RADIO TEST REPORT

Test Report No. : 12804674H-B-R2

Applicant	:	**DENSO Corporation**
Type of Equipment	:	**Control Box**
Model No.	:	**DNNS097**
FCC ID	:	**HYQDNNS097**
Test regulation	:	**FCC Part 15 Subpart C: 2019** ***Bluetooth (except for Low Energy) part**
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 Federal Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 12804674H-B-R1. 12804674H-B-R1 is replaced with this report.

Date of test: August 3 to 10, 2019

Representative test engineer:
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Approved by:
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Consumer Technology Division

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REVISION HISTORY

Original Test Report No.: 12804674H-B

Revision	Test report No.	Date	Page revised	Contents
- (Original)	12804674H-B	October 10, 2019	-	-
1	12804674H-B-R1	November 19, 2019	P.6	- Deletion of Clock frequency(ies) in the system - Addition of Clock frequency (maximum) in Radio Specification
1	12804674H-B-R1	November 19, 2019	P.12	Correction of Cable No. 5 and 12 information: - Cable's shield: from Shielded to Unshielded
1	12804674H-B-R1	November 19, 2019	P.16	Correction of 99 % Occupied Bandwidth data: Hopping On mode DH5: from 78708.2 to 78602.2 3DH5: from 78602.2 to 78708.2
2	12804674H-B-R2	November 28, 2019	P.12	Correction of Name of Cable No.12 from Signal Cable to Signal and DC Cable

Reference: Abbreviations (Including words undescribed in this report)

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

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SECTION 1: Customer information

Company Name	:	DENSO Corporation
Address	:	1-1 Showa-cho, Kariya-shi, Aichi-ken 448-8661, Japan
Telephone Number	:	+81-566-26-5919
Facsimile Number	:	+81-566-25-4920
Contact Person	:	Isamu Suzuki

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	:	Control Box
Model No.	:	DNNS097
Serial No.	:	Refer to SECTION 4.2
Rating	:	DC 12 V
Receipt Date of Sample (Information from test lab.)	:	July 24, 2019
Country of Mass-production	:	United States of America
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: DNNS097 (referred to as the EUT in this report) is a Control Box.

Feature of EUT:
Operating Temperature : -30 deg. C to +70 deg. C

Radio Specification

Clock frequency (Maximum) : 37.4 MHz (Bluetooth and Wi-Fi Module IC)

	IEEE802.11b	IEEE802.11g/n (20 M band)	IEEE802.11a/n/ac (20 M band)	IEEE802.11n/ac (40 M band)	IEEE802.11ac (80 M band)
Frequency of operation	2412 MHz - 2462 MHz	2412 MHz - 2462 MHz	(USA) 5180 MHz - 5825 MHz (CANADA) 5280 MHz - 5580 MHz 5660 MHz - 5825 MHz	(USA) 5190 MHz - 5795 MHz (CANADA) 5310 MHz - 5550 MHz 5670 MHz - 5795 MHz	(USA) 5210 MHz - 5775 MHz (CANADA) 5530 MHz 5690 MHz - 5775 MHz
Type of modulation	DSSS/CCK (DQPSK, DBPSK)	OFDM (64QAM, 16QAM, QPSK, BPSK)	OFDM (64QAM, 16QAM, QPSK, BPSK, 256QAM(IEEE802.11ac only))		
Channel spacing	5 MHz		20 MHz	40 MHz	80 MHz
Antenna type	ASSEMBLY WiFi Antenna				
Antenna Connector type	MHF PLUG				
Antenna Gain	-2.9 dBi (max.)				

	GPS/GLONASS	Bluetooth Ver.4.2 with EDR function *1)
Frequency of operation	GPS: 1575.42 MHz GLONASS: 1598.0625 MHz - 1605.375 MHz	2402 MHz - 2480 MHz
Type of modulation	GPS: BPSK GLONASS: FDMA	BT: FHSS (GFSK, π/4-DQPSK, 8-DPSK) LE: GFSK
Channel spacing	-	BT: 1 MHz LE: 2 MHz
Antenna type	External Antenna	ASSEMBLY BT Antenna
Antenna Connector type	FAKRA	MHF PLUG
Antenna Gain	26.5 dBic	-2.9 dBi (max.)

*1) This test report applies to Bluetooth (except for Low Energy).

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 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.247 Operation within the bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz

* The revisions made after testing date do not affect the test specification applied to the EUT.

3.2 Procedures and results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Conducted Emission	**FCC:** ANSI C63.10-2013 6. Standard test methods **IC:** RSS-Gen 8.8	**FCC:** Section 15.207 **IC:** RSS-Gen 8.8	N/A	N/A	*1)
Carrier Frequency Separation	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **IC:** -	**FCC:** Section15.247(a)(1) **IC:** RSS-247 5.1 (b)	See data.	Complied a)	Conducted
20dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **IC:** -	**FCC:** Section15.247(a)(1) **IC:** RSS-247 5.1 (a)		Complied a)	Conducted
Number of Hopping Frequency	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **IC:** -	**FCC:** Section15.247(a)(1)(iii) **IC:** RSS-247 5.1 (d)		Complied b)	Conducted
Dwell time	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **IC:** -	**FCC:** Section15.247(a)(1)(iii) **IC:** RSS-247 5.1 (d)		Complied c)	Conducted
Maximum Peak Output Power	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **IC:** RSS-Gen 6.12	**FCC:** Section15.247(a)(b)(1) **IC:** RSS-247 5.4 (b)		Complied d)	Conducted
Spurious Emission & Band Edge Compliance	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **IC:** RSS-Gen 6.13	**FCC:** Section15.247(d) **IC:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	8.6 dB 599.968 MHz, QP, Hori.	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 15.31 (e)
The EUT provides stable voltage constantly to the wireless transmitter regardless of input voltage.
Instead of a new battery, DC power supply was used for the test.
That does not affect the test result, therefore the 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 vehicle. 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	**IC:** -	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

EMI

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.
Ise EMC Lab.

Antenna Terminal test

Test Item	Uncertainty (+/-)
20 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %
Maximum Peak Output Power / Average Output Power	1.3 dB
Carrier Frequency Separation	0.42 %
Dwell time / Burst rate	0.10 %
Conducted Spurious Emission	2.7 dB

Conducted emission

using Item	Frequency range	Uncertainty (+/-)
AMN (LISN)	0.009 MHz to 0.15 MHz	3.8 dB
	0.15 MHz to 30 MHz	3.4 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)	4.8 dB
	(Vertical)	5.0 dB
	200 MHz to 1000 MHz (Horizontal)	5.2 dB
	(Vertical)	6.3 dB
10 m	30 MHz to 200 MHz (Horizontal)	4.8 dB
	(Vertical)	4.9 dB
	200 MHz to 1000 MHz (Horizontal)	5.0 dB
	(Vertical)	5.0 dB
3 m	1 GHz to 6 GHz	5.0 dB
	6 GHz to 18 GHz	5.3 dB
1 m	10 GHz to 26.5 GHz	5.8 dB
	26.5 GHz to 40 GHz	5.8 dB
10 m	1 GHz to 18 GHz	5.2 dB

3.5 Test Location

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Test site	IC Registration Number	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	2973C-1	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	2973C-2	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	2973C-3	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	2973C-4	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.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 m 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)

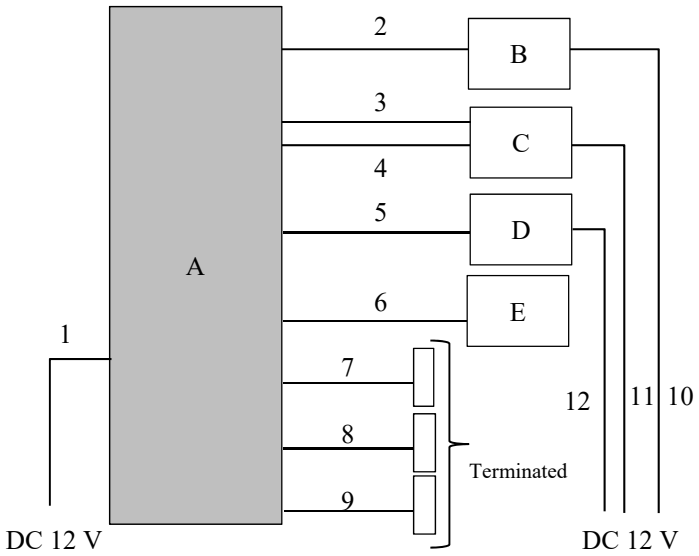
Test Item	Mode	Tested frequency
Spurious Emission (Conducted/Radiated)	Tx (Hopping Off) DH5, 3DH5	2402 MHz 2441 MHz 2480 MHz
Carrier Frequency Separation	Tx (Hopping On) DH5, 3DH5	2402 MHz 2441 MHz 2480 MHz
20dB Bandwidth	Tx (Hopping Off) DH5, 3DH5	2402 MHz 2441 MHz 2480 MHz
Number of Hopping Frequency	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 test items based on Bluetooth Core specification.

*EUT has the power settings by the software as follows;
Power settings: BDR/EDR: 0 dBm
Software: TYAA BT Validation V1.0.0.0

*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.

4.2 Configuration and peripherals



*Cabling and setup 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	Control Box	DNNS097	No.2 for RE* No.1 for AT*	DENSO CORPORATION	EUT
B	Display	39710-TYAA-A010-M1	M17007A-ES1	Panasonic Corporation	-
C	Jig	cPhy	No.6	MICROCHIP	-
D	Touch Pad	-	-	VISTEON CORPORATION	-
E	GPS Antenna	V3-000624	No.6	Yokowo Co.,Ltd	-

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	2.0	Unshielded	Unshielded	-
2	Display Cable	1.0	Shielded	Shielded	-
3	Signal Cable	1.0	Shielded	Shielded	-
4	Signal Cable	1.0	Shielded	Shielded	-
5	Signal Cable	2.0	Unshielded	Unshielded	-
6	GPS Antenna Cable	2.0	Shielded	Shielded	-
7	USB Cable	1.0	Shielded	Shielded	-
8	USB Cable	1.0	Shielded	Shielded	-
9	USB Cable	1.0	Shielded	Shielded	-
10	DC Cable	2.0	Unshielded	Unshielded	-
11	DC Cable	2.0	Unshielded	Unshielded	-
12	Signal and DC Cable	2.0	Unshielded	Unshielded	-

SECTION 5: Radiated Spurious Emission

Test Procedure

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 1.5 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 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

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

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

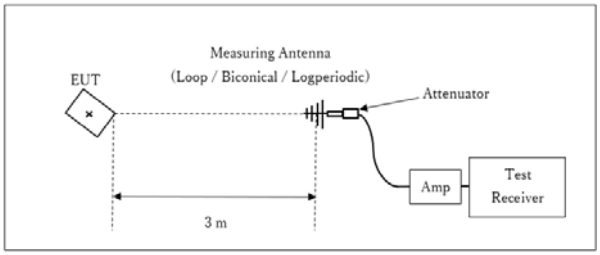
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9 (IC) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (IC).

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

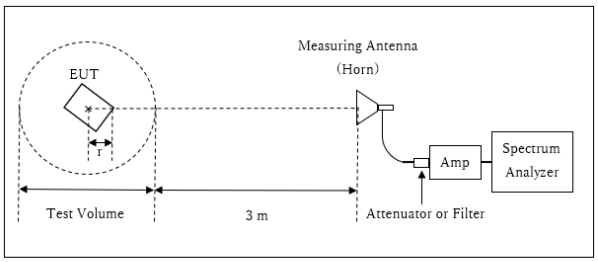
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



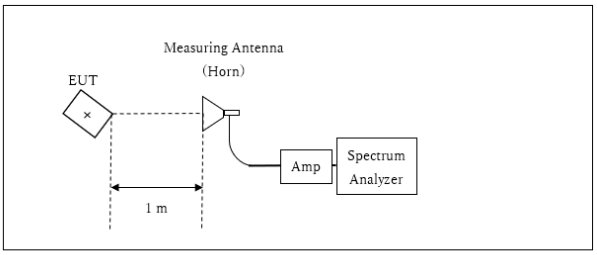
r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (4.0 m / 3.0 m) = 2.5dB
* Test Distance: (3 + Test Volume /2) - r = 4.0 m

Test Volume : 2.0 m
(Test Volume has been calibrated based on CISPR 16-1-4.)
r = 0.0m

* 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 x log (1.0 m / 3.0 m) = -9.5 dB
*Test Distance: 1 m

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

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

Measurement range : 30 MHz - 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	2 to 5 times of OBW	1 to 5 % of OBW	3 times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth *1)	1.5 to 5 times of OBW	1 to 5 % of OBW	3 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

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

Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, Tx, Hopping On

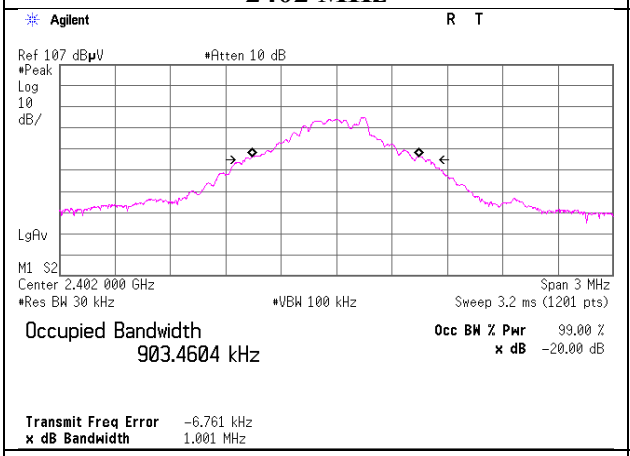
Mode	Freq. [MHz]	20dB Bandwidth [MHz]	99% Occupied Bandwidth [kHz]	Carrier Frequency Separation [MHz]	Limit for Carrier Frequency separation [MHz]
DH5	2402.0	1.001	903.460	1.000	>= 0.667
DH5	2441.0	1.009	905.253	1.000	>= 0.673
DH5	2480.0	0.972	903.002	1.000	>= 0.648
DH5	Hopping On	-	78602.2	-	-
3DH5	2402.0	1.319	1211.200	1.000	>= 0.879
3DH5	2441.0	1.324	1212.200	1.000	>= 0.883
3DH5	2480.0	1.317	1211.500	1.000	>= 0.878
3DH5	Hopping On	-	78708.2	-	-

Limit: Two-thirds of 20dB Bandwidth or 25kHz (whichever is greater).
No limit applies to 20dB Bandwidth.

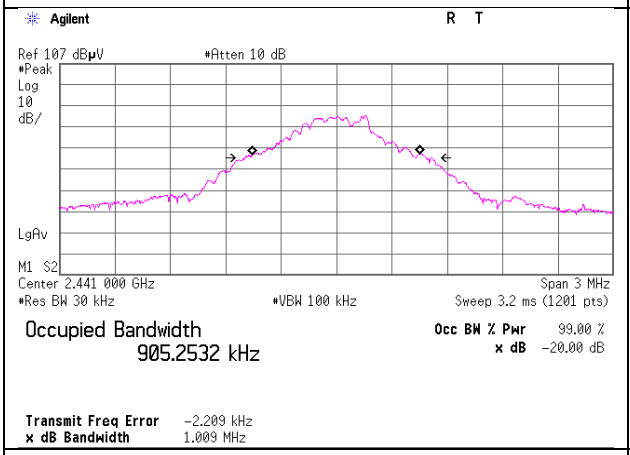
20dB Bandwidth and 99% Occupied Bandwidth

DH5

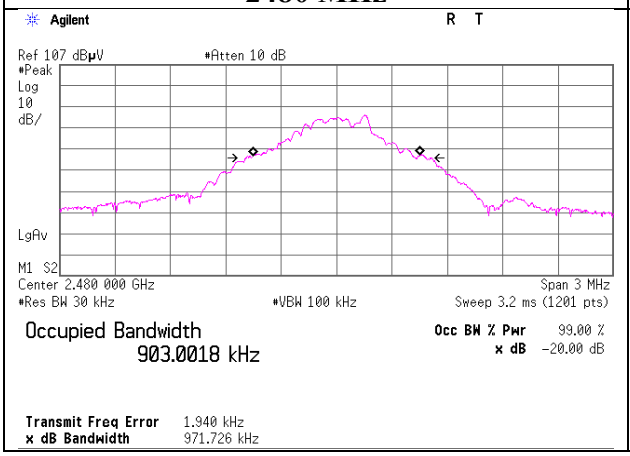
2402 MHz



2441 MHz

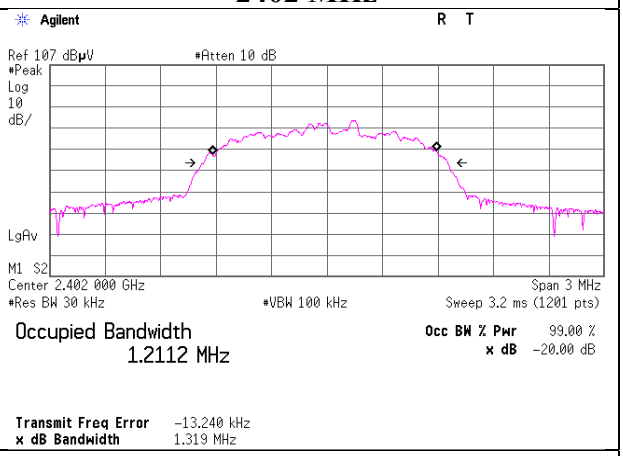


2480 MHz

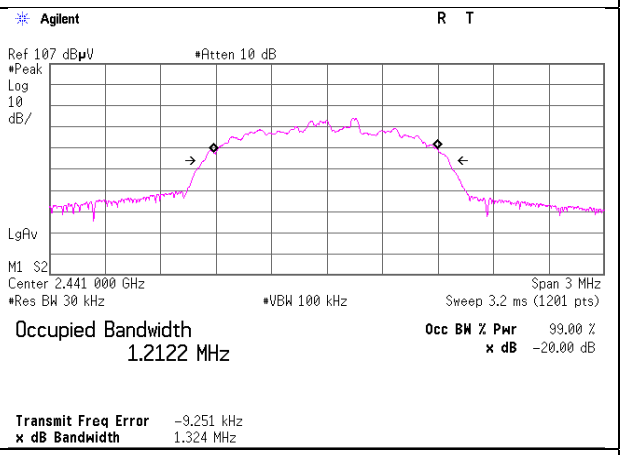


3DH5

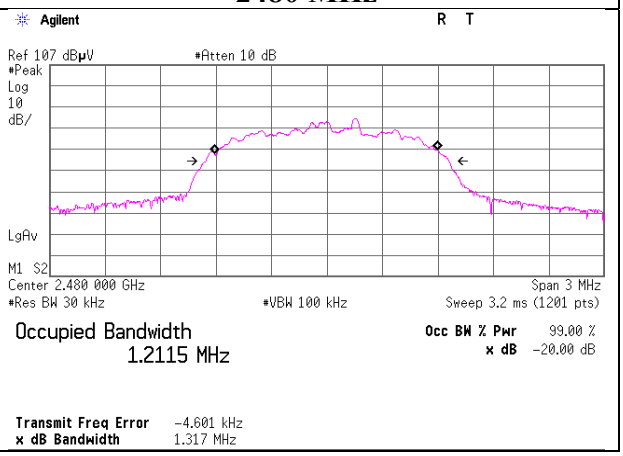
2402 MHz



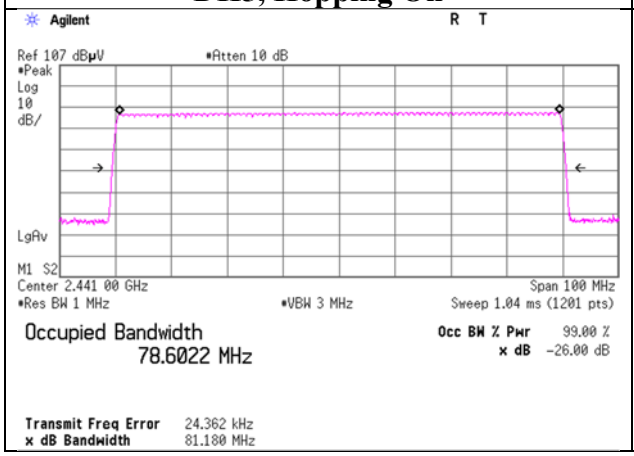
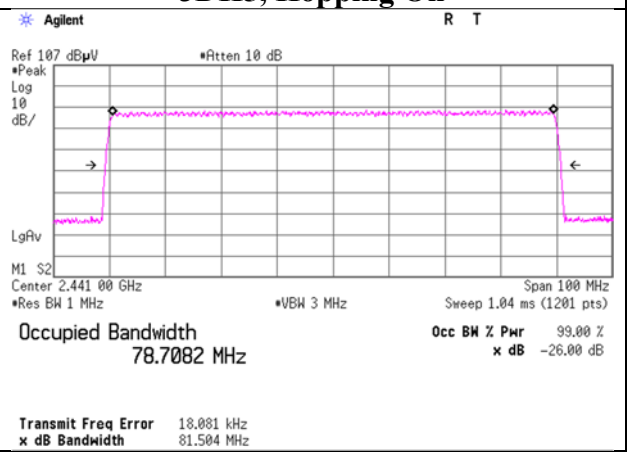
2441 MHz



2480 MHz



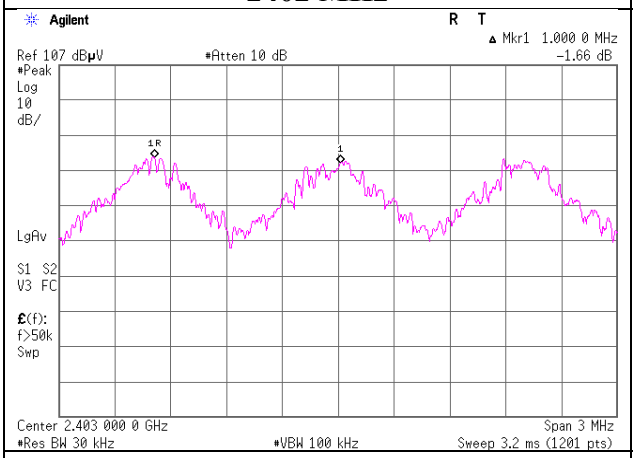
20dB Bandwidth and 99% Occupied Bandwidth

DH5, Hopping On	3DH5, Hopping On
	

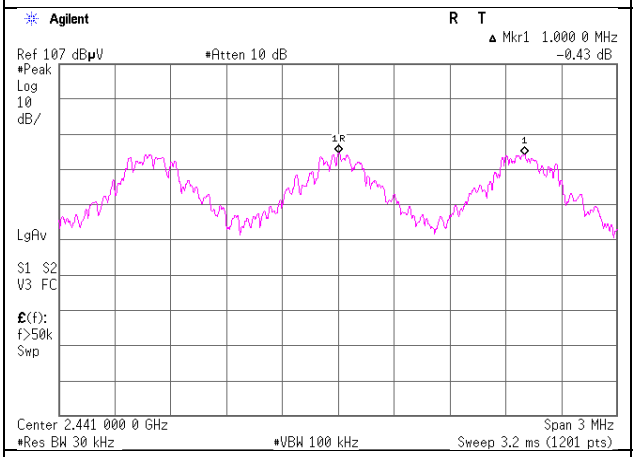
Carrier Frequency Separation

DH5

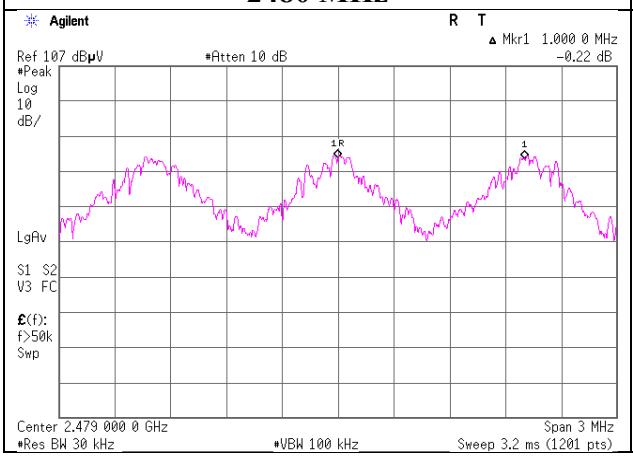
2402 MHz



2441 MHz

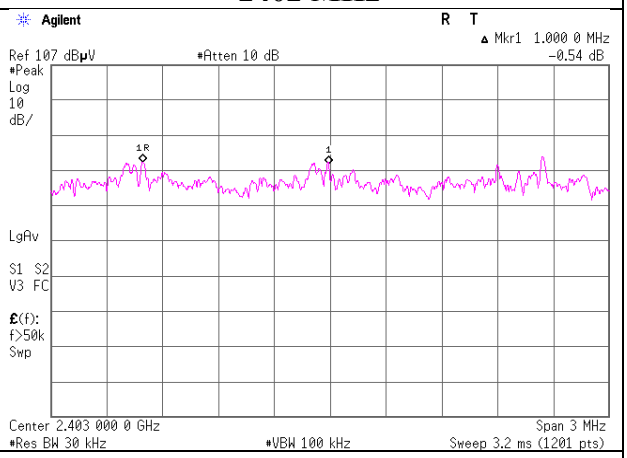


2480 MHz

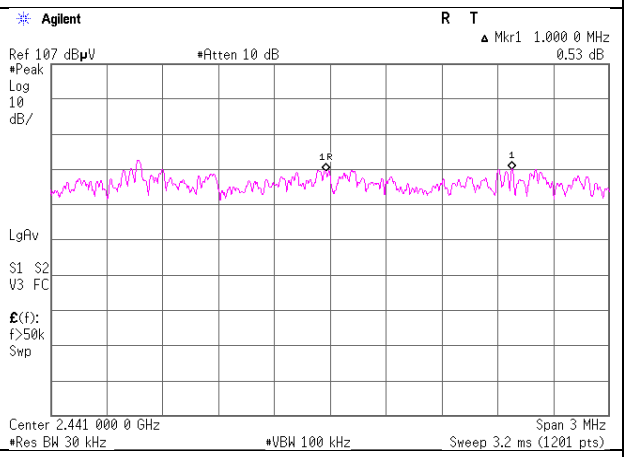


3DH5

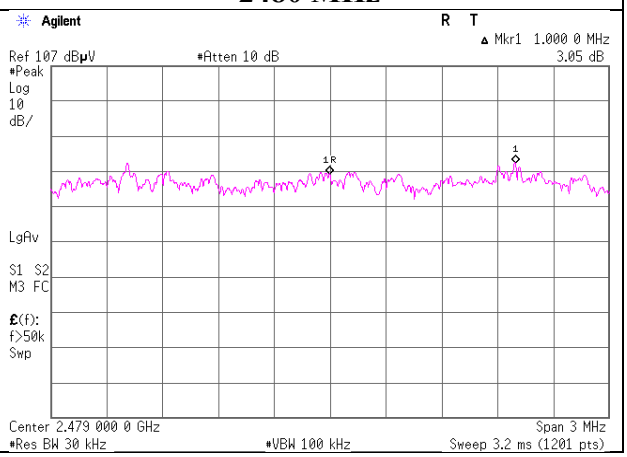
2402 MHz



2441 MHz



2480 MHz



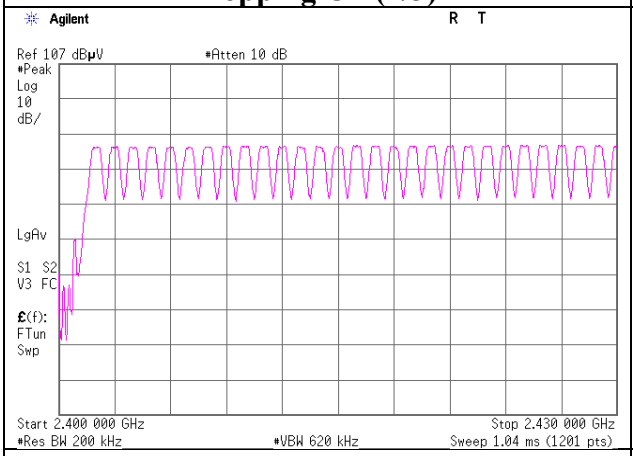
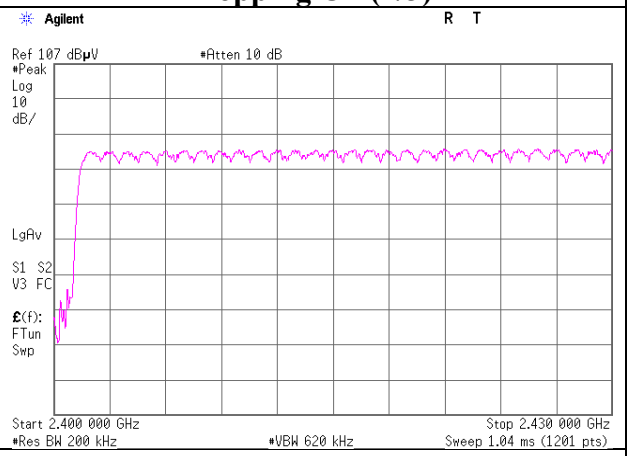
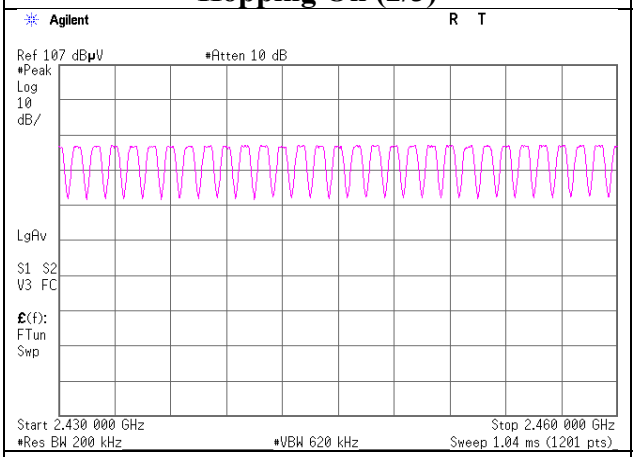
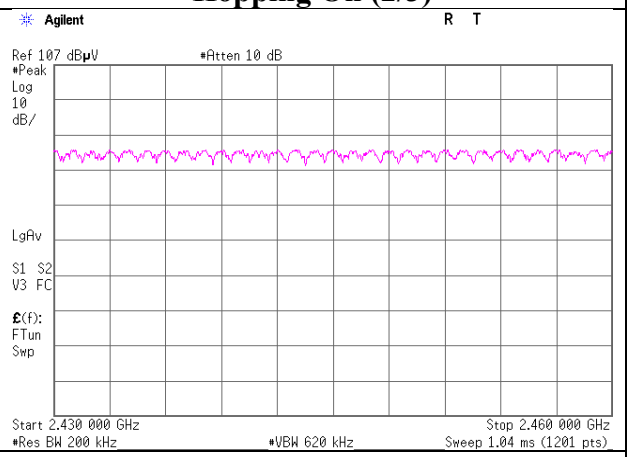
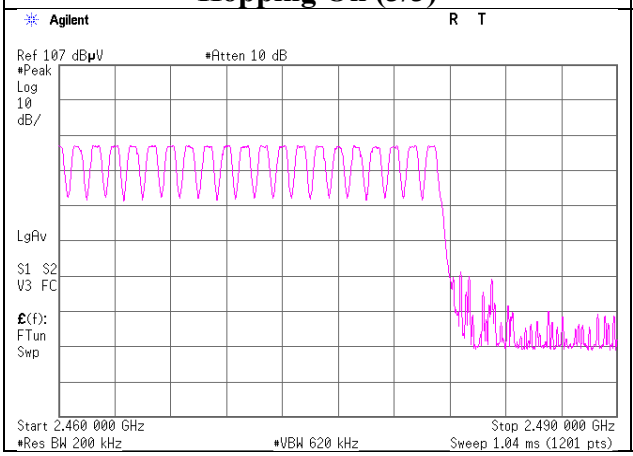
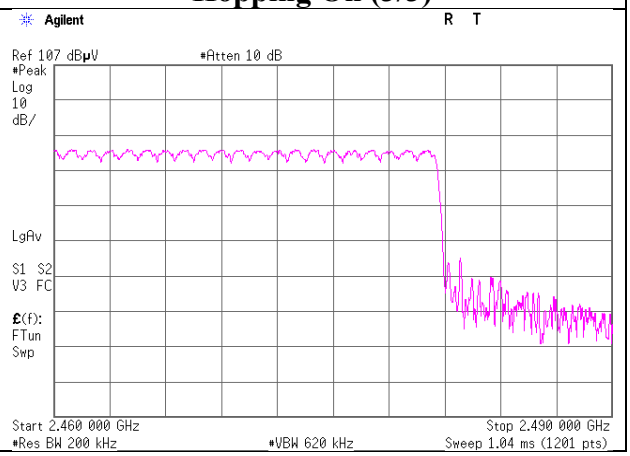
Number of Hopping Frequency

Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % 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

DH5	3DH5
Hopping On (1/3)	**Hopping On (1/3)**
	
Hopping On (2/3)	**Hopping On (2/3)**
	
Hopping On (3/3)	**Hopping On (3/3)**
	

Dwell time

Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % 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	50.0 times /	5 sec. x	31.6 sec. =	316 times	0.422	133	400
DH3	26.8 times /	5 sec. x	31.6 sec. =	170 times	1.685	287	400
DH5	21.2 times /	5 sec. x	31.6 sec. =	134 times	2.944	395	400
3DH1	50.4 times /	5 sec. x	31.6 sec. =	319 times	0.428	137	400
3DH3	26.0 times /	5 sec. x	31.6 sec. =	165 times	1.694	280	400
3DH5	21.0 times /	5 sec. x	31.6 sec. =	133 times	2.944	392	400

Sample Calculation
Result = Number of transmission x Length of transmission

*Average data of 5 tests.(except Inquiry)

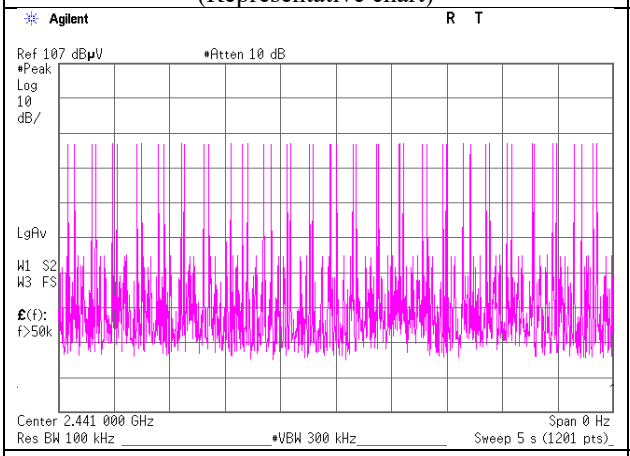
Mode	Sampling [times]					Average [times]
	1	2	3	4	5	
DH1	50	50	49	50	51	50
DH3	30	27	29	21	27	26.8
DH5	20	23	21	21	21	21.2
3DH1	50	52	51	49	50	50.4
3DH3	27	29	27	24	23	26
3DH5	23	20	22	20	20	21

Sample Calculation
Average = Summation (Sampling 1 to 5) / 5

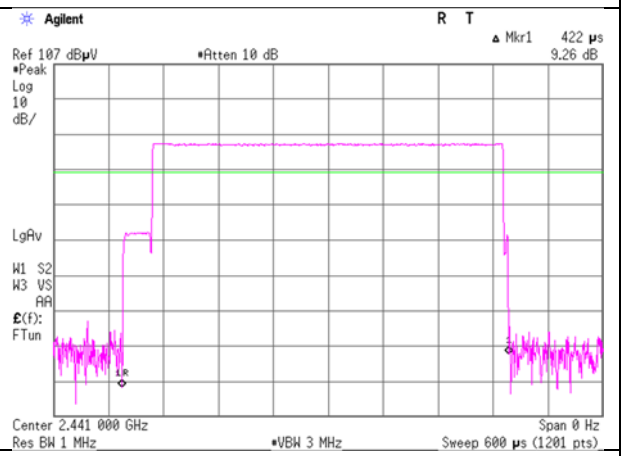
This device complies with the Bluetooth protocol for FHSS operation, employing a pseudo random channel selection and hopping rate to ensure that the occupancy time in N x 0.4s, where N is the number of channels being used in the hopping sequence ($20 \leq N \leq 79$), is always less than 0.4s regardless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

Dwell time

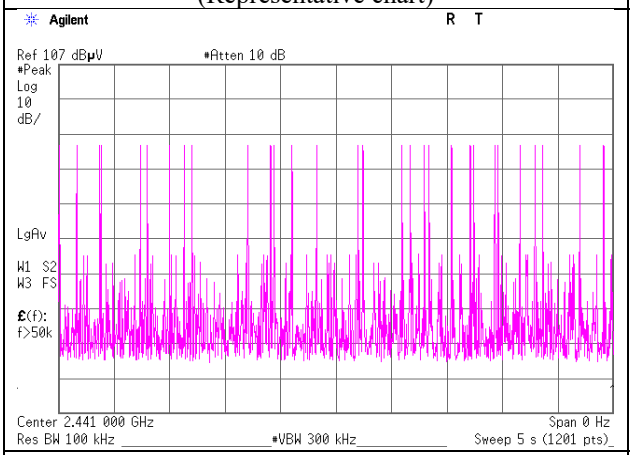
DH1 (1/2)
(Representative chart)



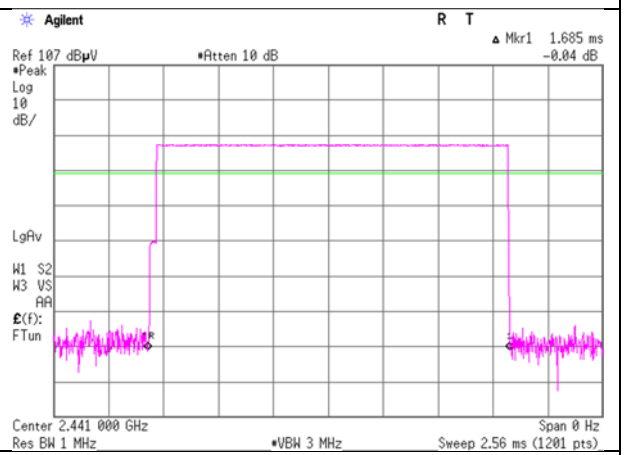
DH1 (2/2)



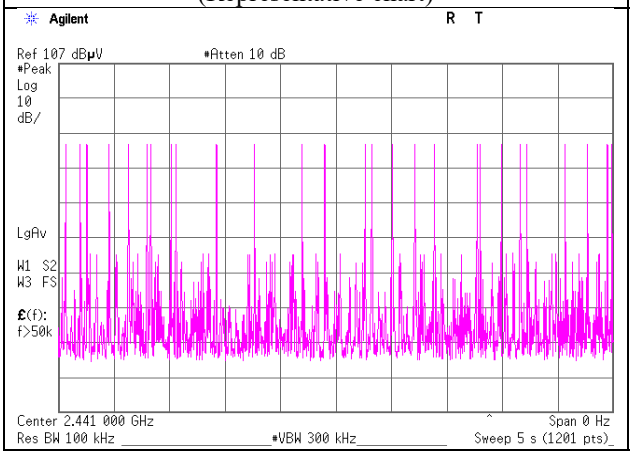
DH3 (1/2)
(Representative chart)



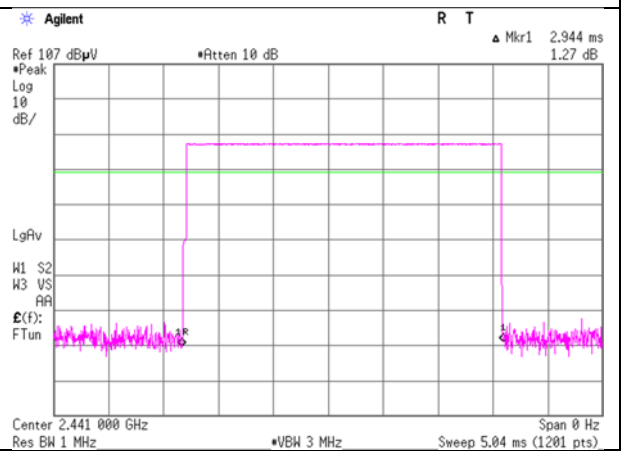
DH3 (2/2)



DH5 (1/2)
(Representative chart)

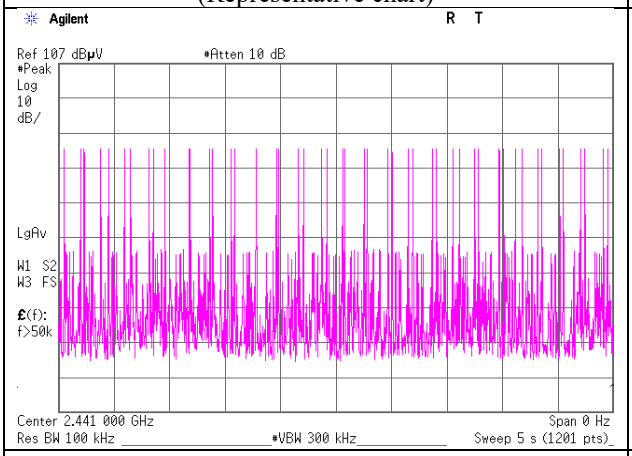


DH5 (2/2)

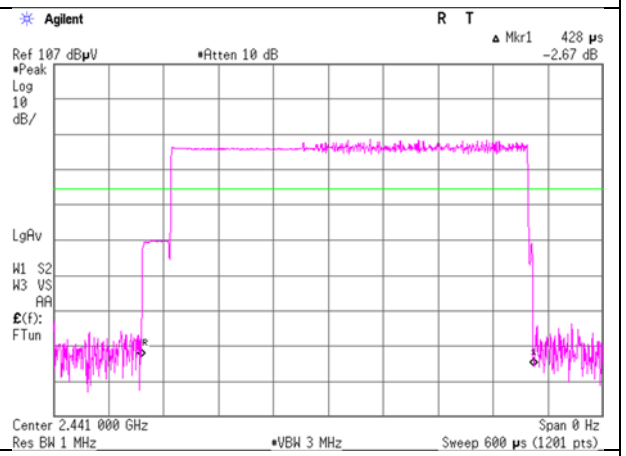


Dwell time

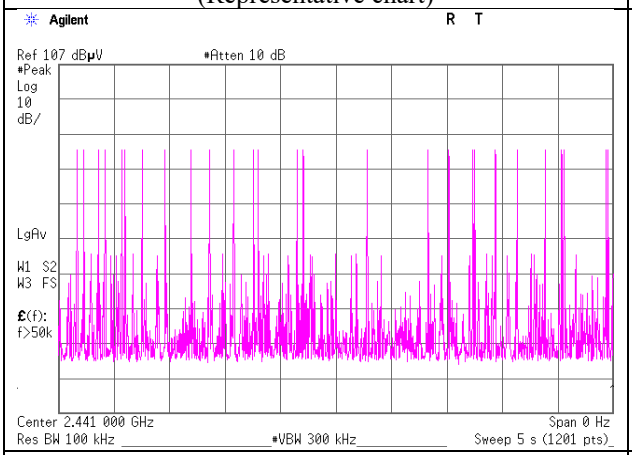
3DH1 (1/2)
(Representative chart)



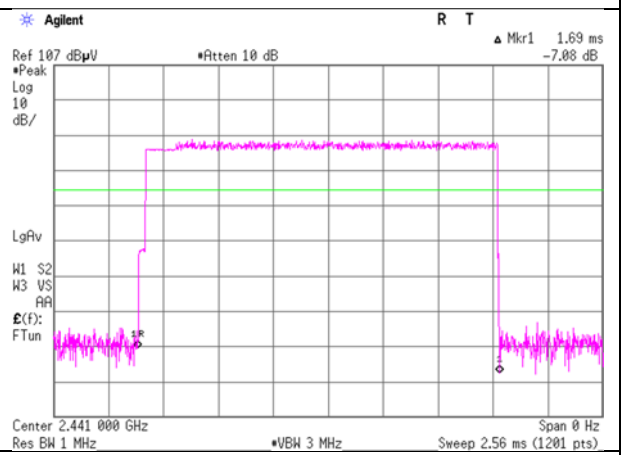
3DH1 (2/2)



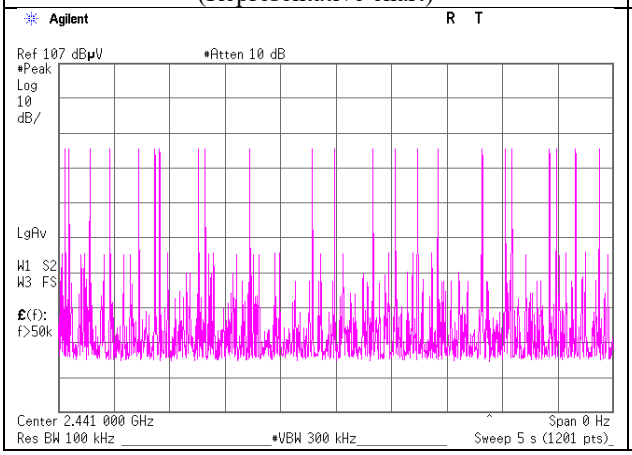
3DH3 (1/2)
(Representative chart)



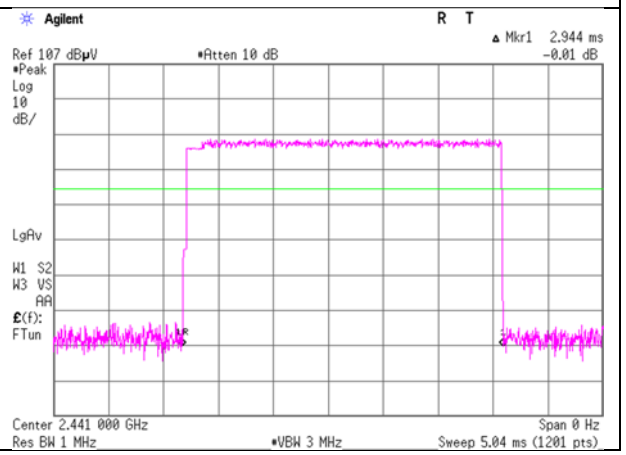
3DH3 (2/2)



3DH5 (1/2)
(Representative chart)



3DH5 (2/2)



Maximum Peak Output Power

Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 10, 2019
Temperature / Humidity	23 deg. C / 68 % RH
Engineer	Yuta Moriya
Mode	Tx, Hopping Off

					Conducted Power					e.i.r.p. for RSS-247					
Mode	Freq.	Reading	Cable Loss	Atten. Loss	Result		Limit		Margin	Antenna Gain	Result		Limit		Margin
	[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dBm]	[mW]	[dB]	[dBi]	[dBm]	[mW]	[dBm]	[mW]	[dB]
DH5	2402.0	-14.01	3.90	10.10	-0.01	1.00	20.96	125	20.97	-2.90	-2.91	0.51	36.02	4000	38.93
DH5	2441.0	-13.19	3.91	10.10	0.82	1.21	20.96	125	20.14	-2.90	-2.08	0.62	36.02	4000	38.10
DH5	2480.0	-13.16	3.91	10.10	0.85	1.22	20.96	125	20.11	-2.90	-2.05	0.62	36.02	4000	38.07
2DH5	2402.0	-12.77	3.90	10.10	1.23	1.33	20.96	125	19.73	-2.90	-1.67	0.68	36.02	4000	37.69
2DH5	2441.0	-11.77	3.91	10.10	2.24	1.67	20.96	125	18.72	-2.90	-0.66	0.86	36.02	4000	36.68
2DH5	2480.0	-11.78	3.91	10.10	2.23	1.67	20.96	125	18.73	-2.90	-0.67	0.86	36.02	4000	36.69
3DH5	2402.0	-12.22	3.90	10.10	1.78	1.51	20.96	125	19.18	-2.90	-1.12	0.77	36.02	4000	37.14
3DH5	2441.0	-11.67	3.91	10.10	2.34	1.71	20.96	125	18.62	-2.90	-0.56	0.88	36.02	4000	36.58
3DH5	2480.0	-11.56	3.91	10.10	2.45	1.76	20.96	125	18.51	-2.90	-0.45	0.90	36.02	4000	36.47

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 / SAR testing)

Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 10, 2019
Temperature / Humidity	23 deg. C / 68 % RH
Engineer	Yuta Moriya
Mode	Tx, Hopping Off

Mode	Freq.	Reading	Cable Loss	Atten. Loss	Result (Time average)		Duty factor	Result (Burst power average)	
	[MHz]	[dBm]	[dB]	[dB]	[dBm]	[mW]	[dB]	[dBm]	[mW]
DH5	2402.0	-15.74	3.90	10.10	-1.74	0.67	1.09	-0.65	0.86
DH5	2441.0	-15.12	3.91	10.10	-1.11	0.77	1.09	-0.02	1.00
DH5	2480.0	-15.01	3.91	10.10	-1.00	0.79	1.09	0.09	1.02
2DH5	2402.0	-16.91	3.90	10.10	-2.91	0.51	1.07	-1.84	0.65
2DH5	2441.0	-15.93	3.91	10.10	-1.92	0.64	1.07	-0.85	0.82
2DH5	2480.0	-15.95	3.91	10.10	-1.94	0.64	1.07	-0.87	0.82
3DH5	2402.0	-16.65	3.90	10.10	-2.65	0.54	1.09	-1.56	0.70
3DH5	2441.0	-15.92	3.91	10.10	-1.91	0.64	1.09	-0.82	0.83
3DH5	2480.0	-15.90	3.91	10.10	-1.89	0.65	1.09	-0.80	0.83

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

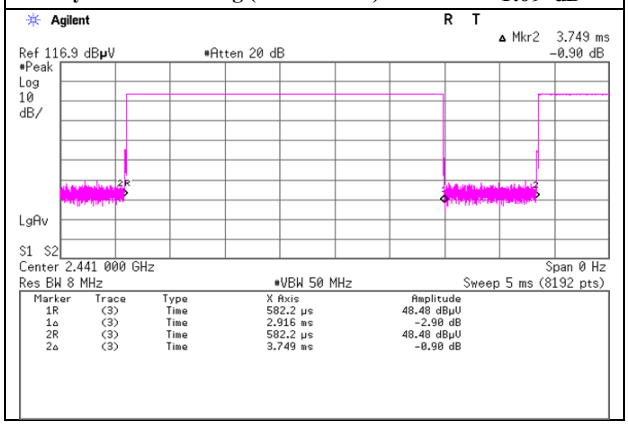
*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst Rate Confirmation

Report No.	12804674H
Test place	Ise EMC Lab. No.3 Semi Anechoic Chamber
Date	August 3, 2019
Temperature / Humidity	23 deg. C / 49 % RH
Engineer	Junki Nagatomi
Mode	Tx, Hopping Off

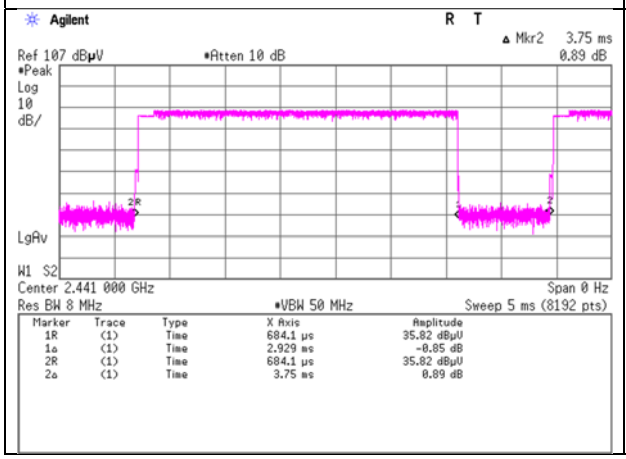
DH5

Tx on / (Tx on + Tx off) =	**0.778**
Tx on / (Tx on + Tx off) * 100 =	**77.8 %**
Duty factor = 10 * log (3.749 / 2.916) =	**1.09 dB**



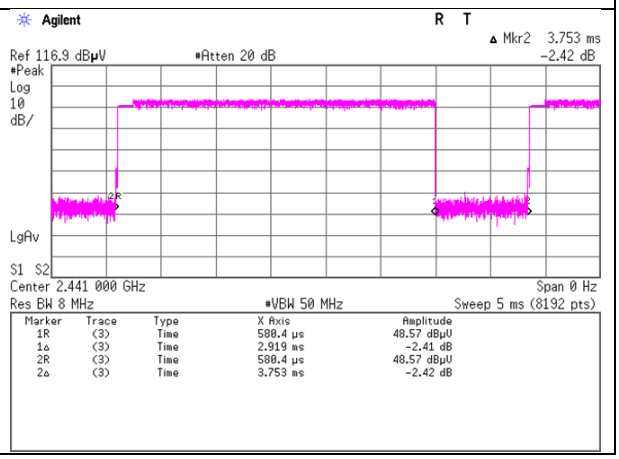
2DH5

Tx on / (Tx on + Tx off) =	**0.781**
Tx on / (Tx on + Tx off) * 100 =	**78.1 %**
Duty factor = 10 * log (3.75 / 2.929) =	**1.07 dB**



3DH5

Tx on / (Tx on + Tx off) =	**0.778**
Tx on / (Tx on + Tx off) * 100 =	**77.8 %**
Duty factor = 10 * log (3.753 / 2.919) =	**1.09 dB**



Radiated Spurious Emission

Report No.	12804674H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	August 3, 2019	August 6, 2019	August 7, 2019
Temperature / Humidity	23 deg. C / 49 % RH	22 deg. C / 66 % RH	22 deg. C / 66 % RH
Engineer	Junki Nagatomi	Junki Nagatomi	Junki Nagatomi
	(1 GHz -10 GHz)	(Above 10 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.	57.285	QP	42.2	8.3	7.5	32.2	-	25.8	40.0	14.2	
Hori.	168.207	QP	34.7	15.9	8.8	32.1	-	27.4	43.5	16.1	
Hori.	250.211	QP	39.2	11.7	9.6	32.0	-	28.5	46.0	17.6	
Hori.	356.361	QP	42.6	15.1	10.4	31.9	-	36.1	46.0	9.9	
Hori.	449.965	QP	36.8	16.5	11.0	32.0	-	32.3	46.0	13.7	
Hori.	599.954	QP	37.4	19.3	11.9	32.0	-	36.6	46.0	9.4	
Hori.	2390.000	PK	45.3	27.3	5.5	36.7	-	41.4	73.9	32.5	
Hori.	4804.000	PK	43.3	31.7	7.7	36.2	-	46.6	73.9	27.3	Floor noise
Hori.	7206.000	PK	44.4	36.3	8.9	36.3	-	53.3	73.9	20.6	Floor noise
Hori.	9608.000	PK	44.5	38.5	9.4	36.8	-	55.7	73.9	18.3	Floor noise
Hori.	2390.000	AV	36.6	27.3	5.5	36.7	1.1	33.9	53.9	20.1	*1)
Hori.	4804.000	AV	35.2	31.7	7.7	36.2	-	38.5	53.9	15.5	Floor noise
Hori.	7206.000	AV	35.7	36.3	8.9	36.3	-	44.6	53.9	9.3	Floor noise
Hori.	9608.000	AV	36.6	38.5	9.4	36.8	-	47.7	53.9	6.2	Floor noise
Vert.	50.400	QP	41.7	10.7	7.4	32.2	-	27.6	40.0	12.4	
Vert.	161.463	QP	35.0	15.5	8.8	32.1	-	27.2	43.5	16.3	
Vert.	356.352	QP	35.6	15.1	10.4	31.9	-	29.1	46.0	16.9	
Vert.	449.955	QP	33.6	16.5	11.0	32.0	-	29.1	46.0	16.9	
Vert.	599.930	QP	33.3	19.3	11.9	32.0	-	32.5	46.0	13.5	
Vert.	849.929	QP	30.5	21.6	13.3	31.2	-	34.2	46.0	11.8	
Vert.	2390.000	PK	45.0	27.3	5.5	36.7	-	41.2	73.9	32.7	
Vert.	4804.000	PK	43.3	31.7	7.7	36.2	-	46.5	73.9	27.4	Floor noise
Vert.	7206.000	PK	44.4	36.3	8.9	36.3	-	53.3	73.9	20.6	Floor noise
Vert.	9608.000	PK	44.5	38.5	9.4	36.8	-	55.7	73.9	18.3	Floor noise
Vert.	2390.000	AV	36.4	27.3	5.5	36.7	1.1	33.7	53.9	20.2	*1)
Vert.	4804.000	AV	35.2	31.7	7.7	36.2	-	38.5	53.9	15.5	Floor noise
Vert.	7206.000	AV	35.7	36.3	8.9	36.3	-	44.6	53.9	9.3	Floor noise
Vert.	9608.000	AV	36.6	38.5	9.4	36.8	-	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 (4 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)

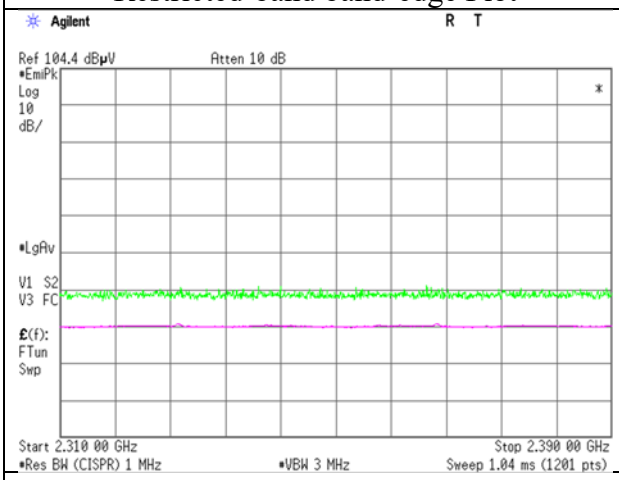
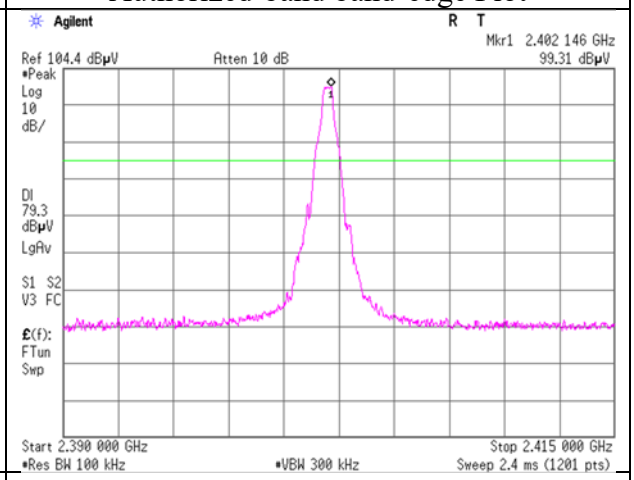
20dBc Data Sheet

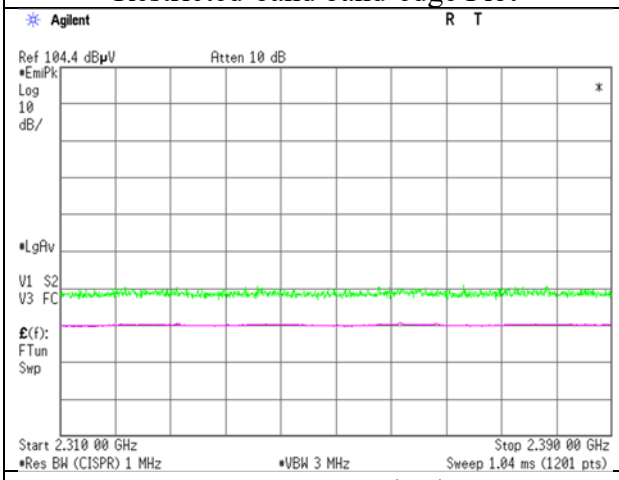
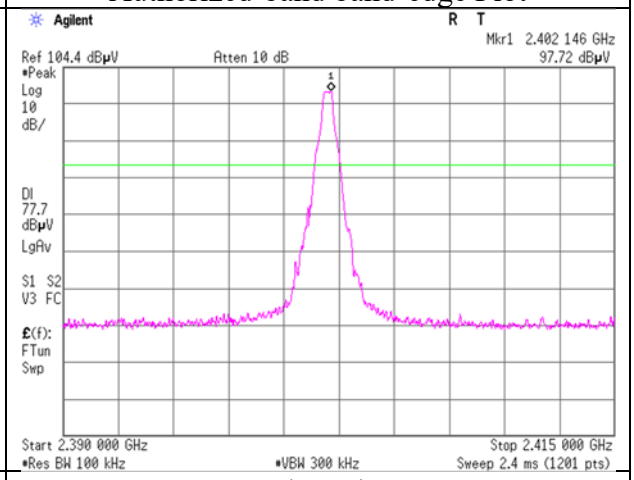
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	99.3	27.2	5.6	36.7	95.4	-	-	Carrier
Hori.	2400.000	PK	42.9	27.2	5.6	36.7	38.9	75.4	36.5	
Vert.	2402.000	PK	97.7	27.2	5.6	36.7	93.8	-	-	Carrier
Vert.	2400.000	PK	42.0	27.2	5.6	36.7	38.0	73.8	35.8	

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

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	12804674H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 3, 2019
Temperature / Humidity	23 deg. C / 49 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)
Mode	Tx, Hopping Off, DH5 2402 MHz

Horizontal	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

Vertical	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

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

Radiated Spurious Emission

Report No.	12804674H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	August 3, 2019	August 6, 2019	August 8, 2019
Temperature / Humidity	23 deg. C / 49 % RH	22 deg. C / 66 % RH	24 deg. C / 54 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)	Junki Nagatomi (Above 10 GHz)	Akihiko Maeda (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.	57.341	QP	41.9	8.3	7.5	32.2	-	25.5	40.0	14.5	
Hori.	155.587	QP	28.5	15.4	8.7	32.1	-	20.5	43.5	23.0	
Hori.	243.918	QP	46.2	11.6	9.5	32.0	-	35.3	46.0	10.7	
Hori.	299.667	QP	43.5	13.6	10.0	31.9	-	35.2	46.0	10.8	
Hori.	335.632	QP	32.6	14.7	10.2	31.9	-	25.5	46.0	20.5	
Hori.	599.936	QP	37.5	19.3	11.9	32.0	-	36.7	46.0	9.3	
Hori.	4882.000	PK	42.6	31.7	7.7	36.2	-	45.9	73.9	28.0	Floor noise
Hori.	7323.000	PK	43.6	36.0	8.9	36.3	-	52.3	73.9	21.6	Floor noise
Hori.	9764.000	PK	43.9	38.8	9.4	36.9	-	55.2	73.9	18.7	Floor noise
Hori.	4882.000	AV	34.7	31.7	7.7	36.2	-	38.0	53.9	16.0	Floor noise
Hori.	7323.000	AV	35.0	36.0	8.9	36.3	-	43.6	53.9	10.3	Floor noise
Hori.	9764.000	AV	35.9	38.8	9.4	36.9	-	47.3	53.9	6.6	Floor noise
Vert.	51.221	QP	41.4	10.4	7.4	32.2	-	27.0	40.0	13.0	
Vert.	153.655	QP	38.8	15.2	8.7	32.1	-	30.6	43.5	12.9	
Vert.	243.863	QP	42.5	11.6	9.5	32.0	-	31.6	46.0	14.4	
Vert.	299.997	QP	34.8	13.6	10.0	31.9	-	26.5	46.0	19.5	
Vert.	335.742	QP	32.7	14.7	10.2	31.9	-	25.6	46.0	20.4	
Vert.	599.943	QP	31.5	19.3	11.9	32.0	-	30.7	46.0	15.3	
Vert.	4882.000	PK	44.0	31.7	7.7	36.2	-	47.3	73.9	26.6	Floor noise
Vert.	7323.000	PK	43.6	36.0	8.9	36.3	-	52.2	73.9	21.7	Floor noise
Vert.	9764.000	PK	43.6	38.8	9.4	36.9	-	54.9	73.9	19.0	Floor noise
Vert.	4882.000	AV	34.7	31.7	7.7	36.2	-	38.0	53.9	16.0	Floor noise
Vert.	7323.000	AV	35.0	36.0	8.9	36.3	-	43.6	53.9	10.3	Floor noise
Vert.	9764.000	AV	35.9	38.8	9.4	36.9	-	47.3	53.9	6.6	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.	12804674H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	August 3, 2019	August 6, 2019	August 7, 2019
Temperature / Humidity	23 deg. C / 49 % RH	22 deg. C / 66 % RH	22 deg. C / 66 % RH
Engineer	Junki Nagatomi	Junki Nagatomi	Junki Nagatomi
	(1 GHz -10 GHz)	(Above 10 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.	58.150	QP	44.1	8.1	7.5	32.2	-	27.5	40.0	12.5	
Hori.	159.038	QP	29.4	15.5	8.7	32.1	-	21.5	43.5	22.0	
Hori.	237.645	QP	41.6	11.4	9.5	32.0	-	30.5	46.0	15.5	
Hori.	356.368	QP	33.9	15.1	10.4	31.9	-	27.4	46.0	18.6	
Hori.	449.949	QP	33.1	16.5	11.0	32.0	-	28.6	46.0	17.4	
Hori.	599.922	QP	36.5	19.3	11.9	32.0	-	35.7	46.0	10.3	
Hori.	2483.500	PK	48.6	27.9	5.6	36.7	-	45.4	73.9	28.5	
Hori.	4960.000	PK	43.3	32.0	7.7	36.2	-	46.8	73.9	27.1	Floor noise
Hori.	7440.000	PK	44.1	36.4	8.9	36.3	-	53.1	73.9	20.8	Floor noise
Hori.	9920.000	PK	43.7	38.7	9.4	36.9	-	54.8	73.9	19.1	Floor noise
Hori.	2483.500	AV	37.7	27.9	5.6	36.7	1.1	35.6	53.9	18.3	*1)
Hori.	4960.000	AV	35.1	32.0	7.7	36.2	-	38.6	53.9	15.3	Floor noise
Hori.	7440.000	AV	35.2	36.4	8.9	36.3	-	44.2	53.9	9.7	Floor noise
Hori.	9920.000	AV	35.5	38.7	9.4	36.9	-	46.6	53.9	7.3	Floor noise
Vert.	49.995	QP	43.4	10.9	7.4	32.2	-	29.4	40.0	10.6	
Vert.	158.604	QP	38.8	15.4	8.7	32.1	-	30.8	43.5	12.7	
Vert.	356.361	QP	34.8	15.1	10.4	31.9	-	28.3	46.0	17.7	
Vert.	449.968	QP	32.8	16.5	11.0	32.0	-	28.3	46.0	17.7	
Vert.	577.053	QP	32.9	18.6	11.8	32.0	-	31.3	46.0	14.7	
Vert.	597.744	QP	33.9	19.2	11.9	32.0	-	33.0	46.0	13.0	
Vert.	2483.500	PK	46.8	27.9	5.6	36.7	-	43.6	73.9	30.3	
Vert.	4960.000	PK	43.2	32.0	7.7	36.2	-	46.7	73.9	27.2	Floor noise
Vert.	7440.000	PK	43.8	36.4	8.9	36.3	-	52.8	73.9	21.1	Floor noise
Vert.	9920.000	PK	43.8	38.7	9.4	36.9	-	54.9	73.9	19.0	Floor noise
Vert.	2483.500	AV	38.1	27.9	5.6	36.7	1.1	36.0	53.9	17.9	*1)
Vert.	4960.000	AV	35.1	32.0	7.7	36.2	-	38.6	53.9	15.3	Floor noise
Vert.	7440.000	AV	35.2	36.4	8.9	36.3	-	44.2	53.9	9.7	Floor noise
Vert.	9920.000	AV	35.5	38.7	9.4	36.9	-	46.6	53.9	7.3	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 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

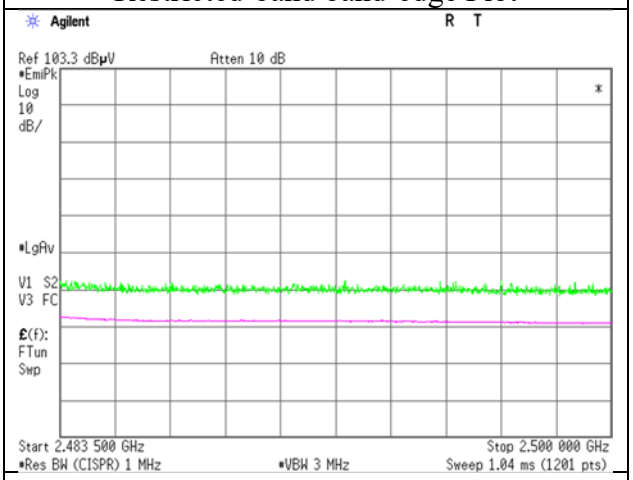
*1) Not Out of Band emission(Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	12804674H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 3, 2019
Temperature / Humidity	23 deg. C / 49 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)
Mode	Tx, Hopping Off, DH5 2480 MHz

Horizontal

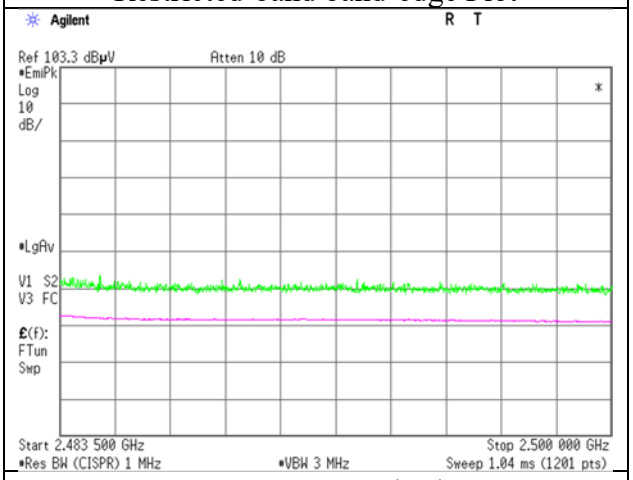
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

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

Radiated Spurious Emission

Report No.	12804674H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	August 3, 2019	August 6, 2019	August 8, 2019
Temperature / Humidity	23 deg. C / 49 % RH	22 deg. C / 66 % RH	24 deg. C / 54 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)	Junki Nagatomi (Above 10 GHz)	Akihiko Maeda (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.	56.406	QP	44.0	8.6	7.5	32.2	-	27.9	40.0	12.1	
Hori.	152.984	QP	30.0	15.2	8.7	32.1	-	21.8	43.5	21.7	
Hori.	243.685	QP	46.3	11.6	9.5	32.0	-	35.4	46.0	10.6	
Hori.	299.535	QP	43.6	13.6	10.0	31.9	-	35.3	46.0	10.7	
Hori.	344.115	QP	32.3	14.9	10.3	31.9	-	25.6	46.0	20.4	
Hori.	599.978	QP	37.6	19.3	11.9	32.0	-	36.8	46.0	9.2	
Hori.	2390.000	PK	45.9	27.3	5.5	36.7	-	42.1	73.9	31.8	
Hori.	4804.000	PK	44.9	31.7	7.7	36.2	-	48.1	73.9	25.8	Floor noise
Hori.	7206.000	PK	44.5	36.3	8.9	36.3	-	53.5	73.9	20.4	Floor noise
Hori.	9608.000	PK	43.9	38.5	9.4	36.8	-	55.0	73.9	18.9	Floor noise
Hori.	2390.000	AV	36.6	27.3	5.5	36.7	1.1	33.9	53.9	20.0	*1)
Hori.	4804.000	AV	35.2	31.7	7.7	36.2	-	38.4	53.9	15.5	Floor noise
Hori.	7206.000	AV	35.5	36.3	8.9	36.3	-	44.4	53.9	9.5	Floor noise
Hori.	9608.000	AV	36.6	38.5	9.4	36.8	-	47.8	53.9	6.1	Floor noise
Vert.	51.192	QP	42.3	10.4	7.4	32.2	-	27.9	40.0	12.1	
Vert.	155.830	QP	40.7	15.5	8.7	32.1	-	32.8	43.5	10.7	
Vert.	237.563	QP	35.0	11.4	9.5	32.0	-	23.9	46.0	22.1	
Vert.	299.645	QP	34.8	13.6	10.0	31.9	-	26.5	46.0	19.5	
Vert.	344.021	QP	32.5	14.9	10.3	31.9	-	25.8	46.0	20.2	
Vert.	599.983	QP	31.4	19.3	11.9	32.0	-	30.6	46.0	15.4	
Vert.	2390.000	PK	44.3	27.3	5.5	36.7	-	40.5	73.9	33.4	
Vert.	4804.000	PK	43.6	31.7	7.7	36.2	-	46.8	73.9	27.1	Floor noise
Vert.	7206.000	PK	44.0	36.3	8.9	36.3	-	52.9	73.9	21.0	Floor noise
Vert.	9608.000	PK	45.7	38.5	9.4	36.8	-	56.8	73.9	17.1	Floor noise
Vert.	2390.000	AV	36.7	27.3	5.5	36.7	1.1	34.0	53.9	19.9	*1)
Vert.	4804.000	AV	35.2	31.7	7.7	36.2	-	38.4	53.9	15.5	Floor noise
Vert.	7206.000	AV	35.5	36.3	8.9	36.3	-	44.4	53.9	9.5	Floor noise
Vert.	9608.000	AV	36.6	38.5	9.4	36.8	-	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 (4 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)

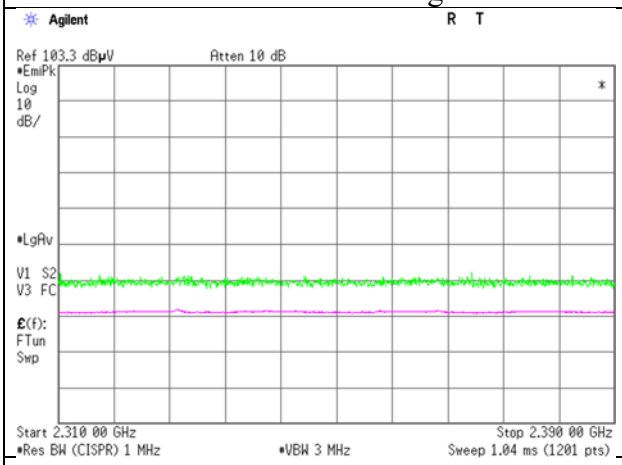
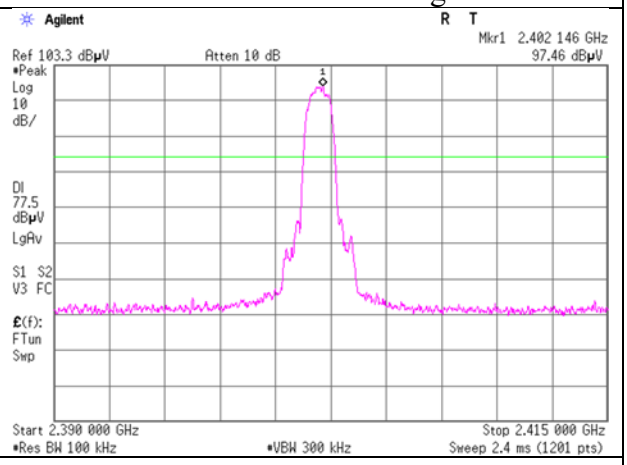
20dBc Data Sheet

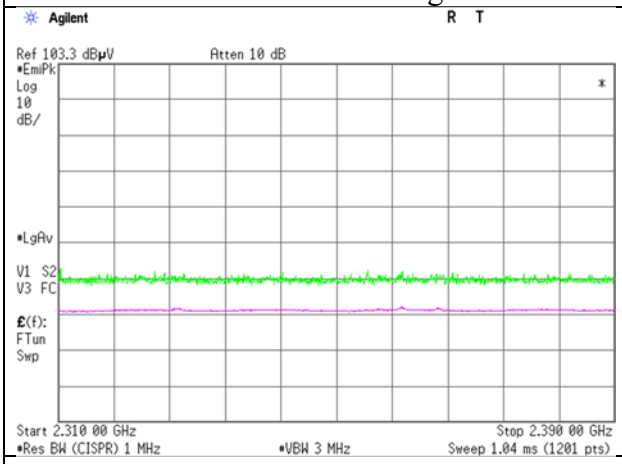
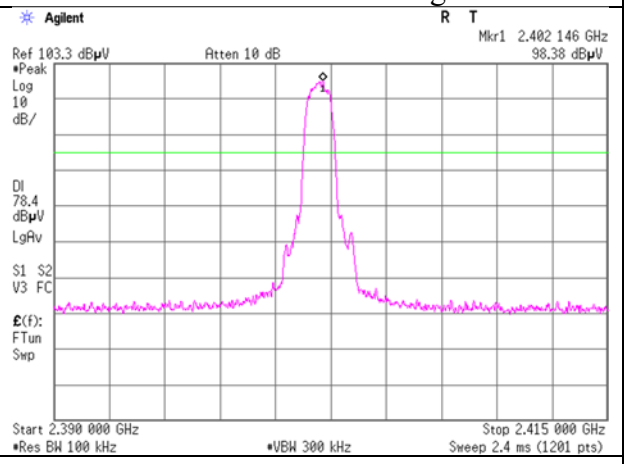
Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	97.5	27.2	5.6	36.7	93.6	-	-	Carrier
Hori.	2400.000	PK	41.6	27.2	5.6	36.7	37.6	73.6	35.9	
Vert.	2402.000	PK	98.4	27.2	5.6	36.7	94.5	-	-	Carrier
Vert.	2400.000	PK	42.0	27.2	5.6	36.7	38.0	74.5	36.4	

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

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	12804674H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 3, 2019
Temperature / Humidity	23 deg. C / 49 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)
Mode	Tx, Hopping Off, 3DH5 2402 MHz

Horizontal	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

Vertical	
Restricted-band band-edge Plot	Authorized-band band-edge Plot
	
Trace Green : Peak Plot Trace Purple : Average Plot	20dBc Plot

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

Radiated Spurious Emission

Report No.	12804674H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	August 3, 2019	August 6, 2019	August 8, 2019
Temperature / Humidity	23 deg. C / 49 % RH	22 deg. C / 66 % RH	24 deg. C / 54 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)	Junki Nagatomi (Above 10 GHz)	Akihiko Maeda (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.	57.421	QP	41.2	8.3	7.5	32.2	-	24.8	40.0	15.2	
Hori.	156.418	QP	28.6	15.5	8.7	32.1	-	20.7	43.5	22.8	
Hori.	243.839	QP	46.5	11.6	9.5	32.0	-	35.6	46.0	10.4	
Hori.	299.654	QP	39.3	13.6	10.0	31.9	-	31.0	46.0	15.0	
Hori.	344.045	QP	32.2	14.9	10.3	31.9	-	25.5	46.0	20.5	
Hori.	599.968	QP	38.2	19.3	11.9	32.0	-	37.4	46.0	8.6	
Hori.	4882.000	PK	43.8	31.7	7.7	36.2	-	47.1	73.9	26.8	Floor noise
Hori.	7323.000	PK	43.4	36.0	8.9	36.3	-	52.1	73.9	21.8	Floor noise
Hori.	9764.000	PK	44.9	38.8	9.4	36.9	-	56.3	73.9	17.6	Floor noise
Hori.	4882.000	AV	34.4	31.7	7.7	36.2	-	37.7	53.9	16.2	Floor noise
Hori.	7323.000	AV	35.1	36.0	8.9	36.3	-	43.7	53.9	10.2	Floor noise
Hori.	9764.000	AV	35.8	38.8	9.4	36.9	-	47.1	53.9	6.8	Floor noise
Vert.	51.216	QP	41.4	10.4	7.4	32.2	-	27.0	40.0	13.0	
Vert.	163.632	QP	38.5	15.6	8.8	32.1	-	30.8	43.5	12.7	
Vert.	239.565	QP	41.7	11.5	9.5	32.0	-	30.7	46.0	15.3	
Vert.	299.781	QP	35.0	13.6	10.0	31.9	-	26.7	46.0	19.3	
Vert.	344.061	QP	32.6	14.9	10.3	31.9	-	25.9	46.0	20.1	
Vert.	599.969	QP	32.2	19.3	11.9	32.0	-	31.4	46.0	14.6	
Vert.	4882.000	PK	43.4	31.7	7.7	36.2	-	46.7	73.9	27.2	Floor noise
Vert.	7323.000	PK	43.1	36.0	8.9	36.3	-	51.7	73.9	22.2	Floor noise
Vert.	9764.000	PK	45.0	38.8	9.4	36.9	-	56.3	73.9	17.6	Floor noise
Vert.	4882.000	AV	34.4	31.7	7.7	36.2	-	37.7	53.9	16.2	Floor noise
Vert.	7323.000	AV	35.1	36.0	8.9	36.3	-	43.7	53.9	10.2	Floor noise
Vert.	9764.000	AV	35.8	38.8	9.4	36.9	-	47.1	53.9	6.8	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.	12804674H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	August 3, 2019	August 6, 2019	August 8, 2019
Temperature / Humidity	23 deg. C / 49 % RH	22 deg. C / 66 % RH	24 deg. C / 54 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)	Junki Nagatomi (Above 10 GHz)	Akihiko Maeda (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.	56.432	QP	44.7	8.6	7.5	32.2	-	28.6	40.0	11.4	
Hori.	156.201	QP	30.0	15.5	8.7	32.1	-	22.1	43.5	21.4	
Hori.	241.613	QP	45.8	11.6	9.5	32.0	-	34.9	46.0	11.1	
Hori.	299.654	QP	43.8	13.6	10.0	31.9	-	35.5	46.0	10.5	
Hori.	350.065	QP	33.1	15.0	10.3	31.9	-	26.5	46.0	19.5	
Hori.	599.987	QP	36.5	19.3	11.9	32.0	-	35.7	46.0	10.3	
Hori.	2483.500	PK	46.2	27.9	5.6	36.7	-	43.0	73.9	30.9	
Hori.	4960.000	PK	44.3	32.0	7.7	36.2	-	47.8	73.9	26.1	Floor noise
Hori.	7440.000	PK	43.3	36.4	8.9	36.3	-	52.3	73.9	21.6	Floor noise
Hori.	9920.000	PK	43.5	38.7	9.4	36.9	-	54.6	73.9	19.3	Floor noise
Hori.	2483.500	AV	37.7	27.9	5.6	36.7	1.1	35.5	53.9	18.4	*1)
Hori.	4960.000	AV	34.9	32.0	7.7	36.2	-	38.4	53.9	15.5	Floor noise
Hori.	7440.000	AV	34.8	36.4	8.9	36.3	-	43.9	53.9	10.1	Floor noise
Hori.	9920.000	AV	35.7	38.7	9.4	36.9	-	46.8	53.9	7.1	Floor noise
Vert.	51.180	QP	43.2	10.4	7.4	32.2	-	28.8	40.0	11.2	
Vert.	156.556	QP	41.2	15.4	8.7	32.1	-	33.3	43.5	10.2	
Vert.	237.534	QP	42.9	11.4	9.5	32.0	-	31.8	46.0	14.2	
Vert.	299.513	QP	35.0	13.6	10.0	31.9	-	26.7	46.0	19.3	
Vert.	350.021	QP	33.6	15.0	10.3	31.9	-	27.0	46.0	19.0	
Vert.	599.992	QP	32.3	19.3	11.9	32.0	-	31.5	46.0	14.5	
Vert.	2483.500	PK	46.0	27.9	5.6	36.7	-	42.7	73.9	31.2	
Vert.	4960.000	PK	43.4	32.0	7.7	36.2	-	46.9	73.9	27.0	Floor noise
Vert.	7440.000	PK	42.8	36.4	8.9	36.3	-	51.9	73.9	22.1	Floor noise
Vert.	9920.000	PK	44.1	38.7	9.4	36.9	-	55.3	73.9	18.6	Floor noise
Vert.	2483.500	AV	36.9	27.9	5.6	36.7	1.1	34.7	53.9	19.2	*1)
Vert.	4960.000	AV	34.9	32.0	7.7	36.2	-	38.4	53.9	15.5	Floor noise
Vert.	7440.000	AV	34.8	36.4	8.9	36.3	-	43.9	53.9	10.1	Floor noise
Vert.	9920.000	AV	35.7	38.7	9.4	36.9	-	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 (4 m / 3.0 m) = 2.5 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

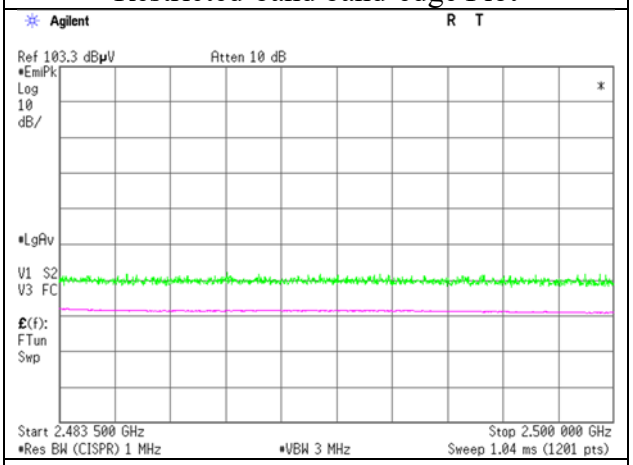
*1) Not Out of Band emission(Leakage Power)

Radiated Spurious Emission
(Reference Plot for band-edge)

Report No.	12804674H
Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 3, 2019
Temperature / Humidity	23 deg. C / 49 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)
Mode	Tx, Hopping Off, 3DH5 2480 MHz

Horizontal

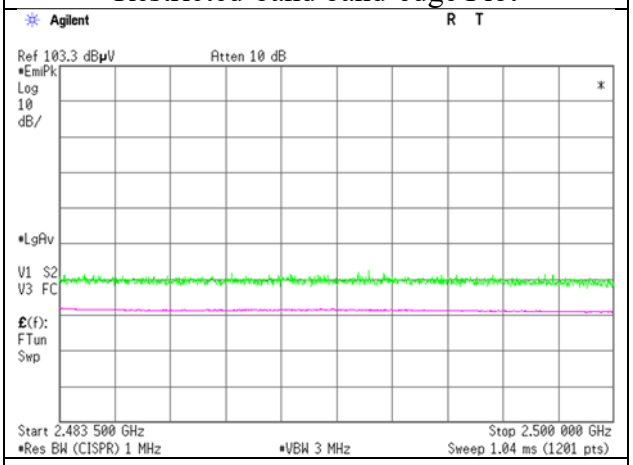
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

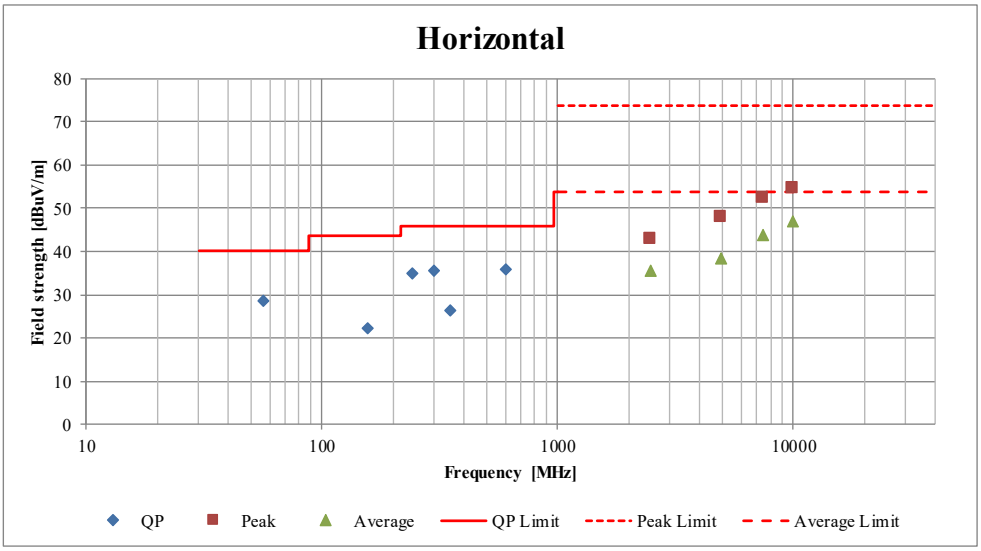


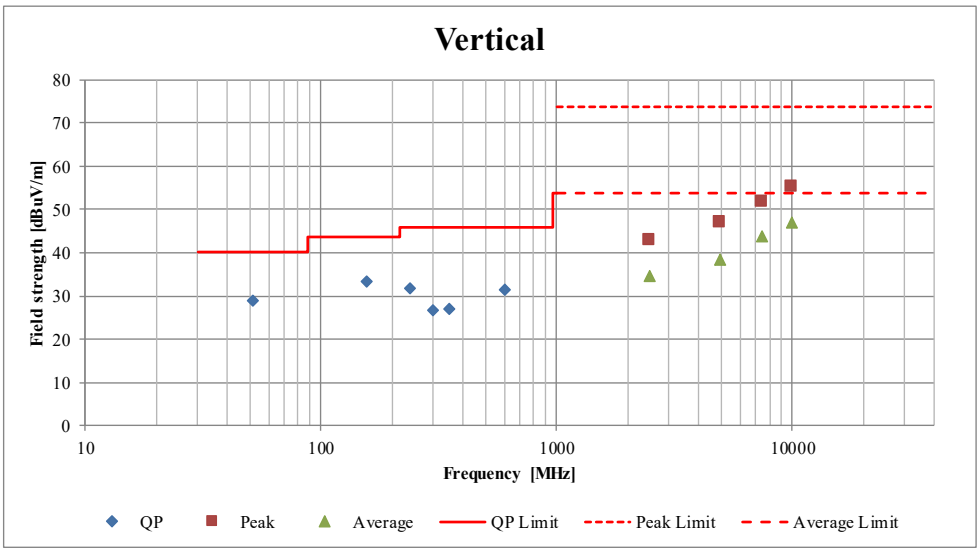
Trace Green : Peak Plot
Trace Purple : Average Plot

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

Radiated Spurious Emission
(Plot data, Worst case)

Report No.	12804674H		
Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.3	No.3	No.3
Date	August 3, 2019	August 6, 2019	August 8, 2019
Temperature / Humidity	23 deg. C / 49 % RH	22 deg. C / 66 % RH	24 deg. C / 54 % RH
Engineer	Junki Nagatomi (1 GHz -10 GHz)	Junki Nagatomi (Above 10 GHz)	Akihiko Maeda (Below 1 GHz)
Mode	Tx, Hopping Off, 3DH5 2480 MHz		





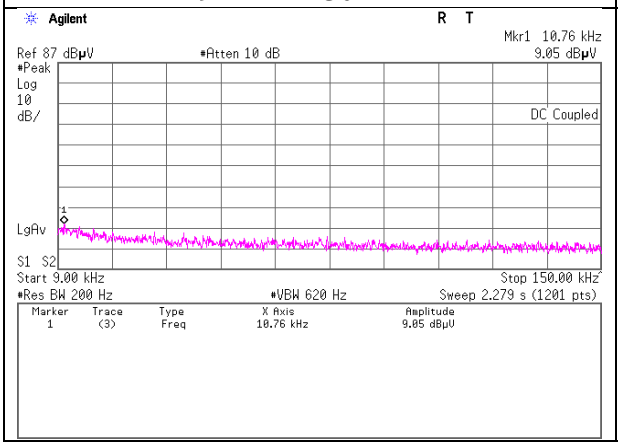
*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

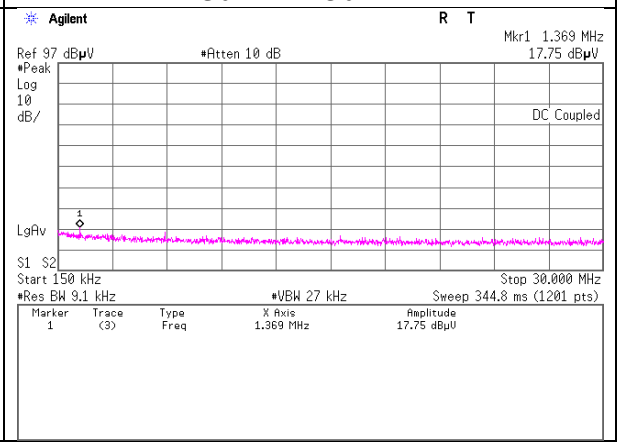
Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, DH5

2402 MHz

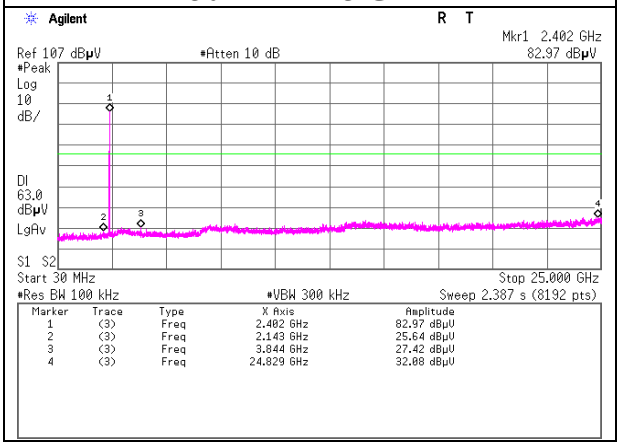
9 kHz - 150 kHz



150 kHz - 30 MHz



30 MHz - 25 GHz

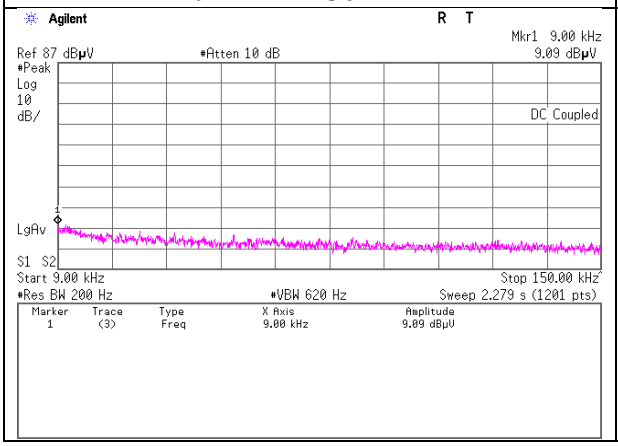


Conducted Spurious Emission

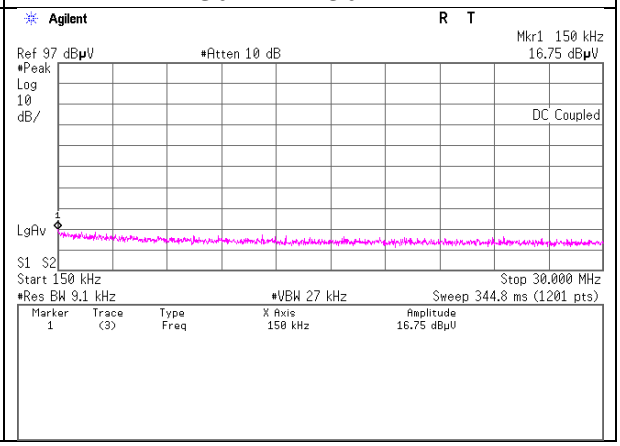
Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, DH5

2441 MHz

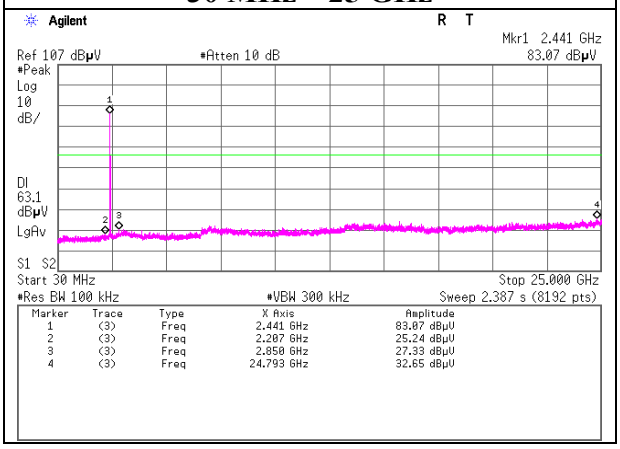
9 kHz – 150 kHz



150 kHz – 30 MHz



30 MHz – 25 GHz

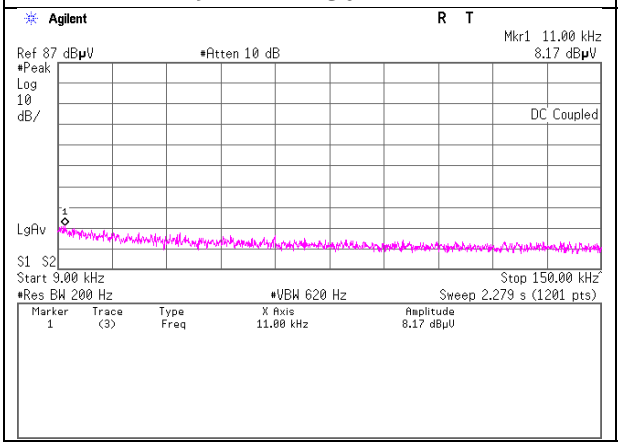


Conducted Spurious Emission

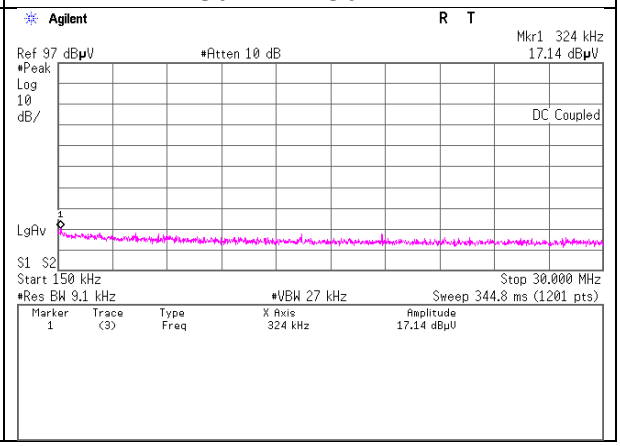
Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, DH5

2480 MHz

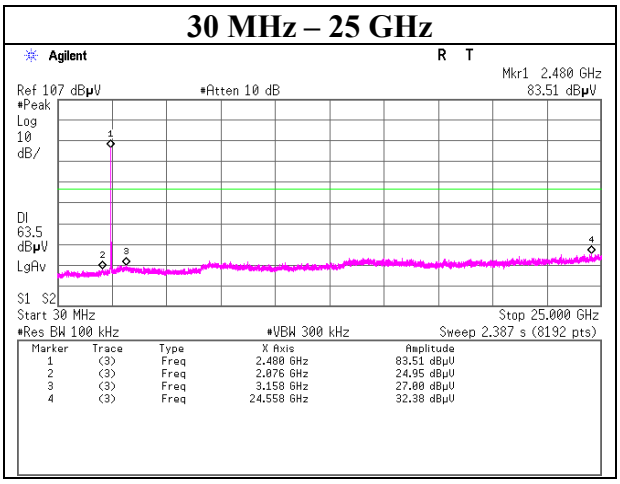
9 kHz – 150 kHz



150 kHz – 30 MHz



30 MHz – 25 GHz

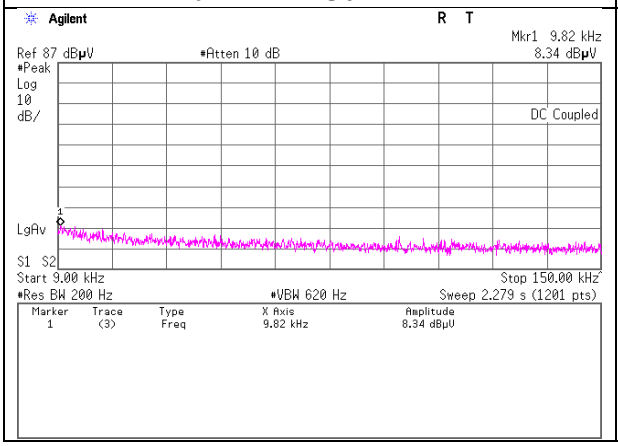


Conducted Spurious Emission

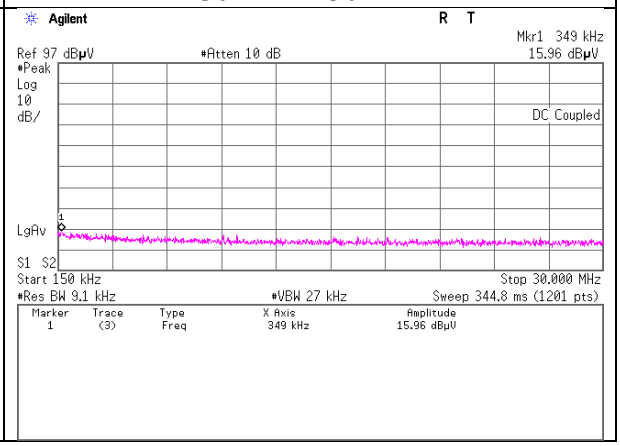
Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, 3DH5

2402 MHz

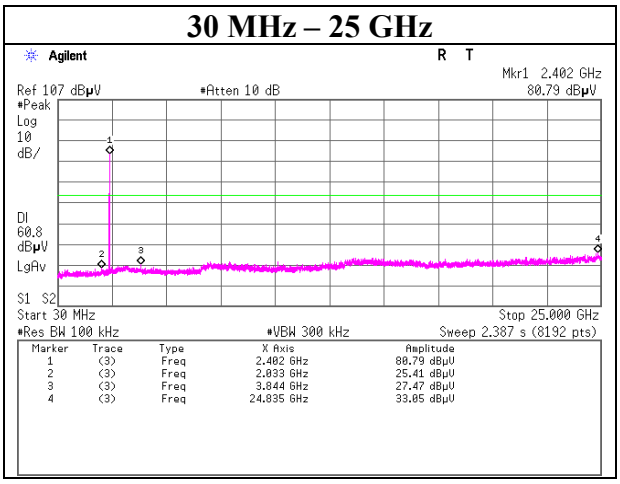
9 kHz – 150 kHz



150 kHz – 30 MHz



30 MHz – 25 GHz

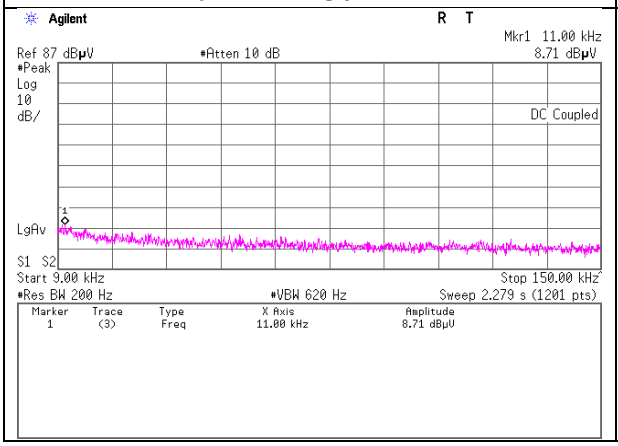


Conducted Spurious Emission

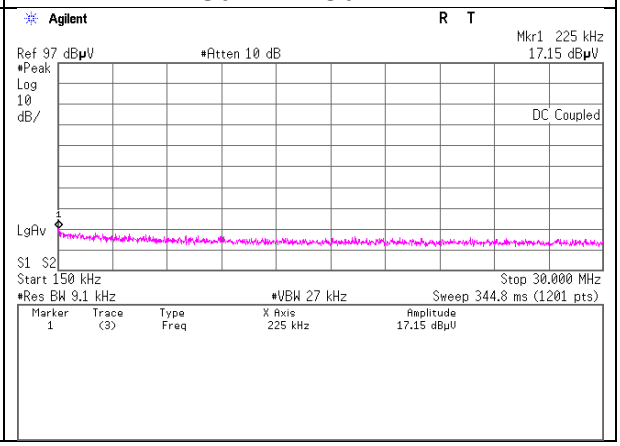
Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, 3DH5

2441 MHz

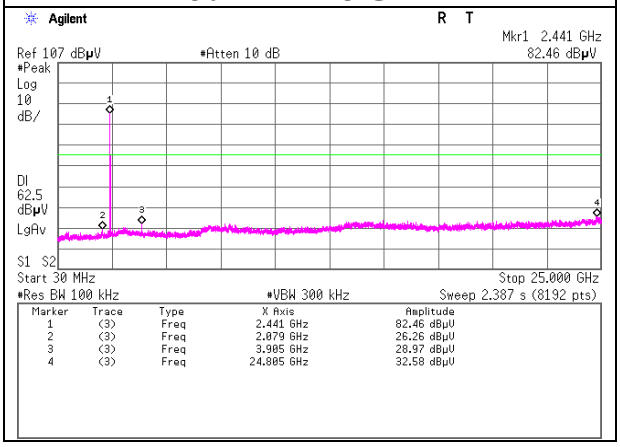
9 kHz - 150 kHz



150 kHz - 30 MHz



30 MHz - 25 GHz

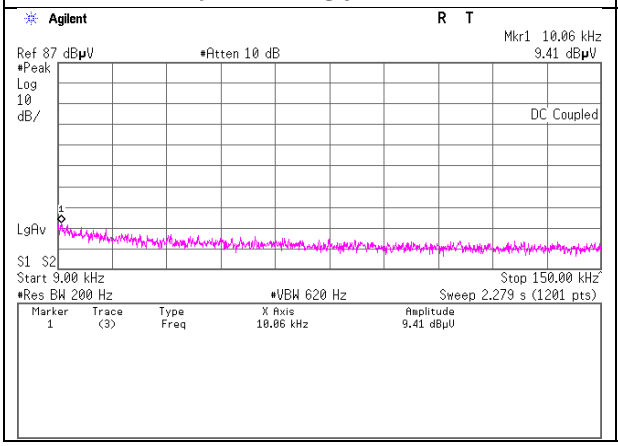


Conducted Spurious Emission

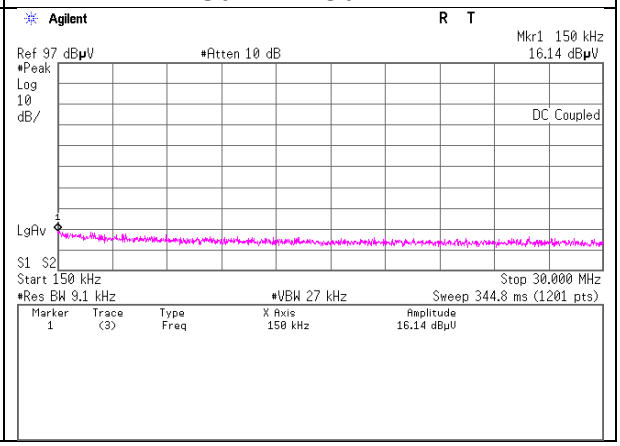
Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx, Hopping Off, 3DH5

2480 MHz

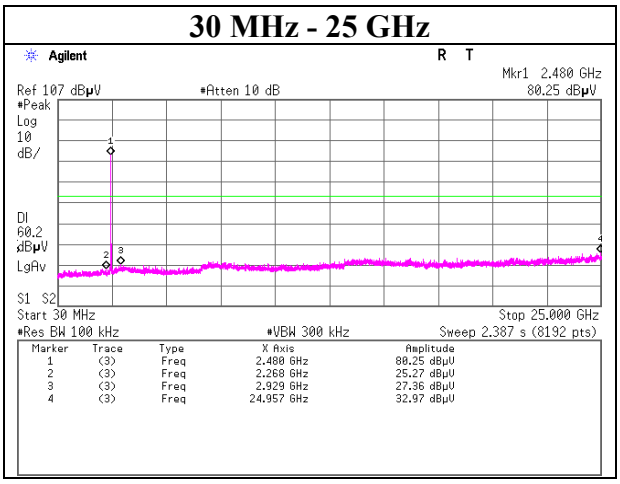
9 kHz - 150 kHz



150 kHz - 30 MHz



30 MHz - 25 GHz

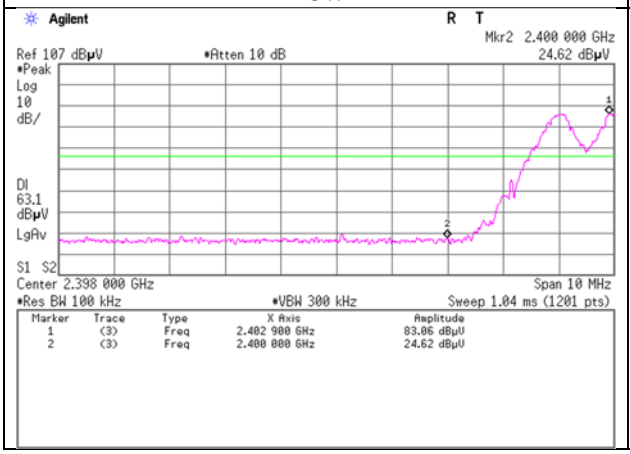


Conducted Emission Band Edge compliance

Report No.	12804674H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	August 9, 2019
Temperature / Humidity	24 deg. C / 68 % RH
Engineer	Junya Okuno
Mode	Tx DH5

Hopping On

Low



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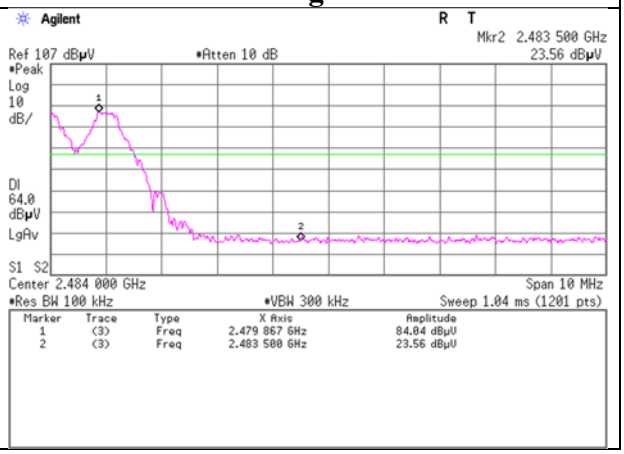

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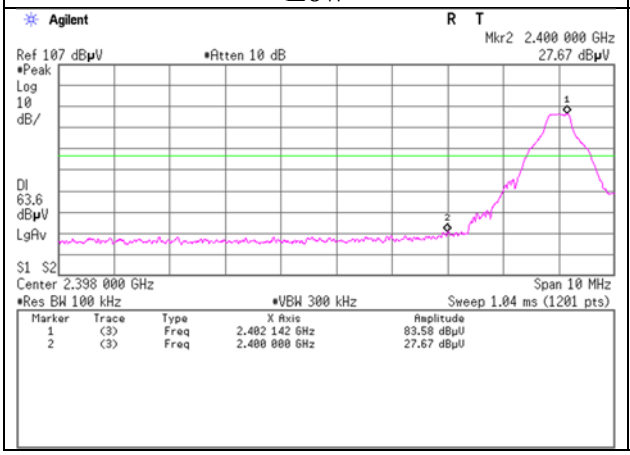

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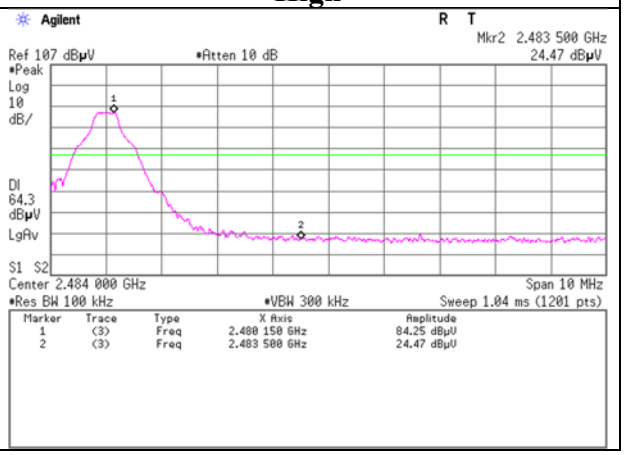

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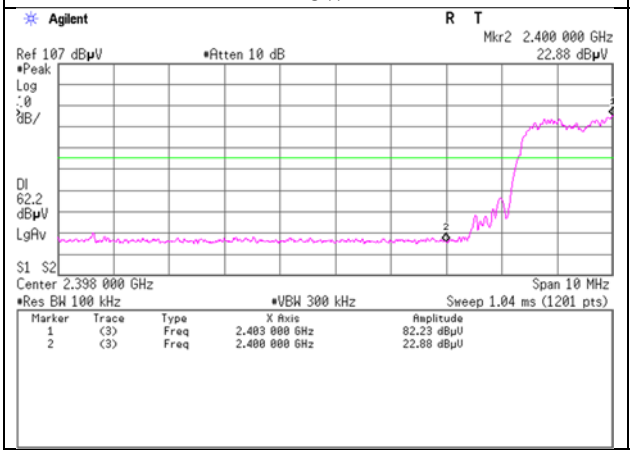
Hopping On

Low



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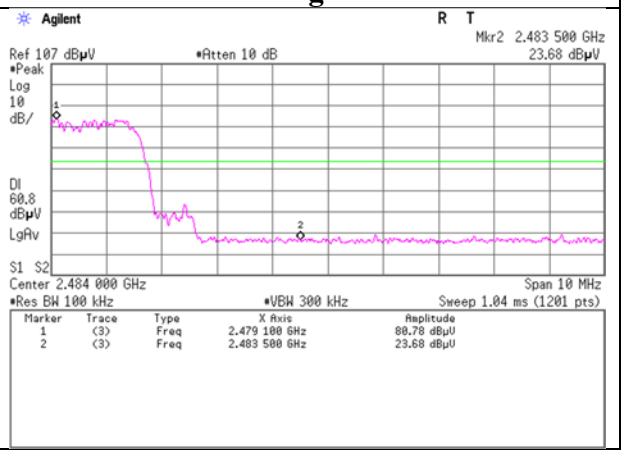

Hopping Off

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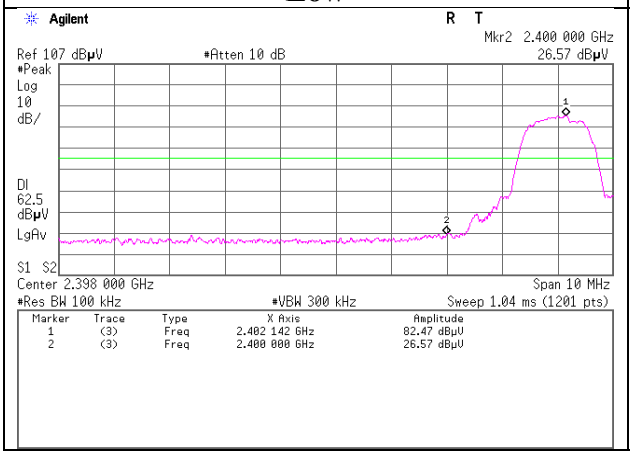

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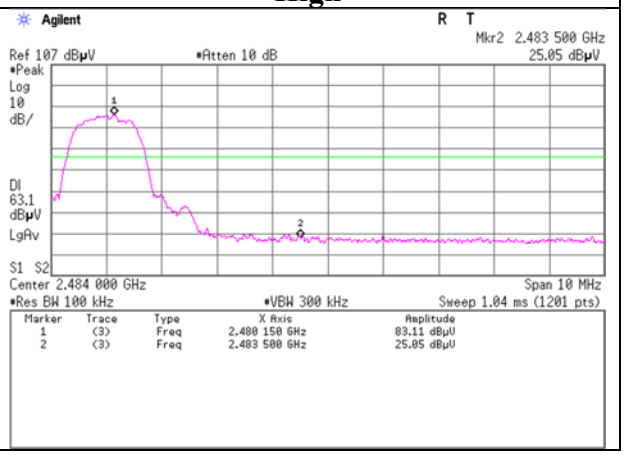

APPENDIX 2: Test instruments

Test Instruments

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
AT	141361	Attenuator(10dB) 1-18GHz	Orient Microwave	BX10-0476-00	-	03/04/2019	03/31/2020	12
RE	142013	AC3_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	04/08/2019	04/30/2021	24
RE	141588	Pre Amplifier	MITEQ, Inc	AMF-6F-2600400-33-8P / AMF-4F-2600	1871355 /1871328	09/21/2018	09/30/2019	12
RE	142183	Measure	KOMELON	KMC-36	-	-	-	-
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	177964	Microwave Cable	Junkosha INC.	MMX221	1901S329(1m)/ 1902S579(5m)	03/05/2019	03/31/2020	12
RE	141507	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	258	05/10/2019	05/31/2020	12
RE	141532	DIGITAL HiTESTER	HIOKI	3805	51201197	01/29/2019	01/31/2020	12
RE	141576	Pre Amplifier	AGILENT	8449B	3008A01671	02/08/2019	02/29/2020	12
RE	141884	Spectrum Analyzer	AGILENT	E4448A	MY44020357	03/13/2019	03/31/2020	12
RE	178648	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141513	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170306	05/10/2019	05/31/2020	12
RE	141580	MicroWave System Amplifier	AGILENT	83017A	MY39500779	03/05/2019	03/31/2020	12
RE	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	06/27/2019	06/30/2020	12
RE	142314	Attenuator	Pasternack	PE7390-6	D/C 1504	06/11/2019	06/30/2020	12
RE	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/08/2019	02/29/2020	12
RE	141266	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	9111B-191	08/24/2019	08/31/2020	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141424	Biconical Antenna	Schwarzbeck	VHA9103+BBA9106	1915	08/24/2019	08/31/2020	12
RE	141323	Coaxial cable	UL Japan	-	-	07/02/2019	07/31/2020	12
RE	141296	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	2	09/19/2018	09/30/2019	12
AT	141938	Terminator	TME	CT-01BP	-	12/05/2018	12/31/2019	12
AT	141174	Attenuator(20dB) (above1GHz)	HIROSE ELECTRIC CO.,LTD.	AT-120	901247	01/10/2019	01/31/2020	12
AT	141414	Microwave Cable	Junkosha	MWX221	1207S407	08/06/2019	08/31/2020	12
AT	141900	Spectrum Analyzer	AGILENT	E4440A	MY46185823	11/15/2018	11/30/2019	12
AT	141830	Power sensor	ANRITSU	MA2411B	738285	05/16/2019	05/31/2020	12
AT	141809	Power Meter	ANRITSU	ML2495A	825002	05/16/2019	05/31/2020	12

***Hyphens for Last Calibration Date, Calibration Due Date and Cal Int 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