RADIO TEST REPORT

Test Report No. 15317905H-C-R1

Customer	**TandD Corporation**
Description of EUT	**Data Logger**
Model Number of EUT	**TR42A(n)**
FCC ID	**SRD50131**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**September 13, 2024**
Remarks	**-**

Representative Test Engineer	Approved By
Shosei Hamaguchi 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".

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REVISION HISTORY

Original Test Report No.: 15317905H-C

This report is a revised version of 15317905H-C. 15317905H-C is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15317905H-C	June 28, 2024	-
1	15317905H-C-R1	September 13, 2024	**Clause 2.1 Identification of EUT** - Corrected Test Date: May 24 to June 11, 2024 ↓ May 27 to June 11, 2024
			Clause 2.2 Product Description Corrected Rating of General Specification: DC 3.0 V to 3.6 V → DC 3.6 V
			Clause 2.2 Product Description **APPENDIX 1: Test Data (Maximum Peak Output Power / Conducted Spurious Emission)** - Corrected Antenna Gain: 2.93 dBi → -6.23 dBi - Corrected relevant data of antenna gain
			Clause 4.2 Configuration and Peripherals <u>Antenna Terminal Conducted Tests</u> - Corrected frequency of power supply of Item D for: AC 100 V / 50 Hz → AC 100 V / 60 Hz - Corrected information of cable No 2 to 4 in List of Cables Used: No.2 DC Cable (2.5 m) → USB Cable (1.5 m) No.3 USB Cable (1.5 m) → DC Cable (1.8 m) No.4 DC Cable (1.8 m) → AC Cable (1.0 m)

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

Company Name	TandD Corporation
Address	817-1 Shimadachi, Matsumoto, Nagano, 390-0852 Japan
Telephone Number	+81-263-40-0131
Contact Person	Shoji Kawayanagi

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	Data Logger
Model Number	TR42A(n)
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	May 24, 2024
Test Date	May 27 to June 11, 2024

2.2 Product Description

General Specification

Rating	DC 3.6 V
Operating temperature	-40 deg. C to 80 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)]	-6.23 dBi

2.3 Variant models

EUT, TR42A(n), has variant models: TR41A(n) and TR43A(n).
The difference between EUT and variant model is the way the sensors are mounted.
TR41A(n): Internal temperature sensor (1 ch)
TR42A(n) (EUT): External temperature sensor (1 ch)
TR43A(n): External temperature and humidity sensor (1 ch)

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	-	N/A	*1)
	ISED: RSS-Gen 8.8	**ISED:** RSS-Gen 8.8			
6dB 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)	7.8 dB 7206.0 MHz Horizontal, AV	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *2)
	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) The test is not applicable since the EUT is not the device that is designed to be connected to the public utility (AC) power line.
*2) 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 Part 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.

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

Antenna Terminal Conducted

Item	Unit	Calculated Uncertainty (+/-)
Antenna terminated conducted emission / Power density / Burst power	dB	3.47
Adjacent channel power (ACP)	dB	2.28
Bandwidth (OBW)	%	0.96
Time readout (time span upto 100 msec)	%	0.11
Time readout (time span upto 1000 msec)	%	0.11
Time readout (time span upto 60 sec)	%	0.02
Power measurement (Power meter < 8 GHz)	dB	1.46
Power measurement (Call box < 6 GHz)	dB	1.69
Frequency readout (Frequency counter)	ppm	0.67
Frequency readout (Spectrum analyzer frequency readout function)	ppm	2.13
Temperature (constant temperature bath)	deg. C	0.69
Humidity (constant temperature bath)	%RH	2.98
Modulation characteristics	%	6.93
Frequency for mobile	ppm	0.08
Contention-based protocol	dB	2.26

3.5 Test Location

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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)	Maximum Packet Size, PRBS9

*Power of the EUT was set by the software as follows;
Power Setting: +4 dBm
Software: Technical Standards RTR501_nrf.exe
Version 1.0.0.0
(Date: May 21, 2024, Storage location: Driven by connected PC)

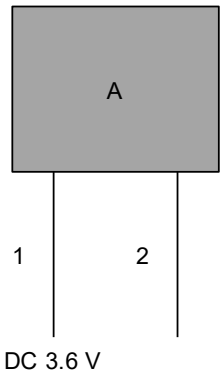
*This setting of software is the worst case.
Any conditions under the normal use do not exceed the condition of setting.
In addition, end users cannot change the settings of the output power of the product.

*The Details of Operating Mode(s)

Test Item	Operating Mode	Tested Frequency
Conducted Spurious Emission, Radiated Spurious Emission (Below 1 GHz) *1)	Tx BT LE	2402 MHz
6dB Bandwidth, 99% Occupied Bandwidth, Maximum Peak Output Power, Radiated Spurious Emission (Above 1 GHz), Power Density	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

Radiated Spurious Emission



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

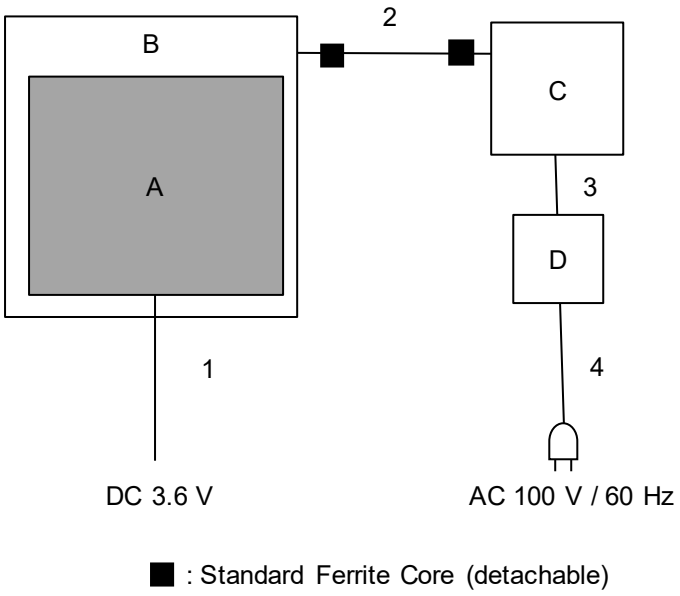
Description of EUT

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	Data Logger	TR42A(n)	5F430003	TandD Corporation	EUT

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.5	Unshielded	Unshielded	-
2	Signal Cable	0.6	Unshielded	Unshielded	-

Antenna Terminal Conducted Tests



* 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	Data Logger	TR42A(n)	5F430003	TandD Corporation	EUT
B	Communication adapter	TR-50U2	565C3442	TandD Corporation	-
C	Laptop PC	HP630	5CB123RJN	Hewlett Packard Japan, G.K.	-
D	Adapter	N17908	WBGSV0AAR0NG3I	Hewlett Packard Japan, G.K.	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.5	Unshielded	Unshielded	-
2	USB Cable	1.5	Shielded	Shielded	-
3	DC Cable	1.8	Unshielded	Unshielded	-
4	AC Cable	1.0	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

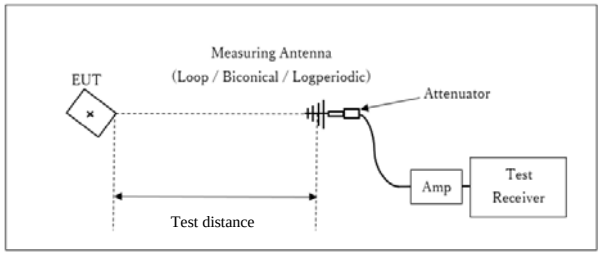
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired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

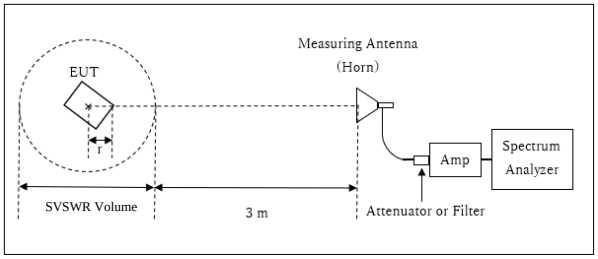
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz



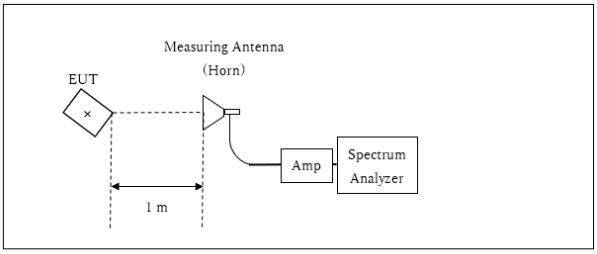
r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.75 m / 3.0 m) = 1.94 dB
* Test Distance: (3 + SVSWR Volume /2) - r = 3.75 m

SVSWR Volume : 1.5 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.0 m

* The test was performed with r = 0.0 m since EUT is small and it was the rather conservative condition.

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.

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 6: 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
6dB Bandwidth	3 Hz	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/ Average *2)	-	Power Meter (Sensor: 50 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	10 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *3)
Conducted Spurious Emission *4) *5)	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) Reference data
*3) Section 11.10.2 Method PKPSD (peak PSD) of "ANSI C63.10-2013".
*4) 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)
*5) 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

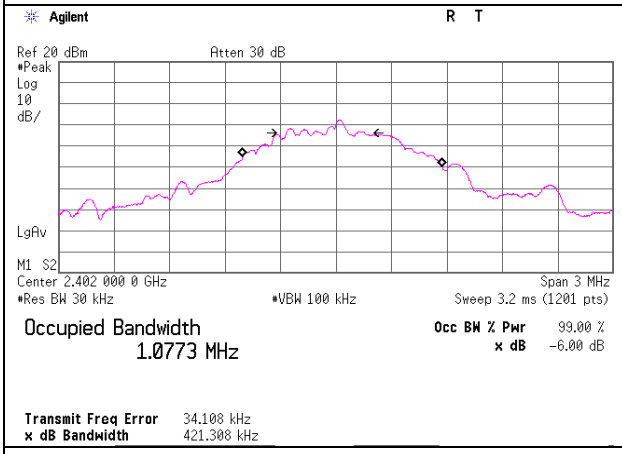
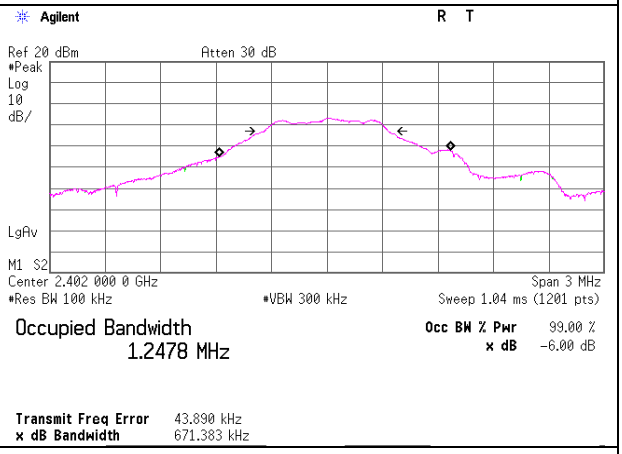
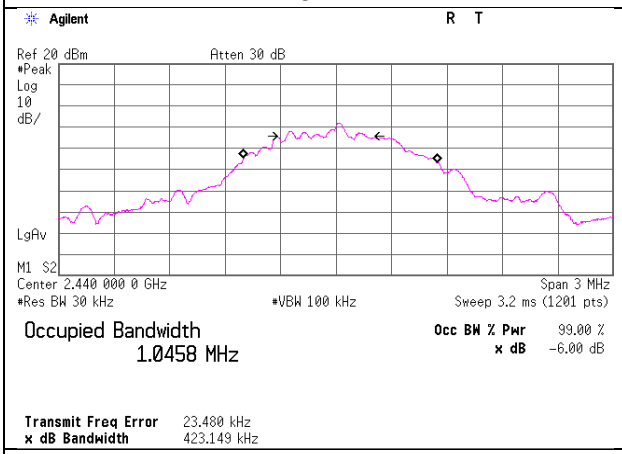
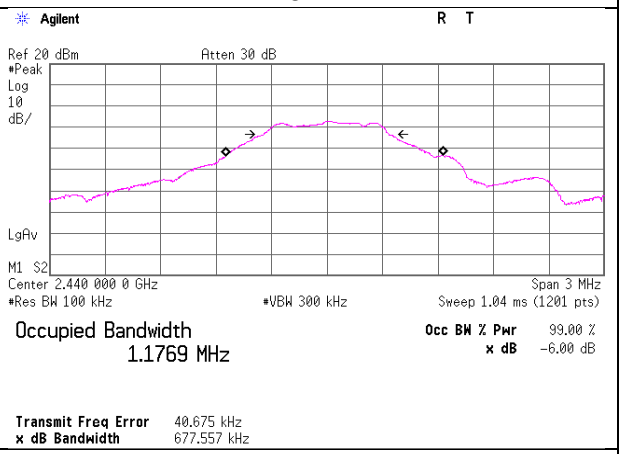
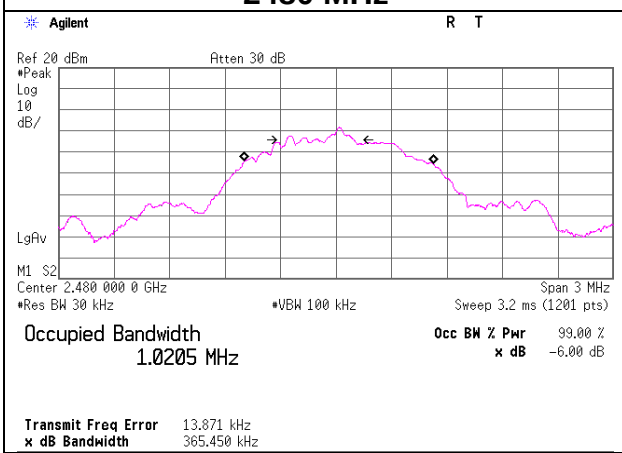
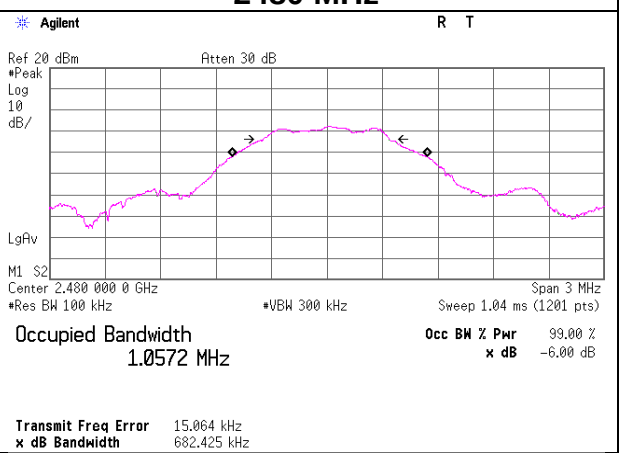
99 % Occupied Bandwidth and 6 dB Bandwidth

Test place	Ise EMC Lab. No.4 shielded room
Date	May 27, 2024
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Shousei Hamaguchi
Mode	Tx BT LE

Mode	Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
BT LE	2402	***1077.3***	0.671	> 0.5000
	2440	1045.8	0.678	> 0.5000
	2480	1020.5	0.682	> 0.5000

99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE

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

Maximum Peak Output Power

Test place	Ise EMC Lab. No.4 shielded room
Date	May 27, 2024
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Shousei Hamaguchi
Mode	Tx BT LE

				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	-6.46	0.70	9.73	***3.97***	***2.49***	30.00	1000	26.03	-6.23	***-2.26***	***0.59***	36.02	4000	38.28
2440	-6.77	0.70	9.73	3.66	2.32	30.00	1000	26.34	-6.23	-2.57	0.55	36.02	4000	38.59
2480	-7.38	0.70	9.73	3.05	2.02	30.00	1000	26.95	-6.23	-3.18	0.48	36.02	4000	39.20

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
e.i.r.p. Result = Conducted Power Result + Antenna Gain

Average Output Power
(Reference data for RF Exposure)

Test place	Ise EMC Lab. No.4 shielded room
Date	May 27, 2024
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Shousei Hamaguchi
Mode	Tx BT LE

Freq.	Reading	Cable Loss	Atten. Loss	Result (Time average)		Duty factor	Result (Burst power average)	
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dB]	[dBm]	[mW]
2402	-8.39	0.70	9.73	***2.04***	***1.60***	0.88	***2.92***	***1.96***
2440	-8.74	0.70	9.73	1.69	1.48	0.88	2.57	1.81
2480	-9.34	0.70	9.73	1.09	1.29	0.88	1.97	1.57

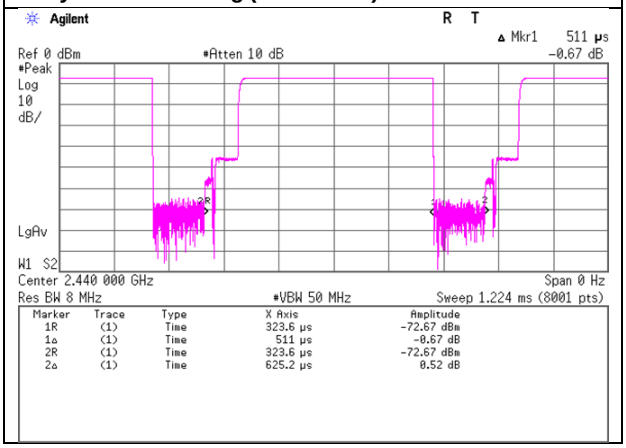
Sample Calculation:
Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
Result (Burst power average) = Time average + Duty factor

Burst rate confirmation

Test place	Ise EMC Lab. No.4 shielded room
Date	May 27, 2024
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Shousei Hamaguchi
Mode	Tx BT LE

BT LE

Tx on / (Tx on + Tx off) =	**0.817**
Tx on / (Tx on + Tx off) * 100 =	**81.7 %**
Duty factor = 10 * log (625.2 / 511) =	**0.88 dB**



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

Radiated Spurious Emission

Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.2	No.2	No.2
Date	June 4, 2024	June 5, 2024	June 11, 2024
Temperature / Humidity	21 deg. C / 50 % RH	20 deg. C / 55 % RH	21 deg. C / 65 % RH
Engineer	Yuichiro Yamazaki (Below 1 GHz)	Junya Okuno (1 GHz to 10 GHz)	Shousei Hamaguchi (Above 10 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.	30.0	21.4	-	18.7	6.6	28.6	-	18.1	-	40.0	-	21.9	-	
Hori.	80.8	25.5	-	6.9	7.2	28.5	-	11.2	-	40.0	-	28.8	-	
Hori.	137.6	23.1	-	14.2	7.7	28.3	-	16.7	-	43.5	-	26.8	-	
Hori.	216.0	20.0	-	11.5	8.2	27.9	-	11.8	-	43.5	-	31.7	-	Floor noise
Hori.	614.0	20.6	-	19.4	10.2	29.3	-	20.9	-	46.0	-	25.1	-	Floor noise
Hori.	960.0	20.3	-	22.1	11.5	28.7	-	25.2	-	46.0	-	20.8	-	Floor noise
Hori.	2332.6	54.4	40.1	27.9	4.3	34.4	0.9	52.1	38.8	73.9	53.9	21.8	15.1	*2)
Hori.	2387.1	54.3	39.9	27.7	4.3	34.4	0.9	51.9	38.3	73.9	53.9	22.1	15.6	*2)
Hori.	2390.0	47.9	36.0	27.7	4.3	34.4	0.9	45.4	34.5	73.9	53.9	28.5	19.4	*1)
Hori.	4804.0	48.2	39.5	31.6	6.1	33.6	0.9	52.3	44.4	73.9	53.9	21.6	9.5	*2)
Hori.	7206.0	44.3	36.6	35.6	6.5	33.4	0.9	53.0	46.1	73.9	53.9	20.9	7.8	*2)
Hori.	9608.0	43.8	34.6	35.7	7.4	34.0	-	52.9	43.7	73.9	53.9	21.1	10.2	Floor noise
Vert.	30.0	23.3	-	18.7	6.6	28.6	-	20.0	-	40.0	-	20.0	-	
Vert.	80.8	24.1	-	6.9	7.2	28.5	-	9.8	-	40.0	-	30.2	-	
Vert.	137.6	22.3	-	14.2	7.7	28.3	-	15.9	-	43.5	-	27.6	-	
Vert.	216.0	20.1	-	11.5	8.2	27.9	-	11.9	-	43.5	-	31.6	-	Floor noise
Vert.	614.0	20.7	-	19.4	10.2	29.3	-	21.0	-	46.0	-	25.0	-	Floor noise
Vert.	960.0	20.3	-	22.1	11.5	28.7	-	25.2	-	46.0	-	20.8	-	Floor noise
Vert.	2332.6	54.9	39.9	27.9	4.3	34.4	0.9	52.6	38.5	73.9	53.9	21.3	15.4	*2)
Vert.	2387.1	54.8	40.0	27.7	4.3	34.4	0.9	52.4	38.5	73.9	53.9	21.5	15.4	*2)
Vert.	2390.0	48.5	36.4	27.7	4.3	34.4	0.9	46.1	34.8	73.9	53.9	27.8	19.1	*1)
Vert.	4804.0	46.5	38.4	31.6	6.1	33.6	0.9	50.6	43.4	73.9	53.9	23.4	10.5	*2)
Vert.	7206.0	43.6	35.9	35.6	6.5	33.4	0.9	52.3	45.5	73.9	53.9	21.6	8.4	*2)
Vert.	9608.0	43.8	34.7	35.7	7.4	34.0	-	52.9	43.7	73.9	53.9	21.0	10.2	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)
*2) Noise synchronized with duty of carrier freqency

20dBc Data Sheet

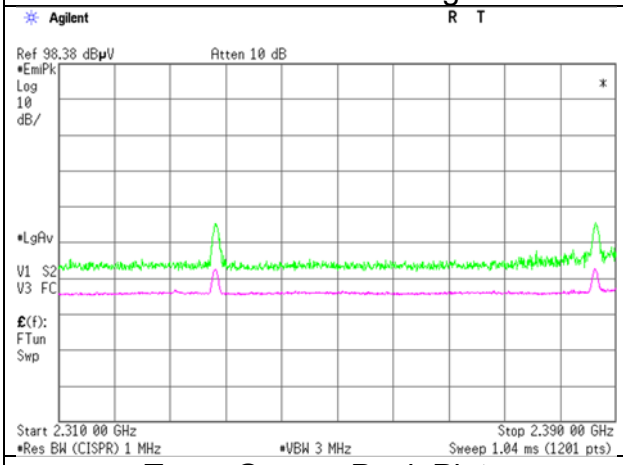
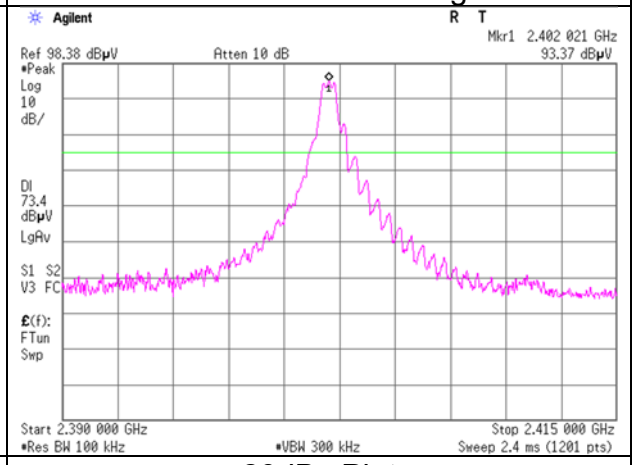
Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.0	93.4	27.6	4.3	34.4	90.9	-	-	Carrier
Hori.	2400.0	53.1	27.6	4.3	34.4	50.7	70.9	20.3	
Hori.	2445.8	52.6	27.5	4.3	34.4	50.1	70.9	20.8	
Vert.	2402.0	93.9	27.6	4.3	34.4	91.5	-	-	Carrier
Vert.	2400.0	54.0	27.6	4.3	34.4	51.5	71.5	20.0	
Vert.	2445.8	51.8	27.5	4.3	34.4	49.3	71.5	22.2	

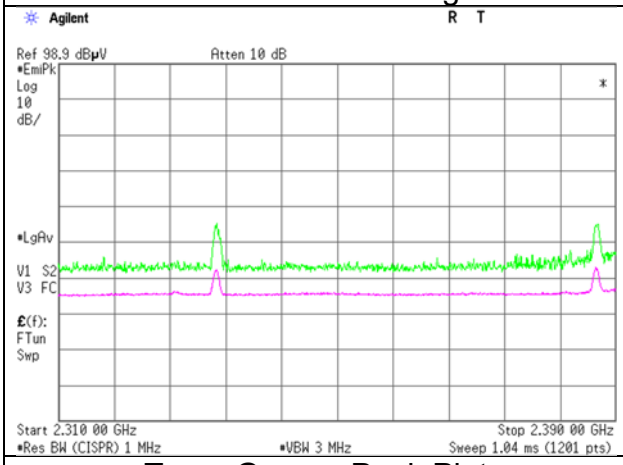
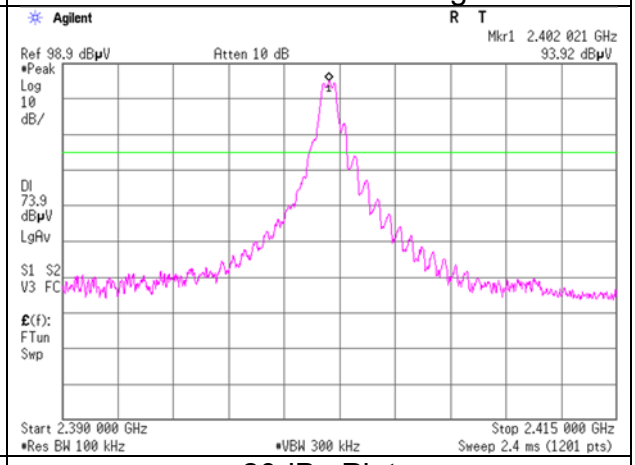
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

Distance factor:	1 GHz - 6 GHz	20log (3.75 m / 3.0 m) = 1.94 dB
	6 GHz - 10 GHz	20log (3.75 m / 3.0 m) = 1.94 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.2
Date	June 5, 2024
Temperature / Humidity	20 deg. C / 55 % 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.2	No.2
Date	June 5, 2024	June 11, 2024
Temperature / Humidity	20 deg. C / 55 % RH	21 deg. C / 65 % RH
Engineer	Junya Okuno	Shousei Hamaguchi
	(1 GHz to 10 GHz)	(Above 10 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	46.5	37.3	31.6	6.1	33.6	0.9	50.6	42.3	73.9	53.9	23.3	11.6	*2)
Hori.	7320.0	44.4	35.2	35.6	6.6	33.5	0.9	53.1	44.8	73.9	53.9	20.8	9.1	*2)
Hori.	9760.0	42.8	34.2	36.0	7.5	34.1	-	52.2	43.6	73.9	53.9	21.7	10.3	Floor noise
Vert.	4880.0	45.6	36.0	31.6	6.1	33.6	0.9	49.7	41.0	73.9	53.9	24.2	12.9	*2)
Vert.	7320.0	43.8	35.2	35.6	6.6	33.5	0.9	52.5	44.8	73.9	53.9	21.4	9.1	*2)
Vert.	9760.0	42.9	34.2	36.0	7.5	34.1	-	52.3	43.6	73.9	53.9	21.6	10.3	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.

*2) Noise synchronized with duty of carrier freqency

Distance factor:	1 GHz - 6 GHz	20log (3.75 m / 3.0 m) = 1.94 dB
	6 GHz - 10 GHz	20log (3.75 m / 3.0 m) = 1.94 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.2	No.2
Date	June 5, 2024	June 11, 2024
Temperature / Humidity	20 deg. C / 55 % RH	21 deg. C / 65 % RH
Engineer	Junya Okuno	Shousei Hamaguchi
	(1 GHz to 10 GHz)	(Above 10 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.	2483.5	58.1	44.3	27.5	4.4	34.3	0.9	55.6	42.7	73.9	53.9	18.3	11.2	*1)
Hori.	4960.0	45.0	35.8	31.7	6.0	33.6	0.9	49.2	40.8	73.9	53.9	24.7	13.1	*2)
Hori.	7440.0	44.0	35.4	35.5	6.6	33.5	0.9	52.7	44.9	73.9	53.9	21.3	9.0	*2)
Hori.	9920.0	43.1	34.9	36.2	7.5	34.1	-	52.7	44.5	73.9	53.9	21.2	9.4	Floor noise
Vert.	2483.5	57.4	44.5	27.5	4.4	34.3	0.9	55.0	42.9	73.9	53.9	19.0	11.0	*1)
Vert.	4960.0	44.4	35.5	31.7	6.0	33.6	0.9	48.6	40.5	73.9	53.9	25.3	13.4	*2)
Vert.	7440.0	43.8	35.2	35.5	6.6	33.5	0.9	52.4	44.7	73.9	53.9	21.5	9.2	*2)
Vert.	9920.0	43.0	34.9	36.2	7.5	34.1	-	52.6	44.5	73.9	53.9	21.3	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)
*2) Noise synchronized with duty of carrier freqency

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	93.8	27.5	4.4	34.3	91.3	-	-	Carrier
Hori.	2445.8	53.0	27.5	4.3	34.4	50.6	71.3	20.7	
Hori.	2504.1	50.4	27.5	4.4	34.3	47.9	71.3	23.4	
Hori.	2570.9	51.5	27.6	4.4	34.3	49.2	71.3	22.1	
Vert.	2480.0	93.1	27.5	4.4	34.3	90.7	-	-	Carrier
Vert.	2445.8	51.5	27.5	4.3	34.4	49.1	70.7	21.6	
Vert.	2504.1	49.8	27.5	4.4	34.3	47.4	70.7	23.3	
Vert.	2570.9	50.7	27.6	4.4	34.3	48.4	70.7	22.2	

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

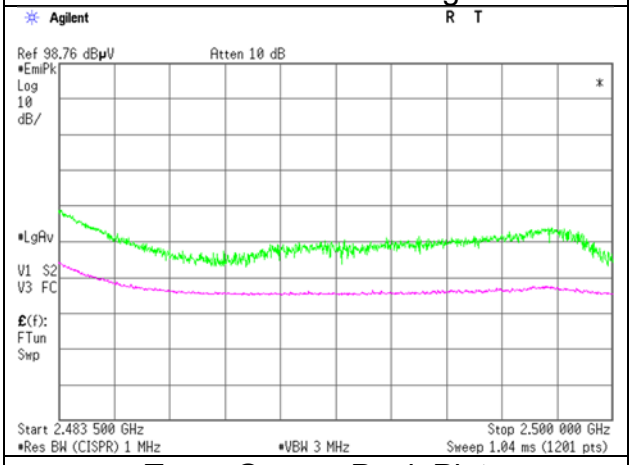
Distance factor:	1 GHz - 6 GHz	20log (3.75 m / 3.0 m) = 1.94 dB
	6 GHz - 10 GHz	20log (3.75 m / 3.0 m) = 1.94 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.2
Date	June 5, 2024
Temperature / Humidity	20 deg. C / 55 % RH
Engineer	Junya Okuno
	(1 GHz to 10 GHz)
Mode	Tx BT LE 2480 MHz

Horizontal

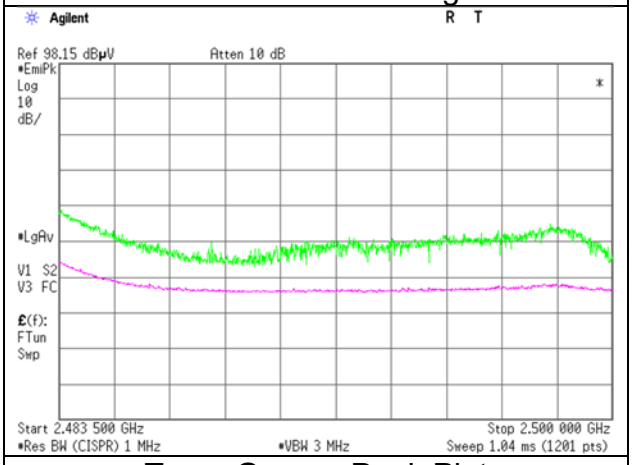
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

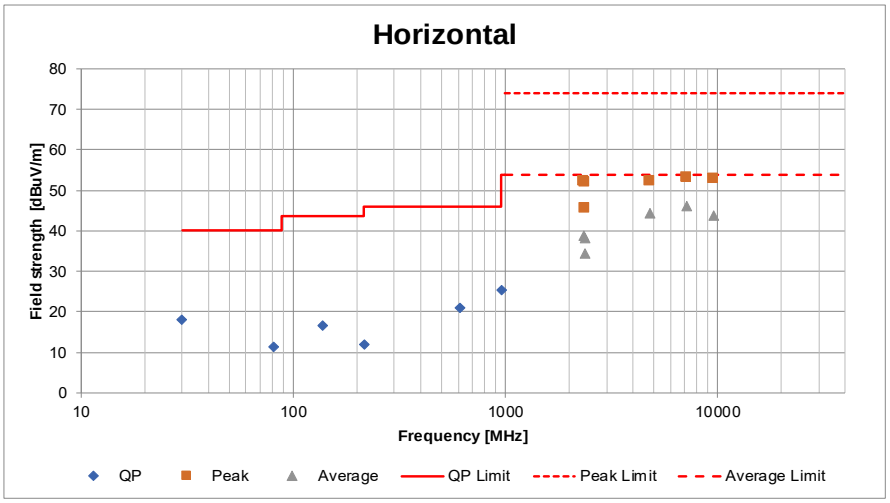


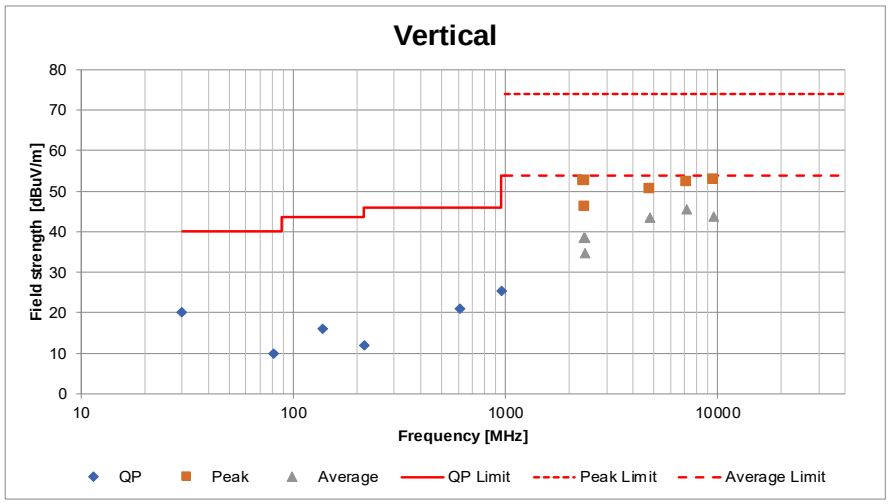
Trace Green : Peak Plot
Trace Purple : Average Plot

* 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.2	No.2	No.2
Date	June 4, 2024	June 5, 2024	June 11, 2024
Temperature / Humidity	21 deg. C / 50 % RH	20 deg. C / 55 % RH	21 deg. C / 65 % RH
Engineer	Yuichiro Yamazaki (Below 1 GHz)	Junya Okuno (1 GHz to 10 GHz)	Shousei Hamaguchi (Above 10 GHz)
Mode	Tx BT LE 2402 MHz		



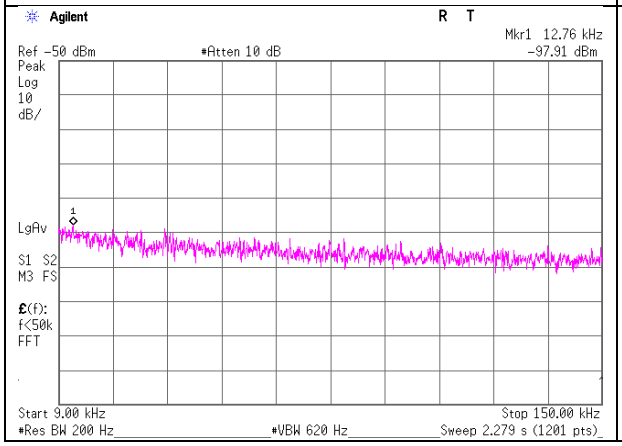


*These plots data contain sufficient number to show the trend of characteristic features for EUT.

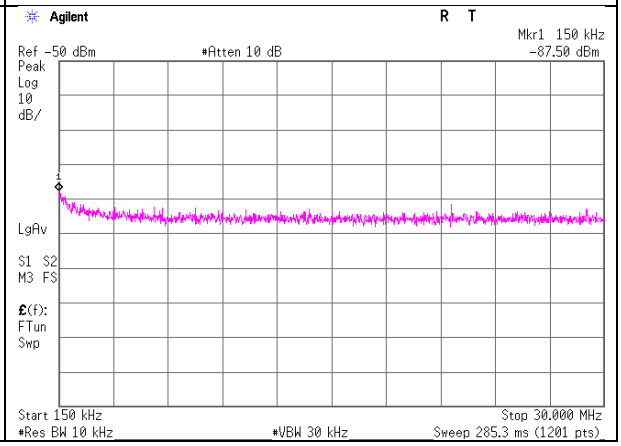
Conducted Spurious Emission

Test place	Ise EMC Lab. No.4 shielded room
Date	May 27, 2024
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Shousei Hamaguchi
Mode	Tx BT LE 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
12.76	-97.9	0.70	9.7	2.0	1	-85.5	300	6.0	-24.3	45.4	69.7	
150.00	-87.5	0.70	9.7	2.0	1	-75.1	300	6.0	-13.9	24.0	37.9	

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	Ise EMC Lab. No.4 shielded room
Date	May 27, 2024
Temperature / Humidity	23 deg. C / 59 % RH
Engineer	Shousei Hamaguchi
Mode	Tx BT LE

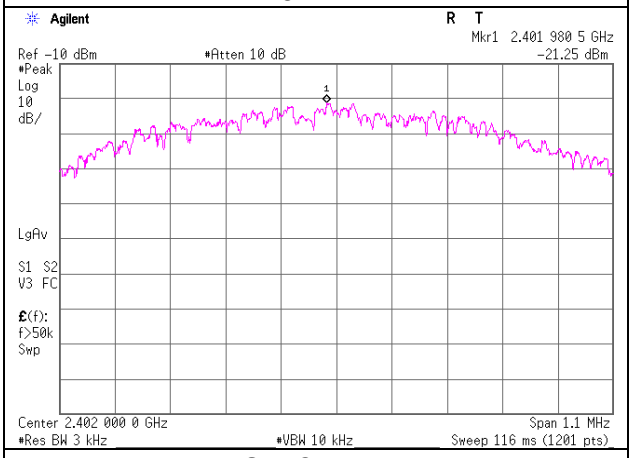
Freq. [MHz]	Reading [dBm / 3 kHz]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Margin [dB]
2402	-21.25	0.70	9.73	***-10.82***	8.00	18.82
2440	-21.40	0.70	9.73	-10.97	8.00	18.97
2480	-21.55	0.70	9.73	-11.12	8.00	19.12

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

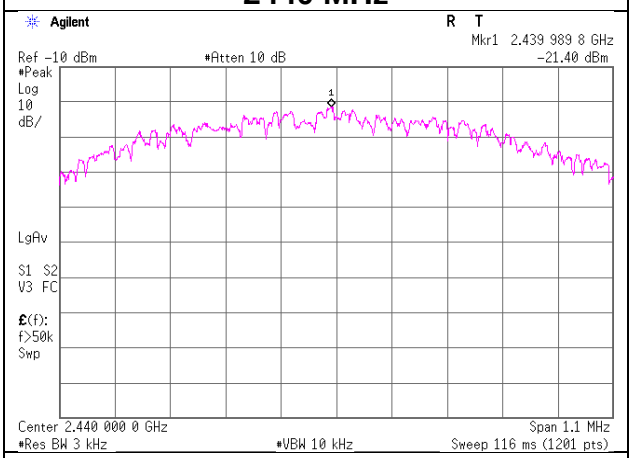
Power Density

BT LE

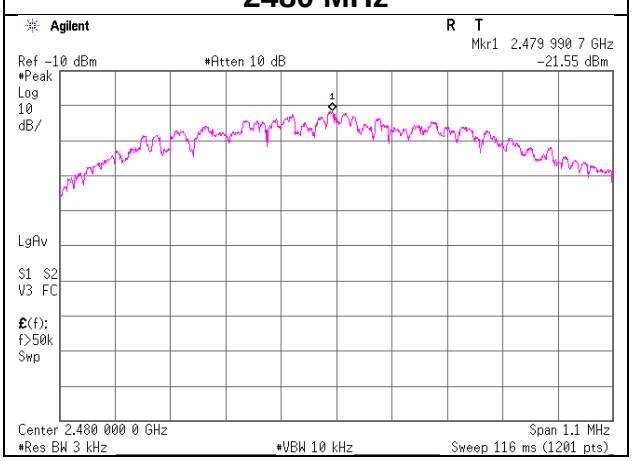
2402 MHz



2440 MHz



2480 MHz



APPENDIX 2: Test Instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	09/04/2023	12
RE	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-190	07/11/2023	12
RE	141317	Coaxial Cable	UL Japan	-	-	09/12/2023	12
RE	141404	High Pass Filter 3.5-24GHz	TOKIMEC	TF323DCA	601	05/23/2024	12
RE	141427	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103B+ BBA9106	08031	07/11/2023	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	141901	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY48250080	01/26/2024	12
RE	141978	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180899	05/09/2024	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	04/17/2023	24
RE	142228	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	213780	EMI Test Receiver	Rohde & Schwarz	ESW8	103079	01/30/2024	12
RE	220646	Attenuator	Huber+Suhner	6806_N-50-1	-	03/12/2024	12
RE	238713	Double Ridge Horn Antenna	Schwarzbeck Mess-Elektronik OHG	BBHA 9120 C	688	08/10/2023	12
RE	244707	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202102	01/25/2024	12
RE	246001	Microwave Cable	Huber+Suhner	SF103/11PC35/ 11PC35/1000mm / SF126E/5000mm	800673(1m) / 610204(5m)	03/06/2024	12
AT	141244	Attenuator (10dB)	Weinschel - API Technologies Corp	WA8-10-34	A198	02/17/2024	12
AT	141419	Attenuator	Weinschel Associates	WA56-10	56100305	05/22/2024	12
AT	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	02/01/2024	12
AT	141809	Power Meter	Anritsu Corporation	ML2495A	825002	05/22/2024	12
AT	141830	Power sensor	Anritsu Corporation	MA2411B	738285	05/22/2024	12
AT	141884	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY44020357	05/09/2024	12
AT	195231	Microwave Cable	Huber+Suhner	SF102D/11PC24/ 11PC24/1000mm	537062/126E	02/13/2024	12
AT	244710	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202104	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:

AT: Antenna Terminal Conducted test
RE: Radiated Emission