RADIO TEST REPORT

Test Report No.: 14617448H-E-R1

Customer	**DENSO TEN Limited**
Description of EUT	**Car Audio**
Model Number of EUT	**TN0036B**
FCC ID	**BABTN0036B**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied (Refer to SECTION 3)**
Issue Date	**July 14, 2023**
Remarks	**Bluetooth (BR / EDR) parts**

Representative Test Engineer	**Approved By**
Keiya Ido Engineer	Ryota Yamanaka Engineer

CERTIFICATE 5107.02

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

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- This test report covers Radio technical requirements.
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- The information provided from the customer for this report is identified in Section 1.
- For test report(s) referred in this report, the latest version (including any revisions) is always referred.

REVISION HISTORY

Original Test Report No.: 14617448H-E

This report is a revised version of 14617448H-E. 14617448H-E is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14617448H-E	February 20, 2023	-
1	14617448H-E-R1	July 14, 2023	P.6 Correction of Frequency of Operation (WLAN) from 5755 MHz to 5775 MHz to 5765 MHz
1	14617448H-E-R1	July 14, 2023	P.18 Correction of test data for 99% Occupied Bandwidth (3DH5)
1	14617448H-E-R1	July 14, 2023	P.28 Correction of Duty factor and re-calculation of Result
1	14617448H-E-R1	July 14, 2023	P.37, 38 Correction of Distance factor formula (1 GHz to 10 GHz)
1	14617448H-E-R1	July 14, 2023	P.44 Correction of test Mode from [Tx, Hopping Off DH5] to [Tx, Hopping Off 3DH5]

Reference: Abbreviations (Including words undescribed in this report)

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

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SECTION 1: Customer Information

Company Name	DENSO TEN Limited
Address	2-28, Gosho-dori 1-chome, Hyoto-ku, Kobe 652-8510 Japan
Telephone Number	+81 78 682 2159
Contact Person	Kaoru Abe

The information provided from the customer is as follows;
- Customer, Description of EUT, Model Number of EUT, FCC ID on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer Information
- SECTION 2: Equipment Under Test (EUT) other than the Receipt Date and Test Date
- SECTION 4: Operation of EUT during testing

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

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	Car Audio
Model Number	TN0036B
Serial Number	Refer to SECTION 4.2
Condition	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	December 20, 2022
Test Date	December 22, 2022 to January 11, 2023

2.2 Product Description

General Specification

Rating	DC 12 V
Operating temperature	-20 deg. C to +65 deg. C

Radio Specification

WLAN (IEEE802.11a/11n-20)

Equipment Type	Transceiver
Frequency of Operation	5765 MHz
Type of Modulation	OFDM
Antenna Gain	0.72 dBi

Bluetooth (BR / EDR)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	FHSS (GFSK, π/4 DQPSK, 8 DPSK)
Antenna Gain	0.14 dBi

AM / FM (incl. RDS) / DAB

Equipment Type	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 229.072 MHz
Type of Modulation	AM FM DAB: OFDM
Antenna Connector Type	HFC IV
Impedance	AM, FM: 75 ohm DAB: 50 ohm

SECTION 3: Test Specification, Procedures & Results

3.1 Test Specification

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

3.2 Procedures and Results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Conducted Emission	**FCC:** ANSI C63.10-2013 6. Standard test methods **ISED:** RSS-Gen 8.8	**FCC:** Section 15.207 **ISED:** RSS-Gen 8.8	-	N/A	*1)
Carrier Frequency Separation	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **ISED:** -	**FCC:** Section15.247(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:** Section15.247(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:** Section15.247(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:** Section15.247(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:** Section15.247(b)(1) **ISED:** RSS-247 5.4 (b)		Complied d)	Conducted
Spurious Emission & Band Edge Compliance	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02 **ISED:** RSS-Gen 6.13	**FCC:** Section15.247(d) **ISED:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10	5.0 dB 243.7 MHz, QP, Hori.	Complied e) / f)	Conducted/ Radiated (above 30 MHz) *2)

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

*1) 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)

FCC Part 15.31 (e)
This EUT provides the stable voltage constantly to RF part 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	**ISED:** 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

Measurement uncertainty is not taken into account when stating conformity with a specified requirement.
Note: When margins obtained from test results are less than the measurement uncertainty, the test results may exceed the limit.

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

Radiated emission

Measurement distance	Frequency range		Uncertainty (+/-)
3 m	9 kHz to 30 MHz		3.2 dB
10 m			3.0 dB
3 m	30 MHz to 200 MHz	Horizontal	4.8 dB
		Vertical	5.0 dB
	200 MHz to 1000 MHz	Horizontal	5.1 dB
		Vertical	6.2 dB
10 m	30 MHz to 200 MHz	Horizontal	4.8 dB
		Vertical	4.8 dB
	200 MHz to 1000 MHz	Horizontal	4.9 dB
		Vertical	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		5.4 dB
0.5m	26.5 GHz to 40 GHz		5.4 dB
10 m	1 GHz to 18 GHz		5.3 dB

Antenna Terminal test

Test Item	Uncertainty (+/-)
20 dB Bandwidth / 99 % Occupied Bandwidth	0.96 %
Maximum Peak Output Power / Average Output Power	1.5 dB
Carrier Frequency Separation	0.42 %
Dwell time / Burst rate	0.10 %
Conducted Spurious Emission	2.7 dB

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
*A2LA Certificate Number: 5107.02 / FCC Test Firm Registration Number: 884919
ISED Lab Company Number: 2973C / CAB identifier: JP0002
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 Japan
Telephone: +81-596-24-8999

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.10 shielded room	3.8 x 2.8 x 2.8	3.8 x 2.8	-	-
No.11 measurement room	4.0 x 3.4 x 2.5	N/A	-	-
No.12 measurement room	2.6 x 3.4 x 2.5	N/A	-	-
Large Chamber	16.9 x 22.1 x 10.17	16.9 x 22.1	-	10 m
Small Chamber	5.3 x 6.69 x 3.59	5.3 x 6.69	-	-

3.6 Test Data, Test Instruments, and Test Set Up

Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1 Operating Mode(s)

Mode	Remarks*
Bluetooth (BT)	BR / EDR, Payload: PRBS9

*EUT has the power settings by the software as follows;
Power Setting: BR: +6.5 dBm
EDR: +6.0 dBm
Software: Bluetooth test software V1.0
(Date: December 1, 2022, 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.

Details of Operating Mode(s)

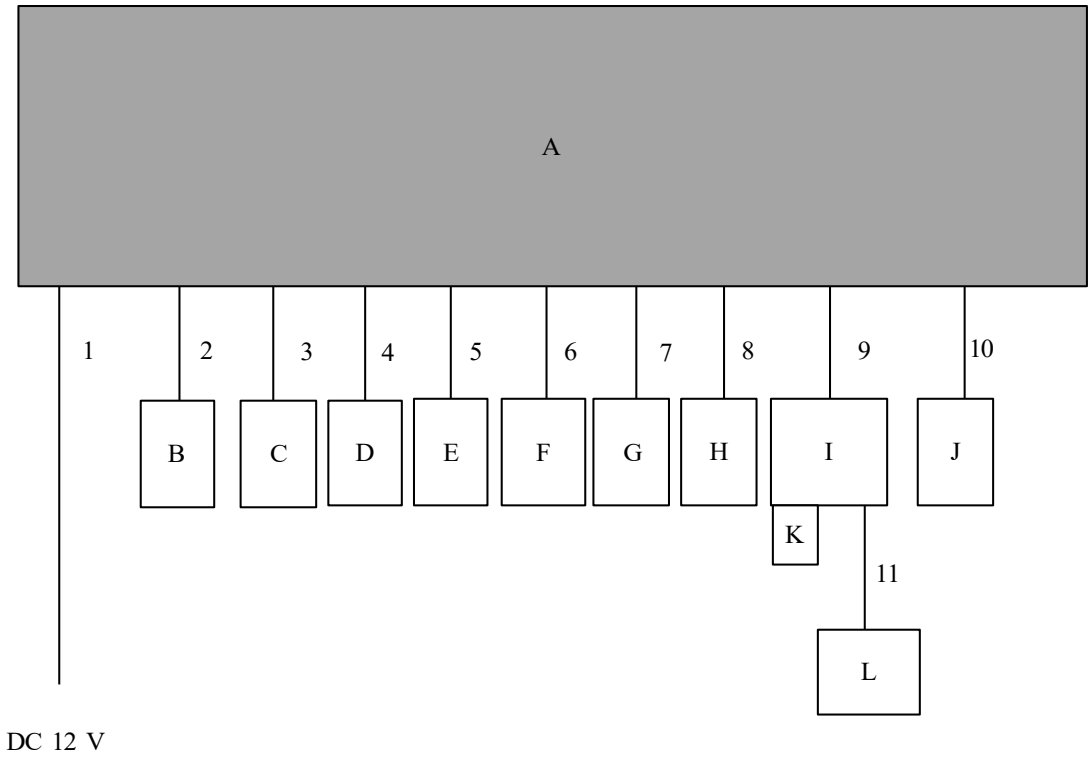
Test Item	Mode	Hopping	Tested Frequency
Radiated Spurious Emission (Below 1 GHz)	Tx 3DH5 *1)	Off	2402 MHz
Radiated Spurious Emission (Above 1 GHz), Conducted Spurious Emission	Tx DH5 Tx 3DH5	Off	2402 MHz 2441 MHz 2480 MHz
Carrier Frequency Separation	Tx DH5 Tx 3DH5	On	2402 MHz 2441 MHz 2480 MHz
20dB Bandwidth	Tx DH5 Tx 3DH5	Off	2402 MHz 2441 MHz 2480 MHz
Number of Hopping Frequency	Tx DH5 Tx 3DH5	On	-
Dwell time	Tx DH1, DH3, DH5 Tx 3DH1, 3DH3, 3DH5	On	-
Maximum Peak Output Power	Tx DH5 Tx 2DH5 Tx 3DH5	Off	2402 MHz 2441 MHz 2480 MHz
Band Edge Compliance (Conducted)	Tx DH5 Tx 3DH5	On Off	2402 MHz 2480 MHz
99% Occupied Bandwidth	Tx DH5 Tx 3DH5	On 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.

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

4.2 Configuration and Peripherals

for Radiated Spurious Emission test



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

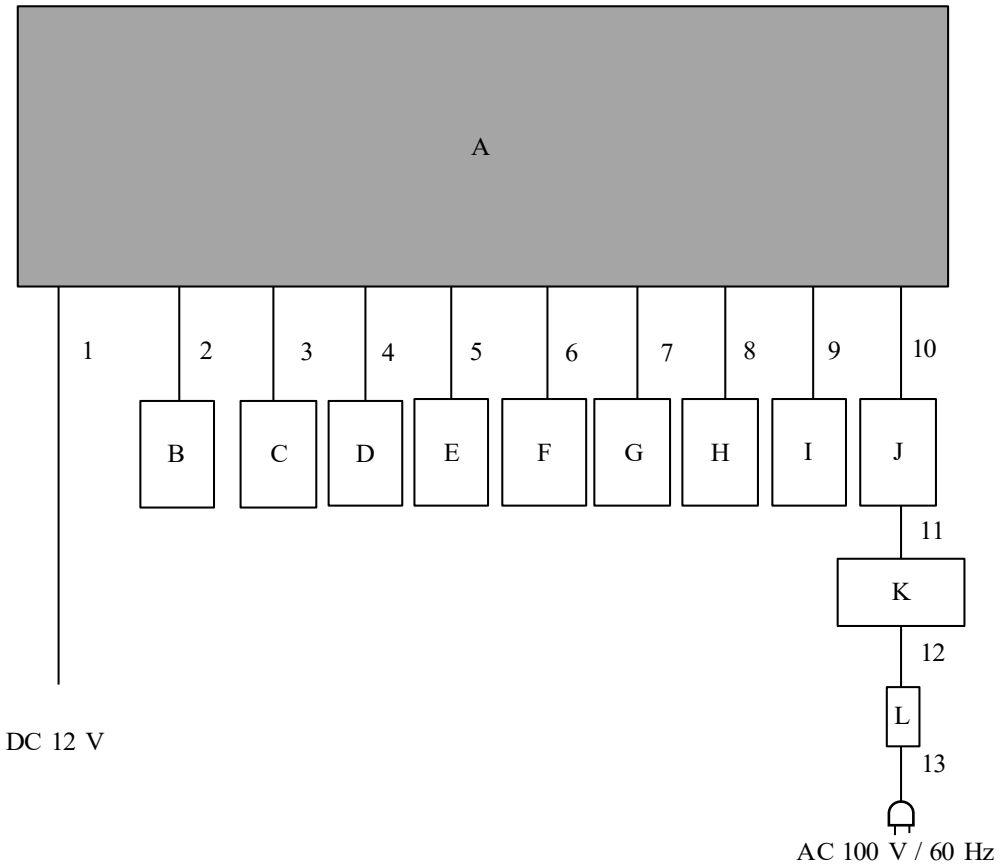
Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	Car Audio	TN0036B	1100229982-0011	DENSO TEN Limited	EUT
B	Microphone module	86730-78010	No.5	Panasonic	-
C	Back camera	867B0-78070	No.5	Panasonic	-
D	Steering switch	84250-58150-BO	No.4	TOKAI RIKA	-
E	Speaker Dummy Load	SP Dummy	-	DENSO TEN Limited	-
F	AM/FM Sharkfin AMP	86760-K0010	-	YOKOWO	-
G	DAB Antenna AMP	863C0-60050	No.2	DENSO TEN Limited	-
H	GNSS Antenna	86880-78010	UI034346	HARADA	-
I	USB I/F Box	86190-78020	501002	Panasonic	-
J	Jig Board	-	-	-	-
K	USB Memory	RUF3-K16GB	P10416	Buffalo Inc.	-
L	iPhone6 64GB	MG4H2J/A	F78P6KZCG5MT	Apple	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	4.0	Unshielded	Unshielded	-
2	Audio Cable	3.0	Shielded	Shielded	-
3	Signal Cable	4.0	Unshielded	Unshielded	-
4	Signal Cable	3.0	Unshielded	Unshielded	-
5	Speaker Cable	3.0	Unshielded	Unshielded	-
6	Antenna Cable	3.2	Shielded	Shielded	-
7	Antenna Cable	3.0	Shielded	Shielded	-
8	Antenna Cable	3.0	Shielded	Shielded	-
9	Signal Cable	2.8	Unshielded	Unshielded	-
10	Signal Cable	0.2	Unshielded	Unshielded	-
11	USB Cable	1.0	Shielded	Shielded	-

for Antenna Terminal Conducted Tests



* 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	TN0036B	115000-40690000	DENSO TEN Limited	EUT
B	Microphone module	86730-78010	No.5	Panasonic	-
C	Back camera	867B0-78070	No.5	Panasonic	-
D	Steering switch	84250-58150-BO	No.4	TOKAI RIKA	-
E	Speaker Dummy Load	SP Dummy	-	DENSO TEN Limited	-
F	AM/FM Sharkfin AMP	86760-K0010	-	YOKOWO	-
G	DAB Antenna AMP	863C0-60050	No.2	DENSO TEN Limited	-
H	GNSS Antenna	86880-78010	UI034346	HARADA	-
I	USB I/F Box	86190-78020	501002	Panasonic	-
J	Jig Board	-	-	-	-
K	Laptop PC	PR63PBAA337AD7X	6F053913H	TOSHIBA	-
L	AC Adapter	PA51770-1ACA	FX10800NSKACC	TOSHIBA	-

List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	DC Cable	4.0	Unshielded	Unshielded	-
2	Audio Cable	3.0	Shielded	Shielded	-
3	Signal Cable	4.0	Unshielded	Unshielded	-
4	Signal Cable	3.0	Unshielded	Unshielded	-
5	Speaker Cable	3.0	Unshielded	Unshielded	-
6	Antenna Cable	3.2	Shielded	Shielded	-
7	Antenna Cable	3.0	Shielded	Shielded	-
8	Antenna Cable	3.0	Shielded	Shielded	-
9	Signal Cable	2.8	Unshielded	Unshielded	-
10	Signal Cable	0.2	Unshielded	Unshielded	-
11	USB Cable	1.0	Shielded	Shielded	-
12	DC Cable	1.7	Unshielded	Unshielded	-
13	AC Cable	0.8	Unshielded	Unshielded	-

SECTION 5: Radiated Spurious Emission

Test Procedure

[For below 1 GHz]
EUT was placed on a urethane platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]
EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane. Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.

The height of the measuring antenna varied between 1 m and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.
The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.
The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

Frequency	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.

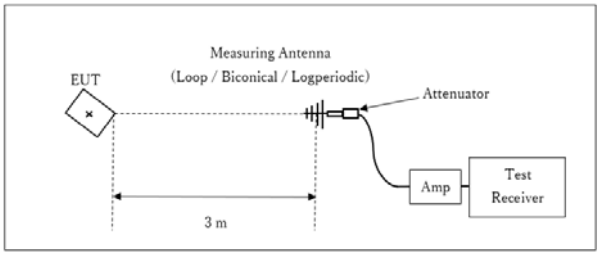
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9 (ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

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

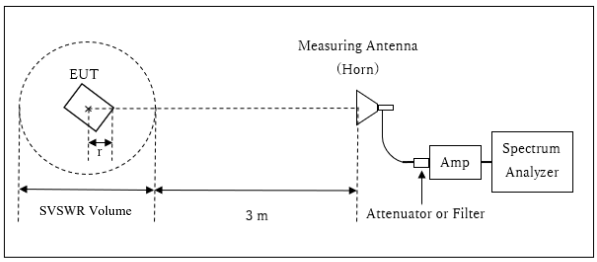
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 10 GHz

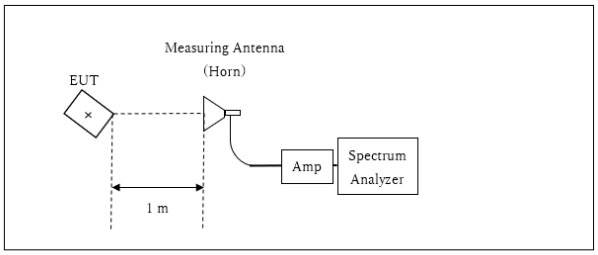


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.85 m / 3.0 m) = 2.17 dB
* Test Distance: (3 + SVSWR Volume /2) - r = 3.85 m

SVSWR Volume : 2.0 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.15 m

10 GHz to 26.5 GHz



× : Center of turn table

Distance Factor: 20 x log (1.0 m / 3.0 m) = -9.5 dB
*Test Distance: 1 m

The 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 to 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) *4)	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) The measurement was performed with Max Hold since the duty cycle was not 100 %.
*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.
(9 kHz -150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 9.1 kHz)
*4) The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohmes. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to 45.5 – 51.5 = -6.0 dBuA/m, which has the same margin, 3 dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

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

Test Data : APPENDIX
Test Result : Pass

APPENDIX 1: Test data

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

Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off, Tx, Hopping On

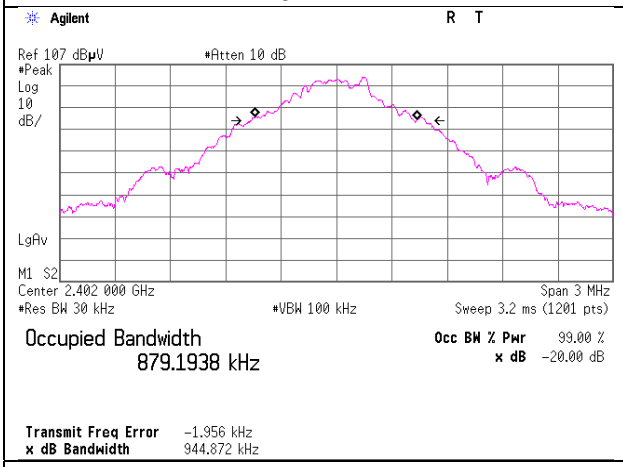
Mode	Freq. [MHz]	20 dB Bandwidth [MHz]	99 % Occupied Bandwidth [kHz]	Carrier Frequency Separation [MHz]	Limit for Carrier Frequency separation [MHz]
DH5	2402.0	0.945	879.194	1.000	>= 0.630
DH5	2441.0	0.939	878.036	1.000	>= 0.626
DH5	2480.0	0.941	877.896	1.000	>= 0.627
DH5	Hopping On	-	78617.300	-	-
3DH5	2402.0	1.310	1198.200	1.000	>= 0.873
3DH5	2441.0	1.312	1202.000	1.000	>= 0.875
3DH5	2480.0	1.310	1196.500	1.000	>= 0.873
3DH5	Hopping On	-	78716.200	-	-

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

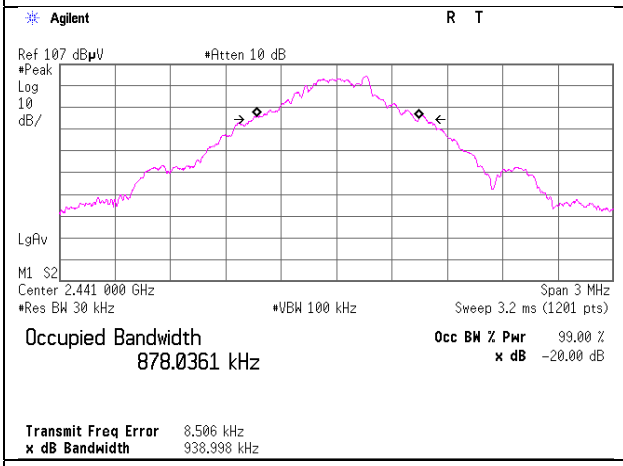
20dB Bandwidth and 99% Occupied Bandwidth

DH5

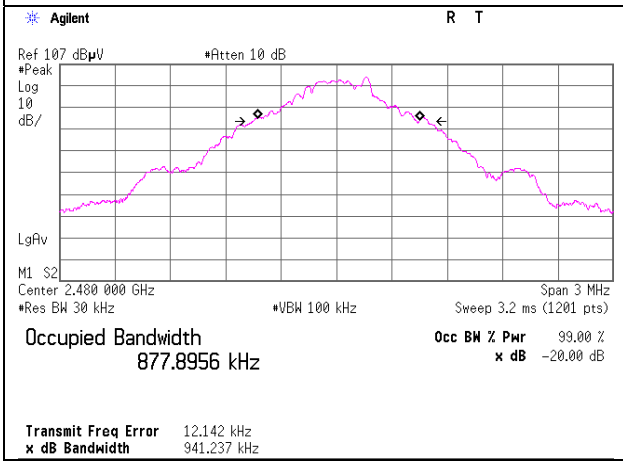
2402 MHz



2441 MHz

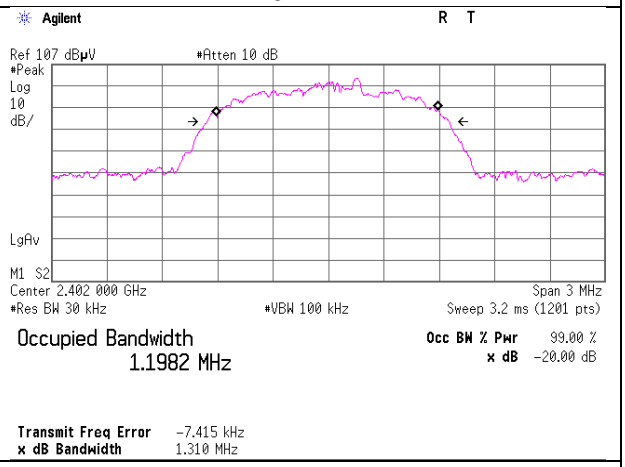


2480 MHz

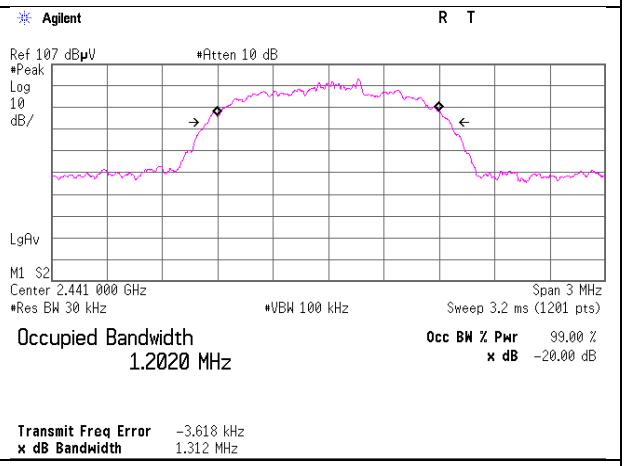


3DH5

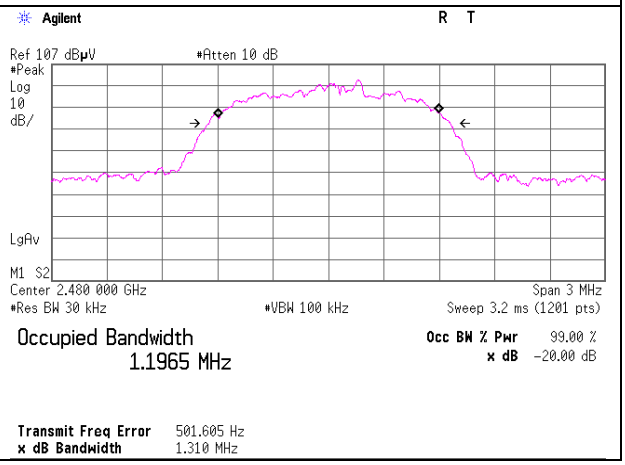
2402 MHz



2441 MHz

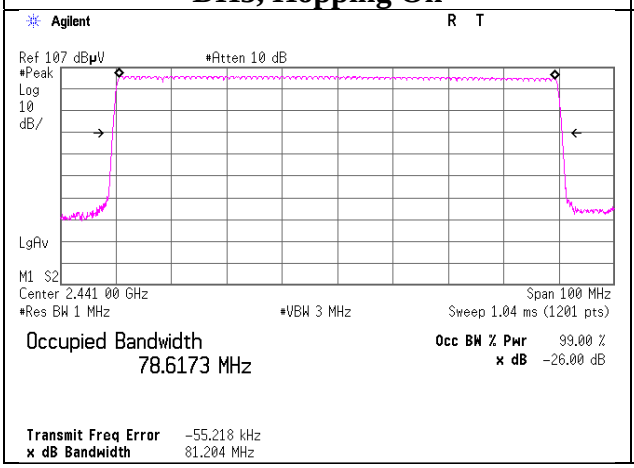


2480 MHz

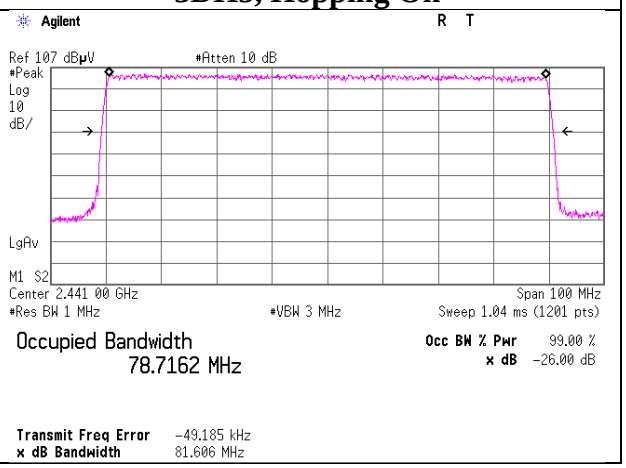


20dB Bandwidth and 99% Occupied Bandwidth

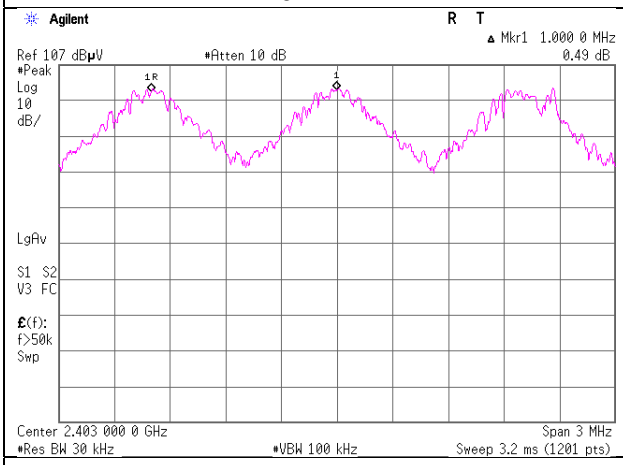
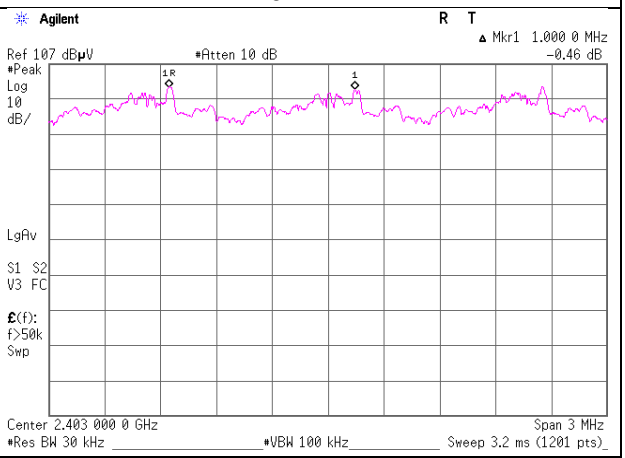
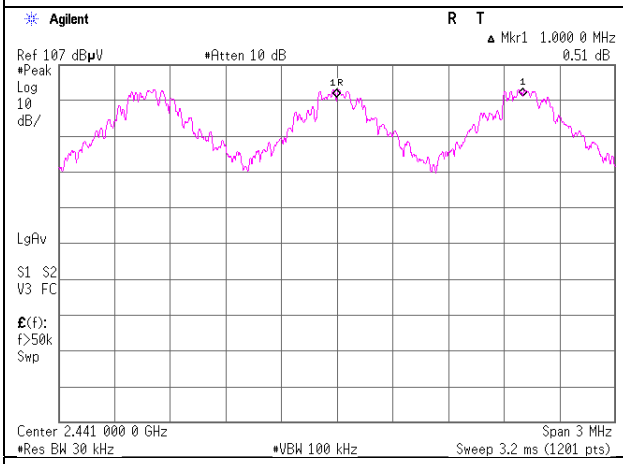
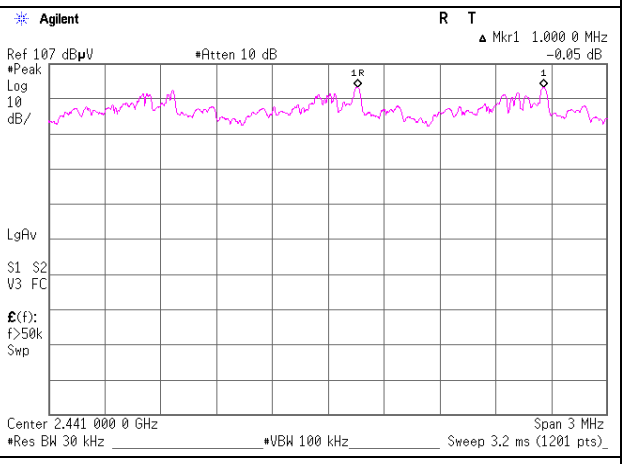
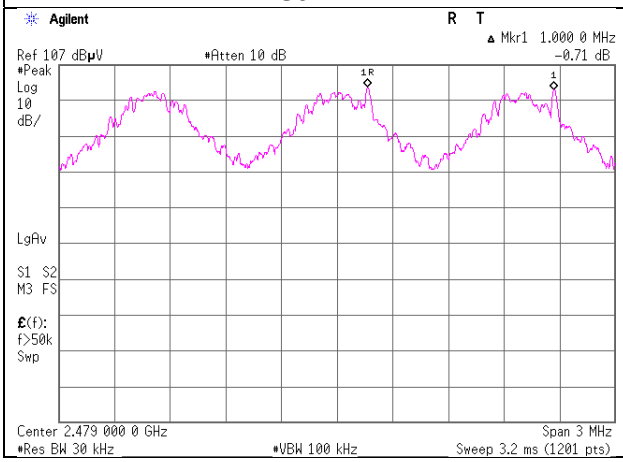
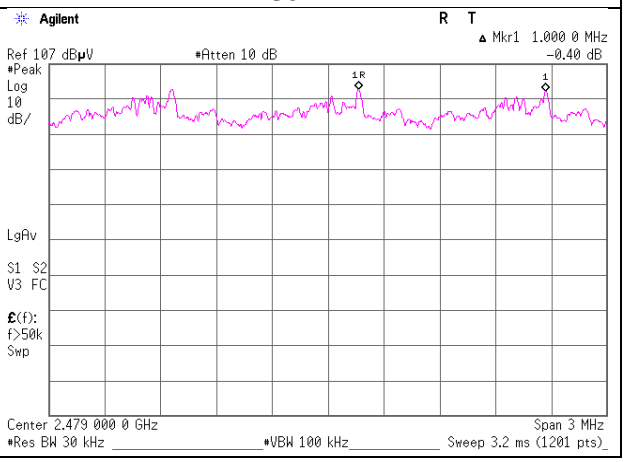
DH5, Hopping On



3DH5, Hopping On



Carrier Frequency Separation

DH5	3DH5
2402 MHz	**2402 MHz**
	
2441 MHz	**2441 MHz**
	
2480 MHz	**2480 MHz**
	

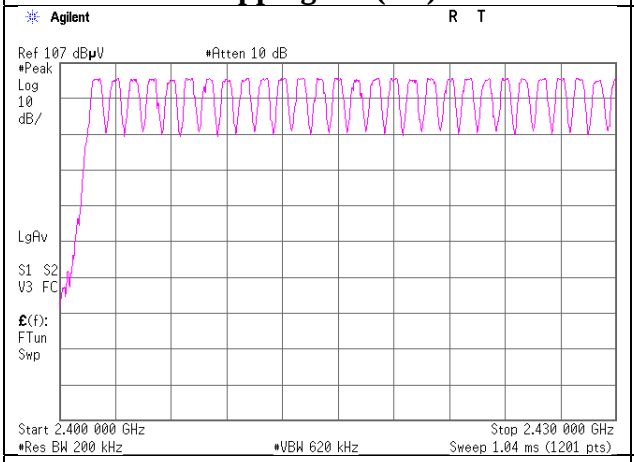
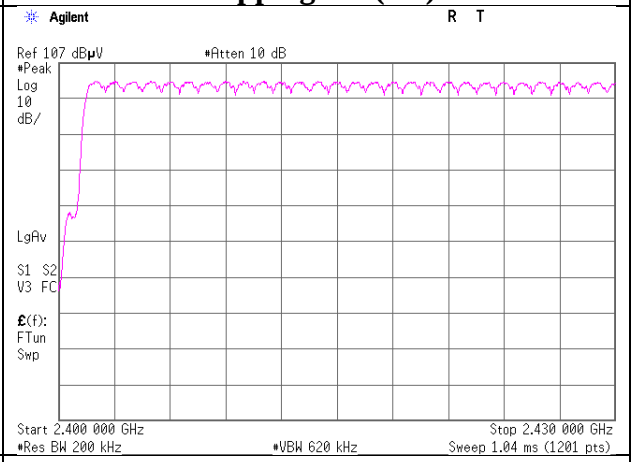
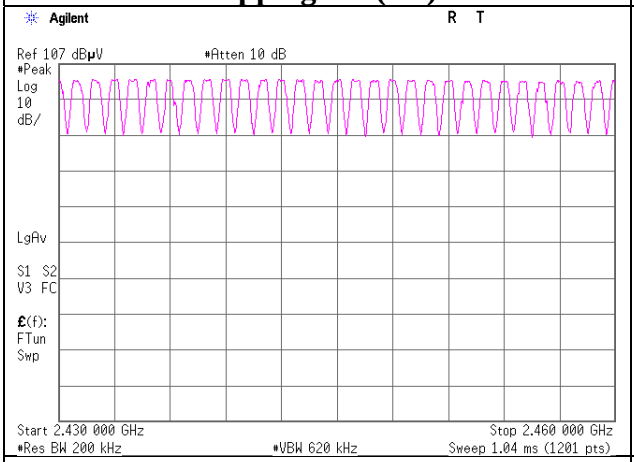
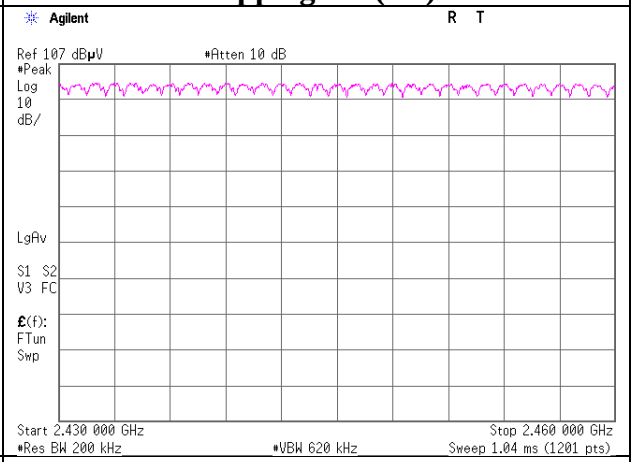
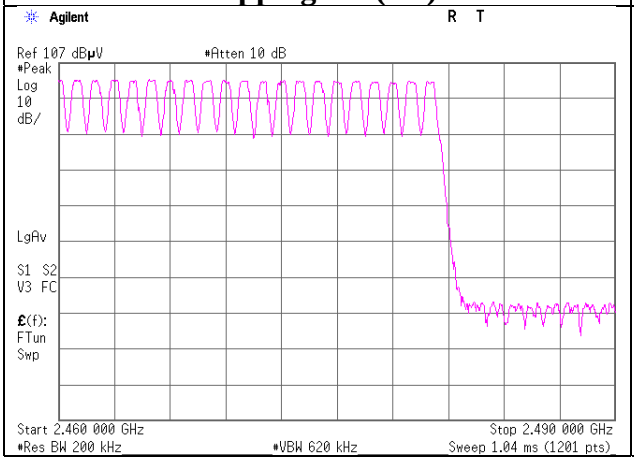
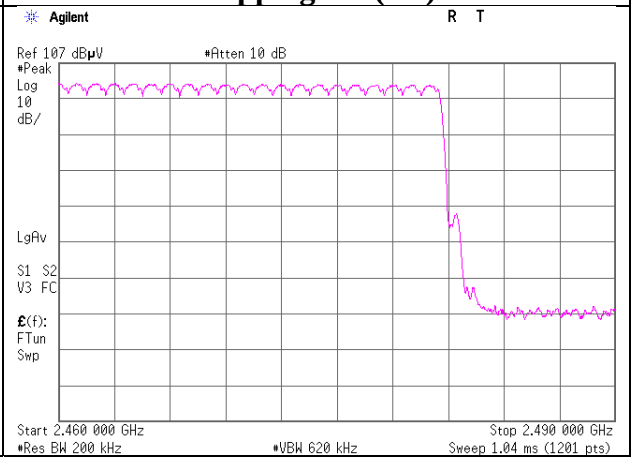
Number of Hopping Frequency

Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
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

Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
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 [ms]	Result [ms]	Limit [ms]
DH1	50.0 times	/	5 s	x	31.6 s	=	316 times	0.422	133	400
DH3	28.8 times	/	5 s	x	31.6 s	=	183 times	1.690	309	400
DH5	20.0 times	/	5 s	x	31.6 s	=	127 times	2.933	372	400
3DH1	50.2 times	/	5 s	x	31.6 s	=	318 times	0.428	136	400
3DH3	27.2 times	/	5 s	x	31.6 s	=	172 times	1.682	289	400
3DH5	17.8 times	/	5 s	x	31.6 s	=	113 times	2.940	332	400

Sample Calculation
Result = Number of transmission x Length of transmission

*Average data of 5 tests.(except Inquiry)

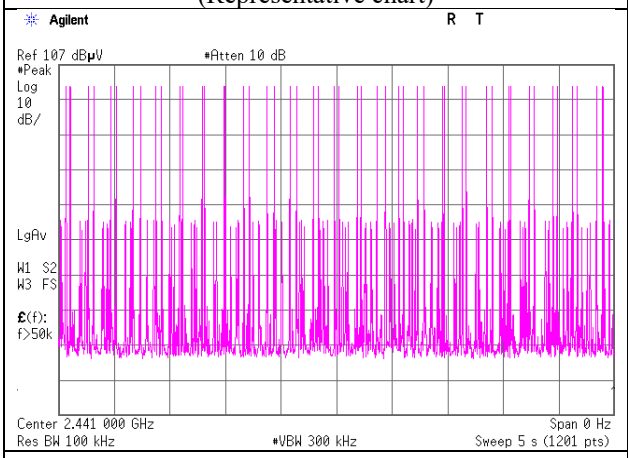
Mode	Sampling [times]					Average [times]
	1	2	3	4	5	
DH1	50	50	50	50	50	50
DH3	31	30	29	29	25	28.8
DH5	21	21	22	19	17	20
3DH1	51	50	50	50	50	50.2
3DH3	25	27	27	28	29	27.2
3DH5	17	16	24	17	15	17.8

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

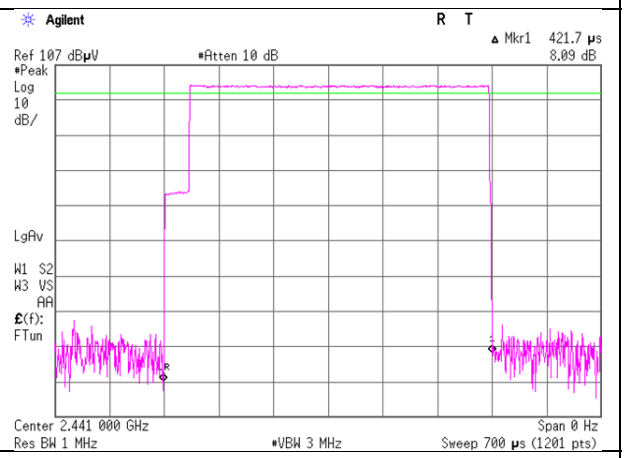
This device complies with the Bluetooth protocol for FHSS operation, employing a pseudo random channel selection and hopping rate to ensure that the occupancy time in N x 0.4 s, where N is the number of channels being used in the hopping sequence ($20 \leq N \leq 79$), is always less than 0.4 s regardless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

Dwell time

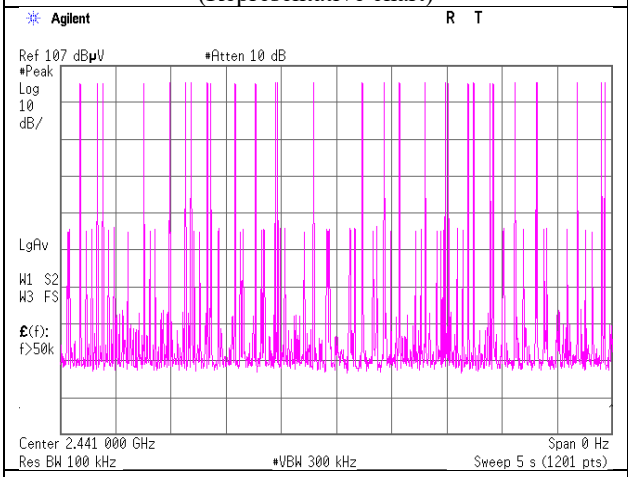
DH1 (1/2)
(Representative chart)



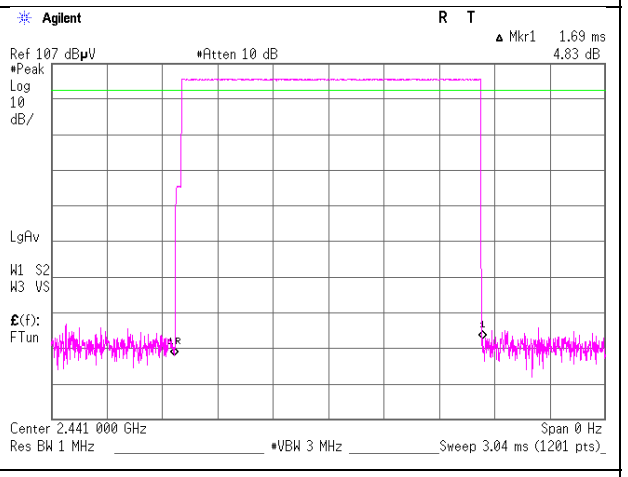
DH1 (2/2)



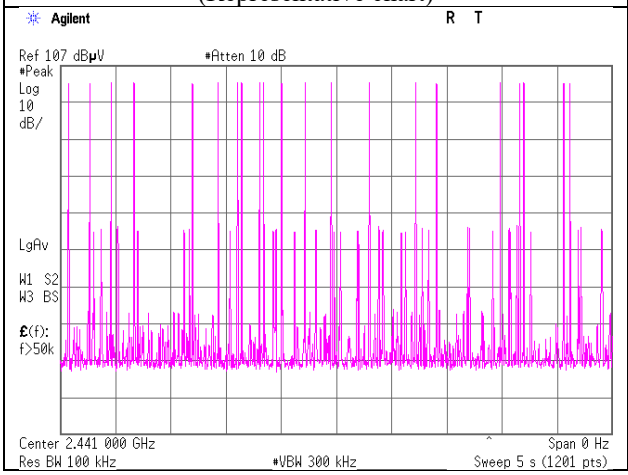
DH3 (1/2)
(Representative chart)



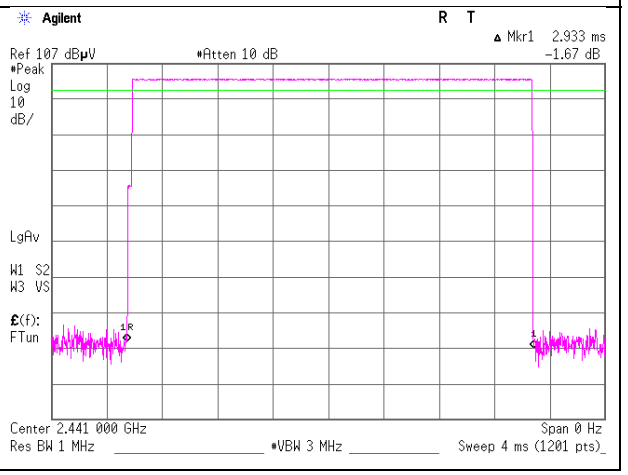
DH3 (2/2)



DH5 (1/2)
(Representative chart)

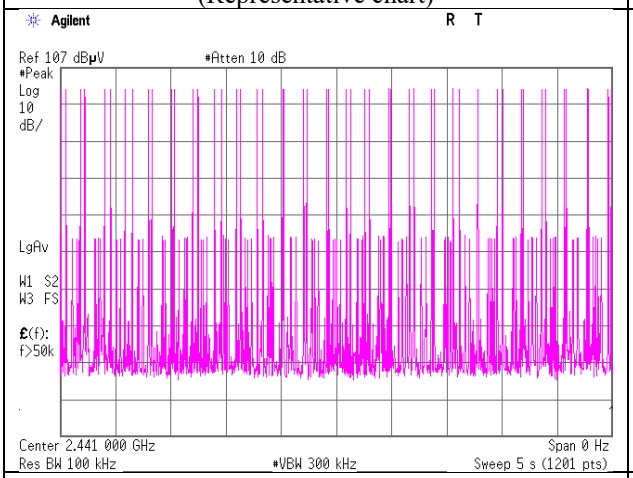


DH5 (2/2)

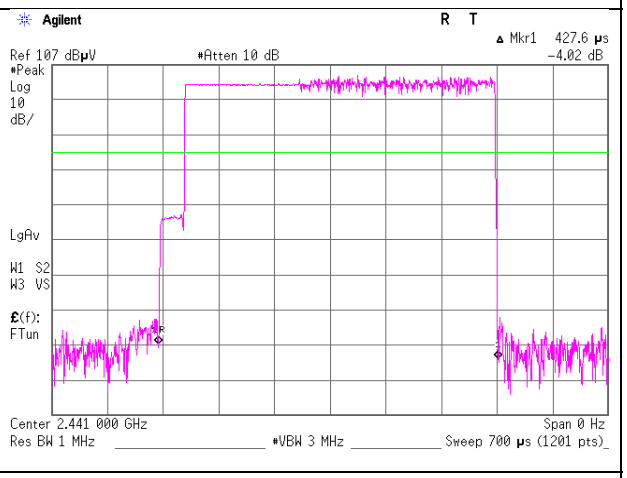


Dwell time

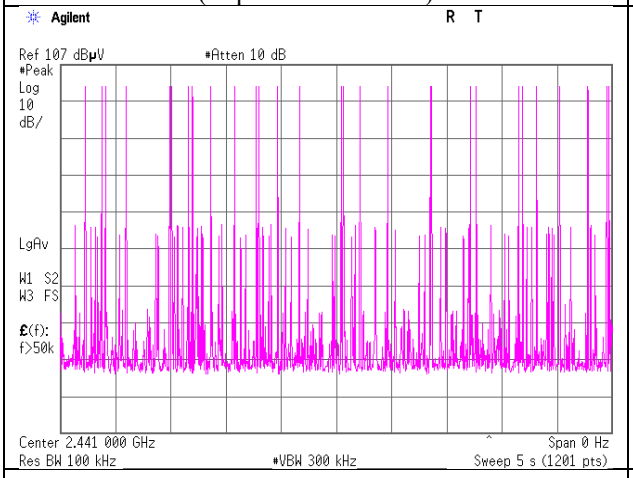
3DH1 (1/2)
(Representative chart)



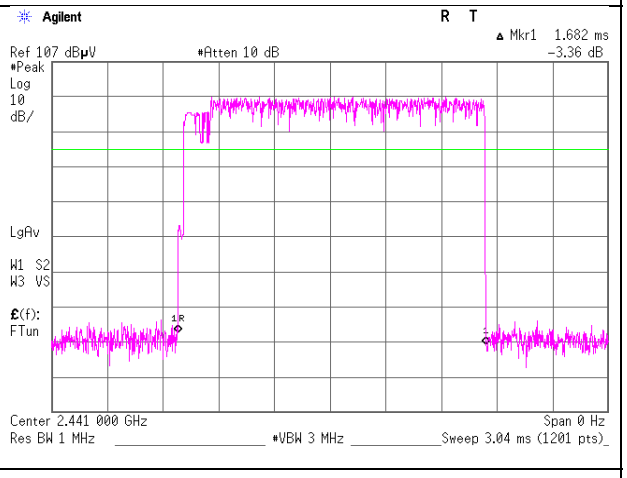
3DH1 (2/2)



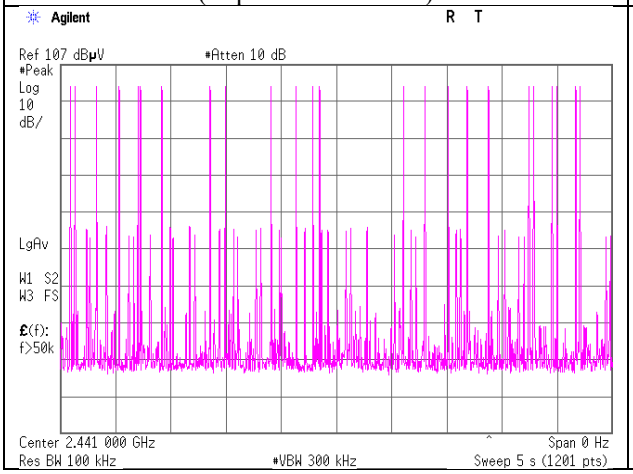
3DH3 (1/2)
(Representative chart)



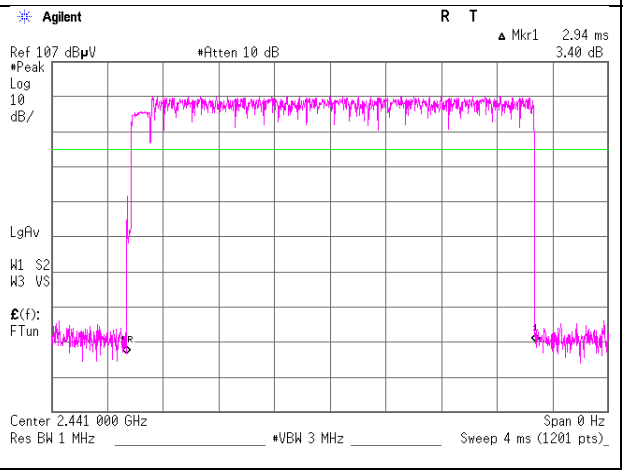
3DH3 (2/2)



3DH5 (1/2)
(Representative chart)



3DH5 (2/2)



Maximum Peak Output Power

Test place	Ise EMC Lab. No.6 Measurement Room
Date	December 22, 2022
Temperature / Humidity	23 deg. C / 45 % RH
Engineer	Tetsuro Yoshida
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	-4.84	0.77	10.02	5.95	3.94	20.96	125	15.01	0.14	6.09	4.07	36.02	4000	29.93
DH5	2441.0	-4.94	0.81	10.02	5.89	3.88	20.96	125	15.07	0.14	6.03	4.01	36.02	4000	29.99
DH5	2480.0	-5.67	0.85	10.02	5.20	3.31	20.96	125	15.76	0.14	5.34	3.42	36.02	4000	30.68
2DH5	2402.0	-3.29	0.77	10.02	7.50	5.63	20.96	125	13.46	0.14	7.64	5.81	36.02	4000	28.38
2DH5	2441.0	-3.49	0.81	10.02	7.34	5.42	20.96	125	13.62	0.14	7.48	5.60	36.02	4000	28.54
2DH5	2480.0	-4.17	0.85	10.02	6.70	4.67	20.96	125	14.26	0.14	6.84	4.83	36.02	4000	29.18
3DH5	2402.0	-2.97	0.77	10.02	7.82	6.06	20.96	125	13.14	0.14	7.96	6.26	36.02	4000	28.06
3DH5	2441.0	-3.19	0.81	10.02	7.64	5.81	20.96	125	13.32	0.14	7.78	6.00	36.02	4000	28.24
3DH5	2480.0	-3.77	0.85	10.02	7.10	5.12	20.96	125	13.86	0.14	7.24	5.29	36.02	4000	28.78

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: 20 ch) 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 20 dB BW without 2/3 relaxation, 125 mW power limit was applied to it.

Average Output Power
(Reference data for RF Exposure)

Test place	Ise EMC Lab. No.6 Measurement Room
Date	December 22, 2022
Temperature / Humidity	23 deg. C / 45 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off

Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average) [dBm]	Result (Time average) [mW]	Duty factor [dB]	Result (Burst power average) [dBm]	Result (Burst power average) [mW]
DH5	2402.0	-6.27	0.77	10.02	4.52	2.83	1.08	5.60	3.63
DH5	2441.0	-6.38	0.81	10.02	4.45	2.79	1.08	5.53	3.58
DH5	2480.0	-7.14	0.85	10.02	3.73	2.36	1.08	4.81	3.02
2DH5	2402.0	-6.90	0.77	10.02	3.89	2.45	1.07	4.96	3.14
2DH5	2441.0	-7.13	0.81	10.02	3.70	2.35	1.07	4.77	3.00
2DH5	2480.0	-7.87	0.85	10.02	3.00	1.99	1.07	4.07	2.55
3DH5	2402.0	-6.85	0.77	10.02	3.94	2.48	1.07	5.01	3.17
3DH5	2441.0	-7.15	0.81	10.02	3.68	2.34	1.07	4.75	2.99
3DH5	2480.0	-7.78	0.85	10.02	3.09	2.04	1.07	4.16	2.60

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

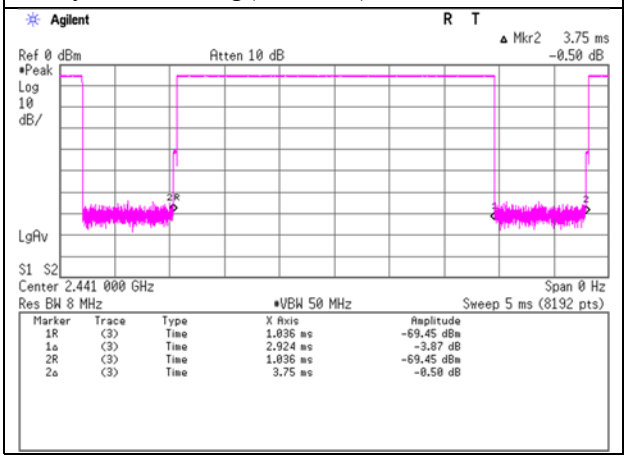
*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst Rate Confirmation

Test place	Ise EMC Lab. No.6 Measurement Room
Date	December 22, 2022
Temperature / Humidity	23 deg. C / 45 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off

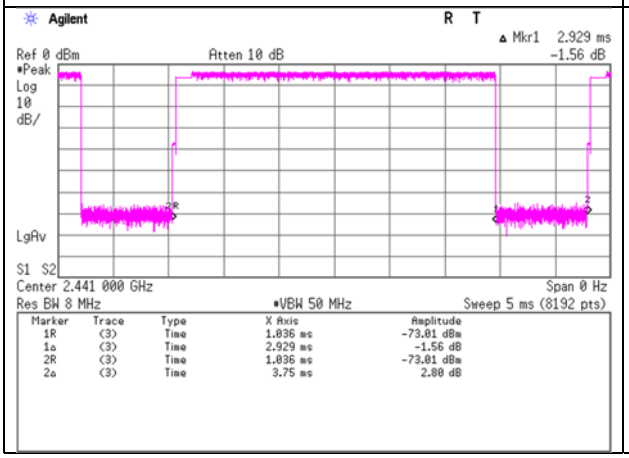
DH5

Tx on / (Tx on + Tx off) =	**0.780**
Tx on / (Tx on + Tx off) * 100 =	**78.0 %**
Duty factor = 10 * log (3.75 / 2.924) =	**1.08 dB**



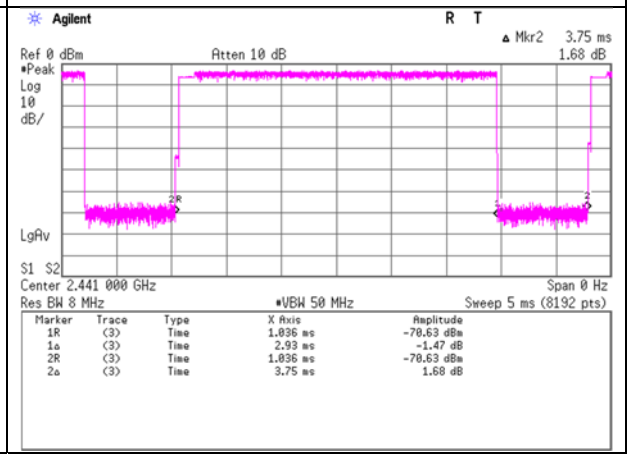
2DH5

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) =	**0.781**
Tx on / (Tx on + Tx off) * 100 =	**78.1 %**
Duty factor = 10 * log (3.75 / 2.93) =	**1.07 dB**



Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	January 5, 2023	January 8, 2023
Temperature / Humidity	20 deg. C / 40 % RH	22 deg. C / 42 % RH
Engineer	Keiya Ido	Keiya Ido
	(1 GHz -10 GHz)	(Above 10 GHz)
Mode	Tx, Hopping Off, DH5 2402 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	1300.0	59.1	46.9	26.0	4.0	36.7	-	52.4	40.2	73.9	53.9	21.5	13.7	
Hori.	2390.0	45.4	36.7	27.6	4.8	36.3	1.1	41.6	33.9	73.9	53.9	32.4	20.0	*1)
Hori.	4804.0	42.5	35.1	31.5	6.7	35.8	-	45.0	37.6	73.9	53.9	28.9	16.3	Floor noise
Hori.	7206.0	43.3	35.4	35.9	7.4	35.9	-	50.7	42.8	73.9	53.9	23.2	11.1	Floor noise
Hori.	9608.0	45.0	36.2	38.7	8.2	36.3	-	55.6	46.8	73.9	53.9	18.3	7.1	Floor noise
Vert.	1300.0	61.7	51.0	26.0	4.0	36.7	-	55.0	44.3	73.9	53.9	18.9	9.6	
Vert.	2390.0	45.5	36.6	27.6	4.8	36.3	1.1	41.6	33.8	73.9	53.9	32.3	20.1	*1)
Vert.	4804.0	42.8	34.9	31.5	6.7	35.8	-	45.3	37.5	73.9	53.9	28.6	16.5	Floor noise
Vert.	7206.0	43.5	35.5	35.9	7.4	35.9	-	50.9	42.9	73.9	53.9	23.0	11.0	Floor noise
Vert.	9608.0	43.7	36.1	38.7	8.2	36.3	-	54.3	46.7	73.9	53.9	19.6	7.2	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= 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).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)

20dBc Data Sheet

Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.0	99.9	27.6	4.8	36.3	96.0	-	-	Carrier
Hori.	2400.0	41.7	27.6	4.8	36.3	37.8	76.0	38.3	
Vert.	2402.0	100.3	27.6	4.8	36.3	96.4	-	-	Carrier
Vert.	2400.0	41.2	27.6	4.8	36.3	37.3	76.4	39.2	

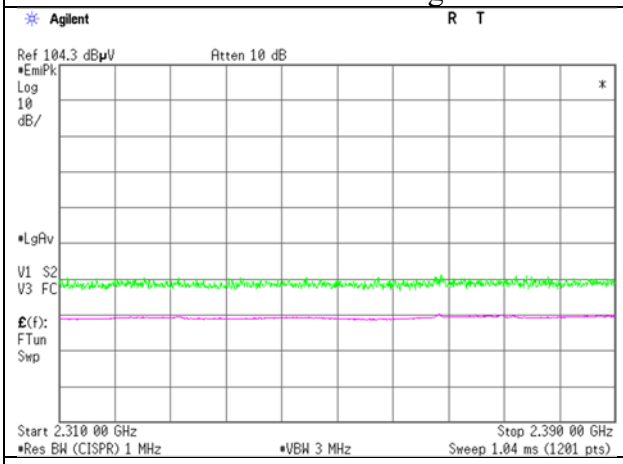
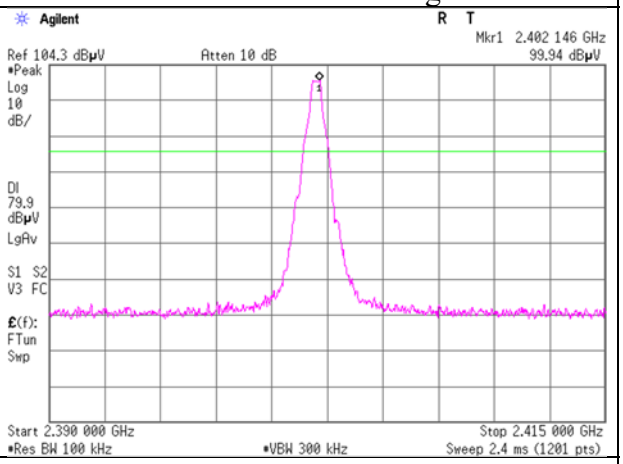
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

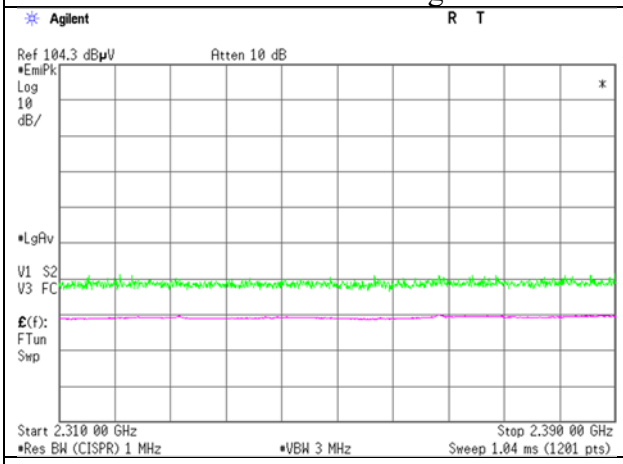
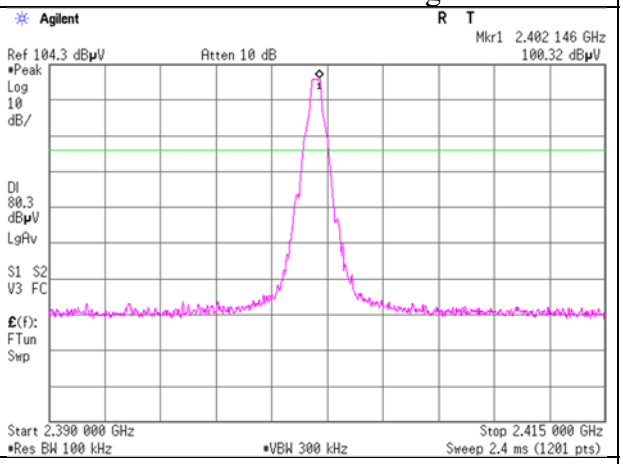
Distance factor: 1 GHz - 10 GHz 20log (3.85 m / 3.0 m) = 2.17 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

***These results have sufficient margin without taking account Duty cycle correction factor.**

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	January 5, 2023
Temperature / Humidity	20 deg. C / 40 % RH
Engineer	Keiya Ido (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

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	January 5, 2023	January 8, 2023
Temperature / Humidity	20 deg. C / 40 % RH	22 deg. C / 42 % RH
Engineer	Keiya Ido	Keiya Ido
	(1 GHz -10 GHz)	(Above 10 GHz)
Mode	Tx, Hopping Off, DH5 2441 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	1300.0	58.9	46.8	26.0	4.0	36.7	-	52.2	40.1	73.9	53.9	21.7	13.8	
Hori.	4882.0	44.4	35.6	31.6	6.7	35.7	1.1	46.9	39.2	73.9	53.9	27.0	14.7	
Hori.	7323.0	43.2	35.2	36.1	7.4	35.9	-	50.8	42.8	73.9	53.9	23.1	11.1	Floor noise
Hori.	9764.0	43.9	35.7	39.1	8.3	36.4	-	54.9	46.8	73.9	53.9	19.0	7.1	Floor noise
Vert.	1300.0	60.6	50.8	26.0	4.0	36.7	-	53.9	44.1	73.9	53.9	20.0	9.8	
Vert.	4882.0	44.7	37.2	31.6	6.7	35.7	1.1	47.3	40.8	73.9	53.9	26.7	13.1	
Vert.	7323.0	43.3	35.2	36.1	7.4	35.9	-	50.9	42.8	73.9	53.9	23.0	11.1	Floor noise
Vert.	9764.0	43.7	35.8	39.1	8.3	36.4	-	54.7	46.8	73.9	53.9	19.2	7.1	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= 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).
*QP detector was used up to 1GHz.

Distance factor:	1 GHz - 10 GHz	20log (3.85 m / 3.0 m) = 2.17 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	January 5, 2023	January 8, 2023
Temperature / Humidity	20 deg. C / 40 % RH	22 deg. C / 42 % RH
Engineer	Keiya Ido	Keiya Ido
	(1 GHz -10 GHz)	(Above 10 GHz)
Mode	Tx, Hopping Off, DH5 2480 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	1300.0	59.0	46.8	26.0	4.0	36.7	-	52.3	40.1	73.9	53.9	21.6	13.8	
Hori.	2483.5	50.7	38.2	27.5	4.8	36.3	1.1	46.7	35.3	73.9	53.9	27.2	18.6	*1)
Hori.	4960.0	43.2	34.8	31.7	6.7	35.7	-	45.9	37.4	73.9	53.9	28.0	16.5	Floor noise
Hori.	7440.0	43.9	35.2	36.3	7.4	35.9	-	51.7	43.0	73.9	53.9	22.2	10.9	Floor noise
Hori.	9920.0	44.0	35.5	39.1	8.3	36.4	-	55.0	46.4	73.9	53.9	18.9	7.5	Floor noise
Vert.	1300.0	60.7	50.7	26.0	4.0	36.7	-	54.0	44.0	73.9	53.9	19.9	9.9	
Vert.	2483.5	50.7	38.6	27.5	4.8	36.3	1.1	46.8	35.7	73.9	53.9	27.1	18.2	*1)
Vert.	4960.0	43.3	34.9	31.7	6.7	35.7	-	45.9	37.5	73.9	53.9	28.0	16.4	Floor noise
Vert.	7440.0	43.8	35.1	36.3	7.4	35.9	-	51.5	42.8	73.9	53.9	22.4	11.1	Floor noise
Vert.	9920.0	43.8	35.6	39.1	8.3	36.4	-	54.8	46.5	73.9	53.9	19.1	7.4	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= 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).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)

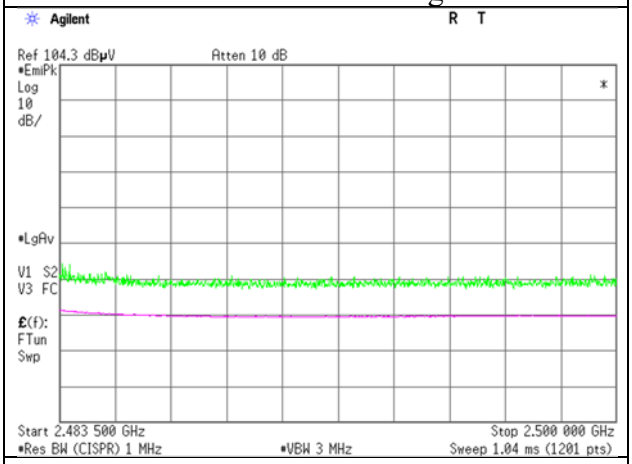
Distance factor:	1 GHz - 10 GHz	20log (3.85 m / 3.0 m) = 2.17 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	January 5, 2023
Temperature / Humidity	20 deg. C / 40 % RH
Engineer	Keiya Ido (1 GHz -10 GHz)
Mode	Tx, Hopping Off, DH5 2480 MHz

Horizontal

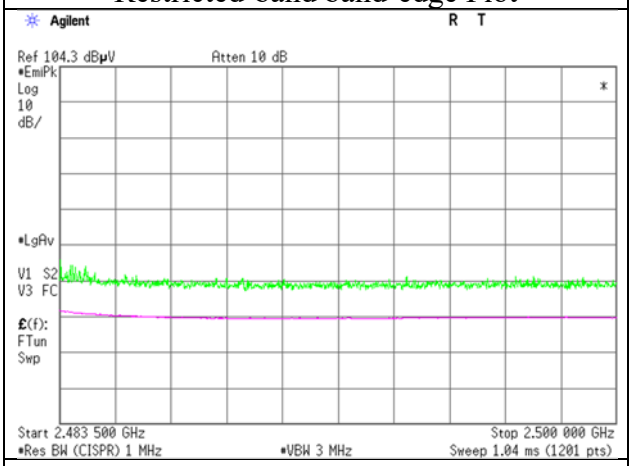
Restricted-band band-edge Plot



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

Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.1	No.1	No.1
Date	January 6, 2023	January 8, 2023	January 11, 2023
Temperature / Humidity	21 deg. C / 40 % RH	22 deg. C / 42 % RH	19 deg. C / 39 % RH
Engineer	Keiya Ido	Keiya Ido	Keiya Ido
	(1 GHz -10 GHz)	(Above 10 GHz)	(Below 1 GHz)
Mode	Tx, Hopping Off, 3DH5 2402 MHz		

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	146.2	41.3	-	14.7	9.0	39.1	-	25.9	-	43.5	-	17.6	-	
Hori.	200.0	42.6	-	16.5	9.6	39.1	-	29.6	-	43.5	-	13.9	-	
Hori.	243.7	57.2	-	12.9	10.0	39.0	-	41.0	-	46.0	-	5.0	-	
Hori.	389.4	50.0	-	16.0	11.1	38.7	-	38.5	-	46.0	-	7.5	-	
Hori.	408.0	43.4	-	16.7	11.3	38.7	-	32.8	-	46.0	-	13.2	-	
Hori.	926.3	34.4	-	22.3	14.4	38.2	-	32.9	-	46.0	-	13.1	-	
Hori.	1300.0	58.7	47.6	26.0	4.0	36.7	-	52.0	40.9	73.9	53.9	21.9	13.0	
Hori.	2390.0	45.4	37.0	27.6	4.8	36.3	1.1	41.5	34.2	73.9	53.9	32.4	19.7	*1)
Hori.	4804.0	42.6	35.0	31.5	6.7	35.8	-	45.1	37.5	73.9	53.9	28.8	16.4	Floor noise
Hori.	7206.0	43.1	35.8	35.9	7.4	35.9	-	50.6	43.2	73.9	53.9	23.4	10.7	Floor noise
Hori.	9608.0	44.4	36.4	38.7	8.2	36.3	-	55.0	47.0	73.9	53.9	18.9	6.9	Floor noise
Vert.	146.2	38.9	-	14.7	9.0	39.1	-	23.5	-	43.5	-	20.0	-	
Vert.	200.0	36.7	-	16.5	9.6	39.1	-	23.7	-	43.5	-	19.8	-	
Vert.	243.7	51.4	-	12.9	10.0	39.0	-	35.2	-	46.0	-	10.8	-	
Vert.	389.4	45.6	-	16.0	11.1	38.7	-	34.1	-	46.0	-	11.9	-	
Vert.	408.0	38.9	-	16.7	11.3	38.7	-	28.3	-	46.0	-	17.7	-	
Vert.	926.3	33.9	-	22.3	14.4	38.2	-	32.4	-	46.0	-	13.6	-	
Vert.	1300.0	61.4	50.8	26.0	4.0	36.7	-	54.7	44.1	73.9	53.9	19.2	9.8	
Vert.	2390.0	45.5	36.9	27.6	4.8	36.3	1.1	41.6	34.1	73.9	53.9	32.3	19.8	*1)
Vert.	4804.0	42.9	34.9	31.5	6.7	35.8	-	45.4	37.4	73.9	53.9	28.5	16.5	Floor noise
Vert.	7206.0	43.5	35.4	35.9	7.4	35.9	-	51.0	42.8	73.9	53.9	23.0	11.1	Floor noise
Vert.	9608.0	44.4	36.6	38.7	8.2	36.3	-	55.0	47.3	73.9	53.9	18.9	6.6	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= 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).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)

20dBc Data Sheet

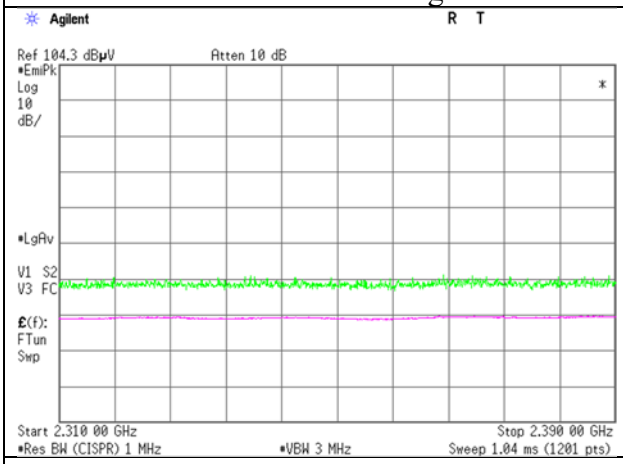
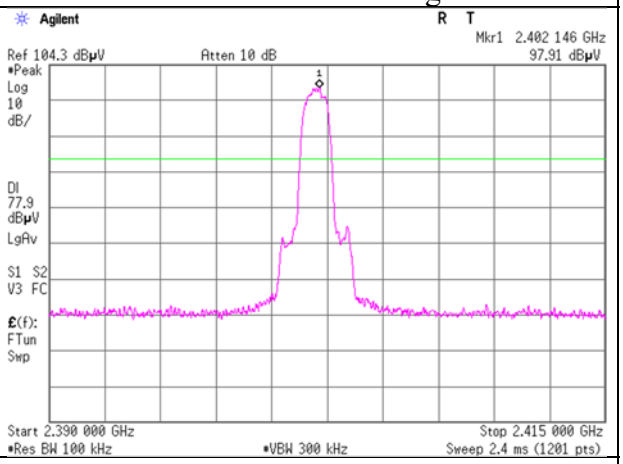
Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.0	97.9	27.6	4.8	36.3	94.0	-	-	Carrier
Hori.	2400.0	40.5	27.6	4.8	36.3	36.6	74.0	37.4	
Vert.	2402.0	99.4	27.6	4.8	36.3	95.5	-	-	Carrier
Vert.	2400.0	41.2	27.6	4.8	36.3	37.3	75.5	38.2	

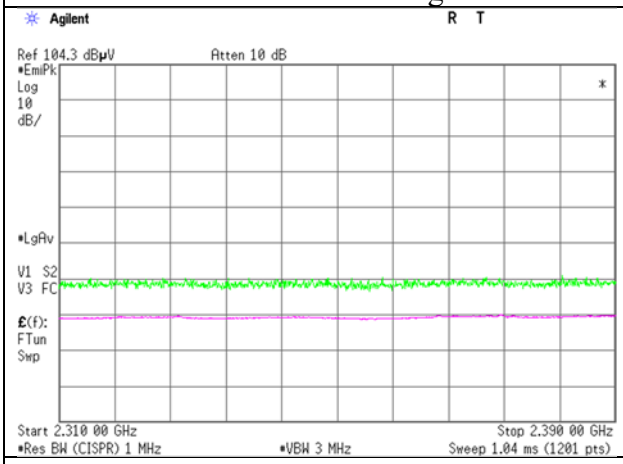
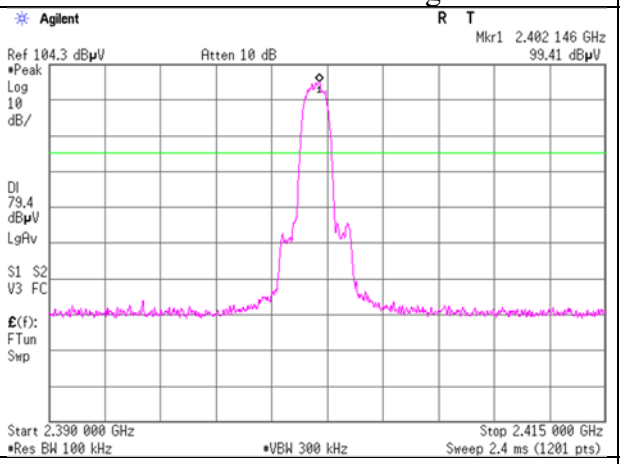
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

Distance factor: 1 GHz - 10 GHz 20log (3.85 m / 3.0 m) = 2.17 dB
10 GHz - 26.5 GHz 20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	January 6, 2023
Temperature / Humidity	21 deg. C / 40 % RH
Engineer	Keiya Ido (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

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	January 6, 2023	January 8, 2023
Temperature / Humidity	21 deg. C / 40 % RH	22 deg. C / 42 % RH
Engineer	Keiya Ido	Keiya Ido
	(1 GHz -10 GHz)	(Above 10 GHz)
Mode	Tx, Hopping Off, 3DH5 2441 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	1300.0	58.5	47.1	26.0	4.0	36.7	-	51.8	40.4	73.9	53.9	22.1	13.5	
Hori.	4882.0	44.9	35.7	31.6	6.7	35.7	1.1	47.4	39.3	73.9	53.9	26.5	14.6	
Hori.	7323.0	43.3	35.6	36.1	7.4	35.9	-	50.9	43.1	73.9	53.9	23.0	10.8	Floor noise
Hori.	9764.0	43.8	36.1	39.1	8.3	36.4	-	54.8	47.1	73.9	53.9	19.1	6.8	Floor noise
Vert.	1300.0	61.0	50.7	26.0	4.0	36.7	-	54.3	44.0	73.9	53.9	19.6	9.9	
Vert.	4882.0	45.4	37.3	31.6	6.7	35.7	1.1	47.9	40.9	73.9	53.9	26.0	13.0	
Vert.	7323.0	43.1	35.1	36.1	7.4	35.9	-	50.7	42.7	73.9	53.9	23.2	11.2	Floor noise
Vert.	9764.0	44.1	35.9	39.1	8.3	36.4	-	55.1	46.9	73.9	53.9	18.8	7.0	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= 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).
*QP detector was used up to 1GHz.

Distance factor:	1 GHz - 10 GHz	20log (3.85 m / 3.0 m) = 2.17 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.1	No.1
Date	January 6, 2023	January 8, 2023
Temperature / Humidity	21 deg. C / 40 % RH	22 deg. C / 42 % RH
Engineer	Keiya Ido	Keiya Ido
	(1 GHz -10 GHz)	(Above 10 GHz)
Mode	Tx, Hopping Off, 3DH5 2480 MHz	

Polarity [Hori/Vert]	Frequency [MHz]	Reading (QP / PK) [dBuV]	Reading (AV) [dBuV]	Ant. Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result (QP / PK) [dBuV/m]	Result (AV) [dBuV/m]	Limit (QP / PK) [dBuV/m]	Limit (AV) [dBuV/m]	Margin (QP / PK) [dB]	Margin (AV) [dB]	Remark
Hori.	1300.0	59.2	46.9	26.0	4.0	36.7	-	52.5	40.2	73.9	53.9	21.4	13.7	
Hori.	2483.5	48.5	38.3	27.5	4.8	36.3	1.1	44.6	35.4	73.9	53.9	29.4	18.5	*1)
Hori.	4960.0	43.1	34.8	31.7	6.7	35.7	-	45.7	37.4	73.9	53.9	28.2	16.5	Floor noise
Hori.	7440.0	43.9	35.0	36.3	7.4	35.9	-	51.6	42.7	73.9	53.9	22.3	11.2	Floor noise
Hori.	9920.0	43.9	35.1	39.1	8.3	36.4	-	54.8	46.1	73.9	53.9	19.1	7.8	Floor noise
Vert.	1300.0	60.9	50.4	26.0	4.0	36.7	-	54.2	43.7	73.9	53.9	19.7	10.2	
Vert.	2483.5	50.3	38.8	27.5	4.8	36.3	1.1	46.3	35.9	73.9	53.9	27.6	18.0	*1)
Vert.	4960.0	43.4	35.0	31.7	6.7	35.7	-	46.1	37.6	73.9	53.9	27.8	16.3	Floor noise
Vert.	7440.0	43.7	35.1	36.3	7.4	35.9	-	51.5	42.8	73.9	53.9	22.4	11.1	Floor noise
Vert.	9920.0	43.9	35.4	39.1	8.3	36.4	-	54.9	46.4	73.9	53.9	19.0	7.5	Floor noise

Result (QP / PK) = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amplifier)
Result (AV)= 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).
*QP detector was used up to 1GHz.
*1) Not Out of Band emission(Leakage Power)

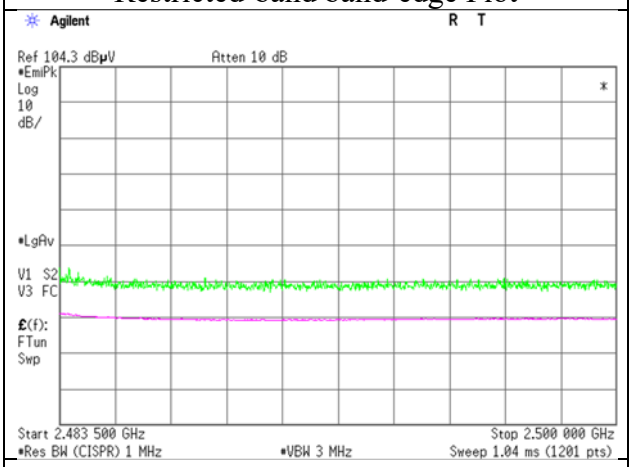
Distance factor:	1 GHz - 10 GHz	20log (3.85 m / 3.0 m) = 2.17 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	January 6, 2023
Temperature / Humidity	21 deg. C / 40 % RH
Engineer	Keiya Ido (1 GHz -10 GHz)
Mode	Tx, Hopping Off, 3DH5 2480 MHz

Horizontal

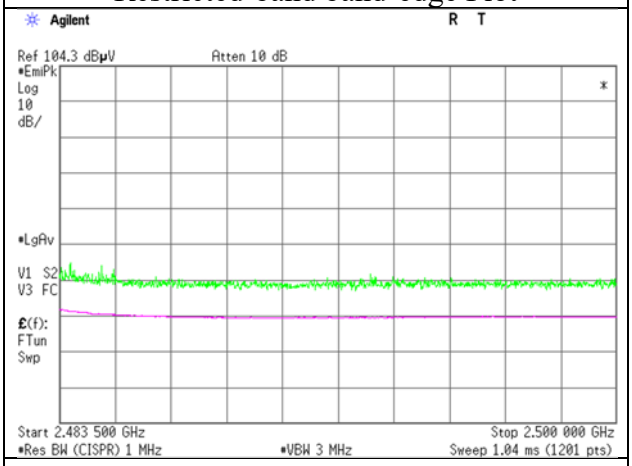
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

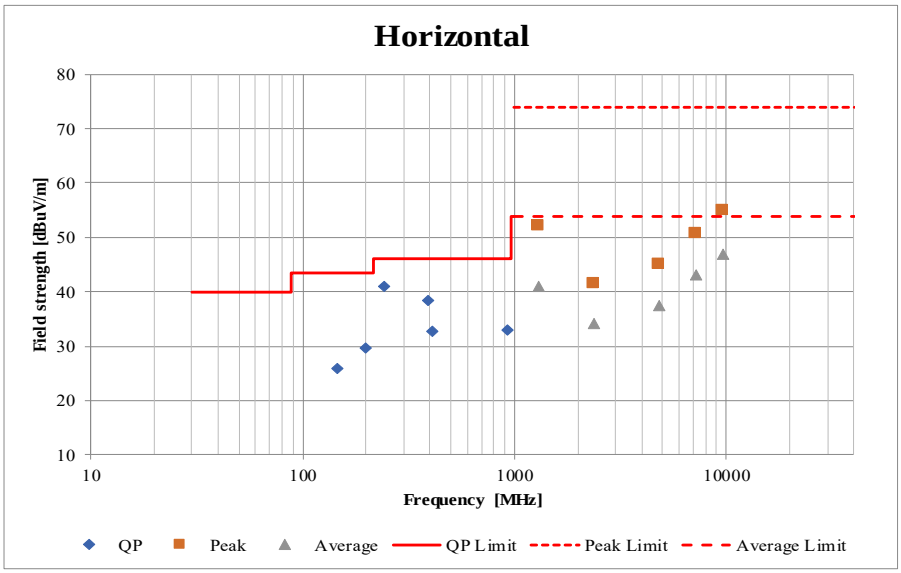


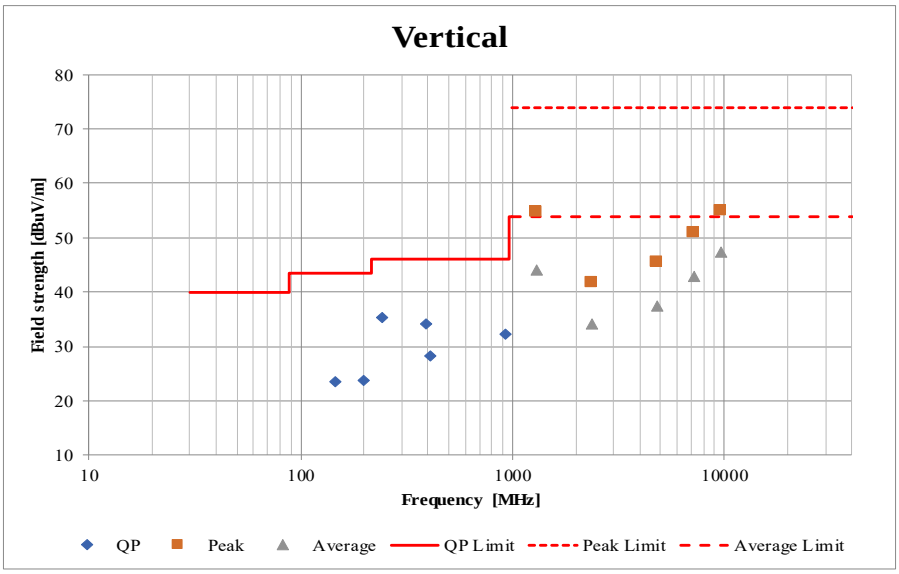
Trace Green : Peak Plot
Trace Purple : Average Plot

* 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 mode for Maximum Peak Output Power)

Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.1	No.1	No.1
Date	January 6, 2023	January 8, 2023	January 11, 2023
Temperature / Humidity	21 deg. C / 40 % RH	22 deg. C / 42 % RH	19 deg. C / 39 % RH
Engineer	Keiya Ido (1 GHz -10 GHz)	Keiya Ido (Above 10 GHz)	Keiya Ido (Below 1 GHz)
Mode	Tx, Hopping Off, 3DH5 2402 MHz		





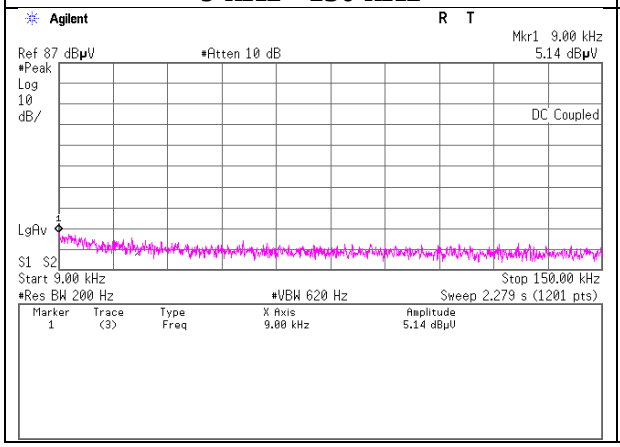
*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

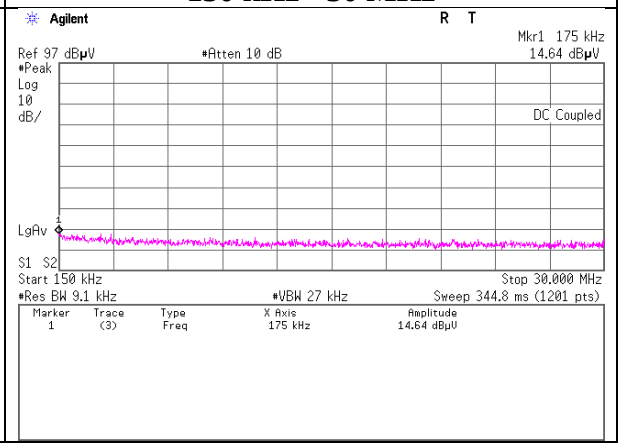
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off, DH5

2402 MHz

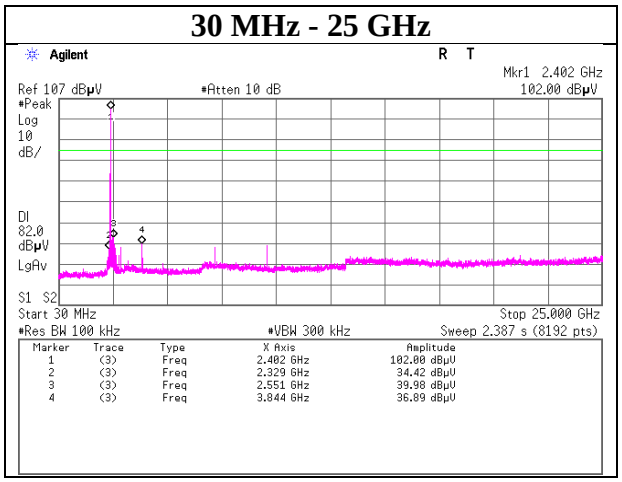
9 kHz - 150 kHz



150 kHz - 30 MHz



30 MHz - 25 GHz

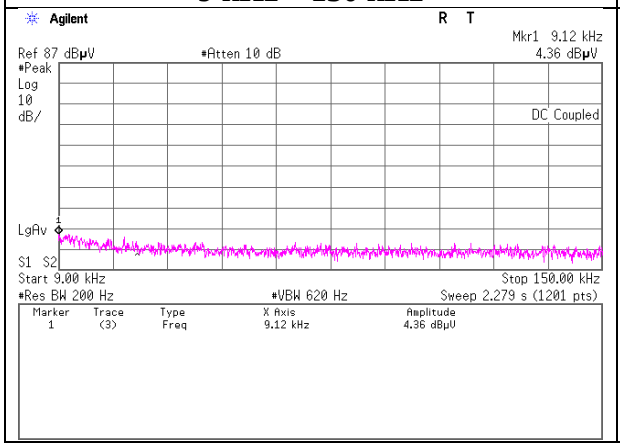


Conducted Spurious Emission

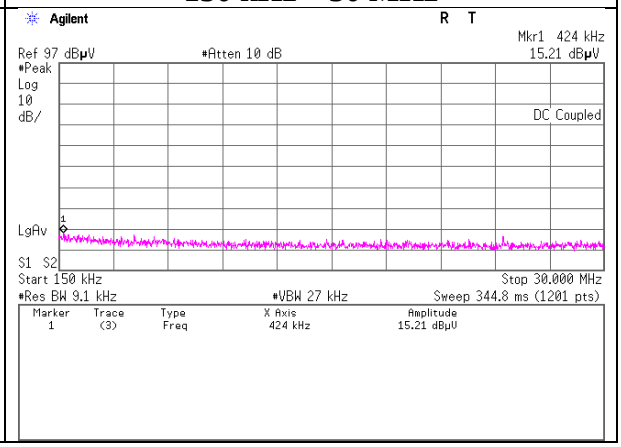
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off, DH5

2441 MHz

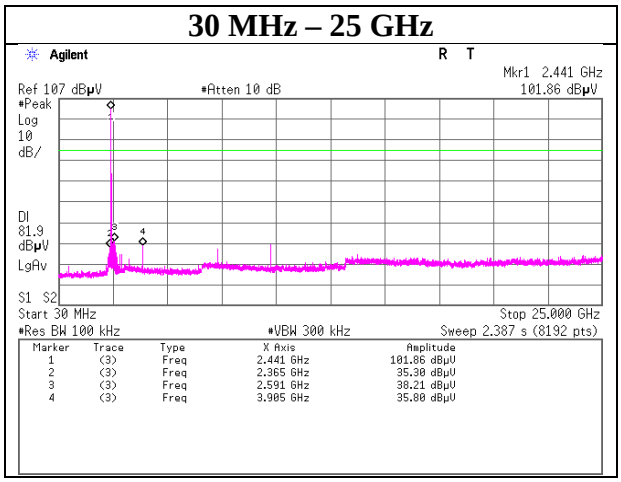
9 kHz – 150 kHz



150 kHz – 30 MHz



30 MHz – 25 GHz

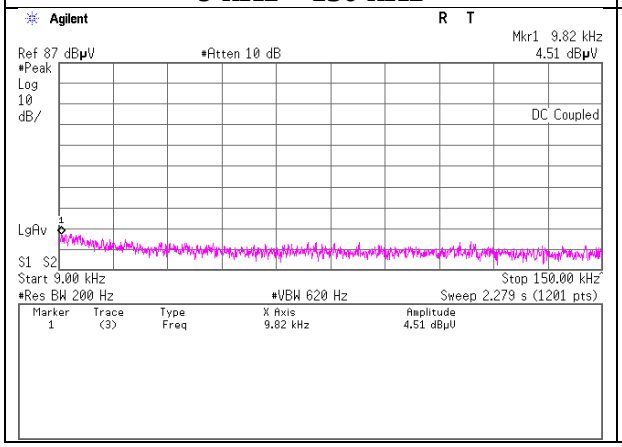


Conducted Spurious Emission

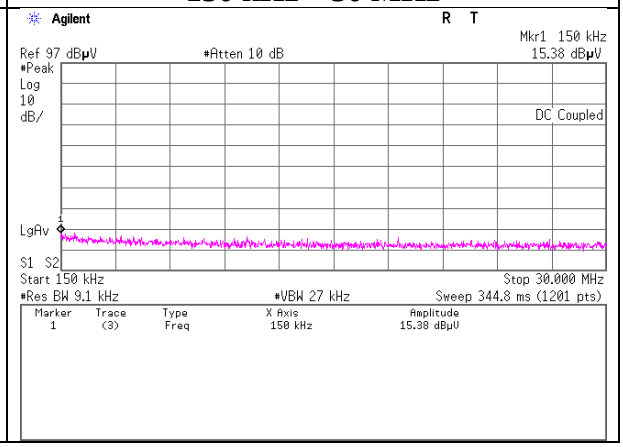
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off, DH5

2480 MHz

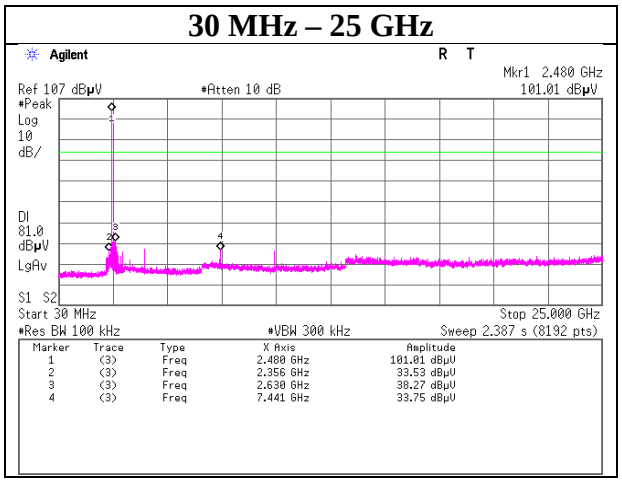
9 kHz – 150 kHz



150 kHz – 30 MHz



30 MHz – 25 GHz

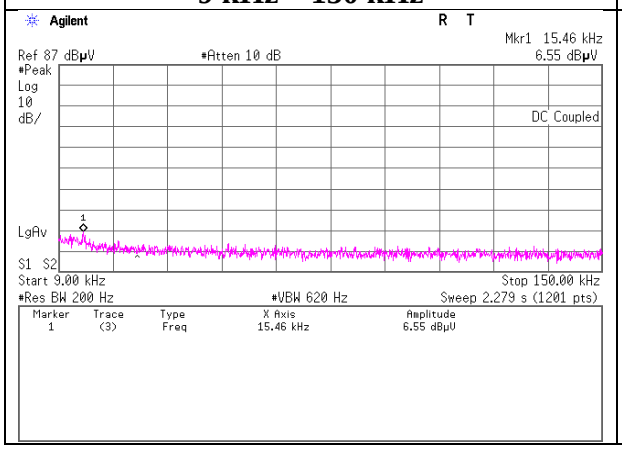


Conducted Spurious Emission

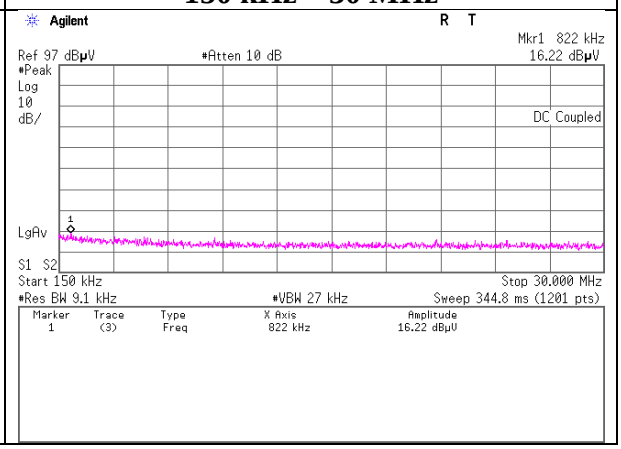
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off, 3DH5

2402 MHz

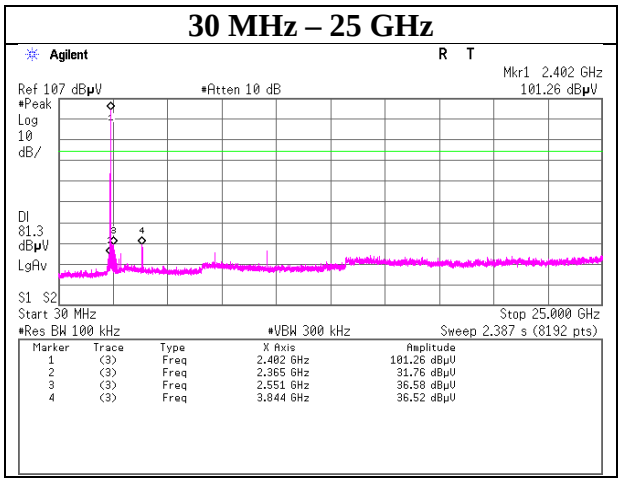
9 kHz – 150 kHz



150 kHz – 30 MHz



30 MHz – 25 GHz

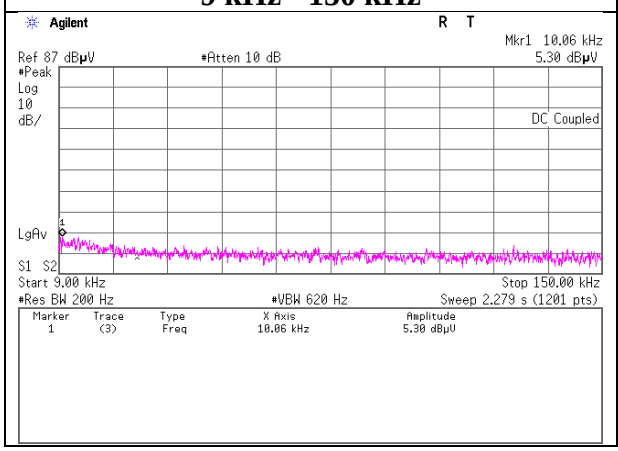


Conducted Spurious Emission

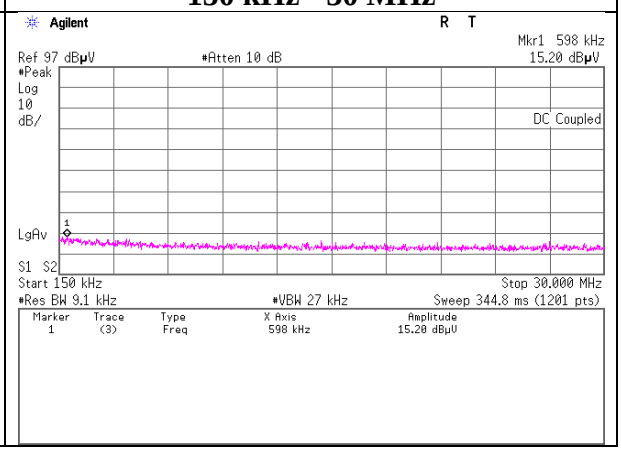
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off, 3DH5

2441 MHz

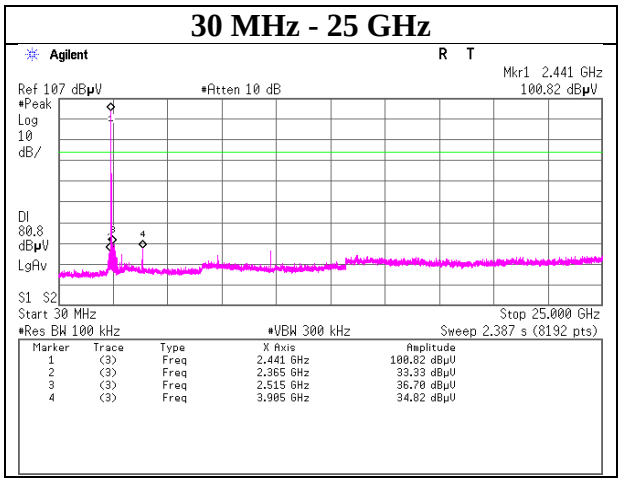
9 kHz - 150 kHz



150 kHz - 30 MHz



30 MHz - 25 GHz

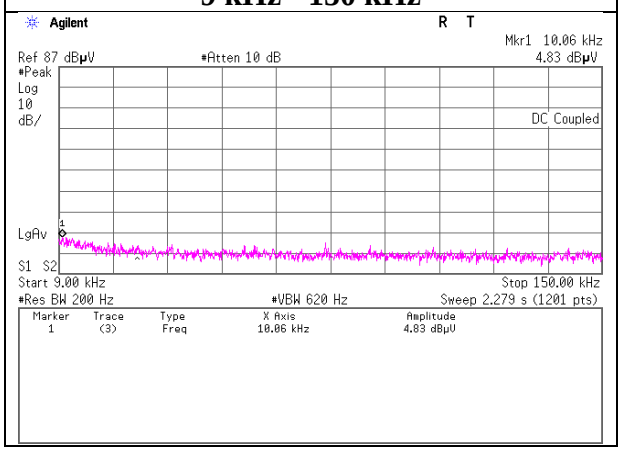


Conducted Spurious Emission

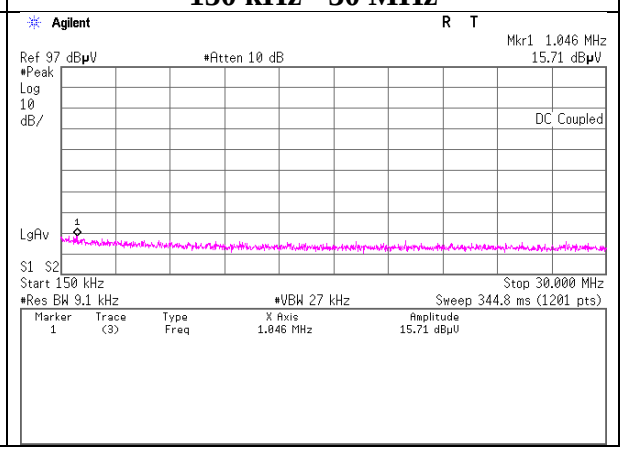
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx, Hopping Off, 3DH5

2480 MHz

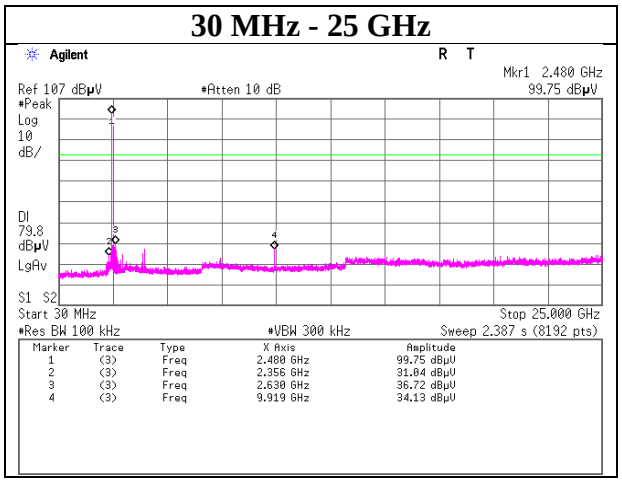
9 kHz - 150 kHz



150 kHz - 30 MHz



30 MHz - 25 GHz

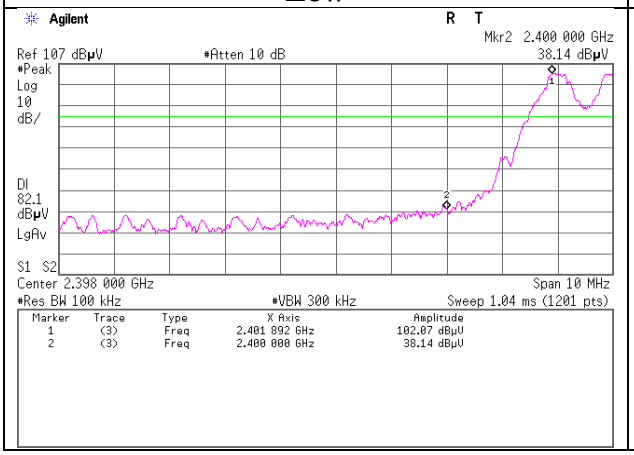


Conducted Emission Band Edge compliance

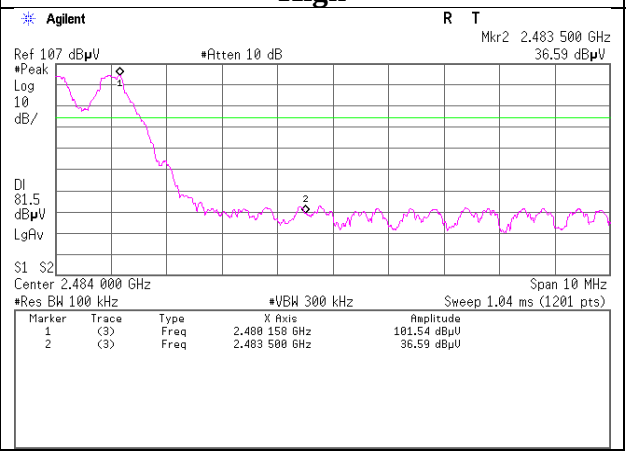
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx DH5

Hopping On

Low

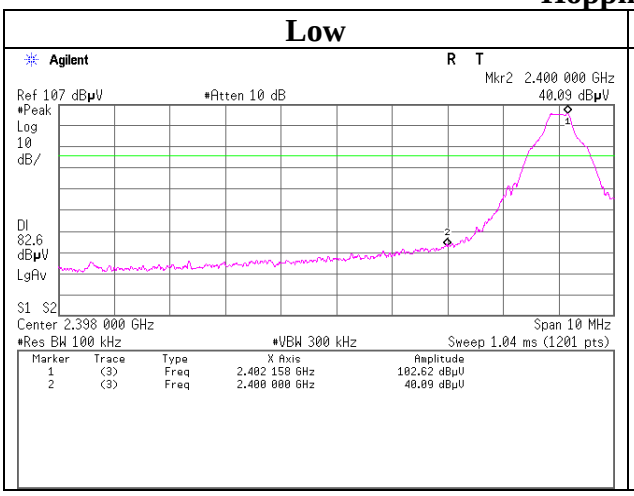


High

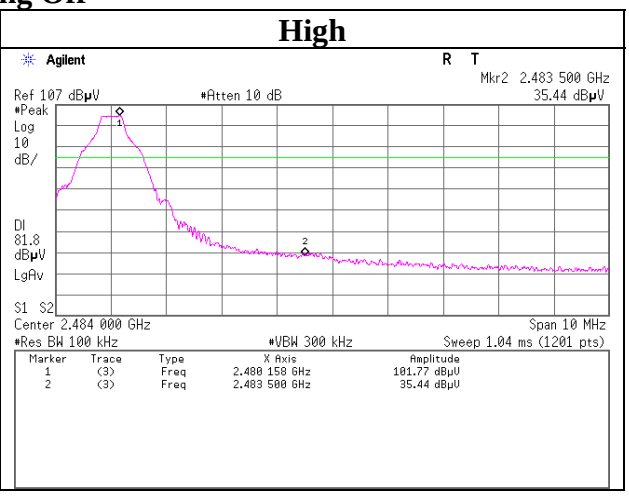


Hopping Off

Low



High

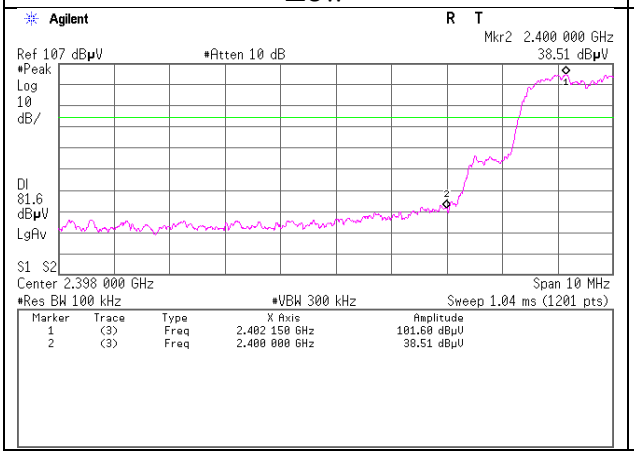


Conducted Emission Band Edge compliance

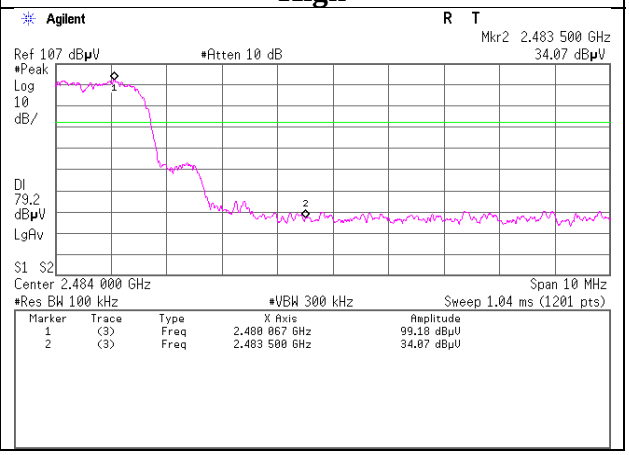
Test place	Ise EMC Lab. No.8 Measurement Room
Date	December 23, 2022
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Tetsuro Yoshida
Mode	Tx 3DH5

Hopping On

Low

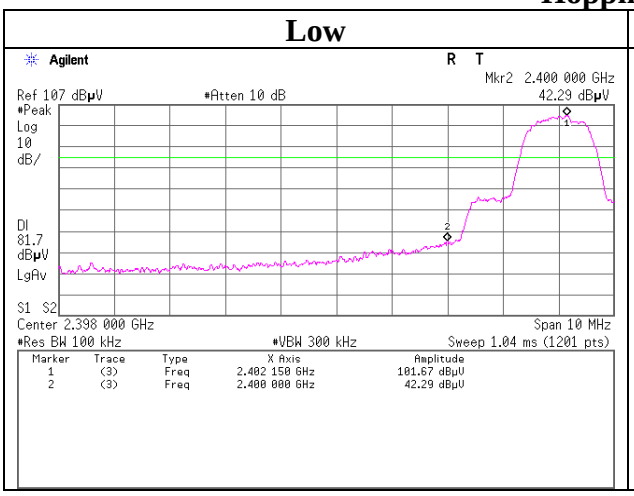


High

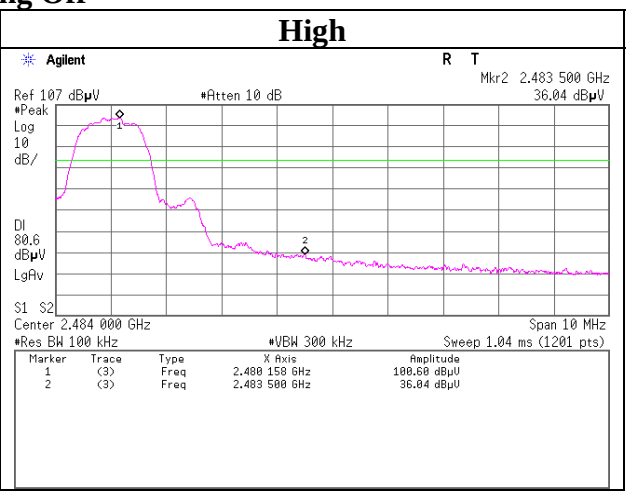


Hopping Off

Low



High



APPENDIX 2: Test Instruments

Test Equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	KBA-05	141198	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+ BBA9106	2513	05/14/2022	12
RE	MAEC-01	141998	AC1_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	06/28/2022	24
RE	MAEC-01-SVSWR	141994	AC1_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 10m	DA-06881	04/05/2021	24
RE	MAT-34	141331	Attenuator(6dB)	TME	UFA-01	-	02/25/2022	12
RE	MCC-02	141350	Coaxial Cable	Suhner/storm/Agilent/TSJ	-	-	03/08/2022	12
RE	MCC-217	141393	Microwave Cable	Junkosha	MWX221	1604S254(1 m) / 1608S088(5 m)	08/02/2022	12
RE	MHA-05	141511	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	253	09/20/2022	12
RE	MHA-17	141506	Horn Antenna 15-40GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9170	BBHA9170307	07/22/2022	12
RE	MHF-06	141404	High Pass Filter 3.5-24GHz	TOKIMEC	TF323DCA	601	05/19/2022	12
RE	MJM-25	142226	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	MLA-20	141264	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	189	05/14/2022	12
RE	MMM-09	141533	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201195	01/16/2022	12
RE	MOS-27	141566	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	A08Q26	01/10/2022	12
RE	MPA-01	141576	Pre Amplifier	Keysight Technologies Inc	8449B	3008A01671	02/22/2022	12
RE	MPA-19	141585	Pre Amplifier	MITEQ	MLA-10K01-B01-35	1237616	02/28/2022	12
RE	MSA-03	141884	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY44020357	03/31/2022	12
RE	MTR-09	141950	EMI Test Receiver	Rohde & Schwarz	ESU26	100412	10/11/2022	12
AT	MAT-10	141156	Attenuator(10dB)	Weinschel Corp	2	BL1173	11/10/2022	12
AT	MAT-57	141333	Attenuator(10dB)	Suhner	6810.19.A	-	12/21/2022	12
AT	MCC-38	141395	Coaxial Cable	UL Japan	-	-	11/18/2022	12
AT	MCC-98	141377	Microwave Cable 1G-40GHz	Suhner	SUCOFLEX102	30819/2	06/15/2022	12
AT	MMM-17	141557	DIGIITAL HiTESTER	HIOKI E.E. CORPORATION	3805	70900530	01/16/2022	12
AT	MOS-28	141567	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0008	01/10/2022	12
AT	MPM-12	141809	Power Meter	Anritsu Corporation	ML2495A	825002	05/18/2022	12
AT	MPSE-17	141830	Power sensor	Anritsu Corporation	MA2411B	738285	05/18/2022	12
AT	MSA-14	141901	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY48250080	01/10/2022	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
AT: Antenna Terminal Conducted