


# RADIO TEST REPORT

## Test Report No. 15058381S-B

Customer	ALPS ALPINE CO., LTD.
Description of EUT	Head unit
Model Number of EUT	AH00ICB 4
FCC ID	A269ZUA171
Test Regulation	FCC Part 15 Subpart C
Test Result	Complied
Issue Date	March 25, 2024
Remarks	Bluetooth (BR / EDR) parts Antenna Terminal Conducted Tests

**Representative Test Engineer**Yuta Shiba  
Engineer**Approved By**Kazuya Noda  
Leader

CERTIFICATE 1266.03

- ☐ 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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- For test report(s) referred in this report, the latest version (including any revisions) is always referred.

## **REVISION HISTORY**

**Original Test Report No.: 15058381S-B**

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	15058381S-B	March 25, 2024	-

## 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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<b>CONTENTS</b>	<b>PAGE</b>
<b>SECTION 1: Customer Information .....</b>	<b>5</b>
<b>SECTION 2: Equipment Under Test (EUT).....</b>	<b>5</b>
<b>SECTION 3: Test Specification, Procedures &amp; Results .....</b>	<b>7</b>
<b>SECTION 4: Operation of EUT during testing .....</b>	<b>9</b>
<b>SECTION 5: Antenna Terminal Conducted Tests .....</b>	<b>11</b>
<b>APPENDIX 1: Test data .....</b>	<b>12</b>
20 dB Bandwidth, 99 %Occupied Bandwidth and Carrier Frequency Separation .....	12
Number of Hopping Frequency .....	16
Dwell time .....	18
Maximum Peak Output Power .....	21
Conducted Spurious Emission.....	23
Conducted Emission Band Edge compliance .....	29
<b>APPENDIX 2: Test Instruments .....</b>	<b>31</b>
<b>APPENDIX 3: Photographs of test setup.....</b>	<b>32</b>
Antenna Terminal Conducted Tests .....	32

## **SECTION 1: Customer Information**

Company Name	ALPS ALPINE CO., LTD.
Address	20-1 Yoshima Industrial park, Iwaki, Fukushima, Japan 970-1192
Telephone Number	+81-246-36-4111
Contact Person	Kenji Nagase

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	Head unit
Model Number	AH00ICB 4
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	January 12, 2024
Test Date	January 20 to March 11, 2024

### **2.2 Product Description**

#### **General Specification**

Rating	DC 13.2 V
Operating temperature	-30 deg. C - +70 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.

### Bluetooth (BR / EDR / Low Energy)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480 MHz
Type of Modulation	BT: FHSS (GFSK, $\pi/4$ DQPSK, 8 DPSK) BT LE: GFSK
Antenna Type	Planar Inverted-F Antenna
Antenna Gain <sup>a)</sup>	-0.2 dBi

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

Equipment Type	Transceiver
Frequency of Operation	2412 MHz to 2462 MHz
Type of Modulation	DSSS, OFDM
Antenna Type	Planar Inverted-F Antenna
Antenna Gain <sup>a)</sup>	-0.78 dBi

### WLAN (IEEE802.11a/11n-20/11ac-20/11n-40/11ac-40/11ac-80)

Equipment Type	Transceiver	
Frequency of Operation	20 MHz Band	5180 MHz to 5240 MHz
		5260 MHz to 5320 MHz
		5500 MHz to 5720 MHz
		5745 MHz to 5825 MHz
	40 MHz Band	5190 MHz to 5230 MHz
		5270 MHz to 5310 MHz
		5510 MHz to 5710 MHz
		5755 MHz to 5795 MHz
	80 MHz Band	5210 MHz
		5290 MHz
		5530 MHz to 5690 MHz
		5775 MHz
Type of Modulation	OFDM	
Antenna Type	Planar Inverted-F Antenna	
Antenna Gain <sup>a)</sup>	+2.71 dBi (Chain 1)	
	+2.29 dBi (Chain 2)	

## 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 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	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	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	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	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	Conducted
Spurious Emission	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	See data.	Complied	Conducted
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 does not have AC Mains.					

#### **FCC Part 15.31 (e)**

The EUT provides stable voltage constantly to the RF Part regardless of input voltage. Instead of a new battery, DC power supply was used for the test. That does not affect the test result, therefore the EUT complies with the requirement.

#### **FCC Part 15.203 Antenna requirement**

It is impossible for end users to replace the antenna, because the antenna is mounted inside of the 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  $k = 2$ .

Antenna terminal test	Uncertainty (+/-)
Power Measurement above 1 GHz (Average Detector) SPM-06	1.1 dB
Power Measurement above 1 GHz (Peak Detector) SPM-06	1.8 dB
Power Measurement above 1 GHz (Average Detector) SPM-07	1.0 dB
Power Measurement above 1 GHz (Peak Detector) SPM-07	1.2 dB
Power Measurement above 1 GHz (Average Detector) SPM-13	0.81 dB
Power Measurement above 1 GHz (Peak Detector) SPM-13	1.1 dB
Spurious Emission (Conducted) below 1 GHz	0.91 dB
Conducted Emissions Power Density Measurement 1 GHz to 3 GHz	1.3 dB
Conducted Emissions Power Density Measurement 3 GHz to 18 GHz	2.5 dB
Spurious Emission (Conducted) 18 GHz to 26.5 GHz	2.8 dB
Spurious Emission (Conducted) 26.5 GHz to 40 GHz	2.6 dB
Bandwidth Measurement	0.012 %
Duty Cycle and Time Measurement	0.27 %
Temperature SCH-01	0.96 deg.C.
Humidity SCH-01	4.0 %
Temperature SCH-02	2.2 deg.C.
Voltage	0.74 %

### 3.5 Test Location

UL Japan, Inc. Shonan EMC Lab.

1-22-3, Megumigaoka, Hiratsuka-shi, Kanagawa-ken 259-1220 Japan

Telephone: +81-463-50-6400

A2LA Certificate Number: 1266.03

(FCC test firm registration number: 626366, ISED lab company number: 2973D / CAB identifier: JP0001)

Test room	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber (SAC1)	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.2 Semi-anechoic chamber (SAC2)	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber (SAC3)	12.7 x 7.7 x 5.35	12.7 x 7.7	5 m
No.4 Semi-anechoic chamber (SAC4)	8.1 x 5.1 x 3.55	8.1 x 5.1	-
Wireless anechoic chamber 1 (WAC1)	9.5 x 6.0 x 5.4	9.5 x 6.0	3 m
Wireless anechoic chamber 2 (WAC2)	9.5 x 6.0 x 5.4	9.5 x 6.0	3 m
No.1 Shielded room	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.2 Shielded room	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.3 Shielded room	6.3 x 4.7 x 2.7	6.3 x 4.7	-
No.4 Shielded room	4.4 x 4.7 x 2.7	4.4 x 4.7	-
No.5 Shielded room	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.6 Shielded room	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.8 Shielded room	3.45 x 5.5 x 2.4	3.45 x 5.5	-
No.1 Measurement room	2.55 x 4.1 x 2.5	-	-
No.2 Measurement room	4.5 x 3.5 x 2.5	-	-
Wireless shielded room 1	3.0 x 4.5 x 2.7	3.0 x 4.5	-
Wireless shielded room 2	3.0 x 4.5 x 2.7	3.0 x 4.5	-

### 3.6 Test Data, Test Instruments, and Test Set Up

Refer to APPENDIX.



## SECTION 4: Operation of EUT during testing

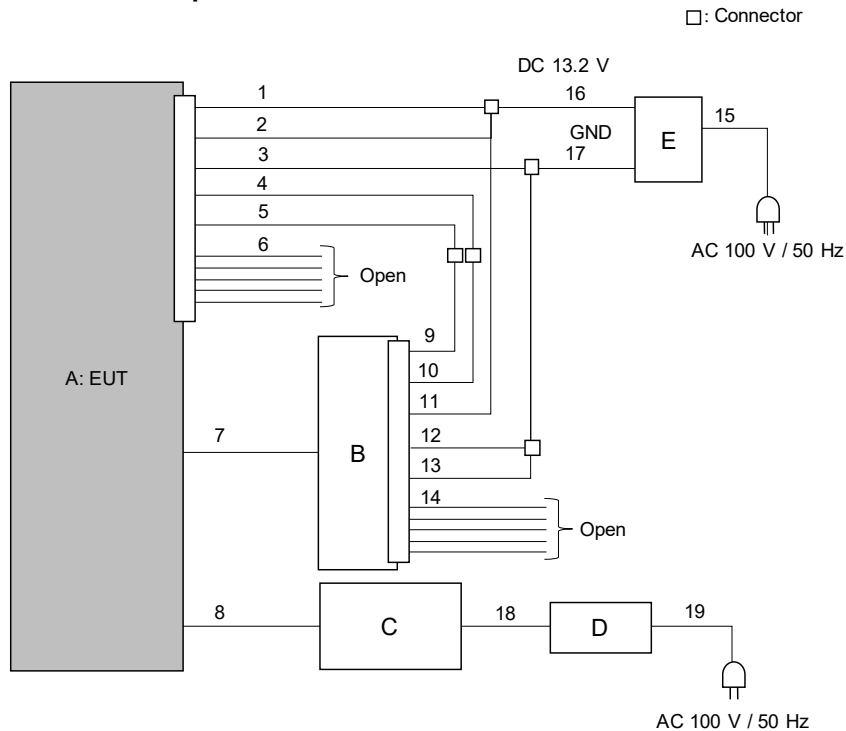
### 4.1 Operating Mode(s)

Mode	Remarks*
Bluetooth (BT)	BR / EDR, Payload: PRBS9
<p>*EUT has the power settings by the software as follows;  Power Setting: BR: 8 (Setting value)  EDR: 9 (Setting value)  Software: QRCT (Qualcomm Radio Control Toolkit) Version: 4.0.00195.0  (Date: 2021.10.18, Storage location: Driven by connected PC)</p> <p>*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.</p>	

#### Details of Operating Mode(s)

Test Item	Mode	Hopping	Tested Frequency
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
20 dB 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
<p>*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.</p>			

## 4.2 Configuration and Peripherals



### Description of EUT and Support Equipment

No.	Item	Model Number	Serial Number	Manufacturer	Remarks
A	Head unit	AH001CB 4	No.3	ALPS ALPINE	EUT
B	Display	QH00274A	No.28	ALPS ALPINE	-
C	Laptop Computer	ThinkPad L580	PF-1PMM0X	LENOVO	-
D	AC Adapter	ADLX45YLC2A	8SSA10E75842L1CZ9480J61	LENOVO	-
E	Power Supply(DC)	PW16-5ADP	19100034	GW Instek	-

### List of Cables Used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	+B	2.2	Unshielded	Unshielded	-
2	ACC	2.2	Unshielded	Unshielded	-
3	GND	2.2	Unshielded	Unshielded	-
4	BCAN H	2.2	Unshielded	Unshielded	-
5	BCAN L	2.2	Unshielded	Unshielded	-
6	Signal	2.2	Unshielded	Unshielded	-
7	GVIF	2.4	Shielded	Shielded	-
8	USB	2.2 + 1.0	Shielded	Shielded	-
9	BCAN L	0.6	Unshielded	Unshielded	-
10	BCAN H	0.6	Unshielded	Unshielded	-
11	+B	0.6	Unshielded	Unshielded	-
12	GND	0.6	Unshielded	Unshielded	-
13	DISP CONT	0.6	Unshielded	Unshielded	-
14	Signal	0.6	Unshielded	Unshielded	-
15	AC	1.5	Unshielded	Unshielded	-
16	DC+	1.0	Unshielded	Unshielded	-
17	DC-	1.0	Unshielded	Unshielded	-
18	DC	1.8	Unshielded	Unshielded	-
19	AC	0.9	Unshielded	Unshielded	-

## SECTION 5: 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
20 dB 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 *1)	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/ Average *2)	-	Power Meter (Sensor: 160 MHz BW)
Carrier Frequency Separation	3 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
Number of Hopping Frequency	30 MHz	100 kHz	300 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	Hopping ON: 13 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
	Hopping OFF: 10 MHz						

\*1) The measurement was performed with Max Hold since the duty cycle was not 100 %. 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

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

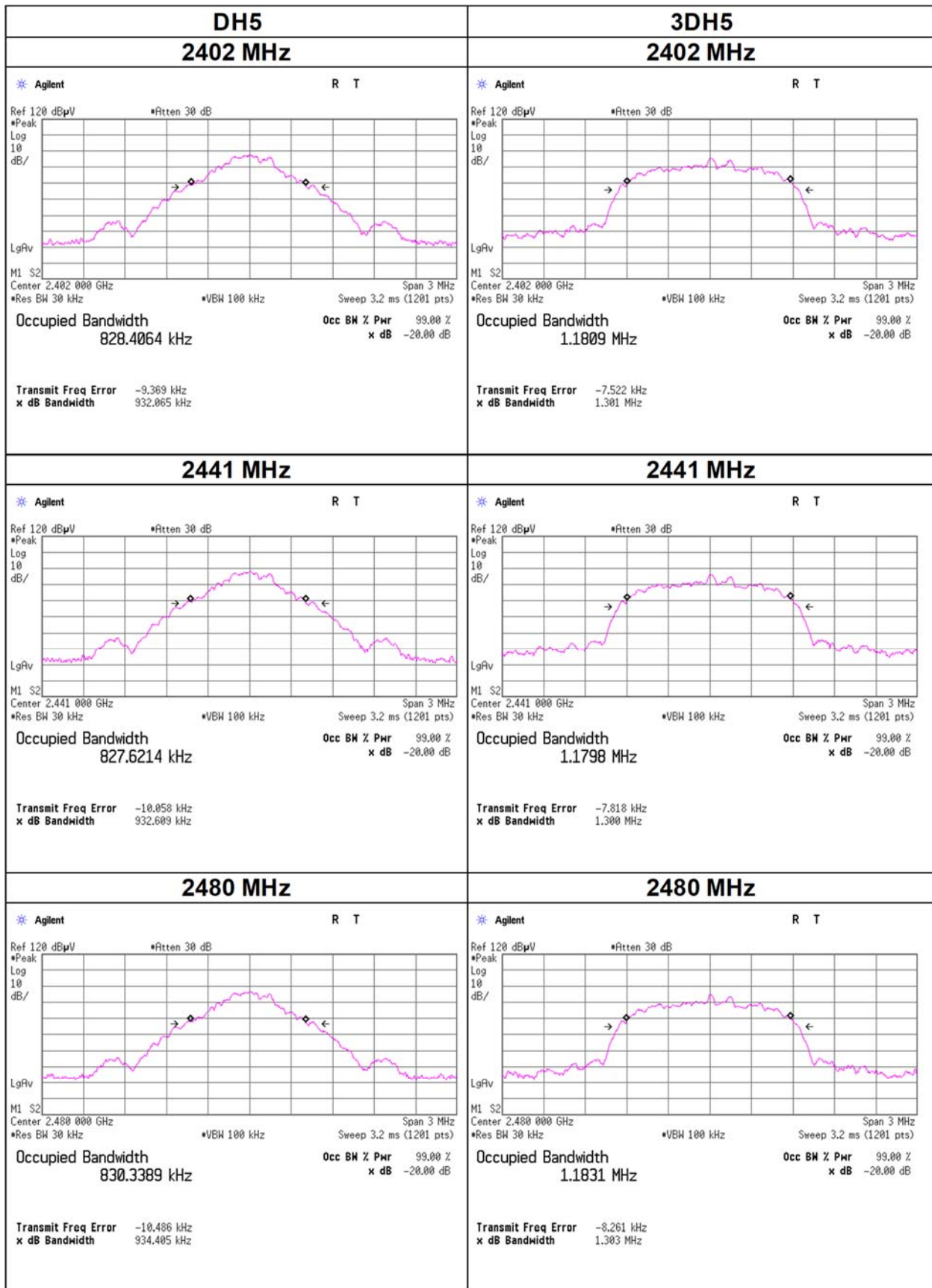
Test place	Shonan EMC Lab. No.1 Wireless Shielded Room(January 26,2024) No.2 Measurement Room(March 11, 2024)	
Date	January 26, 2024	March 11, 2024
Temperature / Humidity	21 deg. C / 28 % RH	22 deg. C / 24 % RH
Engineer	Yuta Shiba	Shiro Kobayashi
Mode	Tx, Hopping Off, Tx, Hopping On	

Mode	Freq. [MHz]	20 dB Bandwidth [MHz]	99 % Occupied Bandwidth [kHz]	Carrier Frequency Separation [MHz]	Limit for Carrier Frequency separation [MHz]
DH5	2402.0	0.932	828.4	2402.250	$\geq 0.621$
DH5	2441.0	0.933	827.6	2440.500	$\geq 0.622$
DH5	2480.0	0.934	830.3	2478.750	$\geq 0.623$
DH5	Hopping On	-	78537.8	-	-
3DH5	2402.0	1.301	1180.9	2402.250	$\geq 0.867$
3DH5	2441.0	1.300	1179.8	2440.500	$\geq 0.867$
3DH5	2480.0	1.303	1183.1	2478.750	$\geq 0.869$
3DH5	Hopping On	-	78478.1	-	-

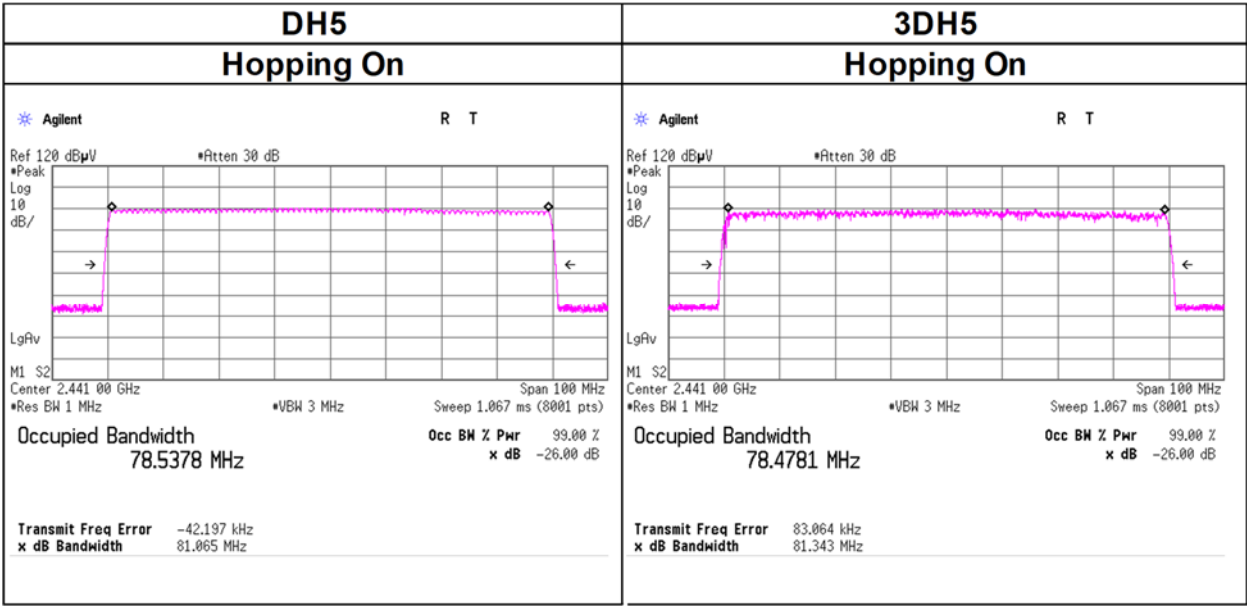
Limit: Two-thirds of 20 dB Bandwidth or 25 kHz (whichever is greater).

No limit applies to 20 dB Bandwidth.

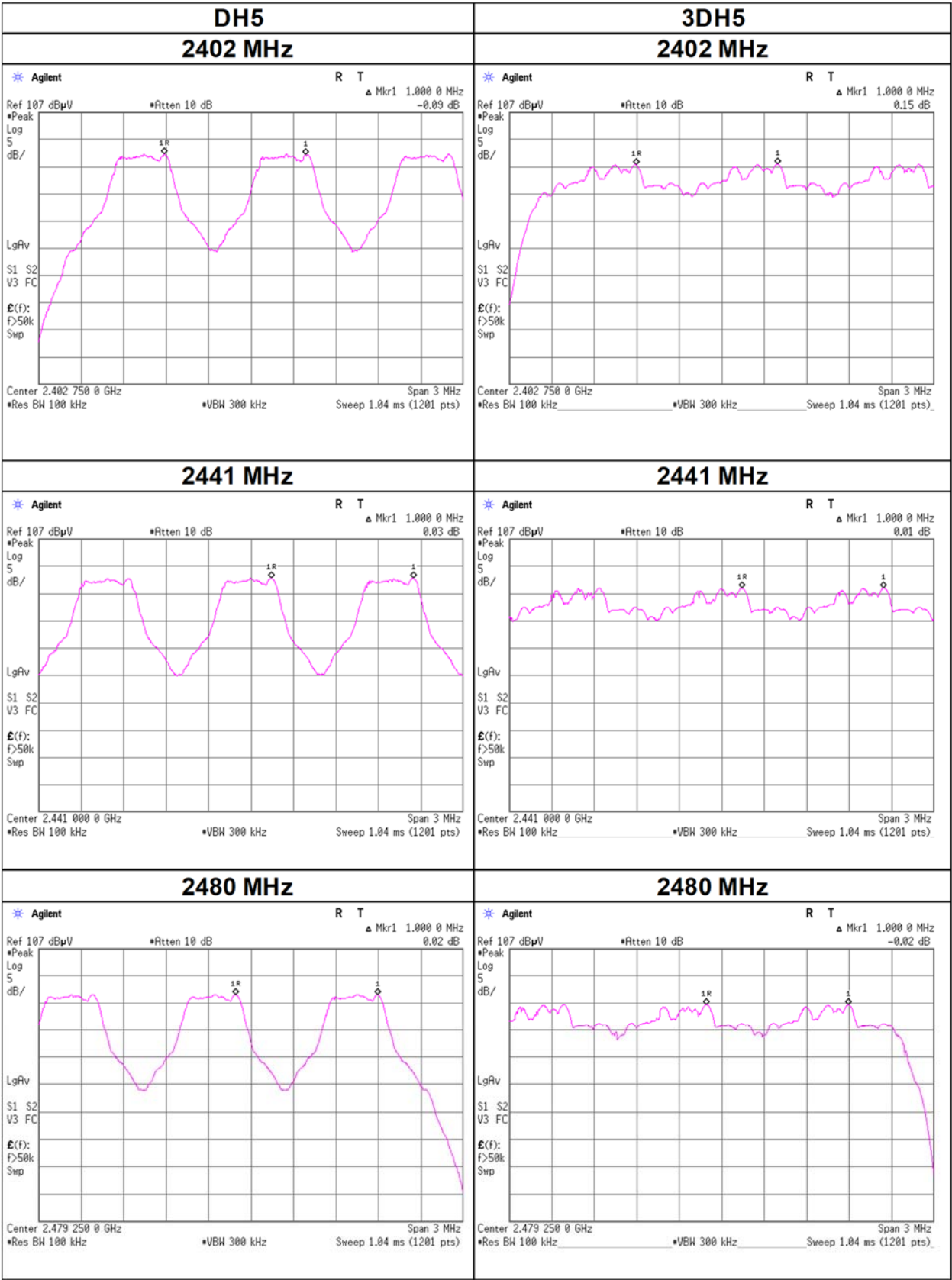
## 20 dB Bandwidth and 99 % Occupied Bandwidth



20 dB Bandwidth and 99 % Occupied Bandwidth



**Carrier Frequency Separation**



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**Number of Hopping Frequency**



### Dwell time

Test place	Shonan EMC Lab. No.1 Wireless Shielded Room(January 26,2024) No.2 Measurement Room(March 11, 2024)	
Date	January 26, 2024	March 11, 2024
Temperature / Humidity	21 deg. C / 28 % RH	22 deg. C / 24 % RH
Engineer	Yuta Shiba	Shiro Kobayashi
Mode	Tx. Hopping On	

Mode	Number of transmission in a 31.6 (79 Hopping x 0.4)	Length of transmission [ms]	Result [ms]	Limit [ms]
DH1	50.6 times / 5 s x 31.6 s = 320 times	0.406	130	400
DH3	27.2 times / 5 s x 31.6 s = 172 times	1.663	286	400
DH5	20.6 times / 5 s x 31.6 s = 131 times	2.913	382	400
3DH1	51.0 times / 5 s x 31.6 s = 323 times	0.413	133	400
3DH3	26.4 times / 5 s x 31.6 s = 167 times	1.670	279	400
3DH5	20.2 times / 5 s x 31.6 s = 128 times	2.919	374	400

### Sample Calculation

Result = Number of transmission x Length of transmission

\*Average data of 5 tests.

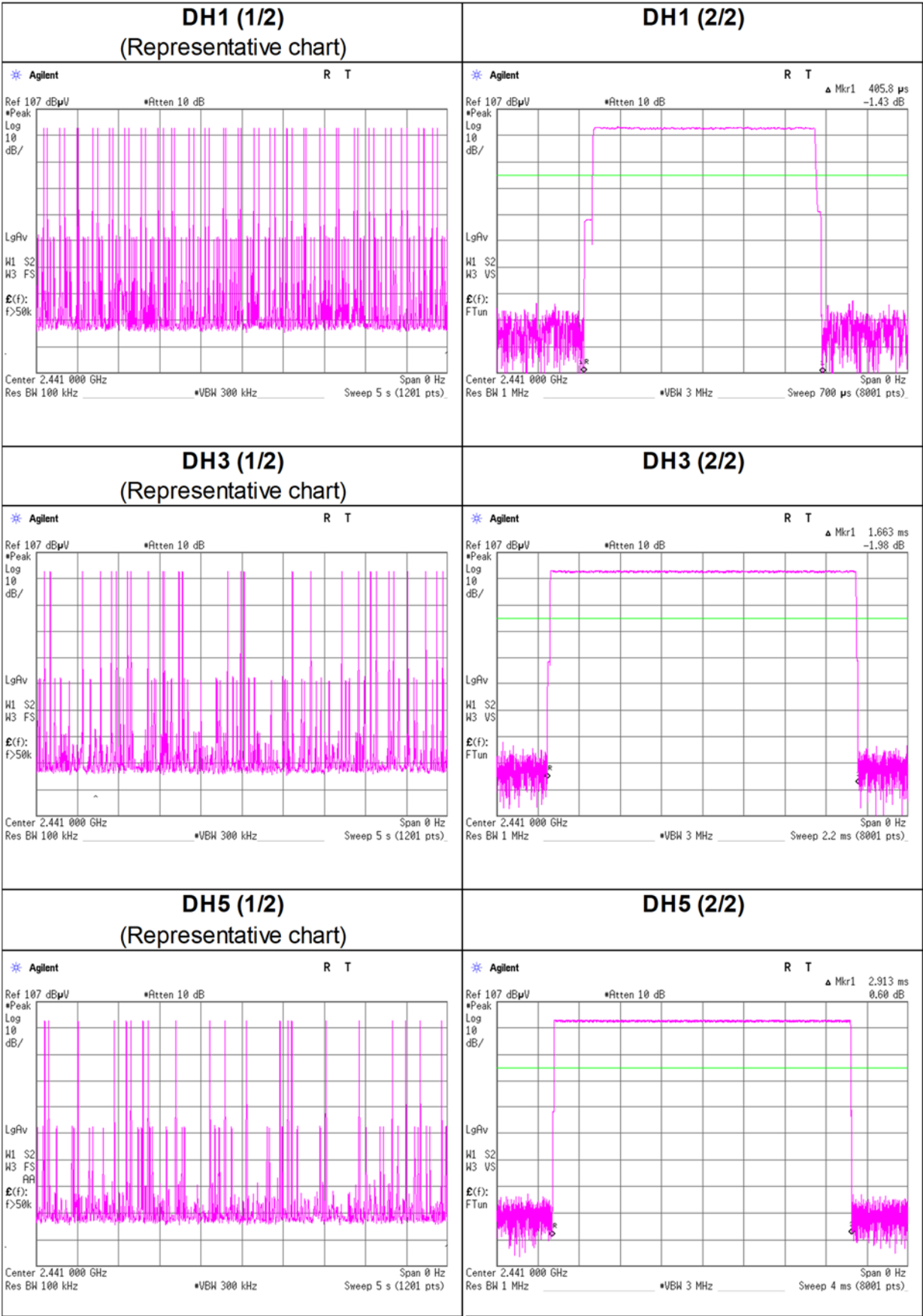
Mode	Sampling [times]					Average [times]
	1	2	3	4	5	
DH1	51	51	51	50	50	50.6
DH3	28	27	26	29	26	27.2
DH5	21	20	21	20	21	20.6
3DH1	51	52	50	51	51	51
3DH3	26	26	27	26	27	26.4
3DH5	20	21	19	19	22	20.2

### Sample Calculation

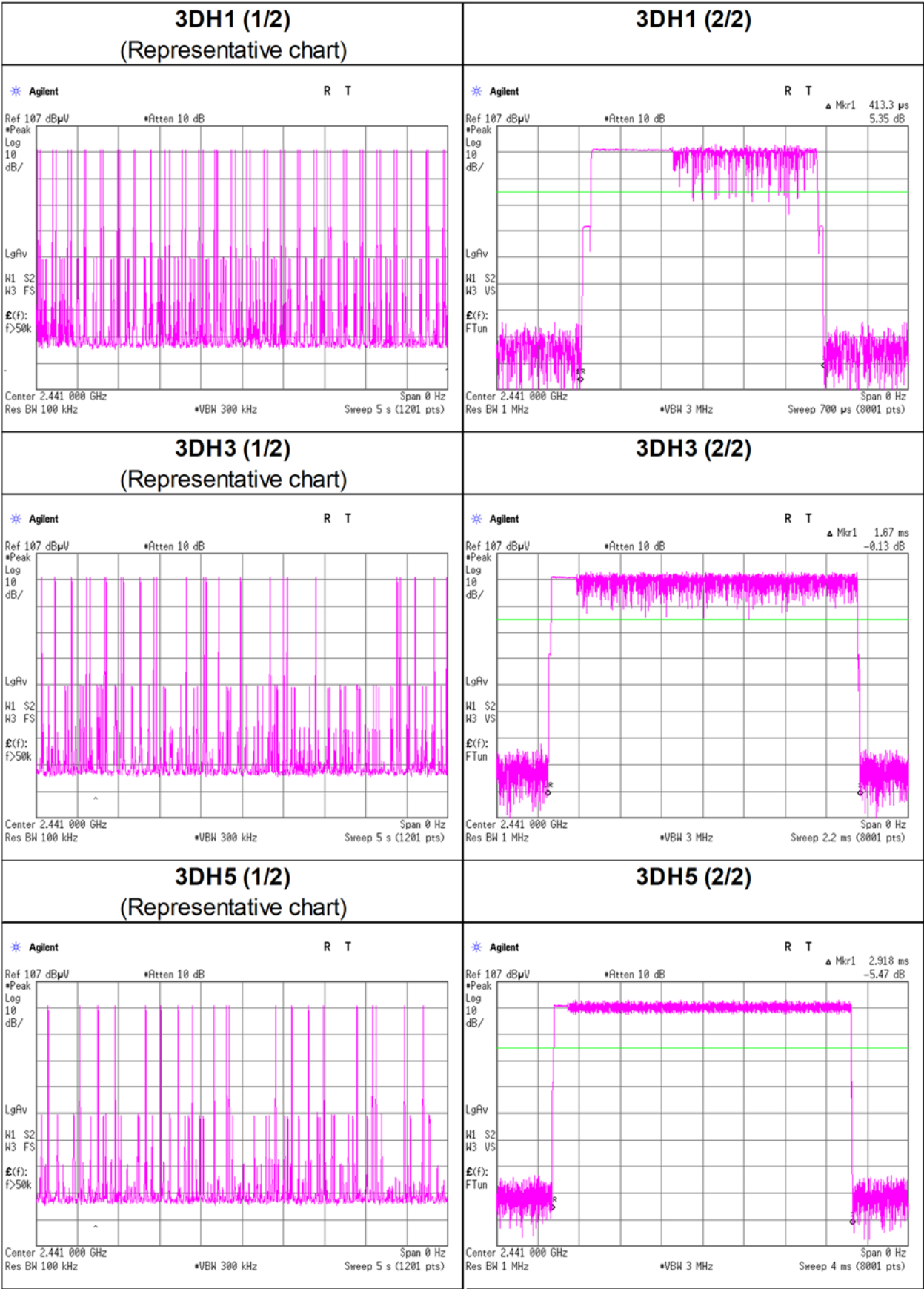
Average = Summation (Sampling 1 to 5) / 5

This device complies with the Bluetooth protocol for FHSS operation, employing a pseudo random channel selection and hopping rate to ensure that the occupancy time in  $N \times 0.4$  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



Dwell time



Maximum Peak Output Power

Test place Shonan EMC Lab. No.5 Shielded Room(January 26,2024)  
No.2 Measurement Room(March 11, 2024)  
Date January 20, 2024 March 11, 2024  
Temperature / Humidity 23 deg. C / 26 % RH 22 deg. C / 24 % RH  
Engineer Miku Ikudome Shiro Kobayashi  
Mode Tx, Hopping Off

Maximum peak output power

Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Conducted Power					e.i.r.p. for RSS-247				
					Result		Limit		Margin [dB]	Antenna Gain [dBi]	Result		Limit	
					[dBm]	[mW]	[dBm]	[mW]			[dBm]	[mW]	[dBm]	[mW]
DH5	2402	-7.16	1.00	9.91	3.75	2.37	20.97	125	17.22	-0.20	3.55	2.26	36.02	4000
DH5	2441	-6.82	1.01	9.91	4.10	2.57	20.97	125	16.87	-0.20	3.90	2.45	36.02	4000
DH5	2480	-7.94	1.01	9.91	2.98	1.99	20.97	125	17.99	-0.20	2.78	1.90	36.02	4000
2DH5	2402	-5.73	1.00	9.91	5.18	3.30	20.97	125	15.79	-0.20	4.98	3.15	36.02	4000
2DH5	2441	-5.26	1.01	9.91	5.66	3.68	20.97	125	15.31	-0.20	5.46	3.51	36.02	4000
2DH5	2480	-5.52	1.01	9.91	5.40	3.47	20.97	125	15.57	-0.20	5.20	3.31	36.02	4000
3DH5	2402	-5.20	1.00	9.91	5.71	3.73	20.97	125	15.26	-0.20	5.51	3.56	36.02	4000
3DH5	2441	-4.73	1.01	9.91	6.19	4.16	20.97	125	14.78	-0.20	5.99	3.97	36.02	4000
3DH5	2480	-4.97	1.01	9.91	5.95	3.93	20.97	125	15.02	-0.20	5.75	3.75	36.02	4000

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 power (Reference data for RF Exposure)

Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
					[dBm]	[mW]		[dBm]	[mW]
					[dBm]	[mW]		[dBm]	[mW]
DH5	2402	-8.74	1.00	9.91	2.17	1.65	1.10	3.27	2.12
DH5	2441	-8.35	1.01	9.91	2.57	1.81	1.10	3.67	2.33
DH5	2480	-9.54	1.01	9.91	1.38	1.37	1.10	2.48	1.77
2DH5	2402	-9.45	1.00	9.91	1.46	1.40	1.10	2.56	1.80
2DH5	2441	-8.96	1.01	9.91	1.96	1.57	1.10	3.06	2.02
2DH5	2480	-9.22	1.01	9.91	1.71	1.48	1.10	2.81	1.91
3DH5	2402	-9.43	1.00	9.91	1.48	1.40	1.09	2.57	1.81
3DH5	2441	-8.94	1.01	9.91	1.98	1.58	1.09	3.07	2.03
3DH5	2480	-9.20	1.01	9.91	1.72	1.48	1.09	2.81	1.91

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

## Burst Rate Confirmation

Test place	Shonan EMC Lab. No.1 Wireless Shielded Room(January 26,2024) No.2 Measurement Room(March 11, 2024)	
Date	February 5, 2024	March 11, 2024
Temperature / Humidity	22 deg. C / 28 % RH	22 deg. C / 24 % RH
Engineer	Miku Ikudome	Shiro Kobayashi
Mode	Tx, Hopping Off	

## DH5

$\text{Tx on} / (\text{Tx on} + \text{Tx off}) = 0.776$   
 $\text{Tx on} / (\text{Tx on} + \text{Tx off}) * 100 = 77.6 \%$   
 $\text{Duty factor} = 10 * \log(3.75 / 2.91) = 1.10 \text{ dB}$   
 $\text{VBW: } 1 / \text{on time} = 343.65 \text{ Hz} < 360.00 \text{ Hz}$

Agilent R T  
 Ref 117 dBμV Atten 20 dB Mkr1 2.91 ms 3.57 dB  
 #Peak Log 10 dB/  
 LgRv  
 W1 S2 Center 2.441 000 GHz Span 0 Hz  
 Res BW 8 MHz VBW 50 MHz Sweep 4 ms (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	86.5 μs	43.81 dBμV
1a	(1)	Time	2.91 ms	3.57 dB
2R	(1)	Time	86.5 μs	43.81 dBμV
2a	(1)	Time	3.75 ms	3.32 dB

## 2DH5

$\text{Tx on} / (\text{Tx on} + \text{Tx off}) = 0.776$   
 $\text{Tx on} / (\text{Tx on} + \text{Tx off}) * 100 = 77.6 \%$   
 $\text{Duty factor} = 10 * \log(3.75 / 2.91) = 1.10 \text{ dB}$   
 $\text{VBW: } 1 / \text{on time} = 343.65 \text{ Hz} < 360.00 \text{ Hz}$

Agilent R T  
 Ref 117 dBμV Atten 20 dB ▲ Mkr2 3.75 ms 1.58 dB  
 #Peak Log 10 dB/  
 LgAv  
 H1 S2  
 Center 2.441 000 GHz Span 0 Hz  
 Res BW 8 MHz \*VBW 50 MHz Sweep 4 ms (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	86.5 μs	43.85 dBμV
1a	(1)	Time	2.91 μs	2.41 dB
2R	(1)	Time	86.5 μs	43.85 dBμV
2a	(1)	Time	3.75 μs	1.58 dB

## 3DH5

$\text{Tx on} / (\text{Tx on} + \text{Tx off}) = 0.777$   
 $\text{Tx on} / (\text{Tx on} + \text{Tx off}) * 100 = 77.7\%$   
 $\text{Duty factor} = 10 * \log(3.75 / 2.915) = 1.09 \text{ dB}$   
 $\text{VBW: } 1 / \text{on time} = 343.05 \text{ Hz} < 360.00 \text{ Hz}$

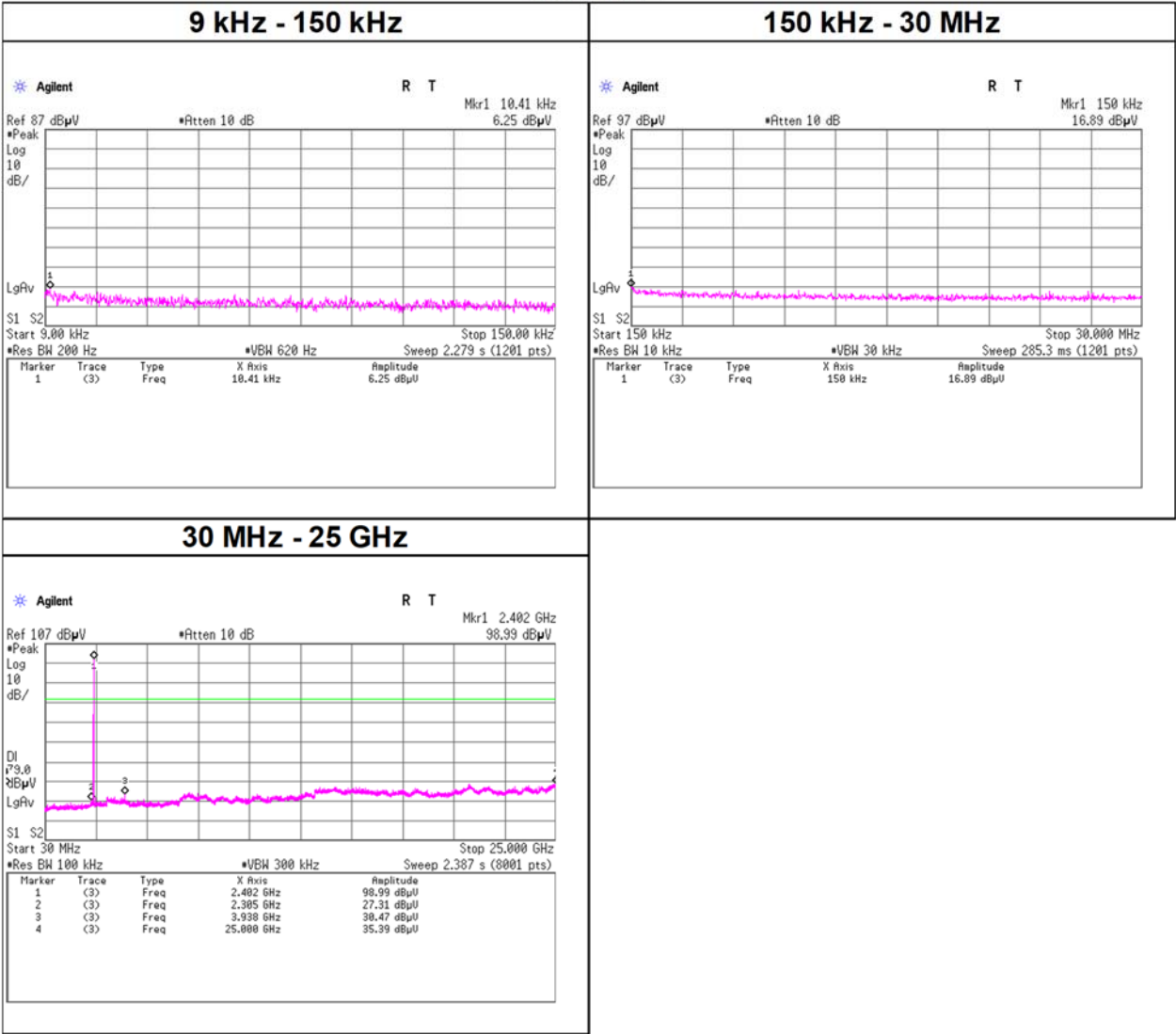
Agilent R T  
 Ref 117 dBμV Atten 20 dB ▲ Mkr2 3.75 ms  
-0.23 dB  
 #Peak  
 Log 10  
 dB/  
 LgRv  
 W1 S2  
 Center 2.441 000 GHz Span 0 Hz  
 Res BW 8 MHz #VBW 50 MHz Sweep 4 ms (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	84 μs	46.24 dBμV
1a	(1)	Time	2.915 ns	-0.36 dB
2R	(1)	Time	84 μs	46.24 dBμV
2a	(1)	Time	3.75 ns	-0.23 dB

Conducted Spurious Emission

Test place Shonan EMC Lab. No.1 Wireless Shielded Room  
Date February 5, 2024  
Temperature / Humidity 22 deg. C / 28 % RH  
Engineer Miku Ikudome  
Mode Tx, Hopping Off, DH5

2402 MHz



Conducted Spurious Emission

Test place

Shonan EMC Lab. No.1 Wireless Shielded Room

Date

February 5, 2024

Temperature / Humidity

22 deg. C / 28 % RH

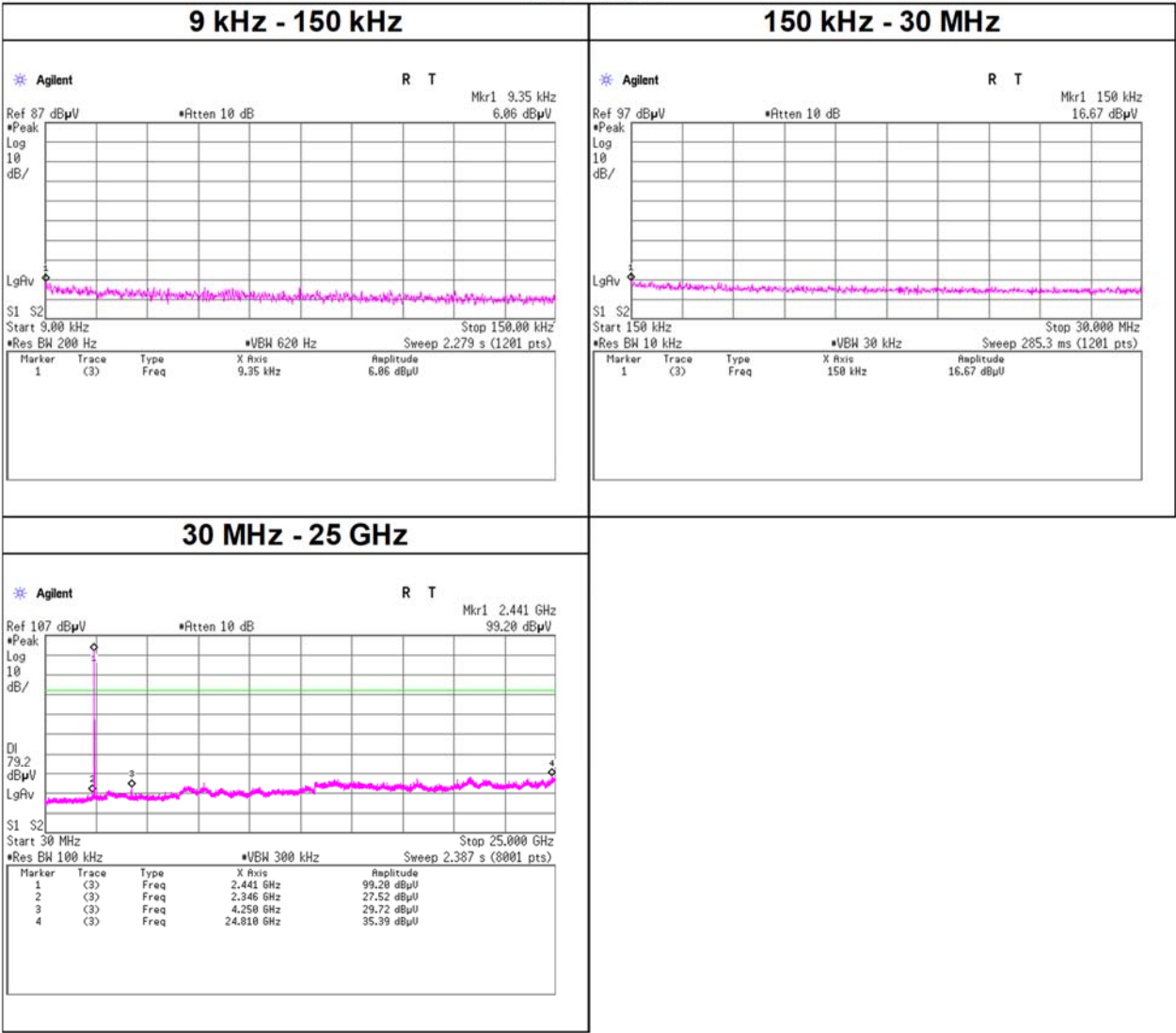
Engineer

Miku Ikudome

Mode

Tx, Hopping Off, DH5

2441 MHz

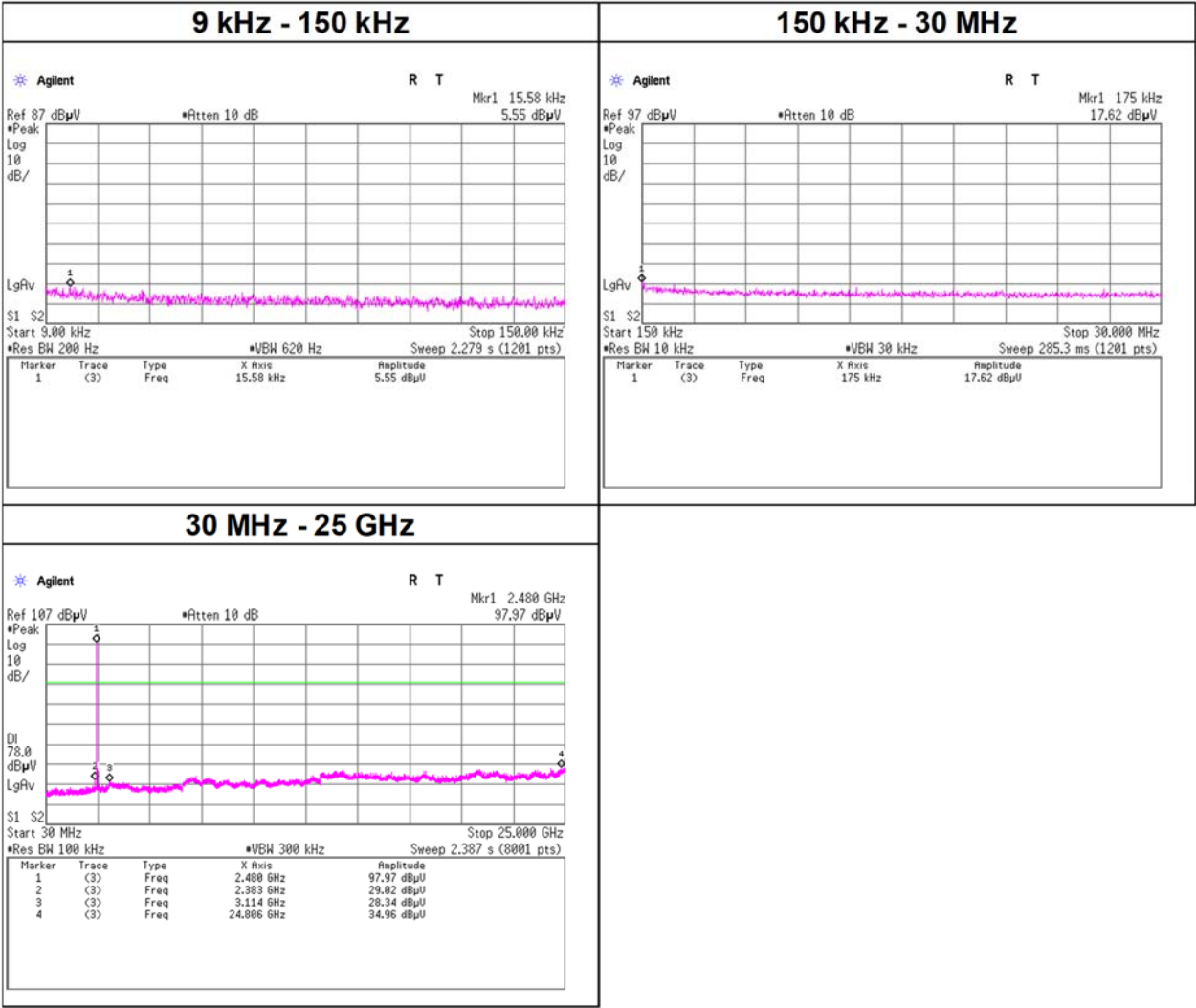




Conducted Spurious Emission

Test place Shonan EMC Lab. No.1 Wireless Shielded Room  
Date February 5, 2024  
Temperature / Humidity 22 deg. C / 28 % RH  
Engineer Miku Ikudome  
Mode Tx, Hopping Off, DH5

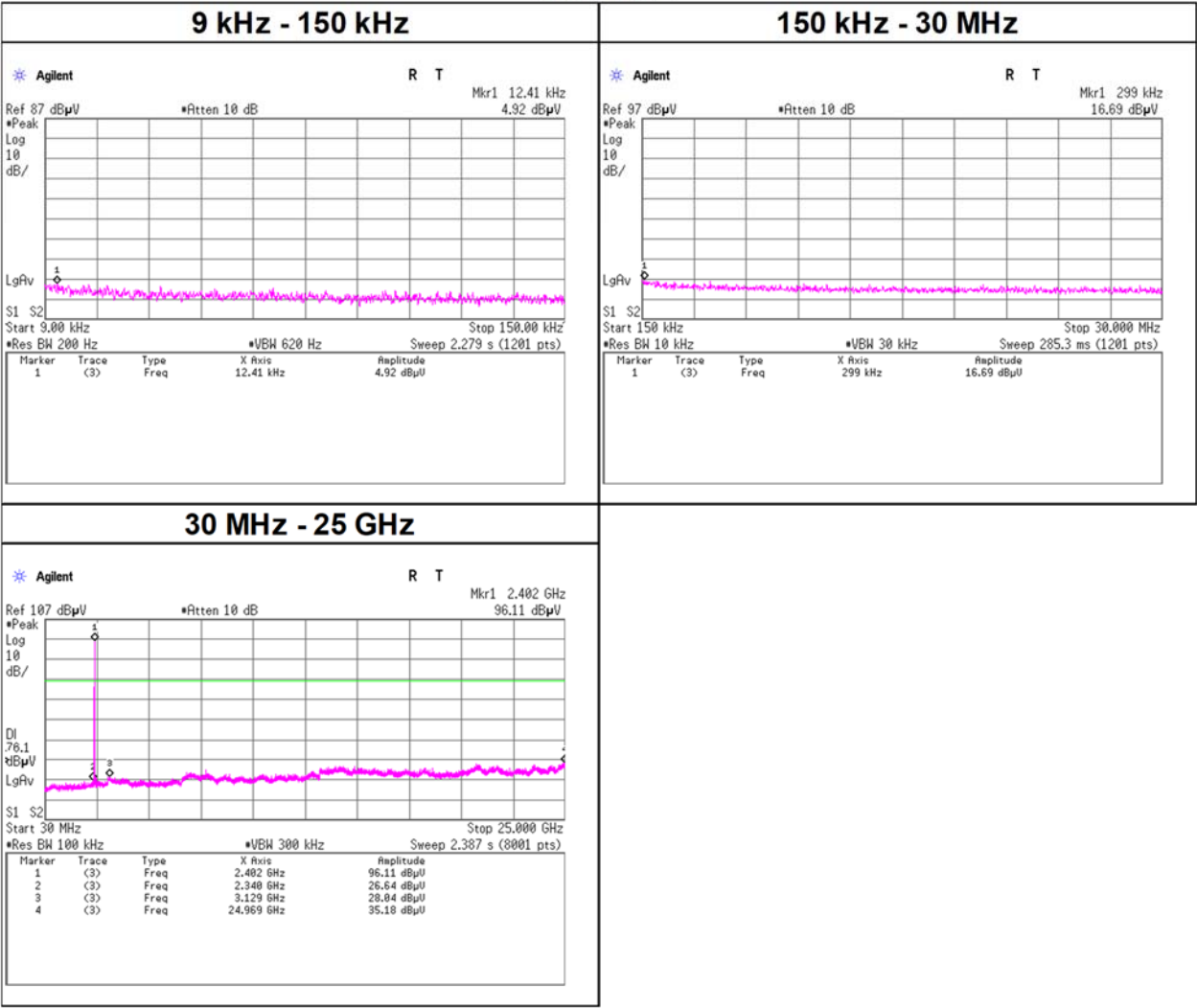
2480 MHz



Conducted Spurious Emission

Test place Shonan EMC Lab. No.2 Measurement Room  
Date March 11, 2024  
Temperature / Humidity 22 deg. C / 24 % RH  
Engineer Shiro Kobayashi  
Mode Tx, Hopping Off, 3DH5

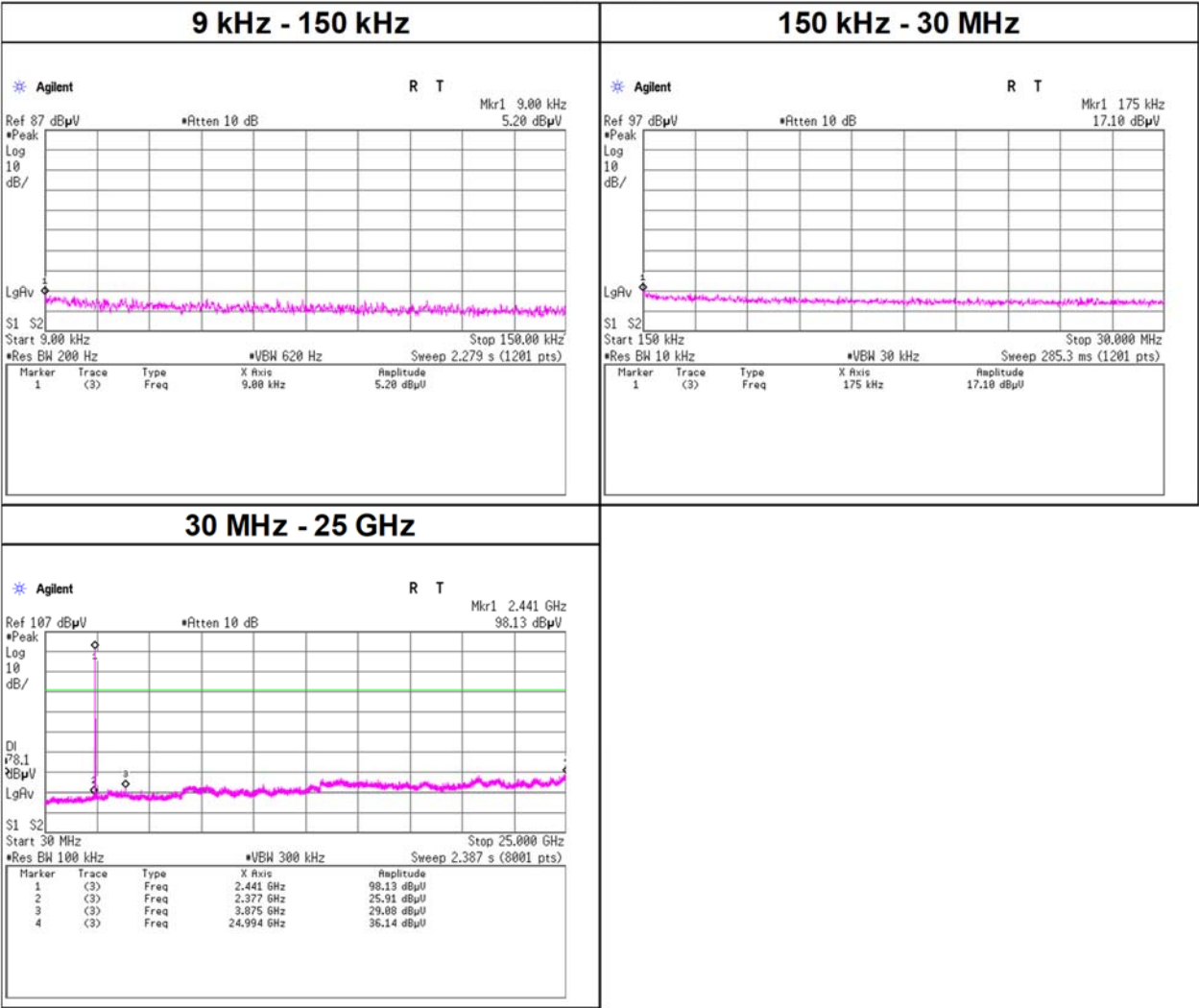
2402 MHz



Conducted Spurious Emission

Test place Shonan EMC Lab. No.2 Measurement Room  
Date March 11, 2024  
Temperature / Humidity 22 deg. C / 24 % RH  
Engineer Shiro Kobayashi  
Mode Tx, Hopping Off, 3DH5

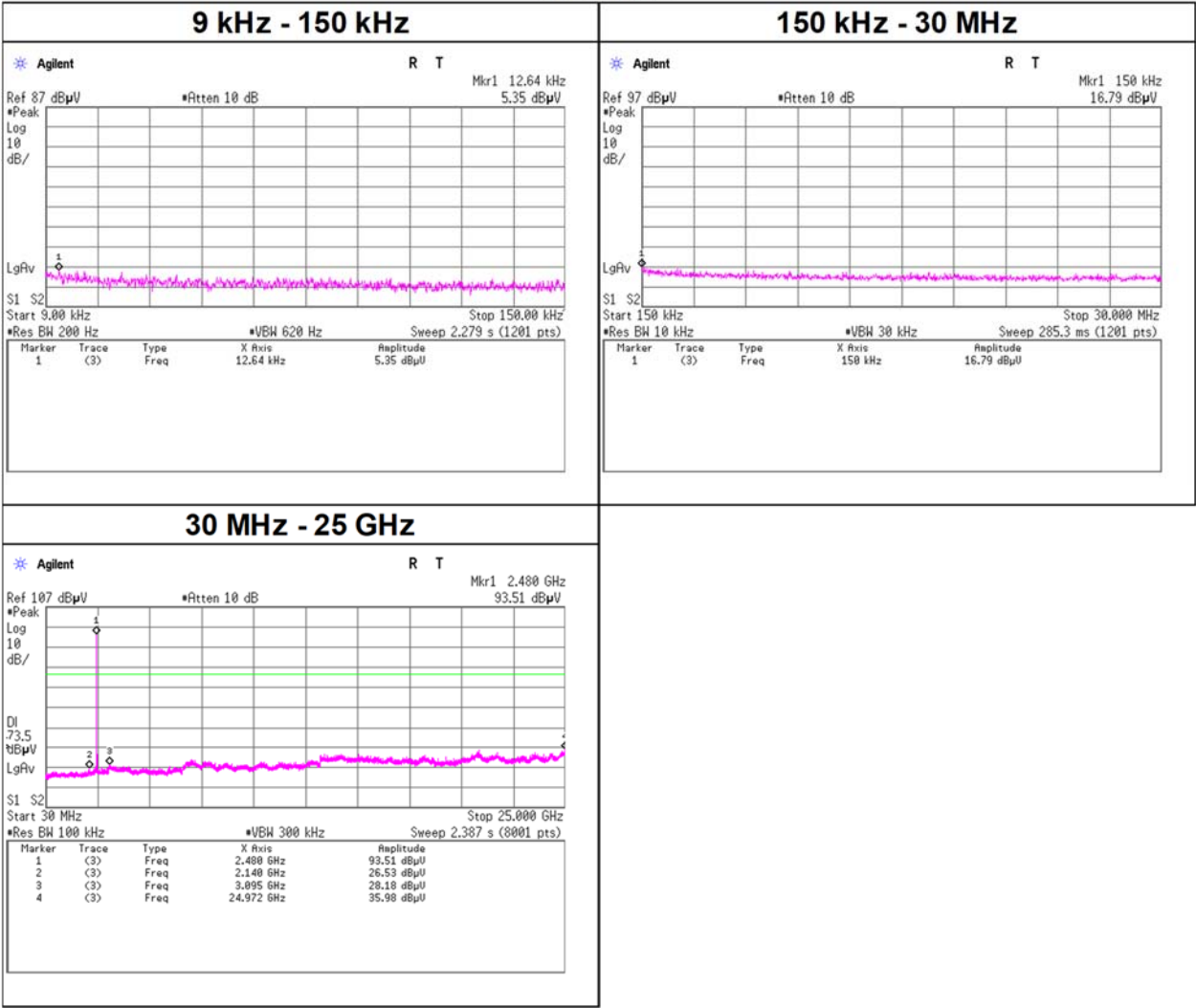
2441 MHz



Conducted Spurious Emission

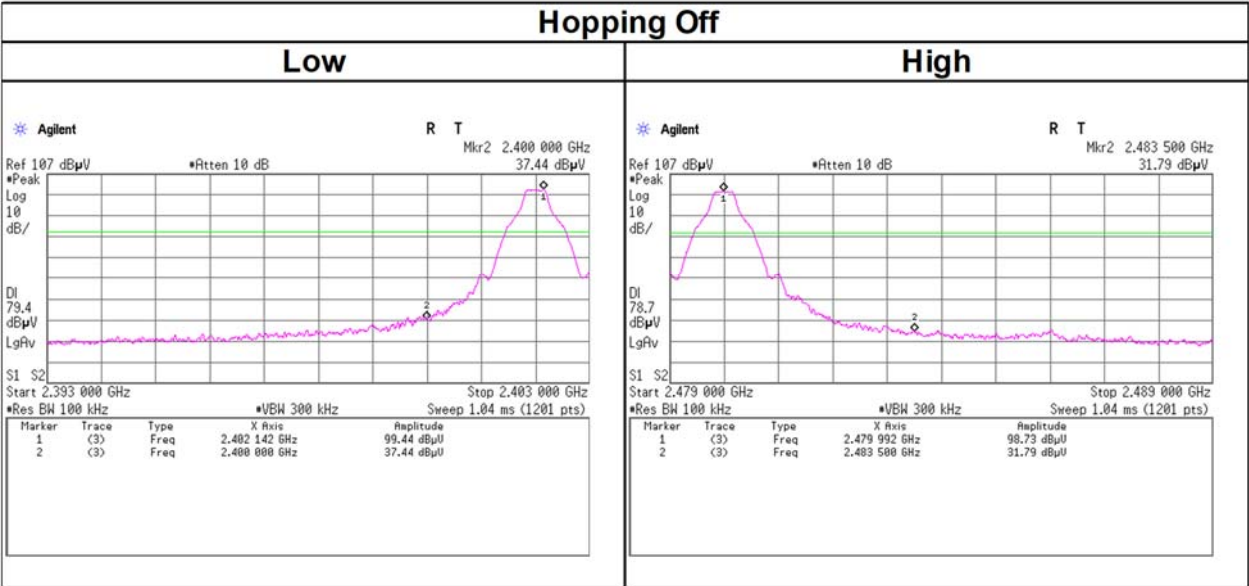
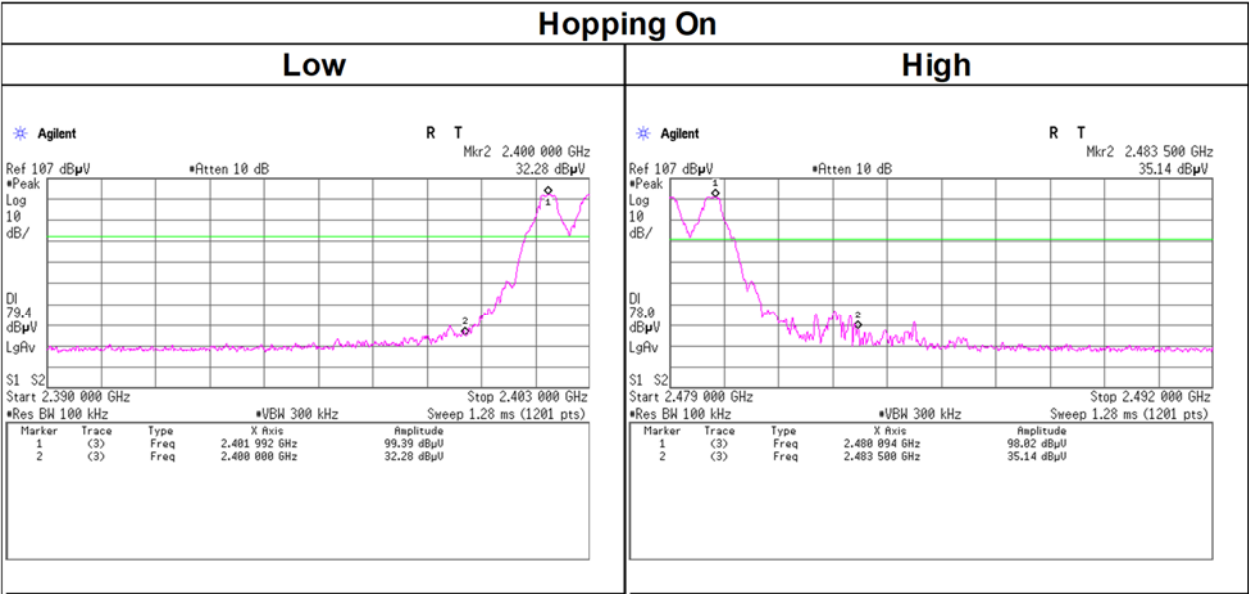
Test place Shonan EMC Lab. No.2 Measurement Room  
Date March 11, 2024  
Temperature / Humidity 22 deg. C / 24 % RH  
Engineer Shiro Kobayashi  
Mode Tx, Hopping Off, 3DH5

2480 MHz



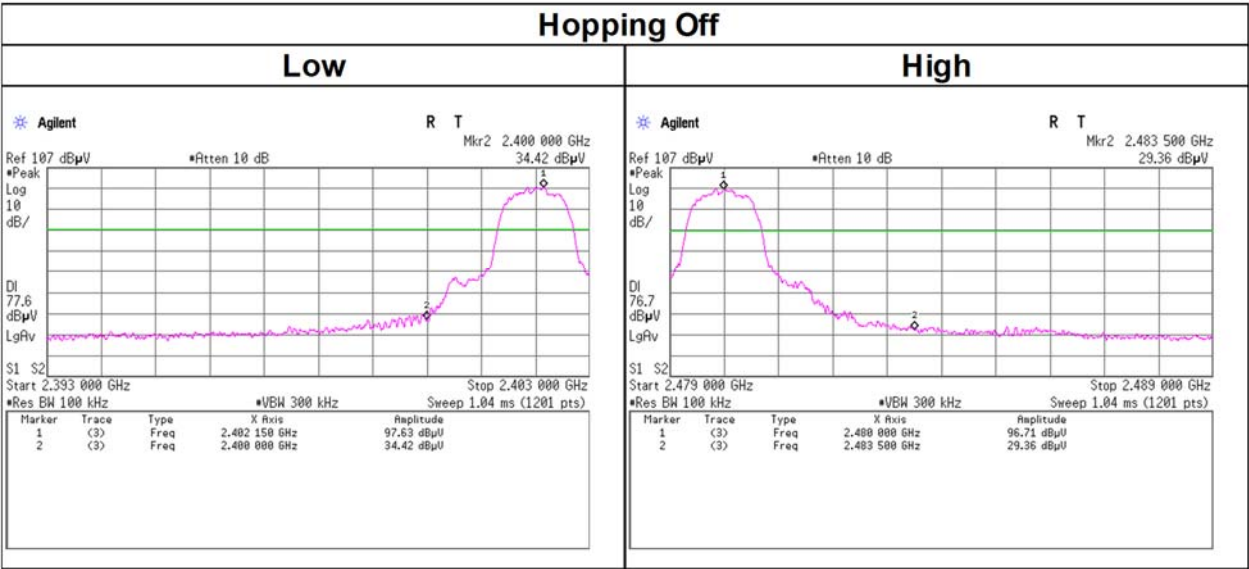
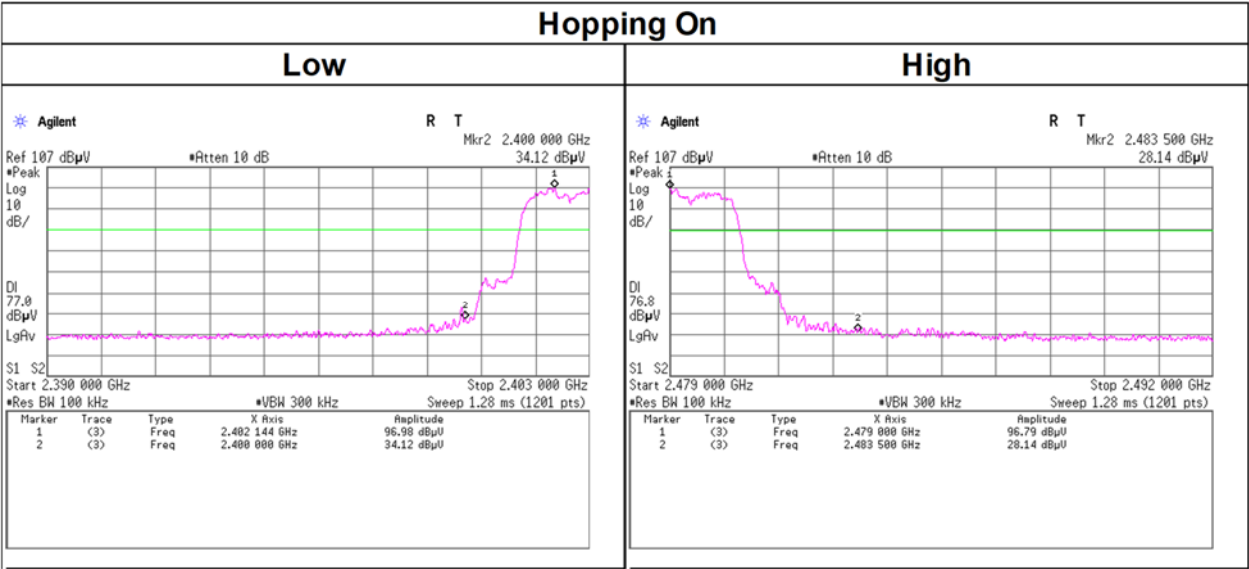
Conducted Emission Band Edge compliance

Test place Shonan EMC Lab. No.1 Wireless Shielded Room  
Date February 5, 2024  
Temperature / Humidity 22 deg. C / 28 % RH  
Engineer Miku Ikudome  
Mode Tx DH5



Conducted Emission Band Edge compliance

Test place Shonan EMC Lab. No.2 Measurement Room  
Date March 11, 2024  
Temperature / Humidity 22 deg. C / 24 % RH  
Engineer Shiro Kobayashi  
Mode Tx 3DH5



## APPENDIX 2: Test Instruments

### Test Equipment

Test Item	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
AT	145801	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY48250152	2023/09/23	12
AT	146212	Digital Hitester	HIOKI E.E. CORPORATION	3805-50	80997828	2023/09/25	12
AT	146247	Power Meter	Keysight Technologies Inc	8990B	MY51000272	2023/05/29	12
AT	146310	Power sensor	Keysight Technologies Inc	N1923A	MY5326009	2023/05/29	12
AT	191845	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	-	2023/08/07	12
AT	197396	Microwave cable	RS Pro	R-132G7210 100CO	-	2023/04/12	12
AT	204924	Terminator	Weinschel - API Technologies Corp	M1459A	110107	2024/02/14	12
AT	235604	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY45300743	2023/05/18	12
AT	239652	Coaxial Cable	Huber+Suhner	SUCOFLEX 102	2001220/2	2023/08/22	12
AT	242068	Attenuator	Weinschel Corp.	54A-10	120524	2023/11/02	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