

RADIO TEST REPORT

Test Report No. 14844284H-A-R1

Customer	MIWA LOCK CO., LTD.
Description of EUT	Hotel Card Lock (Slim type)
Model Number of EUT	ALVBS
FCC ID	VBU-V2VBS24
Test Regulation	FCC Part 15 Subpart C
Test Result	Complied
Issue Date	August 1, 2023
Remarks	-

Representative test engineerYuichiro Yamazaki
Engineer**Approved by**Takumi Shimada
Engineer

CERTIFICATE 5107.02

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

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

REVISION HISTORY

Original Test Report No. 14844284H-A

This report is a revised version of 14844284H-A. 14844284H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14844284H-A	July 13, 2023	-
1	14844284H-A-R1	August 1, 2023	Correction of each the Configuration and peripherals for Radiated Emission test and Frequency Tolerance test in Clause 4.2.
1	14844284H-A-R1	August 1, 2023	Correction of the mode name of plot data for Spurious Emission test; from "Mode 1 Without Tag" to "Mode 1 With Tag"

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	MIWA LOCK CO., LTD.
Address	3-1-12, Shiba, Minato-ku, Tokyo, 105-8510, Japan,
Telephone Number	+81-3-4330-3069
Contact Person	Tatsuya Nakamura

The information provided from the customer is as follows;

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

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

SECTION 2: Equipment Under Test (EUT)

2.1 Identification of EUT

Description	Hotel Card Lock (Slim type)
Model Number	ALVBS
Serial Number	Refer to SECTION 4.2
Condition	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification	No Modification by the test lab
Receipt Date	June 14, 2023
Test Date	June 14 to 20, 2023

2.2 Product Description

General Specification

Rating	DC 3.0 V
Operating Temperature	0 deg. C to 40 deg. C

Radio Specification

Bluetooth Low Energy *1)

Equipment Type	Transceiver
Frequency of Operation	2402 MHz to 2480MHz
Type of Modulation	GFSK
Antenna Gain	0.9 dBi

RFID

Radio Type	Transceiver
Frequency of Operation	13.56 MHz
Type of Modulation	ASK

Detector

Radio Type	Transmitter
Frequency of Operation	13.56 MHz
Type of Modulation	Unmodulated

*1) This is a FCC certificated module.
Model number: EYSHCN (FCC ID: RYYEYSHCN)

Variant model

This tested model (ALVBS) has variant models: ALV2S and ALV3S.
The differences of these models are follows;

Model No.	Difference from the base model
ALVBS (EUT)	- (Original)
ALV2S	Removed BT LE function (not mount BT LE module)
ALV3S	Increased MPU memory capacity (ROM, RAM) Increased EEPROM capacity

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 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators Section 15.207 Conducted limits Section 15.225 Operation within the band 13.110-14.010 MHz.

* The customer has declared that the EUT has complies with FCC Part 15 Subpart B as SDoC.

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)	Complied	-
Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.4, 6.12	<FCC> Section 15.225(a) ----- <ISED> RSS-210 B.6	73.44 dB, 13.56000 MHz, QP, 0 deg. <Mode 1 With Tag>	Complied	Radiated
Spectrum Mask	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.4, 6.13	<FCC> Section 15.225(b)(c) ----- <ISED> RSS-210 B.6	40.92 dB, 13.77410 MHz, QP, 0 deg. <Mode 1 With Tag>	Complied	Radiated
20 dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> -	<FCC> Section15.215(c) ----- <ISED> -	See data	Complied	Radiated
Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.4, 6.13	<FCC> Section 15.209, Section 15.225 (d) ----- <ISED> RSS-210 B.6 RSS-Gen 8.9	14.93 dB 40.680 MHz, Vertical, QP <Mode 1 With Tag>	Complied	Radiated
Frequency Tolerance	<FCC> ANSI C63.10:2013 6 Standard test methods ----- <ISED> RSS-Gen 6.11, 8.11	<FCC> Section 15.225(e) ----- <ISED> RSS-210 B.6	See data	Complied	Radiated

Note: UL Japan, Inc.'s EMI Work Procedures: Work Instructions-ULID-003591 and Work Instructions-ULID-003593.
*1) The test was not performed since the EUT was DC device.

FCC Part 15.31 (e)

The test was performed with the New Battery and the stable voltage was supplied to the EUT during the tests. Therefore, the EUT complies with the requirement.
However, the supply voltage was varied and tested at 85 % and 115 % of the nominal rated supply voltage during frequency tolerance test according to Section 15.225(e).

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% emission bandwidth	<ISED>RSS-Gen 6.7	-	N/A	-	Radiated

Other than above, no addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

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

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

Radiated emission

Measurement distance	Frequency Range		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	4.8
		Vertical	dB	5.0
	200 MHz to 1000 MHz	Horizontal	dB	5.1
		Vertical	dB	6.2
10 m	30 MHz to 200 MHz	Horizontal	dB	4.8
		Vertical	dB	4.8
	200 MHz to 1000 MHz	Horizontal	dB	4.9
		Vertical	dB	5.0
3 m	1 GHz to 6 GHz		dB	4.9
	6 GHz to 18 GHz		dB	5.2
1 m	10 GHz to 26.5 GHz		dB	5.5
	26.5 GHz to 40 GHz		dB	5.4

20 dB Bandwidth and 99% Occupied Bandwidth, Frequency Tolerance

Item	Unit	Calculated Uncertainty (+/-)
Bandwidth (OBW)	%	0.96
Frequency Readout (Frequency counter)	ppm	0.67
Frequency Readout (Spectrum analyzer frequency readout function)	ppm	1.61

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	-	-

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)

The mode is used:

Test mode	Remarks
1) Transmitting mode (Tx) - RFID (Without Tag ^{*1}) / With Tag)	The EUT Transmits and Receives at the same time and there is no receiving mode.
2) Transmitting mode (Tx) - Detector (Without Tag ^{*1}) / With Tag)	-

The EUT was operated in a manner similar to typical use during the tests.

*Power of the EUT was set by the software as follows;

Software: radio test firmware Version: ZF02
(Date: 2023.01 19, Storage location: EUT memory)

*This setting of software is the worst case.

Any conditions under the normal use do not exceed the condition of setting.

In addition, end users cannot change the settings of the output power of the product.

Justification: The system was configured in typical fashion (as a user would normally use it) for testing.

*1) After the pre-check the distance between EUT and Tag, the test was performed at the following worst distances.

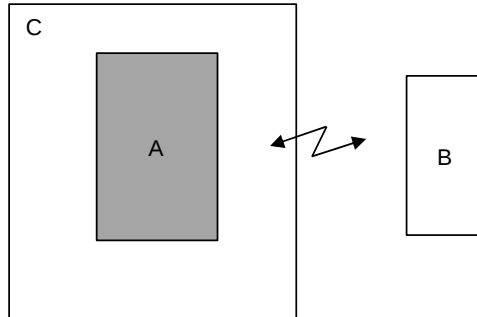
- Mode 1: 3 cm (Below 30 MHz), 0 cm (Above 30 MHz)
- Mode 2: 2 cm (Below 30 MHz), 0 cm (Above 30 MHz)

Test Item	Operating mode*	
	Mode 1	Mode 2
Electric Field Strength of Fundamental Emission	Tx Modulated on	Tx Modulated off
Spectrum Mask		
20 dB Bandwidth and 99 % Occupied Bandwidth		
Electric Field Strength of Spurious Emission		
Frequency Tolerance		

Frequency Tolerance	
Temperature	-20 deg. C to +50 deg. C Step 10 deg. C
Voltage	Normal Voltage DC 3.0 V Maximum Voltage DC 3.45 V (DC 3.0 V +15 %) Minimum Voltage DC 2.55 V (DC 3.0 V -15 %)
*This EUT provides stable voltage constantly to RF Part regardless of input voltage	

4.2 Configuration and peripherals

Radiated Emission test

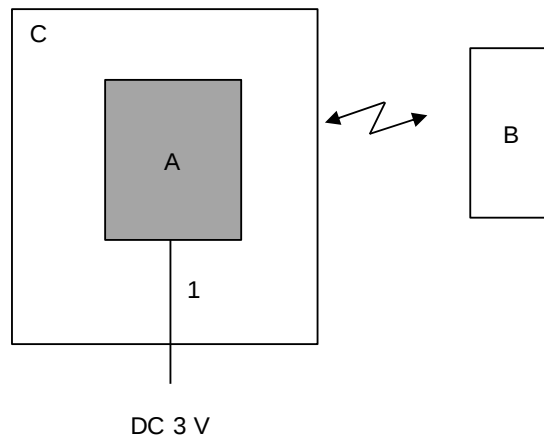


* Setup was taken into consideration and test data was taken under worse case conditions.

Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remark
A	Hotel Card Lock (Slim type)	ALVBS	V0FS14A	MIWA LOCK CO., LTD.	EUT
B	Tag	-	MIVGEN102	MIWA LOCK CO., LTD.	-
C	Jig	-	-	-	-

Frequency Tolerance test



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

Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remark
A	Hotel Card Lock (Slim type)	ALVBS	V0FS14A	MIWA LOCK CO., LTD.	EUT
B	Tag	-	MIVGEN102	MIWA LOCK CO., LTD.	-
C	Jig	-	-	-	-

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	DC Cable	2.0	Unshielded	Unshielded	-

SECTION 5: Radiated Emission (Fundamental, Spurious Emission and Spectrum Mask)

Test Procedure

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.

[Limit conversion]

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 Ohms. 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.

[Frequency: From 9 kHz to 30 MHz]

The EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

The measurements were performed for vertical polarization (antenna angle: 0 deg., 45 deg., 90 deg., 135 deg and 180 deg.) and horizontal polarization.

*Refer to Figure 2 about Direction of the Loop Antenna.

Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 m open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

These tests were performed in semi anechoic chamber. Therefore the measured level of emissions may be higher than if measurements were made without a ground plane. However test results were confirmed to pass against standard limit.

[Frequency: From 30 MHz to 1 GHz]

The measuring antenna height varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

The measurements were performed for both vertical and horizontal antenna polarization.

[Test instruments and test settings]

Frequency	Below 30 MHz	30 MHz to 200 MHz	200 MHz to 1 GHz
Antenna Type	Loop	Biconical	Logperiodic

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.

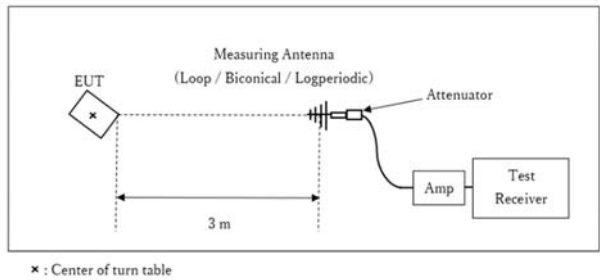
Frequency	From 9 kHz to 90 kHz and From 110 kHz to 150 kHz	From 90 kHz to 110 kHz	From 150 kHz to 490 kHz	From 490 kHz to 30 MHz	From 30 MHz to 1 GHz
Instrument used	Test Receiver				
Detector	PK / AV	QP	PK / AV	QP	QP
IF Bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz
Test Distance	3 m *1)	3 m *1)	3 m *1)	3 m *2)	3 m

*1) Distance Factor: $40 \times \log (3 \text{ m} / 300 \text{ m}) = -80 \text{ dB}$

*2) Distance Factor: $40 \times \log (3 \text{ m} / 30 \text{ m}) = -40 \text{ dB}$

Figure 1: Test Setup

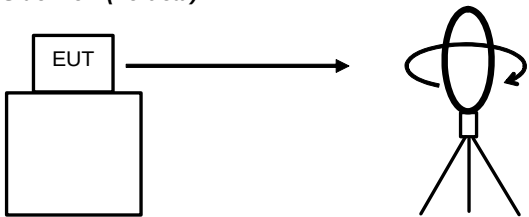
Below 1 GHz



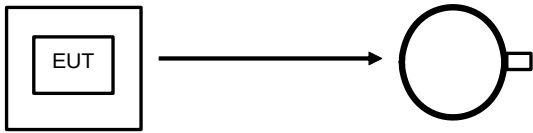
Test Distance: 3 m

Figure 2: Direction of the Loop Antenna

Side View (Vertical)

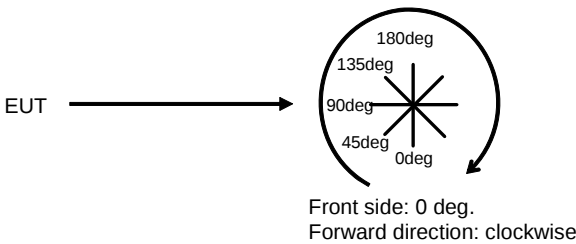


Top View (Horizontal)



Antenna was not rotated.

Top View (Vertical)



The test was made on EUT at the normal use position.

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

Measurement range : 9 kHz to 1 GHz
Test data : APPENDIX
Test result : Pass

SECTION 6: Other test

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	2 MHz (Mode 1)	18 kHz (Mode 1)	56 kHz (Mode 1)	Auto	Peak	Max Hold	Spectrum Analyzer
	100 kHz (Mode 2)	3 kHz (Mode 2)	9.1 kHz (Mode 2)				
99 % Occupied Bandwidth	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Sample *1)	Clear Write (Single)*1)	Spectrum Analyzer
Frequency Tolerance	-	-	-	-	-	-	Spectrum Analyzer *2)
*1) The measurement was performed with Sample detector, Clear Write (Single) since the duty cycle was 100 %.							
*2) The measurement was performed with Marker Frequency Counter Function.							

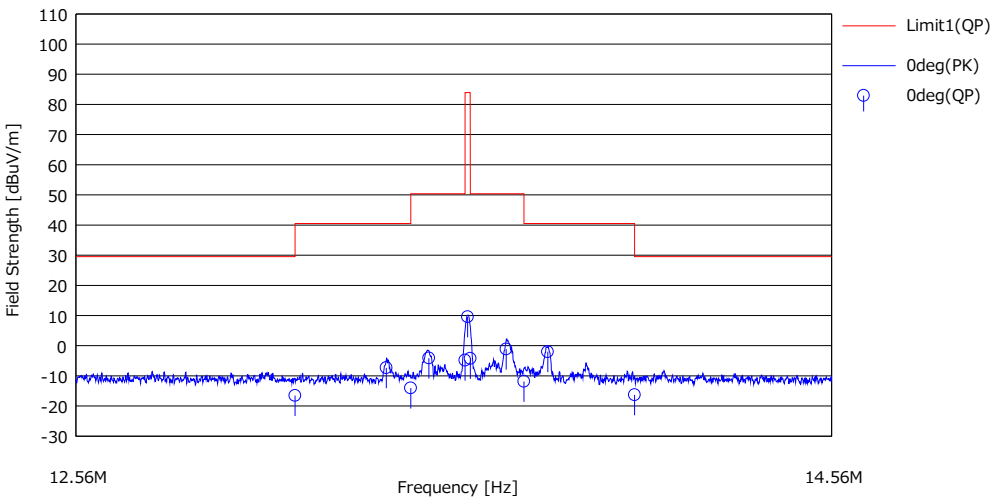
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Fundamental Emission and Spectrum Mask

Test place Ise EMC Lab.
Semi Anechoic Chamber No.4
Date June 14, 2023
Temperature / Humidity 21 deg. C / 61 % RH
Engineer Yuichiro Yamazaki
Mode Mode 1 without Tag

Limit : FCC15.225(a), 9-90kHz:PK, 110-490kHz:PK, other:QP



No.	Freq. [MHz]	Reading [dBUV]	Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result [dBUV/m]	Limit [dBUV/m]	Margin [dB]	Antenna [deg]	Table [deg]	Comment
		<QP>				<QP>	<QP>	<QP>			
1	13.11000	28.30	20.55	-33.26	32.13	-16.54	29.50	46.04	0deg	0	
2	13.34599	37.50	20.55	-33.25	32.13	-7.33	40.50	47.83	0deg	0	
3	13.41000	30.80	20.55	-33.25	32.13	-14.03	40.50	54.53	0deg	0	
4	13.45783	40.70	20.55	-33.25	32.13	-4.13	50.40	54.53	0deg	0	
5	13.55300	40.00	20.54	-33.25	32.13	-4.84	50.40	55.24	0deg	0	
6	13.56000	54.40	20.54	-33.25	32.13	9.56	83.90	74.34	0deg	0	
7	13.56700	40.60	20.54	-33.25	32.13	-4.24	50.40	54.64	0deg	0	
8	13.66238	43.70	20.54	-33.24	32.13	-1.13	50.40	51.53	0deg	0	
9	13.71000	33.00	20.54	-33.24	32.13	-11.83	40.50	52.33	0deg	0	
10	13.77411	42.80	20.54	-33.23	32.13	-2.02	40.50	42.52	0deg	0	
11	14.01000	28.50	20.54	-33.23	32.13	-16.32	29.50	45.82	0deg	0	

RESULT = READING + ANT FACTOR + LOSS (CABLE + Attenuator + Distance Factor*) - GAIN(AMP)
*) Distance Factor: 40 x log (3 m / 30 m) = -40 dB

Result of the fundamental Emission at 3 m without Distance factor

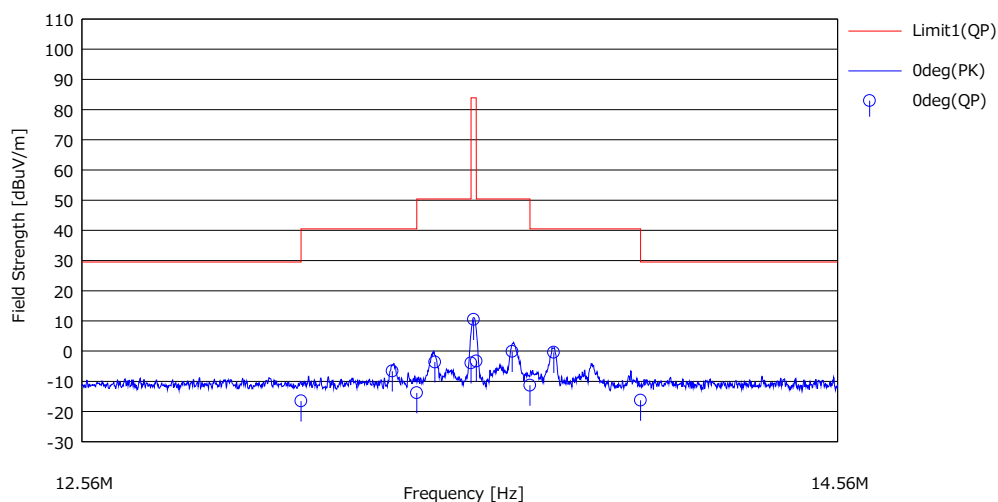
QP											
Ant Deg [deg]	Frequency	Detector	Reading	Ant Factor	Loss	Gain	Duty Factor	Result	Limit	Margin	Remark
	[MHz]		[dBUV]	[dB/m]	[dB]	[dB]	[dB]	[dBUV/m]	[dBUV/m]	[dB]	
0	13.56000	QP	54.40	20.54	6.75	32.13	-	49.56	-	-	Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amplifier)

Fundamental Emission and Spectrum Mask

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	June 14, 2023
Temperature / Humidity	21 deg. C / 61 % RH
Engineer	Yuichiro Yamazaki
Mode	Mode 1 with Tag

Limit : FCC15.225(a), 9-90kHz:PK, 110-490kHz:PK, other:QP



No.	Freq.	Reading	Ant.Fac	Loss	Gain	Result	Limit	Margin	Antenna	Table	Comment
		<QP>				<QP>	<QP>	<deg>			
	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]		[deg]	
1	13.11000	28.30	20.55	-33.26	32.13	-16.54	29.50	46.04	0deg	0	
2	13.34599	38.20	20.55	-33.25	32.13	-6.63	40.50	47.13	0deg	0	
3	13.41000	31.00	20.55	-33.25	32.13	-13.83	40.50	54.33	0deg	0	
4	13.45783	41.20	20.55	-33.25	32.13	-3.63	50.40	54.03	0deg	0	
5	13.55300	40.90	20.54	-33.25	32.13	-3.94	50.40	54.34	0deg	0	
6	13.56000	55.30	20.54	-33.25	32.13	10.46	83.90	73.44	0deg	0	
7	13.56700	41.50	20.54	-33.25	32.13	-3.34	50.40	53.74	0deg	0	
8	13.66238	44.70	20.54	-33.24	32.13	-0.13	50.40	50.53	0deg	0	
9	13.71000	33.50	20.54	-33.24	32.13	-11.33	40.50	51.83	0deg	0	
10	13.77410	44.40	20.54	-33.23	32.13	-0.42	40.50	40.92	0deg	0	
11	14.01000	28.50	20.54	-33.23	32.13	-16.32	29.50	45.82	0deg	0	

$$\text{RESULT} = \text{READING} + \text{ANT FACTOR} + \text{LOSS (CABLE + Attenuator + Distance Factor*)} - \text{GAIN(AMP)}$$

*) Distance Factor: $40 \times \log (3 \text{ m} / 30 \text{ m}) = -40 \text{ dB}$

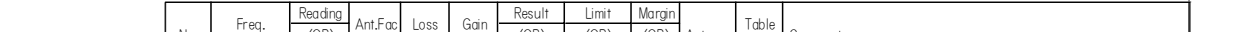
Result of the fundamental Emission at 3 m without Distance factor

QP

Ant Deg [deg]	Frequency	Detector	Reading	Ant Factor	Loss	Gain	Duty Factor	Result	Limit	Margin	Remark
	[MHz]		[dBuV]	[dB/m]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	
0	13.56000	OP	55.30	20.54	6.75	32.13	-	50.46	-	-	Fundamental

$$\text{Result} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter)} - \text{Gain(Amplifier)}$$

Limit : FCC15.225(a), 9-90kHz:PK, 110-490kHz:PK, other:QP



*) Distance Factor: $40 \times \log(3 \text{ m} / 30 \text{ m}) = -40 \text{ dB}$

Result of the fundamental Emission at 3 m without Distance factor

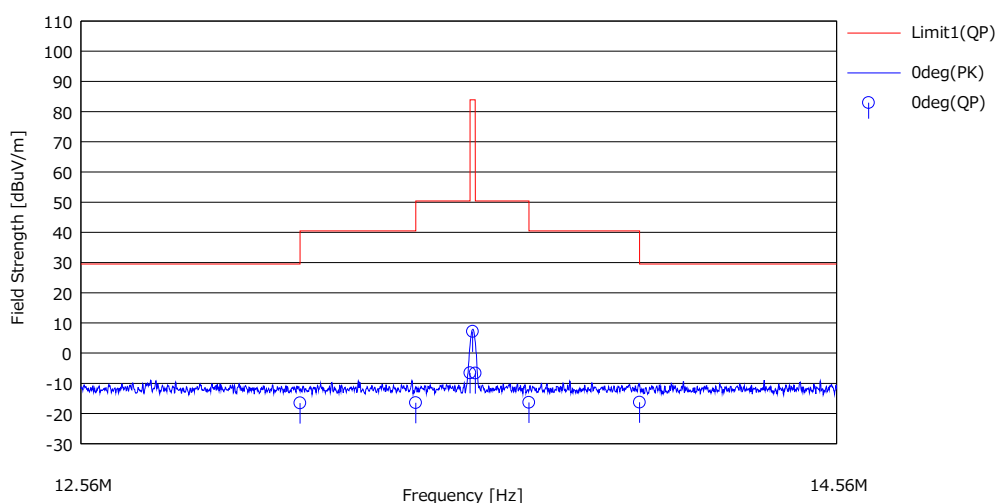
$$\text{Result} = \text{Reading} + \text{Ant Factor} + \text{Loss (Cable+Attenuator+Filter)} - \text{Gain(Amplifier)}$$

Fundamental Emission and Spectrum Mask

Test place
Semi Anechoic Chamber
Date
Temperature / Humidity
Engineer
Mode

Ise EMC Lab.
No.4
June 14, 2023
21 deg. C / 61 % RH
Yuichiro Yamazaki
Mode 2 with Tag

Limit : FCC15.225(a), 9-90kHz:PK, 110-490kHz:PK, other:QP



No.	Freq. [MHz]	Reading [QP] [dBuV]	Ant.Fac [dB/m]	Loss [dB]	Gain [dB]	Result [QP] [dBuV/m]	Limit [QP] [dBuV/m]	Margin [QP] [dB]	Antenna	Table	Comment
1	13.11000	28.30	20.55	-33.26	32.13	-16.54	29.50	46.04	0deg	0	
2	13.41000	28.40	20.55	-33.25	32.13	-16.43	40.50	56.93	0deg	0	
3	13.55300	38.30	20.54	-33.25	32.13	-6.54	50.40	56.94	0deg	0	
4	13.56000	52.00	20.54	-33.25	32.13	7.16	83.90	76.74	0deg	0	
5	13.56700	38.20	20.54	-33.25	32.13	-6.64	50.40	57.04	0deg	0	
6	13.71000	28.50	20.54	-33.24	32.13	-16.33	40.50	56.83	0deg	0	
7	14.01000	28.50	20.54	-33.23	32.13	-16.32	29.50	45.82	0deg	0	

RESULT = READING + ANT FACTOR + LOSS (CABLE + Attenuator + Distance Factor*) - GAIN(AMP)

*) Distance Factor: 40 x log (3 m / 30 m) = -40 dB

Result of the fundamental Emission at 3 m without Distance factor

Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0	13.56000	QP	52.00	20.54	6.75	32.13	-	47.16	-	-	- Fundamental

Result = Reading + Ant Factor + Loss (Cable+Attenuator+Filter) - Gain(Amplifier)

Spurious Emission

Test place	Ise EMC Lab.	No.4
Semi Anechoic Chamber	No.4	No.4
Date	June 14, 2023	June 15, 2023
Temperature / Humidity	21 deg. C / 61 % RH	21 deg. C / 64 % RH
Engineer	Yuichiro Yamazaki	Yuichiro Yamazaki
	(Below 30 MHz)	(Above 30 MHz)
Mode	Mode 1	

Without Tag

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	27.120	QP	28.10	19.90	-32.90	32.11	-	-17.01	29.5	46.51	
Hori.	40.680	QP	22.50	14.76	7.20	32.09	-	12.37	40.0	27.63	*
Hori.	67.800	QP	26.20	6.53	7.55	32.08	-	8.20	40.0	31.80	*
Hori.	122.040	QP	24.00	13.14	8.09	32.03	-	13.20	43.5	30.32	*
Hori.	596.640	QP	24.50	19.19	11.29	32.24	-	22.74	46.0	23.28	*
Hori.	610.200	QP	23.30	19.46	11.35	32.25	-	21.86	46.0	24.16	*
Hori.	664.440	QP	23.40	19.40	11.53	32.27	-	22.06	46.0	23.96	*
Vert.	40.680	QP	23.60	14.76	7.20	32.09	-	13.47	40.0	26.53	*
Vert.	67.800	QP	36.40	6.53	7.55	32.08	-	18.40	40.0	21.60	*
Vert.	122.040	QP	25.30	13.14	8.09	32.03	-	14.50	43.5	29.02	*
Vert.	596.640	QP	25.40	19.19	11.29	32.24	-	23.64	46.0	22.38	*
Vert.	610.200	QP	25.00	19.46	11.35	32.25	-	23.56	46.0	22.46	*
Vert.	664.440	QP	22.60	19.40	11.53	32.27	-	21.26	46.0	24.76	*

Result = Reading + Ant Factor + Loss (Cable + Attenuator + D.Factor) - Gain(Amplifier)

*Result = Reading + Ant Factor + Loss (Cable + Attenuator) - Gain(Amplifier)

With Tag

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	27.120	QP	28.10	19.90	-32.90	32.11	-	-17.01	29.5	46.51	
Hori.	40.680	QP	30.70	14.76	7.20	32.09	-	20.57	40.0	19.43	*
Hori.	67.800	QP	30.90	6.53	7.55	32.08	-	12.90	40.0	27.10	*
Hori.	122.040	QP	25.30	13.14	8.09	32.03	-	14.50	43.5	29.02	*
Hori.	596.640	QP	24.90	19.19	11.29	32.24	-	23.14	46.0	22.88	*
Hori.	610.200	QP	23.90	19.46	11.35	32.25	-	22.46	46.0	23.56	*
Hori.	664.440	QP	24.00	19.40	11.53	32.27	-	22.66	46.0	23.36	*
Vert.	40.680	QP	35.20	14.76	7.20	32.09	-	25.07	40.0	14.93	*
Vert.	67.800	QP	36.40	6.53	7.55	32.08	-	18.40	40.0	21.60	*
Vert.	122.040	QP	25.00	13.14	8.09	32.03	-	14.20	43.5	29.32	*
Vert.	596.640	QP	26.00	19.19	11.29	32.24	-	24.24	46.0	21.78	*
Vert.	610.200	QP	25.70	19.46	11.35	32.25	-	24.26	46.0	21.76	*
Vert.	664.440	QP	23.20	19.40	11.53	32.27	-	21.86	46.0	24.16	*

Result = Reading + Ant Factor + Loss (Cable + Attenuator + D.Factor) - Gain(Amplifier)

*Result = Reading + Ant Factor + Loss (Cable + Attenuator) - Gain(Amplifier)

Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	June 14, 2023	June 15, 2023
Temperature / Humidity	21 deg. C / 61 % RH	21 deg. C / 64 % RH
Engineer	Yuichiro Yamazaki	Yuichiro Yamazaki
	(Below 30 MHz)	(Above 30 MHz)
Mode	Mode 2	

Without Tag

PK or QP

Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	27.120	QP	28.10	19.90	-32.90	32.11	-	-17.01	29.5	46.51	
Hori.	122.040	QP	37.00	13.14	8.09	32.03	-	26.20	43.5	17.32	*
Hori.	149.160	QP	29.80	14.91	8.34	32.03	-	21.02	43.5	22.50	*
Hori.	596.640	QP	25.50	19.19	11.29	32.24	-	23.74	46.0	22.28	*
Hori.	610.200	QP	25.90	19.46	11.35	32.25	-	24.46	46.0	21.56	*
Hori.	678.000	QP	26.10	19.52	11.58	32.28	-	24.92	46.0	21.10	*
Hori.	705.120	QP	27.90	19.98	11.66	32.26	-	27.28	46.0	18.74	*
Vert.	122.040	QP	34.90	13.14	8.09	32.03	-	24.10	43.5	19.42	*
Vert.	149.160	QP	31.60	14.91	8.34	32.03	-	22.82	43.5	20.70	*
Vert.	596.640	QP	26.10	19.19	11.29	32.24	-	24.34	46.0	21.68	*
Vert.	610.200	QP	24.00	19.46	11.35	32.25	-	22.56	46.0	23.46	*
Vert.	678.000	QP	23.50	19.52	11.58	32.28	-	22.32	46.0	23.70	*
Vert.	705.120	QP	27.60	19.98	11.66	32.26	-	26.98	46.0	19.04	*

Result = Reading + Ant Factor + Loss (Cable + Attenuator + D.Factor) - Gain(Amplifier)

*Result = Reading + Ant Factor + Loss (Cable + Attenuator) - Gain(Amplifier)

With Tag

PK or QP

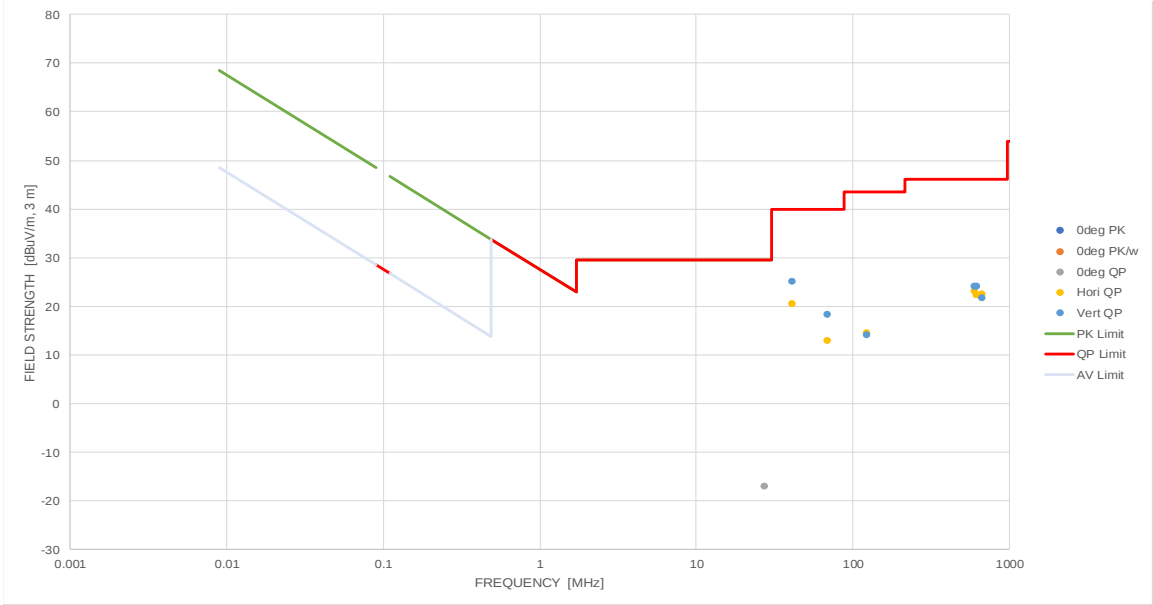
Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	27.120	QP	28.10	19.90	-32.90	32.11	-	-17.01	29.5	46.51	
Hori.	122.040	QP	39.30	13.14	8.09	32.03	-	28.50	43.5	15.02	*
Hori.	149.160	QP	30.70	14.91	8.34	32.03	-	21.92	43.5	21.60	*
Hori.	596.640	QP	25.80	19.19	11.29	32.24	-	24.04	46.0	21.98	*
Hori.	610.200	QP	26.00	19.46	11.35	32.25	-	24.56	46.0	21.46	*
Hori.	678.000	QP	26.70	19.52	11.58	32.28	-	25.52	46.0	20.50	*
Hori.	705.120	QP	28.20	19.98	11.66	32.26	-	27.58	46.0	18.44	*
Vert.	122.040	QP	35.30	13.14	8.09	32.03	-	24.50	43.5	19.02	*
Vert.	149.160	QP	32.70	14.91	8.34	32.03	-	23.92	43.5	19.60	*
Vert.	596.640	QP	26.60	19.19	11.29	32.24	-	24.84	46.0	21.18	*
Vert.	610.200	QP	24.20	19.46	11.35	32.25	-	22.76	46.0	23.26	*
Vert.	678.000	QP	23.60	19.52	11.58	32.28	-	22.42	46.0	23.60	*
Vert.	705.120	QP	26.10	19.98	11.66	32.26	-	25.48	46.0	20.54	*

Result = Reading + Ant Factor + Loss (Cable + Attenuator + D.Factor) - Gain(Amplifier)

*Result = Reading + Ant Factor + Loss (Cable + Attenuator) - Gain(Amplifier)

Spurious Emission
(Plot data, Worst case for Spurious Emission)

Test place	Ise EMC Lab.	No.4
Semi Anechoic Chamber	No.4	No.4
Date	June 14, 2023	June 15, 2023
Temperature / Humidity	21 deg. C / 61 % RH	21 deg. C / 64 % RH
Engineer	Yuichiro Yamazaki	Yuichiro Yamazaki
	(Below 30 MHz)	(Above 30 MHz)
Mode	Mode 1 With Tag	



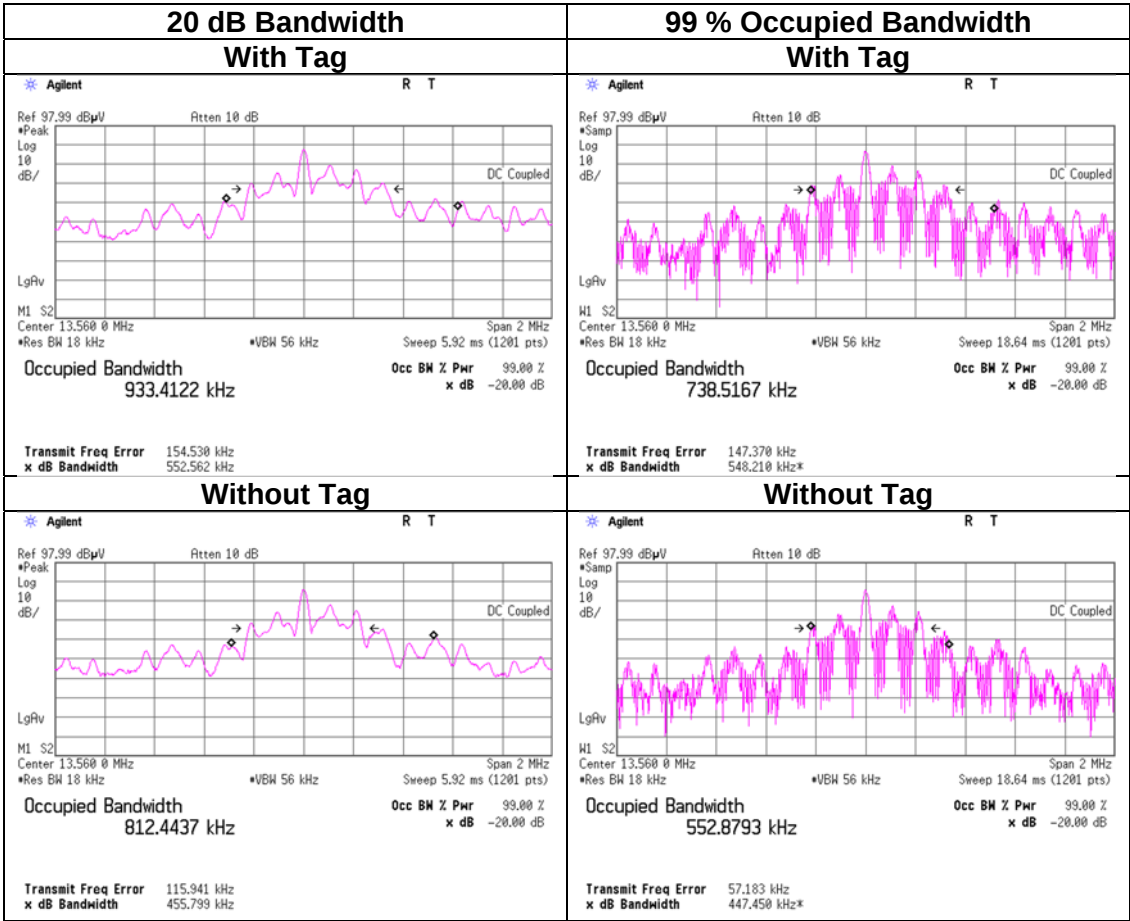
*These plots data contains sufficient number to show the trend of characteristic features for EUT.

20 dB Bandwidth and 99% Occupied Bandwidth

Test place
Semi Anechoic Chamber
Date
Temperature / Humidity
Engineer
Mode

Ise EMC Lab.
No.4
June 14, 2023
21 deg. C / 61 % RH
Yuichiro Yamazaki
Mode 1

FREQ	Mode	20dB Bandwidth	99% Occupied Bandwidth
[MHz]		[kHz]	[kHz]
13.56	With Tag	552.56	738.52
	Without Tag	455.80	552.88

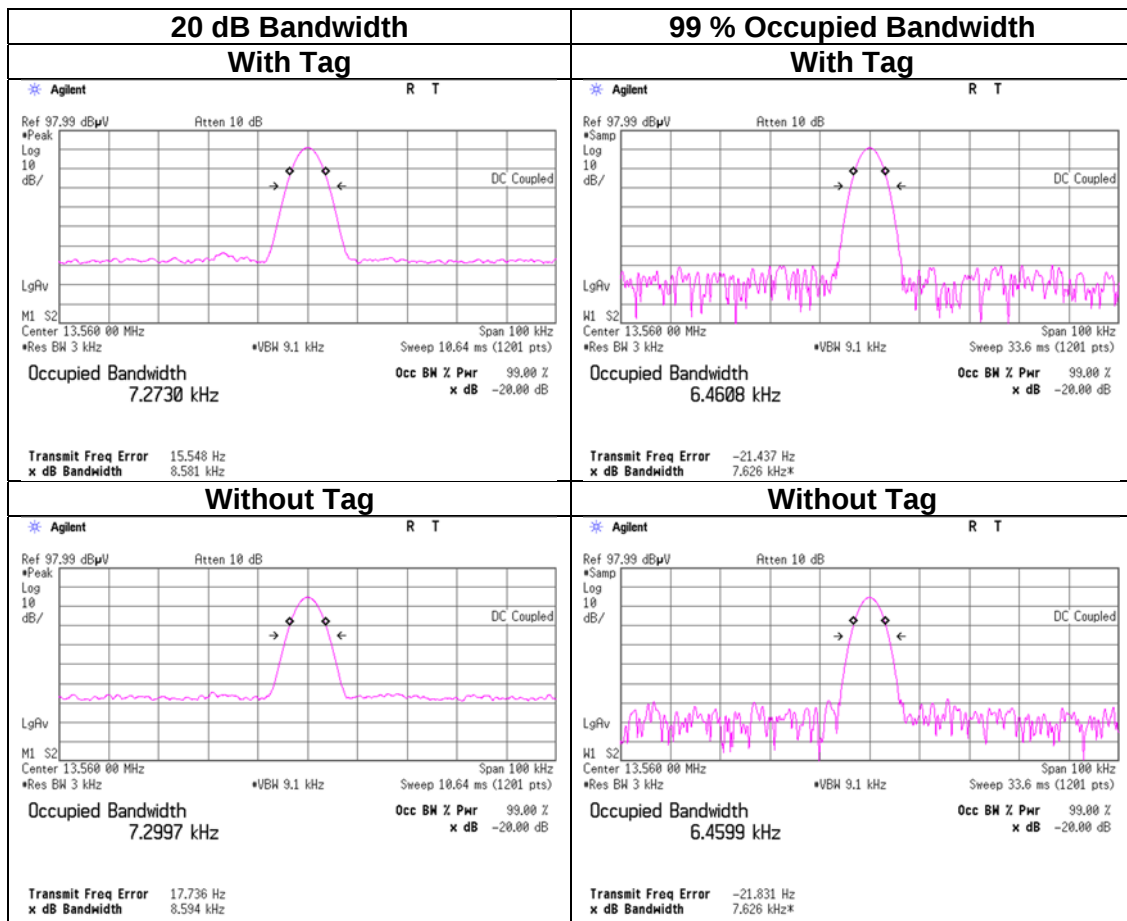


20 dB Bandwidth and 99% Occupied Bandwidth

Test place
Semi Anechoic Chamber
Date
Temperature / Humidity
Engineer
Mode

Ise EMC Lab.
No.4
June 14, 2023
21 deg. C / 61 % RH
Yuichiro Yamazaki
Mode 2

FREQ [MHz]	Mode	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	With Tag	8.58	6.46
	Without Tag	8.59	6.46



Since the transmitter signal is CW-like it is impractical to use a RBW setting of 1 - 5% of the emission bandwidth since the emission bandwidth will be proportional to the RBW.

Frequency Tolerance

Test place Ise EMC Lab.
Measurement Room No.6
Date June 19, 2023
Temperature / Humidity 24 deg. C / 36 % RH
Engineer Junki Nagatomi
Mode Mode 1 Without Tag

Test condition		Tested timing	Measured frequency [MHz]	Frequency error [MHz]	Result		Limit [+/- %]
Temp. [deg. C]	Voltage [V]				[%]	[ppm]	
50	3	Power on	13.560019	0.000019	0.00014	1.4	0.01
		+ 2 min.	13.560018	0.000018	0.00013	1.3	0.01
		+ 5 min.	13.560017	0.000017	0.00013	1.3	0.01
		+ 10 min.	13.560015	0.000015	0.00011	1.1	0.01
40	3	Power on	13.560018	0.000018	0.00013	1.3	0.01
		+ 2 min.	13.560017	0.000017	0.00013	1.3	0.01
		+ 5 min.	13.560015	0.000015	0.00011	1.1	0.01
		+ 10 min.	13.560013	0.000013	0.00010	1.0	0.01
30	3	Power on	13.560034	0.000034	0.00025	2.5	0.01
		+ 2 min.	13.560031	0.000031	0.00023	2.3	0.01
		+ 5 min.	13.560029	0.000029	0.00021	2.1	0.01
		+ 10 min.	13.560028	0.000028	0.00021	2.1	0.01
20	3	Power on	13.560051	0.000051	0.00038	3.8	0.01
		+ 2 min.	13.560049	0.000049	0.00036	3.6	0.01
		+ 5 min.	13.560048	0.000048	0.00035	3.5	0.01
		+ 10 min.	13.560048	0.000048	0.00035	3.5	0.01
20	2.55 (3V -15%)	Power on	13.560051	0.000051	0.00038	3.8	0.01
		+ 2 min.	13.560050	0.000050	0.00037	3.7	0.01
		+ 5 min.	13.560048	0.000048	0.00035	3.5	0.01
		+ 10 min.	13.560049	0.000049	0.00036	3.6	0.01
20	3.45 (3V +15%)	Power on	13.560051	0.000051	0.00038	3.8	0.01
		+ 2 min.	13.560051	0.000051	0.00038	3.8	0.01
		+ 5 min.	13.560052	0.000052	0.00038	3.8	0.01
		+ 10 min.	13.560050	0.000050	0.00037	3.7	0.01
10	3	Power on	13.560074	0.000074	0.00055	5.5	0.01
		+ 2 min.	13.560073	0.000073	0.00054	5.4	0.01
		+ 5 min.	13.560071	0.000071	0.00052	5.2	0.01
		+ 10 min.	13.560071	0.000071	0.00052	5.2	0.01
0	3	Power on	13.560098	0.000098	0.00072	7.2	0.01
		+ 2 min.	13.560098	0.000098	0.00072	7.2	0.01
		+ 5 min.	13.560097	0.000097	0.00072	7.2	0.01
		+ 10 min.	13.560096	0.000096	0.00071	7.1	0.01
-10	3	Power on	13.560098	0.000098	0.00072	7.2	0.01
		+ 2 min.	13.560098	0.000098	0.00072	7.2	0.01
		+ 5 min.	13.560099	0.000099	0.00073	7.3	0.01
		+ 10 min.	13.560099	0.000099	0.00073	7.3	0.01
-20	3	Power on	13.560092	0.000092	0.00068	6.8	0.01
		+ 2 min.	13.560092	0.000092	0.00068	6.8	0.01
		+ 5 min.	13.560093	0.000093	0.00069	6.9	0.01
		+ 10 min.	13.560093	0.000093	0.00069	6.9	0.01

Calculation formula: Frequency error = Measured frequency - Tested frequency
Result [%] = Frequency error / Tested frequency * 100

Tested frequency: 13.56 MHz
Limit (+/-): 0.01 % (+/- 100ppm)

*The test was begun from 50 deg. C and the temperature was lowered each 10 deg. C.

Frequency Tolerance

Test place Ise EMC Lab.
Measurement Room No.8
Date June 20, 2023
Temperature / Humidity 21 deg. C / 49 % RH
Engineer Yuichiro Yamazaki
Mode Mode 1 With Tag

Test condition		Tested timing	Measured frequency [MHz]	Frequency error [MHz]	Result		Limit [+/- %]
Temp. [deg. C]	Voltage [V]				[%]	[ppm]	
50	3	Power on	13.560017	0.000017	0.00013	1.3	0.01
		+ 2 min.	13.560016	0.000016	0.00012	1.2	0.01
		+ 5 min.	13.560016	0.000016	0.00012	1.2	0.01
		+ 10 min.	13.560014	0.000014	0.00010	1.0	0.01
40	3	Power on	13.560028	0.000028	0.00021	2.1	0.01
		+ 2 min.	13.560027	0.000027	0.00020	2.0	0.01
		+ 5 min.	13.560026	0.000026	0.00019	1.9	0.01
		+ 10 min.	13.560025	0.000025	0.00018	1.8	0.01
30	3	Power on	13.560048	0.000048	0.00035	3.5	0.01
		+ 2 min.	13.560046	0.000046	0.00034	3.4	0.01
		+ 5 min.	13.560044	0.000044	0.00032	3.2	0.01
		+ 10 min.	13.560041	0.000041	0.00030	3.0	0.01
20	3	Power on	13.560070	0.000070	0.00052	5.2	0.01
		+ 2 min.	13.560068	0.000068	0.00050	5.0	0.01
		+ 5 min.	13.560066	0.000066	0.00049	4.9	0.01
		+ 10 min.	13.560065	0.000065	0.00048	4.8	0.01
20	2.55 (3V -15%)	Power on	13.560068	0.000068	0.00050	5.0	0.01
		+ 2 min.	13.560067	0.000067	0.00049	4.9	0.01
		+ 5 min.	13.560065	0.000065	0.00048	4.8	0.01
		+ 10 min.	13.560063	0.000063	0.00046	4.6	0.01
20	3.45 (3V +15%)	Power on	13.560067	0.000067	0.00049	4.9	0.01
		+ 2 min.	13.560066	0.000066	0.00049	4.9	0.01
		+ 5 min.	13.560064	0.000064	0.00047	4.7	0.01
		+ 10 min.	13.560063	0.000063	0.00046	4.6	0.01
10	3	Power on	13.560090	0.000090	0.00066	6.6	0.01
		+ 2 min.	13.560089	0.000089	0.00066	6.6	0.01
		+ 5 min.	13.560089	0.000089	0.00066	6.6	0.01
		+ 10 min.	13.560087	0.000087	0.00064	6.4	0.01
0	3	Power on	13.560099	0.000099	0.00073	7.3	0.01
		+ 2 min.	13.560098	0.000098	0.00072	7.2	0.01
		+ 5 min.	13.560098	0.000098	0.00072	7.2	0.01
		+ 10 min.	13.560097	0.000097	0.00072	7.2	0.01
-10	3	Power on	13.560089	0.000089	0.00066	6.6	0.01
		+ 2 min.	13.560091	0.000091	0.00067	6.7	0.01
		+ 5 min.	13.560092	0.000092	0.00068	6.8	0.01
		+ 10 min.	13.560094	0.000094	0.00069	6.9	0.01
-20	3	Power on	13.560055	0.000055	0.00041	4.1	0.01
		+ 2 min.	13.560059	0.000059	0.00044	4.4	0.01
		+ 5 min.	13.560060	0.000060	0.00044	4.4	0.01
		+ 10 min.	13.560062	0.000062	0.00046	4.6	0.01

Calculation formula: Frequency error = Measured frequency - Tested frequency
Result [%] = Frequency error / Tested frequency * 100

Tested frequency: 13.56 MHz
Limit (+/-): 0.01 % (+/- 100ppm)

*The test was begun from 50 deg. C and the temperature was lowered each 10 deg. C.

Frequency Tolerance

Test place Ise EMC Lab.
Measurement Room No.6
Date June 19, 2023
Temperature / Humidity 24 deg. C / 36 % RH
Engineer Junki Nagatomi
Mode Mode 2 Without Tag

Test condition		Tested timing	Measured frequency [MHz]	Frequency error [MHz]	Result		Limit [+/- %]
Temp. [deg. C]	Voltage [V]				[%]	[ppm]	
50	3	Power on	13.559940	-0.000060	-0.00044	-4.4	0.01
		+ 2 min.	13.559941	-0.000059	-0.00044	-4.4	0.01
		+ 5 min.	13.559939	-0.000061	-0.00045	-4.5	0.01
		+ 10 min.	13.559942	-0.000058	-0.00043	-4.3	0.01
40	3	Power on	13.559940	-0.000060	-0.00044	-4.4	0.01
		+ 2 min.	13.559939	-0.000061	-0.00045	-4.5	0.01
		+ 5 min.	13.559937	-0.000063	-0.00046	-4.6	0.01
		+ 10 min.	13.559941	-0.000059	-0.00044	-4.4	0.01
30	3	Power on	13.559940	-0.000060	-0.00044	-4.4	0.01
		+ 2 min.	13.559940	-0.000060	-0.00044	-4.4	0.01
		+ 5 min.	13.559941	-0.000059	-0.00044	-4.4	0.01
		+ 10 min.	13.559943	-0.000057	-0.00042	-4.2	0.01
20	3	Power on	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 2 min.	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 5 min.	13.559955	-0.000045	-0.00033	-3.3	0.01
		+ 10 min.	13.559955	-0.000045	-0.00033	-3.3	0.01
20	2.55 (3V -15%)	Power on	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 2 min.	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 5 min.	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 10 min.	13.559957	-0.000043	-0.00032	-3.2	0.01
20	3.45 (3V +15%)	Power on	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 2 min.	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 5 min.	13.559957	-0.000043	-0.00032	-3.2	0.01
		+ 10 min.	13.559957	-0.000043	-0.00032	-3.2	0.01
10	3	Power on	13.559961	-0.000039	-0.00029	-2.9	0.01
		+ 2 min.	13.559961	-0.000039	-0.00029	-2.9	0.01
		+ 5 min.	13.559962	-0.000038	-0.00028	-2.8	0.01
		+ 10 min.	13.559963	-0.000037	-0.00027	-2.7	0.01
0	3	Power on	13.559964	-0.000036	-0.00027	-2.7	0.01
		+ 2 min.	13.559964	-0.000036	-0.00027	-2.7	0.01
		+ 5 min.	13.559965	-0.000035	-0.00026	-2.6	0.01
		+ 10 min.	13.559965	-0.000035	-0.00026	-2.6	0.01
-10	3	Power on	13.559961	-0.000039	-0.00029	-2.9	0.01
		+ 2 min.	13.559960	-0.000040	-0.00029	-2.9	0.01
		+ 5 min.	13.559959	-0.000041	-0.00030	-3.0	0.01
		+ 10 min.	13.559957	-0.000043	-0.00032	-3.2	0.01
-20	3	Power on	13.559946	-0.000054	-0.00040	-4.0	0.01
		+ 2 min.	13.559944	-0.000056	-0.00041	-4.1	0.01
		+ 5 min.	13.559942	-0.000058	-0.00043	-4.3	0.01
		+ 10 min.	13.559938	-0.000062	-0.00046	-4.6	0.01

Calculation formula: Frequency error = Measured frequency - Tested frequency
Result [%] = Frequency error / Tested frequency * 100

Tested frequency: 13.56 MHz
Limit (+/-): 0.01 % (+/- 100ppm)

*The test was begun from 50 deg. C and the temperature was lowered each 10 deg. C.

Frequency Tolerance

Test place Ise EMC Lab.
Measurement Room No.8
Date June 20, 2023
Temperature / Humidity 21 deg. C / 49 % RH
Engineer Yuichiro Yamazaki
Mode Mode 2 With Tag

Test condition		Tested timing	Measured frequency [MHz]	Frequency error [MHz]	Result		Limit [+/- %]
Temp. [deg. C]	Voltage [V]				[%]	[ppm]	
50	3	Power on	13.559942	-0.000058	-0.00043	-4.3	0.01
		+ 2 min.	13.559942	-0.000058	-0.00043	-4.3	0.01
		+ 5 min.	13.559941	-0.000059	-0.00044	-4.4	0.01
		+ 10 min.	13.559940	-0.000060	-0.00044	-4.4	0.01
40	3	Power on	13.559938	-0.000062	-0.00046	-4.6	0.01
		+ 2 min.	13.559938	-0.000062	-0.00046	-4.6	0.01
		+ 5 min.	13.559938	-0.000062	-0.00046	-4.6	0.01
		+ 10 min.	13.559939	-0.000061	-0.00045	-4.5	0.01
30	3	Power on	13.559945	-0.000055	-0.00041	-4.1	0.01
		+ 2 min.	13.559945	-0.000055	-0.00041	-4.1	0.01
		+ 5 min.	13.559946	-0.000054	-0.00040	-4.0	0.01
		+ 10 min.	13.559946	-0.000054	-0.00040	-4.0	0.01
20	3	Power on	13.559957	-0.000043	-0.00032	-3.2	0.01
		+ 2 min.	13.559957	-0.000043	-0.00032	-3.2	0.01
		+ 5 min.	13.559956	-0.000044	-0.00032	-3.2	0.01
		+ 10 min.	13.559955	-0.000045	-0.00033	-3.3	0.01
20	2.55 (3V -15%)	Power on	13.559958	-0.000042	-0.00031	-3.1	0.01
		+ 2 min.	13.559958	-0.000042	-0.00031	-3.1	0.01
		+ 5 min.	13.559958	-0.000042	-0.00031	-3.1	0.01
		+ 10 min.	13.559959	-0.000041	-0.00030	-3.0	0.01
20	3.45 (3V +15%)	Power on	13.559958	-0.000042	-0.00031	-3.1	0.01
		+ 2 min.	13.559958	-0.000042	-0.00031	-3.1	0.01
		+ 5 min.	13.559959	-0.000041	-0.00030	-3.0	0.01
		+ 10 min.	13.559960	-0.000040	-0.00029	-2.9	0.01
10	3	Power on	13.559967	-0.000033	-0.00024	-2.4	0.01
		+ 2 min.	13.559967	-0.000033	-0.00024	-2.4	0.01
		+ 5 min.	13.559968	-0.000032	-0.00024	-2.4	0.01
		+ 10 min.	13.559968	-0.000032	-0.00024	-2.4	0.01
0	3	Power on	13.559965	-0.000035	-0.00026	-2.6	0.01
		+ 2 min.	13.559965	-0.000035	-0.00026	-2.6	0.01
		+ 5 min.	13.559964	-0.000036	-0.00027	-2.7	0.01
		+ 10 min.	13.559962	-0.000038	-0.00028	-2.8	0.01
-10	3	Power on	13.559932	-0.000068	-0.00050	-5.0	0.01
		+ 2 min.	13.559933	-0.000067	-0.00049	-4.9	0.01
		+ 5 min.	13.559934	-0.000066	-0.00049	-4.9	0.01
		+ 10 min.	13.559936	-0.000064	-0.00047	-4.7	0.01
-20	3	Power on	13.559901	-0.000099	-0.00073	-7.3	0.01
		+ 2 min.	13.559901	-0.000099	-0.00073	-7.3	0.01
		+ 5 min.	13.559900	-0.000100	-0.00074	-7.4	0.01
		+ 10 min.	13.559899	-0.000101	-0.00074	-7.4	0.01

Calculation formula: Frequency error = Measured frequency - Tested frequency
Result [%] = Frequency error / Tested frequency * 100

Tested frequency: 13.56 MHz
Limit (+/-): 0.01 % (+/- 100ppm)

*The test was begun from 50 deg. C and the temperature was lowered each 10 deg. C.

APPENDIX 2: Test instruments

Test Equipment

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/22/2022	24
RE	MAT-34	141331	Attenuator(6dB)	TME	UFA-01	-	02/01/2023	12
RE	MBA-08	141427	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103B+ BBA9106	08031	07/30/2022	12
RE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/ SFM141/ 421-010/ sucoform141-PE/ RFM-E121(SW)	-/04178	06/11/2022	12
RE	MCC-219	159670	Coaxial Cable	UL Japan	-	-	11/18/2022	12
RE	MCC-50	141397	Coaxial Cable	UL Japan	-	-	11/18/2022	12
RE	MJM-29	142230	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	MLA-23	141267	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-192	09/21/2022	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	10/11/2022	12
RE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/18/2023	12
RE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/13/2023	12
RE	MPA-14	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	04/05/2023	12
RE	MRENT-130	141855	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187750	12/01/2022	12
RE	MTR-08	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	05/17/2023	12
FT	MCH-04	141429	Temperature and Humidity Chamber	Espec	PL-2KP	14015723	08/11/2022	12
FT	MCH-05	141440	Temperature and Humidity Chamber	Espec	PL-1KP	14019569	04/23/2023	12
FT	MLPA-08	202511	Loop Antenna	UL Japan	-	-	-	-
FT	MMM-17	141557	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	70900530	01/18/2023	12
FT	MMM-18	141558	Digital Tester(TRUE RMS MULTIMETER)	Fluke Corporation	115	17930030	05/29/2023	12
FT	MOS-14	141561	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1401	01/13/2023	12
FT	MOS-28	141567	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0008	01/13/2023	12
FT	MSA-14	141901	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY48250080	01/16/2023	12

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

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

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

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

Test item:

RE: Radiated Emission

FT: Frequency Tolerance