RADIO TEST REPORT

Test Report No.: 14624609H-A-R1

Customer	**OMRON Corporation**
Description of EUT	**RFID Device**
Model Number of EUT	**V680-HAM42-DRT**
FCC ID	**E4E6CYSIDV6800108**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**October 25, 2023**
Remarks	**For Permissive Change**

Representative test engineer	**Approved by**
H. Furutaka	S. Miyazono
Hiroyuki Furutaka Engineer	Shinichi Miyazono 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".

Report Cover Page - Form-ULID-003532 (DCS:13-EM-F0429) Issue# 22.0

ANNOUNCEMENT

- This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
- The results in this report apply only to the sample tested. (Laboratory was not involved in sampling.)
- This sample tested is in compliance with the limits of the above regulation.
- The test results in this test report are traceable to the national or international standards.
- This test report must not be used by the customer to claim product certification, approval, or endorsement by the A2LA accreditation body.
- This test report covers Radio technical requirements.
  It does not cover administrative issues such as Manual or non-Radio test related Requirements.
  (if applicable)
- The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
- The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan, Inc. has been accredited.
- 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.: 14624609H-A

This report is a revised version of 14624609H-A. 14624609H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14624609H-A	July 19, 2023	-
1	14624609H-A-R1	October 25, 2023	Correction of the Description of EUT; from “Radio Frequency Identification System (RFID System)” to “RFID Device”

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

CONTENTS PAGE

SECTION 1: Customer Information

Company Name	OMRON Corporation
Address	3-2, NARUTANI, NAKAYAMA-CHO, AYABE-SHI, KYOTO, 623-0105 Japan
Telephone Number	+81-773-42-6654
Contact Person	Shota Suzuki

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	RFID Device
Model Number	V680-HAM42-DRT
Serial Number	Refer to SECTION 4.2
Condition	Production model
Modification	No Modification by the test lab
Receipt Date	June 7, 2023
Test Date	June 18 to 24, 2023

2.2 Product Description

General Specification

Rating	DC 24.0 V
Operating temperature	-10 deg. C to 55 deg. C

Radio Specification

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

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.

* 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	6.48 dB 0.39401 MHz AV, Phase L (Mode 2)	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	66.21 dB, 13.56000 MHz, QP, 45 deg. (Mode 2)	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	44.31 dB, 13.11000 MHz, QP, 45 deg. (Mode 2)	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	1.48 dB 48.530 MHz, Vertical, QP (Mode 2)	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.

FCC Part 15.31 (e)
This EUT provides stable voltage constantly to RF Module regardless of input voltage. Therefore, this 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
The EUT has an external and particular antenna connector, but it is installed by the professionals. 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.

Conducted emission

Item	Frequency Range	Unit	Calculated Uncertainty (+/-)
AMN (LISN)	0.009 MHz to 0.15 MHz	dB	3.7
	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	4.8
		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	-	-

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

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

SECTION 4: Operation of EUT during testing

4.1 Operating Mode(s)

The mode is used :

Test mode	Remarks
1) Transmitting 13.56MHz With Tag	The EUT Transmits and Receives at the same time and there is no receiving mode.
2) Transmitting 13.56MHz Without Tag	
3) Transmitting 13.56MHz 50 ohm terminated	
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: V680HAMDRT_V1_30 (Date: 2019.10.23, 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.	

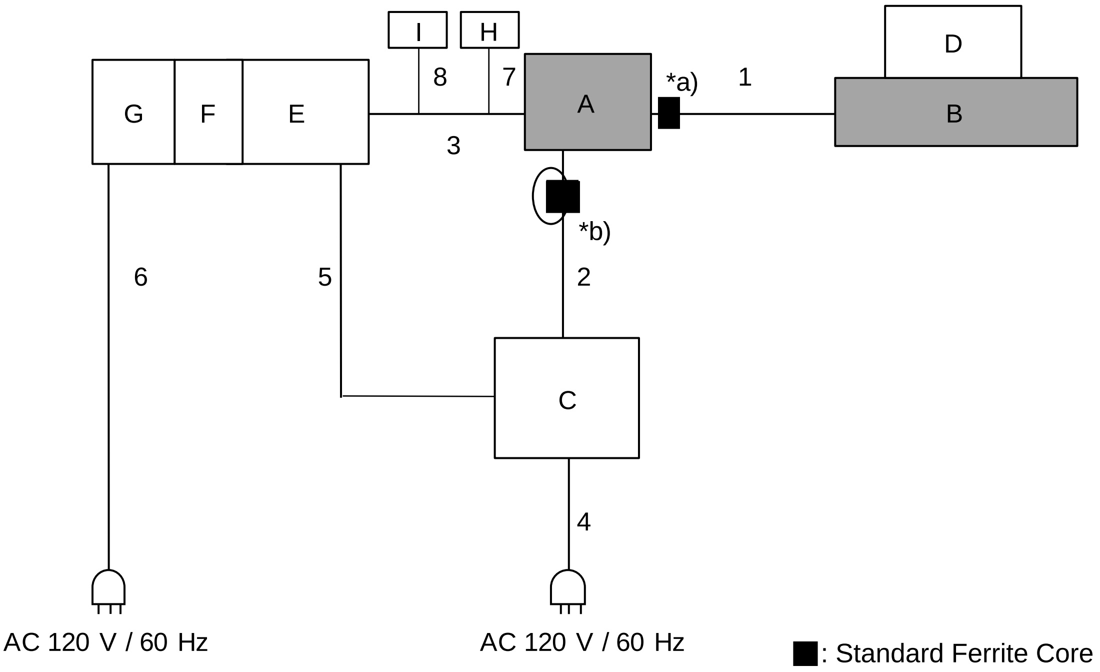
Test Item	Operating mode
Conducted Emission	1) to 3)
Electric Field Strength of Fundamental Emission	1), 2)
Spectrum Mask	
20 dB Bandwidth and 99 % Occupied Bandwidth	
Electric Field Strength of Spurious Emission*	2)
Frequency Tolerance	2)

*After the comparison of the test data between with Tag and without Tag, the tests were performed with the worst case.

Frequency Tolerance	
Temperature	-20 deg. C to +50 deg. C Step 10 deg. C
Voltage	Normal Voltage DC 24.0 V Maximum Voltage DC 27.6 V (DC 24 V +15 %) Minimum Voltage DC 20.4 V (DC 24 V -15 %)
*This EUT provides stable voltage constantly to RF Part regardless of input voltage	

4.2 Configuration and peripherals

Conducted Emission test



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

*As a result of comparing AC 120 V and AC 240 V at pre-check, the test was performed with AC 120 V of the worst voltage as representative.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Amplifier	V680-HAM42-DRT	07X21A	OMRON Corporation	EUT *1)
B	Antenna	V680-HS61	28520	OMRON Corporation	EUT *1)
C	Power Supply	S8VS-03024	20Y60M	OMRON Corporation	-
D	Tag	V680-D1KP52MT	06720	OMRON Corporation	Mode1 only
E	DEVICENET UNIT	CJ1W-DRM21	150924M 0085	OMRON Corporation	-
F	PROGRAMMABLE CONTROLLER	CJ2H-CPU67	150912K 0002	OMRON Corporation	-
G	POWER SUPPLY UNIT	CJ1W-PA205R	29X15M	OMRON Corporation	-
H	Terminal block with terminator	DRS1-T	04Y6YL	OMRON Corporation	-
I	Terminal block with terminator	DRS1-T	10Y5YK	OMRON Corporation	-

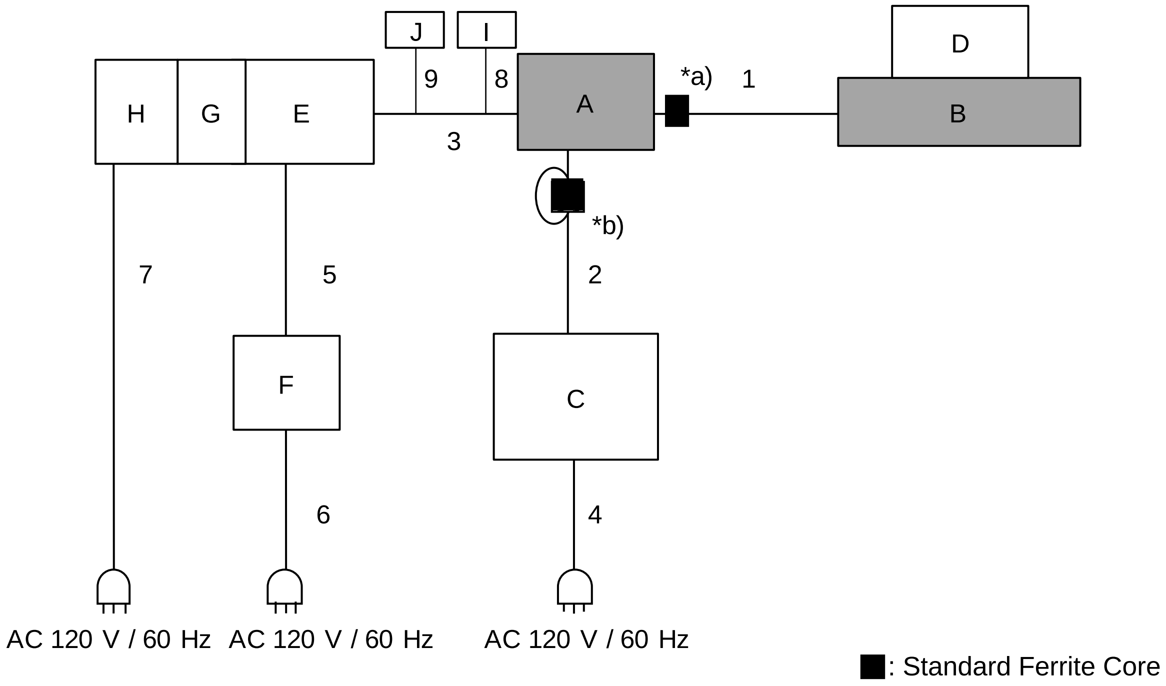
*1) RFID Device (Model Number: V680-HAM42-DRT) is composed of these items.

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Antenna Cable	2.00	Shielded	Shielded	-
2	DC Cable	0.20	Unshielded	Unshielded	-
3	Signal Cable	2.50	Shielded	Unshielded	-
4	AC Cable	1.80	Unshielded	Unshielded	-
5	DC Cable	0.50	Unshielded	Unshielded	-
6	AC Cable	2.00	Unshielded	Unshielded	-
7	Signal Cable	0.05	Unshielded	Unshielded	-
8	Signal Cable	0.05	Unshielded	Unshielded	-

*a) Ferrite Core Model No. ZCAT1325-0530 (Manufacture TDK) 5 cm from Item A, 1 turn
*b) Ferrite Core Model No. ZCAT2032-0930 (Manufacture TDK) 10 cm from Item A, 2 turns

Radiated Emission test



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

Description of EUT and Support equipment

No.	**Item**	**Model number**	**Serial number**	**Manufacturer**	**Remarks**
A	Amplifier	V680-HAM42-DRT	07X21A	OMRON Corporation	EUT *1)
B	Antenna	V680-HS61	28520	OMRON Corporation	EUT *1)
C	Power Supply	S8VS-03024	2952920987	OMRON Corporation	-
D	Tag	V680-D1KP52MT	06720	OMRON Corporation	Mode1 only
E	DEVICENET UNIT	CJ1W-DRM21	221024K 0026	OMRON Corporation	-
F	Power Supply	S8VS-03024	2952920974	OMRON Corporation	-
G	PROGRAMMABLE CONTROLLER	CJ2M-CPU11	180801K 0019	OMRON Corporation	-
H	POWER SUPPLY UNIT	CJ1W-PA202	180720YK 0016	OMRON Corporation	-
I	Terminal block with terminator	DRS1-T	22Z1YK	OMRON Corporation	-
J	Terminal block with terminator	DRS1-T	03Z1YK	OMRON Corporation	-

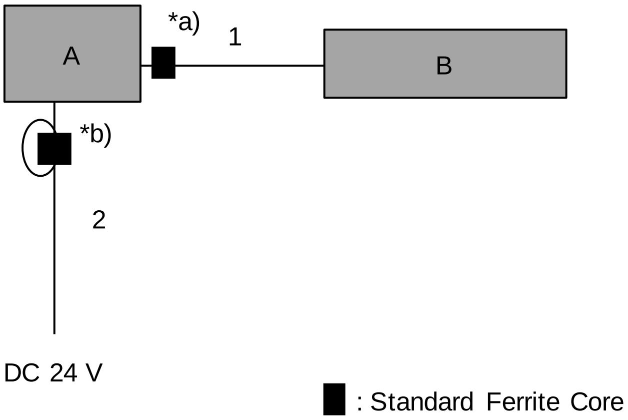
*1) RFID Device (Model Number: V680-HAM42-DRT) is composed of these items.

List of cables used

No.	**Name**	**Length (m)**	**Shield**		**Remarks**
			Cable	**Connector**	
1	Antenna Cable	2.00	Shielded	Shielded	-
2	DC Cable	0.65	Unshielded	Unshielded	-
3	Signal Cable	2.50	Shielded	Unshielded	-
4	AC Cable	1.60	Unshielded	Unshielded	-
5	DC Cable	0.10	Unshielded	Unshielded	-
6	AC Cable	1.80	Unshielded	Unshielded	-
7	AC Cable	0.60	Unshielded	Unshielded	-
8	Signal Cable	0.05	Unshielded	Unshielded	-
9	Signal Cable	0.05	Unshielded	Unshielded	-

*a) Ferrite Core Model No. ZCAT1325-0530 (Manufacture TDK) 5 cm from Item A, 1 turn
*b) Ferrite Core Model No. ZCAT2032-0930 (Manufacture TDK) 10 cm from Item A, 2 turns

Frequency Tolerance test



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

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Amplifier	V680-HAM42-DRT	07X21A	OMRON Corporation	EUT *1)
B	Antenna	V680-HS61	28520	OMRON Corporation	EUT *1)

*1) RFID Device (Model Number: V680-HAM42-DRT) is composed of these items.

List of cables used

No.	Name	Length (m)	Shield		Remarks
			Cable	Connector	
1	Antenna Cable	2.00	Shielded	Shielded	-
2	DC Cable	2.65	Unshielded	Unshielded	-

*a) Ferrite Core Model No. ZCAT1325-0530 (Manufacture TDK) 5 cm from Item A, 1 turn
*b) Ferrite Core Model No. ZCAT2032-0930 (Manufacture TDK) 10 cm from Item A, 2 turns

SECTION 5: Conducted Emission

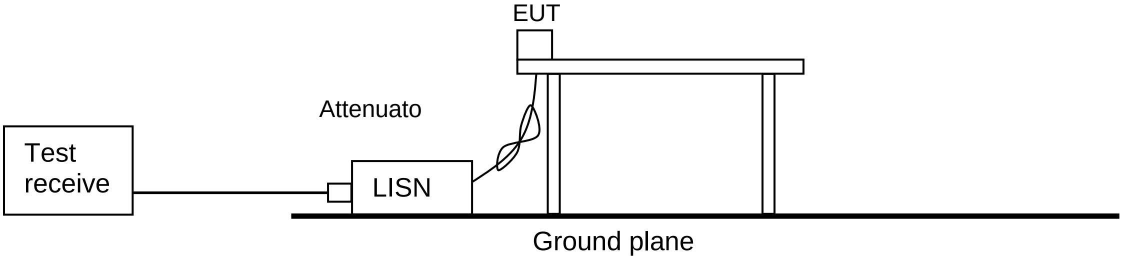
Test Procedure and conditions

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 rear of tabletop was located 40 cm to the vertical conducting plane. The rear of EUT, including peripherals aligned and flushed with rear of tabletop. All other surfaces of tabletop were at least 80 cm from any other grounded conducting surface. EUT was located 80 cm from a Line Impedance Stabilization Network (LISN)/ Artificial mains Network (AMN) and excess AC cable was bundled in center.

For the tests on EUT with other peripherals (as a whole system)
I/O cables that were connected to the peripherals were bundled in center. They were folded back and forth forming a bundle 30 cm to 40 cm long and were hanged at a 40 cm height to the ground plane. All unused 50 ohm connectors of the LISN (AMN) were resistivity terminated in 50 ohm when not connected to the measuring equipment.

The AC Mains Terminal Continuous disturbance Voltage has been measured with the EUT in a Semi Anechoic Chamber.
The EUT was connected to a LISN (AMN).
An overview sweep with peak detection has been performed.

Figure 1: Test Setup



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

Detector : **QP and CISPR AV**
Measurement range : **0.15 MHz to 30 MHz**
Test data : **APPENDIX**
Test result : **Pass**

SECTION 6: 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 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.

[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., and 135 deg.) and horizontal polarization.
*Refer to Figure 3 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

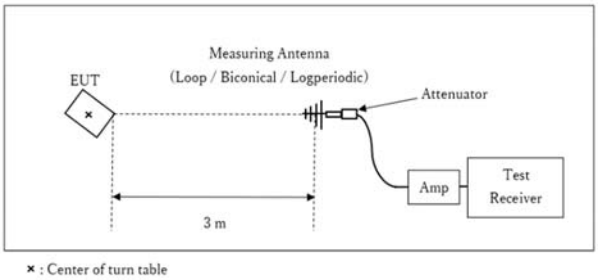
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

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 x log (3 m / 300 m) = -80 dB
*2) Distance Factor: 40 x log (3 m / 30 m) = -40 dB

Figure 2: Test Setup

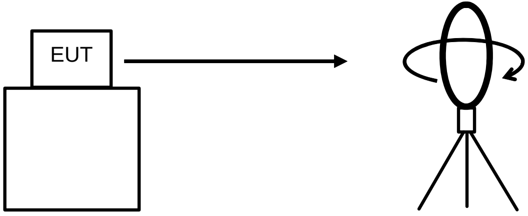
Below 1 GHz



Test Distance: 3 m

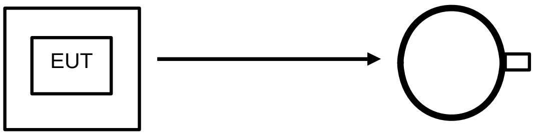
Figure 3: Direction of the Loop Antenna

Side View (Vertical)



……

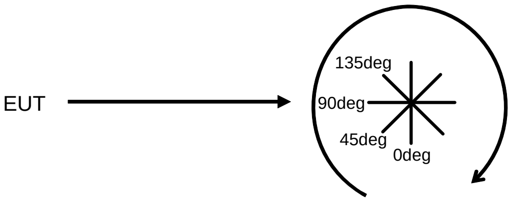
Top View (Horizontal)



Antenna was not rotated.

……

Top View (Vertical)



Front side: 0 deg.
Forward direction: clockwise

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

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

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

SECTION 7: Other test

Test	**Span**	**RBW**	**VBW**	**Sweep**	**Detector**	**Trace**	**Instrument used**
20 dB Bandwidth *1)	10 kHz	200 Hz	620 Hz	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 *1)	Max Hold *1)	Spectrum Analyzer
Frequency Tolerance	-	-	-	-	-	-	Frequency counter
Peak hold was applied as Worst-case measurement.							

*1) 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.

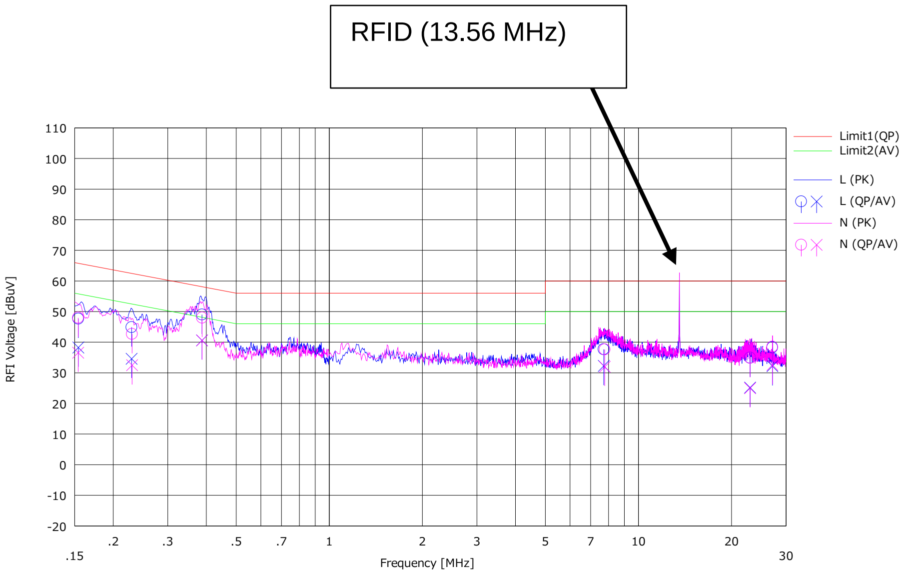
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	June 19, 2023
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Takafumi Noguchi
Mode	Mode 1

Limit : FCC_Part 15 Subpart C(15.207)



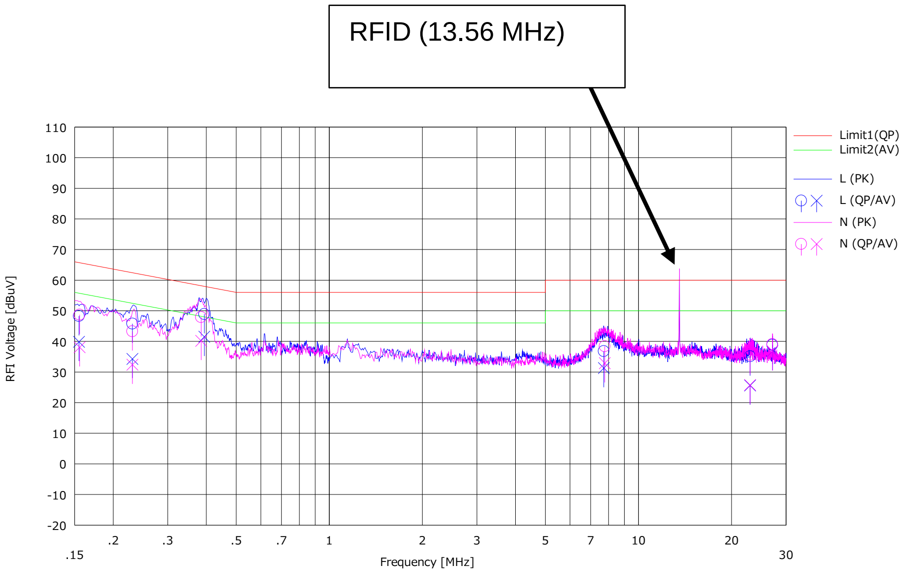
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈A V〉			〈QP〉	〈A V〉	〈QP〉	〈A V〉	〈QP〉	〈A V〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15425	34.50	25.10	0.04	13.13	47.67	38.27	65.77	55.77	18.10	17.50	L	
2	0.22938	31.70	21.40	0.04	13.14	44.88	34.58	62.47	52.47	17.59	17.89	L	
3	0.38741	35.80	27.40	0.04	13.16	49.00	40.60	58.12	48.12	9.12	7.52	L	
4	7.71800	24.00	18.60	0.16	13.52	37.68	32.28	60.00	50.00	22.32	17.72	L	
5	22.96565	20.60	10.90	0.40	13.90	34.90	25.20	60.00	50.00	25.10	24.80	L	
6	27.12000	23.80	17.70	0.50	13.98	38.28	32.18	60.00	50.00	21.72	17.82	L	
7	0.15409	34.80	23.40	0.05	13.13	47.98	36.58	65.78	55.78	17.80	19.20	N	
8	0.22998	29.50	19.30	0.04	13.14	42.68	32.48	62.45	52.45	19.77	19.97	N	
9	0.38786	34.80	27.40	0.04	13.16	48.00	40.60	58.11	48.11	10.11	7.51	N	
10	7.77934	23.90	18.30	0.18	13.52	37.60	32.00	60.00	50.00	22.40	18.00	N	
11	22.96305	20.50	10.60	0.46	13.90	34.86	24.96	60.00	50.00	25.14	25.04	N	
12	27.12000	24.00	18.10	0.50	13.98	38.48	32.58	60.00	50.00	21.52	17.42	N	

CHART: WITH FACTOR Peak hold data. CALCULATION : RESULT = READING + LISN + LOSS (CABLE + ATT)
Except for the above table: adequate margin data below the limits.

Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	June 19, 2023
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Takafumi Noguchi
Mode	Mode 2

Limit : FCC_Part 15 Subpart C(15.207)


RFID (13.56 MHz)

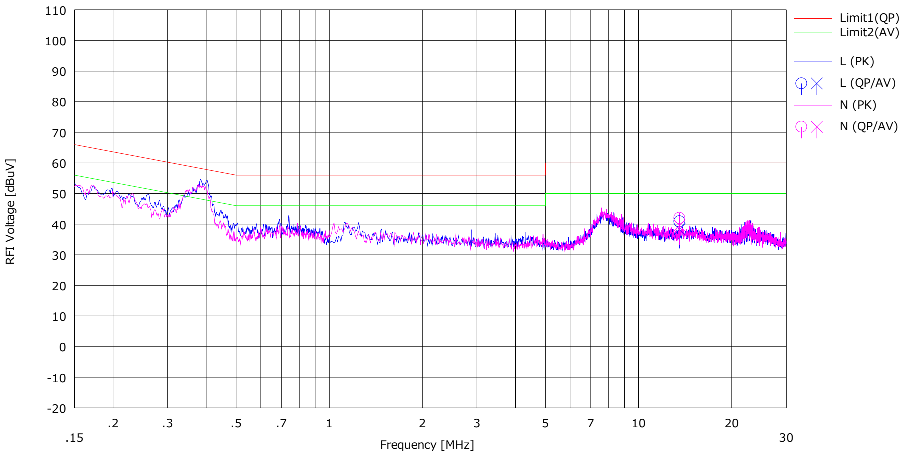
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		<QP>	<AV>			<QP>	<AV>	<QP>	<AV>	<QP>	<AV>		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.15500	35.10	26.70	0.04	13.13	48.27	39.87	65.73	55.73	17.46	15.86	L	
2	0.23071	32.60	21.10	0.04	13.14	45.78	34.28	62.42	52.42	16.64	18.14	L	
3	0.39401	35.70	28.30	0.04	13.16	48.90	41.50	57.98	47.98	9.08	6.48	L	
4	7.72455	23.10	17.60	0.16	13.52	36.78	31.28	60.00	50.00	23.22	18.72	L	
5	22.96285	20.80	11.30	0.40	13.90	35.10	25.60	60.00	50.00	24.90	24.40	L	
6	27.12000	24.40	22.30	0.50	13.98	38.88	36.78	60.00	50.00	21.12	13.22	L	
7	0.15575	35.50	24.90	0.05	13.13	48.68	38.08	65.69	55.69	17.01	17.61	N	
8	0.23070	30.10	19.20	0.04	13.14	43.28	32.38	62.42	52.42	19.14	20.04	N	
9	0.38491	34.70	27.00	0.04	13.16	47.90	40.20	58.17	48.17	10.27	7.97	N	
10	7.77945	24.70	19.20	0.18	13.52	38.40	32.90	60.00	50.00	21.60	17.10	N	
11	22.96395	21.20	11.40	0.46	13.90	35.56	25.76	60.00	50.00	24.44	24.24	N	
12	27.12000	24.60	22.30	0.50	13.98	39.08	36.78	60.00	50.00	20.92	13.22	N	

CHART: WITH FACTOR Peak hold data. CALCULATION : RESULT = READING + LISN + LOSS (CABLE + ATT)
Except for the above table: adequate margin data below the limits.

Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	June 19, 2023
Temperature / Humidity	22 deg. C / 38 % RH
Engineer	Takafumi Noguchi
Mode	Mode 3

Limit : FCC_Part 15 Subpart C(15.207)



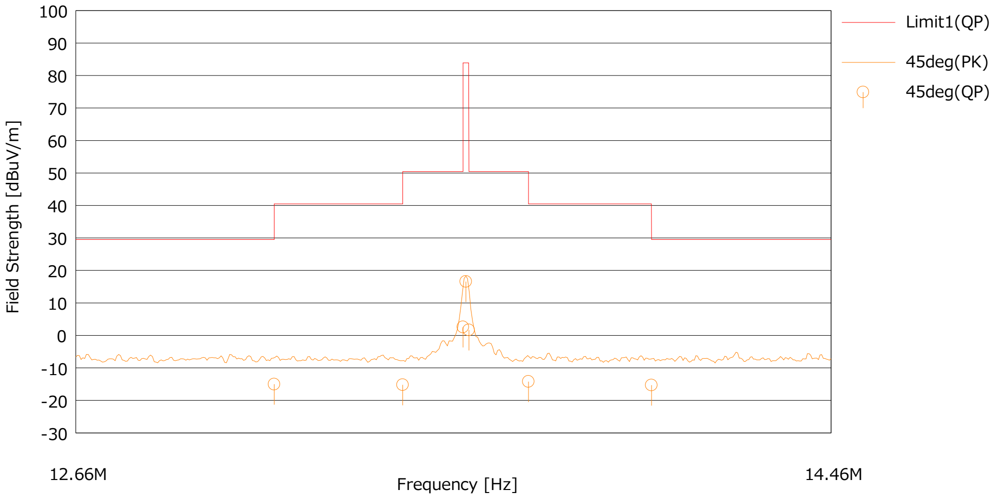
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈A V〉			〈QP〉	〈A V〉	〈QP〉	〈A V〉	〈QP〉	〈A V〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	13.56000	26.90	24.40	0.30	13.68	40.88	38.38	60.00	50.00	19.12	11.62	L	
2	13.56000	28.00	25.60	0.31	13.68	41.99	39.59	60.00	50.00	18.01	10.41	N	

CHART: WITH FACTOR Peak hold data. CALCULATION : RESULT = READING + LISN + LOSS (CABLE + ATT)
Except for the above table: adequate margin data below the limits.

Fundamental emission and Spectrum Mask

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	June 18, 2023
Temperature / Humidity	23 deg. C / 45 % RH
Engineer	Junki Nagatomi
Mode	Mode 1

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



No.	Freq.	Reading (QP)	Ant.Fac	Loss	Gain	Result (QP)	Limit (QP)	Margin (QP)	Antenna	Table	Comment
	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]		[deg]	
1	13.11000	29.80	20.55	-33.23	32.13	-15.01	29.50	44.51	45deg	337	
2	13.41000	29.60	20.55	-33.22	32.13	-15.20	40.50	55.70	45deg	337	
3	13.55300	47.40	20.54	-33.22	32.13	2.59	50.40	47.81	45deg	337	
4	13.56000	61.40	20.54	-33.22	32.13	16.59	83.90	67.31	45deg	337	
5	13.56700	46.50	20.54	-33.22	32.13	1.69	50.40	48.71	45deg	337	
6	13.71000	30.60	20.54	-33.21	32.13	-14.20	40.50	54.70	45deg	337	
7	14.01000	29.50	20.54	-33.20	32.13	-15.29	29.50	44.79	45deg	337	

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

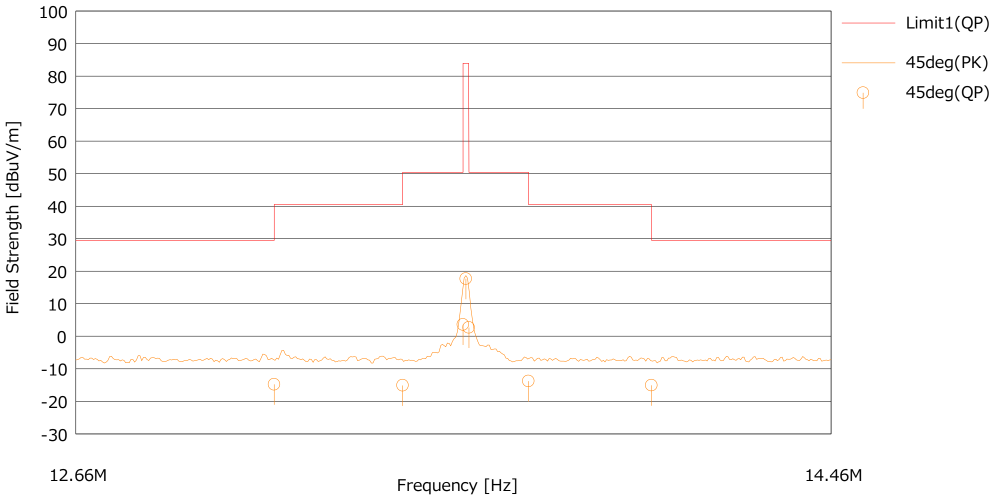
Ant Deg [deg]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
45	13.56000	QP	61.40	20.54	6.78	32.13	-	56.59	-	-	Fundamental

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

Fundamental emission and Spectrum Mask

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.4
Date	June 18, 2023
Temperature / Humidity	23 deg. C / 45 % RH
Engineer	Junki Nagatomi
Mode	Mode 2

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〉	〈QP〉			
	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]		[deg]	
1	13.11000	30.00	20.55	-33.23	32.13	-14.81	29.50	44.31	45deg	352	
2	13.41000	29.70	20.55	-33.22	32.13	-15.10	40.50	55.60	45deg	352	
3	13.55300	48.40	20.54	-33.22	32.13	3.59	50.40	46.81	45deg	352	
4	13.56000	62.50	20.54	-33.22	32.13	17.69	83.90	66.21	45deg	352	
5	13.56700	47.50	20.54	-33.22	32.13	2.69	50.40	47.71	45deg	352	
6	13.71000	31.00	20.54	-33.21	32.13	-13.80	40.50	54.30	45deg	352	
7	14.01000	29.70	20.54	-33.20	32.13	-15.09	29.50	44.59	45deg	352	

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 [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
45	13.56000	QP	62.50	20.54	6.78	32.13	-	57.69	-	-	Fundamental

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

Spurious emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	June 18, 2023	June 23, 2023
Temperature / Humidity	23 deg. C / 45 % RH	21 deg. C / 62 % RH
Engineer	Junki Nagatomi	Takumi Nishida
Mode	Mode 2	

PK or QP

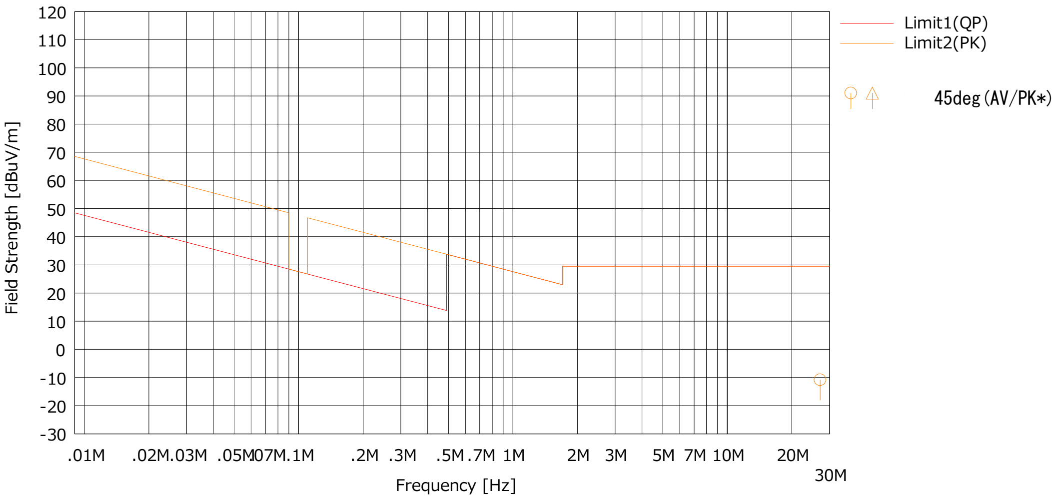
Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
45deg.	27.120	QP	34.20	19.90	-32.86	32.11	-	-10.87	29.5	40.37	
Hori.	48.530	QP	38.10	11.73	7.35	32.16	-	25.02	40.0	14.98	
Hori.	100.001	QP	45.20	10.29	8.09	32.12	-	31.46	43.5	12.06	
Hori.	131.836	QP	44.50	13.89	8.45	32.09	-	34.75	43.5	8.77	
Hori.	266.658	QP	46.20	12.86	9.72	31.99	-	36.79	46.0	9.23	
Hori.	366.372	QP	46.90	15.09	10.48	31.97	-	40.50	46.0	5.52	
Hori.	667.211	QP	41.80	19.54	12.41	31.93	-	41.82	46.0	4.20	
Vert.	48.530	QP	51.60	11.73	7.35	32.16	-	38.52	40.0	1.48	
Vert.	100.001	QP	55.40	10.29	8.09	32.12	-	41.66	43.5	1.86	
Vert.	131.836	QP	49.10	13.89	8.45	32.09	-	39.35	43.5	4.17	
Vert.	266.658	QP	45.70	12.86	9.72	31.99	-	36.29	46.0	9.73	
Vert.	366.372	QP	43.60	15.09	10.48	31.97	-	37.20	46.0	8.82	
Vert.	667.211	QP	41.20	19.54	12.41	31.93	-	41.22	46.0	4.80	

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

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

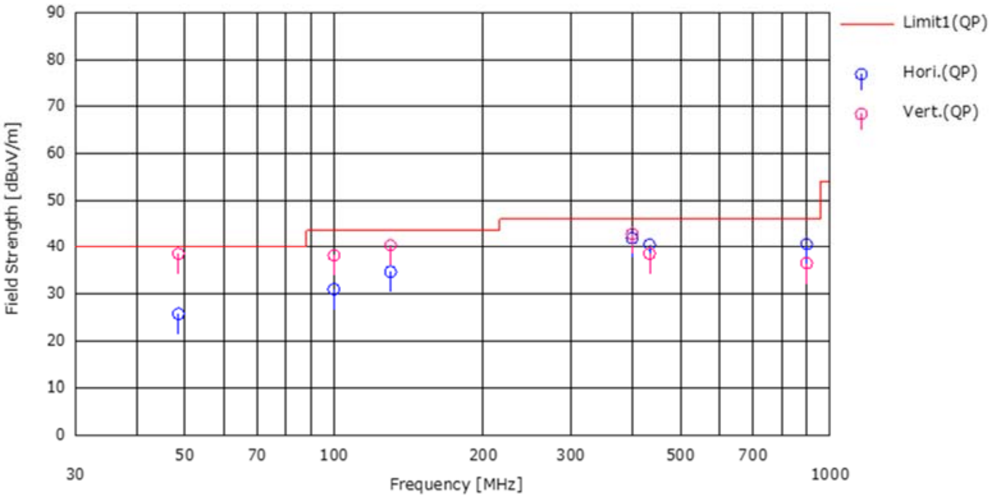
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.4	No.4
Date	June 18, 2023	June 23, 2023
Temperature / Humidity	23 deg. C / 45 % RH	21 deg. C / 62 % RH
Engineer	Junki Nagatomi	Takumi Nishida
Mode	Mode 2	

(below 30MHz)



* Data above 490 kHz were measured using a QP detector.

(above 30MHz)

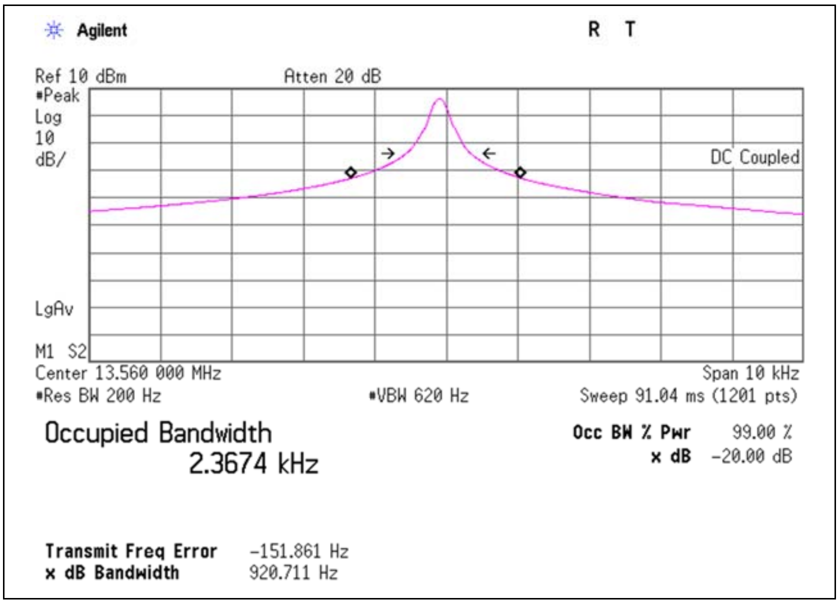


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

20 dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	June 20, 2023
Temperature / Humidity	23 deg. C / 57 % RH
Engineer	Takafumi Noguchi
Mode	Mode 1

FREQ [MHz]	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	0.9207	2.3674



Occupied Bandwidth
2.3674 kHz

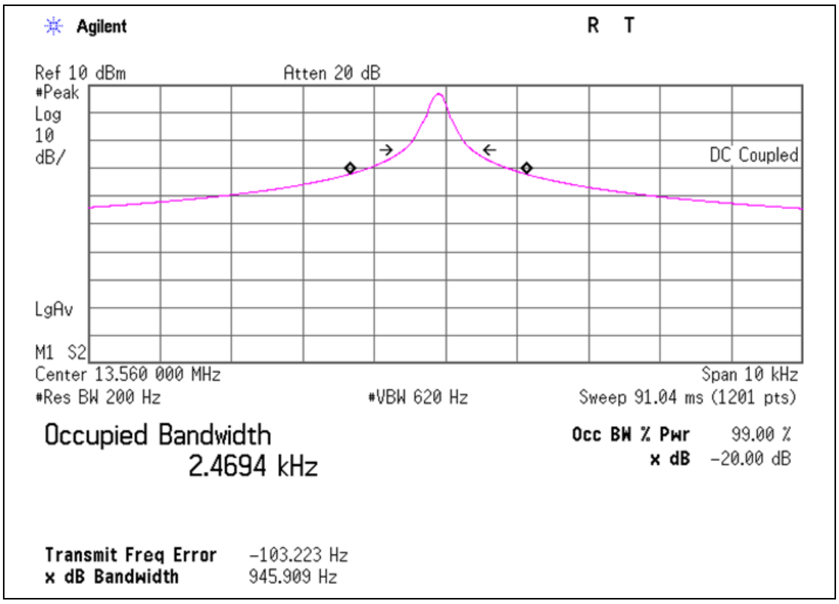
Occ BW % Pwr 99.00 %
x dB -20.00 dB

Transmit Freq Error -151.861 Hz
x dB Bandwidth 920.711 Hz

20 dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.1
Date	June 20, 2023
Temperature / Humidity	23 deg. C / 57 % RH
Engineer	Takafumi Noguchi
Mode	Mode 2

FREQ [MHz]	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	0.9459	2.4694



Ref 10 dBm
Atten 20 dB
Center 13.560 000 MHz
Span 10 kHz
#Res BW 200 Hz
#VBW 620 Hz
Sweep 91.04 ms (1201 pts)

Occupied Bandwidth
2.4694 kHz

Occ BW % Pwr 99.00 %
x dB -20.00 dB

Transmit Freq Error -103.223 Hz
x dB Bandwidth 945.909 Hz

Frequency Tolerance

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.11	No.6
Date	June 20, 2023	June 26, 2023
Temperature / Humidity	23 deg. C / 40 % RH	22 deg. C / 51 % RH
Engineer	Nachi Konegawa	Hiroki Numata
Mode	Mode 2	

Test condition		Tested timing	Measured frequency	Frequency error	Result		Limit
Temp. [deg. C]	Voltage [V]		[MHz]	[MHz]	[%]	[ppm]	[+/- %]
50	24	Power on	13.559841	-0.000159	-0.00117	-11.7	0.01
		+ 2 min.	13.559827	-0.000173	-0.00128	-12.8	0.01
		+ 5 min.	13.559827	-0.000173	-0.00128	-12.8	0.01
		+ 10 min.	13.559824	-0.000176	-0.00130	-13.0	0.01
40	24	Power on	13.559975	-0.000025	-0.00018	-1.8	0.01
		+ 2 min.	13.559944	-0.000056	-0.00041	-4.1	0.01
		+ 5 min.	13.559937	-0.000063	-0.00046	-4.6	0.01
		+ 10 min.	13.559942	-0.000058	-0.00043	-4.3	0.01
30	24	Power on	13.560098	0.000098	0.00072	7.2	0.01
		+ 2 min.	13.560084	0.000084	0.00062	6.2	0.01
		+ 5 min.	13.560095	0.000095	0.00070	7.0	0.01
		+ 10 min.	13.560071	0.000071	0.00052	5.2	0.01
20	24	Power on	13.560253	0.000253	0.00187	18.7	0.01
		+ 2 min.	13.560220	0.000220	0.00162	16.2	0.01
		+ 5 min.	13.560222	0.000222	0.00164	16.4	0.01
		+ 10 min.	13.560211	0.000211	0.00156	15.6	0.01
20	20.4 (24V -15%)	Power on	13.560207	0.000207	0.00153	15.3	0.01
		+ 2 min.	13.560209	0.000209	0.00154	15.4	0.01
		+ 5 min.	13.560211	0.000211	0.00156	15.6	0.01
		+ 10 min.	13.560194	0.000194	0.00143	14.3	0.01
20	27.6 (24V +15%)	Power on	13.559904	-0.000096	-0.00071	-7.1	0.01
		+ 2 min.	13.559893	-0.000107	-0.00079	-7.9	0.01
		+ 5 min.	13.559886	-0.000114	-0.00084	-8.4	0.01
		+ 10 min.	13.559878	-0.000122	-0.00090	-9.0	0.01
10	24	Power on	13.560387	0.000387	0.00285	28.5	0.01
		+ 2 min.	13.560346	0.000346	0.00255	25.5	0.01
		+ 5 min.	13.560305	0.000305	0.00225	22.5	0.01
		+ 10 min.	13.560290	0.000290	0.00214	21.4	0.01
0	24	Power on	13.560877	0.000877	0.00647	64.7	0.01
		+ 2 min.	13.560807	0.000807	0.00595	59.5	0.01
		+ 5 min.	13.560771	0.000771	0.00569	56.9	0.01
		+ 10 min.	13.560776	0.000776	0.00572	57.2	0.01
-10	24	Power on	13.560826	0.000826	0.00609	60.9	0.01
		+ 2 min.	13.560801	0.000801	0.00591	59.1	0.01
		+ 5 min.	13.560727	0.000727	0.00536	53.6	0.01
		+ 10 min.	13.560741	0.000741	0.00546	54.6	0.01
-20	24	Power on	13.560521	0.000521	0.00384	38.4	0.01
		+ 2 min.	13.560616	0.000616	0.00454	45.4	0.01
		+ 5 min.	13.560510	0.000510	0.00376	37.6	0.01
		+ 10 min.	13.560573	0.000573	0.00423	42.3	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 (1/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
CE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
CE	MAEC-03	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/23/2022	24
CE	MAT-67	141248	Attenuator	JFW Industries, Inc.	50FP-013H2 N	-	12/22/2022	12
CE	MCC-112	141216	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM14/sucoform141-PE/421-010/RFM-E321(SW)	-/00640	07/09/2022	12
CE	MJM-16	142183	Measure	KOMELON	KMC-36	-	10/03/2022	12
CE	MLS-24	141358	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-730	07/28/2022	12
CE	MMM-08	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201197	01/17/2023	12
CE	MOS-13	141554	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1301	01/13/2023	12
CE	MTR-03	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	05/24/2023	12
CE	MLS-23	141357	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-729	07/28/2022	12
CE	MTA-56	141938	Terminator	TME	CT-01BP	-	12/14/2022	12
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAEC-01	141998	AC1_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 10m	DA-06881	06/28/2022	24
RE	MAEC-03	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/23/2022	24
RE	MAEC-04	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/22/2022	24
RE	MAT-08	141213	Attenuator(6dB)	Weinschel Corp	2	BK7971	11/19/2022	12
RE	MAT-34	141331	Attenuator(6dB)	TME	UFA-01	-	02/01/2023	12
RE	MAT-95	142314	Attenuator	Pasternack Enterprises	PE7390-6	D/C 1504	06/23/2023	12
RE	MBA-05	141425	Biconical Antenna	Schwarzbeck Mess-Elektronik OHG	VHA9103+BBA9106	VHA 91031302	08/26/2022	12
RE	MCC-03	141215	Coaxial Cable	Fujikura/Suhner/TSJ	5D-2W/3D-2W/RG400u/RFM-E421(SW)	-/01068 (Switcher)	06/23/2023	12
RE	MCC-113	141217	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM141/421-010/sucoform141-PE/RFM-E121(SW)	-/04178	06/27/2023	12
RE	MCC-219	159670	Coaxial Cable	UL Japan	-	-	11/18/2022	12
RE	MCC-51	141323	Coaxial cable	UL Japan	-	-	09/27/2022	12
RE	MJM-16	142183	Measure	KOMELON	KMC-36	-	10/03/2022	12
RE	MJM-25	142226	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	MJM-29	142230	Measure, Tape, Steel	KOMELON	KMC-36	-	-	-
RE	MLA-22	141266	Logperiodic Antenna (200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-191	08/26/2022	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	10/11/2022	12
RE	MMM-08	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201197	01/17/2023	12
RE	MMM-09	141533	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201195	01/18/2023	12
RE	MMM-10	141545	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201148	01/18/2023	12
RE	MOS-13	141554	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1301	01/13/2023	12
RE	MOS-15	141562	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	0010	01/13/2023	12
RE	MOS-27	141566	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	A08Q26	01/13/2023	12
RE	MPA-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/07/2023	12

Test equipment (2/2)

Test Item	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Cal Int
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-03	141942	Test Receiver	Rohde & Schwarz	ESCI	100300	05/24/2023	12
RE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	04/10/2023	12
FT	MCH-04	141429	Temperature and Humidity Chamber	Espec	PL-2KP	14015723	08/11/2022	12
FT	MCH-06	141430	Temperature and Humidity Chamber	Espec	PL-1KT	14007630	04/12/2023	12
FT	MFC-01	141498	Microwave Counter	ADVANTEST	R5373	120100309	07/15/2022	12
FT	MLPA-08	202511	Loop Antenna	UL Japan	-	-	-	-
FT	MMM-15	141548	DIGIITAL HiTESTER	HIOKI E.E. CORPORATION	3805	070500636	05/29/2023	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-45	192349	Thermo-Hygrometer	Mother tool	MT-893	-	12/17/2022	12
FT	MSA-04	141885	Spectrum Analyzer	Keysight Technologies Inc	E4448A	US44300523	11/21/2022	12
FT	MSA-15	141902	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46187105	05/23/2023	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:
CE: Conducted Emission
RE: Radiated Emission
FT: Frequency Tolerance