



RADIO TEST REPORT

Test Report No. : 13148763M-A-R1

Applicant : MIWA LOCK CO., LTD.
Type of Equipment : BLE board
Model No. : RDV2HT
FCC ID : VBU-RDV2HT
Test regulation : FCC Part 15 Subpart C: 2019
Test Result : Complied (Refer to SECTION 3.2)

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this test report are traceable to the national or international standards.
5. This test report must not be used by the customer to claim product certification, approval, or endorsement by any agency of the Federal Government.
6. This test report covers Radio technical requirements.
It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
7. The all test items in this test report are conducted by UL Japan, Inc. Kashima EMC Lab.
8. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
9. The information provided from the customer for this report is identified in SECTION 1.
10. This report is a revised version of 13148763M-A. 13148763M-A is replaced with this report.

Date of test: December 23, 2019 to January 29, 2020

Representative test engineer:

K. Ando

Kazuhiro Ando
Engineer
Consumer Technology Division

Approved by:

T. Yamashita

Tomoyuki Yamashita
Leader
Consumer Technology Division



CERTIFICATE 1266.01

- The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
 There is no testing item of "Non-accreditation".

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan
Telephone : +81 478 88 6500
Facsimile : +81 478 82 3373

REVISION HISTORY

Original Test Report No.: 13148763M

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13148763M-A	February 5, 2020	-	-
1	13148763M-A-R1	March 3, 2020	P.31	Modify from EMI to CE, RE, LIMS ID: 143654, 143542, 144216, 178804
1	13148763M-A-R1	March 3, 2020	P.31	Modify the LIMS ID from 178804 to PRE0189702 and add as CE,RE
1	13148763M-A-R1	March 3, 2020	P.31	Add to the Test equipment as RE(GHz), LIMS ID: 143655, 143543, 144215
1	13148763M-A-R1	March 3, 2020	P.31	Delete from the Test equipment, LIMS ID:143133

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Reference: Abbreviations (Including words undescribed in this report)

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

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

CONTENTS	PAGE
SECTION 1: Customer information.....	5
SECTION 2: Equipment under test (E.U.T.).....	5
SECTION 3: Test specification, procedures & results.....	6
SECTION 4: Operation of E.U.T. during testing.....	9
SECTION 5: Conducted Emission.....	10
SECTION 6: Radiated Spurious Emission	11
SECTION 7: Antenna Terminal Conducted Tests.....	13
APPENDIX 1: Test data	14
Conducted Emission	14
6 dB Bandwidth and 99 % Occupied Bandwidth.....	16
Maximum Peak Output Power	18
Average Output Power	19
Radiated Spurious Emission	21
Conducted Spurious Emission	27
Power Density	30
APPENDIX 2: Test instruments	31
APPENDIX 3: Photographs of test setup	32
Conducted Emission	32
Radiated Spurious Emission	33
Worst Case Position	35

SECTION 1: Customer information

Company Name : MIWA LOCK CO., LTD.
Address : 3-1-12 Shiba, Minato-ku, Tokyo, 105-8510 JAPAN
Telephone Number : +81-3-4330-3069
Facsimile Number : +81-3-3455-2437
Contact Person : Keiji Iwata

The information provided from the customer is as follows;

- Applicant, Type of Equipment, Model No., 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 (E.U.T.) except the Receipt Date of Sample
 - SECTION 4: Operation of E.U.T. 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 (E.U.T.)

2.1 Identification of E.U.T.

Type of Equipment : BLE board
Model No. : RDV2HT
Serial No. : Refer to SECTION 4.2
Rating : DC 24.0 V (DC 10.8 V to 26.4 V)
Receipt Date of Sample : December 23, 2019
Country of Mass-production : JAPAN
Condition of EUT : Production prototype
(Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT : No Modification by the test lab.

2.2 Product Description

Model: RDV2HT (referred to as the EUT in this report) is a BLE board.

Radio Specification

[Bluetooth Low Energy]

Equipment Type : Transceiver
Frequency of Operation : 2402 MHz - 2480 MHz
Type of Modulation : GFSK
Antenna Type : PCB Antenna
Antenna Gain : 2.25 dBi
Clock frequency (Maximum) : 64 MHz

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on July 19, 2019 and effective August 19, 2019 except 15.258

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 ----- ISED: RSS-Gen 8.8	FCC: Section 15.207 ----- ISED: RSS-Gen 8.8	QP 21.3 dB, 0.50000 MHz, N	Complied a)	-
6dB Bandwidth	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ----- ISED: -	FCC: Section 15.247(a)(2) ----- ISED: RSS-247 5.2(a)	See data.	Complied b)	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ----- ISED: RSS-Gen 6.12	FCC: Section 15.247(b)(3) ----- ISED: RSS-247 5.4(d)		Complied c)	Conducted
Power Density	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ----- ISED: -	FCC: Section 15.247(e) ----- ISED: RSS-247 5.2(b)		Complied d)	Conducted
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ----- ISED: RSS-Gen 6.13	FCC: Section 15.247(d) ----- ISED: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10		9.9 dB 4804.000 MHz, AV, Hori	Complied e), f)

Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.

*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)

Symbols:

Complied The data of this test item has enough margin, more than the measurement uncertainty.

Complied# The data of this test item meets the limits unless the measurement uncertainty is taken into consideration.

* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

FCC Part 15.31 (e)

This EUT provides the stable voltage constantly to RF Module regardless of input voltage. Therefore, this EUT complies with the requirement.

FCC Part 15.203/212 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 15.203/212.

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99% Occupied Bandwidth	RSS-Gen 6.7	ISED: -	N/A	- b)	Conducted
Co-location & Co-operation (Confirmation testing for Radiated Spurious Emission at simultaneous transmission)	ANSI C63.4-2014 13. Measurement of intentional radiators	Section15.247(d) RSS-247 5.5	-	N/A *1)	Radiated

Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.
*1) The EUT does not have the Co-location & Co-operation.
b) 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

There is no applicable rule of uncertainty in this applied standard. Therefore, the results are derived depending on whether or not laboratory uncertainty is applied.

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

Conducted emission

Frequency range	Required Uncertainty (+/-)	Uncertainty (+/-)
0.15 MHz to 30 MHz	3.4 dB	3.3 dB

Radiated emission

Measurement distance	Frequency range	Required Uncertainty (+/-)	Uncertainty (+/-)
3 m	9 kHz to 30 MHz	Not Defined	2.9 dB
	30 MHz to 200 MHz	6.3 dB	6.1 dB
	200 MHz to 1000 MHz		6.2 dB
	1 GHz to 6 GHz	5.2 dB	5.0 dB
	6 GHz to 18 GHz	5.5 dB	5.4 dB
	18 GHz to 40 GHz	Not Defined	5.5 dB
1 m	1 GHz to 18 GHz	Not Defined	5.4 dB
	18 GHz to 40 GHz		5.6 dB

Antenna Terminal test

Test Item	Required Uncertainty (+/-)	Uncertainty (+/-)
6 dB Bandwidth / 99 % Occupied Bandwidth	Not Defined	1.6 %
Maximum Output Power	0.75 dB	0.73 dB
Burst Rate	Not Defined	0.256 %
Power Density	4 dB	2.2 dB
Conducted Spurious Emission (9 kHz to 30 MHz)	4 dB	2.2 dB

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

3.5 Test Location

UL Japan, Inc. Kashima EMC Lab.

1614 Mushihata, Katori-shi, Chiba-ken, 289-0341 JAPAN

Telephone: +81 478 88 6500, Facsimile: +81 478 82 3373

A2LA Certificate Number: 1266.01/FCC Test Firm Registration Number: 910230 / ISED Lab Company Number: 4659A

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.

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

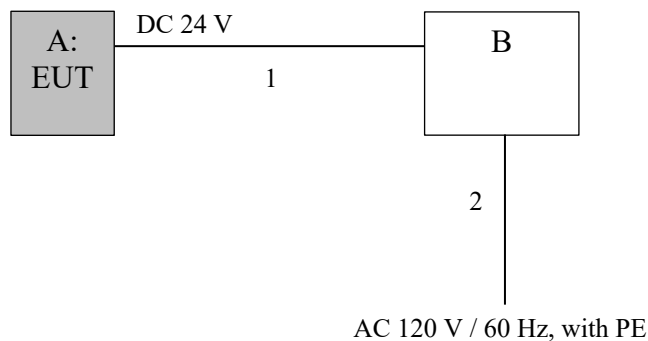
SECTION 4: Operation of E.U.T. during testing

4.1 Operating Mode(s)

Mode	Frequency	Remarks*
Bluetooth Low Energy (BT LE)	2402 MHz, 2440 MHz, 2480 MHz	PRBS9
*Power of the EUT was set by the software as follows; - Power Setting: Fixed - Software: DTM Tool for BTS04 (DLE) ver.:0.0.8.1 *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.		

Test Item	Operating Mode	Tested frequency
Conducted emission Spurious Emission 6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth	Tx BT LE	2402 MHz 2440 MHz 2480 MHz

4.2 Configuration and peripherals



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

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remark
A	BLE board	RDV2HT	3 *1) T2 *2),*3)	MIWA LOCK CO., LTD.	EUT
B	DC Power Supply	ZX-800H	428880100025	Takasago	*1)
		PAD 35-10L	15314224	KIKUSUI ELECTRONICS CORP.	*2)
		PAN 35-20A	JJ001598	KIKUSUI ELECTRONICS CORP.	*3)

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	0.6 + 1.2 *1) 0.7 + 1.2 *2),*3)	Unshielded	Unshielded	-
2	AC Cable	2.5 *1) 2.9 *2) 2.8 *3)	Unshielded	Unshielded	3 wire

*1) Used for Antenna Terminal conducted test

*2) Used for Conducted Emission test

*3) Used for and Radiated Emission test

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

SECTION 5: Conducted Emission

Test Procedure and conditions

EUT was placed on a urethane platform 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. All unused 50ohm connectors of the LISN (AMN) were resistivity terminated in 50 ohm when not connected to the measuring equipment.

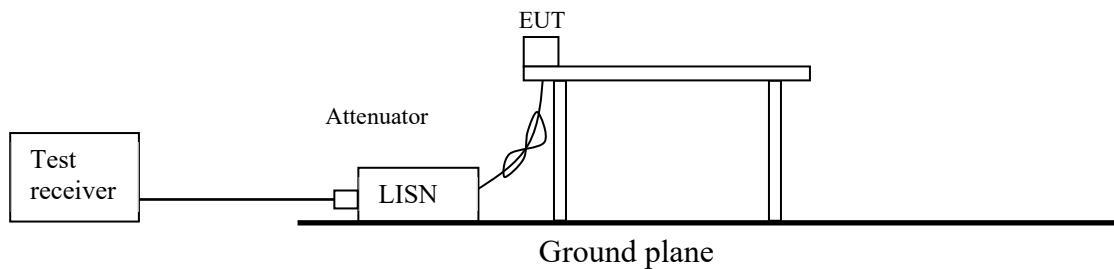
The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Semi Anechoic Chamber. The EUT was connected to a LISN (AMN).

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 - 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.

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.

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 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.

UL Japan, Inc.

Kashima EMC Lab.

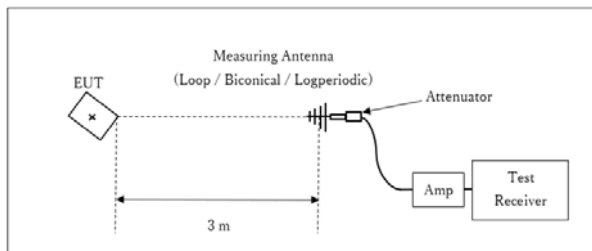
1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Figure 2: Test Setup

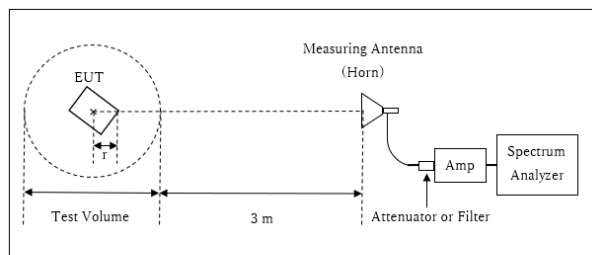
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



r : Radius of an outer periphery of EUT

× : Center of turn table

Distance Factor: $20 \times \log (3.97 \text{ m} / 3.0 \text{ m}) = 2.43 \text{ dB}$

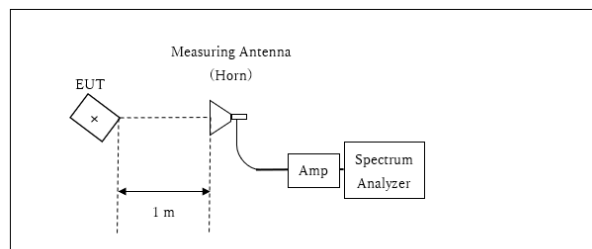
* Test Distance: $(3 + \text{Test Volume} / 2) - r = 3.97 \text{ m}$

Test Volume : 2.0 m

(Test Volume has been calibrated based on CISPR 16-1-4.)

$r = 0.03 \text{ m}$

10 GHz – 26.5 GHz



× : Center of turn table

Distance Factor: $20 \times \log (1.0 \text{ m} / 3.0 \text{ m}) = -9.54 \text{ dB}$

*Test Distance: 1 m

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

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

Measurement range : 30 MHz - 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	10 MHz	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 *5)	9kHz to 150kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	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 low enough as shown in the chart. (9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 10 kHz).							

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

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

APPENDIX 1: Test data

Conducted Emission

DATA OF CONDUCTED EMISSION TEST

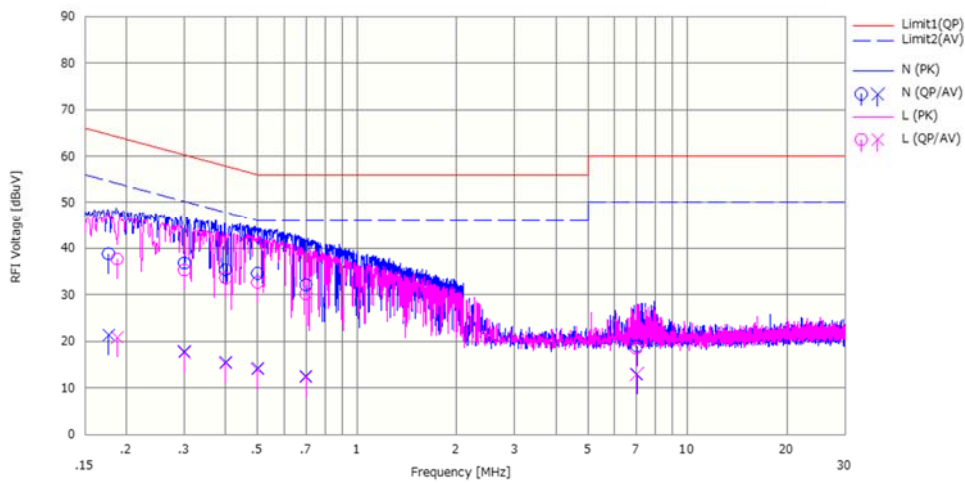
UL Japan, Inc. Kashima EMC Lab. No.10 Semi-Anechoic Chamber
Date : 2020/01/29

Mode : Tx BT LE 2402 MHz
Order No. : 13148763M
Power : DC 24V
Temp./Humi. : 18deg.C. / 52%RH

Remarks : -

Limit : FCC_Part 15 Subpart C(15.207)

Tested by : Kazuhiro Ando

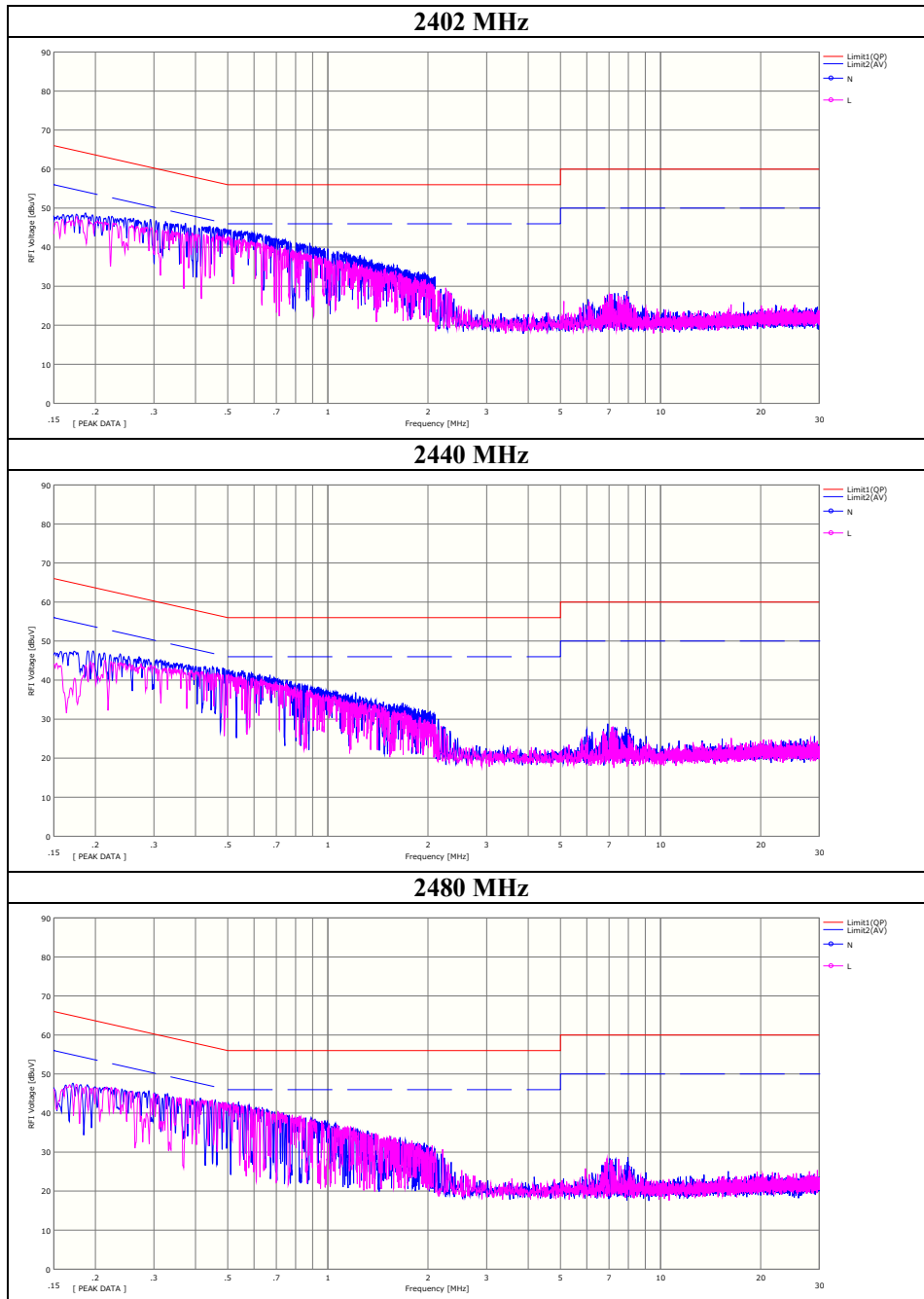


No.	Freq. [MHz]	Reading		C.Fac. [dB]	Results		Limit		Margin		Phase	Comment
		(QP) [dBuV]	(AV) [dBuV]		(QP) [dBuV]	(AV) [dBuV]	(QP) [dBuV]	(AV) [dBuV]	(QP) [dB]	(AV) [dB]		
1	0.17678	28.46	11.04	10.35	38.81	21.39	64.64	54.64	25.8	33.2	N	
2	0.30000	26.42	7.42	10.39	36.81	17.81	60.24	50.24	23.4	32.4	N	
3	0.40000	25.00	5.12	10.40	35.40	15.52	57.85	47.85	22.4	32.3	N	
4	0.50000	24.20	3.86	10.42	34.62	14.28	56.00	46.00	21.3	31.7	N	
5	0.70000	21.74	2.12	10.45	32.19	12.57	56.00	46.00	23.8	33.4	N	
6	7.03625	7.99	2.00	11.03	19.02	13.03	60.00	50.00	40.9	36.9	N	
7	0.18763	27.45	10.66	10.23	37.68	20.89	64.14	54.14	26.4	33.2	L	
8	0.30000	25.07	7.32	10.25	35.32	17.57	60.24	50.24	24.9	32.6	L	
9	0.40000	23.38	5.00	10.26	33.64	15.26	57.85	47.85	24.2	32.5	L	
10	0.50000	22.38	3.68	10.29	32.67	13.97	56.00	46.00	23.3	32.0	L	
11	0.70000	19.93	2.04	10.31	30.24	12.35	56.00	46.00	25.7	33.6	L	
12	6.99754	7.62	2.00	10.94	18.56	12.94	60.00	50.00	41.4	37.0	L	

Calculation: Result[dBuV]=Reading[dBuV]+C.Fac(AMN+Cable+ATT)[dB]
AMN:CLS-07

Conducted Emission

Report No. 13148763M-A-R1
Test place Kashima EMC Lab. No.10 Semi Anechoic Chamber
Date January 29, 2020
Temperature / Humidity 18 deg. C / 52 % RH
Engineer Kazuhiro Ando
Mode Tx BT LE

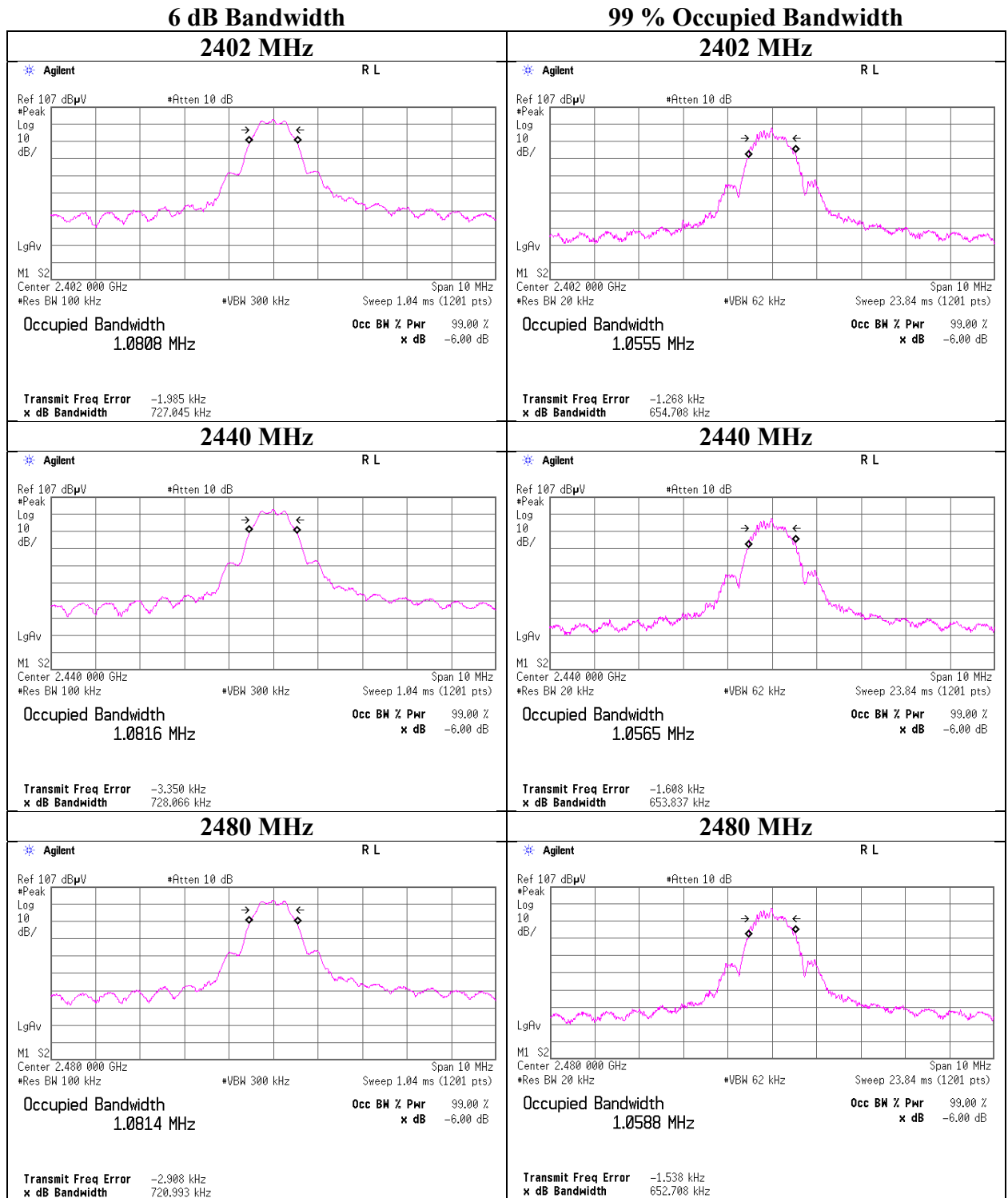


6 dB Bandwidth and 99 % Occupied Bandwidth

Report No. 13148763M-A-R1
Test place Kashima EMC Lab. No.2 Measurement Room
Date December 23, 2019
Temperature / Humidity 22 deg. C / 41 % RH
Engineer Kazuhiro Ando
Mode Tx BT LE

Mode	Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
BT LE	2402	1055.5	0.727	> 0.5000
	2440	1056.5	0.728	> 0.5000
	2480	1058.8	0.721	> 0.5000

99% Occupied Bandwidth



Maximum Peak Output Power

Report No. 13148763M-A-R1
Test place Kashima EMC Lab. No.2 Measurement Room
Date December 23, 2019
Temperature / Humidity 22 deg. C / 41 % RH
Engineer Kazuhiro Ando
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Conducted Power					e.i.r.p. for RSS-247					
				Result		Limit		Margin [dB]	Antenna Gain [dBi]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]			[dBm]	[mW]	[dBm]	[mW]	
2402	-7.24	1.03	10.04	3.83	2.42	30.00	1000	26.17	2.25	6.08	4.06	36.02	4000	29.94
2440	-7.34	1.03	10.04	3.73	2.36	30.00	1000	26.27	2.25	5.98	3.96	36.02	4000	30.04
2480	-7.50	1.04	10.04	3.58	2.28	30.00	1000	26.42	2.25	5.83	3.83	36.02	4000	30.19

Sample Calculation:

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

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

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Average Output Power
(Reference data for RF Exposure)

Report No. 13148763M-A-R1
Test place Kashima EMC Lab. No.2 Measurement Room
Date December 23, 2019
Temperature / Humidity 22 deg. C / 41 % RH
Engineer Kazuhiro Ando
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
				[dBm]	[mW]		[dBm]	[mW]
2402	-9.47	1.03	10.04	1.60	1.45	1.96	3.56	2.27
2440	-9.59	1.03	10.04	1.48	1.41	1.96	3.44	2.21
2480	-9.76	1.04	10.04	1.32	1.36	1.96	3.28	2.13

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.

UL Japan, Inc.

Kashima EMC Lab.

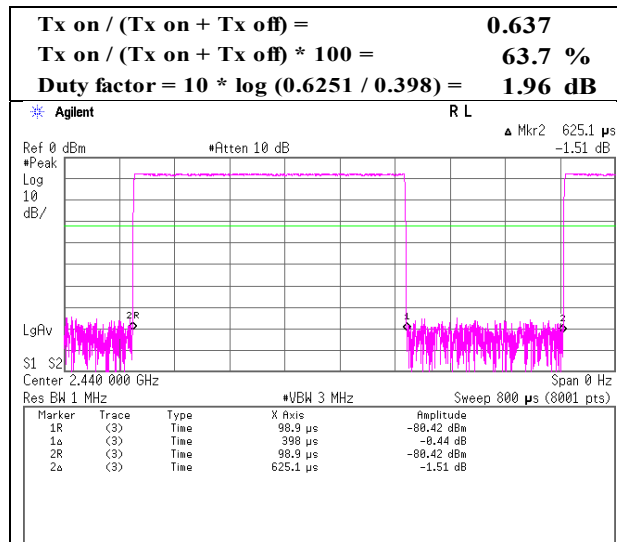
1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Burst rate confirmation

Report No. 13148763M-A-R1
 Test place Kashima EMC Lab. No.2 Measurement Room
 Date December 23, 2019
 Temperature / Humidity 22 deg. C / 41 % RH
 Engineer Kazuhiro Ando
 Mode Tx BT LE



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

Radiated Spurious Emission

Report No.	13148763M-A-R1		
Test place	Kashima EMC Lab.		
Semi Anechoic Chamber	No.10	No.11	No.11
Date	January 29, 2020	January 28, 2020	January 28, 2020
Temperature / Humidity	18 deg. C / 52 % RH	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando	Hiromitsu Tanabe	Hiromitsu Tanabe
Mode	(30 MHz - 1000 MHz) Tx BT LE 2402 MHz	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)

(* 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.	377.461	QP	25.63	15.06	9.29	31.46	0.00	18.52	46.00	27.4	100	300	
Hori.	440.436	QP	25.59	16.82	9.75	31.42	0.00	20.74	46.00	25.2	100	78	
Hori.	844.435	QP	24.01	22.71	11.73	31.15	0.00	27.30	46.00	18.7	100	71	
Hori.	2390.000	PK	50.50	27.60	13.69	43.90	2.43	50.32	73.90	23.5	201	146	
Hori.	4804.000	PK	54.50	32.65	5.79	45.21	2.43	50.16	73.90	23.7	142	53	
Hori.	7206.000	PK	49.80	37.21	7.13	44.08	2.43	52.49	73.90	21.4	150	0	Floor noise
Hori.	9608.000	PK	47.10	38.11	7.96	41.88	2.43	53.72	73.90	20.1	150	0	Floor noise
Vert.	76.194	QP	28.80	10.03	6.57	31.73	0.00	13.67	40.00	26.3	100	180	
Vert.	91.967	QP	34.30	7.82	6.77	31.70	0.00	17.19	43.50	26.3	100	251	
Vert.	156.221	QP	28.91	13.47	7.45	31.60	0.00	18.23	43.50	25.2	100	175	
Vert.	221.412	QP	32.11	9.71	8.03	31.50	0.00	18.35	46.00	27.6	100	0	
Vert.	437.312	QP	29.09	16.75	9.73	31.43	0.00	24.14	46.00	21.8	100	38	
Vert.	842.753	QP	23.37	22.71	11.72	31.15	0.00	26.65	46.00	19.3	119	0	
Vert.	916.676	QP	26.06	23.74	12.05	31.10	0.00	30.75	46.00	15.2	115	0	
Vert.	2390.000	PK	49.80	27.60	13.69	43.90	2.43	49.62	73.90	24.2	351	301	
Vert.	4804.000	PK	52.70	32.65	5.79	45.21	2.43	48.36	73.90	25.5	158	325	
Vert.	7206.000	PK	49.70	37.21	7.13	44.08	2.43	52.39	73.90	21.5	150	0	Floor noise
Vert.	9608.000	PK	46.60	38.11	7.96	41.88	2.43	53.22	73.90	20.6	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 10 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.43\text{ dB}$

10 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

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	41.50	27.60	13.69	43.90	1.96	2.43	43.28	53.9	10.6	*1)
Hori.	4804.000	AV	46.30	32.65	5.79	45.21	1.96	2.43	43.92	53.9	9.9	
Hori.	7206.000	AV	40.30	37.21	7.13	44.08	1.96	2.43	44.95	53.9	8.9	Floor noise
Hori.	9608.000	AV	38.00	38.11	7.96	41.88	1.96	2.43	46.58	53.9	7.3	Floor noise
Vert.	2390.000	AV	41.30	27.60	13.69	43.90	1.96	2.43	43.08	53.9	10.8	*1)
Vert.	4804.000	AV	44.20	32.65	5.79	45.21	1.96	2.43	41.82	53.9	12.0	
Vert.	7206.000	AV	40.60	37.21	7.13	44.08	1.96	2.43	45.25	53.9	8.6	Floor noise
Vert.	9608.000	AV	37.80	38.11	7.96	41.88	1.96	2.43	46.38	53.9	7.5	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor

Distance factor : 1 GHz - 10 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.43\text{ dB}$

10 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

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	89.40	27.62	13.70	43.89	2.43	89.26	-	-	Carrier
Hori.	2400.000	PK	43.00	27.61	13.70	43.89	2.43	42.85	69.26	26.4	
Vert.	2402.000	PK	82.67	27.62	13.70	43.89	2.43	82.53	-	-	Carrier
Vert.	2400.000	PK	41.20	27.61	13.70	43.89	2.43	41.05	62.53	21.4	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 10 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.43\text{ dB}$

10 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

UL Japan, Inc.

Kashima EMC Lab.

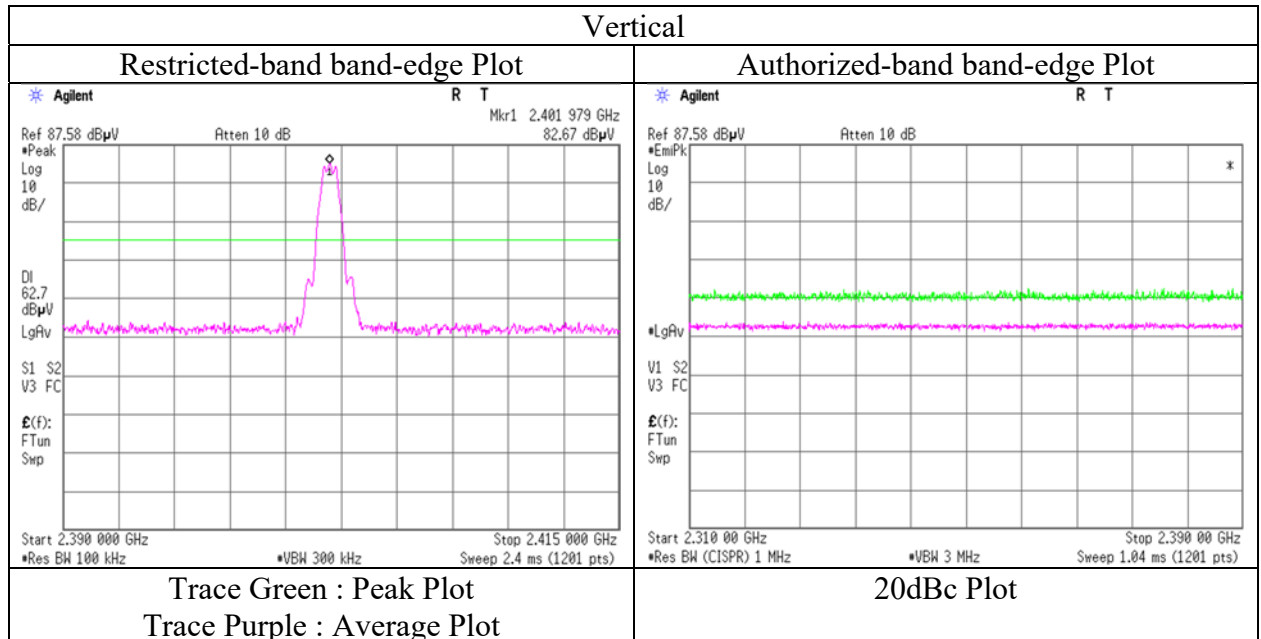
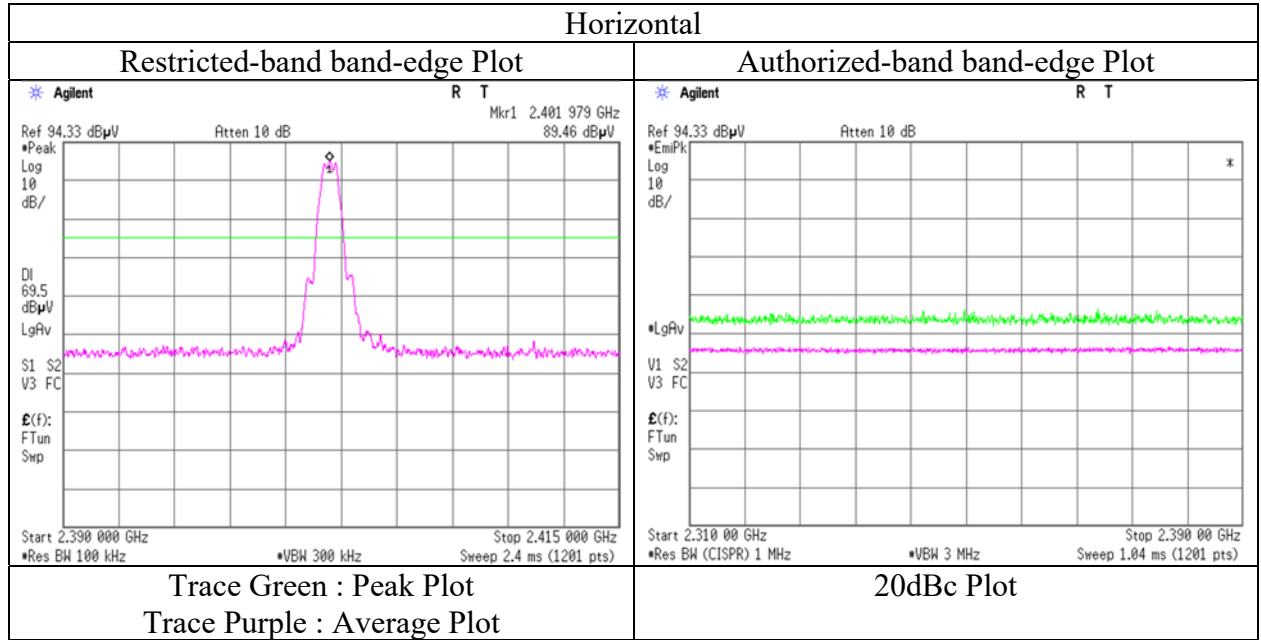
1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	13148763M-A-R1	No.11	No.11
Test place	Kashima EMC Lab.	January 28, 2020	January 28, 2020
Semi Anechoic Chamber	No.10	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Date	January 29, 2020	Hiromitsu Tanabe	Hiromitsu Tanabe
Temperature / Humidity	18 deg. C / 52 % RH	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)
Engineer	Kazuhiro Ando		
Mode	(30 MHz - 1000 MHz) Tx BT LE 2402 MHz		



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

Radiated Spurious Emission

Report No.	13148763M-A-R1		
Test place	Kashima EMC Lab.		
Semi Anechoic Chamber	No.10	No.11	No.11
Date	January 29, 2020	January 28, 2020	January 28, 2020
Temperature / Humidity	18 deg. C / 52 % RH	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)
Mode	Tx BT LE 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.	377.626	QP	25.63	15.07	9.30	31.46	0.00	18.54	46.00	27.4	100	140	
Hori.	440.436	QP	25.99	16.82	9.75	31.42	0.00	21.14	46.00	24.8	100	78	
Hori.	848.616	QP	23.32	22.74	11.74	31.15	0.00	26.65	46.00	19.3	100	75	
Hori.	4880.000	PK	52.70	32.67	5.84	45.25	2.43	48.39	73.90	25.5	152	136	
Hori.	7320.000	PK	49.30	37.41	7.17	43.82	2.43	52.49	73.90	21.4	150	0	Floor noise
Hori.	9760.000	PK	46.50	38.14	8.02	41.77	2.43	53.32	73.90	20.5	150	0	Floor noise
Vert.	76.197	QP	28.78	10.03	6.57	31.73	0.00	13.65	40.00	26.3	100	180	
Vert.	91.923	QP	33.76	7.82	6.77	31.70	0.00	16.65	43.50	26.8	100	254	
Vert.	157.814	QP	28.96	13.45	7.46	31.60	0.00	18.27	43.50	25.2	100	177	
Vert.	221.362	QP	32.20	9.72	8.03	31.50	0.00	18.45	46.00	27.5	100	0	
Vert.	437.451	QP	29.52	16.75	9.73	31.43	0.00	24.57	46.00	21.4	100	39	
Vert.	842.629	QP	22.97	22.71	11.72	31.15	0.00	26.25	46.00	19.7	118	0	
Vert.	916.676	QP	25.31	23.74	12.05	31.10	0.00	30.00	46.00	16.0	116	0	
Vert.	4880.000	PK	52.10	32.67	5.84	45.25	2.43	47.79	73.90	26.1	147	172	
Vert.	7320.000	PK	48.70	37.41	7.17	43.82	2.43	51.89	73.90	22.0	150	0	Floor noise
Vert.	9760.000	PK	47.00	38.14	8.02	41.77	2.43	53.82	73.90	20.0	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 10 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.43\text{ dB}$

10 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

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	42.30	32.67	5.84	45.25	1.96	2.43	39.95	53.9	13.9	
Hori.	7320.000	AV	38.90	37.41	7.17	43.82	1.96	2.43	44.05	53.9	9.8	Floor noise
Hori.	9760.000	AV	36.40	38.14	8.02	41.77	1.96	2.43	45.18	53.9	8.7	Floor noise
Vert.	4880.000	AV	42.10	32.67	5.84	45.25	1.96	2.43	39.75	53.9	14.1	
Vert.	7320.000	AV	38.50	37.41	7.17	43.82	1.96	2.43	43.65	53.9	10.2	Floor noise
Vert.	9760.000	AV	36.40	38.14	8.02	41.77	1.96	2.43	45.18	53.9	8.7	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor

Distance factor : 1 GHz - 10 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.43\text{ dB}$

10 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Duty factor refer to "Duty factor Calculation chart" sheet.

*1) Not out of band emission (Leakage Power)

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Radiated Spurious Emission

Report No.	13148763M-A-R1		
Test place	Kashima EMC Lab.		
Semi Anechoic Chamber	No.10	No.11	No.11
Date	January 29, 2020	January 28, 2020	January 28, 2020
Temperature / Humidity	18 deg. C / 52 % RH	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)
Mode	Tx BT LE 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.	377.514	QP	25.76	15.07	9.29	31.46	0.00	18.66	46.00	27.3	100	304	
Hori.	438.876	QP	25.98	16.79	9.74	31.42	0.00	21.09	46.00	24.9	100	80	
Hori.	843.426	QP	23.45	22.71	11.72	31.15	0.00	26.73	46.00	19.2	100	72	
Hori.	2483.500	PK	52.30	27.93	13.75	43.87	2.43	52.54	73.90	21.3	285	161	
Hori.	4960.000	PK	51.50	32.70	5.90	45.32	2.43	47.21	73.90	26.6	145	33	
Hori.	7440.000	PK	49.30	37.47	7.20	43.49	2.43	52.91	73.90	20.9	100	0	Floor noise
Hori.	9920.000	PK	46.70	38.29	8.09	41.76	2.43	53.75	73.90	20.1	100	0	Floor noise
Vert.	76.209	QP	28.80	10.02	6.57	31.73	0.00	13.66	40.00	26.3	100	180	
Vert.	91.944	QP	33.80	7.82	6.77	31.70	0.00	16.69	43.50	26.8	100	260	
Vert.	157.879	QP	29.01	13.46	7.46	31.60	0.00	18.33	43.50	25.1	100	151	
Vert.	221.323	QP	32.65	9.72	8.03	31.50	0.00	18.90	46.00	27.1	100	0	
Vert.	437.261	QP	29.40	16.75	9.73	31.43	0.00	24.45	46.00	21.5	100	39	
Vert.	836.028	QP	22.67	22.71	11.69	31.16	0.00	25.91	46.00	20.0	118	0	
Vert.	916.676	QP	25.26	23.74	12.05	31.10	0.00	29.95	46.00	16.0	115	0	
Vert.	2483.500	PK	50.90	27.93	13.75	43.87	2.43	51.14	73.90	22.7	369	83	
Vert.	4960.000	PK	51.80	32.70	5.90	45.32	2.43	47.51	73.90	26.3	154	237	
Vert.	7440.000	PK	49.50	37.47	7.20	43.49	2.43	53.11	73.90	20.7	150	0	Floor noise
Vert.	9920.000	PK	46.70	38.29	8.09	41.76	2.43	53.75	73.90	20.1	150	0	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 10 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.43\text{ dB}$

10 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

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	41.30	27.93	13.75	43.87	1.96	2.43	43.50	53.9	10.4	*1)
Hori.	4960.000	AV	43.30	32.70	5.90	45.32	1.96	2.43	40.97	53.9	12.9	
Hori.	7440.000	AV	40.00	37.47	7.20	43.49	1.96	2.43	45.57	53.9	8.3	Floor noise
Hori.	9920.000	AV	37.30	38.29	8.09	41.76	1.96	2.43	46.31	53.9	7.5	Floor noise
Vert.	2483.500	AV	41.40	27.93	13.75	43.87	1.96	2.43	43.60	53.9	10.3	*1)
Vert.	4960.000	AV	42.50	32.70	5.90	45.32	1.96	2.43	40.17	53.9	13.7	
Vert.	7440.000	AV	40.20	37.47	7.20	43.49	1.96	2.43	45.77	53.9	8.1	Floor noise
Vert.	9920.000	AV	37.40	38.29	8.09	41.76	1.96	2.43	46.41	53.9	7.4	Floor noise

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor

Distance factor : 1 GHz - 10 GHz : $20\log(3.97\text{ m} / 3.0\text{ m}) = 2.43\text{ dB}$

10 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Duty factor refer to "Duty factor Calculation chart" sheet.

*1) Not out of band emission (Leakage Power)

UL Japan, Inc.

Kashima EMC Lab.

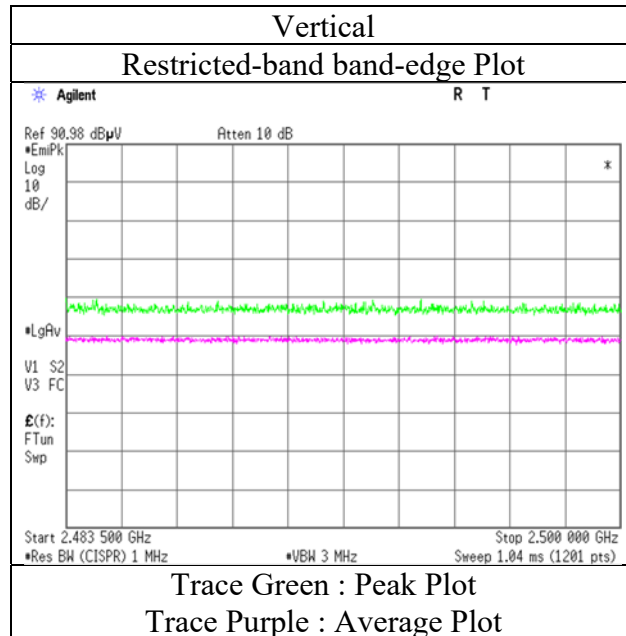
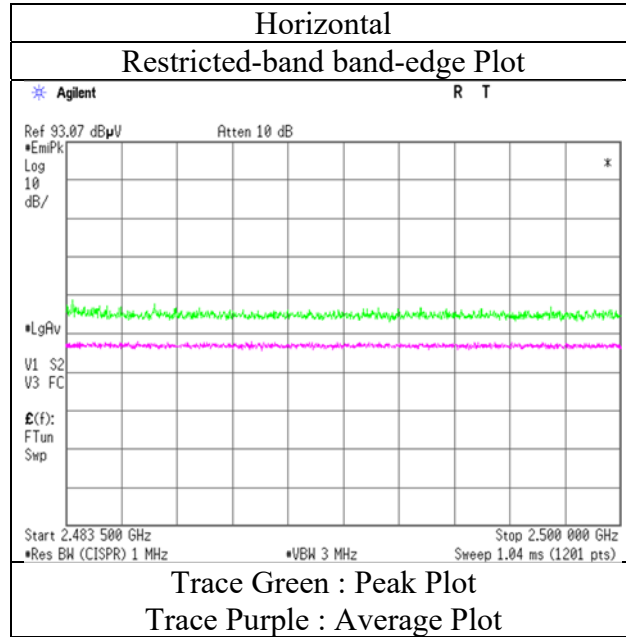
1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Radiated Spurious Emission
(Reference Plot for band-edge)

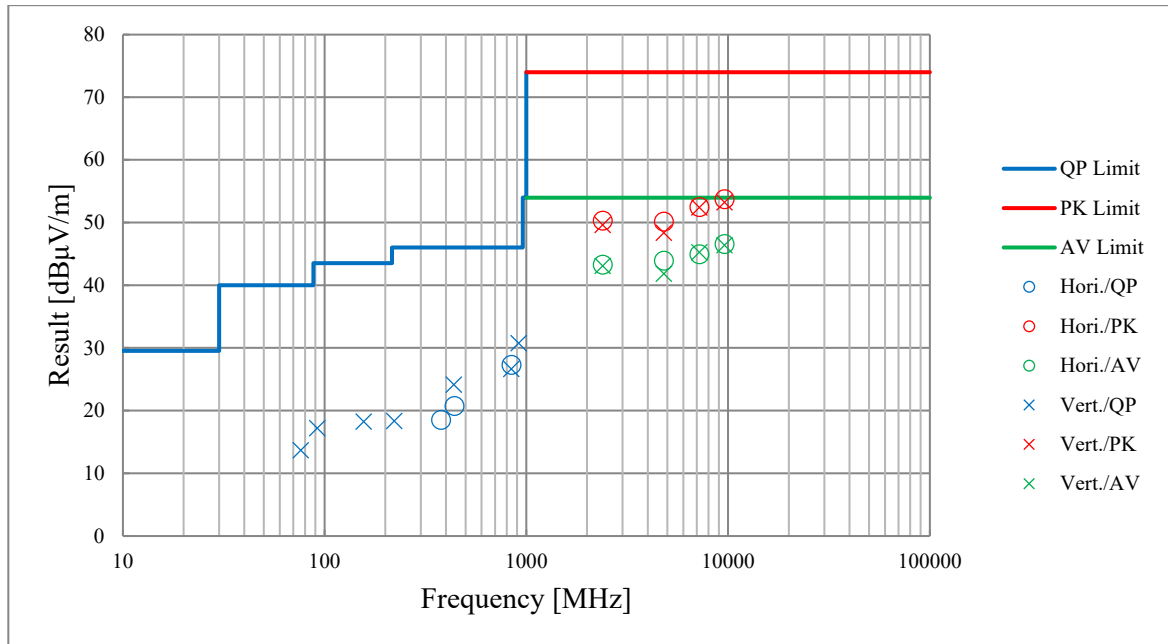
Report No.	13148763M-A-R1		
Test place	Kashima EMC Lab.		
Semi Anechoic Chamber	No.10	No.11	No.11
Date	January 29, 2020	January 28, 2020	January 28, 2020
Temperature / Humidity	18 deg. C / 52 % RH	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando	Hiromitsu Tanabe	Hiromitsu Tanabe
	(30 MHz - 1000 MHz)	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)
Mode	Tx BT LE 2480 MHz		



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

Radiated Spurious Emission
(Plot data, Worst case)

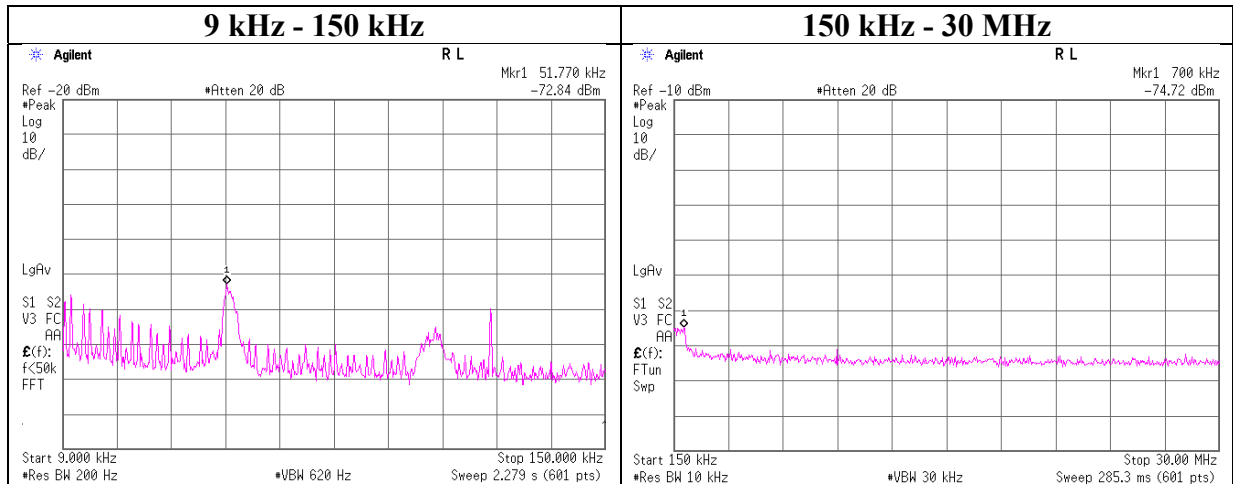
Report No.	13148763M-A-R1		
Test place	Kashima EMC Lab.		
Semi Anechoic Chamber	No.10	No.11	No.11
Date	January 29, 2020	January 28, 2020	January 28, 2020
Temperature / Humidity	18 deg. C / 52 % RH	22 deg. C / 41 % RH	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando (30 MHz - 1000 MHz)	Hiromitsu Tanabe (1 GHz - 10 GHz)	Hiromitsu Tanabe (10 GHz - 26.5 GHz)
Mode	Tx BT LE 2402 MHz		



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

Conducted Spurious Emission

Report No. 13148763M-A-R1
 Test place Kashima EMC Lab. No.2 Measurement Room
 Date December 23, 2019
 Temperature / Humidity 22 deg. C / 41 % RH
 Engineer Kazuhiro Ando
 Mode Tx BT LE 2402 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
51.77	-72.84	0.01	9.95	2.25	1	-60.6	300	6.0	0.6	33.3	32.7	-
700.00	-74.72	0.01	9.95	2.25	1	-62.5	30	6.0	18.7	30.7	12.0	-

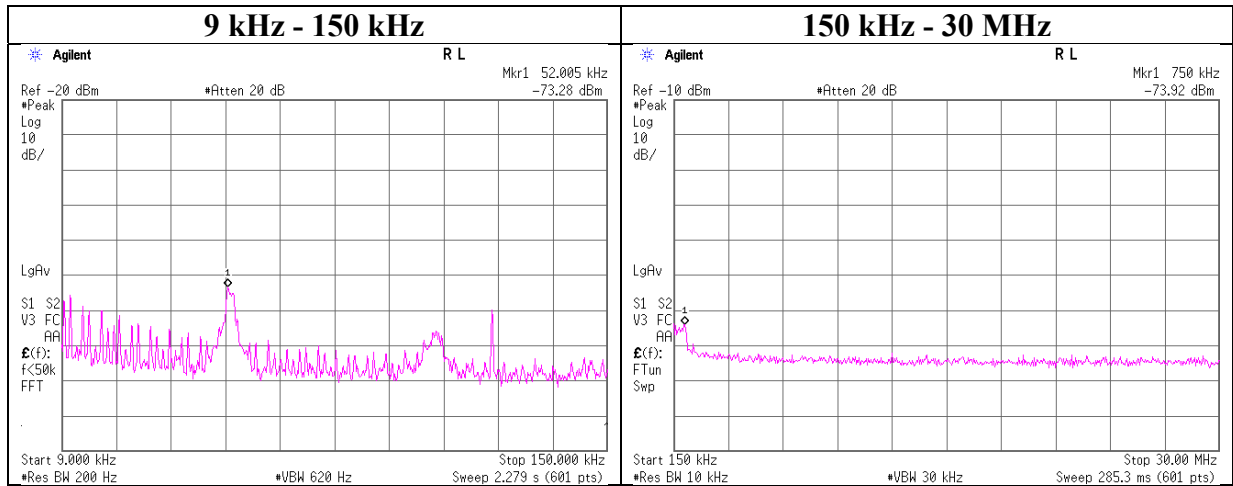
$$E \text{ [dBuV/m]} = \text{EIRP [dBm]} - 20 \log(\text{Distance [m]}) + \text{Ground bounce [dB]} + 104.8 \text{ [dBuV/m]}$$

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

N: Number of output

Conducted Spurious Emission

Report No. 13148763M-A-R1
 Test place Kashima EMC Lab. No.2 Measurement Room
 Date December 23, 2019
 Temperature / Humidity 22 deg. C / 41 % RH
 Engineer Kazuhiro Ando
 Mode Tx BT LE 2440 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
52.01	-73.28	0.01	9.95	2.25	1	-61.1	300	6.0	0.2	33.2	33.0	-
750.00	-73.92	0.01	9.95	2.25	1	-61.7	30	6.0	19.5	30.1	10.6	-

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

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

N: Number of output

UL Japan, Inc.

Kashima EMC Lab.

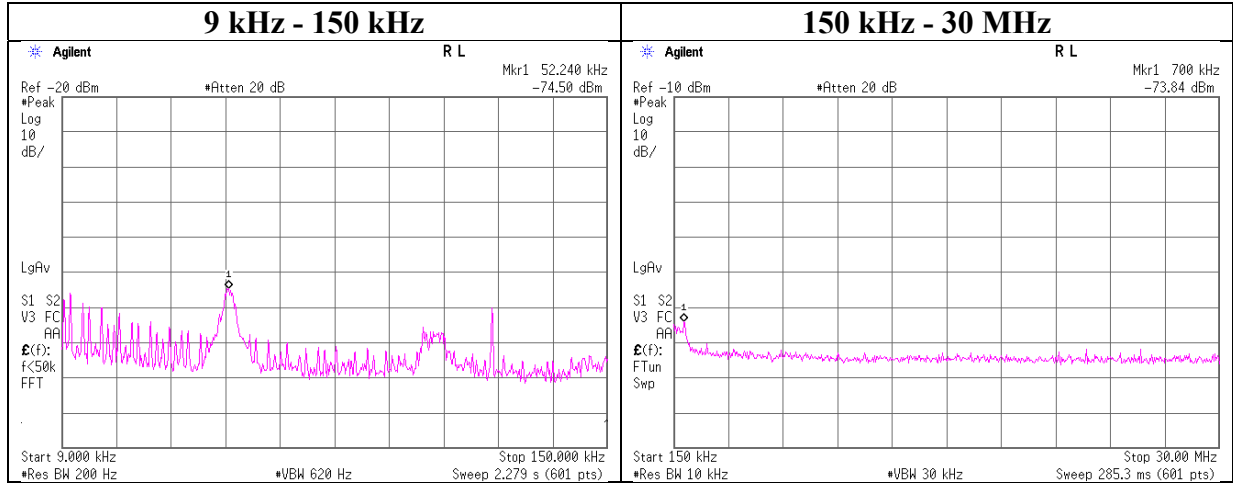
1614, Mushihata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

Conducted Spurious Emission

Report No. 13148763M-A-R1
 Test place Kashima EMC Lab. No.2 Measurement Room
 Date December 23, 2019
 Temperature / Humidity 22 deg. C / 41 % RH
 Engineer Kazuhiro Ando
 Mode Tx BT LE 2480 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
52.24	-74.50	0.01	9.95	2.25	1	-62.3	300	6.0	-1.0	33.2	34.2	-
700.00	-73.84	0.01	9.95	2.25	1	-61.6	30	6.0	19.6	30.7	11.1	-

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

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

N: Number of output

Power Density

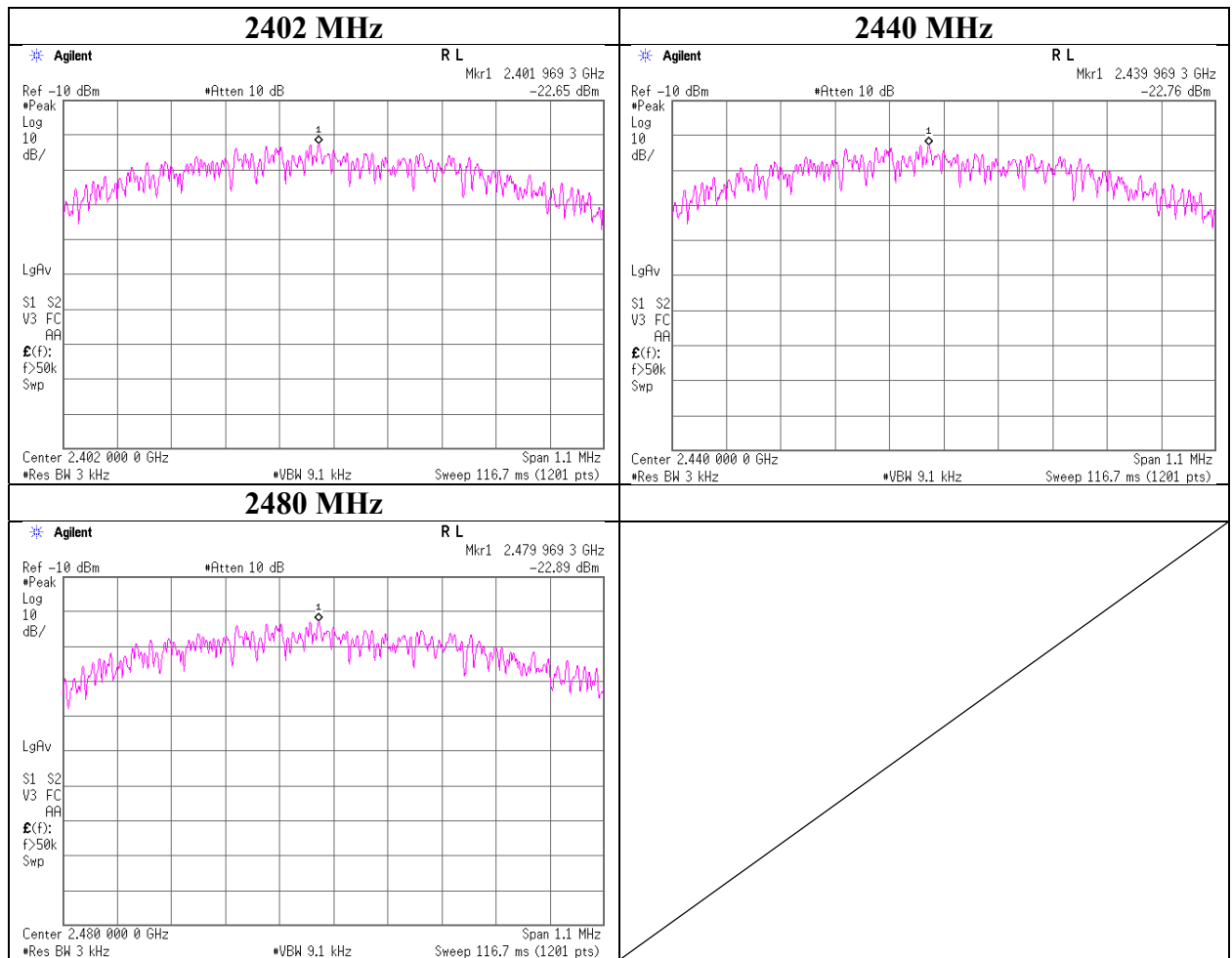
Report No.	13148763M-A-R1
Test place	Kashima EMC Lab. No.2 Measurement Room
Date	December 23, 2019
Temperature / Humidity	22 deg. C / 41 % RH
Engineer	Kazuhiro Ando
Mode	Tx BT LE 2480 MHz

Freq.	Reading	Cable Loss	Atten. Loss	Result	Limit	Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[dBm]	[dB]
2402	-22.65	1.03	10.04	-11.58	8.00	19.58
2440	-22.76	1.03	10.04	-11.69	8.00	19.69
2480	-22.89	1.04	10.04	-11.81	8.00	19.81

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.



UL Japan, Inc.

Kashima EMC Lab.

1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373

APPENDIX 2: Test instruments

Test equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
CE	CLS-07	143501	A.M.N.	Rohde & Schwarz	ESH3-Z5	844982/034	2019/07/17	12
CE	CCC-S10-C	143157	10 Site CE System	UL Japan Inc.	none	none	2019/08/04	12
CE	CTR-09	144199	Test Receiver	AGILENT	N9038A	MY53290016	2019/07/17	12
RE	CBL-08	143121	LOGBICON	Schwarzbeck	VULB 9168	343	2019/04/03	12
RE	CAT5-03	178806	5dB Fixed Atten.	PASTERNAK	PE7047-5	none	2019/04/03	12
RE	CCC-S10-R3	143165	10 Site RE 3m System	UL Japan Inc.	none	none	2019/08/04	12
RE	CAF-28	183880	Pre-Amplifier	UL Japan Inc.	ZKL-2	001	2019/04/08	12
RE	CTR-09	144199	Test Receiver	AGILENT	N9038A	MY53290016	2019/07/17	12
RE(GHz)	TSA-01	143642	Spectrum Analyzer	AGILENT	N9030A	MY53310670 Version A.13.12	2019/05/26	12
RE(GHz)	CCC-W05	142990	Micro Wave Cable	Shuner	SUCOFLEX104A	MY1477/4A	2019/05/23	12
RE(GHz)	CCC-W07	143111	Micro Wave Cable	Junkosha	MWX221	MRA-12-14-148	2019/05/23	12
RE(GHz)	CAT10-17	143023	10dB Fixed Atten.	Weinschel - API Technologies Corp	54A-10	56251	2019/05/23	12
RE(GHz)	CHF-04	143442	HPF	MICRO-TRONICS	HPM50111-02	009	2019/05/23	12
RE(GHz)	CAF-22	142940	Pre-Amplifier	Micro Wave Factory	MPR-1G26.5-35	161399	2019/06/09	12
RE(GHz)	CHA-25	143456	Double Ridged Wave Guide	ETS-Lindgren	3115	00204573	2019/02/04	12
RE(GHz)	CCC-W09	143113	Micro Wave Cable	Suhner	SUCOFLEX104	MY588/4	2019/07/12	12
RE(GHz)	CHA-07	143438	Double Ridged Horn	ETS-Lindgren	3160-09	00166043	2019/06/08	12
RE(GHz)	CAF-19	142937	Pre-Amplifier	TOYO	HAP18-26W	00000035	2019/06/12	12
RE(GHz)	CSA-07	143643	Spectrum Analyzer	AGILENT	E4448A	MY52490024	2019/06/01	12
CE, RE	CSCL-13	143654	Ruler	TAJIMA	L19-55	none	-	-
CE, RE	COS-10	143542	Temperature & Humidity Indicator	HIOKI	3641/9680-50	090999895/09090 5406	2019/06/21	12
CE, RE	CTS-14	144216	Digital Multimeter	Fluke Corporation	115	994460954	2019/10/27	12
CE, RE	COTS- CEMI-03	PRE0189 702	EMI Software	TSJ	TEPTO-DV3 (RE,CE,ME,PE)	-	-	-
RE(GHz)	CSCL-16	143655	Ruler	TAJIMA	G3 gold	none	-	-
RE(GHz)	COS-11	143543	Temperature, Humidity & Atmospheric Logger	T&D	TR-73U	F8060468	2019/06/25	12
RE(GHz)	CTS-13	144215	Digital Multimeter	Fluke Corporation	FLK-83-V	14610320	2019/10/27	12
AT	CSA-07	143643	Spectrum Analyzer	AGILENT	E4448A	MY52490024	2019/06/01	12
AT	CAT10-17	143023	10dB Fixed Atten.	Weinschel - API Technologies Corp	54A-10	56251	2019/05/23	12
AT	CCC-W01	143109	Micro Wave Cable	Suhner	SUCOFLEX102	MY3662/2	2019/05/23	12
AT	CTS-08	144210	Digital Multimeter	Fluke Corporation	112	89790193	2019/10/27	12
AT	COS-02	143534	Temperature & Humidity Indicator	A&D	AD-5681	6878345	2019/07/24	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: CE: Conducted Emission test
RE: Radiated Emission test
AT: Antenna Terminal Conducted test

UL Japan, Inc.

Kashima EMC Lab.

1614, Mushiata, Katori-shi, Chiba-ken, 289-0341 Japan

Telephone : +81 478 88 6500

Facsimile : +81 478 82 3373