



RADIO TEST REPORT

Test Report No. : 13062395H-A-R1

Applicant : MITSUBISHI ELECTRIC CORPORATION
SANDA WORKS

Type of Equipment : Car Audio

Model No. : AR-100

FCC ID : UJHAR100

Test regulation : FCC Part 15 Subpart C: 2019

Test Result : Complied (Refer to SECTION 3.2)

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
6. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
7. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 13062395H-A. 13062395H-A is replaced with this report.

Date of test: October 28 to November 13, 2019

Representative test engineer:

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- ☐ This report contains data that are not covered by the NVLAP accreditation.
- ☒ There is no testing item of "Non-accreditation".

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REVISION HISTORY

Original Test Report No.: 13062395H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13062395H-A	January 6, 2020	-	-
1	13062395H-A-R1	March 13, 2020	P1	Corrected the sentence about NVLAP accreditation
1	13062395H-A-R1	March 13, 2020	P6	Radio Specification Frequency of Operation of FM: FM: 87.7 MHz - 107.9 MHz ↓ FM: 87.75 MHz - 107.9 MHz
1	13062395H-A-R1	March 13, 2020	P19	Carrier Frequency Separation Updated the data of DH5 2402 MHz

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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		

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SECTION 1: Customer information

Company Name	:	MITSUBISHI ELECTRIC CORPORATION SANDA WORKS
Address	:	2-3-33, Miwa, Sanda-city, Hyogo, 669-1513, Japan
Telephone Number	:	+81-79-559-3182
Facsimile Number	:	+81-79-559-3875
Contact Person	:	Kenji Otani

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.)
- 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	:	Car Audio
Model No.	:	AR-100
Serial No.	:	Refer to SECTION 4.2
Rating	:	DC 12 V
Receipt Date of Sample (Information from test lab.)	:	October 28, 2019
Country of Mass-production	:	Thailand
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: AR-100 (referred to as the EUT in this report) is a Car Audio.

Radio Specification

[Bluetooth (BR / EDR function)]

Equipment Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480MHz
Type of Modulation	:	FHSS
Channel spacing	:	1 MHz
Antenna Type	:	PCB pattern antenna
Antenna connector type	:	MHF-SW23
Antenna Gain	:	3.0 dBi
Clock frequency (max)	:	26 MHz

[AM / FM / DAB]

Equipment Type	:	Receiver
Frequency of Operation	:	AM: 530 kHz - 1710 kHz FM: 87.75 MHz - 107.9 MHz
Channel spacing	:	AM: 9 kHz FM: 100 kHz

[GNSS]

Equipment Type	:	Receiver
Frequency of Operation	:	See table below.
Antenna type	:	Patch Antenna
Antenna Gain	:	26.5 dBi

Supported GNSS and GNSS signals

GNSS	RNSS Frequency Band / Frequency [MHz]		
	1559 to 1610	1215 to 1300	1164 to 1215
BDS	☐ B1I 1561.098	-	-
Galileo	☐ E1 1575.42	☐ E6 1278.75	☐ E5a 1176.45 ☐ E5b 1207.14
GLONASS	☒ G1 1598.0625 - 1605.375	☐ G2 1242.9375 - 1248.625	-
GPS	☒ L1 1575.42	☐ L2 1227.6	☐ L5 1176.45
SBAS	☐ L1 1575.42	-	☐ L5 1176.45

- ☒ Supported GNSS signal
☐ Not supported GNSS signal

*This test report applies to Bluetooth part.

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

*The customer has declared that the EUT has complies with FCC Part 15 Subpart B as SDoC.

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	-	N/A	*1)
Carrier Frequency Separation	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(1) ISED: RSS-247 5.1 (b)	See data.	Complied a)	Conducted
20dB Bandwidth	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(1) ISED: RSS-247 5.1 (a)		Complied a)	Conducted
Number of Hopping Frequency	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(1)(iii) ISED: RSS-247 5.1 (d)		Complied b)	Conducted
Dwell time	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(1)(iii) ISED: RSS-247 5.1 (d)		Complied c)	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: RSS-Gen 6.12	FCC: Section 15.247(b)(1) ISED: RSS-247 5.4 (b)		Complied d)	Conducted
Spurious Emission & Band Edge Compliance	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	3.4 dB, 7323.000 MHz, AV, Horizontal	Complied e) / f)	Conducted/ Radiated (above 30 MHz) *2)

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

*1) The test is not applicable since the EUT is not the device that is designed to be connected to the public utility (AC) power line.

*2) Radiated test was selected over 30 MHz based on section 15.247(d).

a) Refer to APPENDIX 1 (data of 20dB Bandwidth, 99%Occupied Bandwidth and Carrier Frequency Separation)

b) Refer to APPENDIX 1 (data of Number of Hopping Frequency)

c) Refer to APPENDIX 1 (data of Dwell time)

d) Refer to APPENDIX 1 (data of Maximum Peak Output Power)

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 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.

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3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99% Occupied Bandwidth	RSS-Gen 6.7	ISED: -	N/A	- a)	Conducted
a) Refer to APPENDIX 1 (data of 20dB Bandwidth, 99%Occupied Bandwidth and Carrier Frequency Separation)					

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 $k=2$.
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Antenna Terminal test

Test Item	Uncertainty (+/-)
20 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %
Maximum Peak Output Power / Average Output Power	1.4 dB
Carrier Frequency Separation	0.42 %
Dwell time / Burst rate	0.10 %
Conducted Spurious Emission	2.6 dB

Conducted emission

using Item	Frequency range	Uncertainty (+/-)
AMN (LISN)	0.009 MHz to 0.15 MHz	3.4 dB
	0.15 MHz to 30 MHz	2.9 dB

Radiated emission

Measurement distance	Frequency range	Uncertainty (+/-)
3 m	9 kHz to 30 MHz	3.3 dB
10 m		3.2 dB
3 m	30 MHz to 200 MHz (Horizontal) (Vertical)	4.8 dB
		5.0 dB
	200 MHz to 1000 MHz (Horizontal) (Vertical)	5.2 dB
		6.3 dB
10 m	30 MHz to 200 MHz (Horizontal) (Vertical)	4.8 dB
		4.8 dB
	200 MHz to 1000 MHz (Horizontal) (Vertical)	5.0 dB
		5.0 dB
3 m	1 GHz to 6 GHz	4.9 dB
	6 GHz to 18 GHz	5.2 dB
1 m	10 GHz to 26.5 GHz	5.5 dB
	26.5 GHz to 40 GHz	5.5 dB
10 m	1 GHz to 18 GHz	5.2 dB

3.5 Test Location

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*NVLAP Lab. code: 200572-0 / FCC Test Firm Registration Number: 199967 / ISED Lab Company Number: 2973C

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Test site	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms	Maximum measurement distance
No.1 semi-anechoic chamber	19.2 x 11.2 x 7.7	7.0 x 6.0	No.1 Power source room	10 m
No.2 semi-anechoic chamber	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.3 Preparation room	3 m
No.3 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.4 semi-anechoic chamber	12.0 x 8.5 x 5.9	6.8 x 5.75	No.4 Preparation room	3 m
No.4 shielded room	4.0 x 6.0 x 2.7	N/A	-	-
No.5 semi-anechoic chamber	6.0 x 6.0 x 3.9	6.0 x 6.0	-	-
No.5 measurement room	6.4 x 6.4 x 3.0	6.4 x 6.4	-	-
No.6 shielded room	4.0 x 4.5 x 2.7	4.0 x 4.5	-	-
No.6 measurement room	4.75 x 5.4 x 3.0	4.75 x 4.15	-	-
No.7 shielded room	4.7 x 7.5 x 2.7	4.7 x 7.5	-	-
No.8 measurement room	3.1 x 5.0 x 2.7	3.1 x 5.0	-	-
No.9 measurement room	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.11 measurement room	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 x 2.0 m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

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

4.1 Operating Mode(s)

Bluetooth (BT): Transmitting (Tx), Payload: PRBS9

Details of Operating Mode(s)

Test Item	Mode	Tested frequency
Spurious Emission (Conducted/Radiated)	Tx (Hopping Off) DH5, 3DH5	2402 MHz 2441 MHz 2480 MHz
Carrier Frequency Separation	Tx (Hopping On) DH5, 3DH5	2402 MHz 2441 MHz 2480 MHz
20dB Bandwidth	Tx (Hopping Off) DH5, 3DH5	2402 MHz 2441 MHz 2480 MHz
Number of Hopping Frequency	Tx (Hopping On) DH5, 3DH5	-
Dwell time	Tx (Hopping On), -DH1, DH3, DH5 -3DH1, 3DH3, 3DH5	-
Maximum Peak Output Power	Tx (Hopping Off) DH5, 2DH5, 3DH5	2402 MHz 2441 MHz 2480 MHz
Band Edge Compliance (Conducted)	Tx DH5, 3DH5 -Hopping On -Hopping Off	2402 MHz 2480 MHz
99% Occupied Bandwidth	Tx DH5, 3DH5 -Hopping On -Hopping Off	2402 MHz 2441 MHz 2480 MHz
*As a result of preliminary test, the formal test was performed with the above modes, which had the maximum payload length (except Dwell time test) *2DH mode (2Mb/s EDR: pi/4DQPSK) was excluded for other tests than power measurement by using 3DH mode (3 Mb/s EDR: 8DPSK) as a representative. * It is considered that the non-tested packet type (e.g. inquiry) can be omitted as it is complied with above all the test items based on Bluetooth Core specification. *EUT has the power settings by the software as follows; - Power settings: 4 dBm - Software: HCITester2.1.00, Ver. 1.0.0.1 *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.		

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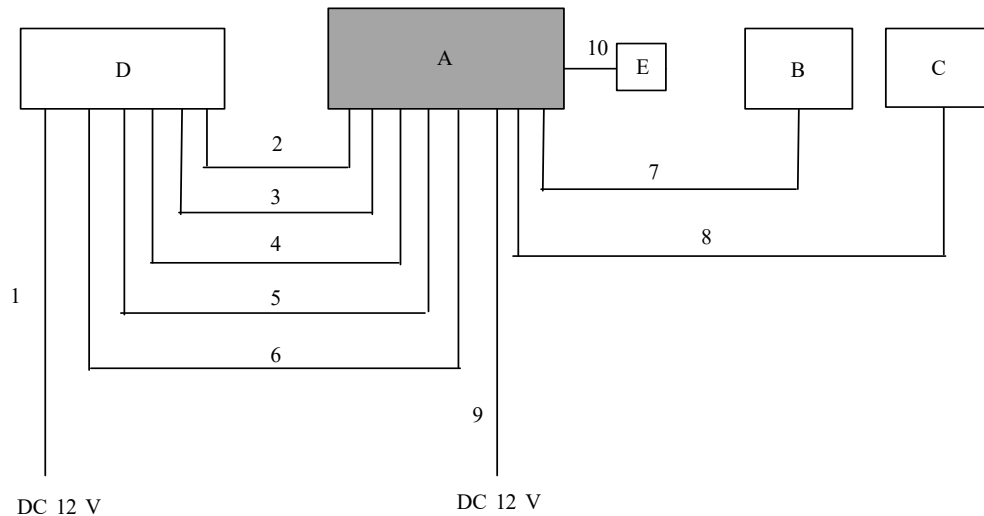
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4.2 Configuration and peripherals



* 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	Car Audio	AR-100	998U6020 for AT* 998U6007 for RE*	MITSUBISHI ELECTRIC CORPORATION SANDA WORKS	EUT
B	Terminator	-	-	-	-
C	Speaker	-	-	-	-
D	Dummy Board	PCB-ZIGU-DUMMY	NJ00055410	MITSUBISHI ELECTRIC CORPORATION SANDA WORKS	-
E	UART Board	-	-	MITSUBISHI ELECTRIC CORPORATION SANDA WORKS	-

List of cables used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	2.00	Unshielded	Unshielded	-
2	GPS Cable	2.00	Unshielded	Unshielded	-
3	Signal Cable	2.00	Unshielded	Unshielded	-
4	USB Cable	2.00	Shielded	Shielded	-
5	Signal Cable	2.00	Unshielded	Unshielded	-
6	Signal Cable	2.00	Unshielded	Unshielded	-
7	Speaker Cable	2.00	Unshielded	Unshielded	-
8	Speaker Cable	2.00	Unshielded	Unshielded	-
9	DC Cable	2.00	Unshielded	Unshielded	-
10	Signal Cable	0.05	Unshielded	Unshielded	-

*RE: Radiated Emission test

*AT: Antenna Terminal Conducted tests

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SECTION 5: Radiated Spurious Emission

Test Procedure

[For below 1 GHz]

EUT was placed on a urethane platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]

EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane.

The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.

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	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Biconical	Logperiodic	Horn

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

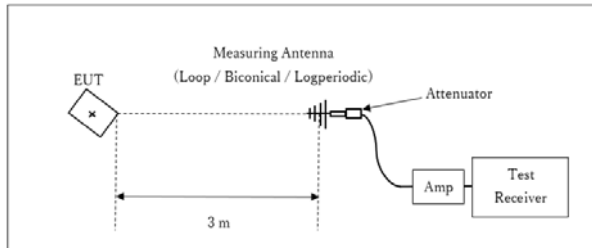
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9 (ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *1)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (RMS) Trace: 100 traces Duty factor was added to the results.	RBW: 100 kHz VBW: 300 kHz

*1) Average Power Measurement was performed based on KDB 558074 D01 15.247 Meas Guidance v05r02.

Figure 2: Test Setup

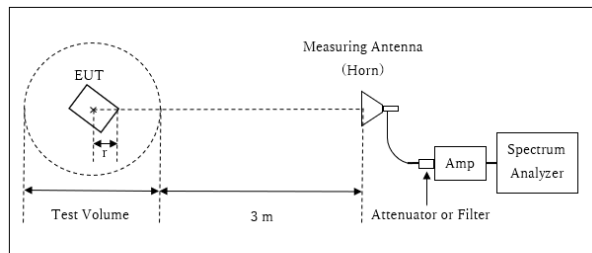
Below 1 GHz



x : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



r : Radius of an outer periphery of EUT

x : Center of turn table

Distance Factor: $20 \times \log (3.9 \text{ m} / 3.0 \text{ m}) = 2.28 \text{ dB}$

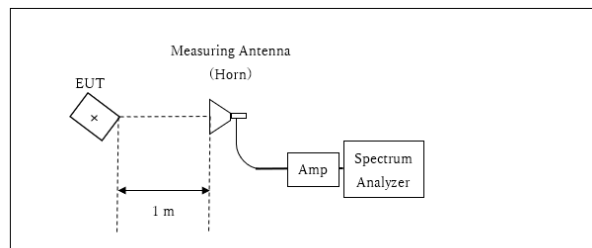
* Test Distance: $(3 + \text{Test Volume} / 2) - r = 3.9 \text{ m}$

Test Volume : 2.0 m

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

r = 0.1 m

10 GHz - 26.5 GHz



x : Center of turn table

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

*Test Distance: 1 m

The test was made on EUT at the normal use position.

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 6: Antenna Terminal Conducted Tests

Test Procedure

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

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument used
20dB Bandwidth	3 MHz	30 kHz	100 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: 50MHz BW)
Carrier Frequency Separation	3 MHz	30 kHz	100 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
Number of Hopping Frequency	30 MHz	200 kHz	620 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
Dwell Time	Zero Span	100 kHz, 1 MHz	300 kHz, 3 MHz	As necessary capture the entire dwell time per hopping channel	Peak	Clear Write	Spectrum Analyzer
Conducted Spurious Emission *3)	9 kHz to 150 kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150 kHz to 30 MHz	9.1 kHz	27 kHz				
	30 MHz to 25 GHz	100 kHz	300 kHz				
Conducted Spurious Emission Band Edge compliance	10 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
*1) Peak hold was applied as Worst-case measurement. *2) Reference data *3) 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.							

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

20 dB Bandwidth, 99 % Occupied Bandwidth and Carrier Frequency Separation

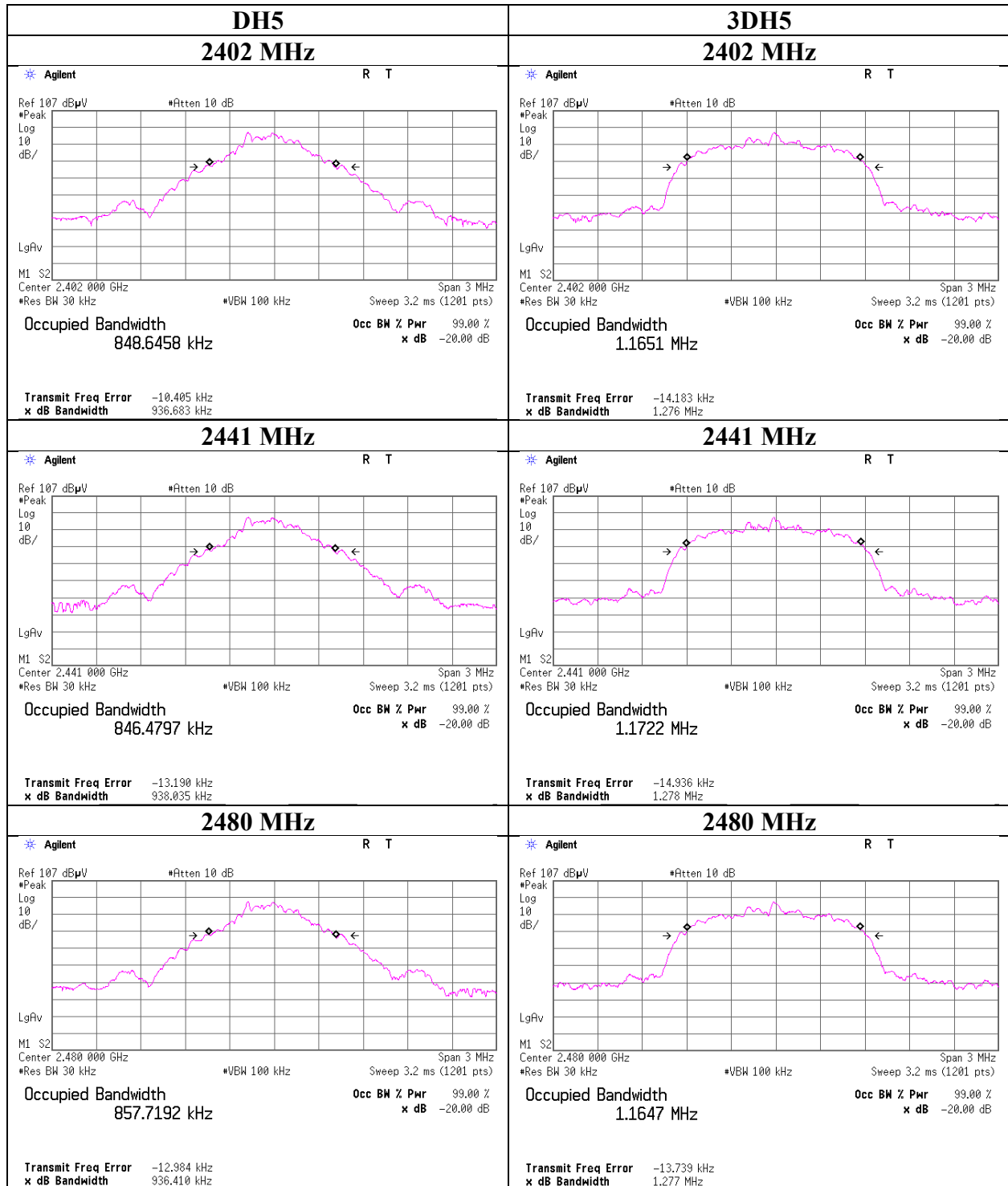
Report No.	13062395H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	October 30, 2019
Temperature / Humidity	25 deg. C / 48 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, Tx, Hopping On

Mode	Freq. [MHz]	20dB Bandwidth [MHz]	99% Occupied Bandwidth [kHz]	Carrier Frequency Separation [MHz]	Limit for Carrier Frequency separation [MHz]
DH5	2402.0	0.937	848.646	1.000	≥ 0.625
DH5	2441.0	0.938	846.480	1.000	≥ 0.625
DH5	2480.0	0.936	857.719	1.000	≥ 0.624
DH5	Hopping On	-	78618.500	-	-
3DH5	2402.0	1.276	1165.100	1.000	≥ 0.851
3DH5	2441.0	1.278	1172.200	1.000	≥ 0.852
3DH5	2480.0	1.277	1164.700	1.000	≥ 0.851
3DH5	Hopping On	-	78746.300	-	-

Limit: Two-thirds of 20dB Bandwidth or 25kHz (whichever is greater).

No limit applies to 20dB Bandwidth.

20 dB Bandwidth and 99 % Occupied Bandwidth



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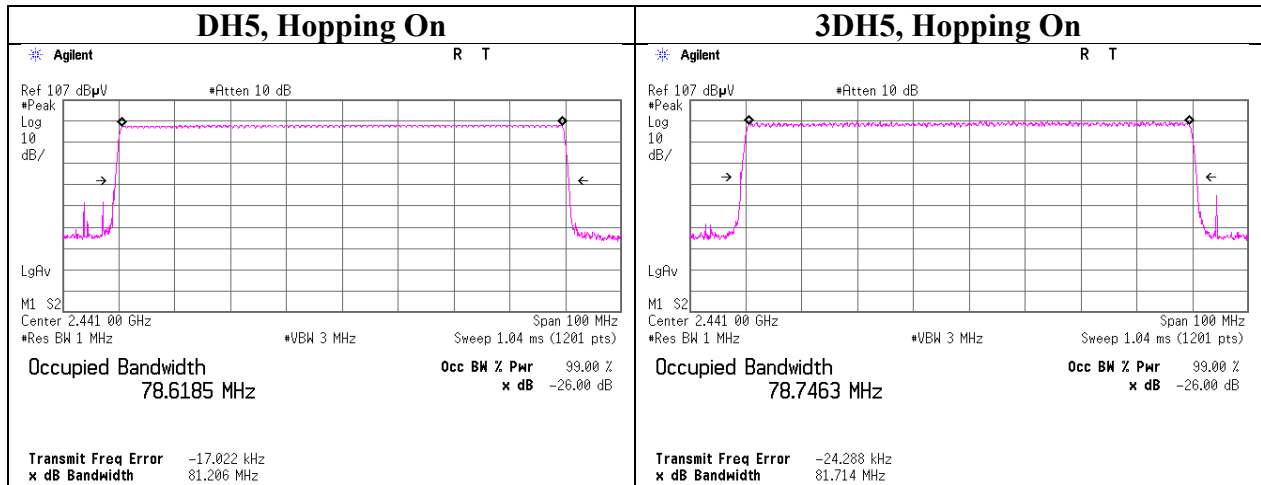
Ise EMC Lab.

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Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

20 dB Bandwidth and 99 % Occupied Bandwidth



UL Japan, Inc.

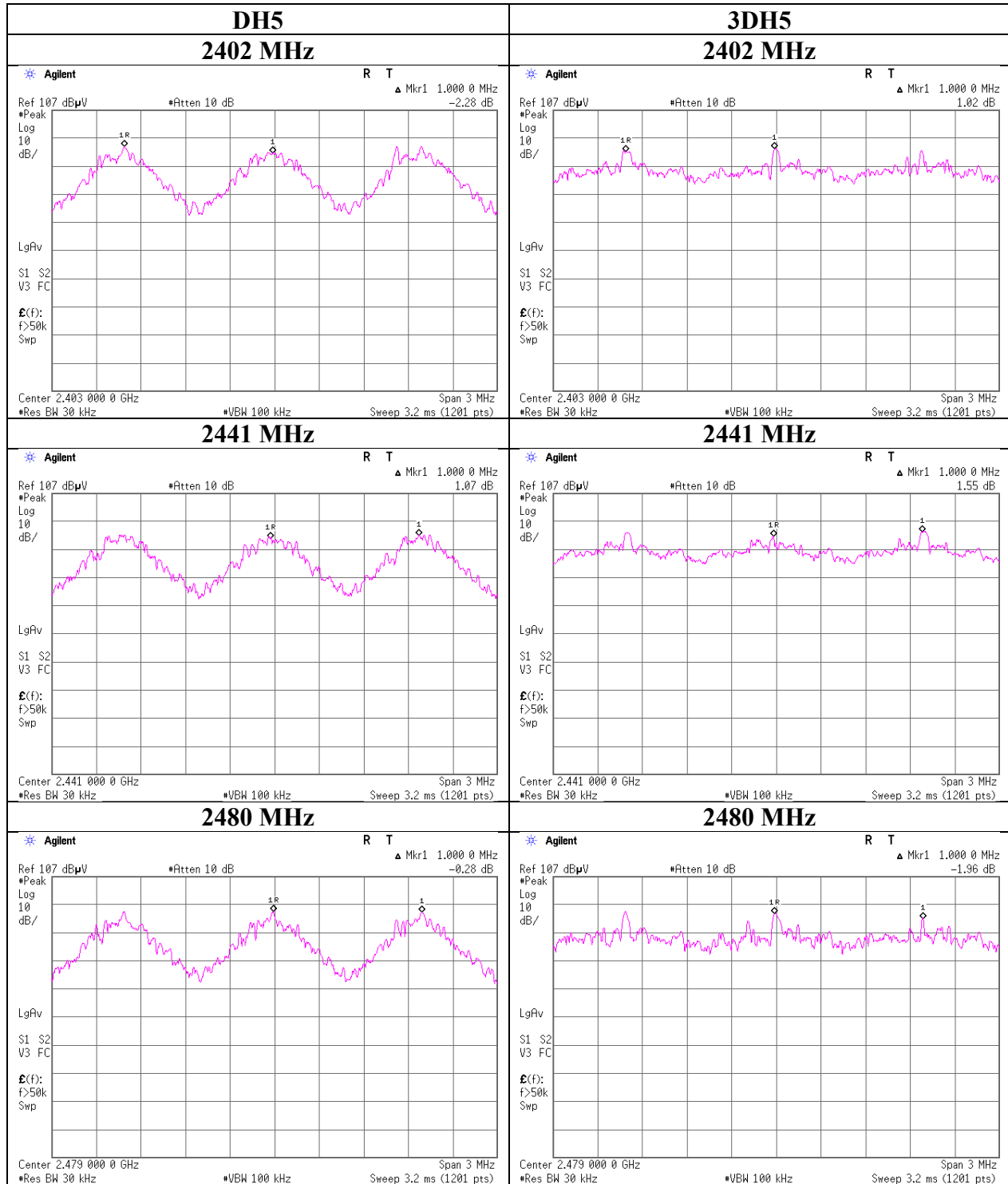
Ise EMC Lab.

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Carrier Frequency Separation



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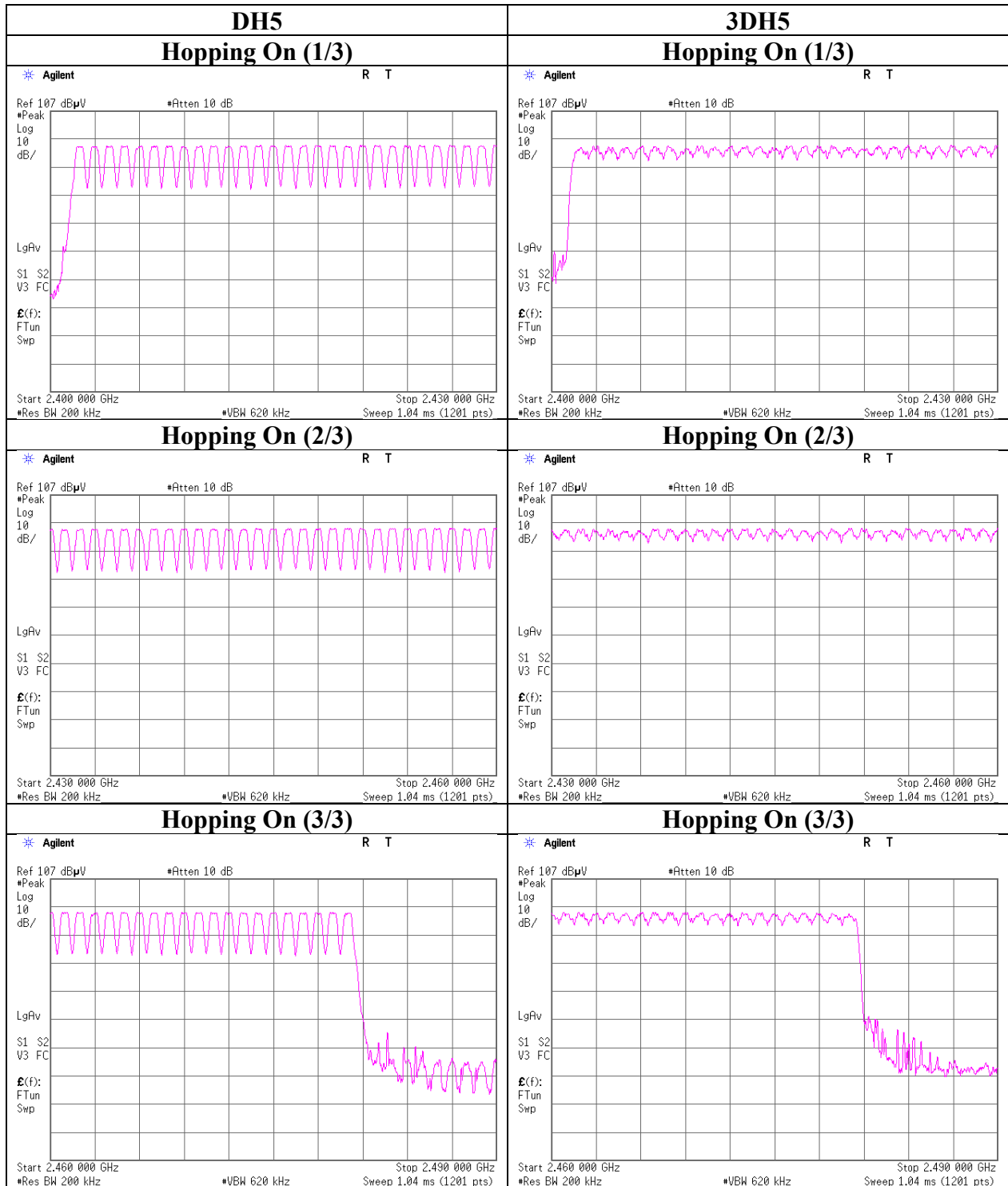
Number of Hopping Frequency

Report No. 13062395H
Test place Ise EMC Lab. No.8 Measurement Room
Date October 30, 2019
Temperature / Humidity 25 deg. C / 48 % RH
Engineer Junya Okuno
Mode Tx, Hopping On

Mode	Number of channel [channels]	Limit [channels]
DH5	79	>= 15
3DH5	79	>= 15

Test was not performed at AFH mode whose number of hopping channel is 20 channels because this Bluetooth radio is in compliance of Bluetooth Specification.

Number of Hopping Frequency



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Dwell time

Report No. 13062395H
Test place Ise EMC Lab. No.8 Measurement Room
Date October 30, 2019
Temperature / Humidity 25 deg. C / 48 % RH
Engineer Junya Okuno
Mode Tx, Hopping On

Mode	Number of transmission in a 31.6(79 Hopping x 0.4) / 12.8 (32 Hopping x 0.4) second period				Length of transmission [msec]	Result [msec]	Limit [msec]
DH1	51.2 times	/	5 sec.	x 31.6 sec. = 324 times	0.455	147	400
DH3	27.6 times	/	5 sec.	x 31.6 sec. = 175 times	1.718	301	400
DH5	20.0 times	/	5 sec.	x 31.6 sec. = 127 times	2.970	377	400
3DH1	50.2 times	/	5 sec.	x 31.6 sec. = 318 times	0.452	144	400
3DH3	27.0 times	/	5 sec.	x 31.6 sec. = 171 times	1.705	292	400
3DH5	20.4 times	/	5 sec.	x 31.6 sec. = 129 times	2.973	384	400

Sample Calculation

Result = Number of transmission x Length of transmission

*Average data of 5 tests.(except Inquiry)

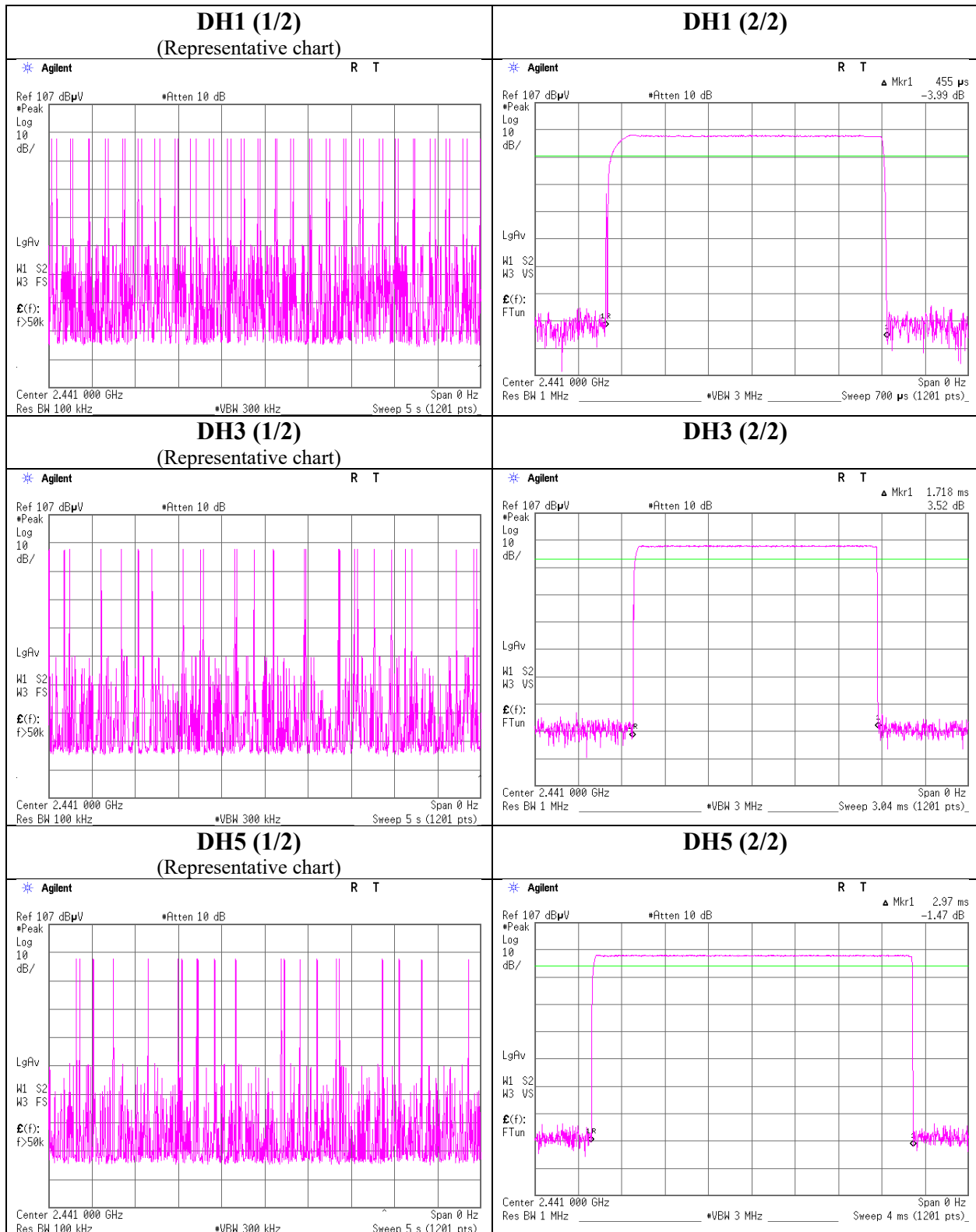
Mode	Sampling [times]					Average [times]
	1	2	3	4	5	
DH1	51	52	51	52	50	51.2
DH3	28	28	26	27	29	27.6
DH5	20	21	20	21	18	20
3DH1	49	51	50	51	50	50.2
3DH3	27	26	28	24	30	27
3DH5	18	22	20	21	21	20.4

Sample Calculation

Average = Summation (Sampling 1 to 5) / 5

This device complies with the Bluetooth protocol for FHSS operation, employing a pseudo random channel selection and hopping rate to ensure that the occupancy time in $N \times 0.4s$, where N is the number of channels being used in the hopping sequence ($20 \leq N \leq 79$), is always less than $0.4s$ regardless of packet size. This is confirmed in the test report for $N = 79$.

Dwell time



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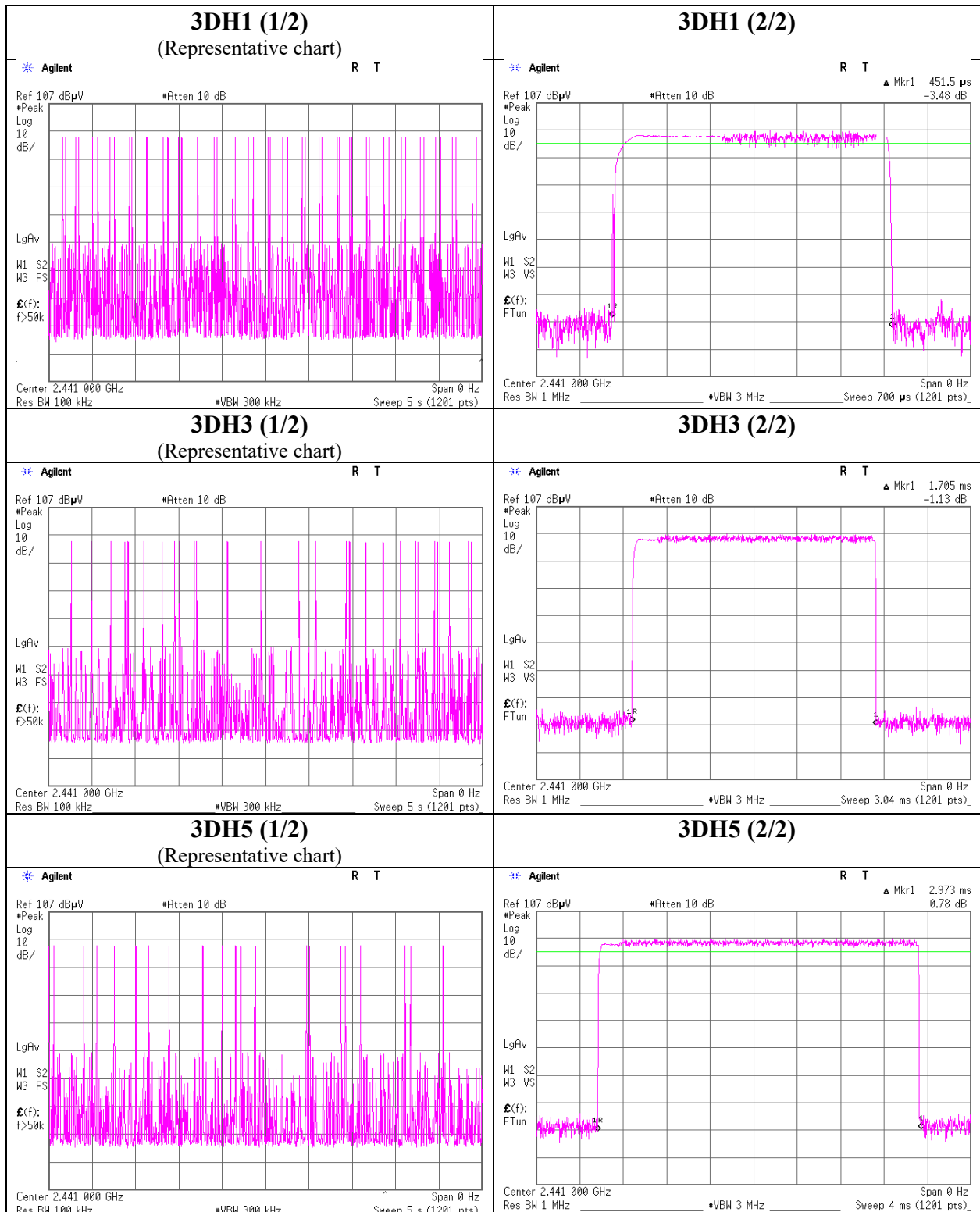
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Dwell time



UL Japan, Inc.

Ise EMC Lab.

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Telephone : +81 596 24 8999

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Maximum Peak Output Power

Report No. 13062395H
Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
Date October 28, 2019
Temperature / Humidity 23 deg. C / 60 % RH
Engineer Junya Okuno
Mode Tx, Hopping Off

Mode	Freq.	Reading	Cable Loss	Atten. Loss	Conducted Power					e.i.r.p. for RSS-247							
					Result		Limit		Margin	Antenna Gain	Result		Limit		Margin		
					[dBm]	[mW]	[dBm]	[mW]			[dB]	[dBi]	[dBm]	[mW]		[dBm]	[mW]
DH5	2402.0	-12.71	2.33	10.03	-0.35	0.92	20.96	125	21.31	3.00	2.65	1.84	36.02	4000	33.37		
DH5	2441.0	-12.18	2.34	10.04	0.20	1.05	20.96	125	20.76	3.00	3.20	2.09	36.02	4000	32.82		
DH5	2480.0	-12.20	2.35	10.04	0.19	1.04	20.96	125	20.77	3.00	3.19	2.08	36.02	4000	32.83		
2DH5	2402.0	-11.02	2.33	10.03	1.34	1.36	20.96	125	19.62	3.00	4.34	2.72	36.02	4000	31.68		
2DH5	2441.0	-10.50	2.34	10.04	1.88	1.54	20.96	125	19.08	3.00	4.88	3.08	36.02	4000	31.14		
2DH5	2480.0	-10.51	2.35	10.04	1.88	1.54	20.96	125	19.08	3.00	4.88	3.08	36.02	4000	31.14		
3DH5	2402.0	-10.48	2.33	10.03	1.88	1.54	20.96	125	19.08	3.00	4.88	3.08	36.02	4000	31.14		
3DH5	2441.0	-10.00	2.34	10.04	2.38	1.73	20.96	125	18.58	3.00	5.38	3.45	36.02	4000	30.64		
3DH5	2480.0	-10.04	2.35	10.04	2.35	1.72	20.96	125	18.61	3.00	5.35	3.43	36.02	4000	30.67		

Sample Calculation:

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

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

Test was not performed at AFH mode, because the decrease of number of channel (min: 20ch) at AFH mode does not influence on the output power and bandwidth of the EUT.

As this device had AFH mode and frequency separation could not meet the requirement of over 20dB BW without 2/3 relaxation, 125mW power limit was applied to it.

Average Output Power (Reference data for RF Exposure)

Report No.	13062395H
Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Date	October 28, 2019
Temperature / Humidity	23 deg. C / 60 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off

Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
					[dBm]	[mW]		[dBm]	[mW]
DH5	2402.0	-14.38	2.33	10.03	-2.02	0.63	1.04	-0.98	0.80
DH5	2441.0	-13.86	2.34	10.04	-1.48	0.71	1.04	-0.44	0.90
DH5	2480.0	-13.83	2.35	10.04	-1.44	0.72	1.04	-0.40	0.91
2DH5	2402.0	-14.90	2.33	10.03	-2.54	0.56	1.04	-1.50	0.71
2DH5	2441.0	-14.36	2.34	10.04	-1.98	0.63	1.04	-0.94	0.81
2DH5	2480.0	-14.36	2.35	10.04	-1.97	0.64	1.04	-0.93	0.81
3DH5	2402.0	-14.89	2.33	10.03	-2.53	0.56	1.04	-1.49	0.71
3DH5	2441.0	-14.36	2.34	10.04	-1.98	0.63	1.04	-0.94	0.81
3DH5	2480.0	-14.36	2.35	10.04	-1.97	0.64	1.04	-0.93	0.81

Sample Calculation:

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

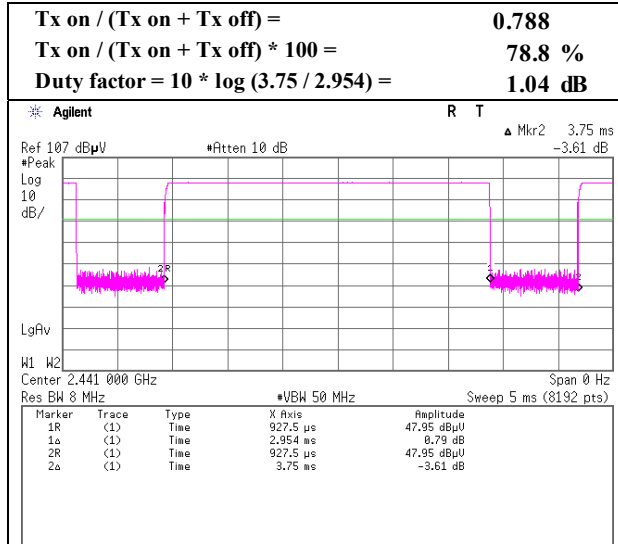
Result (Burst power average) = Time average + Duty factor

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

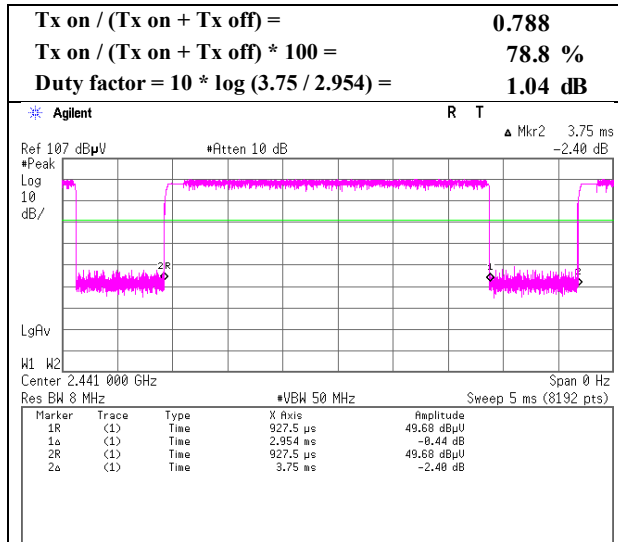
Burst Rate Confirmation

Report No. 13062395H
Test place Ise EMC Lab. No.3 Semi Anechoic Chamber
Date October 29, 2019
Temperature / Humidity 21 deg. C / 58 % RH
Engineer Junya Okuno
Mode Tx, Hopping Off

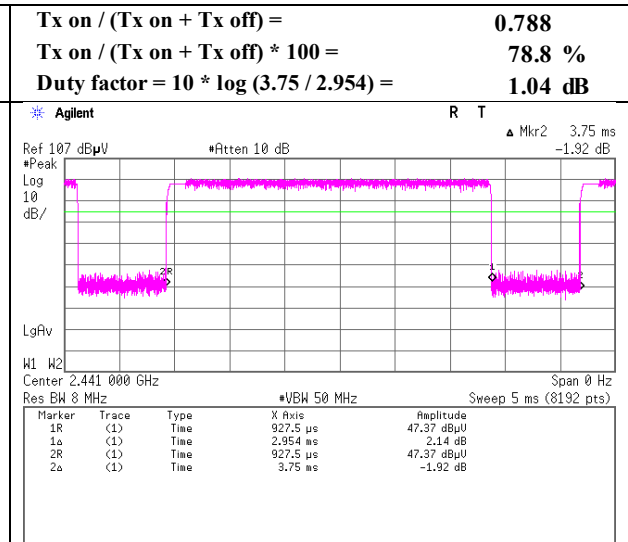
DH5



2DH5



3DH5



Radiated Spurious Emission

Report No.	13062395H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.2
Date	October 28, 2019	October 29, 2019	November 13, 2019
Temperature / Humidity	23 deg. C / 60 % RH	21 deg. C / 58 % RH	22 deg. C / 32 % RH
Engineer	Junya Okuno	Junya Okuno	Takumi Shimada
	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)	(30 MHz - 1.0 GHz)
Mode	Tx, Hopping Off, DH5 2402 MHz		

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	49.212	QP	34.8	11.6	7.3	30.4	-	23.3	40.0	16.7	
Hori.	147.451	QP	35.0	14.8	8.5	29.9	-	28.4	43.5	15.1	
Hori.	245.740	QP	38.7	11.6	9.3	29.3	-	30.4	46.0	15.6	
Hori.	332.854	QP	38.5	14.5	10.1	29.4	-	33.7	46.0	12.3	
Hori.	495.002	QP	38.5	17.5	11.0	30.0	-	36.9	46.0	9.1	
Hori.	575.588	QP	36.3	18.4	11.4	29.9	-	36.2	46.0	9.8	
Hori.	2323.990	PK	45.3	27.9	5.3	32.8	-	45.8	73.9	28.1	
Hori.	2350.000	PK	45.9	27.7	5.4	32.8	-	46.2	73.9	27.7	
Hori.	2375.975	PK	43.8	27.7	5.4	32.8	-	44.1	73.9	29.8	
Hori.	2390.000	PK	43.9	27.7	5.4	32.8	-	44.2	73.9	29.7	
Hori.	4804.000	PK	42.3	31.6	7.6	31.8	-	49.7	73.9	24.3	Floor noise
Hori.	7206.000	PK	43.2	36.0	8.8	32.7	-	55.3	73.9	18.6	
Hori.	9608.000	PK	42.3	38.5	9.6	33.3	-	57.2	73.9	16.7	Floor noise
Hori.	2323.990	AV	37.0	27.9	5.3	32.8	1.0	38.5	53.9	15.4	
Hori.	2350.000	AV	34.7	27.7	5.4	32.8	1.0	36.0	53.9	17.9	
Hori.	2375.975	AV	33.5	27.7	5.4	32.8	1.0	34.8	53.9	19.1	
Hori.	2390.000	AV	32.4	27.7	5.4	32.8	1.0	33.7	53.9	20.2	*1)
Hori.	4804.000	AV	30.7	31.6	7.6	31.8	-	38.1	53.9	15.8	Floor noise
Hori.	7206.000	AV	36.5	36.0	8.8	32.7	1.0	49.7	53.9	4.2	
Hori.	9608.000	AV	32.2	38.5	9.6	33.3	-	47.0	53.9	6.9	Floor noise
Vert.	49.212	QP	38.2	11.6	7.3	30.4	-	26.7	40.0	13.3	
Vert.	147.451	QP	37.9	14.8	8.5	29.9	-	31.3	43.5	12.2	
Vert.	245.738	QP	38.6	11.6	9.3	29.3	-	30.3	46.0	15.7	
Vert.	332.854	QP	34.8	14.5	10.1	29.4	-	30.0	46.0	16.0	
Vert.	494.970	QP	36.5	17.5	11.0	30.0	-	34.9	46.0	11.1	
Vert.	575.588	QP	35.6	18.4	11.4	29.9	-	35.5	46.0	10.5	
Vert.	2390.000	PK	42.9	27.7	5.4	32.8	-	43.2	73.9	30.7	
Vert.	4804.000	PK	42.0	31.6	7.6	31.8	-	49.3	73.9	24.6	Floor noise
Vert.	7206.000	PK	43.2	36.0	8.8	32.7	-	55.3	73.9	18.6	
Vert.	9608.000	PK	42.6	38.5	9.6	33.3	-	57.4	73.9	16.5	Floor noise
Vert.	2390.000	AV	34.2	27.7	5.4	32.8	1.0	35.5	53.9	18.4	*1)
Vert.	4804.000	AV	31.0	31.6	7.6	31.8	-	38.3	53.9	15.6	Floor noise
Vert.	7206.000	AV	34.4	36.0	8.8	32.7	1.0	47.6	53.9	6.4	
Vert.	9608.000	AV	32.4	38.5	9.6	33.3	-	47.2	53.9	6.7	Floor noise

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

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

Distance factor: 1 GHz - 10 GHz 20log (3.9 m / 3.0 m) = 2.28 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

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

20dBc Data Sheet

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	91.8	27.7	5.4	32.7	92.1	-	-	Carrier
Hori.	2400.000	PK	50.9	27.7	5.4	32.7	51.2	72.1	21.0	
Vert.	2402.000	PK	83.0	27.7	5.4	32.7	83.3	-	-	Carrier
Vert.	2400.000	PK	43.2	27.7	5.4	32.7	43.5	63.3	19.8	

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

UL Japan, Inc.

Ise EMC Lab.

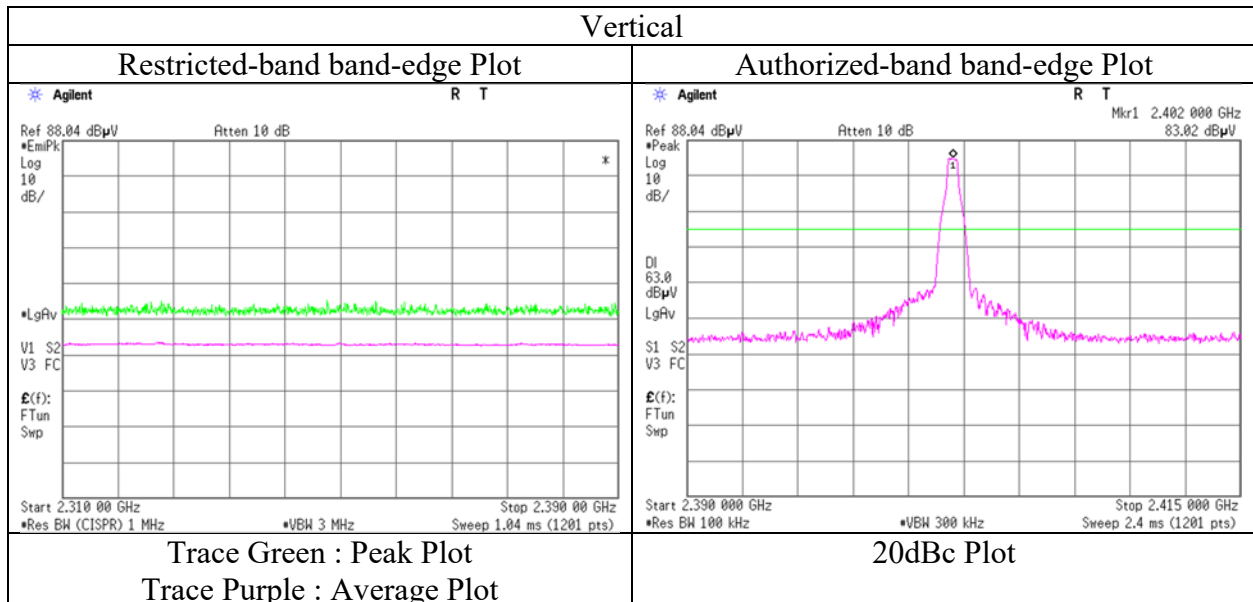
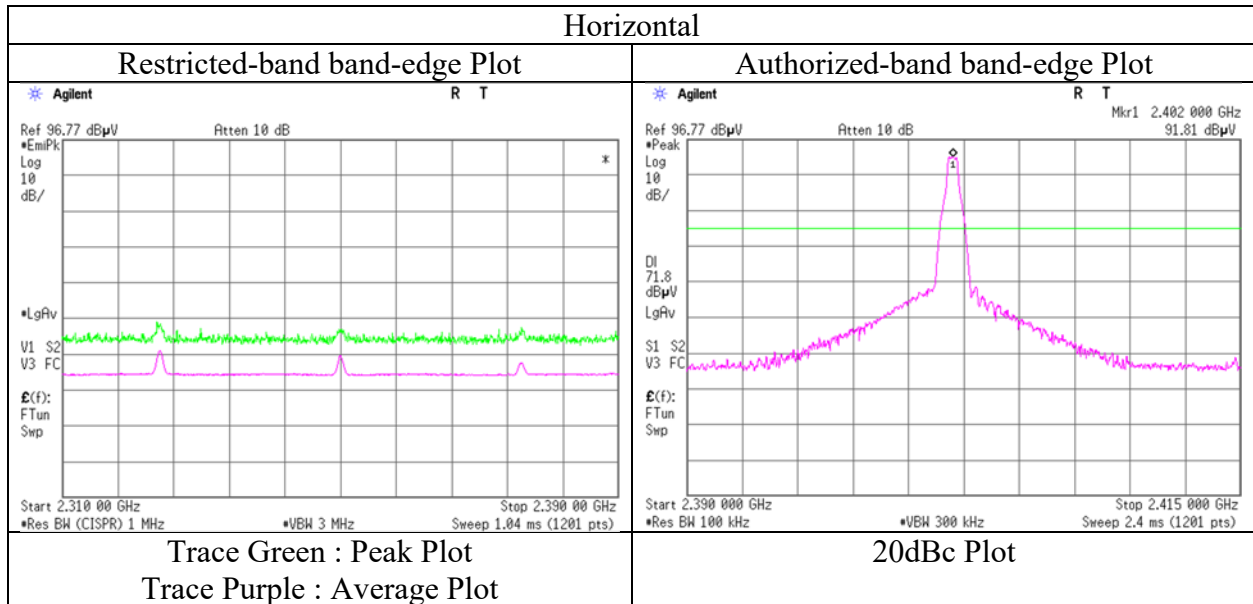
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

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Facsimile : +81 596 24 8124

Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13062395H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 28, 2019
Temperature / Humidity	23 deg. C / 60 % RH
Engineer	Junya Okuno
	(1 GHz -10 GHz)
Mode	Tx, Hopping Off, DH5 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.

UL Japan, Inc.

Ise EMC Lab.

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Radiated Spurious Emission

Report No. 13062395H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3 No.3 No.2
Date October 28, 2019 October 29, 2019 November 13, 2019
Temperature / Humidity 23 deg. C / 60 % RH 21 deg. C / 58 % RH 22 deg. C / 32 % RH
Engineer Junya Okuno Junya Okuno Takumi Shimada
(1 GHz -10 GHz) (10 GHz - 26.5 GHz) (30 MHz – 1.0 GHz)
Mode Tx, Hopping Off, DH5 2441 MHz

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	49.212	QP	34.5	11.6	7.3	30.4	-	23.0	40.0	17.0	
Hori.	147.434	QP	34.8	14.8	8.5	29.9	-	28.2	43.5	15.3	
Hori.	245.591	QP	38.9	11.6	9.3	29.3	-	30.6	46.0	15.4	
Hori.	332.872	QP	38.6	14.5	10.1	29.4	-	33.8	46.0	12.2	
Hori.	494.938	QP	38.4	17.5	11.0	30.0	-	36.8	46.0	9.2	
Hori.	577.498	QP	36.5	18.4	11.4	29.9	-	36.5	46.0	9.5	
Hori.	4882.000	PK	41.9	31.5	7.6	31.8	-	49.2	73.9	24.7	Floor noise
Hori.	7323.000	PK	43.9	36.2	8.9	32.7	-	56.2	73.9	17.7	
Hori.	9764.000	PK	43.0	38.8	9.7	33.4	-	58.1	73.9	15.8	Floor noise
Hori.	4882.000	AV	32.2	31.5	7.6	31.8	-	39.5	53.9	14.4	Floor noise
Hori.	7323.000	AV	37.1	36.2	8.9	32.7	1.0	50.5	53.9	3.4	
Hori.	9764.000	AV	32.7	38.8	9.7	33.4	-	47.8	53.9	6.1	Floor noise
Vert.	49.212	QP	38.4	11.6	7.3	30.4	-	26.9	40.0	13.1	
Vert.	147.434	QP	38.1	14.8	8.5	29.9	-	31.5	43.5	12.0	
Vert.	245.591	QP	38.7	11.6	9.3	29.3	-	30.4	46.0	15.6	
Vert.	332.872	QP	34.8	14.5	10.1	29.4	-	30.0	46.0	16.0	
Vert.	494.938	QP	36.8	17.5	11.0	30.0	-	35.2	46.0	10.8	
Vert.	577.498	QP	35.4	18.4	11.4	29.9	-	35.4	46.0	10.6	
Vert.	4882.000	PK	41.7	31.5	7.6	31.8	-	49.1	73.9	24.9	Floor noise
Vert.	7323.000	PK	43.8	36.2	8.9	32.7	-	56.2	73.9	17.7	
Vert.	9764.000	PK	43.0	38.8	9.7	33.4	-	58.1	73.9	15.9	Floor noise
Vert.	4882.000	AV	32.1	31.5	7.6	31.8	-	39.4	53.9	14.5	Floor noise
Vert.	7323.000	AV	36.4	36.2	8.9	32.7	1.0	49.8	53.9	4.1	
Vert.	9764.000	AV	32.7	38.8	9.7	33.4	-	47.8	53.9	6.1	Floor noise

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

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

Distance factor: 1 GHz - 10 GHz 20log (3.9 m / 3.0 m) = 2.28 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Report No.	13062395H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.2
Date	October 28, 2019	October 29, 2019	November 13, 2019
Temperature / Humidity	23 deg. C / 60 % RH	21 deg. C / 58 % RH	22 deg. C / 32 % RH
Engineer	Junya Okuno	Junya Okuno	Takumi Shimada
	(1 GHz - 10 GHz)	(10 GHz - 26.5 GHz)	(30 MHz - 1.0 GHz)
Mode	Tx, Hopping Off, DH5 2480 MHz		

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	49.209	QP	34.7	11.6	7.3	30.4	-	23.2	40.0	16.8	
Hori.	147.467	QP	34.9	14.8	8.5	29.9	-	28.3	43.5	15.2	
Hori.	245.630	QP	38.5	11.6	9.3	29.3	-	30.2	46.0	15.8	
Hori.	332.888	QP	38.7	14.5	10.1	29.4	-	33.9	46.0	12.1	
Hori.	494.902	QP	38.6	17.5	11.0	30.0	-	37.0	46.0	9.0	
Hori.	579.394	QP	36.1	18.5	11.4	29.9	-	36.2	46.0	9.8	
Hori.	2483.500	PK	64.9	27.5	5.5	32.7	-	65.1	73.9	8.8	
Hori.	4960.000	PK	41.3	31.6	7.6	31.8	-	48.6	73.9	25.3	Floor noise
Hori.	7440.000	PK	43.2	36.3	8.9	32.7	-	55.7	73.9	18.2	
Hori.	9920.000	PK	42.6	38.9	9.7	33.4	-	57.8	73.9	16.1	Floor noise
Hori.	2483.500	AV	48.2	27.5	5.5	32.7	1.0	49.4	53.9	4.5	*1)
Hori.	4960.000	AV	32.2	31.6	7.6	31.8	-	39.6	53.9	14.3	Floor noise
Hori.	7440.000	AV	35.0	36.3	8.9	32.7	1.0	48.5	53.9	5.4	
Hori.	9920.000	AV	32.6	38.9	9.7	33.4	-	47.8	53.9	6.2	Floor noise
Vert.	49.209	QP	38.0	11.6	7.3	30.4	-	26.5	40.0	13.5	
Vert.	147.467	QP	38.2	14.8	8.5	29.9	-	31.6	43.5	11.9	
Vert.	245.630	QP	38.4	11.6	9.3	29.3	-	30.1	46.0	15.9	
Vert.	332.888	QP	34.9	14.5	10.1	29.4	-	30.1	46.0	15.9	
Vert.	494.902	QP	36.7	17.5	11.0	30.0	-	35.1	46.0	10.9	
Vert.	579.394	QP	35.5	18.5	11.4	29.9	-	35.6	46.0	10.4	
Vert.	2483.500	PK	58.7	27.5	5.5	32.7	-	58.9	73.9	15.0	
Vert.	4960.000	PK	41.2	31.6	7.6	31.8	-	48.6	73.9	25.3	Floor noise
Vert.	7440.000	PK	43.1	36.3	8.9	32.7	-	55.6	73.9	18.3	
Vert.	9920.000	PK	42.7	38.9	9.7	33.4	-	57.9	73.9	16.1	Floor noise
Vert.	2483.500	AV	42.3	27.5	5.5	32.7	1.0	43.6	53.9	10.4	*1)
Vert.	4960.000	AV	32.2	31.6	7.6	31.8	-	39.5	53.9	14.4	Floor noise
Vert.	7440.000	AV	35.1	36.3	8.9	32.7	1.0	48.6	53.9	5.3	
Vert.	9920.000	AV	32.6	38.9	9.7	33.4	-	47.8	53.9	6.1	Floor noise

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

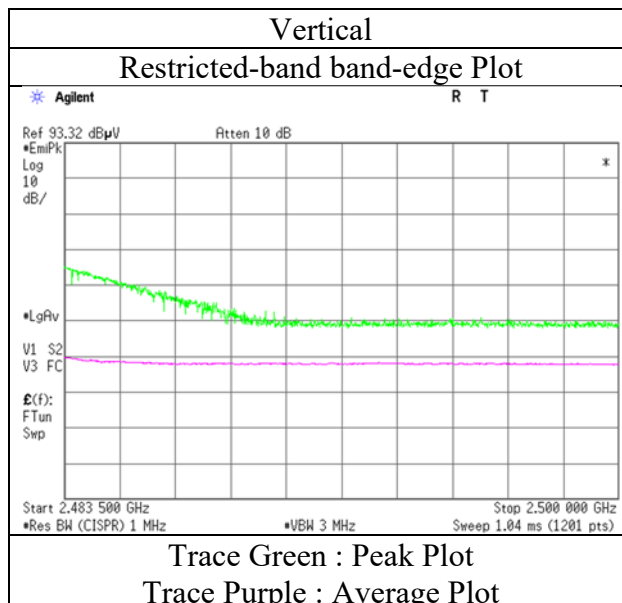
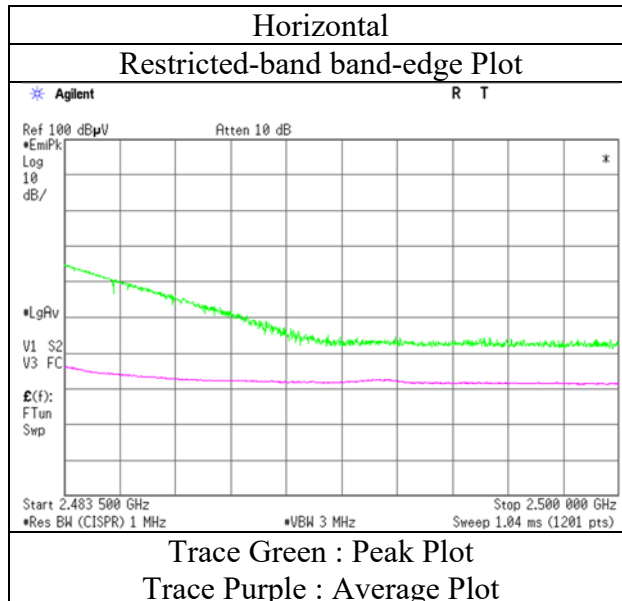
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log (3.9 m / 3.0 m) = 2.28 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

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

Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13062395H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 28, 2019
Temperature / Humidity	23 deg. C / 60 % RH
Engineer	Junya Okuno
	(1 GHz -10 GHz)
Mode	Tx, Hopping Off, DH5 2480 MHz



* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.

Final result of restricted band edge was shown in tabular data.

UL Japan, Inc.

Ise EMC Lab.

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Radiated Spurious Emission

Report No. 13062395H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3 No.2
Date October 29, 2019 November 13, 2019
Temperature / Humidity 21 deg. C / 58 % RH 22 deg. C / 32 % RH
Engineer Junya Okuno Takumi Shimada
(1 GHz - 26.5 GHz) (30 MHz - 1.0 GHz)
Mode Tx, Hopping Off, 3DH5 2402 MHz

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	49.211	QP	34.9	11.6	7.3	30.4	-	23.4	40.0	16.6	
Hori.	147.440	QP	34.7	14.8	8.5	29.9	-	28.1	43.5	15.4	
Hori.	245.627	QP	38.4	11.6	9.3	29.3	-	30.1	46.0	15.9	
Hori.	332.891	QP	38.7	14.5	10.1	29.4	-	33.9	46.0	12.1	
Hori.	494.972	QP	38.5	17.5	11.0	30.0	-	36.9	46.0	9.1	
Hori.	579.103	QP	35.9	18.5	11.4	29.9	-	36.0	46.0	10.1	
Hori.	2323.990	PK	45.3	27.9	5.3	32.8	-	45.7	73.9	28.2	
Hori.	2350.000	PK	46.7	27.7	5.4	32.8	-	47.0	73.9	26.9	
Hori.	2375.975	PK	43.7	27.7	5.4	32.8	-	44.0	73.9	29.9	
Hori.	2390.000	PK	43.5	27.7	5.4	32.8	-	43.9	73.9	30.1	
Hori.	4804.000	PK	41.7	31.6	7.6	31.8	-	49.0	73.9	24.9	Floor noise
Hori.	7206.000	PK	43.9	36.0	8.8	32.7	-	56.0	73.9	17.9	
Hori.	9608.000	PK	42.0	38.5	9.6	33.3	-	56.8	73.9	17.1	Floor noise
Hori.	2323.990	AV	37.8	27.9	5.3	32.8	1.0	39.3	53.9	14.6	
Hori.	2350.000	AV	38.9	27.7	5.4	32.8	1.0	40.2	53.9	13.7	
Hori.	2375.975	AV	35.8	27.7	5.4	32.8	1.0	37.1	53.9	16.8	
Hori.	2390.000	AV	34.6	27.7	5.4	32.8	1.0	36.0	53.9	17.9	*1)
Hori.	4804.000	AV	30.9	31.6	7.6	31.8	-	38.3	53.9	15.6	Floor noise
Hori.	7206.000	AV	36.2	36.0	8.8	32.7	1.0	49.4	53.9	4.5	
Hori.	9608.000	AV	32.1	38.5	9.6	33.3	-	46.9	53.9	7.0	Floor noise
Vert.	49.211	QP	37.8	11.6	7.3	30.4	-	26.3	40.0	13.7	
Vert.	147.440	QP	38.3	14.8	8.5	29.9	-	31.7	43.5	11.8	
Vert.	245.627	QP	38.5	11.6	9.3	29.3	-	30.2	46.0	15.8	
Vert.	332.891	QP	35.1	14.5	10.1	29.4	-	30.3	46.0	15.7	
Vert.	494.972	QP	36.5	17.5	11.0	30.0	-	34.9	46.0	11.1	
Vert.	579.103	QP	35.4	18.5	11.4	29.9	-	35.5	46.0	10.6	
Vert.	2390.000	PK	43.1	27.7	5.4	32.8	-	43.4	73.9	30.5	
Vert.	4804.000	PK	41.8	31.6	7.6	31.8	-	49.1	73.9	24.8	Floor noise
Vert.	7206.000	PK	43.3	36.0	8.8	32.7	-	55.4	73.9	18.5	
Vert.	9608.000	PK	41.9	38.5	9.6	33.3	-	56.7	73.9	17.2	Floor noise
Vert.	2390.000	AV	34.2	27.7	5.4	32.8	1.0	35.5	53.9	18.4	*1)
Vert.	4804.000	AV	30.9	31.6	7.6	31.8	-	38.2	53.9	15.7	Floor noise
Vert.	7206.000	AV	36.0	36.0	8.8	32.7	1.0	49.2	53.9	4.7	
Vert.	9608.000	AV	32.0	38.5	9.6	33.3	-	46.8	53.9	7.1	Floor noise

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

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

Distance factor: 1 GHz - 10 GHz 20log (3.9 m / 3.0 m) = 2.28 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

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

20dBc Data Sheet

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	91.8	27.7	5.4	32.7	92.1	-	-	Carrier
Hori.	2400.000	PK	51.4	27.7	5.4	32.7	51.8	72.1	20.3	
Vert.	2402.000	PK	79.8	27.7	5.4	32.7	80.1	-	-	Carrier
Vert.	2400.000	PK	40.2	27.7	5.4	32.7	40.5	60.1	19.6	

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

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Ise EMC Lab.

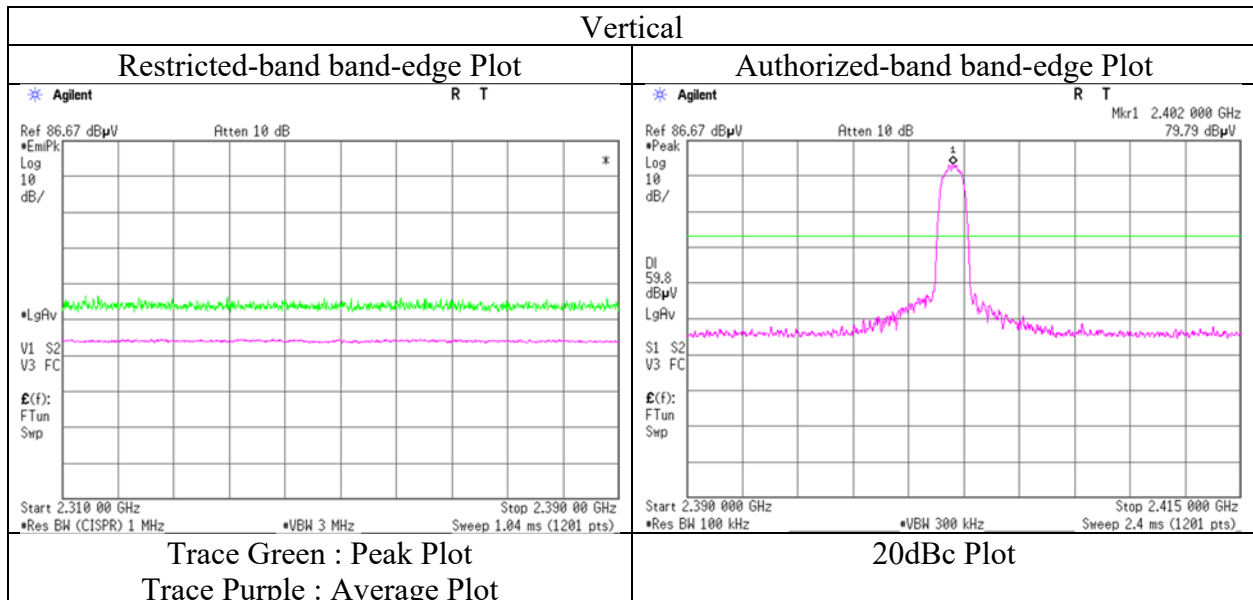
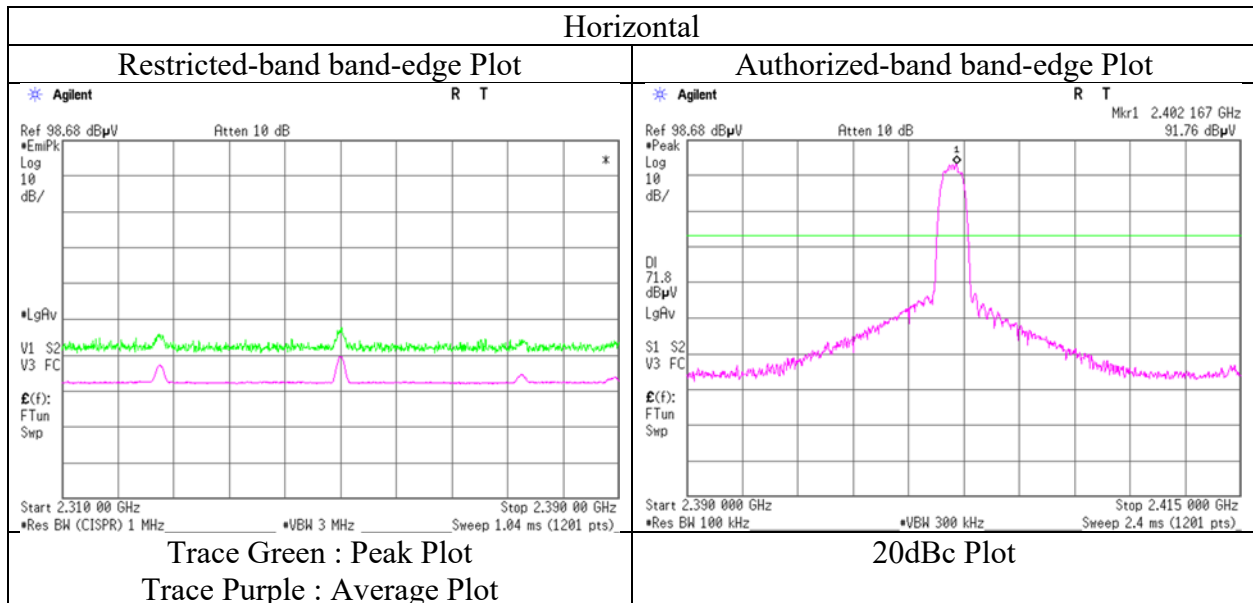
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Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13062395H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 29, 2019
Temperature / Humidity	21 deg. C / 58 % RH
Engineer	Junya Okuno
	(1 GHz - 26.5 GHz)
Mode	Tx, Hopping Off, 3DH5 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.

UL Japan, Inc.

Ise EMC Lab.

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

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Radiated Spurious Emission

Report No. 13062395H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3 No.2
Date October 29, 2019 November 13, 2019
Temperature / Humidity 21 deg. C / 58 % RH 22 deg. C / 32 % RH
Engineer Junya Okuno Takumi Shimada
(1 GHz - 26.5 GHz) (30 MHz - 1.0 GHz)
Mode Tx, Hopping Off, 3DH5 2441 MHz

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	49.214	QP	35.0	11.6	7.3	30.4	-	23.5	40.0	16.5	
Hori.	147.443	QP	34.9	14.8	8.5	29.9	-	28.3	43.5	15.2	
Hori.	245.621	QP	38.6	11.6	9.3	29.3	-	30.3	46.0	15.7	
Hori.	332.881	QP	38.5	14.5	10.1	29.4	-	33.7	46.0	12.3	
Hori.	494.965	QP	38.6	17.5	11.0	30.0	-	37.0	46.0	9.0	
Hori.	591.016	QP	36.1	18.9	11.5	29.9	-	36.6	46.0	9.4	
Hori.	4882.000	PK	42.4	31.5	7.6	31.8	-	49.7	73.9	24.2	Floor noise
Hori.	7323.000	PK	43.6	36.2	8.9	32.7	-	55.9	73.9	18.0	
Hori.	9764.000	PK	42.9	38.8	9.7	33.4	-	58.0	73.9	15.9	Floor noise
Hori.	4882.000	AV	32.3	31.5	7.6	31.8	-	39.6	53.9	14.3	Floor noise
Hori.	7323.000	AV	36.4	36.2	8.9	32.7	1.0	49.8	53.9	4.1	
Hori.	9764.000	AV	32.6	38.8	9.7	33.4	-	47.7	53.9	6.2	Floor noise
Vert.	49.214	QP	37.7	11.6	7.3	30.4	-	26.2	40.0	13.8	
Vert.	147.443	QP	38.2	14.8	8.5	29.9	-	31.6	43.5	11.9	
Vert.	245.621	QP	38.4	11.6	9.3	29.3	-	30.1	46.0	15.9	
Vert.	332.881	QP	35.2	14.5	10.1	29.4	-	30.4	46.0	15.6	
Vert.	494.965	QP	36.6	17.5	11.0	30.0	-	35.0	46.0	11.0	
Vert.	591.016	QP	35.4	18.9	11.5	29.9	-	35.9	46.0	10.1	
Vert.	4882.000	PK	41.9	31.5	7.6	31.8	-	49.2	73.9	24.7	Floor noise
Vert.	7323.000	PK	43.5	36.2	8.9	32.7	-	55.8	73.9	18.1	
Vert.	9764.000	PK	42.9	38.8	9.7	33.4	-	58.0	73.9	15.9	Floor noise
Vert.	4882.000	AV	32.2	31.5	7.6	31.8	-	39.5	53.9	14.4	Floor noise
Vert.	7323.000	AV	35.9	36.2	8.9	32.7	1.0	49.3	53.9	4.6	
Vert.	9764.000	AV	32.6	38.8	9.7	33.4	-	47.7	53.9	6.2	Floor noise

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

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

Distance factor: 1 GHz - 10 GHz 20log (3.9 m / 3.0 m) = 2.28 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Report No. 13062395H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3
Date October 29, 2019 No.2
Temperature / Humidity 21 deg. C / 58 % RH 22 deg. C / 32 % RH
Engineer Junya Okuno Takumi Shimada
(1 GHz - 26.5 GHz) (30 MHz - 1.0 GHz)
Mode Tx, Hopping Off, 3DH5 2480 MHz

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	49.210	QP	34.4	11.6	7.3	30.4	-	22.9	40.0	17.1	
Hori.	147.473	QP	34.7	14.8	8.5	29.9	-	28.1	43.5	15.4	
Hori.	245.633	QP	38.6	11.6	9.3	29.3	-	30.3	46.0	15.7	
Hori.	332.868	QP	38.3	14.5	10.1	29.4	-	33.5	46.0	12.5	
Hori.	494.947	QP	38.5	17.5	11.0	30.0	-	36.9	46.0	9.1	
Hori.	592.658	QP	36.7	19.0	11.5	29.9	-	37.3	46.0	8.7	
Hori.	2483.500	PK	65.3	27.5	5.5	32.7	-	65.5	73.9	8.4	
Hori.	4960.000	PK	41.3	31.6	7.6	31.8	-	48.7	73.9	25.2	Floor noise
Hori.	7440.000	PK	42.9	36.3	8.9	32.7	-	55.3	73.9	18.6	
Hori.	9920.000	PK	42.5	38.9	9.7	33.4	-	57.7	73.9	16.2	Floor noise
Hori.	2483.500	AV	48.7	27.5	5.5	32.7	1.0	49.9	53.9	4.0	*1)
Hori.	4960.000	AV	32.2	31.6	7.6	31.8	-	39.6	53.9	14.4	Floor noise
Hori.	7440.000	AV	34.8	36.3	8.9	32.7	1.0	48.3	53.9	5.6	
Hori.	9920.000	AV	32.5	38.9	9.7	33.4	-	47.7	53.9	6.2	Floor noise
Vert.	49.210	QP	38.2	11.6	7.3	30.4	-	26.7	40.0	13.3	
Vert.	147.473	QP	38.0	14.8	8.5	29.9	-	31.4	43.5	12.1	
Vert.	245.633	QP	38.9	11.6	9.3	29.3	-	30.6	46.0	15.4	
Vert.	332.868	QP	34.7	14.5	10.1	29.4	-	29.9	46.0	16.1	
Vert.	494.947	QP	36.6	17.5	11.0	30.0	-	35.0	46.0	11.0	
Vert.	592.658	QP	35.8	19.0	11.5	29.9	-	36.4	46.0	9.6	
Vert.	2483.500	PK	58.1	27.5	5.5	32.7	-	58.3	73.9	15.6	
Vert.	4960.000	PK	41.1	31.6	7.6	31.8	-	48.5	73.9	25.4	Floor noise
Vert.	7440.000	PK	42.8	36.3	8.9	32.7	-	55.3	73.9	18.6	
Vert.	9920.000	PK	42.7	38.9	9.7	33.4	-	57.9	73.9	16.0	Floor noise
Vert.	2483.500	AV	41.6	27.5	5.5	32.7	1.0	42.9	53.9	11.0	*1)
Vert.	4960.000	AV	32.1	31.6	7.6	31.8	-	39.5	53.9	14.4	Floor noise
Vert.	7440.000	AV	34.9	36.3	8.9	32.7	1.0	48.4	53.9	5.5	
Vert.	9920.000	AV	32.5	38.9	9.7	33.4	-	47.7	53.9	6.2	Floor noise

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

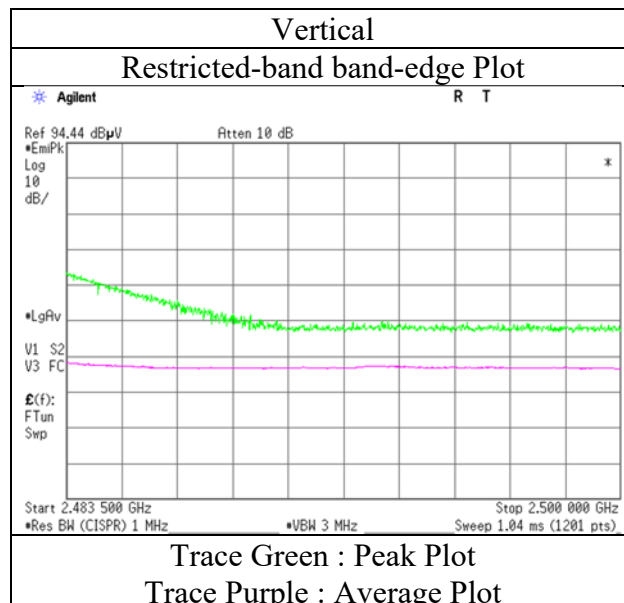
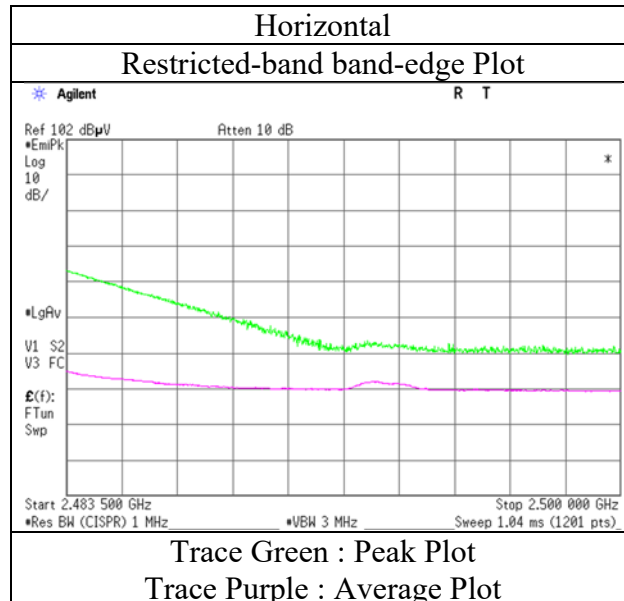
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20 dB).

Distance factor: 1 GHz - 10 GHz 20log(3.9 m / 3.0 m) = 2.28 dB
10 GHz - 26.5 GHz 20log(1.0 m / 3.0 m) = -9.5 dB

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

Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13062395H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	October 29, 2019
Temperature / Humidity	21 deg. C / 58 % RH
Engineer	Junya Okuno
	(1 GHz - 26.5 GHz)
Mode	Tx, Hopping Off, 3DH5 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.

UL Japan, Inc.

Ise EMC Lab.

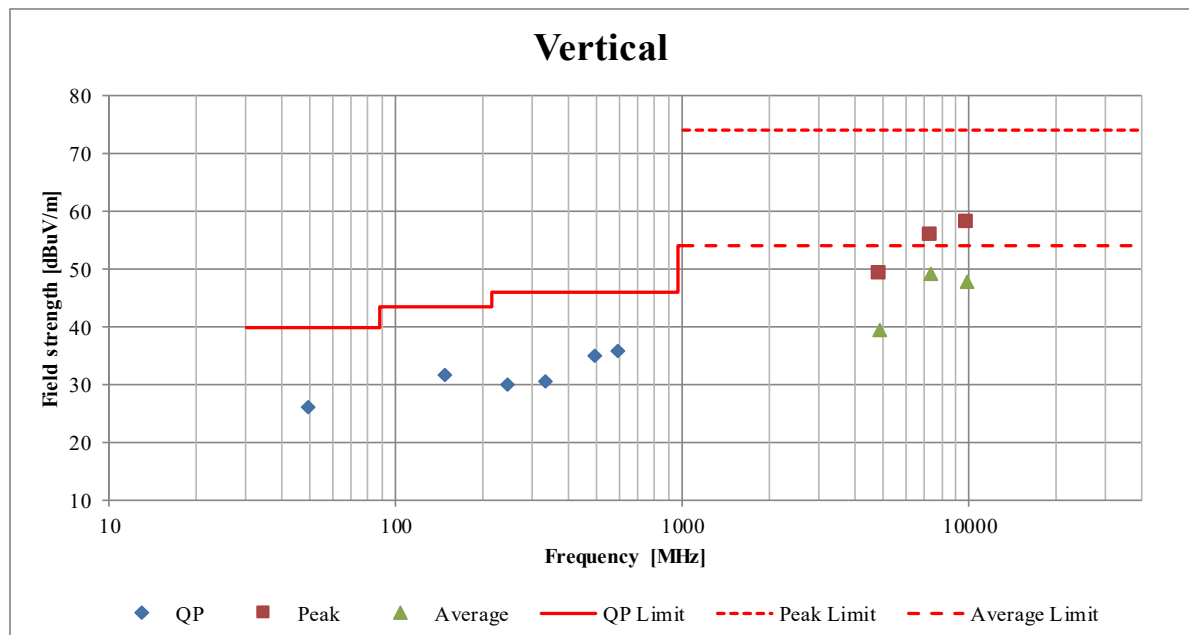
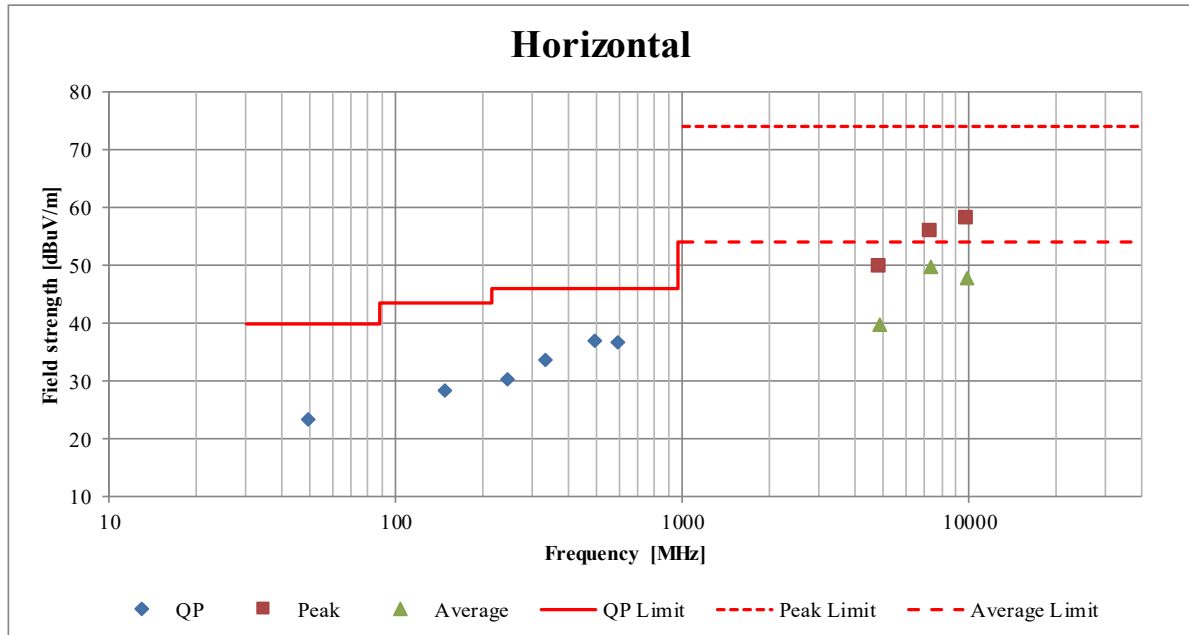
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Radiated Spurious Emission (Plot data, Worst case)

Report No.	13062395H	
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.2
Date	October 29, 2019	November 13, 2019
Temperature / Humidity	21 deg. C / 58 % RH	22 deg. C / 32 % RH
Engineer	Junya Okuno	Takumi Shimada
	(1 GHz - 26.5 GHz)	(30 MHz - 1.0 GHz)
Mode	Tx, Hopping Off, 3DH5 2441 MHz	



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

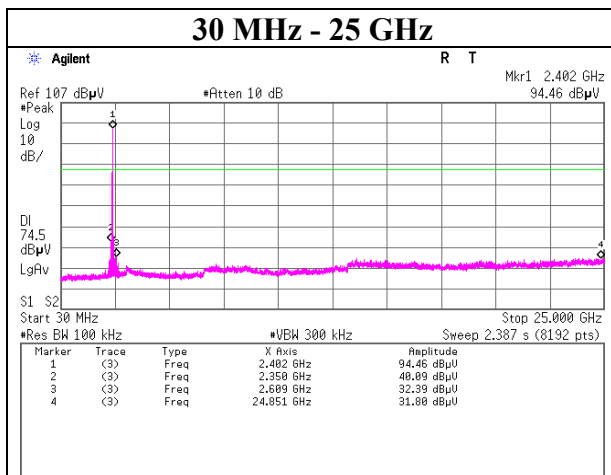
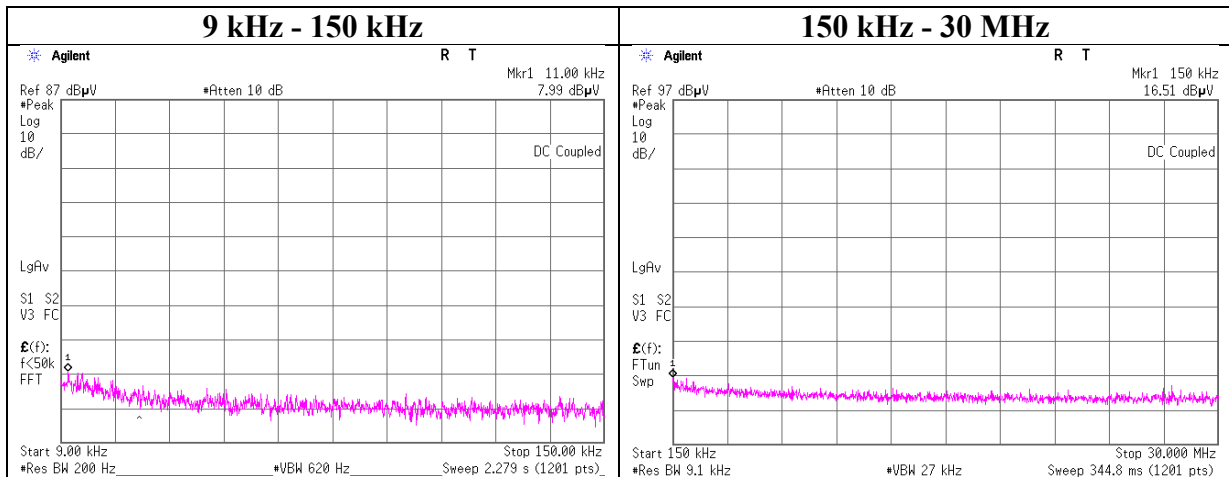
UL Japan, Inc.
Ise EMC Lab.

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Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No.	13062395H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	October 30, 2019
Temperature / Humidity	25 deg. C / 48 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, DH5

2402 MHz



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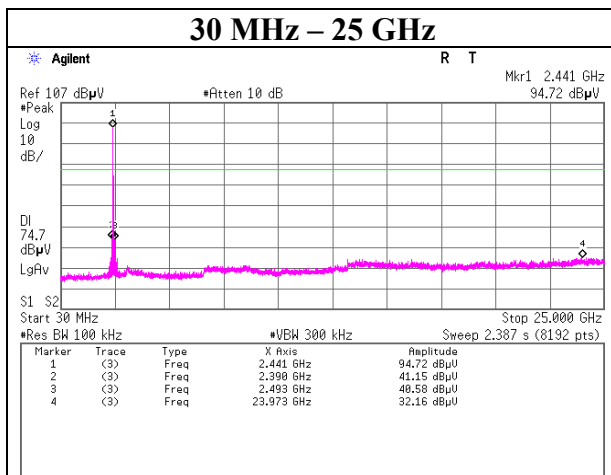
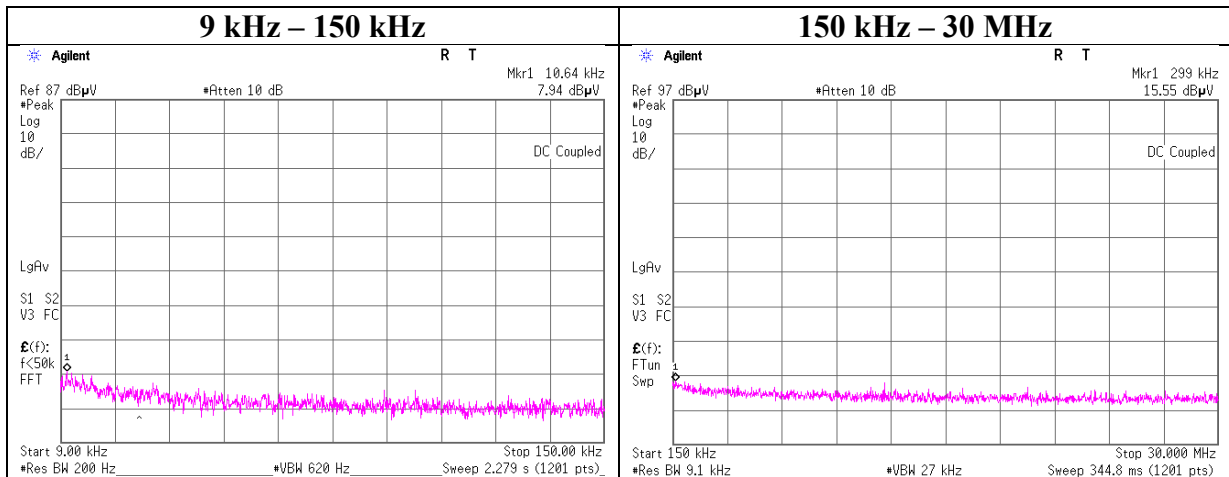
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No.	13062395H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	October 30, 2019
Temperature / Humidity	25 deg. C / 48 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, DH5

2441 MHz



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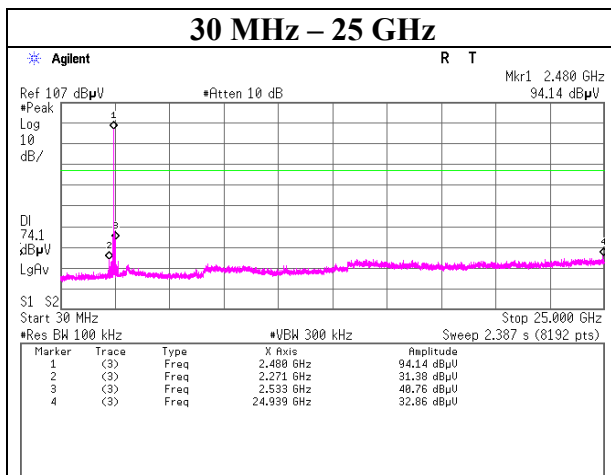
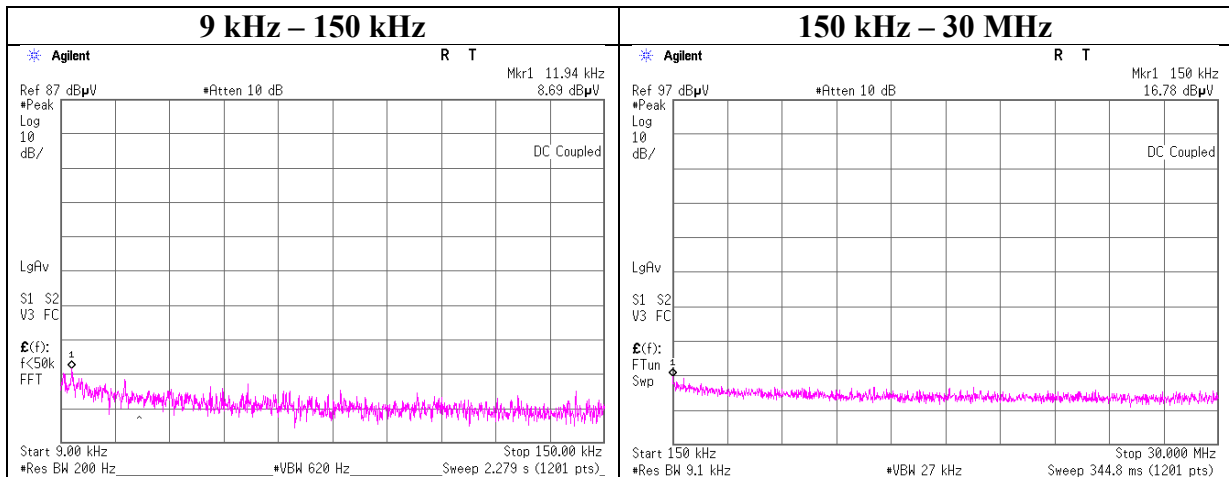
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No.	13062395H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	October 30, 2019
Temperature / Humidity	25 deg. C / 48 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, DH5

2480 MHz



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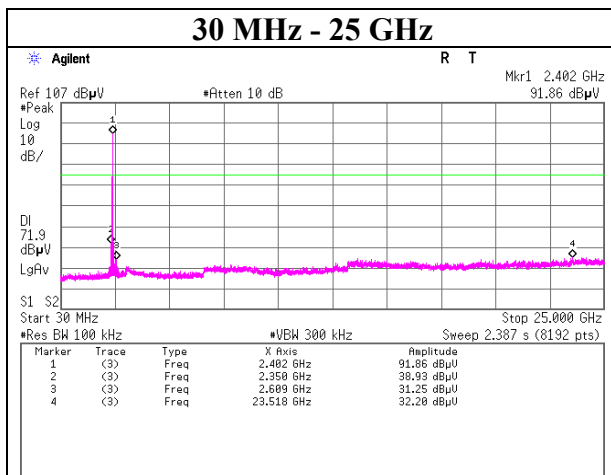
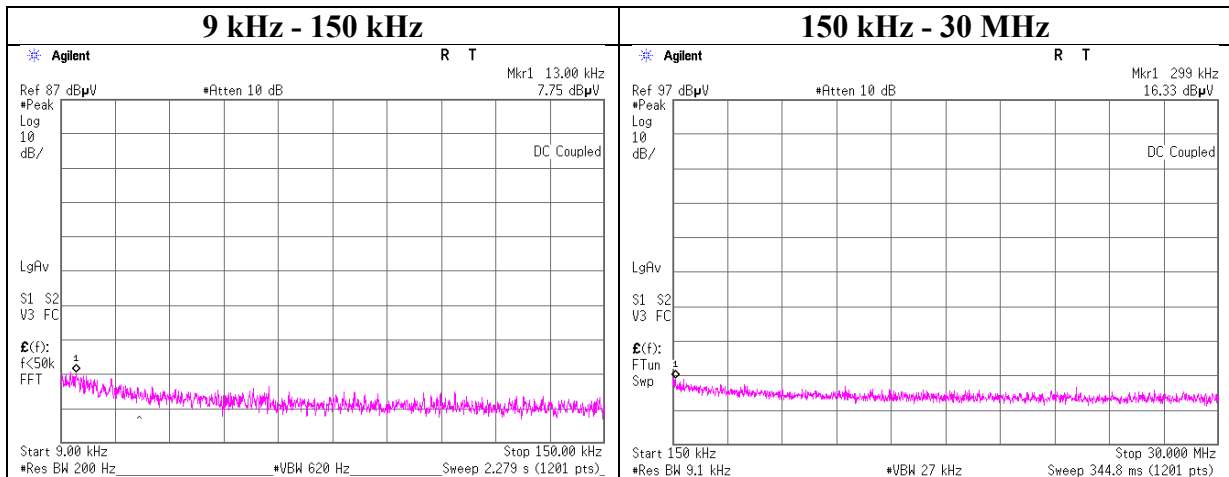
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No.	13062395H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	October 30, 2019
Temperature / Humidity	25 deg. C / 48 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, 3DH5

2402 MHz



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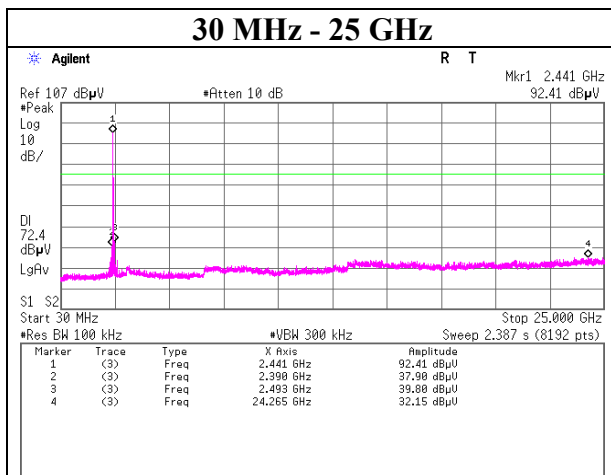
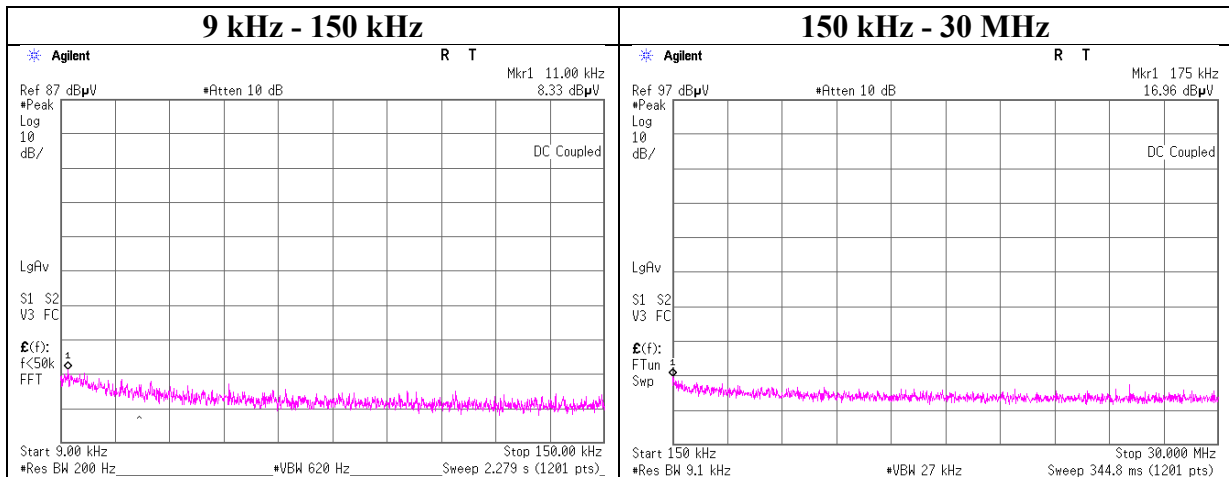
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No. 13062395H
Test place Ise EMC Lab. No.8 Measurement Room
Date October 30, 2019
Temperature / Humidity 25 deg. C / 48 % RH
Engineer Junya Okuno
Mode Tx, Hopping Off, 3DH5

2441 MHz



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Ise EMC Lab.

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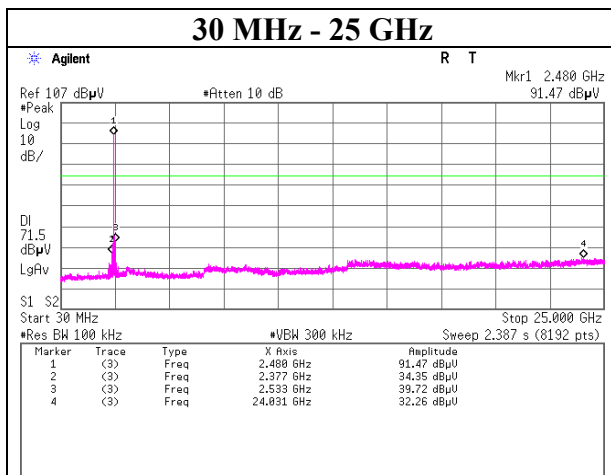
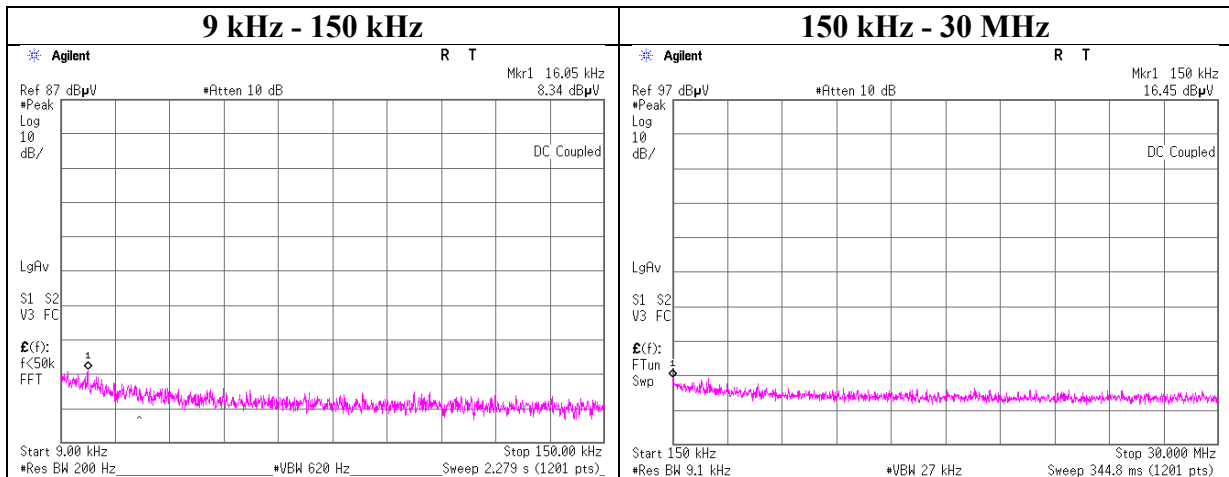
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No. 13062395H
Test place Ise EMC Lab. No.8 Measurement Room
Date October 30, 2019
Temperature / Humidity 25 deg. C / 48 % RH
Engineer Junya Okuno
Mode Tx, Hopping Off, 3DH5

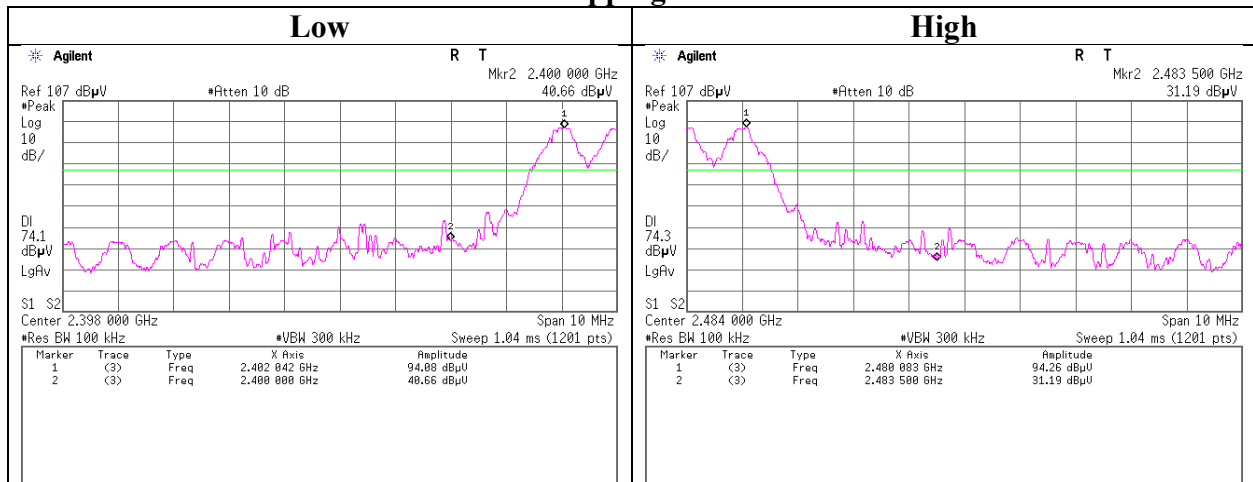
2480 MHz



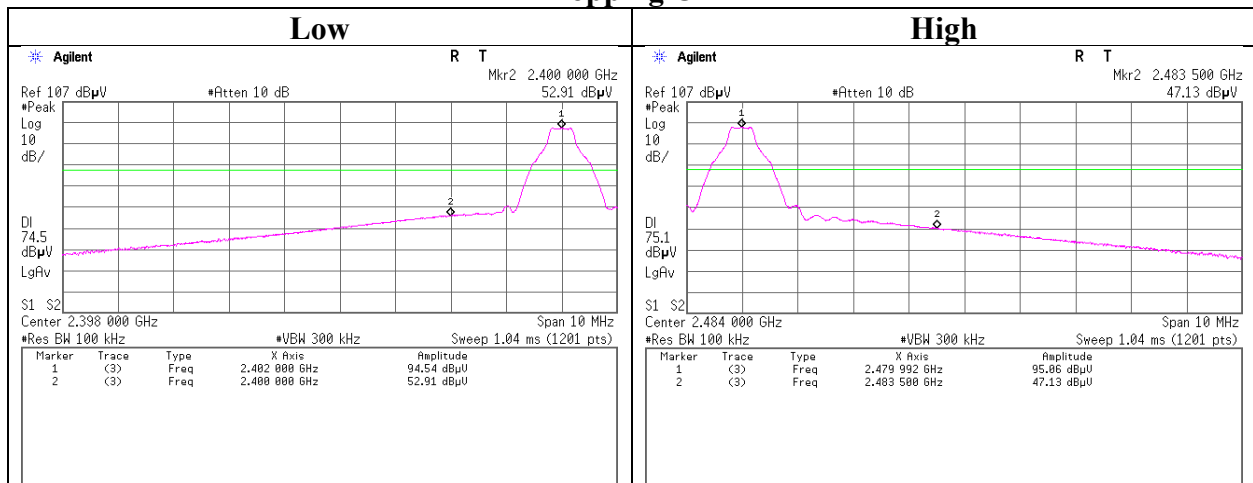
Conducted Emission Band Edge compliance

Report No.	13062395H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	October 30, 2019
Temperature / Humidity	25 deg. C / 48 % RH
Engineer	Junya Okuno
Mode	Tx DH5

Hopping On



Hopping Off



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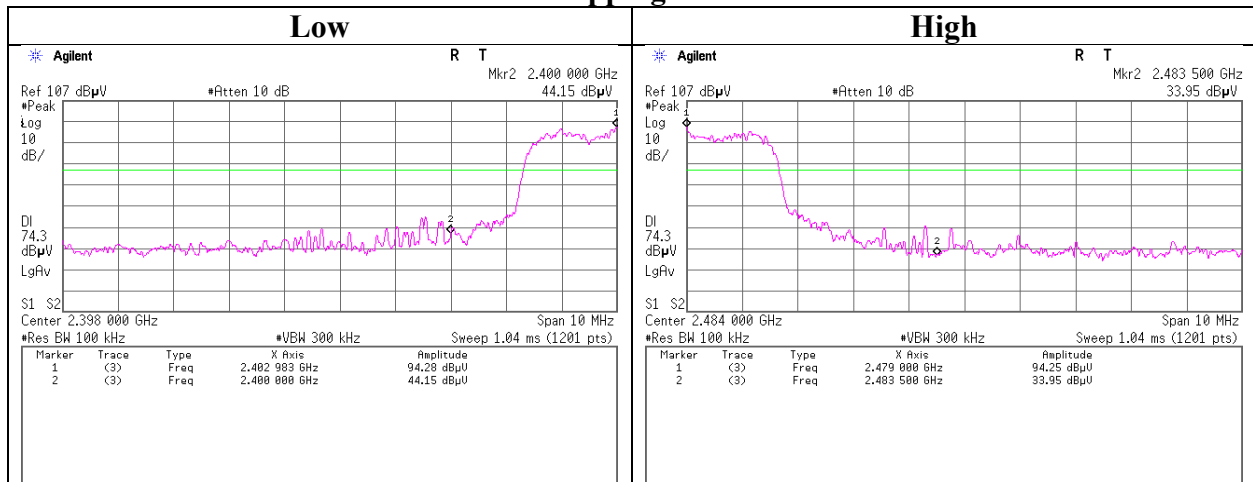
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

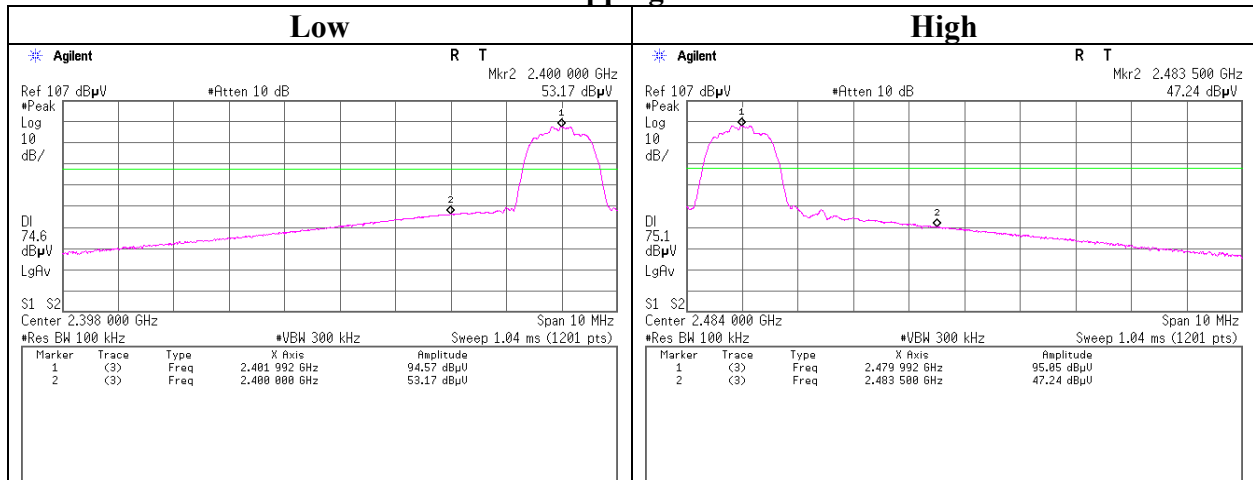
Conducted Emission Band Edge compliance

Report No.	13062395H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	October 30, 2019
Temperature / Humidity	25 deg. C / 48 % RH
Engineer	Junya Okuno
Mode	Tx 3DH5

Hopping On



Hopping Off



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APPENDIX 2: Test instruments

Test Instruments

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
AT	141224	Microwave Cable	Junkosha	MWX221	1409S496	03/05/2019	03/31/2020	12
AT	141810	Power Meter	ANRITSU	ML2495A	824014	10/09/2019	10/31/2020	12
AT	141269	Attenuator(10dB) 1-18GHz	Orient Microwave	BX10-0476-00	-	03/26/2019	03/31/2020	12
RE	178648	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141507	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	258	09/26/2019	09/30/2020	12
RE	141532	DIGITAL HiTESTER	HIOKI	3805	51201197	01/29/2019	01/31/2020	12
RE	142183	Measure	KOMELON	KMC-36	-	-	-	-
RE	177964	Microwave Cable	Junkosha INC.	MMX221	1901S329(1m)/ 1902S579(5m)	03/05/2019	03/31/2020	12
RE	141554	Thermo-Hygrometer	CUSTOM	CTH-180	1301	01/11/2019	01/31/2020	12
RE	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	06/26/2018	06/30/2020	24
RE	141580	MicroWave System Amplifier	AGILENT	83017A	MY39500779	03/05/2019	03/31/2020	12
RE	141513	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170306	10/08/2019	10/31/2020	12
RE	141296	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	002	09/11/2019	09/30/2020	12
RE	141855	Spectrum Analyzer	AGILENT	E4440A	MY46187750	11/19/2019	11/30/2020	12
AT	141832	Power sensor	ANRITSU	MA2411B	738174	10/09/2019	10/31/2020	12
RE	142013	AC3_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	04/08/2019	04/30/2021	24
RE	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	08/08/2019	08/31/2020	12
RE	142004	AC2_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-06902	06/29/2018	06/30/2020	24
RE	141578	Pre Amplifier	AGILENT	8447D	2944A10845	09/06/2019	09/30/2020	12
RE	141265	Logperiodic Antenna (200-1000MHz)	Schwarzbeck	VUSLP9111B	9111B-190	08/23/2019	08/31/2020	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141542	Digital Tester	Fluke Corporation	FLUKE 26-3	78030611	08/20/2019	08/31/2020	12
RE	141317	Coaxial Cable	Fujikura/Agilent	-	-	09/03/2019	09/30/2020	12
RE	141427	Biconical Antenna	Schwarzbeck	VHA9103B +BBA9106	8031	08/23/2019	08/31/2020	12
RE	141203	Attenuator(6dB)	Weinschel Corp	2	BK7970	11/07/2019	11/30/2020	12
RE	141556	Thermo-Hygrometer	CUSTOM	CTH-201	0003	12/05/2018	12/31/2019	12
RE	142228	Measure	KOMELON	KMC-36	-	-	-	-

*Hyphens for Last Calibration Date, Calibration Due 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.

All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

Test item: RE: Radiated Emission test
AT: Antenna Terminal Conducted test

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