RADIO TEST REPORT

Test Report No. 14630329M-A-R1

Customer	**ALPS ALPINE CO., LTD.**
Description of EUT	**Bluetooth(TM) Low Energy Module**
Model Number of EUT	**UGPZAA**
FCC ID	**CWTUGPZAA**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied (Refer to SECTION 3)**
Issue Date	**March 14, 2023**
Remarks	**-**

Representative Test Engineer	**Approved By**
Hiromitsu Tanabe Engineer	Kazuhiro Ando Engineer

CERTIFICATE 1266.01

☐ 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# 21.0

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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.: 14630329M-A

This report is a revised version of 14630329M-A. 14630329M-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14630329M-A	March 8, 2023	-
1	14630329M-A-R1	March 14, 2023	P.6 3.2 Procedures and Results - FCC Part 15.31 (e) comment was corrected. P.7 3.4 Uncertainty - Required Uncertainty was deleted from the uncertainty table. P.26, 28-29, 31, 33-34, 36 Test Data - Duty factor was deleted from the floor noise measurement since it was considered Duty factor.

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	ALPS ALPINE CO., LTD.
Address	6-3-36, Furukawanakazato, Osaki-city, Miyagi-pref, JAPAN 989-6181
Telephone Number	+81-229-23-5111
Contact Person	Yuji Ouchi

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	Bluetooth(TM) Low Energy Module
Model Number	UGPZAA
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	February 6, 2023
Test Date	February 15 to February 24, 2023

2.2 Product Description

General Specification

Rating	DC 3.0 V to 3.63 V (Typical: DC 3.3 V)
Operating temperature	-40 deg. C to 105 deg. C

Radio Specification

Bluetooth (Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	GFSK
Antenna Gain	2.1 dBi

SECTION 3: Test Specification, Procedures & Results

3.1 Test Specification

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

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	22.6 dB, 0.20748 MHz, N Mode: Tx BT LE, 2M-PHY 2440MHz	Complied a)	-
	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 b)	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 c)	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 d)	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)	4.5 dB 7206.000 MHz, AV, Hori. Mode: Tx BT LE 1M-PHY, 2402 MHz	Complied e), f)	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *1)
	ISED: RSS-Gen 6.13	**ISED:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10			

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

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

a) Refer to APPENDIX 1 (data of Conducted Emission)
b) Refer to APPENDIX 1 (data of 6 dB Bandwidth and 99 % Occupied Bandwidth)
c) Refer to APPENDIX 1 (data of Maximum Peak Output Power)
d) Refer to APPENDIX 1 (data of Power Density)
e) Refer to APPENDIX 1 (data of Conducted Spurious Emission)
f) Refer to APPENDIX 1 (data of Radiated Spurious Emission)

FCC Part 15.31 (e)

The RF Module has its own regulator.
The RF Module is constantly provided with voltage through the regulator regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC Part 15.203/212 Antenna requirement

The antenna is not removable from the EUT. Therefore, the equipment complies with the antenna requirement of Section 15.203/212.

3.3 Addition to Standard

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
99% Occupied Bandwidth	**ISED:** RSS-Gen 6.7	**ISED:** -	N/A	- a)	Conducted
a) Refer to APPENDIX 1 (data of 6 dB Bandwidth and 99 % Occupied Bandwidth)					

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 $k = 2$.

Conducted emission

Frequency range	Calculate Uncertainty (+/-)
0.15 MHz to 30 MHz	3.2 dB

Radiated emission

Measurement distance	Frequency range	Calculate Uncertainty (+/-)
3 m	9 kHz to 30 MHz	2.9 dB
	30 MHz to 200 MHz	6.2 dB
	200 MHz to 1000 MHz	6.3 dB
	1 GHz to 6 GHz	5.0 dB
	6 GHz to 18 GHz	5.4 dB
	18 GHz to 40 GHz	5.5 dB
1 m	1 GHz to 18 GHz	5.4 dB
	18 GHz to 40 GHz	5.6 dB
0.5m	26.5 GHz to 40 GHz	5.9 dB

Antenna Terminal test

Test Item	Calculate Uncertainty (+/-)
6 dB Bandwidth / 99 % Occupied Bandwidth	1.6 %
Maximum Output Power	0.73 dB
Burst Rate	0.256 %
Power Density	2.2 dB
Conducted Spurious Emission (9 kHz to 30 MHz)	2.2 dB

3.5 Test Location

UL Japan, Inc. Kashima EMC Lab.
1614 Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan
Telephone: +81 478 88 6500
A2LA Certificate Number: 1266.01 / FCC Test Firm Registration Number: 910230
ISED Lab Company Number: 4659A / CAB identifier: JP0006

Test site	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Open site	6.0 x 5.5 x 2.5	20 x 40	10 m
No.5 Open site	8.6 x 7.1 x 2.4	18 x 23	10 m
No.1 Shielded room	5.4 x 4.5 x 2.3	-	-
No.5 Shielded Room	4.2 x 3.1 x 2.5	-	-
No.9 Shielded Room	6.1 x 3.6 x 2.8	-	-
No.6 Semi-anechoic Chamber	8.5 x 5.5 x 5.2	-	3 m
No.10 Semi-anechoic Chamber	18.4 x 9.9 x 7.7	-	10 m
No.11 Semi-anechoic Chamber	9.0 x 6.5 x 5.2	-	3 m
No.1 Measurement room	5.0 x 3.7 x 2.6	-	-
No.2 Measurement room	4.3 x 4.4 x 2.7	-	-
No.3 Measurement room	4.5 x 5.3 x 2.7	-	-

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 (BLE) 1M-PHY	Maximum Packet Size, PRBS9
Bluetooth Low Energy (BLE) 2M-PHY	Maximum Packet Size, PRBS9

*Power of the EUT was set by the software as follows;
Power Setting: Fixed
Software: HCI_BT_MANU for UGCZ1 V1.6.0.7
(Date: 2023.1.19, 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.

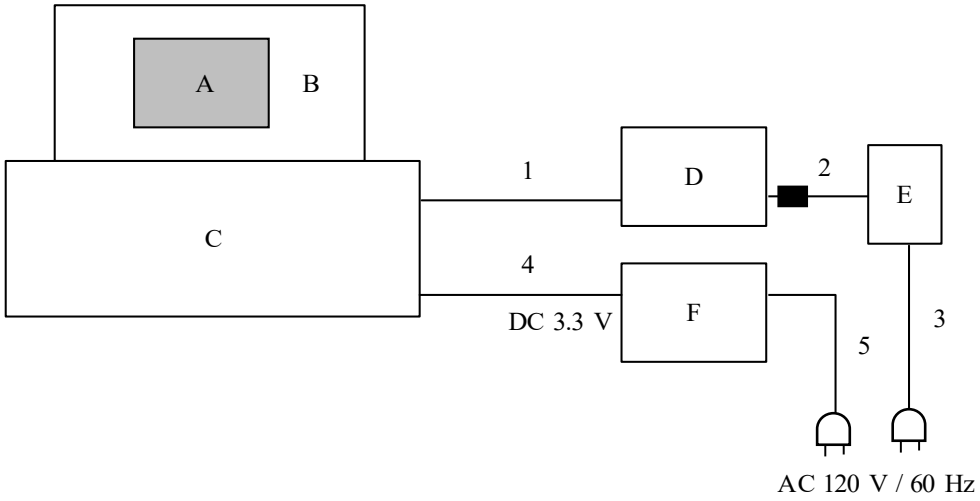
*The Details of Operating Mode(s)

Test Item	Operating Mode	Tested frequency
Conducted Emission, Radiated Spurious Emission, Maximum Peak Output Power, Power Density, 6dB Bandwidth, 99% Occupied Bandwidth, Conducted Spurious Emission	Tx BLE, 1M-PHY *1) Tx BLE, 2M-PHY *1)	2402 MHz 2440 MHz 2480 MHz

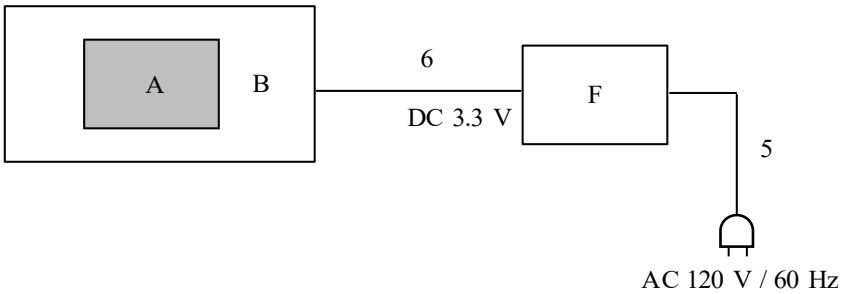
*1) Conducted emissions were limited to the channel that had the highest power during the antenna terminal test, as preliminary testing indicated that changing the operating frequency had no significant impact on the emissions in those frequency bands.

4.2 Configuration and Peripherals

Antenna Terminal Conducted



Conducted Emission and Radiated Emission



■ : Standard Ferrite Core

* 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	Bluetooth(TM) Low Energy Module	UGPZAA	21 *1) 15 *2)	ALPS ALPINE CO., LTD.	EUT
B	EVALUATION V1	FY0402Z11-1	21 *1) 15 *2)	ALPS ALPINE CO., LTD.	-
C	Quick Starter Kit	FY0402Z11-2	none	ALPS ALPINE CO., LTD.	-
D	Laptop PC	PC-VY10GCZ7A	07001701A	NEC	-
E	AC Adapter	ADP69	0603627DB	NEC	-
F	DC Power Supply	GSV3000	1708192899	DIAMOND ANTENNA	-

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

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	USB	1.8	Shielded	Shielded	-
2	DC	1.8	Unshielded	Unshielded	-
3	AC	0.8	Unshielded	Unshielded	2 wire
4	DC	1.0	Unshielded	Unshielded	-
5	AC	1.7	Unshielded	Unshielded	2 wire
6	DC	1.8	Unshielded	Unshielded	-

SECTION 5: Conducted Emission

Test Procedure and Conditions

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

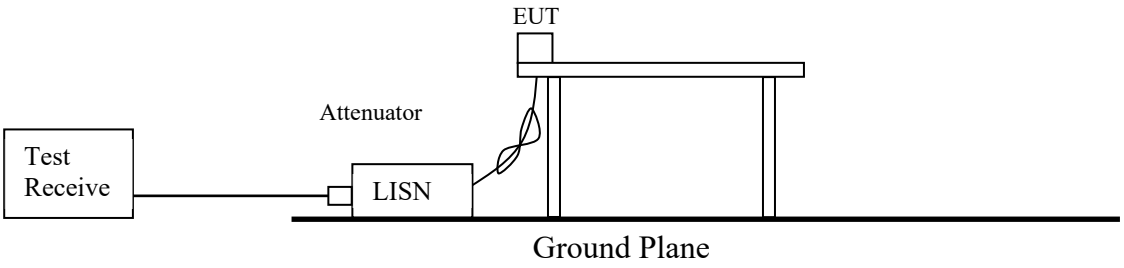
For the tests on EUT with other peripherals (as a whole system)
I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane.

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

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

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

Figure 1: Test Setup



SECTION 6: Radiated Spurious Emission

Test Procedure

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

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 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	Below 1 GHz	Above 1 GHz
Antenna Type	Hybrid	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.

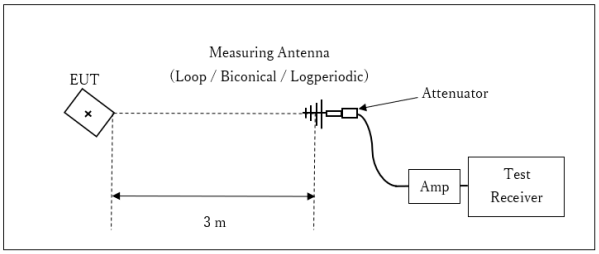
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *1)	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

*1) Average Power Measurement was performed based on ANSI C63.10-2013.

Figure 2: Test Setup

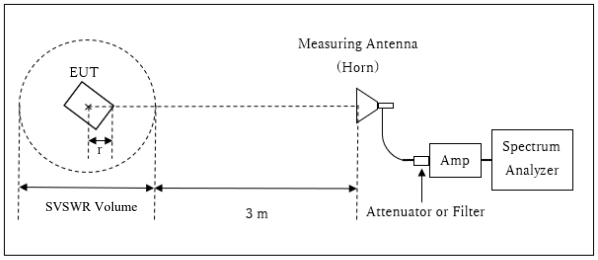
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

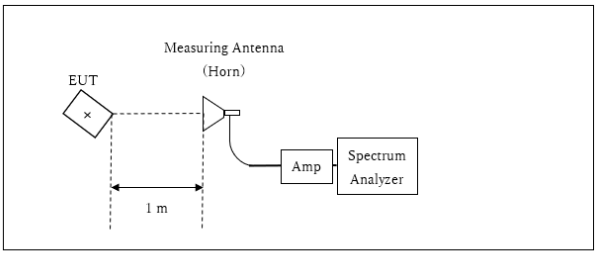


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.99 m / 3.0 m) = 2.48 dB
* Test Distance: (3 + SVSWR Volume /2) - r = 3.99 m

SVSWR Volume : 2.0 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.01 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

SECTION 7: Antenna Terminal Conducted Tests

Test Procedure

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

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument Used
6dB Bandwidth	3 MHz (BLE, 1M-PHY) 5 MHz (BLE, 2M-PHY)	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: 160 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	9.1 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.

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

Test Data : **APPENDIX**
Test Result : **Pass**

APPENDIX 1: Test Data

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

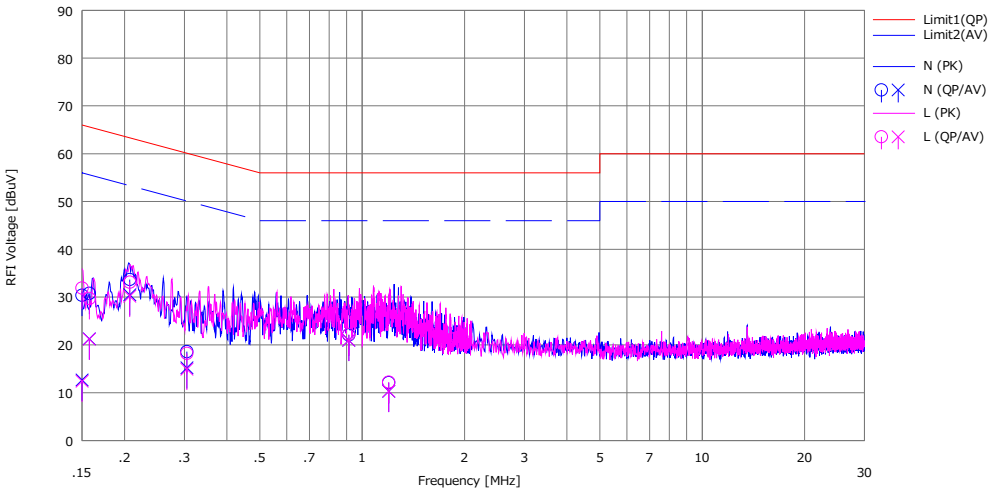
UL Japan, Inc. Kashima EMC Lab. No.5 Shielded Room
Date : 2023/02/24

Mode : Tx BT LE, 1M-PHY 2480MHz
Order No. : 14630329
Power : DC 3.3 V(AC 120V / 60Hz)
Temp./Humi. : 22 deg.C / 39 %RH

Remarks : -

Limit : FCC_Part 15 Subpart C(15.207)

Tested by : Hiromitsu Tanabe



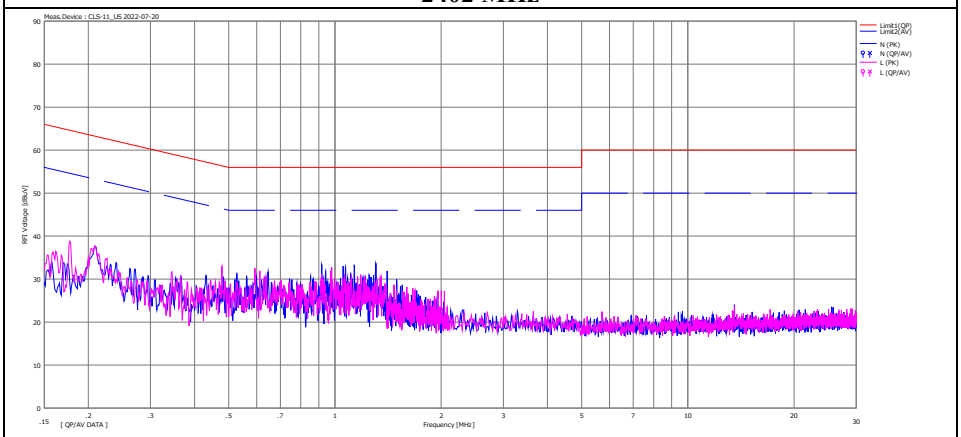
No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈AV〉		〈QP〉	〈AV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15000	20.30	2.60	10.08	30.38	12.68	66.00	56.00	35.6	43.3	N	
2	0.15760	20.70	11.20	10.08	30.78	21.28	65.59	55.59	34.8	34.3	N	
3	0.20720	23.60	20.40	10.09	33.69	30.49	63.32	53.32	29.6	22.8	N	
4	0.30497	8.50	5.10	10.10	18.60	15.20	60.11	50.11	41.5	34.9	N	
5	0.91332	11.90	10.80	10.18	22.08	20.98	56.00	46.00	33.9	25.0	N	
6	1.19700	1.90	0.10	10.21	12.11	10.31	56.00	46.00	43.8	35.6	N	
7	0.15000	21.80	2.30	10.10	31.90	12.40	66.00	56.00	34.1	43.6	L	
8	0.15760	19.60	11.10	10.10	29.70	21.20	65.59	55.59	35.8	34.3	L	
9	0.20720	23.00	20.10	10.11	33.11	30.21	63.32	53.32	30.2	23.1	L	
10	0.30497	8.10	4.80	10.12	18.22	14.92	60.11	50.11	41.8	35.1	L	
11	0.91332	12.00	10.80	10.20	22.20	21.00	56.00	46.00	33.8	25.0	L	
12	1.19700	2.00	0.10	10.23	12.23	10.33	56.00	46.00	43.7	35.6	L	

Calculation:Result[dBuV]=Reading[dBuV]+C.Fac(LISN+Cable+ATT)[dB]
LISN:CLS-11

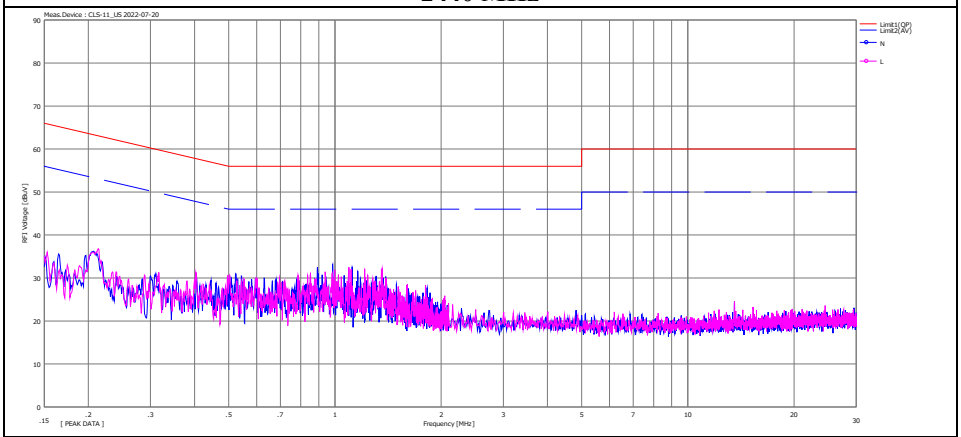
Conducted Emission

Test place	Kashima EMC Lab. No.5 Shielded Room
Date	February 24, 2023
Temperature / Humidity	22 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE, 1M-PHY

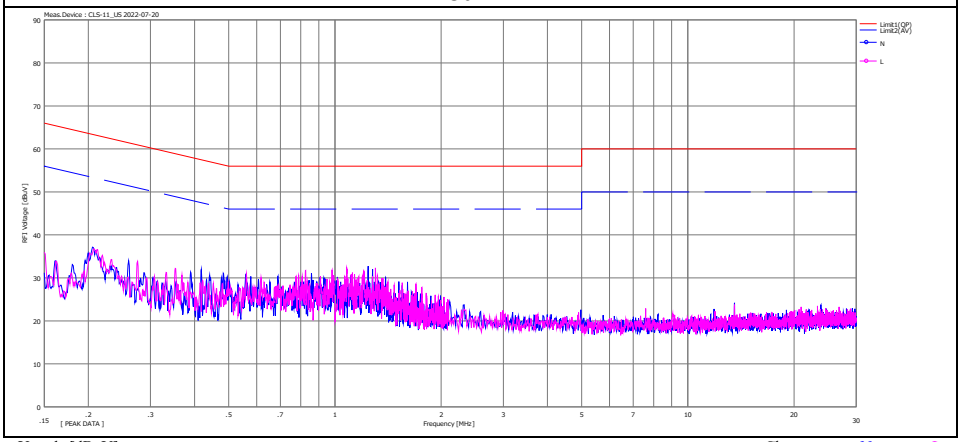
2402 MHz



2440 MHz



2480 MHz



Y scale [dBuV]

Chart — N — L

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

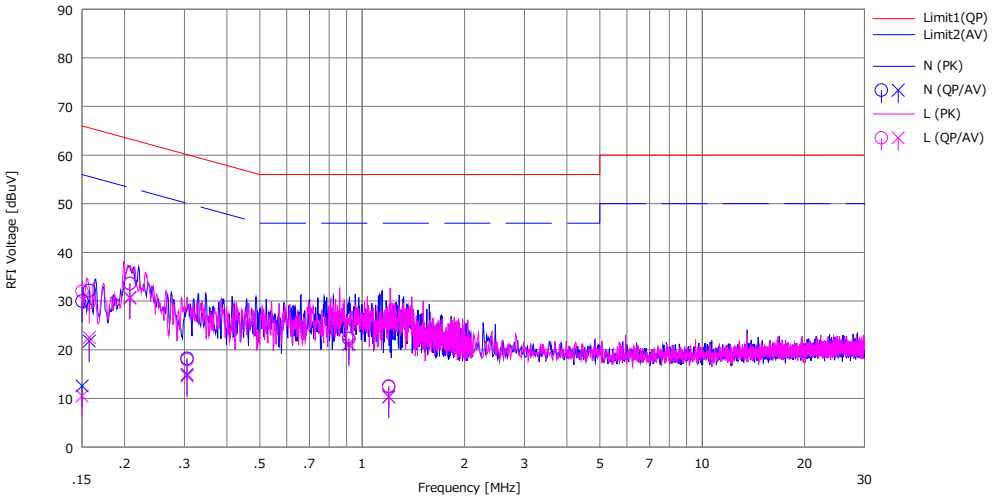
UL Japan, Inc. Kashima EMC Lab. No.5 Shielded Room
Date : 2023/02/24

Mode : Tx BT LE, 2M-PHY 2440MHz
Order No. : 14630329
Power : DC 3.3 V(AC 120V / 60Hz)
Temp./Humi. : 22 deg.C / 39 %RH

Remarks : -

Limit : FCC_Part 15 Subpart C(15.207)

Tested by : Hiromitsu Tanabe



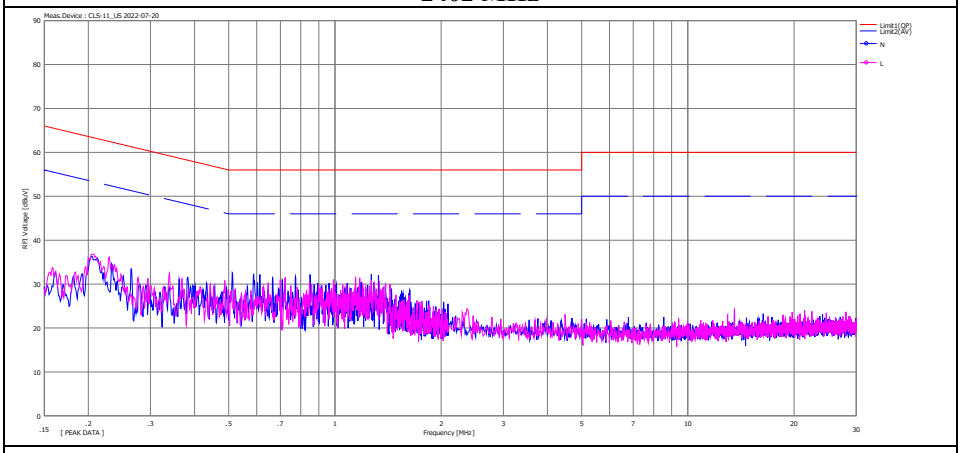
No.	Freq.	Reading		C.Fac	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈AV〉		〈QP〉	〈AV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15000	19.90	2.50	10.08	29.98	12.58	66.00	56.00	36.0	43.4	N	
2	0.15750	22.10	11.70	10.08	32.18	21.78	65.59	55.59	33.4	33.8	N	
3	0.20748	23.50	20.60	10.09	33.59	30.69	63.31	53.31	29.7	22.6	N	
4	0.30553	8.10	4.80	10.10	18.20	14.90	60.09	50.09	41.8	35.1	N	
5	0.91350	12.10	10.90	10.18	22.28	21.08	56.00	46.00	33.7	24.9	N	
6	1.19675	2.20	0.10	10.21	12.41	10.31	56.00	46.00	43.5	35.6	N	
7	0.15000	21.90	0.40	10.10	32.00	10.50	66.00	56.00	34.0	45.5	L	
8	0.15750	19.60	12.40	10.10	29.70	22.50	65.59	55.59	35.8	33.0	L	
9	0.20748	23.50	20.50	10.11	33.61	30.61	63.31	53.31	29.7	22.7	L	
10	0.30553	7.80	4.50	10.12	17.92	14.62	60.09	50.09	42.1	35.4	L	
11	0.91350	12.10	11.00	10.20	22.30	21.20	56.00	46.00	33.7	24.8	L	
12	1.19675	2.30	0.10	10.23	12.53	10.33	56.00	46.00	43.4	35.6	L	

Calculation:Result[dBuV]=Reading[dBuV]+C.Fac(LISN+Cable+ATT)[dB]
LISN:CLS-11

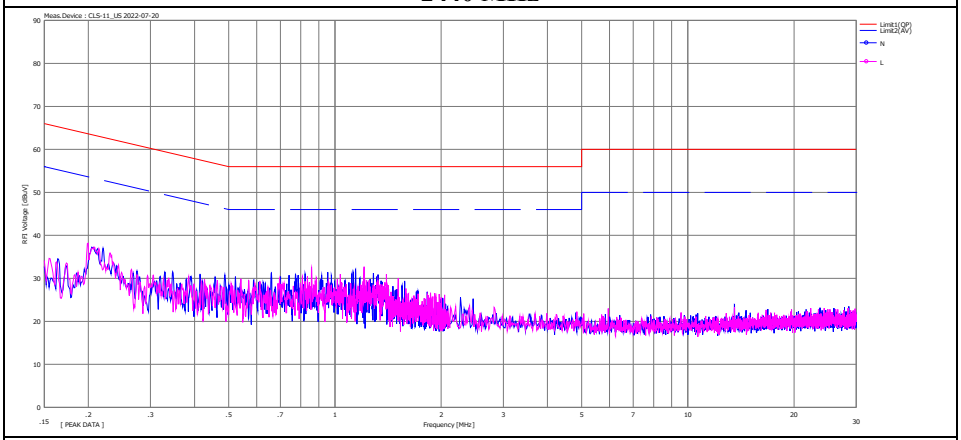
Conducted Emission

Test place	Kashima EMC Lab. No.5 Shielded Room
Date	February 24, 2023
Temperature / Humidity	22 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE, 2M-PHY

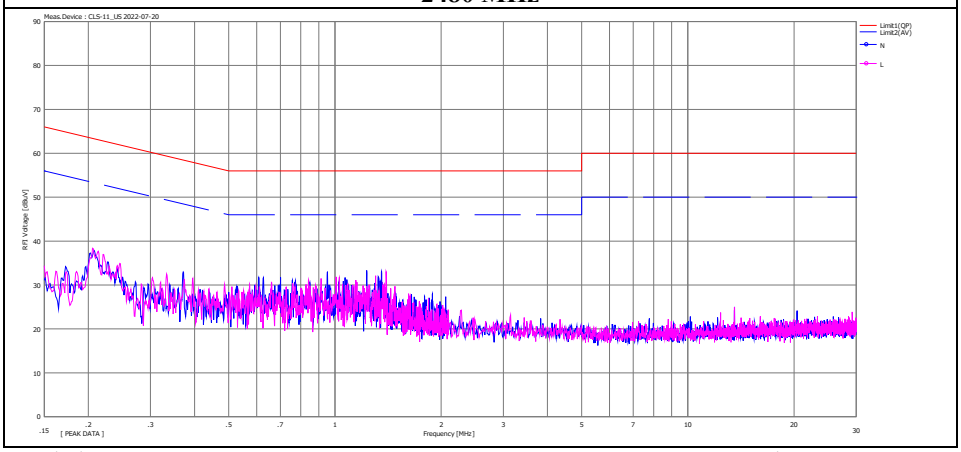
2402 MHz



2440 MHz



2480 MHz



Y scale [dBuV]

Chart — N — L

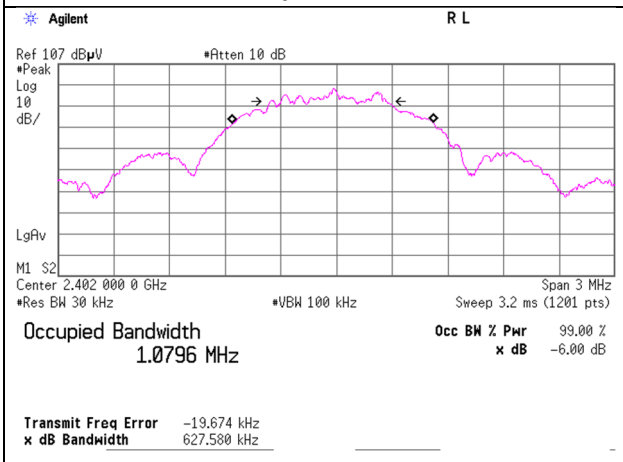
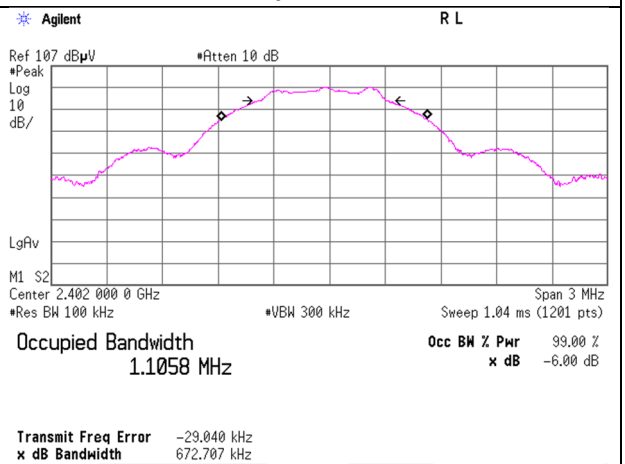
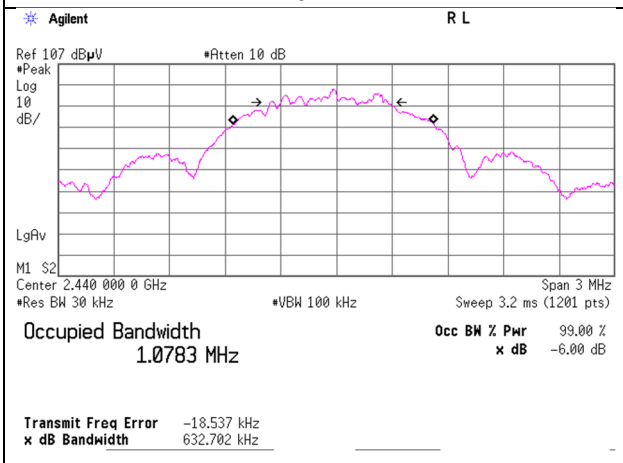
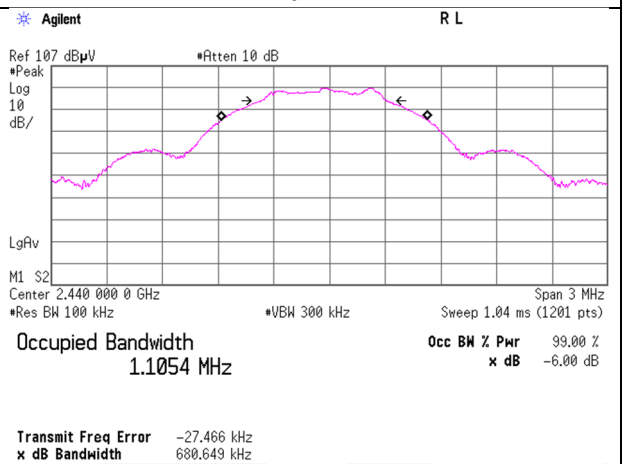
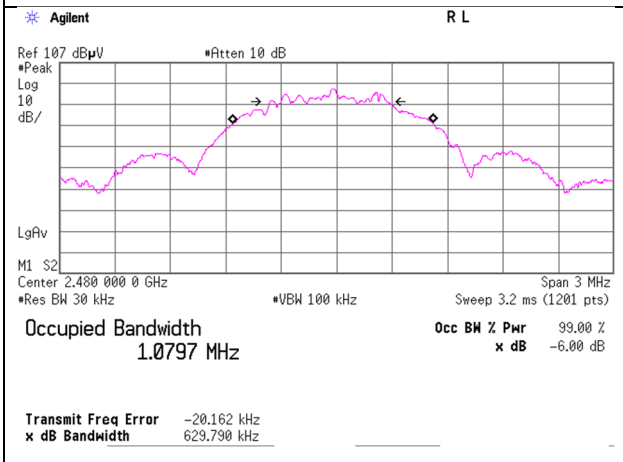
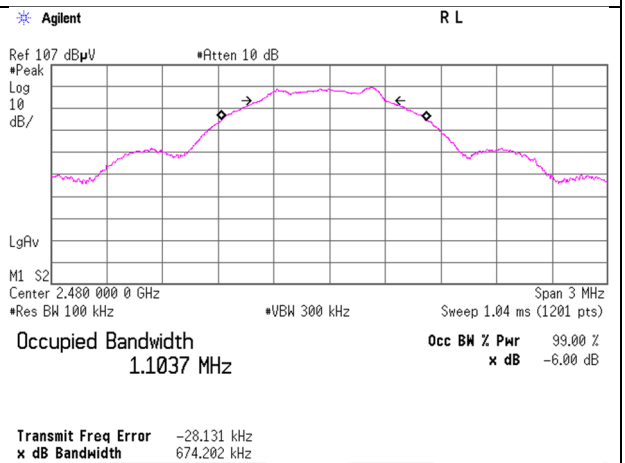
99 % Occupied Bandwidth and 6 dB Bandwidth

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE

Mode	Frequency [MHz]	99 % Occupied Bandwidth [kHz]	6 dB Bandwidth [MHz]	Limit for 6 dB Bandwidth [MHz]
1M-PHY	2402	1079.6	0.673	> 0.5000
	2440	1078.3	0.681	> 0.5000
	2480	1079.7	0.674	> 0.5000
2M-PHY	2402	2075.2	1.155	> 0.5000
	2440	2077.2	1.162	> 0.5000
	2480	2069.9	1.154	> 0.5000

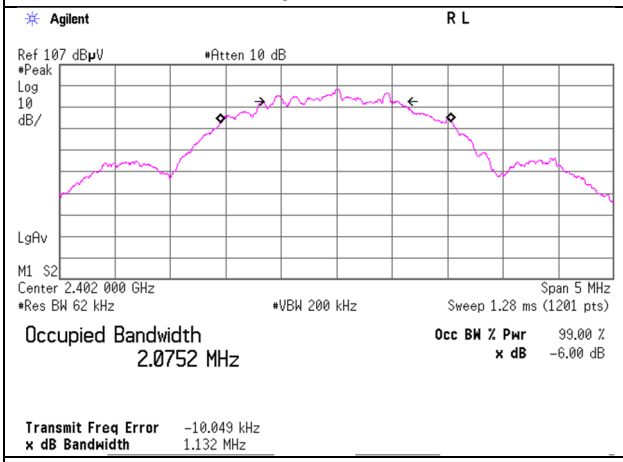
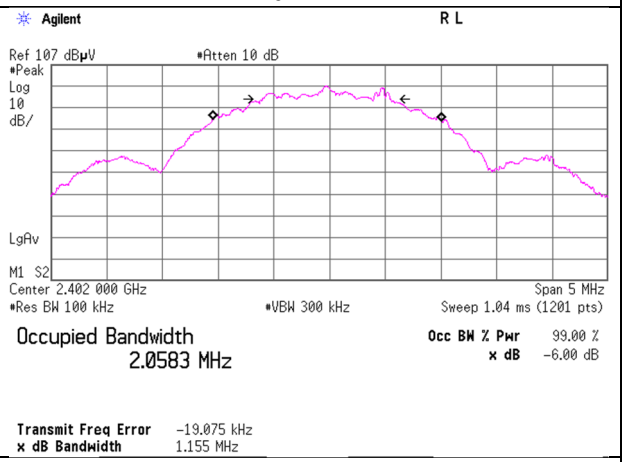
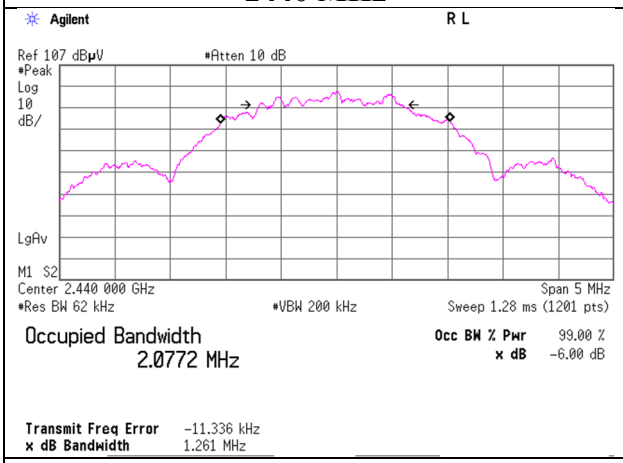
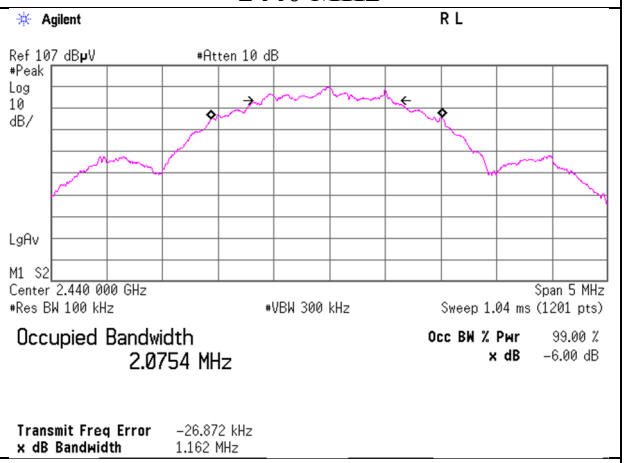
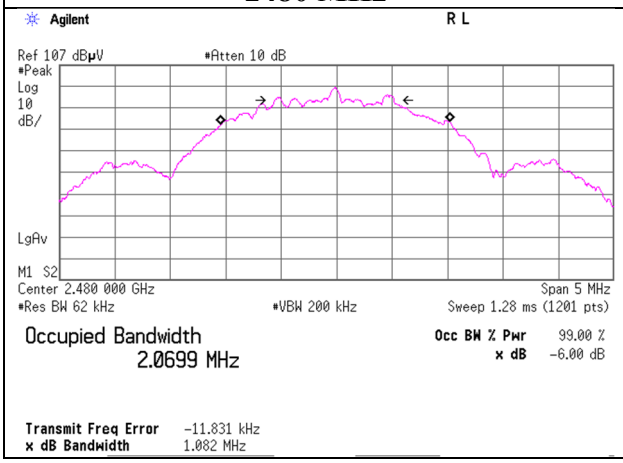
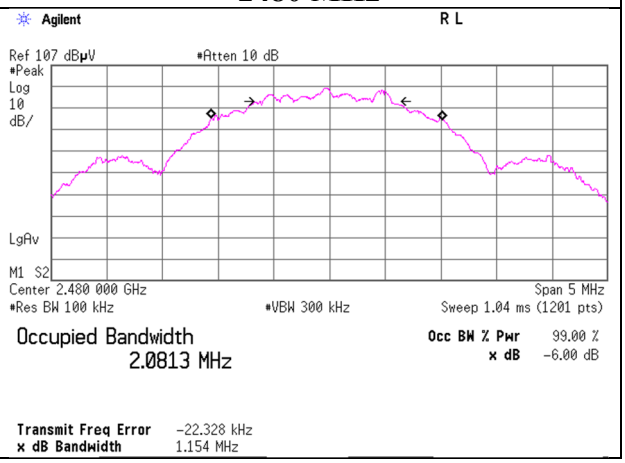
99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE 1M-PHY

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

99 % Occupied Bandwidth and 6 dB Bandwidth

BT LE 2M-PHY

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

Maximum Peak Output Power

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE

1M-PHY				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	-9.47	2.21	10.04	2.78	1.90	30.00	1000	27.22	2.10	4.88	3.08	36.02	4000	31.14
2440	-9.49	2.22	10.05	2.78	1.90	30.00	1000	27.22	2.10	4.88	3.08	36.02	4000	31.14
2480	-9.47	2.23	10.05	2.81	1.91	30.00	1000	27.19	2.10	4.91	3.10	36.02	4000	31.11

2M-PHY				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	-9.50	2.21	10.04	2.75	1.88	30.00	1000	27.25	2.10	4.85	3.05	36.02	4000	31.17
2440	-9.50	2.22	10.05	2.77	1.89	30.00	1000	27.23	2.10	4.87	3.07	36.02	4000	31.15
2480	-9.52	2.23	10.05	2.76	1.89	30.00	1000	27.24	2.10	4.86	3.06	36.02	4000	31.16

Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss
e.i.r.p. Result = Conducted Power Result + Antenna Gain
*The equipment and cables were not used for factor 0 dB of the data sheets.

Average Output Power
(Reference data for RF Exposure)

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE

1M-PHY

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	-10.52	2.21	10.04	1.73	1.49	0.67	2.40	1.74
2440	-10.53	2.22	10.05	1.74	1.49	0.67	2.41	1.74
2480	-10.53	2.23	10.05	1.75	1.50	0.67	2.42	1.75

2M-PHY

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	-12.25	2.21	10.04	0.00	1.00	2.37	2.37	1.73
2440	-12.24	2.22	10.05	0.03	1.01	2.37	2.40	1.74
2480	-12.25	2.23	10.05	0.03	1.01	2.37	2.40	1.74

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

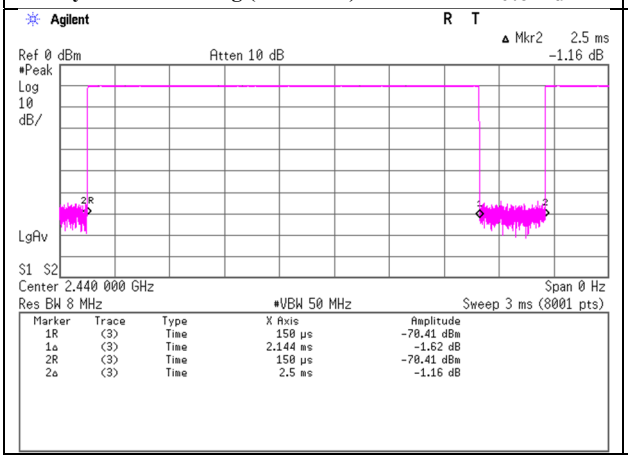
*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst rate confirmation

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE

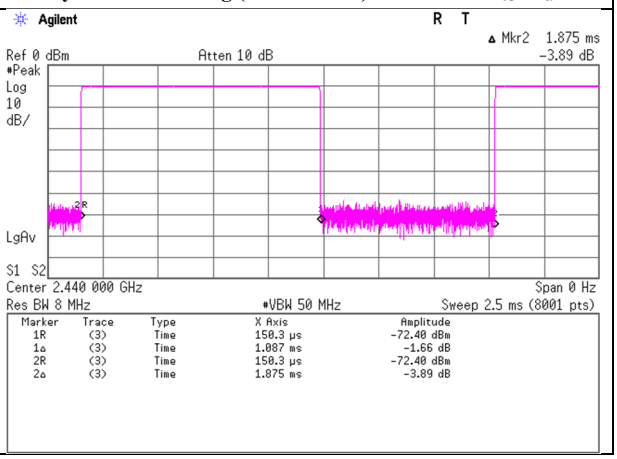
1M-PHY

Tx on / (Tx on + Tx off) =	**0.858**
Tx on / (Tx on + Tx off) * 100 =	**85.8 %**
Duty factor = 10 * log (2.5 / 2.144) =	**0.67 dB**



2M-PHY

Tx on / (Tx on + Tx off) =	**0.580**
Tx on / (Tx on + Tx off) * 100 =	**58.0 %**
Duty factor = 10 * log (1.875 / 1.087) =	**2.37 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	Kashima EMC Lab.			
Semi Anechoic Chamber	No.11	No.11	No.11	No.11
Date	February 17, 2023	February 16, 2023	February 15, 2023	February 15, 2023
Temperature / Humidity	20 deg. C / 38 % RH	20 deg. C / 39 % RH	23 deg. C / 38 % RH	23 deg. C / 38 % RH
Engineer	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz – 2.8 GHz)	(2.8 GHz - 10 GHz)	(10 GHz – 26.5 GHz)
Mode	Tx BT LE 1M-PHY, 2402 MHz			

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	48.000	QP	22.10	13.81	5.90	32.19	0.00	9.62	40.0	30.3	100	0	
Hori.	2390.000	PK	53.50	27.58	13.69	46.25	2.48	51.00	73.9	22.9	190	205	
Hori.	4804.000	PK	53.20	32.49	5.81	45.78	2.48	48.20	73.9	25.7	150	105	
Hori.	7206.000	PK	54.20	37.06	7.17	44.92	2.48	55.99	73.9	17.9	150	324	
Hori.	9608.000	PK	47.30	37.96	8.07	43.30	2.48	52.51	73.9	21.3	150	0	Floor noise
Hori.	9608.000	AV	39.20	37.96	8.07	43.30	2.48	44.41	53.9	9.4	150	0	Floor noise
Vert.	48.000	QP	22.20	13.81	5.90	32.19	0.00	9.72	40.0	30.2	100	0	
Vert.	144.000	QP	22.30	13.45	6.74	32.09	0.00	10.40	43.5	33.1	100	0	
Vert.	240.000	QP	22.40	11.36	7.34	32.03	0.00	9.07	46.0	36.9	100	0	
Vert.	480.000	QP	22.70	17.48	8.48	31.99	0.00	16.67	46.0	29.3	100	0	
Vert.	720.000	QP	23.70	20.94	9.35	32.04	0.00	21.95	46.0	24.0	100	0	
Vert.	960.000	QP	21.70	23.99	10.12	30.90	0.00	24.91	46.0	21.1	100	0	
Vert.	2390.000	PK	53.80	27.58	13.69	46.25	2.48	51.30	73.9	22.6	348	239	
Vert.	4804.000	PK	53.20	32.49	5.81	45.78	2.48	48.20	73.9	25.7	150	156	
Vert.	7206.000	PK	53.30	37.06	7.17	44.92	2.48	55.09	73.9	18.8	400	0	
Vert.	9608.000	PK	47.50	37.96	8.07	43.30	2.48	52.71	73.9	21.1	150	0	Floor noise
Vert.	9608.000	AV	39.00	37.96	8.07	43.30	2.48	44.21	53.9	9.6	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2390.000	AV	44.50	27.58	13.69	46.25	0.67	2.48	42.67	53.9	11.2	*1)
Hori.	4804.000	AV	44.50	32.49	5.81	45.78	0.67	2.48	40.17	53.9	13.7	
Hori.	7206.000	AV	46.90	37.06	7.17	44.92	0.67	2.48	49.36	53.9	**4.5**	
Vert.	2390.000	AV	44.40	27.58	13.69	46.25	0.67	2.48	42.57	53.9	11.3	*1)
Vert.	4804.000	AV	44.70	32.49	5.81	45.78	0.67	2.48	40.37	53.9	13.5	
Vert.	7206.000	AV	45.90	37.06	7.17	44.92	0.67	2.48	48.36	53.9	5.5	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Duty factor Calculation chart" sheet.
*1) Not out of band emission (Leakage Power)

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	99.70	27.61	13.70	46.24	2.48	97.25	-	-	Carrier
Hori.	2400.000	PK	55.30	27.60	13.70	46.24	2.48	52.84	77.25	24.4	
Vert.	2402.000	PK	95.30	27.61	13.70	46.24	2.48	92.85	-	-	Carrier
Vert.	2400.000	PK	52.20	27.60	13.70	46.24	2.48	49.74	72.85	23.1	

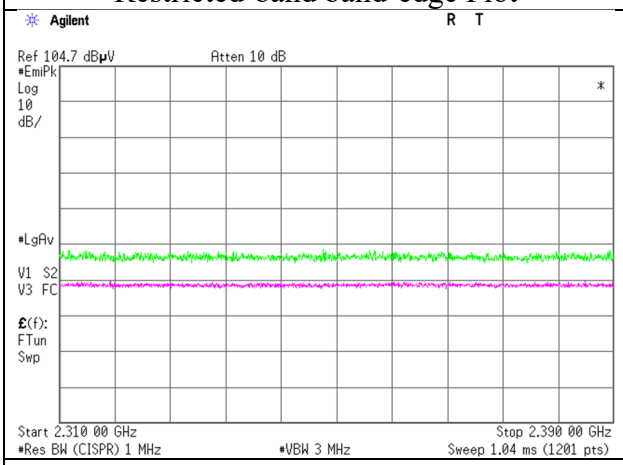
Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Kashima EMC Lab.
Semi Anechoic Chamber	No.11
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe (1 GHz – 2.8 GHz)
Mode	Tx BT LE 1M-PHY, 2402 MHz

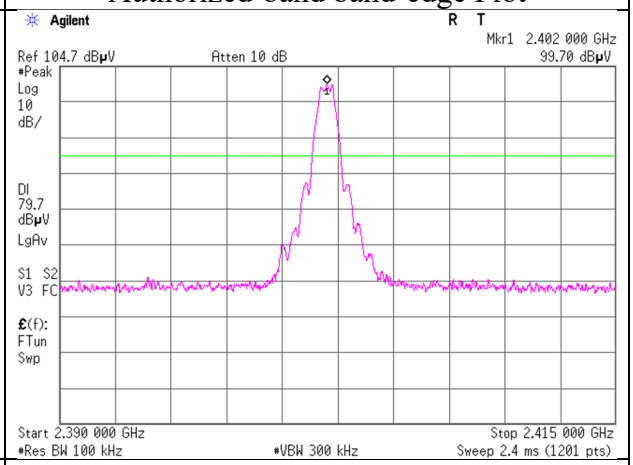
Horizontal

Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

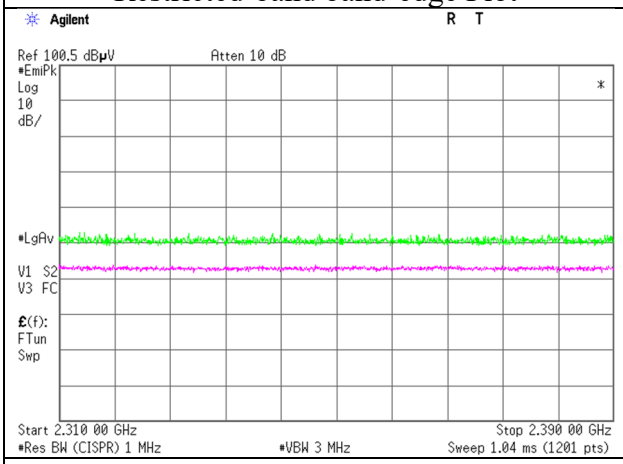
Authorized-band band-edge Plot



20dBc Plot

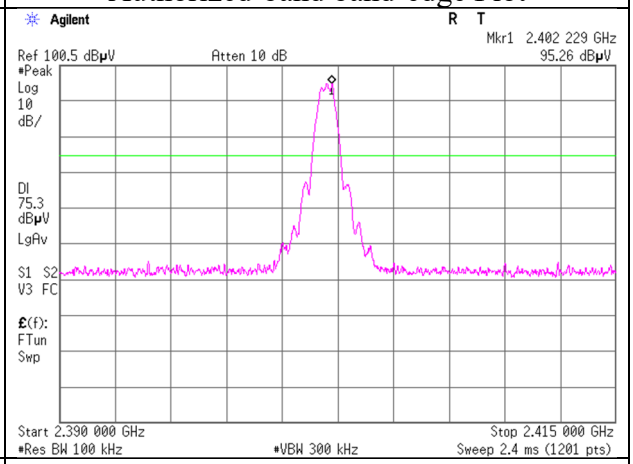
Vertical

Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Authorized-band band-edge 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 was shown in tabular data.

Radiated Spurious Emission

Test place	Kashima EMC Lab.			
Semi Anechoic Chamber	No.11	No.11	No.11	No.11
Date	February 17, 2023	February 16, 2023	February 15, 2023	February 15, 2023
Temperature / Humidity	20 deg. C / 38 % RH	20 deg. C / 39 % RH	23 deg. C / 38 % RH	23 deg. C / 38 % RH
Engineer	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz – 2.8 GHz)	(2.8 GHz - 10 GHz)	(10 GHz – 26.5 GHz)
Mode	Tx BT LE 1M-PHY, 2440 MHz			

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	48.000	QP	22.20	13.81	5.90	32.19	0.00	9.72	40.0	30.2	100	0	
Hori.	4880.000	PK	52.70	32.53	5.85	45.76	2.48	47.80	73.9	26.1	150	103	
Hori.	7320.000	PK	51.80	37.22	7.18	44.75	2.48	53.93	73.9	19.9	150	324	
Hori.	9760.000	PK	47.40	37.93	8.12	43.19	2.48	52.74	73.9	21.1	150	0	Floor noise
Hori.	9760.000	AV	38.70	37.93	8.12	43.19	2.48	44.04	53.9	9.8	150	0	Floor noise
Vert.	48.000	QP	22.20	13.81	5.90	32.19	0.00	9.72	40.0	30.2	100	0	
Vert.	144.000	QP	22.30	13.45	6.74	32.09	0.00	10.40	43.5	33.1	100	0	
Vert.	240.000	QP	22.40	11.36	7.34	32.03	0.00	9.07	46.0	36.9	100	0	
Vert.	480.000	QP	22.70	17.48	8.48	31.99	0.00	16.67	46.0	29.3	100	0	
Vert.	720.000	QP	23.70	20.94	9.35	32.04	0.00	21.95	46.0	24.0	100	0	
Vert.	960.000	QP	21.60	23.99	10.12	30.90	0.00	24.81	46.0	21.2	100	0	
Vert.	4880.000	PK	52.80	32.53	5.85	45.76	2.48	47.90	73.9	26.0	150	155	
Vert.	7320.000	PK	51.20	37.22	7.18	44.75	2.48	53.33	73.9	20.5	400	0	
Vert.	9760.000	PK	47.60	37.93	8.12	43.19	2.48	52.94	73.9	20.9	150	0	Floor noise
Vert.	9760.000	AV	38.80	37.93	8.12	43.19	2.48	44.14	53.9	9.7	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	4880.000	AV	44.40	32.53	5.85	45.76	0.67	2.48	40.17	53.9	13.7	
Hori.	7320.000	AV	42.80	37.22	7.18	44.75	0.67	2.48	45.60	53.9	**8.3**	
Vert.	4880.000	AV	44.50	32.53	5.85	45.76	0.67	2.48	40.27	53.9	13.6	
Vert.	7320.000	AV	42.00	37.22	7.18	44.75	0.67	2.48	44.80	53.9	9.1	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Duty factor Calculation chart" sheet.
*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission

Test place	Kashima EMC Lab.			
Semi Anechoic Chamber	No.11	No.11	No.11	No.11
Date	February 17, 2023	February 16, 2023	February 15, 2023	February 15, 2023
Temperature / Humidity	20 deg. C / 38 % RH	20 deg. C / 39 % RH	23 deg. C / 38 % RH	23 deg. C / 38 % RH
Engineer	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz – 2.8 GHz)	(2.8 GHz - 10 GHz)	(10 GHz – 26.5 GHz)
Mode	Tx BT LE 1M-PHY, 2480 MHz			

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	48.000	QP	22.10	13.81	5.90	32.19	0.00	9.62	40.0	30.3	100	0	
Hori.	2483.500	PK	55.20	27.94	13.77	46.18	2.48	53.21	73.9	20.6	302	200	
Hori.	4960.000	PK	54.00	32.66	5.90	45.75	2.48	49.29	73.9	24.6	150	97	
Hori.	7440.000	PK	52.30	37.25	7.22	44.71	2.48	54.54	73.9	19.3	150	320	
Hori.	9920.000	PK	47.00	38.14	8.18	43.29	2.48	52.51	73.9	21.3	150	0	Floor noise
Hori.	9920.000	AV	38.70	38.14	8.18	43.29	2.48	44.21	53.9	9.6	150	0	Floor noise
Vert.	48.000	QP	22.10	13.81	5.90	32.19	0.00	9.62	40.0	30.3	100	0	
Vert.	144.000	QP	22.20	13.45	6.74	32.09	0.00	10.30	43.5	33.2	100	0	
Vert.	240.000	QP	22.40	11.36	7.34	32.03	0.00	9.07	46.0	36.9	100	0	
Vert.	480.000	QP	22.70	17.48	8.48	31.99	0.00	16.67	46.0	29.3	100	0	
Vert.	720.000	QP	23.70	20.94	9.35	32.04	0.00	21.95	46.0	24.0	100	0	
Vert.	960.000	QP	21.60	23.99	10.12	30.90	0.00	24.81	46.0	21.2	100	0	
Vert.	2483.500	PK	54.10	27.94	13.77	46.18	2.48	52.11	73.9	21.7	359	267	
Vert.	4960.000	PK	54.40	32.66	5.90	45.75	2.48	49.69	73.9	24.2	150	154	
Vert.	7440.000	PK	53.10	37.25	7.22	44.71	2.48	55.34	73.9	18.5	400	0	
Vert.	9920.000	PK	47.80	38.14	8.18	43.29	2.48	53.31	73.9	20.5	150	0	Floor noise
Vert.	9920.000	AV	38.50	38.14	8.18	43.29	2.48	44.01	53.9	9.8	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2483.500	AV	45.40	27.94	13.77	46.18	0.67	2.48	44.08	53.9	9.8	*1)
Hori.	4960.000	AV	45.90	32.66	5.90	45.75	0.67	2.48	41.86	53.9	12.0	
Hori.	7440.000	AV	43.70	37.25	7.22	44.71	0.67	2.48	46.61	53.9	**7.2**	
Vert.	2483.500	AV	44.70	27.94	13.77	46.18	0.67	2.48	43.38	53.9	10.5	*1)
Vert.	4960.000	AV	45.80	32.66	5.90	45.75	0.67	2.48	41.76	53.9	12.1	
Vert.	7440.000	AV	43.10	37.25	7.22	44.71	0.67	2.48	46.01	53.9	7.8	

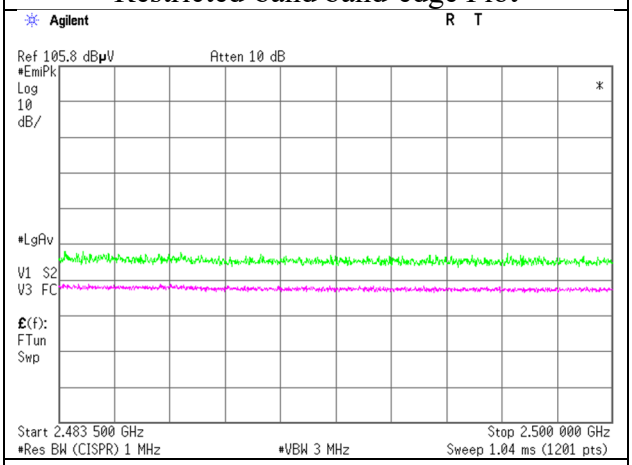
Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Duty factor Calculation chart" sheet.
*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Kashima EMC Lab.
Semi Anechoic Chamber	No.11
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe (1 GHz – 2.8 GHz)
Mode	Tx BT LE 1M-PHY, 2480 MHz

Horizontal

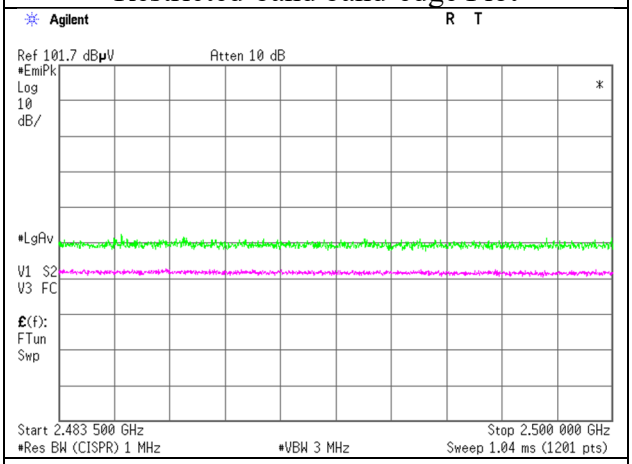
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

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

Radiated Spurious Emission

Test place	Kashima EMC Lab.			
Semi Anechoic Chamber	No.11	No.11	No.11	No.11
Date	February 17, 2023	February 16, 2023	February 15, 2023	February 15, 2023
Temperature / Humidity	20 deg. C / 38 % RH	20 deg. C / 39 % RH	23 deg. C / 38 % RH	23 deg. C / 38 % RH
Engineer	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz – 2.8 GHz)	(2.8 GHz - 10 GHz)	(10 GHz – 26.5 GHz)
Mode	Tx BT LE 2M-PHY, 2402 MHz			

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	48.000	QP	22.20	13.81	5.90	32.19	0.00	9.72	40.0	30.2	100	0	
Hori.	2390.000	PK	54.10	27.58	13.69	46.25	2.48	51.60	73.9	22.3	305	190	
Hori.	4804.000	PK	53.50	32.49	5.81	45.78	2.48	48.50	73.9	25.4	150	109	
Hori.	7206.000	PK	54.30	37.06	7.17	44.92	2.48	56.09	73.9	17.8	150	331	
Hori.	9608.000	PK	47.50	37.96	8.07	43.30	2.48	52.71	73.9	21.1	150	0	Floor noise
Hori.	9608.000	AV	39.10	37.96	8.07	43.30	2.48	44.31	53.9	9.5	150	0	Floor noise
Vert.	48.000	QP	22.10	13.81	5.90	32.19	0.00	9.62	40.0	30.3	100	0	
Vert.	144.000	QP	22.20	13.45	6.74	32.09	0.00	10.30	43.5	33.2	100	0	
Vert.	240.000	QP	22.40	11.36	7.34	32.03	0.00	9.07	46.0	36.9	100	0	
Vert.	480.000	QP	22.80	17.48	8.48	31.99	0.00	16.77	46.0	29.2	100	0	
Vert.	720.000	QP	23.70	20.94	9.35	32.04	0.00	21.95	46.0	24.0	100	0	
Vert.	960.000	QP	21.60	23.99	10.12	30.90	0.00	24.81	46.0	21.2	100	0	
Vert.	2390.000	PK	53.40	27.58	13.69	46.25	2.48	50.90	73.9	23.0	332	25	
Vert.	4804.000	PK	54.40	32.49	5.81	45.78	2.48	49.40	73.9	24.5	150	152	
Vert.	7206.000	PK	52.90	37.06	7.17	44.92	2.48	54.69	73.9	19.2	400	0	
Vert.	9608.000	PK	47.40	37.96	8.07	43.30	2.48	52.61	73.90	21.2	150	0	Floor noise
Vert.	9608.000	AV	39.20	37.96	8.07	43.30	2.48	44.41	53.90	9.4	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2390.000	AV	44.30	27.58	13.69	46.25	2.37	2.48	44.17	53.9	9.7	*1)
Hori.	4804.000	AV	44.50	32.49	5.81	45.78	2.37	2.48	41.87	53.9	12.0	
Hori.	7206.000	AV	44.70	37.06	7.17	44.92	2.37	2.48	48.86	53.9	**5.0**	
Vert.	2390.000	AV	44.40	27.58	13.69	46.25	2.37	2.48	44.27	53.9	9.6	*1)
Vert.	4804.000	AV	44.80	32.49	5.81	45.78	2.37	2.48	42.17	53.9	11.7	
Vert.	7206.000	AV	44.30	37.06	7.17	44.92	2.37	2.48	48.46	53.9	5.4	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Duty factor Calculation chart" sheet.
*1) Not out of band emission (Leakage Power)

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	100.20	27.61	13.70	46.24	2.48	97.75	-	-	Carrier
Hori.	2400.000	PK	68.50	27.60	13.70	46.24	2.48	66.04	77.75	11.7	
Vert.	2402.000	PK	94.20	27.61	13.70	46.24	2.48	91.75	-	-	Carrier
Vert.	2400.000	PK	62.60	27.60	13.70	46.24	2.48	60.14	71.75	11.6	

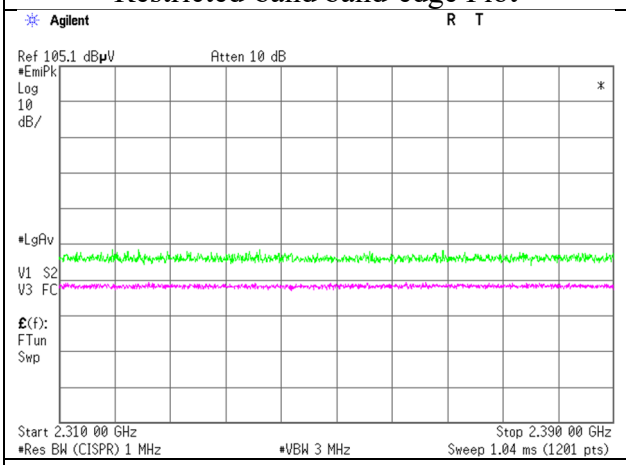
Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Kashima EMC Lab.
Semi Anechoic Chamber	No.11
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe (1 GHz – 2.8 GHz)
Mode	Tx BT LE 2M-PHY, 2402 MHz

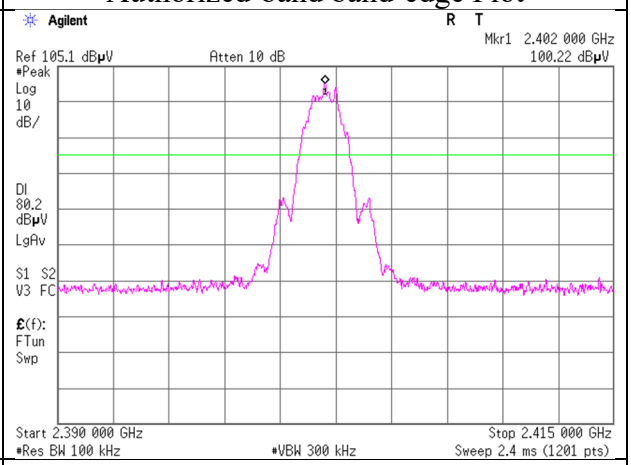
Horizontal

Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

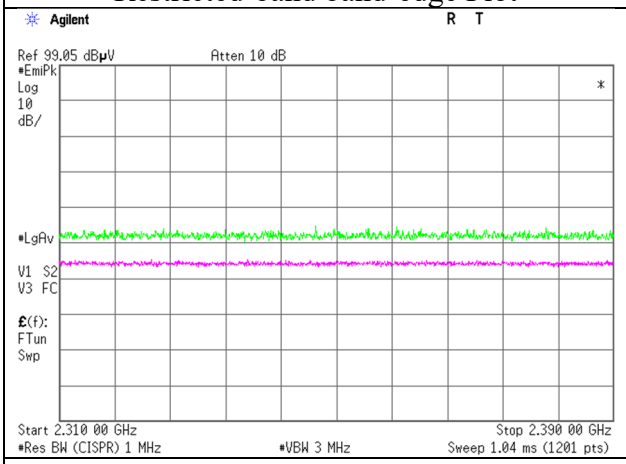
Authorized-band band-edge Plot



20dBc Plot

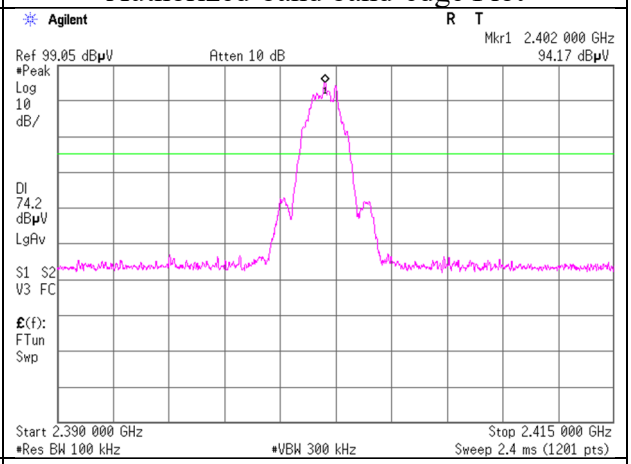
Vertical

Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Authorized-band band-edge 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 was shown in tabular data.

Radiated Spurious Emission

Test place	Kashima EMC Lab.			
Semi Anechoic Chamber	No.11	No.11	No.11	No.11
Date	February 17, 2023	February 16, 2023	February 15, 2023	February 15, 2023
Temperature / Humidity	20 deg. C / 38 % RH	20 deg. C / 39 % RH	23 deg. C / 38 % RH	23 deg. C / 38 % RH
Engineer	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz – 2.8 GHz)	(2.8 GHz - 10 GHz)	(10 GHz – 26.5 GHz)
Mode	Tx BT LE 2M-PHY, 2440 MHz			

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	48.000	QP	22.10	13.81	5.90	32.19	0.00	9.62	40.0	30.3	100	0	
Hori.	4880.000	PK	52.40	32.53	5.85	45.76	2.48	47.50	73.9	26.4	150	98	
Hori.	7320.000	PK	51.20	37.22	7.18	44.75	2.48	53.33	73.9	20.5	150	325	
Hori.	9760.000	PK	47.60	37.93	8.12	43.19	2.48	52.94	73.9	20.9	150	0	Floor noise
Hori.	9760.000	AV	38.90	37.93	8.12	43.19	2.48	44.24	53.9	9.6	150	0	Floor noise
Vert.	48.000	QP	22.10	13.81	5.90	32.19	0.00	9.62	40.0	30.3	100	0	
Vert.	144.000	QP	22.20	13.45	6.74	32.09	0.00	10.30	43.5	33.2	100	0	
Vert.	240.000	QP	22.30	11.36	7.34	32.03	0.00	8.97	46.0	37.0	100	0	
Vert.	480.000	QP	22.80	17.48	8.48	31.99	0.00	16.77	46.0	29.2	100	0	
Vert.	720.000	QP	23.70	20.94	9.35	32.04	0.00	21.95	46.0	24.0	100	0	
Vert.	960.000	QP	21.60	23.99	10.12	30.90	0.00	24.81	46.0	21.2	100	0	
Vert.	4880.000	PK	51.90	32.53	5.85	45.76	2.48	47.00	73.9	26.9	150	160	
Vert.	7320.000	PK	51.10	37.22	7.18	44.75	2.48	53.23	73.9	20.6	400	0	
Vert.	9760.000	PK	47.70	37.93	8.12	43.19	2.48	53.04	73.9	20.8	150	0	Floor noise
Vert.	9760.000	AV	38.80	37.93	8.12	43.19	2.48	44.14	53.9	9.7	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	4880.000	AV	43.40	32.53	5.85	45.76	2.37	2.48	40.87	53.9	13.0	
Hori.	7320.000	AV	42.20	37.22	7.18	44.75	2.37	2.48	46.70	53.9	**7.2**	
Vert.	4880.000	AV	42.90	32.53	5.85	45.76	2.37	2.48	40.37	53.9	13.5	
Vert.	7320.000	AV	41.40	37.22	7.18	44.75	2.37	2.48	45.90	53.9	8.0	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Duty factor Calculation chart" sheet.
*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission

Test place	Kashima EMC Lab.			
Semi Anechoic Chamber	No.11	No.11	No.11	No.11
Date	February 17, 2023	February 16, 2023	February 15, 2023	February 15, 2023
Temperature / Humidity	20 deg. C / 38 % RH	20 deg. C / 39 % RH	23 deg. C / 38 % RH	23 deg. C / 38 % RH
Engineer	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz – 2.8 GHz)	(2.8 GHz - 10 GHz)	(10 GHz – 26.5 GHz)
Mode	Tx BT LE 2M-PHY, 2480 MHz			

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

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	48.000	QP	22.10	13.81	5.90	32.19	0.00	9.62	40.0	30.3	100	0	
Hori.	2483.500	PK	56.70	27.94	13.77	46.18	2.48	54.71	73.9	19.1	206	205	
Hori.	4960.000	PK	53.40	32.66	5.90	45.75	2.48	48.69	73.9	25.2	150	98	
Hori.	7440.000	PK	51.40	37.25	7.22	44.71	2.48	53.64	73.9	20.2	150	325	
Hori.	9920.000	PK	47.60	38.14	8.18	43.29	2.48	53.11	73.9	20.7	150	0	Floor noise
Hori.	9920.000	AV	38.70	38.14	8.18	43.29	2.48	44.21	53.9	9.6	150	0	Floor noise
Vert.	48.000	QP	22.00	13.81	5.90	32.19	0.00	9.52	40.0	30.4	100	0	
Vert.	144.000	QP	22.10	13.45	6.74	32.09	0.00	10.20	43.5	33.3	100	0	
Vert.	240.000	QP	22.30	11.36	7.34	32.03	0.00	8.97	46.0	37.0	100	0	
Vert.	480.000	QP	22.80	17.48	8.48	31.99	0.00	16.77	46.0	29.2	100	0	
Vert.	720.000	QP	23.50	20.94	9.35	32.04	0.00	21.75	46.0	24.2	100	0	
Vert.	960.000	QP	21.60	23.99	10.12	30.90	0.00	24.81	46.0	21.2	100	0	
Vert.	2483.500	PK	54.20	27.94	13.77	46.18	2.48	52.21	73.9	21.6	375	230	
Vert.	4960.000	PK	53.60	32.66	5.90	45.75	2.48	48.89	73.9	25.0	150	162	
Vert.	7440.000	PK	52.10	37.25	7.22	44.71	2.48	54.34	73.9	19.5	400	0	
Vert.	9920.000	PK	47.80	38.14	8.18	43.29	2.48	53.31	73.90	20.5	150	0	Floor noise
Vert.	9920.000	AV	38.70	38.14	8.18	43.29	2.48	44.21	53.90	9.6	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2483.500	AV	48.00	27.94	13.77	46.18	2.37	2.48	48.38	53.9	**5.5**	*1)
Hori.	4960.000	AV	44.20	32.66	5.90	45.75	2.37	2.48	41.86	53.9	12.0	
Hori.	7440.000	AV	42.30	37.25	7.22	44.71	2.37	2.48	46.91	53.9	6.9	
Vert.	2483.500	AV	45.00	27.94	13.77	46.18	2.37	2.48	45.38	53.9	8.5	*1)
Vert.	4960.000	AV	44.20	32.66	5.90	45.75	2.37	2.48	41.86	53.9	12.0	
Vert.	7440.000	AV	42.10	37.25	7.22	44.71	2.37	2.48	46.71	53.9	7.1	

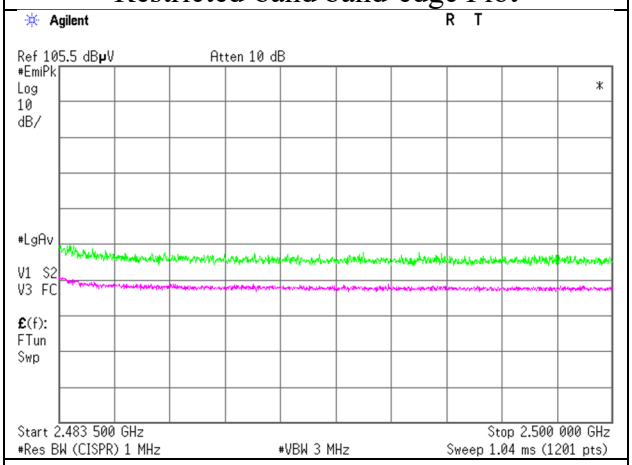
Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amprifier) + Duty factor + Distance factor
Distance factor : 1 GHz - 10 GHz : 20log (3.99m / 3.0 m) = 2.48 dB
10 GHz - 26.5 GHz : 20log (1.0 m / 3.0 m) = -9.54 dB
Duty factor refer to "Duty factor Calculation chart" sheet.
*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Kashima EMC Lab.
Semi Anechoic Chamber	No.11
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe (1 GHz – 2.8 GHz)
Mode	Tx BT LE 2M-PHY, 2480 MHz

Horizontal

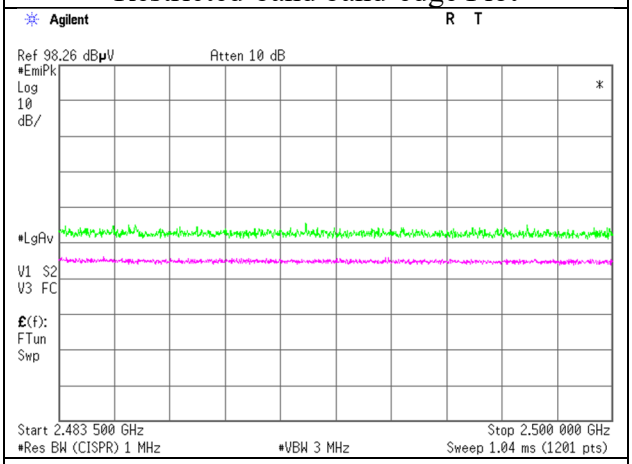
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

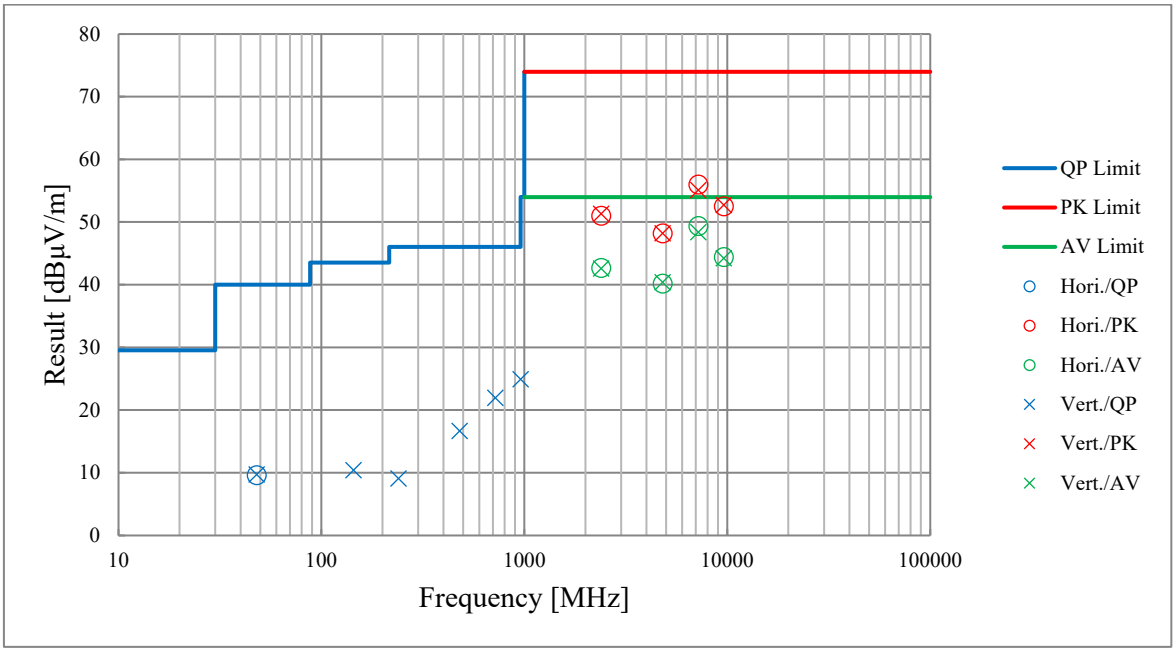


Trace Green : Peak Plot
Trace Purple : Average Plot

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

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

Test place	Kashima EMC Lab.			
Semi Anechoic Chamber	No.11	No.11	No.11	No.11
Date	February 17, 2023	February 16, 2023	February 15, 2023	February 15, 2023
Temperature / Humidity	20 deg. C / 38 % RH	20 deg. C / 39 % RH	23 deg. C / 38 % RH	23 deg. C / 38 % RH
Engineer	Hiromitsu Tanabe (30 MHz - 1000 MHz)	Hiromitsu Tanabe (1 GHz – 2.8 GHz)	Hiromitsu Tanabe (2.8 GHz - 10 GHz)	Hiromitsu Tanabe (10 GHz – 26.5 GHz)
Mode	Tx BT LE 1M-PHY, 2402 MHz			

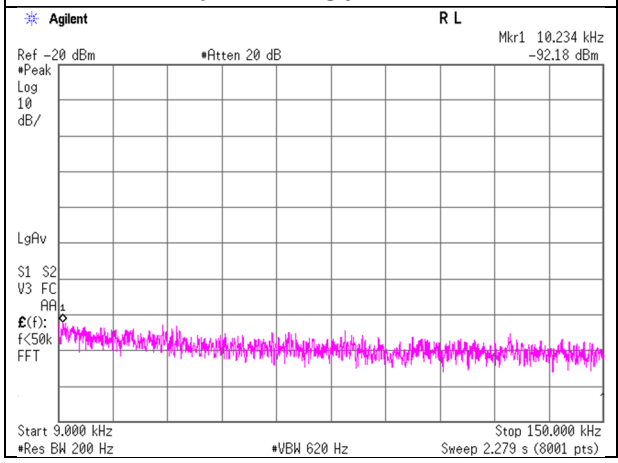


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

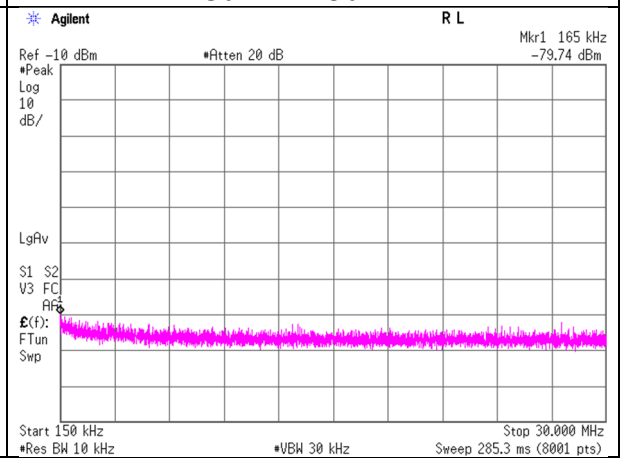
Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE 1M-PHY, 2402 MHz

9 kHz - 150 kHz



150 kHz - 30 MHz



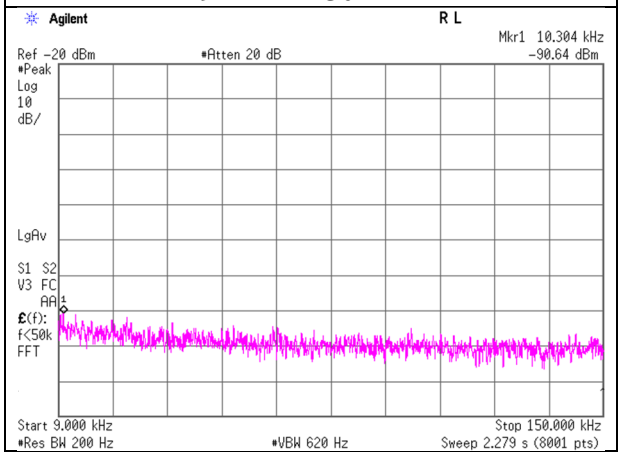
Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
10.23	-92.2	1.01	10.0	2.1	1	-79.1	300	6.0	-17.9	47.4	65.3	
165.00	-79.7	1.01	10.0	2.1	1	-66.7	300	6.0	-5.4	23.2	28.6	

E [dBuV/m] = EIRP [dBm] - 20 log (Distance [m]) + Ground bounce [dB] + 104.8 [dBuV/m]
EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)
N: Number of output

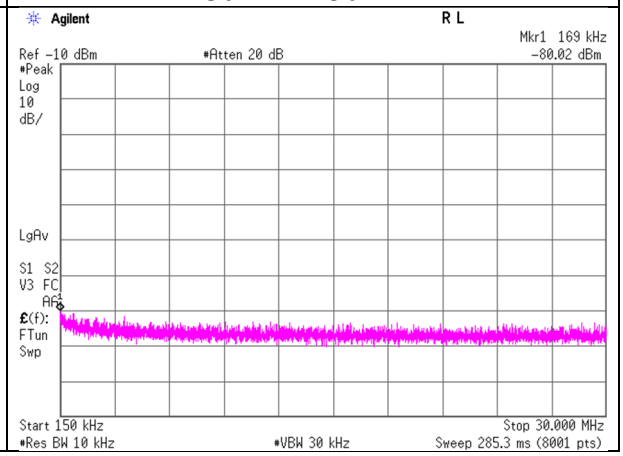
Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE 1M-PHY, 2440 MHz

9 kHz - 150 kHz



150 kHz - 30 MHz



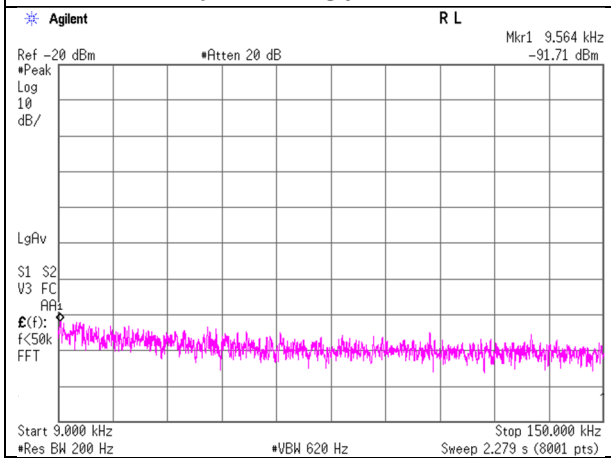
Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
10.30	-90.6	1.01	10.0	2.1	1	-77.6	300	6.0	-16.3	47.3	63.6	
169.00	-80.0	1.01	10.0	2.1	1	-66.9	300	6.0	-5.7	23.0	28.7	

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

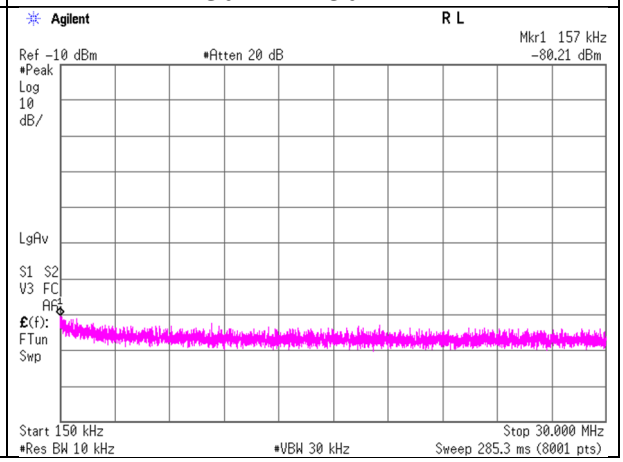
Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE 1M-PHY, 2480 MHz

9 kHz - 150 kHz



150 kHz - 30 MHz



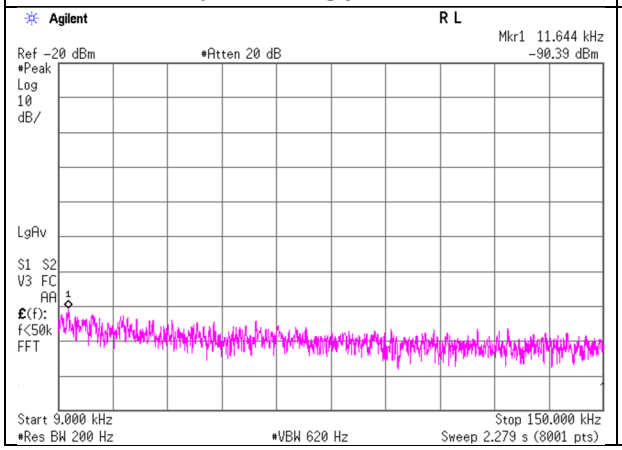
Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
9.56	-91.7	1.01	10.0	2.1	1	-78.7	300	6.0	-17.4	47.9	65.3	
157.00	-80.2	1.01	10.0	2.1	1	-67.2	300	6.0	-5.9	23.6	29.5	

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

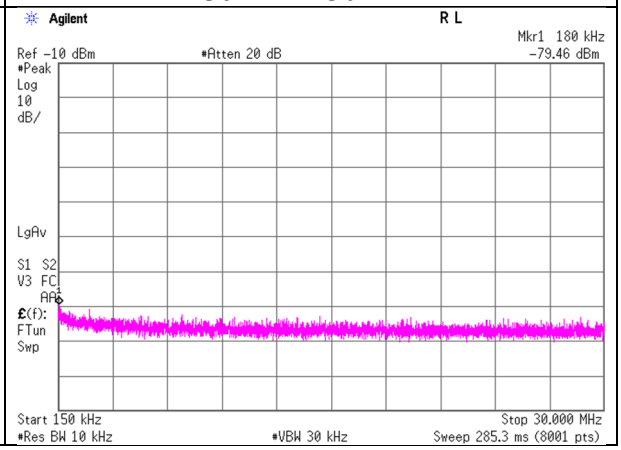
Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE 2M-PHY, 2402 MHz

9 kHz - 150 kHz



150 kHz - 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
11.64	-90.4	1.01	10.0	2.1	1	-77.3	300	6.0	-16.1	46.2	62.3	
180.00	-79.5	1.01	10.0	2.1	1	-66.4	300	6.0	-5.1	22.4	27.5	

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

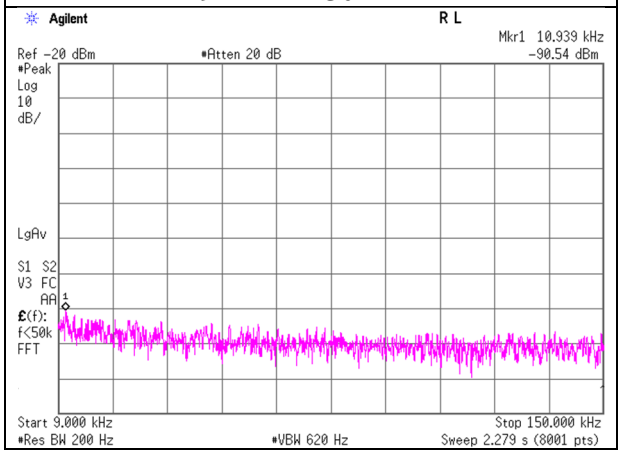
EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

N: Number of output

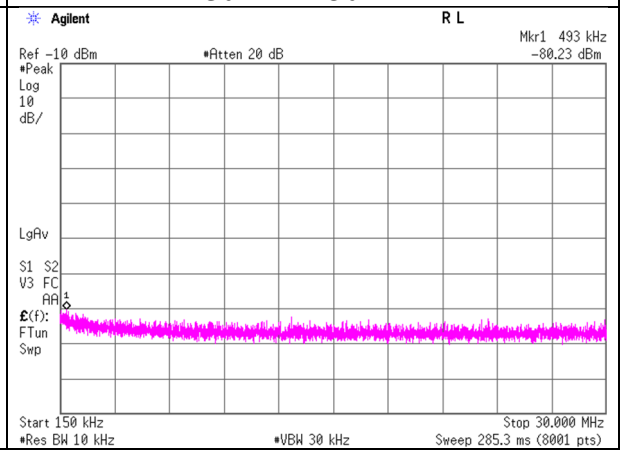
Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE 2M-PHY, 2440 MHz

9 kHz - 150 kHz



150 kHz - 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
10.94	-90.5	1.01	10.0	2.1	1	-77.5	300	6.0	-16.2	46.8	63.0	
493.00	-80.2	1.02	10.0	2.1	1	-67.2	30	6.0	14.1	33.7	19.6	

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

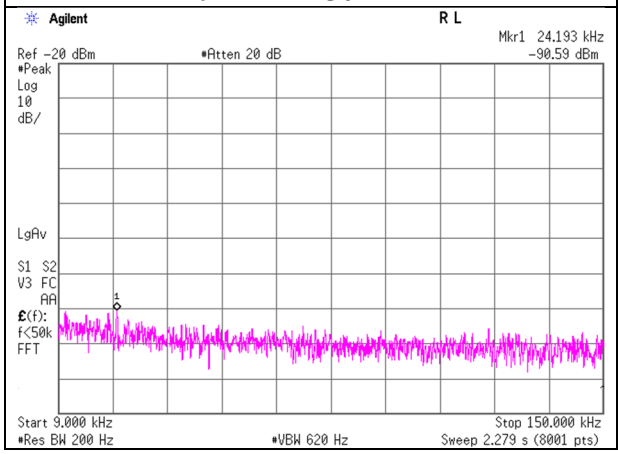
EIRP[dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * log (N)

N: Number of output

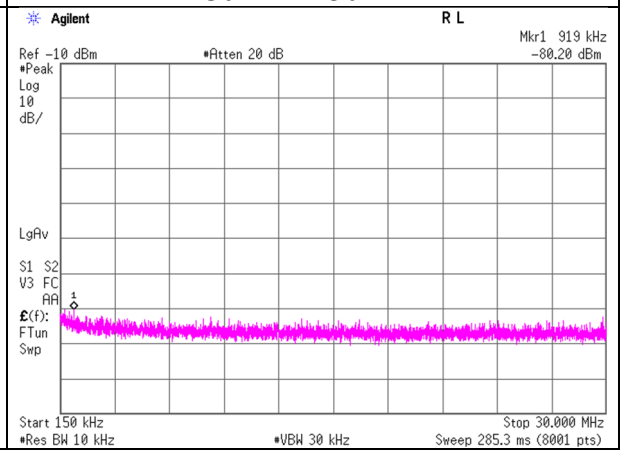
Conducted Spurious Emission

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE 2M-PHY, 2480 MHz

9 kHz - 150 kHz



150 kHz - 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
24.19	-90.6	1.01	10.0	2.1	1	-77.5	300	6.0	-16.3	39.9	56.2	
919.00	-80.2	1.02	10.0	2.1	1	-67.1	30	6.0	14.1	28.3	14.2	

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

Power Density

Test place	Kashima EMC Lab. No.2 Measurement Room
Date	February 16, 2023
Temperature / Humidity	20 deg. C / 39 % RH
Engineer	Hiromitsu Tanabe
Mode	Tx BT LE

1M-PHY

Freq. [MHz]	Reading dBm / 3 kHz	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Margin [dB]
2402	-25.70	2.21	10.04	-13.45	8.00	21.45
2440	-25.91	2.22	10.05	-13.64	8.00	21.64
2480	-26.18	2.23	10.05	-13.90	8.00	21.90

2M-PHY

Freq. [MHz]	Reading dBm / 3 kHz	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Margin [dB]
2402	-27.18	2.21	10.04	-14.93	8.00	22.93
2440	-27.59	2.22	10.05	-15.32	8.00	23.32
2480	-27.54	2.23	10.05	-15.26	8.00	23.26

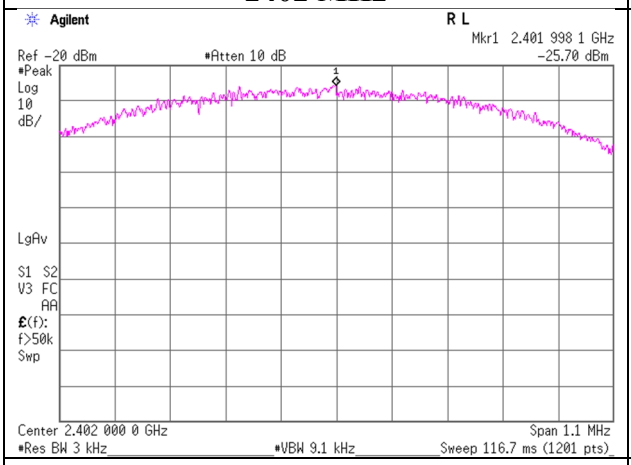
Sample Calculation:
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

*The equipment and cables were not used for factor 0 dB of the data sheets.

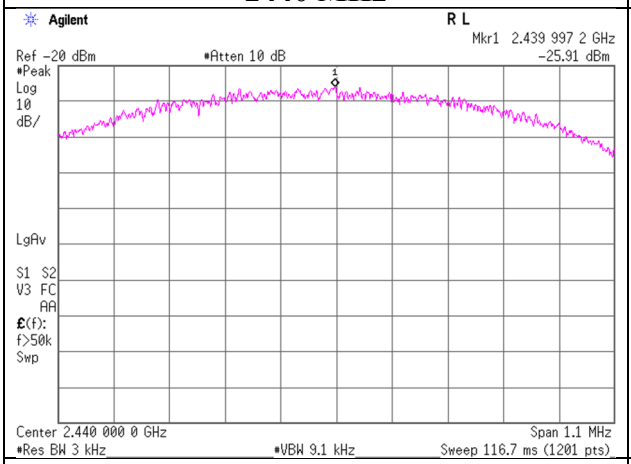
Power Density

BT LE 1M-PHY

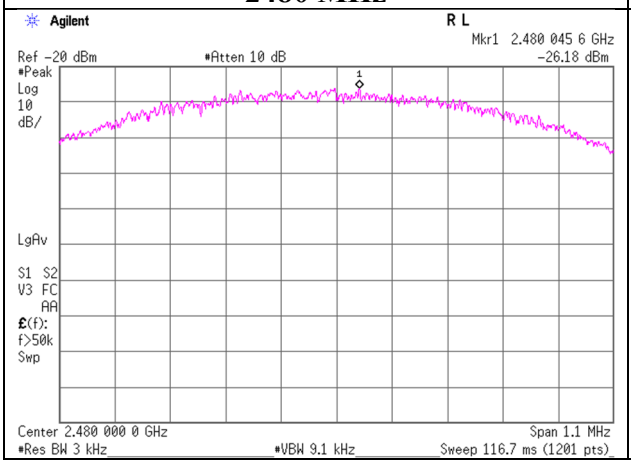
2402 MHz



2440 MHz

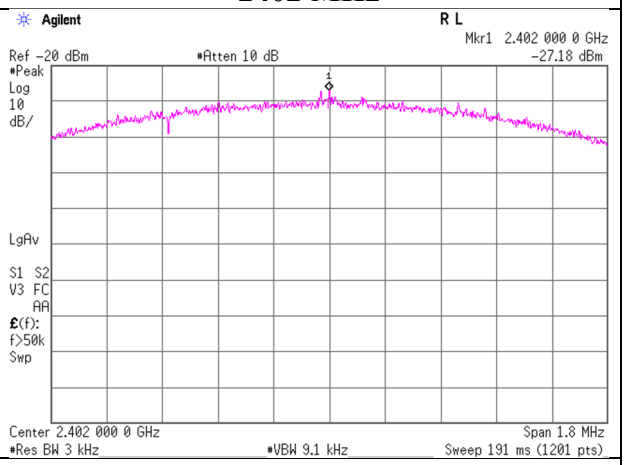


2480 MHz

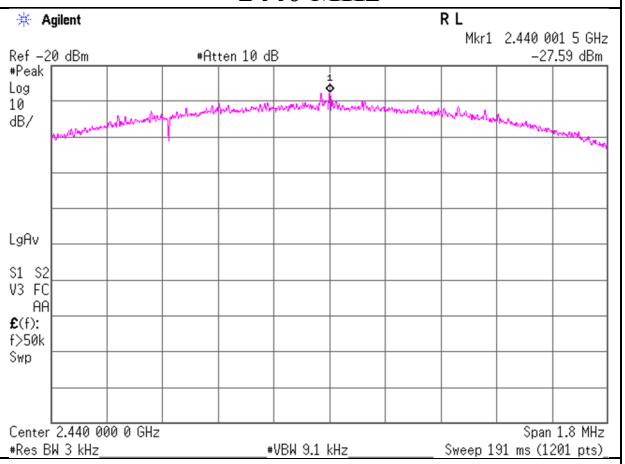


BT LE 2M-PHY

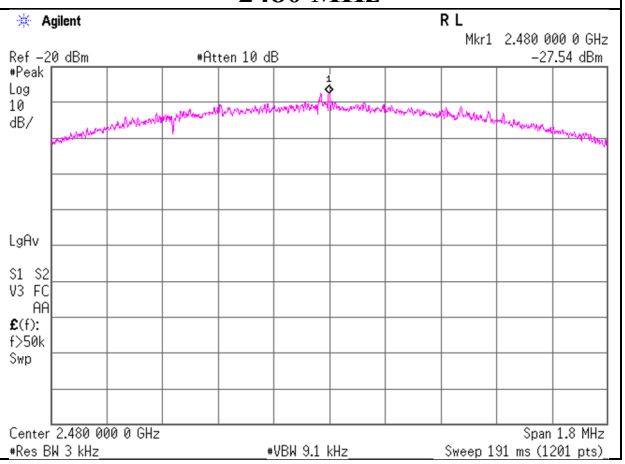
2402 MHz



2440 MHz



2480 MHz



APPENDIX 2: Test Instruments

Test Equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
CE	CLS-11	143505	A.M.N.	Rohde & Schwarz	ESH3-Z5	835239/022	2022/07/20	12
CE	CCC-S5-C(SR)	143167	5 Site CE (SR) System	N/A	none(No.5 CE SR)	-	2022/07/01	12
CE	CTR-04	144195	Test Receiver	Rohde & Schwarz	ESCI	100053	2022/09/14	12
CE	CSCL-21	222614	Measure	SHINWA RULES CO., LTD.	80862	none	-	-
CE	COS-30	222854	Temperature & Humidity Logger	HIOKI E.E. CORPORATION	LR5001/LR9504	220820033 /220899853	2022/09/20	12
CE	CBM-05	143128	Barometer	OTA	No.11	15404	2021/11/24	36
CE	CTS-09	144211	Digital Multimeter	Fluke Corporation	112	89790194	2022/10/19	12
CE	COTS-CEMI-03	178804	EMI Software	TSJ (Techno Science Japan)	TEPTO-DV3(RE,CE,ME,PE)	-	-	-
RE	CCC-S11-R	143169	11Site RE 3m System	N/A	none(No.11 RE)	none	2022/11/17	12
RE	CBL-09	143122	LOGBICON	Schwarzbeck Mess-Elektronik OHG	VULB 9168	508	2022/04/18	12
RE	CAT5-04	178807	5dB Fixed Atten.	Pasternack Enterprises	PE7047-5	none	2022/04/01	12
RE	CAF-16	142936	Pre-Amplifier	SONOMA INSTRUMENT	310N	325015	2022/05/06	12
RE	CTR-02	144194	Test Receiver	Rohde & Schwarz	ESCI	100601	2022/09/21	12
RE	CAEC-11(NSA)	144648	Semi Anechoic Chamber	TDK	NSA (No.11)	11	2022/05/10	12
RE	CAEC-11(SVSWR)	144644	Semi Anechoic Chamber	TDK	SVSWR (No.11)	11	2022/05/10	12
RE	TSA-01	143642	Spectrum Analyzer	Keysight Technologies Inc	N9030A	MY53310670 Version A.13.12	2022/05/25	12
RE	CSA-07	143643	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY52490024	2022/06/23	12
RE	TPA-14	175395	Pre Amplifier	Erzia Technologies S.L.	ERZ-LNA-0100 -2700-45-4	16A2001702002	2022/12/16	12
RE	CAT10-17	143023	10dB Fixed Atten.	Weinschel - API Technologies Corp	54A-10	56251	2022/05/30	12
RE	CHF-04	143442	HPF	MICRO-TRONICS	HPM50111-02	009	2022/05/30	12
RE	CCC-W04	142989	Micro Wave Cable	Suhner	SUCOFLEX102	MY3771/2	2022/05/19	12
RE	CCC-W07	143111	Micro Wave Cable	Junkosha	MWX221	MRA-12-14-148	2022/05/19	12
RE	CCC-G14	192241	Microwave Cable	Huber+Suhner	SF104/PC35m /PC35m/1000mm	805411/4	2023/01/12	12
RE	CHA-25	143456	Double Ridged Wave Guide	ETS-Lindgren (Cedar Park, Texas)	3115	00204573	2022/02/05	12
RE	CHA-07	143438	Double Ridged Horn	ETS-Lindgren (Cedar Park, Texas)	3160-09	00166043	2022/06/18	12
RE	CAF-19	142937	Pre-Amplifier	TOYO	HAP18-26W	00000035	2022/06/18	12
RE	CCC-W10	142992	Micro Wave Cable	Suhner	SUCOFLEX102	MY010/2A	2022/08/03	12
RE	CSCL-27	222746	Measure	SHINWA RULES CO., LTD.	80862	none	-	-
RE	COS-26	200033	Temperature & Humidity Logger	HIOKI E.E. CORPORATION	LR5001/LR9504	200636447 /200699543	2022/07/22	12

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	CCC-W10	142992	Micro Wave Cable	Suhner	SUCOFLEX102	MY010/2A	2022/08/03	12
RE	CSCL-27	222746	Measure	SHINWA RULES CO., LTD.	80862	none	-	-
RE	COS-26	200033	Temperature & Humidity Logger	HIOKI E.E. CORPORATION	LR5001/LR9504	200636447/200699543	2022/07/22	12
RE	CTS-13	144215	Digital Multimeter	Fluke Corporation	FLK-83-V	14610320	2022/10/13	12
RE	CBM-02	143125	Barometer	OTA	No.11	15408	2021/11/24	36
RE	COTS-CEMI-03	178804	EMI Software	TSJ (Techno Science Japan)	TEPTO-DV3(RE,CE,ME,PE)	-	-	-
AT	CSA-07	143643	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY52490024	2022/06/23	12
AT	CAT10-17	143023	10dB Fixed Atten.	Weinschel - API Technologies Corp	54A-10	56251	2022/05/30	12
AT	CCC-W02	143110	Micro Wave Cable	Suhner	SUCOFLEX102	MY3773/2	2022/05/19	12
AT	CPM-16	143588	Peak Power Analyzer	Keysight Technologies Inc	8990B	MY51000276	2022/06/23	12
AT	CPSO-24	143606	Power Sensor	Keysight Technologies Inc	N1923A	MY54070024	2022/06/23	12
AT	CTS-08	144210	Digital Multimeter	Fluke Corporation	112	89790193	2022/10/12	12
AT	COS-27	200034	Temperature & Humidity Logger	HIOKI E.E. CORPORATION	LR5001/LR9504	200636456/200699552	2022/07/22	12
AT	CBM-05	143128	Barometer	OTA	No.11	15404	2021/11/24	36

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