RADIO TEST REPORT

Test Report No. 15243440H-A-R1

Customer	**Denso Wave Incorporated**
Description of EUT	**RF Tag Handy Terminal**
Model Number of EUT	**BHT-1408QUMWB**
FCC ID	**PZWBHT1408QUM**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**October 31, 2024**
Remarks	**Bluetooth (BR / EDR) parts**

Representative Test Engineer	Approved By
	
Nachi Konegawa Engineer	Ryota Yamanaka Engineer

CERTIFICATE 5107.02

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☒ There is no testing item of "Non-accreditation".

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REVISION HISTORY

Original Test Report No.: 15243440H-A

This report is a revised version of 15243440H-A. 15243440H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15243440H-A	July 3, 2024	-
1	15243440H-A-R1	October 31, 2024	Correction of the Frequency of Operation for WLAN in Radio Specification of clause 2.2; From 2412 MHz to 2472 MHz To 2412 MHz to 2462 MHz
1	15243440H-A-R1	October 31, 2024	Correction of the note *1) in Section 3.2.
1	15243440H-A-R1	October 31, 2024	Correction of erroneous description in Figure 1: Test Setup (1 GHz to 10 GHz).
1	15243440H-A-R1	October 31, 2024	Addition of "*1)" to the Remarks for 2486.0 MHz in Radiated Spurious Emission test data (DH5 2480 MHz, DH5 2480 MHz)
1	15243440H-A-R1	October 31, 2024	Correction from "6 GHz to 10 GHz" to "6 GHz to 26.5 GHz" in Radiated Spurious Emission.
1	15243440H-A-R1	October 31, 2024	Addition of the information such as date for Below 1 GHz in Radiated Spurious Emission (Plot data).

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 Wave Incorporated
Address	1 Yoshiike, Kusagi, Agui-cho, Chita-gun, Aichi 470-2297 Japan
Telephone Number	+81-569-49-5284
Contact Person	Shoji Ogiso

The information provided by 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

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	RF Tag Handy Terminal
Model Number	BHT-1408QUMWB
Serial Number	Refer to SECTION 4.2
Condition	Engineering prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	April 9 and 17, 2024
Test Date	April 10 to 26, 2024

2.2 Product Description

General Specification

Rating	DC 3.7 V
Operating temperature	-20 deg. C to 50 deg. C

Radio Specification

This report contains data provided by the customer which can impact the validity of results. UL Japan, Inc. is only responsible for the validity of results after the integration of the data provided by the customer. The data provided by the customer is marked “a)” in the table below.

UHF

Equipment Type	Transceiver
Frequency of Operation	915.25 MHz to 927.50 MHz
Type of Modulation	PR-ASK
Antenna Gain	2.0 dBi

WLAN (IEEE802.11b/11g/11n-20)

Equipment Type	Transceiver
Frequency of Operation	2412 MHz to 2462 MHz
Type of Modulation	DSSS, OFDM
Antenna Gain	0.75 dBi

Bluetooth (BR / EDR / Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	BR / EDR: GFSK, π/4 DQPSK, 8 DPSK Low Energy: GFSK
Antenna Gain[a)]	0.75 dBi

* WLAN and Bluetooth do not transmit simultaneously.

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

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

3.2 Procedures and Results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Conducted Emission	**FCC:** ANSI C63.10-2013 6. Standard test methods	**FCC:** Section 15.207	-	N/A	*1)
	ISED: RSS-Gen 8.8	**ISED:** RSS-Gen 8.8			
Carrier Frequency Separation	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(a)(1)	See data.	Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.1 (b)			
20dB Bandwidth	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(a)(1)		Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.1 (a)			
Number of Hopping Frequency	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(a)(1)(iii)		Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.1 (d)			
Dwell time	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(a)(1)(iii)		Complied	Conducted
	ISED: -	**ISED:** RSS-247 5.1 (d)			
Maximum Peak Output Power	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(b)(1)		Complied	Conducted
	ISED: RSS-Gen 6.12	**ISED:** RSS-247 5.4 (b)			
Spurious Emission & Band Edge Compliance	**FCC:** KDB 558074 D01 15.247 Meas Guidance v05r02	**FCC:** Section15.247(d)	8.1 dB 4882.0 MHz, Horizontal, AV	Complied	Conducted/ Radiated (above 30 MHz) *2)
	ISED: RSS-Gen 6.13	**ISED:** RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10			

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 battery is charged using a dedicated charger and is not charged via AC power from the main unit.
*2) Radiated test was selected over 30 MHz based on section 15.247(d).

FCC Part 15.31 (e)
The EUT is a battery-operated device and test was performed with the full-charged battery.
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	-	Conducted

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.

Conducted emission

Item	Frequency range	Unit	Calculated Uncertainty (+/-)
AMN (LISN)	0.15 MHz to 30 MHz	dB	3.3

Radiated emission

Measurement distance	Frequency range		Unit	Calculated Uncertainty (+/-)
3 m	9 kHz to 30 MHz		dB	3.3
10 m			dB	3.1
3 m	30 MHz to 200 MHz	Horizontal	dB	4.7
		Vertical	dB	4.7
	200 MHz to 1000 MHz	Horizontal	dB	4.8
		Vertical	dB	6.0
10 m	30 MHz to 200 MHz	Horizontal	dB	5.2
		Vertical	dB	5.1
	200 MHz to 1000 MHz	Horizontal	dB	5.2
		Vertical	dB	5.2
3 m	1 GHz to 6 GHz		dB	5.0
	6 GHz to 18 GHz		dB	5.2
1 m	10 GHz to 18 GHz		dB	5.3
	18 GHz to 26.5 GHz		dB	5.2
	26.5 GHz to 40 GHz		dB	4.7
0.5 m	26.5 GHz to 40 GHz		dB	4.8

Antenna Terminal Conducted

Item	Unit	Calculated Uncertainty (+/-)
Antenna terminated conducted emission / Power density / Burst power	dB	3.47
Adjacent channel power (ACP)	dB	2.28
Bandwidth (OBW)	%	0.96
Time readout (time span upto 100 msec)	%	0.11
Time readout (time span upto 1000 msec)	%	0.11
Time readout (time span upto 60 sec)	%	0.02
Power measurement (Power meter < 8 GHz)	dB	1.46
Power measurement (Call box < 6 GHz)	dB	1.69
Frequency readout (Frequency counter)	ppm	0.67
Frequency readout (Spectrum analyzer frequency readout function)	ppm	2.13
Temperature (constant temperature bath)	deg. C	0.69
Humidity (constant temperature bath)	%RH	2.98
Modulation characteristics	%	6.93
Frequency for mobile	ppm	0.08
Contention-based protocol	dB	2.26

3.5 Test Location

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

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	-	-

* Size of vertical conducting plane (for Conducted Emission test): 2.0 x 2.0 m for No.1, No.2, No.3, No.4, and No.5 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test Data, Test Instruments, and Test Set Up

Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1 Operating Mode(s)

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

*EUT has the power settings by the software as follows;
Power Setting: DH5: 3.10 dBm / 3DH5: 2.70 dBm
Software: QRCT Version: 3.0.156.0
(Date: 2015.10.19, Storage location: Driven by connected PC)

*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
Conducted Emission, Radiated Spurious Emission (Below 1 GHz)	Tx DH5 *1)	Off	2480 MHz
Radiated Spurious Emission (Above 1 GHz), Conducted Spurious Emission	Tx DH5 Tx 3DH5	Off	2402 MHz 2441 MHz 2480 MHz
20dB Bandwidth, Carrier Frequency Separation	Tx DH5 Tx 3DH5	On	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) Conducted emissions and Spurious emissions for frequencies below 1 GHz were 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

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

Description of EUT

No.	Item	Model number	Serial Number	Manufacturer	Remarks
A	RF Tag Handy Terminal	BHT-1408QUMWB	4969005020300824 *1) 4969005020300820 *2)	Denso Wave Incorporated	EUT

*1) Used for Radiated Emission test
*2) Used for Antenna Terminal Conducted test

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

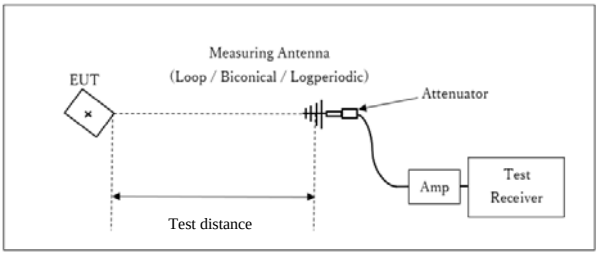
In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired 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	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 the results.	RBW: 100 kHz VBW: 300 kHz

Figure 1: Test Setup

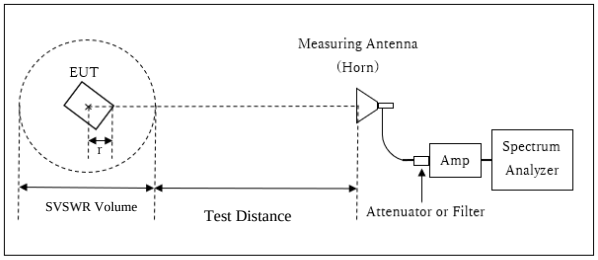
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz to 6 GHz

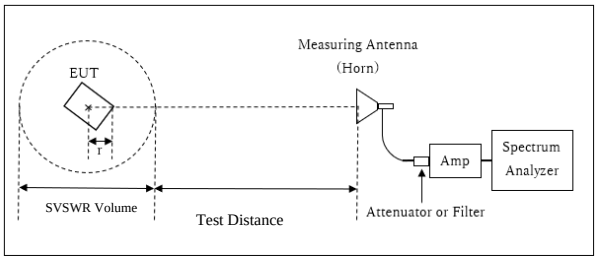


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (3.9 m * / 3.0 m) = 2.28 dB
* (Test Distance + SVSWR Volume /2) - r = 3.9 m

Test Distance: 3.0 m
SVSWR Volume : 2.0 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.1 m

6 GHz to 10 GHz

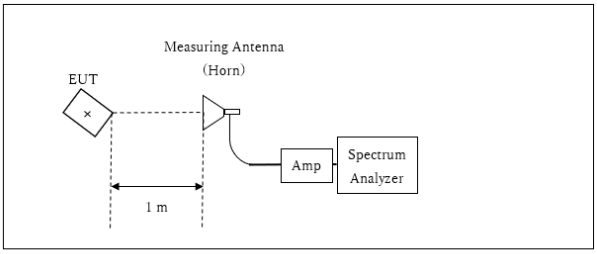


r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (4.9 m * / 3.0 m) = 4.27 dB
* (Test Distance + SVSWR Volume /2) - r = 4.9 m

Test Distance: 4.3 m
SVSWR Volume : 1.4 m
(SVSWR Volume has been calibrated based on CISPR 16-1-4.)
r = 0.1 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 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.

Test results are rounded off and limit are rounded down, 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	10 kHz	30 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.
(9 kHz -150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 10 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.

Test results are rounded off and limit are rounded down, 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.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off, Tx, Hopping On

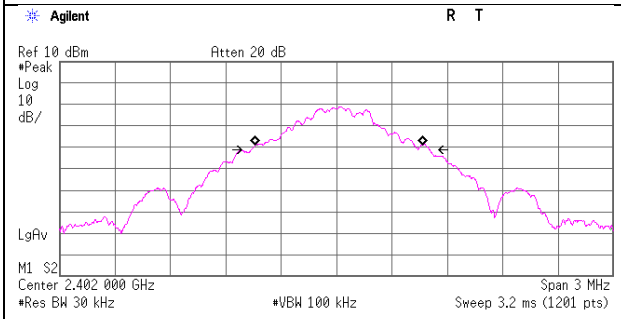
Mode	Freq. [MHz]	20 dB Bandwidth [MHz]	99 % Occupied Bandwidth [kHz]	Carrier Frequency Separation [MHz]	Limit for Carrier Frequency separation [MHz]
DH5	2402.0	0.963	903.943	1.000	>= 0.642
DH5	2441.0	1.031	906.401	1.000	>= 0.687
DH5	2480.0	0.960	***909.593***	1.000	>= 0.640
DH5	Hopping On	-	78607.100	-	-
3DH5	2402.0	1.298	***1183.896***	1.000	>= 0.865
3DH5	2441.0	1.299	1182.791	1.000	>= 0.866
3DH5	2480.0	1.300	1182.333	1.000	>= 0.867
3DH5	Hopping On	-	78711.000	-	-

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

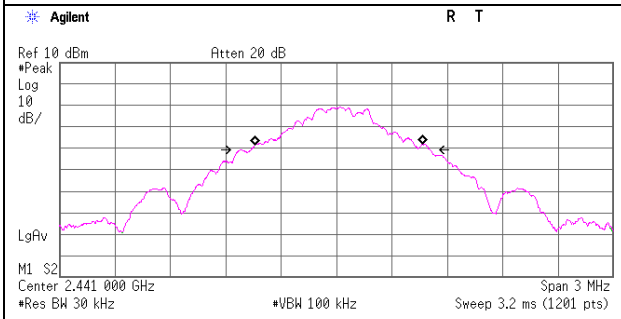


Occupied Bandwidth
903.9432 kHz

Occ BW % Pwr 99.00 %
x dB -20.00 dB

Transmit Freq Error 12.269 kHz
x dB Bandwidth 963.433 kHz

2441 MHz

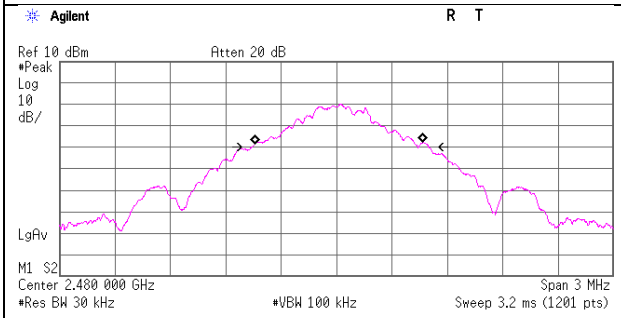


Occupied Bandwidth
906.4013 kHz

Occ BW % Pwr 99.00 %
x dB -20.00 dB

Transmit Freq Error 12.129 kHz
x dB Bandwidth 1.031 MHz

2480 MHz



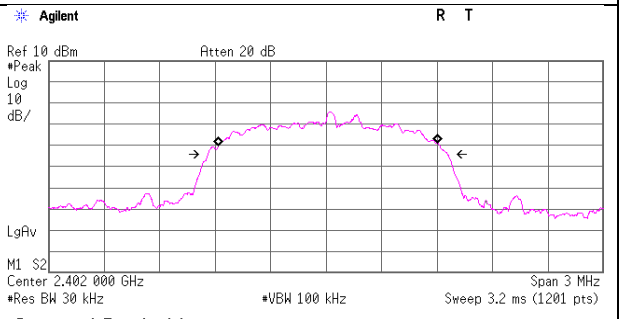
Occupied Bandwidth
909.5926 kHz

Occ BW % Pwr 99.00 %
x dB -20.00 dB

Transmit Freq Error 11.084 kHz
x dB Bandwidth 960.285 kHz

3DH5

2402 MHz

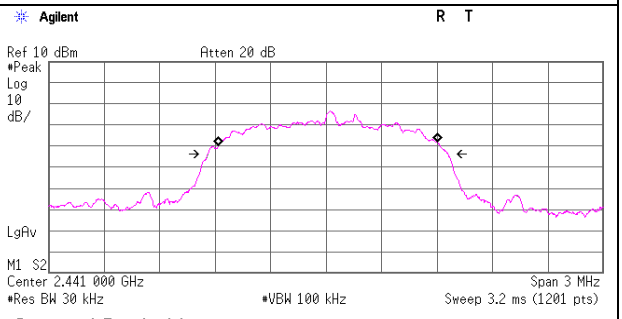


Occupied Bandwidth
1.1839 MHz

Occ BW % Pwr 99.00 %
x dB -20.00 dB

Transmit Freq Error 9.892 kHz
x dB Bandwidth 1.298 MHz

2441 MHz

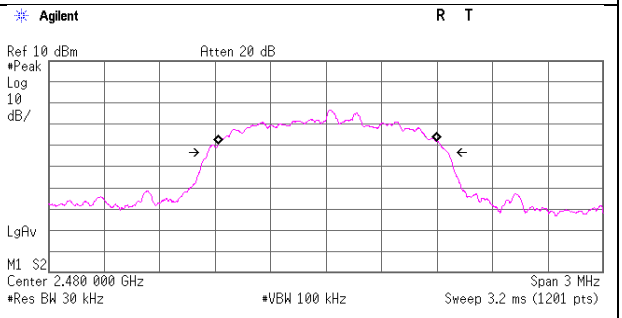


Occupied Bandwidth
1.1828 MHz

Occ BW % Pwr 99.00 %
x dB -20.00 dB

Transmit Freq Error 10.210 kHz
x dB Bandwidth 1.299 MHz

2480 MHz



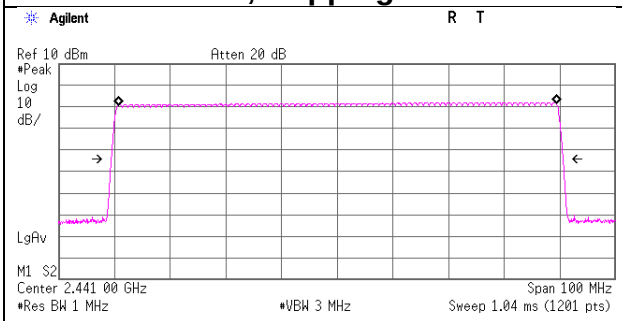
Occupied Bandwidth
1.1823 MHz

Occ BW % Pwr 99.00 %
x dB -20.00 dB

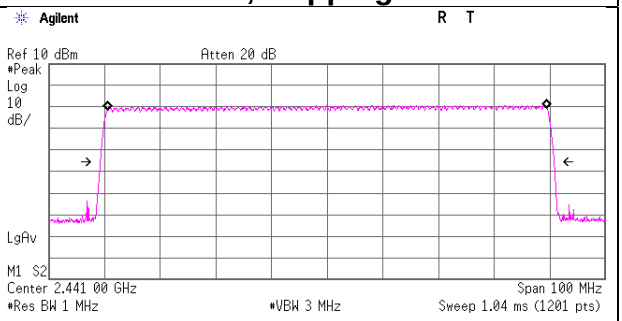
Transmit Freq Error 9.761 kHz
x dB Bandwidth 1.300 MHz

20dB Bandwidth and 99% Occupied Bandwidth

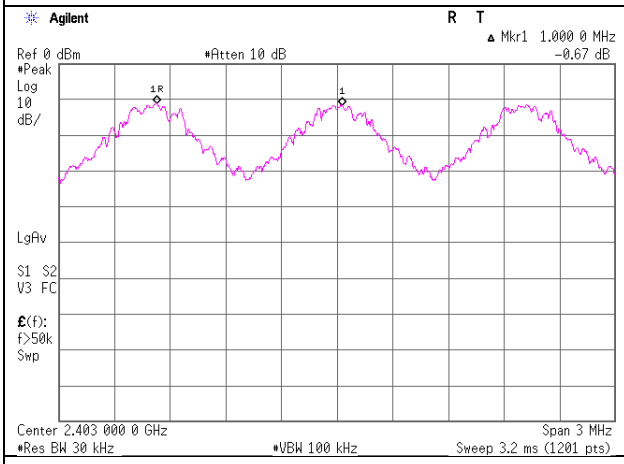
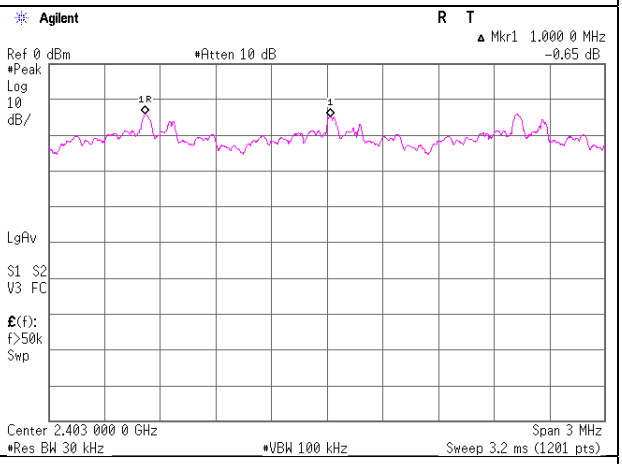
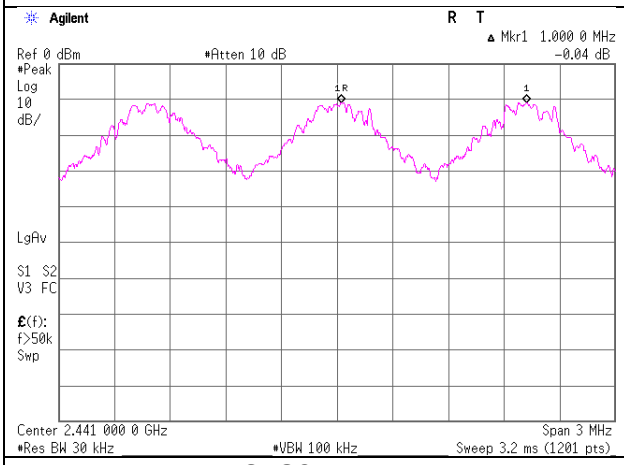
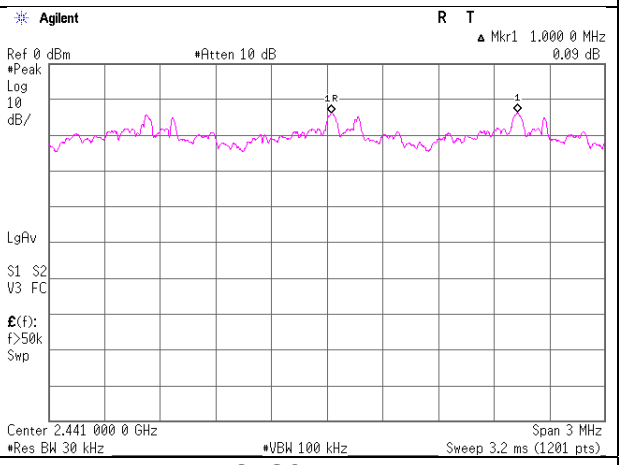
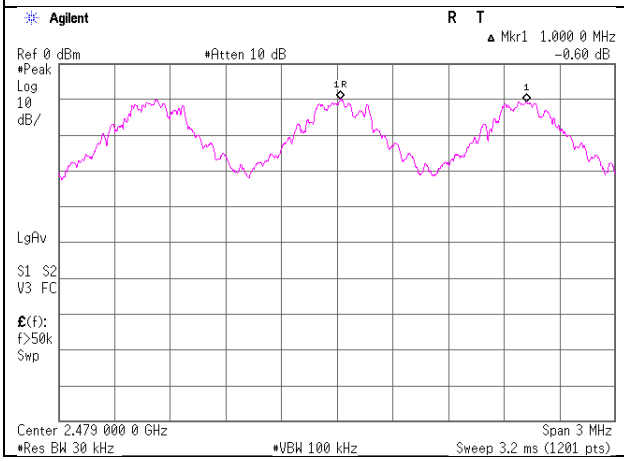
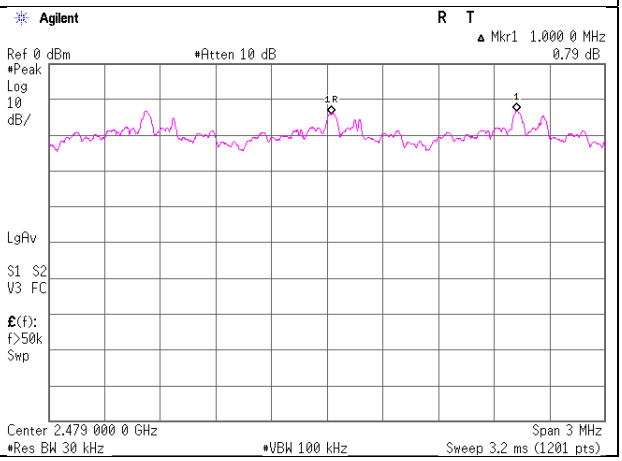
DH5, Hopping On



3DH5, Hopping On



Carrier Frequency Separation

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

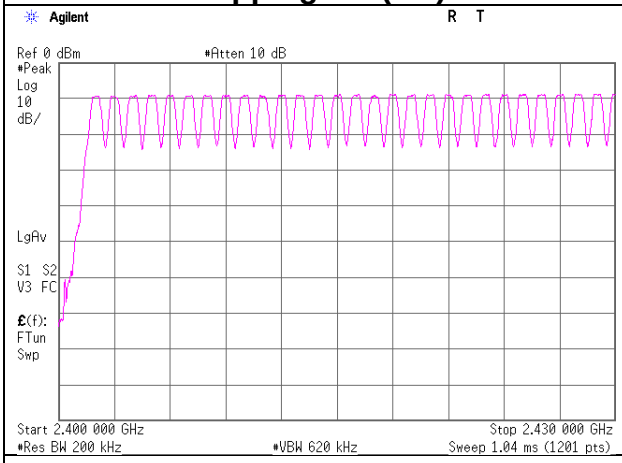
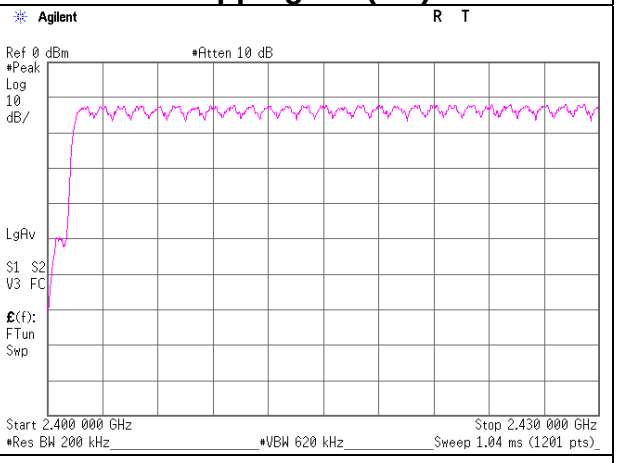
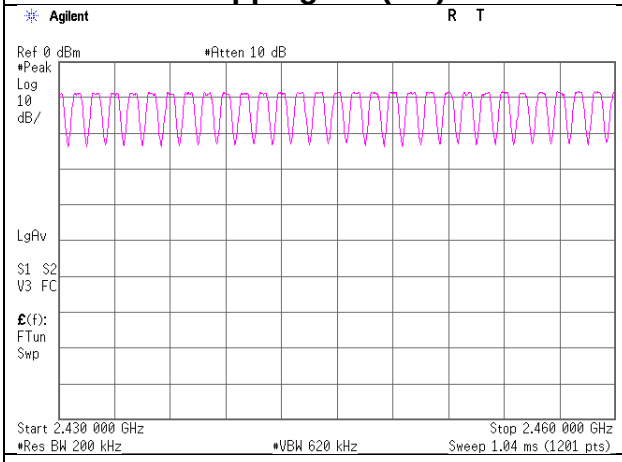
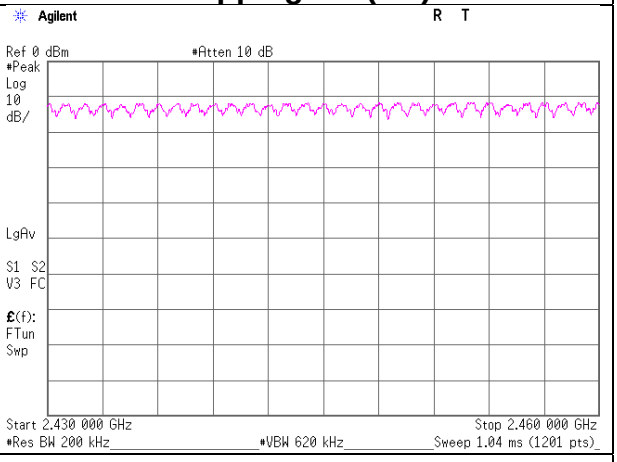
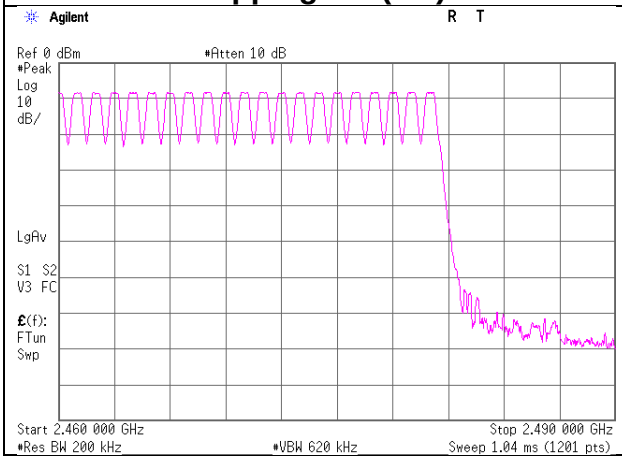
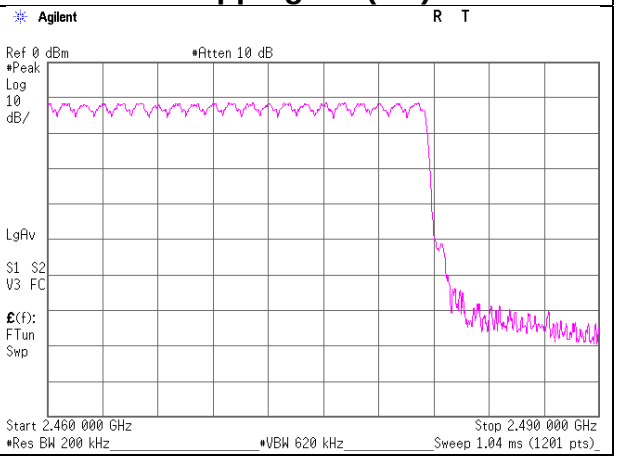
Number of Hopping Frequency

Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
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.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
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	51.4 times	/	5 s	x	31.6 s	=	325 times	0.404	131	400
DH3	29.8 times	/	5 s	x	31.6 s	=	189 times	1.675	316	400
DH5	20.6 times	/	5 s	x	31.6 s	=	131 times	2.910	381	400
3DH1	49.4 times	/	5 s	x	31.6 s	=	313 times	0.412	129	400
3DH3	27.6 times	/	5 s	x	31.6 s	=	175 times	1.667	292	400
3DH5	20.0 times	/	5 s	x	31.6 s	=	127 times	2.920	371	400

Sample Calculation
Result = Number of transmission x Length of transmission

*Average data of 5 tests.(except Inquiry)

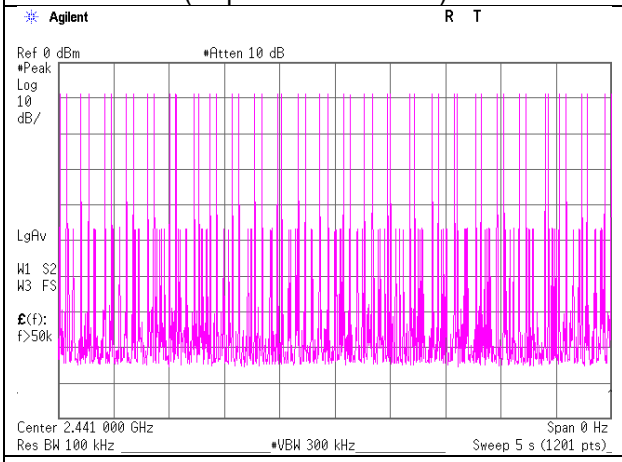
Mode	Sampling [times]					Average [times]
	1	2	3	4	5	
DH1	52	50	53	50	52	51.4
DH3	34	29	29	32	25	29.8
DH5	19	24	23	19	18	20.6
3DH1	50	50	49	50	48	49.4
3DH3	27	28	31	25	27	27.6
3DH5	22	19	22	18	19	20

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

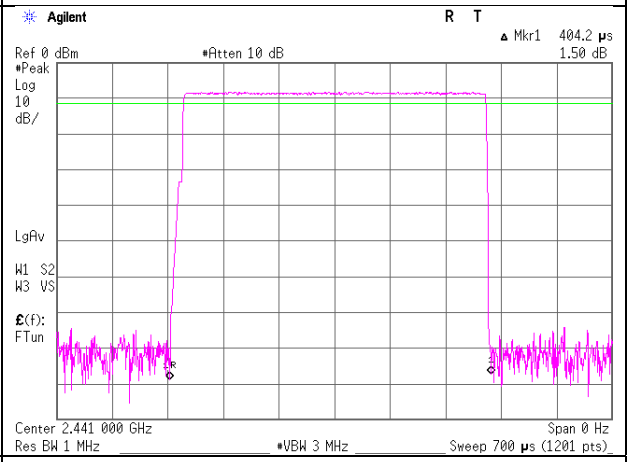
This device complies with the Bluetooth protocol for FHSS operation, employing a pseudo random channel selection and hopping rate to ensure that the occupancy time in N x 0.4 s, where N is the number of channels being used in the hopping sequence ($20 \leq N \leq 79$), is always less than 0.4 s regardless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

Dwell time

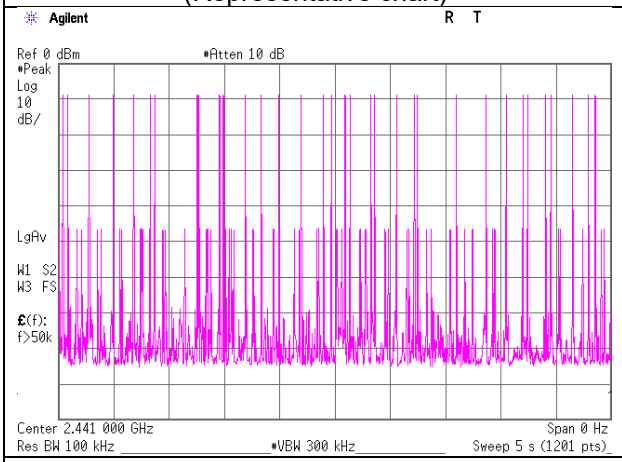
DH1 (1/2)
(Representative chart)



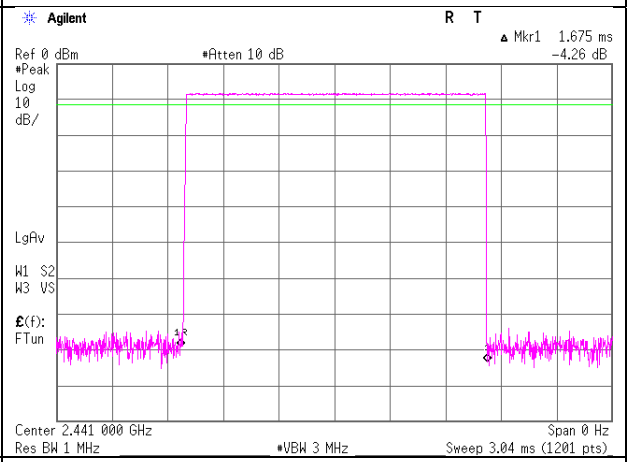
DH1 (2/2)



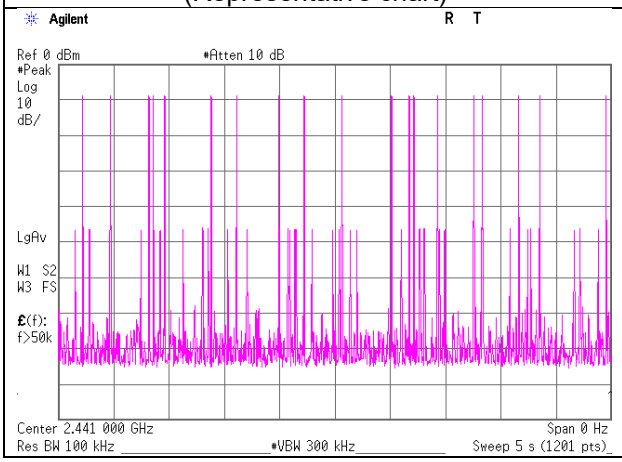
DH3 (1/2)
(Representative chart)



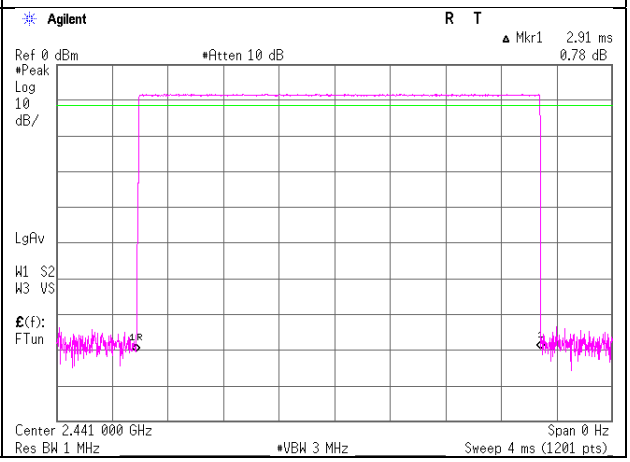
DH3 (2/2)



DH5 (1/2)
(Representative chart)

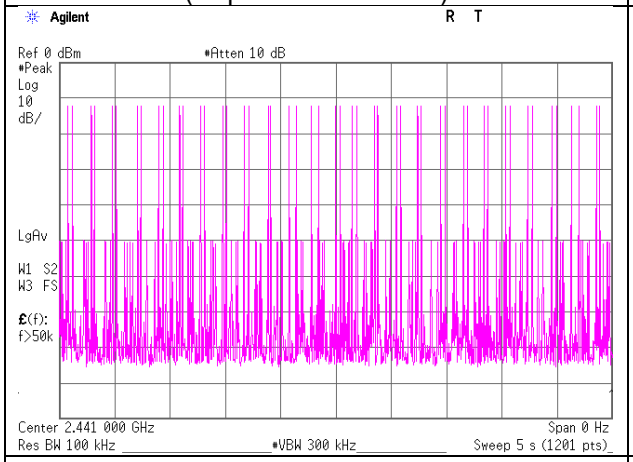


DH5 (2/2)

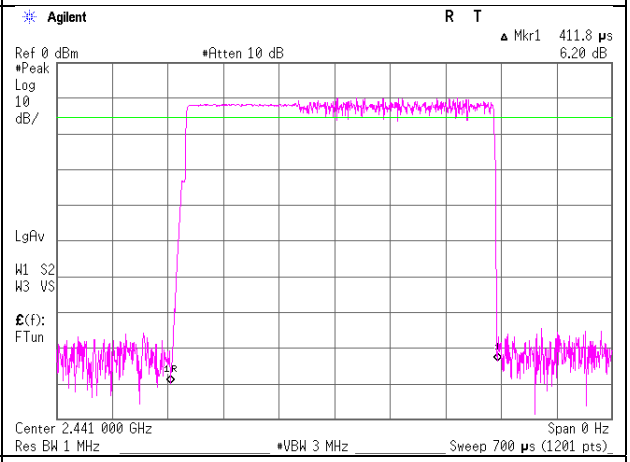


Dwell time

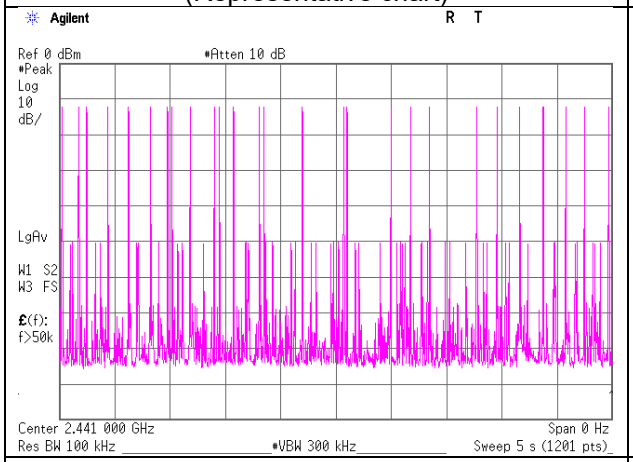
3DH1 (1/2)
(Representative chart)



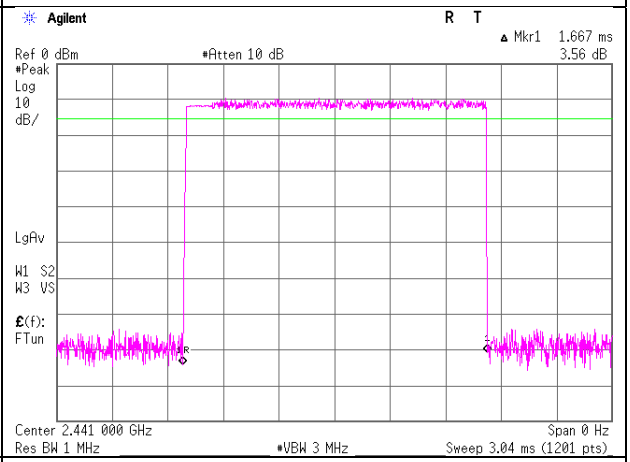
3DH1 (2/2)



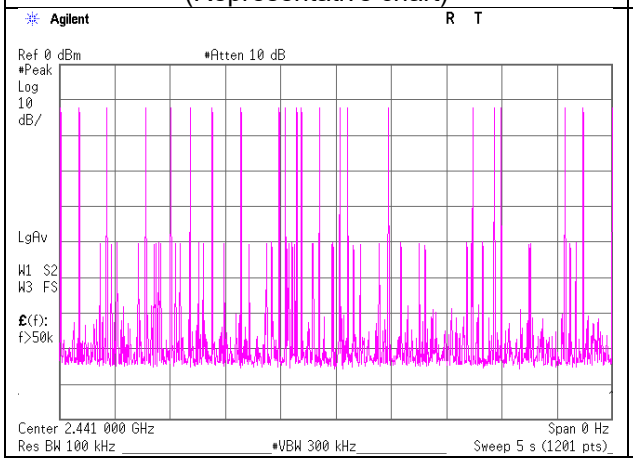
3DH3 (1/2)
(Representative chart)



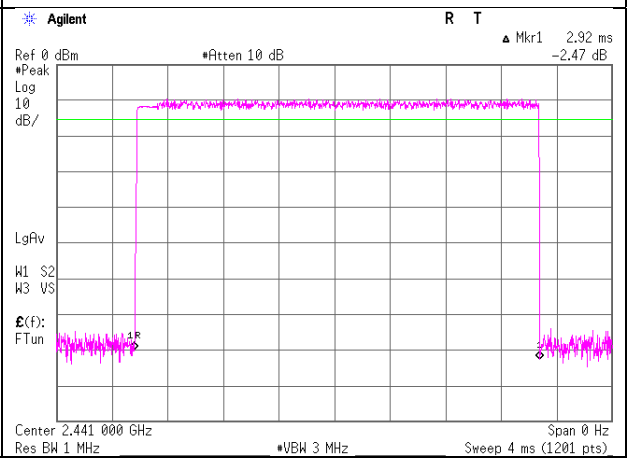
3DH3 (2/2)



3DH5 (1/2)
(Representative chart)



3DH5 (2/2)



Maximum Peak Output Power

Test place	Ise EMC Lab. No.8 Measurement Room
Date	April 10, 2024
Temperature / Humidity	20 deg. C / 45 % RH
Engineer	Nachi Konegawa
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	-9.03	0.89	9.75	1.61	1.45	20.96	125	19.35	0.75	2.36	1.72	36.02	4000	33.66
DH5	2441.0	-8.42	0.89	9.76	2.23	1.67	20.96	125	18.73	0.75	2.98	1.99	36.02	4000	33.04
DH5	2480.0	-8.13	0.90	9.76	***2.53***	***1.79***	20.96	125	18.43	0.75	***3.28***	***2.13***	36.02	4000	32.74
2DH5	2402.0	-10.16	0.89	9.75	0.48	1.12	20.96	125	20.48	0.75	1.23	1.33	36.02	4000	34.79
2DH5	2441.0	-9.53	0.89	9.76	1.12	1.29	20.96	125	19.84	0.75	1.87	1.54	36.02	4000	34.15
2DH5	2480.0	-9.20	0.90	9.76	***1.46***	***1.40***	20.96	125	19.50	0.75	***2.21***	***1.66***	36.02	4000	33.81
3DH5	2402.0	-9.67	0.89	9.75	0.97	1.25	20.96	125	19.99	0.75	1.72	1.49	36.02	4000	34.30
3DH5	2441.0	-9.03	0.89	9.76	1.62	1.45	20.96	125	19.34	0.75	2.37	1.73	36.02	4000	33.65
3DH5	2480.0	-8.76	0.90	9.76	***1.90***	***1.55***	20.96	125	19.06	0.75	***2.65***	***1.84***	36.02	4000	33.37

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.

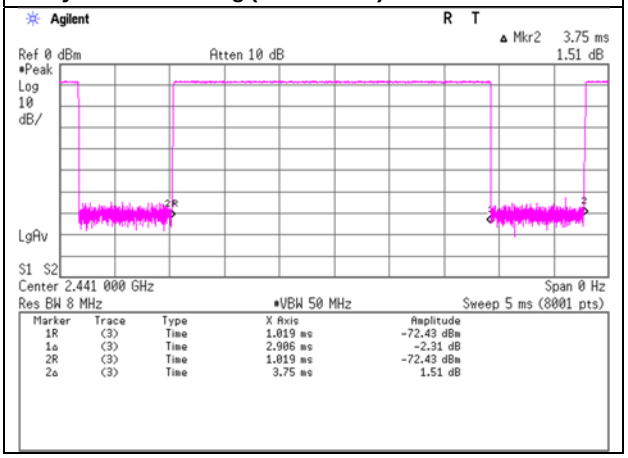
As this device had AFH mode and frequency separation could not meet the requirement of over 20 dB BW without 2/3 relaxation, 125 mW power limit was applied to it.

Burst Rate Confirmation

Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off

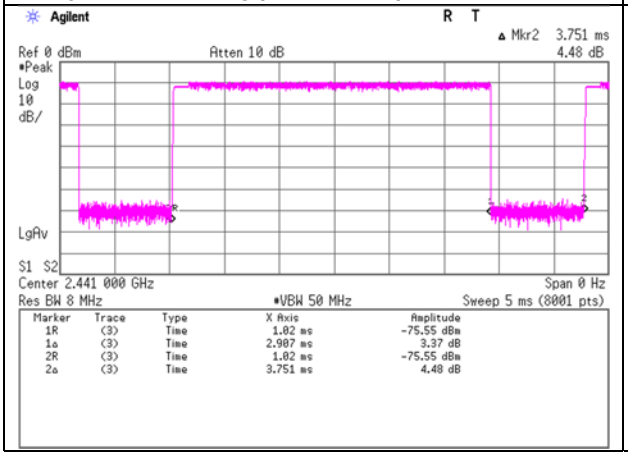
DH5

Tx on / (Tx on + Tx off) =	**0.775**
Tx on / (Tx on + Tx off) * 100 =	**77.5 %**
Duty factor = 10 * log (3.75 / 2.906) =	**1.11 dB**



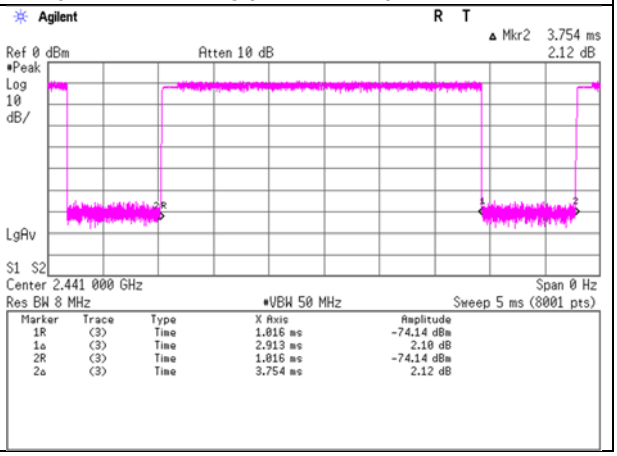
2DH5

Tx on / (Tx on + Tx off) =	**0.775**
Tx on / (Tx on + Tx off) * 100 =	**77.5 %**
Duty factor = 10 * log (3.751 / 2.907) =	**1.11 dB**



3DH5

Tx on / (Tx on + Tx off) =	**0.776**
Tx on / (Tx on + Tx off) * 100 =	**77.6 %**
Duty factor = 10 * log (3.754 / 2.913) =	**1.10 dB**



Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	April 24, 2024	April 26, 2024
Temperature / Humidity	21 deg. C / 60 % RH	21 deg. C / 45 % RH
Engineer	Yuichiro Yamazaki	Ken Fujita
	(1 GHz to 6 GHz)	(6 GHz to 26.5 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.	2390.0	41.7	33.4	27.8	5.3	31.8	1.1	43.1	35.9	73.9	53.9	30.8	18.0	*1)
Hori.	4804.0	40.9	34.4	31.3	7.5	30.9	1.1	48.8	43.5	73.9	53.9	25.1	10.4	
Hori.	7206.0	41.8	34.0	35.6	8.0	33.4	-	52.0	44.2	73.9	53.9	21.9	9.7	Floor noise
Hori.	9608.0	41.4	33.2	35.7	8.6	34.0	-	51.6	43.4	73.9	53.9	22.3	10.5	Floor noise
Vert.	2390.0	42.0	33.5	27.8	5.3	31.8	1.1	43.4	36.0	73.9	53.9	30.6	17.9	*1)
Vert.	4804.0	42.4	34.5	31.3	7.5	30.9	1.1	50.3	43.6	73.9	53.9	23.6	10.3	
Vert.	7206.0	42.0	34.0	35.6	8.0	33.4	-	52.2	44.2	73.9	53.9	21.7	9.7	Floor noise
Vert.	9608.0	41.8	33.2	35.7	8.6	34.0	-	52.0	43.4	73.9	53.9	21.9	10.5	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)

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	93.5	27.8	5.3	31.8	94.9	-	-	Carrier
Hori.	2400.0	37.8	27.8	5.3	31.8	39.1	74.9	35.8	
Vert.	2402.0	94.5	27.8	5.3	31.8	95.8	-	-	Carrier
Vert.	2400.0	39.0	27.8	5.3	31.8	40.4	75.8	35.5	

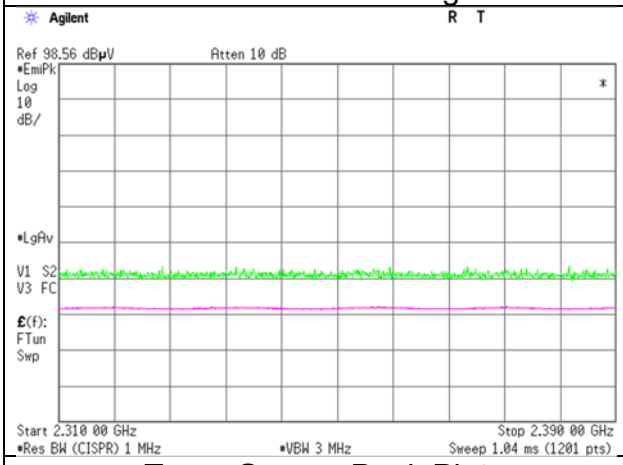
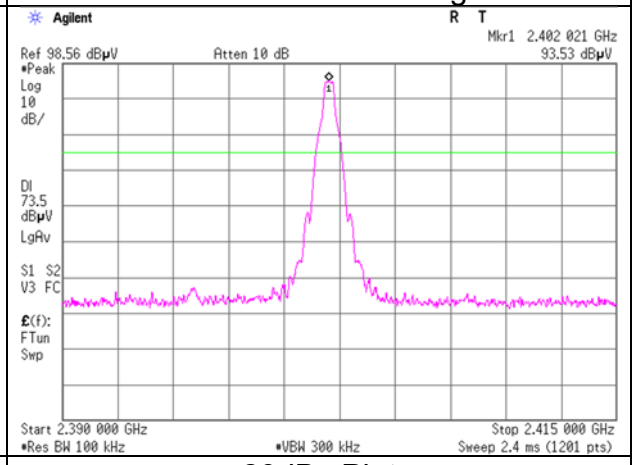
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

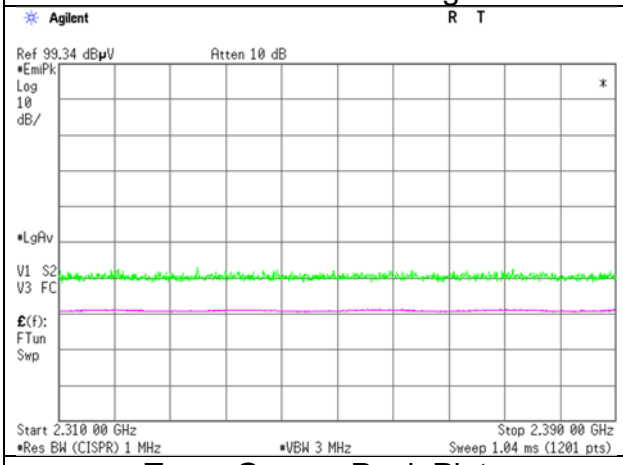
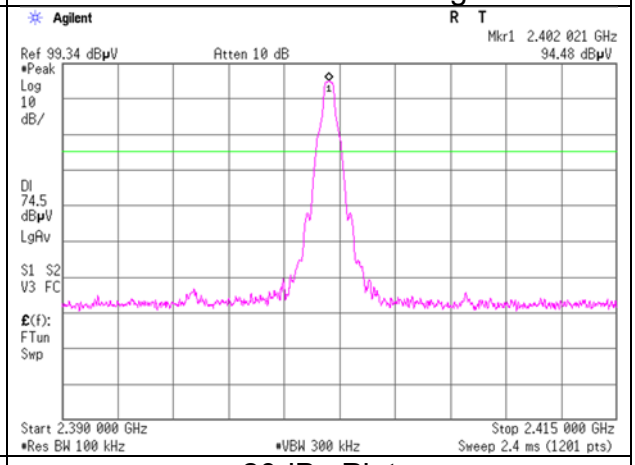
Distance factor:	1 GHz - 6 GHz	20log (3.9 m / 3.0 m) = 2.28 dB
	6 GHz - 10 GHz	20log (4.9 m / 3.0 m) = 4.27 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

*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.4
Date	April 24, 2024
Temperature / Humidity	21 deg. C / 60 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 6 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 and authorized band edge were shown in tabular data.

Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	April 24, 2024	April 26, 2024
Temperature / Humidity	21 deg. C / 60 % RH	21 deg. C / 45 % RH
Engineer	Yuichiro Yamazaki	Ken Fujita
	(1 GHz to 6 GHz)	(6 GHz to 26.5 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.	4882.0	43.7	36.7	31.4	7.5	30.8	1.1	51.8	45.8	73.9	53.9	22.1	8.1	
Hori.	7323.0	41.7	34.0	35.6	8.0	33.5	-	51.8	44.2	73.9	53.9	22.1	9.7	Floor noise
Hori.	9764.0	41.4	33.5	36.0	8.6	34.1	-	52.0	44.1	73.9	53.9	21.9	9.8	Floor noise
Vert.	4882.0	42.6	35.1	31.4	7.5	30.8	1.1	50.6	44.2	73.9	53.9	23.3	9.7	
Vert.	7323.0	41.6	34.0	35.6	8.0	33.5	-	51.8	44.2	73.9	53.9	22.1	9.7	Floor noise
Vert.	9764.0	40.6	33.5	36.0	8.6	34.1	-	51.2	44.1	73.9	53.9	22.7	9.8	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.

Radiated Spurious Emission

Test place	Ise EMC Lab.		
Semi Anechoic Chamber	No.4	No.4	No.3
Date	April 24, 2024	April 26, 2024	April 26, 2024
Temperature / Humidity	21 deg. C / 60 % RH	21 deg. C / 45 % RH	21 deg. C / 52 % RH
Engineer	Yuichiro Yamazaki	Ken Fujita	Nachi Konegawa
	(1 GHz to 6 GHz)	(6 GHz to 26.5 GHz)	(Below 1 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.	32.3	20.8	-	17.7	6.9	32.1	-	13.3	-	40.0	-	26.7	-	Floor noise
Hori.	160.6	19.7	-	15.5	8.5	32.0	-	11.7	-	43.5	-	31.9	-	Floor noise
Hori.	186.1	19.5	-	16.3	8.7	32.0	-	12.5	-	43.5	-	31.0	-	Floor noise
Hori.	414.3	19.6	-	16.1	10.4	32.1	-	14.0	-	46.0	-	32.0	-	Floor noise
Hori.	543.9	19.4	-	17.8	11.2	32.2	-	16.2	-	46.0	-	29.8	-	Floor noise
Hori.	709.4	19.3	-	20.0	12.0	32.2	-	19.1	-	46.0	-	26.9	-	Floor noise
Hori.	2483.5	44.5	33.7	27.7	5.4	31.7	1.1	45.9	36.2	73.9	53.9	28.1	17.7	*1)
Hori.	2486.0	44.1	34.1	27.7	5.4	31.7	1.1	45.5	36.5	73.9	53.9	28.4	17.4	*1)
Hori.	4960.0	43.5	34.8	31.6	7.5	30.8	1.1	51.8	44.2	73.9	53.9	22.1	9.7	
Hori.	7440.0	40.9	34.5	35.5	8.0	33.5	-	51.0	44.5	73.9	53.9	22.9	9.4	Floor noise
Hori.	9920.0	41.3	33.6	36.2	8.7	34.1	-	52.1	44.4	73.9	53.9	21.9	9.5	Floor noise
Vert.	32.3	20.8	-	17.7	6.9	32.1	-	13.3	-	40.0	-	26.7	-	Floor noise
Vert.	160.6	19.7	-	15.5	8.5	32.0	-	11.7	-	43.5	-	31.9	-	Floor noise
Vert.	186.1	19.5	-	16.3	8.7	32.0	-	12.5	-	43.5	-	31.0	-	Floor noise
Vert.	414.3	19.6	-	16.1	10.4	32.1	-	14.0	-	46.0	-	32.0	-	Floor noise
Vert.	543.9	19.4	-	17.8	11.2	32.2	-	16.2	-	46.0	-	29.8	-	Floor noise
Vert.	709.4	19.3	-	20.0	12.0	32.2	-	19.1	-	46.0	-	26.9	-	Floor noise
Vert.	2483.5	45.4	34.2	27.7	5.4	31.7	1.1	46.8	36.7	73.9	53.9	27.1	17.2	*1)
Vert.	2486.0	45.8	34.5	27.7	5.4	31.7	1.1	47.2	36.9	73.9	53.9	26.8	17.0	*1)
Vert.	4960.0	42.3	34.3	31.6	7.5	30.8	1.1	50.6	43.7	73.9	53.9	23.3	10.2	
Vert.	7440.0	41.6	34.5	35.5	8.0	33.5	-	51.7	44.5	73.9	53.9	22.2	9.4	Floor noise
Vert.	9920.0	40.5	33.6	36.2	8.7	34.1	-	51.3	44.4	73.9	53.9	22.6	9.5	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)

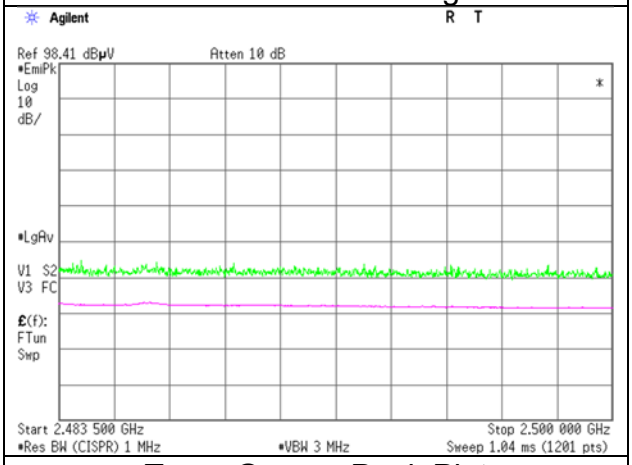
Distance factor:	1 GHz - 6 GHz	20log (3.9 m / 3.0 m) = 2.28 dB
	6 GHz - 10 GHz	20log (4.9 m / 3.0 m) = 4.27 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 24, 2024
Temperature / Humidity	21 deg. C / 60 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 6 GHz)
Mode	Tx, Hopping Off, DH5 2480 MHz

Horizontal

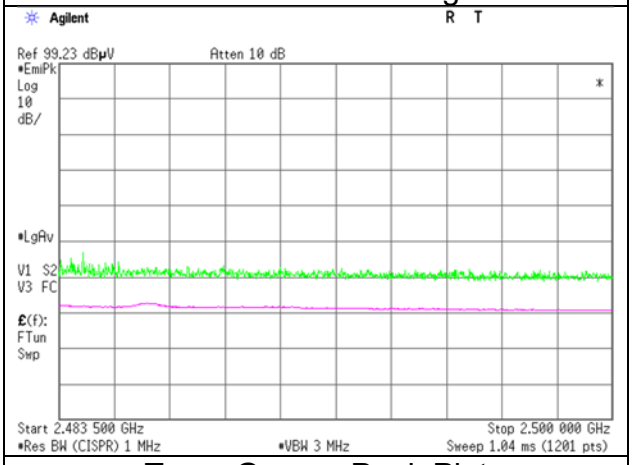
Restricted-band band-edge Plot



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.4	No.4
Date	April 24, 2024	April 26, 2024
Temperature / Humidity	21 deg. C / 60 % RH	21 deg. C / 45 % RH
Engineer	Yuichiro Yamazaki	Ken Fujita
	(1 GHz to 6 GHz)	(6 GHz to 26.5 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.	2390.0	43.8	33.6	27.8	5.3	31.8	1.1	45.2	36.1	73.9	53.9	28.7	17.9	*1)
Hori.	4804.0	41.5	33.2	31.3	7.5	30.9	1.1	49.5	42.3	73.9	53.9	24.4	11.6	
Hori.	7206.0	42.7	34.6	35.6	8.0	33.4	-	52.9	44.8	73.9	53.9	21.0	9.2	Floor noise
Hori.	9608.0	41.2	33.8	35.7	8.6	34.0	-	51.4	44.1	73.9	53.9	22.5	9.8	Floor noise
Vert.	2390.0	44.5	33.6	27.8	5.3	31.8	1.1	45.9	36.1	73.9	53.9	28.1	17.8	*1)
Vert.	4804.0	41.8	33.1	31.3	7.5	30.9	1.1	49.7	42.2	73.9	53.9	24.2	11.7	
Vert.	7206.0	41.6	34.6	35.6	8.0	33.4	-	51.8	44.8	73.9	53.9	22.1	9.2	Floor noise
Vert.	9608.0	40.9	33.8	35.7	8.6	34.0	-	51.2	44.1	73.9	53.9	22.7	9.8	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

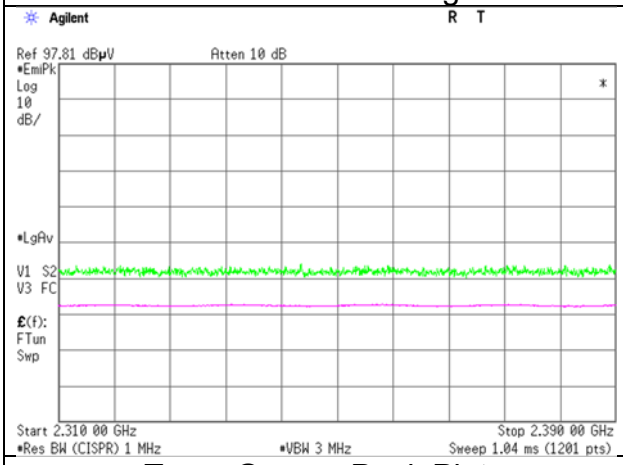
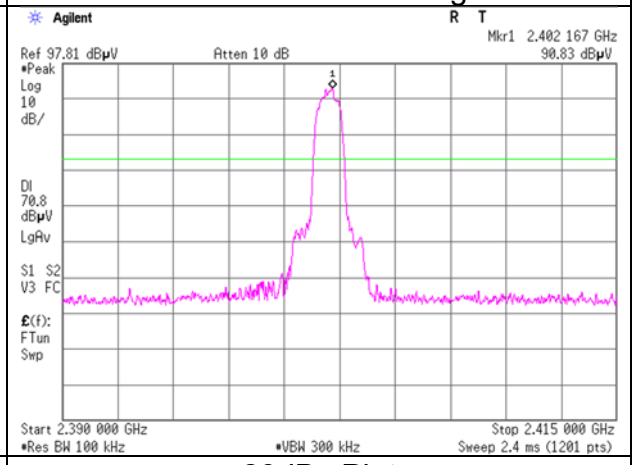
Polarity [Hori/Vert]	Frequency [MHz]	Reading (PK) [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.0	90.8	27.8	5.3	31.8	92.2	-	-	Carrier
Hori.	2400.0	41.5	27.8	5.3	31.8	42.8	72.2	29.4	
Vert.	2402.0	90.7	27.8	5.3	31.8	92.1	-	-	Carrier
Vert.	2400.0	41.2	27.8	5.3	31.8	42.5	72.1	29.6	

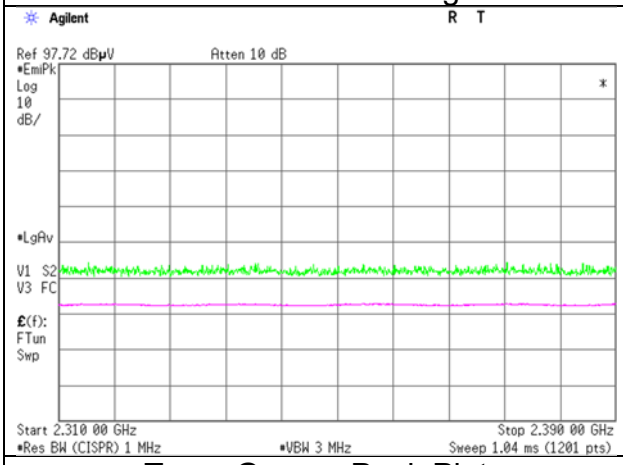
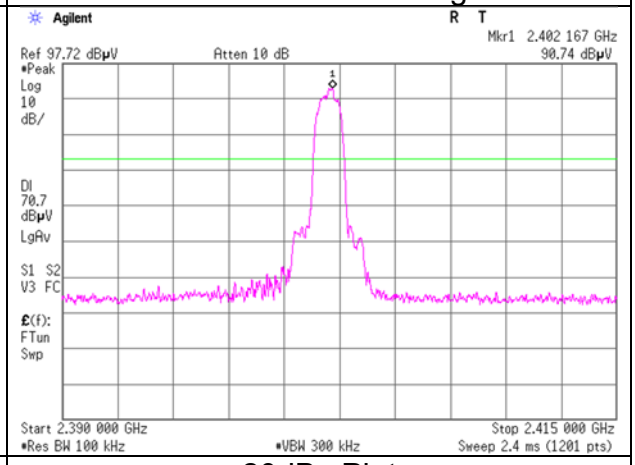
Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter+Distance factor(above 1 GHz)) - Gain(Amprifier)

Distance factor:	1 GHz - 6 GHz	20log (3.9 m / 3.0 m) = 2.28 dB
	6 GHz - 10 GHz	20log (4.9 m / 3.0 m) = 4.27 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.4
Date	April 24, 2024
Temperature / Humidity	21 deg. C / 60 % RH
Engineer	Yuichiro Yamazaki (1 GHz to 6 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 and authorized band edge were shown in tabular data.

Radiated Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	April 24, 2024	April 26, 2024
Temperature / Humidity	21 deg. C / 60 % RH	21 deg. C / 45 % RH
Engineer	Yuichiro Yamazaki	Ken Fujita
	(1 GHz to 6 GHz)	(6 GHz to 26.5 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.	4882.0	42.0	33.3	31.4	7.5	30.8	1.1	50.0	42.5	73.9	53.9	23.9	11.4	
Hori.	7323.0	41.0	34.2	35.6	8.0	33.5	-	51.2	44.4	73.9	53.9	22.7	9.5	Floor noise
Hori.	9764.0	41.2	33.7	36.0	8.6	34.1	-	51.8	44.3	73.9	53.9	22.1	9.6	Floor noise
Vert.	4882.0	42.2	33.2	31.4	7.5	30.8	1.1	50.3	42.4	73.9	53.9	23.6	11.5	
Vert.	7323.0	41.3	34.2	35.6	8.0	33.5	-	51.5	44.4	73.9	53.9	22.4	9.5	Floor noise
Vert.	9764.0	40.3	33.7	36.0	8.6	34.1	-	50.9	44.3	73.9	53.9	23.0	9.6	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.

Distance factor:	1 GHz - 6 GHz	20log (3.9 m / 3.0 m) = 2.28 dB
	6 GHz - 10 GHz	20log (4.9 m / 3.0 m) = 4.27 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.4	No.4
Date	April 24, 2024	April 26, 2024
Temperature / Humidity	21 deg. C / 60 % RH	21 deg. C / 45 % RH
Engineer	Yuichiro Yamazaki	Ken Fujita
	(1 GHz to 6 GHz)	(6 GHz to 26.5 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.	2483.5	45.1	33.9	27.7	5.4	31.7	1.1	46.5	36.4	73.9	53.9	27.4	17.5	*1)
Hori.	2486.0	43.8	33.8	27.7	5.4	31.7	1.1	45.2	36.3	73.9	53.9	28.7	17.6	*1)
Hori.	4960.0	41.7	33.1	31.6	7.5	30.8	1.1	50.0	42.5	73.9	53.9	23.9	11.4	
Hori.	7440.0	41.2	34.2	35.5	8.0	33.5	-	51.3	44.3	73.9	53.9	22.6	9.6	Floor noise
Hori.	9920.0	41.4	33.9	36.2	8.7	34.1	-	52.2	44.7	73.9	53.9	21.8	9.2	Floor noise
Vert.	2483.5	45.8	34.5	27.7	5.4	31.7	1.1	47.2	36.9	73.9	53.9	26.7	17.0	*1)
Vert.	2486.0	44.0	34.2	27.7	5.4	31.7	1.1	45.3	36.6	73.9	53.9	28.6	17.3	*1)
Vert.	4960.0	41.0	32.7	31.6	7.5	30.8	1.1	49.3	42.1	73.9	53.9	24.6	11.8	
Vert.	7440.0	41.6	34.2	35.5	8.0	33.5	-	51.6	44.3	73.9	53.9	22.3	9.6	Floor noise
Vert.	9920.0	40.3	33.9	36.2	8.7	34.1	-	51.1	44.7	73.9	53.9	22.8	9.2	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)

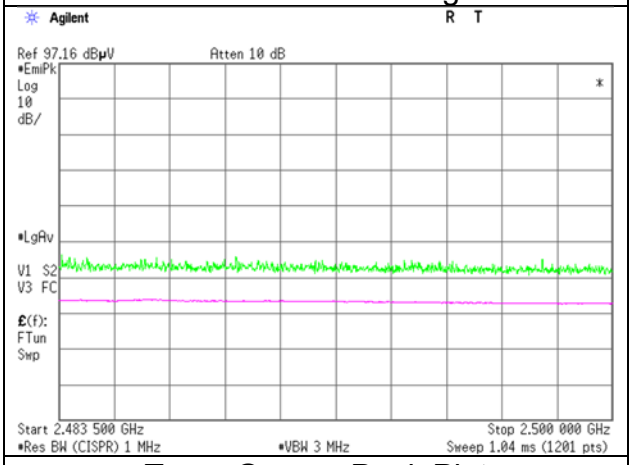
Distance factor:	1 GHz - 6 GHz	20log (3.9 m / 3.0 m) = 2.28 dB
	6 GHz - 10 GHz	20log (4.9 m / 3.0 m) = 4.27 dB
	10 GHz - 26.5 GHz	20log (1.0 m / 3.0 m) = -9.5 dB

Radiated Spurious Emission
(Reference Plot for band-edge)

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	April 24, 2024
Temperature / Humidity	21 deg. C / 60 % RH
Engineer	Yuichiro Yamazaki
	(1 GHz to 6 GHz)
Mode	Tx, Hopping Off, 3DH5 2480 MHz

Horizontal

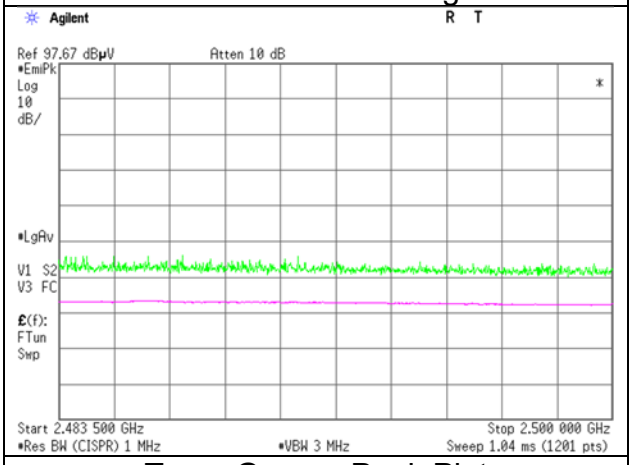
Restricted-band band-edge Plot



Trace Green : Peak Plot
Trace Purple : Average Plot

Vertical

Restricted-band band-edge Plot

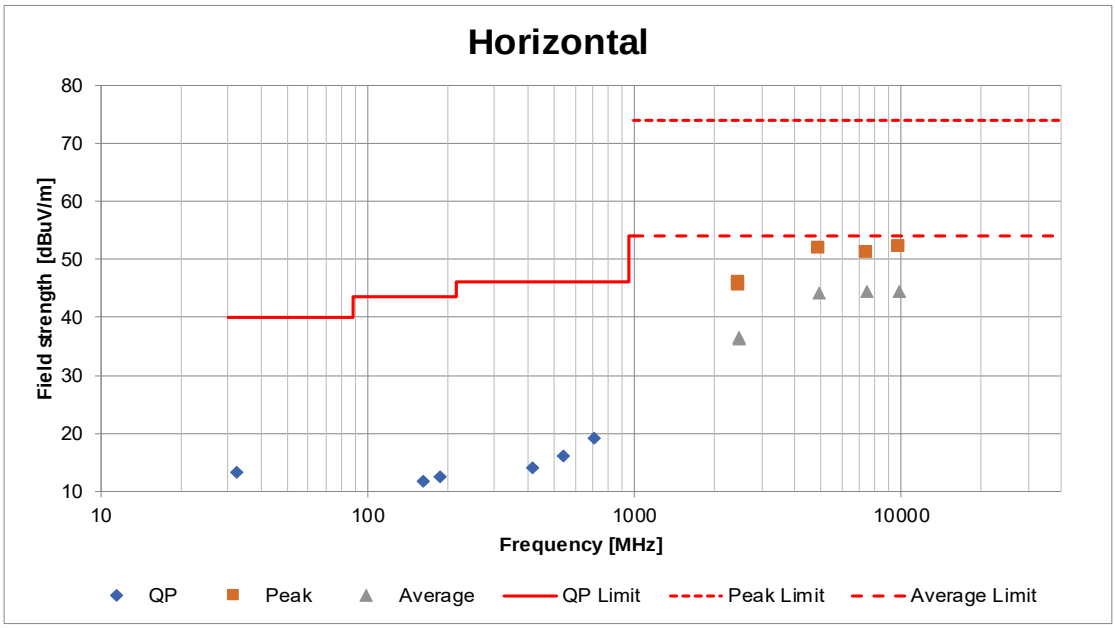


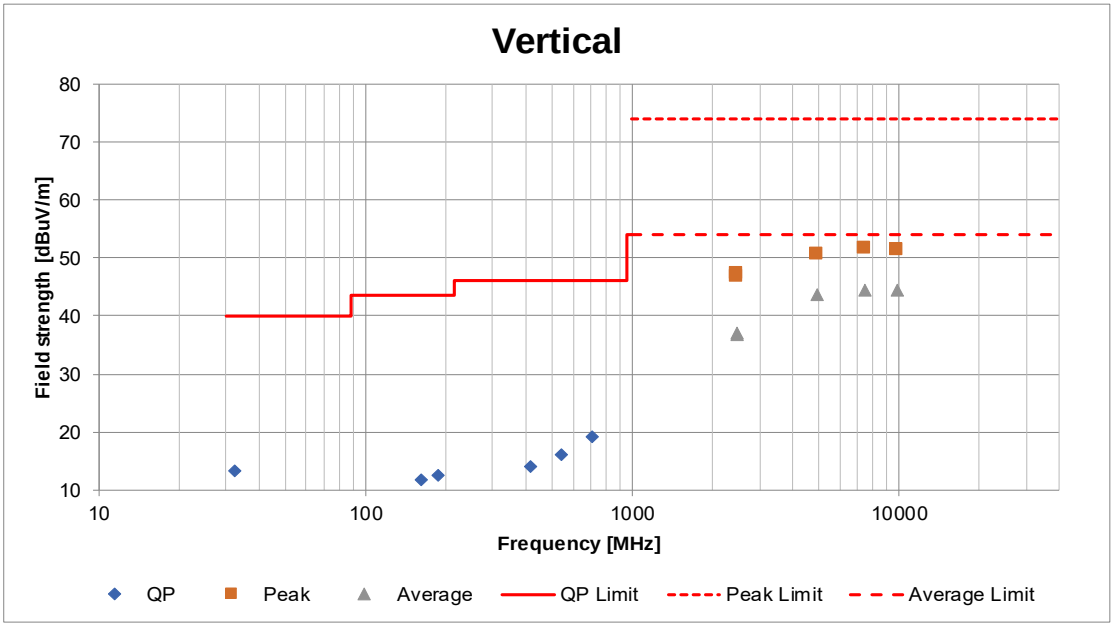
Trace Green : Peak Plot
Trace Purple : Average Plot

* 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.4	No.4	No.3
Date	April 24, 2024	April 26, 2024	April 26, 2024
Temperature / Humidity	21 deg. C / 60 % RH	21 deg. C / 45 % RH	21 deg. C / 52 % RH
Engineer	Yuichiro Yamazaki	Ken Fujita	Nachi Konegawa
	(1 GHz to 6 GHz)	(6 GHz to 26.5 GHz)	(Below 1 GHz)
Mode	Tx, Hopping Off, DH5 2480 MHz		





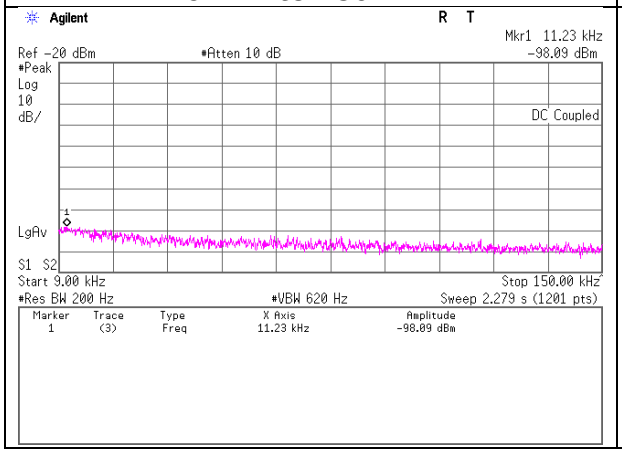
*These plots data contain sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

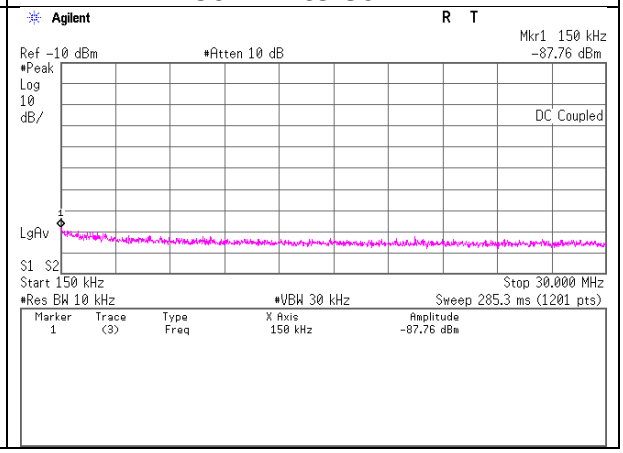
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off, DH5

2402 MHz

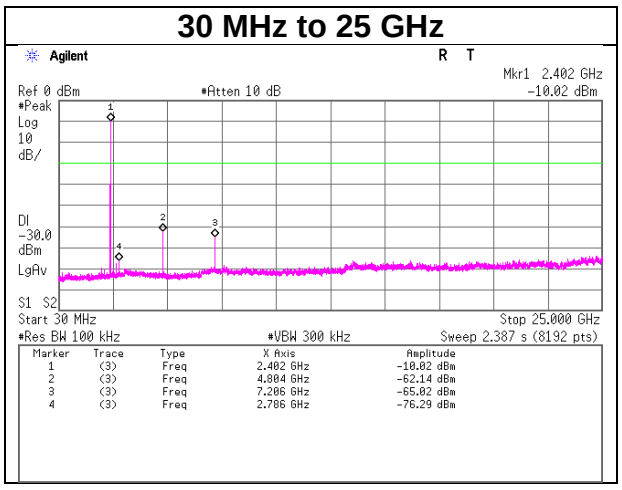
9 kHz to 150 kHz



150 kHz to 30 MHz



30 MHz to 25 GHz

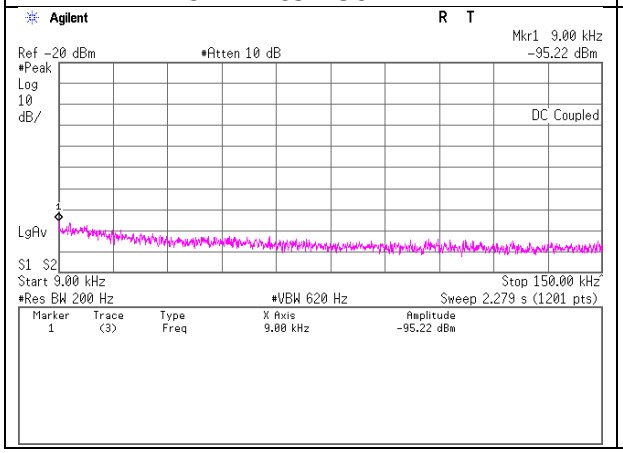


Conducted Spurious Emission

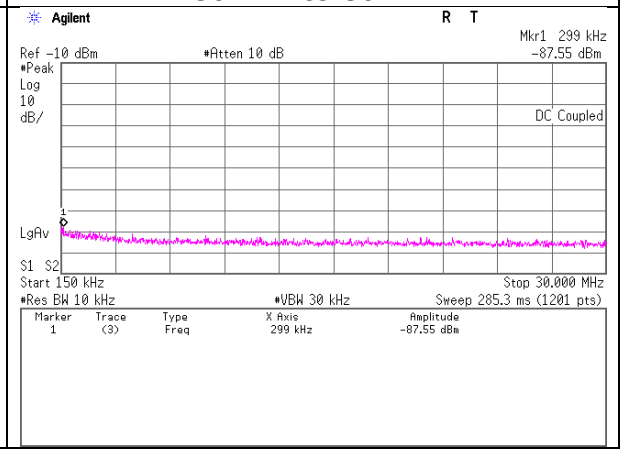
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off, DH5

2441 MHz

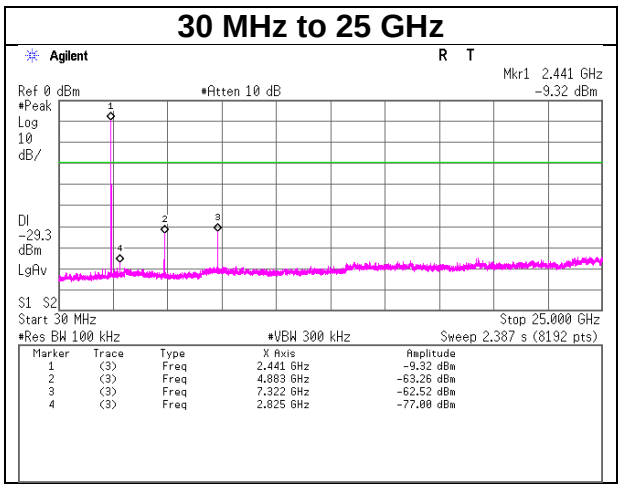
9 kHz to 150 kHz



150 kHz to 30 MHz



30 MHz to 25 GHz

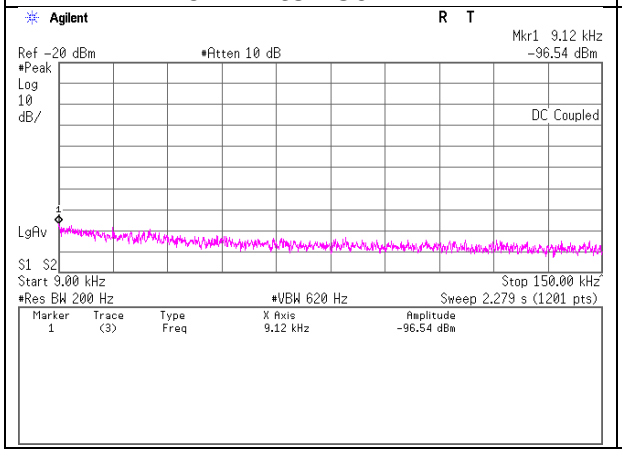


Conducted Spurious Emission

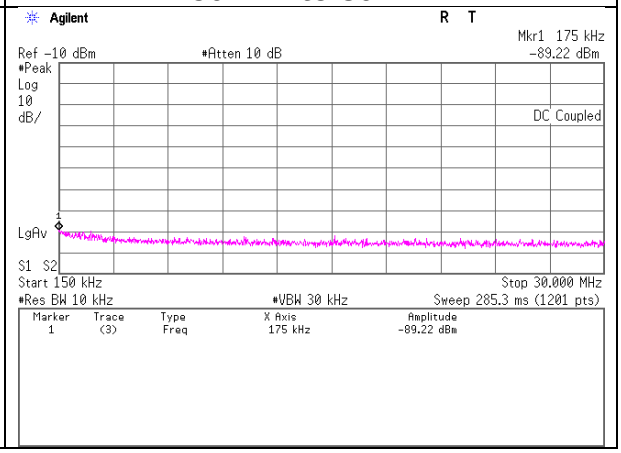
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off, DH5

2480 MHz

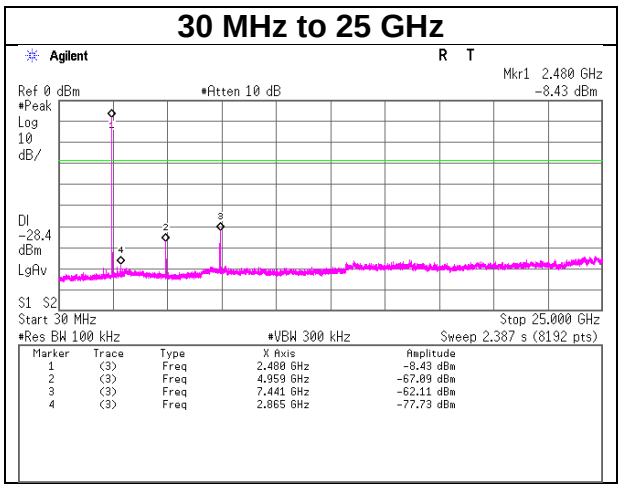
9 kHz to 150 kHz



150 kHz to 30 MHz



30 MHz to 25 GHz

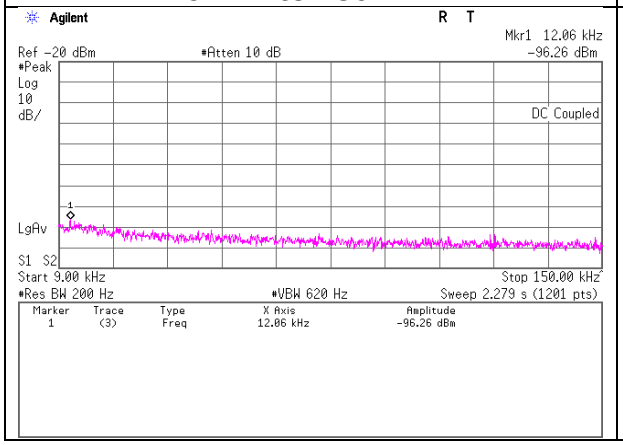


Conducted Spurious Emission

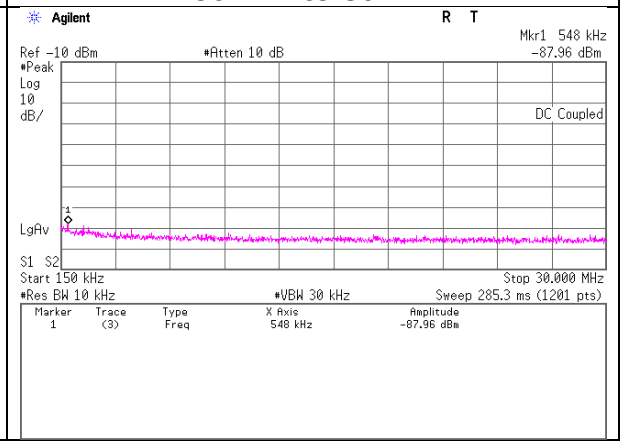
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off, 3DH5

2402 MHz

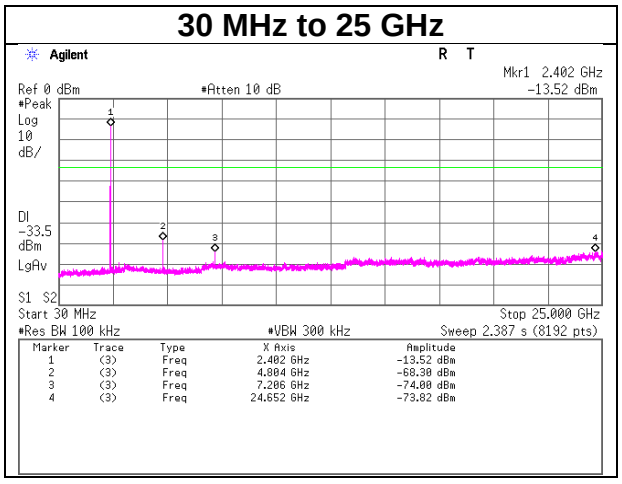
9 kHz to 150 kHz



150 kHz to 30 MHz



30 MHz to 25 GHz

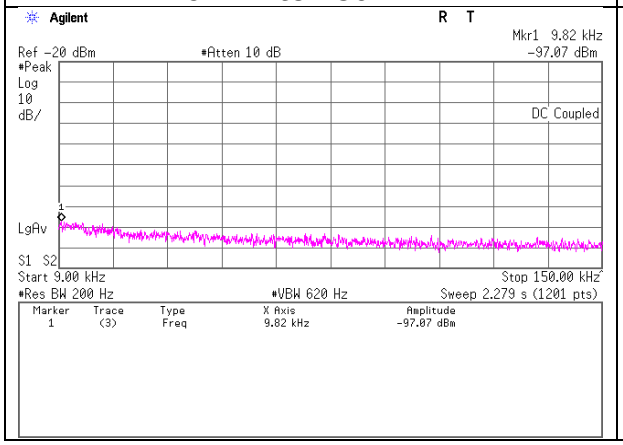


Conducted Spurious Emission

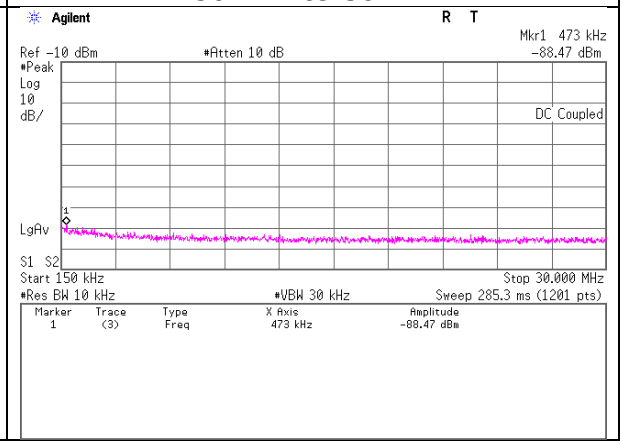
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off, 3DH5

2441 MHz

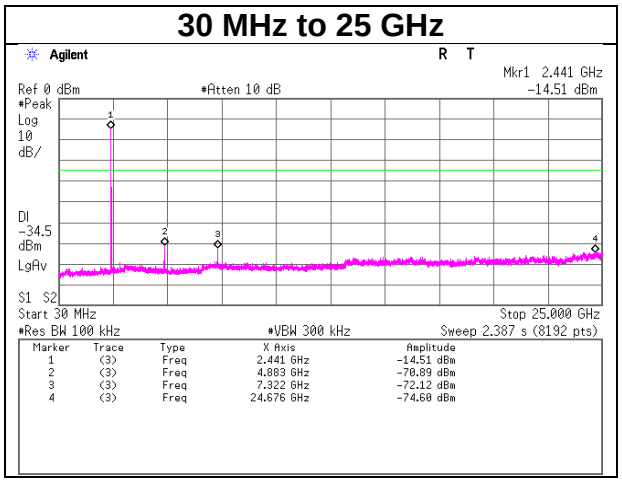
9 kHz to 150 kHz



150 kHz to 30 MHz



30 MHz to 25 GHz

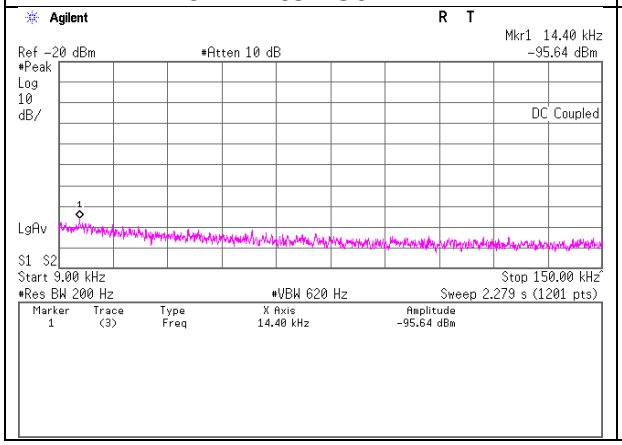


Conducted Spurious Emission

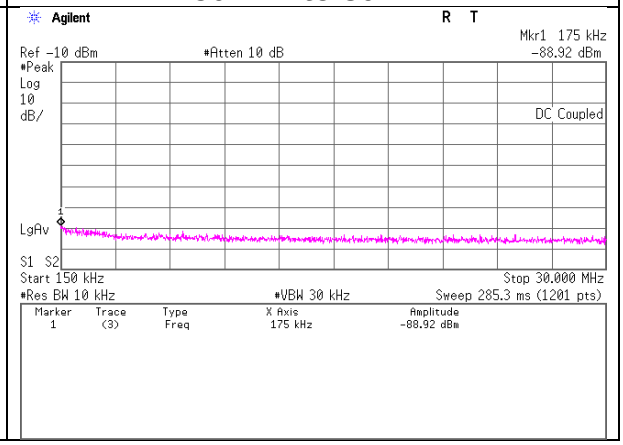
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx, Hopping Off, 3DH5

2480 MHz

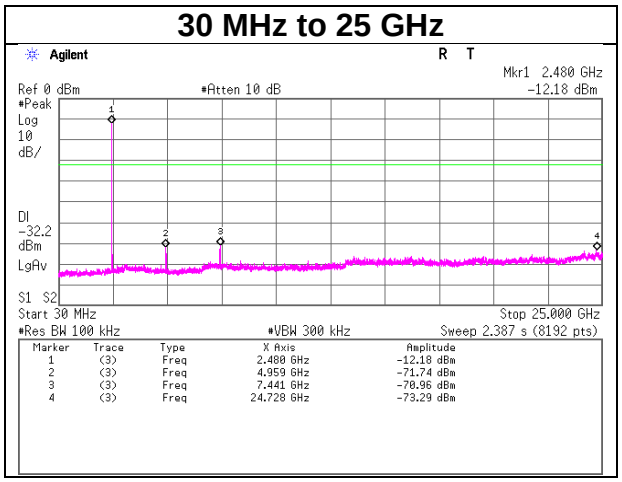
9 kHz to 150 kHz



150 kHz to 30 MHz



30 MHz to 25 GHz

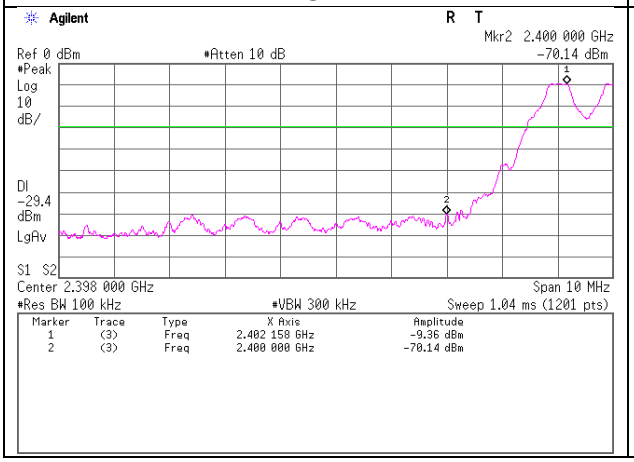


Conducted Emission Band Edge compliance

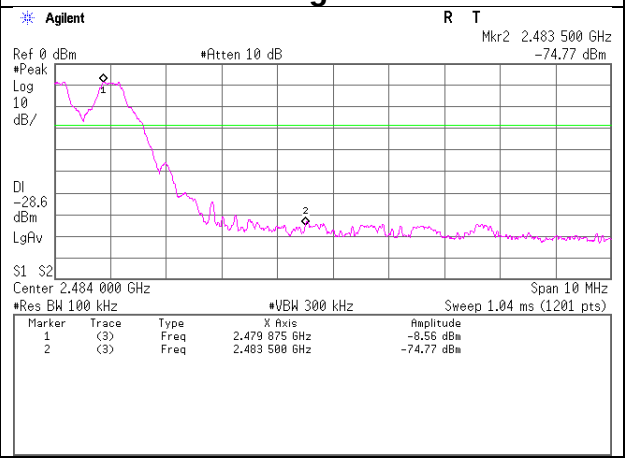
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx DH5

Hopping On

Low

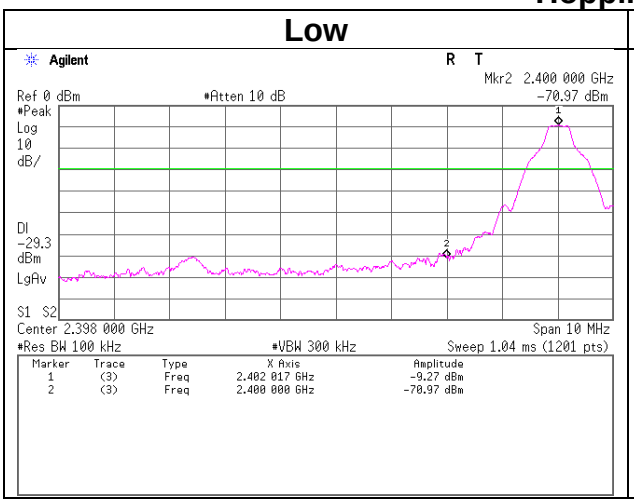


High

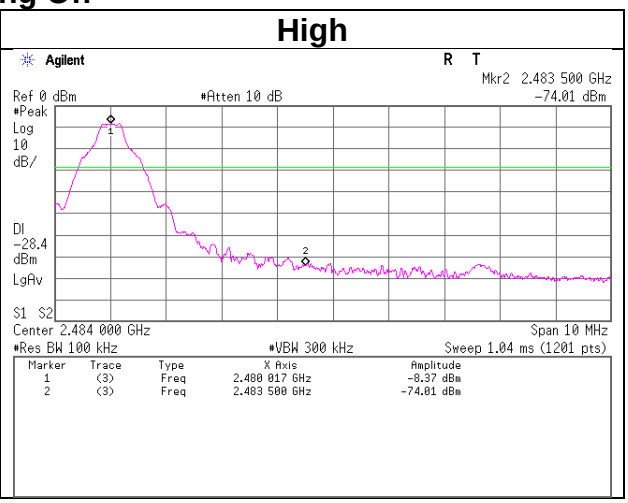


Hopping Off

Low



High

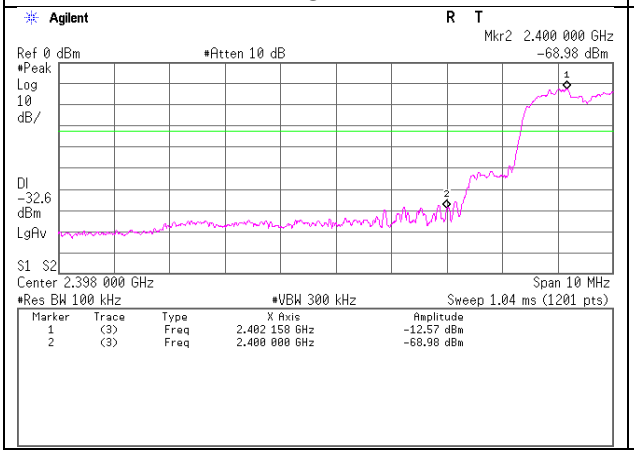


Conducted Emission Band Edge compliance

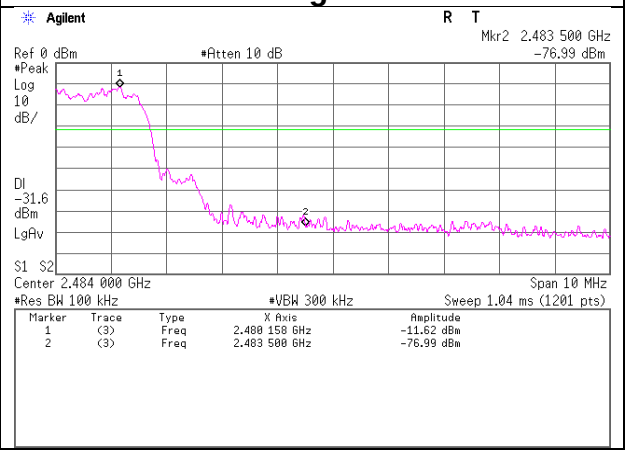
Test place	Ise EMC Lab. No.4 Preparation Room
Date	April 11, 2024
Temperature / Humidity	21 deg. C / 48 % RH
Engineer	Nachi Konegawa
Mode	Tx 3DH5

Hopping On

Low

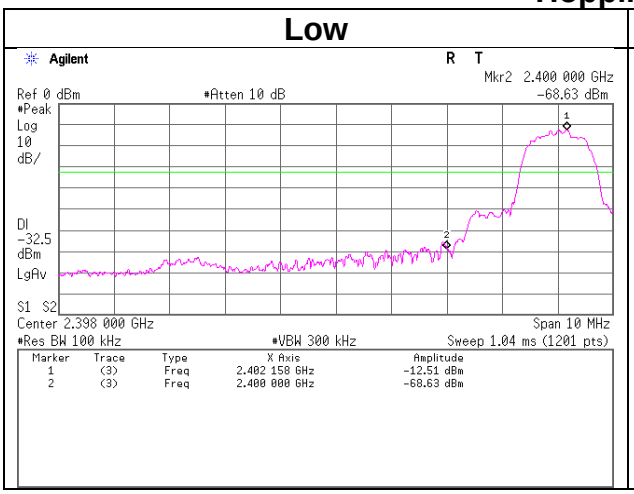


High

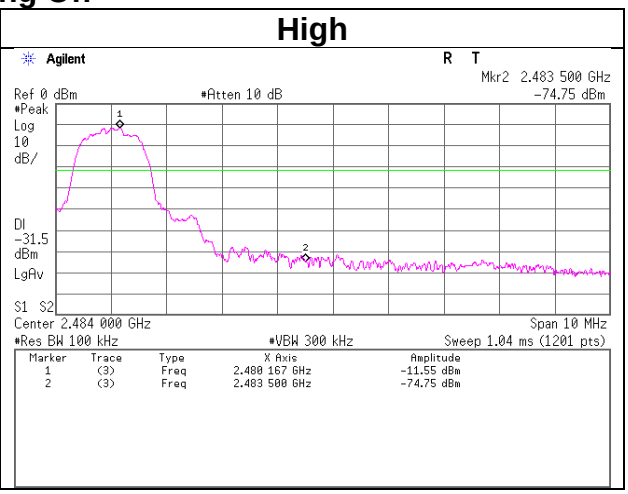


Hopping Off

Low



High



APPENDIX 2: Test Instruments

Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
AT	141312	Attenuator	Weinschel Associates	WA56-10	56100304	05/18/2023	12
AT	141375	Microwave Cable 1G-40GHz	Suhner	SUCOFLEX102	30817/2	05/27/2024	12
AT	141809	Power Meter	Anritsu Corporation	ML2495A	825002	05/22/2024	12
AT	141830	Power sensor	Anritsu Corporation	MA2411B	738285	05/22/2024	12
AT	141902	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187105	05/30/2024	12
AT	244710	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202104	01/25/2024	12
AT	244711	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202105	01/25/2024	12
RE	141266	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-191	08/10/2023	12
RE	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-192	09/21/2023	12
RE	141296	High Pass Filter 3.5-18.0GHz	UL Japan	HPF SELECTOR	002	09/01/2023	12
RE	141323	Coaxial cable	UL Japan	-	-	09/10/2023	12
RE	141331	Attenuator(6dB)	TME	UFA-01	-	02/17/2024	12
RE	141397	Coaxial Cable	UL Japan	-	-	11/22/2023	12
RE	141424	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	1915	03/15/2024	12
RE	141425	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	VHA 91031302	08/10/2023	12
RE	141508	Horn Antenna 1-18GHz	Schwarzbeck Mess-Elektronik OHG	BBHA9120D	557	05/17/2024	12
RE	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	051201197	01/31/2024	12
RE	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	02/01/2024	12
RE	141581	MicroWave System Amplifier	Keysight Technologies Inc	83017A	00650	10/05/2023	12
RE	141900	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46185823	06/16/2023	12
RE	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	04/10/2023	12
RE	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	12/11/2023	24
RE	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	12/13/2023	24
RE	142017	AC4_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	04/14/2023	12
RE	142183	Measure	KOMELON	KMC-36	-	10/20/2023	12
RE	142230	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	142314	Attenuator	Pasternack Enterprises	PE7390-6	D/C 1504	06/23/2023	12
RE	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	244709	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202103	01/25/2024	12
RE	244710	Thermo-Hygrometer	HIOKI E.E. CORPORATION	LR5001	231202104	01/25/2024	12
RE	246001	Microwave Cable	Huber+Suhner	SF103/11PC35/11PC35/ 1000mm / SF126E/5000mm	800673(1m) / 610204(5m)	03/06/2024	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:

AT: Antenna Terminal Conducted test
RE: Radiated Emission