RADIO TEST REPORT

Test Report No. 14907916H-A-R1

Customer	**Guangzhou BDE Technology Inc.**
Description of EUT	**BDE Bluetooth 5.1 Dual Mode Transceiver Module Based on CC2564C**
Model Number of EUT	**BDE-BD2564CN**
FCC ID	**2ABRU-2564C**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**December 22, 2023**
Remarks	***Bluetooth Low Energy part(s)** ***Radiated Spurious Emission only** ***For Permissive Change**

Representative Test Engineer	Approved By
Tomoya Sone Engineer	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

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- The information provided from the customer for this report is identified in Section 1.
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REVISION HISTORY

Original Test Report No.: 14907916H-A

This report is a revised version of 14907916H-A. 14907916H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14907916H-A	November 30, 2023	-
1	14907916H-A-R1	December 22, 2023	-Cover Page Remove the variant model of remarks

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

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SECTION 1: Customer Information

Company Name	Guangzhou BDE Technology Inc.
Address	B2-403, Chuangyi Building, 162 Science Avenue, Huangpu district, Guangzhou 510663, China
Telephone Number	+86-150-11900258
Contact Person	Jacky Tian

The information provided from 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

* The laboratory is exempted from liability of any test results affected from the above information in SECTION 2 and 4.

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	BDE Bluetooth 5.1 Dual Mode Transceiver Module Based on CC2564C
Model Number	BDE-BD2564CN
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	August 7, 2023
Test Date	August 8 to November 8, 2023

2.2 Product Description

General Specification

Rating	DC 3.3 V

Radio Specification

Bluetooth (Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	GFSK

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	**FCC:** Section15.247(d)	5.4 dB 360.0 MHz, QP, Horizontal	Complied	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 it is soldered on the circuit board.
Therefore the equipment complies with the requirement of 15.203/212.

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	4.8
		Vertical	dB	5.0
	200 MHz to 1000 MHz	Horizontal	dB	5.1
		Vertical	dB	6.2
10 m	30 MHz to 200 MHz	Horizontal	dB	4.8
		Vertical	dB	4.8
	200 MHz to 1000 MHz	Horizontal	dB	4.9
		Vertical	dB	5.0
3 m	1 GHz to 6 GHz		dB	4.9
	6 GHz to 18 GHz		dB	5.2
1 m	10 GHz to 26.5 GHz		dB	5.5
	26.5 GHz to 40 GHz		dB	5.4
10 m	1 GHz to 18 GHz		dB	5.3

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	-	-

SECTION 4: Operation of EUT during testing

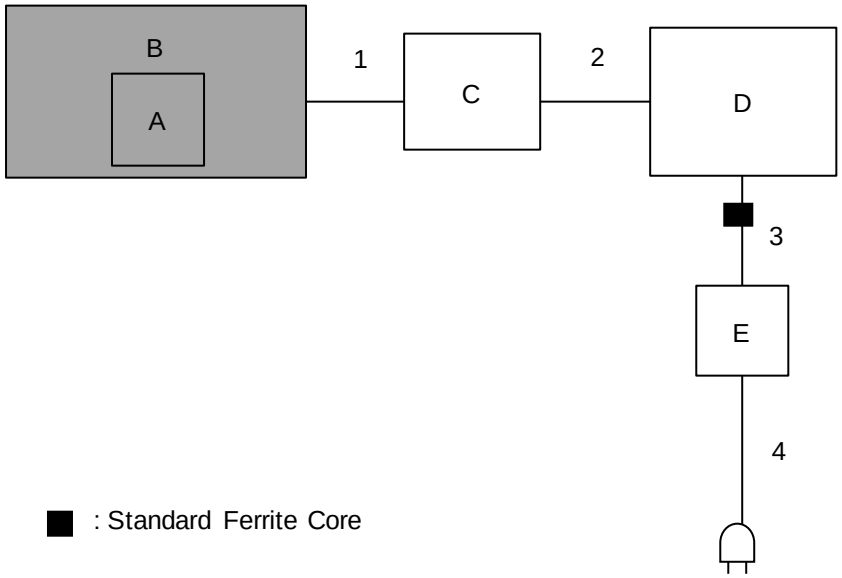
4.1 Operating Mode(s)

Mode	Remarks*
Bluetooth Low Energy (BT LE)	MaximumPacket Size, PN9
*Transmitting duty was 100 %. * As a result of preliminary check of Radiated Spurious Emission test, the formal test was performed with the worst condition.	
*Power of the EUT was set by the software as follows; Power Setting: 15 Software: HCITester (Date: August 7, 2023, Storage location: Driven by connected PC) *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
Radiated Spurious Emission (Below 1 GHz)	Tx BT LE *1)	2480 MHz
Radiated Spurious Emission (Above 1 GHz)	Tx BT LE	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



* 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	BDE Bluetooth 5.1 Dual Mode Transceiver Module Based on CC2564C	BDE-BD2564CN	2231	Guangzhou BDE Technology Inc.	EUT
B	Antenna	R5UA1697Z3X	44	Panasonic	EUT
C	Jig	-	-	Panasonic	-
D	Laptop PC	CF-SZ5ADCVS	6HKSA95525	Panasonic	-
E	AC Adapter	CF-AA64L2C	64L2CM116703424A	Panasonic	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Signal Cable	0.3	Unshielded	Unshielded	-
2	USB Cable	2.5	Shielded	Shielded	-
3	DC Cable	0.9	Unshielded	Unshielded	-
4	AC Cable	0.9	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, 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

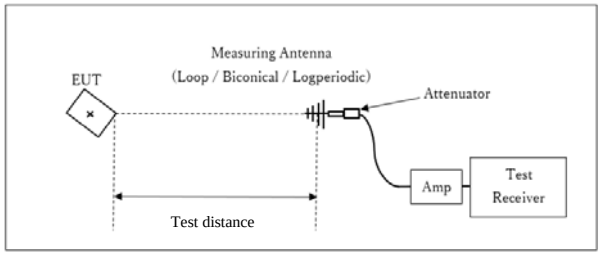
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired 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	11.12.2.5.1 RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces 11.12.2.5.2 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

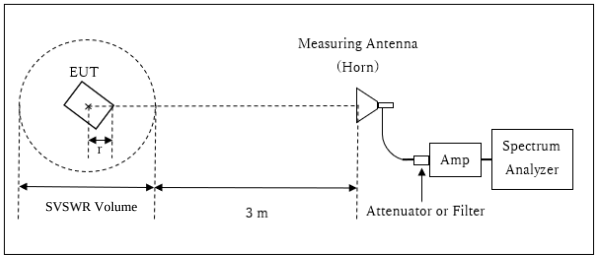
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

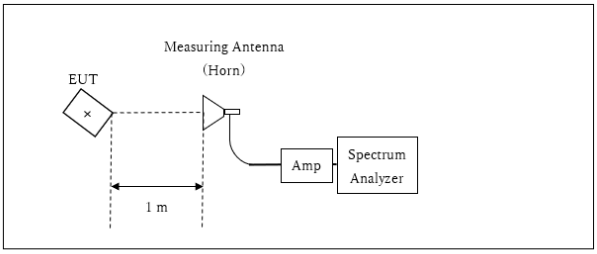


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.95 m / 3.0 m) = 2.39 dB
* Test Distance: (3 + SVSWR Volume /2) - r = 3.95 m

SVSWR Volume : 2.0 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.05 m

10 GHz to 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.5 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.

The test results and limit are rounded off to one decimal place, so some differences might be observed.

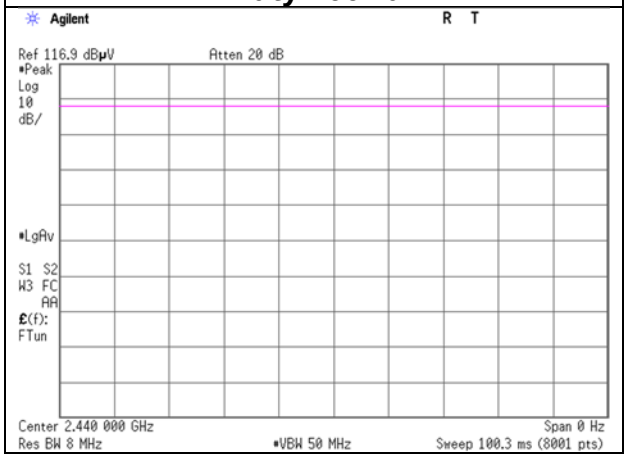
Measurement Range : 30 MHz to 26.5 GHz
Test Data : APPENDIX
Test Result : Pass

APPENDIX 1: Test Data

Burst Rate Confirmation

Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Date	August 8, 2023
Temperature / Humidity	21 deg. C / 57 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off

Duty 100 %

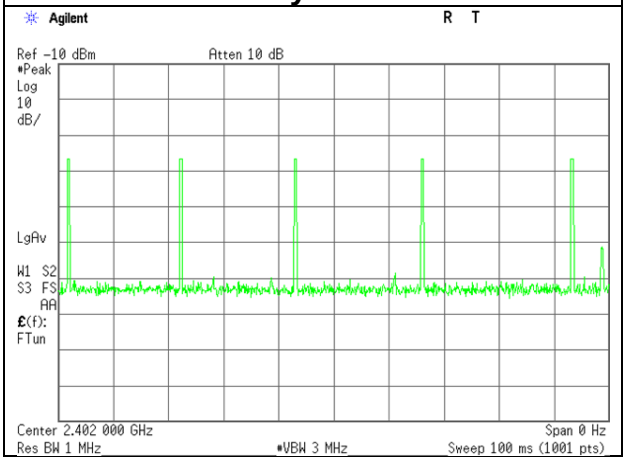


* Since the burst rate is not different between the channels, the data has been obtained on the representative channel.

Duty cycle correction factor

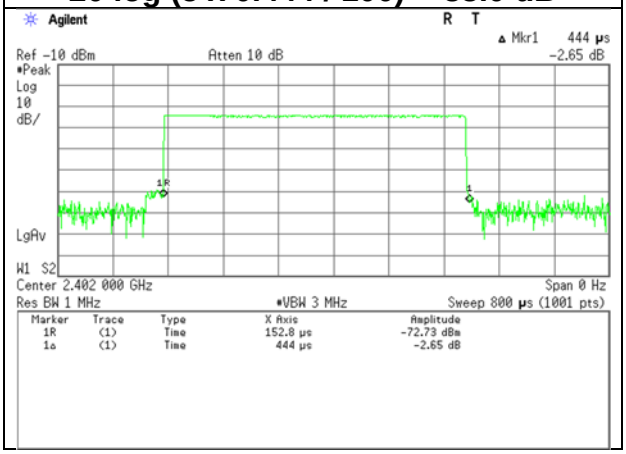
Test place	Ise EMC Lab. No.6 Measurement Room
Date	November 8, 2023
Temperature / Humidity	22 deg. C / 34 % RH
Engineer	Tomoya Sone
Mode	Data Communication

Worst Duty in 100msec



Worst Duty cycle

Averaging factor (Duty factor)= 20 log (5 x 0.444 / 100)= -33.0 dB



Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	August 8, 2023	August 8, 2023
Temperature / Humidity	21 deg. C / 57 % RH	22 deg. C / 61 % RH
Engineer	Junya Okuno	Keiya Ido
	(1 GHz to 18 GHz)	(Above 18 GHz)
Mode	Tx BT LE 2402 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	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.	2376.0	43.2	33.2	27.7	5.4	32.4	-	43.8	33.9	73.9	53.9	30.1	20.1	
Hori.	2390.0	43.4	-	27.7	5.4	32.4	-	44.0	-	73.9	-	29.9	-	*1)
Hori.	4804.0	48.8	-	31.5	7.5	31.4	-	56.4	-	73.9	-	17.5	-	
Hori.	12010.0	44.3	-	39.3	-1.8	32.9	-	48.8	-	73.9	-	25.1	-	
Hori.	19216.0	56.8	-	38.0	-2.5	32.2	-	60.2	-	73.9	-	13.7	-	
Vert.	2389.3	49.9	36.8	27.7	5.4	32.4	-	50.5	37.4	73.9	53.9	23.4	16.5	
Vert.	2390.0	43.8	-	27.7	5.4	32.4	-	44.4	-	73.9	-	29.5	-	*1)
Vert.	4804.0	48.4	-	31.5	7.5	31.4	-	56.0	-	73.9	-	17.9	-	
Vert.	12010.0	43.9	-	39.3	-1.8	32.9	-	48.4	-	73.9	-	25.5	-	
Vert.	19216.0	56.2	-	38.0	-2.5	32.2	-	59.6	-	73.9	-	14.3	-	

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)

Peak measurement value with duty cycle correction factor

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	DCCF	Result [dBuV/m]		Limit	Margin [dB]		Remark
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m]	Hor	Ver	
2390.000	PK	43.4	43.8	27.7	5.4	32.4	-33.0	11.1	11.5	53.9	42.8	42.4	*1)
4804.000	PK	48.8	48.4	31.5	7.5	31.4	-33.0	23.4	23.0	53.9	30.5	30.9	
12010.000	PK	44.3	43.9	39.3	-1.8	32.9	-33.0	15.9	15.5	53.9	38.0	38.4	
19216.000	PK	56.8	56.2	38.0	-2.5	32.2	-33.0	27.1	26.5	53.9	26.8	27.4	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amprifier) + Duty factor (Refer to Duty factor data sheet)

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + DCCF
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Duty cycle correction factor (DCCF) refer to "Duty cycle correction factor" sheet.
*1) Not Out of Band emission(Leakage Power)

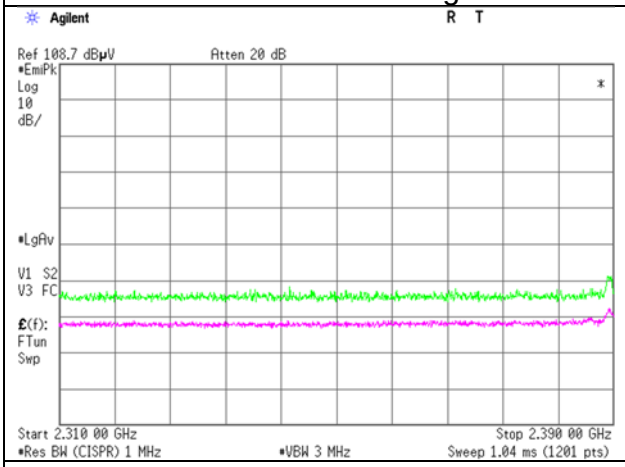
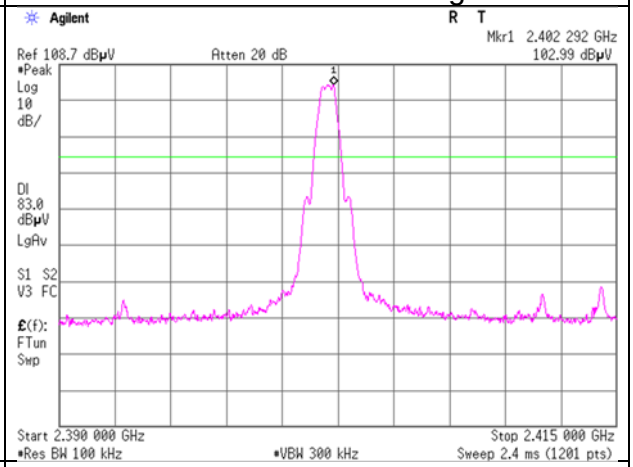
20dBc Data Sheet

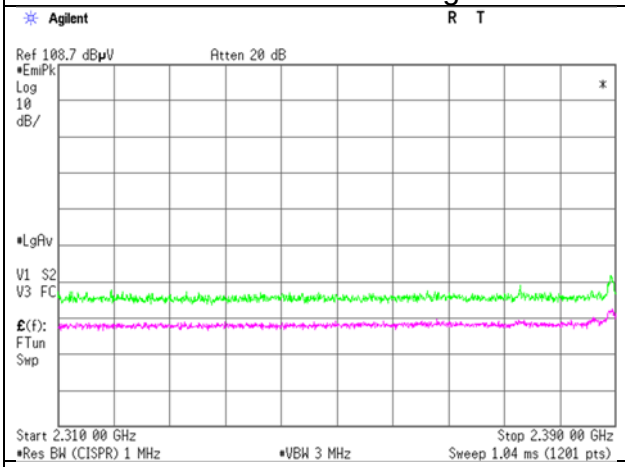
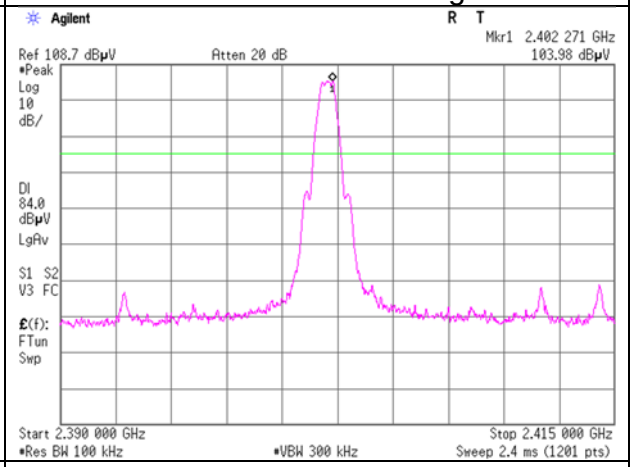
Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.0	103.0	27.6	5.4	32.4	103.6	-	-	Carrier
Hori.	2400.0	45.3	27.6	5.4	32.4	45.9	83.6	37.7	
Hori.	7206.0	47.8	35.8	8.8	32.3	60.2	83.6	23.4	
Hori.	9608.0	38.6	38.8	9.3	32.9	53.7	83.6	29.8	
Hori.	14412.0	43.6	40.3	-1.0	32.2	50.7	83.6	32.9	
Hori.	21618.0	37.9	38.1	-2.0	32.4	41.7	83.6	41.9	
Vert.	2402.0	104.0	27.6	5.4	32.4	104.6	-	-	Carrier
Vert.	2400.0	45.9	27.6	5.4	32.4	46.5	84.6	38.1	
Vert.	7206.0	46.7	35.8	8.8	32.3	59.1	84.6	25.5	
Vert.	9608.0	37.6	38.8	9.3	32.9	52.8	84.6	31.8	
Vert.	14412.0	43.4	40.3	-1.0	32.2	50.6	84.6	34.0	
Vert.	21618.0	48.3	38.1	-2.0	32.4	52.1	84.6	32.5	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)
Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 8, 2023
Temperature / Humidity	21 deg. C / 57 % RH
Engineer	Junya Okuno
	(1 GHz to 10 GHz)
Mode	Tx BT LE 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	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	August 8, 2023	August 8, 2023
Temperature / Humidity	21 deg. C / 57 % RH	22 deg. C / 61 % RH
Engineer	Junya Okuno	Keiya Ido
	(1 GHz to 18 GHz)	(Above 18 GHz)
Mode	Tx BT LE 2440 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	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.	4880.0	48.1	-	31.5	7.5	31.4	-	55.7	-	73.9	-	18.2	-	
Hori.	7320.0	51.6	-	36.0	8.8	32.3	-	64.1	-	73.9	-	9.8	-	
Hori.	12200.0	43.9	-	39.1	-1.7	32.9	-	48.4	-	73.9	-	25.5	-	
Hori.	19520.0	51.9	-	37.9	-2.4	32.2	-	55.3	-	73.9	-	18.6	-	
Vert.	4880.0	47.0	-	31.5	7.5	31.4	-	54.7	-	73.9	-	19.3	-	
Vert.	7320.0	49.8	-	36.0	8.8	32.3	-	62.3	-	73.9	-	11.6	-	
Vert.	12200.0	43.0	-	39.1	-1.7	32.9	-	47.5	-	73.9	-	26.4	-	
Vert.	19520.0	54.9	-	37.9	-2.4	32.2	-	58.3	-	73.9	-	15.7	-	

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.

Peak measurement value with duty cycle correction factor

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	DCCF	Result [dBuV/m]		Limit	Margin [dB]		Remark
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m]	Hor	Ver	
4880.000	PK	48.1	47.0	31.5	7.5	31.4	-33.0	22.7	21.6	53.9	31.2	32.3	
7320.000	PK	51.6	49.8	36.0	8.8	32.3	-33.0	31.1	29.3	53.9	22.8	24.6	
12200.000	PK	43.9	43.0	39.1	-1.7	32.9	-33.0	15.4	14.5	53.9	38.5	39.4	
19520.000	PK	51.9	54.9	37.9	-2.4	32.2	-33.0	22.2	25.2	53.9	31.7	28.7	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + DCCF
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Duty cycle correction factor (DCCF) refer to "Duty cycle correction factor" sheet.

20dBc Data Sheet

Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2440.0	102.3	27.6	5.4	32.4	102.9	-	-	Carrier
Hori.	9760.0	35.7	39.1	9.4	33.0	51.2	82.9	31.8	
Hori.	14640.0	44.3	40.2	-0.9	32.1	51.5	82.9	31.5	
Hori.	21960.0	37.9	38.1	-1.9	32.3	41.9	82.9	41.0	
Vert.	2440.0	105.1	27.6	5.4	32.4	105.7	-	-	Carrier
Vert.	9760.0	34.7	39.1	9.4	33.0	50.2	85.7	35.6	
Vert.	14640.0	46.1	40.2	-0.9	32.1	53.3	85.7	32.4	
Vert.	21960.0	48.0	38.1	-1.9	32.3	52.0	85.7	33.7	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)
Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	August 8, 2023	August 8, 2023
Temperature / Humidity	21 deg. C / 57 % RH	22 deg. C / 61 % RH
Engineer	Junya Okuno	Keiya Ido
	(1 GHz to 18 GHz)	(Above 18 GHz)
		(Below 1 GHz)
Mode	Tx BT LE 2480 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	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.	120.0	35.6	-	10.9	8.3	32.1	-	22.7	-	43.5	-	20.8	-	
Hori.	240.0	44.6	-	11.6	9.5	32.0	-	33.7	-	46.0	-	12.3	-	
Hori.	360.0	46.9	-	15.2	10.5	32.0	-	40.6	-	46.0	-	5.4	-	
Hori.	480.0	42.8	-	17.4	11.3	32.0	-	39.5	-	46.0	-	6.5	-	
Hori.	720.0	39.1	-	20.1	12.7	31.8	-	40.1	-	46.0	-	5.9	-	
Hori.	960.0	32.8	-	22.2	14.0	30.5	-	38.4	-	46.0	-	7.6	-	
Hori.	2483.5	49.8	-	27.5	5.4	32.4	-	50.4	-	73.9	-	23.5	-	*1)
Hori.	2486.8	49.2	37.0	27.5	5.4	32.4	1.1	49.8	38.7	73.9	53.9	24.1	15.2	
Hori.	4960.0	53.4	-	31.6	7.6	31.4	-	61.3	-	73.9	-	12.7	-	
Hori.	7440.0	48.0	-	36.2	8.8	32.4	-	60.6	-	73.9	-	13.3	-	
Hori.	12400.0	46.2	-	38.9	-1.7	32.8	-	50.6	-	73.9	-	23.3	-	
Hori.	19840.0	47.8	-	37.8	-2.3	32.2	-	51.1	-	73.9	-	22.8	-	
Vert.	120.0	44.7	-	10.9	8.3	32.1	-	31.8	-	43.5	-	11.7	-	
Vert.	240.0	44.5	-	11.6	9.5	32.0	-	33.6	-	46.0	-	12.4	-	
Vert.	360.0	42.8	-	15.2	10.5	32.0	-	36.5	-	46.0	-	9.5	-	
Vert.	480.0	40.7	-	17.4	11.3	32.0	-	37.4	-	46.0	-	8.6	-	
Vert.	720.0	35.4	-	20.1	12.7	31.8	-	36.4	-	46.0	-	9.6	-	
Vert.	960.0	29.8	-	22.2	14.0	30.5	-	35.4	-	46.0	-	10.6	-	
Vert.	2483.5	50.6	-	27.5	5.4	32.4	-	51.2	-	73.9	-	22.7	-	*1)
Vert.	2486.8	49.7	36.3	27.5	5.4	32.4	1.1	50.3	38.0	73.9	53.9	23.6	15.9	
Vert.	4960.0	52.1	-	31.6	7.6	31.4	-	59.9	-	73.9	-	14.0	-	
Vert.	7440.0	46.2	-	36.2	8.8	32.4	-	58.8	-	73.9	-	15.1	-	
Vert.	12400.0	44.4	-	38.9	-1.7	32.8	-	48.8	-	73.9	-	25.1	-	
Vert.	19840.0	49.6	-	37.8	-2.3	32.2	-	52.9	-	73.9	-	21.1	-	

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)

Peak measurement value with duty cycle correction factor

Frequency [MHz]	Detector	Reading [dBuV] Hor	Reading [dBuV] Ver	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	DCCF [dB]	Result [dBuV/m] Hor	Result [dBuV/m] Ver	Limit [dBuV/m]	Margin [dB] Hor	Margin [dB] Ver	Remark
2483.500	PK	49.8	50.6	27.5	5.4	32.4	-33.0	17.3	18.1	53.9	36.6	35.8	*1)
4960.000	PK	53.4	52.1	31.6	7.6	31.4	-33.0	28.3	26.9	53.9	25.7	27.0	
7440.000	PK	48.0	46.2	36.2	8.8	32.4	-33.0	27.6	25.8	53.9	26.3	28.1	
12400.000	PK	46.2	44.4	38.9	-1.7	32.8	-33.0	17.6	15.8	53.9	36.3	38.1	
19840.000	PK	47.8	49.6	37.8	-2.3	32.2	-33.0	18.1	19.9	53.9	35.8	34.0	

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amprifier) + Duty factor (Refer to Duty factor data sheet)

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier) + DCCF
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Duty cycle correction factor (DCCF) refer to "Duty cycle correction factor" sheet.
*1) Not Out of Band emission(Leakage Power)

20dBc Data Sheet

Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2480.0	101.4	27.5	5.4	32.4	102.0	-	-	Carrier
Hori.	9920.0	36.7	39.1	9.4	33.1	52.2	82.0	29.8	
Hori.	14880.0	45.9	39.3	-0.8	32.1	52.3	82.0	29.7	
Hori.	22320.0	36.1	38.2	-1.8	32.1	40.4	82.0	41.6	
Vert.	2480.0	103.4	27.5	5.4	32.4	104.0	-	-	Carrier
Vert.	9920.0	34.4	39.1	9.4	33.1	49.8	84.0	34.2	
Vert.	14880.0	46.1	39.3	-0.8	32.1	52.5	84.0	31.5	
Vert.	22320.0	40.6	38.2	-1.8	32.1	44.9	84.0	39.1	

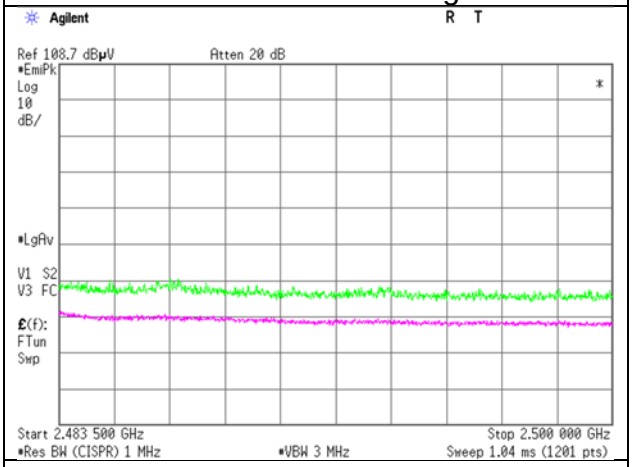
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)
Distance factor: 1 GHz - 10 GHz 20log (3.95 m / 3.0 m) = 2.39 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 8, 2023
Temperature / Humidity	21 deg. C / 57 % RH
Engineer	Junya Okuno
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2480 MHz

Horizontal

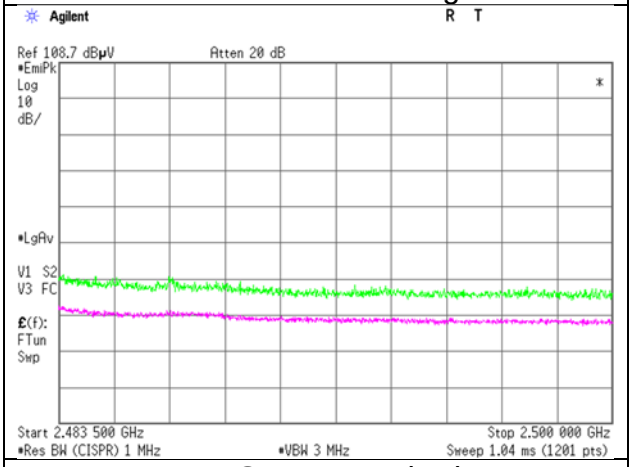
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

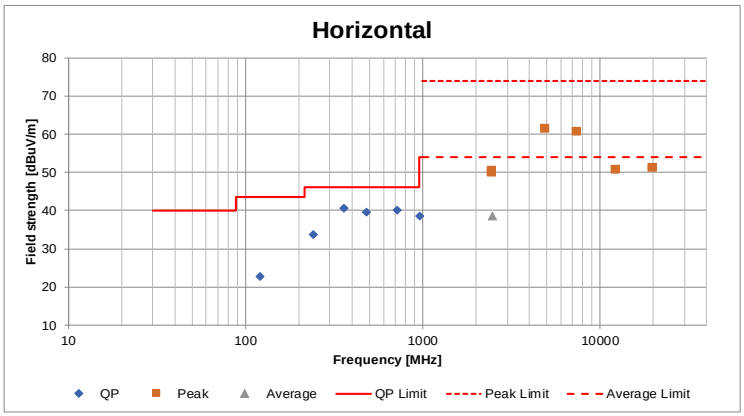


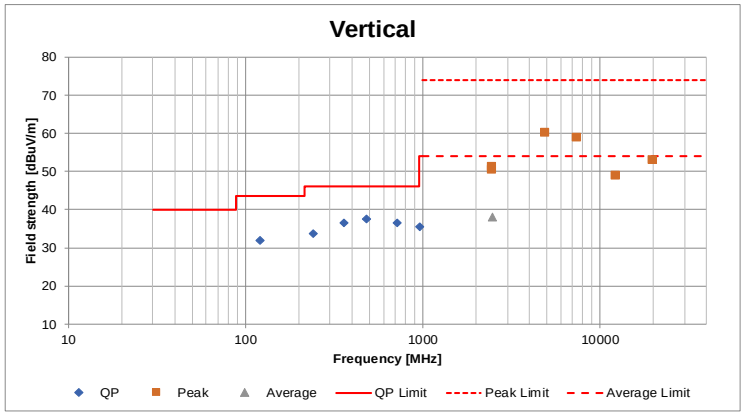
Trace Green : Peak Plot
Trace Purple : Average Plot

* 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	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	August 8, 2023	August 8, 2023
Temperature / Humidity	21 deg. C / 57 % RH	22 deg. C / 61 % RH
Engineer	Junya Okuno (1 GHz to 18 GHz)	Keiya Ido (Above 18 GHz) (Below 1 GHz)
Mode	Tx BT LE 2480 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	141558	Digital Tester(TRUE RMS MULTIMETER)	Fluke Corporation	115	17930030	05/29/2023	12
RE	141561	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1401	01/13/2023	12
RE	141885	Spectrum Analyzer	Keysight Technologies Inc	E4448A	US44300523	11/21/2022	12
RE	202511	Loop Antenna	UL Japan	-	-	-	-
RE	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	09/04/2023	12
RE	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-192	09/21/2023	12
RE	141323	Coaxial cable	UL Japan	-	-	09/10/2023	12
RE	141507	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	258	11/14/2022	12
RE	141513	Horn Antenna 15-40GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9170	BBHA9170306	07/19/2023	12
RE	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201197	01/17/2023	12
RE	141554	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1301	01/13/2023	12
RE	141580	MicroWave System Amplifier	Keysight Technologies Inc	83017A	MY39500779	03/08/2023	12
RE	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/07/2023	12
RE	141884	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY44020357	03/13/2023	12
RE	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	05/17/2023	12
RE	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/23/2022	24
RE	142013	AC3_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	10/18/2023	12
RE	142183	Measure	KOMELON	KMC-36	-	10/20/2023	12
RE	142314	Attenuator	Pasternack Enterprises	PE7390-6	D/C 1504	06/23/2023	12
RE	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	197990	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHBB 9124 + BBA 9106	01365	11/12/2022	12
RE	234602	Microwave Cable	Huber+Suhner	SF126E/11PC35/11PC35/ 1000M,5000M	537063/126E / 537074/126E	03/16/2023	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

APPENDIX 3: Photographs of Test Setup

Radiated Spurious Emission

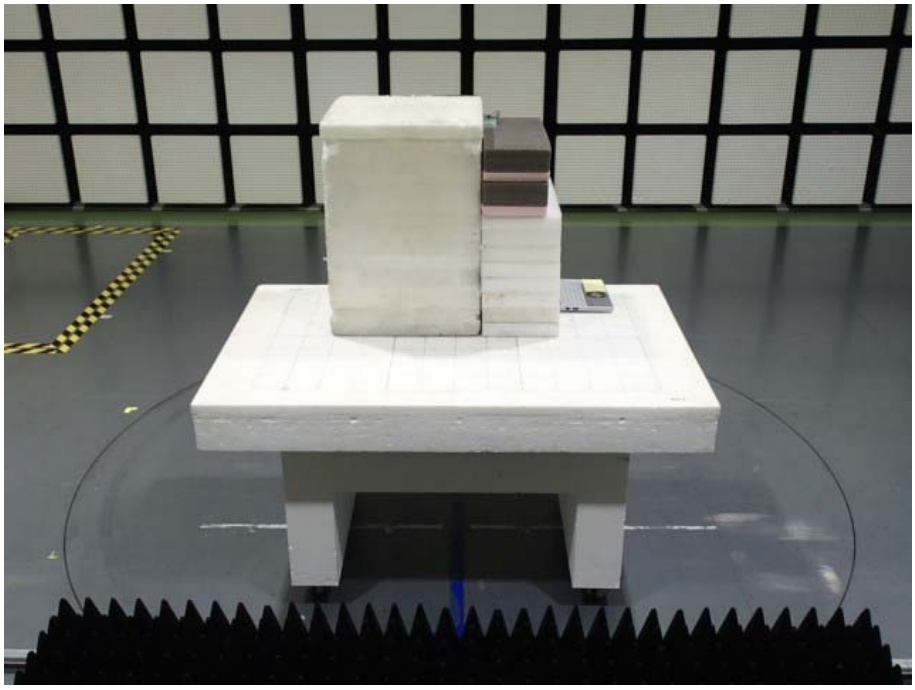


Photo 1

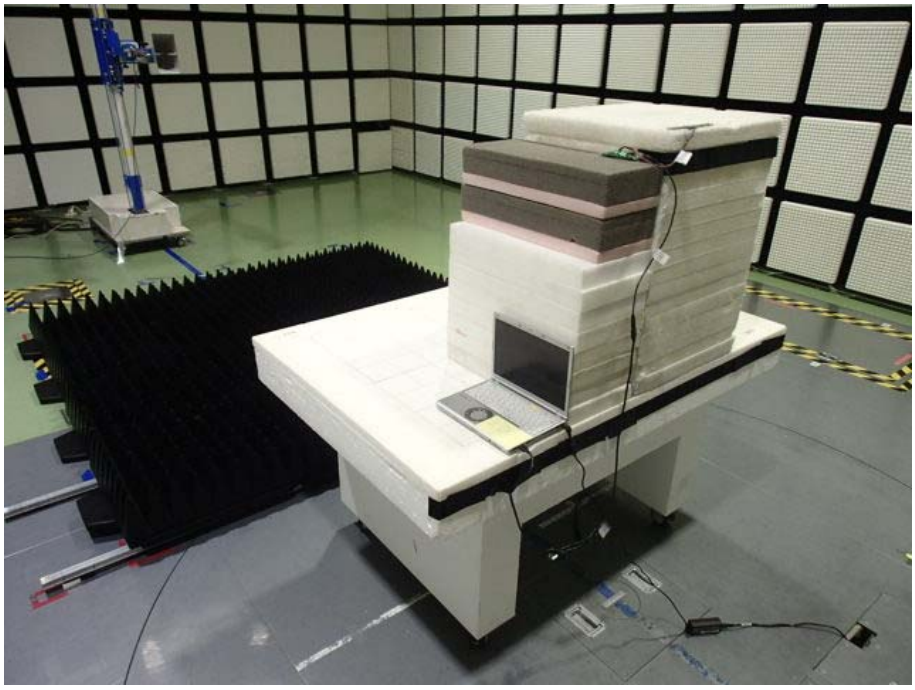


Photo 2

Worst Case Position

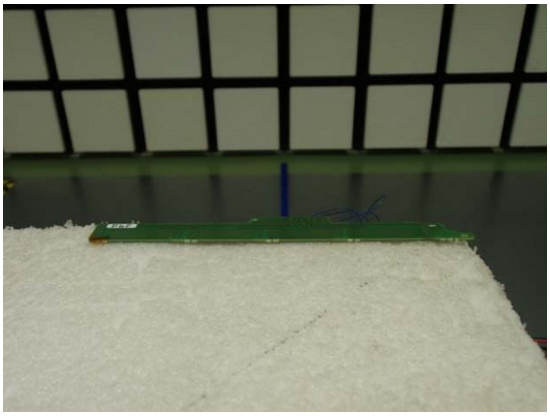
Carrior

Test Range	Horizontal	Vertical
Below 1 GHz	X-axis	X-axis
Above 1 GHz	X-axis	Z-axis

Harmonics

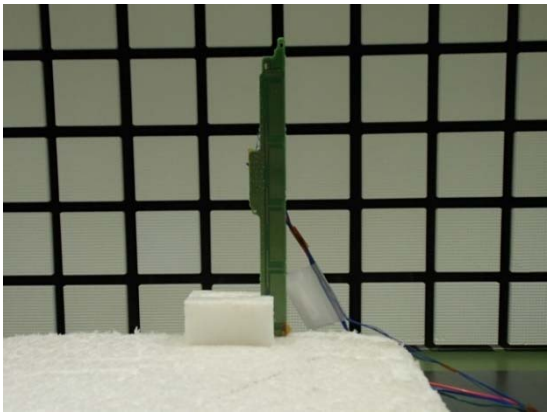
Test Range	Horizontal	Vertical
Below 1 GHz	X-axis	X-axis
Above 1 GHz	X-axis	X-axis

X-axis



Y-axis

Z-axis



End of Report