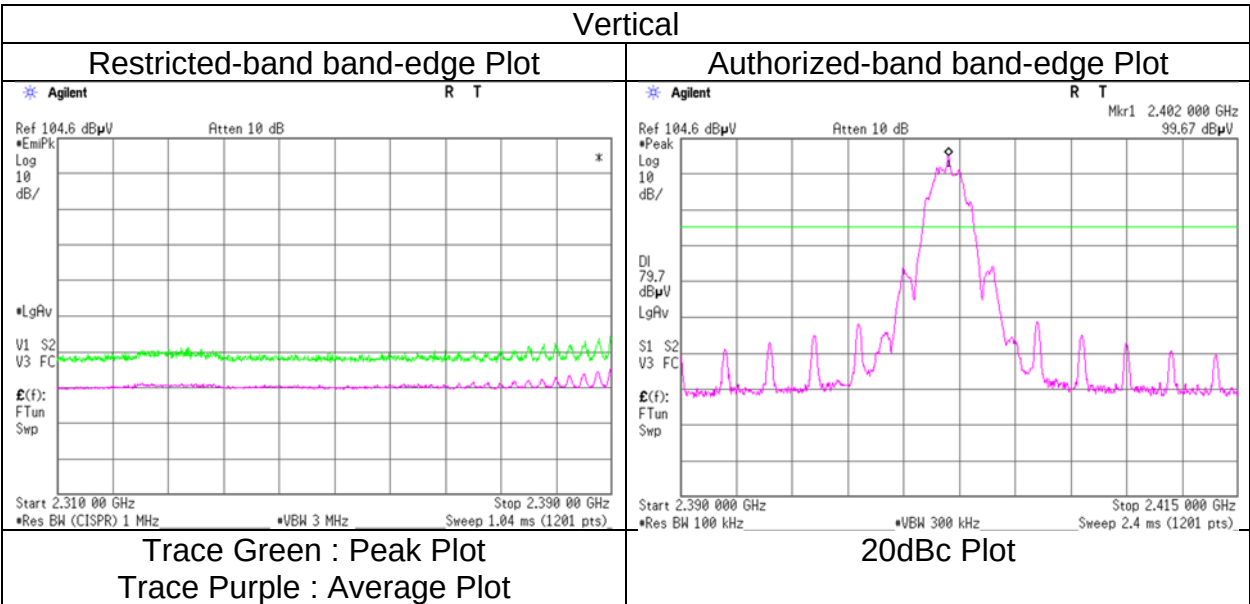
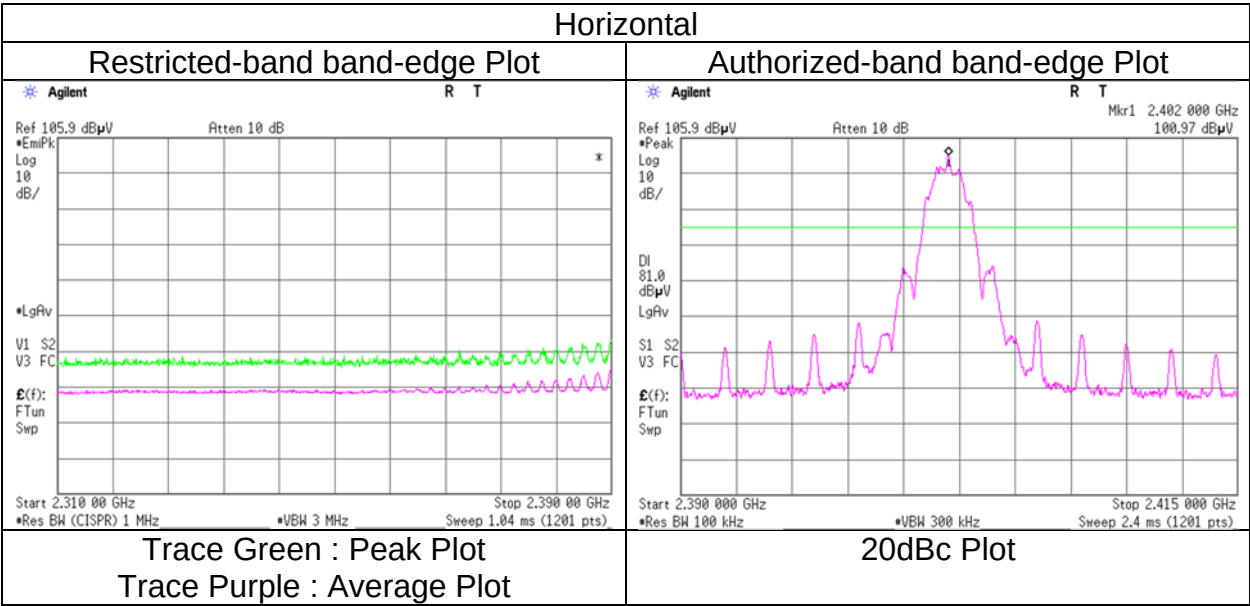
20dBc Data Sheet

Polarity	Frequency	Reading (PK)	Ant Factor	Loss	Gain	Result	Limit	Margin	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
Hori.	2402.0	101.0	27.6	4.9	34.4	99.1	-	-	Carrier
Hori.	2400.0	69.8	27.6	4.9	34.4	67.9	79.1	11.2	
Vert.	2402.0	99.7	27.6	4.9	34.4	97.8	-	-	Carrier
Vert.	2400.0	68.4	27.6	4.9	34.4	66.6	77.8	11.2	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Distance factor: 1 GHz - 6 GHz 20log (3.7 m / 3.0 m) = 1.83 dB
 6 GHz - 10 GHz 20log (3.7 m / 3.0 m) = 1.83 dB
 10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 1

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2M-PHY 2402 MHz



* 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.

Antenna: Model 1

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 10 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 2M-PHY 2440 MHz	

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	4880.0	42.3	33.6	31.6	7.0	33.6	-	47.3	38.6	73.9	53.9	26.6	15.3	Floor noise
Hori.	7320.0	48.2	38.9	35.6	8.2	33.5	4.4	58.5	53.6	73.9	53.9	15.4	0.3	
Hori.	9760.0	43.1	34.0	36.0	9.0	34.1	-	54.1	45.0	73.9	53.9	19.8	8.9	Floor noise
Vert.	4880.0	42.3	33.5	31.6	7.0	33.6	-	47.3	38.6	73.9	53.9	26.6	15.3	Floor noise
Vert.	7320.0	48.0	38.1	35.6	8.2	33.5	4.4	58.3	52.8	73.9	53.9	15.6	1.1	
Vert.	9760.0	42.8	34.3	36.0	9.0	34.1	-	53.8	45.3	73.9	53.9	20.1	8.6	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

$$\text{Result (AV)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz))} - \text{Gain(Amplifier)} + \text{Duty factor}$$

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*OP detector was used up to 1GHz.

Distance factor:	1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Antenna: Model 1

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 10 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 2M-PHY 2480 MHz	

Polarity	Frequency	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dBm]	Loss	Gain	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
[Hori/Vert]	[MHz]				[dB]	[dB]								
Hori.	2483.5	56.7	48.6	27.5	4.9	34.3	4.4	54.7	51.0	73.9	53.9	19.2	2.9	*1)
Hori.	2484.0	60.3	48.7	27.5	4.9	34.3	4.4	58.4	51.2	73.9	53.9	15.6	2.7	
Hori.	4960.0	41.7	33.3	31.7	7.0	33.6	-	46.8	38.4	73.9	53.9	27.1	15.5	Floor noise
Hori.	7440.0	45.5	35.7	35.5	8.3	33.5	4.4	55.7	50.4	73.9	53.9	18.2	3.5	
Hori.	9920.0	42.5	33.7	36.2	9.1	34.1	-	53.7	44.9	73.9	53.9	20.2	9.0	Floor noise
Vert.	2483.5	54.6	46.6	27.5	4.9	34.3	4.4	52.7	49.0	73.9	53.9	21.2	4.9	*1)
Vert.	2484.0	58.3	46.8	27.5	4.9	34.3	4.4	56.3	49.3	73.9	53.9	17.6	4.7	
Vert.	4960.0	41.9	33.2	31.7	7.0	33.6	-	47.1	38.4	73.9	53.9	26.9	15.5	Floor noise
Vert.	7440.0	45.5	35.9	35.5	8.3	33.5	4.4	55.8	50.6	73.9	53.9	18.1	3.4	
Vert.	9920.0	42.9	33.9	36.2	9.1	34.1	-	54.1	45.1	73.9	53.9	19.8	8.8	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

$$\text{Result (AV)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz))} - \text{Gain(Amplifier)} + \text{Duty factor}$$

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

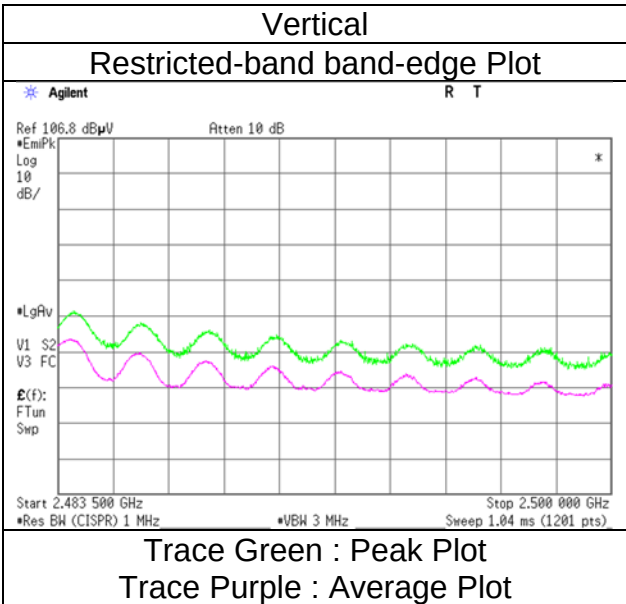
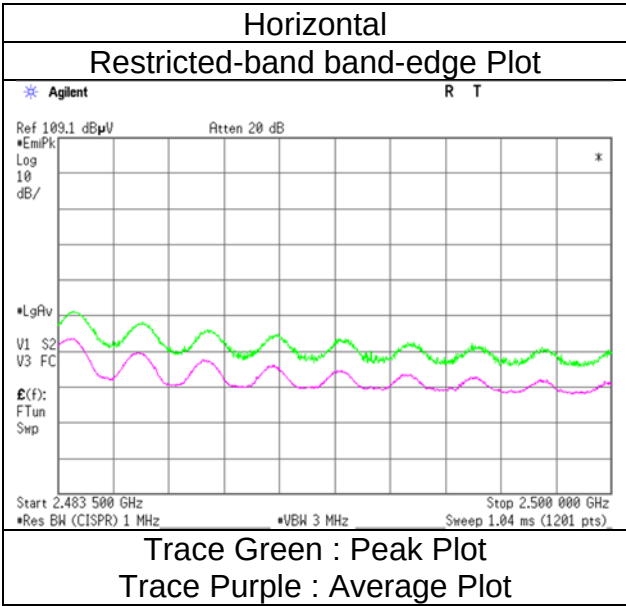
*OP detector was used up to 1GHz.

*1) Not Out of Band emission(Leakage Power)

Distance factor:	1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 1

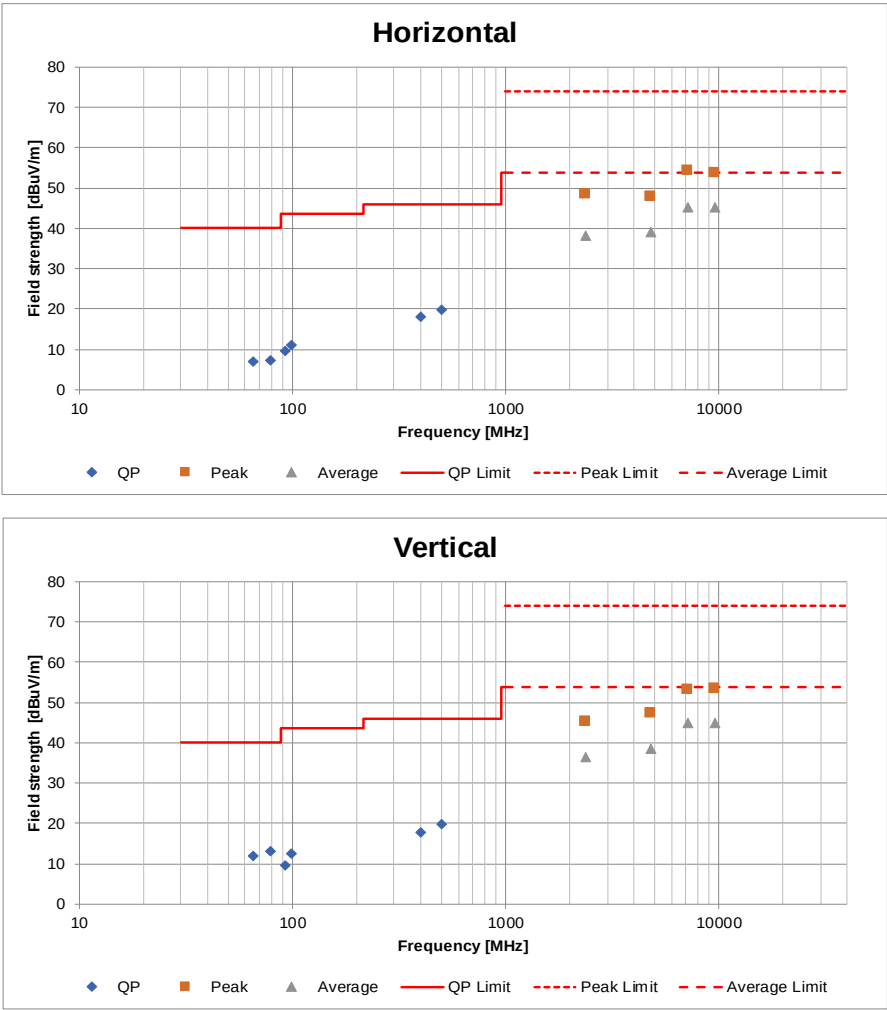
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2M-PHY 2480 MHz



* 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)
Antenna: Model 1

Test place	Ise EMC Lab.	No.2	No.2
Semi Anechoic Chamber	No.2	March 22, 2024	March 22, 2024
Date	March 21, 2024	19 deg. C / 47 % RH	19 deg. C / 47 % RH
Temperature / Humidity	22 deg. C / 50 % RH	Hiroki Numata	Hiroki Numata
Engineer	Nachi Konegawa	(Above 10 GHz)	(Below 1GHz)
Mode	(1 GHz to 10 GHz)		
	Tx BT LE 1M-PHY 2402 MHz		



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

Radiated Spurious Emission Antenna: Model 2

Test place	Ise EMC Lab.	No.2
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki	Hiroki Numata
	(1 GHz to 10 GHz)	(Above 10 GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz	

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	66.2	21.7	-	6.6	7.1	28.5	-	6.9	-	40.0	-	33.1	-	
Hori.	78.8	21.6	-	6.8	7.2	28.5	-	7.1	-	40.0	-	32.9	-	
Hori.	161.8	21.0	-	15.6	7.8	28.2	-	16.3	-	43.5	-	27.2	-	
Hori.	174.4	21.0	-	16.1	7.9	28.1	-	16.9	-	43.5	-	26.6	-	
Hori.	356.9	20.7	-	15.2	9.1	28.1	-	16.8	-	46.0	-	29.2	-	
Hori.	493.4	21.2	-	17.8	9.8	29.1	-	19.7	-	46.0	-	26.3	-	
Hori.	2390.0	51.1	39.0	27.7	4.8	34.4	1.8	49.2	38.9	73.9	53.9	24.7	15.0	*1)
Hori.	4804.0	42.1	33.8	31.6	7.0	33.6	-	47.1	38.8	73.9	53.9	26.8	15.1	Floor noise
Hori.	7206.0	44.6	35.5	35.6	8.1	33.4	1.8	54.8	47.6	73.9	53.9	19.1	6.3	
Hori.	9608.0	42.5	33.8	35.7	9.0	34.0	-	53.1	44.4	73.9	53.9	20.8	9.5	Floor noise
Vert.	66.2	23.4	-	6.6	7.1	28.5	-	8.6	-	40.0	-	31.4	-	
Vert.	78.8	26.5	-	6.8	7.2	28.5	-	12.0	-	40.0	-	28.0	-	
Vert.	161.8	21.1	-	15.6	7.8	28.2	-	16.4	-	43.5	-	27.1	-	
Vert.	174.4	21.0	-	16.1	7.9	28.1	-	16.9	-	43.5	-	26.6	-	
Vert.	356.9	20.7	-	15.2	9.1	28.1	-	16.8	-	46.0	-	29.2	-	
Vert.	493.4	21.2	-	17.8	9.8	29.1	-	19.7	-	46.0	-	26.3	-	
Vert.	2390.0	49.5	37.2	27.7	4.8	34.4	1.8	47.6	37.1	73.9	53.9	26.3	16.8	*1)
Vert.	4804.0	42.0	33.8	31.6	7.0	33.6	-	47.0	38.7	73.9	53.9	26.9	15.2	Floor noise
Vert.	7206.0	44.5	36.0	35.6	8.1	33.4	1.8	54.7	48.1	73.9	53.9	19.2	5.8	
Vert.	9608.0	43.0	33.9	35.7	9.0	34.0	-	53.6	44.5	73.9	53.9	20.3	9.4	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)

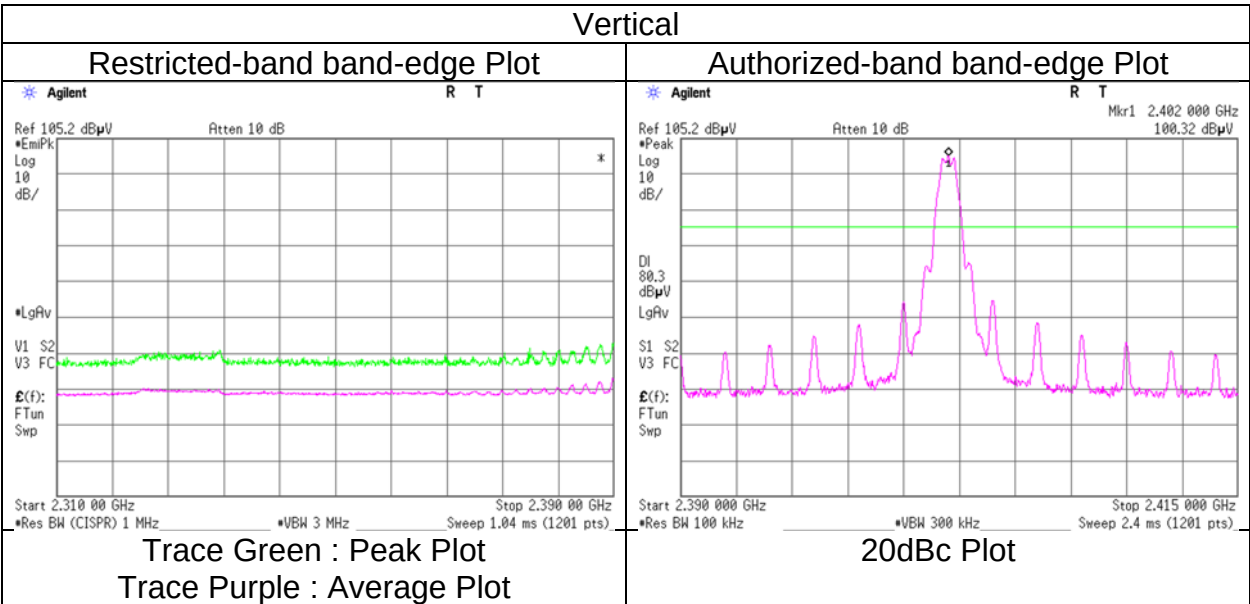
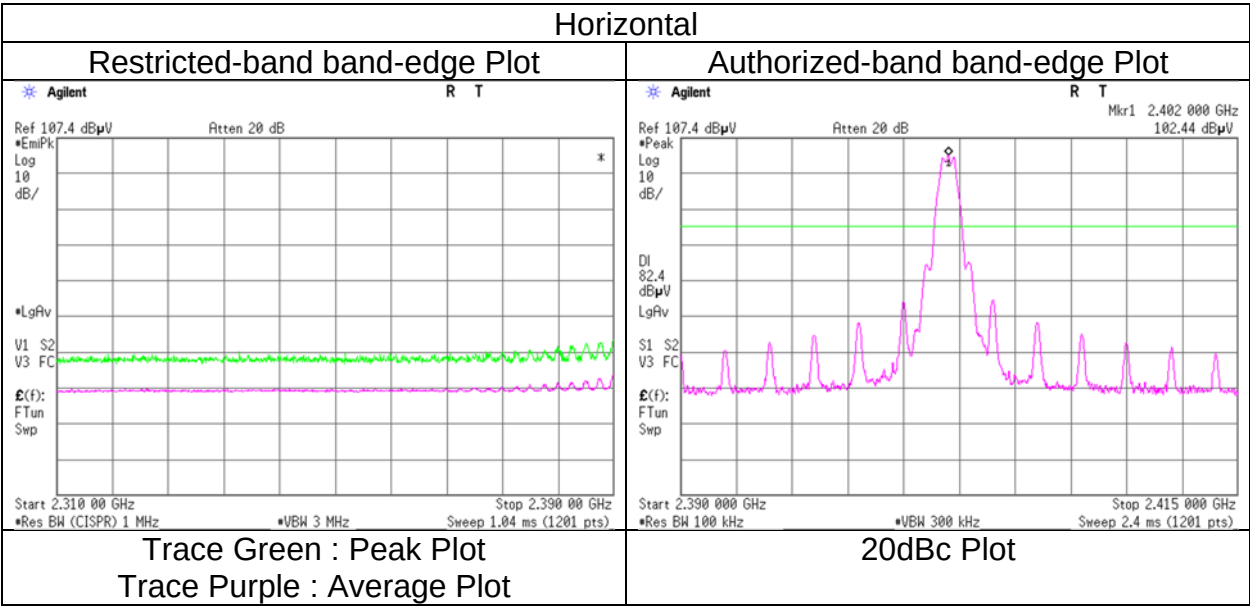
20dBc Data Sheet

Polarity	Frequency	Reading (PK)	Ant Factor	Loss	Gain	Result	Limit	Margin	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
Hori.	2402.0	102.4	27.6	4.9	34.4	100.6	-	-	Carrier
Hori.	2400.0	61.4	27.6	4.9	34.4	59.5	80.6	21.1	
Vert.	2402.0	100.4	27.6	4.9	34.4	98.5	-	-	Carrier
Vert.	2400.0	58.8	27.6	4.9	34.4	56.9	78.5	21.6	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Distance factor:
1 GHz - 6 GHz 20log (3.7 m / 3.0 m) = 1.83 dB
6 GHz - 10 GHz 20log (3.7 m / 3.0 m) = 1.83 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 2

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 10 GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz



* 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

Antenna: Model 2

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 10 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 1M-PHY 2440 MHz	

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dBm]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	4880.0	43.3	33.7	31.6	7.0	33.6	-	48.4	38.7	73.9	53.9	25.5	15.2	Floor noise
	7320.0	44.4	35.3	35.6	8.2	33.5	1.8	54.7	47.5	73.9	53.9	19.2	6.4	
Hori.	9760.0	42.3	33.8	36.0	9.0	34.1	-	53.3	44.8	73.9	53.9	20.6	9.1	Floor noise
Vert.	4880.0	43.2	33.8	31.6	7.0	33.6	-	48.3	38.9	73.9	53.9	25.7	15.0	Floor noise
Vert.	7320.0	44.9	35.5	35.6	8.2	33.5	1.8	55.2	47.7	73.9	53.9	18.7	6.2	
Vert.	9760.0	42.4	33.9	36.0	9.0	34.1	-	53.4	44.9	73.9	53.9	20.5	9.0	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

$$\text{Result (AV)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor (above 1 GHz))} - \text{Gain (Amplifier)} + \text{Duty factor}$$

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*OP detector was used up to 1GHz.

Distance factor:	1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Antenna: Model 2

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 10 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 1M-PHY 2480 MHz	

Polarity	Frequency	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
[Hori/Vert]	[MHz]													
Hori.	2483.5	52.9	42.2	27.5	4.9	34.3	1.8	50.9	42.1	73.9	53.9	23.0	11.8	*1)
Hori.	2484.0	52.3	43.5	27.5	4.9	34.3	1.8	53.4	43.4	73.9	53.9	20.5	10.5	
Hori.	4960.0	45.3	33.3	31.7	7.0	33.6	-	47.4	38.5	73.9	53.9	26.5	15.4	Floor noise
Hori.	7440.0	44.8	35.0	35.5	8.3	33.5	1.8	55.0	47.1	73.9	53.9	18.9	6.8	
Hori.	9920.0	42.9	33.9	36.2	9.1	34.1	-	54.1	45.1	73.9	53.9	19.8	8.8	Floor noise
Vert.	2483.5	51.4	40.3	27.5	4.9	34.3	1.8	49.5	40.2	73.9	53.9	24.4	13.7	*1)
Vert.	2484.0	54.1	41.9	27.5	4.9	34.3	1.8	52.2	41.8	73.9	53.9	21.8	12.2	
Vert.	4960.0	41.9	33.5	31.7	7.0	33.6	-	47.1	38.7	73.9	53.9	26.8	15.2	Floor noise
Vert.	7440.0	44.8	34.9	35.5	8.3	33.5	1.8	55.0	47.0	73.9	53.9	18.9	6.9	
Vert.	9920.0	42.4	34.1	36.2	9.1	34.1	-	53.6	45.4	73.9	53.9	20.3	8.6	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

$$\text{Result (AV)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz))} - \text{Gain(Amplifier)} + \text{Duty factor}$$

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

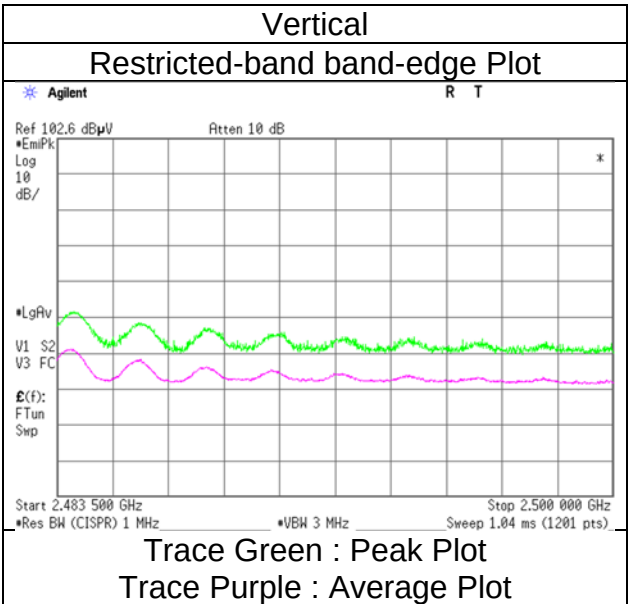
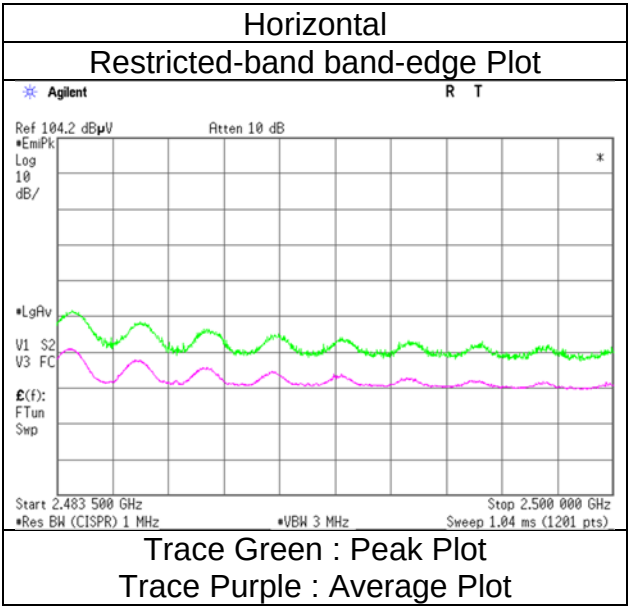
*OP detector was used up to 1GHz.

*1) Not Out of Band emission(Leakage Power)

Distance factor:	1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 2

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 10 GHz)
Mode	Tx BT LE 1M-PHY 2480 MHz



* 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

Antenna: Model 2

Test place	Ise EMC Lab.	No.2
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki	Hiroki Numata
	(1 GHz to 10 GHz)	(Above 10 GHz)
Mode	Tx BT LE 2M-PHY 2402 MHz	

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	2390.0	50.9	38.2	27.7	4.8	34.4	4.4	49.0	40.8	73.9	53.9	24.9	13.2	*1)
Hori.	4804.0	41.8	33.7	31.6	7.0	33.6	-	46.8	38.7	73.9	53.9	27.1	15.2	Floor noise
Hori.	7206.0	44.3	35.0	35.6	8.1	33.4	4.4	54.6	49.7	73.9	53.9	19.4	4.2	
Hori.	9608.0	42.5	33.9	35.7	9.0	34.0	-	53.1	44.5	73.9	53.9	20.8	9.4	Floor noise
Vert.	2390.0	48.8	37.2	27.7	4.8	34.4	4.4	46.9	39.7	73.9	53.9	27.0	14.2	*1)
Vert.	4804.0	41.8	33.5	31.6	7.0	33.6	-	46.8	38.5	73.9	53.9	27.1	15.4	Floor noise
Vert.	7206.0	44.7	35.3	35.6	8.1	33.4	4.4	54.9	49.9	73.9	53.9	19.0	4.0	
Vert.	9608.0	42.6	34.0	35.7	9.0	34.0	-	53.2	44.6	73.9	53.9	20.7	9.3	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

Result (AV)= Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*QP detector was used up to 1GHz.

*1) Not Out of Band emission(Leakage Power)

20dBc Data Sheet

Polarity	Frequency	Reading (PK)	Ant Factor	Loss	Gain	Result	Limit	Margin	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
Hori.	2402.0	101.9	27.6	4.9	34.4	100.0	-	-	Carrier
Hori.	2400.0	70.8	27.6	4.9	34.4	68.9	80.0	11.1	
Vert.	2402.0	99.2	27.6	4.9	34.4	97.3	-	-	Carrier
Vert.	2400.0	68.1	27.6	4.9	34.4	66.2	77.3	11.1	

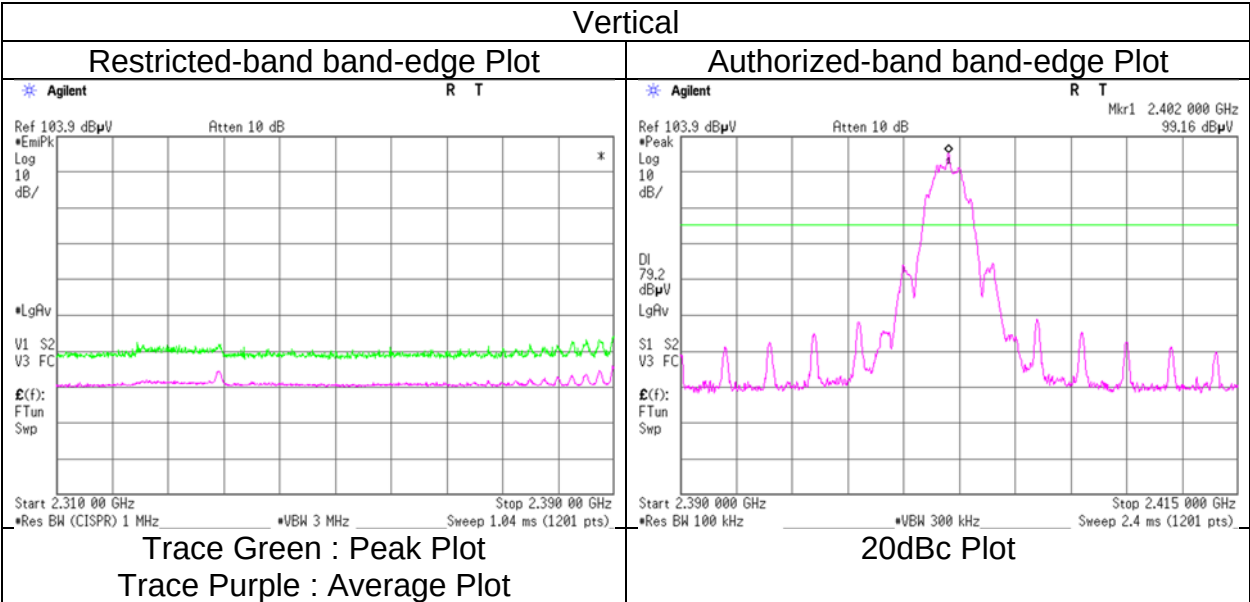
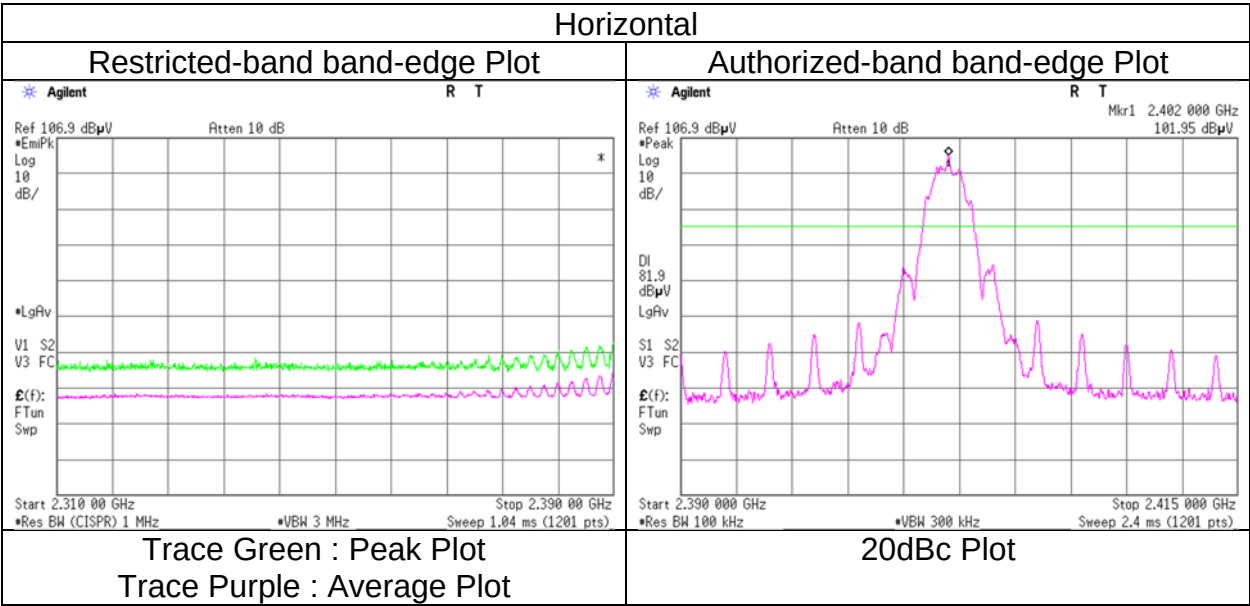
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

Distance factor:

1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 2

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2M-PHY 2402 MHz



* 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.

Antenna: Model 2

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 10 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 2M-PHY 2440 MHz	

Polarity	Frequency	Reading (QP / PK)	Reading (AV)	Ant. Factor	Loss	Gain	Duty Factor	Result (QP / PK)	Result (AV)	Limit (QP / PK)	Limit (AV)	Margin (QP / PK)	Margin (AV)	Remark
[Hori/Vert]	[MHz]	[dBuV]	[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dBuV/m]	[dB]	[dB]	
Hori.	4880.0	43.1	33.6	31.6	7.0	33.6	-	48.2	38.7	73.9	53.9	25.8	15.2	Floor noise
Hori.	7320.0	43.7	34.5	35.6	8.2	33.5	4.4	54.0	49.3	73.9	53.9	19.9	4.7	
Hori.	9760.0	42.3	34.1	36.0	9.0	34.1	-	53.3	45.1	73.9	53.9	20.6	8.8	Floor noise
Vert.	4880.0	43.3	33.6	31.6	7.0	33.6	-	48.4	38.6	73.9	53.9	25.6	15.3	Floor noise
Vert.	7320.0	43.5	34.7	35.6	8.2	33.5	4.4	53.8	49.5	73.9	53.9	20.1	4.5	
Vert.	9760.0	42.9	34.1	36.0	9.0	34.1	-	53.9	45.1	73.9	53.9	20.0	8.8	Floor noise

$$\text{Result (QP / PK)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz))} - \text{Gain(Amplifier)}$$

Result (AV)= Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + Duty factor

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

*OP detector was used up to 1GHz.

Distance factor:	1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Antenna: Model 2

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.2	No.2
Date	March 21, 2024	March 22, 2024
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 10 GHz)	Hiroki Numata (Above 10 GHz)
Mode	Tx BT LE 2M-PHY 2480 MHz	

Polarity	Frequency	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss	Gain	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
[Hori/Vert]	[MHz]				[dB]	[dB]								
Hori.	2483.5	52.8	43.3	27.5	4.9	34.3	4.4	50.9	45.8	73.9	53.9	23.0	8.1	*1)
Hori.	2484.0	56.0	43.9	27.5	4.9	34.3	4.4	54.0	46.4	73.9	53.9	19.9	7.5	
Hori.	4960.0	42.1	33.2	31.7	7.0	33.6	-	47.3	38.4	73.9	53.9	26.6	15.5	Floor noise
Hori.	7440.0	44.7	34.7	35.5	8.3	33.5	4.4	54.9	49.3	73.9	53.9	19.0	4.6	
Vert.	9920.0	42.7	34.0	36.2	9.1	34.1	-	53.9	45.3	73.9	53.9	20.0	8.7	Floor noise
Vert.	2483.5	51.3	41.7	27.5	4.9	34.3	4.4	49.3	44.2	73.9	53.9	24.6	9.7	*1)
Vert.	2484.0	54.2	42.3	27.5	4.9	34.3	4.4	52.3	44.8	73.9	53.9	21.6	9.1	
Vert.	4960.0	41.2	33.6	31.7	7.0	33.6	-	46.4	38.8	73.9	53.9	27.5	15.1	Floor noise
Vert.	7440.0	44.4	34.5	35.5	8.3	33.5	4.4	54.6	49.1	73.9	53.9	19.3	4.8	
Vert.	9920.0	42.9	34.2	36.2	9.1	34.1	-	54.1	45.4	73.9	53.9	19.8	8.5	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)

$$\text{Result (AV)} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter+Distance factor (above 1 GHz))} - \text{Gain (Amplifier)} + \text{Duty factor}$$

*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

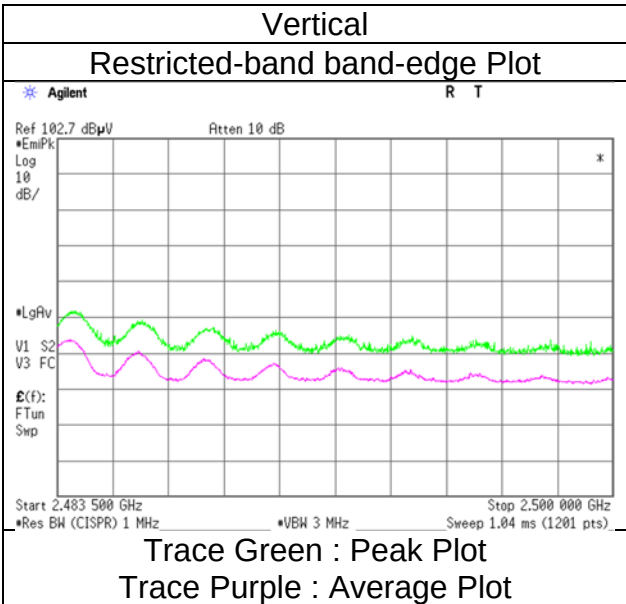
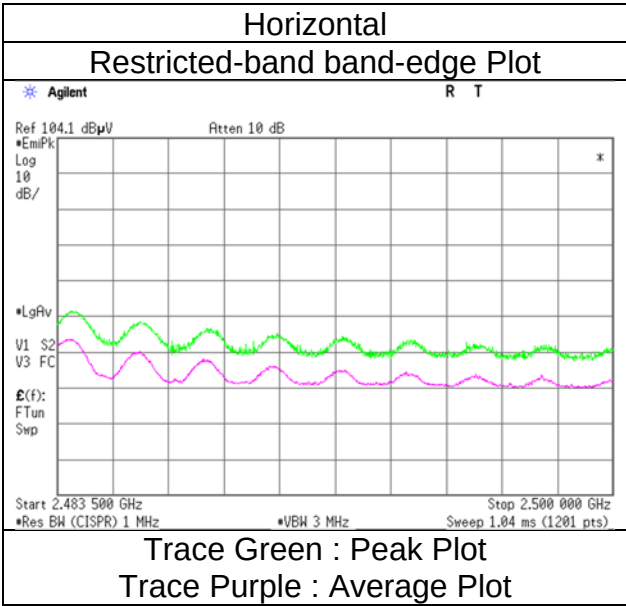
*OP detector was used up to 1GHz.

*1) Not Out of Band emission(Leakage Power)

Distance factor:	1 GHz - 6 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	6 GHz - 10 GHz	$20\log(3.7\text{ m} / 3.0\text{ m}) = 1.83\text{ dB}$
	10 GHz - 26.5 GHz	$20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Radiated Spurious Emission
(Reference Plot for band-edge)
Antenna: Model 2

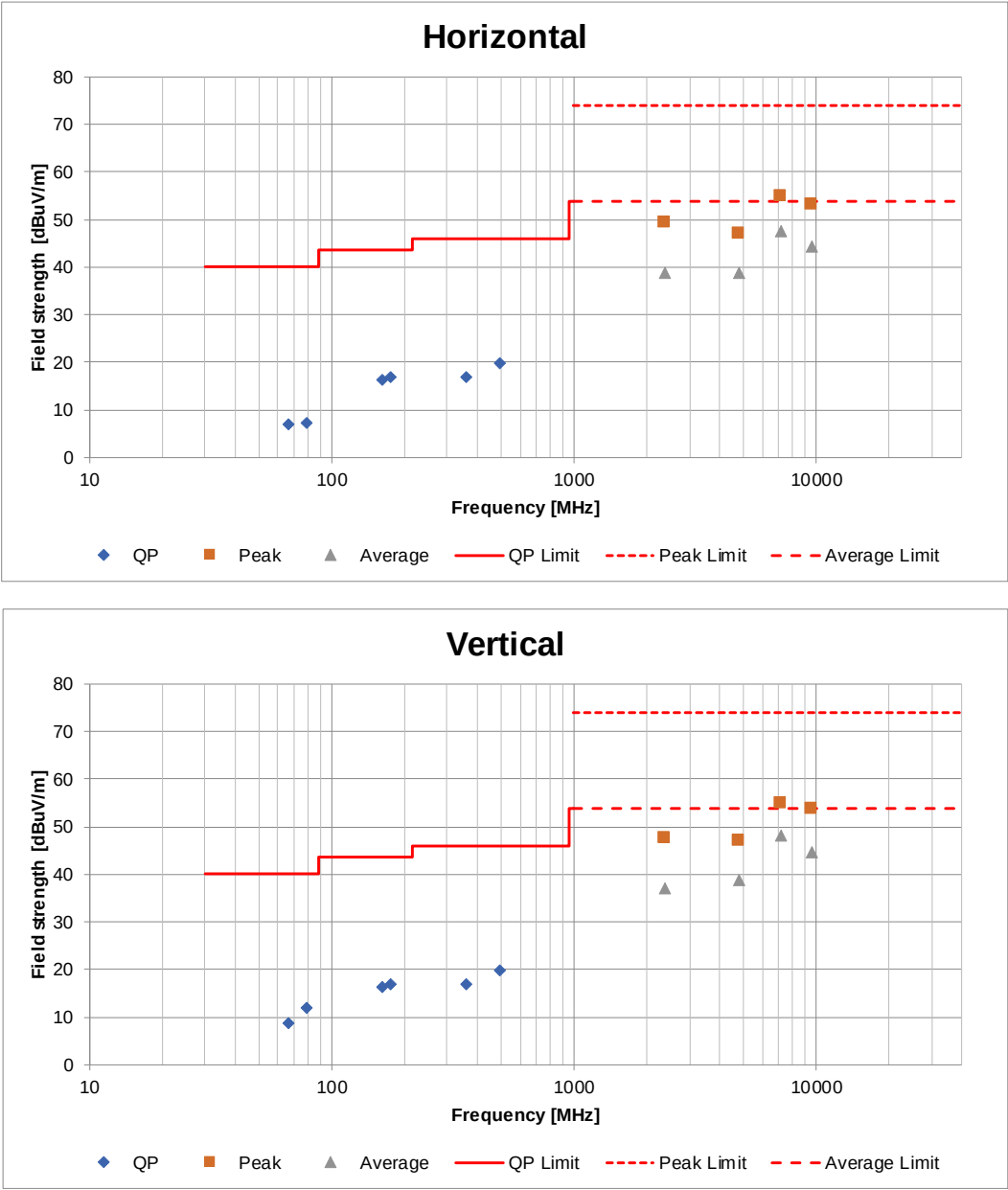
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	March 21, 2024
Temperature / Humidity	23 deg. C / 53 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2M-PHY 2480 MHz



* 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)
Antenna: Model 2

Test place	Ise EMC Lab.	No.2	No.2
Semi Anechoic Chamber	No.2	March 21, 2024	March 22, 2024
Date	March 21, 2024	23 deg. C / 53 % RH	19 deg. C / 47 % RH
Temperature / Humidity	23 deg. C / 53 % RH	19 deg. C / 47 % RH	19 deg. C / 47 % RH
Engineer	Yuichiro Yamazaki	Hiroki Numata	Hiroki Numata
	(1 GHz to 10 GHz)	(Above 10 GHz)	(Below 1GHz)
Mode	Tx BT LE 1M-PHY 2402 MHz		



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

APPENDIX 2: Test Instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-190	07/11/2023	12
RE	141296	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	002	09/01/2023	12
RE	141317	Coaxial Cable	UL Japan	-	-	09/12/2023	12
RE	141425	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+ BBA9106	VHA 91031302	08/10/2023	12
RE	141503	Horn Antenna 18-26.5GHz	EMCO	3160-09	1265	06/23/2023	12
RE	141512	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	254	10/17/2023	12
RE	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/01/2023	12
RE	141579	Pre Amplifier	Keysight Technologies Inc	8449B	3008A02142	02/17/2024	12
RE	141594	Pre Amplifier	Keysight Technologies Inc	8447D	2944A10150	02/17/2024	12
RE	141903	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46186390	01/26/2024	12
RE	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	05/17/2023	12
RE	142004	AC2_Semi Anechoic Chamber (NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	12/12/2023	24
RE	142006	AC2_Semi Anechoic Chamber (SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-06902	10/20/2023	12
RE	142228	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	220646	Attenuator	Huber+Suhner	6806 N-50-1	-	03/12/2024	12
RE	238712	Double Ridge Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	687	08/10/2023	12
RE	240023	Microwave Cable	Huber+Suhner	SF126E/ 11PC35/11PC35/ 1000MM,5000MM	537060/126E / 537075/126E	09/08/2023	12
RE	244707	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202102	01/25/2024	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:

RE: Radiated Emission