



RADIO TEST REPORT

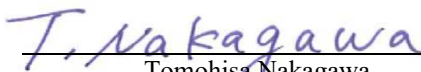
Test Report No. : 13198340H-A-R1

Applicant : DENSO TEN Limited
Type of EUT : Car Audio
Model Number of EUT : TN0020A
FCC ID : BABTN0020A
Test regulation : FCC Part 15 Subpart C: 2020
Test Result : Complied (Refer to SECTION 3.2)

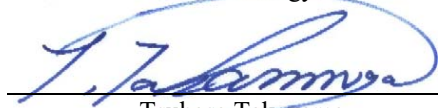
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6. This test report covers Radio technical requirements.
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7. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
8. The opinions and the interpretations to the result 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 13198340H-A. 13198340H-A is replaced with this report.

Date of test: June 15 to 18, 2020

Representative test engineer:


Tomohisa Nakagawa
Engineer
Consumer Technology Division

Approved by:


Tsubasa Takayama
Leader
Consumer Technology Division



CERTIFICATE 5107.02

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

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REVISION HISTORY

Original Test Report No.: 13198340H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13198340H-A	July 31, 2020	-	-
1	13198340H-A-R1	October 30, 2020	P.16	Correction of data on “Hopping On” mode
1	13198340H-A-R1	October 30, 2020	P.47	Addition of Test Receiver (Local ID: MTR-10)

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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	:	DENSO TEN Limited
Address	:	2-28, Goshō-dori 1-Chome, Hyogo-ku, Kobe, 652-8510 JAPAN
Telephone Number	:	+81-78-682-2159
Facsimile Number	:	+81-78-671-7160
Contact Person	:	Daisuke Fukii

The information provided from the customer is as follows;

- Applicant, Type of EUT, Model Number of EUT, FCC ID on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (EUT) other than the Receipt Date
- SECTION 4: Operation of EUT during testing

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

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

Type	:	Car Audio
Model Number	:	TN0020A
Serial Number	:	Refer to SECTION 4.2
Rating	:	DC 12V
Receipt Date	:	June 15, 2020
Country of Mass-production	:	Thailand
Condition	:	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	:	No Modification by the test lab.

2.2 Product Description

Model: TN0020A (referred to as the EUT in this report) is a Car Audio. There are 2 types, Left-hand steering wheel (LHD) and Right-hand steering wheel (RHD).

The EUT is Right-hand steering wheel type.

General Specification

Operating Temperature : -20 deg. C to +65 deg. C

Radio Specification

[Bluetooth (Ver.5.0 + EDR)]

Equipment Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480MHz
Type of Modulation	:	GFSK, PI/4-DQPSK, 8DPSK
Antenna Type	:	Inverted F PCB Antenna
Antenna Gain	:	1.78 dBi max
Clock frequency (Maximum)	:	20 MHz

[AM / FM (incl. RDS) / DAB]

Type of Receiver	:	Receiver
Frequency of Operation	:	AM: 531 kHz to 1602 kHz FM: 87.5 MHz to 108.0 MHz DAB (Band III): 174.928 MHz to 239.200 MHz
Channel spacing	:	AM: 9 kHz FM: 0.05 MHz RDS: 0.1 MHz
Antenna connector type	:	AM / FM / RDS: JASO DAB: HFC III

*This test report applies for Bluetooth.

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on June 26, 2020 and effective July 27, 2020

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 revision does not affect the test result conducted before its effective date.

* Also the EUT complies with FCC Part 15 Subpart B.

3.2 Procedures and results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Conducted Emission	FCC: ANSI C63.10-2013 6. Standard test methods ISED: RSS-Gen 8.8	FCC: Section 15.207 ISED: RSS-Gen 8.8	N/A	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(a)(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	9.4 dB 9920.000 MHz, Hori/Vert., AV	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.

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FCC Part 15.31 (e)

This EUT provides 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.

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
0.5 m	26.5 GHz to 40 GHz	5.5 dB
10 m	1 GHz to 18 GHz	5.2 dB

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3.5 Test Location

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*A2LA Certificate Number: 5107.02 / 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 EUT 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: 0 dBm Software: Bluetooth test software V1.0.0 (Date: June 15, 2020, Storage location: EUT memory) *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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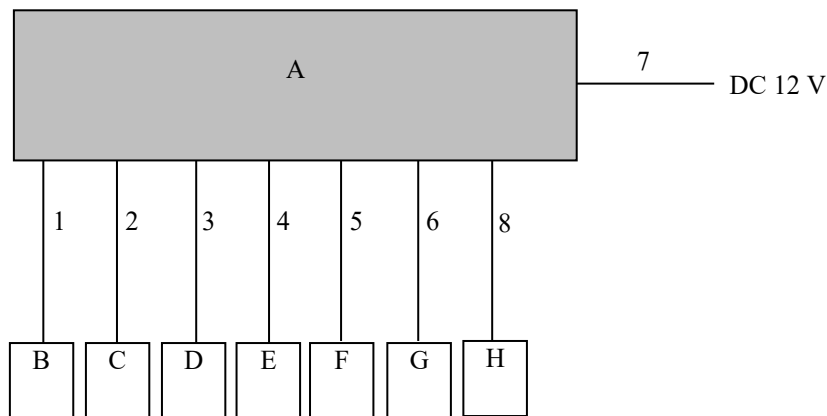
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4.2 Configuration and peripherals

Radiated Spurious Emission



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

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Car Audio	TN0020A	BS500005	DENSO TEN Limited	EUT
B	USB Memory	USM4GRB	-	SONY	-
C	Speaker Dummy	-	-	-	-
D	Steering Switch	8425-58150-B0	884-6A93	TOKAI RIKA	-
E	Camera	86790-62010	5XC300003	Panasonic	-
F	Microphone	-	No.5	HOSHIDEN	-
G	Radio Antenna AMP	146000-64900101	PQ600047	DENSO TEN Limited	-
H	DAB Antenna AMP	146001-58000101	PQB02907	DENSO TEN Limited	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	USB Cable	3.0	Shielded	Shielded	-
2	Speaker Cable	4.0	Unshielded	Unshielded	-
3	Signal Cable	4.0	Unshielded	Unshielded	-
4	Signal Cable	4.0	Unshielded	Unshielded	-
5	Signal Cable	4.0	Unshielded	Unshielded	-
6	Radio Cable	4.0	Shielded	Shielded	-
7	DC Cable	4.0	Unshielded	Unshielded	-
8	Radio Cable	4.0	Shielded	Shielded	-

*RE: Radiated Spurious Emission, AT: Antenna Terminal Conducted test

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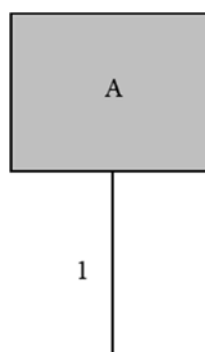
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Antenna Terminal Conducted Tests



DC 12 V

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

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Car Audio	TN0020A	100126857-0012	DENSO TEN Limited	EUT

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.1	Unshielded	Unshielded	-

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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, 0.5 m by 1.0 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]

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

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

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.

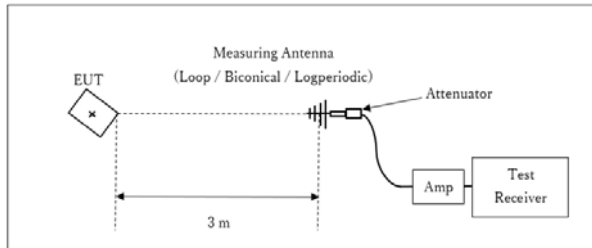
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9 (ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

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 1: Test Setup

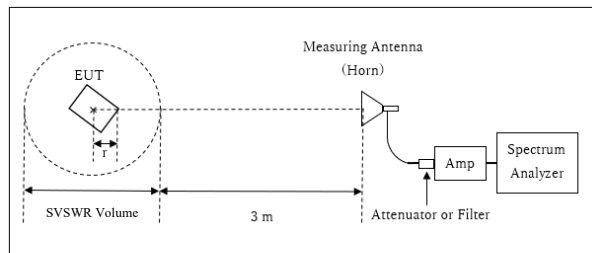
Below 1 GHz



× : 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: $20 \times \log (4.0 \text{ m} / 3.0 \text{ m}) = 2.5 \text{ dB}$

* Test Distance: $(3 + \text{SVSWR Volume} / 2) - r = 4.0 \text{ m}$

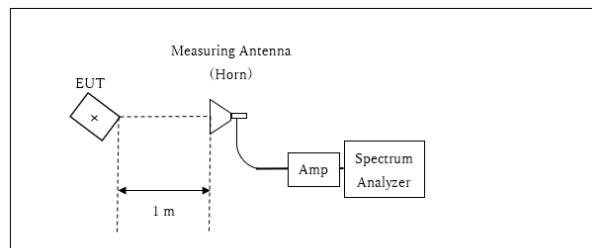
SVSWR Volume : 2.0 m

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

r = 0 m

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

10 GHz - 26.5 GHz



× : 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 low enough as shown in the chart.
(9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 9.1 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

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APPENDIX 1: Test data

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

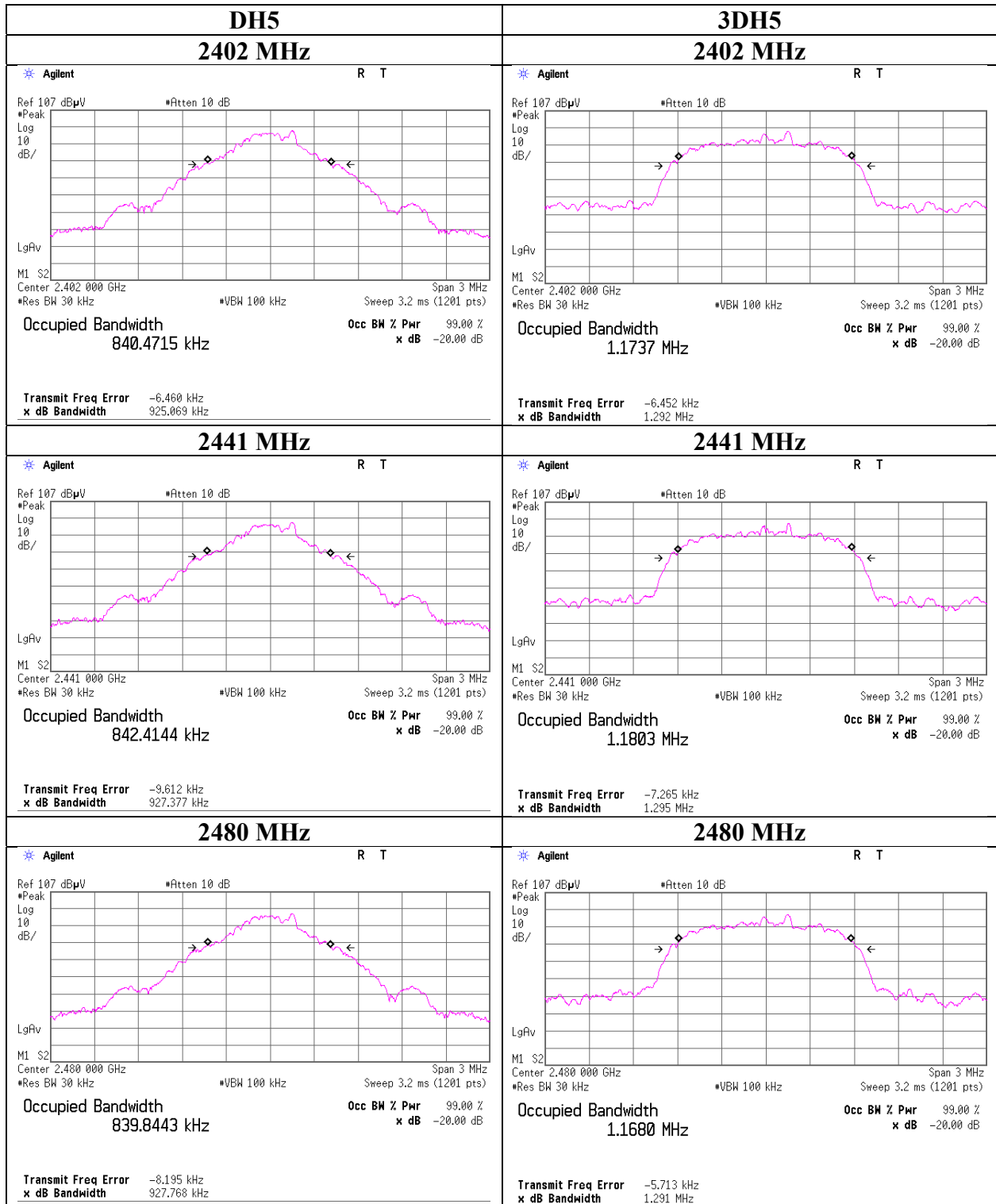
Report No. 13198340H
Test place Ise EMC Lab. No.8 Measurement Room
Date June 15, 2020
Temperature / Humidity 24 deg. C / 68 % RH
Engineer Hiroyuki Furutaka
Mode Tx, Hopping Off, Tx, Hopping On

Mode	Freq. [MHz]	20dB Bandwidth [MHz]	99% Occupied Bandwidth [kHz]	Carrier Frequency Separation [MHz]	Limit for Carrier Frequency separation [MHz]
DH5	2402.0	0.925	840.472	1.000	≥ 0.617
DH5	2441.0	0.927	842.414	1.000	≥ 0.618
DH5	2480.0	0.928	839.844	1.000	≥ 0.619
DH5	Hopping On	-	78611.700	-	-
3DH5	2402.0	1.292	1173.700	1.000	≥ 0.861
3DH5	2441.0	1.295	1180.300	1.000	≥ 0.863
3DH5	2480.0	1.291	1168.000	1.000	≥ 0.861
3DH5	Hopping On	-	78700.200	-	-

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

No limit applies to 20dB Bandwidth.

20dB Bandwidth and 99% Occupied Bandwidth



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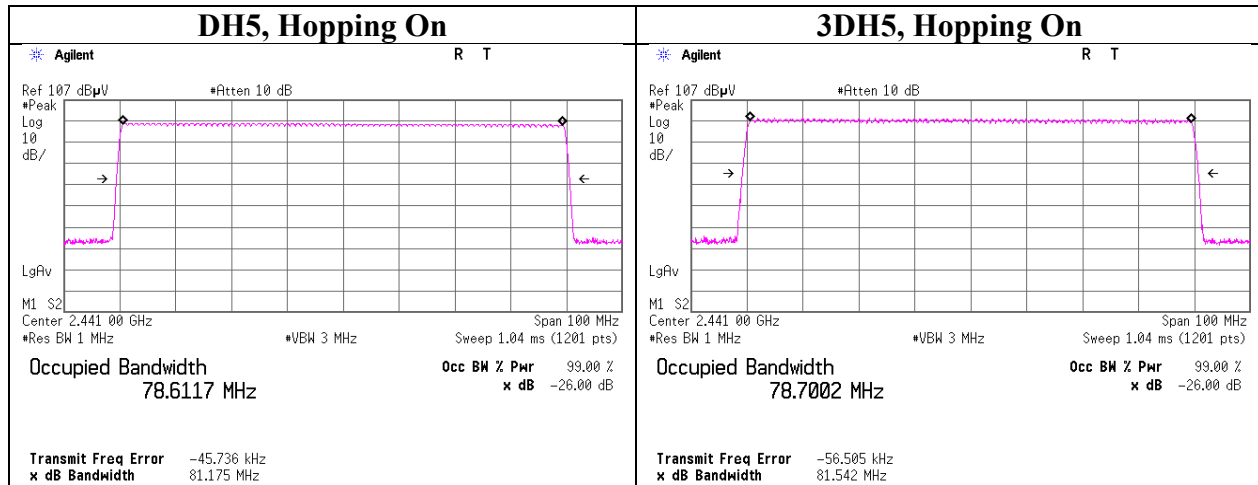
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20dB Bandwidth and 99% Occupied Bandwidth



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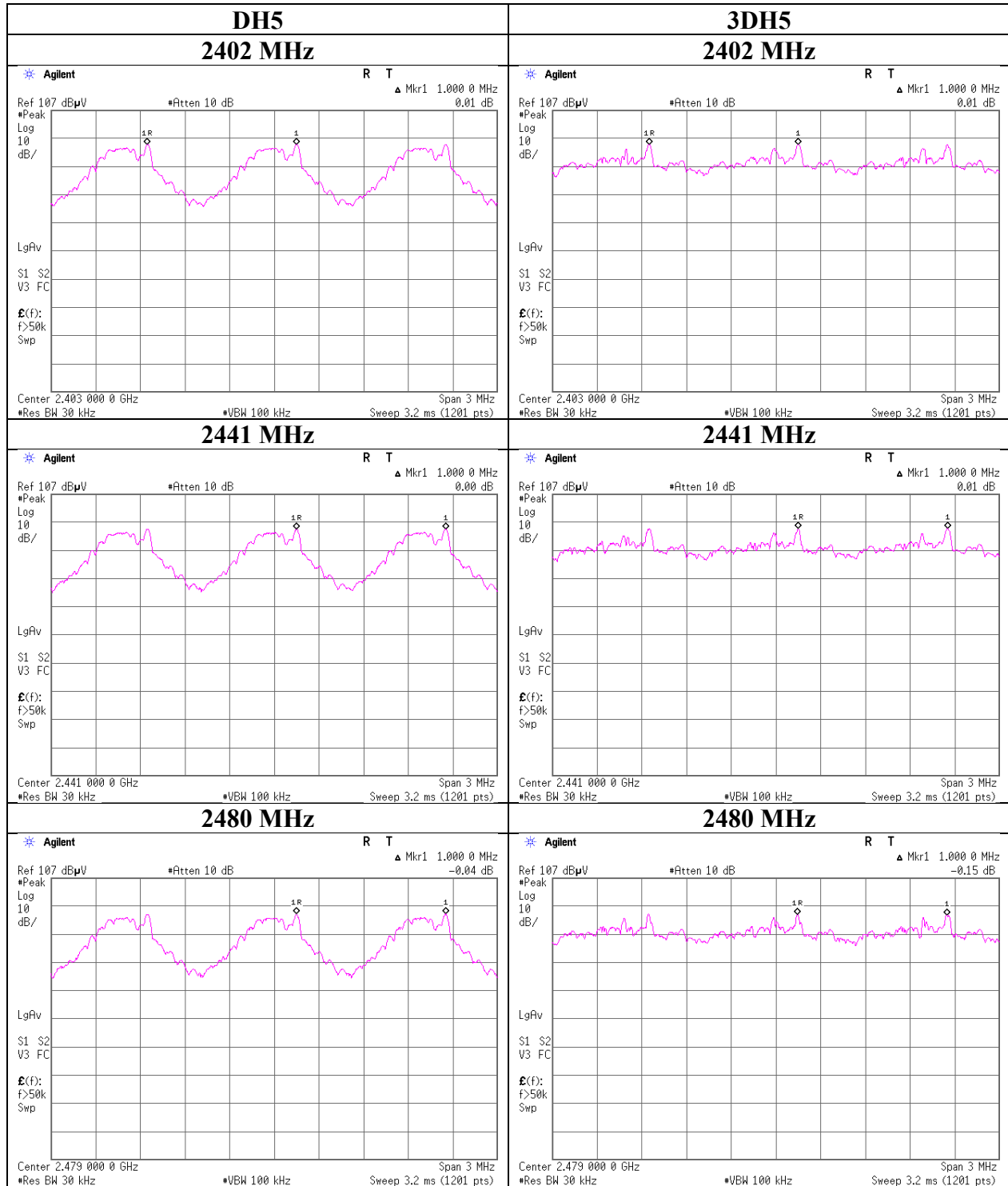
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Carrier Frequency Separation



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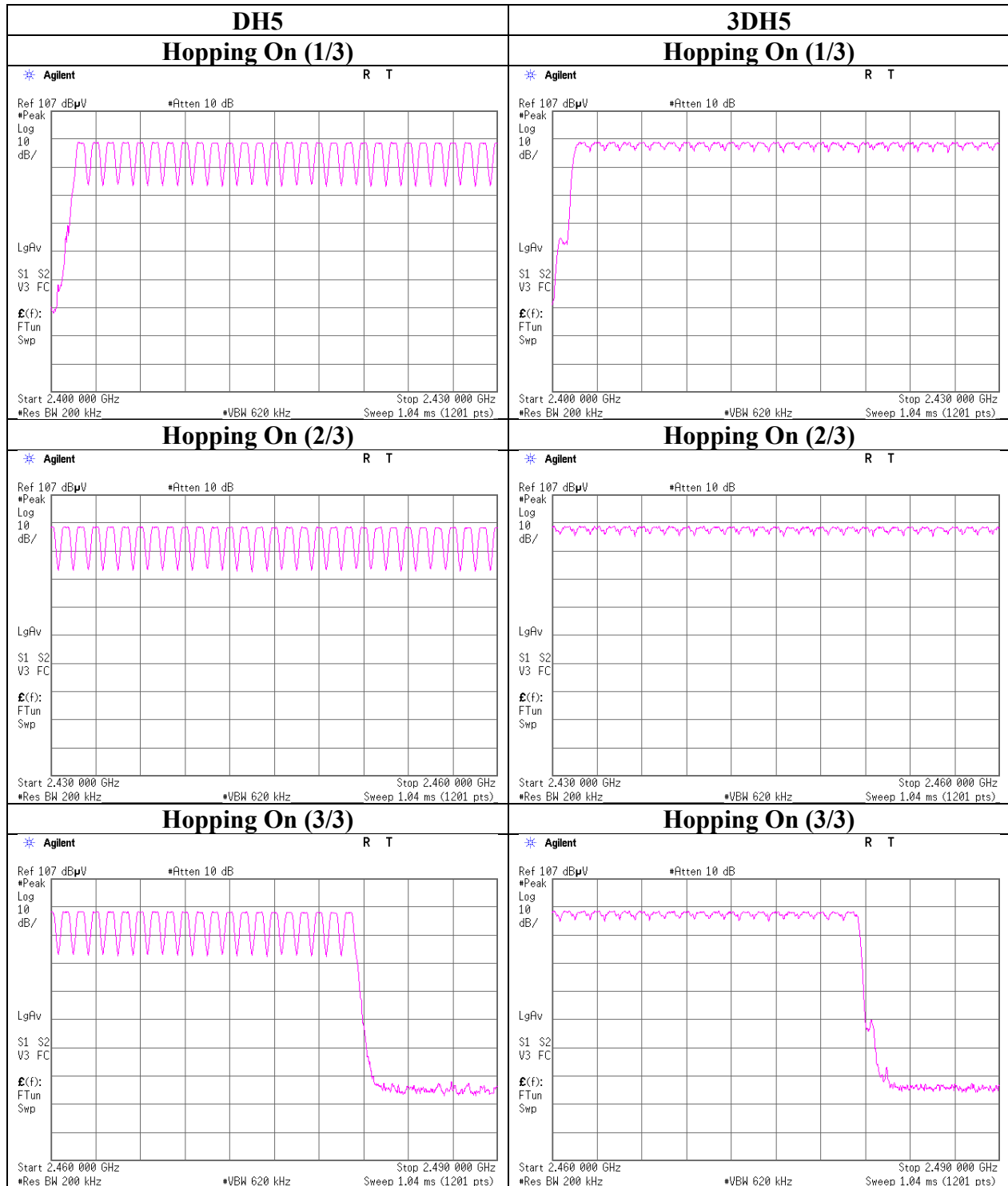
Number of Hopping Frequency

Report No. 13198340H
Test place Ise EMC Lab. No.8 Measurement Room
Date June 15, 2020
Temperature / Humidity 24 deg. C / 68 % RH
Engineer Hiroyuki Furutaka
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. 13198340H
Test place Ise EMC Lab. No.8 Measurement Room
Date June 15, 2020
Temperature / Humidity 24 deg. C / 68 % RH
Engineer Hiroyuki Furutaka
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	50.8 times	/	5 sec.	x 31.6 sec. = 322 times	0.449	144	400
DH3	28.0 times	/	5 sec.	x 31.6 sec. = 177 times	1.713	303	400
DH5	20.6 times	/	5 sec.	x 31.6 sec. = 131 times	2.963	388	400
3DH1	50.2 times	/	5 sec.	x 31.6 sec. = 318 times	0.458	146	400
3DH3	26.0 times	/	5 sec.	x 31.6 sec. = 165 times	1.713	283	400
3DH5	20.0 times	/	5 sec.	x 31.6 sec. = 127 times	2.993	380	400

Sample Calculation

Result = Number of transmission x Length of transmission

*Average data of 5 tests.(except Inquiry)

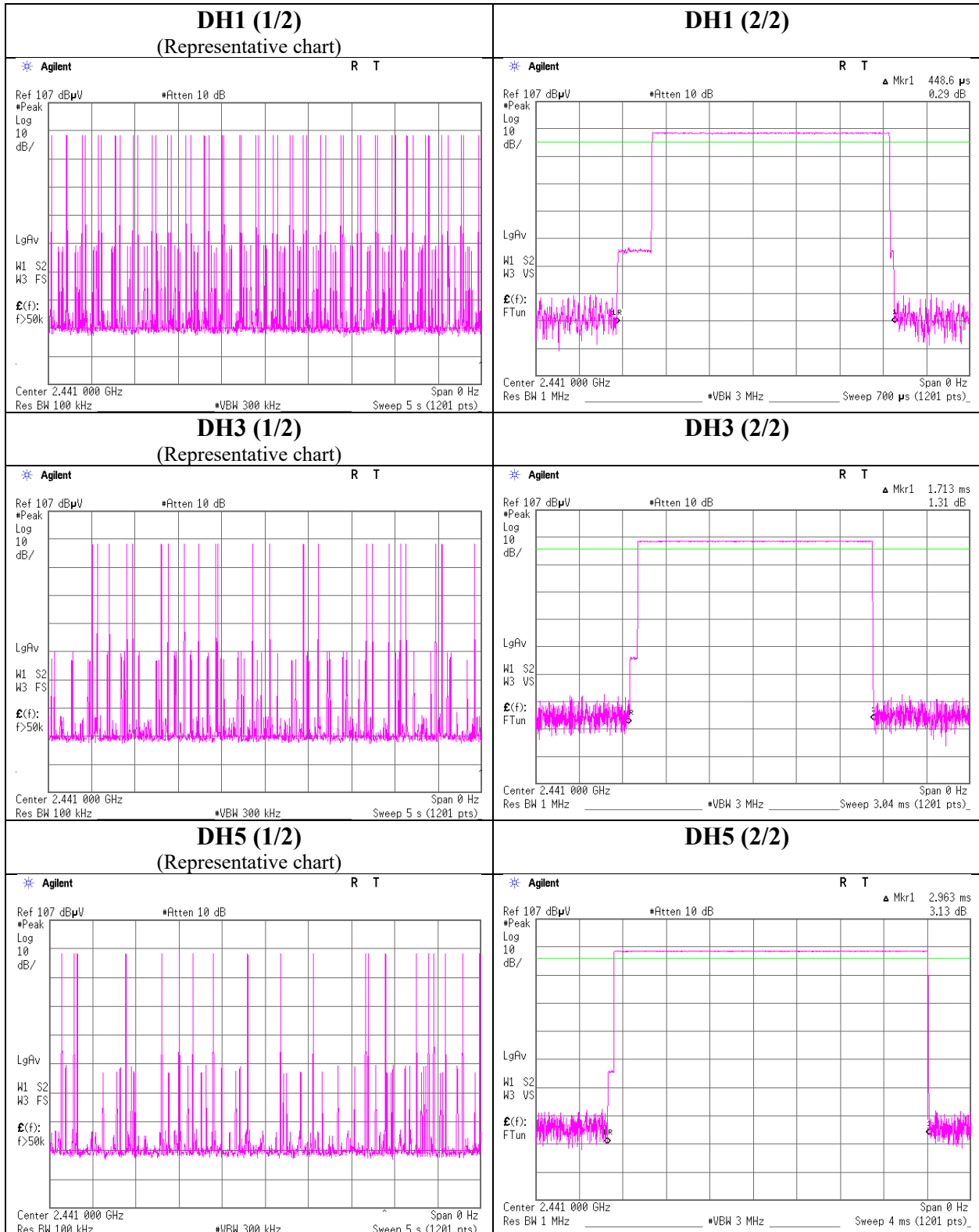
Mode	Sampling [times]					Average [times]
	1	2	3	4	5	
DH1	50	51	51	51	51	50.8
DH3	23	29	30	27	31	28
DH5	20	20	23	20	20	20.6
3DH1	51	50	50	49	51	50.2
3DH3	26	29	23	24	28	26
3DH5	20	21	21	20	18	20

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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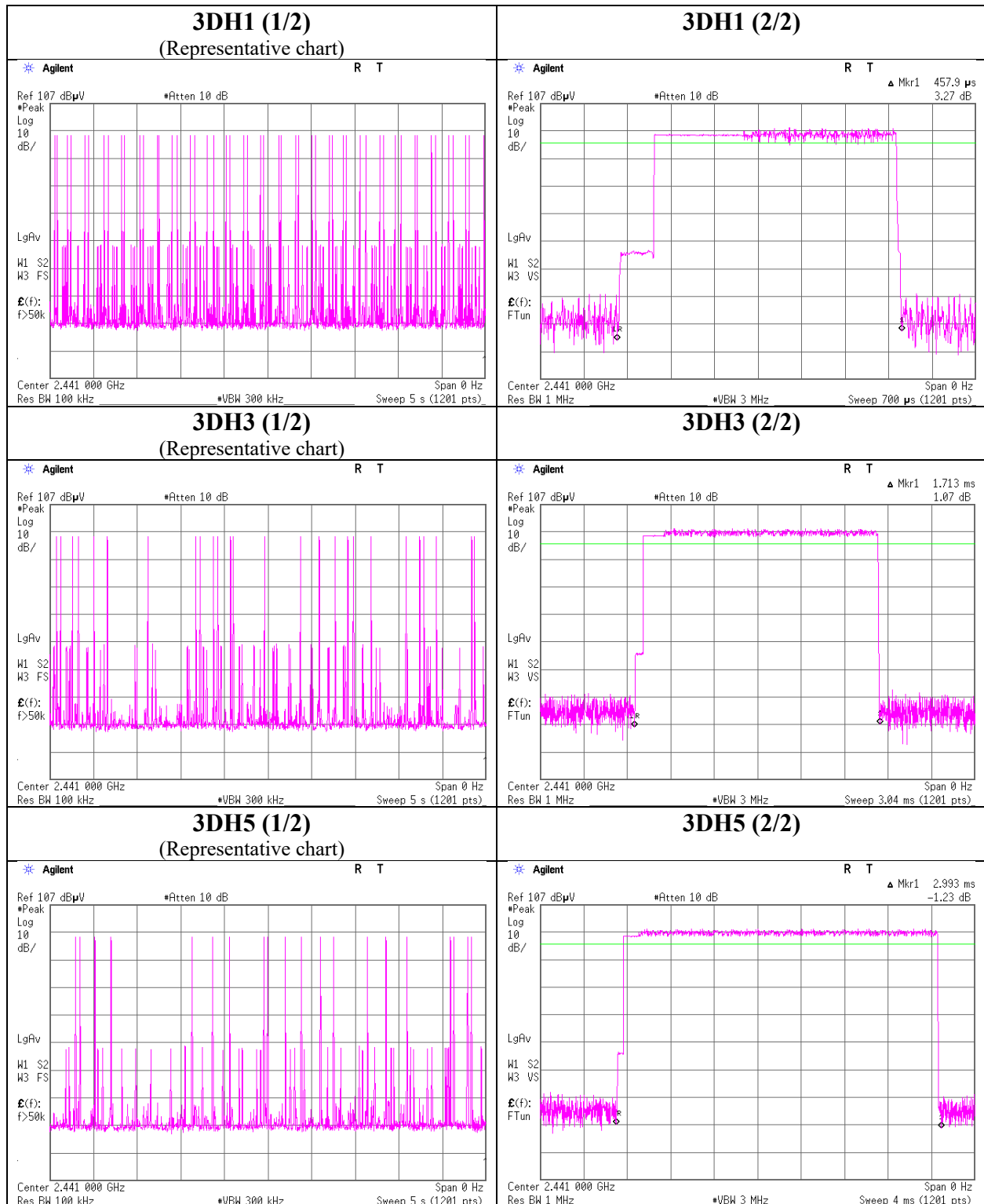
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Dwell time



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Maximum Peak Output Power

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, Hopping Off

					Conducted Power					e.i.r.p. for RSS-247					
Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result		Limit		Margin [dB]	Antenna Gain [dBi]	Result		Limit		Margin [dB]
					[dBm]	[mW]	[dBm]	[mW]			[dBm]	[mW]	[dBm]	[mW]	
DH5	2402.0	-11.60	1.00	10.03	-0.57	0.88	20.96	125	21.53	1.78	1.21	1.32	36.02	4000	34.81
DH5	2441.0	-11.78	1.01	10.03	-0.74	0.84	20.96	125	21.70	1.78	1.04	1.27	36.02	4000	34.98
DH5	2480.0	-12.20	1.01	10.03	-1.16	0.77	20.96	125	22.12	1.78	0.62	1.15	36.02	4000	35.40
2DH5	2402.0	-9.19	1.00	10.03	1.84	1.53	20.96	125	19.12	1.78	3.62	2.30	36.02	4000	32.40
2DH5	2441.0	-9.31	1.01	10.03	1.73	1.49	20.96	125	19.23	1.78	3.51	2.24	36.02	4000	32.51
2DH5	2480.0	-9.59	1.01	10.03	1.45	1.40	20.96	125	19.51	1.78	3.23	2.10	36.02	4000	32.79
3DH5	2402.0	-8.84	1.00	10.03	2.19	1.66	20.96	125	18.77	1.78	3.97	2.49	36.02	4000	32.05
3DH5	2441.0	-8.90	1.01	10.03	2.14	1.64	20.96	125	18.82	1.78	3.92	2.47	36.02	4000	32.10
3DH5	2480.0	-9.14	1.01	10.03	1.90	1.55	20.96	125	19.06	1.78	3.68	2.33	36.02	4000	32.34

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.

However, the limit level 125mW of AFH mode was used for the test.

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Average Output Power (Reference data for RF Exposure)

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
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	-12.89	1.00	10.03	-1.86	0.65	1.03	-0.83	0.83
DH5	2441.0	-13.14	1.01	10.03	-2.10	0.62	1.03	-1.07	0.78
DH5	2480.0	-13.56	1.01	10.03	-2.52	0.56	1.03	-1.49	0.71
2DH5	2402.0	-12.61	1.00	10.03	-1.58	0.69	1.03	-0.55	0.88
2DH5	2441.0	-12.82	1.01	10.03	-1.78	0.66	1.03	-0.75	0.84
2DH5	2480.0	-12.93	1.01	10.03	-1.89	0.65	1.03	-0.86	0.82
3DH5	2402.0	-12.62	1.00	10.03	-1.59	0.69	1.03	-0.56	0.88
3DH5	2441.0	-12.78	1.01	10.03	-1.74	0.67	1.03	-0.71	0.85
3DH5	2480.0	-13.24	1.01	10.03	-2.20	0.60	1.03	-1.17	0.76

Sample Calculation:

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

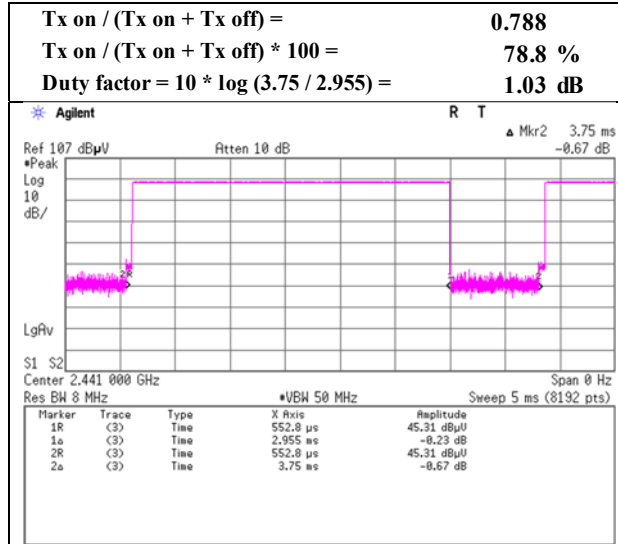
Result (Burst power average) = Time average + Duty factor

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

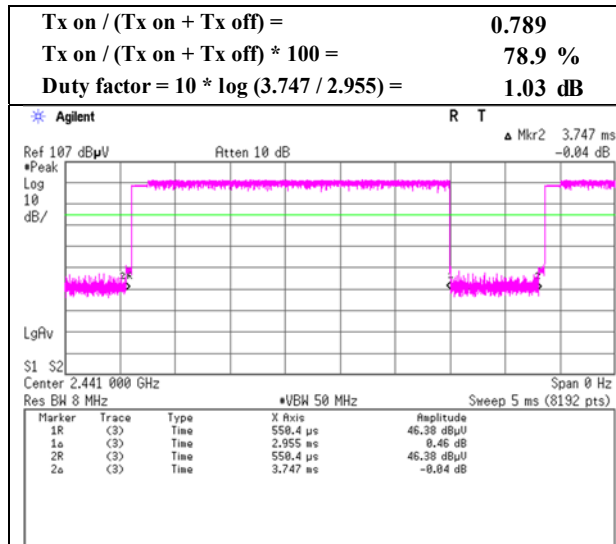
Burst Rate Confirmation

Report No. 13198340H
Test place Ise EMC Lab. No.8 Measurement Room
Date June 15, 2020
Temperature / Humidity 24 deg. C / 68 % RH
Engineer Hiroyuki Furutaka
Mode Tx, Hopping Off

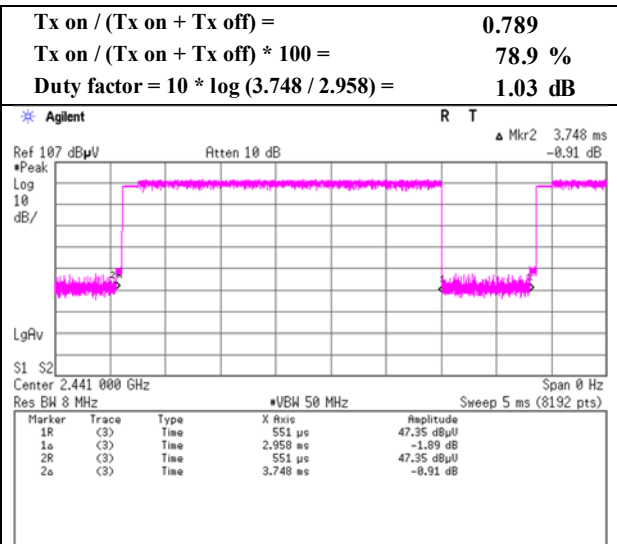
DH5



2DH5



3DH5



Radiated Spurious Emission

Report No. 13198340H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3
Date June 17, 2020
Temperature / Humidity 22 deg. C / 55 % RH
Engineer Takeshi Hiyaji
(1 GHz - 10 GHz)
No.3
June 17, 2020
22 deg. C / 55 % RH
Tomohisa Nakagawa
(10 GHz - 18 GHz)
No.3
June 18, 2020
23 deg. C / 52 % RH
Ken Fujita
(18 GHz - 26.5 GHz)
(Below 1 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.	36.157	QP	27.1	16.2	7.1	32.2	-	18.3	40.0	21.7	
Hori.	74.365	QP	29.2	6.4	7.8	32.2	-	11.2	40.0	28.8	
Hori.	129.365	QP	28.2	13.8	8.4	32.1	-	18.3	43.5	25.2	
Hori.	220.508	QP	22.1	11.0	9.3	32.0	-	10.4	46.0	35.6	
Hori.	479.916	QP	23.2	17.2	11.2	32.0	-	19.6	46.0	26.4	
Hori.	780.366	QP	21.2	20.6	12.9	31.6	-	23.2	46.0	22.8	
Hori.	2381.977	PK	43.0	27.7	5.6	32.7	-	43.6	73.9	30.4	
Hori.	2390.000	PK	42.5	27.7	5.6	32.7	-	43.1	73.9	30.9	
Hori.	4804.000	PK	40.0	31.6	7.7	31.7	-	47.7	73.9	26.2	Floor noise
Hori.	7206.000	PK	42.3	36.0	9.1	32.6	-	54.8	73.9	19.1	Floor noise
Hori.	9608.000	PK	41.5	38.5	9.6	33.3	-	56.3	73.9	17.6	Floor noise
Hori.	2381.977	AV	31.9	27.7	5.6	32.7	1.0	33.5	53.9	20.4	*1)
Hori.	2390.000	AV	29.8	27.7	5.6	32.7	1.0	31.4	53.9	22.6	*1)
Hori.	4804.000	AV	27.7	31.6	7.7	31.7	-	35.3	53.9	18.6	Floor noise
Hori.	7206.000	AV	28.8	36.0	9.1	32.6	-	41.3	53.9	12.6	Floor noise
Hori.	9608.000	AV	29.1	38.5	9.6	33.3	-	43.9	53.9	10.0	Floor noise
Vert.	35.442	QP	28.0	16.5	7.1	32.2	-	19.4	40.0	20.6	
Vert.	74.103	QP	29.3	6.4	7.8	32.2	-	11.3	40.0	28.7	
Vert.	128.225	QP	28.1	13.7	8.4	32.1	-	18.1	43.5	25.4	
Vert.	220.508	QP	22.4	11.0	9.3	32.0	-	10.7	46.0	35.3	
Vert.	479.916	QP	23.1	17.2	11.2	32.0	-	19.5	46.0	26.5	
Vert.	780.366	QP	21.3	20.6	12.9	31.6	-	23.3	46.0	22.7	
Vert.	2381.977	PK	41.3	27.7	5.6	32.7	-	41.9	73.9	32.1	
Vert.	2390.000	PK	41.1	27.7	5.6	32.7	-	41.7	73.9	32.2	
Vert.	4804.000	PK	40.6	31.6	7.7	31.7	-	48.2	73.9	25.7	Floor noise
Vert.	7206.000	PK	42.2	36.0	9.1	32.6	-	54.7	73.9	19.2	Floor noise
Vert.	9608.000	PK	42.3	38.5	9.6	33.3	-	57.1	73.9	16.8	Floor noise
Vert.	2381.977	AV	29.8	27.7	5.6	32.7	1.0	31.3	53.9	22.6	*1)
Vert.	2390.000	AV	29.4	27.7	5.6	32.7	1.0	31.0	53.9	22.9	*1)
Vert.	4804.000	AV	27.3	31.6	7.7	31.7	-	35.0	53.9	18.9	Floor noise
Vert.	7206.000	AV	28.9	36.0	9.1	32.6	-	41.4	53.9	12.5	Floor noise
Vert.	9608.000	AV	28.6	38.5	9.6	33.3	-	43.4	53.9	10.5	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 (4.0 m / 3.0 m) = 2.5 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	92.8	27.7	5.2	34.3	91.4	-	-	Carrier
Hori.	2400.000	PK	39.7	27.8	5.2	34.3	38.4	71.4	33.1	
Vert.	2402.000	PK	87.7	27.7	5.2	34.3	86.4	-	-	Carrier
Vert.	2400.000	PK	40.5	27.8	5.2	34.3	39.2	66.4	27.2	

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

Distance factor: 1 GHz - 10 GHz 20log (4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5dB

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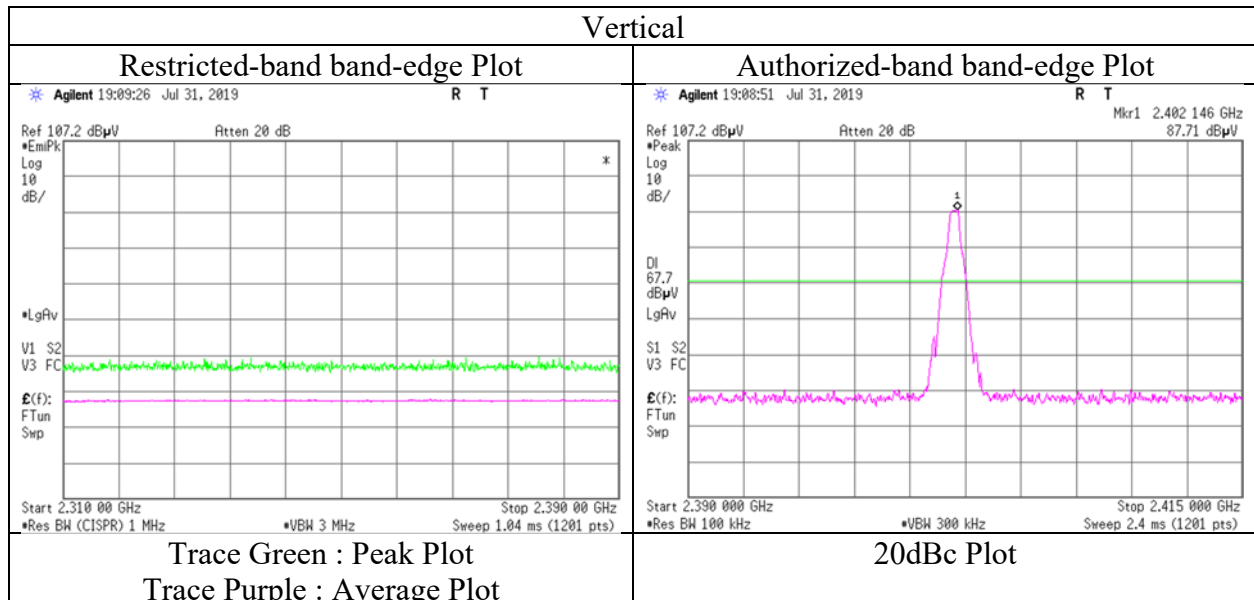
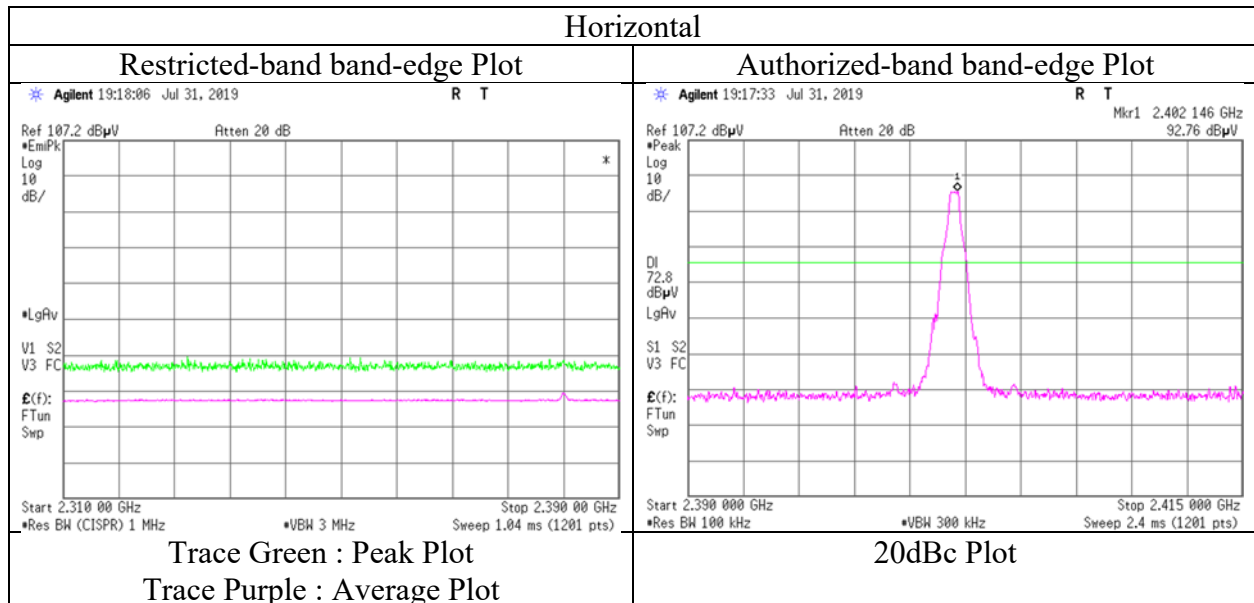
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Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13198340H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	June 17, 2020
Temperature / Humidity	22 deg. C / 55 % RH
Engineer	Takeshi Hiyaji (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.

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Radiated Spurious Emission

Report No.	13198340H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	June 17, 2020	June 17, 2020	June 18, 2020
Temperature / Humidity	22 deg. C / 55 % RH	22 deg. C / 55 % RH	23 deg. C / 52 % RH
Engineer	Takeshi Hiyaji (1 GHz - 10 GHz)	Tomohisa Nakagawa (10 GHz - 18 GHz)	Ken Fujita (18 GHz - 26.5 GHz) (Below 1 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.	36.112	QP	27.0	16.2	7.1	32.2	-	18.2	40.0	21.8	
Hori.	74.331	QP	29.2	6.4	7.8	32.2	-	11.2	40.0	28.8	
Hori.	129.367	QP	28.1	13.8	8.4	32.1	-	18.2	43.5	25.3	
Hori.	330.919	QP	23.1	14.6	10.2	32.0	-	15.9	46.0	30.2	
Hori.	480.094	QP	23.4	17.2	11.2	32.0	-	19.8	46.0	26.2	
Hori.	862.573	QP	21.4	21.7	13.3	31.1	-	25.3	46.0	20.7	
Hori.	4882.000	PK	40.5	31.5	7.7	31.6	-	48.1	73.9	25.8	Floor noise
Hori.	7323.000	PK	41.1	36.2	9.1	32.6	-	53.8	73.9	20.1	Floor noise
Hori.	9764.000	PK	40.8	38.8	9.6	33.4	-	55.8	73.9	18.1	Floor noise
Hori.	4882.000	AV	28.7	31.5	7.7	31.6	-	36.3	53.9	17.6	Floor noise
Hori.	7323.000	AV	30.0	36.2	9.1	32.6	-	42.7	53.9	11.2	Floor noise
Hori.	9764.000	AV	29.9	38.8	9.6	33.4	-	44.9	53.9	9.0	Floor noise
Vert.	34.442	QP	27.8	16.9	7.1	32.2	-	19.6	40.0	20.4	
Vert.	73.291	QP	29.1	6.4	7.7	32.2	-	11.1	40.0	28.9	
Vert.	128.923	QP	28.4	13.8	8.4	32.1	-	18.5	43.5	25.0	
Vert.	330.919	QP	23.3	14.6	10.2	32.0	-	16.1	46.0	30.0	
Vert.	480.094	QP	23.8	17.2	11.2	32.0	-	20.2	46.0	25.8	
Vert.	862.573	QP	21.5	21.7	13.3	31.1	-	25.4	46.0	20.6	
Vert.	4882.000	PK	41.2	31.5	7.7	31.6	-	48.8	73.9	25.1	Floor noise
Vert.	7323.000	PK	41.1	36.2	9.1	32.6	-	53.8	73.9	20.1	Floor noise
Vert.	9764.000	PK	41.9	38.8	9.6	33.4	-	56.9	73.9	17.0	Floor noise
Vert.	4882.000	AV	29.0	31.5	7.7	31.6	-	36.6	53.9	17.3	Floor noise
Vert.	7323.000	AV	30.1	36.2	9.1	32.6	-	42.8	53.9	11.1	Floor noise
Vert.	9764.000	AV	30.0	38.8	9.6	33.4	-	45.0	53.9	8.9	Floor noise

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

*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 (4 m / 3.0 m) = 2.5 dB
 10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Report No. 13198340H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3
Date June 17, 2020
Temperature / Humidity 22 deg. C / 55 % RH
Engineer Takeshi Hiyaji
(1 GHz - 10 GHz)

No.3
June 17, 2020
22 deg. C / 55 % RH
Tomohisa Nakagawa
(10 GHz - 18 GHz)

No.3
June 18, 2020
23 deg. C / 52 % RH
Ken Fujita
(18 GHz - 26.5 GHz)
(Below 1 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.	33.412	QP	27.6	17.3	7.1	32.2	-	19.8	40.0	20.2	
Hori.	73.835	QP	29.8	6.4	7.8	32.2	-	11.8	40.0	28.2	
Hori.	129.977	QP	25.4	13.8	8.4	32.1	-	15.5	43.5	28.0	
Hori.	330.826	QP	22.5	14.6	10.2	32.0	-	15.3	46.0	30.8	
Hori.	480.257	QP	23.2	17.2	11.2	32.0	-	19.7	46.0	26.4	
Hori.	644.438	QP	21.1	19.2	12.2	32.0	-	20.5	46.0	25.5	
Hori.	2483.500	PK	42.3	27.5	5.7	32.7	-	42.7	73.9	31.2	
Hori.	4960.000	PK	43.1	31.6	7.0	31.6	-	50.0	73.9	23.9	
Hori.	7440.000	PK	42.4	36.3	8.3	32.7	-	54.3	73.9	19.6	
Hori.	9920.000	PK	41.0	38.9	9.1	33.5	-	55.6	73.9	18.3	
Hori.	2483.500	AV	29.8	27.5	5.7	32.7	-	30.3	53.9	23.6	
Hori.	4960.000	AV	29.0	31.6	7.0	31.6	-	35.9	53.9	18.0	
Hori.	7440.000	AV	30.7	36.3	8.3	32.7	-	42.6	53.9	11.3	
Hori.	9920.000	AV	29.9	38.9	9.1	33.5	-	44.5	53.9	9.4	
Vert.	33.412	QP	26.7	17.3	7.1	32.2	-	18.9	40.0	21.1	
Vert.	73.835	QP	29.9	6.4	7.8	32.2	-	11.9	40.0	28.1	
Vert.	129.977	QP	25.5	13.8	8.4	32.1	-	15.6	43.5	27.9	
Vert.	330.826	QP	23.2	14.6	10.2	32.0	-	16.0	46.0	30.1	
Vert.	480.257	QP	22.4	17.2	11.2	32.0	-	18.9	46.0	27.2	
Vert.	644.438	QP	22.1	19.2	12.2	32.0	-	21.5	46.0	24.5	
Vert.	2483.500	PK	40.9	27.5	5.7	32.7	-	41.3	73.9	32.6	
Vert.	4960.000	PK	40.4	31.6	7.0	31.6	-	47.4	73.9	26.5	
Vert.	7440.000	PK	42.8	36.3	8.3	32.7	-	54.7	73.9	19.2	
Vert.	9920.000	PK	42.3	38.9	9.1	33.5	-	56.9	73.9	17.0	
Vert.	2483.500	AV	29.6	27.5	5.7	32.7	-	30.1	53.9	23.9	
Vert.	4960.000	AV	28.9	31.6	7.0	31.6	-	35.9	53.9	18.0	
Vert.	7440.000	AV	30.8	36.3	8.3	32.7	-	42.7	53.9	11.2	
Vert.	9920.000	AV	29.9	38.9	9.1	33.5	-	44.5	53.9	9.4	

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

*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 (4 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

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Ise EMC Lab.

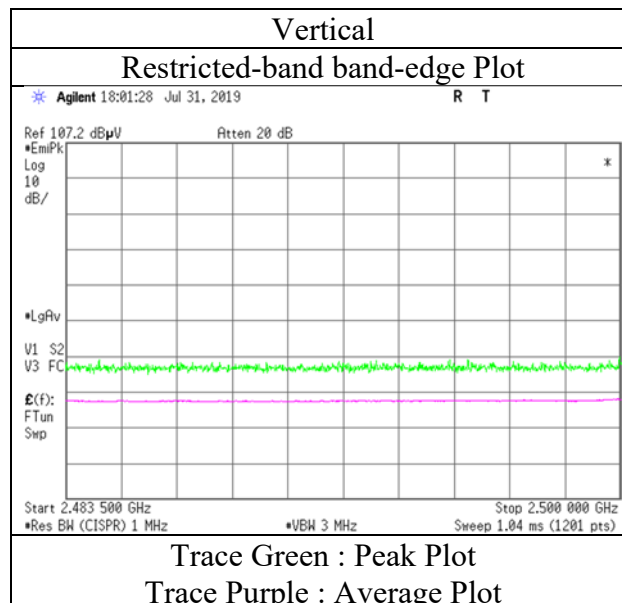
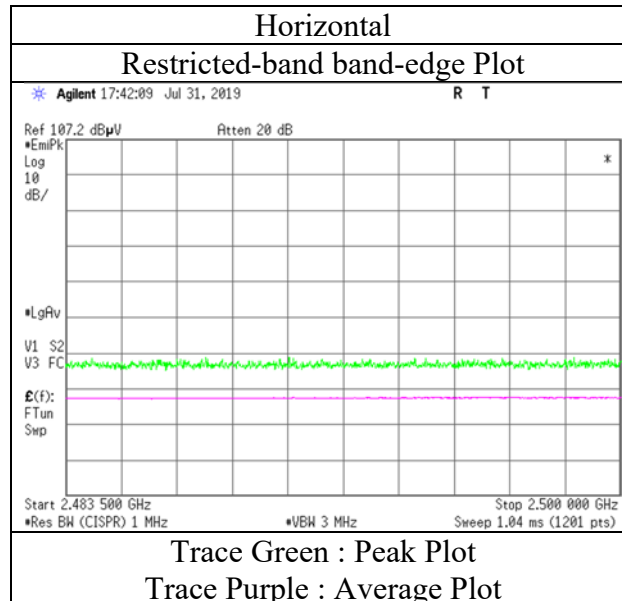
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

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Facsimile : +81 596 24 8124

Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13198340H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	June 17, 2020
Temperature / Humidity	22 deg. C / 55 % RH
Engineer	Takeshi Hiyaji
	(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.

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

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Radiated Spurious Emission

Report No.	13198340H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	June 17, 2020	June 17, 2020	June 18, 2020
Temperature / Humidity	22 deg. C / 55 % RH	22 deg. C / 55 % RH	23 deg. C / 52 % RH
Engineer	Takeshi Hiyaji (1 GHz - 10 GHz)	Tomohisa Nakagawa (10 GHz - 18 GHz)	Ken Fujita (18 GHz - 26.5 GHz) (Below 1 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.	34.419	QP	26.7	16.9	7.1	32.2	-	18.5	40.0	21.5	
Hori.	74.139	QP	29.2	6.4	7.8	32.2	-	11.2	40.0	28.8	
Hori.	128.475	QP	27.8	13.7	8.4	32.1	-	17.8	43.5	25.7	
Hori.	291.167	QP	21.9	13.4	9.9	32.0	-	13.2	46.0	32.8	
Hori.	479.663	QP	21.8	17.2	11.2	32.0	-	18.2	46.0	27.8	
Hori.	486.545	QP	23.1	17.5	11.2	32.0	-	19.8	46.0	26.2	
Hori.	2382.197	PK	43.1	27.7	5.6	32.7	-	43.6	73.9	30.3	
Hori.	2390.000	PK	41.5	27.7	5.6	32.7	-	42.1	73.9	31.8	
Hori.	4804.000	PK	39.8	31.6	7.7	31.7	-	47.4	73.9	26.5	Floor noise
Hori.	7206.000	PK	42.5	36.0	9.1	32.6	-	55.0	73.9	18.9	Floor noise
Hori.	9608.000	PK	41.4	38.5	9.6	33.3	-	56.2	73.9	17.7	Floor noise
Hori.	2382.197	AV	31.3	27.7	5.6	32.7	1.0	32.9	53.9	21.0	*1)
Hori.	2390.000	AV	29.5	27.7	5.6	32.7	1.0	31.1	53.9	22.8	*1)
Hori.	4804.000	AV	27.5	31.6	7.7	31.7	-	35.1	53.9	18.8	Floor noise
Hori.	7206.000	AV	28.8	36.0	9.1	32.6	-	41.3	53.9	12.6	Floor noise
Hori.	9608.000	AV	28.5	38.5	9.6	33.3	-	43.3	53.9	10.6	Floor noise
Vert.	34.419	QP	26.5	16.9	7.1	32.2	-	18.3	40.0	21.7	
Vert.	74.139	QP	29.4	6.4	7.8	32.2	-	11.4	40.0	28.6	
Vert.	128.475	QP	27.6	13.7	8.4	32.1	-	17.6	43.5	25.9	
Vert.	291.167	QP	22.0	13.4	9.9	32.0	-	13.3	46.0	32.7	
Vert.	479.663	QP	22.1	17.2	11.2	32.0	-	18.5	46.0	27.5	
Vert.	486.400	QP	23.2	17.5	11.2	32.0	-	19.9	46.0	26.1	
Vert.	2382.197	PK	42.5	27.7	5.6	32.7	-	43.1	73.9	30.8	
Vert.	2390.000	PK	41.7	27.7	5.6	32.7	-	42.3	73.9	31.6	
Vert.	4804.000	PK	40.3	31.6	7.7	31.7	-	48.0	73.9	25.9	Floor noise
Vert.	7206.000	PK	41.8	36.0	9.1	32.6	-	54.3	73.9	19.6	Floor noise
Vert.	9608.000	PK	42.1	38.5	9.6	33.3	-	56.9	73.9	17.0	Floor noise
Vert.	2382.197	AV	28.0	27.7	5.6	32.7	1.0	29.6	53.9	24.3	*1)
Vert.	2390.000	AV	28.0	27.7	5.6	32.7	1.0	29.6	53.9	24.3	*1)
Vert.	4804.000	AV	27.6	31.6	7.7	31.7	-	35.2	53.9	18.7	Floor noise
Vert.	7206.000	AV	28.8	36.0	9.1	32.6	-	41.3	53.9	12.6	Floor noise
Vert.	9608.000	AV	28.4	38.5	9.6	33.3	-	43.3	53.9	10.6	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 (4.0 m / 3.0 m) = 2.5 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	93.8	27.7	5.6	32.7	94.3	-	-	Carrier
Hori.	2400.000	PK	38.6	27.7	5.6	32.7	39.1	74.3	35.2	
Vert.	2402.000	PK	87.7	27.7	5.6	32.7	88.2	-	-	Carrier
Vert.	2400.000	PK	34.0	27.7	5.6	32.7	34.6	68.2	33.6	

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

Distance factor: 1 GHz - 10 GHz 20log(4.0 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5dB

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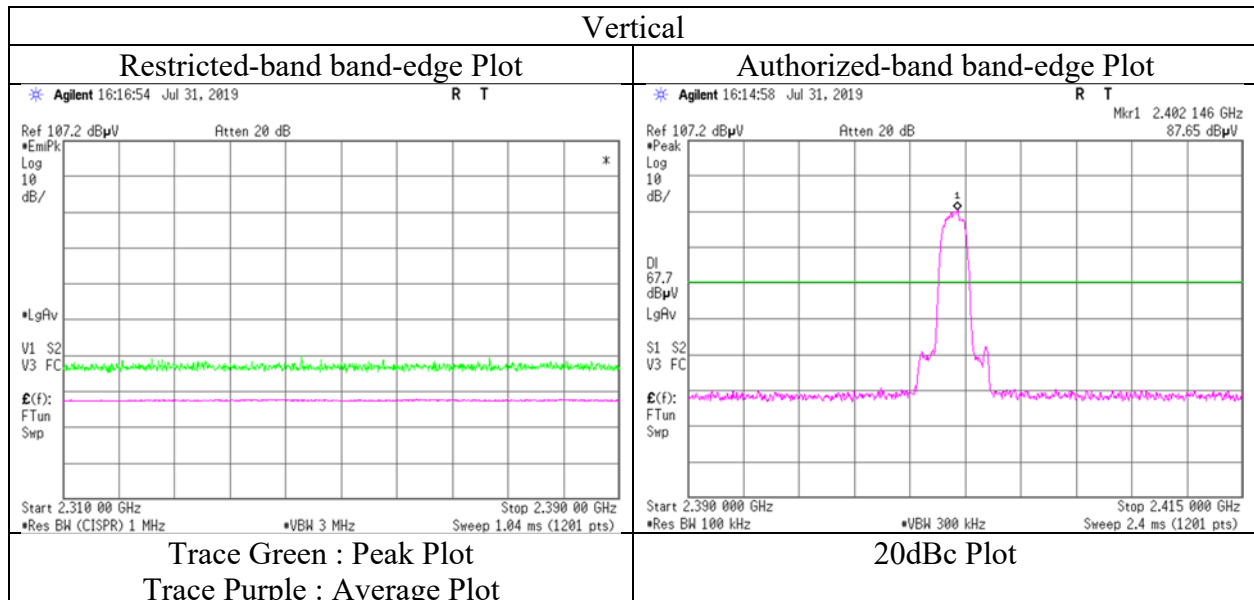
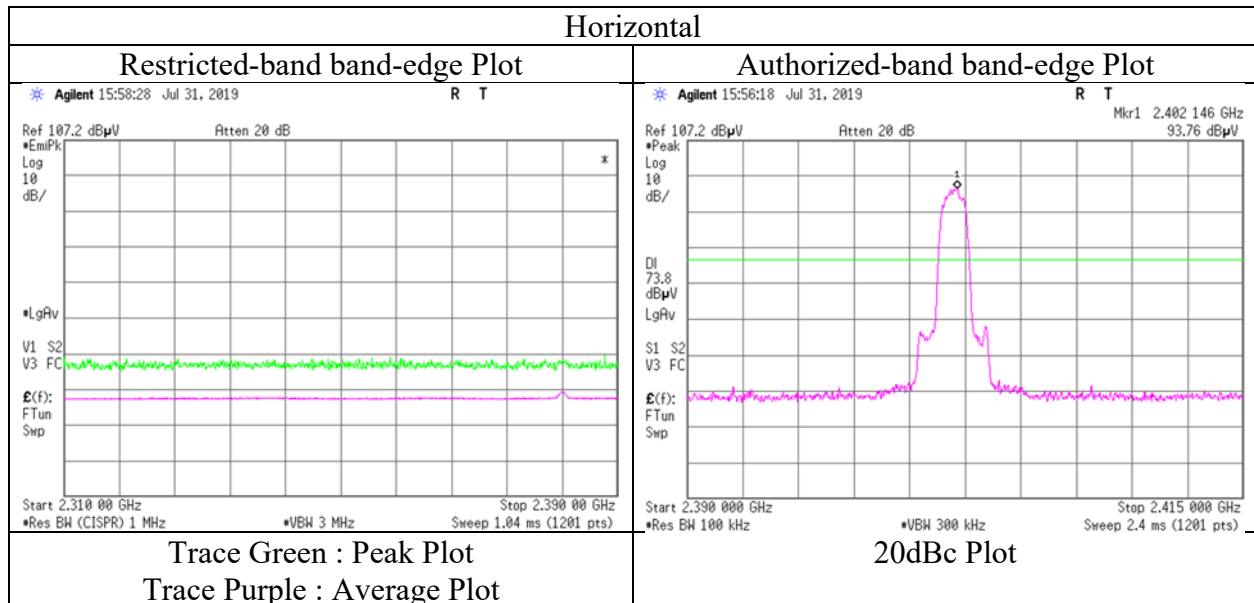
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN

Telephone : +81 596 24 8999

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Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13198340H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	June 17, 2020
Temperature / Humidity	22 deg. C / 55 % RH
Engineer	Takeshi Hiyaji (1 GHz -10 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

Report No.	13198340H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	June 17, 2020	June 17, 2020	June 18, 2020
Temperature / Humidity	22 deg. C / 55 % RH	22 deg. C / 55 % RH	23 deg. C / 52 % RH
Engineer	Takeshi Hiyaji (1 GHz - 10 GHz)	Tomohisa Nakagawa (10 GHz - 18 GHz)	Ken Fujita (18 GHz - 26.5 GHz) (Below 1 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.	35.110	QP	27.1	16.7	7.1	32.2	-	18.7	40.0	21.3	
Hori.	74.132	QP	29.1	6.4	7.8	32.2	-	11.1	40.0	28.9	
Hori.	129.112	QP	27.9	13.8	8.4	32.1	-	18.0	43.5	25.5	
Hori.	281.231	QP	22.2	13.3	9.8	32.0	-	13.3	46.0	32.7	
Hori.	479.223	QP	21.9	17.2	11.2	32.0	-	18.3	46.0	27.7	
Hori.	485.142	QP	23.2	17.4	11.2	32.0	-	19.9	46.0	26.1	
Hori.	4882.000	PK	40.5	31.5	7.7	31.6	-	48.1	73.9	25.8	Floor noise
Hori.	7323.000	PK	41.1	36.2	9.1	32.6	-	53.8	73.9	20.1	Floor noise
Hori.	9764.000	PK	40.8	38.8	9.6	33.4	-	55.8	73.9	18.1	Floor noise
Hori.	4882.000	AV	28.7	31.5	7.7	31.6	-	36.3	53.9	17.6	Floor noise
Hori.	7323.000	AV	30.0	36.2	9.1	32.6	-	42.7	53.9	11.2	Floor noise
Hori.	9764.000	AV	29.9	38.8	9.6	33.4	-	44.9	53.9	9.0	Floor noise
Vert.	34.115	QP	27.1	17.1	7.1	32.2	-	19.1	40.0	21.0	
Vert.	73.412	QP	29.3	6.4	7.7	32.2	-	11.3	40.0	28.7	
Vert.	127.361	QP	27.8	13.5	8.4	32.1	-	17.6	43.5	25.9	
Vert.	289.567	QP	22.1	13.4	9.9	32.0	-	13.4	46.0	32.6	
Vert.	478.231	QP	23.2	17.2	11.2	32.0	-	19.6	46.0	26.4	
Vert.	485.118	QP	23.6	17.4	11.2	32.0	-	20.3	46.0	25.7	
Vert.	4882.000	PK	41.2	31.5	7.7	31.6	-	48.8	73.9	25.1	Floor noise
Vert.	7323.000	PK	41.1	36.2	9.1	32.6	-	53.8	73.9	20.1	Floor noise
Vert.	9764.000	PK	41.9	38.8	9.6	33.4	-	56.9	73.9	17.0	Floor noise
Vert.	4882.000	AV	29.0	31.5	7.7	31.6	-	36.6	53.9	17.3	Floor noise
Vert.	7323.000	AV	30.1	36.2	9.1	32.6	-	42.8	53.9	11.1	Floor noise
Vert.	9764.000	AV	30.0	38.8	9.6	33.4	-	45.0	53.9	8.9	Floor noise

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

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

Distance factor: 1 GHz - 10 GHz $20\log(4\text{ m} / 3.0\text{ m}) = 2.5\text{ dB}$
 10 GHz - 26.5 GHz $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.5\text{ dB}$

Radiated Spurious Emission

Report No. 13198340H
Test place Ise EMC Lab.
Semi Anechoic Chamber No.3
Date June 17, 2020
Temperature / Humidity 22 deg. C / 55 % RH
Engineer Takeshi Hiyaji
(1 GHz - 10 GHz)

No.3
June 17, 2020
22 deg. C / 55 % RH
Tomohisa Nakagawa
(10 GHz - 18 GHz)

No.3
June 18, 2020
23 deg. C / 52 % RH
Ken Fujita
(18 GHz - 26.5 GHz)
(Below 1 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.	36.157	QP	27.3	16.2	7.1	32.2	-	18.5	40.0	21.5	
Hori.	74.365	QP	29.3	6.4	7.8	32.2	-	11.3	40.0	28.7	
Hori.	129.365	QP	28.1	13.8	8.4	32.1	-	18.2	43.5	25.3	
Hori.	282.227	QP	23.0	13.3	9.8	32.0	-	14.2	46.0	31.9	
Hori.	479.165	QP	22.0	17.2	11.2	32.0	-	18.4	46.0	27.6	
Hori.	485.221	QP	23.4	17.4	11.2	32.0	-	20.1	46.0	25.9	
Hori.	2483.500	PK	43.1	27.5	5.7	32.7	-	43.5	73.9	30.4	
Hori.	4960.000	PK	41.0	31.6	7.0	31.6	-	48.0	73.9	25.9	Floor noise
Hori.	7440.000	PK	43.3	36.3	8.3	32.7	-	55.2	73.9	18.7	Floor noise
Hori.	9920.000	PK	42.2	38.9	9.1	33.5	-	56.8	73.9	17.1	Floor noise
Hori.	2483.500	AV	30.0	27.5	5.7	32.7	-	30.4	53.9	23.5	
Hori.	4960.000	AV	29.1	31.6	7.0	31.6	-	36.0	53.9	17.9	Floor noise
Hori.	7440.000	AV	30.8	36.3	8.3	32.7	-	42.7	53.9	11.2	Floor noise
Hori.	9920.000	AV	30.0	38.9	9.1	33.5	-	44.6	53.9	9.3	Floor noise
Vert.	35.442	QP	27.8	16.5	7.1	32.2	-	19.2	40.0	20.8	
Vert.	74.103	QP	29.4	6.4	7.8	32.2	-	11.4	40.0	28.6	
Vert.	128.225	QP	27.9	13.7	8.4	32.1	-	17.9	43.5	25.6	
Vert.	289.301	QP	23.0	13.4	9.9	32.0	-	14.3	46.0	31.7	
Vert.	465.122	QP	23.7	16.9	11.1	32.0	-	19.7	46.0	26.3	
Vert.	476.558	QP	23.3	17.2	11.2	32.0	-	19.6	46.0	26.4	
Vert.	2483.500	PK	42.1	27.5	5.7	32.7	-	42.5	73.9	31.4	
Vert.	4960.000	PK	41.1	31.6	7.0	31.6	-	48.1	73.9	25.8	Floor noise
Vert.	7440.000	PK	42.5	36.3	8.3	32.7	-	54.4	73.9	19.5	Floor noise
Vert.	9920.000	PK	41.5	38.9	9.1	33.5	-	56.1	73.9	17.8	Floor noise
Vert.	2483.500	AV	30.6	27.5	5.7	32.7	-	31.0	53.9	22.9	
Vert.	4960.000	AV	29.0	31.6	7.0	31.6	-	35.9	53.9	18.0	Floor noise
Vert.	7440.000	AV	30.8	36.3	8.3	32.7	-	42.7	53.9	11.2	Floor noise
Vert.	9920.000	AV	29.9	38.9	9.1	33.5	-	44.5	53.9	9.5	Floor noise

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

*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 (4 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

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Ise EMC Lab.

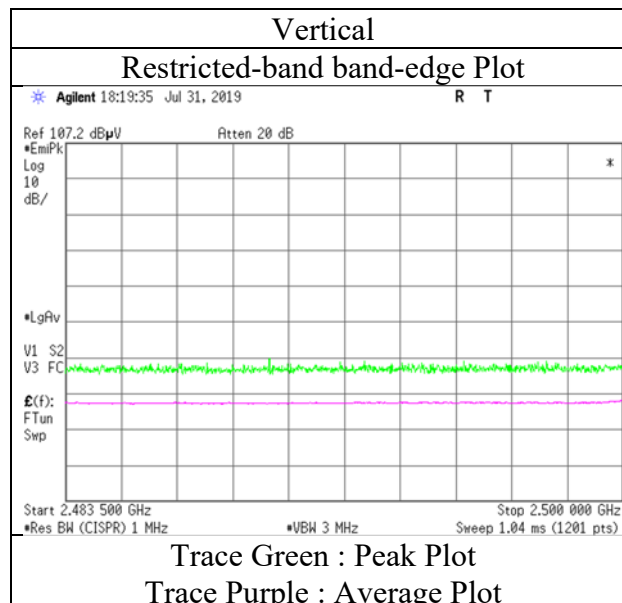
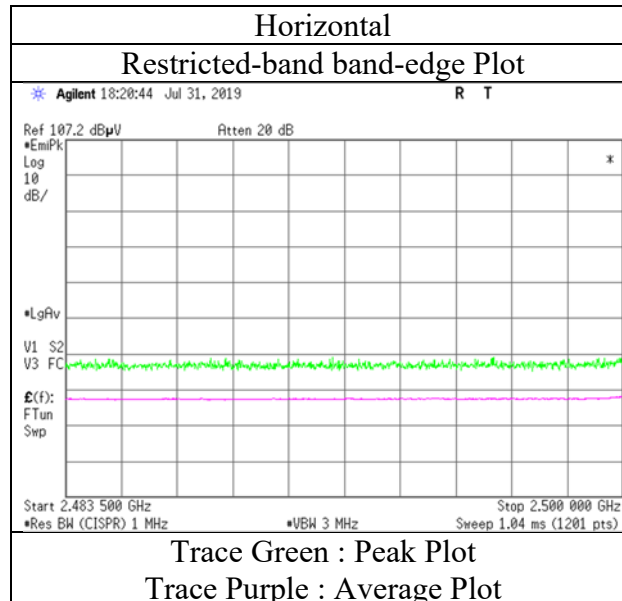
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Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13198340H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	June 17, 2020
Temperature / Humidity	22 deg. C / 55 % RH
Engineer	Takeshi Hiyaji
	(1 GHz - 10 GHz)
Mode	Tx, Hopping Off, 3DH5 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.

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Ise EMC Lab.

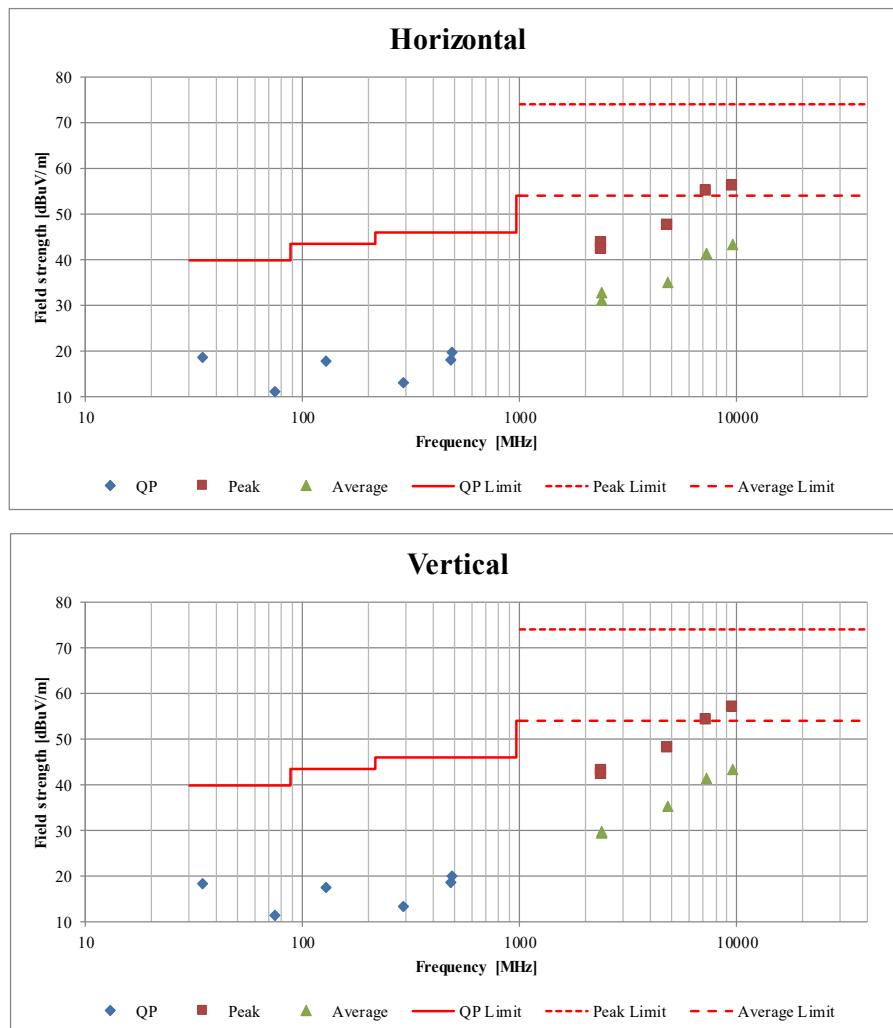
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Telephone : +81 596 24 8999

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Radiated Spurious Emission **(Plot data, Worst case)**

Report No.	13198340H	No.3	No.3
Test place	Ise EMC Lab.	June 17, 2020	June 18, 2020
Semi Anechoic Chamber	No.3	June 17, 2020	June 18, 2020
Date	June 17, 2020	June 17, 2020	June 18, 2020
Temperature / Humidity	22 deg. C / 55 % RH	22 deg. C / 55 % RH	23 deg. C / 52 % RH
Engineer	Takeshi Hiyaji (1 GHz - 10 GHz)	Tomohisa Nakagawa (10 GHz - 18 GHz)	Ken Fujita (18 GHz - 26.5 GHz) (Below 1 GHz)
Mode	Tx, Hopping Off, 3DH5 2402 MHz		

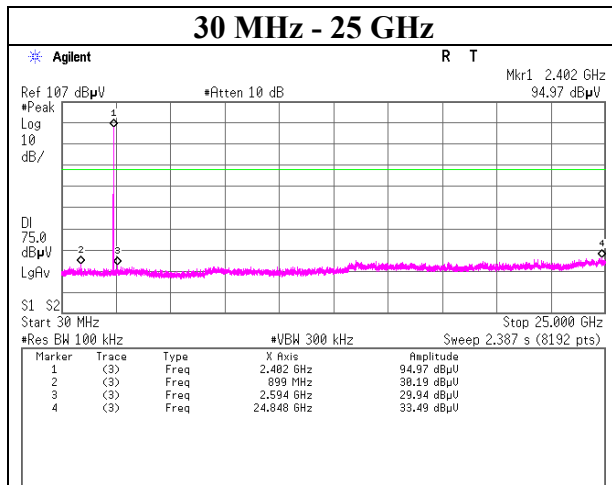
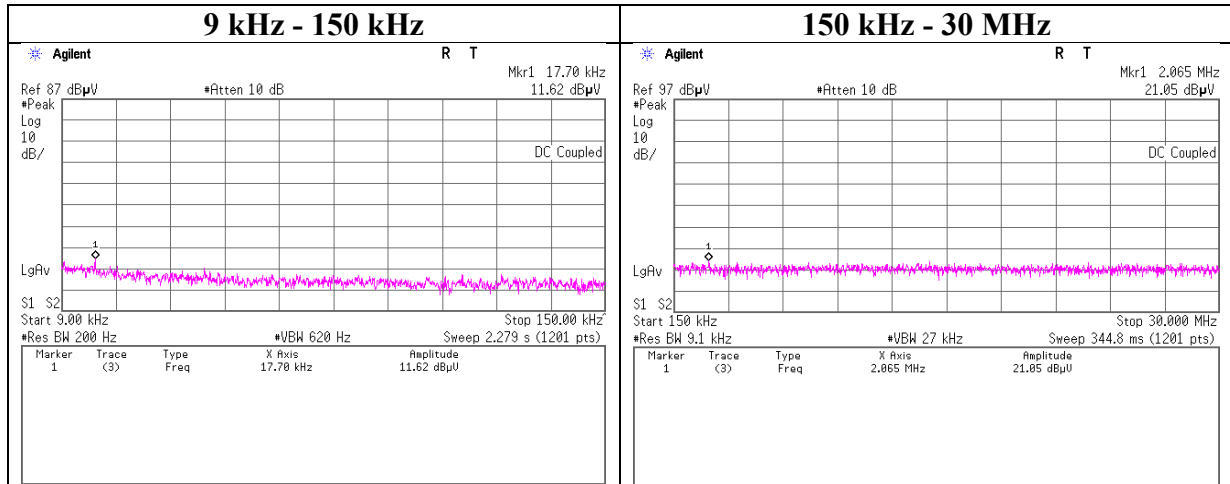


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, Hopping Off, DH5

2402 MHz



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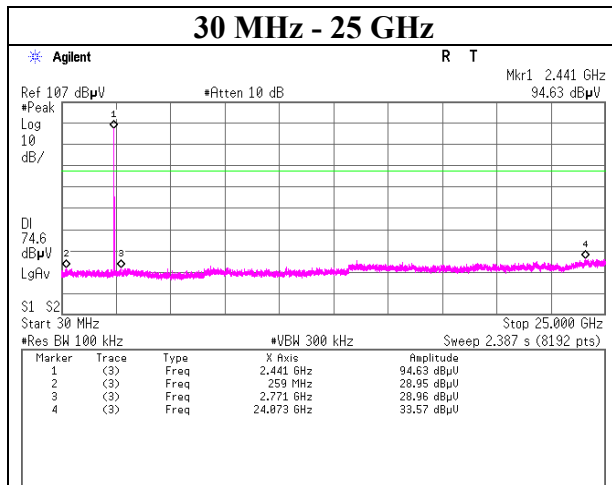
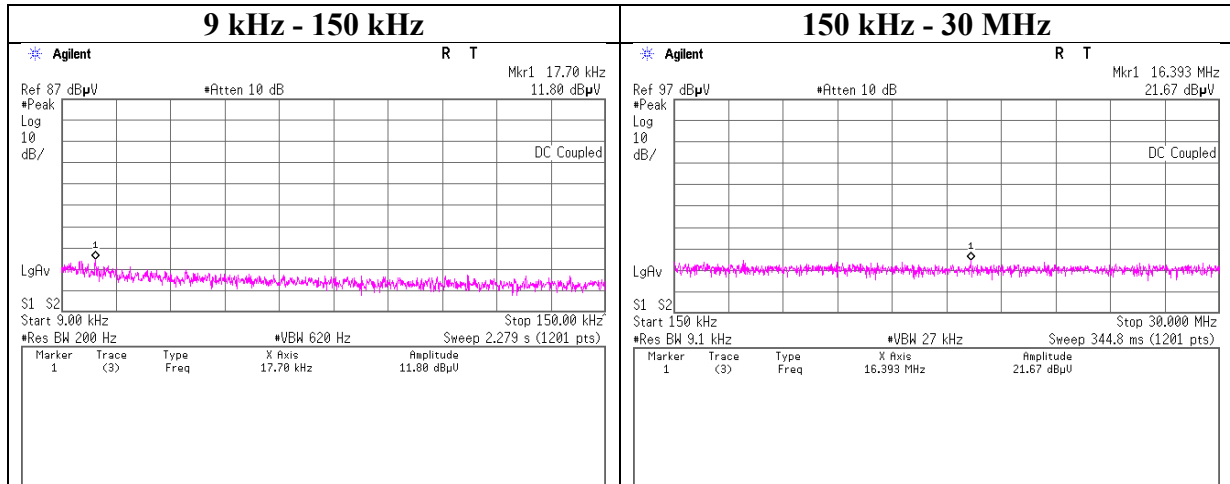
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, Hopping Off, DH5

2441 MHz



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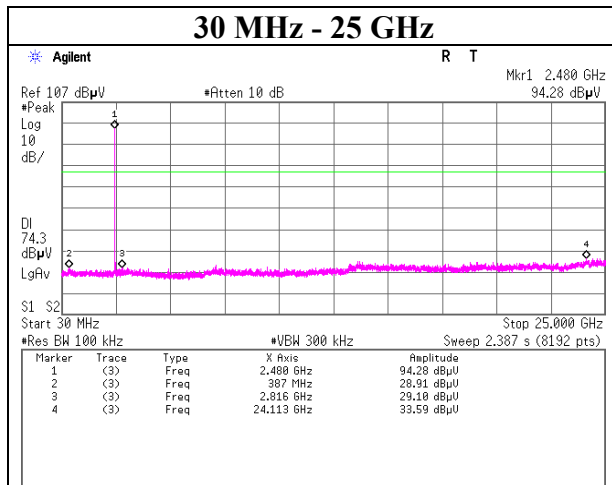
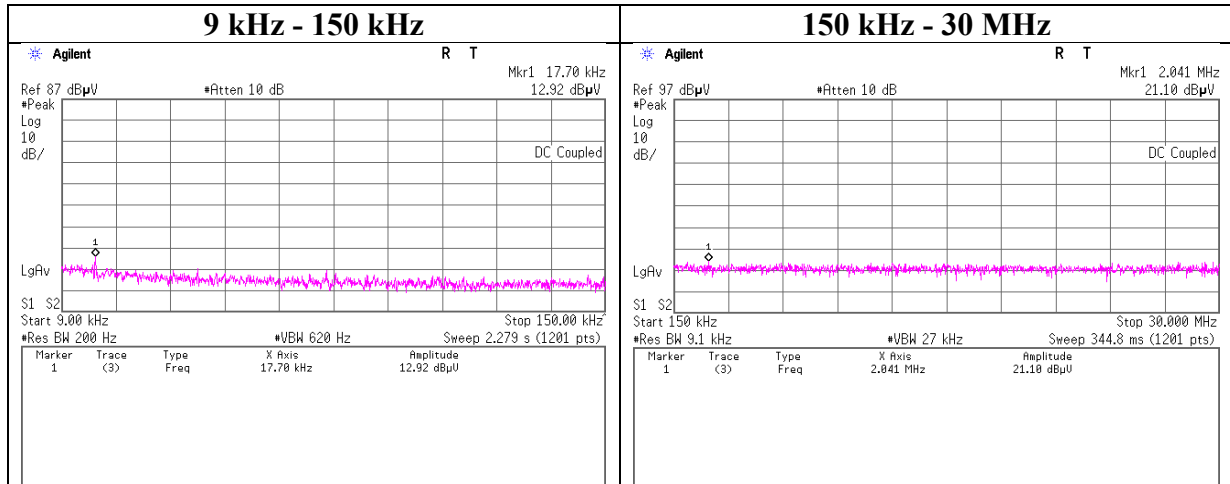
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, Hopping Off, DH5

2480 MHz



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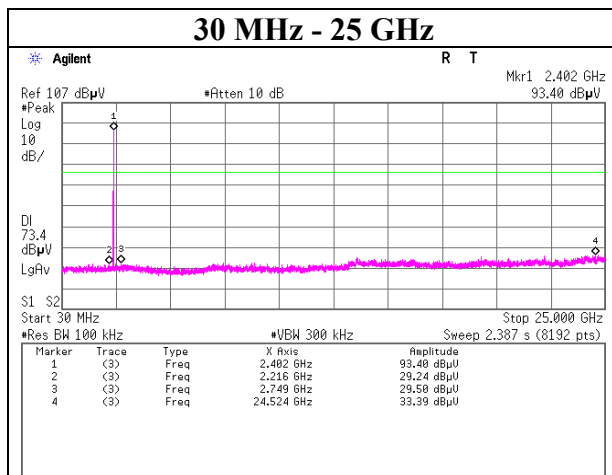
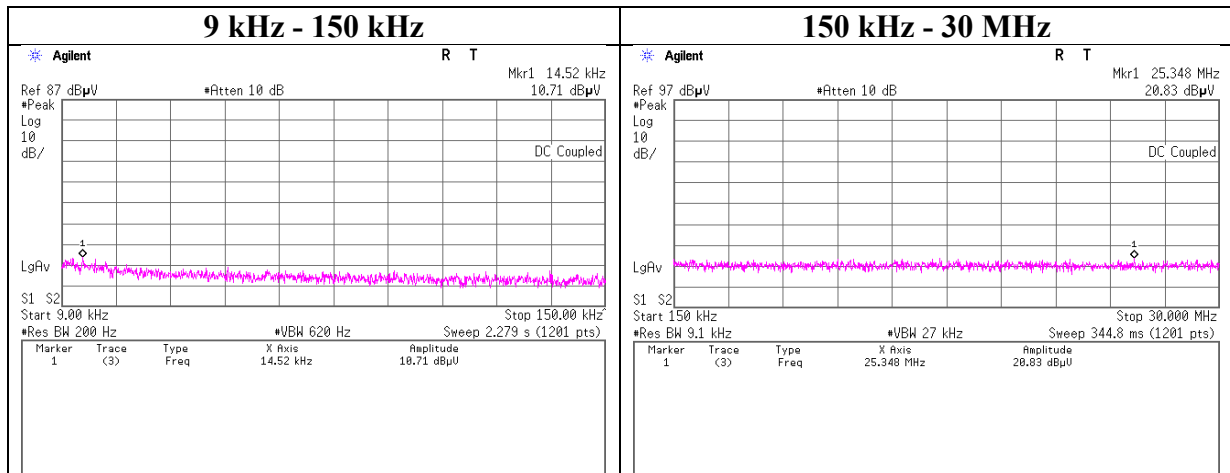
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No. 13198340H
Test place Ise EMC Lab. No.8 Measurement Room
Date June 15, 2020
Temperature / Humidity 24 deg. C / 68 % RH
Engineer Hiroyuki Furutaka
Mode Tx, Hopping Off, 3DH5

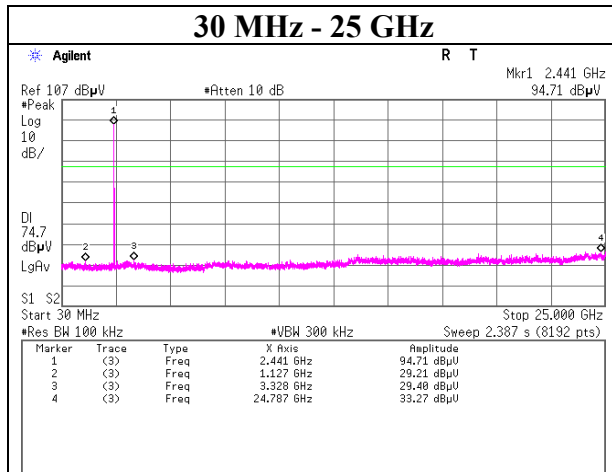
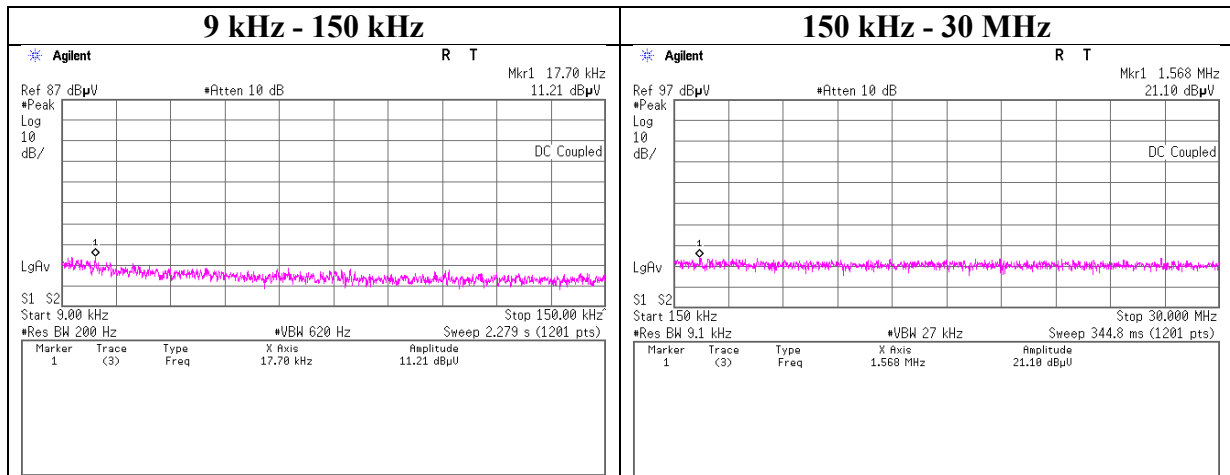
2402 MHz



Conducted Spurious Emission

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, Hopping Off, 3DH5

2441 MHz



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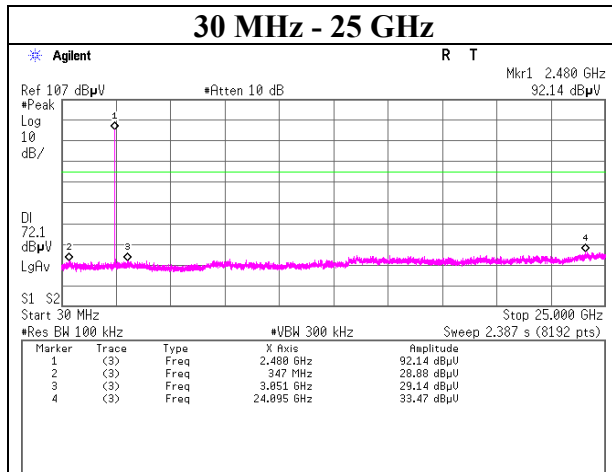
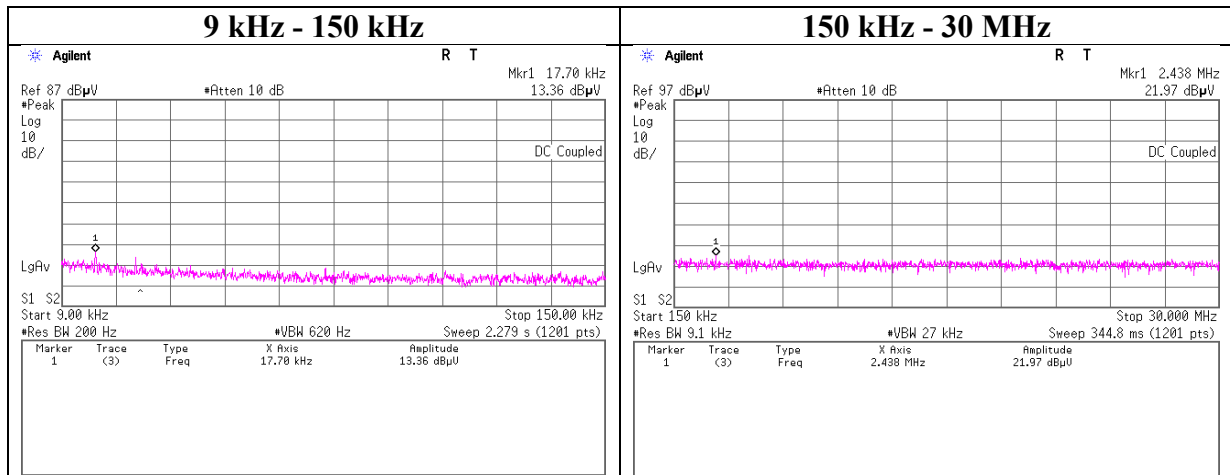
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

Conducted Spurious Emission

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, Hopping Off, 3DH5

2480 MHz



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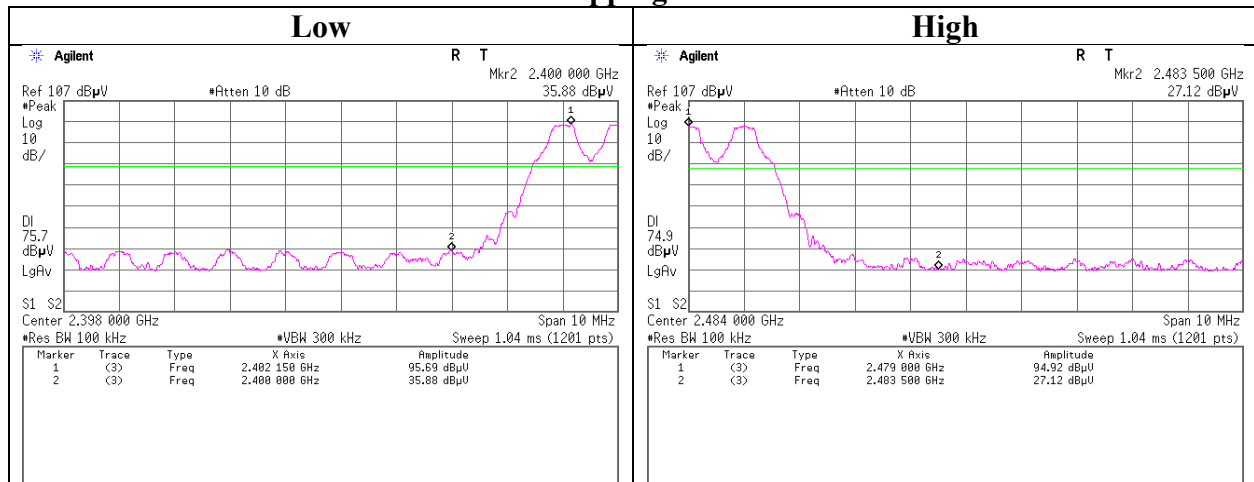
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

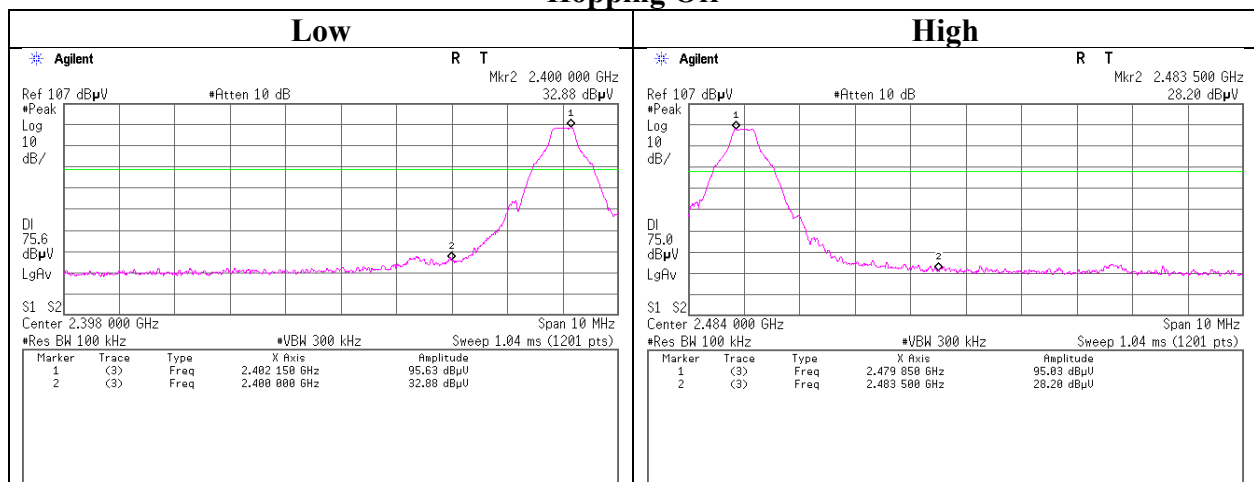
Conducted Emission Band Edge compliance

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, DH5

Hopping On



Hopping Off



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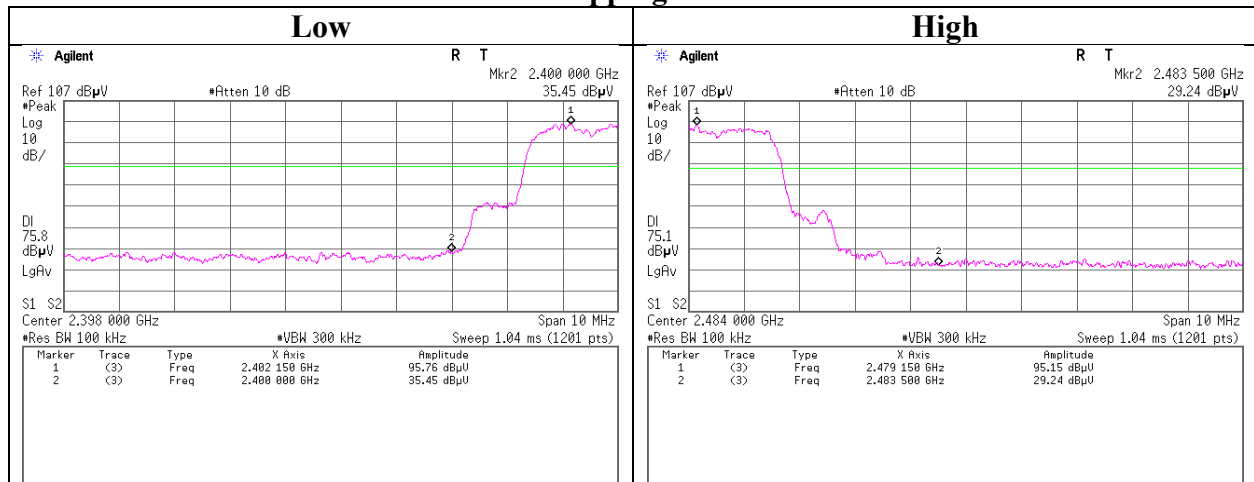
Telephone : +81 596 24 8999

Facsimile : +81 596 24 8124

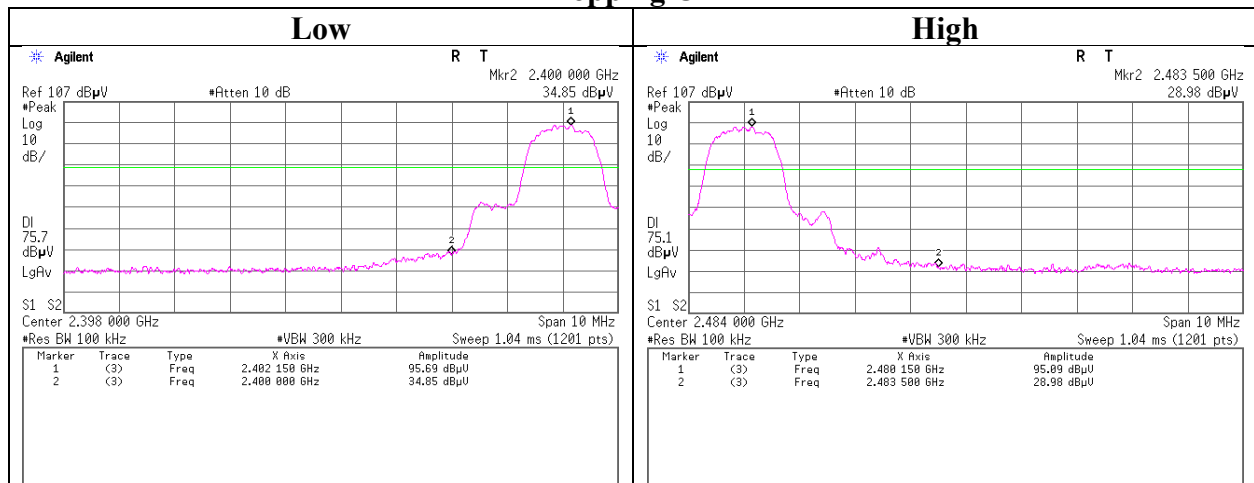
Conducted Emission Band Edge compliance

Report No.	13198340H
Test place	Ise EMC Lab. No.8 Measurement Room
Date	June 15, 2020
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Hiroyuki Furutaka
Mode	Tx, 3DH5

Hopping On



Hopping Off



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APPENDIX 2: Test instruments

Test equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	MAEC-03	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/22/2020	24
RE	MOS-13	141554	Thermo-Hygrometer	CUSTOM	CTH-201	1301	01/07/2020	12
RE	MMM-08	141532	DIGITAL HiTESTER	Hioki	3805	51201197	01/06/2020	12
RE	MJM-16	142183	Measure	KOMELON	KMC-36	-	-	-
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAEC-03-SVSWR	142013	AC3_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	04/08/2019	24
RE	MHA-20	141507	Horn Antenna 1-18GHz	Schwarzbeck Mess - Elektronik	BBHA9120D	258	09/26/2019	12
RE	MCC-231	177964	Microwave Cable	Junkosha INC.	MMX221	1901S329(1m)/1902S579(5m)	03/02/2020	12
RE	MPA-11	141580	MicroWave System Amplifier	Keysight Technologies Inc	83017A	MY39500779	03/24/2020	12
RE	MSA-10	141899	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY46180655	08/07/2019	12
RE	MHF-25	141232	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	001	09/11/2019	12
RE	MAT-95	142314	Attenuator	Pasternack	PE7390-6	D/C 1504	06/05/2020	12
RE	MBA-03	141424	Biconical Antenna	Schwarzbeck Mess - Elektronik	VHA9103+BBA9106	1915	08/24/2019	12
RE	MCC-51	141323	Coaxial cable	UL Japan	-	-	07/02/2019	12
RE	MLA-22	141266	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess - Elektronik	VUSLP9111B	9111B-191	08/24/2019	12
RE	MPA-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/10/2020	12
AT	MCC-244	197219	Microwave cable	HUBER+SUNER	SF126E/11PC35/11PC35/2000MM	536999/126E	03/23/2020	12
AT	MPSE-17	141830	Power sensor	ANRITSU	MA2411B	738285	05/07/2020	12
AT	MPM-12	141809	Power Meter	ANRITSU	ML2495A	825002	05/07/2020	12
AT	MSA-15	141902	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187105	10/09/2019	12
AT	MAT-57	141333	Attenuator(10dB)	Suhner	6810.19.A	-	12/09/2019	12
AT	MOS-28	141567	Thermo-Hygrometer	CUSTOM	CTH-201	0008	01/07/2020	12
RE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	03/10/2020	12

*Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.

The expiration date of the calibration is the end of the expired month.

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

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

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

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