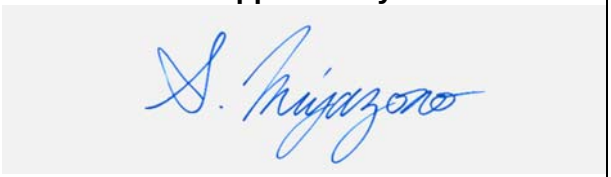
RADIO TEST REPORT

Test Report No. 14624751H-A-R1

Customer	**OMRON Corporation**
Description of EUT	**ReaderWriter/RFID System**
Model Number of EUT	**V680-HAM81**
FCC ID	**E4E6CYSIDV6800208**
Test Regulation	**FCC Part 15 Subpart C**
Test Result	**Complied**
Issue Date	**November 15, 2023**
Remarks	**For Permissive Change**

Representative test engineer	Approved by
	
Junya Okuno 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".

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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. 14624751H-A

This report is a revised version of 14624751H-A. 14624751H-A is replaced with this report.

Revision	Test Report No.	Date	Page Revised Contents
- (Original)	14624751H-A	May 26, 2023	-
1	14624751H-A-R1	November 15, 2023	Correction of the Description of EUT; from “Radio Frequency Identification System (RFID System)” to “ReaderWriter/RFID System”
1	14624751H-A-R1	November 15, 2023	Update for Uncertainty in Section 3.4
1	14624751H-A-R1	November 15, 2023	Correction of the following contents due to re-test. - Cover page: Representative test engineer - SECTION2.1: Test Date: from April 28 to May 16, 2023 to May 10 to November 6, 2023 - SECTION3.2: Worst Margin: (CE) from 1.52 dB,13.56000 MHz to 0.28 dB, 27.12000 MHz (Fundamental Emission) from 66.57 dB to 66.73 dB (Spectrum Mask) from 45.62 dB to 45.33 dB (Spurious Emission) from 9.48 dB, 691.554 MHz, Horizontal to 8.06 dB, 691.566 MHz, Vertical - SECTION: 4.2 Configuration and peripherals - APPENDIX 1: Test data (other than FT) - APPENDIX 2: Test instruments (other than FT) - APPENDIX 3: Photographs of test setup (other than FT)

* CE: Conducted Emission, FT: Frequency Tolerance

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	ReaderWriter/RFID System
Model Number	V680-HAM81
Serial Number	Refer to SECTION 4.2
Condition	Production model
Modification	No Modification by the test lab
Receipt Date	April 14 and 20, 2023
Test Date	May 10 to Novemver 6, 2023

2.2 Product Description

General Specification

Rating	DC 24 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

Variant model

Model	Differences
V680-HAM81 (tested model)	Interface: PNP Transistor Output
V680-HAM91	Interface: NPN Transistor Output

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	<FCC> Section 15.207	0.28 dB, 27.12000 MHz, AV, Phase L	Complied	-
	<ISED> RSS-Gen 8.8	<ISED> RSS-Gen 8.8			
Electric Field Strength of Fundamental Emission	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.225(a)	66.73 dB, 13.56000 MHz, QP, 0 deg.	Complied	Radiated
	<ISED> RSS-Gen 6.4, 6.12	<ISED> RSS-210 B.6			
Spectrum Mask	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.225(b)(c)	45.33 dB, 13.11000 MHz, QP, 0 deg.	Complied	Radiated
	<ISED> RSS-Gen 6.4, 6.13	<ISED> RSS-210 B.6			
20 dB Bandwidth	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section15.215(c)	See data	Complied	Radiated
	<ISED> -	<ISED> -			
Electric Field Strength of Spurious Emission	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.209, Section 15.225 (d)	8.06 dB 691.566 MHz, Vertical, QP	Complied	Radiated
	<ISED> RSS-Gen 6.4, 6.13	<ISED> RSS-210 B.6 RSS-Gen 8.9			
Frequency Tolerance	<FCC> ANSI C63.10:2013 6 Standard test methods	<FCC> Section 15.225(e)	See data	Complied	Radiated
	<ISED> RSS-Gen 6.11, 8.11	<ISED> RSS-210 B.6			
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

-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	2.13

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 mode (Tx)	The EUT Transmits and Receives at the same time and there is no receiving mode.
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: rx130_ham8191 Ver.1.20 (Date: 2020.11.11, 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.	

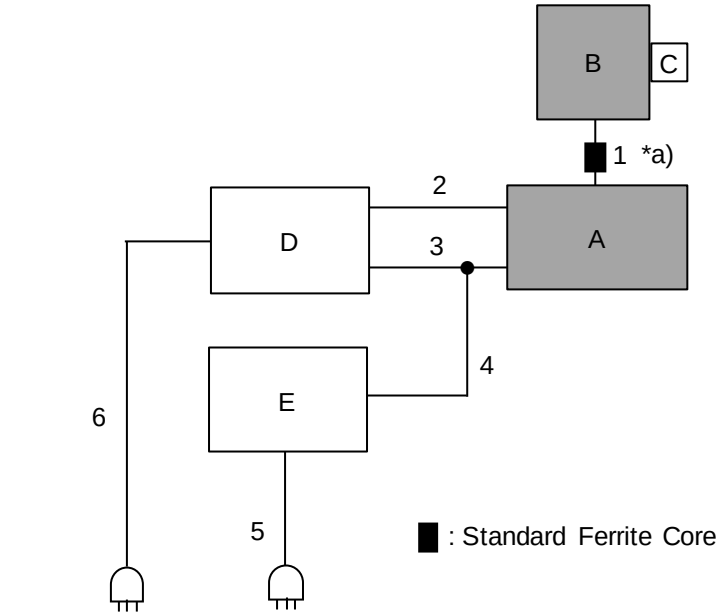
Test Item	Operating mode*
Conducted Emission	Tx Mod on, without Tag
Electric Field Strength of Fundamental Emission	Tx Mod on, without Tag
Spectrum Mask	Tx Mod on, without Tag
20 dB Bandwidth and 99 % Occupied Bandwidth	Tx Mod on, without Tag
Electric Field Strength of Spurious Emission	Tx Mod on, without Tag
Frequency Tolerance	Tx Mod off, without Tag

This EUT has two modes which Tag is attached or not. The worst case was confirmed with and without Tag attached, as a result, the test without Tag attached was the worst case. Therefore the test without Tag attached was performed only.

Frequency Tolerance:	
Temperature	-20 deg. C to +50 deg. C (Step 10 deg. C)
Voltage	Normal Voltage DC 24 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 and Radiated Emission tests



* Cabling and setup were taken into consideration and test data was taken under worse case conditions.
* 1) Conducted emission test was performed on this port.

Description of EUT and Support Equipment

No.	Item	Model number	Serial Number	Manufacturer	Remark
A	RFID Reader/Writer	V680-HAM81	06722A	OMRON Corporation	EUT *1)
B	RFID Antenna	V680-HS61	28520	OMRON Corporation	EUT *1)
C	RF Tag	V680-D1KP52MT	09811V	OMRON Corporation	-
D	PLC	Cj1 Series	-	OMRON Corporation	-
E	Power Supply Unit	S8VK-G03024	-	OMRON Corporation	-

*1) ReaderWriter/RFID System (Model Number: V680-HAM81) is composed of these items.

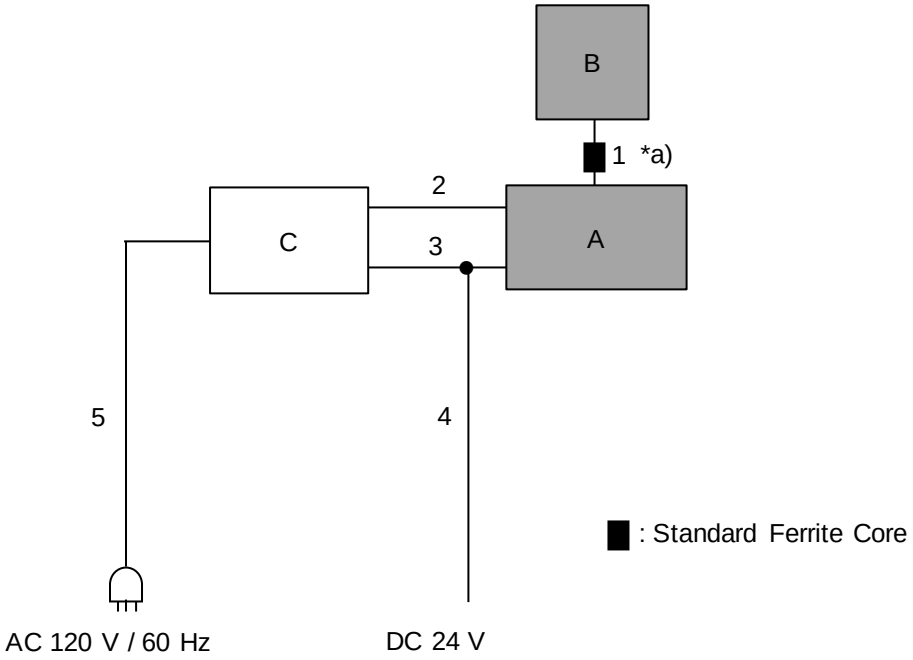
List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna Cable	2.0	Shielded	Shielded	-
2	Signal Cable	10.0	Unshielded	Unshielded	-
3	Signal Cable	10.0	Unshielded	Unshielded	-
4	DC Cable	10.0	Unshielded	Unshielded	-
5	AC Cable	1.0 for CE* 1.8 for RE*	Unshielded	Unshielded	-
6	AC Cable	1.8	Unshielded	Unshielded	-

*a) Ferrite Core Model No. ZCAT1325-0530 (Manufacture TDK Corporation) 0 cm from Item A, 1 turn

* CE: Conducted Emission
RE: Radiated Emission

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	RFID Reader/Writer	V680-HAM81	06722A	OMRON Corporation	EUT *1)
B	RFID Antenna	V680-HS61	28520	OMRON Corporation	EUT *1)
C	PLC	Cj1 Series	-	OMRON Corporation	-

*1) ReaderWriter/RFID System (Model Number: V680-HAM81) is composed of these items.

List of Cables Used

No.	Name	Length (m)	Shield		Remark
			Cable	Connector	
1	Antenna Cable	2.0	Shielded	Shielded	-
2	Signal Cable	10.0	Unshielded	Unshielded	-
3	Signal Cable	10.0	Unshielded	Unshielded	-
4	DC Cable	10.2	Unshielded	Unshielded	-
5	AC Cable	1.8	Unshielded	Unshielded	-

*a) Ferrite Core Model No. ZCAT1325-0530 (Manufacture TDK Corporation) 0 cm from Item A, 1 turn

SECTION 5: Conducted Emission

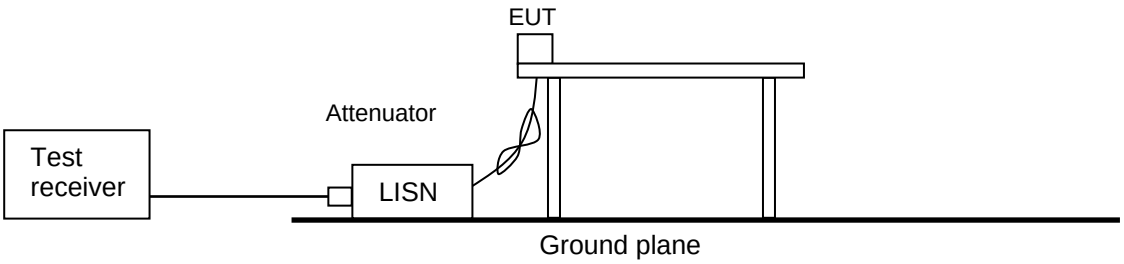
Test Procedure and conditions

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., 135 deg., and 180 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

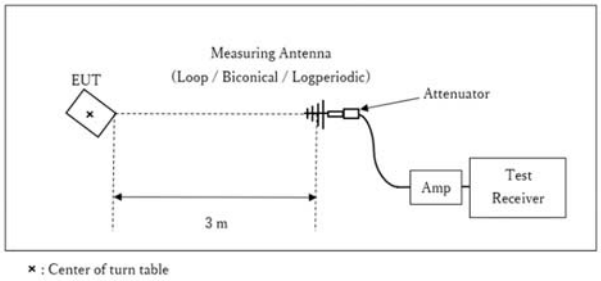
The test was made with the detector (RBW/VBW) in the following table.
When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

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

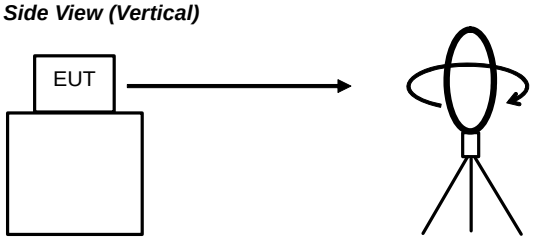
Below 1 GHz



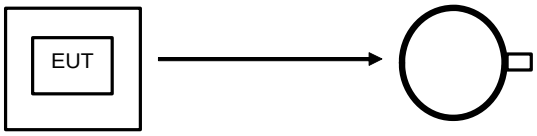
Test Distance: 3 m

Figure 3: Direction of the Loop Antenna

Side View (Vertical)

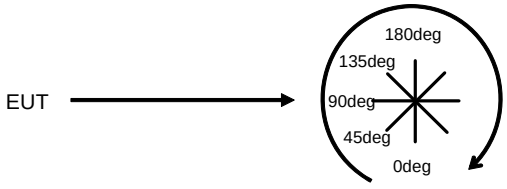


Top View (Horizontal)



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)	Enough width to display emission skirts	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth *1)	Enough width to display emission skirts	200 Hz	620 Hz	Auto	Peak	Max Hold	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.

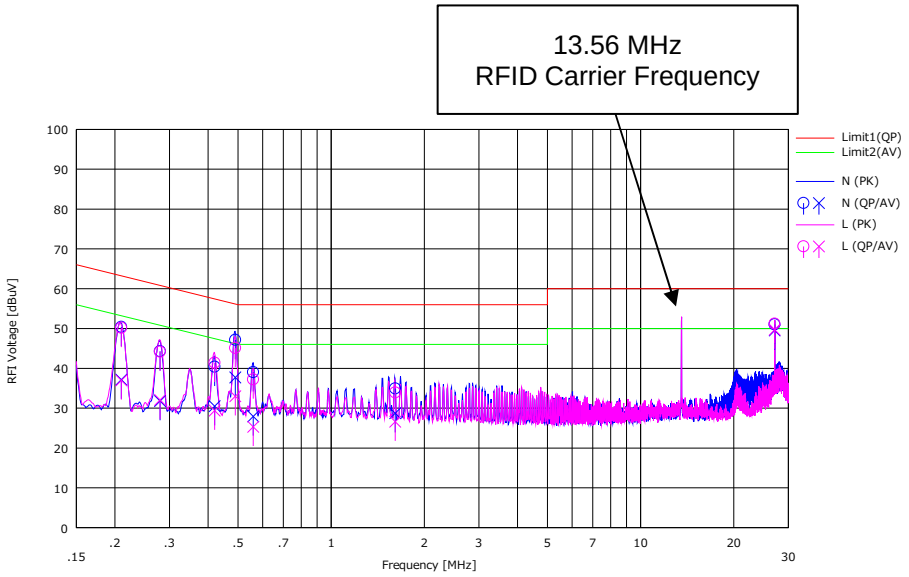
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Conducted Emission

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.3
Date	November 5, 2023
Temperature / Humidity	22 deg. C / 52 % RH
Engineer	Junya Okuno
Mode	Mode 1

Limit : FCC_Part 15 Subpart C(15.207)



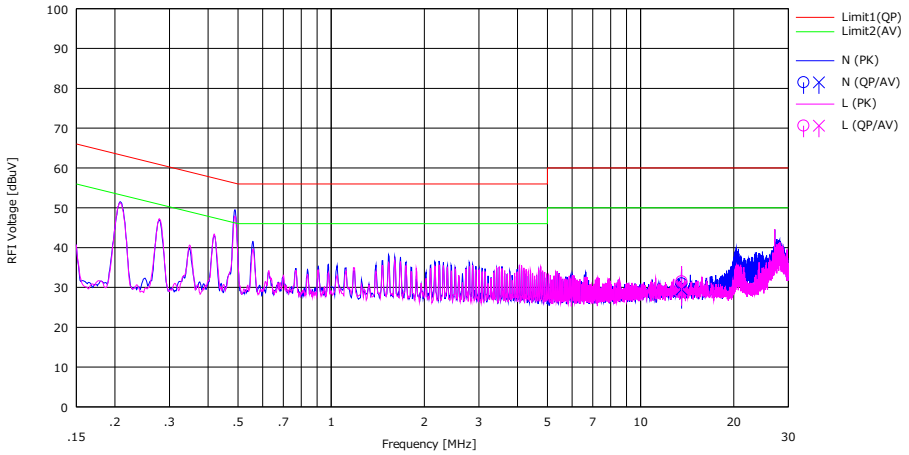
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		〈QP〉	〈AV〉			〈QP〉	〈AV〉	〈QP〉	〈AV〉	〈QP〉	〈AV〉		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	0.20984	37.20	24.00	0.06	13.13	50.39	37.19	63.21	53.21	12.82	16.02	N	
2	0.27985	31.10	18.60	0.06	13.14	44.30	31.80	60.82	50.82	16.52	19.02	N	
3	0.42013	27.20	17.30	0.06	13.15	40.41	30.51	57.45	47.45	17.04	16.94	N	
4	0.48967	33.90	24.50	0.06	13.16	47.12	37.72	56.17	46.17	9.05	8.45	N	
5	0.55972	25.80	14.70	0.06	13.17	39.03	27.93	56.00	46.00	16.97	18.07	N	
6	1.60989	21.60	15.40	0.09	13.25	34.94	28.74	56.00	46.00	21.06	17.26	N	
7	27.12000	36.50	35.00	0.55	13.96	51.01	49.51	60.00	50.00	8.99	0.49	N	
8	0.20984	37.00	23.80	0.04	13.13	50.17	36.97	63.21	53.21	13.04	16.24	L	
9	0.27985	31.00	18.90	0.04	13.14	44.18	32.08	60.82	50.82	16.64	18.74	L	
10	0.42013	28.20	16.20	0.04	13.15	41.39	29.39	57.45	47.45	16.06	18.06	L	
11	0.48967	31.90	19.80	0.04	13.16	45.10	33.00	56.17	46.17	11.07	13.17	L	
12	0.55972	24.00	12.10	0.04	13.17	37.21	25.31	56.00	46.00	18.79	20.69	L	
13	1.60989	20.60	13.30	0.06	13.25	33.91	26.61	56.00	46.00	22.09	19.39	L	
14	27.12000	36.70	35.20	0.56	13.96	51.22	49.72	60.00	50.00	8.78	0.28	L	

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	November 5, 2023
Temperature / Humidity	22 deg. C / 52 % RH
Engineer	Junya Okuno
Mode	Mode 1 (Antenna: 50 ohm terminated)

Limit : FCC_Part 15 Subpart C(15.207)



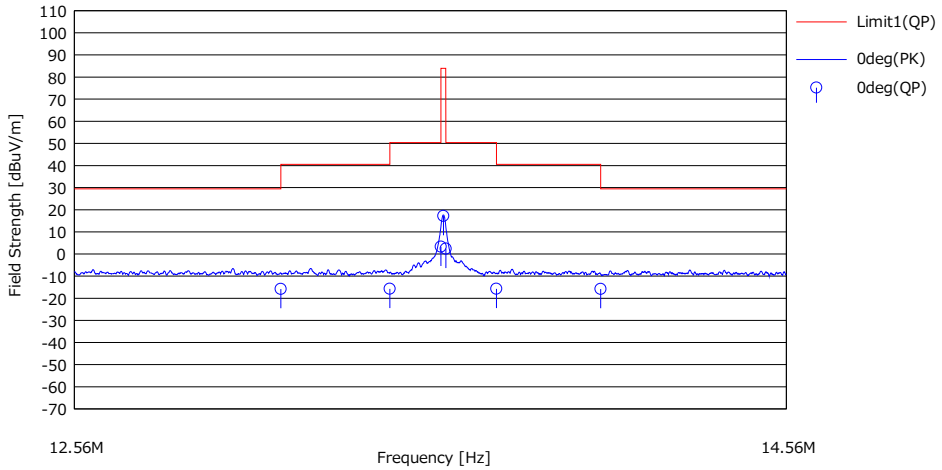
No.	Freq.	Reading		LISN	LOSS	Results		Limit		Margin		Phase	Comment
		(QP)	(AV)			(QP)	(AV)	(QP)	(AV)	(QP)	(AV)		
	[MHz]	[dBuV]	[dBuV]	[dB]	[dB]	[dBuV]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]		
1	13.56000	17.00	15.50	0.33	13.67	31.00	29.50	60.00	50.00	29.00	20.50	N	
2	13.56000	17.50	16.20	0.34	13.67	31.51	30.21	60.00	50.00	28.49	19.79	L	

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.3
Date	November 5, 2023
Temperature / Humidity	22 deg. C / 52 % RH
Engineer	Junya Okuno
Mode	Mode 1

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 [deg]	Comment
1	13.11000	30.10	19.71	-33.44	32.20	-15.83	29.50	45.33	0deg	180	
2	13.41000	30.20	19.70	-33.43	32.19	-15.72	40.50	56.22	0deg	180	
3	13.55300	49.20	19.69	-33.43	32.19	3.27	50.40	47.13	0deg	180	
4	13.56000	63.10	19.69	-33.43	32.19	17.17	83.90	66.73	0deg	180	
5	13.56700	48.30	19.69	-33.43	32.19	2.37	50.40	48.03	0deg	180	
6	13.71000	30.20	19.68	-33.42	32.19	-15.73	40.50	56.23	0deg	180	
7	14.01000	30.10	19.66	-33.41	32.19	-15.84	29.50	45.34	0deg	180	

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
0 deg	13.56000	QP	63.10	19.69	6.57	32.19	-	57.17	-	-	Fundamental

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

Spurious Emission

Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	November 5, 2023	November 6, 2023
Temperature / Humidity	22 deg. C / 52 % RH	23 deg. C / 45 % RH
Engineer	Junya Okuno	Takumi Nishida
Mode	Mode 1	

PK or QP

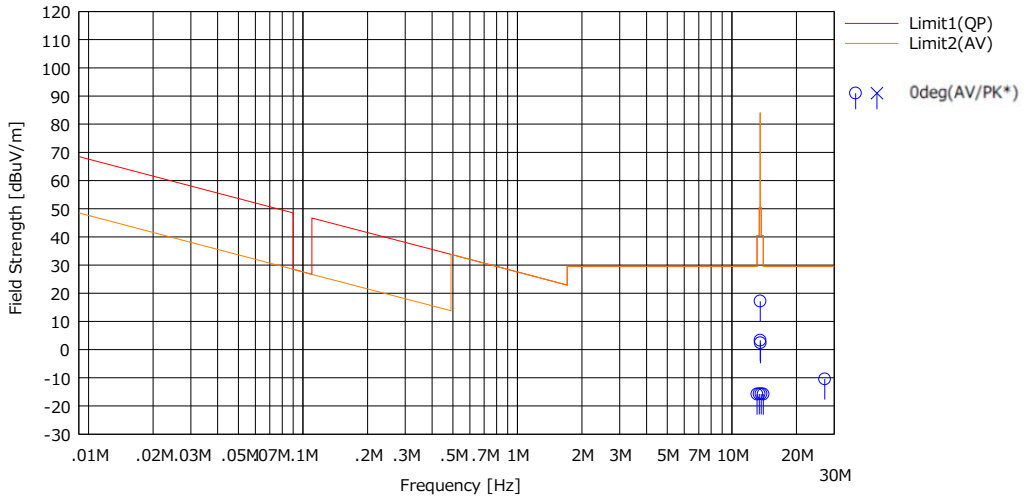
Ant Deg [deg] or Polarity [Hori/Vert]	Frequency [MHz]	Detector	Reading [dBuV]	Ant Factor [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
0deg	27.120	QP	34.50	20.29	-33.09	32.17	-	-10.47	29.5	39.97	
Hori.	190.109	QP	32.12	16.40	8.77	32.05	-	25.24	43.5	18.28	
Hori.	216.958	QP	34.10	11.25	9.01	32.03	-	22.33	46.0	23.69	
Hori.	677.998	QP	32.56	19.51	11.87	31.93	-	32.01	46.0	14.01	
Hori.	691.566	QP	35.76	19.62	11.94	31.92	-	35.40	46.0	10.62	
Hori.	718.673	QP	30.81	20.13	12.07	31.82	-	31.19	46.0	14.83	
Hori.	732.233	QP	30.54	20.10	12.14	31.75	-	31.03	46.0	14.99	
Vert.	190.109	QP	32.54	16.40	8.77	32.05	-	25.66	43.5	17.86	
Vert.	216.958	QP	40.40	11.25	9.01	32.03	-	28.63	46.0	17.39	
Vert.	677.998	QP	34.22	19.51	11.87	31.93	-	33.67	46.0	12.35	
Vert.	691.566	QP	38.32	19.62	11.94	31.92	-	37.96	46.0	8.06	
Vert.	718.673	QP	30.99	20.13	12.07	31.82	-	31.37	46.0	14.65	
Vert.	732.233	QP	31.21	20.10	12.14	31.75	-	31.70	46.0	14.32	

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

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

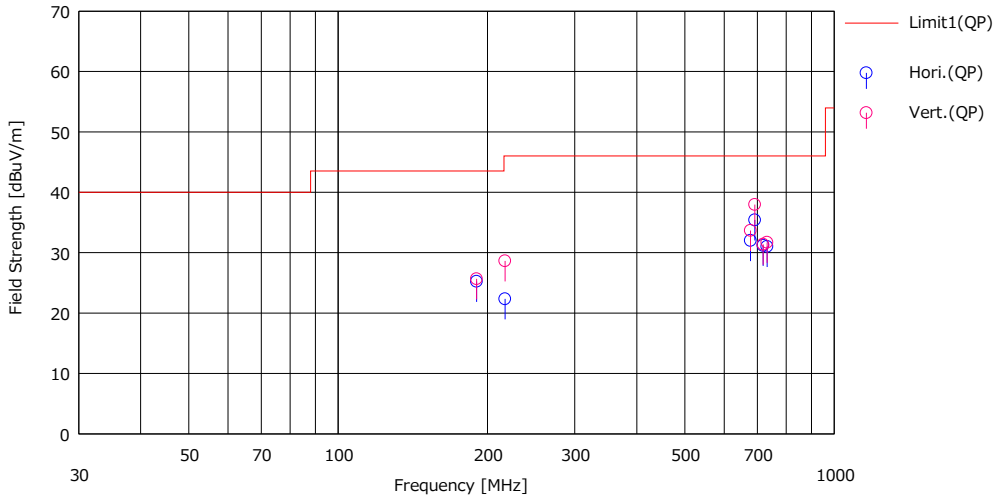
Test place	Ise EMC Lab.	
Semi Anechoic Chamber	No.3	No.3
Date	November 5, 2023	November 6, 2023
Temperature / Humidity	22 deg. C / 52 % RH	23 deg. C / 45 % RH
Engineer	Junya Okuno	Takumi Nishida
Mode	Mode 1	

(below 30MHz)



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

(above 30MHz)

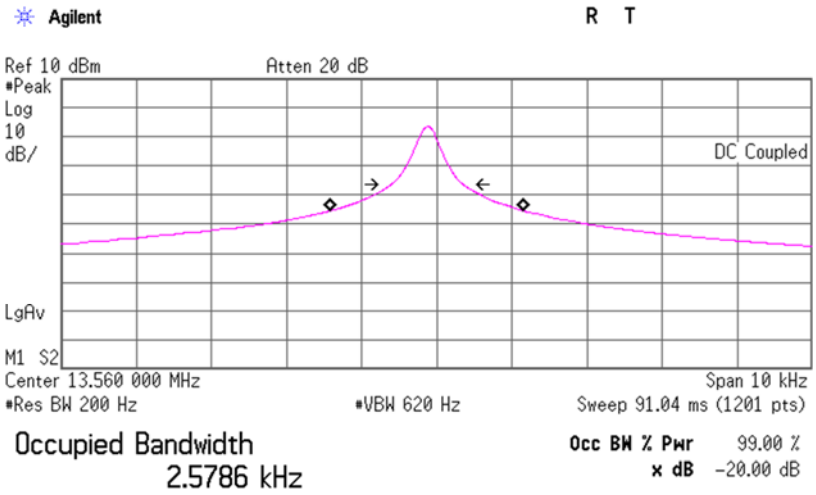


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

20 dB Bandwidth and 99% Occupied Bandwidth

Test place	Ise EMC Lab.
Test Place	No.3 Semi Anechoic Chamber
Date	November 5, 2023
Temperature / Humidity	22 deg. C / 52 % RH
Engineer	Junya Okuno
Mode	Mode 1

FREQ [MHz]	20dB Bandwidth [kHz]	99% Occupied Bandwidth [kHz]
13.56	0.978	2.5786



Frequency Tolerance

Test place	Ise EMC Lab.
Semi Anechoic Chamber	No.6
Date	May 10, 2023
Temperature / Humidity	24 deg. C / 37 % RH
Engineer	Ken Fujita
Mode	Mode 1

Test condition		Tested timing	Measured frequency	Frequency error	Result		Limit
Temp. [deg. C]	Voltage [V]		[MHz]	[MHz]	[%]	[ppm]	[+/- %]
50	24	Power on	13.559831	-0.000169	-0.00125	-12.5	0.01
		+ 2 min.	13.559832	-0.000168	-0.00124	-12.4	0.01
		+ 5 min.	13.559831	-0.000169	-0.00125	-12.5	0.01
		+ 10 min.	13.559831	-0.000169	-0.00125	-12.5	0.01
40	24	Power on	13.559867	-0.000133	-0.00098	-9.8	0.01
		+ 2 min.	13.559861	-0.000139	-0.00103	-10.3	0.01
		+ 5 min.	13.559858	-0.000142	-0.00105	-10.5	0.01
		+ 10 min.	13.559855	-0.000145	-0.00107	-10.7	0.01
30	24	Power on	13.559874	-0.000126	-0.00093	-9.3	0.01
		+ 2 min.	13.559869	-0.000131	-0.00097	-9.7	0.01
		+ 5 min.	13.559870	-0.000130	-0.00096	-9.6	0.01
		+ 10 min.	13.559871	-0.000129	-0.00095	-9.5	0.01
20	24	Power on	13.559871	-0.000129	-0.00095	-9.5	0.01
		+ 2 min.	13.559870	-0.000130	-0.00096	-9.6	0.01
		+ 5 min.	13.559871	-0.000129	-0.00095	-9.5	0.01
		+ 10 min.	13.559870	-0.000130	-0.00096	-9.6	0.01
20	20.4 (24V -15%)	Power on	13.559870	-0.000130	-0.00096	-9.6	0.01
		+ 2 min.	13.559873	-0.000127	-0.00094	-9.4	0.01
		+ 5 min.	13.559873	-0.000127	-0.00094	-9.4	0.01
		+ 10 min.	13.559871	-0.000129	-0.00095	-9.5	0.01
20	27.6 (24V +15%)	Power on	13.559921	-0.000079	-0.00058	-5.8	0.01
		+ 2 min.	13.559922	-0.000078	-0.00058	-5.8	0.01
		+ 5 min.	13.559921	-0.000079	-0.00058	-5.8	0.01
		+ 10 min.	13.559923	-0.000077	-0.00057	-5.7	0.01
10	24	Power on	13.559954	-0.000046	-0.00034	-3.4	0.01
		+ 2 min.	13.559952	-0.000048	-0.00035	-3.5	0.01
		+ 5 min.	13.559951	-0.000049	-0.00036	-3.6	0.01
		+ 10 min.	13.559953	-0.000047	-0.00035	-3.5	0.01
0	24	Power on	13.559988	-0.000012	-0.00009	-0.9	0.01
		+ 2 min.	13.559989	-0.000011	-0.00008	-0.8	0.01
		+ 5 min.	13.559991	-0.000009	-0.00007	-0.7	0.01
		+ 10 min.	13.559992	-0.000008	-0.00006	-0.6	0.01
-10	24	Power on	13.559988	-0.000012	-0.00009	-0.9	0.01
		+ 2 min.	13.559981	-0.000019	-0.00014	-1.4	0.01
		+ 5 min.	13.559983	-0.000017	-0.00013	-1.3	0.01
		+ 10 min.	13.559985	-0.000015	-0.00011	-1.1	0.01
-20	24	Power on	13.559990	-0.000010	-0.00007	-0.7	0.01
		+ 2 min.	13.559989	-0.000011	-0.00008	-0.8	0.01
		+ 5 min.	13.559991	-0.000009	-0.00007	-0.7	0.01
		+ 10 min.	13.559992	-0.000008	-0.00006	-0.6	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.

APPENDIX 2: Test instruments

Test Equipment

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	MAT-67	141248	Attenuator	JFW Industries, Inc.	50FP-013H2 N	-	12/22/2022	12
CE	MAT-95	142314	Attenuator	Pasternack Enterprises	PE7390-6	D/C 1504	06/23/2023	12
CE	MCC-112	141216	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM14/ sucoform141-PE/ 421-010/RFM-E321(SW)	-/00640	07/25/2023	12
CE	MJM-16	142183	Measure	KOMELON	KMC-36	-	10/20/2023	12
CE	MLS-23	141357	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-729	07/05/2023	12
CE	MLS-24	141358	LISN(AMN)	Schwarzbeck Mess-Elektronik OHG	NSLK8127	8127-730	07/13/2023	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	MTA-54	141936	Terminator	TME	CT-01BP	-	12/14/2022	12
CE	MTR-10	141951	EMI Test Receiver	Rohde & Schwarz	ESR26	101408	04/10/2023	12
RE	COTS-MEMI-02	178648	EMI measurement program	TSJ (Techno Science Japan)	TEPTO-DV	-	-	-
RE	MAEC-03	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	05/23/2022	24
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	08/10/2023	12
RE	MCC-112	141216	Coaxial cable	Fujikura/Suhner/TSJ	5D-2W/SFM14/ sucoform141-PE/ 421-010/RFM-E321(SW)	-/00640	07/25/2023	12
RE	MCC-219	159670	Coaxial Cable	UL Japan	-	-	11/18/2022	12
RE	MCC-51	141323	Coaxial cable	UL Japan	-	-	09/10/2023	12
RE	MJM-16	142183	Measure	KOMELON	KMC-36	-	10/20/2023	12
RE	MLA-22	141266	Logperiodic Antenna(200-1000MHz)	Schwarzbeck Mess-Elektronik OHG	VUSLP9111B	9111B-191	08/10/2023	12
RE	MLPA-02	142152	Loop Antenna	Rohde & Schwarz	HFH2-Z2	836553/009	10/17/2023	12
RE	MLPA-07	142645	Loop Antenna	UL Japan	-	-	-	-
RE	MMM-08	141532	DIGITAL HiTESTER	HIOKI E.E. CORPORATION	3805	51201197	01/17/2023	12
RE	MOS-13	141554	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1301	01/13/2023	12
RE	MPA-13	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	02/07/2023	12
RE	MSA-16	141903	Spectrum Analyzer	Keysight Technologies Inc	E4440A	MY46186390	01/16/2023	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	MFC-01	141498	Microwave Counter	ADVANTEST	R5373	120100309	07/15/2022	12
FT	MMM-18	141558	Digital Tester(TRUE RMS MULTIMETER)	Fluke Corporation	115	17930030	05/17/2022	12
FT	MOS-14	141561	Thermo-Hygrometer	CUSTOM. Inc	CTH-201	1401	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:
CE: Conducted Emission, RE: Radiated Emission, FT: Frequency Tolerance